DISCUSSION PAPER

Capital Regional District
Core Area Wastewater Management Program

Integrated Resource Management Strategy

Discussion Paper – Biosolids/Organic Residuals Strategy Evaluation
031-DP-9

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1 Objective

Building on previous work completed under this Activity 031, the overall objective of this Discussion Paper is to provide more detailed information on a diverse range of biosolids management / organic residuals energy and resource recovery strategies. This information will enable further development of options for the overall Distributed Wastewater Management Strategy for the Core Area under Activity 036, which includes not only liquid-stream wastewater treatment but also biosolids management and potentially some level of solid waste management integration with wastewater management.

In meeting this objective, this Discussion Paper presents the results of an evaluation conducted on the short-list of broad biosolids management / organic residuals energy and resource recovery alternatives or strategies identified previously in Discussion Paper 031-DP-3. As will become clear to the reader, the analysis is complex and interpretation of the findings involves many nuances. This Discussion Paper is not intended to be an exhaustive written treatise of the analysis and results, but instead highlights key points and serves as background information for discussion.

2 Thematic Strategies

Discussion Paper 031-DP-3 identified and described briefly four short-listed thematic alternatives or strategies that were selected for evaluation. **Table 2-1** summaries the four strategies (#1, #2, #4 and #5, with #3 eliminated per 031-DP-3) with additional information and refinements provided in the following discussion. Table 2-1 also includes three additional sub-strategies that evolved during the analysis of the four strategies.

As shown in Table 2-1, the four broad short-listed strategies include:

- Maximum Beneficial Reuse
- Maximum Integration and Maximum Energy Recovery
- Separate Digestion and Balanced Energy Recovery/Beneficial Reuse
- No Digestion and Balanced Energy Recovery/Beneficial Reuse

Table 2-1. Short-List of Thematic Strategies

Thematic Strategies	Stabilization	Thermal Destruction	Material End Use	Energy End Use
1a/b/c/d. Maximum Beneficial Reuse				
SW organics	compost - Hartland Area	n/a	SW organics land application - distributed within/outside CRD	n/a
WW sludges[1]	digest - Macaulay Area	n/a (1a, 1c); 100% of biosolids to dryer at Hartland Area and Lower Mainland cement kiln (1b); 50% of biosolids to dryer at Hartland Area and Lower Mainland cement kiln (1d)	100% of biosolids to "conventional "land application outside CRD (1a, 1b); 50% of biosolids to "industrialized" land application outside CRD (1d);	co-generation (heat and electricity) (1a) or pipeline natural gas/vehicle fuel (1b, 1c, 1d)
2. Maximum Integration and Maximum Energy Recovery				
SW organics	co-digest - Hartland Area	co-mass burn with MSW - Hartland Area	bottom ash - reuse; fly ash - separate monofill disposal	pipeline natural gas/vehicle fuel; electricity
WW sludges	co-digest - Hartland Area	co-mass burn with MSW - Hartland Area	bottom ash - reuse; fly ash - separate monofill disposal	pipeline natural gas/vehicle fuel; electricity
4. Separate Digestion and Balanced Energy Recovery / Benefical Reuse				
SW organics	digest - Hartland Area	n/a	same as Strategy 1	same as Strategy 2
WW sludges[1]	digest - Macaulay Area	FBC - Hartland Area	FBC fly ash - separate monofill disposal	same as Strategy 2
5a/b. No Digestion and Balanced Energy Recovery / Beneficial Reuse				
SW organics	compost - Hartland Area	n/a	same as Strategy 1	n/a
WW sludges	n/a	FBC - Macaulay Area (5a) or dryer at Macaulay Area and Lower Mainland cement kiln (5b)	FBC fly ash - separate monofill disposal (5a)	electricity (5a)

Notes:
1. Includes potential for co-digestion of locally generated SW organics.

The implicit assumption in all described strategies is that wastewater sludges generated at all wastewater treatment facilities would be processed at a single location. Given the potential size of a larger distributed treatment facility in the West Shore or other area, it is possible that these facilities could process their own sludges along with some locally generated solid waste organics. However, it is important to note that the assumption described does not have a direct impact on the strategies considered in this paper and the information required in this context. Further consideration of solids processing at distributed wastewater treatment facilities will be assessed in the separate Distributed Wastewater Management Strategy Activity.

Strategy 1a – Maximum Beneficial Reuse (Biosolids to Land Application, Co-Gen)
For this strategy the source-separated solid waste organics would be composted in the area of the Hartland landfill. The wastewater sludges would be anaerobically (thermophilic temperature) digested at a Macaulay area wastewater treatment facility. The resulting biogas would be used to fuel boilers to heat sludge entering the digesters, with excess gas directed to a co-generation system to produce heat and electrical power for on-site use.

There would be no thermal destruction of either solid waste organics or wastewater sludges/biosolids. The residuals from the solid waste organics composting process would be distributed for residential, urban space, and agriculture land application within the CRD up to the limits of demand and then outside the CRD for the remainder.

A recent biosolids market survey (SYLVIS (2008)) found that there is sufficient land area available in the CRD and Cowichan Valley Regional District to recycle biosolids for over a century at the production rates envisioned. While there are only limited opportunities for mine reclamation and landfill use, both agriculture and forestry applications have significant long-term potential. For the purposes of the evaluation, it was assumed that biosolids would be used for forest tree farm fertilization only.

Strategy 1a provides the CRD with the option for some co-digestion of solid waste organics, generated locally, with wastewater sludges. Accepting solid waste organics that require minimal processing (e.g. fats/oils/grease) reduces costs associated with pre-processing.

Strategy 1b – Maximum Beneficial Reuse (Biosolids to Cement Kiln; Biomethane)
Strategy 1b is the same as Strategy 1a, with two exceptions. First, digested biosolids would be hauled to and dryed at a facility located in the Hartland area. The dried biosolids would then be transported via a truck to a cement kiln in the Lower Mainland for use as a coal substitute fuel. Although the energy required for drying would be provided by purchased natural gas, the dried biosolids would be a saleable, revenue generating product that is equivalent to a low-grade coal. The biogenic nature of dried sludges makes it attractive to the cement industries since it reduces the carbon footprint of their operations.

Second, biogas from the co-digestion system, in excess of digester heating requirements, would be upgraded to pipeline quality (e.g. biomethane) and injected into a utility natural gas pipeline as a saleable product.

Strategy 1c – Maximum Beneficial Reuse (Biosolids to Land Application; Biomethane)
Strategy 1c is the same as Strategy 1a, except that excess digester gas would be upgraded to biomethane, and injected into a utility natural gas pipeline, rather than being combusted in a co-generation system to produce electricity and heat.

Strategy 1d – Maximum Beneficial Reuse (50% Biosolids to "Industrialized" Land Application / 50% to Cement Kiln; Biomethane)
Strategy 1 d combines the final uses of biosolids from Options 1b and 1c, with the intent of providing the CRD additional flexibility in biosolids management. In this strategy, 50% of the digested biosolids would be dryed and transported to a cement kiln for use as a coal substitute fuel. The other 50% of digested biosolids would be hauled to a land application site where willow trees are grown and harvested, with the tree biomass subsequently reused.

As described in Discussion Paper 031-DP-3, the purposeful (i.e. “industrialized”) growing and harvesting of trees in this manner is termed “coppice”. In Strategy 1d, the harvested trees are assumed to be chipped and sold in the form of woodchips as a saleable, revenue generating product. The analysis assumes that the woodchips would be used in CRD solid waste and other composting operations, as well as other typical uses of woodchip products in the near-term. However, the potential exists to sell the woodchips as a green fuel as such markets develop over time. Harnessing the sun’s energy to drive biomass growth through photosynthesis, where biosolids provide some of the carbon and nutrients required for growth, leverages the energy potential contained in the biosolids in this latter context. The net ratio of energy input to energy output for such coppice is approximately 1:40 at the point of harvest (Volk et al 2004).

The strategy assumes that the CRD would lease the land required for willow coppice from private landowners. The land leases would be for a fixed time, allowing the CRD to rotate through land plots as dictated by planting / harvesting cycles. Due to the limited time required annually for planting and harvesting, the strategy assumes that the CRD would contract these activities to the private sector.

Strategy 2 – Maximum Integration and Maximum Energy Recovery
In this strategy the wastewater sludges would be co-digested with the solid waste organics in a thermophilic, anaerobic digestion system located in the Hartland landfill area. Biogas from the co-digestion system, in excess of digester heating requirements, would be upgraded to pipeline quality (e.g. biomethane) and injected into a utility natural gas pipeline as a saleable product.

The resulting biosolids from this co-digestion would be dewatered and thermally destroyed with municipal solids waste (MSW) at a MSW energy-from-waste (EFW) facility located in the Hartland area. Based on the mass generation projections, the biosolids mass is such that its relative fraction of the combined MSW + biosolids mass is less than the 20% limit imposed by MSW EFW operations. Therefore, no excess biosolids would need to be diverted to another thermal destruction system (e.g. fluidized bed combustion (FBC) system dedicated to biosolids). The MSW EFW facility would produce some electricity and heat for sale (not included in this analysis). The resulting bottom ash would be hauled to the Hartland landfill for use as cover material, with the fly ash transported to a separate mono-fill at the Hartland landfill for disposal.

Strategy 4 – Separate Digestion and Balanced Energy Recovery / Beneficial Reuse
In this strategy the digestion of the solid waste organics and wastewater sludges would be kept separate. The solid waste organics would be digested at a Hartland landfill area digestion facility, with the end product land applied as per Strategy 1. The wastewater sludges would be digested at the Macaulay area treatment facility, dewatered and then hauled to a FBC system located in the Hartland area; there would be no co-mass burning with MSW. The FBC fly ash would be disposed as per Strategy 2.

As in Strategy 2, the excess biogas from the two digestion systems would be upgraded to pipeline quality (biomethane) and injected into a utility natural gas pipeline. Relative to Strategy 2, the difference is that there would be two biogas cleaning/upgrading systems, one at the Macaulay area facility and one at the Hartland area facility.

Strategy 4 provides the CRD with the option for some co-digestion of solid waste organics, generated locally, with wastewater sludges.

Strategy 5a – No Digestion and Balanced Energy Recovery / Beneficial Reuse (Sludge to FBC System)
In this strategy the solid waste organics would be composted at Hartland, as in Strategy 1, with the resulting product used in the CRD area up to the limits of available use and then outside the CRD for the remainder. For Strategy 5a, it is assumed that the undigested, raw wastewater solids would be dewatered and then thermally oxidized in a FBC system at the Macaulay area wastewater treatment plant facility, with the fly ash going to disposal. Some electricity would be produced but the excess above the needs of the FBC system would be used on-site at the treatment facility.

Strategy 5b – No Digestion and Balanced Energy Recovery / Beneficial Reuse (Sludge to Cement Kiln)
Strategy 5b is the same as Strategy 5a, except that the undigested, raw wastewater solids would be dewatered and dried at the Macaulay area treatment facility and transported via a truck to a cement kiln in the Lower Mainland for use as a coal substitute fuel.

3 Methodology

3.1 Overview

The biosolids / organics strategy evaluation was conducted within the Sustainability Assessment Framework (SAF) described previously in Discussion Papers 031-DP-1 and 031-DP-3. Two key information inputs into the SAF are the findings of the economic life cycle analysis (LCA) and the carbon footprint analysis (CFA). Section 3.2 describes the LCA, with Section 3.3 outlining the CFA. Section 3.4 then describes the SAF methodology.

3.2 Life Cycle Analysis

Each of the strategies was subjected to a financial life cycle analysis. The LCA included the capital expenditures, operations (e.g. labour, energy, chemicals, administration, etc.) and maintenance costs, revenue generated from saleable products, and costs of greenhouse gas (GHG) emissions incurred during an analysis horizon that extended from Year 2016 (i.e. the date the first facilities would be in service) to Year 2065, which was the end of the planning horizon. The costs of all future expenditures were brought back to a present (i.e. Year 2008) value, with the total net present value (TNPV) being the summation of all these present values.

The LCA analysis details and assumptions are documented in the LCA worksheets contained in **Appendix A**; however, it is worth describing several key points in more detail.

Land Costs
Land costs were not included in the capital costs, under the assumption that the CRD owns or would have to buy land in the Macaulay and Hartland areas to meet other requirements of the wastewater management program. It was assumed that the land purchases would be conservative, meaning that sufficient land would be bought to provide the CRD future flexibility to site facilities. As a result, these assumptions treat all strategies equal and thus remove the land costs as an analysis variable.

The annual cost to lease land for the willow coppice program in Strategy 1d was included as an operations costs in the analysis.

LCA Base Scenario and Sensitivity Analysis
The LCA was initially conducted with what was defined as the Discount Rate Base scenario. In this scenario, the investment rate of return was set at 7% per year with all inflation rates (e.g. labour, energy, GHG costs, etc.) set at 3% per year. Therefore, the overall discount rate was 4% per year.

A subsequent sensitivity analysis was then conducted to assess the impact of investment rates of return and inflation rates on the TNPV of each strategy. The examined scenarios included:

Discount Rate Low - The investment rate of return was set at 4% per year with all inflation rates (e.g. labour, energy, GHG costs, etc.) set at 2% per year. Therefore, the overall discount rate was 2% per year.

Discount Rate High - The investment rate of return was set at 10% per year with all inflation rates (e.g. labour, energy, GHG costs, etc.) set at 4% per year. Therefore, the overall discount rate was 6% per year.

Energy High – The investment rate of return was set at 7% per year and all inflation rates were set at 3% per year, with the exception of energy (electricity, natural gas/biomethane, diesel fuel, cement kiln coal substitute) set at 4% per year.

Two additional scenarios were also considered in the sensitivity analysis, which focused on the future price of GHG emissions (i.e. for the purposes of purchasing off-sets on an open market or paying a carbon tax) expressed as carbon dioxide equivalents (CO2e). Based on the Intergovernmental Panel on Climate Change (IPCC) information provided in Discussion Paper 032-DP-1, the price of CO2e in Year 2065 CO2e was assumed to vary between US$15 and US$155 t / CO2e. Using this information, the following scenarios were analyzed:

CO2e Low – The investment rate of return was set at 7% per year and all inflation rates were set at 3% per year, with the exception of CO2e set at 0.0% per year (i.e. CO2e remains constant at the $15 / t per the current 2009 value from the Province of British Columbia Carbon Tax (2008)).

CO2e High – The investment rate of return was set at 7% per year and all inflation rates were set at 3% per year, with the exception of CO2e set at 4.2% per year to give a 2065 CO2e price of about $155 / t.

Price of Saleable Products

The biosolids / organics strategies evaluated produce saleable products that could be used outside the wastewater infrastructure and sites proper and thus are a potential revenue source for the CRD. As discussed in Section 2, these products include pipeline grade natural gas (biomethane), a low-grade coal substitute, and woodchips. The various strategies also produce biosolids for use in the forest tree farm fertilization and compost derived from solid waste organics, the latter of which would be suitable for residential and urban space land application within and outside the CRD. However, the evaluation assumes that neither the biosolids nor compost would be revenue generating, saleable products. Rather, these products would be offered to the public at no charge in the initial years to gain public acceptance of the products. The analysis conservatively assumes a free product throughout the analysis horizon.

For the purpose of the evaluation the biomethane was priced at the same rate as utility-supplied natural gas. For dried wastewater sludges/biosolids sold to cement kilns as a low-grade coal substitute, the evaluation assumes that the price of the dried sludges/biosolids was the same as the

market rate for low-grade coal on an energy-equivalent basis. Woodchips from the willow coppice program were priced at the current market rate for woodchips.

GHG Credits

The LCA assumes that the CRD would claim the GHG credits (i.e. would be credited the price of the CO2e mass) for the biomethane and coal substitute products sold. The LCA also assumes that the CRD would receive the GHG credits for solid waste organics compost it used as a commercial fertilizer replacement.

3.3 Carbon Footprint Analysis

The carbon footprint analysis for each strategy was conducted in accordance with the general methodology and rationale described in Discussion Paper 032-DP-1, to which the reader is directed for additional information. Like the LCA, the CFA extended from Year 2016 to Year 2065. The total GHG emissions for a given strategy are the summation of predicted emissions for the entire analysis duration.

Scope 1 direct GHG emissions included such sources as vehicles (e.g. transporting material) and treatment process units (e.g. methane leakage from digester systems). Scope 2 indirect GHG emissions included those associated with consumption of purchased electricity or natural gas. GHG emission off-sets, such as the avoided use of commercial fertilizer, are an example of a Scope 3 item.

The CFA analysis details and assumptions are documented in the LCA/CFA worksheets contained in **Appendix A**.

3.4 Sustainability Assessment Framework

As presented previously in Discussion Papers 031-DP-1 and 031-DP-3, the two evaluation elements of the sustainability assessment framework (SAF) include the multi-objective alternative analysis (MOAA) and the risk identification and analysis (RIA). The reader is directed to the prior Discussion Papers for further information on the SAF and associated MOAA and RIA. However, for ease of reference, Appendix B contains the relevant MOAA Objectives Hierarchy, Performance Measures and Scales, the Objectives Hierarchy Weights that were developed in consultation with CRD staff, and the RIA Risk Assessment Matrix and the Risk Impacts used in the biosolids / organics strategy evaluation documented in this Discussion Paper. Some modifications were made to the performance scales used in the evaluation, related to life cycle costs, GHG emissions, non-GHG emissions, and chemical demand based on the information generated in the current evaluation.

As noted above, CRD staff provided key input for the relative weightings of the various objectives used in the MOAA analysis. These weightings formed the MOAA Base scenario. A sensitivity analysis was conducted on the relative weights used in the objectives hierarchy. The sensitivity

analysis considered eight scenarios relative to the Base scenario, where the relative weightings were adjusted independently as follows:

- Minimize net present value (relative importance weight = 50 versus 100 in Base scenario)
- Environmental (relative importance weight = 70 versus 100 in Base scenario)
- Socioeconomic (relative importance weight = 80 and 60 versus 70 in Base scenario)
- Flexibility (relative importance weight = 100 and 20 versus 60 in Base scenario)
- Ease/Safety of Operations and Maintenance (relative importance weight = 90 and 20 versus 50 in Base scenario)

4 Results and Discussion

4.1 Life Cycle Analysis

General Findings

Figure 4-1 summarizes the total net present value (TNPV), which includes both costs and revenues, for each strategy under the Discount Rate Base scenario. Figure 4-1 also shows a category labeled “electrical value”. This category refers to electricity generated by facilities that is not saleable off-site, but is used on-site to reduce external electrical demand, and is thus not considered as part of revenue. The category was included for illustrative purposes to show the value of the produced power.

From a TNPV perspective, the strategies form two main groups based on the level of analysis and associated uncertainty. Strategies 1b, 1d, 2 and 4 form the group with the higher TNPV, with Strategies 1a, 1c, 5a and 5b forming the lower TNPV group. Although Strategies 1a and 5a do not generate saleable products, their low capital cost NPV, relative to the other strategies, contribute to their low TNPV. The same conclusion applies to Strategy 5b, which benefits from the sale of a coal substitute. Strategy 1c has the lowest overall capital cost NPV.

Strategies 1a and 1c provide an interesting comparison. Combusting biogas in a co-generation system produces electricity with a NPV ($8.3M, Strategy 1a) almost identical to the value of the biogas upgraded to biomethane in Strategy 1c (NPV = $8.0M). However, Strategy 1c benefits more financially via the GHG offset NPV because biomethane more significantly offsets GHG emissions from avoided natural gas combustion relative to avoided GHG emissions associated with off-site electrical power production. The low GHG intensity of BC Hydro-supplied electrical power contributes to this latter finding.

One other related point is noteworthy in the biogas/co-generation versus biogas/biomethane comparison. The analysis assumes that biomethane has the same value as natural gas, i.e. $10/GJ. However, given the energy content of diesel fuel (0.039 GJ/L), and using the assumed $1.50/L value of diesel fuel, it can be shown that diesel fuel has a potential value of $42/GJ. Therefore, biomethane as a diesel fuel replacement, rather than a natural gas replacement, has a greater potential value. The “potential” part is key, since significant infrastructure would be required

Strategy	Capital Cost NPV	O&M Cost NPV	GHG NPV	Revenue NPV	Electrical Value NPV	Total NPV
1a	$ 91,798,072	$ 67,831,638	$ 143,221		$ (8,266,481)	$ 151,506,450
1b	$ 108,776,104	$ 86,353,030	$ (1,772,325)	$ (10,646,477)		$ 182,710,332
1c	$ 81,082,914	$ 69,363,875	$ (375,570)	$ (7,964,522)		$ 142,106,697
1d	$ 100,275,069	$ 89,048,851	$ (1,064,935)	$ (15,282,609)		$ 172,976,375
2	$ 129,164,107	$ 82,748,339	$ (2,107,662)	$ (29,508,328)		$ 180,296,457
4	$ 130,823,874	$ 75,593,577	$ (1,898,697)	$ (26,283,048)	$ (971,680)	$ 177,264,027
5a	$ 82,700,578	$ 78,834,409	$ 1,360		$ (5,023,440)	$ 156,512,907
5b	$ 71,081,258	$ 92,898,024	$ (3,225,474)	$ (6,025,634)		$ 154,728,174

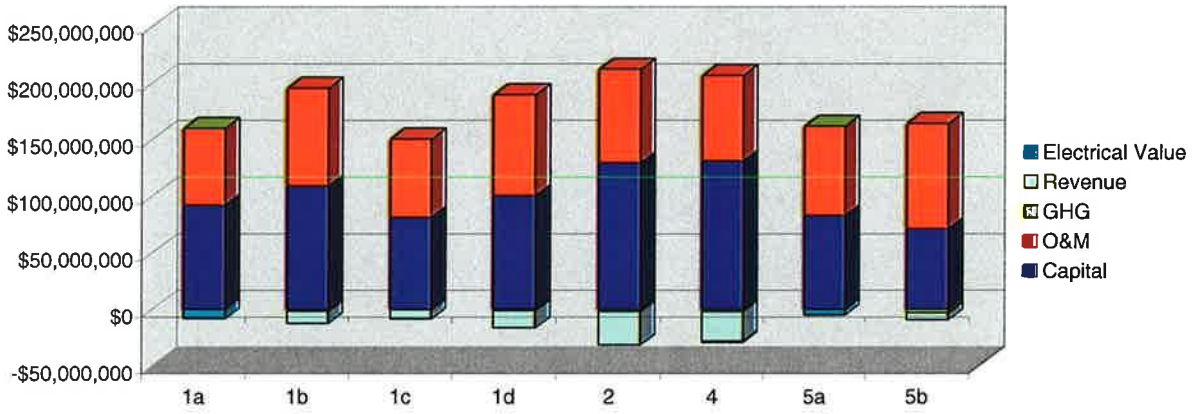


Figure 4-1. Total Net Present Value Summary (discount rate base scenario)

to compress, store and distribute biomethane for use as a diesel fuel replacement. The actual market value of biomethane in this context is also uncertain. However, these values show the potential for biomethane as a vehicle fuel.

It is important to note that Strategy 2 includes a MSW incinerator, of which part of its capacity is used to process digested wastewater sludges and solid waste organics. These proportional costs are included in the LCA and the TNPV. However, a real capital cost of approximately $200M, as well as future O&M costs, would be incurred by the CRD solid waste program to pay for the capacity needed to process the residual solid waste material. These costs are not included in the LCA or TNPV.

Biomethane production in Strategies 2 and 4 generate significant revenues that are bolstered by digestion of solid waste organics in addition to wastewater sludges. However, these sales do not entirely off-set the significant overall capital investment required in these strategies, which do include thermal reduction elements. Strategies 1b, 1c and 1d also produce biomethane, but to a much lower extent since the solid waste organics are composted rather than digested in this alternative.

Strategy 5b generates notable revenues in the sale of dried wastewater sludges as a coal substitute for cement kiln use. Although Strategy 5b has one of the lowest capital cost NPV of all alternatives, the need for natural gas for sludge drying adds a considerable operation cost that is not incurred in the other strategies except for Strategy 1b. Strategy 1b also produces a coal substitute product, but its revenues are even lower since the wastewater solids are digested prior to drying (i.e. reduces calorific value of dried solids and thus their commercial value). Finally, Strategy 1d also provides a coal substitute product following solids digestion, but these revenues are one-half of those of Strategy 1b since only one-half of the Strategy 1d solids are converted into the coal substitute product.

Strategy 1d gains revenue from the sale of the woodchips from the willow coppice program, which is unique to this particular strategy, and has a NPV of approximately $6.0M. For the given analysis assumptions for this strategy, the woodchips have a significantly higher potential revenue value than the equal amount of dried biosolids (NPV of $6.0M versus $1.3M)

As shown in Figure 4-1, Strategies 1a and 5a would induce a cost to the CRD for greenhouse gases (GHG) emitted, where the other strategies would receive a “credit”. As described above and noted in Appendix A, the LCA assumed that the CRD would receive a financial GHG credit for its saleable products (i.e. biomethane, dried wastewater sludges) and its own use of solid waste organics compost as a commercial fertilizer replacement. However, regardless of strategy, the cost/credit is relatively small and comprises less than 2% of the TNPV.

Sensitivity Analysis

Figure 4-2 contains the results of the sensitivity analysis described in Section 3.2. Figure 4-2a shows the Discount Rate Base data, which are the same TNPVs provided in Figure 4-1. Figures 4-2b through 4-2f contain the data for the other scenarios assessed.

In general, from a TNPV perspective, the strategy groupings from the Discount Rate Base scenario are preserved in the Discount Rate High (Figure 4-2c), CO2e Low (Figure 4-2e) and CO2e High (Figure 4-2f) scenarios. The low relative cost of the GHG emissions does not practically impact the TNPV under either of the CO2e scenarios.

The Discount Rate Low (Figure 4-2b) and Energy High (Figure 4-2d) scenarios do induce a noticeable change in the relative TNPVs and the strategy groupings. Strategies 5a and 5b are particularly sensitive to the low discount rate, since these strategies have high O&M costs, much of which are incurred in the future, relative to capital costs that are primarily incurred in the near-term. The same situation, but to a lesser extent, applies to Strategy 1b. The Energy High scenario induces a similar but more subtle effect, where Strategies 1b, 1d and 5b use of natural gas make them particularly sensitive to energy price increases.

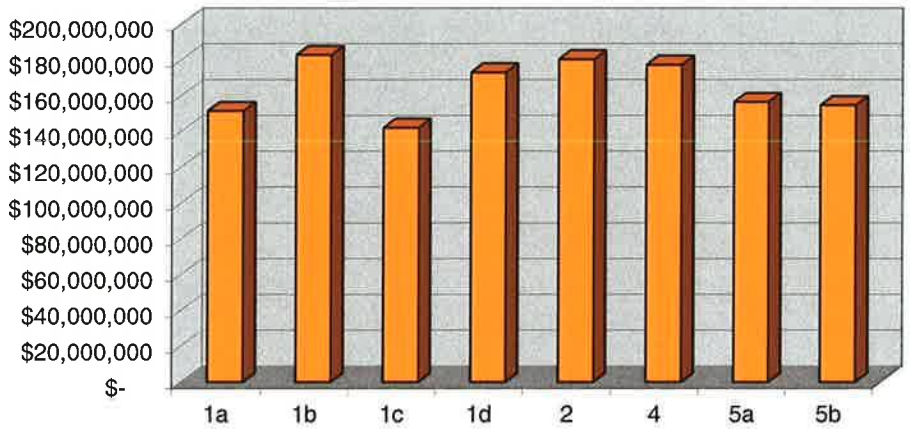
4.2 Carbon Footprint Analysis

Figure 4-3 shows the total estimated amount of GHGs (i.e. CO2e) emitted over the time frame of the analysis. The numerically negative values represent an environmentally positive situation – GHGs are being off-set rather than being generated. Consider Strategy 5b, where dried wastewater sludges are being used as a replacement for coal that would normally be used to fuel a cement kiln, which stands out for having the lowest carbon footprint. The sludges, which are a biogenic fuel whose emissions are assumed to not contribute to the carbon footprint, off-set the combustion of coal and the use of natural gas to dry the sludges. In a similar, but less significant manner, the biomethane produced in Strategies 2 and 4 off-set the use of natural gas by the public and benefit from the biomethane associated with solid waste organics. These strategies also have significant environmental benefits from a GHG perspective. Although Strategies 1b and 1d produce less biomethane (i.e. no solid waste organics digested) or coal substitute compared to the other strategies, their production of both of these off-setting products contributes to a positive environmental result. Finally, Strategy 1c does benefit from the production of biomethane, again offsetting natural gas use.

Strategies 1a and 5a are close to being GHG neutral. Their GHG emissions are partially off-set by using composted solid waste organics as a replacement for synthetically produced commercial fertilizer. Commercial fertilizers are energy intensive to produce and distribute, with the hydrogen in the formed ammonia originating from fossil fuels. Strategies 1b, 1c, 1d, 4 and 5b also benefit from this use of composted solid waste organics. In addition, Strategy 1a benefits from producing electricity, using digester biogas, which off-sets GHGs associated with purchased electricity. Strategy 5a provides a similar off-set using electricity produced by the FBC system.

a) Discount Rate Base - Investment rate of return = 7% per year and all inflation rates set at 3% per year. Thus discount rate = 4% per year.

Strategy	Total NPV	
1a	$	151,506,450
1b	$	182,710,332
1c	$	142,106,697
1d	$	172,976,375
2	$	180,296,457
4	$	177,264,027
5a	$	156,512,907
5b	$	154,728,174



b) Discount Rate Low - Investment rate of return = 4% per year and all inflation rates set at 2% per year. Thus discount rate = 2% per year.

Strategy	Total NPV	
1a	$	206,348,708
1b	$	257,329,154
1c	$	196,844,803
1d	$	243,510,457
2	$	235,085,753
4	$	234,701,428
5a	$	231,848,866
5b	$	232,789,035

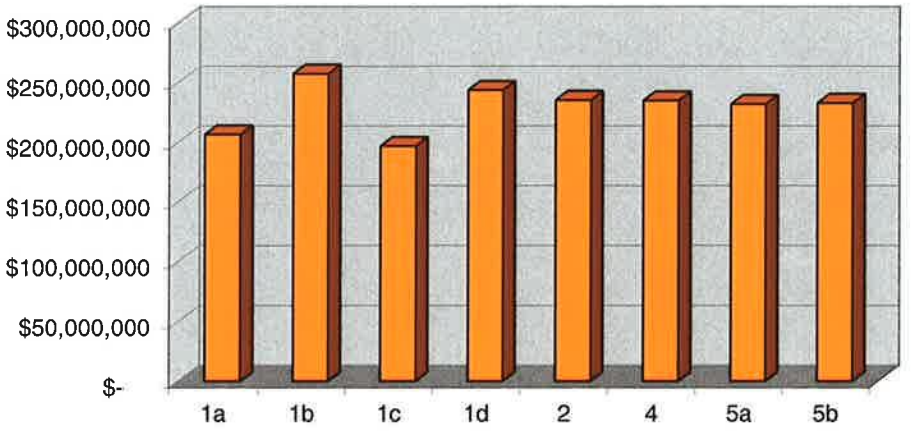
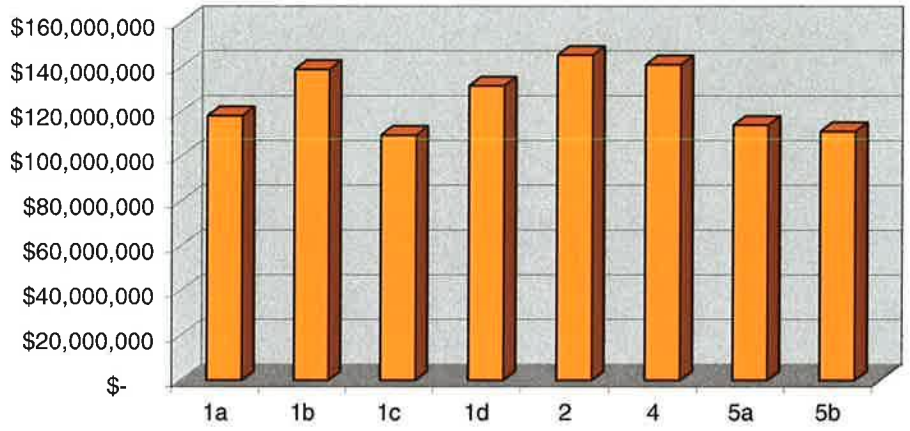


Figure 4-2. Total Net Present Value Sensitivity Analysis Summary

c) Discount Rate High - Investment rate of return = 10% per year and all inflation rates set at 4% per year. Thus discount rate = 6% per year.

Strategy	Total NPV
1a	$ 118,309,204
1b	$ 138,911,733
1c	$ 109,551,447
1d	$ 131,591,431
2	$ 145,281,316
4	$ 141,083,342
5a	$ 114,037,038
5b	$ 111,261,419



d) Energy High - Investment rate of return = 7% per year and all inflation rates set at 3% per year, with the exception of energy (electricity, natural gas, diesel fuel, coal) set at 4% per year.

Strategy	Total NPV
1a	$ 149,102,477
1b	$ 182,884,146
1c	$ 140,249,003
1d	$ 172,195,222
2	$ 171,995,932
4	$ 169,284,067
5a	$ 155,174,058
5b	$ 158,411,709

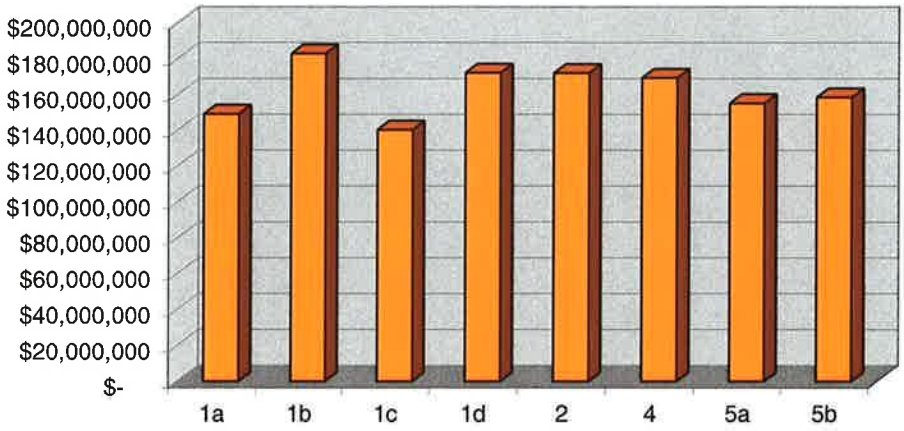
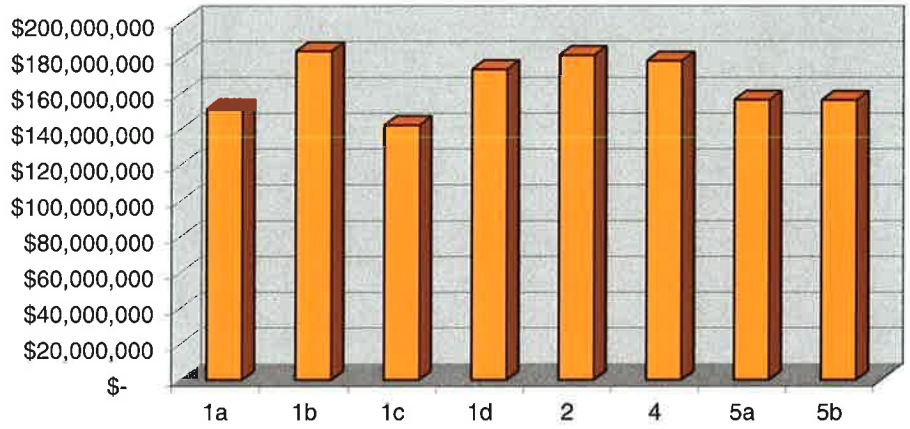


Figure 4-2. Total Net Present Value Sensitivity Analysis Summary (continued)

e) CO2e Low - Investment rate of return = 7% per year and all inflation rates set at 3% per year, with the exception of CO2e set at 0.0% per year (i.e. CO2e remains constant at $15 / t).

