APPENDIX A

February 5, 2016

Capital Regional District

Core Area Liquid Waste Management Plan

Phase 2: Wastewater Treatment System Feasibility and Costing Analysis

Technical Memorandum #3 - Costing and Financial Analysis *R1*

Project: 1692.0037.01

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Table of Contents

Appendices

1.0 REPORT SUMMARY & OVERVIEW

Life-cycle costing analysis provides the Core Area Liquid Waste Management Committee (Committee) with financial information on seven wastewater option sets for treatment and resource recovery. Each option set provides notable differences with respect to locations of treatment, levels of service for treated effluent, new piping and conveyance infrastructure, and opportunities for water reuse and heat recovery at select locations across the Core Area. While the option sets adhere to engineering and regulatory standards, they are suited to the local context by way of design consideration to public consultation results (early 2015), Committee resolutions and direct references to the Project Charter which guides the Phase 2 work to date.

Technical Memorandum #3 presents the life cycle costing results and includes the relative performance of each option set against the Project Charter and Committee aspirations. While costing results frame part of the feasibility for a given option set, illustrating the performance of an option set in light of the project criteria supports the Committee's need to provide direction on a *system* of upgrades and services. Results of this memo are presented to the Committee for potential direction regarding public consultation for each option set and to uncover public sentiment for levels of service and cost. Input provided by the Technical and Community Advisory Committee, Technical Oversight Panel, technical and administrative staff of each of the Core Area municipalities and First Nations frames the presentation to the Committee and continues to be an important resource for this evaluation and decision-making process.

Cost estimates for the seven option sets are based on factors outlined in Technical Memorandum #1 and comply with the terms of reference. Cost estimates in Technical Memorandum #3 differ from the previous liquid waste management plan because the seven proposed option sets reflect a markedly different suite of conditions and factors, such as:

- The terms of reference for Phase 2 clarify that the primary project objective is to characterize the performance of new option sets against revised goals and criteria;
- Cost estimate contingencies for Phase 2 (2015) are 35%, whereas previous liquid waste management plans included contingencies of 14% and 20% for treatment and conveyance, respectively;
- Phase 2 cost estimates include piping and pumping infrastructure (not treatment) sized for a potential 2045 flow scenario rather than the 2030 flow scenario (to avoid the unnecessary and costly impact of upgrading systems within 10 years after construction);
- Cost estimate unit rates for Phase 2 are derived from separate databases and project experiences and do not directly align with estimates of the previous plan; and
- Option sets reflect only the sites which have been brought forward by member municipalities.

Cost estimates for Phase 2 reflect a new direction in liquid waste management as outlined in the seven option sets. It is common for cost estimates to be conservative at the conceptual stage and they include multiple factors with varying levels of uncertainty. Indeed, it is common that cost estimates tend to improve and often decrease as more investigation and optimization is complete on the preferred option set. Technical Memorandum #3 provides the results of life cycle costing analysis and includes criteria performance as it relates to the Project Charter.

1.1 Technical Process Update

Engineering and financial feasibility studies are iterative. Each issue or design element undergoes scoping, testing, refinement and costing. Typically, the iterative process repeats itself to stimulate ideas, strengthen the foundation of solutions and often to reduce project scope and cost. While most engineering and feasibility studies include iterative analysis, Phase 2 for the Core Area has been aided by multiple teams and committees, each looking to significantly contribute towards option sets: collaboration with the Technical Oversight Panel, Westside Technical Staff, Eastside Technical Committee, CRD Staff and the Technical and Community Advisory Committee has improved the option sets. While there is much more iteration and optimization to come, key innovations and technical updates for Phase 2 include:

- **Efficient Pumping:** Option set configurations in Technical Memorandum #2 included a pump station at Gorge Road to capitalize on redirecting flows to Rock Bay over a shorter distance and reduced pumping needs. Costing for TM#3 reveals that constructing one pump station at Macaulay Point to Rock Bay will be more efficient and as a result, reduces capital and operating costs.
- **Wet-Weather Treatment Facilities:** Option set configurations in Technical Memorandum #2 identified the potential for a primary treatment facility at Clover Point for flows in excess of 2x average dry weather flow. The driver for this strategy was to reduce the size of pipes and pumps from/to Clover Point to Rock Bay. Costing for TM #3 reveals that centralizing wet-weather treatment at Rock Bay will reduce capital costs.
- **Sidestream Treatment and Water Reuse:** Each option set includes the provision for water reuse. Providing sidestream tertiary plants allows for reuse systems that treat only enough *supply* to meet potential *demands.* A facility in Colwood, if approved by the Ministry of Environment, would be a leading-edge water reuse system utilizing aquifer recharge and soil irrigation for up to 100% of flows. There are few facilities in Canada capable of achieving this standard and as a concept, provides for interesting public input on choices for water reuse. Overall, while treating to tertiary levels has some environmental appeal, it does come with higher capital and operating costs. Pursuing sidestream water reuse at all facilities in any option set illustrates the relationship of increased levels of service for water and the associated cost.
- **Harbour Outfall Concept Check:** There is a significant cost to convey treated effluent from Rock Bay back to the Clover Point Outfall such that some interest emerged into the feasibility of reducing the outfall and relocating it to the Harbour. An environmental impact study is ultimately needed to assess the potential for this approach; however, costing for Technical Memorandum #3 reveals that the extra treatment costs would outweigh potential outfall cost savings by a factor of roughly 2 to 1.
- **Integration with Solid Waste for Expanded Resource Recovery:** Incorporating resource recovery for both wastewater solids and municipal solid waste is growing in feasibility and application. Phase 2 uncovers key tactics at a concept level for integration and provides information to allow the CRD to consider a road-map for integrated resource recovery.
- **Phasing-in Enhanced Treatment:** Making the jump from preliminary treatment (e.g. screens) to secondary treatment (and beyond) will mark a significant advancement in wastewater and environmental performance for the Core Area. Regardless of the level of treatment selected (i.e.

regulations or beyond), the CRD will have ample opportunity to collect and report on real-time data for effluent and water quality, and quantity. This type of data can lead to reliable information regarding the opportunity to phase-in enhanced treatment over time and defer costs to ratepayers.

- **Treatment Levels of Service:** Wastewater utilities typically design levels of service to meet the regulations. Implementing tertiary levels of treatment where it is not required would demonstrate environmental stewardship including additional removal of some emerging contaminants of concern.
- **Reduced Infrastructure:** Small-scale water reuse plants that *scalp* flows to suit supply-demand for reuse, reconfiguring existing pump stations, selecting sites adjacent to existing infrastructure and many other design elements have led to seven option sets with a reduced amount of new infrastructure. Further innovation is needed to optimize pipe routing and to minimize disruption to local residents and businesses in the preferred option set.
- **Request for Statements of Interest (RFSI):** Based on the analysis of solids alternatives and option sets, there are two viable and comparable solids recovery options in anaerobic digestion or gasification. Each option is defined and costed for public input. There are however other technologies that may be more cost effective but have not been vetted as viable for the CRD. The CRD can use the RFSI approach to tell the market that it will either choose between its current choices, or, consider a more innovative or cost-effective market-based solution that out performs the defined choices based on a suite of goals and criteria for solids treatment and recovery. Myriad solids recovery options and technologies provide for more innovation and market competitiveness: the RFSI positions the Core Area for maximizing what the market can do for solids recovery.
- **Technology Innovation:** Engineering feasibility and costing is based on representative design, whereby select technologies are costed on a provisional basis to support the comparison of the option sets. Representative design gives the private sector ample opportunity to provide innovative solutions to meet the performance targets of the preferred option set because technologies have not been prescribed. Smaller footprint technologies may emerge through canvassing the private sector.
- **Regulatory Innovation:** Regulations often dictate the location and scope of infrastructure. Phase 2 discussions with the provincial Ministry of Environment has opened the door to further innovations in technologies to meet the regulations, for example, by considering less expensive primary treatment options.
- **Construction Phasing:** The Core Area wastewater system will evolve due to dynamic conditions of flow quality and quantity. Incrementally upgrading the system over time will allow for the results of water conservation and inflow and infiltration management to offset the need to increase capacity.

Innovation will continue and the preferred option set(s) will evolve as needed during subsequent design phases to optimize the Charter goals and to meet local needs. Option set summaries illustrate their relative performance including costing, characterization and criteria results.

1.2 Charter Elements and Summary Outcomes

The Project Charter provides guidance to the technical analysis herein and was foundational to creating the seven option sets. Technical Memorandum #3 characterizes each option set in light of the Charter and provides key results and differentiators to enable all readers the opportunity to weigh the tradeoffs for service, benefits and costs. Project criteria stemming from the Charter were developed in Technical Memo #1 which is provided in Appendix A to this report. Section 4 summarizes the performance of each option set under a common framework including life-cycle costing results[1], criteria performance and overall characterization of each option. Table 1-1 below provides an executive summary of the option sets based on the 2030 design capacity scenario of 108 MLD (average dry weather flow) for the Core Area, and costs include full system development such as conveyance, solids, liquid treatment, land and resource recovery infrastructures. Resource incomes are conceptual estimates only based on potential payments for treated effluent reuse and they are highly contingent on securing new utility customers.

Table 1-1: Option Set Summary

OPTION SET	SUMMARY CHARACTERIZATION	2030 CAPITAL AND NET-OPERATING COST		
Rock Bay Central - Secondary	The 1 Plant secondary treatment (1a) option set centralizes all flows at Rock Bay, including up to 10 MLD for local reuse. This option set addresses the need to meet pending regulations and provides for the base level of service.	**Capital 2030** $1,031 M	**2030 Operating** $21.8 M	**Est. Resource Income** Up to $0.9 M
Rock Bay Central – Tertiary	The 1 Plant full tertiary treatment (1b) option set centralizes all flows at Rock Bay, including up to 10 MLD for local reuse. This option set represents a clear sentiment towards water stewardship by raising levels of service for treated effluent quality.	**Capital 2030** $1,131 M	**2030 Operating** $26.4M	**Est. Resource Income** Up to $0.9 M
2 Plant: Rock Bay + Colwood	The 2 Plant option set treats over 80% of flows to secondary levels, on top of up to 20% tertiary quality effluent. This option set represents a notable increase in water reuse from the 1-plant option with minimal extra conveyance infrastructure.	**Capital 2030** $1,088 M	**2030 Operating** $22.8 M	**Est. Resource Income** Up to $2.4 M
3 Plant Secondary: Colwood/Langford, Esquimalt Nation and Rock Bay	The 3 Plant option set treats over 80% of flows to secondary levels, on top of up to 20% tertiary quality effluent from sidestream re-use facilities at Esquimalt and Rock Bay. The secondary plant at Colwood/Langford allows for sub-regional flow management, including locating capacity for future growth in the Westshore.	**Capital 2030** $1,125 M	**2030 Operating** $23.0 M	**Est. Resource Income** Up to $1.6
3 Plant Tertiary: Colwood/Langford (tertiary), Esquimalt Nation and Rock Bay (both secondary)	The 3 Plant Tertiary option set treats 70% of flows to secondary levels, on top of up to 30% tertiary quality effluent from the Colwood/Langford plant on top of sidestream re-use facilities at Esquimalt and Rock Bay. This option increases water reuse to three systems and raises effluent quality to levels similar to the 4 plant option at a lower cost.	**Capital 2030** $1,178 M	**2030 Operating** $24.1 M	**Est. Resource Income** Up to $2.8

[1] Borrowing costs are not included in the operating costs in this report but are available through the CRD.

<table>
<tr><th>OPTION SET</th><th>SUMMARY CHARACTERIZATION</th><th colspan="2">2030 CAPITAL AND NET-OPERATING COST</th></tr>
<tr><td rowspan="2">4 Plant: Rock Bay, Colwood, East Saanich and Esquimalt Nation</td><td rowspan="2">The 4 Plant option set is a sub-regional system treating over 75% of flows to secondary levels, on top of up to 25% tertiary quality effluent. This option set represents the middle ground for distributed facilities and includes water reuse systems in four major growth centers.</td><td colspan="2">Capital 2030
$1,195 M</td></tr>
<tr><td>2030 Operating
$25.3 M</td><td>Est. Resource Income
Up to $3.8M</td></tr>
<tr><td rowspan="2">7 Plant: Rock Bay, Colwood, East Saanich, Esquimalt Township, View Royal, Langford and Core Saanich</td><td rowspan="2">The 7 Plant option set is a sub-regional system treating up to 45% of flows to tertiary quality, including tertiary treatment for all flows on the Westside. This option set represents a distributed system which maximizes the potential for water reuse and situates facilities in 7 growth areas.</td><td colspan="2">Capital 2030
$1,348 M</td></tr>
<tr><td>2030 Operating
$26.6 M</td><td>Est. Resource Income
Up to $4 M</td></tr>
</table>

While resource recovery provides for some cost-offsets by way of new incomes (i.e. contingent incomes), water and heat recovery systems demonstrate an overall increase in costs associated with higher levels of service. Risks related to securing customers and revenues warrants due diligence in expanding the scope of service. The drivers for resource recovery ultimately go beyond financial, in terms of environmental stewardship and water innovation: public sentiment for increased levels of service and their costs is an important outcome of upcoming public consultation. Further public input can shape the direction for services in the Core Area beyond the base expectations of meeting the regulations.

2.0 TECHNICAL CRITERIA OVERVIEW

The Project Charter outlines 10 goals and commitments for option set performance and overall system evaluation. Phase 2 includes technical criteria which relate directly to the goals and commitments. These criteria guide representative design elements, and shape the approach to option sets, technologies, levels of service and resource recovery approaches. These criteria also help to characterize the performance of each option set for further consideration by political and public audiences. Technical criteria within the Project Charter provide a robust framework consistent with a goal-oriented, evaluative process to effectively illustrate and screen multiple options.

Each option set provides various levels of performance: there is no perfect technical answer to a multiple-accounts characterization of the options. Each option set is a *choice* and the engineering feasibility and financial analysis provides figures and statistics to allow for informed input and decision-making based on best available information.

While Appendix B provides the full list of technical criteria and their direct relation to Charter goals and commitments, the following summary-list provides the framework for much of this memorandum. The criteria relate to these performance topics:

- Wastewater treated above regulations
- Ability to reduce operating costs
- Carbon footprint and energy balance
- Ability to enhance treatment levels over time
- Extent of new infrastructure
- Amount of income/cost-offsets through resource recovery
- Integration of other waste streams
- Facility location, land use and relative interruptions

Sections 3 and 4 provide for coverage of the performance of the technical criteria. Two specific technical criteria are not evaluated in detail in the memo due to their inability to provide for meaningful differentiation of the option sets. In the case of 'extent of alternatives to bring in costs less than original estimate', no option set can meet this goal in part due to cost escalations from the previous LWMP amendment, because cost contingencies are different than the previous option, but also due to changing conditions such as facility location and levels of service. The 1 plant option with secondary treatment presents the lowest cost option of the available sites. In the case of 'ability of an alternative to meet the preliminary criteria', all option sets meet this criterion in that all system configurations are guided by all criteria and perform to some degree against each commitment. All remaining criteria provide for a broad characterization of the performance of any option set. Section 4 provides for a dashboard type presentation of the option sets in light of their performance against technical criteria.

2.1 Key Areas for Policy Direction and Public Input

Key focus areas for future policy direction and public input provide a lens on the multiple-account nature of this assignment. Dialogue with public, political and technical stakeholders continues to reinforce the importance of the following focus areas:

- **Integration with Solid Waste and Location of Solids-Energy Recovery:** the reduction of landfill emissions appears to be the primary driver for integration with solid waste materials. Direction by the Committee to substantively integrate solid waste may lead to gasification of wastewater solids located at Hartland Landfill, as an alternative to anaerobic digestion. Public input on the integration of solid waste and their preferences on location can support the Committee's decision for solids-energy recovery.
- **Water Reuse:** water reuse requires an increase in effluent quality (a form of environmental stewardship) and demonstrates water innovation, but it will also increase operating and capital costs. Committee direction to pursue higher levels of service to include water reuse can be achieved for every option set, to varying degrees. Water reuse feasibility may be presented in tandem with long-term potable supply plans to allow for a fulsome, regional water security dialogue. Phasing-in water reuse can occur in all option sets. Public input on elevated levels of service and water reuse is key.
- **Heat Recovery:** key conditions must be present for financially viable heat recovery systems. In particular, the small energy-price differential between electricity and natural gas at this time greatly reduces the financial viability of heat recovery from wastewater in the form of district heating systems. All option sets provide for one or more heat recovery system opportunities. Committee direction for heat recovery may be to: a) include the concept of heat recovery systems for future implementation (beyond 2030); or to b) include heat recovery costs in the option set summaries; or to c) not include heat recovery in the liquid waste management plan. Public input on the *concept* of heat recovery will be beneficial for future decisions.
- **Centralized or Distributed Facilities:** a key driver for distributed facilities is to recover resources in strategic locations and typically to recover resources where they are first generated. Distributed heat recovery, water reuse and solids-energy facilities all result in increased levels of service and costs (albeit some revenues emerge to offset a portion of the costs). Pursuing heat recovery and water reuse at this time would be driven by social, and partly environmental, outcomes. Public input on the benefits and drawbacks of centralized and distributed facilities can support Committee decision making.
- **Effluent quality:** meeting the regulations is a significant advancement in effluent quality from the current practice of preliminary treatment. Going further to achieve tertiary effluent quality allows for water reuse, may allow for reduced outfall lengths and could result in removal of greater emerging contaminants of concern (for some contaminants only, as secondary treatment removes a large portion of many contaminants already). Committee direction to treat to tertiary levels beyond water reuse demands would demonstrate water stewardship and increase capital and operating costs.

Upcoming public consultation is designed to provide qualitative and quantitative input regarding many of these focus areas to support Committee decision-making.

3.0 RESOURCE RECOVERY FEASIBILITY ANALYSIS

3.1 Solids Management

The Project Charter indicates that any option set must incorporate sustainable practices into the design and consideration of the solids management alternatives. Anaerobic digestion and gasification provide two energy positive processes that meet the terms of reference and the goals and commitments of Phase 2.

- **Anaerobic Digestion** is a process that maintains the wastewater solids at near body temperatures (35-39 degrees C) without the presence of air. Under these mesophilic[2] conditions the bacteria consume themselves and produce an energy-rich byproduct (methane). Typically, anaerobic digestion can reduce the organic content of the solids by 35-50% and the overall mass of the solids by 30%. Anaerobic digestion is the industry standard for stabilization and energy recovery in the wastewater industry. Anaerobic digestion produces a 'wet dirt' material at concentrations from 3% to 5% dry solids. The 'wet dirt' can be dewatered to produce a *cake* with a 20% to 25% dry solids concentration, which contains the residual nutrients and carbon. This material must then be managed or disposed of as the end product of anaerobic digestion. Anaerobic digestion typically produces 1,377 kg of wet cake at 20% dry solids per ML of treated wastewater. Anaerobic digesters do not have any specific setback requirements in the BC *Municipal Wastewater Regulation*. There is however, a requirement under BC regulations that requires a 15 m setback for any gas flare(s).

- **Gasification** is a thermal/chemical process that converts the organic carbon in the wastewater solids into a synthetic gas that offers energy recovery potential but also may be processed into higher value items like plastics or as feedstock for biodiesel production. The process has a challenging requirement to maintain materials at elevated temperatures (>400 degrees Celsius) for a period of time. As this process is thermally based, it is critical that the energy content of the feed stocks be sufficient to maintain the high temperatures and derive energy out of the process. Gasification has been used in the municipal solid waste market as the energy content of these materials is typically sufficient for an efficient and energy positive operation. Gasification proponents claim to process 70% to 90% of the carbon content of the liquid waste solids feed; leaving mostly inorganic ash. The disposal or management of this material is significantly easier since there is only about 25% of the solids that remain as ash or biochar. Gasification will typically produce 14-60 kg of ash or biochar per ML of wastewater treated.

Wastewater solids typically contain large amounts of energy in carbon form. Through the two selected processes, part or all of the energy contained in the reduced carbon is extracted in the form of heat and syngas (low grade gasification gas) or methane (in the case of anaerobic digestion). Energy extracted from the wastewater solids can be converted to electricity through steam turbines (preferred alternative for syngas) or through internal combustion engines to obtain both heat and power.

[2] Thermophillic digestion is an alternative to mesophilic which can reduce the time required for digestion but also requires greater heat/energy needs.

Figure 3-1 shows the energy content of the municipal solid waste and wastewater solids; Figure 3-2 shows the relative moisture content of Municipal Solid Waste and Wastewater Solids

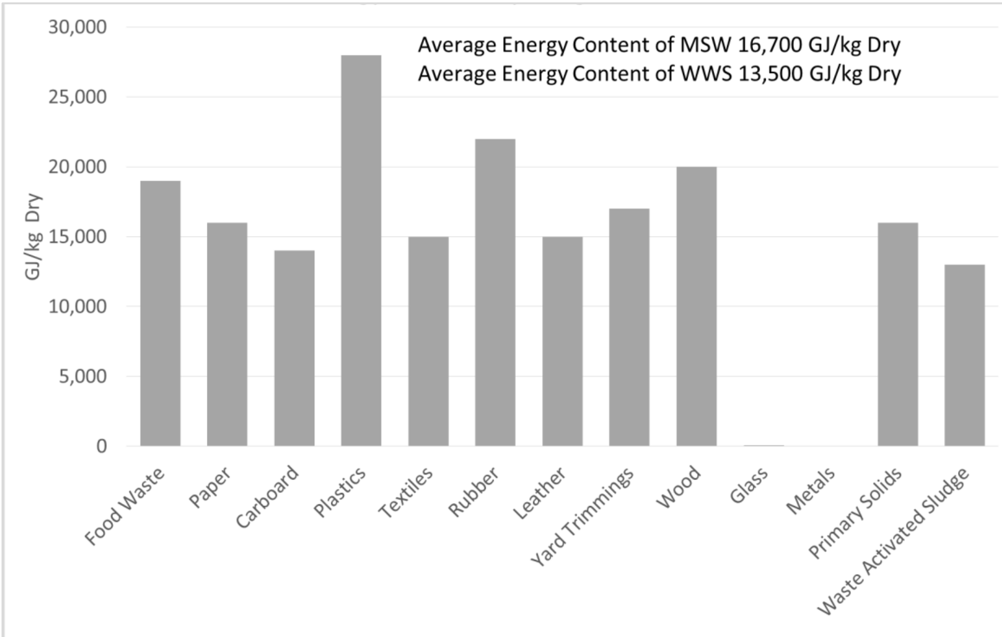
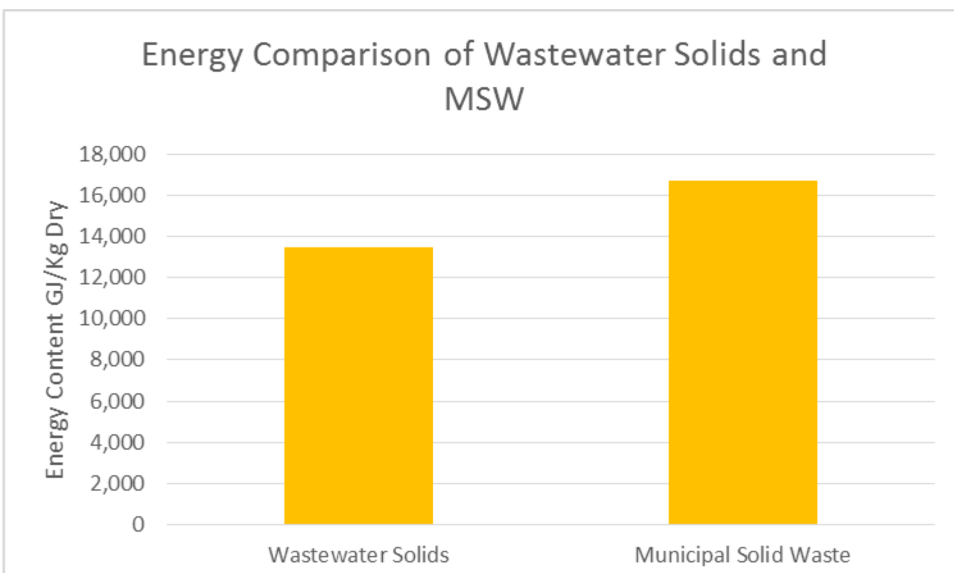


Figure 3-1: Energy Content by Weight Fraction



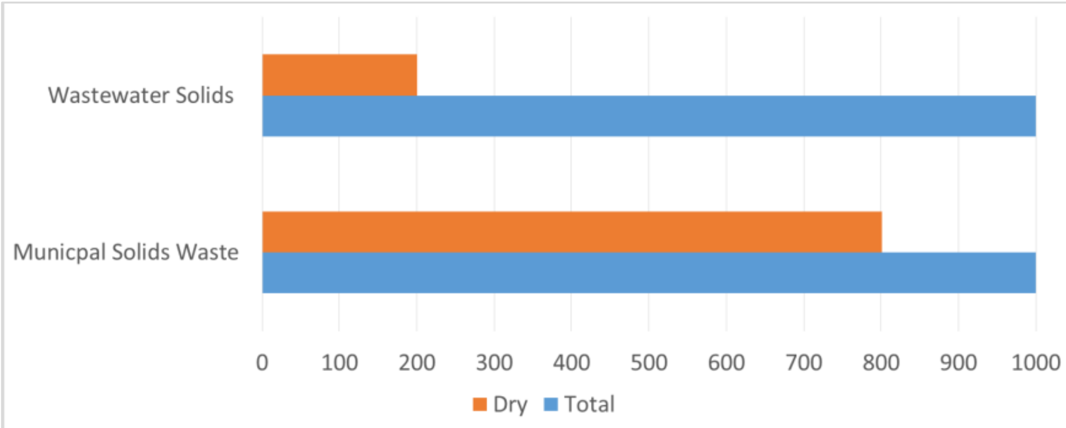


Figure 3-2: Energy Content of MSW and WWS

Figures 3-1 and 3-2 illustrate that wastewater solids contain roughly the same amount of energy as the MSW, however the moisture content (water) in the solids limits the application of thermal technologies. Figure 3-3 shows the Energy content of municipal solid waste (MSW) and wastewater solids (WWS) on a wet basis assuming the energy required to evaporate water is 3.3 GJ/ton of water evaporated.

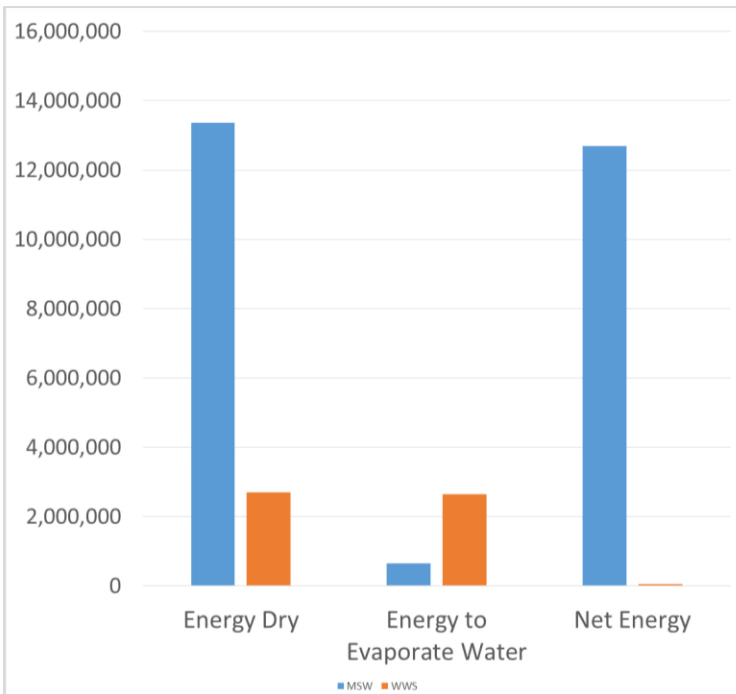


Figure 3-3: Available Energy from MSW and WWS

Anaerobic Digestion – Energy Recovery: The solids produced from the wastewater treatment facilities will be trucked or piped to the solids processing site (either Rock Bay or Hartland; discussion to follow) and introduced into the stabilization process. The separated kitchen scraps (10,000 tons per year) could be received at this station[3], screened and pulped and then introduced into the digesters for conversion to

[3] Costing in TM #3 focuses on solids-energy recovery of wastewater solids and does not present overall costs for inclusion of other solid wastes.

energy. The solids receiving station will be enclosed and odour controlled to avoid any fugitive odours from escaping the site as well as to minimize the visual impact to the neighborhoods. The solids will then be introduced into the digesters and held in enclosed vessels for a period of no less than 18 days. Once the solids are stabilized, they will be conveyed through pumps to the dewatering operation. High speed centrifuges or other methods will dewater the solids to a moisture content of less than 80 percent. The solids will then be held in an enclosed cake storage facility to control any odours and then loaded into the disposal trucks under an enclosed environment to control odours.

The methane gas from the digestion process will be cleaned of hydrogen sulfide and siloxanes and diverted to the c*ombined heat and power* units for the generation of power and heat. The heat generated in the engines will be used to provide the necessary heat for the digestion process and to offset the electrical use of the mechanical equipment at the plant.

Given the CRD policy which prevents land application of biosolids, an alternative to anaerobic digestion would be to dry wastewater sludge to create fuel pellets. These costs are not currently included in the option sets to allow the private sector to propose other alternatives and maintain an open, competitive process for beneficial reuse between the two technologies.

Daily truck traffic for dewatered, stabilized solids would amount to about six trucks per day in 2030.

Gasification – Energy Recovery: As part of the gasification alternative, the solids produced from the wastewater treatment facilities will be conveyed to the solids processing site (either Rock Bay or Hartland; discussion to follow) and introduced into the gasification process. The separated kitchen scraps (10,000 tons per year) could also be received at this station, screened, pulped and stored (holding vessel), potentially combined with yard waste (1,000 tons per year) and the resulting mass can be dosed to the gasifier for energy generation. The wastewater solids will be sent from the holding tank to a solids dryer to reduce their moisture content and then into the gasifier. The solids receiving station will be enclosed and odour controlled to avoid any fugitive odours from escaping the site, as well as to minimize the visual impact to the neighborhoods. Gasified solids are an ash-like material which would be collected and combined with spent odour control materials and loaded into a truck to Hartland, awaiting the market to reuse the materials for beneficial means. Daily truck traffic from the wastewater solids would be almost negligible aside from any additional feedstocks required to enhance the gasification process. Consideration to service governance of solids waste (e.g. service boundaries for regional versus Core Area) and liquid wastes can further inform the feasibility of integration.

The syngas generated from the gasification process will be used as fuel to a steam boiler and the steam will power a steam turbine to generate power. The addition of municipal solid waste should enhance the thermal-energy process to yield significant amounts of excess thermal energy.

Combined Heat and Power

The use of either gasification or anaerobic digestion will yield excess energy that can be converted to electricity or other forms of usable energy. Currently, the project as envisioned is to generate power to offset the mechanical equipment power use in the case of anaerobic digestion the selected technology is an internal combustion engine. In the case of gasification, the selected technology is a steam turbine recognizing that other technologies exist.

Costing Summary

The process descriptions above provide the overall scope of treatment, energy recovery and solids management that will be defined for the proposed Request for Statements of Interest. Overall, net present value analysis at this time strongly suggests that the overall capital and operating costs of anaerobic digestion and gasification can be considered comparable for this type of analysis. Key process components for solids recovery of either anaerobic digestion or gasification may include (depending on the preferred solids-recovery concept):

- Control buildings
- Residuals storage/loadout
- Dewatering facilities
- Energy generation unit(s)
- Gas conditioning/upgrader
- Dryer units and controls
- Receiving stations
- Process units: either gasifier or digester

Operations costs include:

- Labour and waste processing
- Maintenance
- Solids disposal (landfill fees encourage market sector innovation)
- Gas conditioning media
- Revenues from landfill avoidance
- Natural gas
- Power
- Polymer

Key results of the capital, operating and life cycle costing analysis include:

- There are many examples of anaerobic digestion facilities in North America which provide an extensive database of costs for estimating purposes. The limited number of successful gasification (of wastewater solids) facilities increases the uncertainty of their estimates. Gasification proposals within a RFSI may vary widely however that uncertainty is not reflected in these capital costs to allow for a more straightforward comparison (conclusions on the capital costs and associated risks of any proposed technology can stem from the results of the RFSI); these capital costs are comparable given the nature of the cost estimates for Phase 2;

ANAEROBIC DIGESTION – CAPITAL 2030	GASIFICATION – CAPITAL 2030
$258M	$233 M

- Operational costs for gasification may be less than anaerobic digestion by a notable margin; this is primarily related to the mass of solids still present in the digested sludge and the potential cost of its disposal/reuse; market innovation on the reuse of biochar and biosolids will have a significant effect on the operating costs for either technology (which further justifies the value of market engagement through the RFSI),
- Operational costs (including cost-offsets or revenues) for gasification could be up to 40% less than anaerobic digestion for the 2030 scenario,
- Operational costs for gasification decrease further as other municipal solid waste materials are added (relative to anaerobic digestion) because more energy offsets emerge,
- Net present value results between anaerobic digestion and gasification can be considered roughly equal at this conceptual level (the capital cost uncertainty for gasification prevents a clear conclusion on net present value); statements of interest by the wastewater solids market will determine whether even better net present value scenarios exist,
- Capital costs for anaerobic digestion are included in the option set summaries as they represent more reliable costing because they are based on multiple installations across North America at a comparable scale, whereas there are no known operating gasification facilities with biosolids at or near this scale; presenting only the costs for anaerobic digestion will have little effect on public consultation because either process will require debt amortization coupled with operating costs which yield a comparable financial impact to residents on an ongoing basis, and
- Discussions with 3P Canada and senior government funding partners must occur to determine eligibility of gasification and the integration with municipal solid waste (e.g. potential advantage), recognizing that a key driver for eligibility is achieving value for money.

Emissions avoidance and carbon credits are not considered in the financial analysis (however their relative performance is outlined below) due to the uncertainty of eligibility of either wastewater process in BC (there is no wastewater protocol); including carbon credits from non-wastewater solids could be considered in future phases however the analysis would be highly speculative until substantive discussions can occur with the province.

Two financially comparable solids-energy recovery options positions the CRD to canvass the private sector to determine the most cost-effective and environmentally-beneficial alternative.

3.2 RFSI Considerations

A request for statements of interest (RFSI) details the aspirational and obligatory (e.g. risk management, financial assurance) objectives of the CRD in solids recovery, and also serves to identify and assess all of the potential market opportunities to improve upon the alternatives identified in Phase 2. The RFSI provides the CRD the option of evaluating the best technologies in a single, formal process and further provides guidance to the manufacturers on the goals of the CRD for the processing and disposal of the solids generated through the process.

The value of biosolids and their residual resources is driven by the interest and application of users in the resource recovery marketplace. Once the Core Area has a complete and operational treatment system, a growing (yet small) list of proponents will gradually emerge vying for a role in resource recovery activities. The RFSI provides a catalyst for the local market and helps to define the critical information needed in terms of supply and demand, revenue and cost, as well as use and recovery for all residual products. Biosolids recovery financial analysis is always market specific and the life-cycle comparison of any technologies is provisional until better, local and reliable market information is known, for example, from a RFSI.

The RFSI process will also provide opportunity for innovation by encouraging practical, resourceful and complete solutions to recover biosolids including their organics and energy. The RFSI should include the definition of the two *bookend*-type options (anaerobic digestion and gasification) as viable options for the CRD to implement in a way that challenges the market to produce options that are more innovative. For example, a fuel-pellet-focus option may emerge (among many other options) which dries all residuals preserving most of the original calorific value of the organics for use at a kiln or other energy facility. Also, the availability and content of other municipal solid feedstocks should be characterized to inform market proponents of available fuels to drive alternative technologies.

The RFSI process provides significant advantages to this process and strongly encourages innovation by the market. By being goal driven, market solutions will adhere to the progress made during Phase 2 including direction by the Committee and aspirations of the public. The RFSI must specify performance outcomes along with defined evaluation criteria so that responses are directly applicable to the requirements and aspirations of the Core Area, including topics such as:

1. Proposed process must recover and export energy
2. Proposed process should integrate municipal solid waste and wastewater solids
3. Proposed Process must recover and export ammonia
4. Proposed process must minimize carbon emissions
5. Proposed process must not rely on land application or landfilling of solids processed

The comprehensive list of requirements would be detailed to suit political and technical needs, for alignment with senior government funding opportunities (committed or not) and reflect key input received by the public through upcoming public consultation. Each response by the private sector should include an appropriate level of commitment and assurance of cost and responsibilities so that CRD can adequately factor in the proposed options as part of service budgeting and planning.

3.3 Hartland Landfill and Rock Bay

Locating solids-energy treatment and recovery at either Hartland Landfill or Rock Bay is driven by five key factors as outlined in Table 3-1.

