SUMMARY REPORT

Capital Regional District

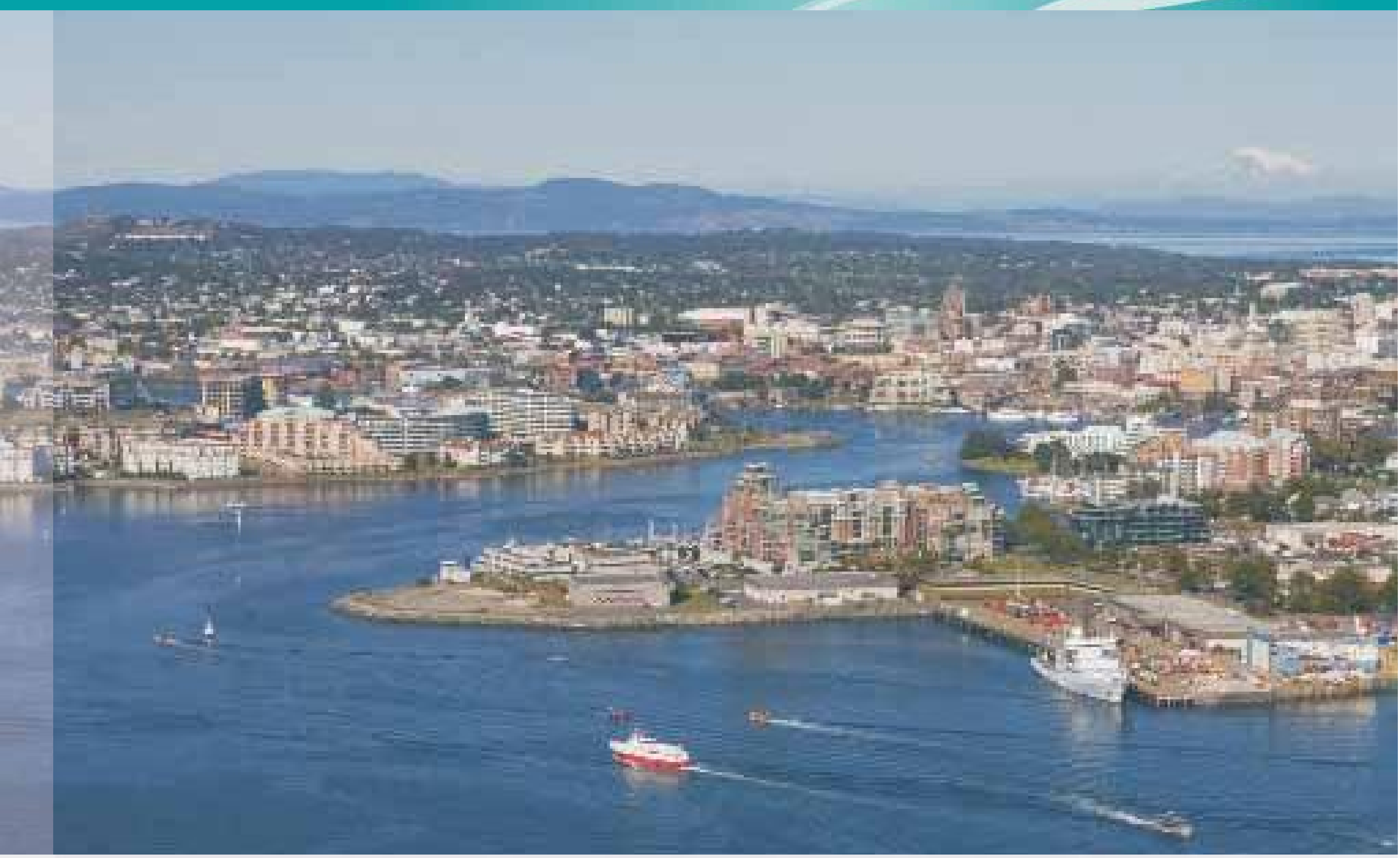
Core Area Wastewater Treatment Program

Conceptual Planning Phase

JUNE 2009

CRD
Making a difference...together

Capital Regional District



Associated Engineering

CH2MHILL

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1 Introduction

The conceptual planning phase of Program Development further refined the distributed wastewater management strategy adopted in 2007. This report summarizes the consulting team's activities during the conceptual planning phase.

1.1 THE BACKGROUND

The Capital Regional District (CRD) provides wastewater management to residential, commercial, industrial and institutional customers, equivalent to a population of approximately 330,000 persons, distributed throughout the Core Area and the West Shore communities. These communities include the Cities of Victoria, Langford and Colwood, the Districts of Oak Bay and Saanich, the Township of Esquimalt and the Town of View Royal. Over the next fifty-five years, the Core Area and West Shore equivalent population is anticipated to grow to over 600,000 persons.

In 2006, the CRD commenced the planning for the expansion and upgrading of the wastewater management system with the principal goal of moving from the existing preliminary level of treatment to secondary treatment. A consulting engineering team, composed of Associated Engineering, CH2M HILL and Kerr Wood Liedal Associates, was engaged to assist the CRD in the planning and initial decision making. Following the original phase of planning (termed the Decision Process), completed in June 2007, the CRD adopted a direction that would see the Core Area and West Shore communities move towards a distributed wastewater management system (CRD, 2007). A distributed wastewater management approach will allow the CRD to take best advantage of the existing sewerage infrastructure, while setting the direction for more localized wastewater management with potential water reuse and energy recovery opportunities.

In February 2008, the CRD extended the consultant team's scope of work to undertake the conceptual planning under the Program Development Phase for the distributed wastewater management strategy. The consultant team prepared a series of discussion papers on various technical aspects of the planning and developed a series of options that covered a range of distributed wastewater management strategies. The options were discussed and debated by the Core Area Liquid Waste Management Committee (CALWMC), culminating in a decision on June 2, 2009 on a preferred distributed wastewater management strategy. This decision completed the conceptual planning phase of the Program.

The Program now moves into the second part of the Program Development Phase. This will see the preliminary engineering completed for the various wastewater system elements and a proposed Amendment to the Liquid Waste Management Plan (LWMP) submitted to the Provincial Minister of Environment. This Amendment is to be submitted by December 31, 2009.

1.2 PURPOSE OF THIS REPORT

The purpose of this report is to document and summarize the consulting team's activities during the conceptual planning phase of the Program.

1.3 REPORT FORMAT

The text of this Summary Report provides a synopsis of the conceptual planning process (Chapter 2) and describes the adopted distributed wastewater management strategy (Chapter 3). A summary is provided in the final chapter (Chapter 4).

The Summary Report is written as a stand-alone document that will allow the reader to understand the conceptual planning work that has been undertaken and the adopted wastewater management strategy. For the reader wishing additional detail, the discussion papers that form the basis of the decision making are contained in the Appendices.

The Summary Report has been printed in hard copy without the Appendices. A CD containing the Summary Report and the Appendices in .pdf format has also been prepared.

1.4 ACKNOWLEDGMENTS

This study was undertaken by the Associated Engineering as the prime consultant. CH2M HILL and KWL Associates were subconsultants to Associated Engineering. The Westland Resource Group provided input into the resource recovery evaluations and into the siting of possible wastewater treatment facilities.

We would like to thank the members of the CALWMC for the many hours that they spent with the consultant team discussing and debating the key issues in developing a long-term sustainable wastewater management approach. We would also like to thank the staff of the CRD, the member municipalities, the Provincial Ministries of Environment and Community Development and Environment Canada for their participation and contributions to this project. Finally, we would like to acknowledge the contribution of the volunteer members of the Technical and Community Advisory Committee (TCAC) and other members of the public and stakeholder groups for their valuable input.

2 The Conceptual Planning Process

Three options were ultimately developed that evaluated a range of distributed wastewater treatment directions. The Core Area Liquid Waste Management Committee selected Option 1, with further investigations of variations on the strategy, as the preferred direction.

2.1 THE PATH FORWARD REPORT

The CRD wastewater system is operated under a Province of British Columbia Liquid Waste Management Plan (LWMP). The LWMP, originally, approved in March 2003, authorizes the CRD to manage the wastewater collection, treatment and disposal system within a set of operating parameters and future environmental goals. Key features of the Plan include a source control program, a program to reduce inflow and infiltration (I/I), preliminary wastewater treatment using fine screening and effluent disposal to the marine environment through two major outfalls.

In July 2006, as a result of continuing environmental studies on the impact of the discharges on the marine environment and a review by an independent scientific review panel, the Provincial Minister of Environment requested that the CRD provide an amendment to the LWMP, detailing a fixed schedule for the provision of wastewater treatment. This amendment was to be submitted by June 30, 2007.

The CRD complied with this request and entered into a strategy development phase, termed The Decision Process. This phase saw the CRD Core Area Liquid Waste Management Committee (CALWMC) work with staff, the consulting team and an appointed Technical and Community Advisory Committee (TCAC) to develop a strategy for wastewater management over the next 60 years. In June 2007, the CRD submitted proposed wording to amend the existing LWMP to the Minister, accompanied by a supporting report, entitled *The Core Area Wastewater Management Program – The Path Forward – The Supporting Report to the Response to the Minister of Environment, June 13, 2007* (CRD, 2007).

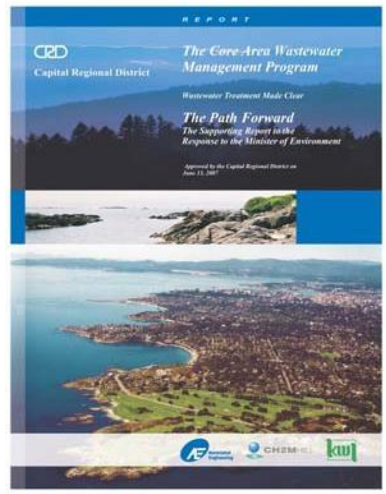


Figure 2- 1
The Path Forward Report

With this direction, the CRD Board made a bold and innovative move to depart from a traditional centralized approach to wastewater treatment to a more distributed wastewater treatment strategy. This distributed approach will allow the CRD to take best advantage of the existing sewerage infrastructure, while setting the direction for more localized wastewater management with potential water reuse and energy recovery opportunities.

The overall Program was expected to take 10 years to complete, with an estimated cost of $1.2 billion (CRD, 2007).