Strategy	Total NPV	
1a	$	151,437,230
1b	$	183,595,186
1c	$	142,297,440
1d	$	173,509,594
2	$	181,343,436
4	$	178,207,710
5a	$	156,512,990
5b	$	156,331,714



f) CO2e High - Investment rate of return = 7% per year and all inflation rates set at 3% per year, with the exception of CO2e set at 4.2% per year (i.e. CO2e increases to approximately $155 / t by year 2065.

Strategy	Total NPV	
1a	$	151,558,264
1b	$	182,034,234
1c	$	141,959,774
1d	$	172,568,420
2	$	179,498,402
4	$	176,544,178
5a	$	156,512,495
5b	$	153,505,356

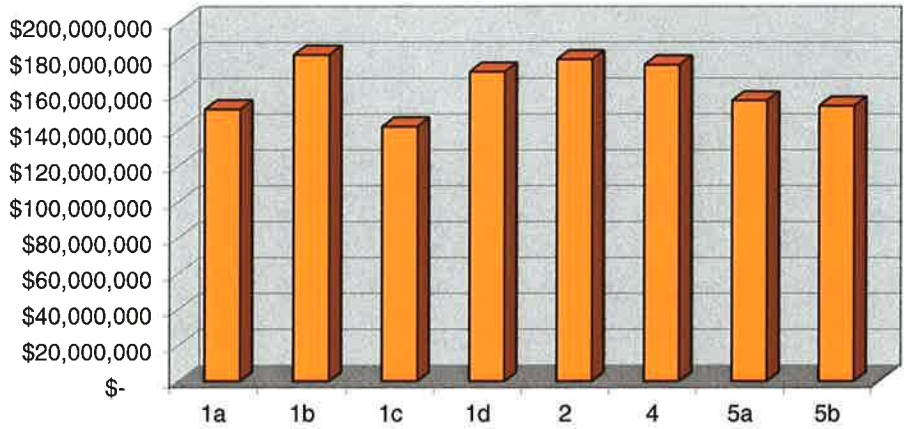


Figure 4-2. Total Net Present Value Sensitivity Analysis Summary (continued)

Strategy	Carbon Footprint (t CO2e)
1a	5,162
1b	-417,021
1c	-109,901
1d	-261,401
2	-463,173
4	-421,084
5a	-25,188
5b	-734,655

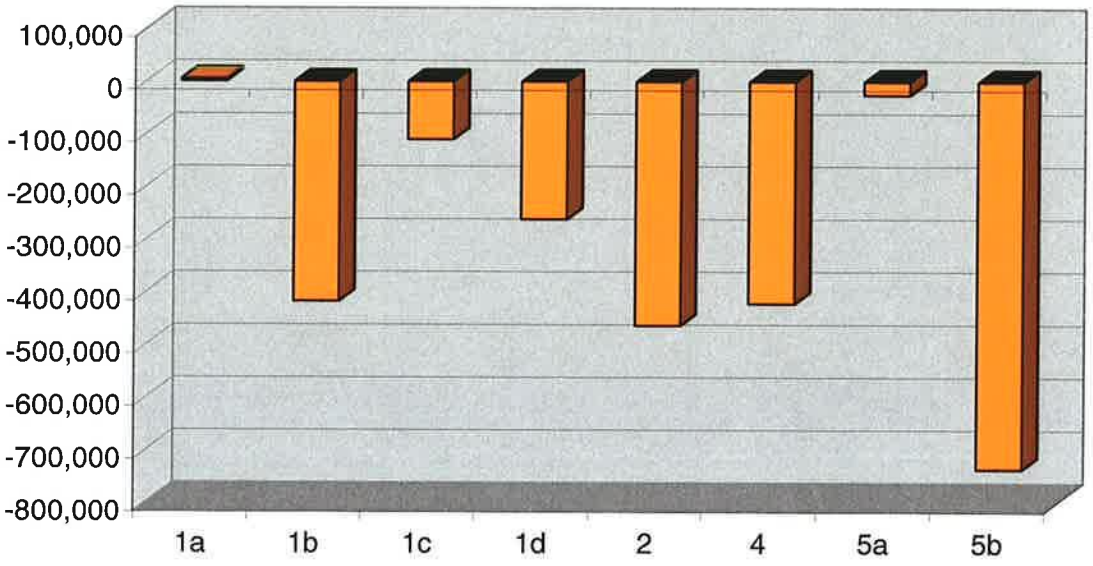


Figure 4-3. Carbon Footprint Summary

Strategies with digester systems (1a, 1b, 1c, 1d, 2 and 4) are disadvantaged because of the assumed loss (i.e. leakage) of digester gas and thus methane from the system.

4.3 Sustainability Assessment Framework Analysis

MOAA Scores and RIA Ratings

Table 4-1 presents the Multi-Objective Alternative Analysis (MOAA) scores, and the rationale for the scores, for each strategy. As noted in Table B-1 (Appendix B), where there where no specific units (e.g. $, t CO2e, etc.) assigned to a particular objective, the scoring for the various strategies was based on a relative rating of 1 (lowest score) to 5 (highest score) per the performance scales described in Table B-1. These scores were assigned by the consultant team based on their professional judgment. Alternatively, for some objectives, the actual calculated values (e.g. $, t CO2e, etc.) obtained from the LCA and CFA were used directly as the scores for the strategies.

Table 4-2 presents the Risk Identification and Assessment (RIA) ratings and outcomes for the various strategies. The ratings were based on the risk outcomes identified in Table B-4 (Appendix B) and were again assigned by the consultant team based on their professional judgment. Further discussion on these ratings and outcomes is provided later in the Discussion Paper.

SAF Results

Based on the objectives hierarchy weightings developed by CRD staff shown in Table B-2 (Appendix B), the individual MOAA scores for each strategy were normalized and added to provide the Total Score for each strategy. Table 4-3 provides the MOAA total score summary. In Table 4-3 a higher numeric value, either for the individual normalized scores or the total score, is a more positive result. The reader will note the presence of several zero values in Table 4-3 – such a result is an artifact of the normalization procedure. Take for example the 0.0 score for Strategy 1b for Objective 1. The 0.0 value simply means that Strategy 1b had the highest TNPV value of all strategies and thus was assigned no points that contribute to the total score. Also note that not all Objectives have a zero value – this results from there being several sub-objectives within some of the main Objectives, which creates a situation where there was at least one score that was not zero and thus the score sum for the Objective is greater than zero.

Figure 4-4 graphically presents the same information as that of Table 4-3, along with the RIA summary from Table 4-2. Figure 4-5 illustrates the sub-objective scores within the main Environmental, Socioeconomic and Flexibility objectives.

From a MOAA total score perspective, Strategies 1c and 5b clearly stand out from the other strategies with their higher and essentially equal values. While Strategy 1c has a lower TNPV that provides it additional points in the MOAA analysis, it concedes notable points to Strategy 5b, which scores higher from an environmental perspective: fewer vehicle non-CO2e emissions (i.e. based on diesel fuel consumption) and a much more substantial GHG off-set (Figures 4-3 and 4-5a).

Table 4-1. MOAA Scores and Rationale

Objectives Hierarchy	Scores								Rationale							
	1a. Maximum Beneficial Reuse (Biosolids to Land Application; Co-Gen)	1b. Maximum Beneficial Reuse (Biosolids to Cement Kiln; Biomethane)	1c. Maximum Beneficial Reuse (100% Biosolids to Land Application; Biomethane)	1d. Maximum Beneficial Reuse (50% Biosolids to "Industrialized" Land Application / 50% to Cement Kiln; Biomethane)	2. Maximum Integration and Maximum Energy Recovery	4. Separate Digestion and Balanced Energy Recovery / Beneficial Reuse	5a. No Digestion and Balanced Energy Recovery / Beneficial Reuse (FBC)	5b. No Digestion and Balanced Energy Recovery / Beneficial Reuse (Cement Kiln)	1a. Maximum Beneficial Reuse (Biosolids to Land Application; Co-Gen)	1b. Maximum Beneficial Reuse (Biosolids to Cement Kiln; Biomethane)	1c. Maximum Beneficial Reuse (100% Biosolids to Land Application; Biomethane)	1d. Maximum Beneficial Reuse (50% Biosolids to "Industrialized" Land Application / 50% to Cement Kiln; Biomethane)	2. Maximum Integration and Maximum Energy Recovery	4. Separate Digestion and Balanced Energy Recovery / Beneficial Reuse	5a. No Digestion and Balanced Energy Recovery / Beneficial Reuse (FBC)	5b. No Digestion and Balanced Energy Recovery / Beneficial Reuse (Cement Kiln)
1. Minimize Total Net Present Value of Life Cycle Cost (includes accounting for revenues) (M$ TNPV)	$152	$183	$142	$173	$180	$177	$157	$155	- from LCA	- from LCA	- from LCA	- from LCA	- from LCA	- from LCA	- from LCA	- from LCA
2. Minimize Environmental impacts																
Non-CO2e emissions (PM10, NOx) from vehicles (ML of diesel fuel)	13.6	9.7	13.6	12.1	4.2	3.6	7.6	9.1	- from LCA	- from LCA	- from LCA	- from LCA	- from LCA	- from LCA	- from LCA	- from LCA
GHG emissions generated from energy, process, or end use (t CO2e)	5,100	-417,000	-110,000	-261,000	-463,000	-421,000	-25,000	-735,000	- from CFA	- from CFA	- from CFA	- from CFA	- from CFA	- from CFA	- from CFA	- from CFA
Localized odours from LW/SW infrastructure	2	2	2	2	3	2.5	2.5	2	- multiple processing sites and composting	- dewatering/drying composted sludge; plus composting	- similar to 1a	- attributes of both 1b and 1c	- dewatering raw sludge; only one processing site	-similar to 2 but land application of compost	- similar to 4	- dewatering/drying raw sludge; plus composting
Chemical demand, (M$ NPV)	$7.7	$9.2	$7.7	$8.5	$24.9	$13.1	$16.9	$16.9	- from LCA	- from LCA	- from LCA	- from LCA	- from LCA	- from LCA	- from LCA	- from LCA
3. Minimize Socioeconomic impacts																
Community disruption	2	2	2	2	2	2.5	1.5	3	- many new reuse locations	- hauling digested sludges to Hartland and many new reuse locations	- similar to 1a	- similar to 1 b/c	- hauling raw sludges to Hartland area but minimal end use transport	- no hauling of raw sludges to Hartland area but many new reuse locations	- hauling raw sludge to Hartland area and many new reuse locations	- no transport of sludges to Hartland area, but many new reuse locations
Potential siting concerns such as cultural and terrestial resource protection (historic, cultural, archaeologically signifcant resources, endangered species, etc).	3	3	3	3	3	3	3	3	- cultural and/or terrestrial resources may be affected, but effects can likely be mitigated	- cultural and/or terrestrial resources may be affected, but effects can likely be mitigated	- cultural and/or terrestrial resources may be affected, but effects can likely be mitigated	- cultural and/or terrestrial resources may be affected, but effects can likely be mitigated	- cultural and/or terrestrial resources may be affected, but effects can likely be mitigated	- cultural and/or terrestrial resources may be affected, but effects can likely be mitigated	- cultural and/or terrestrial resources may be affected, but effects can likely be mitigated	- cultural and/or terrestrial resources may be affected, but effects can likely be mitigated
Economic development opportunities	1	1	1	3.5	3.5	2	1.5	1	- no exportable steam or electricity; non-industrial site	- no exportable steam or electricity	- similar to 1a	- similar to 1b but with added benefit of biofuel potential from willow coppice	- single industrial-type site with maximum energy recovery	- Macaulay area site decreases energy reuse possibilities; reduced energy recovery due to reduced thermal destruction	- minor possibility of steam or electricity export; non-industrial site	- no possibility of steam or electricity export within CRD
4. Maintain Flexibility																
Consistent with implementation schedules for both wastewater and solid waste programs	4	3	4	3.5	2	2	3	3.5	- no thermal destruction facilities but biosolids land application	- no siting of WTE facility within CRD (dryer only at an additional site - Hartland) but approvals required by cement kiln operator	- similar to 1a	- attributes of both 1b and 1c	- includes maximum thermal destruction	- facilities at multiple sites, including thermal destruction (lesser amount); land application of SW organics	- reduced amount of on-site thermal destruction, but land application of SW organics	- no siting of WTE facility within CRD (dryer only) but approvals required by cement kiln operator
Maintains the abiltiy to adapt to beneficial future technologies and opportunities	5	4	5	4.5	1	2	2	4	- no thermal destruction to preclude gasification/plasma, etc.	- no thermal destruction (only drying) to preclude gasification/plasma, etc.	- similar to 1a	- attributes of both 1b and 1c	- maximum thermal destruction precludes gasification/plasma, etc.	- lesser thermal destruction precludes gasification/plasma, etc. to some degree	- lesser thermal destruction precludes gasification/plasma, etc. to some degree	- no thermal destruction (only drying) to preclude gasification/plasma, etc.
Ability to respond to future regulatory change	3	3.5	3	3.5	3	2	2	3.5	- no WTE facility with CRD but land application of biosolids	- no WTE facility within CRD and no land application of biosolids but cement kiln emission standards	- similar to 1a	- attributes of both 1b and 1c	- thermal destruction but no land application of biosolids	- thermal destruction and land application of SW organics	- reduced thermal destruction and no land application of biosolids; land application of SW organics	- no WTE facility within CRD and no land application of biosolids but cement kiln emission standards
5. Ease and Safety of Operations and Maintenance	3.5	2	3.5	3	1	2	3	2.5	- minimum digestion and no thermal destruction	- no thermal destruction but "steam engineers" not required for drying facilities - safety impacts	- similar to 1a	- attributes of both 1b and 1c	- maximum digestion and thermal destruction	- reduced thermal destruction	- no digestion but some thermal destruction	- no thermal destruction or digesters but "steam engineers" not required for drying facilities - safety impacts

Table 4-2. RIA Ratings and Outcomes

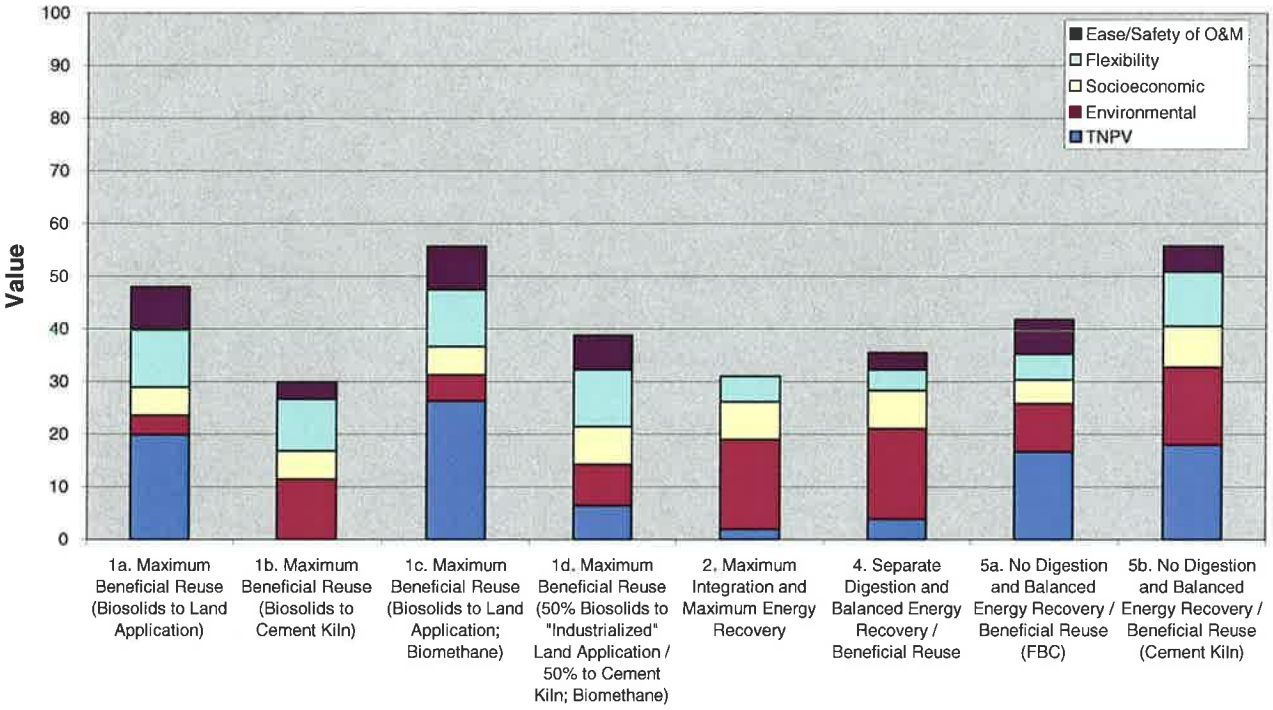
Risk Impact	Rating							
	1a Maximum Beneficial Reuse (Biosolids to Land Application; Co-Gen)	1b Maximum Beneficial Reuse (Biosolids to Cement Kiln; Biomethane)	1c Maximum Beneficial Reuse (100% Biosolids to Land Application; Biomethane)	1d Maximum Beneficial Reuse (50% Biosolids to "Industrialized" Land Application / 50% to Cement Kiln; Biomethane)	2 Maximum Integration and Maximum Energy Recovery	4 Separate Digestion and Balanced Energy Recovery / Beneficial Reuse	5a No Digestion and Balanced Energy Recovery / Beneficial Reuse (FBC)	5b No Digestion and Balanced Energy Recovery / Beneficial Reuse (Cement Kiln)
Public Acceptability	almost certain / moderate	possible / minor	almost certain / moderate	possible / minor	almost certain / moderate	likely / moderate	almost certain / moderate	likely / minor
Technologic and Financial	possible / minor	possible / minor	possible / minor	unlikely / minor	unlikely / major	possible / minor	possible / major	possible / major
Climate Change	possible / moderate	possible / minor	possible / moderate	possible / minor	unlikely / minor	possible / minor	possible / minor	possible / minor

Risk Impact	Outcome							
	1a Maximum Beneficial Reuse (Biosolids to Land Application; Co-Gen)	1b Maximum Beneficial Reuse (Biosolids to Cement Kiln; Biomethane)	1c Maximum Beneficial Reuse (100% Biosolids to Land Application; Biomethane)	1d Maximum Beneficial Reuse (50% Biosolids to "Industrialized" Land Application / 50% to Cement Kiln; Biomethane)	2 Maximum Integration and Maximum Energy Recovery	4 Separate Digestion and Balanced Energy Recovery / Beneficial Reuse	5a No Digestion and Balanced Energy Recovery / Beneficial Reuse (FBC)	5b No Digestion and Balanced Energy Recovery / Beneficial Reuse (Cement Kiln)
Public Acceptability	H	M	H	M	H	H	H	M
Technologic and Financial	M	M	M	L	H	M	H	H
Climate Change	M	M	M	M	L	M	M	M

	Low
M	Medium
H	High
C	Critical

Table 4-3. MOAA Score Summary

Objectives Hierarchy	MOAA Scores							
	1a. Maximum Beneficial Reuse (Biosolids to Land Application)	1b. Maximum Beneficial Reuse (Biosolids to Cement Kiln)	1c. Maximum Beneficial Reuse (100% Biosolids to Land Application; Biomethane)	1d. Maximum Beneficial Reuse (50% Biosolids to "Industrialized" Land Application / 50% to Cement Kiln; Biomethane)	2. Maximum Integration and Maximum Energy Recovery	4. Separate Digestion and Balanced Energy Recovery / Beneficial Reuse	5a. No Digestion and Balanced Energy Recovery / Beneficial Reuse (FBC)	5b. No Digestion and Balanced Energy Recovery / Beneficial Reuse (Cement Kiln)
1. Minimize Total Net Present Value of Life Cycle Cost (includes accounting for revenues)	19.9	0.0	26.3	6.4	1.9	3.9	16.7	18.0
2. Minimize Environmental Impacts	3.7	11.5	5.0	7.8	17.0	17.2	9.1	14.7
3. Minimize Socioeconomic Impacts	5.3	5.3	5.3	7.2	7.2	7.3	4.5	7.8
4. Maintain Flexibility	10.9	9.9	10.9	10.9	4.9	3.9	4.9	10.4
5. Ease and Safety of Operations and Maintenance	8.2	3.3	8.2	6.6	0.0	3.3	6.6	4.9
Total Score	48.0	29.9	55.7	38.8	31.1	35.5	41.8	55.8



Risk Signature

Public Acceptability	H	M	H	M	H	H	H	M
Technologic and Financial	M	M	M	L	H	M	H	H
Climate Change	M	M	M	M	L	M	M	M

Figure 4-4. MOAA Score Summary and RIA Risk Signatures

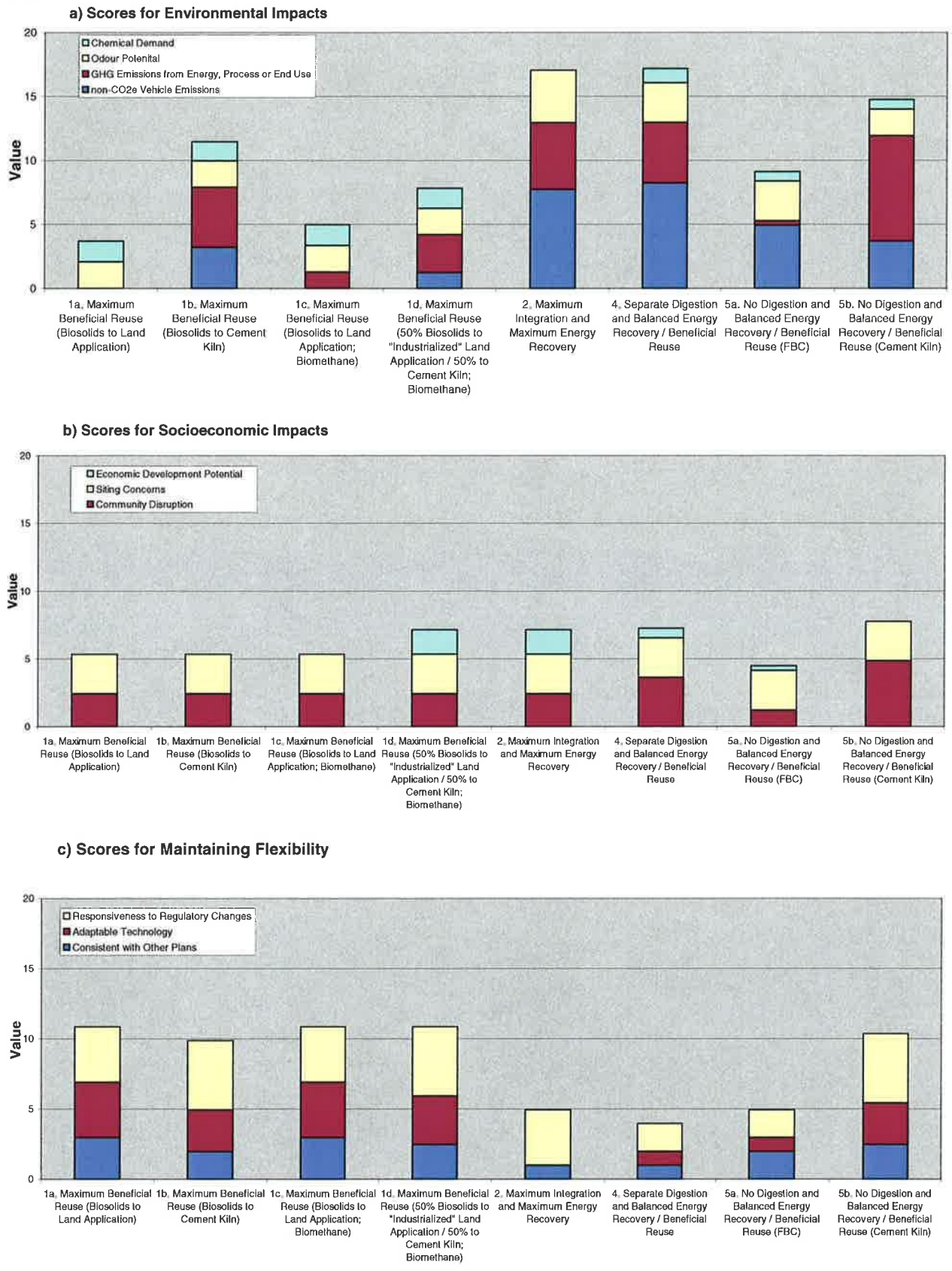


Figure 4-5. MOAA Sub-Category Scores for a) Environmental, b) Socioeconomic and c) Flexibility Categories

The higher TNPVs for Strategies 1b, 1d, 2 and 4 penalize these strategies in the MOAA analysis. Although these same strategies have significant environmental benefits, primarily related to the GHG off-set they provide as well as reduced vehicle emissions, they cannot overcome the disadvantage induced by their high TNPVs.

The remaining objectives, which include socioeconomic (Figure 4-5b), flexibility (Figure 4-5c) and ease/safety of operations and maintenance (Figure 4-4), have only a minor influence on the MOAA total scores given the small relative difference between strategies.

Table 4-5 presents the results of a sensitivity analysis that assessed the impact of changed objective weightings on the MOAA total score values. The upper portion of the table shows the actual scores as they varied with a change in weightings. The lower portion of the table shows the resulting rank order of each of the strategies. The sensitivity analysis findings are notable in that the strategy rankings were practically insensitive to objective weighting. Regardless of scenario, Strategies 5b and 1c ranked the highest, Strategy 1b always ranked the lowest, and there was some minor shuffling of ranking of the other strategies depending on scenario. This finding suggests that the "base" scenario findings are robust.

Discussion and Moving Forward

As evident from the preceding discussion, the SAF analysis is complex, receiving input from the LCA, CFA and RIA evaluations and incorporating new information external to these evaluations. The challenge is one of sifting through this information and identifying a "winning" strategy or combination of specific elements that comprise such a strategy. The strategy / elements will then be adopted for developing the Options for the overall Distributed Wastewater Management Strategy for the Core Area under Activity 036. It is important to note that the same biosolids / solid waste organics strategy will be used for all distributed management options developed in Activity 036. Use of the selected strategy or elements in this context does not imply a final decision, but rather forms a reasonable basis for the development and evaluation of the overall wastewater management Options.

One way to consider this information is at a strategy level. Figure 4-4 is a good place to start as it summarizes not only the MOAA scores but also shows the risk signatures. As discussed previously, Strategies 1c and 5b stand out from the others on the basis of their MOAA total scores. Both of these strategies have a similar risk signature. Strategy 1c was assigned a higher public acceptability risk rating because of its use of land application of biosolids – prior CRD experience suggests that this is a real risk factor. Alternately, Strategy 5b was assigned a higher technologic and financial risk because of its drying of raw wastewater sludges and sending them to a cement kiln for use as a coal substitute fuel – there is uncertainty with long-term contracts with cement kilns and, if the CRD should need to change their course of action, the substantial capital investment in sludge drying equipment could be forfeited.

At the other extreme are Strategies 1b and 2. They had the lowest MOAA total scores, largely owing to their having the highest TNPVs of any of the strategies. In Strategy 1b, the combination of

Table 4-5. MOAA Score Summary - Sensitivity to Changes in Weights

Weights Changing to Reflect Maximum and Minimum Values from May 12/08 Workshop	MOAA Scores							
	1a. Maximum Beneficial Reuse (Biosolids to Land Application)	1b. Maximum Beneficial Reuse (Biosolids to Cement Kiln)	1c. Maximum Beneficial Reuse (100% Biosolids to Land Application; Biomethane)	1d. Maximum Beneficial Reuse (50% Biosolids to "Industrialized" Land Application / 50% to Cement Kiln; Biomethane)	2. Maximum Integration and Maximum Energy Recovery	4. Separate Digestion and Balanced Energy Recovery / Beneficial Reuse	5a. No Digestion and Balanced Energy Recovery / Beneficial Reuse (FBC)	5b. No Digestion and Balanced Energy Recovery / Beneficial Reuse (Cement Kiln)
Base Scenario	49.1	31.8	56.8	40.3	40.9	39.4	47.6	61.5
Total NPV = 50	45.1	36.6	50.3	42.7	46.0	43.1	45.2	60.5
Environmental = 70	51.8	30.2	59.7	40.8	35.6	35.9	46.8	60.1
Socioeconomic = 80	48.6	31.7	56.1	40.3	40.8	39.4	47.0	61.0
Socioeconomic = 60	49.7	31.9	57.6	40.4	40.9	39.4	48.2	62.1
Flexibility = 100	51.0	34.7	58.0	43.0	40.0	38.0	46.0	61.9
Flexibility = 20	46.8	28.2	55.4	37.0	42.0	41.1	49.5	61.1
Ease/Safety of Operations & Maintenance = 90	50.4	31.2	57.4	41.3	37.0	38.0	47.8	59.3
Ease/Safety of Operations & Maintenance = 20	48.0	32.4	56.3	39.5	44.4	40.6	47.4	63.6

Rank Order of Alternatives, 1 = preferred	Rank Order							
	1a. Maximum Beneficial Reuse (Biosolids to Land Application)	1b. Maximum Beneficial Reuse (Biosolids to Cement Kiln)	1c. Maximum Beneficial Reuse (100% Biosolids to Land Application; Biomethane)	1d. Maximum Beneficial Reuse (50% Biosolids to "Industrialized" Land Application / 50% to Cement Kiln; Biomethane)	2. Maximum Integration and Maximum Energy Recovery	4. Separate Digestion and Balanced Energy Recovery / Beneficial Reuse	5a. No Digestion and Balanced Energy Recovery / Beneficial Reuse (FBC)	5b. No Digestion and Balanced Energy Recovery / Beneficial Reuse (Cement Kiln)
Base Scenario	3	8	2	6	5	7	4	1
Total NPV = 50	5	8	2	7	3	6	4	1
Environmental = 70	3	8	2	5	7	6	4	1
Socioeconomic = 80	3	8	2	6	5	7	4	1
Socioeconomic = 60	3	8	2	6	5	7	4	1
Flexibility = 100	3	8	2	5	6	7	4	1
Flexibility = 20	4	8	2	7	5	6	3	1
Ease/Safety of Operations & Maintenance = 90	3	8	2	5	7	6	4	1
Ease/Safety of Operations & Maintenance = 20	3	8	2	7	5	6	4	1

first digesting wastewater solids and then drying them prior to transport to a cement kiln induces significant capital costs. Strategy 2 is impacted by the large capital cost of providing digestion capacity for solid waste organics, relative to the cost of composting infrastructure, in addition to the high costs associated with directing the wastewater sludges and solid waste organics to a MSW ETW facility for thermal destruction. However, although Strategy 1b and 2 have very similar TNPVs and MOAA total scores, their risk signatures are markedly different. Strategy 1 b has the second lowest risk signature of any strategy, largely owing to its flexibility. For example, if the cement kilns refused to accept the dried sludges at some point in time, the biosolids, because of digestion, are a stable product that could be land applied at least for an interim period. Alternately, Strategy 2 was deemed to have a relatively high risk signature. Siting a MSW ETW facility in the Hartland area, along with a substantive co-digestion facility, could encounter significant public opposition. Strategy 2 is also more vulnerable to technologic and financial risks because of this same infrastructure – any changes in direction would have significant cost impacts. Strategy 2 does have some risk benefits due to the lack of land application of either biosolids or solid waste compost and the elimination of potential climate change impacts (e.g. increased precipitation during the wet season) on such practices.

As shown in Figure 4-4, Strategy 1d has the lowest overall risk signature. This result owes to multiple biosolids end uses and the types of end uses themselves. Strategy 1d does involve land application of some biosolids, but the more "industrial" willow coppice program that uses these biosolids would be under the direct control of the CRD as would the land leased by the CRD. This situation would reduce the potential for odour or environmental problems, which can arise due to third party contractual issues or poorly planned programs. As a result, it is reasonable to expect a lower risk of public acceptability concerns. The multiple biosolids end uses of Strategy 1d also reduce the technologic and financial risk by allowing the CRD to not "put all eggs into one basket". Although there are risks associated with sludge drying and cement kiln contracts, as noted above, the use of sludge digestion helps to mitigate this risk as discussed previously.

Another way to examine the SAF information is in the context of specific, fundamental questions rather than focusing singly on the individual strategies, as discussed below.

Does it make sense to <u>fully</u> integrate the wastewater and solid waste programs? The Strategy 2 information suggests likely not. The need to dewater all raw wastewater sludges at a Macaulay area WWTF and transport them to the Hartland landfill area for co-digestion with solid waste organics comes at an economic and environmental cost. However, this finding does not preclude some element of integration between the programs. For example, as identified as an option for Strategies 1 a/b/c/d and 4, solid waste organics generated in areas close to the WWTF could be transported to the WWTF for co-digestion with wastewater sludges. The solid waste organics would be pre-processed (e.g. screened and slurried) at a solid waste transfer station and transported in closed tanker trucks to minimize odour potential. The risks of such an approach are minimized – the CRD would gain experience with this concept before larger-scale implementation and associated commitment.

The approach described above provides the CRD flexibility to consider its solid waste program independent from the wastewater program, at least in the near-term, and study the solid waste question in more detail. For example, there is the question of separate digestion of solid waste organics versus composting. The information generated by the SAF analysis indicates that the former approach exacts a significant capital cost premium. At the same time, the environmental benefits of digestion are significant when the biogas is upgraded to biomethane and then used to off-set natural gas use. In addition, the revenue potential of this biomethane is also significant and needs to be considered in light of the overall operations and maintenance costs, GHG carbon credits/cost and capital costs.

The described program de-coupling also allows the CRD to more fully examine the question of solid waste residuals management and how a MSW EFW facility could fit into its long-term plans. In addition, the decision to not fully integrate the wastewater and solid waste programs in the short-term would not preclude the CRD from using a future MSW EFW facility as a biosolids destination / disposal method in the longer term.

On this basis, for the purposes of developing the options for the overall Distributed Wastewater Management Strategy for the Core Area under Activity 036, it is assumed that wastewater / solid waste integration will focus on local opportunities for co-digestion of wastewater sludges and solid waste organics rather than the full integration of the two programs.

Should wastewater sludges be stabilized via digestion and what should the resulting biosolids end use be? This is a very complex question because ultimately it is associated with the material end use. Wastewater sludges or biosolids have three broad possible destinations: (i) some form of land application, (ii) third party cement kiln, and (iii) CRD thermal destruction facility (e.g. wastewater FBC system or MSW EFW facility).

First consider the information generated for Strategies 1c (i) and 5b (ii). Both strategies have similar TNPVs (i.e. $152M vs. $155M) and both generate similar revenues for their saleable products (biomethane NPV = $8M vs. coal substitute fuel = $6M). Alternately, Strategy 5b offers significant GHG off-sets relative to Strategy 1c (735,000 vs. 110,000 t CO2e), which contributes to the approximate saving in the GHG NPV of about $3M. Both Strategies have similar risk signatures. As discussed previously, Strategy 1c considers the public acceptability risk associated with land application of biosolids in a typical forestry situation, where Strategy 5b carries the technologic and financial risk of dealing with a third party (i.e. cement kiln(s)) and the uncertainty of long-term contracts. In either case, the CRD would incur significant costs should it need to change directions abruptly, although it could be argued that Strategy 1c may be more accommodating in turns of the time needed to implement a changed direction. Strategy 1c also likely carries less technological risk – wastewater sludge digestion is a well-understood process with a very long and successful implementation history. Alternately, drying of raw wastewater sludges has a more limited and recent history, yet there are successful examples of CRD-scale operations in North America.

