Attachment 3(b)

Capital Regional District

Core Area Liquid Waste Management Plan

Wastewater Treatment System Feasibility and Costing Analysis

Technical Memorandum #2
Review and Refine Option Sets

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Appendix A Core Area Sewer Catchments and Facilities

1.0 Report Summary and Overview

Phase 2 feasibility and costing analysis provides the Core Area Liquid Waste Management Committee (the Committee) with engineering and financial characterizations of four option sets to treat wastewater and recover resources. A "fifth" option has been added by enhancing the one plant option from a secondary plus disinfection to an enhanced tertiary level treatment plant for flows discharged to the ocean. Each option set differs from the others to illustrate their relative performance with respect to the Project Charter and technical criteria. Option set design will adhere to engineering principles, regulatory requirements and the regional infrastructure context, but must also build on the public input received to date and the needs and aspirations of the Committee and the two sub-committees, Eastside Select and Westside Select. This memorandum summarizes the four proposed option sets that are to form the basis for life-cycle costing in November 2015. Each option set is described in detail including general site requirements, operational strategies, treatment criteria, flow scenarios and growth phasing. The diverse goals and commitments of the Project Charter warrant that the option sets collectively provide for a range of levels of service to assess their relative performance. Decision making on preferred option set(s) can be informed by way of the life-cycle costing analysis on balance with the qualitative and quantitative performance of each option set against the range of criteria, in addition to public consultation from November onward.

1.1 Making of the Option Sets: Collaborative Process to Date

Liquid waste management in the Core Area is represented by a range of audiences, with common and diverse interests. Engagement in 2015 confirmed a list of given conditions for treatment, uncovered values and priorities, summarized site considerations and provided for input on fifteen (15) option sets. Building on this engagement, key elements of the collaborative process for arriving at four option sets for the Core Area include:

- Extensive public engagement in both Eastside and Westside communities including in-person events, surveys, pop-up booths and representation by public advisory committees, among many other methods to receive input;
- Presentations, discussions and recommendations by technical committees including Westside/Eastside Technical Committee(s), the Technical and Community Advisory Committees (reports to the Core Committee), liaising with the Ministry of Environment and contributions from CRD's Wastewater Commission;
- Discussions with various wastewater treatment and resource recovery vendors through Innovation Days (Westside) a Core Area *Request for Technical Information,* and most recently a vendor engagement workshop as led by the Technical Oversight Panel;
- Extensive dialogue, presentations, and broad consideration to industry best practices between Urban Systems/Carollo Engineers and the Technical Oversight Panel; and
- Preliminary findings from Westside Select Committee's Phase II site feasibility and option set analysis including life-cycle cost projections signalling preliminary financial realities for water reuse and energy revenues.

The amount of feedback, input, ideas and public support for getting to life-cycle costing analysis has significantly contributed to the convergence of four option sets. On aggregate, the option sets should deliver on the following drivers:

- Provide a range of option sets which collectively illustrate cost, footprint, and infrastructure and water reuse factors by way of diverse options including a central/1-plant option and up to a distributed option set with multiple facilities in key site nodes;
- Build on public engagement to date including acceptability of sites when assessing the technical merits of preferred locations and look to local community planning aspirations for land use implications;
- Develop a range of option sets that meets the regulatory requirements and other option sets that exceed regulatory requirements including tertiary treated water quality;
- Provide options for resource recovery options including centralized solids recovery at Hartland Landfill or another site adjacent central liquids treatment as well explore the integration of other waste streams;
- Look to minimize costs to residents and businesses in all option sets and provide a range of diverse options that clearly illustrates the results of costs and revenues; and
- Consider site resiliency with respect to sea level rise and seismic factors so that capital investments can be preserved for the long-term.

These drivers align directly with the Project Charter and build on the results of the collaborative process to date. Direction to proceed to life-cycle costing can be based on the collective ability of the option sets to provide for a diverse illustration of the goals and commitments of this project.

1.2 Four Option Sets Summary

Table 1.1 summarizes the engineering aspects of each option set and includes levels of service differentiators. Sections 2 to 8 of this memorandum provide a more detailed account of the parameters and components of each option set.

Also note that the Rock Bay site is common to all Option Sets. Discussions with the Ministry of Environment have identified the possibility of discharging a highly treated effluent into the Inner Harbour instead of conveying secondary effluent through a new pipeline to Clover Point and through a new parallel outfall. However, a detailed and advanced Environmental Impact Study would be required to determine the effluent quality necessary to protect the environment and public health. Ministry approval for this approach is uncertain. The Core Area LWMP committee has approved preparing a cost estimate to increase treatment of Rock Bay to a tertiary level. This will enable an order of magnitude cost estimate comparison of discharging to the Inner Harbour versus a forcemain through the City. Technical Memo 3 will outline the costs associated with the deep outfall but not with the shallow outfall as the criteria for this outfall have yet to be determined.

Table 1.1 – Summary of Engineering Aspects for Each Option

Option Set Map	Summary Characterization
Rock Bay (Option 1a and 1b) 	***Engineering Description*** • Rock Bay treats 100% of the base and wet weather flows. • Flows > 3 x ADWF at Clover Point and > 4 x ADWF at Macaulay Point are screened at those locations before discharge. • Solids recovery is based on either anaerobic digestion or gasification of mixed waste at Rock Bay or at Hartland Landfill. • Extent of new infrastructure is lowest of all option sets; municipal trunk sewers optimization (e.g. Victoria, Oak Bay) will be considered to minimize pumping and piping from Clover outfall back to Rock Bay • Clover Point may include an innovative, compact technology to maximize treatment including direct discharge to the outfall, thereby reducing the scope/cost of pumping to Rock Bay. • The treated effluent line from Rock Bay to Clover Point could be accessed for reuse/heat recovery projects.
	Levels of Service Differentiators • Focus on meeting regulations and disinfection plus tertiary quality water for local reuse (up to 10 MLD). • Heat recovery is contemplated at/around the plant. • Focus on minimizing operational complexity • Focus treatment and recovery in one location which has high public acceptability and is aligned with local land uses. Note that Option 1b would convert all secondary + disinfection flow treatment to an enhanced tertiary level to increase service levels and the feasibility of a harbor discharge.

Option Set Map	Summary Characterization

Rock Bay and Colwood (Option 2)

Engineering Description

- Rock Bay treats 100% of the base and wet weather flows.
- Flows > 3 x ADWF at Clover Point and > 4 x ADWF are screened at those locations before discharge.
- Rock Bay is designed to handle 100% of the flow in order to provide the alternative method of disposal for reuse plants. Colwood sized to match the feasibility of irrigation and aquifer recharge in the area at an estimated 10 MLD.
- Solids recovery is based on either anaerobic digestion or gasification of solid waste at Rock Bay or at Hartland Landfill; solids at Colwood will be discharged into the CRD trunk line for full treatment at Rock Bay.
- Extent of new conveyance infrastructure is second lowest of all option sets; municipal trunk sewers optimization (e.g. Victoria, Oak Bay) will be considered to minimize pumping and piping from Clover outfall back to Rock Bay; no additional outfall at Colwood is required.
- Clover Point may include an innovative, compact technology to maximize treatment and discharge to the outfall, thereby reducing the scope/cost of pumping to Rock Bay.
- The treated effluent line from Rock Bay to Clover Point could be accessed for reuse/heat recovery projects.

Levels of Service Differentiators

- Focus on increasing the quantity of tertiary effluent to meet potential opportunities for water reuse in Colwood (10 MLD); treatment at Rock Bay will focus on meeting regulations and disinfection plus tertiary quality water for local reuse (up to 10 MLD).
- Heat recovery is contemplated at/around the plants.
- Focus for most of the treatment and recovery at Rock Bay where there is high public acceptability and alignment with local land uses.
- Increases level of service for reuse without extensive new infrastructure.
- Provides for opportunities to phase in greater reuse as flows increase with growth in Colwood-Langford area.

Option Set Map

4-Plant: Rock Bay, Colwood, Esquimalt Nation and East Saanich (Option 3)

Summary Characterization

Engineering Description

- Rock Bay would serve as a sub-regional facility for all Eastside flows (69%). Esquimalt Nation plant would treat the remainder of flows (31%). Wet weather flows greater than 3 x ADWF at Clover and > 4 x ADWF at Macaulay would be screened before discharge out their respective outfalls.
- Colwood reuse facility (10 MLD) would operate year-round and could increase over time to provide for potable substitution of toilet flushing and irrigation; East Saanich plant (3 MLD) would be commissioned initially for irrigation use only (summer).
- Extent of new conveyance infrastructure is second highest of all option sets.
- Includes either anaerobic digestion or gasification of mixed waste at Rock Bay or at Hartland Landfill; residual sludge from Colwood and East Saanich would discharge into the CRD main for full treatment at the main facilities
- Life-cycle costing results for the four plant option could be quickly converted to a two plant option by removing the Colwood and East Saanich facilities (as needed).

Levels of Service Differentiators

- Further increase (beyond the 2-plant) of the quantity of tertiary effluent to meet probable opportunities for reuse in Colwood and East Saanich; treatment at Rock Bay and Esquimalt Nation will focus on meeting regulations and disinfection plus tertiary quality water for local reuse.
- Heat recovery is contemplated at/around each plant, except East Saanich (seasonal initially).
- Treatment and recovery is centered in two locations with high public acceptability at Rock Bay and Esquimalt Nation; other distributed facilities are smaller footprint in Colwood and East Saanich are located in growth centers with moderate acceptability.

Option Set Map	Summary Characterization
7-Plant: Rock Bay, Colwood, Esquimalt (Town), East Saanich, Langford, View Royal and Saanich Core (Option 4)	***Engineering Description***

Engineering Description

- Rock Bay would handle all of the Eastside flows or 69% of the 2030 flows. All the other six plants would provide tertiary treatment – maximizing resource recovery in the Core Area. The Rock Bay Plant will provide all primary treatment requirements for the Eastside. The Esquimalt (Town) plant would provide the primary treatment requirements of the 2 to 4 x ADWF for Westside, as well as tertiary treatment for the 0 to 2 x ADWF from the two First Nations and the Town of Esquimalt.
- Wet weather flows greater than 3 x ADWF at Clover and > 4 x ADWF at Macaulay would be screened before discharge out their respective outfalls.
- The Colwood plant would provide tertiary effluent for reuse (10 MLD) whereas View Royal and Langford plants would initially provide tertiary water quality without significant reuse (lack of potential demands); a new outfall is anticipated for the Westside distributed facilities.
- Extent of new conveyance infrastructure is highest of all option sets.
- East and Core Saanich facilities (3 MLD and 5 MLD respectively) would be commissioned initially for irrigation use only (summer) until sufficient demand occurs for toilet flushing. When not in use, flows would leverage existing infrastructure for treatment at Rock Bay
- Solids recovery includes either anaerobic digestion or gasification of mixed waste at Rock Bay or at Hartland Landfill; solids would be dewatered at each plant for trucking to Rock Bay or Hartland.

Levels of Service Differentiators

- Greatest extent of tertiary effluent quality however provides only marginal increase of potential water reuse. Treatment at Rock Bay and Esquimalt (Town) will focus on meeting regulations and disinfection plus tertiary quality water for local reuse.
- Heat recovery at 5 of 7 plants (not East or Core Saanich).
- All sites are located in growth centers; public acceptability is greatest for Rock Bay; all six distributed facilities cover a relatively small footprint

1.3 Site Feasibility

Phase 1 of public engagement and technical analysis considered approximately 80 public and private sites brought forward by Core Area municipalities. Initially, site profiles centred on access and infrastructure, resource recovery and land use as a technical primer. Public input emphasised the importance of the information in the site profiles but input went further yet to appreciate the types of conditions residents would like to see in future facilities. Future facilities should improve a given location, provide a benefit to the neighborhood, fit within the local form, provide for safe interaction with residents, have no odour or noise, keep trucking to a minimum and should provide aesthetic qualities to promote positive interaction. Many of these considerations are inherent in the Project Charter, which too, frames our technical review of available sites within the proposed option sets.

The list of technically preferred sites across the Core Area evolves. The Eastside Select Committee prioritized 17 locations in July 2015 for further consideration in Phase 2. The Westside Select is considering a narrowed list of feasible sites prior to option sets analysis in November 2015. Collaboration also continues between CRD real estate staff and the technical team to identify sites with the greatest potential under the proposed four option sets. Further discussions with the Committee on site feasibility and a shortened list of preferred sites is scheduled for November 2015 as part of the option sets analysis. As a note, there are feasible sites available for all four proposed option sets.

Three sites on the eastside, Ogden Point, Windsor Park and Royal Jubilee-Trent, were recently removed from proposed option sets due to their lack of evidentiary advantage for cost savings or enhanced resource recovery. In particular for Ogden Point, the opportunity to locate a wet-weather facility at this location including the pumping and piping costs may be better offset by redirecting flows to Rock Bay from strategic locations in the Eastside such as near Bowker Avenue, along Bay Street and near other areas of the City of Victoria.

Life-cycle costing analysis, further site feasibility analysis and option set characterization against the Charter is the emphasis in November 2015 and frames the content of Technical Memorandum #3.

1.4 Life Cycle Costing Analysis and Presentation

Life-cycle costing analysis will be conducted in November 2015 based on the direction from the Core Area Committee on the preferred option sets. The costing methodology is outlined in Technical Memo #1

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While the spreadsheet models will address the technical requirements, the presentation of life-cycle costing will have graphical figures and will include qualitative characterization of the Charter elements. This approach is intended to support public consultation, and further, to support a balanced review of option sets for Committee direction. Results will be focused towards key differentiators of the option sets and levels of service considerations to illustrate relative performance.

Technical Memo #3 includes life cycle costing and municipal allocations which will be based on existing finance protocols established for the Core Area, in relation to the sewer catchments and facilities illustrated in the map in Appendix A.