2.2 CORE AREA WASTEWATER TREATMENT PROGRAM GOALS

The Path Forward report identified five phases for the Program: the Decision Process, Program Development, Design, Construction / Commissioning, and Operation.

The CRD began the Program Development Phase in July 2007 with further development of the adopted strategy described in the Path Forward report. In order to keep the Program on track and to assist the decision making as the project moves through development and implementation, the CRD adopted a series of goals and accompanying strategies.

The three goals are:

Goal 1 - Protect Public Health and the Environment

This is fundamental goal of wastewater management. The CRD is committed to not only meeting the required regulations but also in planning ahead in a proactive manner to ensure that that emerging and future public health and environmental issues can be addressed in the decades to come.

Goal 2 - Manage Wastewater in a Sustainable Manner

Wastewater has traditionally been considered in the context of “disposal”. The strategy adopted by the CRD has changed this approach. The CRD is committed to moving towards the goal of sustainable wastewater management during the detailed planning and implementation of the Program. A sustainable wastewater management approach will be one that continuously moves the CRD forward in terms of the integration of water, energy, waste and infrastructure management within the social, environmental and economic (the triple bottom line) values of the community.

Goal 3 – Provide Cost Effective Wastewater Management

Cost effective wastewater management optimizes the existing investment in wastewater infrastructure while incorporating new strategies and infrastructure investments. The CRD will consider the best integration of public and private sector resources to deliver the wastewater management service in a manner that provides the best value to the community.

In order to achieve the goals, it is necessary to develop strategies. Strategies define the approach to be taken to accomplish the desired outcome or goal. A number of strategies may be pertinent to a goal and, in fact, strategies may overlap to achieve more than one goal. At their July 25, 2007 meeting, the CALWMC adopted a series of strategies. These were put on the CRD web site as part of the public communication process.

2.3 PROVINCIAL INTEGRATED RESOURCE MANAGEMENT STUDY

In the late summer of 2007, the Province, through the Ministry of Community Services, undertook a study to investigate the opportunities and benefits of integrated resource management (IRM) for communities in the Province. As part of the commitment for the Government to work with the CRD in identifying and optimizing resource from waste opportunities, part of the study was to consider the CRD as a case study. This study was originally to be completed in the fall of 2007. The project completion was delayed and the final report, entitled *Resources from Waste – Integrated Resource Management Phase I Study Report, February 29, 2008*, was released on May 20, 2008 (IRM Study Team, 2008).

This report generated considerable interest upon its release. The case study for the CRD suggested that 32 decentralized wastewater treatment plants should be constructed. The report also suggested that revenues from resource recovery would exceed the costs of building and operating the wastewater treatment plants. This conclusion by the authors of the IRM report led the CALWMC to instruct the consultant team to develop and evaluate an option strategy that reflected an aggressive approach to decentralized wastewater management that would see the maximum practical number of local wastewater treatment plants.

2.4 THE DISCUSSION PAPERS

The basis of the conceptual planning work was the development of a series of discussion papers. These are contained in the Appendices. The subject area of the discussion papers is shown in **Table 2-1**.

The intent of a "discussion paper" is two fold. First, it introduces an issue or direction for initial discussion and debate. Second, as this discussion and debate progresses, the discussion paper can be revised and re-released. The discussion paper history thus documents not only the final conclusions, but the pathway of the discussion, as well.

The first series of discussion papers (Activities 030 to 033) covered the subject areas needed to create the "building blocks" for the conceptual planning. These included program development considerations, opportunities and challenges for integrated resource management, development of a greenhouse gas (GHG) assessment strategy and future population and wastewater flow projections. The next two series of papers (Activities 034 and 035) investigated site development and design planning issues for the two common wastewater treatment plants – Macaulay Point / McLoughlin Point and Clover Point.

The major activity of the conceptual design planning process was the development, the evaluation and, ultimately the selection of a strategic direction for distributed wastewater management. This activity is described in the discussion papers under Activity 036. Based on the adopted distributed wastewater management strategy, the biosolids management strategy and the cost estimates were finalized. These are contained in the discussion papers under Activities 037 and 038.

Table 2-1
Discussion Papers

Activity	Activity Code	Subject Area
Project Management	030	• Program development and implementation
Integrated Resource Management Strategy	031	• Decision-making Framework for biosolids management • IRM experience in Sweden • Organic residuals energy and resource recovery • Flow energy recovery • Phosphorus recovery • Heat recovery • Water reuse • Urine separation • Biosolids / solid waste integration strategies
Greenhouse Gas Management Strategy	032	• Methodologies to assess GHG management
Wastewater Flow Management Strategy	033	• Populations, ICI Equivalents, and inflow & infiltration • Design wastewater flows • Sanitary and combined sewer overflow management
Macaulay Point / McLoughlin Point WWTP	034	• Liquid treatment technologies • Solids processing alternatives • Site development considerations
Clover Point Wet Weather Flow Management Facility	035	• Wet weather management strategies • Wet weather flow treatment technologies • Site development considerations
Distributed Wastewater Management	036	• Resource recovery opportunities • Distributed wastewater management scenarios • Sustainability Assessment Framework analysis • Adopted distributed wastewater management strategy
Biosolids / Resource Management Facility	037	• Biosolids management strategy
Cost Estimates	038	• Capital and O&M, revenue and carbon credit costs

2.5 BUILDING THE DISTRIBUTED WASTEWATER MANAGEMENT SCENARIOS

The distributed wastewater management strategy must ultimately provide secondary treatment for the dry weather flows. It must also incorporate wet weather flow management and opportunities for resource recovery – all in an affordable manner. A distributed approach allows the CRD to take best advantage of the existing sewerage infrastructure, while setting the direction for more localized wastewater management with potential water reuse and energy recovery opportunities. The advantages of the distributed treatment approach are three fold. First, it reduces the size of the downstream plants, as the upstream plants reduce the flows reaching the downstream plants. Second, by strategically locating the upstream plants, this approach creates local opportunities for water reuse and heat recovery from the wastewater. Third, by reducing the existing wastewater flows in the lower portions of the sewerage system, capacity is freed up to handle a greater portion of the wet weather wastewater flow – greatly reducing the frequency and volumes of the current sanitary sewer overflows (SSO).

The question then – is how distributed should the strategy be? The consultant team approached this question by developing “book ends”. At one end, the team selected the realistic minimum number of wastewater treatment plants – three dry weather secondary plants. At the other end, the team developed a strategy with what was considered the maximum practical number of plants - ten dry weather secondary plants, with wet weather facilities at two of these plants. A middle option was also developed. In all cases, a common and essential element is a wet weather flow management plant at Clover Point that treats surplus flow during more extreme wet weather events.

The three strategic directions or options are described below. A schematic is shown for each option that shows the approximate location of the wastewater treatment plants. The colour bars at each location provide a relative scale of the primary treatment, secondary treatment and solids processing that occurs at each site.

Option 1: Resource Recovery on a Regional Basis – the Fewest Plants

This option was the closest to the strategy developed in the Path Forward work. It is a distributed wastewater management approach, however, it has the fewest number of decentralized wastewater treatment plants. The elements in Option 1 include:

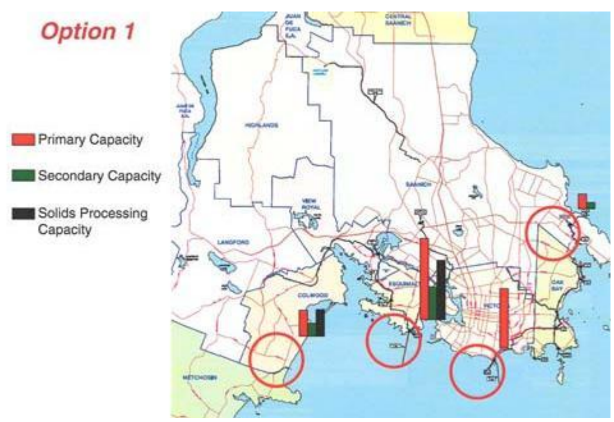


Figure 2-2
Option 1

- Three secondary wastewater treatment plants (Saanich East; Macaulay Point / McLoughlin Point; West Shore)
- Heat energy recovery using the effluent from all three plants
- Wet weather flow plant at Clover Point
- Organic energy and phosphorus

recovery at the Macaulay Point / McLoughlin Point and the West Shore plant

Option 2: Resource Recovery based on a Combined Regional – Local Basis

This option is the “middle” scenario in that the number of decentralized wastewater treatment plants has increased but not to the extent as in Option 3. The addition of a WWTP in the James Bay area was to examine the

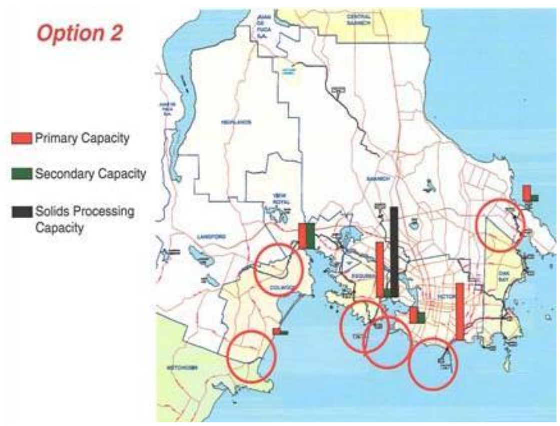


Figure 2-3
Option 2

impacts of downsizing the secondary capacity at Macaulay Point / McLoughlin Point and to provide a more local opportunity for heat energy recovery in the James Bay / Parliament Precinct area. Adding a WWTP in the North Colwood area also allowed the secondary treatment capacity at Macaulay Point / McLoughlin Point to be reduced. The elements of this option are:

- Five secondary wastewater treatment plants (Saanich East; Macaulay Point / McLoughlin Point; James Bay; plus two plants on the West Shore)
- Heat energy recovery using the effluent from all five plants
- Modification of sewerage area boundaries
- Wet weather flow plant at Clover Point
- Organic energy and phosphorus recovery at the Macaulay Point / McLoughlin Point plant

Option 3: Resource Recovery on a Local Scale – the Largest Number of Plants

Option 3 is the most aggressive approach towards decentralization that was considered practical. The challenge

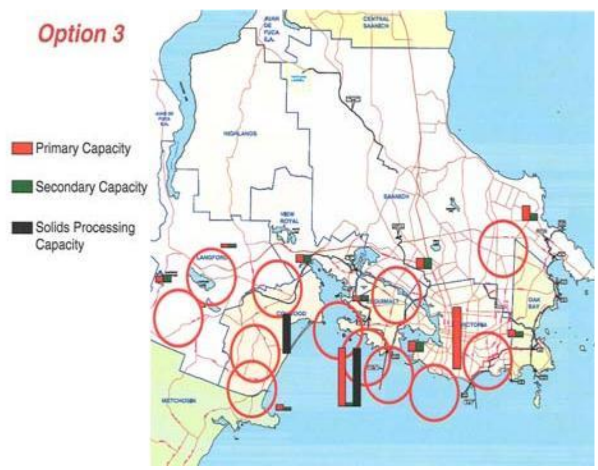


Figure 2-4
Option 3

with inland decentralized WWTPs is disposing of the surplus effluent, not used for reuse, in an environmentally safe manner. This was dealt with in this option by linking the inland decentralized wastewater treatment plants together in a regional water reuse piping system. Surplus water would be discharged to the ocean via a link to the South Colwood plant outfall. The components of Option 3 are:

- Ten secondary wastewater treatment plants
- Aggressive water recycling at individual buildings
- Heat energy recovery using the effluent from all ten plants
- Wet weather flow plant at Clover Point
- Organic energy and phosphorus recovery at the Macaulay Point / McLoughlin Point plant and at an Organic Waste Processing Centre located in the West Shore

It is important to note that these were not intended as "hard and fast" options, where one needs to be selected. Rather they were intended to demonstrate an approach from which conclusions could be drawn.