Now consider Strategy 1b, which is a blend of Strategies 1c and 5b. It has the second lowest risk signature of any strategy, but it does come at a financial premium that manifests itself in having the highest TNPV of all strategies. Strategy 1b has the advantage of directing biosolids to land application, should the cement kiln option be terminated, without incurring significant additional costs. If the forestry land application route was not available, because of public opposition, the dryed sludges could be hauled to a MSW EFW facility. The dryed state of the sludges makes them particularly well suited for feed for such a facility.

Finally, Strategy 1d provides the lowest risk signature of all strategies, as explained previously, but it attains this position with a further blending of approaches without as severe of a financial premium relative to Strategy 1b. As a result, Strategy 1d better balances the cost of a strategy with its risk.

On the basis of the perspectives discussed, digestion of wastewater sludges offers the CRD a robust, flexible approach that does have risk management benefits. This approach may also implicitly include some level of biosolids land application, which can be further mitigated through using a willow coppice program rather than a conventional forestry application program.

Should biogas produced by digestion be used for electrical co-generation or should it be upgraded to biomethane? Review of information generated for Options 1a and 1c by the LCA, CFA and ultimately SAF provide a direct answer to this question. Although the value of electricity produced by co-generation is roughly equal to the saleable value of biomethane, as discussed in Section 4.1, co-generation is more costly, provides less credit in terms of GHG costs and does not offer the environmental (i.e. GHG) benefits provided by biomethane production. These findings are reflected in the lower TNPV, reduced carbon footprint and higher MOAA total score, which are all positive attributes, for Strategy 1c relative to Strategy 1a.

Although biomethane production is something new to North America, there is an established, albeit still limited, history of implementation in Europe (e.g. Sweden). Current industry trends suggest that North American wastewater utilities and municipalities are giving biomethane production serious consideration, which in turn is associated with vendors further developing the technology required and pursuing opportunities available. The relatively low costs of biomethane upgrading, in comparison to electrical co-generation, further mitigate the risk of pursing this direction.

Therefore, these findings suggest that a reasonable approach in developing options for the overall Distributed Wastewater Management Strategy in Activity 036 should include biomethane production rather electrical co-generation.

5 Summary

This Discussion Paper presents the key findings of an evaluation conducted on a short-list of broad biosolids management / organic residuals energy and resource recovery strategies identified previously in Discussion Paper 031-DP-3. The evaluation findings provide direction for developing and evaluating options for the overall Distributed Wastewater Management Strategy in Activity 036 that include, specifically:

- The integration of the wastewater and solid waste programs will focus on local opportunities for co-digestion of wastewater sludges and solid waste organics rather than the full integration of the two programs.

- Wastewater sludges will be assumed to be digested with one-half of the resulting biosolids land applied in an “industrial” willow coppice program and the other one-half of biosolids being dryed and transported to Lower Mainland cement kilns for use as a coal-substitute fuel.

- Biogas produced by digestion will be assumed to be upgraded to biomethane and sold to the natural gas utility rather than being used for co-generation of electricity.

It is important to note that the selected biosolids / organic residuals strategy or elements in this context does not imply a final decision, but rather forms a reasonable basis for the development and evaluation of the overall wastewater management Options conducted in Activity 036.

References

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APPENDIX A - Life Cycle Analysis and Carbon Footprint Analysis Worksheets

Capital Regional District - Core Area Wastewater Management Strategy: Program Development Phase, Integrated Resource Management Strategy - Biosolids Management / Organic Residuals Energy and Resource Recovery

File: 20062935.04.E.03.01
Prepared: D. Shiskowski, D. Forgie
Last Revision: January 27, 2009
Last Revision By: D. Shiskowski

Subject: Key Calculation Assumptions For Life Cycle and Carbon Footprint Analyses

ASSUMPTIONS

Yellow-shaded cell denotes assumed/input value

Note: As of Jan 28/09, do not modify this sheet in anyway unless Decentralized Strategy Option files/worksheets are also open.

Energy and Carbon Equivalents:				
unit electrical price =	$	0.07	/kWh	
unit diesel fuel price =	$	1.50	/L	
unit CO2e price =	$	15	/t CO2e	**Ref:** Based on a 2009 value of $15 t / CO2e per the Province of British Columbia Carbon Tax (2008).
unit natural gas / biomethane price =	$	10.00	/GJ	
unit cement kiln coal price =	$	40.00	/dry t	
unit woodchip price (via willow coppice) =	$	100.00	o dry t	
energy in biogas (not biomethane) =		22,400	KJ/m3	
calorific value of dried sludge =		22,000	KJ/kg	
calorific value of dried biosolids =		18,000	KJ/kg	
calorific value of cement kiln coal =		26,000	KJ/kg	
Maintenance:				
unit allowance (unless otherwise stated) =		1.0%	of capital works	
Administration:				
lump sum annual allowance =	$	100,000	/yr	
NPV Analysis:				
first year in analysis =		2008		
investment rate of return =		7.0%	/yr	**Note:** Values for Discount Rate Base scenario.
capital works and purchased land inflation rate =		3.0%	/yr	
labour inflation rate =		3.0%	/yr	
electricity inflation rate =		3.0%	/yr	
natural gas/biomethane inflation rate =		3.0%	/yr	
diesel fuel inflation rate =		3.0%	/yr	
cement kiln coal substitute =		3.0%	/yr	
woodchips inflation rate (willow coppice) =		3.0%	/yr	
land lease inflation rate (willow coppice) =		3.0%	/yr	
chemicals inflation rate =		3.0%	/yr	
trucking / equipment rate =		3.0%	/yr	
ash disposal inflation rate =		3.0%	/yr	
maintenance inflation rate =		3.0%	/yr	
administration inflation rate =		3.0%	/yr	
GHG CO2e price inflation rate =		3.0%	/yr	
	$	81	/tonne CO2e	**Note / Ref:** Year 2065 CO2e cost assumed to vary between US$15 and US$155 t / CO2e, as per 032-DP-1 and based on Tirpak (2008).
GHG Sources:				
BC Hydro-supplied electricity =		72	g CO2e/kWh	**Ref:** BC Hydro's (2005) prediction for 2010 was 72 t/ GWh, which is a large increase from the 33 value predicted for 2005 and actual values of 46 and 22 for 2000 and 2003, respectively. No other future projections were found.
diesel fuel combustion (mobile truck) =		2,757	g CO2e/L	**Ref:** Table A13-5, EC (2006). Moderately controlled HDDV.
natural gas combustion (stationary) =		0.0562	g CO2e/KJ	**Ref:** Table 2.5, IPCC (2006). Tier 1 Value is for residential category and commercial/institutional category.
biogas escape from digester systems =		1%	of produced and used biogas	**Ref:** de Haas et al (2008)
biogas methane content =		65%		
methane density =		662	g methane / m3 methane	**Ref:** p. 8-9, USEPA (2008).
methane global warming potential =		23	x CO2	**Ref:** IPCC (2006)
GHG Off-sets:				
solids content of finished SW compost =		60%		
fraction of applied compost off-setting commercial fertilizer use =		25%		**Note:** Applicable to all users of compost product, including CRD.
fraction of off-set commercial fertilizer use attributed to CRD use =		20%		**Note:** Applicable to CRD for purposes of financial analysis.
unit avoided commercial fertilizer use emission factor =		0.10	t CO2e/dry t applied compost	**Ref:** Value based on information from Abu-Orf et al (2008) and Yamagata et al (2008) for biosolids, assumed comparable for compost.
cement kiln coal combustion =		2,072	g CO2e/kg	**Ref:** EC (2006).
biomethane combustion (stationary) =		0.0562	g CO2e/KJ	**Note:** as above for natural gas.

Capital Regional District - Core Area Wastewater Management Strategy: Program Development Phase, Integrated Resource Management Strategy - Biosolids Management / Organic Residuals Energy and Resource Recovery

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Prepared:	D. Shiskowski, D. Forgie
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Last Revision By:	D. Shiskowski

Subject: Key Calculation Assumptions For Life Cycle and Carbon Footprint Analyses

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Capital Regional District - Core Area Wastewater Management Strategy: Program Development Phase, Integrated Resource Management Strategy - Biosolids Management / Organic Residuals Energy and Resource Recovery

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Prepared: D. Shiskowski, D. Forgie
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Last Revision By: D. Shiskowski

Subject: Strategy 1a
Maximum Beneficial Reuse (Biosolids to Land Application; Co-Gen)
Material Flows
and GHG Emissions

Note: **Coloured cells contain data linked to external spreadsheets**

Year	Materials										GHG Sources			GHG Offsets	Total GHG Emissions
	Electricity			Biogas (WW Sludges)			Diesel Fuel			Land Applied SW Organics	Electricity Purchased[4]	Biogas Lost	Diesel Fuel Combusted	Avoided Commercial Fertilizer Use via SW Compost3	
	WW Sludges (kWh/yr)	SW Organics (kWh/yr)	Total (kWh/yr)	Boiler (m3/yr)	Co-Gen (m3/yr)	System Loss (m3/yr)	WW Sludges[1] (L/yr)	SW Organics[2] (L/yr)	Total (L/yr)	(wet t/yr)	(t CO2e/yr)	(t CO2e/yr)	(t CO2e/yr)	(t CO2e/yr)	(t CO2e/yr)
2008															
2009															
2010															
2011															
2012															
2013															
2014															
2015															
2016	-5,493,046	472,098	-5,020,948	496,700	3,468,964	39,657	93,910	126,282	220,192	33,629	-362	392	607	-504	134
2017	-5,596,359	476,661	-5,119,698	489,957	3,525,875	40,158	94,170	127,548	221,718	33,954	-369	397	611	-509	131
2018	-5,699,673	481,224	-5,218,449	483,214	3,582,786	40,660	94,430	127,838	222,268	34,279	-376	402	613	-514	125
2019	-5,802,986	485,787	-5,317,199	476,471	3,639,697	41,162	100,550	129,104	229,654	34,604	-383	407	633	-519	139
2020	-5,906,300	490,350	-5,415,950	469,728	3,696,608	41,663	100,810	130,369	231,179	34,929	-390	412	637	-524	136
2021	-6,009,613	494,913	-5,514,700	462,985	3,753,519	42,165	101,070	130,660	231,730	35,254	-397	417	639	-529	130
2022	-6,112,926	499,476	-5,613,450	456,242	3,810,430	42,667	101,340	131,925	233,265	35,579	-404	422	643	-534	127
2023	-6,216,240	504,039	-5,712,201	449,499	3,867,341	43,168	101,600	133,191	234,791	35,904	-411	427	647	-539	125
2024	-6,319,553	508,602	-5,810,951	442,756	3,924,252	43,670	107,710	133,481	241,191	36,229	-418	432	665	-543	135
2025	-6,422,867	513,165	-5,909,702	436,013	3,981,163	44,172	107,980	134,747	242,727	36,554	-425	437	669	-548	132
2026	-6,526,180	517,728	-6,008,452	429,270	4,038,074	44,673	108,240	135,037	243,277	36,879	-433	442	671	-553	127
2027	-6,629,494	522,291	-6,107,202	422,527	4,094,984	45,175	108,500	136,303	244,803	37,204	-440	447	675	-558	124
2028	-6,732,807	526,854	-6,205,953	415,784	4,151,895	45,677	108,770	137,568	246,338	37,529	-447	452	679	-563	121
2029	-6,836,120	531,417	-6,304,703	409,042	4,208,806	46,178	109,030	137,859	246,889	37,854	-454	457	681	-568	116
2030	-6,939,434	535,980	-6,403,454	402,299	4,265,717	46,680	115,140	139,124	254,264	38,179	-461	462	701	-573	129
2031	-7,043,178	541,078	-6,502,100	395,556	4,322,628	47,182	115,370	140,424	255,794	38,543	-468	467	705	-578	126
2032	-7,146,922	546,176	-6,600,746	388,813	4,379,539	47,684	115,590	140,749	256,339	38,906	-475	472	707	-584	120
2033	-7,250,665	551,274	-6,699,392	382,070	4,436,450	48,185	115,810	142,048	257,858	39,269	-482	477	711	-589	116
2034	-7,354,409	556,372	-6,798,038	375,327	4,493,361	48,687	116,040	143,348	259,388	39,632	-489	482	715	-594	113
2035	-7,458,153	561,470	-6,896,684	368,584	4,550,272	49,189	116,260	143,672	259,932	39,995	-497	487	717	-600	107
2036	-7,561,897	566,568	-6,995,330	361,841	4,607,183	49,690	122,340	144,972	267,312	40,358	-504	492	737	-605	120
2037	-7,665,641	571,665	-7,093,976	355,098	4,664,094	50,192	122,560	146,271	268,831	40,721	-511	497	741	-611	116
2038	-7,769,385	576,763	-7,192,622	348,355	4,721,005	50,694	122,790	147,571	270,361	41,085	-518	502	745	-616	113
2039	-7,873,129	581,861	-7,291,268	341,612	4,777,916	51,195	123,010	147,896	270,906	41,448	-525	507	747	-622	107
2040	-7,976,873	586,959	-7,389,914	334,869	4,834,827	51,697	123,230	149,195	272,425	41,811	-532	512	751	-627	103
2041	-8,080,617	592,057	-7,488,560	328,126	4,891,737	52,199	123,460	150,495	273,955	42,174	-539	517	755	-633	100
2042	-8,184,360	597,155	-7,587,206	321,383	4,948,648	52,700	129,530	150,819	280,349	42,537	-546	522	773	-638	110
2043	-8,288,104	602,253	-7,685,852	314,641	5,005,559	53,202	129,760	152,119	281,879	42,900	-553	527	777	-644	107
2044	-8,391,848	607,351	-7,784,498	307,898	5,062,470	53,704	129,980	153,418	283,398	43,263	-560	531	781	-649	103
2045	-8,495,592	612,449	-7,883,143	301,155	5,119,381	54,205	130,210	153,743	283,953	43,626	-568	536	783	-654	97
2046	-8,599,934	616,129	-7,983,805	294,412	5,176,292	54,707	130,380	154,952	285,332	43,889	-575	541	787	-658	95
2047	-8,704,277	619,810	-8,084,466	287,669	5,233,203	55,209	130,550	155,187	285,737	44,151	-582	546	788	-662	90
2048	-8,808,619	623,491	-8,185,128	280,926	5,290,114	55,710	130,720	156,396	287,116	44,413	-589	551	791	-666	87
2049	-8,912,961	627,172	-8,285,789	274,183	5,347,025	56,212	136,740	156,630	293,370	44,675	-597	556	809	-670	98
2050	-9,017,303	630,853	-8,386,451	267,440	5,403,936	56,714	136,910	157,840	294,750	44,937	-604	561	813	-674	96
2051	-9,121,646	634,534	-8,487,112	260,697	5,460,847	57,215	137,080	158,074	295,154	45,200	-611	566	814	-678	91
2052	-9,225,988	638,214	-8,587,774	253,954	5,517,758	57,717	137,250	159,283	296,533	45,462	-618	571	817	-682	88
2053	-9,330,330	641,895	-8,688,435	247,211	5,574,669	58,219	137,420	159,518	296,938	45,724	-626	576	819	-686	83
2054	-9,434,673	645,576	-8,789,096	240,468	5,631,579	58,720	137,590	160,727	298,317	45,986	-633	581	822	-690	81
2055	-9,539,015	649,257	-8,889,758	233,725	5,688,490	59,222	137,760	160,962	298,722	46,248	-640	586	823	-694	76
2056	-9,643,357	652,938	-8,990,419	226,982	5,745,401	59,724	137,930	162,171	300,101	46,511	-647	591	827	-698	73
2057	-9,747,699	656,619	-9,091,081	220,240	5,802,312	60,226	138,100	162,405	300,505	46,773	-655	596	828	-702	68
2058	-9,852,042	660,299	-9,191,742	213,497	5,859,223	60,727	144,120	163,615	307,735	47,035	-662	601	848	-706	82
2059	-9,956,384	663,980	-9,292,404	206,754	5,916,134	61,229	144,290	163,849	308,139	47,297	-669	606	849	-709	77
2060	-10,060,726	667,661	-9,393,065	200,011	5,973,045	61,731	144,460	165,058	309,518	47,559	-676	611	853	-713	74
2061	-10,165,068	671,342	-9,493,726	193,268	6,029,956	62,232	144,630	165,293	309,923	47,822	-684	616	854	-717	69
2062	-10,269,411	675,023	-9,594,388	186,525	6,086,867	62,734	144,800	166,502	311,302	48,084	-691	621	858	-721	67
2063	-10,373,753	678,704	-9,695,049	179,782	6,143,778	63,236	144,970	166,736	311,706	48,346	-698	626	859	-725	62
2064	-10,478,095	682,384	-9,795,711	173,039	6,200,689	63,737	145,140	167,946	313,086	48,608	-705	631	863	-729	59
2065	-10,582,438	686,065	-9,896,372	166,296	6,257,600	64,239	145,310	168,180	313,490	48,870	-713	636	864	-733	54
Totals =	-401,608,090	29,233,984	-372,374,106	16,574,892	243,164,099	2,597,390	6,175,340	7,429,102	13,604,442	2,082,421	-26,811	25,706	37,503	-31,236	**5,162**

Notes:
1. Includes transport of biosolids to land application site plus actual land application.
2. Includes transport of compost product to distribution site for public pickup.
3. Assumes that land applied biosolids are not off-setting commercial fertilizer use.
4. Negative values imply an off-set and are considered as an offset in the analysis.

Capital Regional District - Core Area Wastewater Management Strategy: Program Development Phase, Integrated Resource Management Strategy - Biosolids Management / Organic Residuals Energy and Resource Recovery

File: 20062935.04.E.03.01
Prepared: D. Shiskowski, D. Forgie
Last Revision: November 28, 2008
Last Revision By: D. Shiskowski

Subject: Strategy 1a
Maximum Beneficial Reuse (Biosolids to Land Application; Co-Gen)
Discount Rate Base
Life-Cycle Analysis

Yellow-shaded cell denotes assumed/input values
Note: Other coloured cells contain data linked to external spreadsheets

Year	Capital Costs				Operations & Maintenance Costs																GHG CO_2e[4]		Value of Electricity Produced[5]		Total	
					Labour				Electricity[5]		Chemicals			Trucking/Equipment[3]				Maintenance		Administration						
	WW Sludges	SW Organics	Total Cost	Net Present Value	WW Sludges Annual Cost	SW Organics Annual Cost	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	WW Sludges Annual Cost	Total Annual Cost	Net Present Value	WW Sludges[2] Annual Cost	SW Organics[1] Annual Cost	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value
2008																										
2009																										
2010																										
2011																										
2012																										
2013																										
2014																										
2015	$95,200,000	$25,600,000	$120,800,000	$91,798,072																					$120,800,000	$91,798,072
2016			$0	$0	$450,000	$300,000	$750,000	$548,018	$33,047	$24,147	$386,700	$396,700	$282,558	$611,024	$730,200	$1,341,224	$980,019	$1,208,000	$882,674	$100,000	$73,069	$8,056	$5,887	-$384,513	-$280,960	$3,442,514	$2,515,411
2017			$0	$0	$450,000	$300,000	$750,000	$526,940	$33,366	$23,443	$392,400	$392,400	$275,695	$617,024	$737,000	$1,354,024	$951,319	$1,208,000	$848,725	$100,000	$70,259	$8,072	$5,672	-$391,745	-$275,235	$3,454,118	$2,426,817
2018			$0	$0	$450,000	$300,000	$750,000	$506,673	$33,686	$22,757	$398,100	$398,100	$268,942	$623,024	$741,000	$1,364,024	$921,486	$1,208,000	$816,082	$100,000	$67,556	$8,048	$5,437	-$398,977	-$269,535	$3,462,881	$2,339,398
2019			$0	$0	$450,000	$300,000	$750,000	$487,186	$34,005	$22,089	$403,800	$403,800	$262,301	$645,672	$748,800	$1,394,672	$905,952	$1,208,000	$784,694	$100,000	$64,958	$8,307	$5,396	-$406,209	-$263,866	$3,492,575	$2,268,710
2020			$0	$0	$450,000	$300,000	$750,000	$468,448	$34,325	$21,439	$409,500	$409,500	$255,772	$650,672	$755,600	$1,406,472	$878,478	$1,208,000	$754,519	$100,000	$62,460	$8,323	$5,199	-$413,441	-$258,234	$3,503,179	$2,188,075
2021			$0	$0	$450,000	$300,000	$750,000	$450,431	$34,644	$20,806	$415,200	$415,200	$249,358	$656,672	$759,600	$1,416,272	$850,696	$1,208,000	$725,493	$100,000	$60,057	$8,299	$4,984	-$420,673	-$252,645	$3,511,942	$2,109,182
2022			$0	$0	$450,000	$300,000	$750,000	$433,106	$34,963	$20,190	$420,900	$420,900	$243,059	$662,672	$767,400	$1,430,272	$825,946	$1,208,000	$697,590	$100,000	$57,748	$8,316	$4,802	-$427,905	-$247,104	$3,524,546	$2,035,338
2023			$0	$0	$450,000	$300,000	$750,000	$416,448	$35,283	$19,591	$426,600	$426,600	$236,876	$668,672	$774,200	$1,443,072	$801,287	$1,208,000	$670,760	$100,000	$55,526	$8,332	$4,627	-$435,137	-$241,616	$3,536,150	$1,963,499
2024			$0	$0	$450,000	$300,000	$750,000	$400,431	$35,602	$19,008	$432,300	$432,300	$230,809	$690,720	$779,200	$1,469,920	$784,802	$1,208,000	$644,961	$100,000	$53,391	$8,550	$4,565	-$442,369	-$236,184	$3,562,004	$1,901,783
2025			$0	$0	$450,000	$300,000	$750,000	$385,030	$35,922	$18,441	$438,000	$438,000	$224,857	$696,720	$786,000	$1,482,720	$761,189	$1,208,000	$620,155	$100,000	$51,337	$8,567	$4,398	-$449,601	-$230,813	$3,573,608	$1,834,595
2026			$0	$0	$450,000	$300,000	$750,000	$370,221	$36,241	$17,890	$443,700	$443,700	$219,023	$702,720	$790,000	$1,492,720	$736,849	$1,208,000	$596,303	$100,000	$49,363	$8,543	$4,217	-$456,833	-$225,505	$3,582,371	$1,768,359
2027			$0	$0	$450,000	$300,000	$750,000	$355,982	$36,560	$17,353	$449,400	$449,400	$213,304	$708,720	$797,800	$1,506,520	$715,058	$1,208,000	$573,368	$100,000	$47,464	$8,559	$4,062	-$464,065	-$220,265	$3,594,975	$1,706,328
2028			$0	$0	$450,000	$300,000	$750,000	$342,290	$36,880	$16,831	$455,100	$455,100	$207,702	$714,720	$804,600	$1,519,320	$693,398	$1,208,000	$551,315	$100,000	$45,639	$8,576	$3,914	-$471,296	-$215,094	$3,606,579	$1,645,996
2029			$0	$0	$450,000	$300,000	$750,000	$329,125	$37,199	$16,324	$460,800	$460,800	$202,215	$719,720	$808,600	$1,528,320	$670,678	$1,208,000	$530,111	$100,000	$43,883	$8,552	$3,753	-$478,528	-$209,994	$3,614,342	$1,586,095
2030			$0	$0	$450,000	$300,000	$750,000	$316,467	$37,519	$15,831	$466,500	$466,500	$196,842	$742,568	$816,400	$1,558,968	$657,815	$1,208,000	$509,722	$100,000	$42,196	$8,810	$3,717	-$485,760	-$204,969	$3,644,036	$1,537,621
2031			$0	$0	$450,000	$300,000	$750,000	$304,295	$37,675	$15,367	$471,300	$471,300	$191,219	$747,568	$824,300	$1,571,868	$637,748	$1,208,000	$490,117	$100,000	$40,573	$8,825	$3,580	-$493,022	-$200,032	$3,654,846	$1,482,867
2032			$0	$0	$450,000	$300,000	$750,000	$292,591	$38,232	$14,915	$476,200	$185,776	$185,776	$752,568	$829,300	$1,581,868	$617,121	$1,208,000	$471,267	$100,000	$39,012	$8,799	$3,433	-$500,285	-$195,172	$3,662,815	$1,428,943
2033			$0	$0	$450,000	$300,000	$750,000	$281,338	$38,589	$14,475	$481,000	$481,000	$180,431	$757,568	$836,100	$1,593,668	$597,812	$1,208,000	$453,141	$100,000	$37,512	$8,813	$3,306	-$507,547	-$190,389	$3,672,524	$1,377,625
2034			$0	$0	$450,000	$300,000	$750,000	$270,517	$38,946	$14,047	$485,900	$175,259	$175,259	$762,568	$843,900	$1,606,468	$579,436	$1,208,000	$435,713	$100,000	$36,069	$8,828	$3,184	-$514,809	-$185,686	$3,683,333	$1,328,539
2035			$0	$0	$450,000	$300,000	$750,000	$260,112	$39,303	$13,631	$490,700	$170,183	$170,183	$767,568	$848,900	$1,616,468	$560,618	$1,208,000	$418,954	$100,000	$34,682	$8,802	$3,053	-$522,071	-$181,063	$3,691,202	$1,280,170
2036			$0	$0	$450,000	$300,000	$750,000	$250,108	$39,660	$13,226	$495,600	$495,600	$165,271	$789,416	$856,700	$1,646,116	$548,943	$1,208,000	$402,841	$100,000	$33,348	$9,059	$3,021	-$529,335	-$176,521	$3,719,102	$1,240,237
2037			$0	$0	$450,000	$300,000	$750,000	$240,489	$40,017	$12,831	$500,500	$500,500	$160,486	$794,416	$864,500	$1,658,916	$531,934	$1,208,000	$387,347	$100,000	$32,065	$9,073	$2,909	-$536,595	-$172,060	$3,729,911	$1,196,001
2038			$0	$0	$450,000	$300,000	$750,000	$231,239	$40,373	$12,448	$505,300	$505,300	$155,793	$798,416	$872,300	$1,670,716	$515,113	$1,208,000	$372,449	$100,000	$30,832	$9,088	$2,802	-$543,857	-$167,681	$3,739,621	$1,152,995
2039			$0	$0	$450,000	$300,000	$750,000	$222,345	$40,730	$12,075	$510,200	$510,200	$151,254	$803,416	$877,300	$1,680,716	$498,265	$1,208,000	$358,124	$100,000	$29,646	$9,062	$2,687	-$551,119	-$163,385	$3,747,590	$1,111,011
2040			$0	$0	$450,000	$300,000	$750,000	$213,793	$41,087	$11,712	$515,000	$515,000	$146,805	$808,416	$885,100	$1,693,516	$482,750	$1,208,000	$344,350	$100,000	$28,506	$9,077	$2,587	-$558,381	-$159,171	$3,758,299	$1,071,333
2041			$0	$0	$450,000	$300,000	$750,000	$205,571	$41,444	$11,360	$519,900	$519,900	$142,502	$813,416	$891,900	$1,705,316	$467,417	$1,208,000	$331,106	$100,000	$27,409	$9,092	$2,492	-$565,643	-$155,039	$3,768,108	$1,032,817
2042			$0	$0	$450,000	$300,000	$750,000	$197,664	$41,801	$11,017	$524,800	$524,800	$138,312	$835,264	$896,900	$1,732,164	$456,515	$1,208,000	$318,371	$100,000	$26,355	$9,308	$2,453	-$572,905	-$150,990	$3,793,167	$999,697
2043			$0	$0	$450,000	$300,000	$750,000	$190,062	$42,158	$10,683	$529,600	$529,600	$134,209	$840,264	$904,700	$1,744,964	$442,201	$1,208,000	$306,126	$100,000	$25,342	$9,322	$2,362	-$580,167	-$147,023	$3,803,877	$963,961
2044			$0	$0	$450,000	$300,000	$750,000	$182,752	$42,515	$10,359	$534,500	$534,500	$130,241	$845,264	$912,500	$1,757,764	$428,312	$1,208,000	$294,352	$100,000	$24,367	$9,337	$2,275	-$587,429	-$143,138	$3,814,686	$929,520
2045			$0	$0	$450,000	$300,000	$750,000	$175,723	$42,871	$10,045	$539,300	$539,300	$126,356	$850,264	$917,500	$1,767,764	$414,182	$1,208,000	$283,031	$100,000	$23,430	$9,311	$2,182	-$594,691	-$139,334	$3,822,555	$895,613
2046			$0	$0	$450,000	$300,000	$750,000	$168,964	$43,129	$9,716	$543,000	$543,000	$122,330	$854,264	$924,300	$1,778,564	$400,685	$1,208,000	$272,145	$100,000	$22,529	$9,322	$2,100	-$601,995	-$135,621	$3,830,020	$862,848
2047			$0	$0	$450,000	$300,000	$750,000	$162,465	$43,387	$9,398	$546,700	$546,700	$118,426	$857,264	$927,300	$1,784,564	$386,573	$1,208,000	$261,678	$100,000	$21,662	$9,293	$2,013	-$609,299	-$131,987	$3,832,644	$830,230
2048			$0	$0	$450,000	$300,000	$750,000	$156,217	$43,644	$9,091	$550,400	$550,400	$114,642	$861,264	$934,100	$1,795,364	$373,955	$1,208,000	$251,613	$100,000	$20,829	$9,304	$1,938	-$616,603	-$128,432	$3,840,109	$799,853
2049			$0	$0	$450,000	$300,000	$750,000	$150,208	$43,902	$8,793	$554,100	$554,100	$110,974	$882,112	$937,100	$1,819,212	$364,346	$1,208,000	$241,936	$100,000	$20,028	$9,517	$1,906	-$623,907	-$124,955	$3,860,823	$773,238
2050			$0	$0	$450,000	$300,000	$750,000	$144,431	$44,160	$8,504	$557,800	$557,800	$107,416	$886,112	$944,000	$1,830,112	$352,434	$1,208,000	$232,631	$100,000	$19,257	$9,528	$1,835	-$631,211	-$121,555	$3,868,388	$744,955
2051			$0	$0	$450,000	$300,000	$750,000	$138,876	$44,417	$8,225	$561,500	$561,500	$103,972	$889,112	$947,000	$1,836,112	$339,990	$1,208,000	$223,683	$100,000	$18,517	$9,498	$1,759	-$638,515	-$118,233	$3,871,013	$716,788
2052			$0	$0	$450,000	$300,000	$750,000	$133,535	$44,675	$7,954	$565,200	$565,200	$100,632	$893,112	$953,800	$1,846,912	$328,836	$1,208,000	$215,080	$100,000	$17,805	$9,509	$1,693	-$645,819	-$114,986	$3,878,477	$690,549
2053			$0	$0	$450,000	$300,000	$750,000	$128,399	$44,933	$7,692	$568,900	$568,900	$97,395	$897,112	$956,600	$1,853,912	$317,387	$1,208,000	$206,808	$100,000	$17,120	$9,480	$1,623	-$653,123	-$111,814	$3,882,102	$664,610
2054			$0	$0	$450,000	$300,000	$750,000	$123,460	$45,190	$7,439	$572,500	$572,500	$94,241	$901,112	$963,600	$1,864,712	$306,957	$1,208,000	$198,854	$100,000	$16,461	$9,491	$1,562	-$660,427	-$108,715	$3,889,466	$640,260
2055			$0	$0	$450,000	$300,000	$750,000	$118,712	$45,448	$7,194	$576,200	$576,200	$91,202	$904,112	$966,600	$1,870,712	$296,101	$1,208,000	$191,205	$100,000	$15,828	$9,462	$1,498	-$667,731	-$105,680	$3,892,091	$616,050
2056			$0	$0	$450,000	$300,000	$750,000	$114,146	$45,706	$6,956	$579,900	$579,900	$88,256	$908,112	$973,400	$1,881,512	$286,356	$1,208,000	$183,851	$100,000	$15,219	$9,473	$1,442	-$675,035	-$102,737	$3,899,555	$593,492
2057			$0	$0	$450,000	$300,000	$750,000	$109,756	$45,963	$6,726	$583,600	$583,600	$85,405	$912,112	$976,400	$1,888,512	$276,367	$1,208,000	$176,780	$100,000	$14,634	$9,443	$1,382	-$682,339	-$99,854	$3,903,180	$571,196
2058			$0	$0	$450,000	$300,000	$750,000	$105,534	$46,221	$6,504	$587,300	$587,300	$82,641	$916,960	$983,200	$1,916,160	$269,628	$1,208,000	$169,981	$100,000	$14,071	$9,696	$1,364	-$689,643	-$97,041	$3,927,734	$552,682
2059			$0	$0	$450,000	$300,000	$750,000	$101,475	$46,479	$6,289	$591,000	$591,000	$79,969	$935,960	$986,200	$1,922,160	$260,069	$1,208,000	$163,443	$100,000	$13,530	$9,667	$1,308	-$696,947	-$94,297	$3,930,359	$531,780
2060			$0	$0	$450,000	$300,000	$750,000	$97,573	$46,736	$6,080	$594,700	$594,700	$77,369	$939,960	$993,000	$1,932,960	$251,472	$1,208,000	$157,157	$100,000	$13,010	$9,678	$1,259	-$704,251	-$91,621	$3,937,823	$512,298
2061			$0	$0	$450,000	$300,000	$750,000	$93,820	$46,994	$5,879	$598,400	$598,400	$74,856	$943,960	$996,000	$1,939,960	$242,675	$1,208,000	$151,112	$100,000	$12,509	$9,649	$1,207	-$711,555	-$89,011	$3,941,448	$493,048
2062			$0	$0	$450,000	$300,000	$750,000	$90,211	$47,252	$5,684	$602,100	$602,100	$72,422	$947,960	$1,002,800	$1,950,760	$234,641	$1,208,000	$145,300	$100,000	$12,028	$9,660	$1,162	-$718,859	-$86,466	$3,948,913	$474,982
2063			$0	$0	$450,000	$300,000	$750,000	$86,742	$47,509	$5,495	$605,800	$605,800	$70,064	$950,960	$1,005,800	$1,956,760	$226,310	$1,208,000	$139,712	$100,000	$11,566	$9,630	$1,114	-$726,163	-$83,985	$3,951,537	$457,017
2064			$0	$0	$450,000	$300,000	$750,000	$83,405	$47,767	$5,312	$609,400	$609,400	$67,770	$954,960	$1,012,600	$1,967,560	$218,807	$1,208,000	$134,338	$100,000	$11,121	$9,641	$1,072	-$733,467	-$81,567	$3,958,902	$440,258
2065			$0	$0	$450,000	$300,000	$750,000	$80,198	$48,025	$5,135	$613,100	$613,100	$65,559	$958,960	$1,015,600	$1,974,560	$211,140	$1,208,000	$129,171	$100,000	$10,693	$9,612	$1,028	-$740,771	-$79,211	$3,962,526	$423,713
Total Capital =	$95,200,000	$25,600,000	$120,800,000																							
Total Net Present Value =				$91,798,072				$12,243,521		$628,399			$7,748,948				$25,858,070		$19,720,231		$1,632,469		$143,221		-$8,266,481		**$151,506,450**

Notes:
1. Includes transport of compost product to distribution site for pickup by public.
2. Includes transport of biosolids to land application site and land application costs.
3. Includes **diesel fuel**, driver, maintenance costs.
4. Excludes CO_2e off-sets of commerical fertilizers by non-CRD end users (i.e. assumes that the CRD would not be able to sell these "credits").
5. Includes only SW organics electrical cost. Electricity produced by WW sludge co-gen considered in note 6.
6. Not a saleable product; overall revenue neutral.