2.0 Technology Needs and Considerations

2.1 Representative Sites and Characteristics

Technical Memorandum #1 points to a representative design methodology whereby wastewater treatment plants are categorized into different capacities to suit the range of plants sizes. The plant categories include their level of service, land use considerations and flow capacities. For reference, Table 3.1 from Technical Memo #1 is repeated here.

Table 2.1 - Site Characterization Summary

Site Characterization	Neighbouring Land Use	Flow Range (Average Dry Weather Flow)	Anticipated Plant Purpose – Liquid Train
Small Distributed	Residential	< 5 ML/day	Tertiary treatment for local reuse
Medium Distributed	Residential	6-15 ML/day	Tertiary treatment for local reuse
Large Distributed	Residential	16 – 25 ML/day	Tertiary treatment for local reuse
Extra Large Distributed or Central	Non-Residential	>26 ML/day	Primary & Secondary treatment for outfall and tertiary treatment for local reuse

Core Area option sets include plants based on the categories in Table 2.1.

It is noted that this work in Phase 2 is only addressing representative technologies (as discussed below). Specific providers of technology and project delivery options will be pursued during the subsequent implementation stage.

2.2 Liquid Treatment Options and Representative Designs

Representative design includes the provisional selection of suitable technologies to allow for feasibility and costing analysis. Further design assignments and additional engagement with the private sector for alternative technologies is critical to delivering a treatment and recovery solution that meets Core Area needs while maximizing the efficiency of the market place.

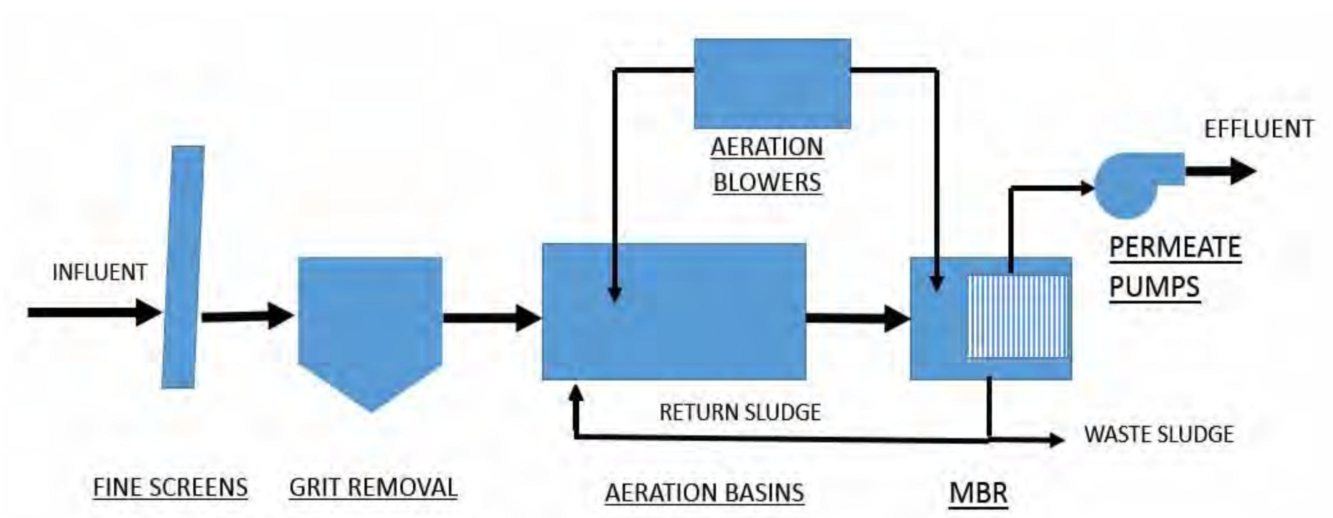
The small, medium and large plants located in residential areas will be part of distributed facilities in the 2, 4 and 7 plant option sets. Three key drivers for distributed facilities are: to reduce footprint, reduce negative interruptions to the surrounding neighborhood and to enable water reuse. These drivers trigger the need for tertiary level plants, which are defined in Technical Memo #1 as achieving the *Greater Exposure Potential* category, with Colwood requiring meeting the *Indirect Potable Reuse* category for aquifer recharge.

Common tertiary technologies reviewed for representative design include membrane bioreactors, sequencing batch reactors with ultrafiltration membranes, moving bed bioreactors with ultrafiltration membranes and continuous flow intermittent cleaning with ceramic membranes. Construction phasing is possible for certain plants in the two, four and seven plant option sets. Common considerations for selecting technologies include:

1. Method of procurement
2. Competition amongst a reasonable number of manufacturers
3. Financial security of manufacturer
4. Proven in the market place
5. Life cycle costing (capital and operating)
6. Flexibility
7. Ability to phase construction
8. Carbon footprint
9. Operational complexity
10. Physical area requirements
11. Amount of commonality with equipment desired within the entire CRD

Membrane bioreactor (MBR) processes were selected for representative design because they are recognized by their ability to reliably meet tertiary quality requirements, they are established in the marketplace, there are multiple manufacturers of the technology (creates competition) and for their small physical footprint. A typical generic MBR plant would include grit removal, fine screens, anoxic and aerated bioreactors, membranes, a waste sludge wasting system and ultraviolet light for primary disinfection with sodium hypochlorite for secondary disinfection (chlorine residual). Odour control facilities would also be provided. A typical process schematic for an MBR process is shown in Figure 2.1 below.

Figure 2.1 – Membrane Bioreactor (MBR)



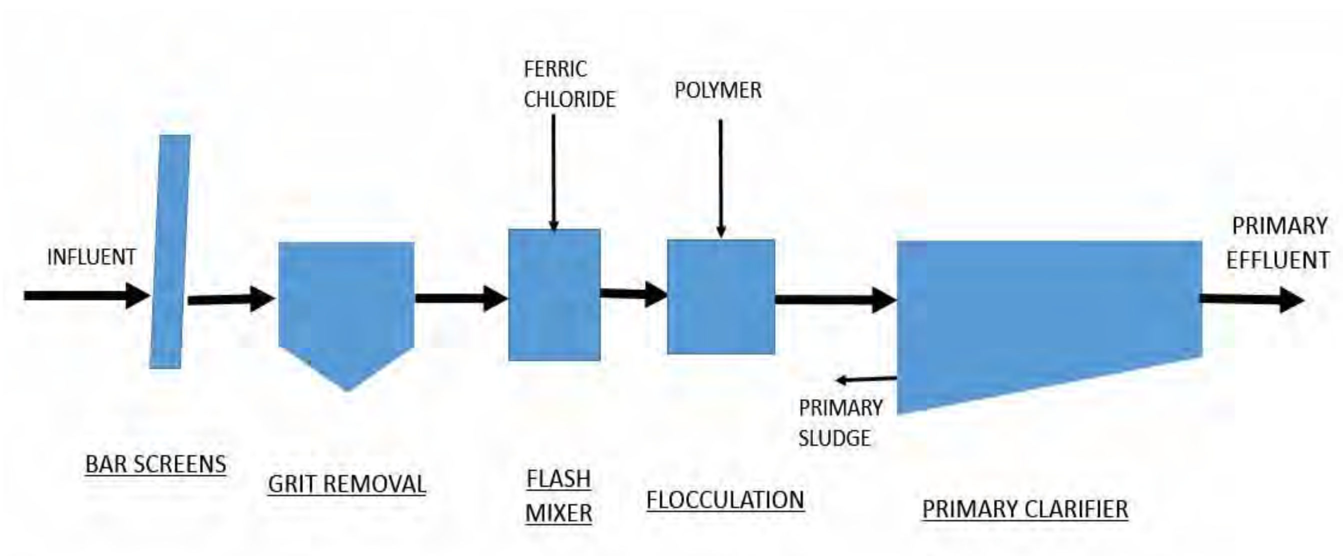
Each distributed facility would extract 2 x ADWF from the CRD trunk sewers. Any wet weather flows above this amount will be left in the trunk sewer to be treated at the extra-large distributed or central plants.

The effluent quality targets for the extra-large distributed or central plants located in non-residential areas are designed to meet the federal and provincial regulations. Regulations require that effluent met a secondary level of treatment for all flows up to 2xADWF and also primary treatment for all flows between 2 to 4 x ADWF to a primary treatment level. Each of the large or extra-large plants is proposed to include 'sidestream' tertiary level treatment to meet the potential water reuse demands in the immediate area. However, it is recognized that because the demand for reuse in the vicinity may be a small fraction of the treatments plants' capacity, these facilities will operate at reduced capacities much of the time.

Primary treatment technologies are wide ranging. A focused set of technologies were reviewed based on design criteria in Technical Memo #1 and include: traditional primary clarification (PC), ballasted flocculation (BF) and chemically enhanced primary treatment (CEPT). The mechanical fine mesh screen systems were reviewed, and since they do not consistently achieve the $CBOD_5$ < 130 mg/L requirement, they are not being selected as the representative technology. However, these filters may be considered again in subsequent stages in an effort to select technologies that, on balance, meet the effluent requirements of the MWR with slight variations on primary quality and secondary quality: the result could be smaller facilities and lower costs. This approach will need to be approved by the Ministry of Environment.

For the primary treatment technology we have selected the CEPT process as the representative technology, because it is established in the market, occupies a relatively small physical footprint and provides a high level of reliability. The CEPT process includes chemical addition, mechanical mixing and primary clarifiers with sludge removal pumps. The primary clarifiers would be covered and odour control facilities provided. Figure 2.2 provides a schematic of a CEPT system with a headworks that includes screens and grit removal.

Figure 2.2 – Chemically Enhanced Primary Treatment (CEPT)



Representative technologies for the large plants were selected in part due to available options for plants with flows of this size and based on the technical criteria from Technical Memo #1. These technologies included conventional activated sludge (CAS), moving bed bioreactors (MBBR) and integrated fixed-film activated sludge (IFAS). Process schematics of CAS, MBBR and IFAS are provided in Figures 2.3, 2.4 and 2.5 below.

Figure 2.3 – Conventional Activated Sludge (CAS)

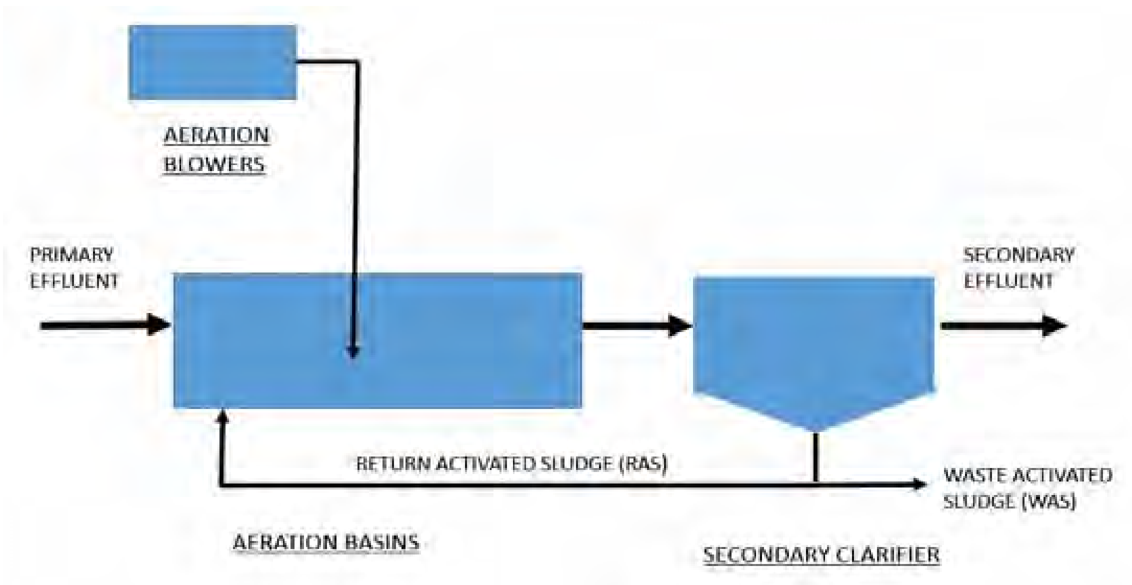


Figure 2.4 – Moving Bed Biological Reactors (MBBR)