Table 3-1: Key Factors and Considerations

FACTOR	CONSIDERATIONS
1. Neighborhood interest in gasification or anaerobic digestion at Rock Bay or Hartland Landfill e.g. odour	» *Local industrial land uses at either location present noise, vibration, aesthetic, air and odour concerns* » *Solids-energy recovery would not significantly affect current neighborhood conditions except if additional municipal solids are received, stockpiled and sorted at Rock Bay; odour management equipment is accounted for at all facilities* » *Neighborhood input (with consideration to the local context for land use) will further influence the suitability of siting solids-energy recovery in Rock Bay.*
2. Cost of land	» *Prime industrial land in Rock Bay is about five times costlier (per hectare) than land at Hartland Landfill.*
3. Costs of trucking and pumping wastewater solids to Hartland Landfill	» *Processing all solids at Rock Bay could eliminate most of the costs of trucking/pumping since there will only be some residuals to convey off the site* » *Trucking solids (20% solids) or pumping solids (at 1 to 2% waste dry solids) from Rock Bay to Hartland present a similar net present value at approximately $38M+; trucking net present value includes a lower capital cost than pumping (a liquid return line to Rock Bay is still required for trucking) but the higher operational costs of trucking, including potential carbon taxes, results in a comparable net present value.*
4. Integration of solid waste[4]	» *Hartland landfill already includes receiving and sorting of different solid wastes which provides distinct advantages. Duplicating this function in Rock Bay would increase costs, noise and traffic.* » *Integrating some municipal solid wastes into the gasification or anaerobic digestion processes would be more efficient at Hartland (which also allows for greater expansion opportunities).* » *Excess heat from the existing landfill methane cogeneration facility would reduce the cost and emissions of drying wastewater solids for either anaerobic digestion or gasification.*
5. Final destination of residuals	» *The market response to residuals is not yet known however the ability to provide excess land for temporary storage until suitable customers exist provides an advantage to Hartland.*

In summary, the cost of land at Rock Bay and the cost of transporting to Hartland (either trucking or pumping to Hartland) offset themselves yielding no clear advantage for two of the five factors (Appendix C outlines trucking and pumping costs). However, Hartland Landfill provides for the opportunity to more

[4] . Further study can confirm the capacity of the local electricity grid to accommodate new power at both locations.

easily integrate other municipal solid wastes, to utilize excess heat resources from the methane cogeneration facility, to provide greater flexibility for storage facilities and for expansion. Overall, if integration with solid waste is pursued then Hartland Landfill provides distinct advantages, including strong engineering and financial feasibility, a lower risk of odour nuisance, and improved resource recovery considerations. Rock Bay is still a viable solids-energy recovery location but is not conducive to integration with municipal solid wastes. Costs for transporting solids to Hartland can be added to the option sets on direction from the Committee.

3.4 Solids Transport: Trucking or Piping Considerations

Solids treatment is best done at a central facility in order to maximize economies of scale and to reduce operational complexity. Any option set with multiple plants requires that solids are conveyed to the desired location, either Rock Bay or Hartland, for treatment and recovery. Each option set (of 7) may include either of the available solids treatment location, and, whether to pump or to truck solids prior to treatment: Seven option sets, two locations and two transport mechanisms yields many, many scenarios. However, the practical transport of solids prior to treatment-recovery in the 2030 scenario can be separated into two distinct strategies:

- *For sub-regional or distributed-type treatment option sets (*3 Plant, 4 Plant and 7 Plant): dewatering and trucking occurs at each major plant with solids trucked to the central facility, either Rock Bay or Hartland, to avoid the cost and impacts arising from separate solids-transport pipes distributed throughout the core area. In other words, multiple plant option sets are not conducive to a piped method of solids transport to Hartland or Rock Bay. Proposed solids transport methods by trucking, for all sub-regional or distributed-type plant option sets, can be summarized as:

Table 3-2: Solids Transport Summary – Distributed-type Options

Option Set	Plant + Solids Transport Method
3 Plant (approach for either secondary or tertiary)	» **Colwood/Langford**: dewater and truck to central facility (either Rock Bay or Hartland; 1-2 trucks per day) » **Esquimalt Nation:** dewater and truck to central facility (either Rock Bay or Hartland; 1-2 trucks per day) » **Rock Bay:** central location of solids treatment, or, dewater and truck to Hartland; 3-4 trucks per day)
4 Plant	» **Colwood:** 1% to 2% waste dry solids returned to the CRD sewer main for dewatering at Esquimalt (no trucks) » **Esquimalt Nation:** dewater and truck to central facility (either Rock Bay or Hartland; 1-2 trucks per day) » **East Saanich:** 1% to 2% waste dry solids returned to the Eastside collection system for processing at Rock Bay (no trucks) » **Rock Bay:** central location of solids treatment, or, dewater and truck to Hartland (3-4 trucks per day)

7 Plant	» **View Royal** 1% to 2% waste dry solids returned to the CRD sewer main for dewatering at Esquimalt (no trucks) » **Colwood + Langford + Esquimalt:** dewater and truck to central facility (either Rock Bay or Hartland; 2-3 trucks per day) » **Core Saanich and East Saanich:** 1% to 2% waste dry solids returned to the Eastside collection system for processing at Rock Bay (no trucks) » **Rock Bay:** central location of solids treatment, or, dewater and truck to Hartland (3-4 trucks per day)

- *For central-type treatment option sets* (Rock Bay Secondary, Rock Bay Tertiary, and 2 Plant): Rock Bay hosts central solids treatment or all solids are pumped or dewatered and trucked to Hartland. Proposed solids transport methods, per option set, can be summarized as:

Table 3-3: Solids Transport Summary - Central Type Options

Option Set	Plant + Solids Transport Method
1 Plant (approach for either secondary or tertiary)	» **Rock Bay:** central location of solids treatment, or: ▪ dewater and truck to Hartland (~6 trucks per day) OR ▪ pump 1% to 2% waste dry solids to Hartland
2 Plant	» **Colwood:** 1% to 2% waste dry solids returned to the CRD sewer main for dewatering at Rock Bay (no trucks) » **Rock Bay:** central location of solids treatment, or: ▪ dewater and truck to Hartland (~6 trucks per day) OR ▪ pump 1% to 2% waste dry solids to Hartland

There are many hybrids and permutations for solids transport including options within *sub-regional or distributed-type treatment option sets* that pump from Rock Bay to Hartland (for Rock Bay flows only) while also employing trucks at the other, smaller facilities. This approach is not cost-effective, and therefore not proposed, because it incurs most of the capital/operating costs of the pump to Hartland scenario as well as the cost and carbon footprint of trucking: this creates the least desirable solids transport scenario. Overall, selecting the preferred option set and choosing the preferred location, either Hartland or Rock Bay, will narrow down the solids transport options.

3.5 Heat Recovery

Charter goals and commitments related to heat recovery comes from public interest in the economic and environmental feasibility of beneficial heating systems from wastewater throughout the Core Area. Analysis for Phase 2 is desktop oriented and spans methodology, supply and demand, heating economics, service infrastructure, costs and income possibilities.

Heat recovery typically occurs via district heating systems (DHS) in select locations which are highly suited for heat distribution. While heat can be extracted from raw wastewater throughout the conveyance system, the efficiencies of low-grade heat extraction are low and strongly encourage heat recovery from treated effluent (after the plant). Three primary factors influence the efficient distribution of excess heat energy from a wastewater facility:

- **Supply:** Heat pumps convert thermal heat in wastewater and concentrate the supply for extraction for use in nearby buildings. Heat availability is a function of the ability to extract heat from the wastewater by dropping the wastewater temperature.

- **Demand:** New developments provide for the lowest-barrier demands because they negate the retrofit costs of existing buildings and their current heating systems. Treatment plants situated adjacent growth centers allow for heat distribution systems to be incrementally installed to suit actual development. This approach eliminates the uncertainty of partnerships with existing/different heat strategies and allows for capital investments to occur when they're needed.

- **Infrastructure Requirements:** Heat distribution systems originate at or near the plant or any treated effluent conveyance line. The further the development is from the source, the higher the infrastructure costs and the lower the feasibility of heat recovery.

All option sets provide treatment facilities near growth centers. Typically, the most feasible DHS scenario arises where infrastructure costs are lowest and the amount of demand is greatest. Key economic factors that drive the financial viability of heat recovery include value of the heat supplied (e.g. $/GJ) relative to the cost of infrastructure and operations.

Cost-Income Analysis

Local and regional planning documents outline growth projections for use at the DHS conceptual stage. Growth rates, densities, timing and building heights can be adjusted to illustrate the demand potential across the Core Area. Planning figures are converted into heating demand estimates for 2030 and 2045 scenarios. Five locations demonstrate highest potential for heat recovery systems including Rock Bay, Langford, Esquimalt, Colwood and View Royal (in descending order of demand). Potential revenues relate to cost offsets from purchasing natural gas at a flat rate of $14.00 per gigajoule (GJ) which includes basic charges, delivery charges, carbon tax savings and storage and transport costs.

Current record lows in natural gas prices combined with increasing electricity prices is narrowing the economic advantage that heat pump technology offers. For example, one unit of natural gas heat currently has a value of $14 per GJ, while a unit of heat pump heat at current electricity prices has a value of $11.67 per GJ. When infrastructure and utility operations costs are included the price differential is largely eliminated which means district heating systems struggle to yield a positive return. If the price of natural gas were to increase by 50% to 100% (some historical evidence) then the feasibility would increase dramatically. Price negotiations, either reduced electricity rates or premium heating charges based on renewable sources, would also affect financial viability of DHS in the short term.

Capital and operations costs are critical to service financing. Operating costs require detailed analysis once the system configuration and the ownership / governance model are known. Table 3-4 outlines two capital and operating cost scenarios, as an example, for two heat recovery systems for the Core Area option sets.

Table 3-4: Capital and Operating Cost Scenarios

SCENARIO	2030 CAPITAL COST	2030 OPERATING COST	2030 INCOME
Rock Bay DHS	$21.3M	$2.15M/year	$2.15M/year
6 DHS under 7 Plant Scenario	$71.3M	$5.15M/year	$5.875M/year

Current energy prices coupled with the cost of DHS infrastructures results in insufficient revenues that may cover operating investments but do not payback capital investments in a reasonable time period. The capital, operating costs and potential incomes for DHSs are not included in the option set summaries.

Ingredients for Successful Heat Recovery

Overall, while a significant heat resource exists in treated effluent, current energy pricing for both electricity and natural gas pose significant challenges to achieve a positive business case. Further, partnerships for DHS face multiple barriers and conditions, such as proximity-to-source needs and retrofit costs of existing buildings, which further encourages greater emphasis on heat recovery potential in the future. Yet, heat recovery from wastewater has serious potential in broader district heating systems when the ingredients in Table 3-5 are applied:

Table 3-5: Ingredients for Successful Heat Recovery

INGREDIENT	APPLICATION
Secure partnerships with reliable building owners who are ready to invest in heating system infrastructure	*New development; preference to single-owner buildings; public agencies*
Low-infrastructure district heating systems	*New buildings situated 'on top' of effluent pipes or adjacent treatment plants*
Natural gas prices significantly exceed electricity pricing	*Future conditions may present this opportunity*
Lens on cost-effective heat recovery utilities	*Business cases based on reinvesting incomes into the utility; unlikely to offset other wastewater costs*
Public support inherent in triple-bottom line business case	*Seek out public input on the concept noting that implementation likely to occur when these ingredients for success can be met (likely in the future)*

Heat recovery from treated effluent is an attractive energy off-set strategy. Each option set provides for a DHS however current energy prices indicate the capital and operating costs will only increase with more, distributed systems. Heat recovery options should be pursued based on the preferred option set as willing customers come forward and energy prices create a viable servicing strategy. Capital and operating costs for heat recovery are not included in base costs but would be added on direction by the Committee.

3.6 Water Recovery

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. Conceptual supply-demand estimates focus on water applications that require less than potable-quality water and also demands that are situated in clusters which can reduce the cost of additional pipes to convey flows. Water recovery target markets should deliver on the following key themes:

- Demonstrate reliable long-term demands and incomes
- Support community amenities including augmenting environmental flows such as aquifer recharge
- Reduce the scope of infrastructure needs
- Pursue future partnerships with industry
- Service large tracts of irrigable land such as parks and green spaces
- Demonstrate synergy with conventional public utility services
- Service growth centers where new developments can be encouraged to include additional plumbing systems for toilet flushing or irrigation

A servicing approach that meets these themes typically presents the lowest capital cost for system set up, provides long-term demands, supports community amenities such as parks and growth and generally conforms to public utility service delivery. 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.

Summary of Water Reuse across the Core Area

Technical Memorandum #2 outlines the land application (irrigation), toilet flushing and aquifer recharge possibilities across the Core Area based on the applied target-market framework. All reuse systems could be phased in, with the exception of Colwood which is presented as a full-time water reuse facility employing aquifer recharge until established potable-substitution customers are confirmed. Life cycle costing is based on reuse income for treated effluent phased-in over time: if aquifer recharge is the preferred reuse strategy then life cycle costing would notably change. 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.

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 is based on the 2030 flows with consideration to long-term flow increases.

- **Colwood-Langford**: approximately 19.5 km of reuse pipe and a pumping system equivalent to 10 MLD.
- **Esquimalt:** approximately 17 km of reuse pipe and pumping system equivalent to the proposed demand of roughly 5 MLD for irrigation and toilet flushing
- **East Saanich:** approximately 20 km of reuse pipe and pump system equivalent to the proposed demand, or roughly 3 MLD during peak demand periods
- **Core Saanich:** approximately 10 km of reuse pipe and pumping system equivalent to the proposed demand of roughly 5 MLD for irrigation and toilet flushing
- **Rock Bay:** approximately 18.5 km 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.

Life-cycle costing includes capital allowances for reuse systems including distribution pipes and pump facilities. Pricing for reclaimed water is proposed at 80% of potable water retail rates for toilet substitution and 80% of wholesale CRD potable rate for land application. Reuse by aquifer recharge will not result in revenue.

Cost-Income Summary

Table 3-6 outlines the capital and operating costs plus potential revenues for two reuse scenarios (however, life cycle costing for water reuse was conducted for all seven option sets). Example treatment capital and operating costs are included given the intention to achieve tertiary effluent for water reuse.

Table 3-6: Cost-Income Summary

SCENARIO	2030 CAPITAL COST	2030 OPERATING COST	2030 Revenues
1 Plant Sidestream Reuse	$24.2M	$300K to $400K/year	Up to $800K/year
7 Plant Option Set with 5 Water Reuse Systems	$205M[5]	$2.5M to $3.0M/year	Up to $4M+/year

Results of the cost-revenue and feasibility analysis for water reuse include five key outcomes:

- Revenues for water reuse are set to be phased in as customers confirm partnerships with CRD or the municipality for service, gradually over a 20-year period. Detailed studies must engage with the individual customer and determine their affordability limits for water service. Questions emerge, such as; *will municipalities pay for the additional cost of park irrigation? Can golf courses afford the proposed rates?*
- Water reclamation provides for innovative uses of treated effluent however it is unlikely to present a positive business case until (if) potable supplies become unreliable. Revenues from water re-use will be challenged to cover both the operating and capital financing costs of their delivery systems, and will likely create an overall operating deficit.

[5] Includes the treatment capacity costs for exceeding secondary effluent.

- Further study is needed to discern which revenues are actual new incomes that do not result in a loss in income to the potable water utility. Generally, however, installing two sets of pipes providing a similar level of service in the same area can lead to some level of redundancy and added cost to be borne by the taxpayer.
- 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 beyond the four plant option for a long time: this is because supply would likely exceed demand. Pursuing full tertiary treatment for all flows would be driven partly for water reuse but largely to achieve enhanced water quality that is ultimately returned to the environment.

3.7 Carbon and Energy Footprint Discussion

Carbon footprint and offset credits can be a powerful lens for evaluating the feasibility of projects that achieve significant reductions in greenhouse gas (GHG) emissions. The GHG profiles differ significantly between solids-energy recovery and wastewater (liquids) treatment, and therefore are discussed separately below.

Carbon Footprint and Offsets for Solids-Energy Recovery

Solids-energy recovery by either anaerobic digestion or gasification will both create and reduce GHG emissions. The relative performance between these two technologies from an emissions perspective, including the introduction of other wastes, provides helpful direction for the Committee and the region in pursuing either technology.

For context, electricity is considered carbon neutral in BC; therefore, its offset or increased use does not result in any change to the overall GHG footprint. If the business case for either technology is to consider carbon credits, then significantly more analysis is needed to complete the business case and make a fully informed investment decision. For example, there are limits to the amount and types of offsets that the Province of BC will coordinate each year. At minimum, responses to the Request for Statements of Interest should dictate a regulatory compliant carbon footprint and offset scorecard.

At a conceptual level, considerations for either gasification or anaerobic digestion from a GHG emissions perspective include:

- Both anaerobic digestion and gasification create biogas (methane or syngas) which can be captured and reused to fuel/heat the treatment process. Being renewable fuels that are fully consumed, neither gas would be subject to the BC Carbon Tax, nor create significant liabilities under the Climate Action Charter.
- Anaerobic digestion of wastewater solids combined with proper land application of biosolids (if considered by the CRD) likely presents the lowest overall carbon footprint strategy.
- Both anaerobic digestion (if solids drying were also included) and gasification require input gas to fuel the treatment operation. Gases created by both technologies lessen the amount of import carbon-based fuels (i.e. natural gas) for heating and drying. For solids-energy recovery of only wastewater

solids, the amount of gas that is created and imported is likely to be similar between the two recovery processes.

- Gasification of dried wastewater solids (on their own) does not produce excess energy that can be exported over and above process requirements, therefore other feedstocks typically drive the gasification process. This introduces biomass-to-energy considerations which are essentially considered emissions neutral in BC, in that carbon penalties are not applied to renewable fuels.
- Hartland Landfill currently utilizes methane capture from decayed materials to generate electricity to sell to the grid, albeit landfill-methane capture still sees emissions of methane released as the gas capture rate is approximately 63% (with intentions to meet 75% in 2016). Any excess methane that is being flared could be utilized in the gasification or anaerobic digestion process. Yard, garden and kitchen organics are already diverted from the landfill and are reportedly beneficially reused therefore there would be limited, if any at all, carbon emissions reductions in their gasification. Emissions reductions from gasification would likely come from other materials that produce elevated emissions, either by their decay or further processing activities, such as scrap wood.
- Importing materials (yard, garden and kitchen organics) that are currently managed by private sector solid waste management companies could reduce GHG emissions through the avoidance of unmanaged decomposing of organic material; however, the carbon footprint reduction would be limited to any inefficiencies of the activities of the private sector companies, which is likely marginal overall. While introducing materials not managed by the CRD would increase biogas production (gasifier), it may not yield a positive net environmental benefit because these materials are already beneficially reused.
- Regulations limit the CRD’s ability to control the flow of materials to Hartland Landfill for gasification. A comprehensive regional service led by the CRD for municipal solid waste could increase the amount of material available for recovery, including the potential benefits and drawbacks of more material going to Hartland and the impacts to the existing management approach including impacts to private sector solid management companies.
- Utilizing paper, plastics and scrap wood (examples) already managed by the CRD for use in the gasifier could be justified by the improved efficiency of gasification over the less efficient landfill-gas capture. Materials already recycled are unlikely to yield an improved carbon footprint.
- Food scraps are already sent from Hartland Landfill to Harvest Power in the Vancouver area for resource recovery via anaerobic digestion. The current carbon footprint would be reduced by eliminating the transport costs and their associated emissions; additional emissions reductions could occur if gasification is considered a more efficient process for resource recovery of yard and kitchen scraps. Unfortunately, the efficiency of gasifiers including wastewater solids and food scraps is difficult to determine due to the lack of operating facilities.

Takeaways from these considerations include:

- Anaerobic digestion of wastewater solids including drying the wet cake appears to show a similar carbon footprint to gasification of wastewater solids alone.

- Gasifying yard and garden waste would not likely present a strong carbon footprint reduction strategy because these materials are already diverted from the landfill and beneficially reused. Carbon footprint reductions at the landfill could focus on sending high-energy content materials that would otherwise decay as part of the less-efficient landfill methane capture into a gasifier, particularly for those materials that are difficult to divert (e.g. some paper, some plastics and scrap wood), because it is reported to be a more efficient recovery process.

- Anaerobic digestion of wastewater solids and food scraps and gasification of dried wastewater sludge and food scraps likely presents a similar carbon footprint. Whichever process can reliably demonstrate greater efficiency over the other would likely yield a lower carbon footprint.

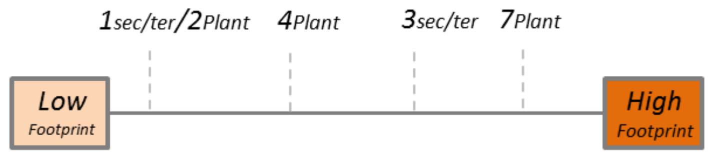
Direction by the Committee to fully integrate wastewater solids with municipal solids for gasification would likely yield an overall reduced carbon footprint, over anaerobic digestion and drying of wastewater solids on its own, because of the potential avoidance of emissions at the landfill, and not necessarily as a function of wastewater process emissions.

Carbon Footprint for Wastewater (Liquids) Treatment

Key factors for carbon and energy footprint in wastewater treatment and conveyance relate to extent of construction, energy use for treatment, energy use for conveyance and trucking to distribute solids to a central solids-energy recovery facility. Table 3-7 outlines the factors and their considerations with respect to how the option sets qualitatively perform against each other for low to high carbon footprint.

Table 3-7: Carbon Footprint for Option Sets

FACTOR	CONSIDERATION	RELATIVE CARBON FOOTPRINT
Extent of Construction	Scope of new infrastructure, total building footprint, redundant facilities.	Low Footprint — 1sec 1ter 2Plant 3sec 3ter 4Plant 7Plant — High Footprint
Energy use for treatment	Level of treatment	Low Footprint — 1sec 2Plant 3sec 4Plant 3ter 1ter 7Plant — High Footprint
Energy use for conveyance	Pumping distance, pressure for raw, treated and reclaimed effluent; overall efficiency	Low Footprint — 1sec/ter 2Plant 4Plant 3sec 3ter 7Plant — High Footprint

FACTOR	CONSIDERATION	RELATIVE CARBON FOOTPRINT
Trucking to distribute solids to a recovery facility	Distance for trucking and number of trips per day	

Qualitative performance of the criteria reveals the overall carbon and energy ranking of the option sets for wastewater treatment (liquids) including, in order of smallest to largest footprint: Rock Bay – Secondary; 2 Plant, Rock Bay – Tertiary, 3 Plant – Secondary, 4 Plant, 3 Plant – Tertiary, and 7 Plant.

OPTION SET >>

1A Rock Bay - Secondary

Description

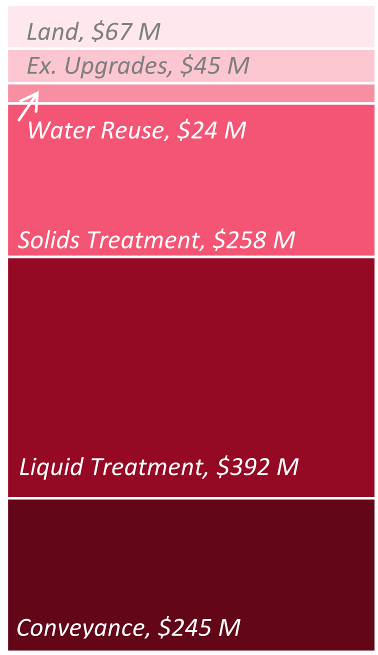
- Rock Bay is a central facility for all flows up to 4xADWF including secondary treatment and disinfection plus sidestream tertiary for local reuse in the Rock Bay-North Downtown areas.
- Solids-energy recovery can be centralized at Rock Bay or Hartland Landfill. Truck traffic is estimated at ~5-6 trucks per day in 2030.
- Macaulay catchment flows are directed to Rock Bay for treatment. Any flows not reused are routed through the Clover Point outfall. All flows meet or exceed the regulations.
- Heat recovery systems can be considered around Rock Bay and along the effluent line to Clover.
- Available site(s) are suitable from a technical perspective and align well with public input to date.
- Life cycle costs are reflective of the economies of scale made available by a central plant.

Scenario	2030 Capital	2030 Operating	Est. Resource Income
Rock Bay Secondary	$1,031 M	$21.8 M*	Up to $0.9 M

Life Cycle Costing Analysis | Highlights

- A central plant at Rock Bay demonstrates the lowest capital, operating and life cycle costs
- Resource incomes at Rock Bay water reuse includes gradual, small-scale irrigation demands initially, with phased-in toilet flushing demands over 20+ years
- Sensitivity analysis related to resource incomes and discount rates had minimal effect on the net present value**.

Total $1,031M



**Operating costs account for asset depreciation as per factors outlined in TM #1 but should be refined to complete detailed cash flow analysis. This note applies to all option set summaries.*

***Sensitivity analysis related to energy and commodity prices would have a greater effect on net present value performance but was not conducted. This note applies to all option set summaries.*

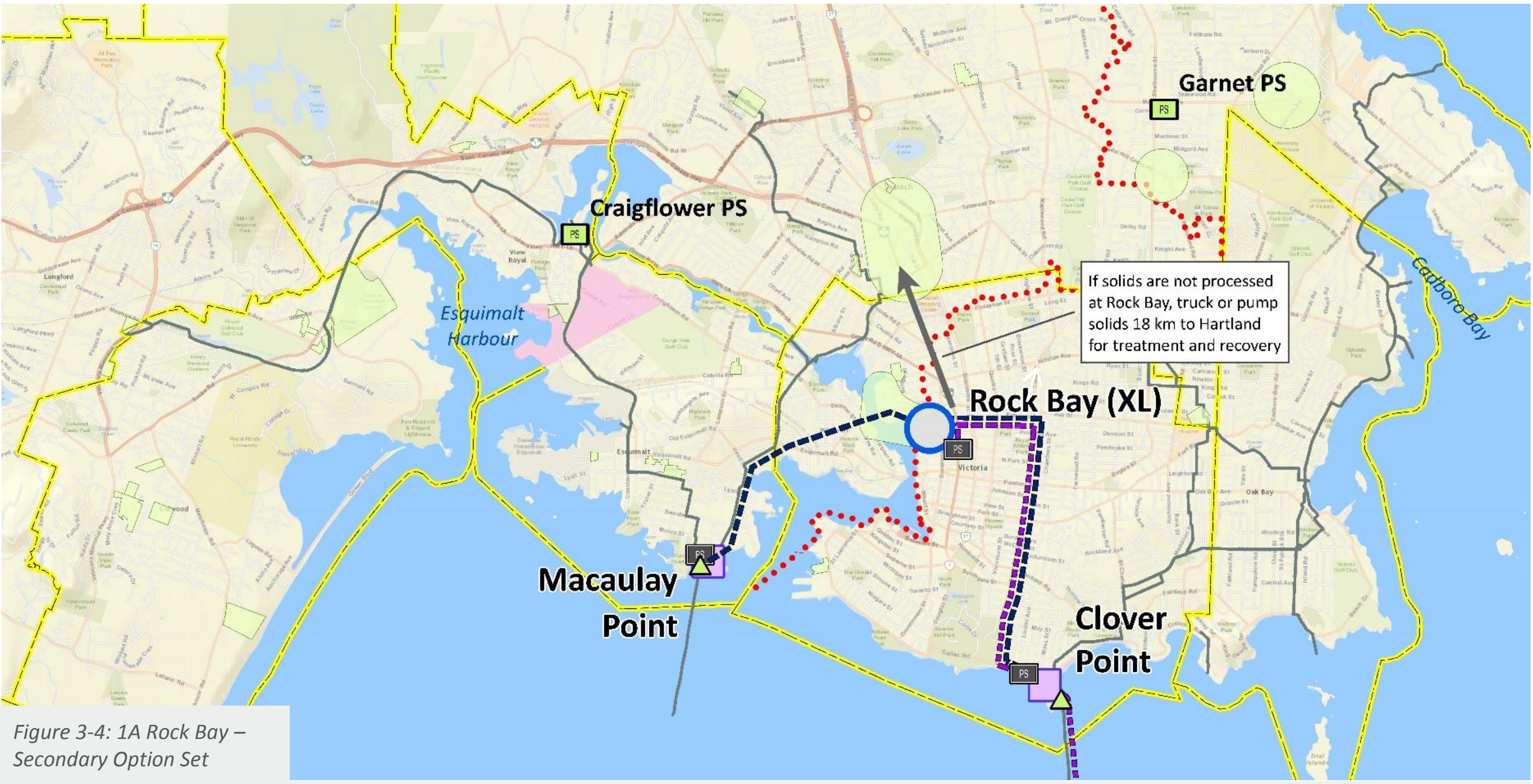


Figure 3-4: 1A Rock Bay – Secondary Option Set

CRITERIA RESULTS >>

» Length of New Conveyance Pipe

16.7 km

» % of Effluent @ Tertiary Quality

10%

» Rank: Low Carbon and Energy Footprint

1st

» Rank: Low Operating Costs

1st

» Ratio of Income to Costs for Water Reuse

0.45

» Ratio of Income to Costs for Heat Recovery

0.60

Option Set Characterization

» *Neighborhood-Land Use: A central plant at Rock Bay appears to align the best of all locations given public sentiment to date. The industrial, mixed-use designation supports the site activities and other routine treatment processes. Capital works at Rock Bay should consider local planning objectives and provide for positive public interaction.*

» *Overall: The 1 Plant secondary treatment (1a) option set centralizes all flows at Rock Bay, including up to 10MLD for local reuse. This option set addresses the need to meet pending regulations and provides for the base level of service.*

Option set >>

1B Rock Bay -Tertiary

Description

- Rock Bay is a central facility for all flows up to 4xADWF including full tertiary treatment plus disinfection. Water reuse can be implemented in the Gorge-Rock Bay-North Downtown areas, or other areas as needed over time. Full tertiary treatment opens up the possibility of a harbour outfall.
- Solids-energy recovery can be centralized at Rock Bay or Hartland Landfill. Truck traffic is estimated at ~5-6 trucks per day in 2030.
- Macaulay catchment flows are directed to Rock Bay for treatment. Any flows not reused are routed through the Clover Point outfall. All flows will exceed the regulations.
- Heat recovery systems can be considered around Rock Bay and along the effluent line to Clover.
- Available site(s) are suitable from a technical perspective and align well with public input to date.
- Life cycle costs are reflective of the economies of scale presented by a central plant however with the added cost of additional energy, operations and treatment processes for tertiary quality.

Scenario	2030 Capital	2030 Operating	Est. Resource Income
Rock Bay Tertiary	$1,131 M	$26.4M	Up to $0.9 M

Life Cycle Costing Analysis | Highlights

- A central plant at Rock Bay with tertiary treatment demonstrates the 4th highest capital costs and 3rd highest operating costs;
- Net present value for Option 1b is approximately 15% higher than for Option 1a
- Resource incomes reflect the proposed reuse system near Rock Bay as in Option 1a
- Sensitivity analysis related to resource incomes and discount rates did not change the relative financial performance of Option 1b

Total $1,131M

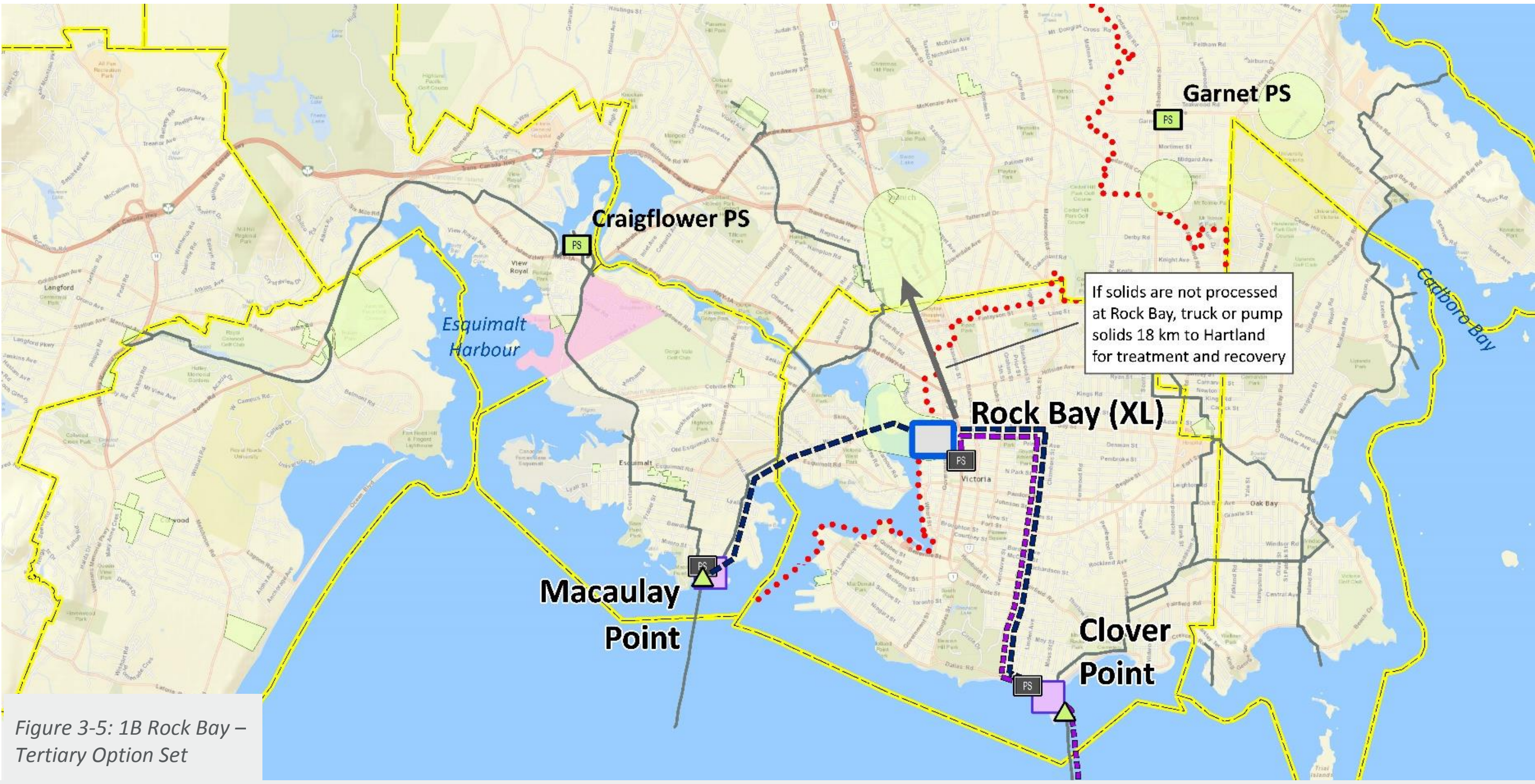


Figure 3-5: 1B Rock Bay – Tertiary Option Set

CRITERIA RESULTS >>

Length of New Conveyance Pipe	16.7 km
% of Effluent @ Tertiary Quality	Up to 100%
Rank: Low Carbon and Energy Footprint	3rd
Rank: Low Operating Cost	6th
Ratio of Income to Costs for Water Reuse	0.45
Ratio of Income to Costs for Heat Recovery	0.60

Option Set Characterization

- *Neighborhood-Land Use: A central plant at Rock Bay appears to align the best of all locations given public sentiment to date. The industrial, mixed-use designation supports the site activities including and other routine treatment processes. Capital works at Rock Bay should consider local planning objectives and provide for positive public interaction.*
- *Overall: The 1 Plant full tertiary treatment (1b) option set centralizes all flows at Rock Bay, including up to 10MLD for local reuse. This option set represents a clear sentiment towards water stewardship by raising levels of service for treated effluent quality.*

Option set >>
2-Plant Rock Bay and Colwood

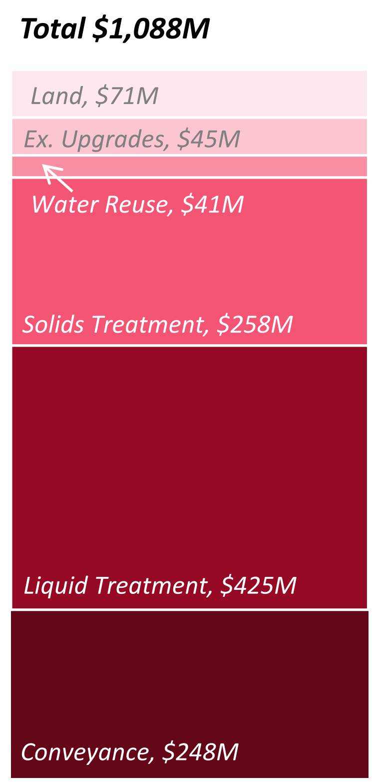
Description

- Rock Bay provides secondary treatment for up to 100% of all flows but accounts for additional capacity at Colwood to treat up to 10MLD at tertiary quality. Sidestream tertiary provided at Rock Bay for local reuse.
- The Colwood plant requires minimal new conveyance infrastructure but requires redundant capacity at Rock Bay to avoid a second outfall. Reuse systems provided at both Rock Bay and Colwood.
- Solids-energy recovery can be centralized at Rock Bay or Hartland Landfill. Truck traffic is estimated at ~5-6 trucks per day in 2030. Waste solids from Colwood flow in the CRD sewer to Rock Bay.
- Flows from the rest of Macaulay catchment (except Colwood) are directed to Rock Bay for treatment. Any flows not reused are routed through the Clover Point outfall.
- Heat recovery systems possible in Colwood (e.g. civic recreational facilities) and adjacent to the treated effluent outfall route from Rock Bay to Clover point.
- Available sites are suitable from a technical perspective and align well with public input to date.
- Life cycle costs illustrate the effect of increased levels of service for tertiary reuse at Colwood.