2.6 OPTION DEVELOPMENT – WHAT WAS LEARNED?

The objective of the development of the three strategic directions is to provide information to the consultant team, the CRD staff and the CALWMC to allow the ultimate selection of the best distributed wastewater management strategy for the CRD. Several key findings are discussed below:

Wet Weather Flow Management

Goals and targets for wet weather flow management, including the elimination of CSO and the reduction of SSOs have already been set in the LWMP. The best approach to achieve these goals is a combination of sewer separation in the CSO areas, the continued management of the sanitary sewer system asset through replacement and remediation and the treatment of surplus wet weather flows at the end of the pipe, with discharge to the non-embayed marine environment. Wet weather flow treatment will be provided primarily at Clover Point, with some surplus wet weather flows treated at Saanich East, Macaulay Point / McLoughlin Point and South Colwood. What this means is that the member municipalities will have a number of "tools" to plan their sewer system management in a cost effective manner to provide reliable performance for conveying actual wastewater, while at the same time accommodating extraneous rainfall-induced infiltration / inflow.

Secondary Wastewater Treatment Technologies

While it is not the intent to make final decisions on wastewater treatment technology, the option development has yielded some conclusions. The first is that the CRD should consider a blending of technologies that aim at providing an effluent quality that meets the final use. The opportunity for potential water reuse and the need for small plant footprints suggest that membrane bioreactor (MBR) technologies are an appropriate choice for the dry weather treatment technology. This would be combined with high-rate primary treatment technologies that would be aimed at producing an effluent that meets the goals for wet weather discharges. By blending the effluent streams prior to marine discharge, the CRD can have the potential for water reuse and a cost effective dry weather / wet weather treatment strategy. The second point is that the limited area available at some sites, limit the traditional concept of expansion of tankage to accommodate future flow increases. This means that the "structure" of the plant will need to be built in the first stage. In latter stages, the structure will not be expanded but the technology within the structure will be changed. For example, the blend between dry weather and wet weather technologies could change or improvements in membrane technology could yield higher performance from the same footprint.

Biosolids / Organic Residuals Management

The most appropriate direction for biosolids management incorporates anaerobic digestion; biomethane production and two or more directions for the residual biosolids use to reduce operational risk. The analysis concluded that full integration of biosolids and source separated organic waste was not an appropriate direction; however, there are opportunities for partial integration through the use of local separated organic waste to provide an additional feed stock into the wastewater anaerobic digesters. The option analysis also concluded that in order to take advantage of the economy of scale required for successful biosolids processing and resource recovery, processing should occur at one or two sites. Depending upon the option, this requires either transport of the solids through the interceptor system and removal at a downstream plant or dewatering of the solids and truck haul to one of the biosolids processing centers.

Water Reuse

Given the long term population growth and the potential impacts of climate change, water reuse may emerge as a key part of the overall watershed management strategy in the decades ahead. It is thus critical that the wastewater management strategy be planned so that this can be incorporated. All three strategic directions provide this opportunity. The question simply becomes one of the higher cost of smaller, local plants versus the cost of the non-potable water distribution system to provide the water from a smaller number of larger plants.

Heat Energy Recovery

The work has concluded that there are potential opportunities in the short term and even greater opportunities in the longer term for heat energy recovery from wastewater effluent. All three strategies provide the opportunities. The differences are in the locations of the opportunities. As with water reuse, the major issue is economics and timing. As heat recovery from effluent is an "add-on" technology, the key is locating the plants in the right locations to take advantage of future opportunities. Examples of this are wastewater treatment plants that are located in areas of new community development, so that the source of the heat is located in close proximity to a future district heating system.

2.7 COMMON ELEMENTS

In developing the three options, some common themes or conclusions emerged. These are:

- *A wastewater treatment plant is required at or near Macaulay Point / McLoughlin Point.* This is one of the two existing major wastewater discharge points. In order to develop a cost effective overall strategy, a facility at least handling the surplus wet weather flow is required at this location. Under all the scenarios, it makes sense to provide some degree of dry weather secondary capacity – the question is how much?

- *A wet weather flow management plant is required at Clover Point.* This is the second of the two existing major wastewater discharge points. Given the significant wet weather flows at this point, in makes sense in all scenarios to develop this site as a wet weather flow relief point.

- *Wastewater treatment plants in the east and west area of the sewerage area are required.* In all scenarios, wastewater treatment plants in Saanich East and in the vicinity of the South Colwood area in the west are required. The major reason for this is their location within the sewerage area and their ability to contribute to the overall management of wastewater dry weather and wet weather flow. The capacity of the Saanich East plant is essentially governed by the build-out of the upstream sewerage area. This plant is situated to take advantage of the resource recovery partnering opportunities with the University of Victoria. There is some flexibility in the sizing of the South Colwood plant, as the flows can be split with other decentralized plants in the West Shore area. Again, this plant is well situated to take advantage of resource recovery opportunities through local community development.

The above are critical elements of any scenario. Decisions that are made on the capacities and function of the above plants will dictate other decisions on the necessity and sizing of other wastewater treatment plants.

2.8 COSTS VERSUS REVENUES

Does a more decentralized wastewater management strategy result in higher costs? Is there a potential increase in the revenue from resource recovery that can be generated? **Figure 2-5** shows the results of this analysis. The capital costs were escalated from 2008 dollars to the expected mid-point of construction using an inflation allowance of 2.0% per year. Stage 1 reflects the elements constructed by 2017. The capital costs do not include off-site infrastructure costs associated with water reuse and its distribution and, similarly, for recoverable heat.

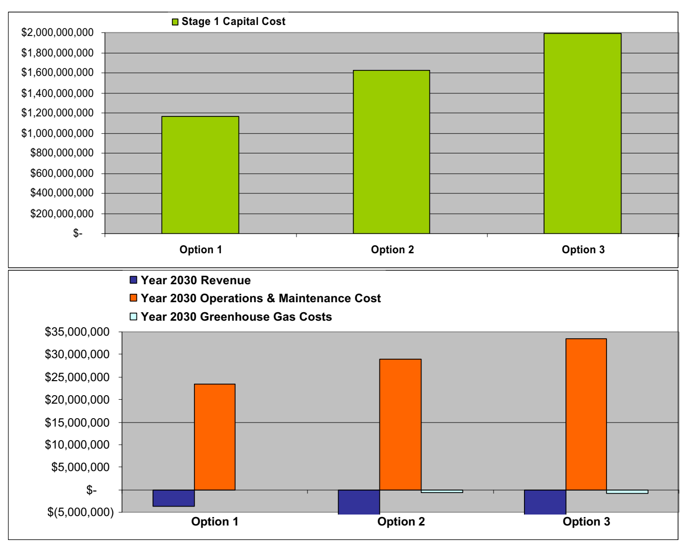


Figure 2-5
Capital Costs, Operations & Maintenance Costs, Greenhouse Gas Costs and Annual Revenues

Annual revenues, in 2008 dollars, include revenue from the sale of water, wastewater heat, biomethane, wood chips from the willow coppice operation and dried biosolids for green fuel in the cement industry. The cost of off-site infrastructure to supply heat to end users, which would be borne by a third-party energy utility, was incorporated into the selling price for the heat. This approach provides insight into the market price the CRD could expect from wastewater-derived heat, which is accounted for in the potential heat revenue. Annual operations & maintenance costs (in 2008 dollars) include items such as labour, energy, chemicals, maintenance and administration. The greenhouse gas costs (in 2008 dollars), which are actually "credits" since they are numerically negative values, consider items such as carbon off-sets from saleable products, direct emissions, and embedded emissions in materials.

The figure shows that as the number of wastewater treatment plants increase, the overall capital costs increase significantly. Capital costs range from approximately $1.2 billion for Option 1 with the fewest plants to $2.0 billion for Option 3 with the most plants. This difference is primarily due to the loss of scale – larger plants are less expensive to build on a unit cost basis compared to smaller plants. It is also due to the fact that many of the wastewater plants, regardless of size, are expensive plants to build due to the urban setting. They require more extensive structural work due to the need to keep the surface footprint as small as possible, as well as more extensive odour control and architectural treatment to fit into the surrounding land use.

As can be seen from the graph, the potential annual revenue from resource recovery increases with the number of plants, although the relative increase significantly slows with additional facilities. Annual (year 2030) revenues are $3.6 million in Option 1; $7.3 million in Option 2 and $8.3 million in Option 3. The initial increase in revenue with the larger number of plants (Option 2) is primarily due to the improved proximity of the water or heat supply to the end user, as compared to fewer, larger plants. Option 3 continues to benefit from this factor, but the relative incremental gain is smaller.