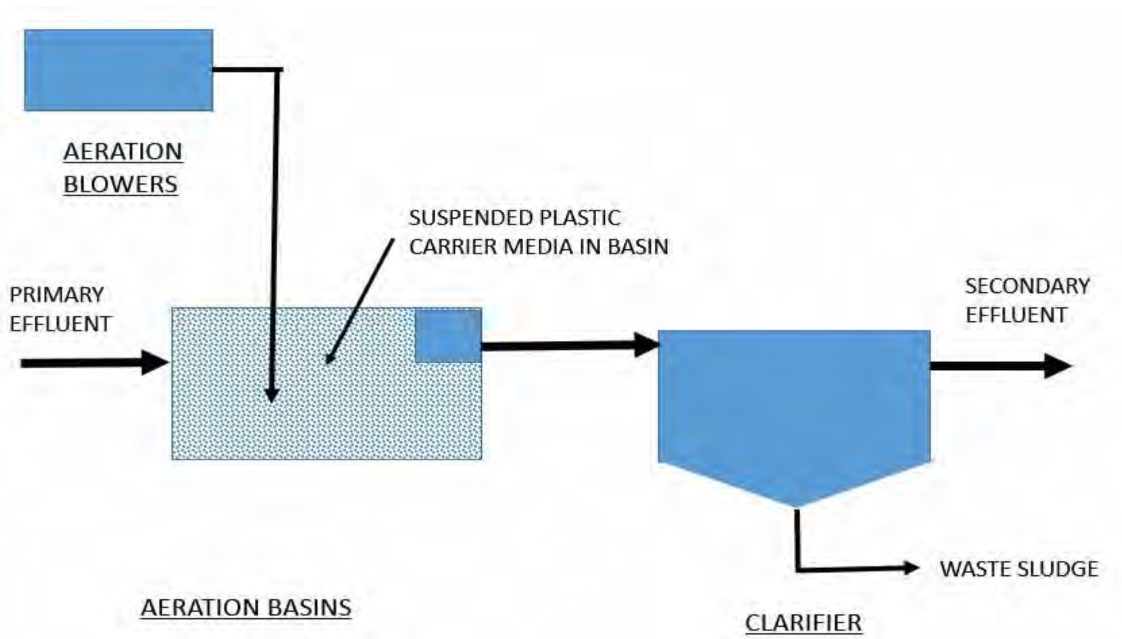
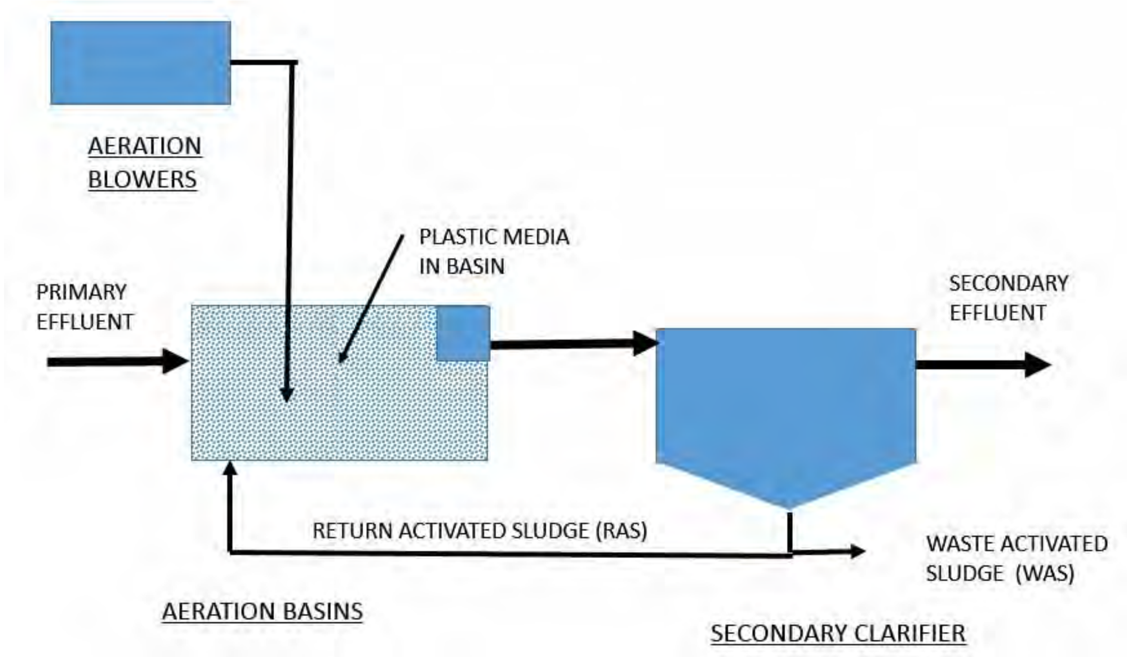


Figure 2.5 – Integrated Fixed-Film Activated Sludge (IFAS)



The MBBR and IFAS systems processes are similar to CAS in that they both typically use aeration and clarification tanks for treatment however they require smaller tanks for biological treatment. This is accomplished by adding media (plastic pieces, ropes, or sponges) to the aeration tanks. Bacteria grow on the surface of the media in a "fixed film," and effectively increase the amount of bacteria that can be held within a given tank size. Both the IFAS and MBBR processes provide a fixed media with an aeration basin. These systems can also be used to upgrade an existing aeration basin in a treatment plant, by retrofitting existing aeration basins with the media to be able to provide increased capacity for the existing basin footprint.

In most option sets and for the extra-large or central plants, secondary treatment includes process-staging which includes CEPT to achieve primary targets followed by CAS to achieve secondary quality. To suit land availability and to minimize footprint, CAS technology was substituted for MBBR or IFAS with the acknowledgement that operating costs are expected to increase for that facility (primarily due to less efficient aeration). Process schematics would differ for the floating media systems and would include: screens to contain the media in the tank, a clarification system, a waste sludge system, and ultraviolet light for primary disinfection. The aeration basins would be covered and odour control facilities would also be included.

Overall, Phase 2 includes characterization of four option sets including multiple flow scenarios which in turn, creates a multi-faceted representative design. Option sets will undergo life-cycle costing based on the selected representative design recognizing that ultimate technologies can be confirmed as future phases unfold.

2.3 Solids Treatment Options and Representative Designs

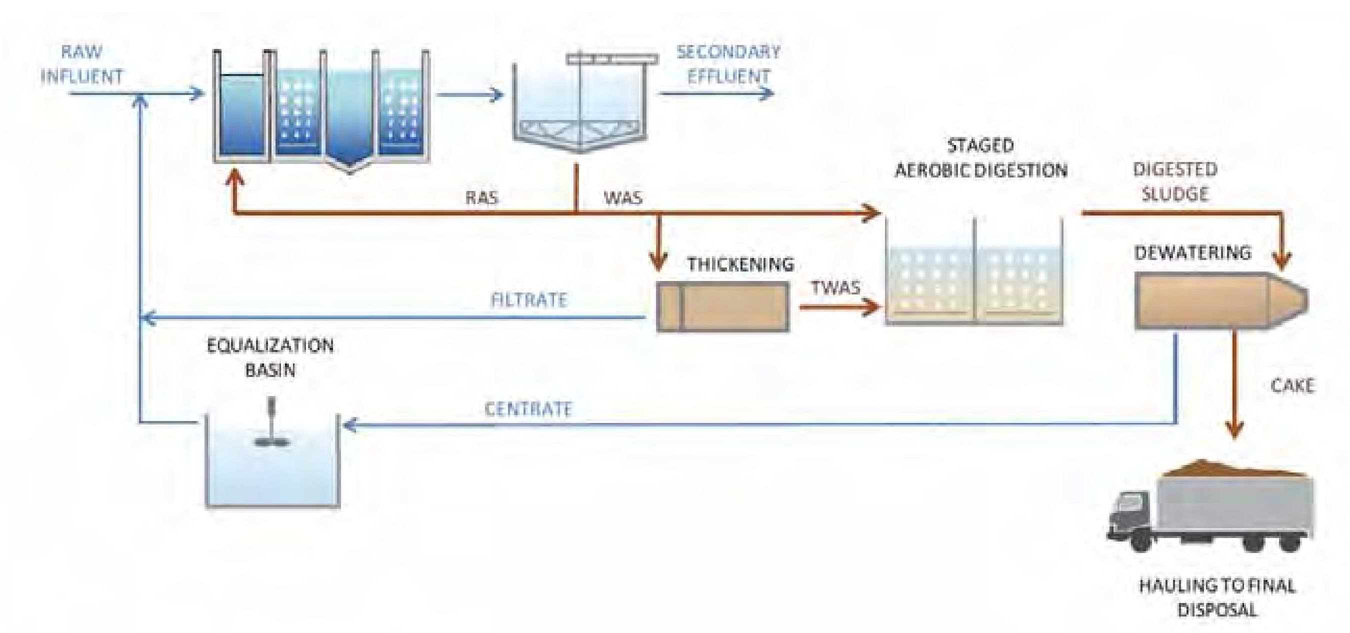
Solids treatment alternatives are narrowed based largely on these local boundary conditions:

1. The land application of any sewage solids is not allowed by CRD policy. This includes highly processed forms like pelletized solids, biochar or solids converted through thermochemical methods. New markets must be developed through partnerships to reflect the value of the by-product in an effort to offset the treatment and development costs.
2. The landfilling of sewage solids is strongly discouraged by the CRD. Under extraordinary circumstances, the landfill may accept sewage solids at a cost of $121 dollars per wet tonne.
3. The CRD is considering an integrated waste resource plant that may include sewage solids in addition to select yard, garden and kitchen waste managed in an integrated manner with solid waste management services.

In addition to these boundary conditions, Phase 2 analysis includes review of three key technologies for the stabilization and treatment of the sewage solids generated at the liquid treatment plants: aerobic digestion, anaerobic digestion and gasification.

Aerobic Digestion - Collected sewage solids are kept under aeration for a period of no less than 28 days (using reactors in series) at a concentration of less than 2% solids (to maintain adequate air transfer and avoid odors and anaerobic conditions). The resulting is a wet-soil like material with high potential for odors, bacterial regrowth and additional degradation. This process is energy intensive and can be capital intensive in larger applications. Figure 2.6 shows a generic flow schematic for the aerobic digestion alternative. Aerobic digestion is suited to small plants in distributed option sets only but will include extensive odour control.

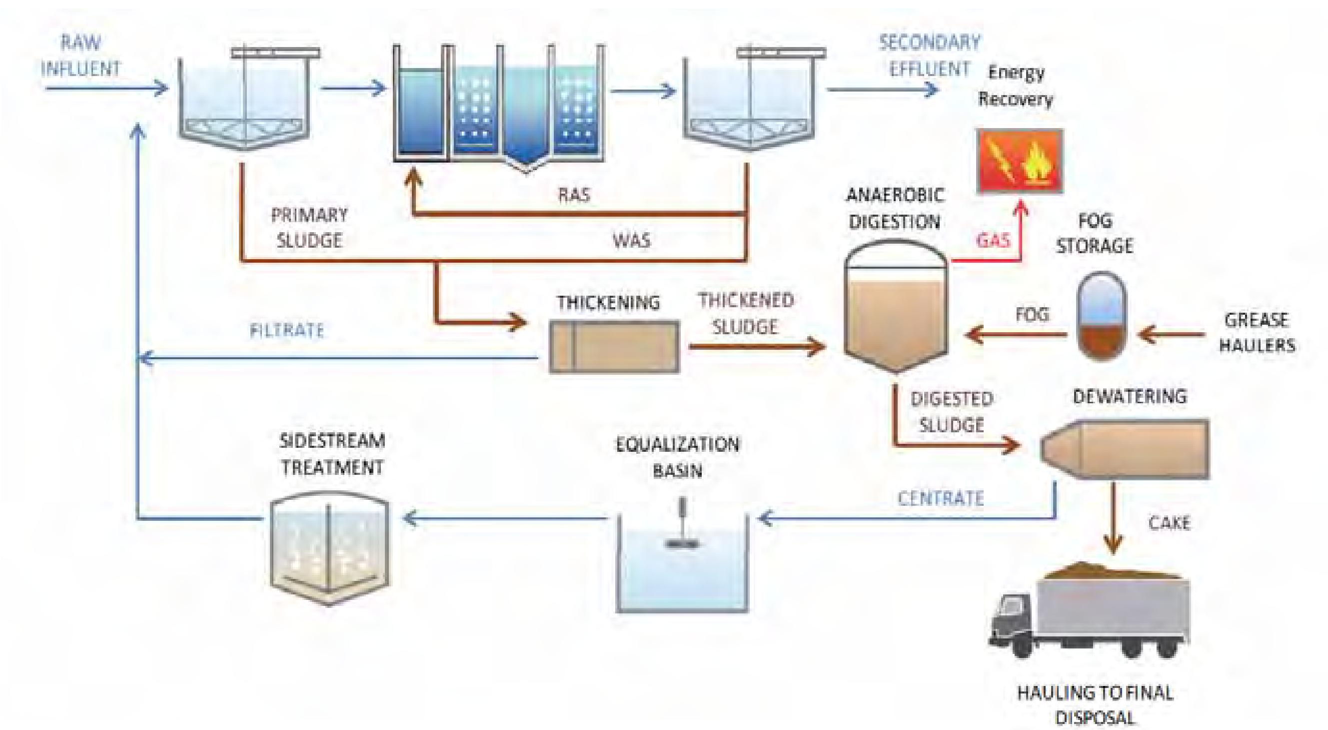
Figure 2.6 – Aerobic Digestion



Anaerobic Digestion - Collected sewage solids are kept under anaerobic (no oxygen) conditions for a period of 15-25 days at a concentration of at least 4% solids to allow the microorganisms to consume the organic matter efficiently and produce a valuable resource in the form of methane gas that can be recovered and reused. These systems produce a wet-soil like material with moderate potential for odors, bacterial regrowth and additional degradation. This process generates energy and is cost effective, compared to aerobic digestion, in facilities larger than 20 ML/d. Anaerobic digestion is particularly suited for facilities that have primary clarification as the performance of the system is far superior to the anaerobic digestion of biological sludge (Waste Activated Sludge).

Figure 2.7 shows the generic process flow diagram for the anaerobic digestion alternative including energy recovery and fats oils and grease digestion to supplement gas production.

Figure 2.7 – Anaerobic Digestion



Gasification is a thermal process that converts part of the organic carbon in the sewage solids into a syngas through non-biological processes. Unlike the previous approaches, this approach will require the participation of a technology manufacturer as the gasification systems require proprietary technology.

The end product of the gasification technology is a biochar that does not look like a soil material. It has the composition and physical properties of activated carbon but is irregular and may produce dust. There is potential value in this product, but there is no defined market in the southern portion of the island. Feasibility and costing analysis will suppose a market can be developed for at or less than the landfill tipping cost of $121/tonne.

It is challenging to achieve energy neutrality for gasification when sewage solids is the only feedstock: water and inorganic content strongly affects energy recovery. Drying sewage solids to a minimum of 80% solids is need for gasification. Manufacturers of gasification technology claim that the use of other feedstocks, like wood waste or yard, garden and kitchen scraps make the process energy positive. Analysis for Phase 2 will include a 3:1 or 4:1 feedstock to sewage solids ratio to generate excess energy for cost off-setting. The increased feedstock will require additional trucking, storage, handling and operational complexity. The following table identifies the feedstock requirements for the gasification process, and the corresponding values for the biosolids.