Scenario	2030 Capital	2030 Operating	Est. Resource Income
2 Plant	$1,088 M	$22.8 M	Up to $2.4 M

Life Cycle Costing Analysis | Highlights

- A central plant at Rock plus tertiary plant in Colwood increases capital and operating costs for expanded water reuse; capital and operating costs both rank 2nd among the option sets
- Net present value for the 2 Plant option is approximately 4% higher than for Option 1a
- Resource incomes for the 2 plant option demonstrate the most cost-effective water reuse approach
- Sensitivity analysis related to discount rates did not change the relative financial performance of the 2 plant option



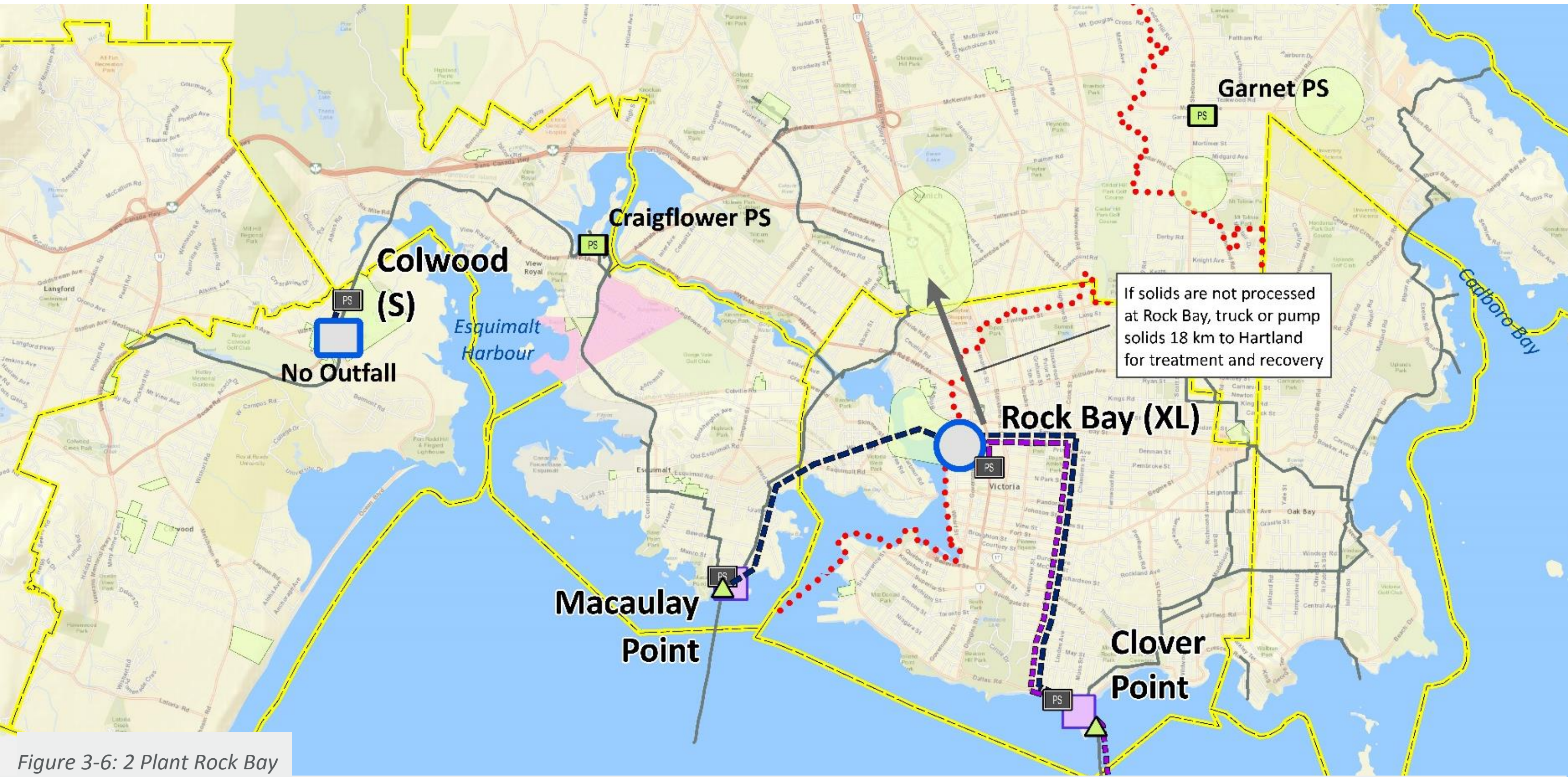


Figure 3-6: 2 Plant Rock Bay & Colwood Option Set

CRITERIA RESULTS >>

» Length of New Conveyance Pipe (incl. Colwood reuse)

36.2 km

» % Of Effluent @ Tertiary Quality

Up to 20%

» Rank: Low Carbon and Energy Footprint

2nd

» Rank: Low Operating Cost

2nd

» Ratio of Income to Costs for Water Reuse

0.40

» Ratio of Income to Costs for Heat Recovery

0.60

Option Set Characterization

» *Neighborhood-Land Use: Rock Bay and Colwood are both situated in growth centers, one mixed-use and the other primarily industrial. Odour will be minimized to unnoticeable levels; noise and trucking will be mitigated and not dissimilar from local land uses. Both facilities should include features that align with local planning objectives and provide for public interaction with the facility and neighboring features e.g. harbourfront, local parks.*

» *Overall: The 2 Plant option set treats over 80% of flows to secondary levels, on top of up to 20% tertiary quality effluent. This option set represents a notable increase in water reuse from the 1-plant option with minimal extra conveyance infrastructure.*

OPTION SET >>

3 Plant - Secondary

Description

- Flows are collected, treated and recovered on a sub-regional basis. Flows from west Saanich and west Victoria are routed back to Rock Bay. Flows from View Royal and Esquimalt are conveyed to Esquimalt Nation, whereas flows from Colwood and Langford are dedicated to a second Westshore plant. All flows meet secondary levels, including disinfection, except for tertiary treated flows at Esquimalt and Rock Bay for reuse.
- Solids-energy recovery can be centralized at Rock Bay or Hartland Landfill. Truck traffic is estimated at 1-2 trucks per day for Colwood/Langford, 1-2 trucks for Esquimalt and 3-4 trucks for Rock Bay.
- Three separate flow catchments result from the 3 plants, including separate outfalls: Colwood/Langford direct to Royal Bay; View Royal/Esquimalt direct to Macaulay Point; Saanich/Victoria/Oak Bay direct to Clover Point. All flows meet or exceed the regulations.
- Three heat recovery systems can be considered around each of the plants as well as along the effluent lines to Clover, Macaulay and Royal Bay outfalls.
- Available site(s) are suitable from a technical perspective and align well with public input to date.
- Life cycle costs are reflective of losing economies of scale among three plants and by adding infrastructure for conveyance and outfall to Royal Bay.

Scenario	2030 Capital	2030 Operating	Est. Resource Income
3 Plant - Secondary	$1,125 M	$23.0 M	Up to $1.6 M

Life Cycle Costing Analysis | Highlights

- The 3 plant, secondary treatment option incurs greater costs than the 2-plant option and less than the 4-plant option; operations costs are comparable to the 2-plant option set
- Resource incomes are limited to Rock Bay and Esquimalt Nation sites; incomes are gradual arising from small-scale irrigation demands initially, with phased-in toilet flushing demands over 20+ years
- Sensitivity analysis related to resource incomes and discount rates had minimal effect on the net present value.

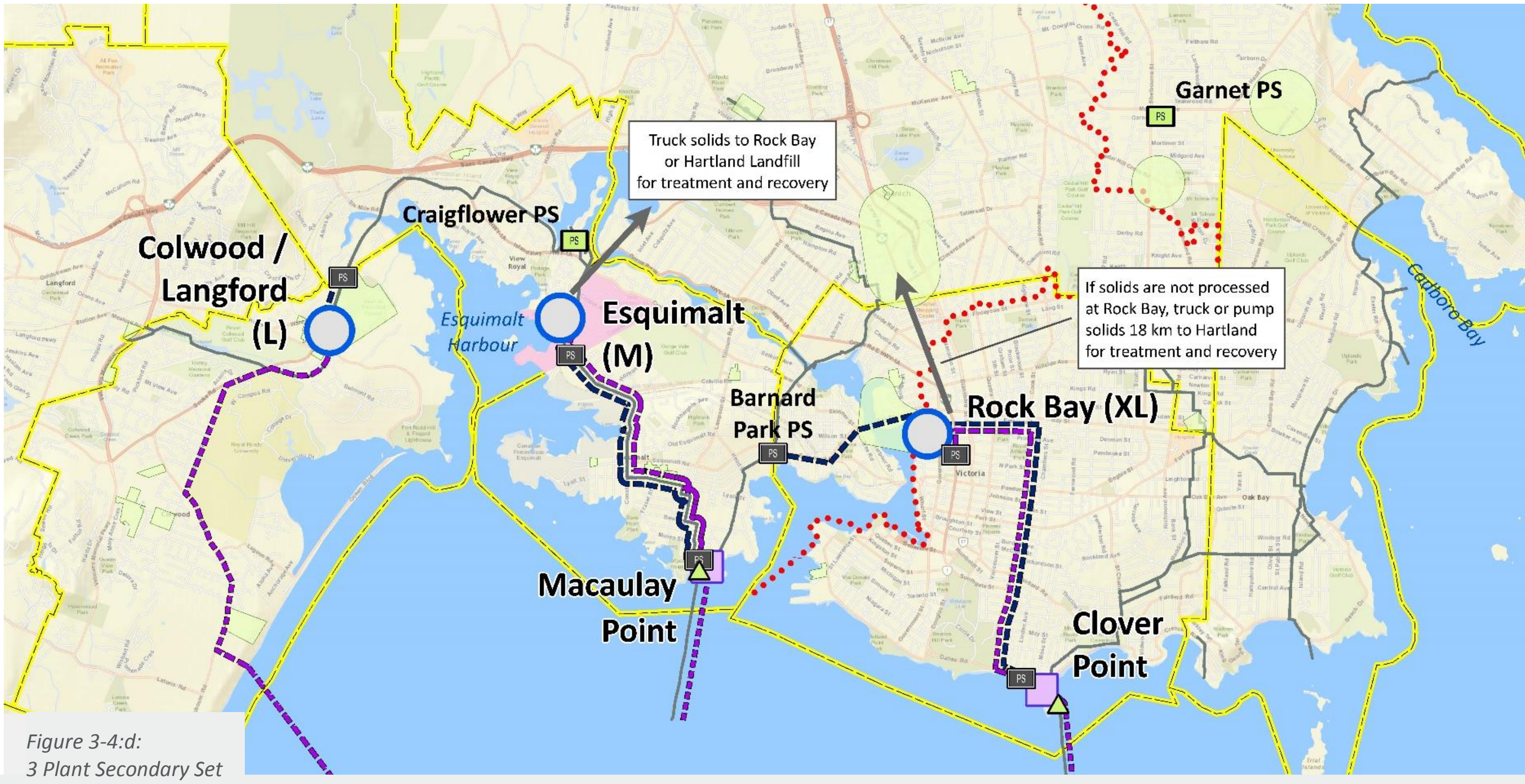


Figure 3-4:d:
3 Plant Secondary Set

CRITERIA RESULTS >>

» Length of New Conveyance Pipe

34.5 km

» % of Effluent @ Tertiary Quality

Up to 20%

» Rank: Low Carbon and Energy Footprint

4th

» Rank: Low Operating Costs

3rd

» Ratio of Income to Costs for Water Reuse

0.48

» Ratio of Income to Costs for Heat Recovery

0.60

Option Set Characterization

» *Neighborhood-Land Use: Rock Bay, Esquimalt Nation and Colwood/Langford are all situated in mixed-use, growth centers. Odour will be minimized to unnoticeable levels; noise and trucking will be mitigated and not dissimilar from local land uses. All facilities should include features that align with local planning objectives and provide for public interaction with the facility.*

» *Overall: This 3 Plant option set treats over 80% of flows to secondary levels, on top of up to 20% tertiary quality effluent from sidestream re-use facilities at Esquimalt and Rock Bay. The secondary plant at Colwood/Langford allows for sub-regional flow management, including locating capacity for future growth in the Westshore.*

OPTION SET >>

3 Plant - Tertiary

Description

- Flows are collected, treated and recovered on a sub-regional basis. Flows from west Saanich and west Victoria are routed back to Rock Bay. Flows from View Royal and Esquimalt are conveyed to Esquimalt Nation, whereas flows from Colwood and Langford are dedicated to a second Westshore plant which treats its flows to tertiary levels. All other flows (incl. at Esquimalt Nation and Rock Bay) meet secondary treatment levels, including disinfection, along with sidestream tertiary treated flows at Esquimalt and Rock Bay for local reuse.
- Solids-energy recovery can be centralized at Rock Bay or Hartland Landfill. Truck traffic is estimated at 1-2 trucks per day for Colwood/Langford, 1-2 trucks for Esquimalt and 3-4 trucks for Rock Bay.
- Three separate flow catchments result from the 3 plants, including separate outfalls: Colwood/Langford direct to Royal Bay; View Royal/Esquimalt direct to Macaulay Point; Saanich/Victoria/Oak Bay direct to Clover Point. All flows meet or exceed the regulations.
- Three heat recovery systems can be considered around each of the plants as well as along the effluent lines to Clover, Macaulay and Royal Bay outfalls.
- Available site(s) are suitable from a technical perspective and align well with public input to date.
- Life cycle costs are reflective of losing economies of scale among three plants, by increasing service levels to treat to tertiary (Colwood/Langford) and by adding infrastructure for conveyance and outfall to Royal Bay.

Scenario	2030 Capital	2030 Operating	Est. Resource Income
3 Plant – Tertiary	$1,178 M	$24.1 M	Up to $3.8 M

Life Cycle Costing Analysis | Highlights

- The 3 plant, secondary and tertiary option incurs greater costs than the 2-plant option and less than the 4-plant option; operations costs are greater than the 2-plant option set but less than the 4 plant option.
- Resource incomes can be generated by reuse systems at all 3 plants; incomes are gradual arising from small-scale irrigation demands initially, with phased-in toilet flushing demands over 20+ years
- Sensitivity analysis related to resource incomes and discount rates had minimal effect on the net present value.

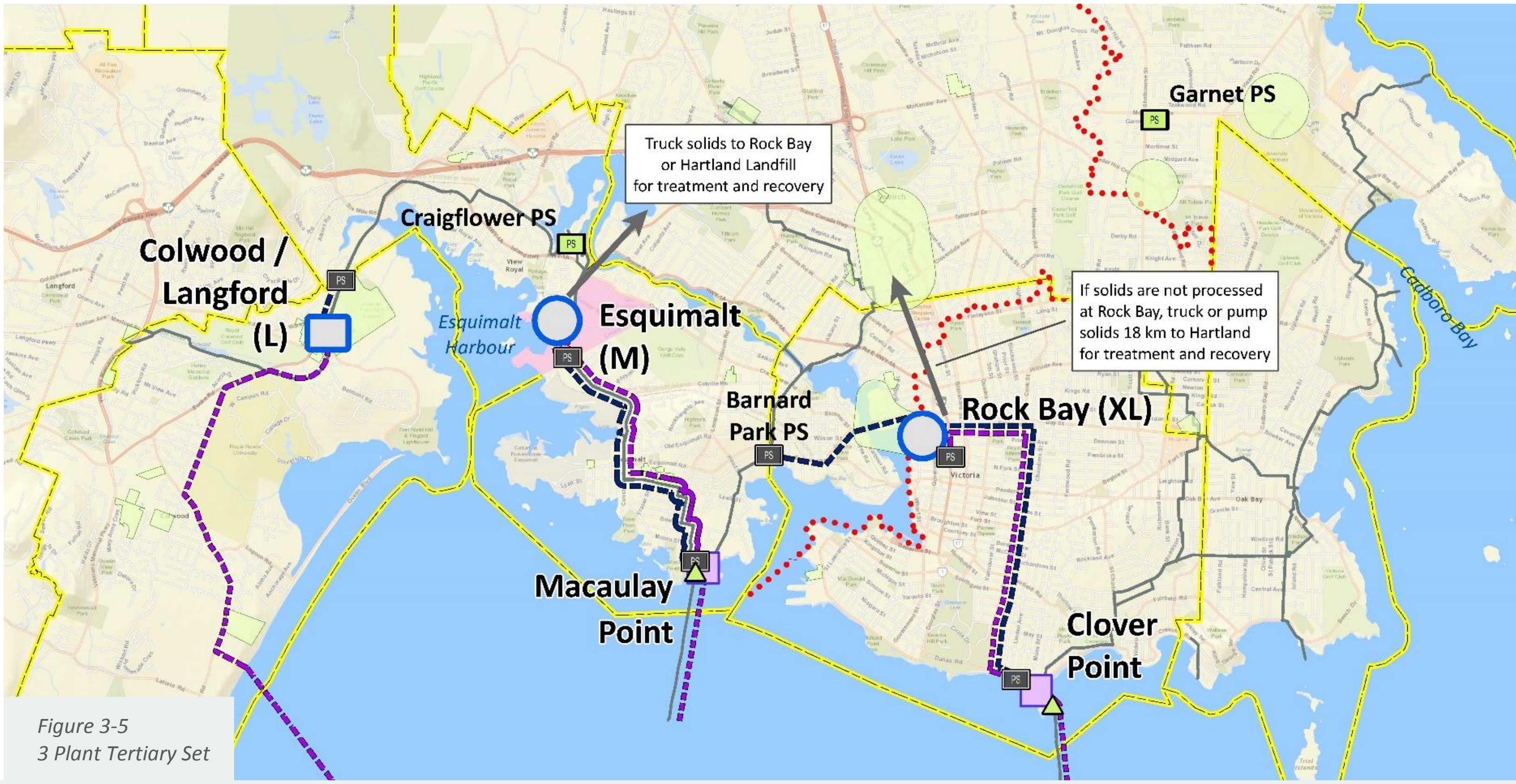


Figure 3-5
3 Plant Tertiary Set

CRITERIA RESULTS >>

» Length of New Conveyance Pipe (incl. Colwood Reuse)

66.8 km

» % of Effluent @ Tertiary Quality

Up to 30%

» Rank: Low Carbon and Energy Footprint

6th

» Rank: Low Operating Costs

4th

» Ratio of Income to Costs for Water Reuse

0.50

» Ratio of Income to Costs for Heat Recovery

0.60

Option Set Characterization

» *Neighborhood-Land Use: Rock Bay, Esquimalt Nation and Colwood/Langford are all situated in mixed-use, growth centers. Odour will be minimized to unnoticeable levels; noise and trucking will be mitigated and not dissimilar from local land uses. All facilities should include features that align with local planning objectives and provide for public interaction with the facility.*

» *Overall: The 3 Plant Tertiary option set treats 70% of flows to secondary levels, on top of up to 30% tertiary quality effluent from the Colwood/Langford plant and sidestream re-use facilities at Esquimalt and Rock Bay. This option increases water reuse to three systems and raises effluent quality to levels similar to the 4 plant option, albeit at a lower overall cost.*

Option Set >>

4 Plant

Description

- Flows are collected, treated and recovered on a sub-regional basis. Flows from west Saanich and west Victoria are pumped to Rock Bay. Flows up to 4xADWF from the Westside are pumped from Macaulay back to Esquimalt Nation for secondary treatment (includes disinfection) plus sidestream tertiary for local reuse in both the Rock Bay and Esquimalt areas.
- The Colwood and East Saanich plants require minimal new conveyance infrastructure but require redundant capacity at Esquimalt Nation and Rock Bay (respectively) to avoid additional outfalls. Reuse systems are proposed for all four plants. The East Saanich facility may only be in use during the irrigation season (initially).
- Solids-energy recovery can be centralized at Rock Bay or Hartland Landfill. Truck traffic is estimated at ~5-6 trucks per day in 2030. Solids from Colwood are piped (uses regular collection trunk) to Esquimalt Nation where they are dewatered and combined for trucking to Rock Bay or Hartland.
- Any flows not reused by any of the four plants are routed through the Macaulay and Clover Point outfalls. All flows meet or exceed the regulations, including up to 25% reuse.
- Available sites are technically suitable to host a treatment facility.
- Life cycle costs are reflective of the infrastructure needs to accommodate sub-regional flows and increased treatment levels for reuse.

Scenario	2030 Capital	2030 Operating	Est. Resource Income
4 Plant	$1,195 M	$25.3 M	Up to $3.8 M

Life Cycle Costing Analysis | Highlights

- Two secondary plants plus an additional two tertiary facilities reflects the 3rd highest capital and 5th highest operating costs;
- Net present value for the 4 plant option is approximately 12% higher than for Option 1a
- Resource incomes for the four plant option are second highest and demonstrate the 2nd most cost-effective water reuse approach
- Sensitivity analysis related to discount rates did not change the relative financial performance

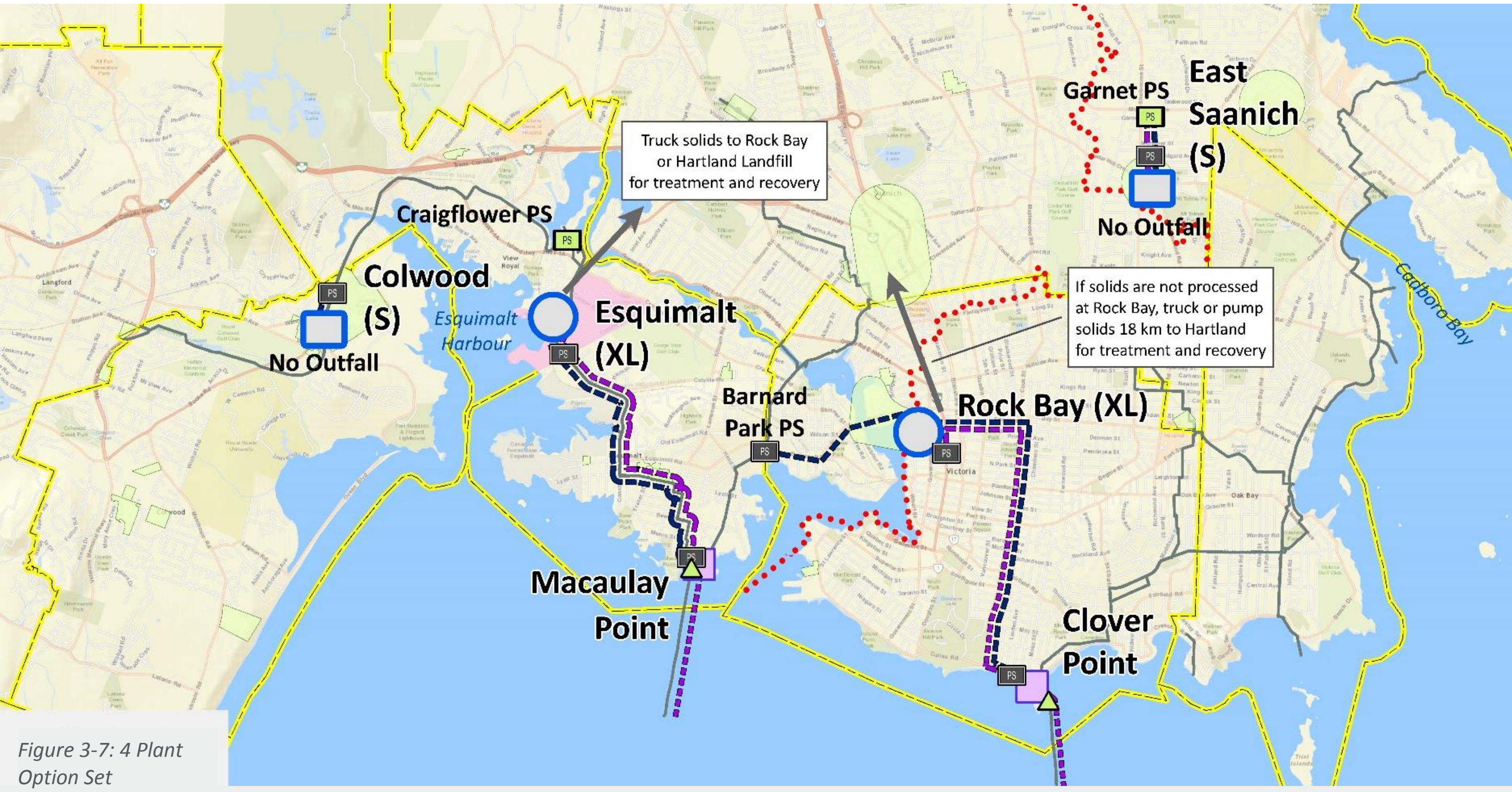


Figure 3-7: 4 Plant Option Set

CRITERIA RESULTS >>

» Length of New Conveyance Pipe (incl. Colwood reuse)

66.8 km

» % of Effluent @ Tertiary Quality

Up to 25%

» Rank: Low Carbon and Energy Footprint

5th

» Rank: Low Operating Cost

5th

» Ratio of Income to Costs for Water Reuse

0.39

» Ratio of Income to Costs for Heat Recovery

0.60

Option Set Characterization

» *Neighborhood-Land Use: Rock Bay, Esquimalt Nation and Colwood are all situated in mixed-use, growth centers. Odour will be minimized to unnoticeable levels; noise and trucking will be mitigated and not dissimilar from local land uses. Each facility should include features that align with local planning objectives and provide for public interaction with the facility and neighboring features e.g. harbor front.*

» *Overall: The 4 Plant option set is a sub-regional system treating over 75% of flows to secondary levels, on top of up to 25% tertiary quality effluent. This option set represents the middle ground for distributed facilities and includes water reuse systems in four major growth centers.*

Option set >>

7 Plant

Description

- Flows are collected, treated and recovered on a sub-regional basis. Flows from west Saanich are partly directed to the Core Saanich Plant, while remaining flows combine with west Victoria flows for pumping to Rock Bay. Westside flows for 0-2x ADWF are treated on a municipal-by-municipal basis with interconnecting piping systems for outfall at either Royal Bay or Macaulay point. Wet-weather flows for the Westside are accommodated at Esquimalt (Town) plant. Almost all flows for Eastside are treated at Rock Bay, except reuse tertiary treatment at East Saanich and Core Saanich.
- The Core Saanich and East Saanich plants require minimal new conveyance infrastructure but require redundant capacity at Rock Bay to avoid additional outfalls.
- Solids-energy recovery can be centralized at Rock Bay or Hartland Landfill. Truck traffic is estimated at 1-2 trucks per day for Colwood and Langford, and ~1-2 trucks per day for Esquimalt in 2030, with solids heading to either Rock Bay or Hartland Landfill. Solids at East Saanich and Core Saanich are piped through existing sewers to Rock Bay.
- Any flows not reused by any of the seven plants are routed through the Macaulay, Clover Point or Royal Bay outfalls. All flows meet or exceed the regulations.
- Available sites are technically suitable to host a treatment facility.
- Life cycle costs are reflective of the infrastructure and capacity needs to treat flows to higher levels of service for the Westside as well as the costs related to additional conveyance, outfalls and water reuse systems.

Scenario	2030 Capital	2030 Operating	Est. Resource Income
7 Plant	$1,348 M	$26.6 M	Up to $4 M

Life Cycle Costing Analysis | Highlights

- 6 tertiary treatment plants coupled with a large secondary treatment plant at Rock Bay reflect the highest capital and operating costs
- Net present value for the 7 plant option is approximately 25% higher than for Option 1a
- Resource incomes are only slightly higher than the 4 plant due to lack of demand relative to supply;
- Sensitivity analysis related to discount rates did not change the relative financial performance

Total: $1,348 M

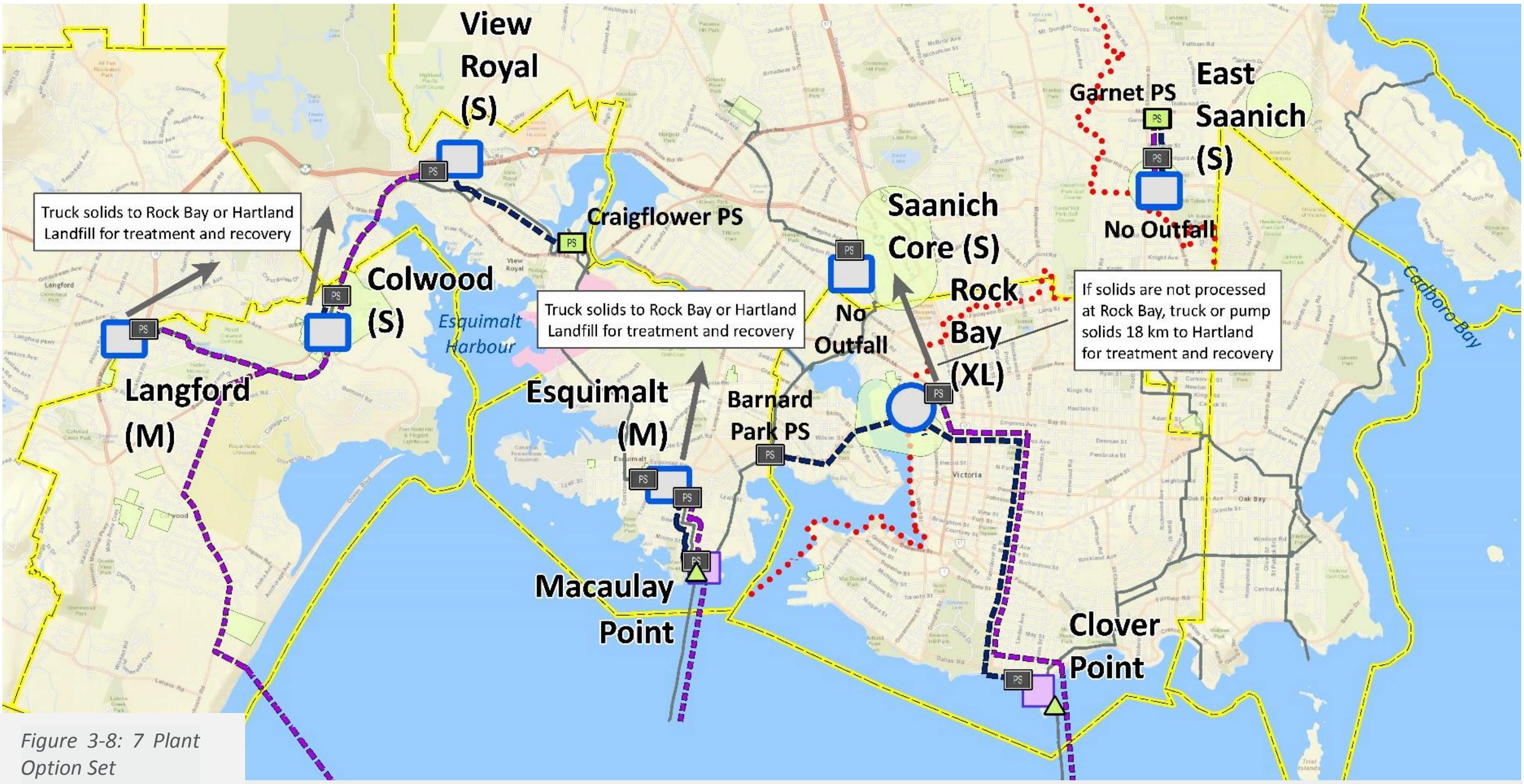


Figure 3-8: 7 Plant Option Set

CRITERIA RESULTS >>

» Length of New Conveyance Pipe **86.7 km**	» % of Effluent @ Tertiary Quality **Up to 45%**	» Rank: Low Carbon and Energy Footprint **7th**
» Rank: Low Operating Cost **7th**	» Ratio of Income to Costs for Water Reuse **0.35**	» Ratio of Income to Costs for Heat Recovery **0.55**

Option Set Characterization

- *Neighborhood-Land Use: Rock Bay, Esquimalt Nation and Colwood are all situated in mixed-use, growth centers. Odour will be minimized to unnoticeable levels; noise and trucking will be mitigated and not dissimilar from local land uses. All facilities should include features that align with local planning objectives and provide for public interaction include contribute to local building form.*
- *Overall: The 7 Plant option set is a sub-regional system treating less than 60% of flows to secondary levels, on top of up to 45% tertiary quality effluent (including all flows on the Westside). This option set represents a fully distributed system which maximizes the potential for water reuse and situates facilities in 7 growth areas.*

4.8 Criteria Results: Remaining Focus Areas

Technical criteria stemming from the Project Charter frame the overall performance characteristics of each option set. Sections 3 and 4 of this memo have covered performance results of most of the technical criteria, except for the criteria outlined in Table 4.1. Performance considerations and results illustrate the application of the criteria to the seven option sets and solids-energy technologies.

Table 4-1: Criteria Considerations and Results

Criteria	Performance Considerations	Result
Certainty of long-term demands and revenues (resource recovery)	*Heat recovery and water reuse customers likely to emerge over time based on need (for water) and energy pricing + new development (for heat)*	*Option set 1a and 2 demonstrate the highest income: cost ratios and likely warrant greatest attention*
Extent of support for community building	*Facilities that suit local land use and enhance the existing site use present the highest performance*	*All option sets include sites in growth nodes or industrial-commercial centers allowing for public investment to enhance community building; sites in Esquimalt (Town) and Core Saanich may pose slightly lower performance (Option Set 7) because these are located in parks;*
Ability to produce high-quality air-emissions	*Very little air quality concerns arise from liquid treatment (aside from odours and all option sets include provision of extensive odour control equipment) however emissions for solids-energy recovery are indicative of option set performance*	*Unlike anaerobic digestion, gasification facilities must undergo air quality permitting (Ministry of Environment), however, gasification can lead to reduced carbon emissions via integration with solid wastes which likely outweighs the air quality concerns*
Ability to improve effluent quality over the life of facility	*Changing regulations or environmental conditions may warrant increased levels of treatment; treatment technologies in the representative design allow for additional processes as required*	*This criterion is likely best suited to evaluating private sector proposals for meeting the performance criteria of the LWMP*
Extent to provide for positive public interaction	*Modern wastewater facilities should be designed and operated to suit local aspirations*	*This criterion is likely best suited to evaluating private sector proposals for meeting the performance criteria of the LWMP; public input can inform local objectives for public interaction*

Criteria	Performance Considerations	Result
Reduction of risk/interruption to neighborhoods from facility failure	*Wastewater facilities can experience unplanned maintenance; while typically rare, consideration should be given to the consequences of these events*	*Option set 1a/1b and perhaps 4 plant demonstrate lower interruption risks; Sites in industrial areas likely pose least risk; anaerobic digestion is considered a reliable technology; there are a very limited examples of gasifiers of wastewater solids and reliability-performance is not well known.* *Option set 1a/1b and 2 provide for lowest trucking configurations in particular if solids are pumped and processed at Hartland Landfill.*
Site/design resiliency for seismic and sea level rise	*Reliable, ongoing operation of wastewater facilities post-disaster provides for public health and environmental protection*	*Seismic risks exist throughout the Core Area and no site is unexposed; sea level rise and resiliency at Rock Bay and Esquimalt Nation can be accommodated with site grading and strategic equipment placement.*

4.9 Future Feasibility Considerations

Phase 2 analyses, including results presented in Technical Memorandum #3, outlines the financial and engineering feasibility of the seven proposed option sets. Preferred option set(s) will require additional engineering analysis typical of preliminary design phases, including:

- Pipe route optimization
- The cost benefit of phosphorous and nitrogen removal (treatment) and recovery if a harbour outfall is pursued
- Site specific land improvement costs such as rock, dewatering, seismic design and other geotechnical considerations
- Procurement strategy
- Further refining of unit processes and technology preferences
- Site area and building footprint optimization
- Architectural requirements and off site development
- Further capital cost estimating

Considerations like these are best studied and refined in subsequent design exercises once a preferred option has been selected.

APPENDIX A – TECHNICAL MEMORANDUM #1 (EXCERPT)

Capital Regional District

Core Area Liquid Waste Management Plan

Wastewater Treatment System Feasibility and Costing Analysis

Technical Memorandum #1

Background and Technical Foundation

carollo
Engineers...Working Wonders With Water™

URBAN systems

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Victoria, BC, V8W 1G2

urbansystems.ca

October 22, 2015

Project: 1692.0037.01

Table of Contents

Appendices

1.0 Introduction and Methodology

1.1 Project Background

Phase 2 analysis is an important chapter in an ongoing decision making process. Phase 1 included a constructive engagement process to characterize sites and option sets and collect public input on their values for wastewater treatment. Future phases, Phase 3 and beyond, allow the Core Area Committee and the Regional Board to confirm detailed performance criteria that ultimately becomes an owners' statement of requirements, or similar, for responses by the treatment and resource recovery market(s) to price, build and commission and potentially operate a core area wastewater solution. It is critical that the Phase 2 methodology respect the multi-phase sequence of this project and deliver on specified milestones, such as to assess systems and technologies, however not to select ultimate products and or technologies but rather to help the Core Area Committee define the required characteristics of the future system and provide a characterization of the option sets. All option sets may proceed to Phase 3 or it may become apparent that a subset of the option sets achieve the desired objectives and move forward to subsequent phases. Overall, the three phase analysis is summarized below.