Capital Regional District - Core Area Wastewater Management Strategy: Program Development Phase, Integrated Resource Management Strategy - Biosolids Management / Organic Residuals Energy and Resource Recovery

File: 20062935.04.E.03.01
Prepared: D. Shiskowski, D. Forgie
Last Revision: November 28, 2008
Last Revision By: D. Shiskowski

Subject: Strategy 1b
Maximum Beneficial Reuse (Biosolids to Cement Kiln; Biomethane)
Material Flows
and GHG Emissions

Note: **Coloured cells contain data linked to external spreadsheets**

Year	Materials													GHG Sources				GHG Offsets			Total GHG Emissions
	Electricity			Biogas (WW Sludges)			Biomethane (WW Sludges)	Diesel Fuel			Natural Gas	Dried WW Biosolids	Land Applied SW Organics	Electricity Purchased[4]	Biogas Lost	Natural Gas Combusted	Diesel Fuel Combusted	Avoided Commercial Fertilizer Use via SW Compost3	Avoided Natural Gas Use via Biomethane	Avoided Coal Use via Dried WW Biosolids	
	WW Sludges (kWh/yr)	SW Organics (kWh/yr)	Total (kWh/yr)	Boiler (m3/yr)	for Biomethane (m3/yr)	System Loss (m3/yr)	Available for Sale (GJ/yr)	WW Sludges[1] (L/yr)	SW Organics[2] (L/yr)	Total (L/yr)	WW Sludges (GJ/yr)	(dry t/yr)	(wet t/yr)	(t CO2e/yr)	(t CO2e/yr)	(t CO2e/yr)	(t CO2e/yr)	(t CO2e/yr)	(t CO2e/yr)	(t CO2e/yr)	(t CO2e/yr)
2008																					
2009																					
2010																					
2011																					
2012																					
2013																					
2014																					
2015																					
2016	1,879,400	472,100	2,351,500	2,369,141	1,681,970	40,511	37,299	35,070	126,282	161,352	42,800	4,833	33,629	169	401	2,407	445	-504	-2,098	-6,933	-6,113
2017	1,885,600	476,700	2,362,300	2,393,156	1,717,658	41,108	38,091	35,070	127,548	162,618	43,430	4,904	33,954	170	407	2,443	448	-509	-2,142	-7,035	-6,219
2018	1,891,700	481,300	2,373,000	2,417,172	1,753,346	41,705	38,882	35,070	127,838	162,908	44,060	4,975	34,279	171	413	2,478	449	-514	-2,187	-7,137	-6,327
2019	1,897,900	485,800	2,383,700	2,441,187	1,789,035	42,302	39,674	36,760	129,104	165,864	44,690	5,047	34,604	172	419	2,514	457	-519	-2,231	-7,239	-6,429
2020	1,904,100	490,400	2,394,500	2,465,203	1,824,723	42,899	40,465	36,760	130,369	167,129	45,320	5,118	34,929	172	425	2,549	461	-524	-2,276	-7,341	-6,534
2021	1,910,200	495,000	2,405,200	2,489,218	1,860,411	43,496	41,256	36,760	130,660	167,420	45,950	5,189	35,254	173	430	2,584	462	-529	-2,320	-7,443	-6,643
2022	1,916,400	499,500	2,415,900	2,513,234	1,896,099	44,093	42,048	36,760	131,925	168,685	46,580	5,260	35,579	174	436	2,620	465	-534	-2,365	-7,546	-6,749
2023	1,922,500	504,100	2,426,600	2,537,249	1,931,787	44,690	42,839	36,760	133,191	169,951	47,210	5,331	35,904	175	442	2,655	468	-539	-2,409	-7,648	-6,855
2024	1,928,700	508,700	2,437,400	2,561,265	1,967,475	45,287	43,631	38,450	133,481	171,931	47,840	5,403	36,229	175	448	2,691	474	-543	-2,454	-7,750	-6,959
2025	1,934,900	513,200	2,448,100	2,585,280	2,003,164	45,884	44,422	38,450	134,747	173,197	48,470	5,474	36,554	176	454	2,726	477	-548	-2,499	-7,852	-7,065
2026	1,941,000	517,800	2,458,800	2,609,296	2,038,852	46,481	45,214	38,450	135,037	173,487	49,100	5,545	36,879	177	460	2,762	478	-553	-2,543	-7,954	-7,174
2027	1,947,200	522,300	2,469,500	2,633,311	2,074,540	47,079	46,005	38,450	136,303	174,753	49,730	5,616	37,204	178	466	2,797	482	-558	-2,588	-8,056	-7,280
2028	1,953,300	526,900	2,480,200	2,657,327	2,110,228	47,676	46,796	38,450	137,568	176,018	50,360	5,688	37,529	179	472	2,832	485	-563	-2,632	-8,159	-7,386
2029	1,959,600	531,500	2,491,100	2,681,342	2,145,916	48,273	47,588	38,450	137,859	176,309	50,990	5,759	37,854	179	478	2,868	486	-568	-2,677	-8,261	-7,494
2030	1,965,700	536,000	2,501,700	2,705,357	2,181,604	48,870	48,379	40,140	139,124	179,264	51,620	5,830	38,179	180	484	2,903	494	-573	-2,721	-8,363	-7,595
2031	1,970,600	541,100	2,511,700	2,729,373	2,208,492	49,379	48,976	40,140	140,424	180,564	52,160	5,891	38,543	181	489	2,934	498	-578	-2,755	-8,450	-7,682
2032	1,975,600	546,200	2,521,800	2,753,388	2,235,379	49,888	49,572	43,340	140,749	184,089	52,700	5,952	38,906	182	494	2,964	507	-584	-2,788	-8,537	-7,762
2033	1,980,500	551,300	2,531,800	2,777,404	2,262,267	50,397	50,168	43,340	142,048	185,388	53,240	6,012	39,269	182	499	2,994	511	-589	-2,822	-8,624	-7,848
2034	1,985,400	556,400	2,541,800	2,801,419	2,289,155	50,906	50,764	43,340	143,348	186,688	53,780	6,073	39,632	183	504	3,025	515	-594	-2,855	-8,711	-7,935
2035	1,990,300	561,500	2,551,800	2,825,435	2,316,042	51,415	51,361	43,340	143,672	187,012	54,310	6,134	39,995	184	509	3,055	516	-600	-2,889	-8,799	-8,024
2036	1,995,300	566,600	2,561,900	2,849,450	2,342,930	51,924	51,957	45,030	144,972	190,002	54,850	6,194	40,358	184	514	3,085	524	-605	-2,922	-8,886	-8,106
2037	2,000,200	571,700	2,571,900	2,873,466	2,369,817	52,433	52,553	45,030	146,271	191,301	55,390	6,255	40,721	185	519	3,115	527	-611	-2,956	-8,973	-8,193
2038	2,005,100	576,800	2,581,900	2,897,481	2,396,705	52,942	53,149	45,030	147,571	192,601	55,930	6,316	41,085	186	524	3,146	531	-616	-2,989	-9,060	-8,279
2039	2,010,100	581,900	2,592,000	2,921,497	2,423,592	53,451	53,746	45,030	147,896	192,926	56,460	6,377	41,448	187	529	3,176	532	-622	-3,023	-9,147	-8,369
2040	2,015,000	587,000	2,602,000	2,945,512	2,450,480	53,960	54,342	45,030	149,195	194,225	57,000	6,437	41,811	187	534	3,206	535	-627	-3,056	-9,234	-8,455
2041	2,020,000	592,100	2,612,100	2,969,528	2,477,367	54,469	54,938	45,030	150,495	195,525	57,540	6,498	42,174	188	539	3,236	539	-633	-3,090	-9,321	-8,541
2042	2,024,900	597,200	2,622,100	2,993,543	2,504,255	54,978	55,534	46,720	150,819	197,539	58,080	6,559	42,537	189	544	3,267	545	-638	-3,124	-9,408	-8,626
2043	2,029,800	602,300	2,632,100	3,017,559	2,531,142	55,487	56,131	46,720	152,119	198,839	58,610	6,620	42,900	190	549	3,296	548	-644	-3,157	-9,495	-8,713
2044	2,034,700	607,400	2,642,100	3,041,574	2,558,030	55,996	56,727	46,720	153,418	200,138	59,150	6,680	43,263	190	554	3,327	552	-649	-3,191	-9,583	-8,799
2045	2,039,600	612,500	2,652,100	3,065,590	2,584,917	56,505	57,323	46,720	153,743	200,463	59,690	6,741	43,626	191	559	3,357	553	-654	-3,224	-9,670	-8,888
2046	2,042,900	616,200	2,659,100	3,089,605	2,599,571	56,892	57,648	46,720	154,952	201,672	60,100	6,787	43,889	191	563	3,380	556	-658	-3,242	-9,736	-8,946
2047	2,046,100	619,900	2,666,000	3,113,620	2,614,225	57,278	57,973	46,720	155,187	201,907	60,510	6,833	44,151	192	567	3,403	557	-662	-3,261	-9,802	-9,006
2048	2,049,300	623,500	2,672,800	3,137,636	2,628,879	57,665	58,298	46,720	156,396	203,116	60,910	6,879	44,413	192	571	3,426	560	-666	-3,279	-9,868	-9,064
2049	2,052,600	627,200	2,679,800	3,161,651	2,643,533	58,052	58,623	48,410	156,630	205,040	61,320	6,925	44,675	193	575	3,449	565	-670	-3,297	-9,934	-9,120
2050	2,055,800	630,900	2,686,700	3,185,667	2,658,187	58,439	58,948	48,410	157,840	206,250	61,730	6,972	44,937	193	578	3,472	569	-674	-3,316	-10,001	-9,178
2051	2,059,000	634,600	2,693,600	3,209,682	2,672,841	58,825	59,273	48,410	158,074	206,484	62,140	7,018	45,200	194	582	3,495	569	-678	-3,334	-10,067	-9,238
2052	2,062,200	638,300	2,700,500	3,233,698	2,687,495	59,212	59,596	48,410	159,283	207,693	62,550	7,064	45,462	194	586	3,518	573	-682	-3,352	-10,133	-9,296
2053	2,065,500	641,900	2,707,400	3,257,713	2,702,149	59,599	59,923	48,410	159,518	207,928	62,960	7,110	45,724	195	590	3,541	573	-686	-3,370	-10,199	-9,356
2054	2,068,700	645,600	2,714,300	3,281,729	2,716,803	59,985	60,248	48,410	160,727	209,137	63,370	7,156	45,986	195	594	3,564	577	-690	-3,389	-10,265	-9,414
2055	2,071,900	649,300	2,721,200	3,305,744	2,731,457	60,372	60,573	48,410	160,962	209,372	63,770	7,202	46,248	196	597	3,587	577	-694	-3,407	-10,331	-9,475
2056	2,075,100	653,000	2,728,100	3,329,760	2,746,111	60,759	60,898	48,410	162,171	210,581	64,180	7,248	46,511	196	601	3,610	581	-698	-3,425	-10,398	-9,532
2057	2,078,300	656,700	2,735,000	3,353,775	2,760,765	61,145	61,223	48,410	162,405	210,815	64,590	7,295	46,773	197	605	3,633	581	-702	-3,443	-10,464	-9,593
2058	2,081,500	660,300	2,741,800	3,377,791	2,775,419	61,532	61,548	50,100	163,615	213,715	65,000	7,341	47,035	197	609	3,656	589	-706	-3,462	-10,530	-9,646
2059	2,084,800	664,000	2,748,800	3,401,806	2,790,073	61,919	61,873	53,400	163,849	217,249	65,410	7,387	47,297	198	613	3,679	599	-709	-3,480	-10,596	-9,697
2060	2,088,000	667,700	2,755,700	3,425,822	2,804,727	62,305	62,198	53,400	165,058	218,458	65,820	7,433	47,559	198	617	3,702	602	-713	-3,498	-10,662	-9,755
2061	2,091,200	671,400	2,762,600	3,449,837	2,819,381	62,692	62,523	53,400	165,293	218,693	66,220	7,479	47,822	199	620	3,725	603	-717	-3,517	-10,728	-9,816
2062	2,094,500	675,100	2,769,600	3,473,853	2,834,035	63,079	62,848	53,400	166,502	219,902	66,630	7,525	48,084	199	624	3,748	606	-721	-3,535	-10,795	-9,873
2063	2,097,700	678,800	2,776,500	3,497,868	2,848,689	63,466	63,173	53,400	166,736	220,136	67,040	7,571	48,346	200	628	3,771	607	-725	-3,553	-10,861	-9,934
2064	2,100,900	682,400	2,783,300	3,521,884	2,863,343	63,852	63,497	53,400	167,946	221,346	67,450	7,617	48,608	200	632	3,794	610	-729	-3,571	-10,927	-9,991
2065	2,104,100	686,100	2,790,200	3,545,899	2,877,997	64,239	63,822	53,400	168,180	221,580	67,860	7,664	48,870	201	636	3,817	611	-733	-3,590	-10,993	-10,052
Totals =	100,385,400	29,236,200	129,621,600	147,875,996	119,703,060	2,675,791	2,654,535	2,230,160	7,429,102	9,659,262	2,826,600	319,217	2,082,421	9,333	26,482	158,981	26,627	-31,236	-149,303	-457,905	**-417,021**

Notes:
1. Includes transport of biosolids to land application site plus actual land application.
2. Includes transport of compost product to distribution site for public pickup.
3. Assumes that land applied biosolids are not off-setting commercial fertilizer use.
4. Negative values imply an off-set and are considered as an offset in the analysis.

Capital Regional District - Core Area Wastewater Management Strategy: Program Development Phase, Integrated Resource Management Strategy - Biosolids Management / Organic Residuals Energy and Resource Recovery

File: 20062935.04.E.03.01
Prepared: D. Shiskowski, D. Forgie
Last Revision: November 28, 2008
Last Revision By: D. Shiskowski

Subject: Strategy 1b
Maximum Beneficial Reuse (Biosolids to Cement Kiln; Biomethane)
Discount Rate Base
Life-Cycle Analysis

Yellow-shaded cell denotes assumed/input values
Note: Other coloured cells contain data linked to external spreadsheets

Year	Capital Costs				Operations & Maintenance Costs																		GHG CO2e[4]		Dried WW Biosolids Revenues		Biomethane Revenues		Total	
					Labour				Electricity		Natural Gas		Chemicals			Trucking/Equipment[3]			Maintenance		Administration									
	WW Sludges	SW Organics	Total Cost	Net Present Value	WW Sludges Annual Cost	SW Organics Annual Cost	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	WW Sludges Annual Cost	Total Annual Cost	Net Present Value	WW Sludges[2] Annual Cost	SW Organics[1] Annual Cost	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Rev	Net Present Value	Total Annual Rev	Net Present Value	Total Annual Cost	Net Present Value
2008																														
2009																														
2010																														
2011																														
2012																														
2013																														
2014																														
2015	$105,315,000	$25,600,000	$130,915,000	$99,484,641																									$130,915,000	$99,484,641
2016			$0	$0	$1,050,000	$300,000	$1,350,000	$986,432	$164,605	$120,275	$428,000	$312,735	$459,500	$459,500	$335,752	$292,100	$730,128	$1,022,228	$746,932	$1,309,150	$956,583	$100,000	$73,069	-$85,636	-$62,574	-$133,834	-$97,791	-$372,994	-$272,543	$4,241,019	$3,098,871
2017			$0	$0	$1,050,000	$300,000	$1,350,000	$948,492	$165,361	$116,180	$434,300	$305,133	$466,600	$466,600	$327,827	$292,100	$736,936	$1,029,036	$722,987	$1,309,150	$919,791	$100,000	$70,259	-$87,167	-$61,242	-$135,807	-$95,416	-$380,908	-$267,621	$4,250,565	$2,986,391
2018			$0	$0	$1,050,000	$300,000	$1,350,000	$912,012	$166,110	$112,218	$440,600	$297,654	$473,700	$473,700	$320,015	$292,100	$740,936	$1,033,036	$697,862	$1,309,150	$884,415	$100,000	$67,556	-$88,738	-$59,948	-$137,779	-$93,079	-$388,822	-$262,674	$4,257,257	$2,876,050
2019			$0	$0	$1,050,000	$300,000	$1,350,000	$876,934	$166,859	$108,388	$446,900	$290,298	$479,700	$479,700	$311,604	$297,000	$748,744	$1,045,744	$679,295	$1,309,150	$850,399	$100,000	$64,958	-$90,199	-$58,592	-$139,751	-$90,780	-$396,736	-$257,712	$4,271,666	$2,774,790
2020			$0	$0	$1,050,000	$300,000	$1,350,000	$843,206	$167,615	$104,692	$453,200	$283,067	$486,800	$486,800	$304,054	$297,000	$755,520	$1,052,552	$657,421	$1,309,150	$817,691	$100,000	$62,460	-$91,730	-$57,294	-$141,724	-$88,520	-$404,651	-$252,744	$4,281,213	$2,674,003
2021			$0	$0	$1,050,000	$300,000	$1,350,000	$810,775	$168,364	$101,115	$459,500	$275,864	$493,900	$493,900	$296,624	$297,000	$759,552	$1,056,552	$634,538	$1,309,150	$786,242	$100,000	$60,057	-$93,301	-$56,034	-$143,696	-$86,300	-$412,565	-$247,776	$4,287,904	$2,575,204
2022			$0	$0	$1,050,000	$300,000	$1,350,000	$779,591	$169,113	$97,659	$465,800	$268,988	$500,000	$500,000	$288,738	$297,000	$767,360	$1,064,360	$614,641	$1,309,150	$756,002	$100,000	$57,748	-$94,832	-$54,763	-$145,669	-$84,120	-$420,479	-$242,816	$4,297,444	$2,481,667
2023			$0	$0	$1,050,000	$300,000	$1,350,000	$749,607	$169,862	$94,316	$472,100	$262,140	$507,000	$507,000	$281,519	$297,000	$774,168	$1,071,168	$594,782	$1,309,150	$726,925	$100,000	$55,526	-$96,363	-$53,507	-$147,641	-$81,980	-$428,393	-$237,872	$4,306,883	$2,391,459
2024			$0	$0	$1,050,000	$300,000	$1,350,000	$720,776	$170,616	$91,094	$478,400	$255,422	$514,100	$514,100	$274,482	$301,900	$779,168	$1,081,068	$577,191	$1,309,150	$698,966	$100,000	$53,391	-$97,864	-$52,250	-$149,613	-$79,880	-$436,307	-$232,948	$4,319,551	$2,306,244
2025			$0	$0	$1,050,000	$300,000	$1,350,000	$693,054	$171,367	$87,975	$484,700	$248,832	$520,200	$520,200	$267,057	$301,900	$785,976	$1,087,876	$558,486	$1,309,150	$672,083	$100,000	$51,337	-$99,395	-$51,027	-$151,586	-$77,820	-$444,222	-$228,051	$4,328,091	$2,221,926
2026			$0	$0	$1,050,000	$300,000	$1,350,000	$666,398	$172,116	$84,961	$491,000	$242,371	$527,200	$527,200	$260,241	$301,900	$789,976	$1,091,876	$538,981	$1,309,150	$646,233	$100,000	$49,363	-$100,966	-$49,840	-$153,558	-$75,801	-$452,136	-$223,187	$4,334,682	$2,139,721
2027			$0	$0	$1,050,000	$300,000	$1,350,000	$640,767	$172,865	$82,049	$497,300	$236,040	$534,300	$534,300	$253,601	$301,900	$797,784	$1,099,684	$521,957	$1,309,150	$621,378	$100,000	$47,464	-$102,497	-$48,649	-$155,531	-$73,821	-$460,050	-$218,359	$4,345,222	$2,062,427
2028			$0	$0	$1,050,000	$300,000	$1,350,000	$616,122	$173,614	$79,235	$503,600	$229,836	$541,400	$541,400	$247,088	$301,900	$804,592	$1,106,492	$504,989	$1,309,150	$597,479	$100,000	$45,639	-$104,028	-$47,477	-$157,503	-$71,882	-$467,964	-$213,573	$4,354,761	$1,987,456
2029			$0	$0	$1,050,000	$300,000	$1,350,000	$592,425	$174,377	$76,522	$509,900	$223,761	$547,400	$547,400	$240,218	$301,900	$808,592	$1,110,492	$487,321	$1,309,150	$574,499	$100,000	$43,863	-$105,599	-$46,340	-$159,475	-$69,983	-$475,876	-$208,831	$4,360,367	$1,913,475
2030			$0	$0	$1,050,000	$300,000	$1,350,000	$569,640	$175,119	$73,892	$516,200	$217,813	$554,500	$554,500	$233,874	$308,700	$816,400	$1,123,100	$473,898	$1,309,150	$552,403	$100,000	$42,196	-$107,080	-$45,174	-$161,448	-$68,124	-$483,793	-$204,139	$4,375,769	$1,846,379
2031			$0	$0	$1,050,000	$300,000	$1,350,000	$547,731	$175,819	$71,334	$521,600	$211,627	$560,400	$560,400	$227,369	$306,700	$824,208	$1,130,908	$458,839	$1,309,150	$531,157	$100,000	$40,573	-$108,290	-$43,936	-$163,129	-$66,186	-$489,755	-$198,707	$4,386,702	$1,779,801
2032			$0	$0	$1,050,000	$300,000	$1,350,000	$526,664	$176,526	$68,867	$527,000	$205,594	$566,300	$566,300	$220,926	$363,900	$829,208	$1,193,108	$465,457	$1,309,150	$510,728	$100,000	$39,012	-$109,428	-$42,660	-$164,811	-$64,296	-$495,718	-$193,390	$4,452,127	$1,736,870
2033			$0	$0	$1,050,000	$300,000	$1,350,000	$506,408	$177,226	$66,480	$532,400	$199,712	$571,200	$571,200	$214,267	$363,900	$836,016	$1,199,916	$450,109	$1,309,150	$491,084	$100,000	$37,512	-$110,652	-$41,510	-$168,493	-$62,454	-$501,686	-$188,189	$4,461,060	$1,673,419
2034			$0	$0	$1,050,000	$300,000	$1,350,000	$486,930	$177,926	$64,176	$537,800	$193,979	$577,100	$577,100	$208,154	$363,900	$843,824	$1,207,724	$435,613	$1,309,150	$472,196	$100,000	$36,069	-$111,889	-$40,357	-$168,174	-$60,659	-$507,643	-$183,101	$4,471,994	$1,613,000
2035			$0	$0	$1,050,000	$300,000	$1,350,000	$468,202	$178,626	$61,950	$543,100	$188,356	$583,100	$583,100	$202,229	$363,900	$848,824	$1,212,724	$420,593	$1,309,150	$454,035	$100,000	$34,682	-$113,168	-$39,249	-$169,856	-$58,909	-$513,605	-$178,127	$4,480,070	$1,553,763
2036			$0	$0	$1,050,000	$300,000	$1,350,000	$450,195	$179,333	$59,804	$548,500	$182,912	$589,000	$589,000	$196,418	$368,800	$856,632	$1,225,432	$408,654	$1,309,150	$436,572	$100,000	$33,348	-$114,328	-$38,126	-$171,536	-$57,204	-$519,568	-$173,284	$4,495,981	$1,499,308
2037			$0	$0	$1,050,000	$300,000	$1,350,000	$432,879	$180,033	$57,726	$553,900	$177,609	$594,900	$594,900	$190,756	$368,800	$864,440	$1,233,240	$395,440	$1,309,150	$419,781	$100,000	$32,065	-$115,559	-$37,054	-$173,219	-$55,543	-$525,531	-$168,512	$4,506,914	$1,445,148
2038			$0	$0	$1,050,000	$300,000	$1,350,000	$416,230	$180,733	$55,723	$559,300	$172,443	$600,800	$600,800	$185,238	$368,800	$872,248	$1,241,048	$382,638	$1,309,150	$403,635	$100,000	$30,832	-$116,789	-$36,008	-$174,901	-$53,925	-$531,493	-$163,869	$4,517,848	$1,392,937
2039			$0	$0	$1,050,000	$300,000	$1,350,000	$400,221	$181,440	$53,790	$564,600	$167,381	$606,700	$606,700	$179,862	$368,800	$877,246	$1,246,048	$369,404	$1,309,150	$388,111	$100,000	$29,646	-$118,068	-$35,002	-$176,583	-$52,350	-$537,456	-$159,334	$4,525,831	$1,341,729
2040	$32,595,000		$32,595,000	$9,291,464	$1,050,000	$300,000	$1,350,000	$384,828	$182,140	$51,920	$570,000	$162,483	$611,600	$611,600	$174,341	$368,800	$885,058	$1,253,856	$357,422	$1,635,100	$466,096	$100,000	$28,506	-$119,298	-$34,007	-$178,264	-$50,816	-$543,418	-$154,906	$37,456,715	$10,677,334
2041			$0	$0	$1,050,000	$300,000	$1,350,000	$370,027	$182,847	$50,117	$575,400	$157,714	$617,500	$617,500	$169,253	$368,800	$891,854	$1,260,654	$345,541	$1,635,100	$448,171	$100,000	$27,409	-$120,529	-$33,036	-$179,946	-$49,322	-$549,381	-$150,582	$4,871,655	$1,335,292
2042			$0	$0	$1,050,000	$300,000	$1,350,000	$355,795	$183,547	$48,374	$580,800	$153,071	$623,400	$623,400	$164,298	$373,700	$896,854	$1,270,554	$334,860	$1,635,100	$430,934	$100,000	$26,355	-$121,729	-$32,082	-$181,628	-$47,868	-$555,344	-$146,362	$4,884,710	$1,287,376
2043			$0	$0	$1,050,000	$300,000	$1,350,000	$342,111	$184,247	$46,691	$586,100	$148,527	$629,300	$629,300	$159,474	$373,700	$904,672	$1,278,372	$323,959	$1,635,100	$414,360	$100,000	$25,342	-$122,968	-$31,162	-$183,309	-$46,453	-$561,306	-$142,244	$4,895,535	$1,240,604
2044			$0	$0	$1,050,000	$300,000	$1,350,000	$328,959	$184,947	$45,066	$591,500	$144,130	$635,300	$635,300	$154,803	$373,700	$912,482	$1,286,180	$313,402	$1,635,100	$398,423	$100,000	$24,367	-$124,198	-$30,263	-$184,991	-$45,077	-$567,269	-$138,226	$4,906,569	$1,195,577
2045			$0	$0	$1,050,000	$300,000	$1,350,000	$316,301	$185,647	$43,497	$596,900	$139,852	$641,200	$641,200	$150,231	$373,700	$917,480	$1,291,180	$302,519	$1,635,100	$383,099	$100,000	$23,430	-$125,469	-$29,397	-$186,673	-$43,737	-$573,231	-$134,306	$4,914,654	$1,151,486
2046			$0	$0	$1,050,000	$300,000	$1,350,000	$304,135	$186,137	$41,934	$601,000	$135,397	$644,900	$644,900	$145,287	$373,700	$924,288	$1,297,988	$292,418	$1,635,100	$368,364	$100,000	$22,529	-$126,287	-$28,451	-$187,950	-$42,342	-$576,461	-$129,873	$4,924,407	$1,109,997
2047			$0	$0	$1,050,000	$300,000	$1,350,000	$292,438	$186,620	$40,426	$605,100	$131,077	$649,500	$649,500	$140,695	$373,700	$927,288	$1,300,988	$281,821	$1,635,100	$354,196	$100,000	$21,662	-$127,145	-$27,542	-$189,226	-$40,991	-$579,731	-$125,582	$4,931,205	$1,068,201
2048			$0	$0	$1,050,000	$300,000	$1,350,000	$281,190	$187,096	$38,970	$609,100	$126,869	$654,200	$654,200	$136,263	$373,700	$934,096	$1,307,796	$272,400	$1,635,100	$340,573	$100,000	$20,829	-$127,971	-$26,655	-$190,505	-$39,680	-$582,980	-$121,428	$4,941,635	$1,029,390
2049			$0	$0	$1,050,000	$300,000	$1,350,000	$270,375	$187,586	$37,569	$613,200	$122,810	$658,900	$658,900	$131,963	$378,500	$937,096	$1,315,596	$263,485	$1,635,100	$327,474	$100,000	$20,028	-$128,759	-$25,786	-$191,783	-$38,410	-$586,230	-$117,409	$4,953,610	$992,099
2050			$0	$0	$1,050,000	$300,000	$1,350,000	$259,976	$188,069	$36,217	$617,300	$118,877	$662,600	$662,600	$127,600	$378,500	$943,904	$1,322,404	$254,662	$1,635,100	$314,879	$100,000	$19,257	-$129,577	-$24,953	-$193,060	-$37,179	-$589,480	-$113,519	$4,963,356	$955,816
2051			$0	$0	$1,050,000	$300,000	$1,350,000	$249,977	$188,552	$34,914	$621,400	$115,064	$667,300	$667,300	$123,563	$378,500	$948,904	$1,325,404	$245,423	$1,635,100	$302,769	$100,000	$18,517	-$130,435	-$24,152	-$194,338	-$35,985	-$592,729	-$109,755	$4,970,254	$920,333
2052			$0	$0	$1,050,000	$300,000	$1,350,000	$240,363	$189,035	$33,657	$625,500	$111,368	$672,000	$672,000	$119,647	$378,500	$953,712	$1,332,212	$237,195	$1,635,100	$291,124	$100,000	$17,805	-$131,253	-$23,369	-$195,615	-$34,829	-$595,979	-$106,112	$4,981,000	$886,849
2053			$0	$0	$1,050,000	$300,000	$1,350,000	$231,118	$189,518	$32,445	$629,600	$107,787	$675,700	$675,700	$115,679	$378,500	$956,712	$1,335,212	$228,586	$1,635,100	$279,927	$100,000	$17,120	-$132,111	-$22,617	-$196,893	-$33,708	-$599,229	-$102,587	$4,986,897	$853,749
2054			$0	$0	$1,050,000	$300,000	$1,350,000	$222,229	$190,001	$31,277	$633,700	$104,316	$680,400	$680,400	$112,003	$378,500	$963,520	$1,342,020	$220,915	$1,635,100	$269,160	$100,000	$16,461	-$132,929	-$21,882	-$198,170	-$32,622	-$602,478	-$99,176	$4,997,643	$822,681
2055			$0	$0	$1,050,000	$300,000	$1,350,000	$213,681	$190,484	$30,150	$637,700	$100,937	$685,100	$685,100	$108,439	$378,500	$966,520	$1,345,020	$212,893	$1,635,100	$258,808	$100,000	$15,828	-$133,786	-$21,178	-$199,448	-$31,569	-$605,728	-$95,976	$5,004,433	$792,114
2056			$0	$0	$1,050,000	$300,000	$1,350,000	$205,463	$190,967	$29,064	$641,800	$97,679	$688,800	$688,800	$104,832	$378,500	$973,328	$1,351,828	$205,741	$1,635,100	$248,854	$100,000	$15,219	-$134,614	-$20,487	-$200,725	-$30,549	-$608,978	-$92,683	$5,014,179	$763,132
2057			$0	$0	$1,050,000	$300,000	$1,350,000	$197,561	$191,450	$28,017	$645,900	$94,522	$693,500	$693,500	$101,468	$378,500	$976,328	$1,354,828	$198,267	$1,635,100	$239,282	$100,000	$14,634	-$135,472	-$19,825	-$202,003	-$29,561	-$612,227	-$89,594	$5,021,076	$734,790
2058			$0	$0	$1,050,000	$300,000	$1,350,000	$189,982	$191,926	$27,006	$650,000	$91,463	$698,200	$698,200	$98,246	$383,400	$983,138	$1,366,538	$192,289	$1,635,100	$230,079	$100,000	$14,071	-$136,220	-$19,166	-$203,280	-$28,604	-$615,477	-$86,605	$5,036,785	$708,739
2059			$0	$0	$1,050,000	$300,000	$1,350,000	$182,656	$192,416	$26,034	$654,100	$88,500	$701,900	$701,900	$94,967	$440,600	$998,136	$1,426,736	$193,038	$1,635,100	$221,230	$100,000	$13,530	-$136,941	-$18,526	-$204,556	-$27,677	-$618,727	-$83,714	$5,100,027	$690,037
2060			$0	$0	$1,050,000	$300,000	$1,350,000	$175,631	$192,899	$25,096	$658,200	$85,630	$706,500	$706,500	$91,913	$440,600	$992,944	$1,433,544	$186,499	$1,635,100	$212,721	$100,000	$13,010	-$137,759	-$17,922	-$205,835	-$26,776	-$621,976	-$80,917	$5,110,673	$664,882
2061			$0	$0	$1,050,000	$300,000	$1,350,000	$168,875	$193,382	$24,191	$662,200	$82,837	$711,200	$711,200	$88,966	$440,600	$997,944	$1,438,544	$179,702	$1,635,100	$204,540	$100,000	$12,509	-$138,626	-$17,341	-$207,113	-$25,906	-$625,226	-$78,211	$5,117,462	$640,159
2062			$0	$0	$1,050,000	$300,000	$1,350,000	$162,380	$193,872	$23,319	$666,300	$80,144	$715,900	$715,900	$86,110	$440,600	$1,002,752	$1,443,352	$173,609	$1,635,100	$196,673	$100,000	$12,028	-$139,443	-$16,772	-$208,390	-$25,066	-$628,476	-$75,594	$5,128,215	$616,831
2063			$0	$0	$1,050,000	$300,000	$1,350,000	$156,135	$194,355	$22,478	$670,400	$77,535	$719,600	$719,600	$83,226	$440,600	$1,005,752	$1,446,352	$167,279	$1,635,100	$189,108	$100,000	$11,566	-$140,301	-$16,227	-$209,668	-$24,249	-$631,725	-$73,063	$5,134,113	$593,788
2064			$0	$0	$1,050,000	$300,000	$1,350,000	$150,130	$194,831	$21,667	$674,500	$75,009	$724,300	$724,300	$80,547	$440,600	$1,012,560	$1,453,160	$161,602	$1,635,100	$181,835	$100,000	$11,121	-$141,119	-$15,693	-$210,945	-$23,459	-$634,975	-$70,614	$5,144,852	$572,145
2065			$0	$0	$1,050,000	$300,000	$1,350,000	$144,356	$195,314	$20,895	$678,600	$72,563	$729,000	$729,000	$77,952	$440,600	$1,015,560	$1,456,160	$155,707	$1,635,100	$174,841	$100,000	$10,693	-$141,978	-$15,182	-$212,223	-$22,693	-$638,225	-$68,245	$5,151,749	$550,877
Total Capital =	$137,910,000	$25,600,000	$163,510,000																											
Total Net Present Value =				$108,776,104				$22,038,338		$2,881,410		$8,575,826			$9,209,798			$19,099,280		$22,915,909		$1,632,469		-$1,772,325		-$2,681,955		-$7,964,522		**$182,710,332**

Notes:
1. Includes transport of compost product to distribution site for pickup by public.
3. Includes **diesel fuel**, driver, maintenance costs.
4. Excludes CO2e off-sets of commerical fertilizers by non-CRD end users (i.e. assumes that the CRD would not be able to sell these "credits"). Includes CO2 off-sets from sale of biomethane and dried WW sludges.