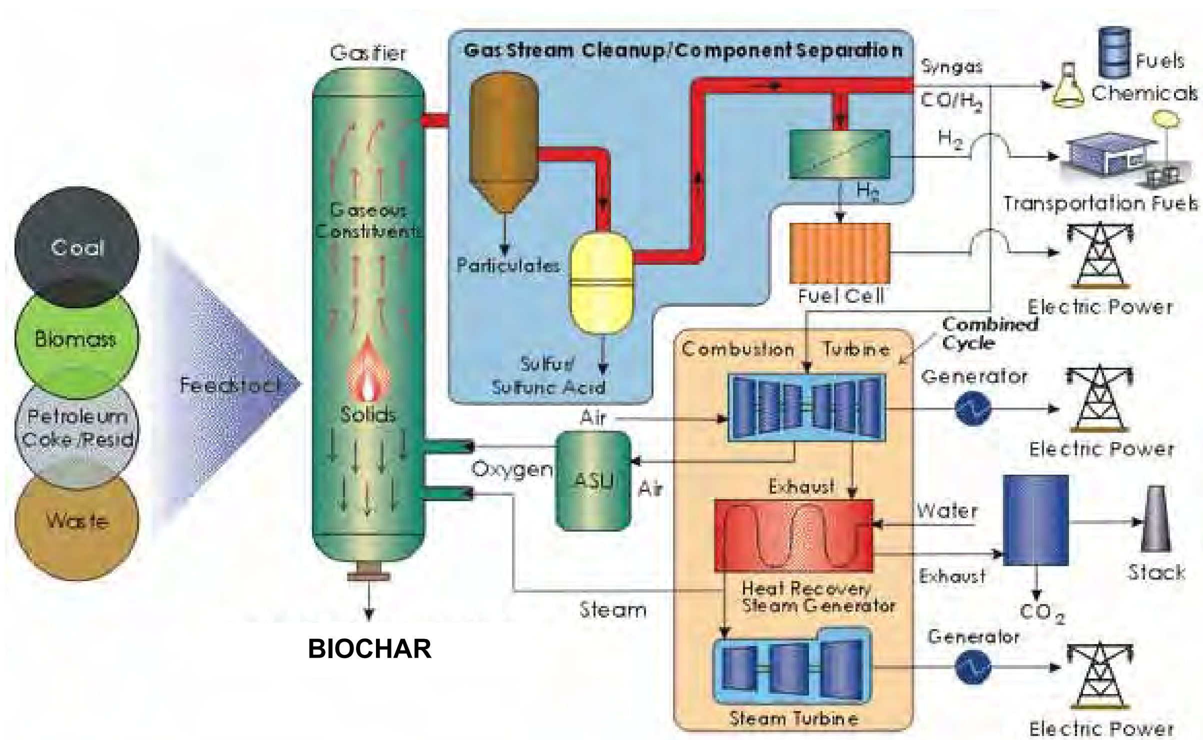
Parameter	Recommended Values (1)	Expected Sludge Value
Moisture Content	< 30%	> 75%
Heat Value Wet Basis	6,520 BTU/lb 15,200 KJ/kg	1,100 BTU/lb (2) 1,100 KJ/kg

(1) *Values recommended from PHG Energy Data*

(2) *Assumes sludge energy value at 6,500 BTU/lb of dry matter at 25% solids.*

Figure 2.8 illustrates the recovery process. In the figure, *biomass* and *waste*, or municipal sludge and yard, garden and kitchen waste are the two primary fuels assessed in Phase 2.

Figure 2.8 – Gasification Process



The ban on land application of wastewater solids represents a limitation on the single best use for the biosolids and the biochar. Managing the residual solids produced from any process presents a significant challenge. There are other disposal options including the sample inventory provided in the following table. Estimated costs or values are based on project experiences and research across North America. However, since there is no established market for solids reuse in the region, alternative uses and costs are presented as possible outcomes pending changes in the regulatory environment or the local market for these materials.

Use	Biosolids Cake	Biosolids Pellets	Biochar	Estimated Cost/(Value) Per Tonne
				
Landfilling	X		X	$121
Soil Amendment	X		X	$30 – ($15)
Potting Soil			X	variable
Fuel Source		X	X	($10 - $30)
Mine Reclamation	X		X	$0
Retail Sale		X	X	($10 - $30)
Nutrient Recovery	X		X	($10 - $30)
Insulation			X	Currently unknown
Air Purification			X	Currently unknown
Water Purification			X	Currently unknown

Technical Memo #3 will include additional review and feasibility of gasification and anaerobic digestion for Core Area option sets at two locations: Rock Bay and Hartland. This approach is consistent with Phase 2 terms of reference and our proposed methodology. In addition, the centralized approach to solids treatment is supported from a life cycle cost perspective, based on the work recently completed for the Westside communities. And, while liquids and solids treatment processes overlap and link together, it's typical to assess solids recovery methods in an isolated manner to illustrate the cost and revenue (or cost-offset) conditions for each approach. Solids recovery scenarios in Technical Memo #3 will include:

1. Providing full level of solids treatment at a central plant;
2. Reintroducing the solids from distributed facilities into the sewer system for treatment at the peak weather facility

3. Providing solids dewatering and transport at the smaller facilities and full treatment at the peak weather facility.
4. Feasibility analysis for solids recovery at Hartland Landfill as an alternative scenario

Purposeful canvassing of the private sector for innovative, financially-backed solids recovery solutions will support the CRD in acquiring the option that best meets the required outcomes of the study. Phase 2 feasibility and financial analysis will include justifiable assumptions for costs, markets and revenues to further inform the refined criteria for solids recovery for both anaerobic digestion and gasification. Please refer to Section 3 for the proposed approach to implementation of a management solution for resource recovery from the resulting solids.

3.0 Resource Recovery Opportunities Characterization Methodology

3.1 Introduction

Recovery of resources available in both the liquids and solids is highly dependent on the market conditions, energy prices, carbon and renewable credit markets and the overall cost for the projects. The following list identifies the resources present in the sewage and the sewage solids that will be considered as resources for recovery. Water recycling through purple pipe, recharge, indirect potable reuse, direct potable reuse and other reclamation alternatives are discussed later in Section 3.2.

Liquid

1. Thermal: Thermal energy recovery from sensible heat contained in the sewage in the form of hotter temperature (then ambient/winter condition) and cooler temperature (than ambient/summer condition).
2. Mechanical: Mechanical energy recovery from the transformation of potential energy into kinetic energy. This type of energy recovery is possible when water has a natural drop in elevation that can be harnessed and converted into energy.

Solids

1. Nutrients: Ammonia and Phosphorus recovery from the sewage solids.
2. Energy: The thermal conversion of the carbon contained in the sewage solids.
3. Bio plastics: The conversion or refinement of bioplastics from the sewage solids.
4. Organic Soil Amendment: The use of treated sewage solids to offset the use of commercial fertilizers
5. Biomethane: The biological conversion of carbon in the sewage solids to a usable gas through anaerobic digestion
6. Biofuels: The conversion of the sewage solids into a usable fuel.
7. Carbon Dioxide: The capture, purification and compression of combustion and digestion by products to produce a commercial pure gas.
8. Electricity: Can be produced from cogeneration of the dried solids or biomethane.

In addition to these recovery options, there are research level efforts to try and recover heavy and precious metals, and other high value organics. Since these are at a research level only at this time, they are not being considered for the evaluation.

As the resource recovery must compete with the products they are offsetting, it is extremely hard for this effort to adequately evaluate the revenue source that could be derived from implementing any of these approaches. In other words, market commodity prices are dynamic and cash flow analysis is subject to multiple caveats and risks. As such we propose the CRD work with the private sector to distribute risk appropriately in an effort to identify and fund the recovery of the resources available in the sewage. A common and well-regarded approach is to issue a Request for Statements of Interest (RFSI). This document, which specifically defines the constraints, goals and evaluation criteria, would be issued to the general private market to propose on resource recovery opportunities with their technologies and provide the CRD with an all-in cost to install the technology, receive (solids or liquid) the product, process it and provide a higher value material as well as the recovered materials extracted from the product. In particular, the market for residual solids recovery (e.g. biochar, biosolids) is uncertain therefore life-cycle costing models will provisionally assume that the cost for delivery of the product a customer will be less than the cost to landfill. The feasibility analysis in Phase 2 will help to refine the criteria for a future RFSI by means of comparing two technologies for solids recovery. Indeed, it is even possible that the private sector could propose a combination of these technologies.

It is noted that the previous grant approval from P3 Canada was based on anaerobic digestion at Hartland Landfill. Any alternative would undergo a business case type application to confirm funding, similar to previous submissions.

Traditional partners in utilizing the resources recovered from the solids include airports, hospitals, government institutions and universities which have long term requirements for heating and power. Often these organizations are willing to convert to the use of bio-fuel based systems as it suits their own capital and sustainability goals.

Through a RFSI process, the CRD will make sure that the market is driving the recovery of resources and how much the CRD is willing to invest to promote the recovery of resources. Procurement options must reflect the level of risk the CRD would like to accept, including financial risk of operation, and how much risk ought to be transferred to the proponent.

Heat recovery is proposed in the areas immediately surrounding each treatment facility as well as in the treated effluent lines to the outfalls. Typically, heat recovery from wastewater treatment plants is best coupled with a broader district energy strategy. At this time, space provisions can be left at select plants to incorporate heat recovery processes as the need arises.

3.2 Water Reuse

3.2.1 Water Reuse Target Market Summary

When treated to a high enough standard, treated effluent can be reused instead of potable water. A target market framework helps to navigate the multiple possibilities for reuse to augment the potable water supply. Water recovery target markets should deliver on the following key themes:

- Demonstrate reliable long-term demands and revenues
- Support community amenities

- Reduce the scope of infrastructure needs
- Demonstrate synergy with conventional public utility services

Conceptual supply-demand estimates focus on water applications that require less than potable-quality water and also demands that are situated in clusters which helps to reduce the cost of additional pipes to convey flows. Ideally, treated effluent reuse throughout the Core Area should include:

- large tracts of irrigable land such as parks and green spaces,
- significant industrial water reuse such as greenhouses or manufacturing operations and
- growth centers where new developments can be encouraged to include additional plumbing systems for toilet flushing or outdoor irrigation
- environmental augmentation

These markets typically present the lowest capital cost for system set up, provide long-term demands, support community amenities such as parks and growth and generally conform to the type of water services provided today.

Spatial analysis based on land use uncovers target markets and illustrates clusters of high demand. Each land parcel is coded based on its land use through the BC Assessment Authority which provides a proxy for water use potential i.e. parks, institutional-vacant, dairy farm, etc. At a conceptual level, these land use codes provide a basis for the potential for land application across the Core Area. Further, local Official Community Plans, land use plans and regional growth centers illustrate where focused, dense development may occur over the next 20 years and beyond. The cost of retrofitting (re-plumbing) existing buildings to allow for treated effluent reuse is prohibitive; it is more feasible to include non-potable water lines in new construction and to phase in non-potable sources over time. Combined, land application and regional growth centers provide for lower-barrier methods for reuse.

Environmental augmentation includes directing treated effluent to natural water courses for beneficial reuse. While these methods don't typically provide revenues, they represent an opportunity to recycle wastewater resources and restore water supplies locally. Typical forms of environmental augmentation include:

- Direct augmentation to streams, rivers or other surface water bodies,
- Indirect augmentation to surface water bodies which includes infiltration to adjacent soils allowing flows to meander into the substrate groundwater or into actual surface flows,
- Aquifer recharge, and
- Wetland enhancement.

Each of these methods requires adequate environmental study to determine the feasibility including risks associated with any option. Water bodies which demonstrate supply issues are typically studied because there is a clearer link to beneficial reuse, instead of simply becoming a vector for disposal. Wetlands throughout the Core Area have not been studied to date.

Colwood has studied the potential for indirect augmentation via aquifer recharge for the permeable soils near Royal Roads University and further west toward Langford. Local infiltration rates are relatively high and may provide for aquifer recharge for 10 to 30 MLD, based on recent reports. If approved by the Director (of the Ministry), this approach could negate the need for an alternate disposal method such as local outfall to the ocean, however we have assumed (for now) any effluent that does not meet the specifications would be discharged into the CRD trunk to be treated by a downstream plant. Westside Technical Staff, in particular the representatives of Colwood, are awaiting formal feedback from the Ministry regarding the potential for aquifer recharge including any waiving of outfall infrastructure. Option sets which include a treatment facility in Colwood take into account the preliminary feasibility results for aquifer recharge. Overall, if the Ministry accepts Colwood's aquifer strategy then the Colwood plant could demonstrate almost 100% reuse: during the winter when there is less need for irrigation, reuse can be focused toward aquifer recharge and toilet flushing, whereas during irrigation seasons, aquifer recharge could be reduced to support land application.

However, beyond Colwood and the creeks identified (preliminary) on the Westside there are no additional water courses known to substantially benefit from direct or indirect stream augmentation. The remainder of the water reuse opportunities relate to irrigation and toilet supply substitution for future development.

3.2.2 Summary of Water Reuse across the Core Area

Table 3.1 summarizes the land application (irrigation), toilet flushing and aquifer recharge possibilities across the Core Area based on the applied target-market framework. It is important to note that while estimates can be developed per municipality, it became clear during analysis and mapping that demands were clustered near growth centers of Colwood-Langford, Esquimalt, Rock Bay (including north downtown) and East Saanich. A small reuse facility may be located in Core Saanich to phase-in reuse over time as growth in the Burnside and Tillicum area occurs. There are significant agricultural lands in north Saanich, west Saanich (towards the Highlands) and further up the Peninsula however the extent of infrastructure needed to reach these lands would be extensive and perhaps unnecessary, until a demonstrable need arises. Overall, establishing five reuse systems provides coverage of most of the major outdoor uses in the Core Area, including growth centers, without the need for extensive reuse infrastructure.