Process Summary	
Phase 1:	Identify Sites and Option Sets and Collect Public Input on Values
Phase 2:	Confirm Performance Criteria and Characterize Financial/Environmental/Social Aspects of Option Sets
Phase 3+:	Finalize/Narrow Options, Determine Preferred Method to Engage with Private Sector, Confirm Funding Approach, Amend LWMP, Select Partners, Deliver Project(s), Operate Systems

.

In effect, Phase 2 technical and costing analysis includes assessments and calculations that enable preliminary performance criteria to be tested and refined. The results of the process and analysis will enable the Committee to decide and direct on future performance criteria and infrastructure siting locations based in part on industry best practice, regional context and long-term service delivery excellence. Phase 2 significantly advances the Committee to confirming its requirements for a Core Area wastewater solution and serves to screen the options based on project criteria.

A process for establishing performance criteria typically involves key ingredients as outlined below.

- **Preliminary Design Criteria:** A project charter frames the project and provides guidance for analysis and outcomes. Preliminary criteria should be derived from the charter goals and commitments and later, the criteria can instruct the engineering and costing analysis.
- **Representative Design:** Employing the preliminary design criteria against technical options and technologies begins to frame up the market possibilities (e.g. technologies, resource recovery pathways, pipe alignments, etc.) for a Core Area system. Representative design includes provisionally selecting technologies and system configurations to characterize the relative value of available options and encourage deeper dialogue on the particulars of any commissioned facilities. While analysis and reporting will refer to specific solutions these are

not recommended outcomes; instead, the results of the representative design allow the criteria to come to life for a deeper understanding including life-cycle costing.

- **Life-Cycle Costing:** Potential ratepayer impacts based on proposed levels of service are crucial to performance criteria. Each option set will be assessed using capital, operating and revenue characteristics which will uncover the trade-offs in Core Area alternatives and likely lead to further iterations in future phases. For Phase 2, these costs are Class D only for the purpose of comparing options with significant contingencies due to the nature of the unknowns.
- **Presentation of Alternatives:** Option sets analysis will convey the ability of multiple solutions to meet the criteria and aspirations of the Core Area. While no single alternative will be able to fully address the criteria, it is the presentation of the alternatives and the ensuing debate that will help to clarify the refined set of technical criteria.
- **Refined Criteria:** Final reporting will center on the evolution and rationale for the stated, refined technical criteria. Future phases will test these criteria further so as to confirm the Committee's final statement of requirements (for one or more contracts) for responses by the wastewater treatment and resource recovery market.

Our work plan and methodology follow these ingredients explicitly. We endeavour to translate the project charter into preliminary design criteria, undertake technical analysis and present alternatives so as to provide information for direction by the Committee on their refined performance criteria. Technology and option set evaluations are provisional for deeper understanding of the criteria.

1.2 Preliminary Criteria

There is a need to focus the broad range of treatment and engineering solutions to arrive at a representative design that can be used to develop Class D life-cycle financial scenarios. While private sector submissions will help to finalize the ultimate system design based on prescribed owner's requirements, establishing criteria based on the Project Charter will guide representative design parameters. These parameters will become a key step in setting performance criteria for the project and ultimately guide the technical analysis through Fall 2015 to support Committee direction on preferred system configurations and outcomes.

These criteria are preliminary but suitable for carrying out Phase 2 and stem from the Committee's Charter. Input from the Technical Oversight Panel and direction by the Committee will enhance these criteria and ensure that design parameters align with Core Area expectations and public input to date. Criteria are used to assess alternatives and arrive at potential options that suit the multiple needs and goals of the project. The Charter's Goals and Commitments (left column) frame the criteria.

The preliminary criteria outlined in this Technical Memo provide the basis for detailed technical criteria to develop a representative design and also allow for a comprehensive presentation of the option sets toward the end of Phase 2. Direction from the Committee in December 2015 will allow the CRD to take further steps to refine the performance criteria for a market response to a Core Area solution.

Technical Memorandum #2 will apply the initial steps of our methodology and the preliminary criteria against the defined option sets for further analysis. Additional feedback from the Technical Oversight Panel and ultimately, direction by the Committee, will finalize the option set analysis through Fall 2015.

1.3 Proposed Option Sets Evaluation: Considerations for Decision Making

Phase 2 feasibility and technical analysis provides for an evaluation of 4 option sets across the Core Area. Each option set includes different extents of infrastructure, facilities, services, risks and operations. Life-cycle costing is a core element of the option set evaluation.

Committee direction from June 2015 centers on life-cycle costing analysis which includes design and construction contingencies, administration costs, escalation, inflation, environmental costs as well as capital, operating and maintenance costs. This type of analysis is consistent with comparisons of major capital projects to screen options and further, supports staff and consultants in determining potential allocations per municipality.

In addition to financial analysis, each option set will be further assessed based on its performance against the preliminary criteria stemming from the Charter and from public values from previous phases. While the assessment will be primarily qualitative in nature, the characterization of social benefits, environmental values, risks and service governance will be supportive for Committee direction. Neither the financial analysis nor the qualitative assessment are enough on their own to confirm direction, but instead, it’s the balance of needs and aspirations reflected across the entire suite of criteria from which reasonable direction can be made.

1.4 Option Set Evaluation Methodology

Evaluating option sets is led by the Project Goals and Commitments and the established technical criteria. Whether centralized or distributed, it is the ability of any one option set to best meet the goals of the project that warrants even further optimization by the Committee in future phases. Designing the option sets must consider the evaluation method, hence why both methods are included.

Option Set Design Consideration

- Confirm flows by catchment area and site node.
- Inventory supply and demand projections for water and heat recovery reuse across site nodes in the Core Area. Locate potential customers and define their product needs including barriers and pricing considerations.
- Locate treatment facilities (liquids and or solids) among available sites with consideration to existing infrastructure, land uses, road access and synergies with neighboring site nodes.

- Apply regulatory requirements and overlay with existing infrastructure to meet reliability needs without excess infrastructure.
- Develop conceptual resource recovery infrastructure systems to convey resources to their demands. Look for synergies with neighboring site nodes to reduce unnecessary infrastructure.
- Incorporate various processes and technologies to meet the resource recovery, regulatory and neighborhood considerations. Each option set should look to address a different level of service (in line with the criteria) to allow for lateral comparison of all option sets.
- Optimize resource recovery infrastructure to suit the supply demand balance e.g. focus toward the size of treatment facility to suit actual reuse needs and look for phasing to support growth.
- Confirm regulatory and risk-management needs including ultimate disposal of water as required. Confirm limitations and service governance considerations for implementation and operation.
- Iterate design considerations for 2030 and 2045 scenarios.

Evaluation

- Summarize the technical and engineering elements and characterize their relative levels of service.
- Create aggregate resource recovery summary (qualitative and quantitative) for comparative and communication purposes including overall benefits to community, climate change considerations, others.
- Inventory life-cycle costing elements including construction, operation, maintenance and revenues.
- Present life-cycle costing results including sensitivity analysis for various risk, revenue and contingency factors.
- Characterize operations and service governance needs, risk considerations, preliminary economic factors (e.g. supply and demand, pricing), qualitative elements such as social-benefits stemming from the ability to deliver on community aspirations such as water reuse, advanced treatment and other returns on investment that aren't readily quantifiable.
- Assess distributed option sets against technical criteria (Section 1.2).
- Discuss option sets against all project goals of the Charter.
- Reflect on criteria, project goals, and financial results and develop balanced scorecard approach to presenting the option sets.
- Consider recommendations for Committee consideration which may include further refinements of the option sets to best suit the needs of the Core Area.

Technical Memorandum #2 will provide extensive inventories of the option set designs whereas Technical Memorandum #3 will present the evaluation of each option set.

2.0 Design Criteria

2.1 Design Horizon

Most of the work undertaken to date targets meeting the population/flow requirements to the year 2030, with preliminary consideration to flows in 2045 and 2065. These design horizons are consistent with funding applications and businesses cases and therefore could be adopted for Phase 2. Phase 2 feasibility and technical analysis will address infrastructure and life cycle costing for both the 2030 and 2045 design years.

2.2 Design Populations

Previous phases of analysis researched and collated residential populations in each of the seven (7) municipalities and two (2) First Nations, as well as developed equivalent populations for the industrial, commercial and institutional sectors within each area. Population and flow projections are a considerable resource for Phase 2 and we propose to utilize available information following a preliminary screening on their suitability at this time.

Growth rates have been estimated a low rate (at 1.3%/year) and a high rate (at 2.1%/year). Aggregate populations provide a scale of growth for the Core Area however Phase 2 design and analysis will consider municipal by municipal growth to account for locally-specific design capacities. Overall, growth rates to 2030 and 2045 are tabulated below and include population equivalent contributions from industrial, commercial, and institutional sources

	@ 1.3%/year growth	@ 2.1%/year growth
Core Area Population (eq.) 2030	436,000	494,000
Core Area Population (eq.) 2045	570,000 (1)	669,000

(1) Derived from Discussion Paper 033-DP-1

Actual flow projections are based on municipal expectations as communicated to the CRD which are outlined in the following section.

2.3 Flows

Table 2.3.1 summarizes the design flows for 2030 and 2045. While there are nuances and potential discrepancies for flow estimates, Table 2.3.1 appears to reflect the most current CRD estimates with general agreement by the municipalities. We intend to move forward for Phase 2 relying upon the flow estimates in column 1, which we note are different than the flow estimates as provided by the Westside Technical Committee.

The flows noted are based on average dry weather flows (ADWF which aligns directly with the regulatory requirements of the Municipal Wastewater Regulation, as outlined in Section 2.5.1.

Recent direction from the Westside Select Committee is that engineering analysis for Westside Option Sets should account for the flows from west Saanich and west Victoria currently destined for the Macaulay outfall. Flows from the Eastside that travel to the Macaulay outfall are represented in Table 2.3.1.

To account for ongoing water conservation programs and demand management initiatives, the projected per capita flow rates decrease around the Core area from 225 to 250 litres per capita per day now to 195 in 2030 and 2045. Flows are presented in megaliters per day (MLD) which is a summation of the population equivalents per catchment area based on the per capita estimates.

Table 2.3.1 - Core Area 2030 and 2045 Design Flow Allocations

Location		ADWF (MLD)		
		2030 (1)	2030 (2)	2045 (3)
A.	**Clover Outfall**			
	- Oak Bay	6.6	-	6.6
	- East Saanich	9.2	-	12.8
	- East Victoria	31.9	-	34.0
	Sub-Total	**47.7**	**-**	**53.4**
B.	**Macaulay Outfall**			
	- Langford	14.1	14.1	23.1
	- Colwood	4.7	4.7	13.1
	- View Royal	3.5	3.5	7.9
	- Esquimalt First Nation	0.3	0.7	0.4
	- Songhees First Nation	0.4	0.7	0.5
	- Esquimalt	7.1	6.2	7.9
	- West Victoria	6.4	1.0	6.8
	- West Saanich	23.7	16.5	32.9
	Sub-Total	**60.2**	**47.4**	**92.6**
	Totals	**107.9**		**146.0**

(1) Core Area LWMP Committee Presentation by CRD Staff, October 14, 2015

(2) Flows assumed by Westside

(3) Derived from CRD 2030 projections (first column). Refer to Appendix A for derivations

2.4 Influent Wastewater Quality and Loads

The CRD collects 24 hour composite samples and tests the influent effluent for numerous parameters. A summary of the 2014 data is included in Appendix B. The most relevant influent sewage concentration data from 2014 are summarized in Table 2.4.1. This data is consistent with historical reports prepared for the Core Area LWMP, the latest being the January 23, 2013 Technical Memo “Indicative/Detailed Design/Wastewater Characterization and Design Loads”. Table 2.4.1 also includes a summary of the 2030 maximum month loads, which are used to size the biological components of the plants. To account for flow and load variability, design factors account for the maximum load that the facility will experience in any 30 consecutive days which typically represents the 92 percentile of the data set analyzed for 2014. The proposed flow-load variability factor is set at 1.25 times the average loading.

Table 2.4.1 – Average Influent Quality Concentrations and Maximum Month Loads for 2030 Flows [(1)]

Parameter	Macaulay		Clover	
	Average (mg/L)	Max Month (kg/d)	Average (mg/L)	Max Month (kg/d)
Carbonaceous BOD_5	226	17,010	192	11,450
Total BOD_5	275	20,700	238	14,190
Total Suspended Solids	270	20,320	238	14,190
Chemical Oxygen Demand (COD)	632	47,560	530	31,600
Ammonia	42	3,160	27	1,610
Alkalinity	217	16,330	168	10,020
Total Kjeldal Nitrogen	54	4,060	40	2,385

(1) Note influent pH ranges from 7.3 to 7.7 typically

2.5 Liquid Effluent Criteria

2.5.1 Introduction

Two regulations currently govern effluent discharges in BC – The Federal Wastewater Systems Effluent Regulation (WSER) and the BC Municipal Wastewater Regulation (MWR). The WSER deals only with discharges to surface waters and has marginally different criteria than the MWR. The MWR addresses discharges to surface water, ground, wet weather flows and for reclaimed water. Both provincial and federal governments intend to harmonize the regulations which will affect the effluent criteria.

There is a strong sentiment within the Core Area to reuse reclaimed water as much as possible. To facilitate this sentiment, it is proposed that effluent destined for reuse meet the *Greater Exposure Potential Category* for reclaimed water as defined in the BC Municipal Wastewater Regulation. This level of quality is similar to the requirements of the Canadian Guidelines for Domestic Reclaimed Water for Use in Toilet and Urinal Flushing and the California Title 22 Regulation and would permit all reclaimed uses except indirect and direct potable reuse applications. It is our understanding that this would also be acceptable for aquifer recharge based on work currently being undertaken by the City of Colwood. If the CRD was to limit the reuse to irrigation on restricted public access sites only, then the standard of effluent quality could be reduced to *Moderate Exposure Potential Category* which is basically equivalent to secondary treatment as defined in Section 2.5.4. Also, secondary treatment is suitable for discharge to most marine environments but the outfall depth must be positioned at 30 m or more which effectively rules out any discharge to the inner harbour.

Stream augmentation is cited in the regulations whereby treatment must be greater than secondary (tertiary) with effluent criteria to suit the receiving environment. However, MWR requires an alternate disposal or storage for reclaimed water (stream augmentation or reuse) as follows:

"Alternate Disposal or Storage

114 (1) A person must not provide or use reclaimed water unless all of the following requirements are met:

(a) There is an alternate method of disposing of the reclaimed water that meets the requirements of this regulation or is authorized by a director.

(b) Treatment processes are built with the minimum number of components specified in the applicable reliability category for the alternate method of disposal, as described in section 35 *[general component and reliability requirements]*;

(c) If there is no immediate means of conveyance of the municipal effluent or reclaimed water to the alternate disposal method, the wastewater facility has 48 hours' emergency storage outside the treatment system.

(2) Despite subsection (1) (a), a director may waive the requirement for an alternate method of disposal for reclaimed water that is not generated from residential development or institutional settings if an alternate method is not required to protect public health or the receiving environment and the wastewater facility has

(a) 48 hours' emergency storage outside the treatment system and the ability to shut down generation of municipal wastewater within 24 hours, or

(b) A dedicated storage system that is designed to accommodate:

i. At least 20 days of design average daily municipal effluent flow at any time,

ii. The maximum anticipated volume of surplus reclaimed water, and

iii. Storm or snowmelt events with a less than 5-year return period.

(3) Despite subsections (1) (a) and (2), if reclaimed water is discharged from a wastewater facility directly into a wetland, a director may waive the requirement for an alternate method of disposal if an alternate method of disposal is not required to protect public health or the receiving environment.

Failure to meet municipal effluent quality requirements

115 (1) If municipal effluent does not meet municipal effluent quality requirements, a provider of reclaimed water must ensure that the municipal effluent is diverted immediately to

(a) An alternate method of disposal, as provided for in section 114 (1) (a) *[alternate disposal or storage]*, or

(b) Emergency storage or a dedicated storage system, as described in section 115 (1) (c) or (2),

Until municipal effluent quality requirements are met and reclaimed water uses may continue.**"**

These regulatory requirements strongly suggest that an alternate ocean outfall is required if stream augmentation is pursued.

A discharge to a wetland may be possible without requiring an alternate method of disposal, but this would require a specific environmental impact study and a waiver from the Director of the Ministry of Environment. A discharge to a wetland has not been considered in our analyses at this time however may be considered at the direction of the Committee.

The MWR and previous liquid waste management plan amendments further regulate the quality of effluent with respect to wet weather flows, as tabulated below:

Effluent Criteria	Macaulay Outfall	Clover Outfall
Secondary	0 – 2 x ADWF	0 – 2 x ADWF
Primary	2 – 4 x ADWF	2 – 3 x ADWF
Screening (6 mm Ø)	> 4 x ADWF	> 3 x ADWF

ADWF = Average Dry Weather Flow

2.5.2 Ammonia and Toxicity

Ammonia and toxicity in wastewater effluent is a complicated topic which is discussed in detail in Appendix C. In summary, the Federal and BC governments have criteria that regulate the amount of ammonia in the effluent, in particular to the un-ionized ammonia concentrations. Our research and analysis concludes (Appendix C) that it is not necessary to reduce ammonia in the wastewater treatment plants to comply with both the federal and provincial regulations before discharging out the Clover and Macaulay outfalls. Enhanced treatment would be required however for any option that contemplates stream augmentation and/or wetland discharges.

2.5.3 Primary Liquid Effluent

The MWR requires primary effluent to meet:

$CBOD_5$ ≤ 130 mg/L

TSS ≤ 130 mg/L

2.5.4 Secondary Liquid Effluent plus Disinfection

Ocean outfall effluent criteria should best address both the federal and provincial regulations, as proposed in the table below, and based on the requirement of outfall diffusers at a minimum depth of 30 m below the surface.

Parameter	Units	Average Concentration	Maximum Concentration
$CBOD_5$	mg/L	≤ 25	≤ 45
TSS	mg/L	≤ 25	≤ 45
Un-ionized Ammonia in Effluent	mg/L	NA	≤ 1.25 (1)
Un-Ionized Ammonia at End of Dilution Zone	mg/L	NA	≤ 0.016 (1)
Total Residual Chlorine	mg/L	NA	≤ 0.02
Faecal Coliforms	cfu/100 mL	NA	≤ 200 (2)

(1) Only one of these parameters need to be met.

(2) It is our understanding that disinfection will be required. This is the standard concentration for discharge to recreational waters.

The frequency of testing and the averaging period is dependent on flow rates as shown below for continuous flow systems.

Flow Range	Testing Frequency	Averaging Period
≤ 2,500 m^3/d	Monthly	Quarterly
> 2,500 but ≤ 17,500 m^3/d	Every 2 Weeks	Quarterly
> 17,500 but ≤ 50,000 m^3/d	Weekly	Monthly
> 50,000 m^3/d	3 Days/Week	Monthly

2.5.5 Enhanced Tertiary Liquid Effluent

In order to provide the ability for reuse we have identified enhanced tertiary treatment targets.

The proposed enhanced tertiary level of treatment is designed to satisfy most reclaimed water applications in the *Greater Exposure Potential* category as defined in the Municipal Wastewater Regulation. Colwood has noted that the BC MoE has confirmed that Indirect Potable Reuse effluent is necessary for aquifer recharge in Colwood, as noted below:

Parameter	Greater Exposure Potential	Indirect Potable Reuse	Monitoring Requirements
pH	6.5 to 9	6.5 to 9	Weekly
$CBOD_5$	$\leq$ 10 mg/L	$\leq$ 5 mg/L	Weekly
TSS	$\leq$ 10 mg/L	$\leq$ 5 mg/L	Weekly
Turbidity	Average 2 NTU Maximum 5 NTU	Maximum 1 NTU	Continuous Monitoring
Faecal Coliform (1)	Median 1 cfu/100 mL Maximum 14 cfu/100 mL	Median 1 cfu/100 ml	Daily

(1) Median is based on the last 5 results.

2.5.6 Emerging Contaminants

In the terms of reference for Phase 2 the base case treatment standard is secondary treatment with advanced oxidation. Advanced oxidation is a chemical treatment process designed to remove organic and sometimes inorganic matter in waste water by oxidation with hydroxyl radicals. Practically in wastewater treatment this is achieved through the use of ozone, hydrogen peroxide and/or ultraviolet light.

Unfortunately, we have not been able to determine what parameters and effluent criteria this system was intended to meet. There are in the order of 1,700 pharmaceuticals and personal care products (PPCPs) alone. At the present time, there are no published standards in Canada for the discharge of emerging contaminants to marine waters. The CRD has prepared a fact sheet on emerging contaminants which can be found in Appendix D. From this fact sheet it is interesting to note the data collected by the CRD on their Ganges MBR plant and Saanich Peninsula secondary plant (conventional activated sludge) for removal efficiencies. Approximately 80% of the contaminants (211 of 266) had removal efficiencies > 90% for the MBR plant. Approximately 45% of the monitored contaminants (145 of 324) had removal efficiencies > 90% for the activated sludge plant.

Urban Systems and Carollo Engineers are of the opinion that treatment targets for emerging contaminants be approached in the following manner:

- That treatment processes and technologies for emerging contaminants be assessed in the future once effluent criteria for emerging contaminants of concern have been identified by the regulators; thorough analysis of options can be conducted for the addition of further treatment works at that time;
- That further monitoring and research be conducted in the early years of operation of the new Core Area system to assess the level of reduction of emerging contaminants already occurring in the effluent; and
- That future proposals by market proponents indicate the level of reduction of emerging contaminants in their proposed system and that proposals are evaluated, in part, by the level of reduction achieved.

Space could be left in the plant(s) if it was desired for emerging contaminant treatment in the future once the specific effluent criteria are known.

2.5.7 Liquid Treatment Summary

In summary it has been assumed for the remainder of Phase 2 that secondary treatment plus disinfection will be provided for all ocean discharges up to 2x ADWF with primary treatment to 3 x at the Clover Outfall and 4 x ADWF at the Macaulay Outfall and any other new outfalls. Water for reclaimed purposes will be treated to Greater Exposure Potential Tertiary Standards given the water quality requirements for anticipated uses. No specific treatment will be added at this time for additional treatment of emerging contaminants of concern beyond what the secondary or tertiary process will achieve.

2.6 Solids Criteria

Solids management is an integral component of wastewater treatment and the processing and disposal of the solids generated during the treatment of the wastewater must be addressed. Unlike the water, the solids management has additional requirements both from a public perception and the acceptability of the materials produced. As such, defining the goals and metrics that the solids management must achieve is critical for the technology evaluation.

Sludge is defined as untreated residual solids, whereas biosolids are treated to an extent defined in the BC Organic Matter Recycling Regulation.

Solids criteria are dependent on end uses, some of the typical criteria and end uses are summarized below:

Table 2.6.1 - Solids Criteria

Criteria	End Use	Comments
Class B Biosolids	Land Application	Stringent regulatory constraints
Class A Biosolids	Land Application	Option to donate or sell to public
Dewatered Sludge (12 – 20% dry solids)	Landfill	Could be quite odourous; occupies large volume
Dried Sludge (60 – 85% dry solids)	Landfill	Less concern with odours, occupies much less volume
Dried Sludge (60 – 85% dry solids)	Biofuel for Incinerators	Minor quantities of ash to dispose
Dried Sludge (60 – 85% dry solids)	Biofuel for Gasification	Biochar and ash to be disposed

In terms of the application of these criteria the following aspects will be considered:

- CRD has a current policy that does not allow the land application of biosolids, within its boundaries.
- CRD strongly discourages solids being discharged to their landfill e.g. residual solids disposal should be minimized.

2.7 Resource Recovery Markets: Design and Evaluation Methodology

Wastewater provides for multiple resources that can be recovered for a variety of beneficial uses. Previous studies served to narrow the broad list of possibilities toward a reasonable list of potential applications, including: water reclamation, heat recovery, solids recovery including potential energy conversion, and fertilizer supplements (i.e. struvite). While each application requires its own unique infrastructure and service-operation requirements, there are common attributes that apply universally to suit the charter and preliminary criteria. Throughout Phase 2, possibilities for resource recovery will be initially examined through a lens for:

- Long-term revenues and demands
- Minimized processing-technology footprint
- Cost of service
- Energy balance
- Complexity of customer agreements or partnerships
- Ability to support other community amenities
- Synergy with public utility services
- Regulatory feasibility

This list of attributes will frame the scan for market opportunities for resource recovery and help to identify target markets where there is greatest potential for applications to meet the project goals. Further, distributed option sets are designed to situate multiple plants throughout the Core Area to capitalize on resource recovery demands. Heat recovery and water reuse demands are distributed in particular and instruct the proposed methodology for identifying target markets, including:

- Review the broad inventory of water reuse and heat recovery possibilities including existing customers and future development.
- Inventory supply and demand projections for water and heat recovery reuse across site nodes in the Core Area. Locate potential customers and define their product needs including barriers and pricing considerations.
- Scan the broad list of recovery possibilities against the list of criteria above:
- Narrow the recovery options based on the results of the scan.
- Develop conceptual resource recovery infrastructure systems to convey resources to their demands. Look for synergies with neighboring site nodes to reduce unnecessary infrastructure.
- Optimize resource recovery infrastructure to suit the supply demand balance e.g. focus toward the size of treatment facility to suit actual reuse needs and look for phasing to support growth.
- Confirm regulatory and risk-management considerations. Confirm limitations and service governance considerations for risks and opportunities related to implementation and operation.

- Confirm cost and revenue projections for life cycle costing analysis.

Table 2.7.1 outlines the preliminary considerations for resource recovery target markets.

Table 2.7.1 Preliminary Resource Recovery Opportunities

Reclaimed Water	• Large parcels, clustered in areas within a few kilometres of site nodes, for irrigation supply at parks and local green spaces • Potable substitution for toilet flushing (only) in new (future flows) town center developments including commercial uses • Aquifer recharge
Heat Recovery	• Opportunities to support local development and sustainability goals by providing hydronic heat opportunities (e.g. low grade heat recovery systems) from pump stations or treatment facilities at various institutional and commercial buildings • Opportunities to integrate with any imminent district energy systems • Heat capture at major treatment facilities to offset heating costs and other fuel costs
Solids Recovery	• Market possibilities whereby treated biosolids are mixed into a beneficial topsoil product and sold for land application elsewhere • Market possibilities for biochar or dried solids which remain after energy recovery processes
Energy Recovery	• Recovery of methane gas from decomposed organic materials to produce electricity, natural gas, bioplastics, diesel fuels, others. • Thermal conversion opportunities of carbon via gasification, incineration or pyrolysis.
Struvite	• Recovery of ammonia and phosphorous as nutrients for use in fertilizers • Confirmation that market possibilities previously identified remain and that they are congruent with solids recovery processes

Each of these applications presents opportunities to recover resources from wastewater. Further consideration to service governance, responsibilities, risks, investment needs and long-term operation will be presented to the Committee and the public as part of the analysis results.

3.0 Facility Characterization Criteria

Technical criteria from Section 2 inform the facility design, or *facility characterization criteria*, which is a significant step toward establishing a representative design for each site (Section 4.0).

The following tables summarize the proposed Facility Characterization Criteria and how they align with the Preliminary Charter Criteria outlined in Section 1.0.

Table 3.1 - Liquid Discharge Requirements

Facility Characterization Criteria	Preliminary Charter Criteria	Comments
Flow Requirements	Meet Regulations (1a)	System must work as a whole but each site in a solution set may play a different part (i.e. Where we treat the flows over 2x average dry weather flow)
Receiving Environment – Regulatory Limits	Meet Regulations (1a)	Tied to discharge location
Receiving Environment – Emerging Contaminants	Improve Effluent Quality (4c)	As outlined earlier this one requires further dialogue and definition if it is to be included
Reuse Requirements	Support Resource Recovery (2c, 3c)	Highly tied to market demand

Table 3.2 - Solids Discharge Requirements

Facility Characterization Criteria	Preliminary Charter Criteria	Comments
Disposal/Reuse Requirements	Support Resource Recovery (2c, 3c)	Consider scale, synergies with energy and solids resource recovery and integration with other regional waste streams.

Table 3.3 - Site Constraints

Facility Characterization Criteria	Preliminary Charter Criteria	Comments
Adjacent Land Use	Safe Solutions (6b, 6c) Community Support (3b)	Certain technologies and solutions integrate better into residential settings than others.
Livability of Neighbourhood	Positive Public Interaction (6b) Community Support (3b) Reduction of Carbon Footprint (5a) Balance Energy Needs (5c)	Certain technologies and solutions integrate better into residential settings than others

Table 3.4 - Risks

Facility Characterization Criteria	Preliminary Charter Criteria	Comments
Certainty for Demand/Revenue	Certainty of Long-Term Demand and Revenue (3a) Ability to Phase with Growth (4a)	Certain technologies and solutions are more resilient to variations in demand/revenues.
Climate Variability Impacts	Site/Design Resiliency (4b)	Location specific
Seismic	Site/Design Resiliency (4b)	Location specific
Neighborhood Impacts	Reduction to Risks to Neighbourhoods from Facility Failure (6b) Reduction of Normal Interruption to Neighbourhood (6c) Ability to Produce High-Quality Air Emissions (5b)	Acceptable levels of risk beyond regulation vary by land use.
Process Risks – Liquids	Safe Solutions (6b, 6c) Reduction to Risks to Neighbourhoods from Facility Failure (6b)	Acceptable levels of risk beyond regulatory requirements vary by land use.
Process Risks – Solids	Safe Solutions (6b, 6c) Reduction to Risks to Neighbourhoods from Facility Failure (6b) Ability to Produce High-Quality Air Emissions (5b)	Acceptable levels of risk beyond regulatory requirements vary by land use.
Process Risks – Energy Recovery	Safe Solutions (6b, 6c) Reduction to Risks to Neighbourhoods from Facility Failure (6b) Ability to Produce High-Quality Air Emissions (5b)	Acceptable levels of risk beyond regulatory requirements vary by land use.

4.0 Methodology to Select Representative WWTP Technology

As outlined in Section 1, the criteria outlined in Section 2 and 3 will be used to arrive at representative designs for the various facility locations within the option sets. We have proposed that four sample site characterizations be used in order to inform the representative design process. These site characterizations will be used to consider facility design requirements, siting considerations and to review indicative technologies. Once the site locations and option sets are confirmed they can be refined prior to costing analysis. The proposed site characterizations are summarized in the table below:

Table 4.1 - 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

Representative design and analysis for solids treatment and recovery will adhere to the criteria outlined in section 3.0 and be considered in synergy with the liquid treatment and energy recovery needs/opportunities for the site.

5.0 Costing Factors

5.1 Introduction

As outlined in the Treasury Board guide on the Public Works and Government Services website cost estimates for projects fall into a number of defined categories. For this project the CRD terms of reference requested that costs be provided with the accuracy of -15% to +25%. This range is consistent with cost estimates which are suitable for budget planning purposes in the early stages of concept development of a project.

Costs will be presented in 2015 Canadian dollars. It is important to recognize that since 2010, and from 2015 until the systems are constructed, prices of all cost elements can be significantly affected by time and typically, cost escalations. For example, the Engineering News Record (ENR) is an industry guide to the construction industry. The ENR states that the construction cost index for Toronto (BC is currently not represented in the ENR) has increased from 9,434 (2010) to 10,515 (2015). This is equivalent to a construction cost increase of 11.5% over the 5 year period. A review of data available from Stats Canada for the Victoria area indicates that their construction price index has risen from 111.5 (2010) to 122.8 (2014; no 2015 data yet available), using a base index of 100 (2007). This is equivalent to a 10.1 % increase over this 4 year period. This would appear to correlate fairly closely with the 11.5 % increase over 5 years for the ENR index. We have used the Stats Canada index for the purposes of calculating all cost escalations.

The impact of the exchange rate between the Euro, the US and Canadian dollars is also relevant, since a portion of the equipment may be manufactured in the USA or Europe.

Some costing considerations are difficult to predict, like the supply and demand and productivity of skilled labour in the Greater Victoria area, especially if other large scale projects in the province were to occur, such as liquefied natural gas and the Metro Vancouver Lion's Gate WWTP. It is also widely known that construction on Vancouver Island carries a premium compared to the mainland.

We will be using all of the recent construction related projects that Urban Systems and Carollo have completed to inform the estimates we provide, including local estimate considerations provided by municipal staff. Previous cost estimating from other consultants on this project have also been reviewed and have been considered in our evaluations.

5.2 Capital Cost Breakdown

Capital cost estimates include multiple factors and contingencies. For Class D cost estimates we have included *general requirements*, *contractor profit and overhead*, *construction and project contingencies, engineering, administration, interim financing and escalation.* Table 5.1 illustrates these cost factors for an example project with a base construction cost estimate of $1,000,000. For comparative purposes the percentages used in this study are the same as those used in previous studies. We have assumed the mid-point of construction is four years or 2019.

Table 5.1 - Capital Cost Breakdown

Description	Total
Construction Cost	$ 1,000,000
General Requirements (Mobilization, Demobilization, Bonds, Insurance, etc.) – 10%	$ 100,000
Contractor Profit/Overhead – 10%	$ 100,000
Construction/Project Contingency – 35%	$ 350,000
Subtotal of Direct Costs	**$ 1,550,000**
Engineering – 15%	$ 233,000
CRD Administration and Project Management and Miscellaneous – 8%	$ 124,000
Interim Financing– 4%	$ 62,000
Escalation to Mid-Point of Construction – 2%/year (4 years)	$ 124,000
Total Capital Project Cost	**$ 2,093,000**

5.3 Pump Stations

The pump stations that will be used to pump effluent from the existing CRD collection system to the proposed treatment plants are typically designed to be low-lift, high-volume facilities. Because of the unique nature of each pump station (siting, access, pump capacity, proximity to major utilities and sensitive areas, geotechnical considerations, etc.), costs for such facilities can vary widely.

Class D cost estimates are commonly derived from cost curves which are based on extensive cost data gathered from the combination of a wide range of pump stations throughout the industry. These curves typically plot station costs against the size of the stations in L/s. Typical curves are shown in Appendix E.

These particular curves were developed by an extensive study undertaken 11 years ago for the Ministry of Public Infrastructure Renewal in Ontario. In conducting our estimates we assessed the application of estimates from Ontario against our experience in the BC market. The unit rates have been multiplied by 1.6 with consideration of the following:

a. 20% - for temporary and permanent site work.

b. 20% - for standby power and SCADA

c. 20% - inflation from 2004 to 2015.

Where possible, the unit rates have been compared to cost data available from recently designed and constructed projects, to confirm general data conformance. These facilities typically comprise a concrete below grade wet well, in which the sewage is collected and from which the sewage is pumped using submersible pumps. An at-grade superstructure (usually concrete block or similar durable material) is located on top of the wet well (typically poured in place concrete), to house mechanical and electrical equipment, including MCCs, PLCs and standby power.

Where pump stations will be included in the design and construction of a wastewater treatment plant, i.e., are not stand alone facilities, experience informs that a 30% cost deduct should be applied to the unit costs rates to account for common infrastructure and other facility synergies.

Below is a summary of a few examples of anticipated pump station costs, based upon the curves in Appendix E and including the 1.6 multiplier. All rates are in 2015 dollars and pertain only to the Construction Cost portion as outlined in Section 5.2, which would be factored up as per Table 5.1.

Pump Station Size	Construction Cost (CDN$)
350 L/s	$ 3,400,000
750 L/s	$ 6,400,000
925 L/s	$ 8,000,000

Estimates and market pricing (historic) for the Craigflower Pump Station upgrade will be examined further in an effort to further refine these estimates, once the tender information is made available.

5.4 Piping

The piping systems that will be used to service the Core Area option sets will comprise PVC pipe installed in existing rights-of-ways, typically existing road allowances. As such, the unit cost rates allow for pavement and any existing surface improvement restoration. In addition, an allowance has been included for temporary site works, traffic control and associated above ground work.

In general, these pipes will provide the connectivity between the existing CRD sewer trunk mains, proposed pump stations, proposed wastewater treatment plants and proposed outfalls. Typically sanitary collection systems are designed for minimum flow velocities of 0.8 m/sec to ensure that material does not build up within the piping systems. From a capital cost and energy perspective, ideally flows should be near 2.5 m/sec. Given the wide range in flows within the CRD system (0 to 4 x ADWF), detailed analysis is required for any pumped and piped system to ensure that the optimum life cycle range of costs are achieved.

For the purposes of this costing exercise, we have sized our pipes such that the resultant velocities are in the 1.5 to 2.5 m/sec range, based upon 2 x ADWF.

The unit cost rates developed are based upon meeting or exceeding accepted industry design standards, such as those detailed by AWWA.

The following is a summary of the unit cost rates developed by Urban Systems as part of the ongoing work with the CRD. All rates are in 2015 CDN dollars and pertain only to the Construction Cost portion outlined in Section 5.2.