The data show that the operations and maintenance costs in all options are significantly larger than the potential revenues. Annual (year 2030) operations and maintenance costs are $23.5 million in Option 1; $29.0 million in Option 2 and $33.4 million in Option 3. Like the capital costs, reduced economies-of-scale impact operations and maintenance costs and result in increased costs with additional infrastructure. Finally, Options 2 and 3 benefit from additional greenhouse gas "credits", relative to Option 1, due to the off-setting effect of using additional wastewater-derived heat for heating purposes. As shown the figure, these credits are relatively small and range from a low of $125,000 in Option 1 to $670,000 on Option 2 and $740,000 in Option 3 for year 2030. Clearly, the optimum in terms of meeting the goal of cost effective wastewater management will trend to a smaller number of plants, not an increasing number of plants.

2.9 THE PEER REVIEW PROCESS

As part of the conceptual planning process, the CRD engaged the services of a Peer Review Team (PRT) to review the work carried out by the consulting team. This group, composed of six senior individuals from the wastewater industry, carried out a three month review, culminating in the submission of their final report in March 2009 (PRT, 2009).

While the PRT agreed on many aspects of the work to date, there were areas of professional disagreement. These are primarily in future technical trends such as the economics of conventional activated sludge versus membrane bioreactor / blending or in operational issues such as the need for chemical addition to deal with low alkalinity wastewater in the nitrification / denitrification process. While these are interesting debates and will need to be readdressed at a later time, they are not critical to the selection of a distributed wastewater management strategy.

During their review, the PRT asked the consultant team to develop the costs for two variations on Option 1, which would combine the two wastewater treatment plants (South Colwood and McLoughlin Point) into a single larger plant in South Colwood (called the “gravel pit” site). These variations were termed Options 1B and 1C (the original Option 1 was termed 1A). The difference between the two variations is how the wet weather flows are handled. The cost analysis showed that the first stage of the two variations is between $50 million and $90 million more expensive than Option 1A. Similarly the life cycle costs were also more expensive. The reason that the PRT suggested looking at the idea of a larger wastewater treatment plant in South Colwood was not siting, per sec, but process technology. The concern raised by the PRT is that by selecting what may be a very “tight” site like McLoughlin Point, the CRD may be limited in terms of process selection and future flexibility to change the process or expand the plant. By going to a site that was unconstrained, the CRD could select a traditional process, such as conventional activated sludge (CAS), and would have more room to make changes or expand the site in the future.

While there is some merit in this point of view, there are other factors that need to be considered. First, while the “gravel pit site” may allow a more traditional tankage layout on a larger footprint now, this is not necessarily the best decision over the long term. The value of this site and future residential / commercial development may dictate that a compact technology and plant footprint may still be the best decision. Second, although the use of a non-nitrifying technology, such as conventional activated sludge, may offer some cost savings in energy use when compared to the membrane bioreactor (MBR) technology, this cost savings is to a large extent off-set by the higher energy costs to pump the wastewater from the core area to the gravel pit site. Third, pumping the raw wastewater to the gravel pit site via a marine route introduces both a regulatory and operational risk. The forcemain would cross existing ship anchorage areas. These would likely need to be relocated to reduce the risk of potential pipeline damage. In the end, a land pipeline route might be required. If this was the case, the capital costs would be even higher for Options 1B and 1C.

As obtaining property at either location is not assured at this time, the consultant’s team recommendation to CRD was to continue to evaluate both the McLoughlin Point and South Colwood site options, as variations on the overall Option1 strategy.

2.10 THE SUSTAINABILITY ASSESSMENT FRAMEWORK ANALYSIS

The SAF is the enhanced triple bottom line (TBL) approach that considers the economic, social and environmental effects of different options in an asset management, or life-cycle cost, context. It was applied to the three options to assist the CALWMC in making a decision on a preferred direction. The SAF includes three distinct yet interdependent elements; measuring the achievement of objectives; identification and evaluation of risk; and a decision/policy making process (**Figure 2-6**). Through these elements, the SAF provides a method of evaluating options that address multiple objectives. The evaluation provides a base for identifying and mitigating risks and incorporating risk management across all resources. However, it is only a tool to inform policy makers to understand the nature of options under consideration and in deliberating a final decision, where local and regional policies must be applied.

At the heart of SAF is the use of the multi-objective alternative analysis (MOAA) technique. MOAA is a technique to evaluate a number of potential alternative actions. The MOAA process begins with the establishment of an objectives hierarchy - goals, objectives and measurements - where the triple bottom line; environmental, social, and economic elements are at the highest level of the hierarchy.

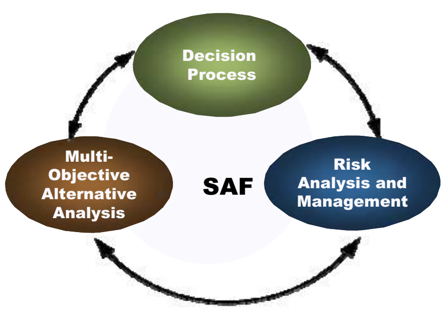


Figure 2-6
The Sustainability Assessment Framework

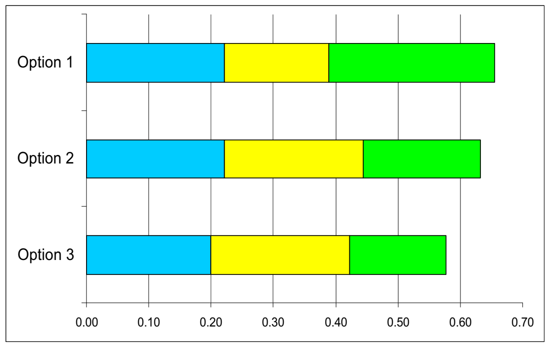
The second step is formulating performance measures against which the alternatives are assessed for each criteria. The performance measures are used to basically answer the question - how well does the alternative achieve or perform under this criteria? The performance measures could be qualitative or quantitative. A narrative statement is used to explain the performance where qualitative judgements are made.

With the objectives hierarchy and performance measures in place, the third step in the MOAA process is weighting the relative importance of each criterion. Weighting is done to establish the relative value between the Social, Economic and Environmental criteria. Weighting is also done to test the sensitivity of the analysis to changes in the relative importance of social, economic and environmental criteria. In a sensitivity test, the weights are adjusted to “stress” the evaluation to favour one or more of the high level goals to understand how the alternatives, or in the CRD case, the options change one relative to the other. In this third step, alternatives are scored using the performance measures and weightings. All measures and weights are normalized and a weighted average of scores and weights is calculated, resulting in a score for each alternative. Normalizing measures and weights is done to make sure that no one goal such as the economic goal, is weighted greater than another goal due only to the number of criteria being used to evaluate how well an alternative performs in achieving that goal.

The performance measures for each of these criteria were set within a 1 to 5 numeric scale – 1 is the worst condition or “lowest performance”, and 5 represents the best condition/performance. This 1 to 5 scale is defined for each criterion. Ratings of how well each option performs against the objective hierarchy was initially conducted by the consultant team and reviewed in meetings with CALWMC.

The results are a summation of the weighted performance ratings as shown in **Figure 2-7** for the three elements equally weighted. The higher the score – the better the option performance. The schematic also demonstrates the summation of the environment and social scores in relation to the net present value cost of the options.

	Environment	Social	Economic	Total Value Score
Option 1	0.22	0.17	0.27	0.65
Option 2	0.22	0.22	0.19	0.63
Option 3	0.20	0.22	0.16	0.58



VALUE SCORE TO NPV RATIO, EQUAL WEIGHTS

	Environment	Social	NPV	Environmental plus Sustainability Value Score	Value Score/NPV Ratio
Option 1	0.22	0.17	$ 1,174,000,000	0.39	0.33
Option 2	0.22	0.22	$ 1,538,000,000	0.44	0.29
Option 3	0.20	0.22	$ 1,666,000,000	0.42	0.25

Figure 2-7
SAF Analysis

The analysis points to Option 1 as the option that most adequately achieves the community's principles of equal balance between economic sustainability and desire to achieve social and environmental sustainability. The SAF analysis also demonstrated that Option 2 produces significant environmental benefits and that further consideration should be given to defining ways to capture the resource recovery benefits of Option 2.

2.11 THE ADOPTED STRATEGY

The CALWMC concluded that Option 1 was the preferred direction. However, they also recognized that there were uncertainties in acquiring and developing wastewater treatment plant sites, in development of a final biosolids management strategy and in setting the wet weather flow management priorities.

At the June 2, 2009 meeting of the CALWMC, the following motion was passed:

> *That the Capital Regional District (CRD) proceed with Option 1 with further investigation of variations on the strategy, including:*
>
> - *Continued analysis of Options 1a, 1b and 1c through the triple bottom line analysis, including an assessment of biosolids integration with solid waste activities and functions.*
> - *Investigation of a wastewater heat recovery system and delivery mechanism in James Bay.*
> - *Integration of inflow and infiltration management with appropriate phasing of the wet weather strategy at Clover Point.*
> - *Relocation of the solids processing from the liquid processing site to allow potential integration with solid waste activities and functions.*
> - *Further development of the biosolids management plan to reduce operational risks associated with biosolids end uses.*
> - *Complete siting investigations in Saanich East / North Oak Bay.*
> - *Investigation of opportunities for heat recovery and water reuse with the University of Victoria.*
> - *Research the possibility of a single larger site in the event that the McLoughlin Point site is not selected.*
> - *Evaluation of the financial and rate impacts of the costs and revenues, including revenues and/or carbon tax benefits of resource recovery and use for each option; and*
>
> *That the CRD look at options for sewage treatment in the West Shore by working in cooperation with the Administrators and Engineers of Colwood and Langford.*

3 The Distributed Wastewater Management Strategy

The adopted Strategy will see the CRD move forward with a distributed wastewater management approach involving the construction of at least three secondary wastewater treatment plants. The direction selected is not only the lowest cost solution but also meets the goal of carbon neutrality due to the resource recovery opportunities that it provides.

3.1 THE ADOPTED STRATEGY – AN OVERVIEW

The adopted Strategy provides the direction for wastewater management for the Core Area and western communities for the next several decades. While the planning horizon is 2065, the strategy will be implemented in phases or stages. The strategy itself is flexible. It will need to be reviewed and perhaps modified depending upon the pace of development and change – both social and technological. It is also important to note that while the CALWMC adopted a distributed wastewater management direction at the June 2, 2009, there are still variations on the details of the strategy that will be evaluated and decisions made over the next six months. This chapter describes the adopted strategy and discusses where decisions on the variations could impact the ultimate direction.