Table 3.1 – Reuse Target Market Scan

Node	Colwood-Langford	Esquimalt	East Saanich	Rock Bay	Core Saanich
Area (ha) w/ Irrigation Potential	275	115	320	50	40
Demand (low) (cm/yr)	45	30	45	30	45
Demand (high) (cm/yr)	60	45	60	45	60
Volume (low) (ML/yr)	1,240	340	1,440	140	180
Volume (high) (ML/yr)	1,650	520	1,930	220	240
Aquifer Recharge (ML/yr)	3,430	n/a	n/a	n/a	n/a
Toilet (2030; ML/yr)	1,780	435	860	1,760	500*

* *Further study is needed to accurately project the real demand for toilet flushing in the Core Saanich/Tillicum areas given the proximity to demands already addressed by a sidestream facility at Rock Bay.*

Securing customers for alternative water supplies can be complex. CRD and municipalities must develop partnerships, agreements or regulations in order to realize actual reuse results. Pricing, liabilities, service governance, standards, and contract tenure will be crucial to securing long-term demand for water reuse.

3.2.3 Water Reuse Infrastructure Systems

Treated effluent systems require their own, separate infrastructure for distribution. Each facility would include a pumping station which raises system pressures to cover the range of elevations and flows and also includes pipes based on conceptual routes. The capacity of each water reuse system will be based on the 2030 flows with consideration to long-term flow increases. This strategy attempts to line up supply with demand to mitigate the costs of oversized or unnecessary infrastructure. The plant in Colwood could reuse up to 100% of the capacity of the plant, if accepted by the Ministry. In short, reuse systems across the Core Area include:

- **Colwood-Langford**: approximately 19,500 meters of reuse pipe and a pumping system equivalent to 10 MLD.
- **Esquimalt:** approximately 17,000 meters of reuse pipe and pumping system equivalent to the proposed demand of roughly 5 MLD for irrigation and toilet flushing
- **East Saanich:** approximately 20,000 meters of reuse pipe and pump system equivalent to the proposed demand, or roughly 3 MLD during peak demand periods
- **Core Saanich:** approximately 10,000 meters of reuse pipe and pumping system equivalent to the proposed demand of roughly 5 MLD for irrigation and toilet flushing
- **Rock Bay:** approximately 18,500 meters of reuse pipe and pump system equivalent to the proposed demand, or roughly 10 MLD during peak demand periods; additional water reuse may occur along the treated effluent line toward Clover Point however these estimates have not yet been included.

Peak design flows are not representative of an average day demand. Also, these peak demand periods are scheduled for longer-term implementation, perhaps 10 years or more, to allow for constructing the works and securing agreements with potential customers. Most reuse facilities would regulate supply to meet demand as demands will fluctuate throughout the year. In other words, Core Saanich and East Saanich plants may be phased in over time or used only during irrigation months. Sidestream tertiary treatment at Rock Bay may also be phased-in or utilized on an as needed-basis.

Overall, additional treatment plants beyond the five reuse target areas listed above would serve to reduce the footprint of downstream facilities but additional plants will be challenged to significantly increase the amount of reuse based on the target-market framework. In effect, while the seven plant option set would provide a higher level of service and boost enhanced tertiary water quality, it may not provide greater reuse opportunities for a long time. Life-cycle costing includes capital allowances for reuse systems including distribution pipes and pump facilities. Technical Memo #3 will study the cost-revenue balance for water reuse systems. Pricing for reclaimed water is proposed at 80% of potable water retail rates except for aquifer recharge which will not result in revenue.

4.0 Existing Outfalls

Option sets include leveraging of both of the existing outfalls at Clover Point and Macaulay Point. The components of each outfall are summarized in Table 4.1.

Table 4.1 – Existing Outfall Characteristics

Parameter	Clover Point	Macaulay Point
1. Grit Removal	No	No
2. Screen Openings	25 mm	25 mm
3. Screens in Parallel	2	2
4. Total Screening Capacity	190 MLD	119 MLD
5. Number of Pumps	4	3
6. Capacity with All Pumps	222 MLD	134 MLD
7. Capacity with One Pump Standby	203 MLD	119 MLD
8. Outfall Diameter	1.07 m	0.9 m
9. Outfall Length from Shore	1,100 m	1,700 m
10. Diffuser Length	196 m	135 m
11. Number of Diffusers	37	28
12. Outfall Depth	67 m	60 m

Upcoming discussions with the Ministry will inform the scope (if any) of environmental impact study required to utilize the outfalls for the 2030 flows or beyond.

It is our understanding that because of deteriorating condition and/or hydraulic restrictions, it is expected that both outfalls will need to be replaced before 2045.

5.0 Option Sets

5.1 Introduction

There are some aspects that are common to all Option Sets. The first is the CRD's approach to reducing infiltration and inflow (I/I) in the Eastside. There are programs in place (and additional ones to come in 2016) to reduce the source of I/I coming from private properties. The District of Oak Bay has an ongoing program to separate storm sewers from sanitary sewers. In addition to these efforts previous LWMP amendments have identified specific capital upgrades to mitigate the quantity of sanitary sewer overflows that occur under storm events. These upgrades include:

- An emergency storage tank near the Arbutus area;
- Extending the siphon from St. Charles and Chandler Road to Clover Point (1600 m);
- The Craigflower Pump Station upgrade (complete);
- Upgrading the Currie Street Pump Station; and
- Upgrading the East Coast Interceptor from the Currie Pump Station to the corner of Lawndale and Richardson (1400 m).

Costs for these upgrades will be included in the overall total in TM #3.

Since 2007 approximately 11 storm events/year have demonstrated flows at Macaulay Point and Clover Point, greater than the current 2 x ADWF. On three occasions since 2007 flows at Macaulay Point have been > 4 x ADWF, whereas the number of exceedances at Clover Point is greater than this. The Ministry of Environment requires, and earlier versions of the LWMP have agreed, that all flows up to 2 x ADWF will be treated to at least a secondary level. In addition, all flows up to 4 x ADWF at Macaulay and up to 3 x ADWF at Clover will be treated to a primary level. The quantity > 2 x ADWF treated to a primary level can be combined with the secondary effluent for discharge out the outfalls. Finally, all flow in excess of these treated primarily or secondarily flows must be screened before discharge.

Solids treatment and resource recovery is being costed based on a central facility at either Rock Bay or at Hartland Landfill. This approach is supported from a life cycle cost perspective based on the work recently completed for the Westside communities. For the Hartland Landfill site the solids could be dewatered and trucked there, or they could be pumped as a dilute liquid. The economics of these two approaches will be examined in TM #3. Figure 5.1 illustrates a potential route if the solids were pumped to Hartland.

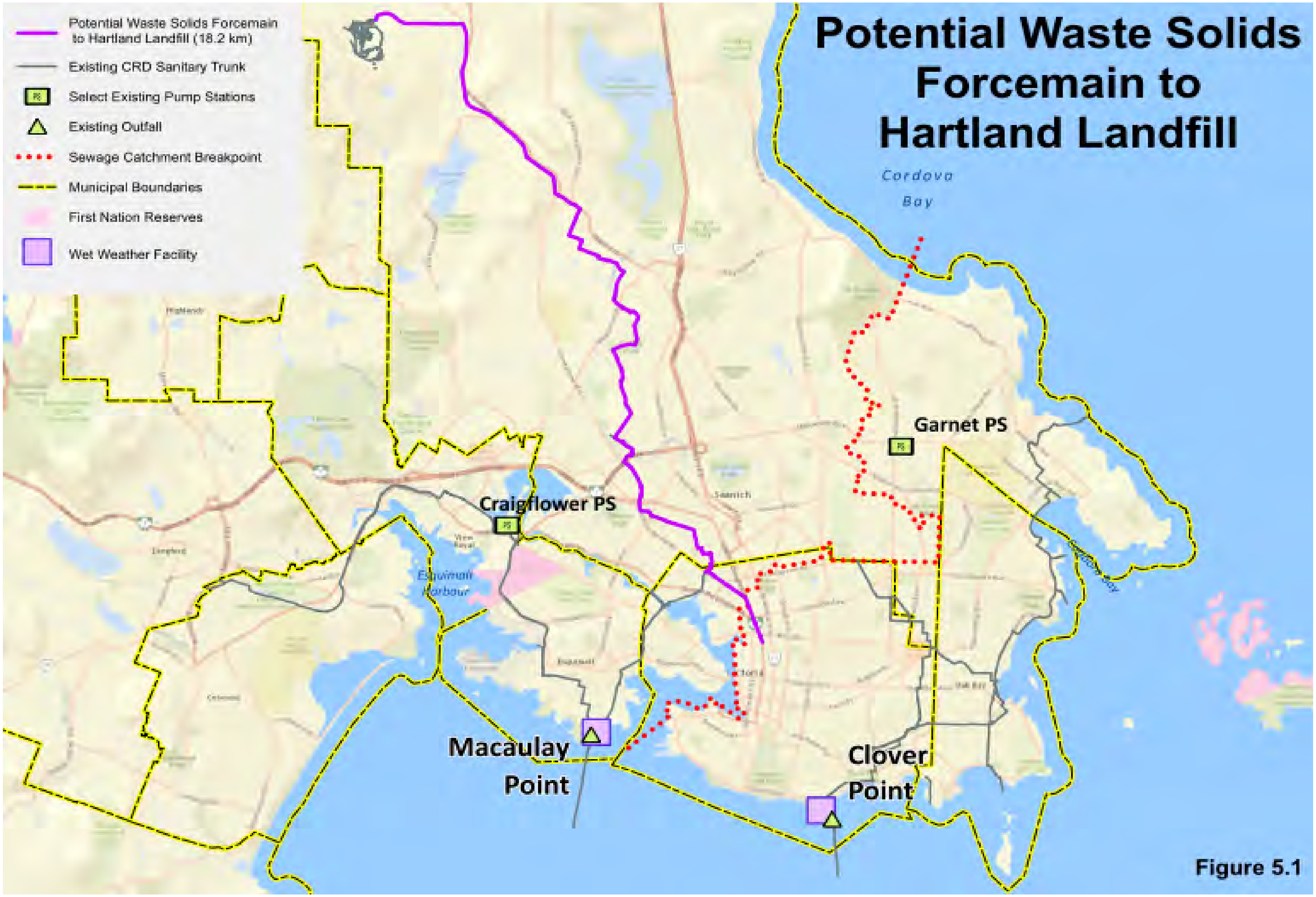

Potential Waste Solids Forcemain to Hartland Landfill
Potential Waste Solids Forcemain to Hartland Landfill (18.2 km)
Existing CRD Sanitary Trunk
Select Existing Pump Stations
Existing Outfall
Sewage Catchment Breakpoint
Municipal Boundaries
First Nation Reserves
Wet Weather Facility
Cordova Bay
Garnet PS
Craigflower PS
Esquimalt Harbour
Macaulay Point
Clover Point

Figure 5.1

A number of suggestions will be made as part of TM #3 for the CRD to consider in order to reduce or defer the capital and operating costs of the selected option. For example:

1. Allow for the selection of alternate technologies through RFEI and RFP processes.
2. Liaise with the Ministry of Environment to consider less expensive primary treatment technologies, but still meeting the intent of the Municipal Wastewater Regulation.
3. Potentially reduce the length of the outfalls if tertiary treatment is implemented (an EIS and agreement from MoE is expected for this to happen).
4. Phasing the construction of plants, for example, an initial plant built at Colwood for 10 MLD, could provide years of service to local flows (i.e., delay construction of any future Westside plant).
5. Phasing the construction of Clover and/or Macaulay outfalls based on actual flows.
6. The possibility of an outfall into the Inner Harbour from Rock Bay, if a tertiary level of treatment is provided (again an EIS and approval from MoE would be required to implement this).
7. Constructing plants using a modular approach. Initial construction could be based on a five or 10 year growth projection and add in modules as actual flows progress. Using this approach could delay key elements of the plant depending on the success of water conservation and I/I reduction programs.

In terms of sea level rise, based on the "Estimated Flood Construction Level and Inundation and Storm Surge in 2100" mapping produced in 2014, the safe construction level in the Rock Bay area appears to be approximately 5 m above sea level. Some of the land in the proposed sites have an elevation of less than 5 m. Site modifications are ongoing therefore the final elevation of the land is not exactly known. In any event, whichever properties are selected, construction will need to account for the potential inundation levels. Conventional cost mitigation strategies are available for example, because sealed storage tanks are often situated at depths of 4 to 5 m anyway – so it will be possible to ensure the top of the tanks and floors of buildings are above the 5 m level, without too much extra cost. This is common to all option sets.

5.2 Option Set 1a and 1b – One Plant at Rock Bay

5.2.1 General Description

Figure 5.2 illustrates the One Plant Option Set (1a and 1b) whereby liquid and solids treatment are centralized at Rock Bay, or liquids only at Rock Bay and solids recovery at Hartland. Option Set 1a involves treatment to a secondary level plus disinfection with a slipstream treating 10 MLD to an enhanced tertiary level for local reuse. Option 1b involves treating all flows up to 2 x ADWF to an enhanced tertiary level. The level of treatment in Option 1b may be to a high enough level that it could be discharged into the Inner Harbour. If the effluent could be discharged to the harbour, then a return pipe back to Clover would not be necessary (unless desired for heat recovery pursuits). However, discharge to the harbour would require a detailed Environment Impact Study would be required to determine the effluent quality necessary to protect the environment and public health. Ministry approval for discharge to the Inner Harbor is uncertain. For this reason TM#3 will not include any reductions in the outfall length for Option 1b.