Capital Regional District - Core Area Wastewater Management Strategy: Program Development Phase, Integrated Resource Management Strategy - Biosolids Management / Organic Residuals Energy and Resource Recovery

File: 20062935.04.E.03.01
Prepared: D. Shiskowski, D. Forgie
Last Revision: November 28, 2008
Last Revision By: D. Shiskowski

Subject: Strategy 1c
Maximum Beneficial Reuse (Biosolids to Land Application; Biomethane)
Material Flows
and GHG Emissions

Note: Coloured cells contain data linked to external spreadsheets

Year	Materials											GHG Sources			GHG Offsets		Total GHG Emissions
	Electricity			Biogas (WW Sludges)			Biomethane (WW Sludges)	Diesel Fuel			Land Applied SW Organics	Electricity Purchased	Biogas Lost	Diesel Fuel Combusted	Avoided Commercial Fertilizer Use via SW Compost3	Avoided Natural Gas Use via Biomethane	
	WW Sludges (kWh/yr)	SW Organics (kWh/yr)	Total (kWh/yr)	Boiler (m3/yr)	for Biomethane (m3/yr)	System Loss (m3/yr)	Available for Sale (GJ/yr)	WW Sludges[1] (L/yr)	SW Organics[2] (L/yr)	Total (L/yr)	Done (wet t/yr)	(t CO2e/yr)	(t CO2e/yr)	(t CO2e/yr)	(t CO2e/yr)	(t CO2e/yr)	(t CO2e/yr)
2008																	
2009																	
2010																	
2011																	
2012																	
2013																	
2014																	
2015																	
2016	1,135,200	472,100	1,607,300	2,369,141	1,681,970	40,511	37,299	93,910	126,282	220,192	33,629	116	401	607	-504	-2,098	-1,479
2017	1,141,400	476,700	1,618,100	2,393,156	1,717,658	41,108	38,091	94,170	127,548	221,718	33,954	117	407	611	-509	-2,142	-1,517
2018	1,147,500	481,300	1,628,800	2,417,172	1,753,346	41,705	38,882	94,430	127,838	222,268	34,279	117	413	613	-514	-2,187	-1,558
2019	1,153,700	485,800	1,639,500	2,441,187	1,789,035	42,302	39,674	100,550	129,104	229,654	34,604	118	419	633	-519	-2,231	-1,581
2020	1,159,900	490,400	1,650,300	2,465,203	1,824,723	42,899	40,465	100,810	130,369	231,179	34,929	119	425	637	-524	-2,276	-1,619
2021	1,166,000	495,000	1,661,000	2,489,218	1,860,411	43,496	41,256	101,070	130,660	231,730	35,254	120	430	639	-529	-2,320	-1,660
2022	1,172,200	499,500	1,671,700	2,513,234	1,896,099	44,093	42,048	101,340	131,925	233,265	35,579	120	436	643	-534	-2,365	-1,699
2023	1,178,300	504,100	1,682,400	2,537,249	1,931,787	44,690	42,839	101,600	133,191	234,791	35,904	121	442	647	-539	-2,409	-1,737
2024	1,184,500	508,700	1,693,200	2,561,265	1,967,475	45,287	43,631	107,710	133,481	241,191	36,229	122	448	665	-543	-2,454	-1,762
2025	1,190,700	513,200	1,703,900	2,585,280	2,003,164	45,884	44,422	107,980	134,747	242,727	36,554	123	454	669	-548	-2,499	-1,801
2026	1,196,800	517,800	1,714,600	2,609,296	2,038,852	46,481	45,214	108,240	135,037	243,277	36,879	123	460	671	-553	-2,543	-1,842
2027	1,203,000	522,300	1,725,300	2,633,311	2,074,540	47,079	46,005	108,500	136,303	244,803	37,204	124	466	675	-558	-2,588	-1,881
2028	1,209,100	526,900	1,736,000	2,657,327	2,110,228	47,676	46,796	108,770	137,568	246,338	37,529	125	472	679	-563	-2,632	-1,919
2029	1,215,400	531,500	1,746,900	2,681,342	2,145,916	48,273	47,588	109,030	137,859	246,889	37,854	126	478	681	-568	-2,677	-1,960
2030	1,221,500	536,000	1,757,500	2,705,357	2,181,604	48,870	48,379	115,140	139,124	254,264	38,179	127	484	701	-573	-2,721	-1,983
2031	1,226,400	541,100	1,767,500	2,729,373	2,208,492	49,379	48,976	115,370	140,424	255,794	38,543	127	489	705	-578	-2,755	-2,012
2032	1,231,400	546,200	1,777,600	2,753,388	2,235,379	49,888	49,572	115,590	140,749	256,339	38,906	128	494	707	-584	-2,788	-2,043
2033	1,236,300	551,300	1,787,600	2,777,404	2,262,267	50,397	50,168	115,810	142,048	257,858	39,269	129	499	711	-589	-2,822	-2,072
2034	1,241,200	556,400	1,797,600	2,801,419	2,289,155	50,906	50,764	116,040	143,348	259,388	39,632	129	504	715	-594	-2,855	-2,101
2035	1,246,100	561,500	1,807,600	2,825,435	2,316,042	51,415	51,361	116,260	143,672	259,932	39,995	130	509	717	-600	-2,889	-2,133
2036	1,251,100	566,600	1,817,700	2,849,450	2,342,930	51,924	51,957	122,340	144,972	267,312	40,358	131	514	737	-605	-2,922	-2,146
2037	1,256,000	571,700	1,827,700	2,873,466	2,369,817	52,433	52,553	122,560	146,271	268,831	40,721	132	519	741	-611	-2,956	-2,175
2038	1,260,900	576,800	1,837,700	2,897,481	2,396,705	52,942	53,149	122,790	147,571	270,361	41,085	132	524	745	-616	-2,989	-2,204
2039	1,265,900	581,900	1,847,800	2,921,497	2,423,592	53,451	53,746	123,010	147,896	270,906	41,448	133	529	747	-622	-3,023	-2,236
2040	1,270,800	587,000	1,857,800	2,945,512	2,450,480	53,960	54,342	123,230	149,195	272,425	41,811	134	534	751	-627	-3,056	-2,265
2041	1,275,800	592,100	1,867,900	2,969,528	2,477,367	54,469	54,938	123,460	150,495	273,955	42,174	134	539	755	-633	-3,090	-2,294
2042	1,280,700	597,200	1,877,900	2,993,543	2,504,255	54,978	55,534	129,530	150,819	280,349	42,537	135	544	773	-638	-3,124	-2,309
2043	1,285,600	602,300	1,887,900	3,017,559	2,531,142	55,487	56,131	129,760	152,119	281,879	42,900	136	549	777	-644	-3,157	-2,338
2044	1,290,500	607,400	1,897,900	3,041,574	2,558,030	55,996	56,727	129,980	153,418	283,398	43,263	137	554	781	-649	-3,191	-2,367
2045	1,295,400	612,500	1,907,900	3,065,590	2,584,917	56,505	57,323	130,210	153,743	283,953	43,626	137	559	783	-654	-3,224	-2,399
2046	1,298,700	616,200	1,914,900	3,089,605	2,599,571	56,892	57,648	130,380	154,952	285,332	43,889	138	563	787	-658	-3,242	-2,413
2047	1,301,900	619,900	1,921,800	3,113,620	2,614,225	57,278	57,973	130,550	155,187	285,737	44,151	138	567	788	-662	-3,261	-2,430
2048	1,305,100	623,500	1,928,600	3,137,636	2,628,879	57,665	58,298	130,720	156,396	287,116	44,413	139	571	791	-666	-3,279	-2,444
2049	1,308,400	627,200	1,935,600	3,161,651	2,643,533	58,052	58,623	136,740	156,630	293,370	44,675	139	575	809	-670	-3,297	-2,445
2050	1,311,600	630,900	1,942,500	3,185,667	2,658,187	58,439	58,948	136,910	157,840	294,750	44,937	140	578	813	-674	-3,316	-2,459
2051	1,314,800	634,600	1,949,400	3,209,682	2,672,841	58,825	59,273	137,080	158,074	295,154	45,200	140	582	814	-678	-3,334	-2,476
2052	1,318,000	638,300	1,956,300	3,233,698	2,687,495	59,212	59,598	137,250	159,283	296,533	45,462	141	586	817	-682	-3,352	-2,490
2053	1,321,300	641,900	1,963,200	3,257,713	2,702,149	59,599	59,923	137,420	159,518	296,938	45,724	141	590	819	-686	-3,370	-2,506
2054	1,324,500	645,600	1,970,100	3,281,729	2,716,803	59,985	60,248	137,590	160,727	298,317	45,986	142	594	822	-690	-3,389	-2,521
2055	1,327,700	649,300	1,977,000	3,305,744	2,731,457	60,372	60,573	137,760	160,962	298,722	46,248	142	597	823	-694	-3,407	-2,537
2056	1,330,900	653,000	1,983,900	3,329,760	2,746,111	60,759	60,898	137,930	162,171	300,101	46,511	143	601	827	-698	-3,425	-2,551
2057	1,334,100	656,700	1,990,800	3,353,775	2,760,765	61,145	61,223	138,100	162,405	300,505	46,773	143	605	828	-702	-3,443	-2,568
2058	1,337,300	660,300	1,997,600	3,377,791	2,775,419	61,532	61,548	144,120	163,615	307,735	47,035	144	609	848	-706	-3,462	-2,566
2059	1,340,600	664,000	2,004,600	3,401,806	2,790,073	61,919	61,873	144,290	163,849	308,139	47,297	144	613	849	-709	-3,480	-2,583
2060	1,343,800	667,700	2,011,500	3,425,822	2,804,727	62,305	62,198	144,460	165,058	309,518	47,559	145	617	853	-713	-3,498	-2,597
2061	1,347,000	671,400	2,018,400	3,449,837	2,819,381	62,692	62,523	144,630	165,293	309,923	47,822	145	620	854	-717	-3,517	-2,614
2062	1,350,300	675,100	2,025,400	3,473,853	2,834,035	63,079	62,848	144,800	166,502	311,302	48,084	146	624	858	-721	-3,535	-2,628
2063	1,353,500	678,800	2,032,300	3,497,868	2,848,689	63,466	63,173	144,970	166,736	311,706	48,346	146	628	859	-725	-3,553	-2,645
2064	1,356,700	682,400	2,039,100	3,521,884	2,863,343	63,852	63,497	145,140	167,946	313,086	48,608	147	632	863	-729	-3,571	-2,659
2065	1,359,900	686,100	2,046,000	3,545,899	2,877,997	64,239	63,822	145,310	168,180	313,490	48,870	147	636	864	-733	-3,590	-2,675
Totals =	63,175,400	29,236,200	92,411,600	147,875,996	119,703,060	2,675,791	2,654,535	6,175,340	7,429,102	13,604,442	2,082,421	6,654	26,482	37,503	-31,236	-149,303	**-109,901**

Notes:
1. Includes transport of biosolids to land application site plus actual land application.
2. Includes transport of compost product to distribution site for public pickup.
3. Assumes that land applied biosolids are not off-setting commercial fertilizer use.

Capital Regional District - Core Area Wastewater Management Strategy: Program Development Phase, Integrated Resource Management Strategy - Biosolids Management / Organic Residuals Energy and Resource Recovery

File: 20062935.04.E.03.01
Prepared: D. Shiskowski, D. Forgie
Last Revision: November 28, 2008
Last Revision By: D. Shiskowski

Subject: Strategy 1c
Maximum Beneficial Reuse (Biosolids to Land Application; Biomethane)
Discount Rate Base
Life-Cycle Analysis

Yellow-shaded cell denotes assumed/input values
Note: Other coloured cells contain data linked to external spreadsheets

Year	Capital Costs				Operations & Maintenance Costs																GHG CO_2e[4]		Biomethane Revenues		Total	
					Labour				Electricity		Chemicals			Trucking/Equipment[3]			Maintenance		Administration							
	WW Sludges	SW Organics	Total Cost	Net Present Value	WW Sludges Annual Cost	SW Organics Annual Cost	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	WW Sludges Annual Cost	Total Annual Cost	Net Present Value	WW Sludges[2] Annual Cost	SW Organics[1] Annual Cost	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Rev	Net Present Value	Total Annual Cost	Net Present Value
2008																										
2009																										
2010																										
2011																										
2012																										
2013																										
2014																										
2015	$80,430,000	$25,600,000	$106,030,000	$80,574,086																					$106,030,000	$80,574,086
2016			$0	$0	$600,000	$300,000	$900,000	$657,621	$112,511	$82,211	$387,000	$387,000	$282,777	$611,100	$730,128	$1,341,228	$980,022	$1,060,300	$774,751	$100,000	$73,069	-$16,127	-$11,784	-$372,994	-$272,543	$3,511,919	$2,566,124
2017			$0	$0	$600,000	$300,000	$900,000	$632,328	$113,267	$79,580	$393,000	$393,000	$276,117	$617,100	$736,936	$1,354,036	$951,328	$1,060,300	$744,953	$100,000	$70,259	-$16,646	-$11,695	-$380,908	-$267,621	$3,523,049	$2,475,248
2018			$0	$0	$600,000	$300,000	$900,000	$608,008	$114,016	$77,025	$399,000	$399,000	$269,550	$623,100	$740,936	$1,364,036	$921,494	$1,060,300	$716,301	$100,000	$67,556	-$17,205	-$11,623	-$388,822	-$262,674	$3,531,325	$2,385,637
2019			$0	$0	$600,000	$300,000	$900,000	$584,623	$114,765	$74,549	$404,000	$404,000	$262,431	$645,900	$748,744	$1,394,644	$905,934	$1,060,300	$688,751	$100,000	$64,958	-$17,492	-$11,356	-$396,736	-$257,712	$3,559,491	$2,312,177
2020			$0	$0	$600,000	$300,000	$900,000	$562,137	$115,521	$72,154	$410,000	$410,000	$256,085	$650,900	$755,552	$1,406,452	$878,466	$1,060,300	$662,260	$100,000	$62,460	-$18,001	-$11,243	-$404,651	-$252,744	$3,569,622	$2,229,575
2021			$0	$0	$600,000	$300,000	$900,000	$540,517	$116,270	$69,829	$416,000	$416,000	$249,839	$656,900	$759,552	$1,416,452	$850,684	$1,060,300	$636,789	$100,000	$60,057	-$18,560	-$11,147	-$412,565	-$247,776	$3,577,897	$2,148,792
2022			$0	$0	$600,000	$300,000	$900,000	$519,728	$117,019	$67,576	$421,000	$421,000	$243,117	$662,900	$767,360	$1,430,260	$825,940	$1,060,300	$612,297	$100,000	$57,748	-$19,079	-$11,016	-$420,479	-$242,816	$3,589,021	$2,072,570
2023			$0	$0	$600,000	$300,000	$900,000	$499,738	$117,768	$65,392	$427,000	$427,000	$237,098	$668,900	$774,168	$1,443,068	$801,284	$1,060,300	$588,747	$100,000	$55,526	-$19,598	-$10,882	-$428,393	-$237,872	$3,600,145	$1,999,033
2024			$0	$0	$600,000	$300,000	$900,000	$480,517	$118,524	$63,281	$433,000	$433,000	$231,182	$690,800	$779,168	$1,469,968	$784,828	$1,060,300	$566,103	$100,000	$53,391	-$19,915	-$10,633	-$436,307	-$232,948	$3,625,569	$1,935,721
2025			$0	$0	$600,000	$300,000	$900,000	$462,036	$119,273	$61,232	$438,000	$438,000	$224,857	$699,800	$785,976	$1,482,776	$761,218	$1,060,300	$544,330	$100,000	$51,337	-$20,434	-$10,490	-$444,222	-$228,051	$3,635,694	$1,866,468
2026			$0	$0	$600,000	$300,000	$900,000	$444,265	$120,022	$59,246	$444,000	$444,000	$219,171	$702,800	$789,976	$1,492,776	$736,876	$1,060,300	$523,394	$100,000	$49,363	-$20,993	-$10,363	-$452,136	-$223,187	$3,643,969	$1,798,766
2027			$0	$0	$600,000	$300,000	$900,000	$427,176	$120,771	$57,323	$450,000	$450,000	$213,589	$708,800	$797,784	$1,506,584	$715,089	$1,060,300	$503,263	$100,000	$47,464	-$21,512	-$10,211	-$460,050	-$218,359	$3,656,093	$1,735,337
2028			$0	$0	$600,000	$300,000	$900,000	$410,746	$121,520	$55,460	$456,000	$456,000	$208,112	$714,800	$804,592	$1,519,392	$693,431	$1,060,300	$483,907	$100,000	$45,639	-$22,031	-$10,055	-$467,964	-$213,573	$3,667,217	$1,673,670
2029			$0	$0	$600,000	$300,000	$900,000	$394,950	$122,283	$53,662	$461,000	$461,000	$202,302	$719,800	$808,592	$1,528,392	$670,710	$1,060,300	$465,295	$100,000	$43,883	-$22,590	-$9,913	-$475,878	-$208,831	$3,673,507	$1,612,058
2030			$0	$0	$600,000	$300,000	$900,000	$379,760	$123,025	$51,911	$467,000	$467,000	$197,053	$742,600	$816,400	$1,559,000	$657,828	$1,060,300	$447,399	$100,000	$42,196	-$22,867	-$9,649	-$483,793	-$204,139	$3,702,665	$1,562,359
2031			$0	$0	$600,000	$300,000	$900,000	$365,154	$123,725	$50,196	$472,000	$472,000	$191,503	$747,600	$824,208	$1,571,808	$637,724	$1,060,300	$430,192	$100,000	$40,573	-$23,237	-$9,428	-$489,755	-$198,707	$3,714,841	$1,507,209
2032			$0	$0	$600,000	$300,000	$900,000	$351,109	$124,432	$48,544	$477,000	$477,000	$186,088	$752,600	$829,208	$1,581,808	$617,097	$1,060,300	$413,646	$100,000	$39,012	-$23,648	-$9,225	-$495,718	-$193,390	$3,724,175	$1,452,881
2033			$0	$0	$600,000	$300,000	$900,000	$337,605	$125,132	$46,939	$481,000	$481,000	$180,431	$757,600	$836,016	$1,593,616	$597,792	$1,060,300	$397,736	$100,000	$37,512	-$24,018	-$9,009	-$501,680	-$186,189	$3,734,350	$1,400,817
2034			$0	$0	$600,000	$300,000	$900,000	$324,620	$125,832	$45,386	$486,000	$486,000	$175,295	$762,600	$843,824	$1,606,424	$579,420	$1,060,300	$382,439	$100,000	$36,069	-$24,387	-$8,796	-$507,643	-$183,101	$3,746,526	$1,351,331
2035			$0	$0	$600,000	$300,000	$900,000	$312,135	$126,532	$43,883	$491,000	$491,000	$170,287	$767,600	$848,824	$1,616,424	$560,903	$1,060,300	$367,730	$100,000	$34,682	-$24,798	-$8,600	-$513,605	-$178,127	$3,755,853	$1,302,592
2036			$0	$0	$600,000	$300,000	$900,000	$300,130	$127,239	$42,431	$496,000	$496,000	$165,405	$789,500	$856,632	$1,646,132	$548,948	$1,060,300	$353,586	$100,000	$33,348	-$24,926	-$8,312	-$519,568	-$173,264	$3,785,177	$1,262,271
2037			$0	$0	$600,000	$300,000	$900,000	$288,586	$127,939	$41,024	$501,000	$501,000	$160,646	$794,500	$864,440	$1,658,940	$531,941	$1,060,300	$339,987	$100,000	$32,065	-$25,296	-$8,111	-$525,531	-$168,512	$3,797,352	$1,217,626
2038			$0	$0	$600,000	$300,000	$900,000	$277,487	$128,639	$39,662	$506,000	$506,000	$156,009	$798,500	$872,248	$1,670,748	$515,123	$1,060,300	$326,910	$100,000	$30,832	-$25,666	-$7,913	-$531,493	-$163,869	$3,808,528	$1,174,240
2039			$0	$0	$600,000	$300,000	$900,000	$266,814	$129,346	$38,346	$511,000	$511,000	$151,491	$803,500	$877,248	$1,680,748	$498,275	$1,060,300	$314,337	$100,000	$29,646	-$26,076	-$7,731	-$537,456	-$159,334	$3,817,862	$1,131,844
2040	$1,785,000		$1,785,000	$508,828	$600,000	$300,000	$900,000	$256,552	$130,046	$37,071	$515,000	$515,000	$146,805	$808,500	$885,056	$1,693,556	$482,762	$1,078,150	$307,335	$100,000	$28,506	-$26,446	-$7,539	-$543,418	-$154,906	$5,631,887	$1,605,414
2041			$0	$0	$600,000	$300,000	$900,000	$246,685	$130,753	$35,839	$520,000	$520,000	$142,529	$813,500	$891,864	$1,705,364	$467,430	$1,078,150	$295,515	$100,000	$27,409	-$26,816	-$7,350	-$549,381	-$150,582	$3,858,070	$1,057,475
2042			$0	$0	$600,000	$300,000	$900,000	$237,197	$131,453	$34,645	$525,000	$525,000	$138,365	$835,300	$896,864	$1,732,164	$456,515	$1,078,150	$284,149	$100,000	$26,355	-$26,985	-$7,112	-$555,344	-$146,362	$3,884,439	$1,023,752
2043			$0	$0	$600,000	$300,000	$900,000	$228,074	$132,153	$33,490	$530,000	$530,000	$134,310	$840,300	$904,672	$1,744,972	$442,203	$1,078,150	$273,220	$100,000	$25,342	-$27,354	-$6,932	-$561,306	-$142,244	$3,896,615	$987,462
2044			$0	$0	$600,000	$300,000	$900,000	$219,302	$132,853	$32,372	$535,000	$535,000	$130,363	$845,300	$912,480	$1,757,780	$428,316	$1,078,150	$262,711	$100,000	$24,367	-$27,724	-$6,756	-$567,269	-$138,226	$3,908,790	$952,450
2045			$0	$0	$600,000	$300,000	$900,000	$210,867	$133,553	$31,291	$540,000	$540,000	$126,520	$850,300	$917,480	$1,767,780	$414,185	$1,078,150	$252,607	$100,000	$23,430	-$28,135	-$6,592	-$573,231	-$134,306	$3,918,117	$918,003
2046			$0	$0	$600,000	$300,000	$900,000	$202,757	$134,043	$30,198	$543,000	$543,000	$122,330	$854,300	$924,288	$1,778,588	$400,690	$1,078,150	$242,891	$100,000	$22,529	-$28,299	-$6,375	-$576,481	-$129,873	$3,929,002	$885,147
2047			$0	$0	$600,000	$300,000	$900,000	$194,959	$134,526	$29,141	$547,000	$547,000	$118,491	$857,300	$927,288	$1,784,588	$386,579	$1,078,150	$233,550	$100,000	$21,662	-$28,503	-$6,174	-$579,731	-$125,582	$3,936,030	$852,625
2048			$0	$0	$600,000	$300,000	$900,000	$187,460	$135,002	$28,119	$551,000	$551,000	$114,767	$861,300	$934,096	$1,795,396	$373,961	$1,078,150	$224,567	$100,000	$20,829	-$28,667	-$5,971	-$582,980	-$121,428	$3,947,901	$822,304
2049			$0	$0	$600,000	$300,000	$900,000	$180,250	$135,492	$27,136	$555,000	$555,000	$111,154	$882,200	$937,096	$1,819,296	$364,365	$1,078,150	$215,930	$100,000	$20,028	-$28,629	-$5,734	-$586,230	-$117,409	$3,973,079	$795,720
2050			$0	$0	$600,000	$300,000	$900,000	$173,317	$135,975	$26,185	$558,000	$558,000	$107,457	$886,200	$943,904	$1,830,104	$352,432	$1,078,150	$207,625	$100,000	$19,257	-$28,794	-$5,545	-$589,480	-$113,519	$3,983,956	$767,210
2051			$0	$0	$600,000	$300,000	$900,000	$166,651	$136,458	$25,266	$562,000	$562,000	$104,065	$889,200	$948,904	$1,836,104	$339,988	$1,078,150	$199,639	$100,000	$18,517	-$28,998	-$5,369	-$592,729	-$109,755	$3,990,985	$739,003
2052			$0	$0	$600,000	$300,000	$900,000	$160,242	$136,941	$24,382	$566,000	$566,000	$100,774	$893,200	$953,712	$1,846,912	$328,836	$1,078,150	$191,961	$100,000	$17,805	-$29,162	-$5,192	-$595,979	-$106,112	$4,002,862	$712,695
2053			$0	$0	$600,000	$300,000	$900,000	$154,079	$137,424	$23,527	$569,000	$569,000	$97,412	$897,200	$956,712	$1,853,912	$317,387	$1,078,150	$184,578	$100,000	$17,120	-$29,366	-$5,027	-$599,229	-$102,587	$4,009,891	$686,487
2054			$0	$0	$600,000	$300,000	$900,000	$148,152	$137,907	$22,701	$573,000	$573,000	$94,324	$901,200	$963,520	$1,864,720	$306,959	$1,078,150	$177,478	$100,000	$16,461	-$29,530	-$4,861	-$602,478	-$99,176	$4,021,768	$662,039
2055			$0	$0	$600,000	$300,000	$900,000	$142,454	$138,390	$21,905	$577,000	$577,000	$91,329	$904,200	$966,520	$1,870,720	$296,102	$1,078,150	$170,652	$100,000	$15,828	-$29,735	-$4,707	-$605,728	-$95,876	$4,028,797	$637,688
2056			$0	$0	$600,000	$300,000	$900,000	$136,975	$138,873	$21,136	$580,000	$580,000	$88,273	$908,200	$973,328	$1,881,528	$286,359	$1,078,150	$164,089	$100,000	$15,219	-$29,899	-$4,550	-$608,978	-$92,683	$4,039,675	$614,817
2057			$0	$0	$600,000	$300,000	$900,000	$131,707	$139,356	$20,394	$584,000	$584,000	$85,463	$912,200	$976,328	$1,888,528	$276,369	$1,078,150	$157,776	$100,000	$14,634	-$30,103	-$4,405	-$612,227	-$89,594	$4,047,703	$592,345
2058			$0	$0	$600,000	$300,000	$900,000	$126,641	$139,832	$19,676	$588,000	$588,000	$82,739	$933,000	$983,136	$1,916,136	$269,625	$1,078,150	$151,709	$100,000	$14,071	-$30,026	-$4,225	-$615,477	-$86,605	$4,076,616	$573,631
2059			$0	$0	$600,000	$300,000	$900,000	$121,771	$140,322	$18,986	$591,000	$591,000	$79,963	$936,000	$986,136	$1,922,136	$260,066	$1,078,150	$145,874	$100,000	$13,530	-$30,230	-$4,090	-$618,727	-$83,714	$4,082,652	$552,385
2060			$0	$0	$600,000	$300,000	$900,000	$117,087	$140,805	$18,318	$595,000	$595,000	$77,408	$940,000	$992,944	$1,932,944	$251,470	$1,078,150	$140,264	$100,000	$13,010	-$30,394	-$3,954	-$621,976	-$80,917	$4,094,529	$532,685
2061			$0	$0	$600,000	$300,000	$900,000	$112,584	$141,288	$17,674	$599,000	$599,000	$74,931	$944,000	$995,944	$1,939,944	$242,673	$1,078,150	$134,869	$100,000	$12,509	-$30,598	-$3,828	-$625,226	-$78,211	$4,102,558	$513,201
2062			$0	$0	$600,000	$300,000	$900,000	$108,254	$141,778	$17,053	$603,000	$603,000	$72,590	$948,000	$1,002,752	$1,950,752	$234,640	$1,078,150	$129,682	$100,000	$12,028	-$30,762	-$3,700	-$628,476	-$75,594	$4,114,442	$494,892
2063			$0	$0	$600,000	$300,000	$900,000	$104,090	$142,261	$16,453	$606,000	$606,000	$70,087	$951,000	$1,005,752	$1,956,752	$226,309	$1,078,150	$124,694	$100,000	$11,566	-$30,967	-$3,581	-$631,725	-$73,063	$4,120,471	$476,555
2064			$0	$0	$600,000	$300,000	$900,000	$100,087	$142,737	$15,879	$610,000	$610,000	$67,836	$955,000	$1,012,560	$1,967,560	$218,807	$1,078,150	$119,898	$100,000	$11,121	-$31,131	-$3,462	-$634,975	-$70,614	$4,132,341	$459,546
2065			$0	$0	$600,000	$300,000	$900,000	$96,237	$143,220	$15,315	$614,000	$614,000	$65,655	$959,000	$1,015,560	$1,974,560	$211,140	$1,078,150	$115,287	$100,000	$10,693	-$31,335	-$3,351	-$638,225	-$68,245	$4,140,370	$442,730
Total Capital =	$82,215,000	$25,600,000	$107,815,000																							
Total Net Present Value =				$81,082,914				$14,692,225		$2,030,991			$7,756,316			$25,858,222		$17,393,652		$1,632,469		-$375,570		-$7,964,522		**$142,106,697**

Notes:
1. Includes transport of compost product to distribution site for pickup by public.
3. Includes **diesel fuel,** driver, maintenance costs.
4. Excludes CO_2e off-sets of commerical fertilizers by non-CRD end users (i.e. assumes that the CRD would not be able to sell these "credits"). Includes CO_2 off-sets from sale of biomethane.

Capital Regional District - Core Area Wastewater Management Strategy: Program Development Phase, Integrated Resource Management Strategy - Biosolids Management / Organic Residuals Energy and Resource Recovery

File: 20062935.04.E.03.01
Prepared: D. Shiskowski, D. Forgie
Last Revision: January 27, 2009
Last Revision By: D. Shiskowski

Subject: Strategy 1d
Maximum Beneficial Reuse (50% Biosolids to Cement Kiln; 50% to "Industrial" Land Applicaiton; Biomethane)
Material Flows
and GHG Emissions