Pipe Diameter (mm)	Construction Unit Cost $/m
300	$ 700
350	$ 740
400	$ 780
450	$ 820
500	$ 870
600	$ 950
750	$ 1,130
900	$ 1,350
1050	$ 1,620
1200	$ 1,850
1350	$ 2,100
1575	$ 2,450

5.5 Outfalls

Developing unit cost rates for outfalls into a marine environment proved to be the most challenging task, given the wide range of unknowns and variabilities. Not too dissimilar from pump stations and their unique features, the unit cost rates for outfalls also vary widely. In particular, geotechnical considerations and seabed profiles will have significant impacts on these costs. However, unlike, pump stations, there is not a large data base on which to draw upon and develop cost curves.

Outfalls are anticipated using steel pipes, installed with concrete collars anchored to the sea floor. Based upon the data available, 2015 costs for these sizes were developed as summarized below and pertain only to the Construction Cost portion outlined in Section 5.2.

Pipe Diameter (mm)	Construction Unit Cost $/m
600	$ 6,150
750	$ 7,000
900	$ 7,800
1050	$ 8,600
1200	$ 9,600
1350	$ 10,800

5.6 Methodology to Provide WWTP Cost Estimates

For Wastewater Treatment Plants the costing methodology is more complicated since each plant includes both liquids and solids treatment processes and costs are largely dependent on the technology selected. For this project we will use the experience database developed by Carollo and Urban Systems in order to determine appropriate costs for the representative facilities. Only the representative technology will be costed in order to arrive at comparative cost estimates between the option sets.

5.7 Revenue Sources

Revenue sources will cover the range of incomes based on exchange of goods or services and also monies that offset costs including potential development contributions or potential partnerships which minimize the extent and impact of new works. Examples of revenues include:

- Utility billings, requisitions, transfers and interest gains
- Retail rates for resource recovery systems including water rates, gas/fuel rates (solids recovery) and incomes collected for any sales related to solids residuals
- Development cost charges and other potential private sector development contributions available to local governments
- Municipal cost-shares for example where infrastructure upgrades are needed for both local and regional benefit
- Grants in terms of secured monies available to CRD
- Other offsetting costs for example, homeowner cost savings that may arise through waste diversion as part of integrated solids recovery

This list of preliminary revenue resources will be refined through high-level feasibility analysis in collaboration with CRD and municipal staff.

5.8 Life Cycle Costing

Life-cycle costs will be prepared for each of the option sets, which will be detailed in Technical Memo #2. Life cycle costing includes capital, as well as operating costs and later, consideration to revenues as part of the aggregate financial scenarios. Operating costs will consider typical cost elements as well as revenue (outlined in Section 5.7) which can reasonably be assumed to accrue given the resource recovery opportunities available. The operating and life cycle costing will be completed in Technical Memo #3.

Below is a summary of the inputs into our life cycle costing model. As this is a constant dollar analysis, all costs will be in $2015. The only escalation that will be included will be 2% per year for initial capital projects for the time from today until midway through construction which is assumed to be 2019.

We propose to conduct sensitivity analysis on the discount rate, escalation factors and revenue projections to monetize the risks inherent in long-term capital financing and service delivery. As a base case, our life cycle analysis will be guided by previous analysis and in particular, will suit treasury board guidelines to suit the funding partners.

Life Cycle: 30 years (2015-2045)

Interest Rate: to be confirmed with funding partners (as needed) e.g. 5%

Inflation Rate: to confirmed with funding partners (as needed) e.g. 2%

Discount Rate: to be confirmed with funding partners (as needed) e.g. 3%

Water Cost: Distribution cost from distribution supplier (i.e., CRD for Westshore & Sooke) is $1.81/m^3

Electricity Cost: Average rate $0.08/kwh

Chemical Costs; Current market prices

Labour Rates:

Labour Type	2015 Annual Salary (1)
Plant Manager	$ 158,000
Chief Plant Operators	$ 135,000
Chief Area Operator	$ 113,000
Plant Operator	$ 90,000
Labourer	$ 56,000

(1) Refer to Appendix F for derivation

Vehicle Rates: $40,000/yr./vehicle

Trucking Rates: Current market prices

Disposal Rates: Current tipping charges to CRD Landfill (i.e. $157 per tonne for screenings and pumpings from Sewage Treatment Plants)

Maintenance/Repairs Pump Stations:	1% of Capital/yr.
Equipment Replacement Reserve for Treatment Facilities:	2% of Capital
Operation & Maintenance Contingency:	15%

While there are multiple financial scenarios to consider, it is important that Phase 2 results remain consistent with previous analysis but also reflect a shift in project outcomes and criteria. Further, qualitative evaluation of various social and environmental factors will support the financial analysis and allow the Committee to review the merits of option sets across a balanced scorecard. Phase 2 evaluations should support the committee in screening away option sets that don't effectively meet the goals and commitments of the project in order to refine the project criteria for ultimate design parameters for a Core Area solution. Additional public investment analysis beyond Phase 2 may be needed (e.g. value for money) to suit the needs of the funding partners.

APPENDIX B – TECHNICAL CRITERIA AND PROJECT CHARTER

Charter Goal/Commitment	Preliminary Charter Criteria
1. Meet or exceed federal regulations for secondary treatment by December 31, 2020.	a. Refer to Section 2.5.4. b. Extent of liquids or solids produced in excess of regulations.
2. Minimize costs to residents and businesses (life cycle cost) and provide value for money.	a. Extent of leveraging of existing infrastructure assets; b. Reduction of consumable and operations costs; c. Extent of revenues from resource recovery;
3. Produce an innovative project that brings in costs at less than original estimates.	a. Extent of alternative to bring in costs less than original estimate.
4. Optimize opportunities for resource recovery to accomplish substantial net environmental benefit and reduce operating costs.	a. Certainty of long-term demand and revenue; b. Extent of support for community building; c. Extent of new infrastructure/services to support resource recovery; d. Extent of integration of other regional waste streams
5. Optimize greenhouse gas reduction through the development, construction and operation phases and ensure best practice for climate change mitigation.	a. Reduction of carbon footprint (buildings, treatment, transportation); b. Ability to produce high-quality air emissions; c. Ability to balance energy needs;
6. Develop and implement the project in a transparent manner and engage the public throughout the process.	a. Ability of an alternative to meet the preliminary criteria
7. Develop innovative solutions that account for and respond to future challenges, demands and opportunities, including being open to investigation integration of other parts of the waste stream if doing so offers the opportunities to optimize other goals and commitments in the future.	a. Ability to phase capacity/expansion with growth; b. Ability to improve effluent quality over life of facility; c. Extent of integration of other regional waste streams (above)
8. Optimize opportunities for climate change mitigation	a. Reduction of carbon footprint (buildings, treatment, transportation); b. Ability to produce high-quality air emissions; c. Ability to balance energy needs;
9. Deliver a solution that adds value to the surrounding community and enhances the livability of neighborhoods.	a. Extent to provide for positive public interaction; b. Reduction of risk to neighborhoods from facility failure; c. Reduction of interruption to neighborhood during normal operation;
10. Deliver solutions that are safe and resilient to earthquakes, tsunamis, sea level rise and storm surges.	a. Site/design resiliency for seismic and sea level rise;

CORE AREA SEWAGE AND RESOURCE RECOVERY SYSTEM 2.0

Phase 2: Analysis, Options Costing and Public Engagement

Project Charter - FINAL

October 2, 2015

TABLE OF CONTENTS

1. VISION

In partnership with the public, the Core Area Liquid Waste Management Committee (CALWMC) will deliver a sewage treatment and resource recovery system that is proven, innovative and maximizes the benefits for people and the planet – economic, social, and environmental – for the long term.

2. BACKGROUND

In 2006, an environmental report commissioned by the Ministry of Environment noted the contamination of seabed sites close to Capital Regional District (CRD) outfalls where the region's wastewater is discharged. As a result, the Province mandated that the CRD plan for and initiate secondary sewage treatment for the region.

In 2007, the CRD received a letter from the Ministry of Environment giving six directives for the Core Area Liquid Waste Management Plan (LWMP). These six directives continue to inform the goals and commitments of this project.

Minister's Requirements:

1. Meet the regulatory standard for liquid waste
2. Minimize total project cost to the taxpayer by maximizing economic and financial benefits, including beneficial reuse of resources and generation of offsetting revenue
3. Optimize the distribution of infrastructure based on number 2 above
4. Aggressively pursue opportunities to minimize and reduce greenhouse gas emissions (e.g., reduced requirement of energy for pumping purposes and beneficial reuse of energy)
5. Optimize 'smart growth' results (e.g., district services, density, Dockside Green-like innovation)
6. Examine the opportunity to save money, transfer risk and add value through a public private partnership

In 2012, the federal government passed a law requiring all high-risk Canadian cities to provide secondary sewage treatment by 2020 at the latest. The CRD's core area was considered to be in the high-risk category.

Between 2009 and 2014, the CALWMC, CRD staff and consultants, and the Core Area Wastewater Program Commission (the Commission) worked to create and implement a publicly acceptable sewage treatment and resource recovery system for the Core Area.

While the approved CALWMP continues to identify McLoughlin Point as the location for the wastewater treatment facility, in April 2014, the CRD's revised McLoughlin Point rezoning application did not meet the zoning requirements for Esquimalt. In June 2014, the plan to build one regional plant at McLoughlin Point was put on hold by the CRD Board, in response to public input.

In June 2014, Langford, Colwood, View Royal, Esquimalt and the Songhees Nation formed the Westside Select Committee to begin planning for a new project to treat sewage and recover resources in those municipalities and the Nation. In September 2015, Esquimalt Nation joined the Westside Select Committee. In January 2015, a similar body – the Eastside Select

Committee, comprised of Saanich, Oak Bay and Victoria – was formed to develop a similar plan for the Eastside municipalities.

Since June 2014 and January 2015, respectively, both Select Committees have been engaged in in-depth public engagement activities to share information with the public, build trust, and seek public input on a range of factors including, but not limited to, level of treatment, treatment technologies, siting of treatment plants, costs, risks and long-term social, economic and environmental benefits.

In July 2015, both select committees presented their work and recommendations to the CALWMC. The CALWMC approved the solution sets and recommendations from the Eastside Select Committee, including potential sites and direction with regard to investigating secondary and tertiary treatment, anaerobic digestion and gasification, and resource recovery and revenue generation. The CALWMC received a presentation from the Westside Select Committee outlining five technically preferred sites and two scenarios, detailing its technical work to date. The Committee accepted the Westside Select Committee's proposal to carry on with further public engagement and more detailed costing and engineering analysis as per its terms of reference to be presented to the CALWMC as more fully-developed solutions in fall 2015.

The work of the Eastside and Westside Select Committees, the CALWMC and the public between June 2014 and July 2015 lays the groundwork for the current project, *Core Area Sewage and Resource Recovery System 2.0.*

3. GOALS AND COMMITMENTS

The *Core Area Sewage and Resource Recovery System 2.0* project will deliver the following goals and meet the following commitments. *NB goals should be measurable. Each of these goals needs a corresponding metric so at project completion, the CALWMC can determine whether it achieved its goals.*

Goals

a) Meet or exceed federal regulations for secondary treatment by December 31, 2020

b) Minimize costs to residents and businesses (life cycle cost) and provide value for money

c) Produce an innovative project that brings in costs at less than original estimates

d) Optimize opportunities for resource recovery to accomplish substantial net environmental benefit and reduce operating costs

e) Optimize greenhouse gas reduction through the development, construction and operation phases and ensure best practice for climate change mitigation

Commitments

a) Develop and implement the project in a transparent manner and engage the public throughout the process

b) Deliver a solution that adds value to the surrounding community and enhances the livability of neighbourhoods

c) Deliver solutions that are safe and resilient to earthquakes, tsunamis, sea level rise and storm surges

d) Develop innovative solutions that account for and respond to future challenges, demands and opportunities, including being open to investigating integration of other parts of the waste stream if doing so offers the opportunities to optimize other goals and commitments in the future

e) Optimize greenhouse gas reduction through the development, construction and operation phases and ensure best practice for climate change mitigation

4. SCOPE

The scope of this phase of the *Core Area Sewage and Resource Recovery System 2.0* project, is to complete the Options Development Phase, by submitting an amendment to the Liquid Waste Management Plan and receiving conditional approval from the Minister of Environment of an Amendment for the Core Area. This Plan amendment will be approved by the provincial and federal funding agencies. Completion of this phase includes securing sites for all facilities (wastewater treatment and resource recovery).

The scope of this phase does not include detailed site assessments such as Environmental and Social Reviews, submission of detailed business cases (as may be required by funding agencies), indicative design, finalized cost sharing agreements or the procurement of infrastructure.

5. KEY STAKEHOLDERS

The graphic illustration (see Attachment 1) outlines all of the *Core Area Sewage and Resource Recovery 2.0* project stakeholders and displays the relationships between them. For a description of the roles and responsibilities of each stakeholder, please see Section 6.

6. ROLES AND RESPONSIBILITIES

Project Lead (TBD)

Federal Government – In 2012, the federal government passed a law requiring all high-risk Canadian cities to provide secondary sewage treatment by 2020 at the latest. The CRD's Core Area was considered to be in the high-risk category. The federal government agreed to contribute up to $253 million towards the project out of three different funding programs: Building Canada Fund ($120 million), Green Infrastructure Fund ($50 million) and 3P Canada ($83.4 million).

- Secondary treatment mandated by 2020
- Funding up to $253 million

Provincial Government – In 2006, an environmental report commissioned by the Ministry of Environment noted the contamination of seabed sites close to CRD outfalls where wastewater is discharged. As a result, the CRD was mandated by the province to plan for and initiate secondary wastewater treatment for the region. Provincial funding agreements provide a maximum of $248 million towards the project.

- Funding up to $248 million
- Approval of LWMP amendment and regulatory requirements

Capital Regional District Board (CRD Board) – The CRD Board is responsible for selecting final site locations and securing lands for wastewater treatment facilities, obtaining the rezoning of lands, approving the architectural design for facilities, and approving funding agreements and the budget. The CRD Board is responsible for delivering the project outlined in the Vision.

- Final approving body for funding, budget and major decisions
- Collect and disburse the local portion of the funding of $287 million

Core Area Liquid Waste Management Committee (CALWMC) – A standing committee of the CRD Board, the CALWMC consists of Directors from municipalities and First Nations participating in the Core Area Liquid Waste Management Plan (CALWMP). The committee is responsible for overseeing the CALWMP and making recommendations to the CRD Board about the CALWMP and certain aspects of the Core Area Wastewater Treatment Program.

- Standing Committee of CRD Board
- Responsible for overseeing CALWMP

Core Area Liquid Waste Management Committee (CALWMC) Chair – The CALWMC Chair is selected by the Chair of the CRD Board annually. The CALWMC Chair is responsible for participating in CALWMC agenda meetings and chairing CALWMC meetings. The Chair is also responsible for building and maintaining relationships, and liaising with the Chair of the Core Area Wastewater Program Commission and the Chair of the Technical Oversight Panel. The CALWMC Chair is the public face of the project and is responsible for communicating with other public bodies at the political level, as well as with the media.

Core Area Liquid Waste Management Committee (CALWMC) Vice Chair – The CALWMC Vice Chair is responsible for fulfilling the roles and responsibilities of the CALWMC Chair in the Chair's absence.

Westside Wastewater Treatment and Resource Recovery Select Committee – In June 2014, Westside participants (Colwood, Esquimalt, Langford, View Royal, and Songhees Nation) formed the Westside Wastewater and Resource Recovery Select Committee to evaluate Westside treatment options and develop a sub-regional wastewater treatment and resource recovery plan. The member municipalities' role is to provide political input and take feedback from the public and report to the Westside Select Committee. The participating municipalities also have zoning authority. In September 2015, the Esquimalt Nation joined the Westside Select Committee. The Songhees and Esquimalt Nation representatives provide political input to the Westside Select Committee. The Committee reports to the CALWMC and is supported by CRD staff, Westside staff, consultants and a technical working group.

The Westside Select Committee participants initiated the Westside Solutions Project as a way to engage residents to work collectively to identify solutions for wastewater treatment and resource recovery that meet the unique needs of the Westside communities. The Westside option sets consider flow scenarios that include Eastside flows from Vic West and Saanich West. This work, along with the work from the Eastside Select Committee, will inform the *Core Area Sewage and Resource Recovery 2.0* project and the amendment to the Liquid Waste Management Plan.

- Representatives from Colwood, Esquimalt, Langford, View Royal and Songhees Nation
- Reports to CALWMC
- Evaluates options to develop a sub-regional wastewater treatment plan
- Supported by CRD staff, Westside municipal staff, consultants and a technical working group

Eastside Wastewater Treatment and Resource Recovery Select Committee – In January 2015, Oak Bay, Saanich and Victoria formed the Eastside Wastewater and Resource Recovery Select Committee to engage with their communities and develop wastewater treatment options that meet the needs of the Eastside municipalities. The role of the participating municipalities is to provide political input and take feedback from the public and report to the Eastside Select Committee. The participating municipalities also have zoning authority. The Eastside Select Committee reports to the CALWMC and is supported by CRD staff, participating municipal staff and consultants.

The Eastside option sets consider a regional option, which includes all flows from Eastside and Westside, as well as a sub-regional and distributed option that includes flows from Eastside municipalities only and Eastside Clover Point outfall catchment flows. The Eastside Select Committee's plan, in combination with the work from the Westside Select Committee, will inform the *Core Area Sewage and Resource Recovery 2.0* project and could form the basis for an amendment to the CALWMP.

- Representatives from Oak Bay, Saanich and Victoria
- Reports to CALWMC
- Working to develop wastewater treatment options for Eastside municipalities
- Supported by CRD staff, participating municipal staff, and consultants

CRD Chief Administrative Officer – The CAO oversees all administrative operations and staff, ensures CRD Board policies are implemented, oversees the operations and functions of the CRD, and aligns the organization to achieve strategic priorities set by the Board. This includes working with federal and provincial staff to coordinate funding agreements and providing advice to the CRD Board regarding potential risks and opportunities for the CRD Board.

- Oversees CRD operations and staff
- Works with partners and stakeholders
- Provides advice to the CRD Board

General Manager of Parks & Environmental Services – The GM of Parks & Environmental Services provides general direction and leadership to CRD staff and advises the CALWMC and the Eastside and Westside Wastewater Treatment and Resource Recovery Select Committees regarding the technical and legal aspects of the CALWMP and the wastewater treatment planning process. The General Manager's role is also to provide information to the Core Area Municipalities' CAOs and First Nations Administrators.

- Provides general direction and leadership to CRD staff
- Advises on technical and legal aspects of the CALWMP
- Informs Core Area Municipal CAOs and First Nation Administrators about the project

General Manager of Finance & Technology – The GM of Finance & Technology is the Chief Financial Officer for the CRD. The GM of Finance and Technology is responsible for the budget and all financial services, information technology and geographic information services (IT & GIS), property and real estate services, insurance and risk management, facilities management, and arts development for the Capital Region.

Corporate Officer – The CRD Corporate Officer provides support and procedural advice to the CRD Board and the CALWMC, and is responsible for maintaining the official records of these bodies. The officer also processes requests for records in accordance with the Freedom of Information and Protection of Privacy Act.

First Nations Liaison – The First Nations Liaison serves as a point of contact for First Nations communities involved with the project and provides departmental support and assistance in the areas of service delivery, referral processes, outreach, engagement and relationship building.

Manager, Corporate Communications – The Senior Manager of Corporate Communications provides professional expertise and leads the CRD Corporate Communications team, which works with the General Manager of Parks & Environmental Services and the CAO on overall communications for the CRD Board. There is a communications coordinator dedicated to working on the CALWMP.

Technical Oversight Panel (ToP) – The role of the Technical Oversight Panel is to review the costing and feasibility studies developed by the Engineering Team during the planning phase of the project and to ensure that the studies for the wastewater treatment options include the necessary due diligence. The Technical Oversight Panel will also advise on how to best engage the private sector in this phase of the project. Fundamental to providing independent technical oversight and confirming due diligence is to ensure that the engagement of the private sector in this phase of the project and the innovative solutions that may come forward is informed by, not necessarily bound by (as per the ToP Terms of Reference), decisions to date regarding sites, option sets, timelines, definitions of treatment and other potential limitations on analysis and costing.

The role of the ToP does not include public consultation, media interaction, land acquisition and rezoning, contract management or direction of the Engineering Team The ToP receives information from and liaises with the Engineering Team (Urban Systems and Carollo Associates), and provides feedback and recommendations to the CALWMC. The Chair of the ToP reports to the CALWMC biweekly. The ToP liaises with the Eastside and Westside Select Committee.

- Independent Technical Oversight Panel
- Reviews costing and feasibility studies

- Reports findings to the CALWMC

Independent Engineering Resources – The Independent Engineering Team's role is to conduct the Feasibility and Costing Analysis (Urban Systems partnered with Carollo) for the CALWMP Wastewater Treatment System. The Engineering Team is also working with the Westside Select Committee to do a more detailed analysis on the Westside flows. The team provides information to and liaises with the ToP, and reports to and receives direction from the CALWMC. Additional external resources may be required for staff to prepare the LWMP amendment. The team is assessing the feasibility of a regional and sub-regional system in the Core. The team is also looking at a distributed system option based on the potential sites put forward from the Eastside Select Committee and Westside Select Committee.

- Conducts feasibility and costing analysis
- Assesses feasibility of regional and sub-regional systems in the Core Area
- Assists with preparation of LWMP amendment

Fairness and Transparency Advisor (FTA) – The FTA's role is to act as a point of contact for the public to submit complaints regarding the process of costing the options, working with the host jurisdiction(s) and preparing an amendment to the LWMP and to ensure that the process is fair, transparent, impartial and objective. The FTA is independent of the CRD. The FTA's role is to investigate appropriate complaints and report to the Board, through the CALWMC, the results of an investigation, to help strengthen the fairness, transparency or objectiveness of the process followed. The FTA is to provide monthly status reports to the CALWMC. The role of the FTA does not restrict the public from going to other sources for complaints and requests to review processes, such as the office of the Ombudsperson.

- Independent of the CRD
- Investigates public complaints regarding process
- Ensures process is fair, transparent, impartial and objective

Core Area Wastewater Treatment Program Commission (the Commission) – As part of the funding negotiations with the Province, the CRD was required to establish an independent non-political governance body to manage, implement and commission the Core Area Wastewater Treatment Program. The Commission governs the implementation and operation of the Wastewater Treatment Program and oversees the procurement process for all components of the Program. The Commission operates autonomously of the CALWMC and Regional Board; however, the Commission is required to seek CRD Board and funder approval on predetermined items as detailed in the CRD Commission bylaw. Several steps have been taken to scale back operations and reduce costs as the CRD continues its planning work to find a new solution to wastewater treatment. The Commission remains in place waiting to implement whatever system of wastewater projects the CRD Board decides upon, and is approved by the Province.

- Independent Commission required by Province
- Manages implementation and operations of the Wastewater Treatment Program
- Oversees procurement process

Technical and Community Advisory Committee (TCAC) – The Technical and Community Advisory Committee is an LWMP requirement of the province, and provides technical and community consultation advice and input to the CALWMC. The TCAC assists the CALWMC in making appropriate recommendations to the CRD Board in the following areas: (a) plant design criteria and treatment technology, including opportunities for resource recovery, sludge management, odour control and general plant design criteria, (b) number and location of treatment plants, and (c) timing/scheduling of treatment.

- Provides technical and community consultation advice
- Makes recommendations regarding design criteria, treatment technology, number and location of treatment plants, and schedule for treatment

Eastside Public Advisory Committee (EPAC) – The Eastside Public Advisory Committee takes input from the public and provides guidance to the Eastside Wastewater and Resource Recovery Select Committee on the public consultation process.

- Takes input from the public
- Provides Eastside Select Committee on the public consultation process

Core Area CAOs + First Nation Administrators – The Core Area CAOs and First Nations Administrators are the principle policy advisors to councils, and provide support to the Eastside and Westside Select Committees. The Core Area CAOs and First Nations Administrators receive project-specific information and updates from the CRD's General Manager of Parks & Environmental Services regarding the progress of the CALWMC and the Eastside and Westside Select Committees.

- Principle policy advisors
- Receive project information
- Provide recommendations from municipal staff perspective

Municipal Councils – The role of municipal councils is to make land-use decisions for facility siting and to negotiate development agreements with the CRD.

Westside Communications Team – The Westside Communications Team is made up of Communications Coordinators from Colwood, Esquimalt, CRD and Aurora Consultants. The Team provides communication and public consultation support to the Westside Select Committee.

Eastside Communications Team – The Eastside Communications Team consists of a consultant from Public Assembly and the CRD Communications Manager and CRD CALWMP Communications Coordinator. The Eastside Communications Team provides communication and public consultation support to the Eastside Select Committee.

Westside Technical Team – The Westside Technical Team consists of municipal staff, supported by Urban Systems. The technical team provides technical information and input to the Westside Select Committee.

- Comprised of municipal staff and supported by Urban Systems and Aurora Innovations for facilitation and coordination support
- Provides technical advice to the Westside Select Committee

Eastside Technical Team – The Eastside Technical Team is comprised of municipal staff and supported by Urban Systems and CRD Staff. The Technical Team provides support and input to the Eastside Select Committee.

- Comprised of municipal staff; provides support and information to the Eastside Select Committee

7. MILESTONES

The Proposed Work Plan Overlay, which was adopted and submitted to 3P Canada in March 2014, provides the overarching timelines and milestones through the completion of the project (Attachment 2). A draft schedule identifying key tasks and milestones of the feasibility and costing exercise to be achieved by the end of 2015 during Phase 2 of the Core Area Sewage and Resource Recovery System 2.0 project is included for discussion (Attachment 3). The scheduling and implementation of the public consultation on the preferred solution sets (after the costing analysis) is anticipated to occur in early December, but is dependent on all of the deadlines being met up until that point.

A detailed schedule is under development and will be circulated for comment.

8. BUDGET

Funding for the project will be drawn from the Core Area Liquid Waste Management Plan operating reserve, funded by all participants in the service based on projected design capacity for 2030. A total budget of $1,250,000 has been identified to support this phase of the project, including engineering and public consultation consulting fees, Technical Oversight Panel honorarium and disbursements, Fairness and Transparency Advisor, public consultation process delivery and CRD staff time.

Phase 2 Budget

Item	Cost
Project Oversight (FTA & ToP)	$280,000
Public Consultation	$240,000
Feasibility and Costing Analysis	$450,000
Property and Zoning	$75,000
LWMP Amendment No. 10	$75,000
Staff and Wages	$300,000
Miscellaneous and Legal	$30,000
TOTAL	$1,450,000

9. CONSTRAINTS, ASSUMPTIONS, RISKS AND DEPENDENCIES

a) Constraints

- The timelines for this phase of the project are extremely aggressive with no buffer
- The schedule is dependent on multiple parties and governance bodies meeting their sub-project schedules

b) Assumptions

- The Minister of Environment will provide direct *conditional* approval of the Liquid Waste Management Plan upon submission to the Province

c) Risks

- The costing analysis and public consultation processes will be subject to criticism due to time constraints
- The governance model of the project is complex, leading to miscommunication or contradictory decision making
- Municipal councils do not endorse siting preferences of the CRD Board
- Potential loss of senior government funding if timelines are not met

d) Risk Mitigation

- Ensure regular, open reporting of all parties to the Core Area Liquid Waste Management Committee to ensure "no surprises" when public consultation is formally conducted
- Engage in close municipal council and staff involvement as preferred sites emerge and municipal planning/siting processes are initiated
- Ensure ongoing and open discussions with the funding agencies to ensure "no surprises" when the LWMP amendment is submitted for approval and the project is submitted for funding
- Ensure transparent and deep engagement with the community
- Ensure there is enough time required to rezone and that there is public support for rezoning

Attachments:	Attachment 1:	Planning Process – Core Area Liquid Waste Management Plan – Roles, Input & Relationships
	Attachment 2:	Proposed Work Plan Overlay – 3P Canada Funding Considerations
	Attachment 3:	Proposed Feasibility and Costing Analysis Schedule (Urban Systems) – August 31, 2015

APPENDIX C – COST TABLES

Cost Components for Option 1a - One Secondary Plant (x 1,000)

Cost Component	Capital Cost Incurred [1]		Operating Cost [1]		
	2015	2030	at 2015	at 2030	at 2045
1. Conveyance					
(a) Clover Pt PS and Forcemain to Rock Bay	$ 51,400	N/A	$ 540	$ 640	$ 730
(b) Macaulay Pt PS and Forcemain to Rock Bay	$ 65,400	N/A	$ 620	$ 730	$ 840
(c) Effluent PS and Forcemain to Clover Point	$ 83,900	N/A	$ 1,000	$ 1,190	$ 1,400
(d) Replace Clover Outfall	$ 32,500	N/A	incl. in (c)		incl. in (c)
(e) Reline Macaulay Outfall	$ 11,100	N/A	incl. in (b)		incl. in (b)
Conveyance Subtotal:	$ 244,300	$ -	$ 2,160	$ 2,560	$ 2,970
2. Liquid Treatment (Secondary)	$ 392,000	$ 162,000	$ 7,000	$ 10,100	$ 12,650
3. Solids Treatment - AD at Rock Bay	$ 258,000	$ 90,600	$ 5,000	$ 8,800	$ 10,300
4. Reuse					
(a) Tertiary Slipstream	$ 8,100	N/A	$ 230	$ 230	$ 230
(b) Effluent Pumping/Piping/Controls	$ 16,100	N/A	$ 70	$ 75	$ 80
Reuse Subtotal:	$ 24,200	$ -	$ 300	$ 305	$ 310
5. Existing System Capacity Upgrades					
(a) Craigflower PS - Constructed	$ 12,100	N/A	N/A	N/A	N/A
(b) Arbutus Attenuation Tank - incl land	$ 20,000	N/A	N/A	N/A	N/A
(c) Siphon Extension (1600 m)	$ 7,500	N/A	N/A	N/A	N/A
(d) Upgrade Currie St PS	$ 2,300	N/A	N/A	N/A	N/A
(e) Upgrade East Coast Interceptor (1400 m)	$ 3,100	N/A	N/A	N/A	N/A
Existing System Subtotal:	$ 45,000	$ -	$ -	$ -	$ -
6. Land Costs	$ 67,200				
Total:	**$ 1,030,700**	**$ 252,600**	**$ 14,460**	**$ 21,765**	**$ 26,230**

[1] Includes all contingencies, engineering, etc. outlined in TM #1

Summary - One Plant Option - Rock Bay - Secondary Treatment

One-Time and Ongoing Costs

Capital Costs to 2045 (1)	Annual Costs (at 2030)			Annual Resource Income (at 2030)
	O&M	Borrowing	Total	
$ 1,283,300,000	$ 21,800,000	$ -	$ 21,800,000	$ 900,000

Notes
(1) Includes initial construction costs in 2015 as well as plant upgrades in 2030. Also includes land costs.

	Initial Capital Costs (at 2015)	Net Annual Costs (at 2030)
One Plant - Rock Bay - Secondary Treatment	$ 1,030,700,000	$ 20,900,000

Net Present Value

Assumptions	
Interest Rate	7%
Inflation	2%
Real Discount Rate	5%
Time period	2015 to 2045

A real discount rate is used because we are using constant dollars.

Resource Income (from 2015 to 2045)

	Total Revenue (no discounting)	Present Value
Reclaimed water use	$ 23,300,000	$ 8,600,000
Heat recovery	$ -	$ -
Carbon credits	$ -	
Total	$ 23,300,000	$ 8,600,000

Costs (from 2015 to 2045)

	Total Costs (no discounting)	Present Value
Capital Costs	$ 1,283,300,000	$ 1,097,300,000
O&M	$ 633,900,000	$ 287,900,000
Borrowing Costs	$ -	$ -
Total	$ 1,917,200,000	$ 1,385,200,000

Net Present Value (2015 to 2045)	-$ 1,376,600,000

Ratio of Resource Income to Costs (at 2030)

Total annual revenues	$ 900,000
Total annual costs	$ 21,800,000
Ratio of revenues to costs	4%

Notes
(1) All costs in constant 2015 dollars.

Capital Costs - One Plant Option - Rock Bay - Secondary Treatment

	Capital costs to be incurred in 2015	Capital costs to be incurred in 2030
Total Construction Costs	$ 1,030,700,000	$ 252,600,000
Grants		
Net Project Costs	$ 1,030,700,000	$ 252,600,000

Notes

(1) Construction costs include general requirements (10%), contractor profit/overhead (10%), contingency (35%), escalation (2%/yr for four years), engineering (15%), CRD admin (8%) and interim financing (4%).
(2) Construction costs include land costs.
(3) Grant information from CRD.

Year	Capital Costs
2015	$ 1,030,700,000
2016	$ -
2017	$ -
2018	$ -
2019	$ -
2020	$ -
2021	$ -
2022	$ -
2023	$ -
2024	$ -
2025	$ -
2026	$ -
2027	$ -
2028	$ -
2029	$ -
2030	$ 252,600,000
2031	$ -
2032	$ -
2033	$ -
2034	$ -
2035	$ -
2036	$ -
2037	$ -
2038	$ -
2039	$ -
2040	$ -
2041	$ -
2042	$ -
2043	$ -
2044	$ -
2045	$ -
Total Capital Costs	$ 1,283,300,000

Present Value of Total Capital Costs (2015 to 2045) $ 1,097,338,000

Annual Costs - One Plant Option - Rock Bay - Secondary Treatment

Year	O&M Costs	Annual Borrowing Costs	Total Annual Costs
2015	$ -		$ -
2016	$ 14,460,000		$ 14,460,000
2017	$ 14,981,786		$ 14,981,786
2018	$ 15,503,571		$ 15,503,571
2019	$ 16,025,357		$ 16,025,357
2020	$ 16,547,143		$ 16,547,143
2021	$ 17,068,929		$ 17,068,929
2022	$ 17,590,714		$ 17,590,714
2023	$ 18,112,500		$ 18,112,500
2024	$ 18,634,286		$ 18,634,286
2025	$ 19,156,071		$ 19,156,071
2026	$ 19,677,857		$ 19,677,857
2027	$ 20,199,643		$ 20,199,643
2028	$ 20,721,429		$ 20,721,429
2029	$ 21,243,214		$ 21,243,214
2030	$ 21,765,000		$ 21,765,000
2031	$ 22,062,667		$ 22,062,667
2032	$ 22,360,333		$ 22,360,333
2033	$ 22,658,000		$ 22,658,000
2034	$ 22,955,667		$ 22,955,667
2035	$ 23,253,333		$ 23,253,333
2036	$ 23,551,000		$ 23,551,000
2037	$ 23,848,667		$ 23,848,667
2038	$ 24,146,333		$ 24,146,333
2039	$ 24,444,000		$ 24,444,000
2040	$ 24,741,667		$ 24,741,667
2041	$ 25,039,333		$ 25,039,333
2042	$ 25,337,000		$ 25,337,000
2043	$ 25,634,667		$ 25,634,667
2044	$ 25,932,333		$ 25,932,333
2045	$ 26,230,000		$ 26,230,000
Total	$ 633,883,000	$ -	$ 633,883,000
Present Value	$ 287,932,000	$ -	$ 287,932,000

Notes

(1) O&M estimates provided by Urban Systems for 2016, 2030 and 2045. These have been highlighted in blue.

(2) O&M costs between 2016, 2030 and 2045 have been interpolated linearly.

Revenue- One Plant Option - Rock Bay - Secondary Treatment

Assumptions	Water Rate (per cubic metre) (1)	Reclaimed water use rate (per cubic metre) 80% of Water Rate	Reclaimed water use rate for toilet flushing (per ML)	Reclaimed water use rate for land application
Rock Bay	$1.26	$1.01	$1,011.30	$ 510.00
Colwood	$1.81	$1.45	$1,448.00	$ 510.00
Esquimalt First Nation	$1.26	$1.01	$1,011.30	$ 510.00
East Saanich	$1.54	$1.23	$1,233.60	$ 510.00
Esquimalt Bullen Park	$1.26	$1.01	$1,011.30	$ 510.00
East Saanich	$1.54	$1.23	$1,233.60	$ 510.00
Saanich Core	$1.54	$1.23	$1,233.60	$ 510.00
Langford	$1.81	$1.45	$1,448.00	$ 510.00
View Royal	$1.81	$1.45	$1,448.00	$ 510.00

Notes:
(1) Source: Respective municipal websites.