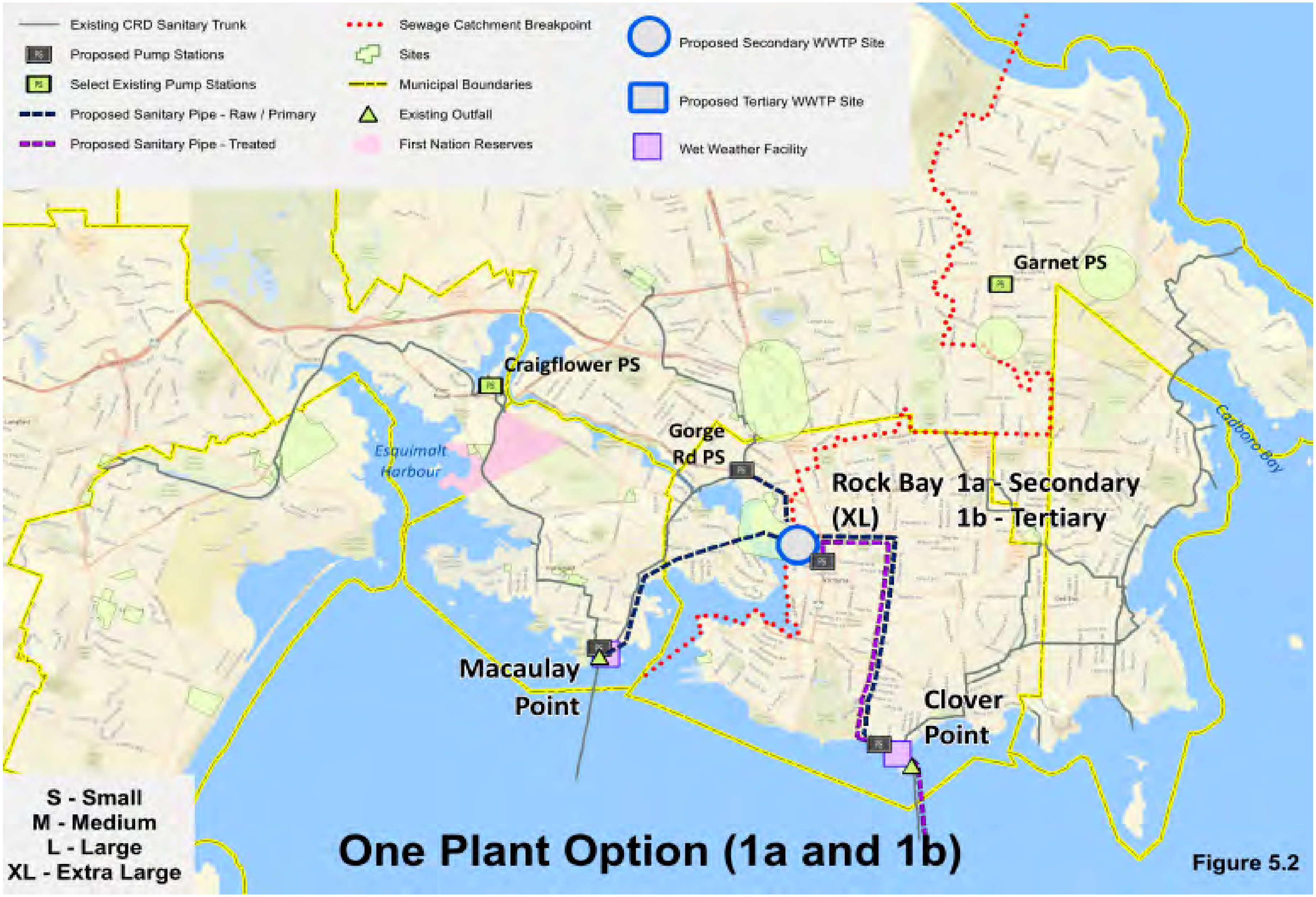

Existing CRD Sanitary Trunk
Proposed Pump Stations
Select Existing Pump Stations
Proposed Sanitary Pipe - Raw / Primary
Proposed Sanitary Pipe - Treated
Sewage Catchment Breakpoint
Sites
Municipal Boundaries
Existing Outfall
First Nation Reserves
Proposed Secondary WWTP Site
Proposed Tertiary WWTP Site
Wet Weather Facility
Garnet PS
Craigflower PS
Gorge Rd PS
Esquimalt Harbour
Cadboro Bay
Rock Bay (XL)
1a - Secondary
1b - Tertiary
Macaulay Point
Clover Point
S - Small
M - Medium
L - Large
XL - Extra Large
One Plant Option (1a and 1b)

Figure 5.2

There are three locations from which sewage would be pumped to Rock Bay: from Clover Point; from Gorge Road to collect flows from most of the West Saanich flows; and, third from Macaulay Point. All treated effluent that is not reused would be pumped back to the Clover outfall. The objective with the Gorge Road pump station is to reduce pumping and piping costs from Macaulay Point. Similarly on the Eastside, additional study will help to identify strategic locations for diverting flows to Rock Bay from key points in Victoria and Oak Bay (to reduce the scope of new infrastructure). Even with the pumping and piping configurations, the one plant option set should be considered the least operationally complex.

Treatment levels would be set at secondary levels from Option 1a to meet the federal and provincial regulations plus disinfection. Sidestream tertiary treatment (up to 10 MLD as reuse connections are confirmed) can be implemented as desired to suit the demand projections for the immediate area including land irrigation (local parks), potentially industrial reuse (minimal) and long-term toilet flushing phased-in with growth. Beyond the conceptual water reuse system in the immediate area (as described in Section 3) the treated effluent forcemain between Rock Bay and Clover Point could be accessed for heat recovery or other water reuse opportunities.

Option Sets 1a and 1b also includes primary treatment of the 1 x ADWF above 2 x ADWF at the Clover Point site (0.5 to 0.8 ha) to minimize the quantity of flow that would otherwise be pumped to/from Rock Bay. In this way, only 2 x ADWF needs to be pumped to Rock Bay.

The Rock Bay plant location includes the possibility of four specific parcels which could be strategically assembled to provide for long-term capacity expansion and to provide for additional flexibility in plant layout to find additional cost savings. Additional site information will be presented in November 2015 as feasibility analysis unfolds.

The current, 2030 and 2045 ADWF design flows are summarized below in Table 5.1. The 2045 design flows are provided as a sample scenario to estimate long-term footprint requirements.

Table 5.1 – Current 2030 and 2045 ADWF Design Flows

Sewershed	Current (MLD)	2030 (MLD)	2045 (MLD)
Macaulay Point	36.2 (1)	60.2 (1)	92.6 (1)
Clover Point	34.3	47.7	53.4
Total	**70.5**	**107.9**	**146.0**

(1) Including West Saanich and West Victoria flows

5.2.2 Components

Table 5.2 summarizes the key components for the Rock Bay Option Set 1a. The difference with Option Set 1b is that item 4 below would be tertiary treatment and item 6 would be deleted.

Table 5.2 – Key Components

Key Components Required	2030 (m^3/d)	2045 (m^3/d)
1. Wet Weather Facility at Clover – 1 x ADWF	48,000	53,000
2. Sewage Pumping Locations		
• Clover Point (2 x ADWF)	96,000	107,000
• Gorge Road (4 x ADWF)	80,000	120,000
• Macaulay Point (4 x ADWF)	160,000	250,000
Total	336,000	477,000
3. Primary Treatment	336,000	477,000
4. Secondary Treatment & Disinfection	216,000	292,000
5. Treated Effluent Pumping	336,000	477,000
6. Tertiary Treatment (Slipstream)	10,000	10,000
7. Outfall Capacity		
• Clover Outfall (including 4 X ADWF from Clover sewershed)	432,000+	477,000+ (1)
• Macaulay Outfall (i.e., only the flow greater than 4 x ADWF)	> 4 x ADWF	> 4 x ADWF

(1) *By 2045 the outfall capacity will have to be increased from approximately 200 MLD to 477 MLD+*

Table 5.3 – Piping and Outfall Lengths (1)

From	To	Purpose	Length
Clover Point	Rock Bay WWTP	Screened Raw Sewage(SRS)	5,300 m
Rock Bay WWTP	Clover Point	Treated Effluent	5,300 m
Macaulay Point	Rock Bay WWTP	Screened Raw Sewage	3,700 m
Gorge Road	Rock Bay WWTP	Raw Sewage	1,100 m
Clover Point	End of Outfall	Treated Effluent/SRS	1,300 m
		Total	**16,700 m(2)**
		Optional Reuse Piping	**18,500 m**

(1) *Pipe lengths are approximate pending a routing review.*

(2) *Not including reuse piping*

6.0 Option Set 2 – Two Plants at Rock Bay + Colwood

6.1 General Description

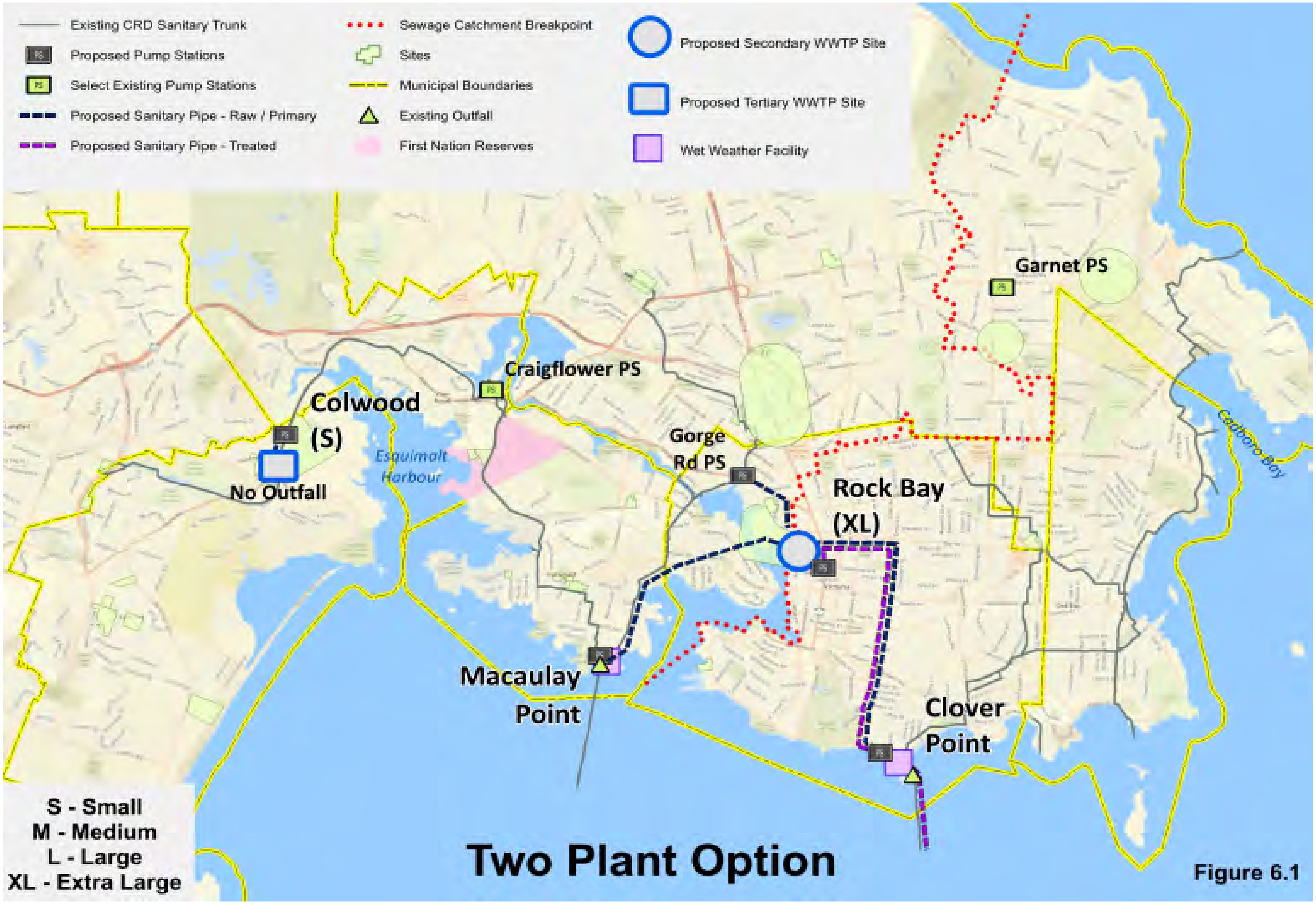
Figure 6.1 illustrates the two plant option set which includes a centralized plant at Rock Bay to provide liquid and solids treatment for most of the Core Area, but also includes a 10 MLD plant in Colwood with a mandate to reuse 100% of the effluent. An alternate location for solids treatment is Hartland Landfill. The City of Colwood has completed some feasibility work that shows the possibility of reusing 100% of the effluent via irrigation and aquifer recharge. The sidestream tertiary capacity at Rock Bay would be up to 10MLD, phased-in as connections are confirmed.

This option set moderately increases levels of service (from the one plant option set) by increasing tertiary quality water at the Colwood plant for reuse where there is elevated reuse potential. The Rock Bay plant would provide secondary treatment as well as disinfection. It is important to note that the distributed reuse facility in Colwood would require an alternative method of disposal (as required by the Ministry of Environment) which has been accounted for by including the capacity of the Colwood plant at Rock Bay in the event that Colwood's flows cannot achieve its targeted water quality (likely infrequent). Since the Rock Bay Plant would be sized to treat 216 MLD to a secondary level, the 10 MLD allocation to Colwood is only approximately 5% of the flow.

In the Rock Bay + Colwood option set there are three locations from which sewage would be pumped to Rock Bay: first is from Clover Point, second is most of the West Saanich flows from Gorge Road (adjacent to the CRD northwest northern trunk) and third, from Macaulay Point. Strategic flow diversions could occur in Oak Bay and Victoria to reduce the scope of new infrastructure and pumping at Clover Point. All treated effluent would be pumped back to the Clover Outfall. The objective with the Gorge Road pump station is to reduce pumping and piping costs from Macaulay Point.

Water reuse in Colwood would consist of an integrated aquifer recharge and irrigation system with the potential for future phasing of substituting potable water for toilet flushing, up to a total of 10 MLD. In addition, the treated effluent forcemain between Rock Bay and Clover Point can be accessed for heat recovery or other water reuse opportunities, in the future. All waste biological solids from Colwood would be returned to the CRD trunk for treatment at the Rock Bay Plant.

This option set also includes primary treatment of the 1 x ADWF above 2 x ADWF at the Clover Point site (0.5 to 0.8 ha) to minimize the quantity of flow that would otherwise be pumped to/from Rock Bay. In this way, only 2 x ADWF needs to be pumped to Rock Bay.