Figure 3-1 illustrates the key Strategy elements. Three wastewater treatment plants (WWTPs) will provide secondary treatment performance under all dry-weather and the majority of wet-weather flow conditions; the latter attained using a split-and-blend approach with specific technology application. The facilities will be located in three areas: MacaulayPoint / McLoughlin Point, Saanich East near the University of Victoria, and South Colwood. The plants would be located along the existing conveyance system.

Although the CRD has not yet secured the McLoughlin Point site, the Committee has decided to focus on this site given the uncertainty of obtaining property from the Department of National Defence (DND) at Macaulay Point. To this end, the CRD is in continued discussion with Imperial Oil and the Department of National Defence regarding the McLoughlin Point site. The CRD has purchased a parcel of land that could accommodate the Saanich East WWTP. However, the CRD is considering other sites in the general area and is currently working through a public consultation program to gather stakeholder feedback. Similarly, the CRD has identified a site, owned by the City of Colwood, which could accommodate the South Colwood WWTP. The CRD is considering phasing in this West Shore WWTP, depending on how much future capacity at the Macaulay / McLoughlin WWTP is initially available for treatment of wastewater from the West Shore communities.

Effluent from the three WWTPs would be suitable for reuse in landscape irrigation and toilet flushing applications. In addition, effluent from these facilities would be available for use as a heat source in adjacent district energy systems (DESs). Alternately, heat can be extracted directly from raw wastewater for use where practical, such as in the James Bay area of Victoria.

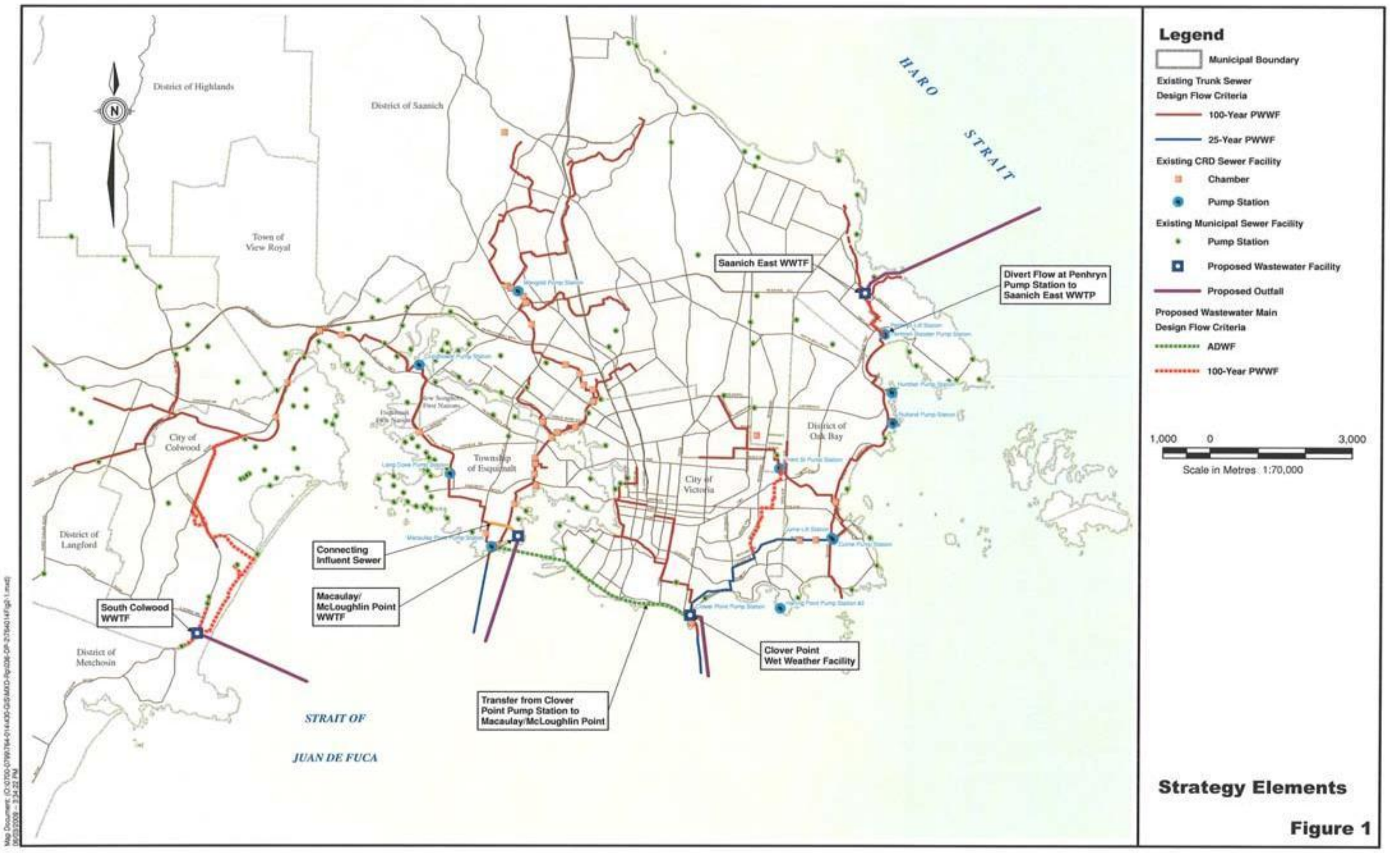


Figure 3-1
Key Strategy Elements

The wet-weather flows within each of the sewerage areas would be managed within the sewerage area, with the ultimate goal of treating the wet-weather flows at the treatment plants. A Clover Point facility would treat wet-weather flows only. The dry-weather flows would be pumped from the Clover Point sewerage area to the secondary treatment plant at Macaulay Point / McLoughlin Point. Key to cost-effective wet-weather flow management is integration of I/I reduction with appropriate phasing of the Clover Point treatment facility.

Solids processing operations would be accommodated at two locations. Dilute sludges produced at the Saanich East and Clover Point plants would be discharged to the collection system and received at the downstream Macaulay Point / McLoughlin Point WWTP. Blended, unthickened sludges would then be pumped to a solid processing facility located in a nearby industrial area. The decision to relocate the solids processing facility from the McLoughlin Point site was made because Transport Canada indicated it would not allow infill development into the harbour, which would be needed to accommodate both the liquid- and solids-stream systems on the McLoughlin Point Site. Alternately, if the CRD was able to acquire a larger site then both systems could possibly be placed on a single site. One benefit of relocating the solids processing facility to another site is possibly greater potential integration with solid waste activities.

Biogas generated by anaerobic sludge digestion would be upgraded to natural-gas quality biomethane and injected into the utility pipeline.

Phosphorus released during sludge processing operations would be recovered as magnesium-ammonium-phosphate (MAP) using a crystallization reactor system, in turn producing a commercial-grade, slow-release fertilizer product. At the same time, MAP production will mitigate facility operation and maintenance difficulties often experienced by unintended MAP formation within facilities.

The South Colwood WWTP would include its own sludge processing operations, similar to those described above.

3.2 WASTEWATER TREATMENT AND RESOURCE RECOVERY

Before describing the strategy's individual wastewater treatment and resource recovery facilities it is worthwhile to provide a brief commentary on secondary treatment technology and resource recovery to give context for the Strategy.

Secondary Treatment Technology

While it was not the intent to make final decisions on wastewater treatment technology during the conceptual planning phase of the program or constrain the Strategy with respect to technology, the option development and analysis yielded important conclusions. Specifically, the CRD should consider a blending of technologies that aim at providing an effluent quality that meets the final use. The opportunity for potential water reuse and the need for small facility footprints suggest that membrane bioreactor (MBR) technologies may be an appropriate choice for the dry-weather treatment technology. This would be combined with high-rate primary treatment technologies that would be aimed at producing an effluent that meets the goals for wet-weather discharges. By blending the effluent streams prior to marine discharge, the CRD can

Figure 3-2
MBR Technology

have the potential for water reuse and a cost-effective dry-weather / wet-weather treatment strategy.

This representative approach and technology, as well as others discussed below and in other sections, were selected for the purposes of developing and evaluating the options. They are contained in the Strategy only to provide a starting basis as the Core Area Wastewater Treatment Program moves from conceptual planning to implementation. Depending on the implementation model selected by the CRD for the entire Program and/or specific facilities, final technology decisions will be made by the CRD or the proponents who may design, construct and possibly operate the facilities under a private-public-partnership (P3) delivery. For the purpose of describing the Strategy, the treatment facility descriptions provided in this Discussion Paper employ a split and blend approach with MBRs as the secondary treatment technology.

Resource Recovery

The resource recovery opportunities associated with the wastewater treatment and solids processing facilities include water reclamation, heat recovery, biomethane production and phosphorous recovery. The key word here is "opportunity". Biomethane and phosphorus recovery systems are add-on systems that can be implemented at a given facility at any time, providing the facility layout is planned initially to accommodate these systems in the future. Similarly, effluent heat recovery is also an add-on feature whether the heat is used on-site for WWTP building heating or exported off-site for use in individual building or DESs. In the latter case, the CRD need only provide effluent pumping stations and pipelines to transport effluent "across the street", where a third-party energy utility would provide the infrastructure needed to capture (e.g. heat exchangers, heat pumps) and distribute the heat to customers. Water reclaimed for reuse is similar to that of effluent heat recovery, but would require the CRD to disinfect the effluent prior to delivery to a third party, who, in turn, would distribute it to customers.

Macaulay Point / McLoughlin Point WWTP

Wastewater destined for the Macaulay Point / McLoughlin Point WWTP will be intercepted upstream of the existing Macaulay Point pumping station using a new tunnel system, which would convey the wastewater to the McLoughlin Point site. In order to construct a facility at this site, the CRD will need to acquire the land that had been occupied by the Imperial Oil tank farm and will need to partner with the DND on lands to the north of the tank farm.

As noted above, this WWTP would receive all of the solids from the Saanich East and Clover Point plants and any future flow from the Macaulay sewerage area not handled by the South Colwood WWTP. Representative liquid-stream technologies used at the Macaulay/McLoughlin Point WWTP may include:

- Influent pumping
- Screening and grit removal
- Lamella-based primary clarification, with chemically-enhance primary treatment (CEPT) capability for wet-weather flows
- Membrane bioreactor (MBR)-based secondary treatment
- Effluent pumping

The WWTP would use a primary effluent split-and-blend approach to accommodate the majority of wastewater flows. Primary treatment, with CEPT capability, would be provided for up to 4.0 times the ultimate (Year 2065) average dry-weather flow (ADWF) or 350 ML/d. Secondary treatment capacity would be provided for up to 1.5 times the ultimate ADWF or 131 ML/d. Wastewater flow rates in excess of 350 ML/d would bypass primary treatment and receiving screening. All flows would be blended prior to discharge to the marine outfall.