Note: Coloured cells contain data linked to external spreadsheets

Year	Materials														GHG Sources				GHG Offsets			Total GHG Emissions
	Electricity			Biogas (WW Sludges)			Biomethane (WW Sludges)	Diesel Fuel			Willow Coppice	Natural Gas	Dried WW Biosolids	Land Applied SW Organics	Electricity Purchased[4]	Biogas Lost	Natural Gas Combusted	Diesel Fuel Combusted	Avoided Commercial Fertilizer Use via SW Compost3	Avoided Natural Gas Use via Biomethane	Avoided Coal Use via Dried WW Biosolids	
	WW Sludges (kWh/yr)	SW Organics (kWh/yr)	Total (kWh/yr)	Boiler (m3/yr)	for Biomethane (m3/yr)	System Loss (m3/yr)	Available for Sale (GJ/yr)	WW Sludges[1] (L/yr)	SW Organics[2] (L/yr)	Total (L/yr)	(odt/yr)	WW Sludges (GJ/yr)	(dry t/yr)	(wet t/yr)	(t CO2e/yr)	(t CO2e/yr)	(t CO2e/yr)	(t CO2e/yr)	(t CO2e/yr)	(t CO2e/yr)	(t CO2e/yr)	(t CO2e/yr)
2008																						
2009																						
2010																						
2011																						
2012																						
2013																						
2014																						
2015																						
2016	1,558,100	472,100	2,030,200	2,369,141	1,681,970	40,511	37,299	78,428	126,282	204,710	0	21,400	2,416	33,629	146	401	1,204	564	-504	-2,098	-3,466	-3,754
2017	1,570,600	476,700	2,047,300	2,393,156	1,717,658	41,108	38,091	78,558	127,548	206,106	0	21,720	2,452	33,954	147	407	1,222	568	-509	-2,142	-3,517	-3,825
2018	1,582,900	481,300	2,064,200	2,417,172	1,753,346	41,705	38,882	71,744	127,838	199,582	3,720	22,030	2,488	34,279	149	413	1,239	550	-514	-2,187	-3,568	-3,919
2019	1,595,300	485,800	2,081,100	2,441,187	1,789,035	42,302	39,674	75,649	129,104	204,753	3,720	22,350	2,523	34,604	150	419	1,257	564	-519	-2,231	-3,620	-3,980
2020	1,607,800	490,400	2,098,200	2,465,203	1,824,723	42,899	40,465	75,779	130,369	206,148	3,720	22,660	2,559	34,929	151	425	1,275	568	-524	-2,276	-3,671	-4,052
2021	1,620,100	495,000	2,115,100	2,489,218	1,860,411	43,496	41,256	75,909	130,660	206,569	3,720	22,980	2,595	35,254	152	430	1,293	569	-529	-2,320	-3,722	-4,126
2022	1,632,500	499,500	2,132,000	2,513,234	1,896,099	44,093	42,048	76,044	131,925	207,969	3,720	23,290	2,630	35,579	154	436	1,310	573	-534	-2,365	-3,773	-4,198
2023	1,644,900	504,100	2,149,000	2,537,249	1,931,787	44,690	42,839	76,174	133,191	209,365	3,720	23,610	2,666	35,904	155	442	1,328	577	-539	-2,409	-3,824	-4,270
2024	1,657,300	508,700	2,166,000	2,561,265	1,967,475	45,287	43,631	80,074	133,481	213,555	3,720	23,920	2,701	36,229	156	448	1,345	589	-543	-2,454	-3,875	-4,334
2025	1,669,700	513,200	2,182,900	2,585,280	2,003,164	45,884	44,422	80,209	134,747	214,956	3,720	24,240	2,737	36,554	157	454	1,363	593	-548	-2,499	-3,926	-4,406
2026	1,682,100	517,800	2,199,900	2,609,296	2,038,852	46,481	45,214	80,339	135,037	215,376	3,720	24,550	2,773	36,879	158	460	1,381	594	-553	-2,543	-3,977	-4,480
2027	1,694,500	522,300	2,216,800	2,633,311	2,074,540	47,079	46,005	80,469	136,303	216,772	3,720	24,870	2,808	37,204	160	466	1,399	598	-558	-2,588	-4,028	-4,552
2028	1,706,800	526,900	2,233,700	2,657,327	2,110,228	47,676	46,796	80,604	137,568	218,172	3,720	25,180	2,844	37,529	161	472	1,416	601	-563	-2,632	-4,079	-4,624
2029	1,719,300	531,500	2,250,800	2,681,342	2,145,916	48,273	47,588	80,734	137,859	218,593	3,720	25,500	2,879	37,854	162	478	1,434	603	-568	-2,677	-4,130	-4,698
2030	1,731,700	536,000	2,267,700	2,705,357	2,181,604	48,870	48,379	84,634	139,124	223,758	3,720	25,810	2,915	38,179	163	484	1,452	617	-573	-2,721	-4,181	-4,760
2031	1,741,900	541,100	2,283,000	2,729,373	2,208,492	49,379	48,976	84,749	140,424	225,173	3,720	26,080	2,945	38,543	164	489	1,467	621	-578	-2,755	-4,225	-4,817
2032	1,752,200	546,200	2,298,400	2,753,388	2,235,379	49,888	49,572	88,059	140,749	228,808	3,720	26,350	2,976	38,906	165	494	1,482	631	-584	-2,788	-4,269	-4,868
2033	1,762,400	551,300	2,313,700	2,777,404	2,262,267	50,397	50,168	88,169	142,048	230,217	3,720	26,620	3,006	39,269	167	499	1,497	635	-589	-2,822	-4,312	-4,926
2034	1,772,600	556,400	2,329,000	2,801,419	2,289,155	50,906	50,764	88,284	143,348	231,632	3,720	26,890	3,036	39,632	168	504	1,512	639	-594	-2,855	-4,356	-4,983
2035	1,782,800	561,500	2,344,300	2,825,435	2,316,042	51,415	51,361	88,394	143,672	232,066	3,720	27,160	3,067	39,995	169	509	1,528	640	-600	-2,889	-4,399	-5,043
2036	1,793,200	566,600	2,359,800	2,849,450	2,342,930	51,924	51,957	101,642	144,972	246,614	4,368	27,430	3,097	40,358	170	514	1,543	660	-605	-2,922	-4,443	-5,064
2037	1,803,400	571,700	2,375,100	2,873,466	2,369,817	52,433	52,553	101,752	146,271	248,024	4,368	27,700	3,128	40,721	171	519	1,558	684	-611	-2,956	-4,486	-5,121
2038	1,813,600	576,800	2,390,400	2,897,481	2,396,705	52,942	53,149	101,867	147,571	249,438	4,368	27,970	3,158	41,085	172	524	1,573	688	-616	-2,989	-4,530	-5,179
2039	1,823,900	581,900	2,405,800	2,921,497	2,423,592	53,451	53,746	93,824	147,896	241,719	4,368	28,230	3,188	41,448	173	529	1,588	666	-622	-3,023	-4,573	-5,262
2040	1,834,100	587,000	2,421,100	2,945,512	2,450,480	53,960	54,342	93,934	149,195	243,129	4,368	28,500	3,219	41,811	174	534	1,603	670	-627	-3,056	-4,617	-5,319
2041	1,844,400	592,100	2,436,500	2,969,528	2,477,367	54,469	54,938	94,049	150,495	244,543	4,368	28,770	3,249	42,174	175	539	1,618	674	-633	-3,090	-4,661	-5,376
2042	1,854,600	597,200	2,451,800	2,993,543	2,504,255	54,978	55,534	97,929	150,819	248,748	4,368	29,040	3,279	42,537	177	544	1,633	686	-638	-3,124	-4,704	-5,426
2043	1,864,900	602,300	2,467,200	3,017,559	2,531,142	55,487	56,131	98,044	152,119	250,162	4,368	29,310	3,310	42,900	178	549	1,649	690	-644	-3,157	-4,748	-5,483
2044	1,875,100	607,400	2,482,500	3,041,574	2,558,030	55,996	56,727	98,154	153,418	251,572	4,368	29,580	3,340	43,263	179	554	1,664	694	-649	-3,191	-4,791	-5,541
2045	1,885,300	612,500	2,497,800	3,065,590	2,584,917	56,505	57,323	98,269	153,743	252,012	4,368	29,850	3,370	43,626	180	559	1,679	695	-654	-3,224	-4,835	-5,601
2046	1,892,600	616,200	2,508,800	3,089,605	2,599,571	56,892	57,648	98,354	154,952	253,306	4,368	30,050	3,394	43,889	181	563	1,690	698	-658	-3,242	-4,868	-5,637
2047	1,899,900	619,900	2,519,800	3,113,620	2,614,225	57,278	57,973	98,439	155,187	253,625	4,368	30,260	3,417	44,151	181	567	1,702	699	-662	-3,261	-4,901	-5,675
2048	1,907,100	623,500	2,530,600	3,137,636	2,628,879	57,665	58,298	98,524	156,396	254,920	4,368	30,460	3,440	44,413	182	571	1,713	703	-666	-3,279	-4,934	-5,710
2049	1,914,400	627,200	2,541,600	3,161,651	2,643,533	58,052	58,623	102,379	156,630	259,009	4,368	30,660	3,463	44,675	183	575	1,724	714	-670	-3,297	-4,967	-5,739
2050	1,921,700	630,900	2,552,600	3,185,667	2,658,187	58,439	58,948	102,464	157,840	260,303	4,368	30,870	3,486	44,937	184	578	1,736	718	-674	-3,316	-5,000	-5,774
2051	1,928,900	634,600	2,563,500	3,209,682	2,672,841	58,825	59,273	102,549	158,074	260,623	4,368	31,070	3,509	45,200	185	582	1,748	718	-678	-3,334	-5,033	-5,812
2052	1,936,100	638,300	2,574,400	3,233,698	2,687,495	59,212	59,598	102,634	159,283	261,917	4,368	31,280	3,532	45,462	185	586	1,759	722	-682	-3,352	-5,066	-5,848
2053	1,943,500	641,900	2,585,400	3,257,713	2,702,149	59,599	59,923	102,719	159,518	262,236	4,368	31,480	3,555	45,724	186	590	1,771	723	-686	-3,370	-5,100	-5,886
2054	1,950,700	645,600	2,596,300	3,281,729	2,716,803	59,985	60,248	102,804	160,727	263,531	4,368	31,690	3,578	45,986	187	594	1,782	726	-690	-3,389	-5,133	-5,922
2055	1,958,000	649,300	2,607,300	3,305,744	2,731,457	60,372	60,573	102,889	160,962	263,850	4,368	31,890	3,601	46,248	188	597	1,794	727	-694	-3,407	-5,166	-5,960
2056	1,965,200	653,000	2,618,200	3,329,760	2,746,111	60,759	60,898	102,974	162,171	265,144	4,368	32,090	3,624	46,511	189	601	1,805	731	-698	-3,425	-5,199	-5,996
2057	1,972,400	656,700	2,629,100	3,353,775	2,760,765	61,145	61,223	112,825	162,405	275,230	4,800	32,300	3,647	46,773	189	605	1,817	759	-702	-3,443	-5,232	-6,007
2058	1,979,700	660,300	2,640,000	3,377,791	2,775,419	61,532	61,548	116,680	163,615	280,295	4,800	32,500	3,670	47,035	190	609	1,828	773	-706	-3,462	-5,265	-6,033
2059	1,987,000	664,000	2,651,000	3,401,806	2,790,073	61,919	61,873	116,765	163,849	280,614	4,800	32,710	3,693	47,297	191	613	1,840	774	-709	-3,480	-5,298	-6,071
2060	1,994,200	667,700	2,661,900	3,425,822	2,804,727	62,305	62,198	107,890	165,058	272,948	4,800	32,910	3,716	47,559	192	617	1,851	752	-713	-3,498	-5,331	-6,131
2061	2,001,500	671,400	2,672,900	3,449,837	2,819,381	62,692	62,523	107,975	165,293	273,268	4,800	33,110	3,740	47,822	192	620	1,862	753	-717	-3,517	-5,364	-6,170
2062	2,008,800	675,100	2,683,900	3,473,853	2,834,035	63,079	62,848	108,060	166,502	274,562	4,800	33,320	3,763	48,084	193	624	1,874	757	-721	-3,535	-5,397	-6,205
2063	2,016,000	678,800	2,694,800	3,497,868	2,848,689	63,466	63,173	108,145	166,736	274,881	4,800	33,520	3,786	48,346	194	628	1,885	758	-725	-3,553	-5,430	-6,243
2064	2,023,300	682,400	2,705,700	3,521,884	2,863,343	63,852	63,497	108,230	167,946	276,176	4,800	33,730	3,809	48,608	195	632	1,897	761	-729	-3,571	-5,463	-6,279
2065	2,030,500	686,100	2,716,600	3,545,899	2,877,997	64,239	63,822	108,315	168,180	276,495	4,800	33,930	3,832	48,870	196	636	1,908	762	-733	-3,590	-5,497	-6,317
Totals =	91,109,500	29,236,200	120,345,700	147,875,996	119,703,060	2,675,791	2,654,535	4,704,074	7,429,102	12,133,176	201,888	1,413,420	159,609	2,082,421	8,665	26,482	79,497	33,447	-31,236	-149,303	-228,952	**-261,401**

Notes:
1. Includes transport of biosolids to land application site plus actual land application and coppice equipment.
2. Includes transport of compost product to distribution site for public pickup.
3. Assumes that land applied biosolids are not off-setting commercial fertilizer use.
4. Negative values imply an off-set and are considered as an offset in the analysis.

Capital Regional District - Core Area Wastewater Management Strategy: Program Development Phase, Integrated Resource Management Strategy - Biosolids Management / Organic Residuals Energy and Resource Recovery

File: 20062935 04 E 03 01
Prepared: D. Shiskowski, D. Forgie
Last Revision: January 27, 2009
Last Revision By: D. Shiskowski

Subject: Strategy 1d
Maximum Beneficial Reuse (50% Biosolids to Cement Kiln; 50% to "Industrial" Land Application; Biomethane)
Life-Cycle Analysis

Yellow-shaded cell denotes assumed/input values
Note: Other coloured cells contain data linked to external spreadsheets

Year	Capital Costs: WW Sludges[5]	Capital Costs: SW Organics	Capital Costs: Total Cost	Capital Costs: Net Present Value	O&M – Labour: WW Sludges Annual Cost	Labour: SW Organics Annual Cost	Labour: Total Annual Cost	Labour: Net Present Value
2008								
2009								
2010								
2011								
2012								
2013								
2014								
2015	$96,191,168	$25,600,000	$121,791,168	$92,551,278				
2016	$119,168		$119,168	$87,075	$1,085,769	$300,000	$1,385,769	$1,012,568
2017	$119,168		$119,168	$83,726	$1,085,769	$300,000	$1,385,769	$973,623
2018	$119,168		$119,168	$80,506	$1,067,885	$300,000	$1,367,885	$924,094
2019	$119,168		$119,168	$77,409	$1,067,885	$300,000	$1,367,885	$888,552
2020	$119,168		$119,168	$74,432	$1,067,885	$300,000	$1,367,885	$854,377
2021	$119,168		$119,168	$71,569	$1,067,885	$300,000	$1,367,885	$821,516
2022	$119,168		$119,168	$68,817	$1,067,885	$300,000	$1,367,885	$789,919
2023	$119,168		$119,168	$66,170	$1,067,885	$300,000	$1,367,885	$759,538
2024	$119,168		$119,168	$63,625	$1,067,885	$300,000	$1,367,885	$730,325
2025	$119,168		$119,168	$61,178	$1,067,885	$300,000	$1,367,885	$702,235
2026	$119,168		$119,168	$58,825	$1,067,885	$300,000	$1,367,885	$675,226
2027	$119,168		$119,168	$56,562	$1,067,885	$300,000	$1,367,885	$649,256
2028	$119,168		$119,168	$54,387	$1,067,885	$300,000	$1,367,885	$624,285
2029	$119,168		$119,168	$52,295	$1,067,885	$300,000	$1,367,885	$600,274
2030	$119,168		$119,168	$50,284	$1,067,885	$300,000	$1,367,885	$577,186
2031	$119,168		$119,168	$48,350	$1,067,885	$300,000	$1,367,885	$554,987
2032	$119,168		$119,168	$46,490	$1,067,885	$300,000	$1,367,885	$533,641
2033	$119,168		$119,168	$44,702	$1,067,885	$300,000	$1,367,885	$513,117
2034	$119,168		$119,168	$42,983	$1,067,885	$300,000	$1,367,885	$493,381
2035	$119,168		$119,168	$41,329	$1,067,885	$300,000	$1,367,885	$474,405
2036	$119,168		$119,168	$39,740	$1,092,000	$300,000	$1,392,000	$464,201
2037	$119,168		$119,168	$38,211	$1,092,000	$300,000	$1,392,000	$446,347
2038	$119,168		$119,168	$36,742	$1,092,000	$300,000	$1,392,000	$429,180
2039	$119,168		$119,168	$35,329	$1,071,000	$300,000	$1,371,000	$406,447
2040	$20,390,168		$20,390,168	$5,812,379	$1,071,000	$300,000	$1,371,000	$390,814
2041	$119,168		$119,168	$32,663	$1,071,000	$300,000	$1,371,000	$375,783
2042	$119,168		$119,168	$31,407	$1,071,000	$300,000	$1,371,000	$361,330
2043	$119,168		$119,168	$30,199	$1,071,000	$300,000	$1,371,000	$347,433
2044	$119,168		$119,168	$29,038	$1,071,000	$300,000	$1,371,000	$334,070
2045	$119,168		$119,168	$27,921	$1,071,000	$300,000	$1,371,000	$321,221
2046	$119,168		$119,168	$26,847	$1,071,000	$300,000	$1,371,000	$308,866
2047	$119,168		$119,168	$25,814	$1,071,000	$300,000	$1,371,000	$296,987
2048	$119,168		$119,168	$24,821	$1,071,000	$300,000	$1,371,000	$285,564
2049	$119,168		$119,168	$23,867	$1,071,000	$300,000	$1,371,000	$274,581
2050	$119,168		$119,168	$22,949	$1,071,000	$300,000	$1,371,000	$264,020
2051	$119,168		$119,168	$22,066	$1,071,000	$300,000	$1,371,000	$253,866
2052	$119,168		$119,168	$21,217	$1,071,000	$300,000	$1,371,000	$244,102
2053	$119,168		$119,168	$20,401	$1,071,000	$300,000	$1,371,000	$234,713
2054	$119,168		$119,168	$19,617	$1,071,000	$300,000	$1,371,000	$225,686
2055	$119,168		$119,168	$18,862	$1,071,000	$300,000	$1,371,000	$217,005
2056	$119,168		$119,168	$18,137	$1,071,000	$300,000	$1,371,000	$208,659
2057	$119,168		$119,168	$17,439	$1,096,154	$300,000	$1,396,154	$204,315
2058	$119,168		$119,168	$16,768	$1,096,154	$300,000	$1,396,154	$196,456
2059	$119,168		$119,168	$16,124	$1,096,154	$300,000	$1,396,154	$188,900
2060	$119,168		$119,168	$15,503	$1,073,077	$300,000	$1,373,077	$178,633
2061	$119,168		$119,168	$14,907	$1,073,077	$300,000	$1,373,077	$171,762
2062	$119,168		$119,168	$14,334	$1,073,077	$300,000	$1,373,077	$165,156
2063	$119,168		$119,168	$13,782	$1,073,077	$300,000	$1,373,077	$158,804
2064	$119,168		$119,168	$13,252	$1,073,077	$300,000	$1,373,077	$152,696
2065	$119,168		$119,168	$12,743	$1,073,077	$300,000	$1,373,077	$146,823
Total Capital =	$122,420,568	$25,600,000	$148,020,568					
Total Net Present Value =				$100,275,069				$22,406,924

Year	Electricity: Total Annual Cost	Electricity: Net Present Value	Natural Gas: Total Annual Cost	Natural Gas: Net Present Value	Chemicals: WW Sludges Annual Cost	Chemicals: Total Annual Cost	Chemicals: Net Present Value	Trucking/Equipment[3]: WW Sludges[2] Annual Cost	Trucking/Equipment: SW Organics[1] Annual Cost	Trucking/Equipment: Total Annual Cost	Trucking/Equipment: Net Present Value
2008											
2009											
2010											
2011											
2012											
2013											
2014											
2015											
2016	$142,114	$103,841	$214,000	$156,368	$423,300	$423,300	$309,301	$849,850	$730,128	$1,579,978	$1,154,474
2017	$143,311	$100,688	$217,200	$152,602	$429,800	$429,800	$301,972	$852,850	$736,936	$1,589,786	$1,116,963
2018	$144,494	$97,615	$220,300	$148,827	$436,400	$436,400	$294,810	$594,650	$740,936	$1,335,586	$902,274
2019	$145,677	$94,629	$223,500	$145,181	$441,900	$441,900	$287,050	$608,500	$748,744	$1,357,244	$881,640
2020	$146,874	$91,737	$226,600	$141,534	$448,400	$448,400	$280,069	$611,000	$755,552	$1,366,552	$853,544
2021	$148,057	$88,919	$229,800	$138,012	$455,000	$455,000	$273,261	$614,000	$759,552	$1,373,552	$824,920
2022	$149,240	$86,182	$232,900	$134,494	$460,500	$460,500	$265,927	$617,000	$767,360	$1,384,360	$799,433
2023	$150,430	$83,528	$236,100	$131,098	$467,000	$467,000	$259,309	$620,000	$774,168	$1,394,168	$774,132
2024	$151,620	$80,951	$239,200	$127,711	$473,600	$473,600	$252,859	$633,450	$779,168	$1,412,618	$754,208
2025	$152,803	$78,445	$242,400	$124,442	$479,100	$479,100	$245,957	$636,450	$785,976	$1,422,426	$730,235
2026	$153,993	$76,015	$245,500	$121,186	$485,600	$485,600	$239,706	$639,450	$789,976	$1,429,426	$705,605
2027	$155,176	$73,653	$248,700	$118,044	$492,200	$492,200	$233,619	$642,450	$797,784	$1,440,234	$683,596
2028	$156,359	$71,360	$251,800	$114,916	$498,700	$498,700	$227,600	$645,450	$804,592	$1,450,042	$661,780
2029	$157,556	$69,141	$255,000	$111,903	$504,200	$504,200	$221,260	$647,950	$808,592	$1,456,542	$639,180
2030	$158,739	$66,981	$258,100	$108,907	$510,800	$510,800	$215,535	$661,750	$816,400	$1,478,150	$623,713
2031	$159,810	$64,839	$260,800	$105,813	$516,200	$516,200	$209,436	$664,250	$824,208	$1,488,458	$603,907
2032	$160,888	$62,766	$263,500	$102,797	$521,700	$521,700	$203,526	$723,950	$829,208	$1,553,158	$605,920
2033	$161,959	$60,754	$266,200	$99,856	$526,100	$526,100	$197,349	$726,450	$836,016	$1,562,466	$586,107
2034	$163,030	$58,803	$268,900	$96,989	$531,600	$531,600	$191,742	$728,950	$843,824	$1,572,774	$567,283
2035	$164,101	$56,913	$271,600	$94,195	$537,100	$537,100	$186,275	$731,450	$848,824	$1,580,274	$548,065
2036	$165,186	$55,086	$274,300	$91,473	$542,500	$542,500	$180,912	$1,054,700	$856,632	$1,911,332	$637,380
2037	$166,257	$53,311	$277,000	$88,820	$548,000	$548,000	$175,717	$1,057,200	$864,440	$1,921,640	$616,177
2038	$167,328	$51,590	$279,700	$86,237	$553,400	$553,400	$170,624	$1,059,200	$872,248	$1,931,448	$595,501
2039	$168,406	$49,926	$282,300	$83,691	$558,900	$558,900	$165,692	$754,900	$877,248	$1,632,148	$483,867
2040	$169,477	$48,311	$285,000	$81,242	$563,300	$563,300	$160,573	$757,400	$885,056	$1,642,456	$468,195
2041	$170,555	$46,748	$287,700	$78,857	$568,800	$568,800	$155,905	$759,900	$891,864	$1,651,764	$452,739
2042	$171,626	$45,232	$290,400	$76,536	$574,200	$574,200	$151,332	$773,250	$896,864	$1,670,114	$440,162
2043	$172,704	$43,766	$293,100	$74,276	$579,700	$579,700	$146,905	$775,750	$904,672	$1,680,422	$425,845
2044	$173,775	$42,344	$295,800	$72,077	$585,200	$585,200	$142,595	$778,250	$912,480	$1,690,730	$411,978
2045	$174,846	$40,966	$298,500	$69,938	$590,600	$590,600	$138,376	$780,750	$917,480	$1,698,230	$397,890
2046	$175,616	$39,564	$300,500	$67,698	$594,000	$594,000	$133,820	$782,750	$924,288	$1,707,038	$384,571
2047	$176,386	$38,209	$302,600	$65,549	$598,300	$598,300	$129,604	$784,250	$927,288	$1,711,538	$370,754
2048	$177,142	$36,897	$304,600	$63,445	$602,600	$602,600	$125,515	$786,250	$934,096	$1,720,346	$358,329
2049	$177,912	$35,632	$306,600	$61,405	$607,000	$607,000	$121,569	$799,150	$937,096	$1,736,246	$347,732
2050	$178,682	$34,410	$308,700	$59,448	$610,300	$610,300	$117,528	$801,150	$943,904	$1,745,054	$336,054
2051	$179,445	$33,228	$310,700	$57,532	$614,700	$614,700	$113,823	$802,650	$946,904	$1,749,554	$323,962
2052	$180,208	$32,085	$312,800	$55,693	$619,000	$619,000	$110,211	$804,650	$953,712	$1,758,362	$313,070
2053	$180,978	$30,983	$314,800	$53,893	$622,400	$622,400	$106,554	$806,650	$956,712	$1,763,362	$301,885
2054	$181,741	$29,917	$316,900	$52,166	$626,700	$626,700	$103,164	$808,650	$963,520	$1,772,170	$291,724
2055	$182,511	$28,888	$318,900	$50,476	$631,100	$631,100	$99,892	$810,150	$966,520	$1,776,670	$281,216
2056	$183,274	$27,893	$320,900	$48,839	$634,400	$634,400	$96,552	$812,150	$973,328	$1,785,478	$271,740
2057	$184,037	$26,932	$323,000	$47,268	$638,800	$638,800	$93,463	$1,153,250	$976,328	$2,129,578	$311,645
2058	$184,800	$26,004	$325,000	$45,732	$643,100	$643,100	$90,492	$1,166,200	$983,136	$2,149,336	$302,439
2059	$185,570	$25,108	$327,100	$44,257	$646,500	$646,500	$87,472	$1,167,700	$986,136	$2,153,836	$291,415
2060	$186,333	$24,241	$329,100	$42,815	$650,800	$650,800	$84,667	$832,600	$992,944	$1,825,544	$237,497
2061	$187,103	$23,405	$331,100	$41,418	$655,100	$655,100	$81,948	$834,600	$995,944	$1,830,544	$228,988
2062	$187,873	$22,598	$333,200	$40,078	$659,500	$659,500	$79,326	$836,600	$1,002,752	$1,839,352	$221,240
2063	$188,636	$21,817	$335,200	$38,768	$662,800	$662,800	$76,656	$838,100	$1,005,752	$1,843,852	$213,252
2064	$189,399	$21,063	$337,300	$37,510	$667,200	$667,200	$74,197	$840,100	$1,012,560	$1,852,660	$206,029
2065	$190,162	$20,334	$339,300	$36,281	$671,500	$671,500	$71,804	$842,100	$1,015,560	$1,857,660	$198,640
Total Net Present Value =		$2,624,248		$4,288,293			$8,483,475				$25,738,902

Year	Land Lease for Willow Coppice: Total Annual Cost	Land Lease: Net Present Value	Maintenance: Total Annual Cost	Maintenance: Net Present Value	Administration: Total Annual Cost	Administration: Net Present Value	GHG CO2e[4]: Total Annual Cost	GHG CO2e: Net Present Value
2008								
2009								
2010								
2011								
2012								
2013								
2014								
2015								
2016	$153,450	$112,124	$1,219,103	$890,787	$100,000	$73,069	-$50,250	-$36,717
2017	$153,450	$107,812	$1,220,295	$857,363	$100,000	$70,259	-$51,264	-$36,017
2018	$153,450	$103,665	$1,221,487	$825,193	$100,000	$67,556	-$52,614	-$35,544
2019	$153,450	$99,678	$1,222,678	$794,229	$100,000	$64,958	-$53,477	-$34,734
2020	$153,450	$95,844	$1,223,870	$764,426	$100,000	$62,460	-$54,494	-$34,037
2021	$153,450	$92,158	$1,225,062	$735,740	$100,000	$60,057	-$55,549	-$33,361
2022	$153,450	$88,614	$1,226,253	$708,131	$100,000	$57,748	-$56,571	-$32,668
2023	$153,450	$85,205	$1,227,445	$681,557	$100,000	$55,526	-$57,585	-$31,975
2024	$153,450	$81,928	$1,228,637	$655,979	$100,000	$53,391	-$58,492	-$31,229
2025	$153,450	$78,777	$1,229,828	$631,361	$100,000	$51,337	-$59,505	-$30,548
2026	$153,450	$75,747	$1,231,020	$607,666	$100,000	$49,363	-$60,568	-$29,895
2027	$153,450	$72,834	$1,232,212	$584,860	$100,000	$47,464	-$61,582	-$29,229
2028	$153,450	$70,033	$1,233,404	$562,909	$100,000	$45,639	-$62,604	-$28,572
2029	$153,450	$67,339	$1,234,595	$541,782	$100,000	$43,883	-$63,659	-$27,936
2030	$153,450	$64,749	$1,235,787	$521,447	$100,000	$42,196	-$64,525	-$27,227
2031	$153,450	$62,259	$1,236,979	$501,875	$100,000	$40,573	-$65,319	-$26,502
2032	$153,450	$59,864	$1,238,170	$483,037	$100,000	$39,012	-$66,022	-$25,757
2033	$153,450	$57,562	$1,239,362	$464,905	$100,000	$37,512	-$66,816	-$25,064
2034	$153,450	$55,348	$1,240,554	$447,454	$100,000	$36,069	-$67,611	-$24,386
2035	$153,450	$53,219	$1,241,745	$430,658	$100,000	$34,682	-$68,446	-$23,738
2036	$180,180	$60,086	$1,242,937	$414,491	$100,000	$33,348	-$68,697	-$22,909
2037	$180,180	$57,775	$1,244,129	$398,932	$100,000	$32,065	-$69,491	-$22,282
2038	$180,180	$55,553	$1,245,320	$383,956	$100,000	$30,832	-$70,286	-$21,670
2039	$180,180	$53,416	$1,246,512	$369,541	$100,000	$29,646	-$71,466	-$21,187
2040	$180,180	$51,362	$1,450,414	$413,452	$100,000	$28,505	-$72,260	-$20,598
2041	$180,180	$49,386	$1,451,605	$397,877	$100,000	$27,409	-$73,055	-$20,024
2042	$180,180	$47,487	$1,452,797	$382,888	$100,000	$26,355	-$73,734	-$19,433
2043	$180,180	$45,660	$1,453,989	$368,463	$100,000	$25,342	-$74,528	-$18,887
2044	$180,180	$43,904	$1,455,180	$354,582	$100,000	$24,367	-$75,322	-$18,354
2045	$180,180	$42,210	$1,456,372	$341,223	$100,000	$23,430	-$76,157	-$17,843
2046	$180,180	$40,592	$1,457,564	$328,368	$100,000	$22,529	-$76,648	-$17,268
2047	$180,180	$39,031	$1,458,755	$315,996	$100,000	$21,662	-$77,170	-$16,717
2048	$180,180	$37,530	$1,459,947	$304,091	$100,000	$20,829	-$77,661	-$16,176
2049	$180,180	$36,086	$1,461,139	$292,634	$100,000	$20,028	-$78,036	-$15,629
2050	$180,180	$34,698	$1,462,330	$281,608	$100,000	$19,257	-$78,519	-$15,121
2051	$180,180	$33,364	$1,463,522	$270,998	$100,000	$18,517	-$79,050	-$14,638
2052	$180,180	$32,080	$1,464,714	$260,787	$100,000	$17,805	-$79,532	-$14,160
2053	$180,180	$30,847	$1,465,906	$250,961	$100,000	$17,120	-$80,063	-$13,707
2054	$180,180	$29,660	$1,467,097	$241,505	$100,000	$16,461	-$80,546	-$13,259
2055	$180,180	$28,519	$1,468,289	$232,405	$100,000	$15,828	-$81,077	-$12,833
2056	$180,180	$27,422	$1,469,481	$223,647	$100,000	$15,219	-$81,568	-$12,414
2057	$198,000	$28,976	$1,470,672	$215,220	$100,000	$14,634	-$81,687	-$11,954
2058	$198,000	$27,861	$1,471,864	$207,110	$100,000	$14,071	-$82,021	-$11,541
2059	$198,000	$26,790	$1,473,056	$199,305	$100,000	$13,530	-$82,544	-$11,168
2060	$198,000	$25,759	$1,474,247	$191,795	$100,000	$13,010	-$83,405	-$10,851
2061	$198,000	$24,768	$1,475,439	$184,567	$100,000	$12,509	-$83,936	-$10,500
2062	$198,000	$23,816	$1,476,631	$177,612	$100,000	$12,028	-$84,419	-$10,154
2063	$198,000	$22,900	$1,477,822	$170,918	$100,000	$11,566	-$84,950	-$9,825
2064	$198,000	$22,019	$1,479,014	$164,477	$100,000	$11,121	-$85,432	-$9,501
2065	$198,000	$21,172	$1,480,206	$158,278	$100,000	$10,693	-$85,963	-$9,192
Total Net Present Value =		$2,685,494		$21,189,044		$1,632,469		-$1,064,935

Year	Dried WW Biosolids Revenues: Total Annual Rev	Dried WW Biosolids: Net Present Value	Biomethane Revenues: Total Annual Rev	Biomethane: Net Present Value	Woodchip Revenues (via Willow Coppice): Total Annual Rev	Woodchip: Net Present Value	Total: Total Annual Cost	Total: Net Present Value
2008								
2009								
2010								
2011								
2012								
2013								
2014								
2015							$121,791,168	$92,551,278
2016	-$66,917	-$48,896	-$372,994	-$272,543	$0	$0	$4,846,721	$3,541,452
2017	-$67,903	-$47,708	-$380,908	-$267,621	$0	$0	$4,858,704	$3,413,661
2018	-$68,890	-$46,539	-$388,822	-$262,674	-$372,000	-$251,310	$4,216,444	$2,848,478
2019	-$69,876	-$45,390	-$396,736	-$257,712	-$372,000	-$241,644	$4,239,418	$2,753,845
2020	-$70,862	-$44,260	-$404,651	-$252,744	-$372,000	-$232,350	$4,250,792	$2,655,032
2021	-$71,848	-$43,150	-$412,565	-$247,776	-$372,000	-$223,414	$4,260,012	$2,558,453
2022	-$72,834	-$42,060	-$420,479	-$242,816	-$372,000	-$214,821	$4,271,872	$2,466,900
2023	-$73,821	-$40,990	-$428,393	-$237,872	-$372,000	-$206,558	$4,283,647	$2,378,666
2024	-$74,807	-$39,940	-$436,307	-$232,948	-$372,000	-$198,614	$4,304,572	$2,298,246
2025	-$75,793	-$38,910	-$444,222	-$228,051	-$372,000	-$190,975	$4,315,540	$2,215,483
2026	-$76,779	-$37,900	-$452,136	-$223,187	-$372,000	-$183,630	$4,324,559	$2,134,724
2027	-$77,765	-$36,911	-$460,050	-$218,359	-$372,000	-$176,567	$4,337,627	$2,058,822
2028	-$78,752	-$35,941	-$467,964	-$213,573	-$372,000	-$169,776	$4,349,487	$1,985,049
2029	-$79,738	-$34,992	-$475,878	-$208,831	-$372,000	-$163,246	$4,357,121	$1,912,051
2030	-$80,724	-$34,062	-$483,793	-$204,139	-$372,000	-$156,967	$4,381,037	$1,848,602
2031	-$81,565	-$33,093	-$489,755	-$198,707	-$372,000	-$150,930	$4,394,110	$1,782,806
2032	-$82,406	-$32,148	-$495,718	-$193,390	-$372,000	-$145,125	$4,461,774	$1,740,634
2033	-$83,246	-$31,227	-$501,680	-$188,180	-$372,000	-$139,543	$4,472,846	$1,677,840
2034	-$84,087	-$30,329	-$507,643	-$183,101	-$372,000	-$134,176	$4,466,019	$1,618,059
2035	-$84,928	-$29,454	-$513,605	-$178,127	-$372,000	-$129,016	$4,496,344	$1,559,407
2036	-$85,769	-$28,602	-$519,568	-$173,264	-$436,800	-$145,663	$4,816,769	$1,606,284
2037	-$86,610	-$27,772	-$525,531	-$168,512	-$436,800	-$140,061	$4,829,942	$1,548,726
2038	-$87,451	-$26,963	-$531,493	-$163,869	-$436,800	-$134,674	$4,842,515	$1,493,038
2039	-$88,291	-$26,175	-$537,456	-$159,334	-$436,800	-$129,494	$4,524,601	$1,341,364
2040	-$89,132	-$25,408	-$543,418	-$154,906	-$436,800	-$124,513	$25,010,384	$7,129,408
2041	-$89,973	-$24,661	-$549,381	-$150,582	-$436,800	-$119,724	$4,751,564	$1,302,376
2042	-$90,814	-$23,934	-$555,344	-$146,362	-$436,800	-$115,120	$4,772,794	$1,257,880
2043	-$91,655	-$23,227	-$561,306	-$142,244	-$436,800	-$110,692	$4,785,974	$1,212,840
2044	-$92,495	-$22,538	-$567,269	-$138,226	-$436,800	-$106,434	$4,799,147	$1,169,402
2045	-$93,336	-$21,868	-$573,231	-$134,306	-$436,800	-$102,341	$4,809,371	$1,126,821
2046	-$93,975	-$21,171	-$576,481	-$129,873	-$436,800	-$98,405	$4,821,162	$1,086,136
2047	-$94,614	-$20,495	-$579,731	-$125,582	-$436,800	-$94,620	$4,829,613	$1,046,194
2048	-$95,253	-$19,840	-$582,980	-$121,428	-$436,800	-$90,981	$4,842,269	$1,008,596
2049	-$95,891	-$19,205	-$586,230	-$117,409	-$436,800	-$87,481	$4,862,287	$973,809
2050	-$96,530	-$18,589	-$589,480	-$113,519	-$436,800	-$84,117	$4,874,086	$938,627
2051	-$97,169	-$17,993	-$592,729	-$109,755	-$436,800	-$80,881	$4,882,521	$904,088
2052	-$97,808	-$17,414	-$595,979	-$106,112	-$436,800	-$77,771	$4,895,313	$871,593
2053	-$98,446	-$16,854	-$599,229	-$102,587	-$436,800	-$74,779	$4,903,255	$839,430
2054	-$99,085	-$16,311	-$602,478	-$99,176	-$436,800	-$71,903	$4,916,047	$809,249
2055	-$99,724	-$15,785	-$605,728	-$95,876	-$436,800	-$69,138	$4,924,489	$779,461
2056	-$100,363	-$15,275	-$608,978	-$92,683	-$436,800	-$66,479	$4,936,173	$751,260
2057	-$101,001	-$14,781	-$612,227	-$89,594	-$480,000	-$70,244	$5,284,494	$773,339
2058	-$101,640	-$14,302	-$615,477	-$86,605	-$480,000	-$67,542	$5,308,283	$746,942
2059	-$102,279	-$13,838	-$618,727	-$83,714	-$480,000	-$64,944	$5,315,834	$719,235
2060	-$102,918	-$13,389	-$621,976	-$80,917	-$480,000	-$62,446	$4,967,970	$646,317
2061	-$103,556	-$12,954	-$625,226	-$78,211	-$480,000	-$60,045	$4,976,812	$622,564
2062	-$104,195	-$12,533	-$628,476	-$75,594	-$480,000	-$57,735	$4,989,711	$600,171
2063	-$104,834	-$12,125	-$631,725	-$73,063	-$480,000	-$55,515	$4,997,046	$577,936
2064	-$105,473	-$11,729	-$634,975	-$70,614	-$480,000	-$53,379	$5,009,938	$557,141
2065	-$106,111	-$11,346	-$638,225	-$68,245	-$480,000	-$51,326	$5,018,773	$536,658
Total Net Present Value =		-$1,340,977		-$7,964,522		-$5,977,110		$172,976,375

Notes:
1. Includes transport of compost product to distribution site for pickup by public.
3. Includes diesel fuel, driver, maintenance costs and same for coppice activities.
4. Excludes CO2e off-sets of commerical fertilizers by non-CRD end users (i.e. assumes that the CRD would not be able to sell these "credits"). Includes CO2 off-sets from sale of biomethane and dried WW sludges.
5. Includes willow coppice planting and harvesting equipment.