Existing CRD Sanitary Trunk
Proposed Pump Stations
Select Existing Pump Stations
Proposed Sanitary Pipe - Raw / Primary
Proposed Sanitary Pipe - Treated
Sewage Catchment Breakpoint
Sites
Municipal Boundaries
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Proposed Secondary WWTP Site
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Wet Weather Facility
Garnet PS
Craigflower PS
Colwood (S)
No Outfall
Esquimalt Harbour
Gorge Rd PS
Rock Bay (XL)
Macaulay Point
Clover Point
Cadboro Bay
S - Small
M - Medium
L - Large
XL - Extra Large
Two Plant Option

Figure 6.1

The Rock Bay plant location includes the possibility of four sites which could be strategically assembled to provide for long-term capacity expansion and to provide for additional flexibility in plant layout to find additional cost savings. Two sites in Colwood demonstrate distinct advantages for hosting the facility. Additional site information will be presented in November 2015 as feasibility analysis unfolds.

The current 2030 and 2045 ADWF design flows for the Rock Bay Plant are summarized below in Table 6.1. The 2045 design flows are provided as a sample scenario to estimate long-term footprint requirements.

Table 6.1 – Current 2030 and 2045 ADWF Design Flows

Sewershed	Current (MLD)	2030 (MLD)	2045 (MLD)
Macaulay Point	36.2 (1)	60.2 (1)	92.6 (1)
Clover Point	34.3	47.7	53.4
Total	**70.5**	**107.9**	**146.0**

(1) *Including West Saanich and West Victoria flows*

6.2 Components

The following key components to implement this option are summarized in Table 6.2.

Table 6.2 – Key Components

Key Components Required	2030	2045
	(m^3/d)	(m^3/d)
Rock Bay		
1. Wet Weather Facility at Clover – 1 x ADWF	48,000	53,000
2. Sewage Pumping Locations		
• Clover Point (2 x ADWF)	96,000	107,000
• Gorge Road (4 x ADWF)	80,000	120,000
• Macaulay Point (4 x ADWF)	160,000	250,000
Total	**336,000**	**477,000**
3. Primary Treatment	336,000	477,000
4. Secondary Treatment and Disinfection	216,000	292,000
5. Treated Effluent Pumping	336,000	477,000
6. Tertiary Treatment (Slipstream)	10,000	10,000
7. Outfall Capacity		
• Clover Outfall (including 4 x ADWF from Clover sewershed)	432,000+	584,000+ (1)
• Macaulay Outfall (i.e., just flow > 4 x ADWF)	> 4 x ADWF	> 4 x ADWF

Key Components Required	2030 (m³/d)	2045 (m³/d)
Colwood		
1. Raw Sewage Pump Station	10,000	10,000
2. Tertiary Treatment	10,000	10,000
3. Treated Effluent Pumping	10,000	10,000

(1) *By 2045 the outfall capacity will have to be increased from approximately 200 MLD to 584 MLD+*

Table 6.3 summarizes the estimated piping and outfall lengths.

Table 6.3 – Piping and Outfall Lengths [(1)]

From	To	Purpose	Length
A. Required			
Rock Bay			
• Clover Point	Rock Bay WWTP	Screened Raw Sewage (SRS)	5,300 m
• Rock Bay WWTP	Clover Point	Treated Effluent	5,300 m
• Macaulay Point	Rock Bay WWTP	Screened Raw Sewage	3,700 m
• Gorge Road	Rock Bay WWTP	Raw Sewage	1,100 m
• Clover Point	End of Outfall	Treated Effluent/SRS	1,300 m
Colwood			
• Galloping Goose Trail	Colwood WWTP	Raw Sewage	30 m
• Colwood WWTP	End of Reuse	Irrigation/Aquifer Recharge	19,500 m
		Required Total	**36,230 m [(2)]**
B. Optional			
Rock Bay			
• Rock Bay WWTP	End of Reuse	Reuse	18,500 m
		Optional Total	**18,500 m**

(1) *Pipe lengths are approximate pending a routing review.*

(2) *Includes Colwood reuse piping only since this is a necessary part of the solution.*

7.0 Option Set 3 – Four Plants

7.1 General Description

Figure 7.1 illustrates the four plant option set. Most wastewater (liquids) would be treated at Esquimalt Nation and at Rock Bay however two distributed facilities in Colwood and East Saanich would provide higher quality treated effluent and additional water reuse. This option set serves to further maximize water reuse. Also note that the four plant option may also be presented as a two plant, sub-regional option set with plants at Rock Bay and Esquimalt Nation only (the works and costs associated with the distributed facilities in Colwood and East Saanich would be 'removed').

The two subregional plants at Rock Bay and Esquimalt Nation would be designed to provide a secondary level of treatment to meet the federal and provincial regulations, but they would also be equipped with disinfection for increased water quality. Sidestream tertiary treatment would be included in the costing for local reuse, for 10 MLD and 5 MLD at Rock Bay and Esquimalt Nation, respectively. The two distributed facilities would provide tertiary treatment for reuse in Colwood and for irrigation near the East Saanich plant. The seasonal nature of demands for the East Saanich plant means that the plant would only operate as needed (initially) with the potential for regular operation (year round) if potable substitution for toilet flushing were to occur. In addition to the aforementioned water reuse opportunities, the treated effluent forcemain between Rock Bay and Clover Point and between Esquimalt Nation and Macaulay Point can be accessed for heat recovery or other water reuse applications.

It is noted that if either or both the Rock Bay and Esquimalt Nation plants were increased to tertiary treatment, there is a possibility that reduced piping and outfalls could ensue. However, this would have to be approved by the Ministry of Environment.

Solids treatment and recovery would occur at either Rock Bay or Hartland Landfill.

The City of Colwood has completed some feasibility work that shows the possibility of reusing 100% of the effluent via irrigation and aquifer recharge with a capacity estimated at 10 MLD. The East Saanich site has opportunities for irrigation and toilet reuse in new developments with a capacity estimated at up to 3MLD. The alternative method of disposal required by the Ministry of Environment for these plants would be to discharge back into the sewer network which can be accommodated by including additional capacity at Rock Bay and Esquimalt Nation. Both distributed plants would also discharge their waste biological solids into the sewer network so dewatering and trucking is not required.

Preferred sites are available in each of the four plant locations. Additional site information will be presented in November 2015 as feasibility analysis unfolds.

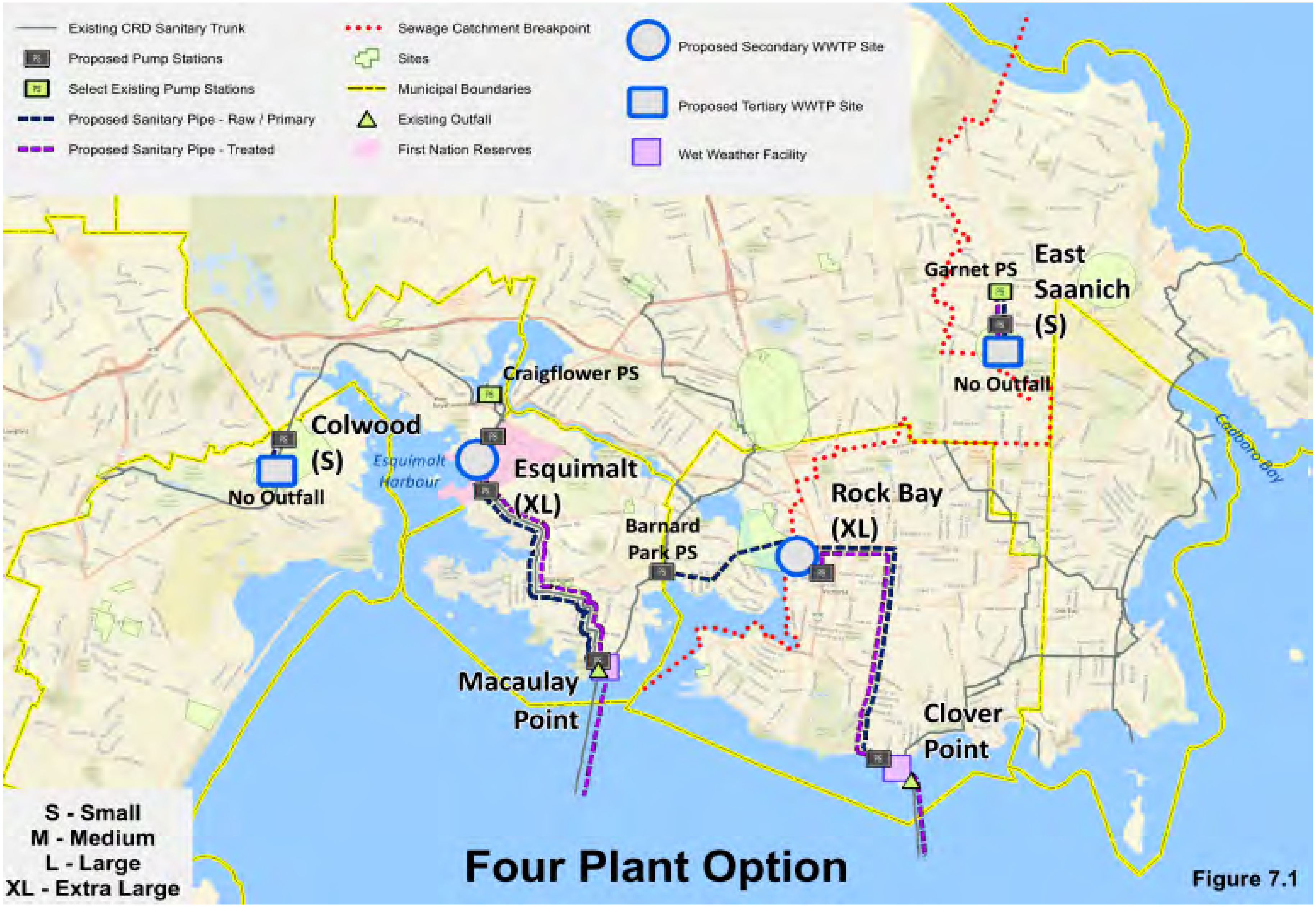
Existing CRD Sanitary Trunk
Proposed Pump Stations
Select Existing Pump Stations
Proposed Sanitary Pipe - Raw / Primary
Proposed Sanitary Pipe - Treated
Sewage Catchment Breakpoint
Sites
Municipal Boundaries
Existing Outfall
First Nation Reserves
Proposed Secondary WWTP Site
Proposed Tertiary WWTP Site
Wet Weather Facility
Garnet PS
East Saanich (S)
No Outfall
Craigflower PS
Colwood (S)
No Outfall
Esquimalt Harbour
Esquimalt (XL)
Barnard Park PS
Rock Bay (XL)
Macaulay Point
Clover Point
Cadboro Bay
S - Small
M - Medium
L - Large
XL - Extra Large
Four Plant Option

Figure 7.1

Rock Bay flows will include wastewater from all Eastside communities including flows currently directed to Macaulay from west Saanich and west Victoria by way of a pump station near Barnard Park. All other eastside flows would be pumped from Clover Point, or, other strategic locations along the eastside to reduce the scope of new infrastructure. This option set also includes maximizing treatment at the Clover Point site (0.5 to 0.8 ha) to minimize the quantity of flow that would otherwise be pumped to/from Rock Bay.

The Esquimalt Nation plant will include two pump stations for collecting flows, including for wastewater that originates upstream of the proposed plant (to avoid having to pump all of the upstream flows from Macaulay Point) and for all other flows that converge at Macaulay (downstream of the plant). It will be possible to utilize the existing screens at Macaulay, so that only screened raw sewage needs to be pumped back to Esquimalt Nation. All treated effluent that is not reused, is pumped back to Macaulay Point for discharge out a new outfall.

The current, 2030 and 2045 ADWF design flows for Rock Bay and Esquimalt Nation are summarized in Table 7.1 below.

Table 7.1 – Current 2030 and 2045 ADWF Design Flows

Plant	Current (MLD)	2030 (MLD)	2045 (MLD)
Esquimalt Nation	14.4	30.1	52.9
Rock Bay	56.1 (1)	77.8 (1)	93.1 (1)
Total	**70.5**	**107.9**	**146.0**

(1) *Including West Saanich and West Victoria*

7.2 Components

The follow key components to implement this option are summarized in Table 7.2.

Table 7.2 – Key Components

Key Components Required	2030 (m³/d)	2045 (m³/d)
Rock Bay		
1. Wet Weather Facility at Clover – 1 x ADWF	48,000	53,000
2. Sewage Pumping Locations		
• Clover Point (2 x ADWF)	96,000	107,000
• Near Barnhard Park (4 x ADWF) – West Saanich and West Victoria	120,000	159,000
3. Primary Treatment	216,000	266,000
4. Secondary Treatment and Disinfection	156,000	186,500
5. Treated Effluent Pumping	216,000	266,000
6. Tertiary Treatment (Slipstream)	10,000	10,000
7. Clover Outfall Capacity (> 4 x ADWF)	317,000+	369,000+ (1)
Esquimalt Nation		
1. Sewage Pumping Locations		
• Near Admirals Road (Langford, Colwood, View Royal) 4 x ADWF	89,000	176,000
• Macaulay Point (Two FNs, Esquimalt Nation) 4 x ADWF	31,000	35,000
2. Primary Treatment	120,000	211,000
3. Secondary Treatment and Disinfection	60,000	105,500
4. Treated Effluent Pumping	120,000	211,000
5. Tertiary Treatment (Slipstream)	10,000	10,000
6. Macaulay Outfall Capacity (> 4 x ADWF)	120,000+	211,000+ (2)
Colwood		
1. Raw Sewage Pump Station	10,000	10,000
2. Tertiary Treatment	10,000	10,000
3. Treated Effluent Pumping Required	10,000	10,000
East Saanich		
1. Garnet Pump Station	3,000	5,000
2. Tertiary Treatment	3,000	5,000
3. Treated Effluent Pumping	3,000	5,000

(1) *By 2045 the Clover Outfall capacity will have to be increased from approximately 200 MLD to 369 MLD+*

(2) By 2045 the Macaulay Outfall capacity will have to be increased from approximately 119 MLD to 211 MLD+

Table 7.3 summarizes the estimated piping and outfall lengths.