Effluent requiring disposal would be returned to the marine environment via a new outfall constructed to the east of the existing Macaulay Point outfall. As the site is only a few meters above sea level, it is expected that the effluent discharge will be pumped from a new station at the McLoughlin Point site. The existing Macaulay Point pumping station would be decommissioned; however, the outfall system would be retained for emergency bypass. Given the treatment process, discharge location and environment, effluent disinfection would not be required, based on the preliminary environmental impact modeling (Golder Associates, 2009).

Beyond directing effluent to marine disposal, effluent will be managed in two other ways. First, the effluent pumping station will have the capability of pumping effluent across the harbour to and from a third-party district energy system (DES) located in Victoria. The DES would recover heat from the effluent and return it to the McLoughlin Point side for disposal out the marine outfall. A variant of this approach would be to recover heat from raw wastewater directly prior to it being pumped to the Macaulay Point / McLoughlin WWTP, where, for example, it could be used in a local DES in the James Bay area. Effluent heat would also be available for a DES system in the DND properties north of McLoughlin Point, should DND redevelop this area. Second, the effluent could be used for non-potable applications. Effluent would be pumped out of the final clearwell and made available to a nearby third-party reclaimed water system.

Solids Processing Facility

Representative solids-stream technologies used at a nearby solids processing facility, which would receive sludges from the Macaulay Point / McLoughlin Point WWTP, include:

- Mechanical sludge thickening
- Anaerobic sludge digestion
- Biogas cleaning and upgrading to biomethane
- Centrifuge sludge dewatering
- Crystallization phosphorus recovery

Primary and secondary sludge would be blended in a blend tank prior to pumping the solids from the McLoughlin Point site to a solids processing facility located on nearby industrial lands. Once received at the site, the sludge would be mechanically thickened and pumped to anaerobic digesters for stabilization. The anaerobic digesters could also accept truck-hauled, locally generated solid waste organics for co-digestion with wastewater sludges. The organic material would include fats, oils and grease (FOG) that require minimal pre-processing prior to digestion. Other solid waste organics could be accepted that received the required pre-processing at a solid waste transfer station. After digestion, the biosolids would be dewatered using centrifuges and then hauled to the willow coppice demonstration program lands or directed to a dryer facility located on the same site.

The biogas generated from the digesters would be upgraded to natural-gas grade biomethane and injected into the utility natural gas pipeline for use off-site as an energy source. Biogas upgrading would involve carbon dioxide removal (pressure swing adsorption), as well as siloxane (activated carbon) and hydrogen sulphide (iron sponge) removal. Phosphorus would be recovered from the digester supernatant and dewatering recycle streams using a crystallization reactor system with magnesium addition and pH control. The magnesium aluminum phosphate (MAP) product would be bagged and made available for sale.

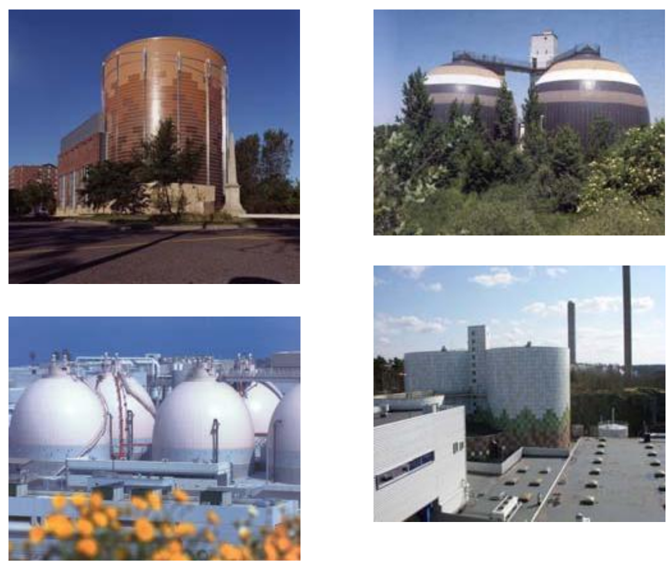


Figure 3-3
Typical Anaerobic Digesters

South Colwood WWTP

The concept and representative liquid-stream and solids-stream technology would be similar to the Macaulay Point / McLoughlin Point WWTP and associated solids processing facility. The South Colwood WWTP primary and secondary treatment capacities would be 109 ML/d (2.9 times ADWF) and 58 ML/d (1.5 times ADWF) for

Year 2065, respectively. At this time wet-weather flows in excess of 109 ML/d are not anticipated and thus planned bypassing, except under emergency conditions, is not part of the concept.

Effluent would be returned to the marine environment via a new outfall extending into Juan de Fuca Strait. Effluent pumping will not be required as the site elevation is significantly higher than sea level. Based on oceanographic modeling completed to date, effluent disinfection does not appear to be required (Golder Associates, 2009).

Similar infrastructure as that used at the Macaulay Point / McLoughlin Point WWTP would be provided to deliver effluent for heat recovery and reclaimed water reuse purposes, where the adjacent development could provide opportunity for its use.

Saanich East WWTP

This facility would function as a liquid-stream-treatment-only facility, reducing the downstream wastewater flows and providing a high quality effluent for water reuse and a source of heat. Sludges generated by the facility would be discharged to the sewer system for transport to and processing at the Macaulay Point / McLoughlin Point WWTP.

The Saanich East WWTF concept uses the same liquid-stream processes as described for the other two facilities. Secondary treatment capacity would be provided for up to 1.5 times the ADWF for the Year 2065 scenario or 26 ML/d. Primary treatment only would be provided for flows between 1.5 and 4 times the ADWF, up to 69 ML/d. Any flow above 4 times the ADWF would receive screening only and be blended with the primary and secondary effluent for discharge to the outfall.

Effluent requiring disposal would be discharged by gravity via a new outfall constructed out into Haro Strait. This outfall would replace the aging Finnerty Cover bypass outfall. Similar infrastructure as that used at the Macaulay Point / McLoughlin Point WWTP would be provided to deliver effluent for heat recovery and reclaimed water reuse purposes, where the University of Victoria, in particular, may provide one such opportunity.

3.3 WET WEATHER FLOW MANAGEMENT

Goals and targets for wet-weather flow management, including the elimination of combined sewer overflows (CSO) and the reduction of sanitary sewer overflows (SSO), have already been set in the LWMP. The analysis concluded that the best approach to achieve these goals is a combination of sewer separation in the CSO areas, the continued management (i.e. I/I reduction) of the sanitary sewer system asset through replacement and remediation and the treatment of surplus wet weather flows at the end of the pipe, with discharge to the non-embayed marine environment.

The Strategy provides wet-weather flow treatment primarily at a Clover Point Wet-Weather Facility, with some surplus wet weather flows treated at Saanich East, Macaulay Point / McLoughlin Point and South Colwood WWTPs. However, the Strategy remains flexible with respect to the timing and level-of-treatment of the Clover Point facility, which will depend on I/I management.

The Clover Point site will be a dedicated wet-weather treatment facility. All flows arriving at Clover Point under 2.0 times ADWF will be pumped to the Macaulay Point / McLoughlin Point

WWTP. The process works at this location would consist of the following:

- Pump station and forcemain to pump the dry-weather wastewater flow to the Macaulay / McLoughlin Point WWTF
- Influent pump station for wet-weather flows
- Screening and grit removal for wet-weather flows
- High-rate, chemically-enhanced primary clarification for wet-weather flows
- Effluent pumping for wet-weather flows

For most days of the year, the pump station and forcemain system would pump the wastewater arriving at this location to the Macaulay Point / McLoughlin Point WWTP. This pump system would be sized for 2.0 times ADWF or about 74 ML/d. On the days where the flow arriving at this site exceeds this capacity, the surplus flow, up to 403 ML/d, would be routed through the wet-weather flow treatment system. This system would have a high-rate, chemically-enhanced primary treatment capacity of 254 ML/d. On days with extremely high wet-weather flows, flows in excess of this capacity would receive screening only and be blended with other effluent prior to being discharged out the Clover Point outfall. The expected peak screened only flow is estimated at 149 ML/d.

The new dry-weather pump station and the wet-weather treatment facility can be located underground in a similar manner to the existing works. Some disruption of public access will be required during the construction period, as it will be necessary to employ a “cut and cover” construction process. Once in operation, truck traffic to deliver chemicals to the site will be minimal as the wet-weather system will only operate during limited periods. Consideration can also be given to constructing the high-rate primary treatment system at an off-site location. This may be particularly attractive if the implementation of primary treatment at this location is deferred and constructed at a later date. The residual sludge from the wet-weather treatment process would be returned to the dry-weather pump station for transport to the Macaulay Point / McLoughlin Point WWTP and ultimately the solids processing site. This eliminates the need to truck-haul sludge from the Clover Point site.

3.4 BIOSOLIDS MANAGEMENT AND RESOURCE RECOVERY

In the conceptual planning of its Core Area Wastewater Treatment Program the CRD has developed an innovative biosolids management strategy that considers local and global issues while balancing the pursuit of evolving approaches with an appropriate level of risk mitigation. The biosolids management strategy provides the joint functions of stabilization of the wastewater solids and extraction of energy and resources as part of the solids processing activities. Key elements of this processing include anaerobic solids digestion, biomethane production with the green fuel produced used in the community natural gas system, and phosphorus recovery to produce a commercial-grade slow release fertilizer product.

The biosolids management strategy recognizes that biosolids can best be managed through a multi-use zero waste strategy. A small portion of the biosolids produced will be directed to a willow coppice demonstration program. This is an emerging biosolids management approach that has significant benefits in terms of greenhouse gas management and production of a value-added final product. The remaining biosolids will be further dried for use as a green fuel in the industrial sector. The initial target customer would be the cement manufacturing sector, where the current use of coal would be partially off-set by the use of the dried biosolids fuel. In order to not fully rely on third-party contracts, the thermal destruction of dried biosolids, either alone or in conjunction with solid waste residuals management, provides the CRD with another option for biosolids management. These three end-uses are described below.