	Rock Bay							
	Reclaimed Water Use (ML/yr)							
Year	Land Application (1)	Toilet Flushing(2)	Total Reclaimed Water Use	Total Annual Revenues from Reclaimed Water Use	Heat Recovery	Total Annual Revenues from Heat Recovery	Carbon Offsets	TOTAL
2015	0	0	0	$ -				$ -
2016	19	0	19	$ 9,520				$ 9,520
2017	37	0	37	$ 19,040				$ 19,040
2018	56	0	56	$ 28,560				$ 28,560
2019	75	0	75	$ 38,080				$ 38,080
2020	93	73	167	$ 121,741				$ 121,741
2021	93	147	240	$ 195,882				$ 195,882
2022	93	220	313	$ 270,023				$ 270,023
2023	93	293	387	$ 344,164				$ 344,164
2024	93	367	460	$ 418,305				$ 418,305
2025	93	440	533	$ 492,446				$ 492,446
2026	93	513	607	$ 566,587				$ 566,587
2027	93	587	680	$ 640,727				$ 640,727
2028	93	660	753	$ 714,868				$ 714,868
2029	93	733	826	$ 789,009				$ 789,009
2030	93	806	900	$ 863,150				$ 863,150
2031	93	880	973	$ 937,291				$ 937,291
2032	93	953	1046	$ 1,011,432				$ 1,011,432
2033	93	1026	1120	$ 1,085,573				$ 1,085,573
2034	93	1100	1193	$ 1,159,714				$ 1,159,714
2035	93	1173	1266	$ 1,233,855				$ 1,233,855
2036	93	1173	1266	$ 1,233,855				$ 1,233,855
2037	93	1173	1266	$ 1,233,855				$ 1,233,855
2038	93	1173	1266	$ 1,233,855				$ 1,233,855
2039	93	1173	1266	$ 1,233,855				$ 1,233,855
2040	93	1173	1266	$ 1,233,855				$ 1,233,855
2041	93	1173	1266	$ 1,233,855				$ 1,233,855
2042	93	1173	1266	$ 1,233,855				$ 1,233,855
2043	93	1173	1266	$ 1,233,855				$ 1,233,855
2044	93	1173	1266	$ 1,233,855				$ 1,233,855
2045	93	1173	1266	$ 1,233,855				$ 1,233,855
Total	2613	21701	24314	$ 23,278,516				$ 23,278,516
Present Value (2015 to 2045)				$ 8,608,000				$ 8,608,000

Notes
(1) Land application assumed to start at 0 in 2015 and increase linearly to max re-use in 2020.
(2) Flushing substitution assumed to be at 0 until 2020 and increase linearly to max re-use in 2035.
(3) Quantity data from Urban Systems, Nov 18, 2015.

Cost Components for Option 1b - One Tertiary Plant (x 1000)

Cost Component	Capital Cost Incurred (1)		Operating Cost (1)		
	2015	2030	at 2015	at 2030	at 2045
1. Conveyance					
(a) Clover Pt PS and Forcemain to Rock Bay	$ 51,400	N/A	$ 540	$ 640	$ 730
(b) Macaulay Pt PS and Forcemain to Rock Bay	$ 65,400	N/A	$ 620	$ 730	$ 840
(c) Effluent PS and Forcemain to Clover Point	$ 83,900	N/A	$ 1,000	$ 1,190	$ 1,400
(d) Replace Clover Outfall	$ 32,500	N/A	incl. in (c)		incl. in (c)
(e) Reline Macaulay Outfall	$ 11,100	N/A	incl. in (b)		incl. in (b)
Conveyance Subtotal:	$ 244,300	$ -	$ 2,160	$ 2,560	$ 2,970
2. Liquid Treatment (Tertiary)	$ 500,000	$ 220,000	$ 12,000	$ 15,000	$ 19,300
3. Solids Treatment - AD at Rock Bay	$ 258,000	$ 90,600	$ 5,000	$ 8,800	$ 10,300
4. Reuse					
(a) Effluent Pumping/Piping/Controls	$ 16,100	N/A	$ 70	$ 75	$ 80
5. Existing System Capacity Upgrades					
(a) Craigflower PS - Constructed	$ 12,100	N/A	N/A	N/A	N/A
(b) Arbutus Attenuation Tank- incl land	$ 20,000	N/A	N/A	N/A	N/A
(c) Siphon Extension (1600 m)	$ 7,500	N/A	N/A	N/A	N/A
(d) Upgrade Currie St PS	$ 2,300	N/A	N/A	N/A	N/A
(f) Upgrade East Coast Interceptor (1400 m)	$ 3,100	N/A	N/A	N/A	N/A
Existing System Subtotal:	$ 45,000	$ -	$ -	$ -	$ -
6. Land Costs	$ 67,200				
Total:	**$ 1,130,600**	**$ 310,600**	**$ 19,230**	**$ 26,435**	**$ 32,650**

(1) Includes all contingencies, engineering, etc. outlined in TM #1

Summary - One Plant Option - Rock Bay - Tertiary Treatment

One-Time and Ongoing Costs

Capital Costs to 2045 [1]	Annual Costs (at 2030)			Annual Resource Income (at 2030)
	O&M	Borrowing	Total	
$ 1,441,200,000	$ 26,400,000	$ -	$ 26,400,000	$ 900,000

Notes
(1) Includes initial construction costs in 2030 as well as plant upgrades in 2030. Also includes land costs.

	Initial Capital Costs (at 2015)	Net Annual Costs (at 2030)
One Plant - Rock Bay - Tertiary Treatment	$ 1,130,600,000	$ 25,500,000

Net Present Value

Assumptions	
Interest Rate	7%
Inflation	2%
Discount Rate	5%
Time period	2015 to 2045

Resource Income (from 2015 to 2045)

	Total Revenue (no discounting)	Present Value
Reclaimed water use	$ 23,300,000	$ 8,600,000
Heat recovery	$ -	$ -
Carbon credits	$ -	
Total	$ 23,300,000	$ 8,600,000

Costs (from 2015 to 2045)

	Total Costs (no discounting)	Present Value
Capital Costs	$ 1,441,200,000	$ 1,219,100,000
O&M	$ 788,700,000	$ 360,800,000
Borrowing Costs	$ -	$ -
Total	$ 2,229,900,000	$ 1,579,900,000

Net Present Value (2015 to 2045)	-$ 1,571,300,000

Ratio of Resource Income to Costs (at 2030)

Total annual revenues	$ 900,000
Total annual costs	$ 26,400,000
Ratio of revenues to costs	3%

Notes
(1) All costs in constant 2015 dollars.

Capital Costs - One Plant Option - Rock Bay - Tertiary Treatment

	Capital costs to be incurred in 2015	Capital costs to be incurred in 2030
Total Construction Costs	$ 1,130,600,000	$ 310,600,000
Grants		
Net Project Costs	$ 1,130,600,000	$ 310,600,000

Notes

(1) Construction costs include general requirements (10%), contractor profit/overhead (10%), contingency (35%), escalation (2%/yr for four years), engineering (15%), CRD admin (8%) and interim financing (4%).
(2) Construction costs include land costs.

Year	Capital Costs
2015	$ 1,130,600,000
2016	$ -
2017	$ -
2018	$ -
2019	$ -
2020	$ -
2021	$ -
2022	$ -
2023	$ -
2024	$ -
2025	$ -
2026	$ -
2027	$ -
2028	$ -
2029	$ -
2030	$ 310,600,000
2031	$ -
2032	$ -
2033	$ -
2034	$ -
2035	$ -
2036	$ -
2037	$ -
2038	$ -
2039	$ -
2040	$ -
2041	$ -
2042	$ -
2043	$ -
2044	$ -
2045	$ -
Total Capital Costs	$ 1,441,200,000

Present Value of Total Capital Costs (2015 to 2045) $ 1,219,051,000

Annual Costs - One Plant Option - Rock Bay - Tertiary Treatment

Year	O&M Costs	Annual Borrowing Costs	Total Annual Costs
2015	$ -		$ -
2016	$ 19,230,000		$ 19,230,000
2017	$ 19,744,643		$ 19,744,643
2018	$ 20,259,286		$ 20,259,286
2019	$ 20,773,929		$ 20,773,929
2020	$ 21,288,571		$ 21,288,571
2021	$ 21,803,214		$ 21,803,214
2022	$ 22,317,857		$ 22,317,857
2023	$ 22,832,500		$ 22,832,500
2024	$ 23,347,143		$ 23,347,143
2025	$ 23,861,786		$ 23,861,786
2026	$ 24,376,429		$ 24,376,429
2027	$ 24,891,071		$ 24,891,071
2028	$ 25,405,714		$ 25,405,714
2029	$ 25,920,357		$ 25,920,357
2030	$ 26,435,000		$ 26,435,000
2031	$ 26,849,333		$ 26,849,333
2032	$ 27,263,667		$ 27,263,667
2033	$ 27,678,000		$ 27,678,000
2034	$ 28,092,333		$ 28,092,333
2035	$ 28,506,667		$ 28,506,667
2036	$ 28,921,000		$ 28,921,000
2037	$ 29,335,333		$ 29,335,333
2038	$ 29,749,667		$ 29,749,667
2039	$ 30,164,000		$ 30,164,000
2040	$ 30,578,333		$ 30,578,333
2041	$ 30,992,667		$ 30,992,667
2042	$ 31,407,000		$ 31,407,000
2043	$ 31,821,333		$ 31,821,333
2044	$ 32,235,667		$ 32,235,667
2045	$ 32,650,000		$ 32,650,000
Total	$ 788,733,000	$ -	$ 788,733,000
Present Value	$ 360,798,000	$ -	$ 360,798,000

Notes

(1) O&M estimates provided by Urban Systems for 2016, 2030 and 2045. These have been highlighted in blue.

(2) O&M costs between 2016, 2030, and 2045 have been interpolated linearly.

Revenue- One Plant Option - Rock Bay - Tertiary Treatment

Assumptions	Water Rate (per cubic metre)	Reclaimed water use rate (per cubic metre) 80% of Water Rate	Reclaimed water use rate for flushing (per ML)	Water rate for land application
Rock Bay	$1.26	$1.01	$1,011.30	$ 510
Colwood	$1.81	$1.45	$1,448.00	$ 510
Esquimalt First Nation	$1.26	$1.01	$1,011.30	$ 510
East Saanich	$1.54	$1.23	$1,233.60	$ 510
Esquimalt Bullen Park	$1.26	$1.01	$1,011.30	$ 510
East Saanich	$1.54	$1.23	$1,233.60	$ 510
Saanich Core	$1.54	$1.23	$1,233.60	$ 510
Langford	$1.81	$1.45	$1,448.00	$ 510
View Royal	$1.81	$1.45	$1,448.00	$ 510

	Rock Bay							
	Reclaimed Water Use (ML/yr)							
Year	Land Application (1)	Toilet Flushing(2)	Total Reclaimed Water Use	Total Annual Revenues from Reclaimed Water Use	Heat Recovery	Total Annual Revenues from Heat Recovery	Carbon Offsets	TOTAL
2015	0	0	0	$ -				$ -
2016	19	0	19	$ 9,520				$ 9,520
2017	37	0	37	$ 19,040				$ 19,040
2018	56	0	56	$ 28,560				$ 28,560
2019	75	0	75	$ 38,080				$ 38,080
2020	93	73	167	$ 121,741				$ 121,741
2021	93	147	240	$ 195,882				$ 195,882
2022	93	220	313	$ 270,023				$ 270,023
2023	93	293	387	$ 344,164				$ 344,164
2024	93	367	460	$ 418,305				$ 418,305
2025	93	440	533	$ 492,446				$ 492,446
2026	93	513	607	$ 566,587				$ 566,587
2027	93	587	680	$ 640,727				$ 640,727
2028	93	660	753	$ 714,868				$ 714,868
2029	93	733	826	$ 789,009				$ 789,009
2030	93	806	900	$ 863,150				$ 863,150
2031	93	880	973	$ 937,291				$ 937,291
2032	93	953	1046	$ 1,011,432				$ 1,011,432
2033	93	1026	1120	$ 1,085,573				$ 1,085,573
2034	93	1100	1193	$ 1,159,714				$ 1,159,714
2035	93	1173	1266	$ 1,233,855				$ 1,233,855
2036	93	1173	1266	$ 1,233,855				$ 1,233,855
2037	93	1173	1266	$ 1,233,855				$ 1,233,855
2038	93	1173	1266	$ 1,233,855				$ 1,233,855
2039	93	1173	1266	$ 1,233,855				$ 1,233,855
2040	93	1173	1266	$ 1,233,855				$ 1,233,855
2041	93	1173	1266	$ 1,233,855				$ 1,233,855
2042	93	1173	1266	$ 1,233,855				$ 1,233,855
2043	93	1173	1266	$ 1,233,855				$ 1,233,855
2044	93	1173	1266	$ 1,233,855				$ 1,233,855
2045	93	1173	1266	$ 1,233,855				$ 1,233,855
Total	2613	21701	24314	$ 23,278,516		-		$ 23,278,516
Present Value (2015 to 2045)				$ 8,608,000				$ 8,608,000

Notes

(1) Land application assumed to start at 0 in 2015 and increase linearly to max re-use in 2020.

(2) Flushing substitution assumed to be at 0 until 2020 and increase linearly to max re-use in 2035.

Cost Components for Option 2 - Two Plants (x 1000)

Cost Component	Capital Cost Incurred [1]		Operating Cost [1]		
	2015	2030	at 2015	at 2030	at 2045
1. Conveyance - Rock Bay					
(a) Clover Pt PS and Forcemain to Rock Bay	$ 51,400	N/A	$ 540	$ 640	$ 730
(b) Macaulay Pt PS and Forcemain to Rock Bay	$ 65,400	N/A	$ 620	$ 730	$ 840
(c) Effluent PS and Forcemain to Clover Point	$ 83,900	N/A	$ 1,000	$ 1,190	$ 1,400
(d) Replace Clover Outfall	$ 32,500	N/A	incl. in (c)		incl. in (c)
(e) Reline Macaulay Outfall	$ 11,100	N/A	incl. in (b)		incl. in (b)
Conveyance - Rock Bay Subtotal:	$ 244,300	$ -	$ 2,160	$ 2,560	$ 2,970
2. Liquid Treatment - Rock Bay - Secondary	$ 392,000	$ 162,000	$ 7,000	$ 10,100	$ 12,650
3. Solids Treatment - AD at Rock Bay	$ 258,000	$ 90,600	$ 5,000	$ 8,800	$ 10,300
4. Reuse - Rock Bay					
(a) Tertiary Slipstream	$ 8,100	N/A	$ 230	$ 230	$ 230
(b) Effluent Pumping/Piping/Controls	$ 16,100	N/A	$ 70	$ 75	$ 80
Reuse - Rock Bay Subtotal:	$ 24,200	$ -	$ 300	$ 305	$ 310
6. Existing System Capacity Upgrades					
(a) Craigflower PS - Constructed	$ 12,100	N/A	N/A	N/A	N/A
(b) Arbutus Attenuation Tank - incl land	$ 20,000	N/A	N/A	N/A	N/A
(c) Siphon Extension (1600 m)	$ 7,500	N/A	N/A	N/A	N/A
(d) Upgrade Currie St PS	$ 2,300	N/A	N/A	N/A	N/A
(f) Upgrade East Coast Interceptor (1400 m)	$ 3,100	N/A	N/A	N/A	N/A
Existing System Subtotal:	$ 45,000	$ -	$ -	$ -	$ -
7. Conveyance - Colwood					
(a) Galloping Goose Trail PS/Forcemain To/From	$ 4,400	N/A	$ 70	$ 70	$ 75
8. Liquid Treatment - Colwood - Tertiary	$ 32,500	N/A	$ 600	$ 900	$ 900
9. Reuse - Colwood					
(a) Effluent Pumping/Piping/Controls	$ 16,600	N/A	$ 70	$ 75	$ 80
10. Land Costs	$ 71,000				
Total:	**$ 1,088,000**	**$ 252,600**	**$ 15,200**	**$ 22,810**	**$ 27,285**

[1] Includes all contingencies, engineering, etc. outlined in TM #1

Summary - Two Plant Option - Rock Bay and Colwood

One-Time and Ongoing Costs

Capital Costs to 2045 [1]	Annual Costs (at 2030)			Annual Resource Income (at 2030)
	O&M	Borrowing	Total	
$ 1,340,600,000	$ 22,800,000	$ -	$ 22,800,000	$ 2,500,000

Notes
(1) Includes initial construction costs in 2015 as well as plant upgrades in 2030. Also includes land costs.

	Intial Capital Costs (at 2015)	Net Annual Costs (at 2030)
Two Plants	$ 1,088,000,000	$ 20,300,000

Net Present Value

Assumptions	
Interest Rate	7%
Inflation	2%
Discount Rate	5%
Time period	2015 to 2045

Resource Income (from 2015 to 2045)

	Total Revenue (no discounting)	Present Value
Reclaimed water use	$ 66,900,000	$ 25,600,000
Heat recovery	$ -	$ -
Total	$ 66,900,000	$ 25,600,000

Costs (from 2015 to 2045)

	Total Costs (no discounting)	Present Value
Capital Costs	$ 1,340,600,000	$ 1,151,900,000
O&M	$ 663,000,000	$ 301,600,000
Borrowing Costs	$ -	$ -
Total	$ 2,003,600,000	$ 1,453,500,000

Net Present Value (2015 to 2045)	-$ 1,427,900,000

Ratio of Resource Income to Costs (at 2030)

Total annual revenues	$ 2,500,000
Total annual costs	$ 22,800,000
Ratio of revenues to costs	11%

Notes
(1) All costs in constant 2015 dollars.

Capital Costs - Two Plant Option - Rock Bay and Colwood

	Capital costs to be incurred in 2015	Capital costs to be incurred in 2030
Total Construction Costs	$ 1,088,000,000	$ 252,600,000
Grants		
Net Project Costs	$ 1,088,000,000	$ 252,600,000

Notes
(1) Construction costs include general requirements (10%), contractor profit/overhead (10%), contingency (35%), escalation (2%/yr for four years), engineering (15%), CRD admin (8%) and interim financing (4%).
(2) Construction costs include land costs.

Year	Capital Costs
2015	$ 1,088,000,000
2016	$ -
2017	$ -
2018	$ -
2019	$ -
2020	$ -
2021	$ -
2022	$ -
2023	$ -
2024	$ -
2025	$ -
2026	$ -
2027	$ -
2028	$ -
2029	$ -
2030	$ 252,600,000
2031	$ -
2032	$ -
2033	$ -
2034	$ -
2035	$ -
2036	$ -
2037	$ -
2038	$ -
2039	$ -
2040	$ -
2041	$ -
2042	$ -
2043	$ -
2044	$ -
2045	$ -
Total Capital Costs	$ 1,340,600,000

Present Value of Total Capital Costs (2015 to 2045) $ 1,151,909,000

Annual Costs - Two Plant Option - Rock Bay and Colwood

Year	O&M Costs	Annual Borrowing Costs	Total Annual Costs
2015	$ -		$ -
2016	$ 15,200,000		$ 15,200,000
2017	$ 15,743,571		$ 15,743,571
2018	$ 16,287,143		$ 16,287,143
2019	$ 16,830,714		$ 16,830,714
2020	$ 17,374,286		$ 17,374,286
2021	$ 17,917,857		$ 17,917,857
2022	$ 18,461,429		$ 18,461,429
2023	$ 19,005,000		$ 19,005,000
2024	$ 19,548,571		$ 19,548,571
2025	$ 20,092,143		$ 20,092,143
2026	$ 20,635,714		$ 20,635,714
2027	$ 21,179,286		$ 21,179,286
2028	$ 21,722,857		$ 21,722,857
2029	$ 22,266,429		$ 22,266,429
2030	$ 22,810,000		$ 22,810,000
2031	$ 23,108,333		$ 23,108,333
2032	$ 23,406,667		$ 23,406,667
2033	$ 23,705,000		$ 23,705,000
2034	$ 24,003,333		$ 24,003,333
2035	$ 24,301,667		$ 24,301,667
2036	$ 24,600,000		$ 24,600,000
2037	$ 24,898,333		$ 24,898,333
2038	$ 25,196,667		$ 25,196,667
2039	$ 25,495,000		$ 25,495,000
2040	$ 25,793,333		$ 25,793,333
2041	$ 26,091,667		$ 26,091,667
2042	$ 26,390,000		$ 26,390,000
2043	$ 26,688,333		$ 26,688,333
2044	$ 26,986,667		$ 26,986,667
2045	$ 27,285,000		$ 27,285,000
Total	$ 663,025,000	$ -	$ 663,025,000
Present Value	$ 301,552,000	$ -	$ 301,552,000

Notes

(1) O&M estimates provided by Urban Systems for 2016, 2030 and 2045. These have been highlighted in blue.

(2) O&M costs between 2016, 2030, and 2045 have been interpolated linearly.

Revenue- Two Plant Option - Rock Bay and Colwood

Assumptions	Water Rate (per cubic metre)	Reclaimed water use rate (per cubic metre) 80% of Water Rate	Reclaimed water use rate for flushing (per ML)	Water rate for land application
Rock Bay	$ 1.26	$ 1.01	$ 1,011.30	$ 510.00
Colwood	$ 1.81	$ 1.45	$ 1,448.00	$ 510.00
Esquimalt First Nation	$ 1.26	$ 1.01	$ 1,011.30	$ 510.00
East Saanich	$ 1.54	$ 1.23	$ 1,233.60	$ 510.00
Esquimalt Bullen Park	$ 1.26	$ 1.01	$ 1,011.30	$ 510.00
East Saanich	$ 1.54	$ 1.23	$ 1,233.60	$ 510.00
Saanich Core	$ 1.54	$ 1.23	$ 1,233.60	$ 510.00
Langford	$ 1.81	$ 1.45	$ 1,448.00	$ 510.00
View Royal	$ 1.81	$ 1.45	$ 1,448.00	$ 510.00

	Rock Bay								Colwood								Total Resource Income			
	Reclaimed Water Use (ML/yr)								Reclaimed Water Use (ML/yr)											
Year	Land Application (1)	Toilet Flushing(2)	Total Reclaimed Water Use	Total Annual Revenues from Reclaimed Water Use	Heat Recovery	Total Annual Revenues from Heat Recovery	Carbon Offsets	TOTAL	Land Application (1)	Toilet Flushing(2)	Total Reclaimed Water Use	Total Annual Revenues from Reclaimed Water Use	Heat Recovery	Total Annual Revenues from Heat Recovery	Carbon Offsets	TOTAL	Reclaimed Water Use	Heat Recovery	Carbon Offsets	Total
2015	0	0	0	$ -				$ -	0	0	0	$ -				$ -	$ -			$ -
2016	19	0	19	$ 9,520				$ 9,520	165	0	165	$ 84,320				$ 84,320	$ 93,840			$ 93,840
2017	37	0	37	$ 19,040				$ 19,040	331	0	331	$ 168,640				$ 168,640	$ 187,680			$ 187,680
2018	56	0	56	$ 28,560				$ 28,560	496	0	496	$ 252,960				$ 252,960	$ 281,520			$ 281,520
2019	75	0	75	$ 38,080				$ 38,080	661	0	661	$ 337,280				$ 337,280	$ 375,360			$ 375,360
2020	93	73	167	$ 121,741				$ 121,741	827	74	901	$ 529,024				$ 529,024	$ 650,764			$ 650,764
2021	93	147	240	$ 195,882				$ 195,882	827	148	975	$ 636,447				$ 636,447	$ 832,329			$ 832,329
2022	93	220	313	$ 270,023				$ 270,023	827	223	1049	$ 743,871				$ 743,871	$ 1,013,893			$ 1,013,893
2023	93	293	387	$ 344,164				$ 344,164	827	297	1123	$ 851,294				$ 851,294	$ 1,195,458			$ 1,195,458
2024	93	367	460	$ 418,304				$ 418,304	827	371	1198	$ 958,718				$ 958,718	$ 1,377,022			$ 1,377,022
2025	93	440	533	$ 492,445				$ 492,445	827	445	1272	$ 1,066,141				$ 1,066,141	$ 1,558,586			$ 1,558,586
2026	93	513	607	$ 566,586				$ 566,586	827	519	1346	$ 1,173,565				$ 1,173,565	$ 1,740,151			$ 1,740,151
2027	93	587	680	$ 640,727				$ 640,727	827	594	1420	$ 1,280,988				$ 1,280,988	$ 1,921,715			$ 1,921,715
2028	93	660	753	$ 714,868				$ 714,868	827	668	1494	$ 1,388,412				$ 1,388,412	$ 2,103,280			$ 2,103,280
2029	93	733	826	$ 789,009				$ 789,009	827	742	1569	$ 1,495,835				$ 1,495,835	$ 2,284,844			$ 2,284,844
2030	93	806	900	$ 863,150				$ 863,150	827	816	1643	$ 1,603,259				$ 1,603,259	$ 2,466,408			$ 2,466,408
2031	93	880	973	$ 937,291				$ 937,291	827	890	1717	$ 1,710,682				$ 1,710,682	$ 2,647,973			$ 2,647,973
2032	93	953	1046	$ 1,011,432				$ 1,011,432	827	964	1791	$ 1,818,106				$ 1,818,106	$ 2,829,537			$ 2,829,537
2033	93	1026	1120	$ 1,085,572				$ 1,085,572	827	1039	1865	$ 1,925,529				$ 1,925,529	$ 3,011,101			$ 3,011,101
2034	93	1100	1193	$ 1,159,713				$ 1,159,713	827	1113	1939	$ 2,032,953				$ 2,032,953	$ 3,192,666			$ 3,192,666
2035	93	1173	1266	$ 1,233,854				$ 1,233,854	827	1187	2014	$ 2,140,376				$ 2,140,376	$ 3,374,230			$ 3,374,230
2036	93	1173	1266	$ 1,233,854				$ 1,233,854	827	1187	2014	$ 2,140,376				$ 2,140,376	$ 3,374,230			$ 3,374,230
2037	93	1173	1266	$ 1,233,854				$ 1,233,854	827	1187	2014	$ 2,140,376				$ 2,140,376	$ 3,374,230			$ 3,374,230
2038	93	1173	1266	$ 1,233,854				$ 1,233,854	827	1187	2014	$ 2,140,376				$ 2,140,376	$ 3,374,230			$ 3,374,230
2039	93	1173	1266	$ 1,233,854				$ 1,233,854	827	1187	2014	$ 2,140,376				$ 2,140,376	$ 3,374,230			$ 3,374,230
2040	93	1173	1266	$ 1,233,854				$ 1,233,854	827	1187	2014	$ 2,140,376				$ 2,140,376	$ 3,374,230			$ 3,374,230
2041	93	1173	1266	$ 1,233,854				$ 1,233,854	827	1187	2014	$ 2,140,376				$ 2,140,376	$ 3,374,230			$ 3,374,230
2042	93	1173	1266	$ 1,233,854				$ 1,233,854	827	1187	2014	$ 2,140,376				$ 2,140,376	$ 3,374,230			$ 3,374,230
2043	93	1173	1266	$ 1,233,854				$ 1,233,854	827	1187	2014	$ 2,140,376				$ 2,140,376	$ 3,374,230			$ 3,374,230
2044	93	1173	1266	$ 1,233,854				$ 1,233,854	827	1187	2014	$ 2,140,376				$ 2,140,376	$ 3,374,230			$ 3,374,230
2045	93	1173	1266	$ 1,233,854				$ 1,233,854	827	1187	2014	$ 2,140,376				$ 2,140,376	$ 3,374,230			$ 3,374,230
Total	2613	21701	24314	$ 23,278,503		-		$ 23,278,503	23147	21960	45106	$ 43,602,156	-			$ 43,602,156	$ 66,880,659	-	-	$ 66,880,659
Present Value (2015 to 2045)				$ 8,608,000				$ 8,608,000				$ 17,025,000				$ 17,025,000	$ 25,632,000			$ 25,632,000

Notes
(1) Land application assumed to start at 0 in 2015 and increase linearly to max re-use in 2020.
(2) Flushing substitution assumed to be at 0 until 2020 and increase linearly to max re-use in 2035.

Table 5 – Cost Components for Option 5a – Three Plants (x 1000)

Cost Component	Capital Cost Incurred (1)		Operating Cost (1)		
	2015	2030	at 2015	at 2030	at 2045
1. Conveyance - Rock Bay					
(a) Clover Pt PS and Forcemain to Rock Bay	$ 51,400	N/A	$ 560	$ 650	$ 730
(b) Barnhard Park PS and Forcemain to Rock Bay	$ 39,600	N/A	$ 320	$ 330	$ 340
(c) Effluent PS and Forcemain to Clover Point	$ 53,700	N/A	$ 710	$ 760	$ 800
(d) Replace Clover Outfall	$ 23,500	N/A	in c above	in c above	in c above
Conveyance - Rock Bay Subtotal:	$ 168,200	$ -	$ 1,590	$ 1,740	$ 1,870
2. Liquid Treatment - Rock Bay (Secondary)	$ 282,000	$ 70,000	$ 5,000	$ 7,800	$ 9,900
3. Solids Treatment - AD at Rock Bay	$ 258,000	$ 90,600	$ 5,000	$ 8,800	$ 10,300
4. Reuse - Rock Bay					
(a) Tertiary Slipstream	$ 8,100	N/A	$ 230	$ 230	$ 230
(b) Effluent Pumping/Piping/Controls	$ 16,100	N/A	$ 70	$ 75	$ 80
Reuse - Rock Bay Subtotal:	$ 24,200	$ -	$ 300	$ 305	$ 310
5. Existing System Capacity Upgrades					
(a) Craigflower PS - Constructed	$ 12,100	N/A	N/A	N/A	N/A
(b) Arbutus Attenuation Tank- incl land	$ 20,000	N/A	N/A	N/A	N/A
(c) Siphon Extension (1600 m)	$ 7,500	N/A	N/A	N/A	N/A
(d) Upgrade Currie St PS	$ 2,300	N/A	N/A	N/A	N/A
(e) Upgrade East Coast Interceptor (1400 m)	$ 3,100	N/A	N/A	N/A	N/A
Existing System Subtotal:	$ 45,000	$ -	$ -	$ -	$ -
6. Conveyance - Colwood					
(a) East Boundary PS/FM to Plant	$ 14,500	N/A	$ 133	$ 140	$ 146
7. Liquid Treatment - Colwood/Langford (Secondary)	$ 71,100	$ 72,600	$ 1,300	$ 2,100	$ 3,800
8. Conveyance - Colwood/Langford					
(a) Effluent PS and FM to Shore	$ 31,900		$ 214	$ 250	$ 285
(b) New Outfall	$ 33,800		in b above	in b above	in b above
9. Conveyance - Esquimalt FN					
(a) Admirals Rd Trunk Tie-in and FM to Plant	$ 1,900		$ 43	$ 44	$ 45
(b) Macaulay Pt PS and Forcemain to WWTP	$ 16,600		$ 138	$ 140	$ 143
(c) Effluent PS and Forcemain to Macaulay	$ 18,700		$ 176	$ 188	$ 200
(d) Replace Macaulay Outfall	$ 12,600		in c above	in c above	in c above
Conveyance - Esquimalt FN Subtotal:	$ 49,800	$ -	$ 357	$ 372	$ 388
10. Liquid Treatment - Esquimalt (Secondary)	$ 51,700	$ 20,200	$ 900	$ 1,300	$ 2,000
11. Reuse - Esquimalt					
(a) Tertiary Slipstream	$ 4,100	N/A	$ 120	$ 120	$ 120
(b) Effluent Pumping/Piping/Controls	$ 14,000	N/A	$ 50	$ 60	$ 70
Reuse Esquimalt FN Subtotal:	$ 18,100	$ -	$ 170	$ 180	$ 190
13. Land Costs	$ 77,000 (2)	N/A			
Total:	**$ 1,125,300**	**$ 253,400**	**$ 14,964**	**$ 22,987**	**$ 29,189**

(1) Includes all contingencies, engineering, etc. outlined in TM #1

(2) Remove East Saanich and Langford VM Way at Meadford Way, but increase area at Colwood. Allow similar land cost to the Four Plant Option.

Summary - Three Plant Option - 5a (Secondary Treatment at Colwood/Langford)

One-Time and Ongoing Costs

Capital Costs to 2045 (1)	Annual Costs (at 2030)			Annual Resource Income (at 2030)
	O&M	Borrowing	Total	
$ 1,378,700,000	$ 23,000,000	$ -	$ 23,000,000	$ 1,200,000

Notes
(1) Includes initial construction costs in 2015 as well as plant upgrades in 2030. Also includes land costs.

	Initial Capital Costs (at 2015)	Net Annual Costs (at 2030)
Four Plants	$ 1,125,300,000	$ 21,800,000

Net Present Value

Assumptions	
Interest Rate	7%
Inflation	2%
Discount Rate	5%
Time period	2015 to 2045

Resource Income (from 2015 to 2045)

	Total Revenue (no discounting)	Present Value
Reclaimed water use	$ 31,900,000	$ 12,100,000
Heat recovery	$ -	$ -
Total	$ 31,900,000	$ 12,100,000

Costs (from 2015 to 2045)

	Total Costs (no discounting)	Present Value
Capital Costs	$ 1,378,700,000	$ 1,187,800,000
O&M	$ 679,100,000	$ 305,700,000
Borrowing Costs	$ -	$ -
Total	$ 2,057,800,000	$ 1,493,500,000

Net Present Value (2015 to 2045)	-$ 1,481,400,000

Ratio of Resource Income to Costs (at 2030)

Total annual revenues	$ 1,200,000
Total annual costs	$ 23,000,000
Ratio of revenues to costs	5%

Notes
(1) All costs in constant 2015 dollars.

Capital Costs - Three Plant Option - 5a (Secondary Treatment at Colwood/Langford)

	Capital costs to be incurred in 2015	Capital costs to be incurred in 2030
Total Construction Costs	$ 1,125,300,000	$ 253,400,000
Grants		
Net Project Costs	$ 1,125,300,000	$ 253,400,000

Notes

(1) Construction costs include general requirements (10%), contractor profit/overhead (10%), contingency (35%), escalation (2%/yr for four years), engineering (15%), CRD admin (8%) and interim financing (4%).

(2) Construction costs include land costs.

Year	Capital Costs
2015	$ 1,125,300,000
2016	$ -
2017	$ -
2018	$ -
2019	$ -
2020	$ -
2021	$ -
2022	$ -
2023	$ -
2024	$ -
2025	$ -
2026	$ -
2027	$ -
2028	$ -
2029	$ -
2030	$ 253,400,000
2031	$ -
2032	$ -
2033	$ -
2034	$ -
2035	$ -
2036	$ -
2037	$ -
2038	$ -
2039	$ -
2040	$ -
2041	$ -
2042	$ -
2043	$ -
2044	$ -
2045	$ -
Total	$ 1,378,700,000

Present Value of Total Capital Costs (2015 to 2045) $ 1,187,800,000

Annual Costs - Three Plant Option - 5a (Secondary Treatment at Colwood/Langford)

Year	O&M Costs	Annual Borrowing Costs	Total Annual Costs
2015	$ -		$ -
2016	$ 14,964,000		$ 14,964,000
2017	$ 15,537,071		$ 15,537,071
2018	$ 16,110,143		$ 16,110,143
2019	$ 16,683,214		$ 16,683,214
2020	$ 17,256,286		$ 17,256,286
2021	$ 17,829,357		$ 17,829,357
2022	$ 18,402,429		$ 18,402,429
2023	$ 18,975,500		$ 18,975,500
2024	$ 19,548,571		$ 19,548,571
2025	$ 20,121,643		$ 20,121,643
2026	$ 20,694,714		$ 20,694,714
2027	$ 21,267,786		$ 21,267,786
2028	$ 21,840,857		$ 21,840,857
2029	$ 22,413,929		$ 22,413,929
2030	$ 22,987,000		$ 22,987,000
2031	$ 23,400,467		$ 23,400,467
2032	$ 23,813,933		$ 23,813,933
2033	$ 24,227,400		$ 24,227,400
2034	$ 24,640,867		$ 24,640,867
2035	$ 25,054,333		$ 25,054,333
2036	$ 25,467,800		$ 25,467,800
2037	$ 25,881,267		$ 25,881,267
2038	$ 26,294,733		$ 26,294,733
2039	$ 26,708,200		$ 26,708,200
2040	$ 27,121,667		$ 27,121,667
2041	$ 27,535,133		$ 27,535,133
2042	$ 27,948,600		$ 27,948,600
2043	$ 28,362,067		$ 28,362,067
2044	$ 28,775,533		$ 28,775,533
2045	$ 29,189,000		$ 29,189,000
Total	$ 679,054,000	$ -	$ 679,054,000
Present Value	$ 305,724,000	$ -	$ 305,724,000

Notes

(1) O&M estimates provided by Urban Systems for 2016, 2030 and 2045. These have been highlighted in blue.

(2) O&M costs between 2016, 2030, and 2045 have been interpolated linearly.

Resource Income- Three Plant Option - 5a (Secondary Treatment at Colwood/Langford)

Assumptions	Water Rate (per cubic metre)(1)	Reclaimed water use rate (per cubic metre) 80% of Water Rate	Reclaimed water use rate for flushing (per ML)	Water rate for land use
Rock Bay	$ 1.26	$ 1.01	$ 1,011.30	$ 510.00
Colwood	$ 1.81	$ 1.45	$ 1,448.00	$ 510.00
Esquimalt First Nation	$ 1.26	$ 1.01	$ 1,011.30	$ 510.00
East Saanich	$ 1.54	$ 1.23	$ 1,233.60	$ 510.00
Esquimalt Bullen Park	$ 1.26	$ 1.01	$ 1,011.30	$ 510.00
East Saanich	$ 1.54	$ 1.23	$ 1,233.60	$ 510.00
Saanich Core	$ 1.54	$ 1.23	$ 1,233.60	$ 510.00
Langford	$ 1.81	$ 1.45	$ 1,448.00	$ 510.00
View Royal	$ 1.81	$ 1.45	$ 1,448.00	$ 510.00

Notes
(1) Source: Respective municipal websites.