Capital Regional District - Core Area Wastewater Management Strategy: Program Development Phase, Integrated Resource Management Strategy - Biosolids Management / Organic Residuals Energy and Resource Recovery

File: 20062935.04.E.03.01
Prepared: D. Shiskowski, D. Forgie
Last Revision: November 28, 2008
Last Revision By: D. Shiskowski

Subject: Strategy 2
Maximum Integration and
Maximum Energy Recovery
Material Flows
and GHG Emissions

Note: **Coloured cells contain data linked to external spreadsheets**

Year	Materials							GHG Sources			GHG Offsets	Total GHG Emissions
	Electricity	Biogas			Biomethane Available for Sale[1]		Diesel Fuel	Electricity Purchased	Biogas Lost	Diesel Fuel Combusted	Avoided Natural Gas Use via Biomethane	
	Total (kWh/yr)	Boiler (m3/yr)	for Biomethane (m3/yr)	System Loss (m3/yr)	(m3/yr)	(GJ/yr)	Total (L/yr)	(t CO2e/yr)	(t CO2e/yr)	(t CO2e/yr)	(t CO2e/yr)	(t CO2e/yr)
2008												
2009												
2010												
2011												
2012												
2013												
2014												
2015												
2016	1,733,500	3,478,868	6,711,877	101,907	4,319,093	148,843	71,720	125	1,009	198	-8,372	-7,041
2017	1,747,000	3,508,284	6,801,507	103,098	4,376,769	150,830	71,720	126	1,020	198	-8,483	-7,140
2018	1,760,300	3,537,701	6,891,136	104,288	4,434,446	152,818	71,720	127	1,032	198	-8,595	-7,239
2019	1,773,800	3,567,117	6,980,765	105,479	4,492,122	154,805	73,410	128	1,044	202	-8,707	-7,333
2020	1,787,100	3,596,534	7,070,394	106,669	4,549,798	156,793	73,410	129	1,056	202	-8,819	-7,432
2021	1,800,400	3,625,951	7,160,023	107,860	4,607,475	158,781	73,410	130	1,067	202	-8,931	-7,531
2022	1,814,000	3,655,367	7,249,652	109,050	4,665,151	160,768	75,100	131	1,079	207	-9,042	-7,625
2023	1,827,300	3,684,784	7,339,281	110,241	4,722,827	162,756	75,100	132	1,091	207	-9,154	-7,725
2024	1,840,800	3,714,200	7,428,910	111,431	4,780,504	164,744	75,100	133	1,103	207	-9,266	-7,824
2025	1,854,100	3,743,617	7,518,539	112,622	4,838,180	166,731	76,790	133	1,115	212	-9,378	-7,918
2026	1,867,600	3,773,033	7,608,169	113,812	4,895,856	168,719	76,790	134	1,126	212	-9,490	-8,017
2027	1,880,900	3,802,450	7,697,798	115,002	4,953,533	170,706	76,790	135	1,138	212	-9,601	-8,116
2028	1,894,500	3,831,866	7,787,427	116,193	5,011,209	172,694	78,480	136	1,150	216	-9,713	-8,210
2029	1,907,800	3,861,283	7,877,056	117,383	5,068,885	174,682	78,480	137	1,162	216	-9,825	-8,309
2030	1,921,100	3,890,699	7,966,685	118,574	5,126,562	176,669	78,480	138	1,174	216	-9,937	-8,409
2031	1,933,300	3,920,116	8,054,470	119,746	5,183,051	178,616	78,480	139	1,185	216	-10,046	-8,506
2032	1,945,500	3,949,533	8,142,254	120,918	5,239,541	180,563	80,170	140	1,197	221	-10,156	-8,598
2033	1,957,500	3,978,949	8,230,039	122,090	5,296,030	182,509	80,170	141	1,208	221	-10,265	-8,695
2034	1,969,700	4,008,366	8,317,823	123,262	5,352,519	184,456	80,170	142	1,220	221	-10,375	-8,792
2035	1,981,900	4,037,782	8,405,608	124,434	5,409,009	186,403	81,860	143	1,232	226	-10,484	-8,884
2036	1,993,900	4,067,199	8,493,392	125,606	5,465,498	188,349	81,860	144	1,243	226	-10,594	-8,981
2037	2,006,100	4,096,615	8,581,177	126,778	5,521,987	190,296	81,860	144	1,255	226	-10,703	-9,078
2038	2,018,300	4,126,032	8,668,961	127,950	5,578,477	192,243	81,860	145	1,266	226	-10,813	-9,175
2039	2,030,300	4,155,448	8,756,746	129,122	5,634,966	194,190	83,550	146	1,278	230	-10,922	-9,268
2040	2,042,600	4,184,865	8,844,530	130,294	5,691,455	196,136	83,550	147	1,290	230	-11,032	-9,365
2041	2,054,800	4,214,281	8,932,315	131,466	5,747,945	198,083	83,550	148	1,301	230	-11,141	-9,462
2042	2,066,800	4,243,698	9,020,100	132,638	5,804,434	200,030	83,550	149	1,313	230	-11,251	-9,559
2043	2,079,000	4,273,115	9,107,884	133,810	5,860,923	201,976	85,240	150	1,324	235	-11,360	-9,651
2044	2,091,200	4,302,531	9,195,669	134,982	5,917,413	203,923	85,240	151	1,336	235	-11,470	-9,748
2045	2,103,200	4,331,948	9,283,453	136,154	5,973,902	205,870	85,240	151	1,348	235	-11,579	-9,845
2046	2,111,800	4,361,364	9,340,575	137,019	6,010,660	207,137	86,930	152	1,356	240	-11,650	-9,903
2047	2,120,500	4,390,781	9,397,698	137,885	6,047,418	208,403	86,930	153	1,365	240	-11,722	-9,965
2048	2,129,300	4,420,197	9,454,820	138,750	6,084,176	209,670	86,930	153	1,373	240	-11,793	-10,027
2049	2,138,000	4,449,614	9,511,942	139,616	6,120,935	210,937	86,930	154	1,382	240	-11,864	-10,089
2050	2,146,500	4,479,030	9,569,064	140,481	6,157,693	212,204	86,930	155	1,390	240	-11,935	-10,151
2051	2,155,100	4,508,447	9,626,186	141,346	6,194,451	213,470	88,620	155	1,399	244	-12,007	-10,208
2052	2,163,800	4,537,863	9,683,308	142,212	6,231,209	214,737	88,620	156	1,407	244	-12,078	-10,270
2053	2,172,400	4,567,280	9,740,431	143,077	6,267,967	216,004	88,620	156	1,416	244	-12,149	-10,332
2054	2,181,100	4,596,696	9,797,553	143,942	6,304,725	217,271	88,620	157	1,425	244	-12,220	-10,394
2055	2,189,600	4,626,113	9,854,675	144,808	6,341,483	218,537	88,620	158	1,433	244	-12,292	-10,456
2056	2,198,200	4,655,530	9,911,797	145,673	6,378,241	219,804	90,310	158	1,442	249	-12,363	-10,514
2057	2,206,900	4,684,946	9,968,919	146,539	6,415,000	221,071	90,310	159	1,450	249	-12,434	-10,576
2058	2,215,500	4,714,363	10,026,041	147,404	6,451,758	222,337	90,310	160	1,459	249	-12,505	-10,638
2059	2,224,200	4,743,779	10,083,164	148,269	6,488,516	223,604	90,310	160	1,467	249	-12,577	-10,700
2060	2,232,700	4,773,196	10,140,286	149,135	6,525,274	224,871	90,310	161	1,476	249	-12,648	-10,762
2061	2,241,300	4,802,612	10,197,408	150,000	6,562,032	226,138	92,000	161	1,485	254	-12,719	-10,820
2062	2,250,000	4,832,029	10,254,530	150,866	6,598,790	227,404	92,000	162	1,493	254	-12,790	-10,882
2063	2,258,600	4,861,445	10,311,652	151,731	6,635,548	228,671	92,000	163	1,502	254	-12,862	-10,944
2064	2,267,300	4,890,862	10,368,775	152,596	6,672,306	229,938	92,000	163	1,510	254	-12,933	-11,006
2065	2,275,800	4,920,278	10,425,897	153,462	6,709,065	231,205	93,690	164	1,519	258	-13,004	-11,063
Totals =	101,562,900	209,978,658	437,788,360	6,477,670	281,716,810	9,708,395	4,153,840	7,313	64,109	11,451	-546,045	**-463,173**

Notes:
1. Accounts for system loss of biogas.

Capital Regional District - Core Area Wastewater Management Strategy: Program Development Phase, Integrated Resource Management Strategy - Biosolids Management / Organic Residuals Energy and Resource Recovery

File: 20062935.04.E.03.01
Prepared: D. Shiskowski, D. Forgie
Last Revision: November 28, 2008
Last Revision By: D. Shiskowski

Subject: **Subject:** Strategy 2
Maximum Intergration and Maximum
Energy Recovery
Discount Rate Base
Life-Cycle Analysis

Yellow-shaded cell denotes assumed/input values
Note: Other coloured cells contain data linked to external spreadsheets

Year	Capital Costs		Operations & Maintenance Costs														GHG CO_2e[3]		Biomethane Revenues		Total	
			Labour		Electricity		Chemicals		Trucking/Equipment[1]		Ash Disposal[2]		Maintenance		Administration							
	Total Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Rev	Net Present Value	Total Annual Cost	Net Present Value
2008																						
2009																						
2010																						
2011																						
2012																						
2013																						
2014																						
2015	$168,273,000	$127,873,650																			$168,273,000	$127,873,650
2016		$0	$750,000	$548,018	$121,345	$88,666	**$1,249,700**	$913,144	**$206,554**	$150,927	$526,800	$384,928	$1,682,730	$1,229,554	$100,000	$73,069	-$105,608	-$77,166	-$1,488,426	-$1,087,578	$3,043,095	$2,223,560
2017		$0	$750,000	$526,940	$122,290	$85,919	**$1,267,400**	$890,458	**$206,554**	$145,122	$533,600	$374,900	$1,682,730	$1,182,264	$100,000	$70,259	-$107,093	-$75,242	-$1,508,302	-$1,059,713	$3,047,178	$2,140,907
2018		$0	$750,000	$506,673	$123,221	$83,244	**$1,285,000**	$868,100	**$206,554**	$139,540	$540,400	$365,075	$1,682,730	$1,136,792	$100,000	$67,556	-$108,579	-$73,352	-$1,528,178	-$1,032,382	$3,051,147	$2,061,246
2019		$0	$750,000	$487,186	$124,166	$80,656	**$1,302,600**	$846,144	**$211,421**	$137,335	$547,200	$355,451	$1,682,730	$1,093,069	$100,000	$64,958	-$109,995	-$71,450	-$1,548,054	-$1,005,587	$3,060,068	$1,987,762
2020		$0	$750,000	$468,448	$125,097	$78,135	**$1,320,300**	$824,655	**$211,421**	$132,053	$554,000	$346,027	$1,682,730	$1,051,028	$100,000	$62,460	-$111,480	-$69,630	-$1,567,931	-$979,325	$3,064,137	$1,913,851
2021		$0	$750,000	$450,431	$126,028	$75,689	**$1,337,900**	$803,508	**$211,421**	$126,974	$560,800	$336,802	$1,682,730	$1,010,604	$100,000	$60,057	-$112,966	-$67,845	-$1,587,807	-$953,596	$3,068,106	$1,842,625
2022		$0	$750,000	$433,106	$126,980	$73,328	**$1,355,500**	$782,767	**$216,288**	$124,901	$567,600	$327,775	$1,682,730	$971,735	$100,000	$57,748	-$114,382	-$66,053	-$1,607,683	-$928,397	$3,077,033	$1,776,910
2023		$0	$750,000	$416,448	$127,911	$71,024	**$1,373,200**	$762,489	**$216,288**	$120,097	$574,400	$318,944	$1,682,730	$934,360	$100,000	$55,526	-$115,868	-$64,337	-$1,627,559	-$903,726	$3,081,102	$1,710,827
2024		$0	$750,000	$400,431	$128,856	$68,797	**$1,390,800**	$742,559	**$216,288**	$115,478	$581,200	$310,307	$1,682,730	$898,423	$100,000	$53,391	-$117,353	-$62,656	-$1,647,435	-$879,579	$3,085,086	$1,647,152
2025		$0	$750,000	$385,030	$129,787	$66,629	**$1,408,400**	$723,035	**$221,155**	$113,535	$588,000	$301,863	$1,682,730	$863,869	$100,000	$51,337	-$118,769	-$60,973	-$1,667,311	-$855,953	$3,093,992	$1,588,373
2026		$0	$750,000	$370,221	$130,732	$64,533	**$1,426,100**	$703,963	**$221,155**	$109,166	$594,800	$293,610	$1,682,730	$830,643	$100,000	$49,363	-$120,255	-$59,361	-$1,687,187	-$832,843	$3,098,075	$1,529,297
2027		$0	$750,000	$355,982	$131,663	$62,493	**$1,443,700**	$685,241	**$221,155**	$104,970	$601,600	$285,545	$1,682,730	$798,695	$100,000	$47,464	-$121,741	-$57,783	-$1,707,064	-$810,245	$3,102,044	$1,472,362
2028		$0	$750,000	$342,290	$132,615	$60,524	**$1,461,300**	$666,918	**$226,022**	$103,154	$608,400	$277,666	$1,682,730	$767,976	$100,000	$45,639	-$123,156	-$56,207	-$1,726,940	-$788,153	$3,110,972	$1,419,807
2029		$0	$750,000	$329,125	$133,546	$58,604	**$1,478,900**	$648,991	**$226,022**	$99,186	$615,200	$269,970	$1,682,730	$738,438	$100,000	$43,883	-$124,642	-$54,697	-$1,746,816	-$766,562	$3,114,941	$1,366,941
2030		$0	$750,000	$316,467	$134,477	$56,743	**$1,496,700**	$631,541	**$226,022**	$95,371	$622,000	$262,456	$1,682,730	$710,037	$100,000	$42,196	-$126,128	-$53,220	-$1,766,692	-$745,465	$3,119,110	$1,316,125
2031		$0	$750,000	$304,295	$135,331	$54,907	**$1,512,200**	$613,539	**$226,022**	$91,703	$628,300	$254,918	$1,682,730	$682,728	$100,000	$40,573	-$127,583	-$51,764	-$1,786,159	-$724,692	$3,120,841	$1,266,208
2032		$0	$750,000	$292,591	$136,185	$53,129	**$1,527,600**	$595,950	**$230,890**	$90,075	$634,500	$247,532	$1,682,730	$656,469	$100,000	$39,012	-$128,968	-$50,313	-$1,805,626	-$704,414	$3,127,310	$1,220,031
2033		$0	$750,000	$281,338	$137,025	$51,400	**$1,543,000**	$578,805	**$230,890**	$86,611	$640,800	$240,375	$1,682,730	$631,220	$100,000	$37,512	-$130,424	-$48,924	-$1,825,093	-$684,623	$3,128,928	$1,173,713
2034		$0	$750,000	$270,517	$137,879	$49,731	**$1,558,400**	$562,098	**$230,890**	$83,279	$647,100	$233,402	$1,682,730	$606,943	$100,000	$36,069	-$131,879	-$47,567	-$1,844,560	-$665,313	$3,130,559	$1,129,159
2035		$0	$750,000	$260,112	$138,733	$48,115	**$1,573,800**	$545,820	**$235,757**	$81,764	$653,400	$226,610	$1,682,730	$583,599	$100,000	$34,682	-$133,264	-$46,218	-$1,864,028	-$646,476	$3,137,128	$1,088,008
2036		$0	$750,000	$250,108	$139,573	$46,544	**$1,589,300**	$529,996	**$235,757**	$78,620	$659,700	$219,995	$1,682,730	$561,153	$100,000	$33,348	-$134,720	-$44,926	-$1,883,495	-$628,103	$3,138,845	$1,046,734
2037		$0	$750,000	$240,489	$140,427	$45,028	**$1,604,700**	$514,549	**$235,757**	$75,596	$666,000	$213,554	$1,682,730	$539,570	$100,000	$32,065	-$136,175	-$43,665	-$1,902,962	-$610,187	$3,140,477	$1,006,998
2038		$0	$750,000	$231,239	$141,281	$43,560	**$1,620,100**	$499,507	**$235,757**	$72,688	$672,200	$207,252	$1,682,730	$518,817	$100,000	$30,832	-$137,630	-$42,434	-$1,922,429	-$592,721	$3,142,009	$968,740
2039		$0	$750,000	$222,345	$142,121	$42,133	**$1,635,500**	$484,861	**$240,624**	$71,335	$678,500	$201,148	$1,682,730	$498,863	$100,000	$29,646	-$139,016	-$41,213	-$1,941,896	-$575,695	$3,148,563	$933,424
2040	$4,527,000	$1,290,457	$750,000	$213,793	$142,982	$40,758	**$1,650,900**	$470,602	**$240,624**	$68,592	$684,800	$195,208	$1,728,000	$492,580	$100,000	$28,506	-$140,471	-$40,042	-$1,961,363	-$559,102	$7,722,472	$2,201,352
2041		$0	$750,000	$205,571	$143,836	$39,425	**$1,666,300**	$456,723	**$240,624**	$65,954	$691,100	$189,426	$1,728,000	$473,635	$100,000	$27,409	-$141,926	-$38,901	-$1,980,830	-$542,934	$3,197,104	$876,308
2042		$0	$750,000	$197,664	$144,676	$38,130	**$1,681,800**	$443,242	**$240,624**	$63,417	$697,400	$183,801	$1,728,000	$455,418	$100,000	$26,355	-$143,381	-$37,788	-$2,000,297	-$527,183	$3,198,821	$843,056
2043		$0	$750,000	$190,062	$145,530	$36,880	**$1,697,200**	$430,097	**$245,491**	$62,211	$703,600	$178,303	$1,728,000	$437,902	$100,000	$25,342	-$144,767	-$36,686	-$2,019,764	-$511,840	$3,205,290	$812,270
2044		$0	$750,000	$182,752	$146,384	$35,669	**$1,712,600**	$417,307	**$245,491**	$59,819	$709,900	$172,980	$1,728,000	$421,060	$100,000	$24,367	-$146,222	-$35,630	-$2,039,231	-$496,897	$3,206,922	$781,427
2045		$0	$750,000	$175,723	$147,224	$34,494	**$1,727,600**	$404,771	**$245,491**	$57,518	$716,200	$167,803	$1,728,000	$404,865	$100,000	$23,430	-$147,677	-$34,600	-$2,058,699	-$482,347	$3,208,139	$751,657
2046		$0	$750,000	$168,964	$147,826	$33,303	**$1,739,200**	$391,816	**$250,358**	$56,402	$720,900	$162,408	$1,728,000	$389,293	$100,000	$22,529	-$148,538	-$33,464	-$2,071,366	-$466,649	$3,216,380	$724,604
2047		$0	$750,000	$162,465	$148,435	$32,154	**$1,750,900**	$379,281	**$250,358**	$54,233	$725,600	$157,180	$1,728,000	$374,320	$100,000	$21,662	-$149,469	-$32,378	-$2,084,033	-$451,445	$3,219,791	$697,473
2048		$0	$750,000	$156,217	$149,051	$31,046	**$1,762,500**	$367,109	**$250,358**	$52,147	$730,300	$152,113	$1,728,000	$359,923	$100,000	$20,829	-$150,400	-$31,327	-$2,096,701	-$436,720	$3,223,109	$671,338
2049		$0	$750,000	$150,208	$149,660	$29,974	**$1,774,200**	$355,333	**$250,358**	$50,141	$735,000	$147,204	$1,728,000	$346,080	$100,000	$20,028	-$151,331	-$30,308	-$2,109,368	-$422,460	$3,226,519	$646,201
2050		$0	$750,000	$144,431	$150,255	$28,935	**$1,785,800**	$343,900	**$250,358**	$48,213	$739,700	$142,448	$1,728,000	$332,769	$100,000	$19,257	-$152,262	-$29,322	-$2,122,036	-$408,651	$3,229,816	$621,982
2051		$0	$750,000	$138,876	$150,857	$27,934	**$1,797,500**	$332,840	**$255,226**	$47,260	$744,400	$137,839	$1,728,000	$319,971	$100,000	$18,517	-$153,123	-$28,354	-$2,134,703	-$395,279	$3,238,157	$599,604
2052		$0	$750,000	$133,535	$151,466	$26,968	**$1,809,100**	$322,104	**$255,226**	$45,442	$749,100	$133,375	$1,728,000	$307,664	$100,000	$17,805	-$154,054	-$27,429	-$2,147,370	-$382,331	$3,241,467	$577,131
2053		$0	$750,000	$128,399	$152,068	$26,034	**$1,820,800**	$311,718	**$255,226**	$43,694	$753,800	$129,049	$1,728,000	$295,831	$100,000	$17,120	-$154,985	-$26,533	-$2,160,038	-$369,795	$3,244,871	$555,517
2054		$0	$750,000	$123,460	$152,677	$25,133	**$1,832,400**	$301,638	**$255,226**	$42,014	$758,500	$124,860	$1,728,000	$284,453	$100,000	$16,461	-$155,916	-$25,666	-$2,172,705	-$357,657	$3,248,182	$534,696
2055		$0	$750,000	$118,712	$153,272	$24,260	**$1,844,100**	$291,889	**$255,226**	$40,398	$763,200	$120,801	$1,728,000	$273,512	$100,000	$15,828	-$156,847	-$24,826	-$2,185,373	-$345,906	$3,251,576	$514,666
2056		$0	$750,000	$114,146	$153,874	$23,419	**$1,855,700**	$282,428	**$260,093**	$39,585	$767,900	$116,870	$1,728,000	$262,993	$100,000	$15,219	-$157,708	-$24,002	-$2,198,040	-$334,530	$3,259,819	$496,127
2057		$0	$750,000	$109,756	$154,483	$22,607	**$1,867,400**	$273,277	**$260,093**	$38,062	$772,600	$113,063	$1,728,000	$252,877	$100,000	$14,634	-$158,639	-$23,215	-$2,210,708	-$323,517	$3,263,230	$477,545
2058		$0	$750,000	$105,534	$155,085	$21,822	**$1,879,000**	$264,399	**$260,093**	$36,598	$777,300	$109,376	$1,728,000	$243,151	$100,000	$14,071	-$159,570	-$22,453	-$2,223,375	-$312,857	$3,266,533	$459,642
2059		$0	$750,000	$101,475	$155,694	$21,065	**$1,890,700**	$255,813	**$260,093**	$35,191	$782,000	$105,805	$1,728,000	$233,799	$100,000	$13,530	-$160,500	-$21,716	-$2,236,042	-$302,538	$3,269,944	$442,425
2060		$0	$750,000	$97,573	$156,289	$20,333	**$1,902,300**	$247,483	**$260,093**	$33,837	$786,600	$102,334	$1,728,000	$224,807	$100,000	$13,010	-$161,431	-$21,002	-$2,248,710	-$292,550	$3,273,141	$425,825
2061		$0	$750,000	$93,820	$156,891	$19,626	**$1,914,000**	$239,428	**$264,960**	$33,145	$791,300	$98,986	$1,728,000	$216,161	$100,000	$12,509	-$162,293	-$20,302	-$2,261,377	-$282,882	$3,281,481	$410,490
2062		$0	$750,000	$90,211	$157,500	$18,944	**$1,925,600**	$231,615	**$264,960**	$31,870	$796,000	$95,744	$1,728,000	$207,847	$100,000	$12,028	-$163,223	-$19,633	-$2,274,045	-$273,526	$3,284,792	$395,100
2063		$0	$750,000	$86,742	$158,102	$18,285	**$1,937,300**	$224,059	**$264,960**	$30,644	$800,700	$92,605	$1,728,000	$199,853	$100,000	$11,566	-$164,154	-$18,985	-$2,286,712	-$264,471	$3,288,196	$380,296
2064		$0	$750,000	$83,405	$158,711	$17,650	**$1,948,900**	$216,732	**$264,960**	$29,465	$805,400	$89,566	$1,728,000	$192,166	$100,000	$11,121	-$165,085	-$18,359	-$2,299,379	-$255,708	$3,291,506	$366,039
2065		$0	$750,000	$80,198	$159,306	$17,035	**$1,740,100**	$186,069	**$269,827**	$28,853	$810,100	$86,624	$1,728,000	$184,775	$100,000	$10,693	-$165,946	-$17,745	-$2,312,047	**-$247,227**	$3,079,340	$329,274
Total Capital =	$172,800,000																					
Total Net Present Value =		$129,164,107		$12,243,521		$2,221,416		$24,860,314		$3,744,185		$10,361,879		$27,684,554		$1,632,469		-$2,107,662		-$29,508,328		**$180,296,457**

Notes:
1. Includes **diesel fuel**, driver, maintenance costs.
2. Assumes dispoal in a purpose built landfill.
3. Assumes CRD would be able to "sell" credits from biomethane.

Capital Regional District - Core Area Wastewater Management Strategy: Program Development Phase, Integrated Resource Management Strategy - Biosolids Management / Organic Residuals Energy and Resource Recovery

File: 20062935.04.E.03.01
Prepared: D. Shiskowski, D. Forgie
Last Revision: November 28, 2008
Last Revision By: D. Shiskowski

Subject: Strategy 4
Separate Digestion and
Balanced Energy / Beneficial Reuse
Material Flows
and GHG Emissions

Note: **Coloured cells contain data linked to external spreadsheets**

Year	Materials														GHG Sources			GHG Offsets		Total GHG Emissions
	Electricity			Biogas					Biomethane[1]		Diesel Fuel									
				WW Sludges		SW Organics			WW Sludges	SW Organics										
	WW Sludges (kWh/yr)	SW Organics (kWh/yr)	Total (kWh/yr)	Boiler (m3/yr)	for Biomethane (m3/yr)	Boiler (m3/yr)	for Biomethane (m3/yr)	System Loss (m3/yr)	Available for Sale (GJ/yr)	Available for Sale (GJ/yr)	WW Sludges[3] (L/yr)	SW Organics[2] (L/yr)	Total (L/yr)	Land Applied SW Organics (dry t/yr)	Electricity Purchased (t CO2e/yr)	Biogas Lost (t CO2e/yr)	Diesel Fuel Combusted (t CO2e/yr)	Avoided Commercial Fertilizer Use via SW Organics (t CO2e/yr)	Avoided Natural Gas Use via Biomethane (t CO2e/yr)	(t CO2e/yr)
2008																				
2009																				
2010																				
2011																				
2012																				
2013																				
2014																				
2015																				
2016	-557,800	887,000	329,200	2,369,141	1,681,970	1,165,570	4,292,897	95,096	37,299	95,199	22,180	41,625	63,805	2,568	24	941	176	-64	-7,452	-6,376
2017	-576,600	890,900	314,300	2,393,156	1,717,658	1,170,393	4,338,533	96,197	38,091	96,211	22,190	41,625	63,815	2,593	23	952	176	-65	-7,554	-6,468
2018	-594,500	894,800	300,300	2,417,172	1,753,346	1,175,215	4,384,169	97,299	38,882	97,223	22,190	41,625	63,815	2,618	22	963	176	-65	-7,655	-6,560
2019	-614,300	898,600	284,300	2,441,187	1,789,035	1,180,037	4,429,804	98,401	39,674	98,235	23,880	41,625	65,505	2,643	20	974	181	-66	-7,757	-6,648
2020	-632,100	902,500	270,400	2,465,203	1,824,723	1,184,860	4,475,440	99,502	40,465	99,247	23,890	41,625	65,515	2,668	19	985	181	-67	-7,858	-6,740
2021	-652,000	906,300	254,300	2,489,218	1,860,411	1,189,682	4,521,076	100,604	41,256	100,259	23,890	42,113	66,003	2,692	18	996	182	-67	-7,960	-6,831
2022	-669,800	909,200	239,400	2,513,234	1,896,099	1,194,505	4,566,711	101,705	42,048	101,271	23,890	42,113	66,003	2,717	17	1,007	182	-68	-8,061	-6,923
2023	-689,700	913,000	223,300	2,537,249	1,931,787	1,199,327	4,612,347	102,807	42,839	102,283	23,890	42,113	66,003	2,742	16	1,017	182	-69	-8,162	-7,015
2024	-707,500	916,900	209,400	2,561,265	1,967,475	1,204,149	4,657,983	103,909	43,631	103,295	25,590	42,113	67,703	2,767	15	1,028	187	-69	-8,264	-7,103
2025	-727,300	920,800	193,500	2,585,280	2,003,164	1,208,972	4,703,619	105,010	44,422	104,307	25,590	42,113	67,703	2,792	14	1,039	187	-70	-8,365	-7,195
2026	-745,200	924,600	179,400	2,609,296	2,038,852	1,213,794	4,749,254	106,112	45,214	105,319	25,590	42,113	67,703	2,816	13	1,050	187	-70	-8,467	-7,287
2027	-765,000	927,500	162,500	2,633,311	2,074,540	1,218,616	4,794,890	107,214	46,005	106,331	25,600	42,600	68,200	2,841	12	1,061	188	-71	-8,568	-7,378
2028	-782,900	931,300	148,400	2,657,327	2,110,228	1,223,439	4,840,526	108,315	46,796	107,344	25,600	42,600	68,200	2,866	11	1,072	188	-72	-8,670	-7,471
2029	-800,600	935,200	134,600	2,681,342	2,145,916	1,228,261	4,886,162	109,417	47,588	108,356	25,600	42,600	68,200	2,891	10	1,083	188	-72	-8,771	-7,563
2030	-820,500	939,100	118,600	2,705,357	2,181,604	1,233,084	4,931,797	110,518	48,379	109,368	27,300	42,600	69,900	2,916	9	1,094	193	-73	-8,872	-7,650
2031	-836,600	943,100	106,500	2,729,373	2,208,492	1,237,906	4,977,433	111,532	48,976	110,380	27,300	42,600	69,900	2,943	8	1,104	193	-74	-8,963	-7,732
2032	-853,600	947,200	93,600	2,753,388	2,235,379	1,242,728	5,023,069	112,546	49,572	111,392	27,300	42,600	69,900	2,971	7	1,114	193	-74	-9,053	-7,814
2033	-868,700	950,300	81,600	2,777,404	2,262,267	1,247,551	5,068,705	113,559	50,168	112,404	27,300	43,088	70,388	2,999	6	1,124	194	-75	-9,144	-7,895
2034	-884,800	954,400	69,600	2,801,419	2,289,155	1,252,373	5,114,340	114,573	50,764	113,416	27,310	43,088	70,398	3,027	5	1,134	194	-76	-9,234	-7,977
2035	-901,900	958,400	56,500	2,825,435	2,316,042	1,257,196	5,159,976	115,586	51,361	114,428	27,310	43,088	70,398	3,054	4	1,144	194	-76	-9,325	-8,059
2036	-917,900	962,500	44,600	2,849,450	2,342,930	1,262,018	5,205,612	116,600	51,957	115,440	29,000	43,088	72,088	3,082	3	1,154	199	-77	-9,415	-8,136
2037	-934,000	966,600	32,600	2,873,466	2,369,817	1,266,840	5,251,247	117,614	52,553	116,452	29,000	43,088	72,088	3,110	2	1,164	199	-78	-9,506	-8,218
2038	-951,100	970,700	19,600	2,897,481	2,396,705	1,271,663	5,296,883	118,627	53,149	117,464	29,010	43,575	72,585	3,138	1	1,174	200	-78	-9,596	-8,299
2039	-967,100	973,700	6,600	2,921,497	2,423,592	1,276,485	5,342,519	119,641	53,746	118,476	29,010	43,575	72,585	3,165	0	1,184	200	-79	-9,687	-8,381
2040	-984,200	977,800	-6,400	2,945,512	2,450,480	1,281,307	5,388,155	120,655	54,342	119,488	29,010	43,575	72,585	3,193	0	1,194	200	-80	-9,777	-8,463
2041	-1,000,200	981,900	-18,300	2,969,528	2,477,367	1,286,130	5,433,790	121,668	54,938	120,500	29,010	43,575	72,585	3,221	-1	1,204	200	-81	-9,867	-8,545
2042	-1,015,300	986,000	-29,300	2,993,543	2,504,255	1,290,952	5,479,426	122,682	55,534	121,512	30,710	43,575	74,285	3,249	-2	1,214	205	-81	-9,958	-8,622
2043	-1,032,400	990,000	-42,400	3,017,559	2,531,142	1,295,775	5,525,062	123,695	56,131	122,524	30,710	44,063	74,773	3,276	-3	1,224	206	-82	-10,048	-8,703
2044	-1,048,500	994,100	-54,400	3,041,574	2,558,030	1,300,597	5,570,698	124,709	56,727	123,536	30,710	44,063	74,773	3,304	-4	1,234	206	-83	-10,139	-8,785
2045	-1,064,600	997,200	-67,400	3,065,590	2,584,917	1,305,419	5,616,333	125,723	57,323	124,548	30,710	44,063	74,773	3,332	-5	1,244	206	-83	-10,229	-8,867
2046	-1,077,300	1,000,700	-76,600	3,089,605	2,599,571	1,310,242	5,661,969	126,614	57,648	125,560	30,720	44,063	74,783	3,352	-6	1,253	206	-84	-10,304	-8,935
2047	-1,091,100	1,004,200	-86,900	3,113,620	2,614,225	1,315,064	5,707,605	127,505	57,973	126,572	30,720	44,063	74,783	3,372	-6	1,262	206	-84	-10,380	-9,002
2048	-1,103,900	1,007,700	-96,200	3,137,636	2,628,879	1,319,887	5,753,241	128,396	58,298	127,584	30,720	44,063	74,783	3,392	-7	1,271	206	-85	-10,455	-9,070
2049	-1,116,600	1,011,200	-105,400	3,161,651	2,643,533	1,324,709	5,798,876	129,288	58,623	128,596	32,410	44,063	76,473	3,412	-8	1,280	211	-85	-10,530	-9,133
2050	-1,130,400	1,013,700	-116,700	3,185,667	2,658,187	1,329,531	5,844,512	130,179	58,948	129,608	32,410	44,550	76,960	3,432	-8	1,288	212	-86	-10,605	-9,199
2051	-1,143,200	1,017,200	-126,000	3,209,682	2,672,841	1,334,354	5,890,148	131,070	59,273	130,620	32,420	44,550	76,970	3,452	-9	1,297	212	-86	-10,680	-9,266
2052	-1,155,000	1,020,700	-134,300	3,233,698	2,687,495	1,339,176	5,935,783	131,962	59,598	131,632	32,420	44,550	76,970	3,472	-10	1,306	212	-87	-10,756	-9,334
2053	-1,167,700	1,024,200	-143,500	3,257,713	2,702,149	1,343,998	5,981,419	132,853	59,923	132,644	32,420	44,550	76,970	3,492	-10	1,315	212	-87	-10,831	-9,401
2054	-1,181,500	1,027,700	-153,800	3,281,729	2,716,803	1,348,821	6,027,055	133,744	60,248	133,656	32,420	44,550	76,970	3,512	-11	1,324	212	-88	-10,906	-9,469
2055	-1,194,300	1,031,200	-163,100	3,305,744	2,731,457	1,353,643	6,072,691	134,635	60,573	134,668	32,420	44,550	76,970	3,532	-12	1,332	212	-88	-10,981	-9,537
2056	-1,207,100	1,033,700	-173,400	3,329,760	2,746,111	1,358,466	6,118,326	135,527	60,898	135,680	32,430	44,550	76,980	3,552	-12	1,341	212	-89	-11,056	-9,604
2057	-1,220,900	1,037,200	-183,700	3,353,775	2,760,765	1,363,288	6,163,962	136,418	61,223	136,692	32,430	44,550	76,980	3,572	-13	1,350	212	-89	-11,132	-9,672
2058	-1,232,700	1,040,700	-192,000	3,377,791	2,775,419	1,368,110	6,209,598	137,309	61,548	137,704	34,120	45,038	79,158	3,592	-14	1,359	218	-90	-11,207	-9,733
2059	-1,245,400	1,044,200	-201,200	3,401,806	2,790,073	1,372,933	6,255,234	138,200	61,873	138,716	34,120	45,038	79,158	3,612	-14	1,368	218	-90	-11,282	-9,801
2060	-1,259,200	1,047,700	-211,500	3,425,822	2,804,727	1,377,755	6,300,869	139,092	62,198	139,728	34,120	45,038	79,158	3,632	-15	1,377	218	-91	-11,357	-9,868
2061	-1,272,000	1,051,200	-220,800	3,449,837	2,819,381	1,382,578	6,346,505	139,983	62,523	140,740	34,130	45,038	79,168	3,652	-16	1,385	218	-91	-11,432	-9,936
2062	-1,284,700	1,053,700	-231,000	3,473,853	2,834,035	1,387,400	6,392,141	140,874	62,848	141,752	34,130	45,038	79,168	3,672	-17	1,394	218	-92	-11,508	-10,004
2063	-1,296,500	1,057,200	-239,300	3,497,868	2,848,689	1,392,222	6,437,777	141,766	63,173	142,764	34,130	45,038	79,168	3,692	-17	1,403	218	-92	-11,583	-10,071
2064	-1,311,300	1,060,700	-250,600	3,521,884	2,863,343	1,397,045	6,483,412	142,657	63,497	143,776	34,130	45,038	79,168	3,712	-18	1,412	218	-93	-11,658	-10,139
2065	-1,323,100	1,064,200	-258,900	3,545,899	2,877,997	1,401,867	6,529,048	143,548	63,822	144,788	34,130	45,525	79,655	3,732	-19	1,421	220	-93	-11,733	-10,205
Totals =	-48,610,600	48,900,600	290,000	147,875,996	119,703,060	64,185,932	270,548,627	6,023,136	2,654,535	5,999,686	1,457,220	2,175,338	3,632,558	159,033	21	59,610	10,014	-3,976	-486,753	**-421,084**

Notes:
1. Accounts for system loss of biogas.
2. Includes transport of compost product to distribution site for public pickup.
3. Hauling FBC ash to landfill.