Willow Coppice Demonstration Program

The term coppice refers to the purposeful short-rotation growing and harvesting of trees. Subsequent to planting, trees are allowed to grow for about 3 years before being mechanically harvested and allowed to grow for another 3 years. This cycle can be repeated many times (e.g. 7 cycles or 21 years) before the tree becomes ineffective in this application and is replaced.

Figure 3-4
Willow Coppice Operation

In the context of a biosolids management program, land applied biosolids provide some of the macro- and micro-nutrients required by trees for their growth. Harnessing the sun's energy to drive biomass growth through photosynthesis, where biosolids provide some growth nutrients, leverages the energy potential contained in the biosolids. The harvested trees are chipped and thus the biomass is now in the form of woodchips. Woodchips are a value-added, saleable product that can be used in composting programs or other typical applications. The potential also exists to sell the woodchips as a green fuel source to third-party energy-from-biomass utilities as these energy markets develop

Biosolids-based willow coppice programs have seen limited implementation elsewhere in the world, most notably in Sweden. The mechanical equipment needed for such programs is commercially available. However, like any agricultural-type activity, the success of a coppice program will depend on many site-specific factors including tree type, land availability and topography, and soil and climate conditions. For these reasons, the CRD has elected to pursue a demonstration-scale program to generate information for use in assessing the long-term feasibility of such a biosolids management approach. Besides addressing the scientific aspects of the approach, the demonstration program will also provide information on the markets and saleability of the woodchips for traditional uses. In addition, the energy-from-biomass sector in British Columbia is still in its infancy but is anticipated to develop over time. By first implementing a demonstration-scale program, the CRD mitigates its risk of generating a green fuel before local markets sufficiently develop.

In terms of scale, the demonstration program would utilize about 1% of the biosolids generated initially by the Core Area Wastewater Management Program. This program is of sufficient scale such that full-size equipment could be used and its use properly evaluated for the topography of the trial sites. At the same time, this scale would still practically allow intensive environmental monitoring of the site areas and thus produce the data needed for rigorous scientific assessment.

Green Fuel Production

Using biosolids to create a green fuel for the cement industry, or any other industry that typically uses coal as an energy source, requires that the biosolids first be dried to reduce its moisture content from approximately 70% to less than 5%. Once dried the biosolids have energy content similar to that of a low-grade coal and, as a result, can be combusted directly without limitation.

The biosolids management strategy envisions the CRD providing the infrastructure needed for biosolids drying, located in an industrial site within the Core Area. This infrastructure may be on the same site as other wastewater-related solids processing facilities, depending on land availability and area requirements. Although the CRD will incur costs for facility construction and operation/maintenance, the dried biosolids will be a saleable, revenue generating green fuel product. The biogenic nature of dried biosolids makes it attractive to cement industries since it reduces the carbon footprint of their operations. The dried biosolids would be truck-hauled to cement kilns in the Lower Mainland.

Initially, the strategy envisions that 99% of the biosolids generated by the Core Area Wastewater Management Program will be dried and directed to the cement industry sector. In the future, should the coppice demonstration program prove successful and additional lands are available, biosolids quantities in excess of the initially installed dryer system capacity would be diverted to a full-scale coppice program. However, it is expected that production of a green fuel via dried biosolids would continue to be a significant long-term element of the District’s biosolids management strategy.

One of the initial key risks to the CRD is the successful engagement of the cement industry in its biosolids management strategy, where third-party contracts need to be developed and accepted. As the CRD moves from the conceptual planning to implementation phase of the Core Area Wastewater Management Program in July 2009, a priority activity will be to begin discussions with the local cement industry with a goal of securing the necessary contracts.

Thermal Destruction

With the biosolids management strategy envisioning that the majority of biosolids will be dried to produce a green fuel for the cement industry, for the foreseeable future, the main risk for the CRD is the third-party contracts with the industrial sector. Once in place, if these contracts are terminated the CRD will have to direct the undried or dried biosolids elsewhere. In the short-term, the biosolids would be disposed of in the existing CRD landfill. Particularly if they are dried, the biosolids would have a minimal short-term impact on long-term landfill capacity. In the longer-term, another biosolids management option would be required.
The thermal destruction of dried biosolids, either alone or in conjunction with solid waste residuals management, provides the CRD with a third option for biosolids management.

The continued development of thermal technologies and the scale-based cost sensitivity of these technologies necessitates a detailed analysis of options available. In addition, provision of a regional facility that would accept biosolids and/or solid waste residuals from other utilities or municipalities may provide notable advantages and partnering opportunities. To this end, as part of its risk mitigation activities during the early part of the implementation phase of the Core Area Wastewater Treatment Program, the CRD should concurrently pursue the analyses required to develop a biosolids end use strategy that focuses on thermal destruction.

3.5 CONVEYANCE SYSTEM MODIFICATIONS

The adopted strategy will require several modifications to the wastewater collection / conveyance system beyond treatment facility-specific changes discussed previously, including:

- Direct wastewater flow from the Penhryn pumping station (PS) to the Saanich East WWTF
- Extend the Trent PS forcemain to Clover Point
- Increase the capacity of the Currie Road PS

Various modifications in the NWT sewer area (NWTN twinning, NWTW wet-weather flow upgrades, diverting wastewater flows to the South Colwood WWTF) are also required. If the construction of a West Shore wastewater treatment plant is delayed, to take advantage of the short-term capacity at the Macaulay Point / McLoughlin Point plant, some additional upgrading of the lower sections of the NWT system may be required. Any upgrading should balance the short-term capacity requirements, the timing of achieving the wet weather flow management goals and the long-term reduced capacity needs, once the West Shore plant is in place.

3.6 FUTURE FLEXIBILITY

The adopted Strategy provides flexibility to accommodate future changes in wastewater management. These are described below:

Small Decentralized Wastewater Treatment Plants

The Strategy can accommodate small-scale, decentralized WWTFs that may serve individual developments such as Dockside Green. How many of these small decentralized plants might be built and what's the impact on the overall wastewater management planning? The Dockside Green development provides a useful model to address this question and to recognize the scale of the type of system. The design flow of the Dockside Green WWTF represents about 0.2% of the future (2065) average dry-weather flow for the planning area. Based on planning work completed to date, there might be up to 10 locations where future developers may consider this type of system given their economics and physical requirements. Based on this number and a similar capacity to the Dockside Green development, wastewater treated in similar systems would be only 2% of the overall wastewater flow generated in the Core Area. As this represents a very small variation in the predictions of future flows, this type of decentralized wastewater treatment can be easily accommodated in the adopted wastewater management Strategy.

Water Recycling

Residence-level internal water recycling may provide a more aggressive approach to water reclamation and reuse. In this approach, only the grey water from bathtubs and showers is treated and used for toilet flushing. This can be done by using simple filtration technologies that are maintainable by the home owner. This approach can also be supplemented by rainwater capture to produce a larger volume of non-potable water that can be used for landscape irrigation or groundwater recharge. The advantage of this direction is that it has much wider application in both new and existing development when compared to a development-level approach described above that provides treatment to all wastewater produced, which requires a sophisticated treatment facility and well trained operations staff.

Urine Separation

Another possible direction for small decentralized WWTFs is further away in terms of application. This is the concept of urine separation and the creation of a "third" waste stream – grey, yellow and black waters – that could be advantageous from the perspectives of nutrient recovery, micro-constituent control and reduction in downstream loading. This approach, and its supporting technologies, are still very much in the emerging stage and it will likely be decades before urine separation is implemented at a reasonable scale in Canada. Nevertheless, the current distributed wastewater management approach allows for this possibility. A future high-density residential / commercial development in the West Shore Area would be an ideal candidate for this type of approach.

3.7 CARBON FOOTPRINT

A relative carbon footprint analysis (CFA) was conducted for the three options developed to highlight differences in greenhouse gas (GHG) emissions and off-sets between the three options. Following the adoption of the Strategy, a more comprehensive total or absolute carbon footprint analysis has been prepared for the Strategy. Key items included in this more comprehensive analysis include methane emissions associated with on-site systems located in the Core Area, GHG emissions associated with construction activities, bioreactor nitrous oxide emissions, and effluent nitrogen-derived marine nitrous oxide emissions. Consistent with the prior CFA analysis, the Strategy CFA includes biosolids management elements and activities.

The CFA extended from Year 2015 to Year 2065, where the net (i.e. emissions minus off-sets) GHG emissions where calculated for each year in the analysis period and summed over this period. The GHG emissions are presented in units of carbon dioxide equivalents (i.e. t CO_2e). Figure 3-5 shows the estimated GHG emission and off-set values. The data contained in these figures indicate that the net carbon footprint, over the 50 year analysis period, is approximately 32,000 t CO_2e (i.e. emissions are greater than off-sets) based on the analysis boundaries and assumptions. However, given the accuracy of

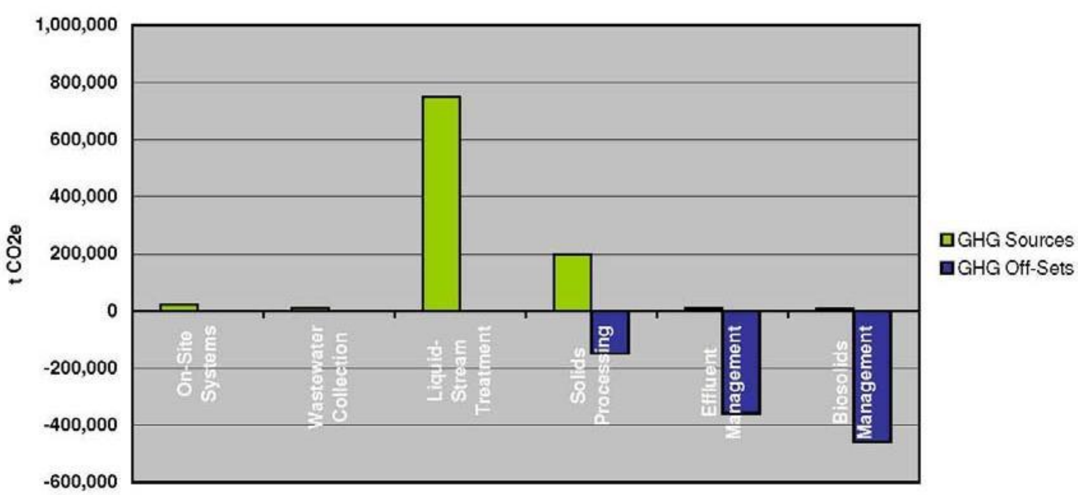


Figure 3-5
Estimated GHG Emission and Off-Set Values

the analysis and recognizing that both the estimated GHG emissions and off-sets are approximately 1,000,000 t CO2e in magnitude, the Strategy yields an essentially carbon neutral footprint. This favourable outcome results from two key factors - the low GHG-intensity of electricity supplied in British Columbia and the potential GHG off-sets provided by recovered resources in the form of heat (avoided natural gas and electricity use), biomethane (avoided natural gas use) and dried biosolids (avoided coal use). At the same time, realizing this low carbon footprint will require the CRD to pursue significant resource recovery measures.