	Rock Bay								Esquimalt First Nation								Total Resource Income			
	Reclaimed Water Use (ML/yr)			Total Annual Revenues from Reclaimed Water Use	Heat Recovery	Total Annual Revenues from Heat Recovery	Carbon Offsets	TOTAL	Reclaimed Water Use (ML/yr)			Total Annual Revenues from Reclaimed Water Use	Heat Recovery	Total Annual Revenues from Heat Recovery	Carbon Offsets	TOTAL	Reclaimed Water Use	Heat Recovery	Carbon Offsets	Total
Year	Land Application (1)	Toilet Flushing(2)	Total Reclaimed Water Use						Land Application (1)	Toilet Flushing(2)	Total Reclaimed Water Use									
2015	0	0	0	$ -				$ -	0	0	0	$ -				$ -	$ -			$ -
2016	19	0	19	$ 9,520				$ 9,520	45	0	45	$ 23,120				$ 23,120	$ 32,640			$ 32,640
2017	37	0	37	$ 19,040				$ 19,040	91	0	91	$ 46,240				$ 46,240	$ 65,280			$ 65,280
2018	56	0	56	$ 28,560				$ 28,560	136	0	136	$ 69,360				$ 69,360	$ 97,920			$ 97,920
2019	75	0	75	$ 38,080				$ 38,080	181	0	181	$ 92,480				$ 92,480	$ 130,560			$ 130,560
2020	93	73	167	$ 121,762				$ 121,762	227	18	245	$ 133,930				$ 133,930	$ 255,692			$ 255,692
2021	93	147	240	$ 195,924				$ 195,924	227	36	263	$ 152,260				$ 152,260	$ 348,184			$ 348,184
2022	93	220	313	$ 270,086				$ 270,086	227	54	281	$ 170,589				$ 170,589	$ 440,675			$ 440,675
2023	93	293	387	$ 344,248				$ 344,248	227	73	299	$ 188,919				$ 188,919	$ 533,167			$ 533,167
2024	93	367	460	$ 418,410				$ 418,410	227	91	317	$ 207,249				$ 207,249	$ 625,659			$ 625,659
2025	93	440	533	$ 492,572				$ 492,572	227	109	335	$ 225,579				$ 225,579	$ 718,151			$ 718,151
2026	93	513	607	$ 566,734				$ 566,734	227	127	354	$ 243,909				$ 243,909	$ 810,642			$ 810,642
2027	93	587	680	$ 640,896				$ 640,896	227	145	372	$ 262,238				$ 262,238	$ 903,134			$ 903,134
2028	93	660	753	$ 715,058				$ 715,058	227	163	390	$ 280,568				$ 280,568	$ 995,626			$ 995,626
2029	93	733	827	$ 789,220				$ 789,220	227	181	408	$ 298,898				$ 298,898	$ 1,088,118			$ 1,088,118
2030	93	807	900	$ 863,382				$ 863,382	227	199	426	$ 317,228				$ 317,228	$ 1,180,609			$ 1,180,609
2031	93	880	973	$ 937,544				$ 937,544	227	218	444	$ 335,558				$ 335,558	$ 1,273,101			$ 1,273,101
2032	93	953	1047	$ 1,011,705				$ 1,011,705	227	236	462	$ 353,887				$ 353,887	$ 1,365,593			$ 1,365,593
2033	93	1027	1120	$ 1,085,867				$ 1,085,867	227	254	480	$ 372,217				$ 372,217	$ 1,458,085			$ 1,458,085
2034	93	1100	1193	$ 1,160,029				$ 1,160,029	227	272	499	$ 390,547				$ 390,547	$ 1,550,576			$ 1,550,576
2035	93	1173	1267	$ 1,234,191				$ 1,234,191	227	290	517	$ 408,877				$ 408,877	$ 1,643,068			$ 1,643,068
2036	93	1173	1267	$ 1,234,191				$ 1,234,191	227	290	517	$ 408,877				$ 408,877	$ 1,643,068			$ 1,643,068
2037	93	1173	1267	$ 1,234,191				$ 1,234,191	227	290	517	$ 408,877				$ 408,877	$ 1,643,068			$ 1,643,068
2038	93	1173	1267	$ 1,234,191				$ 1,234,191	227	290	517	$ 408,877				$ 408,877	$ 1,643,068			$ 1,643,068
2039	93	1173	1267	$ 1,234,191				$ 1,234,191	227	290	517	$ 408,877				$ 408,877	$ 1,643,068			$ 1,643,068
2040	93	1173	1267	$ 1,234,191				$ 1,234,191	227	290	517	$ 408,877				$ 408,877	$ 1,643,068			$ 1,643,068
2041	93	1173	1267	$ 1,234,191				$ 1,234,191	227	290	517	$ 408,877				$ 408,877	$ 1,643,068			$ 1,643,068
2042	93	1173	1267	$ 1,234,191				$ 1,234,191	227	290	517	$ 408,877				$ 408,877	$ 1,643,068			$ 1,643,068
2043	93	1173	1267	$ 1,234,191				$ 1,234,191	227	290	517	$ 408,877				$ 408,877	$ 1,643,068			$ 1,643,068
2044	93	1173	1267	$ 1,234,191				$ 1,234,191	227	290	517	$ 408,877				$ 408,877	$ 1,643,068			$ 1,643,068
2045	93	1173	1267	$ 1,234,191				$ 1,234,191	227	290	517	$ 408,877				$ 408,877	$ 1,643,068			$ 1,643,068
Total	2613	21707	24320	$ 23,284,740		-		$ 23,284,740	6,347	5,365	11,712	$ 8,662,421	-			$ 8,662,421	$ 31,947,161	-	-	$ 31,947,161
Present Value (2015 to 2045)				$ 8,610,000		$ -		$ 8,610,000				$ 3,469,000				$ 3,469,000	$ 12,079,000			$ 12,079,000

Notes
(1) Land application assumed to start at 0 in 2015 and increase linearly to max re-use in 2020.
(2) Flushing substitution assumed to be at 0 until 2020 and increase linearly to max re-use in 2035.
(3) Quantity estimates for 2020 and 2035 provided by Urban Systems, Nov. 18th, 2015.

Table 6 – Cost Components for Option 5b – Three Plants (x 1000)

Cost Component	Capital Cost Incurred [1] 2015		Capital Cost Incurred [1] 2030	Operating Cost [1] at 2015	Operating Cost [1] at 2030	Operating Cost [1] at 2045
1. Conveyance - Rock Bay						
(a) Clover Pt PS and Forcemain to Rock Bay	$ 51,400		N/A	$ 560	$ 650	$ 730
(b) Barnhard Park PS and Forcemain to Rock Bay	$ 39,600		N/A	$ 320	$ 330	$ 340
(c) Effluent PS and Forcemain to Clover Point	$ 53,700		N/A	$ 710	$ 760	$ 800
(d) Replace Clover Outfall	$ 23,500		N/A	in c above	in c above	in c above
Conveyance - Rock Bay Subtotal:	$ 168,200		$ -	$ 1,590	$ 1,740	$ 1,870
2. Liquid Treatment - Rock Bay (Secondary)	$ 282,000		$ 70,000	$ 5,000	$ 7,800	$ 9,900
3. Solids Treatment - AD at Rock Bay	$ 258,000		$ 90,600	$ 5,000	$ 8,800	$ 10,300
4. Reuse - Rock Bay						
(a) Tertiary Slipstream	$ 8,100		N/A	$ 230	$ 230	$ 230
(b) Effluent Pumping/Piping/Controls	$ 16,100		N/A	$ 70	$ 75	$ 80
Reuse - Rock Bay Subtotal:	$ 24,200		$ -	$ 300	$ 305	$ 310
5. Existing System Capacity Upgrades						
(a) Craigflower PS - Constructed	$ 12,100		N/A	N/A	N/A	N/A
(b) Arbutus Attenuation Tank- incl land	$ 20,000		N/A	N/A	N/A	N/A
(c) Siphon Extension (1600 m)	$ 7,500		N/A	N/A	N/A	N/A
(d) Upgrade Currie St PS	$ 2,300		N/A	N/A	N/A	N/A
(e) Upgrade East Coast Interceptor (1400 m)	$ 3,100		N/A	N/A	N/A	N/A
Existing System Subtotal:	$ 45,000		$ -	$ -	$ -	$ -
6. Conveyance - Colwood						
(a) East Boundary PS/FM to Plant	$ 14,500		N/A	$ 133	$ 140	$ 146
7. Liquid Treatment - Colwood/Langford (Tertiary)	$ 106,800		$ 119,500	$ 2,000	$ 3,100	$ 5,800
8. Reuse - Colwood						
(a) Effluent Pumping/Piping/Controls	$ 16,600		N/A	$ 70	$ 75	$ 80
9. Conveyance - Colwood/Langford						
(a) Effluent PS and FM to Shore	$ 31,900			$ 214	$ 250	$ 285
(b) New Outfall	$ 33,800			in b above	in b above	in b above
10. Conveyance - Esquimalt FN						
(a) Admirals Rd Trunk Tie-in and FM to Plant	$ 1,900			$ 43	$ 44	$ 45
(b) Macaulay Pt PS and Forcemain to WWTP	$ 16,600			$ 138	$ 140	$ 143
(c) Effluent PS and Forcemain to Macaulay	$ 18,700			$ 176	$ 188	$ 200
(d) Replace Macaulay Outfall	$ 12,600			in c above	in c above	in c above
Conveyance - Esquimalt FN Subtotal:	$ 49,800		$ -	$ 357	$ 372	$ 388
11. Liquid Treatment - Esquimalt (Secondary)	$ 51,700		$ 20,200	$ 900	$ 1,300	$ 2,000
12. Reuse - Esquimalt						
(a) Tertiary Slipstream	$ 4,100		N/A	$ 120	$ 120	$ 120
(b) Effluent Pumping/Piping/Controls	$ 14,000		N/A	$ 50	$ 60	$ 70
Reuse Esquimalt FN Subtotal:	$ 18,100		$ -	$ 170	$ 180	$ 190
13. Land Costs	$ 77,000	[2]	N/A			
Total:	**$1,177,600**		**$ 300,300**	**$ 15,734**	**$ 24,062**	**$ 31,269**

[1] Includes all contingencies, engineering, etc. outlined in TM #1

[2] Remove East Saanich and Langford VM Way at Meadford Way, but increase area at Colwood. Allow similar land cost to the Four Plant Option.

Summary - Three Plant Option - 5b Tertiary Treatment at Colwood/Langford

One-Time and Ongoing Costs

Capital Costs to 2045 (1)	Annual Costs (at 2030)			Annual Resource Income (at 2030)
	O&M	Borrowing	Total	
$ 1,477,900,000	$ 24,100,000	$ -	$ 24,100,000	$ 2,800,000

Notes
(1) Includes initial construction costs in 2015 as well as plant upgrades in 2030. Also includes land costs.

	Initial Capital Costs (at 2015)	Net Annual Costs (at 2030)
Four Plants	$ 1,177,600,000	$ 21,300,000

Net Present Value

Assumptions	
Interest Rate	7%
Inflation	2%
Discount Rate	5%
Time period	2015 to 2045

Resource Income (from 2015 to 2045)

	Total Revenue (no discounting)	Present Value
Reclaimed water use	$ 75,500,000	$ 29,100,000
Heat recovery	$ -	$ -
Total	$ 75,500,000	$ 29,100,000

Costs (from 2015 to 2045)

	Total Costs (no discounting)	Present Value
Capital Costs	$ 1,477,900,000	$ 1,259,100,000
O&M	$ 717,100,000	$ 322,000,000
Borrowing Costs	$ -	$ -
Total	$ 2,195,000,000	$ 1,581,100,000

Net Present Value (2015 to 2045)	-$ 1,552,000,000

Ratio of Resource Income to Costs (at 2030)

Total annual revenues	$ 2,800,000
Total annual costs	$ 24,100,000
Ratio of revenues to costs	12%

Notes
(1) All costs in constant 2015 dollars.

Capital Costs - Three Plant Option - 5b Tertiary Treatment at Colwood/Langford)

	Capital costs to be incurred in 2015	Capital costs to be incurred in 2030
Total Construction Costs	$ 1,177,600,000	$ 300,300,000
Grants		
Net Project Costs	$ 1,177,600,000	$ 300,300,000

Notes

(1) Construction costs include general requirements (10%), contractor profit/overhead (10%), contingency (35%), escalation (2%/yr for four years), engineering (15%), CRD admin (8%) and interim financing (4%).

(2) Construction costs include land costs.

Year	Capital Costs
2015	$ 1,177,600,000
2016	$ -
2017	$ -
2018	$ -
2019	$ -
2020	$ -
2021	$ -
2022	$ -
2023	$ -
2024	$ -
2025	$ -
2026	$ -
2027	$ -
2028	$ -
2029	$ -
2030	$ 300,300,000
2031	$ -
2032	$ -
2033	$ -
2034	$ -
2035	$ -
2036	$ -
2037	$ -
2038	$ -
2039	$ -
2040	$ -
2041	$ -
2042	$ -
2043	$ -
2044	$ -
2045	$ -
Total	$ 1,477,900,000

Present Value of Total Capital Costs (2015 to 2045) $ 1,259,095,000

Annual Costs - Three Plant Option - 5b Tertiary Treatment at Colwood/Langford)

Year	O&M Costs	Annual Borrowing Costs	Total Annual Costs
2015	$ -		$ -
2016	$ 15,734,000		$ 15,734,000
2017	$ 16,328,857		$ 16,328,857
2018	$ 16,923,714		$ 16,923,714
2019	$ 17,518,571		$ 17,518,571
2020	$ 18,113,429		$ 18,113,429
2021	$ 18,708,286		$ 18,708,286
2022	$ 19,303,143		$ 19,303,143
2023	$ 19,898,000		$ 19,898,000
2024	$ 20,492,857		$ 20,492,857
2025	$ 21,087,714		$ 21,087,714
2026	$ 21,682,571		$ 21,682,571
2027	$ 22,277,429		$ 22,277,429
2028	$ 22,872,286		$ 22,872,286
2029	$ 23,467,143		$ 23,467,143
2030	$ 24,062,000		$ 24,062,000
2031	$ 24,542,467		$ 24,542,467
2032	$ 25,022,933		$ 25,022,933
2033	$ 25,503,400		$ 25,503,400
2034	$ 25,983,867		$ 25,983,867
2035	$ 26,464,333		$ 26,464,333
2036	$ 26,944,800		$ 26,944,800
2037	$ 27,425,267		$ 27,425,267
2038	$ 27,905,733		$ 27,905,733
2039	$ 28,386,200		$ 28,386,200
2040	$ 28,866,667		$ 28,866,667
2041	$ 29,347,133		$ 29,347,133
2042	$ 29,827,600		$ 29,827,600
2043	$ 30,308,067		$ 30,308,067
2044	$ 30,788,533		$ 30,788,533
2045	$ 31,269,000		$ 31,269,000
Total	$ 717,056,000	$ -	$ 717,056,000
Present Value	$ 322,022,000	$ -	$ 322,022,000

Notes

(1) O&M estimates provided by Urban Systems for 2016, 2030 and 2045. These have been highlighted in blue.

(2) O&M costs between 2016, 2030, and 2045 have been interpolated linearly.

Resource Income- Three Plant Option - 5b Tertiary Treatment at Colwood/Langford)

Assumptions	Water Rate (per cubic metre)(1)	Reclaimed water use rate (per cubic metre) 80% of Water Rate	Reclaimed water use rate for flushing (per ML)	Water rate for land use
Rock Bay	$ 1.26	$ 1.01	$ 1,011.30	$ 510.00
Colwood	$ 1.81	$ 1.45	$ 1,448.00	$ 510.00
Esquimalt First Nation	$ 1.26	$ 1.01	$ 1,011.30	$ 510.00
East Saanich	$ 1.54	$ 1.23	$ 1,233.60	$ 510.00
Esquimalt Bullen Park	$ 1.26	$ 1.01	$ 1,011.30	$ 510.00
East Saanich	$ 1.54	$ 1.23	$ 1,233.60	$ 510.00
Saanich Core	$ 1.54	$ 1.23	$ 1,233.60	$ 510.00
Langford	$ 1.81	$ 1.45	$ 1,448.00	$ 510.00
View Royal	$ 1.81	$ 1.45	$ 1,448.00	$ 510.00

Notes
(1) Source: Respective municipal websites.

Rock Bay

Year	Reclaimed Water Use (ML/yr): Land Application (1)	Reclaimed Water Use (ML/yr): Toilet Flushing(2)	Reclaimed Water Use (ML/yr): Total Reclaimed Water Use	Total Annual Revenues from Reclaimed Water Use	Heat Recovery	Total Annual Revenues from Heat Recovery	Carbon Offsets	TOTAL
2015	0	0	0	$ -				$ -
2016	19	0	19	$ 9,520				$ 9,520
2017	37	0	37	$ 19,040				$ 19,040
2018	56	0	56	$ 28,560				$ 28,560
2019	75	0	75	$ 38,080				$ 38,080
2020	93	73	167	$ 121,762				$ 121,762
2021	93	147	240	$ 195,924				$ 195,924
2022	93	220	313	$ 270,086				$ 270,086
2023	93	293	387	$ 344,248				$ 344,248
2024	93	367	460	$ 418,410				$ 418,410
2025	93	440	533	$ 492,572				$ 492,572
2026	93	513	607	$ 566,734				$ 566,734
2027	93	587	680	$ 640,896				$ 640,896
2028	93	660	753	$ 715,058				$ 715,058
2029	93	733	827	$ 789,220				$ 789,220
2030	93	807	900	$ 863,382				$ 863,382
2031	93	880	973	$ 937,544				$ 937,544
2032	93	953	1047	$ 1,011,705				$ 1,011,705
2033	93	1027	1120	$ 1,085,867				$ 1,085,867
2034	93	1100	1193	$ 1,160,029				$ 1,160,029
2035	93	1173	1267	$ 1,234,191				$ 1,234,191
2036	93	1173	1267	$ 1,234,191				$ 1,234,191
2037	93	1173	1267	$ 1,234,191				$ 1,234,191
2038	93	1173	1267	$ 1,234,191				$ 1,234,191
2039	93	1173	1267	$ 1,234,191				$ 1,234,191
2040	93	1173	1267	$ 1,234,191				$ 1,234,191
2041	93	1173	1267	$ 1,234,191				$ 1,234,191
2042	93	1173	1267	$ 1,234,191				$ 1,234,191
2043	93	1173	1267	$ 1,234,191				$ 1,234,191
2044	93	1173	1267	$ 1,234,191				$ 1,234,191
2045	93	1173	1267	$ 1,234,191				$ 1,234,191
Total	2613	21707	24320	$ 23,284,740		-		$ 23,284,740
Present Value (2015 to 2045)				$ 8,610,000		$ -		$ 8,610,000

Colwood

Year	Reclaimed Water Use (ML/yr): Land Application (1)	Reclaimed Water Use (ML/yr): Toilet Flushing(2)	Reclaimed Water Use (ML/yr): Total Reclaimed Water Use	Total Annual Revenues from Reclaimed Water Use	Heat Recovery	Total Annual Revenues from Heat Recovery	Carbon Offsets	TOTAL
2015	0	0	0	$ -				$ -
2016	165	0	165.3333333	$ 84,320				$ 84,320
2017	331	0	330.6666667	$ 168,640				$ 168,640
2018	496	0	496	$ 252,960				$ 252,960
2019	661	0	661.3333333	$ 337,280				$ 337,280
2020	827	74	901	$ 528,993				$ 528,993
2021	827	148	975	$ 636,387				$ 636,387
2022	827	223	1049	$ 743,780				$ 743,780
2023	827	297	1123	$ 851,173				$ 851,173
2024	827	371	1198	$ 958,567				$ 958,567
2025	827	445	1272	$ 1,065,960				$ 1,065,960
2026	827	519	1346	$ 1,173,353				$ 1,173,353
2027	827	593	1420	$ 1,280,747				$ 1,280,747
2028	827	668	1494	$ 1,388,140				$ 1,388,140
2029	827	742	1568	$ 1,495,533				$ 1,495,533
2030	827	816	1643	$ 1,602,927				$ 1,602,927
2031	827	890	1717	$ 1,710,320				$ 1,710,320
2032	827	964	1791	$ 1,817,713				$ 1,817,713
2033	827	1038	1865	$ 1,925,107				$ 1,925,107
2034	827	1113	1939	$ 2,032,500				$ 2,032,500
2035	827	1187	2013	$ 2,139,893				$ 2,139,893
2036	827	1187	2013	$ 2,139,893				$ 2,139,893
2037	827	1187	2013	$ 2,139,893				$ 2,139,893
2038	827	1187	2013	$ 2,139,893				$ 2,139,893
2039	827	1187	2013	$ 2,139,893				$ 2,139,893
2040	827	1187	2013	$ 2,139,893				$ 2,139,893
2041	827	1187	2013	$ 2,139,893				$ 2,139,893
2042	827	1187	2013	$ 2,139,893				$ 2,139,893
2043	827	1187	2013	$ 2,139,893				$ 2,139,893
2044	827	1187	2013	$ 2,139,893				$ 2,139,893
2045	827	1187	2013	$ 2,139,893				$ 2,139,893
Total	23,147	21,953	45,100	$ 43,593,227	-			$ 43,593,227
Present Value (2015 to 2045)				$ 17,021,000		$0		$ 17,021,000

Esquimalt First Nation

Year	Reclaimed Water Use (ML/yr): Land Application (1)	Reclaimed Water Use (ML/yr): Toilet Flushing(2)	Reclaimed Water Use (ML/yr): Total Reclaimed Water Use	Total Annual Revenues from Reclaimed Water Use	Heat Recovery	Total Annual Revenues from Heat Recovery	Carbon Offsets	TOTAL
2015	0	0	0	$ -				$ -
2016	45	0	45	$ 23,120				$ 23,120
2017	91	0	91	$ 46,240				$ 46,240
2018	136	0	136	$ 69,360				$ 69,360
2019	181	0	181	$ 92,480				$ 92,480
2020	227	18	245	$ 133,930				$ 133,930
2021	227	36	263	$ 152,260				$ 152,260
2022	227	54	281	$ 170,589				$ 170,589
2023	227	73	299	$ 188,919				$ 188,919
2024	227	91	317	$ 207,249				$ 207,249
2025	227	109	335	$ 225,579				$ 225,579
2026	227	127	354	$ 243,909				$ 243,909
2027	227	145	372	$ 262,238				$ 262,238
2028	227	163	390	$ 280,568				$ 280,568
2029	227	181	408	$ 298,898				$ 298,898
2030	227	199	426	$ 317,228				$ 317,228
2031	227	218	444	$ 335,558				$ 335,558
2032	227	236	462	$ 353,887				$ 353,887
2033	227	254	480	$ 372,217				$ 372,217
2034	227	272	499	$ 390,547				$ 390,547
2035	227	290	517	$ 408,877				$ 408,877
2036	227	290	517	$ 408,877				$ 408,877
2037	227	290	517	$ 408,877				$ 408,877
2038	227	290	517	$ 408,877				$ 408,877
2039	227	290	517	$ 408,877				$ 408,877
2040	227	290	517	$ 408,877				$ 408,877
2041	227	290	517	$ 408,877				$ 408,877
2042	227	290	517	$ 408,877				$ 408,877
2043	227	290	517	$ 408,877				$ 408,877
2044	227	290	517	$ 408,877				$ 408,877
2045	227	290	517	$ 408,877				$ 408,877
Total	6,347	5,365	11,712	$ 8,662,421	-			$ 8,662,421
Present Value (2015 to 2045)				$ 3,469,000				$ 3,469,000

Total Resource Income

Year	Reclaimed Water Use	Heat Recovery	Carbon Offsets	Total
2015	$ -			$ -
2016	$ 116,960			$ 116,960
2017	$ 233,920			$ 233,920
2018	$ 350,880			$ 350,880
2019	$ 467,840			$ 467,840
2020	$ 784,685			$ 784,685
2021	$ 984,570			$ 984,570
2022	$ 1,184,455			$ 1,184,455
2023	$ 1,384,340			$ 1,384,340
2024	$ 1,584,225			$ 1,584,225
2025	$ 1,784,111			$ 1,784,111
2026	$ 1,983,996			$ 1,983,996
2027	$ 2,183,881			$ 2,183,881
2028	$ 2,383,766			$ 2,383,766
2029	$ 2,583,651			$ 2,583,651
2030	$ 2,783,536			$ 2,783,536
2031	$ 2,983,421			$ 2,983,421
2032	$ 3,183,306			$ 3,183,306
2033	$ 3,383,191			$ 3,383,191
2034	$ 3,583,076			$ 3,583,076
2035	$ 3,782,962			$ 3,782,962
2036	$ 3,782,962			$ 3,782,962
2037	$ 3,782,962			$ 3,782,962
2038	$ 3,782,962			$ 3,782,962
2039	$ 3,782,962			$ 3,782,962
2040	$ 3,782,962			$ 3,782,962
2041	$ 3,782,962			$ 3,782,962
2042	$ 3,782,962			$ 3,782,962
2043	$ 3,782,962			$ 3,782,962
2044	$ 3,782,962			$ 3,782,962
2045	$ 3,782,962			$ 3,782,962
Total	$ 75,540,388	-	-	$ 75,540,388
Present Value (2015 to 2045)	$ 29,100,000			$ 29,100,000

Notes
(1) Land application assumed to start at 0 in 2015 and increase linearly to max re-use in 2020.
(2) Flushing substitution assumed to be at 0 until 2020 and increase linearly to max re-use in 2035.
(3) Quantity estimates for 2020 and 2035 provided by Urban Systems, Nov. 18th, 2015.

Cost Components for Option 3 - Four Plants (x 1000)

Cost Component	Capital Cost Incurred [1]		Operating Cost [1]		
	2015	2030	at 2015	at 2030	at 2045
1. Conveyance - Rock Bay					
(a) Clover Pt PS and Forcemain to Rock Bay	$ 51,400	N/A	$ 560	$ 650	$ 730
(b) Barnhard Park PS and Forcemain to Rock Bay	$ 39,600	N/A	$ 320	$ 330	$ 340
(c) Effluent PS and Forcemain to Clover Point	$ 53,700	N/A	$ 710	$ 760	$ 800
(d) Replace Clover Outfall	$ 23,500	N/A	incl. in (c)		incl. in (c)
Conveyance - Rock Bay Subtotal:	$ 168,200	$ -	$ 1,590	$ 1,740	$ 1,870
2. Liquid Treatment - Rock Bay (Secondary)	$ 282,000	$ 70,000	$ 5,000	$ 7,800	$ 9,900
3. Solids Treatment - AD at Rock Bay	$ 258,000	$ 90,600	$ 5,000	$ 8,800	$ 10,300
4. Reuse - Rock Bay					
(a) Tertiary Slipstream	$ 8,100	N/A	$ 230	$ 230	$ 230
(b) Effluent Pumping/Piping/Controls	$ 16,100	N/A	$ 70	$ 75	$ 80
Reuse - Rock Bay Subtotal:	$ 24,200	$ -	$ 300	$ 305	$ 310
5. Existing System Capacity Upgrades					
(a) Craigflower PS - Constructed	$ 12,100	N/A	N/A	N/A	N/A
(b) Arbutus Attenuation Tank- incl land	$ 20,000	N/A	N/A	N/A	N/A
(c) Siphon Extension (1600 m)	$ 7,500	N/A	N/A	N/A	N/A
(d) Upgrade Currie St PS	$ 2,300	N/A	N/A	N/A	N/A
(e) Upgrade East Coast Interceptor (1400 m)	$ 3,100	N/A	N/A	N/A	N/A
Existing System Subtotal:	$ 45,000	$ -	$ -	$ -	$ -
6. Conveyance - Colwood					
(a) Galloping Goose Trail PS/Forcemain To/From	$ 4,400	N/A	$ 70	$ 70	$ 75
7. Liquid Treatment - Colwood (Tertiary)	$ 32,500	N/A	$ 600	$ 900	$ 900
8. Reuse - Colwood					
(a) Effluent Pumping/Piping/Controls	$ 16,600	N/A	$ 70	$ 75	$ 80
9. Conveyance - Esquimalt FN					
(a) Admirals Rd Trunk Tie-in and FM to Plant	$ 4,600	N/A	N/A		N/A
(b) Macaulay Pt PS and Forcemain to WWTP	$ 16,600	N/A	$ 130	$ 140	$ 150
(c) Effluent PS and Forcemain to Macaulay	$ 42,600	N/A	$ 320	$ 420	$ 530
(d) Replace Macaulay Outfall	$ 34,200	N/A	incl. in (c)		incl. in (c)
Conveyance - Esquimalt FN Subtotal:	$ 98,000	$ -	$ 450	$ 560	$ 680
10. Liquid Treatment - Esquimalt (Secondary)	$ 141,000	$ 100,000	$ 3,000	$ 4,500	$ 6,000
11. Reuse - Esquimalt					
(a) Tertiary Slipstream	$ 4,100	N/A	$ 120	$ 120	$ 120
(b) Effluent Pumping/Piping/Controls	$ 14,000	N/A	$ 50	$ 60	$ 70
Reuse Esquimalt FN Subtotal:	$ 18,100	$ -	$ 170	$ 180	$ 190
12. Conveyance - East Saanich					
(a) Garnet PS Upgrade and Forcemain To/From	$ 4,000	N/A	$ 50	$ 60	$ 70
13. Liquid Treatment - East Saanich (Tertiary)	$ 10,000	$ 6,500	$ 200	$ 300	$ 500
14. Reuse - East Saanich					
(a) Effluent Pumping/Piping/Controls	$ 16,100	N/A	$ 50	$ 55	$ 60
15. Land Costs	$ 77,200	N/A			
Total:	**$ 1,195,300**	**$ 267,100**	**$ 16,550**	**$ 25,345**	**$ 30,935**

[1] Includes all contingencies, engineering, etc. outlined in TM #1

Summary - Four Plant Option

One-Time and Ongoing Costs

Capital Costs to 2045 (1)	Annual Costs (at 2030)			Annual Resource Income (at 2030)
	O&M	Borrowing	Total	
$ 1,462,400,000	$ 25,300,000	$ -	$ 25,300,000	$ 3,800,000

Notes
(1) Includes initial construction costs in 2015 as well as plant upgrades in 2030. Also includes land costs.

	Initial Capital Costs (at 2015)	Net Annual Costs (at 2030)
Four Plants	$ 1,195,300,000	$ 21,500,000

Net Present Value

Assumptions	
Interest Rate	7%
Inflation	2%
Discount Rate	5%
Time period	2015 to 2045

Resource Income (from 2015 to 2045)

	Total Revenue (no discounting)	Present Value
Reclaimed water use	$ 102,300,000	$ 40,200,000
Heat recovery	$ -	$ -
Total	$ 102,300,000	$ 40,200,000

Costs (from 2015 to 2045)

	Total Costs (no discounting)	Present Value
Capital Costs	$ 1,462,400,000	$ 1,260,700,000
O&M	$ 739,100,000	$ 334,600,000
Borrowing Costs	$ -	$ -
Total	$ 2,201,500,000	$ 1,595,300,000

Net Present Value (2015 to 2045)	-$ 1,555,100,000

Ratio of Resource Income to Costs (at 2030)

Total annual revenues	$ 3,800,000
Total annual costs	$ 25,300,000
Ratio of revenues to costs	15%

Notes
(1) All costs in constant 2015 dollars.

Capital Costs - Four Plant Option

	Capital costs to be incurred in 2015	Capital costs to be incurred in 2030
Total Construction Costs	$ 1,195,300,000	$ 267,100,000
Grants		
Net Project Costs	$ 1,195,300,000	$ 267,100,000

Notes

(1) Construction costs include general requirements (10%), contractor profit/overhead (10%), contingency (35%), escalation (2%/yr for four years), engineering (15%), CRD admin (8%) and interim financing (4%).

(2) Construction costs include land costs.

Year	Capital Costs
2015	$ 1,195,300,000
2016	$ -
2017	$ -
2018	$ -
2019	$ -
2020	$ -
2021	$ -
2022	$ -
2023	$ -
2024	$ -
2025	$ -
2026	$ -
2027	$ -
2028	$ -
2029	$ -
2030	$ 267,100,000
2031	$ -
2032	$ -
2033	$ -
2034	$ -
2035	$ -
2036	$ -
2037	$ -
2038	$ -
2039	$ -
2040	$ -
2041	$ -
2042	$ -
2043	$ -
2044	$ -
2045	$ -
Total	$ 1,462,400,000

Present Value of Total Capital Costs (2015 to 2045)	$ 1,260,743,000

Annual Costs - Four Plant Option

Year	O&M Costs	Annual Borrowing Costs	Total Annual Costs
2015	$ -		$ -
2016	$ 16,550,000		$ 16,550,000
2017	$ 17,178,214		$ 17,178,214
2018	$ 17,806,429		$ 17,806,429
2019	$ 18,434,643		$ 18,434,643
2020	$ 19,062,857		$ 19,062,857
2021	$ 19,691,071		$ 19,691,071
2022	$ 20,319,286		$ 20,319,286
2023	$ 20,947,500		$ 20,947,500
2024	$ 21,575,714		$ 21,575,714
2025	$ 22,203,929		$ 22,203,929
2026	$ 22,832,143		$ 22,832,143
2027	$ 23,460,357		$ 23,460,357
2028	$ 24,088,571		$ 24,088,571
2029	$ 24,716,786		$ 24,716,786
2030	$ 25,345,000		$ 25,345,000
2031	$ 25,717,667		$ 25,717,667
2032	$ 26,090,333		$ 26,090,333
2033	$ 26,463,000		$ 26,463,000
2034	$ 26,835,667		$ 26,835,667
2035	$ 27,208,333		$ 27,208,333
2036	$ 27,581,000		$ 27,581,000
2037	$ 27,953,667		$ 27,953,667
2038	$ 28,326,333		$ 28,326,333
2039	$ 28,699,000		$ 28,699,000
2040	$ 29,071,667		$ 29,071,667
2041	$ 29,444,333		$ 29,444,333
2042	$ 29,817,000		$ 29,817,000
2043	$ 30,189,667		$ 30,189,667
2044	$ 30,562,333		$ 30,562,333
2045	$ 30,935,000		$ 30,935,000
Total	$ 739,108,000	$ -	$ 739,108,000
Present Value	$ 334,562,000	$ -	$ 334,562,000

Notes

(1) O&M estimates provided by Urban Systems for 2016, 2030 and 2045. These have been highlighted in blue.

(2) O&M costs between 2016, 2030, and 2045 have been interpolated linearly.

Resource Income- Four Plant Option

Assumptions	Water Rate (per cubic metre)(1)	Reclaimed water use rate (per cubic metre) 80% of Water Rate	Reclaimed water use rate for flushing (per ML)	Water rate for land use
Rock Bay	$ 1.26	$ 1.01	$ 1,011.30	$ 510.00
Colwood	$ 1.81	$ 1.45	$ 1,448.00	$ 510.00
Esquimalt First Nation	$ 1.26	$ 1.01	$ 1,011.30	$ 510.00
East Saanich	$ 1.54	$ 1.23	$ 1,233.60	$ 510.00
Esquimalt Bullen Park	$ 1.26	$ 1.01	$ 1,011.30	$ 510.00
East Saanich	$ 1.54	$ 1.23	$ 1,233.60	$ 510.00
Saanich Core	$ 1.54	$ 1.23	$ 1,233.60	$ 510.00
Langford	$ 1.81	$ 1.45	$ 1,448.00	$ 510.00
View Royal	$ 1.81	$ 1.45	$ 1,448.00	$ 510.00

Notes
(1) Source: Respective municipal websites.