Table 7.3 – Piping and Outfall Lengths [(1)]

From	To	Purpose	Length
A. Required			
Rock Bay			
Clover Point	Rock Bay WWTP	Screened Raw Sewage (SRS)	5,300 m
Rock Bay WWTP	Clover Point	Treated Effluent	5,300 m
Clover Point	End of Outfall	Treated Effluent/SRS	1,300 m
Pump Station near Barnard Park	Rock Bay WWTP	Raw Sewage	2,400 m
Colwood			
Galloping Goose Trail	Colwood WWTP	Raw Sewage	30 m
Colwood WWTP	End of Reuse	Irrigation/Aquifer Recharge	19,500 m
Esquimalt Nation			
Macaulay Point	Esquimalt Nation WWTP	Screened Raw Sewage	4,600 m
Esquimalt Nation WWTP	Macaulay Point	Treated Effluent	4,600 m
Admirals Road	Esquimalt Nation WWTP	Raw Sewage	300 m
Macaulay Point	End of Outfall	Treated Effluent/SRS	1,700 m
East Saanich			
Garnet Pump Station	WWTP	Raw Sewage	900 m
WWTP	Garnet Pump Station	Treated Effluent	900 m
WWTP	End of Reuse	Reuse	20,000 m
		Total	**66,830 m [(2)]**
B. Optional			
• Rock Bay WWTP	End of Reuse	Reuse	18,500 m
• Esquimalt Nation WWTP	End of Reuse	Reuse	17,000 m
		Optional Total	**35,500 m**

(1) *Pipe lengths are approximate pending a routing review.*

(2) *Includes Colwood and East Saanich reuse piping since these are necessary parts of the solution.*

8.0 Option Set 4 – Seven Plants

8.1 General Description

Figure 8.1 illustrates the seven plant option set with facilities at Langford, Colwood, View Royal, Esquimalt (Town), Rock Bay, Core Saanich and East Saanich. The intent of this option is to maximize water reuse and to further increase treated effluent water quality across the Core Area. Under the seven plant option, the Rock Bay plant would be a large, central-type facility equipped with liquids and solids treatment processes (or solids at Hartland Landfill). The other 6 plants would provide tertiary effluent for reuse around each plant, with the exception of Langford and View Royal whereby local reuse demands are minimal and may be accommodated through adjacent reuse systems at Colwood or Esquimalt (Town). Alternative disposal techniques vary in that three of the tertiary plants in Westside would be discharging all excess effluent to a new outfall and Esquimalt (Town) would discharge out the Macaulay outfall. The two tertiary plants in Eastside would be designed for 100% reuse, with their alternative disposal being the CRD trunk with treatment at Rock Bay.

Preferred sites are available in each of the four plant locations. Additional site information will be presented in November 2015 as feasibility analysis unfolds.

The current, 2030 and 2045 ADWF design flows are summarized in Table 8.1 below.

Table 8.1 – Current 2030 and 2045 ADWF Design Flows

Sewer Shed	Current (MLD)	2030 (MLD)	2045 (MLD)
Rock Bay	56.1 (1)	77.8 (1)	93.1 (1)
East Saanich	3	3	5
Saanich Core	5	5	5
Esquimalt	5.5	7.1	7.9
Colwood	2.2	4.7	13.1
Langford	5.2	14.1	23.1
View Royal	1.5	3.5	7.9

(1) *Includes the flows for East Saanich, Saanich Core, West Saanich and West Victoria*


Existing CRD Sanitary Trunk
Proposed Pump Stations
Select Existing Pump Stations
Proposed Sanitary Pipe - Raw / Primary
Proposed Sanitary Pipe - Treated
Sewage Catchment Breakpoint
Sites
Municipal Boundaries
Existing Outfall
First Nation Reserves
Proposed Secondary WWTP Site
Proposed Tertiary WWTP Site
Wet Weather Facility
View Royal (S)
Craigflower PS
Colwood (S)
Esquimalt Harbour
Langford (M)
Esquimalt (M)
Barnard Park PS
Macaulay Point
Saanich Core (S)
No Outfall
Rock Bay (XL)
Garnet PS
East Saanich (S)
No Outfall
Cadboro Bay
Clover Point
S - Small
M - Medium
L - Large
XL - Extra Large
Seven Plant Option

Figure 8.1

The proposed new outfall near Colwood meets the regulations for alternative disposal.

Rock Bay flows will include wastewater from all Eastside communities including flows currently directed to Macaulay from west Saanich and west Victoria by way of a pump station near Barnard Park. All other eastside flows would be pumped from Clover Point, or, other strategic locations along the eastside to reduce the scope of new infrastructure. This option set also includes maximizing treatment at the Clover Point site (0.5 to 0.8 ha) to minimize the quantity of flow that would otherwise be pumped to/from Rock Bay.

The Esquimalt (Town) plant will also include two pump stations to collect flows, including wastewater originating upstream in the trunk immediately adjacent the site, as well as at Macaulay point to collect all remaining flows that arise downstream of the plant. Also, it will be possible to utilize the existing screens at Macaulay, so that only screened raw sewage needs to be pumped back Esquimalt (Town). All treated effluent that is not reused, is pumped back to Macaulay Point for discharge out a new outfall.

The Langford and Colwood plants would include dewatering and trucking their solids to Rock Bay (or Hartland Landfill) however the View Royal plant would discharge their waste biological solids into the sewer for the Esquimalt (Town) plant to handle them. The Esquimalt (Town) plant would either pump their waste solids or dewater and truck them to either Rock Bay or Hartland Landfill. The East Saanich and Saanich Core plants would discharge their waste biological solids into the sewer for the Rock Bay plant to process.

8.2 Components

The following key components to implement this option are summarized in Table 8.2.

Table 8.2 – Key Components

Key Components Required	2030 (m³/d)	2045 (m³/d)
Rock Bay		
1. Wet Weather Facility at Clover – 1 x ADWF	48,000	53,000
2. Sewage Pumping Locations		
• Clover Point (3 x ADWF) – Not including any treatment at Clover	96,000	107,000
• Near Barnhard Park	120,000	159,000
3. Primary Treatment	216,000	266,000
4. Secondary Treatment and Disinfection	156,000	186,500
5. Treated Effluent Pumping	216,000	266,000
6. Tertiary Treatment (Slipstream)	10,000	10,000
7. Clover Outfall Capacity (> 4 x ADWF)	317,000+	369,000+ (1)

Key Components Required	2030 (m³/d)	2045 (m³/d)
East Saanich		
1. Garnet Pump Station (Retrofit)	3,000	5,000
2. Tertiary Treatment	3,000	5,000
3. Treated Effluent Pump Station	3,000	5,000
Saanich Core		
1. Galloping Goose Trail/Boleskine Road Pump Station	5,000	5,000
2. Tertiary Treatment	5,000	5,000
3. Treated Effluent Pump Station	5,000	5,000
Esquimalt (Town)		
1. Sewage Pumping Locations		
• Lyall Street (2 and 4 x ADWF)	63,800	109,400
• Macaulay Point (4 x ADWF)	12,000	14,000
2. Primary Treatment	75,800	123,400
3. Tertiary Treatment	15,600	17,600
4. Treated Effluent Pumping	75,800	123,400
5. Macaulay Outfall Capacity (> 4 x ADWF)	75,800+	123,400+ (2)
Colwood		
1. Raw Sewage Pumping	9,400	26,200
2. Tertiary Treatment	9,400	26,200
3. Treated Effluent Pumping	9,400	26,200
Langford		
1. Raw Sewage Pumping	28,200	46,200
2. Tertiary Treatment	28,200	46,200
3. Treated Effluent Pumping	28,200	46,200
View Royal		
1. Craigflower Pump Station (Retrofit)	7,000	15,800
2. Tertiary Treatment	7,000	15,800
3. Treated Effluent Pump Station	7,000	15,800

(1) *By 2045 the Clover Outfall capacity will have to be increased from approximately 200 MLD to 369 MLD+*

(2) *By 2045 the Macaulay Outfall capacity will have to be increased from approximately 119 MLD to 123 MLD+*

Table 8.3 summarizes the estimated piping and outfall lengths.

Table 8.3 – Piping and Outfall Lengths (1)

From	To	Purpose	Length
A. Required			
Rock Bay			
Clover Point	Rock Bay WWTP	Screened Raw Sewage (SRS)	5,300 m
Rock Bay WWTP	Clover Point	Treated Effluent	5,300 m
Clover Point	End of Outfall	Treated Effluent/SRS	1,300 m
Pump Station near Barnard Park	Rock Bay WWTP	Raw Sewage	2,400 m
East Saanich			
Garnet Pump Station	WWTP	Raw Sewage	900 m
WWTP	Garnet Pump Station	Treated Effluent	900 m
WWTP	End of Reuse	Reuse	10,000 m
Saanich Core			
Galloping Goose Trail	WWTP	Raw Sewage	400 m
WWTP	CRD Trunk	Treated Effluent	400 m
WWTP	End of Reuse	Treated Effluent	10,000 m
Esquimalt (Town)			
Macaulay Point	Esquimalt WWTP	Screened Raw Sewage	1,500 m
Esquimalt WWTP	Macaulay Point	Treated Effluent	1,500 m
Lyall Street	Esquimalt WWTP	Raw Sewage	30 m
Macaulay Point	End of Outfall	Treated Effluent/SRS	1,700 m
Colwood			
Galloping Goose Trail	Colwood WWTP	Raw Sewage	30 m
Colwood WWTP	End of Reuse	Irrigation/Aquifer Recharge	19,500 m
Colwood WWTP	Junction with Langford	Treated Effluent	500 m
Langford			
Langford Site	WWTP	Raw Sewage	300 m
WWTP	Junction with Colwood	Treated Effluent	2,000 m
Junction with Colwood	Marine Shore	Treated Effluent	5,000 m
Marine Shore	End of Outfall	Treated Effluent	2,300 m
View Royal			
Craigflower Pump Station	WWTP	Raw Sewage	1,800 m
WWTP	Junction with Colwood	Treated Effluent	3,600 m
		Total	**86,660 m (2)**

From	To	Purpose	Length
B. Optional			
• Rock Bay WWTP	End of Reuse	Reuse	18,500 m
• Esquimalt WWTP	End of Reuse	Reuse	17,000 m
		Optional Total	**35,500 m**

(1) *Pipe lengths are approximate pending a routing review.*

(2) *Includes Colwood, East Saanich and Saanich Core reuse piping since these are necessary parts of the solution.*

Appendix A

Core Area Sewer Catchments and Facilities

Core Area Trunk Sewer System

FLOW TO MACAULAY POINT

Municipality	Percent	Annual Flow (m^3)	Station	Annual Flow (m^3)
Langford	12.29%	1,912,140	Meaford	1,912,140
Colwood	7.02%	1,092,703	Parsons	3,004,843
			(Meaford)	-1,912,140
View Royal	3.67%	570,489	Craigflower Flow	3,842,080
			(Parsons)	-3,004,843
			(Esquimalt Panhandle)	-52,169
			(Songhees)	-208,039
			(Hallowell (estimated))	-6,540
Saanich	45.43%	7,067,058	Marigold	4,813,387
			Boundary	1,281,722
			Harriet	971,949
Esquimalt Nation	0.04%	6,540	Hallowell (estimated)	6,540
Songhees Nation	1.34%	208,039	Songhees	208,039
Esquimalt	15.17%	2,360,338	Head	679,780
			Wilson	99,305
			Esquimalt Panhandle	52,169
			Langcove ESQ	120,754
			Kinver	211,209
			Lyall	319,080
			Devonshire	853,687
			Pooley Place (estimated)	24,354
Esquimalt DND	0.56%	87,164	Langcove DND	68,940
			Anson	18,224
Victoria	14.48%	2,252,823	Sea Terrace	158,245
			Langford Flume	45,874
			Hereward	566,190
			Cecelia	1,007,625
			Gorge (calculated)	349,091
			Chapman Point (calculated)	84,914
			Selkirk (calculated)	40,884
Total	100%	15,557,293		

For the period of October 1, 2012 to September 30, 2013
Some stations have been omitted from the map
Station names in brackets indcate flows have been subtracted

FLOW TO CLOVER POINT

Municipality	Percent	Annual Flow (m^3)	Station	Annual Flow (m^3)
Saanich	19.38%	3,372,847	Arbutus	2,621,027
			Penrhyn Lift Station	329,162
			Townley	28,048
			Haultain	125,204
			Haro	269,406
Oak Bay	16.23%	2,824,022	Currie	6,181,890
			(Trent Flume)	-212,582
			(Arbutus)	-2,621,027
			(Penrhyn Lift Station)	-329,162
			(Haro)	-269,406
			Harling	74,309
Victoria	64.38%	11,202,459	Clover Point	17,399,328
			(Harling)	-74,309
			(Currie)	-6,181,890
			Trent Flume	212,582
			(Townley)	-28,048
			(Haultain)	-125,204
Total	100%	17,399,328		

For the period of October 1, 2012 to September 30, 2013
Some stations have been omitted from the map
Station names in brackets indcate flows have been subtracted

† The Trent pump station diverts almost all flow south to Victoria away from Oak Bay. Some flows may go to Oak Bay, through the Trent flume, during major rainfall events or when the Trent pump station is down for maintenance.

* Chapman Pt and Gorge, Selkirk, and Pooley Place flows are not directly measured.

CRD - Parks & Environmental Services - Environmental Engineering - Oct 1, 2015 - Technologist: JPB/SR - Map Document: CoreAreaTrunksCostSharingV4.mxd