3.8 PROGRAM BUDGET

The conceptual planning work developed program budget for the adopted Strategy for the planning horizon to 2065. In addition to the various treatment facilities and outfall system costs, regional conveyance system modifications, site land purchases and all solids processing / biosolids management elements and related resource recovery works are included in the cost estimates. The capital costs do not include the costs for local sewer systems. The costs also do not include off-site infrastructure costs associated with water reuse and its distribution and, similarly, for recoverable heat, except for limited “across-the-street” (Saanich East WWTP and South Colwood WWTP) and “across-the-harbour” (Macaulay / McLoughlin Point WWTP) pumping and pipeline systems to supply effluent to third party utilities.

The base construction costs were prepared in 2008 dollars, where other direct costs include design (10%) and construction (15%) contingency allowances. Indirect cost allowances include engineering (15%), administration (3%) and miscellaneous costs (2%). Finally, an interim finance allowance (4%) was also included in the estimate. These additional allowances provide a 1.56 multiplier on the base construction costs. The appendices contain a detailed capital cost summary for all Strategy capital costs incurred through to Year 2065, along with roll-up summaries for both Stage 1 of the Strategy (elements constructed by Year 2017).

A summary of the estimated Stage 1 capital costs, in 2008 dollars, is shown in **Table 3-1** below.

The Stage 1 program budget has been estimated to be $1.190 million, which reflects an assumed annual inflation allowance of 2.0% per year from 2008 until the expected mid-point of construction of the Stage 1 infrastructure in 2014. The consultant team also investigated approaches to further phasing the implementation to reduce the Stage 1 cost. This phasing is not considered in the above figures. A discussion on potential phasing is presented in the following section.

The appendices also contain the detailed economic life cycle and carbon footprint analysis worksheets. This analysis included all capital expenditures, operations (e.g. labour, energy, chemicals, administration) and maintenance costs, potential revenue generated from saleable products, and costs of greenhouse gas (GHG) emissions incurred in each year during an analysis horizon that extended from Year 2015 to Year 2065, which was the end of the planning horizon. To provide context related to the $1.056 million Stage 1 capital cost (2008 dollars), the following values were extracted from the life cycle/carbon footprint analysis worksheets.

Table 3-1
Stage 1 Capital Costs

ITEM	COST ($ MILLION)
DIRECT COSTS	
Liquid-Stream Treatment Facilities	419
Solids Processing / Biosolids Facilities	137
Treatment Facility Related Conveyance Systems	25
Outfalls	32
Heat Recovery Pumping/Piping	5
Wastewater Conveyance Modifications	45
Subtotal	**663**
Design and Construction Contingencies	**165**
Total Direct Cost	**828**
INDIRECT COSTS	
Engineering	124
Administration	25
Miscellaneous	17
Total Indirect Costs	**166**
Subtotal	**994**
Interim Financing	40
Land Purchases	22
Total Capital Cost	**1,056**

Annual Operations and Maintenance Costs:	$23.6 million
Annual Greenhouse Gas Costs:	$0.16 million
Annual Potential Revenues:	$3.4 million

All values shown are in 2008 dollars and the annual costs/revenues are for the Year 2030.

3.9 IMPLEMENTATION PHASING

During the final work on analyzing the three options, the consultant team was asked to look at the potential for reducing the Stage 1 capital expenditures through delaying the implementation of elements of the expected strategy. Two major potential opportunities were identified. These are:

Staging of Plant Construction

The Option 1 strategy assumed that both the Macaulay Point / McLoughlin Point plant and the South Colwood plant would be constructed in the first stage. A variation on this approach is to continue to direct all the wastewater flow from Langford and Colwood to the Macaulay sewerage system and only building the Macaulay Point / McLoughlin Point plant in the first stage. This would mean that capacity for Langford and Colwood would be “borrowed” from the eastern communities, until growth in these communities dictated the need for additional capacity. This would allow the plant in the West Shore to be deferred until about 2025. One of the advantages of this staging is that it allows additional time to plan the long term wastewater management approach for Colwood and Langford. This allows the CRD and the communities the opportunity to work with developers in the planning for the future wastewater treatment needs. The potential downside is that capacity limitations in the existing wastewater conveyance system may limit the ability to handle the planned increase in the serviced population during the next 15 years. Delaying the West Shore plant may also delay the achievement of all of the wet weather flow management goals in the Macaulay Sewerage Area.

Deferring Wet Weather Flow Management Elements to a Future Stage

All of the options assumed that primary treatment would be provided at Clover Point for the wet weather flows, above two times the average dry weather flow (ADWF). While this meets the "letter" of the Municipal Sewage Regulations, the cost to provide primary treatment, over the preliminary treatment currently in place, is relatively high. Under the LWMP legislation, the Minister could allow a longer period to put this level of wet weather treatment in place. This would have the advantage of not only deferring a significant capital cost, it would also allow better planning of the integration of inflow / infiltration (I/I) reduction at the municipal level with the need and capacity of end-of-pipe wet weather treatment at Clover Point. This deferment would not impact achieving the goal of reducing the sanitary sewer overflows (SSOs) to sensitive water bodies in the Clover Point Sewerage area – the only difference is on the level of treatment on the wet weather flow discharged to the open ocean at Clover Point.

These deferments could reduce the first stage capital costs by about 20%, dropping the Stage 1 capital cost to under $1 billion. This will be looked at further in the next phase of implementation planning.

4 Summary

The adopted Strategy is a bold change from traditional thinking and is truly innovative. It considers wastewater as a resource that can be integrated into urban resource management planning in a sustainable yet affordable manner.

Over the last few decades, when the words “Victoria” and “sewage” were used together, it was usually in reference to the debate on why one of Canada’s major urban centers continues to discharge wastewater, with limited treatment, into the marine environment. This debate has been heated and emotional – on both sides of the issue. Ironically, the delay in moving to wastewater treatment may have been a blessing in disguise. As planning now moves ahead, the CRD has the opportunity to look at wastewater management from a different point of view – not as a waste to dispose of, but as a resource to utilize.

The Drivers

The shift to viewing wastewater as a resource has three principle drivers – resource limitations, energy efficiency, and self sufficiency and carbon footprint. While these are not new to the wastewater industry, they have taken on more significance in the past few years. These drivers create resource utilization or integration opportunities that fall into four main areas – energy from organic solids, wastewater heat energy, water reuse, and nutrient recovery.

Distributed Wastewater Management

Looking at wastewater management from a resource recovery approach can be coupled with how we look at overall urban water planning. Traditional thinking in urban areas is to configure the wastewater management system as a “centralized” system, where wastewater would be conveyed to a single large treatment facility, followed by disposal of the effluent, typically to a water body such as a river or ocean. While some elements of resource recovery, such as energy recovery from organic solids, benefit from a larger scale, other elements such as heat recovery or water reuse can be better achieved on a local basis.

Combining the benefits of both a “centralized” approach with “decentralized” elements can thus lead to a distributed approach to wastewater management. Decentralized plants that provide local heat recovery or water reuse can be developed in the sewerage area, with the “central” plant at the end of the sewerage system focused on wet weather flow management and energy recovery from the organic solids.

The Adopted Strategy

At the CALWMC meeting on June 2, 2009, the CRD decided to move forward with a distributed approach to long term wastewater management involving the construction of a least three secondary wastewater treatment plants. This decision was arrived at using a sustainability assessment framework approach that considered the triple bottom line – economics, environment and social impacts. The direction selected is not only the lowest cost solution but also meets the goal of carbon neutrality due to the resource recovery opportunities that it provides.

The advantages of this adopted distributed wastewater management strategy are three fold. First, it reduces the size of the downstream “central” plant, currently planned for Macaulay Point / McLoughlin Point, as the upstream decentralized plants reduce the flows reaching the plant. Second, by strategically locating upstream plants, in Saanich East and on the West Shore, this approach creates local opportunities for water reuse and heat recovery from the wastewater. Third, by reducing the existing wastewater flows in the lower portions of the sewerage system, capacity is freed up to handle a greater portion of the wet weather flow – greatly reducing the frequency and volumes of the current sanitary sewer overflows.

The real innovation of this strategy is the flexibility that it will provide the CRD in future decades. The CRD will no longer need to build larger and larger pipes in the ground to transport the wastewater long distances to a central treatment plant site. They will no longer need to continually expand the central plant to handle higher wastewater flows due to growth – the decentralized plants will handle the growth in the outlying communities.

Looking to the Future

In conclusion, the direction adopted by the CRD for future wastewater management is a bold change from traditional thinking and is truly innovative. It considers wastewater as a resource that can be integrated into urban resource management planning in a sustainable yet affordable manner. While not all of the ideas and opportunities for resource management can or will be implemented in the short term, the key is that the CRD is planning for several decades in the future. The intent is to establish the fundamental concept and facility siting decisions, so that, over time, wastewater management truly becomes a sustainable part the water and energy resources in the community.

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Acronyms and Abbreviations

ADWF	Average dry weather flow
CSO	Combined sewer overflow
CRD	Capital Regional District
DND	Department of National Defence
FOG	Fats, oils and grease
I/I	Inflow and infiltration
LWMP	Liquid Waste Management Plan
MAP	Magnesium aluminum phosphate
MBR	Membrane bioreactors
MoE	Ministry of Environment (Provincial)
ML/d	Mega liters per day
mm	Millimetre
PF	Peaking factor
PWWF	Peak wet weather flow
SETAC	Society of Environmental Toxicology and Chemistry
SSO	Sanitary sewer overflow
TBL	Triple Bottom Line
TCAC	Technical and Community Advisory Committee
UV	Ultraviolet
WWTP	Wastewater treatment plant