	Rock Bay							
	Reclaimed Water Use (ML/yr)							
Year	Land Application (1)	Toilet Flushing(2)	Total Reclaimed Water Use	Total Annual Revenues from Reclaimed Water Use	Heat Recovery	Total Annual Revenues from Heat Recovery	Carbon Offsets	TOTAL
2015	0	0	0	$ -				$ -
2016	19	0	19	$ 9,520				$ 9,520
2017	37	0	37	$ 19,040				$ 19,040
2018	56	0	56	$ 28,560				$ 28,560
2019	75	0	75	$ 38,080				$ 38,080
2020	93	73	167	$ 121,762				$ 121,762
2021	93	147	240	$ 195,924				$ 195,924
2022	93	220	313	$ 270,086				$ 270,086
2023	93	293	387	$ 344,248				$ 344,248
2024	93	367	460	$ 418,410				$ 418,410
2025	93	440	533	$ 492,572				$ 492,572
2026	93	513	607	$ 566,734				$ 566,734
2027	93	587	680	$ 640,896				$ 640,896
2028	93	660	753	$ 715,058				$ 715,058
2029	93	733	827	$ 789,220				$ 789,220
2030	93	807	900	$ 863,382				$ 863,382
2031	93	880	973	$ 937,544				$ 937,544
2032	93	953	1047	$ 1,011,705				$ 1,011,705
2033	93	1027	1120	$ 1,085,867				$ 1,085,867
2034	93	1100	1193	$ 1,160,029				$ 1,160,029
2035	93	1173	1267	$ 1,234,191				$ 1,234,191
2036	93	1173	1267	$ 1,234,191				$ 1,234,191
2037	93	1173	1267	$ 1,234,191				$ 1,234,191
2038	93	1173	1267	$ 1,234,191				$ 1,234,191
2039	93	1173	1267	$ 1,234,191				$ 1,234,191
2040	93	1173	1267	$ 1,234,191				$ 1,234,191
2041	93	1173	1267	$ 1,234,191				$ 1,234,191
2042	93	1173	1267	$ 1,234,191				$ 1,234,191
2043	93	1173	1267	$ 1,234,191				$ 1,234,191
2044	93	1173	1267	$ 1,234,191				$ 1,234,191
2045	93	1173	1267	$ 1,234,191				$ 1,234,191
Total	2613	21707	24320	$ 23,284,740		-		$ 23,284,740
Present Value (2015 to 2045)				$ 8,610,000		$ -		$ 8,610,000

	Colwood							
	Reclaimed Water Use (ML/yr)							
Year	Land Application (1)	Toilet Flushing(2)	Total Reclaimed Water Use	Total Annual Revenues from Reclaimed Water Use	Heat Recovery	Total Annual Revenues from Heat Recovery	Carbon Offsets	TOTAL
2015	0	0	0	$ -				$ -
2016	165	0	165	$ 84,320				$ 84,320
2017	331	0	331	$ 168,640				$ 168,640
2018	496	0	496	$ 252,960				$ 252,960
2019	661	0	661	$ 337,280				$ 337,280
2020	827	74	901	$ 528,993				$ 528,993
2021	827	148	975	$ 636,387				$ 636,387
2022	827	223	1049	$ 743,780				$ 743,780
2023	827	297	1123	$ 851,173				$ 851,173
2024	827	371	1198	$ 958,567				$ 958,567
2025	827	445	1272	$ 1,065,960				$ 1,065,960
2026	827	519	1346	$ 1,173,353				$ 1,173,353
2027	827	593	1420	$ 1,280,747				$ 1,280,747
2028	827	668	1494	$ 1,388,140				$ 1,388,140
2029	827	742	1568	$ 1,495,533				$ 1,495,533
2030	827	816	1643	$ 1,602,927				$ 1,602,927
2031	827	890	1717	$ 1,710,320				$ 1,710,320
2032	827	964	1791	$ 1,817,713				$ 1,817,713
2033	827	1038	1865	$ 1,925,107				$ 1,925,107
2034	827	1113	1939	$ 2,032,500				$ 2,032,500
2035	827	1187	2013	$ 2,139,893				$ 2,139,893
2036	827	1187	2013	$ 2,139,893				$ 2,139,893
2037	827	1187	2013	$ 2,139,893				$ 2,139,893
2038	827	1187	2013	$ 2,139,893				$ 2,139,893
2039	827	1187	2013	$ 2,139,893				$ 2,139,893
2040	827	1187	2013	$ 2,139,893				$ 2,139,893
2041	827	1187	2013	$ 2,139,893				$ 2,139,893
2042	827	1187	2013	$ 2,139,893				$ 2,139,893
2043	827	1187	2013	$ 2,139,893				$ 2,139,893
2044	827	1187	2013	$ 2,139,893				$ 2,139,893
2045	827	1187	2013	$ 2,139,893				$ 2,139,893
Total	23,147	21,953	45,100	$ 43,593,227	-			$ 43,593,227
Present Value (2015 to 2045)				$ 17,021,000		$0		$ 17,021,000

	Esquimalt First Nation							
	Reclaimed Water Use (ML/yr)							
Year	Land Application (1)	Toilet Flushing(2)	Total Reclaimed Water Use	Total Annual Revenues from Reclaimed Water Use	Heat Recovery	Total Annual Revenues from Heat Recovery	Carbon Offsets	TOTAL
2015	0	0	0	$ -				$ -
2016	45	0	45	$ 23,120				$ 23,120
2017	91	0	91	$ 46,240				$ 46,240
2018	136	0	136	$ 69,360				$ 69,360
2019	181	0	181	$ 92,480				$ 92,480
2020	227	18	245	$ 133,930				$ 133,930
2021	227	36	263	$ 152,260				$ 152,260
2022	227	54	281	$ 170,589				$ 170,589
2023	227	73	299	$ 188,919				$ 188,919
2024	227	91	317	$ 207,249				$ 207,249
2025	227	109	335	$ 225,579				$ 225,579
2026	227	127	354	$ 243,909				$ 243,909
2027	227	145	372	$ 262,238				$ 262,238
2028	227	163	390	$ 280,568				$ 280,568
2029	227	181	408	$ 298,898				$ 298,898
2030	227	199	426	$ 317,228				$ 317,228
2031	227	218	444	$ 335,558				$ 335,558
2032	227	236	462	$ 353,887				$ 353,887
2033	227	254	480	$ 372,217				$ 372,217
2034	227	272	499	$ 390,547				$ 390,547
2035	227	290	517	$ 408,877				$ 408,877
2036	227	290	517	$ 408,877				$ 408,877
2037	227	290	517	$ 408,877				$ 408,877
2038	227	290	517	$ 408,877				$ 408,877
2039	227	290	517	$ 408,877				$ 408,877
2040	227	290	517	$ 408,877				$ 408,877
2041	227	290	517	$ 408,877				$ 408,877
2042	227	290	517	$ 408,877				$ 408,877
2043	227	290	517	$ 408,877				$ 408,877
2044	227	290	517	$ 408,877				$ 408,877
2045	227	290	517	$ 408,877				$ 408,877
Total	6,347	5,365	11,712	$ 8,662,421	-			$ 8,662,421
Present Value (2015 to 2045)				$ 3,469,000				$ 3,469,000

	East Saanich							
	Reclaimed Water Use (ML/yr)							
Year	Land Application (1)	Toilet Flushing(2)	Total Reclaimed Water Use	Total Annual Revenues from Reclaimed Water Use	Heat Recovery	Total Annual Revenues from Heat Recovery	Carbon Offsets	TOTAL
2015	0	0	0	$ -				$ -
2016	192	0	192	$ 97,920				$ 97,920
2017	384	0	384	$ 195,840				$ 195,840
2018	576	0	576	$ 293,760				$ 293,760
2019	768	0	768	$ 391,680				$ 391,680
2020	960	36	996	$ 533,804				$ 533,804
2021	960	72	1032	$ 578,008				$ 578,008
2022	960	108	1068	$ 622,212				$ 622,212
2023	960	143	1103	$ 666,416				$ 666,416
2024	960	179	1139	$ 710,620				$ 710,620
2025	960	215	1175	$ 754,824				$ 754,824
2026	960	251	1211	$ 799,028				$ 799,028
2027	960	287	1247	$ 843,232				$ 843,232
2028	960	323	1283	$ 887,436				$ 887,436
2029	960	358	1318	$ 931,640				$ 931,640
2030	960	394	1354	$ 975,844				$ 975,844
2031	960	430	1390	$ 1,020,048				$ 1,020,048
2032	960	466	1426	$ 1,064,252				$ 1,064,252
2033	960	502	1462	$ 1,108,456				$ 1,108,456
2034	960	538	1498	$ 1,152,660				$ 1,152,660
2035	960	573	1533	$ 1,196,864				$ 1,196,864
2036	960	573	1533	$ 1,196,864				$ 1,196,864
2037	960	573	1533	$ 1,196,864				$ 1,196,864
2038	960	573	1533	$ 1,196,864				$ 1,196,864
2039	960	573	1533	$ 1,196,864				$ 1,196,864
2040	960	573	1533	$ 1,196,864				$ 1,196,864
2041	960	573	1533	$ 1,196,864				$ 1,196,864
2042	960	573	1533	$ 1,196,864				$ 1,196,864
2043	960	573	1533	$ 1,196,864				$ 1,196,864
2044	960	573	1533	$ 1,196,864				$ 1,196,864
2045	960	573	1533	$ 1,196,864				$ 1,196,864
Total	26,880	10,607	37,487	$ 26,793,184	-			$ 26,793,184
Present Value (2015 to 2045)				$ 11,087,000				$ 11,087,000

	Total Resource Income			
Year	Reclaimed Water Use	Heat Recovery	Carbon Offsets	Total
2015	$ -			$ -
2016	$ 214,880			$ 214,880
2017	$ 429,760			$ 429,760
2018	$ 644,640			$ 644,640
2019	$ 859,520			$ 859,520
2020	$ 1,318,489			$ 1,318,489
2021	$ 1,562,578			$ 1,562,578
2022	$ 1,806,667			$ 1,806,667
2023	$ 2,050,756			$ 2,050,756
2024	$ 2,294,845			$ 2,294,845
2025	$ 2,538,935			$ 2,538,935
2026	$ 2,783,024			$ 2,783,024
2027	$ 3,027,113			$ 3,027,113
2028	$ 3,271,202			$ 3,271,202
2029	$ 3,515,291			$ 3,515,291
2030	$ 3,759,380			$ 3,759,380
2031	$ 4,003,469			$ 4,003,469
2032	$ 4,247,558			$ 4,247,558
2033	$ 4,491,647			$ 4,491,647
2034	$ 4,735,736			$ 4,735,736
2035	$ 4,979,826			$ 4,979,826
2036	$ 4,979,826			$ 4,979,826
2037	$ 4,979,826			$ 4,979,826
2038	$ 4,979,826			$ 4,979,826
2039	$ 4,979,826			$ 4,979,826
2040	$ 4,979,826			$ 4,979,826
2041	$ 4,979,826			$ 4,979,826
2042	$ 4,979,826			$ 4,979,826
2043	$ 4,979,826			$ 4,979,826
2044	$ 4,979,826			$ 4,979,826
2045	$ 4,979,826			$ 4,979,826
Total	$ 102,333,572	-	-	$ 102,333,572
Present Value (2015 to 2045)	$ 40,187,000			$ 40,187,000

Notes
(1) Land application assumed to start at 0 in 2015 and increase linearly to max re-use in 2020.
(2) Flushing substitution assumed to be at 0 until 2020 and increase linearly to max re-use in 2035.
(3) Quantity estimates for 2020 and 2035 provided by Urban Systems, Nov. 18th, 2015.

Cost Components for Option 4 - Seven Plants (x 1000)

Cost Component	Capital Cost Incurred [1]		Operating Cost [1]		
	2015	2030	at 2015	at 2030	at 2045
1. Conveyance - Rock Bay					
(a) Clover Pt PS and Forcemain to Rock Bay	$ 51,400	N/A	$ 560	$ 645	$ 730
(b) Barnhard Pk PS and Forcemain to Rock Bay	$ 39,600	N/A	$ 320	$ 335	$ 350
(c) Effluent PS and Forcemain to Clover	$ 53,700	N/A	$ 710	$ 755	$ 800
(d) Replace Clover Outfall	$ 23,500	N/A	incl. in (c)		incl. in (c)
Conveyance - Rock Bay Subtotal:	$ 168,200	$ -	$ 1,590	$ 1,735	$ 1,880
2. Liquid Treatment - Rock Bay (Secondary)	$ 282,000	$ 70,000	$ 5,000	$ 7,800	$ 9,900
3. Solids Treatment - AD at Rock Bay	$ 258,000	$ 90,600	$ 5,000	$ 8,800	$ 10,300
4. Reuse - Rock Bay					
(a) Tertiary Slipstream	$ 8,100	N/A	$ 230	$ 230	$ 230
(b) Effluent Pumping/Piping/Controls	$ 16,100	N/A	$ 70	$ 75	$ 80
Reuse - Rock Bay Subtotal:	$ 24,200	$ -	$ 300	$ 305	$ 310
5. Existing System Capacity Upgrades					
(a) Craigflower PS - Constructed	$ 12,100	N/A	N/A	N/A	N/A
(b) Arbutus Attenuation Tank- incl land	$ 20,000	N/A	N/A	N/A	N/A
(c) Siphon Extension (1600 m)	$ 7,500	N/A	N/A	N/A	N/A
(d) Upgrade Currie St PS	$ 2,300	N/A	N/A	N/A	N/A
(e) Upgrade East Coast Interceptor (1400 m)	$ 3,100	N/A	N/A	N/A	N/A
Existing System Subtotal:	$ 45,000	$ -	$ -	$ -	$ -
6. Conveyance - Esquimalt					
(a) Lyall St PS and Forcemain to WWTP	$ 24,100	N/A	$ 230	$ 235	$ 240
(b) Macaulay Pt PS and Forcemain to WWTP	$ 10,100	N/A	$ 120	$ 120	$ 120
(c) Effluent PS and Forcemain to Macaulay Point	$ 19,900	N/A	$ 230	$ 275	$ 320
(d) Replace Macaulay Outfall	$ 34,200	N/A	incl. in (c)		incl. in (c)
Conveyance - Esquimalt Subtotal:	$ 88,300	$ -	$ 580	$ 630	$ 680
7. Liquid Treatment - Esquimalt (Tertiary)	$ 67,000	$ 12,000	$ 1,200	$ 1,900	$ 2,200
8. Reuse - Esquimalt					
(a) Effluent Pumping/Piping/Controls	$ 14,000	N/A	$ 50	$ 50	$ 50
9. Conveyance - View Royal					
(a) Retrofit Craigflower PS and all conveyance to Colwood	$ 14,700	N/A	$ 130	$ 145	$ 160
10. Liquid Treatment - View Royal (Tertiary)	$ 23,000	$ 22,000	$ 400	$ 700	$ 1,300
11. Conveyance - Colwood					
(a) PS at Colwood Border/Forcemain To WWTP	$ 9,900	N/A	$ 80	$ 95	$ 110
(b) View Royal and Colwood Effluent to Junction with Langford	$ 1,100	N/A	$ 5	$ 5	$ 5
Conveyance - Colwood Subtotal:	$ 11,000	$ -	$ 85	$ 100	$ 115
12. Liquid Treatment - Colwood (Tertiary)	$ 32,500	$ 50,600	$ 600	$ 900	$ 2,200
13. Reuse - Colwood					
(a) Effluent Pumping/Piping/Controls (high peak flows)	$ 19,100	N/A	$ 70	$ 75	$ 80

Cost Components for Option 4 - Seven Plants (x 1000)

Cost Component	Capital Cost Incurred [1]		Operating Cost [1]		
	2015	2030	at 2015	at 2030	at 2045
14. Conveyance - Langford					
(a) Raw Sewage PS and Forcemain to WWTP	$ 11,800	N/A	$ 130	$ 135	$ 140
(b) Effluent Pumping and Forcemain to Junction with Colwood/Langford	$ 10,300	N/A	$ 80	$ 85	$ 90
(c) Junction to Marine Shore	$ 12,000	N/A	$ 30	$ 45	$ 60
(d) New Outfall	$ 33,800	N/A	incl. in (c)		incl. in (c)
Conveyance - Langford Subtotal:	$ 67,900	$ -	$ 240	$ 265	$ 290
15. Liquid Treatment - Langford (Tertiary)	$ 82,000	$ 54,000	$ 1,500	$ 2,200	$ 3,700
16. Conveyance - East Saanich					
(a) Garnet PS Upgrade and Forcemain To/From	$ 4,000	N/A	$ 50	$ 55	$ 60
17. Liquid Treatment - East Saanich (Tertiary)	$ 10,000	$ 7,000	$ 200	$ 300	$ 500
18. Reuse - East Saanich					
(a) Effluent Pumping/Piping/Controls	$ 16,100	N/A	$ 50	$ 55	$ 60
19. Conveyance - Saanich Core					
(a) Galloping Goose Trail PS and Forcemain To/From	$ 3,100	N/A	$ 60	$ 65	$ 70
20. Liquid Treatment - Saanich Core (Tertiary)	$ 16,000	N/A	$ 300	$ 500	$ 500
21. Reuse - Saanich Core					
(a) Effluent Pumping/Piping/Controls	$ 8,800	N/A	$ 50	$ 50	$ 50
22. Land Costs	$ 93,400	N/A			
Total:	**$ 1,348,300**	**$ 306,200**	**$ 17,455**	**$ 26,630**	**$ 34,405**

[1] Includes all contingencies, engineering, etc. outlined in TM #1

Summary - Seven Plant Option

One-Time and Ongoing Costs

Capital Costs to 2045 [1]	Annual Costs (at 2030)			Annual Resource Income (at 2030)
	O&M	Borrowing	Total	
$ 1,654,500,000	$ 26,600,000	$ -	$ 26,600,000	$ 4,100,000

Notes
(1) Includes initial construction costs in 2015 as well as plant upgrades in 2030. Also includes land costs.

	Initial Capital Costs (at 2015)	Net Annual Costs (at 2030)
Seven Plants	$ 1,348,300,000	$ 22,500,000

Net Present Value

Assumptions	
Interest Rate	7%
Inflation	2%
Discount Rate	5%
Time period	2015 to 2045

Resource Income (from 2015 to 2045)

	Total Revenue (no discounting)	Present Value
Reclaimed water use	$ 111,700,000	$ 43,700,000
Heat recovery	$ -	$ -
Total	$ 111,700,000	$ 43,700,000

Costs (from 2015 to 2045)

	Total Costs (no discounting)	Present Value
Capital Costs	$ 1,654,500,000	$ 1,424,400,000
O&M	$ 792,300,000	$ 356,200,000
Borrowing Costs	$ -	$ -
Total	$ 2,446,800,000	$ 1,780,600,000

Net Present Value (2015 to 2045)	-$ 1,736,900,000

Ratio of Resource Income to Costs (at 2030)

Total annual revenues	$ 4,100,000
Total annual costs	$ 26,600,000.00
Ratio of revenues to costs	15%

Notes
(1) All costs in constant 2015 dollars.

Capital Costs - Seven Plant Option

	Capital costs to be incurred in 2015	Capital costs to be incurred in 2030
Total Construction Costs	$ 1,348,300,000	$ 306,200,000
Grants		
Net Project Costs	$ 1,348,300,000	$ 306,200,000

Notes
(1) Construction costs include general requirements (10%), contractor profit/overhead (10%), contingency (35%), escalation (2%/yr for four years), engineering (15%), CRD admin (8%) and interim financing (4%).
(2) Construction costs include land costs.

Year	Capital Costs
2015	$ 1,348,300,000
2016	$ -
2017	$ -
2018	$ -
2019	$ -
2020	$ -
2021	$ -
2022	$ -
2023	$ -
2024	$ -
2025	$ -
2026	$ -
2027	$ -
2028	$ -
2029	$ -
2030	$ 306,200,000
2031	$ -
2032	$ -
2033	$ -
2034	$ -
2035	$ -
2036	$ -
2037	$ -
2038	$ -
2039	$ -
2040	$ -
2041	$ -
2042	$ -
2043	$ -
2044	$ -
2045	$ -
Total Capital Costs	$ 1,654,500,000

Present Value of Total Capital Costs (2015 to 2045)	$ 1,424,369,000

Annual Costs - Seven Plant Option

Year	O&M Costs	Annual Borrowing Costs	Total Annual Costs
2015	$ -		$ -
2016	$ 17,455,000		$ 17,455,000
2017	$ 18,110,357		$ 18,110,357
2018	$ 18,765,714		$ 18,765,714
2019	$ 19,421,071		$ 19,421,071
2020	$ 20,076,429		$ 20,076,429
2021	$ 20,731,786		$ 20,731,786
2022	$ 21,387,143		$ 21,387,143
2023	$ 22,042,500		$ 22,042,500
2024	$ 22,697,857		$ 22,697,857
2025	$ 23,353,214		$ 23,353,214
2026	$ 24,008,571		$ 24,008,571
2027	$ 24,663,929		$ 24,663,929
2028	$ 25,319,286		$ 25,319,286
2029	$ 25,974,643		$ 25,974,643
2030	$ 26,630,000		$ 26,630,000
2031	$ 27,148,333		$ 27,148,333
2032	$ 27,666,667		$ 27,666,667
2033	$ 28,185,000		$ 28,185,000
2034	$ 28,703,333		$ 28,703,333
2035	$ 29,221,667		$ 29,221,667
2036	$ 29,740,000		$ 29,740,000
2037	$ 30,258,333		$ 30,258,333
2038	$ 30,776,667		$ 30,776,667
2039	$ 31,295,000		$ 31,295,000
2040	$ 31,813,333		$ 31,813,333
2041	$ 32,331,667		$ 32,331,667
2042	$ 32,850,000		$ 32,850,000
2043	$ 33,368,333		$ 33,368,333
2044	$ 33,886,667		$ 33,886,667
2045	$ 34,405,000		$ 34,405,000
Total	$ 792,288,000	$ -	$ 792,288,000
Present Value	$ 356,170,000	$ -	$ 356,170,000

Notes

(1) O&M estimates provided by Urban Systems for 2016, 2030 and 2045. These have been highlighted in blue.

(2) O&M costs between 2016, 2030, and 2045 have been interpolated linearly.

Resource Income- Seven Plant Option

Assumptions	Water Rate (per cubic metre)	Reclaimed water use rate (per cubic metre) 80% of Water Rate	Reclaimed water use rate (per ML) for flushing	Reclaimed water use rate (per ML) for land application
Rock Bay	$ 1.26	$ 1.01	$ 1,011	$ 510
Colwood	$ 1.81	$ 1.45	$ 1,448	$ 510
Esquimalt First Nation	$ 1.26	$ 1.01	$ 1,011	$ 510
East Saanich	$ 1.54	$ 1.23	$ 1,234	$ 510
Esquimalt Bullen Park	$ 1.26	$ 1.01	$ 1,011	$ 510
East Saanich	$ 1.54	$ 1.23	$ 1,234	$ 510
Saanich Core	$ 1.54	$ 1.23	$ 1,234	$ 510
Langford	$ 1.81	$ 1.45	$ 1,448	$ 510
View Royal	$ 1.81	$ 1.45	$ 1,448	$ 510

	Rock Bay							
	Reclaimed Water Use (ML/yr)							
Year	Land Application (1)	Toilet Flushing(2)	Total Reclaimed Water Use	Total Annual Revenues from Reclaimed Water Use	Heat Recovery	Total Annual Revenues from Heat Recovery	Carbon Offsets	TOTAL
2015	0	0	0	$ -				$ -
2016	19	0	19	$ 9,520				$ 9,520
2017	37	0	37	$ 19,040				$ 19,040
2018	56	0	56	$ 28,560				$ 28,560
2019	75	0	75	$ 38,080				$ 38,080
2020	93	73	167	$ 121,762				$ 121,762
2021	93	147	240	$ 195,924				$ 195,924
2022	93	220	313	$ 270,086				$ 270,086
2023	93	293	387	$ 344,248				$ 344,248
2024	93	367	460	$ 418,410				$ 418,410
2025	93	440	533	$ 492,572				$ 492,572
2026	93	513	607	$ 566,734				$ 566,734
2027	93	587	680	$ 640,896				$ 640,896
2028	93	660	753	$ 715,058				$ 715,058
2029	93	733	827	$ 789,220				$ 789,220
2030	93	807	900	$ 863,382				$ 863,382
2031	93	880	973	$ 937,544				$ 937,544
2032	93	953	1047	$ 1,011,705				$ 1,011,705
2033	93	1027	1120	$ 1,085,867				$ 1,085,867
2034	93	1100	1193	$ 1,160,029				$ 1,160,029
2035	93	1173	1267	$ 1,234,191				$ 1,234,191
2036	93	1173	1267	$ 1,234,191				$ 1,234,191
2037	93	1173	1267	$ 1,234,191				$ 1,234,191
2038	93	1173	1267	$ 1,234,191				$ 1,234,191
2039	93	1173	1267	$ 1,234,191				$ 1,234,191
2040	93	1173	1267	$ 1,234,191				$ 1,234,191
2041	93	1173	1267	$ 1,234,191				$ 1,234,191
2042	93	1173	1267	$ 1,234,191				$ 1,234,191
2043	93	1173	1267	$ 1,234,191				$ 1,234,191
2044	93	1173	1267	$ 1,234,191				$ 1,234,191
2045	93	1173	1267	$ 1,234,191				$ 1,234,191
Total	2613	21707	24320	$ 23,284,740		-		$ 23,284,740
Present Value (2015 to 2045)				$ 8,610,000				$ 8,610,000

	Colwood							
	Reclaimed Water Use (ML/yr)							
Year	Land Application (1)	Toilet Flushing(2)	Total Reclaimed Water Use	Total Annual Revenues from Reclaimed Water Use	Heat Recovery	Total Annual Revenues from Heat Recovery	Carbon Offsets	TOTAL
2015	0	0	0	$ -				$ -
2016	165	0	165	$ 84,320				$ 84,320
2017	331	0	331	$ 168,640				$ 168,640
2018	496	0	496	$ 252,960				$ 252,960
2019	661	0	661	$ 337,280				$ 337,280
2020	827	74	901	$ 528,993				$ 528,993
2021	827	148	975	$ 636,387				$ 636,387
2022	827	223	1049	$ 743,780				$ 743,780
2023	827	297	1123	$ 851,173				$ 851,173
2024	827	371	1198	$ 958,567				$ 958,567
2025	827	445	1272	$ 1,065,960				$ 1,065,960
2026	827	519	1346	$ 1,173,353				$ 1,173,353
2027	827	593	1420	$ 1,280,747				$ 1,280,747
2028	827	668	1494	$ 1,388,140				$ 1,388,140
2029	827	742	1568	$ 1,495,533				$ 1,495,533
2030	827	816	1643	$ 1,602,927				$ 1,602,927
2031	827	890	1717	$ 1,710,320				$ 1,710,320
2032	827	964	1791	$ 1,817,713				$ 1,817,713
2033	827	1038	1865	$ 1,925,107				$ 1,925,107
2034	827	1113	1939	$ 2,032,500				$ 2,032,500
2035	827	1187	2013	$ 2,139,893				$ 2,139,893
2036	827	1187	2013	$ 2,139,893				$ 2,139,893
2037	827	1187	2013	$ 2,139,893				$ 2,139,893
2038	827	1187	2013	$ 2,139,893				$ 2,139,893
2039	827	1187	2013	$ 2,139,893				$ 2,139,893
2040	827	1187	2013	$ 2,139,893				$ 2,139,893
2041	827	1187	2013	$ 2,139,893				$ 2,139,893
2042	827	1187	2013	$ 2,139,893				$ 2,139,893
2043	827	1187	2013	$ 2,139,893				$ 2,139,893
2044	827	1187	2013	$ 2,139,893				$ 2,139,893
2045	827	1187	2013	$ 2,139,893				$ 2,139,893
Total	23147	21953	45100	$ 43,593,227	-			$ 43,593,227
Present Value (2015 to 2045)				$ 17,021,000		$0		$ 17,021,000

	Esquimalt Bullen Park							
	Reclaimed Water Use (ML/yr)							
Year	Land Application (1)	Toilet Flushing(2)	Total Reclaimed Water Use	Total Annual Revenues from Reclaimed Water Use	Heat Recovery	Total Annual Revenues from Heat Recovery	Carbon Offsets	TOTAL
2015	0	0	0	$ -				$ -
2016	45	0	45	$ 23,120				$ 23,120
2017	91	0	91	$ 46,240				$ 46,240
2018	136	0	136	$ 69,360				$ 69,360
2019	181	0	181	$ 92,480				$ 92,480
2020	227	18	245	$ 133,930				$ 133,930
2021	227	36	263	$ 152,260				$ 152,260
2022	227	54	281	$ 170,589				$ 170,589
2023	227	73	299	$ 188,919				$ 188,919
2024	227	91	317	$ 207,249				$ 207,249
2025	227	109	335	$ 225,579				$ 225,579
2026	227	127	354	$ 243,909				$ 243,909
2027	227	145	372	$ 262,238				$ 262,238
2028	227	163	390	$ 280,568				$ 280,568
2029	227	181	408	$ 298,898				$ 298,898
2030	227	199	426	$ 317,228				$ 317,228
2031	227	218	444	$ 335,558				$ 335,558
2032	227	236	462	$ 353,887				$ 353,887
2033	227	254	480	$ 372,217				$ 372,217
2034	227	272	499	$ 390,547				$ 390,547
2035	227	290	517	$ 408,877				$ 408,877
2036	227	290	517	$ 408,877				$ 408,877
2037	227	290	517	$ 408,877				$ 408,877
2038	227	290	517	$ 408,877				$ 408,877
2039	227	290	517	$ 408,877				$ 408,877
2040	227	290	517	$ 408,877				$ 408,877
2041	227	290	517	$ 408,877				$ 408,877
2042	227	290	517	$ 408,877				$ 408,877
2043	227	290	517	$ 408,877				$ 408,877
2044	227	290	517	$ 408,877				$ 408,877
2045	227	290	517	$ 408,877				$ 408,877
Total	6,347	5,365	11,712	$ 8,662,421	-			$ 8,662,421
Present Value (2015 to 2045)				$ 3,469,000				$ 3,469,000

	East Saanich							
	Reclaimed Water Use (ML/yr)							
Year	Land Application (1)	Toilet Flushing(2)	Total Reclaimed Water Use	Total Annual Revenues from Reclaimed Water Use	Heat Recovery	Total Annual Revenues from Heat Recovery	Carbon Offsets	TOTAL
2015	0	0	0	$ -				$ -
2016	192	0	192	$ 97,920				$ 97,920
2017	384	0	384	$ 195,840				$ 195,840
2018	576	0	576	$ 293,760				$ 293,760
2019	768	0	768	$ 391,680				$ 391,680
2020	960	36	996	$ 533,804				$ 533,804
2021	960	72	1032	$ 578,008				$ 578,008
2022	960	108	1068	$ 622,212				$ 622,212
2023	960	143	1103	$ 666,416				$ 666,416
2024	960	179	1139	$ 710,620				$ 710,620
2025	960	215	1175	$ 754,824				$ 754,824
2026	960	251	1211	$ 799,028				$ 799,028
2027	960	287	1247	$ 843,232				$ 843,232
2028	960	323	1283	$ 887,436				$ 887,436
2029	960	358	1318	$ 931,640				$ 931,640
2030	960	394	1354	$ 975,844				$ 975,844
2031	960	430	1390	$ 1,020,048				$ 1,020,048
2032	960	466	1426	$ 1,064,252				$ 1,064,252
2033	960	502	1462	$ 1,108,456				$ 1,108,456
2034	960	538	1498	$ 1,152,660				$ 1,152,660
2035	960	573	1533	$ 1,196,864				$ 1,196,864
2036	960	573	1533	$ 1,196,864				$ 1,196,864
2037	960	573	1533	$ 1,196,864				$ 1,196,864
2038	960	573	1533	$ 1,196,864				$ 1,196,864
2039	960	573	1533	$ 1,196,864				$ 1,196,864
2040	960	573	1533	$ 1,196,864				$ 1,196,864
2041	960	573	1533	$ 1,196,864				$ 1,196,864
2042	960	573	1533	$ 1,196,864				$ 1,196,864
2043	960	573	1533	$ 1,196,864				$ 1,196,864
2044	960	573	1533	$ 1,196,864				$ 1,196,864
2045	960	573	1533	$ 1,196,864				$ 1,196,864
Total	26,880	10,607	37,487	$ 26,793,184	-			$ 26,793,184
Present Value (2015 to 2045)				$ 11,087,000				$ 11,087,000

	Saanich Core							
	Reclaimed Water Use (ML/yr)							
Year	Land Application (1)	Toilet Flushing(2)	Total Reclaimed Water Use	Total Annual Revenues from Reclaimed Water Use	Heat Recovery	Total Annual Revenues from Heat Recovery	Carbon Offsets	TOTAL
2015	0	0	0	$ -				$ -
2016	24	0	24	$ 12,240				$ 12,240
2017	48	0	48	$ 24,480				$ 24,480
2018	72	0	72	$ 36,720				$ 36,720
2019	96	0	96	$ 48,960				$ 48,960
2020	120	21	141	$ 86,900				$ 86,900
2021	120	42	162	$ 112,600				$ 112,600
2022	120	63	183	$ 138,300				$ 138,300
2023	120	83	203	$ 164,000				$ 164,000
2024	120	104	224	$ 189,700				$ 189,700
2025	120	125	245	$ 215,400				$ 215,400
2026	120	146	266	$ 241,100				$ 241,100
2027	120	167	287	$ 266,800				$ 266,800
2028	120	188	308	$ 292,500				$ 292,500
2029	120	208	328	$ 318,200				$ 318,200
2030	120	229	349	$ 343,900				$ 343,900
2031	120	250	370	$ 369,600				$ 369,600
2032	120	271	391	$ 395,300				$ 395,300
2033	120	292	412	$ 421,000				$ 421,000
2034	120	313	433	$ 446,700				$ 446,700
2035	120	333	453	$ 472,400				$ 472,400
2036	120	333	453	$ 472,400				$ 472,400
2037	120	333	453	$ 472,400				$ 472,400
2038	120	333	453	$ 472,400				$ 472,400
2039	120	333	453	$ 472,400				$ 472,400
2040	120	333	453	$ 472,400				$ 472,400
2041	120	333	453	$ 472,400				$ 472,400
2042	120	333	453	$ 472,400				$ 472,400
2043	120	333	453	$ 472,400				$ 472,400
2044	120	333	453	$ 472,400				$ 472,400
2045	120	333	453	$ 472,400				$ 472,400
Total	3,360	6,167	9,527	9,320,800	-			$ 9,320,800
Present Value (2015 to 2045)				$ 3,561,000		$0		$ 3,561,000

	Total Resource Income			
Year	Reclaimed Water Use	Heat Recovery	Carbon Offsets	Total
2015	$ -			$ -
2016	$ 227,120			$ 227,120
2017	$ 454,240			$ 454,240
2018	$ 681,360			$ 681,360
2019	$ 908,480			$ 908,480
2020	$ 1,405,389			$ 1,405,389
2021	$ 1,675,178			$ 1,675,178
2022	$ 1,944,967			$ 1,944,967
2023	$ 2,214,756			$ 2,214,756
2024	$ 2,484,545			$ 2,484,545
2025	$ 2,754,335			$ 2,754,335
2026	$ 3,024,124			$ 3,024,124
2027	$ 3,293,913			$ 3,293,913
2028	$ 3,563,702			$ 3,563,702
2029	$ 3,833,491			$ 3,833,491
2030	$ 4,103,280			$ 4,103,280
2031	$ 4,373,069			$ 4,373,069
2032	$ 4,642,858			$ 4,642,858
2033	$ 4,912,647			$ 4,912,647
2034	$ 5,182,436			$ 5,182,436
2035	$ 5,452,226			$ 5,452,226
2036	$ 5,452,226			$ 5,452,226
2037	$ 5,452,226			$ 5,452,226
2038	$ 5,452,226			$ 5,452,226
2039	$ 5,452,226			$ 5,452,226
2040	$ 5,452,226			$ 5,452,226
2041	$ 5,452,226			$ 5,452,226
2042	$ 5,452,226			$ 5,452,226
2043	$ 5,452,226			$ 5,452,226
2044	$ 5,452,226			$ 5,452,226
2045	$ 5,452,226			$ 5,452,226
Total	$ 111,654,372			$ 111,654,372
Present Value (2015 to 2045)	$ 43,747,000			$ 43,747,000

Notes
(1) Land application assumed to start at 0 in 2015 and increase linearly to max re-use in 2020.
(2) Flushing substitution assumed to be at 0 until 2020 and increase linearly to max re-use in 2035.

Summary - Hartland Trucking Option (not including land costs)

One-Time and Ongoing Costs

Capital Costs to 2045 [1]	Annual Costs (at 2030)		
	Trucking	Pumping	Total
$ 19,300,000	$ 663,000	$ 70,000	$ 733,000

Notes

(1) Includes initial construction costs in 2015. Does not include land costs.

Net Present Value

Assumptions	
Interest Rate	7%
Inflation	2%
Discount Rate	5%
Time period	2015 to 2045

Costs (from 2015 to 2045) - Trucking

	Total Costs (no discounting)	Present Value
Capital Costs	$ 19,300,000	$ 18,381,000
Trucking Costs	$ 20,121,000	$ 9,022,000
Pumping Costs	$ 2,100,000	$ 989,000
Total	**$ 41,521,000**	**$ 28,392,000**

Notes

(1) All costs in constant 2015 dollars.

Summary - Hartland Pumping Option (not including land costs)

One-Time and Ongoing Costs

Capital Costs to 2045 [1]	Annual Costs (at 2030)		
	O&M	Borrowing	Total
$ 36,400,000	$ 324,000	$ -	$ 324,000

Notes
(1) Includes initial construction costs in 2015. Does not include land costs.

Net Present Value

Assumptions	
Interest Rate	7%
Inflation	2%
Discount Rate	5%
Time period	2015 to 2045

Costs (from 2015 to 2045) - Hartland Pumping (not including land costs)

	Total Costs (no discounting)	Present Value
Capital Costs	$ 36,400,000	$ 34,667,000
O&M	$ 9,750,000	$ 4,633,000
Borrowing Costs	$ -	$ -
Total	**$ 46,150,000**	**$ 39,300,000**

Notes
(1) All costs in constant 2015 dollars.