Capital Regional District - Core Area Wastewater Management Strategy: Program Development Phase, Integrated Resource Management Strategy - Biosolids Management / Organic Residuals Energy and Resource Recovery

File: 20062935.04.E.03.01
Prepared: D. Shiskowski, D. Forgie
Last Revision: November 28, 2006
Last Revision By: D. Shiskowski

Subject: Strategy 4
Separate Digestion and
Balanced Energy / Beneficial Reuse
Discount Rate Base
Life-Cycle Analysis

Yellow-shaded cell denotes assumed/input values
Note: Other coloured cells contain data linked to external spreadsheets

Year	Capital Costs				Operations & Maintenance Costs																GHG CO2e[4]		Value of Electricity Produced[5]		Biomethane Revenues		Total	
					Labour				Electricity[3]		Chemicals				Trucking/Equipment[1]				Ash Disposal[2]		Maintenance		Administration							
	WW Sludges	SW Organics	Total Cost	Net Present Value	WW Sludges Annual Cost	SW Organics Annual Cost	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	WW Sludges[2] Annual Cost	SW Organics Annual Cost	Total Annual Cost	Net Present Value	WW Sludges Annual Cost	SW Organics Annual Cost	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Rev	Net Present Value	Total Annual Cost	Net Present Value
2008																														
2009																														
2010																														
2011																														
2012																														
2013																														
2014																														
2015	$102,690,000	$56,800,000	$159,490,000	$121,199,292																									$159,490,000	$121,199,292
2016	$0	$0	$675,000	$675,000	$1,350,000	$986,432	$62,090	$45,369	$459,500	$205,500	$665,000	$485,909	$64,000	$119,880	$183,880	$134,359	$337,000	$246,243	$1,594,900	$1,165,378	$100,000	$73,069	-$94,666	-$69,318	-$39,046	-$28,531	-$1,324,987	-$968,155	$2,833,971	$2,070,755
2017	$0	$0	$675,000	$675,000	$1,350,000	$948,492	$62,363	$43,915	$466,800	$207,500	$674,100	$473,614	$64,000	$119,880	$183,880	$129,192	$342,000	$240,285	$1,594,900	$1,120,556	$100,000	$70,259	-$96,242	-$67,618	-$40,362	-$26,358	-$1,345,021	-$943,589	$2,827,618	$1,986,647
2018	$0	$0	$675,000	$675,000	$1,350,000	$912,012	$62,636	$42,315	$473,700	$209,500	$683,200	$461,545	$64,000	$119,880	$183,880	$124,223	$347,000	$234,421	$1,594,900	$1,077,457	$100,000	$67,556	-$97,617	-$65,946	-$41,615	-$28,114	-$1,361,055	-$919,480	$2,821,329	$1,905,989
2019	$0	$0	$675,000	$675,000	$1,350,000	$876,934	$62,902	$40,860	$479,700	$211,500	$691,200	$448,990	$68,900	$119,880	$188,780	$122,628	$352,000	$228,652	$1,594,900	$1,036,017	$100,000	$64,958	-$98,824	-$64,259	-$43,001	-$27,933	-$1,379,086	-$895,839	$2,818,767	$1,831,017
2020	$0	$0	$675,000	$675,000	$1,350,000	$843,206	$63,175	$39,459	$486,800	$213,500	$700,300	$437,405	$68,900	$119,880	$188,780	$117,911	$357,000	$222,981	$1,594,900	$996,170	$100,000	$62,460	-$100,299	-$62,646	-$44,247	-$27,637	-$1,397,124	-$872,640	$2,812,485	$1,756,670
2021	$0	$0	$675,000	$675,000	$1,350,000	$810,775	$63,441	$38,101	$493,900	$215,400	$709,300	$425,987	$68,900	$121,284	$190,184	$114,220	$362,000	$217,408	$1,594,900	$957,856	$100,000	$60,057	-$101,656	-$61,052	-$45,646	-$27,410	-$1,415,159	-$849,908	$2,807,371	$1,686,034
2022	$0	$0	$675,000	$675,000	$1,350,000	$779,591	$63,644	$36,753	$500,000	$217,400	$717,400	$414,281	$68,900	$121,284	$190,184	$109,827	$367,000	$211,933	$1,594,900	$921,015	$100,000	$57,748	-$103,032	-$59,498	-$46,886	-$27,075	-$1,433,193	-$827,633	$2,800,018	$1,616,940
2023	$0	$0	$675,000	$675,000	$1,350,000	$749,607	$63,910	$35,487	$507,000	$219,400	$726,400	$403,344	$68,900	$121,284	$190,184	$105,602	$372,000	$206,558	$1,594,900	$885,591	$100,000	$55,526	-$104,409	-$57,974	-$48,279	-$26,808	-$1,451,227	-$805,815	$2,793,479	$1,551,120
2024	$0	$0	$675,000	$675,000	$1,350,000	$720,776	$64,183	$34,268	$514,100	$221,400	$735,500	$392,689	$73,800	$121,284	$195,084	$104,157	$377,000	$201,289	$1,594,900	$851,530	$100,000	$53,391	-$105,715	-$56,441	-$49,525	-$26,442	-$1,469,262	-$784,451	$2,792,167	$1,490,761
2025	$0	$0	$675,000	$675,000	$1,350,000	$693,054	$64,456	$33,090	$520,200	$223,400	$743,600	$381,744	$73,800	$121,284	$195,084	$100,151	$382,000	$196,109	$1,594,900	$818,779	$100,000	$51,337	-$107,090	-$54,977	-$50,911	-$26,138	-$1,487,296	-$763,538	$2,784,743	$1,429,612
2026	$0	$0	$675,000	$675,000	$1,350,000	$666,398	$64,722	$31,949	$527,200	$225,400	$752,600	$371,505	$73,800	$121,284	$195,084	$96,299	$387,000	$191,034	$1,594,900	$787,287	$100,000	$49,363	-$108,465	-$53,542	-$52,164	-$25,750	-$1,505,330	-$743,073	$2,778,346	$1,371,470
2027	$0	$0	$675,000	$675,000	$1,350,000	$640,767	$64,925	$30,816	$534,300	$227,400	$761,700	$361,535	$73,800	$122,688	$196,488	$93,262	$392,000	$186,060	$1,594,900	$757,007	$100,000	$47,464	-$109,823	-$52,127	-$53,550	-$25,417	-$1,523,365	-$723,054	$2,773,275	$1,316,314
2028	$0	$0	$675,000	$675,000	$1,350,000	$616,122	$65,191	$29,752	$541,400	$229,300	$770,700	$351,737	$73,900	$122,688	$196,588	$89,720	$397,000	$181,186	$1,594,900	$727,892	$100,000	$45,639	-$111,198	-$50,749	-$54,803	-$25,011	-$1,541,399	-$703,474	$2,766,979	$1,262,813
2029	$0	$0	$675,000	$675,000	$1,350,000	$592,425	$65,464	$28,728	$547,400	$231,300	$778,700	$341,720	$73,900	$122,688	$196,588	$86,269	$402,000	$176,411	$1,594,900	$699,896	$100,000	$43,883	-$112,573	-$49,401	-$56,040	-$24,593	-$1,559,434	-$684,332	$2,759,604	$1,211,007
2030	$0	$0	$675,000	$675,000	$1,350,000	$569,640	$65,737	$27,738	$554,600	$233,300	$787,800	$332,418	$78,700	$122,688	$201,388	$84,977	$407,000	$171,736	$1,594,900	$672,977	$100,000	$42,196	-$113,879	-$48,052	-$57,435	-$24,235	-$1,577,466	-$665,821	$2,758,043	$1,163,777
2031	$0	$0	$675,000	$675,000	$1,350,000	$547,731	$66,017	$26,786	$550,400	$235,500	$795,900	$322,918	$78,700	$122,688	$201,388	$81,708	$411,000	$166,754	$1,594,900	$647,093	$100,000	$40,573	-$115,101	-$46,700	-$58,562	-$23,760	-$1,593,551	-$646,545	$2,751,991	$1,116,555
2032	$0	$0	$675,000	$675,000	$1,350,000	$526,664	$66,304	$25,867	$556,300	$237,700	$804,000	$313,658	$78,700	$122,688	$201,388	$78,566	$415,000	$161,900	$1,594,900	$622,205	$100,000	$39,012	-$116,323	-$45,380	-$59,752	-$23,311	-$1,609,633	-$627,953	$2,745,883	$1,071,228
2033	$0	$0	$675,000	$675,000	$1,350,000	$506,408	$66,521	$24,953	$571,200	$240,000	$811,200	$304,295	$78,700	$124,092	$202,792	$76,071	$419,000	$157,174	$1,594,900	$598,274	$100,000	$37,512	-$117,525	-$44,085	-$60,809	-$22,810	-$1,625,716	-$609,833	$2,740,363	$1,027,956
2034	$0	$0	$675,000	$675,000	$1,350,000	$486,930	$66,808	$24,097	$577,100	$242,200	$819,300	$295,513	$78,700	$124,092	$202,792	$73,145	$424,000	$152,593	$1,594,900	$575,263	$100,000	$36,069	-$118,746	-$42,830	-$61,936	-$22,340	-$1,641,799	-$592,179	$2,735,319	$986,600
2035	$0	$0	$675,000	$675,000	$1,350,000	$468,202	$67,098	$23,267	$583,100	$244,400	$827,500	$286,991	$78,700	$124,092	$202,792	$70,332	$428,000	$148,437	$1,594,900	$553,138	$100,000	$34,682	-$119,958	-$41,607	-$63,133	-$21,896	-$1,657,882	-$574,981	$2,729,297	$946,565
2036	$0	$0	$675,000	$675,000	$1,350,000	$450,195	$67,375	$22,468	$589,000	$246,600	$835,600	$278,654	$83,600	$124,092	$207,692	$69,261	$432,000	$144,062	$1,594,900	$531,863	$100,000	$33,348	-$121,120	-$40,391	-$64,253	-$21,427	-$1,673,965	-$558,229	$2,728,230	$909,803
2037	$0	$0	$675,000	$675,000	$1,350,000	$432,879	$67,662	$21,696	$594,900	$248,800	$843,700	$270,534	$83,600	$124,092	$207,692	$66,597	$436,000	$139,804	$1,594,900	$511,407	$100,000	$32,065	-$122,341	-$39,229	-$65,380	-$20,984	-$1,690,047	-$541,916	$2,722,186	$872,873
2038	$0	$0	$675,000	$675,000	$1,350,000	$416,230	$67,949	$20,959	$600,800	$251,100	$851,900	$262,657	$83,600	$125,496	$209,096	$64,466	$440,000	$135,660	$1,594,900	$491,737	$100,000	$30,832	-$123,543	-$38,091	-$66,577	-$20,527	-$1,706,130	-$526,032	$2,717,595	$837,885
2039	$29,345,000	$3,120,000	$32,465,000	$9,624,592	$675,000	$675,000	$1,350,000	$400,221	$68,159	$20,206	$606,700	$253,300	$860,000	$254,956	$83,600	$61,989	$445,000	$131,925	$1,919,550	$569,070	$100,000	$29,646	-$124,766	-$36,988	-$67,697	-$20,069	-$1,722,213	-$510,568	$35,502,130	$10,524,971
2040	$0	$0	$675,000	$675,000	$1,350,000	$384,828	$68,446	$19,511	$611,600	$255,500	$867,100	$247,174	$83,600	$125,496	$209,096	$59,604	$448,000	$127,811	$1,919,550	$547,189	$100,000	$28,506	-$125,988	-$35,914	-$68,894	-$19,639	-$1,738,296	-$495,515	$3,039,049	$863,730
2041	$0	$0	$675,000	$675,000	$1,350,000	$370,027	$68,733	$18,839	$617,500	$257,700	$875,200	$239,887	$83,700	$125,496	$209,196	$57,339	$453,000	$124,165	$1,919,550	$526,137	$100,000	$27,409	-$127,209	-$34,867	-$70,014	-$19,190	-$1,754,378	-$480,865	$3,024,077	$828,882
2042	$0	$0	$675,000	$675,000	$1,350,000	$355,795	$69,020	$18,190	$623,400	$259,900	$883,300	$232,796	$88,600	$125,496	$214,096	$56,425	$457,000	$120,443	$1,919,550	$505,901	$100,000	$26,355	-$128,359	-$33,829	-$71,071	-$18,731	-$1,770,461	-$466,609	$3,023,075	$796,738
2043	$0	$0	$675,000	$675,000	$1,350,000	$342,111	$69,300	$17,562	$629,300	$262,200	$891,500	$225,920	$88,600	$126,900	$215,500	$54,611	$462,000	$117,078	$1,919,550	$485,444	$100,000	$25,342	-$129,562	-$32,833	-$72,266	-$18,314	-$1,786,544	-$452,738	$3,019,476	$765,182
2044	$0	$0	$675,000	$675,000	$1,350,000	$328,953	$69,587	$16,956	$635,300	$264,400	$899,700	$219,229	$88,600	$126,900	$215,500	$52,511	$466,000	$113,550	$1,919,550	$467,734	$100,000	$24,367	-$130,783	-$31,868	-$73,395	-$17,884	-$1,802,627	-$439,244	$3,013,532	$734,304
2045	$0	$0	$675,000	$675,000	$1,350,000	$316,301	$69,804	$16,355	$641,200	$266,800	$907,800	$212,695	$88,600	$126,900	$215,500	$50,491	$470,000	$110,120	$1,919,550	$449,745	$100,000	$23,430	-$132,006	-$30,928	-$74,522	-$17,466	-$1,818,709	-$426,118	$3,007,417	$704,628
2046	$0	$0	$675,000	$675,000	$1,350,000	$304,135	$70,049	$15,781	$644,900	$268,200	$913,100	$205,708	$88,600	$126,900	$215,500	$48,549	$473,000	$106,580	$1,919,550	$432,447	$100,000	$22,529	-$133,012	-$29,966	-$75,411	-$16,989	-$1,832,079	-$412,741	$3,000,696	$676,013
2047	$0	$0	$675,000	$675,000	$1,350,000	$292,438	$70,294	$15,227	$649,500	$269,800	$919,300	$199,139	$88,600	$126,900	$215,500	$46,682	$476,000	$103,111	$1,919,550	$415,814	$100,000	$21,662	-$134,021	-$29,030	-$76,377	-$16,545	-$1,845,449	-$399,762	$2,994,797	$648,735
2048	$0	$0	$675,000	$675,000	$1,350,000	$281,190	$70,539	$14,693	$654,200	$271,400	$925,600	$192,792	$88,600	$126,900	$215,500	$44,886	$480,000	$99,979	$1,919,550	$399,821	$100,000	$20,828	-$135,026	-$28,125	-$77,275	-$16,095	-$1,858,815	-$387,172	$2,990,069	$622,799
2049	$0	$0	$675,000	$675,000	$1,350,000	$270,375	$70,784	$14,176	$658,900	$273,000	$931,900	$186,639	$93,400	$126,900	$220,300	$44,121	$483,000	$96,734	$1,919,550	$384,443	$100,000	$20,028	-$135,965	-$27,231	-$78,162	-$15,654	-$1,872,189	-$374,958	$2,989,218	$598,674
2050	$0	$0	$675,000	$675,000	$1,350,000	$259,976	$70,959	$13,665	$662,800	$274,800	$937,200	$180,481	$93,400	$128,304	$221,704	$42,695	$486,000	$93,591	$1,919,550	$369,657	$100,000	$19,257	-$136,954	-$26,374	-$79,126	-$15,236	-$1,885,559	-$363,111	$2,983,772	$574,600
2051	$0	$0	$675,000	$675,000	$1,350,000	$249,972	$71,204	$13,185	$667,300	$276,700	$943,500	$174,706	$93,400	$128,304	$221,704	$41,053	$489,000	$90,547	$1,919,550	$355,440	$100,000	$18,517	-$137,961	-$25,546	-$80,024	-$14,818	-$1,898,928	-$351,621	$2,978,044	$551,439
2052	$0	$0	$675,000	$675,000	$1,350,000	$240,363	$71,448	$12,721	$672,000	$277,800	$949,800	$169,108	$93,400	$128,304	$221,704	$39,474	$493,000	$87,777	$1,919,550	$341,769	$100,000	$17,805	-$138,967	-$24,743	-$80,850	-$14,395	-$1,912,296	-$340,478	$2,973,387	$529,401
2053	$0	$0	$675,000	$675,000	$1,350,000	$231,116	$71,694	$12,274	$676,700	$279,400	$955,100	$163,512	$93,400	$128,304	$221,704	$37,955	$496,000	$84,914	$1,919,550	$328,624	$100,000	$17,126	-$139,974	-$23,963	-$81,739	-$13,994	-$1,925,666	-$329,671	$2,966,667	$507,889
2054	$0	$0	$675,000	$675,000	$1,350,000	$222,225	$71,939	$11,842	$680,400	$281,000	$961,400	$158,260	$93,400	$128,304	$221,704	$36,496	$499,000	$82,142	$1,919,550	$315,985	$100,000	$16,461	-$140,983	-$23,208	-$82,705	-$13,614	-$1,939,036	-$319,193	$2,960,867	$487,400
2055	$0	$0	$675,000	$675,000	$1,350,000	$213,681	$72,184	$11,425	$685,100	$282,800	$967,700	$153,170	$93,400	$128,304	$221,704	$35,092	$502,000	$79,458	$1,919,550	$303,831	$100,000	$15,828	-$141,990	-$22,475	-$83,601	-$13,233	-$1,952,408	-$309,032	$2,955,139	$467,747
2056	$0	$0	$675,000	$675,000	$1,350,000	$205,463	$72,359	$11,013	$689,800	$284,200	$973,000	$148,086	$93,400	$128,304	$221,704	$33,742	$505,000	$76,858	$1,919,550	$292,145	$100,000	$15,219	-$142,998	-$21,764	-$84,497	-$12,860	-$1,965,778	-$299,181	$2,948,341	$448,722
2057	$0	$0	$675,000	$675,000	$1,350,000	$197,561	$72,604	$10,625	$693,500	$286,800	$979,300	$143,312	$93,500	$128,304	$221,804	$32,459	$509,000	$74,488	$1,919,550	$280,909	$100,000	$14,634	-$144,006	-$21,074	-$85,463	-$12,507	-$1,979,147	-$289,631	$2,943,642	$430,776
2058	$0	$0	$675,000	$675,000	$1,350,000	$169,962	$72,849	$10,251	$698,200	$287,400	$985,600	$138,686	$98,400	$129,708	$228,108	$32,098	$512,000	$72,045	$1,919,550	$270,105	$100,000	$14,071	-$144,922	-$20,392	-$86,289	-$12,142	-$1,992,517	-$280,372	$2,944,379	$414,311
2059	$0	$0	$675,000	$675,000	$1,350,000	$182,656	$73,094	$9,896	$701,900	$289,000	$990,900	$134,069	$98,400	$129,708	$228,108	$30,863	$515,000	$69,686	$1,919,550	$259,716	$100,000	$13,530	-$145,926	-$19,744	-$87,178	-$11,795	-$2,005,867	-$271,398	$2,937,658	$397,467
2060	$0	$0	$675,000	$675,000	$1,350,000	$175,631	$73,339	$9,541	$706,600	$290,600	$997,100	$129,719	$98,400	$129,708	$228,108	$29,676	$518,000	$67,396	$1,919,550	$249,727	$100,000	$13,010	-$146,937	-$19,116	-$88,144	-$11,467	-$2,019,257	-$262,899	$2,931,759	$381,412
2061	$0	$0	$675,000	$675,000	$1,350,000	$168,876	$73,584	$9,205	$711,299	$292,200	$1,003,400	$125,518	$98,400	$129,708	$228,108	$28,535	$521,000	$65,173	$1,919,550	$240,122	$100,000	$12,509	-$147,944	-$18,507	-$89,040	-$11,138	-$2,032,627	-$254,267	$2,926,031	$366,026
2062	$0	$0	$675,000	$675,000	$1,350,000	$162,380	$73,759	$8,872	$715,900	$293,800	$1,009,700	$121,448	$98,400	$129,708	$228,108	$27,437	$525,000	$63,148	$1,919,550	$230,887	$100,000	$12,028	-$148,952	-$17,916	-$89,929	-$10,817	-$2,045,997	-$246,096	$2,921,239	$351,372
2063	$0	$0	$675,000	$675,000	$1,350,000	$156,135	$74,004	$8,559	$719,600	$295,400	$1,015,000	$117,390	$98,400	$129,708	$228,108	$26,382	$528,000	$61,066	$1,919,550	$222,007	$100,000	$11,566	-$149,959	-$17,344	-$90,755	-$10,496	-$2,059,367	-$238,177	$2,914,582	$337,087
2064	$0	$0	$675,000	$675,000	$1,350,000	$150,130	$74,249	$8,257	$724,300	$297,000	$1,021,300	$113,576	$98,400	$129,708	$228,108	$25,367	$531,000	$59,051	$1,919,550	$213,468	$100,000	$11,121	-$150,968	-$16,789	-$91,791	-$10,206	-$2,072,736	-$230,503	$2,908,712	$323,470
2065	$0	$0	$675,000	$675,000	$1,350,000	$144,356	$74,494	$7,966	$729,000	$298,600	$1,027,600	$109,881	$98,400	$131,112	$229,512	$24,542	$534,000	$57,101	$1,919,550	$205,256	$100,000	$10,695	-$151,954	-$16,248	-$92,617	-$9,904	-$2,086,106	-$223,067	$2,904,479	$310,576
Total Capital =	$132,035,000	$59,920,000	$191,955,000																											
Total Net Present Value =				$130,823,674				$22,038,338		$1,085,369				$13,117,499				$3,294,017		$6,755,109		$27,670,776		$1,632,469		-$1,898,697		-$971,880		-$26,283,048		**$177,264,027**

Notes:
1. Includes **diesel fuel**, driver, maintenance costs.
2. Assumes disposal in a purpose built landfill.
3. Includes chemicals for FBC system operation.
4. Assumes CRD would be able to "sell" credits from biomethane. Excludes CO2e off-sets of commerical fertilizers by non-CRD end users (i.e. assumes that the CRD would not be able to sell these "credits").
5. Includes only SW organics electrical cost. Electricity produced by WW sludge FBC considered in note 6.
6. Not a saleable product; overall revenue neutral.

Capital Regional District - Core Area Wastewater Management Strategy: Program Development Phase, Integrated Resource Management Strategy - Biosolids Management / Organic Residuals Energy and Resource Recovery

File: 20062935.04.E.03.01
Prepared: D. Shiskowski, D. Forgie
Last Revision: November 28, 2008
Last Revision By: D. Shiskowski

Subject: Strategy 5a (FBC)
No Digestion and
Balanced Energy / Beneficial Reuse
Material Flows
and GHG Emissions

Note: **Coloured cells contain data linked to external spreadsheets**

Year	Materials							GHG Sources		GHG Offsets	Total GHG Emissions
	Electricity			Diesel Fuel			Land Applied SW Organics	Electricity Purchased[2]	Diesel Fuel Combusted	Avoided Commercial Fertilizer Use via SW Compost3	
	WW Sludges (kWh/yr)	SW Organics (kWh/yr)	Total (kWh/yr)	WW Sludges[1] (L/yr)	SW Organics (L/yr)	Total (L/yr)	(wet t/yr)	(t CO2e/yr)	(t CO2e/yr)	(t CO2e/yr)	(t CO2e/yr)
2008											
2009											
2010											
2011											
2012											
2013											
2014											
2015											
2016	-3,581,800	472,098	-3,109,702	2,730	126,282	129,012	33,629	-224	356	-504	-373
2017	-3,634,500	476,661	-3,157,839	2,770	127,548	130,318	33,954	-227	359	-509	-377
2018	-3,686,300	481,224	-3,205,076	2,800	127,838	130,638	34,279	-231	360	-514	-385
2019	-3,739,000	485,787	-3,253,213	2,830	129,104	131,934	34,604	-234	364	-519	-390
2020	-3,792,800	490,350	-3,302,450	2,900	130,369	133,269	34,929	-238	367	-524	-394
2021	-3,845,600	494,913	-3,350,687	2,930	130,660	133,590	35,254	-241	368	-529	-402
2022	-3,898,300	499,476	-3,398,824	2,960	131,925	134,885	35,579	-245	372	-534	-407
2023	-3,950,100	504,039	-3,446,061	2,990	133,191	136,181	35,904	-248	375	-539	-411
2024	-4,002,800	508,602	-3,494,198	3,030	133,481	136,511	36,229	-252	376	-543	-419
2025	-4,056,600	513,165	-3,543,435	3,090	134,747	137,837	36,554	-255	380	-548	-423
2026	-4,109,300	517,728	-3,591,572	3,120	135,037	138,157	36,879	-259	381	-553	-431
2027	-4,162,100	522,291	-3,639,809	3,160	136,303	139,463	37,204	-262	384	-558	-436
2028	-4,213,800	526,854	-3,686,946	3,190	137,568	140,758	37,529	-265	388	-563	-440
2029	-4,266,600	531,417	-3,735,183	3,250	137,859	141,109	37,854	-269	389	-568	-448
2030	-4,320,400	535,980	-3,784,420	3,290	139,124	142,414	38,179	-272	393	-573	-453
2031	-4,364,600	541,078	-3,823,522	3,320	140,424	143,744	38,543	-275	396	-578	-457
2032	-4,410,800	546,176	-3,864,624	3,350	140,749	144,099	38,906	-278	397	-584	-465
2033	-4,455,100	551,274	-3,903,826	3,380	142,048	145,428	39,269	-281	401	-589	-469
2034	-4,499,300	556,372	-3,942,928	3,420	143,348	146,768	39,632	-284	405	-594	-474
2035	-4,545,500	561,470	-3,984,030	3,450	143,672	147,122	39,995	-287	406	-600	-481
2036	-4,589,800	566,568	-4,023,232	3,480	144,972	148,452	40,358	-290	409	-605	-486
2037	-4,635,000	571,665	-4,063,335	3,510	146,271	149,781	40,721	-293	413	-611	-490
2038	-4,680,200	576,763	-4,103,437	3,550	147,571	151,121	41,085	-295	417	-616	-495
2039	-4,724,500	581,861	-4,142,639	3,580	147,896	151,476	41,448	-298	418	-622	-502
2040	-4,769,700	586,959	-4,182,741	3,610	149,195	152,805	41,811	-301	421	-627	-507
2041	-4,813,900	592,057	-4,221,843	3,640	150,495	154,135	42,174	-304	425	-633	-512
2042	-4,860,200	597,155	-4,263,045	3,680	150,819	154,499	42,537	-307	426	-638	-519
2043	-4,904,400	602,253	-4,302,147	3,710	152,119	155,829	42,900	-310	430	-644	-524
2044	-4,950,600	607,351	-4,343,249	3,740	153,418	157,158	43,263	-313	433	-649	-528
2045	-4,994,900	612,449	-4,382,451	3,770	153,743	157,513	43,626	-316	434	-654	-536
2046	-5,028,800	616,129	-4,412,671	3,810	154,952	158,762	43,889	-318	438	-658	-538
2047	-5,063,700	619,810	-4,443,890	3,840	155,187	159,027	44,151	-320	438	-662	-544
2048	-5,096,500	623,491	-4,473,009	3,870	156,396	160,266	44,413	-322	442	-666	-546
2049	-5,132,400	627,172	-4,505,228	3,900	156,630	160,530	44,675	-324	443	-670	-552
2050	-5,165,300	630,853	-4,534,447	3,900	157,840	161,740	44,937	-326	446	-674	-555
2051	-5,199,200	634,534	-4,564,666	3,940	158,074	162,014	45,200	-329	447	-678	-560
2052	-5,234,100	638,214	-4,595,886	3,970	159,283	163,253	45,462	-331	450	-682	-563
2053	-5,268,000	641,895	-4,626,105	4,000	159,518	163,518	45,724	-333	451	-686	-568
2054	-5,302,900	645,576	-4,657,324	4,030	160,727	164,757	45,986	-335	454	-690	-571
2055	-5,336,800	649,257	-4,687,543	4,030	160,962	164,992	46,248	-338	455	-694	-576
2056	-5,369,700	652,938	-4,716,762	4,070	162,171	166,241	46,511	-340	458	-698	-579
2057	-5,405,600	656,619	-4,748,981	4,100	162,405	166,505	46,773	-342	459	-702	-585
2058	-5,438,500	660,299	-4,778,201	4,130	163,615	167,745	47,035	-344	462	-706	-587
2059	-5,473,400	663,980	-4,809,420	4,160	163,849	168,009	47,297	-346	463	-709	-593
2060	-5,507,300	667,661	-4,839,639	4,160	165,058	169,218	47,559	-348	466	-713	-595
2061	-5,541,200	671,342	-4,869,858	4,200	165,293	169,493	47,822	-351	467	-717	-601
2062	-5,576,100	675,023	-4,901,077	4,230	166,502	170,732	48,084	-353	471	-721	-603
2063	-5,610,000	678,704	-4,931,296	4,260	166,736	170,996	48,346	-355	471	-725	-609
2064	-5,644,900	682,384	-4,962,516	4,290	167,946	172,236	48,608	-357	475	-729	-612
2065	-5,678,800	686,065	-4,992,735	4,290	168,180	172,470	48,870	-359	475	-733	-617
Totals =	-236,531,700	29,233,984	-207,297,716	179,410	7,429,102	7,608,512	2,082,421	-14,925	20,974	-31,236	**-25,188**

Notes:
1. Hauling FBC ash to landfill.
2. Negative values imply an off-set and are considered as an offset in the analysis.

Capital Regional District - Core Area Wastewater Management Strategy: Program Development Phase, Integrated Resource Management Strategy - Biosolids Management / Organic Residuals Energy and Resource Recovery

File: 20062935.04.E.03.01
Prepared: D. Shiskowski, D. Forgie
Last Revision: November 26, 2008
Last Revision By: D. Shiskowski

Subject: Strategy 5a (FBC)
No Digestion and
Balanced Energy / Beneficial Reuse
Discount Rate Base
Life-Cycle Analysis

Yellow-shaded cell denotes assumed/input values
Note: Other coloured cells contain data linked to external spreadsheets

Year	Capital Costs				Operations & Maintenance Costs																		GHG CO2e[1]		Value of Electricity Produced[6]		Total	
					Labour				Electricity[5]		Chemicals			Trucking/Equipment[3]				Ash Disposal[2]		Maintenance		Administration						
	WW Sludges	SW Organics	Total Cost	Net Present Value	WW Sludges Annual Cost	SW Organics Annual Cost	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	WW Sludges Annual Cost	Total Annual Cost	Net Present Value	WW Sludges Annual Cost	SW Organics Annual Cost	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value
2008																												
2009																												
2010																												
2011																												
2012																												
2013																												
2014																												
2015	$64,540,000	$25,600,000	$90,140,000	$68,498,992																							$90,140,000	$68,498,992
2016			$0	$0	$1,050,000	$300,000	$1,350,000	$986,432	$33,047	$24,147	$844,300	$844,300	$616,922	$7,950	$730,200	$738,100	$539,322	$337,000	$246,243	$901,400	$658,644	$100,000	$73,069	$463	$338	-$250,726	-$183,203	$4,053,584	$2,961,914
2017			$0	$0	$1,050,000	$300,000	$1,350,000	$948,492	$33,366	$23,443	$857,300	$857,300	$602,328	$8,000	$737,000	$745,000	$523,427	$342,000	$240,285	$901,400	$633,312	$100,000	$70,259	$450	$316	-$254,415	-$178,749	$4,075,102	$2,863,112
2018			$0	$0	$1,050,000	$300,000	$1,350,000	$912,012	$33,686	$22,757	$869,200	$869,200	$587,200	$8,100	$741,000	$749,100	$506,065	$347,900	$234,421	$901,400	$608,954	$100,000	$67,556	$398	$269	-$258,041	-$174,323	$4,092,743	$2,764,910
2019			$0	$0	$1,050,000	$300,000	$1,350,000	$876,934	$34,005	$22,089	$882,200	$882,200	$573,060	$8,200	$748,800	$757,000	$491,733	$352,000	$228,652	$901,400	$585,532	$100,000	$64,958	$385	$250	-$261,730	-$170,015	$4,115,260	$2,673,194
2020			$0	$0	$1,050,000	$300,000	$1,350,000	$843,206	$34,325	$21,439	$894,200	$894,200	$558,515	$8,400	$755,600	$764,000	$477,192	$357,000	$222,981	$901,400	$563,012	$100,000	$62,460	$372	$232	-$265,496	-$165,828	$4,135,801	$2,583,209
2021			$0	$0	$1,050,000	$300,000	$1,350,000	$810,775	$34,644	$20,806	$907,100	$907,100	$544,781	$8,500	$759,600	$768,100	$461,301	$362,000	$217,408	$901,400	$541,357	$100,000	$60,057	$319	$191	-$269,192	-$161,670	$4,154,371	$2,495,007
2022			$0	$0	$1,050,000	$300,000	$1,350,000	$779,591	$34,963	$20,190	$919,100	$919,100	$530,757	$8,600	$767,400	$776,000	$448,121	$367,000	$211,933	$901,400	$520,536	$100,000	$57,748	$306	$177	-$272,861	-$157,582	$4,175,888	$2,411,471
2023			$0	$0	$1,050,000	$300,000	$1,350,000	$749,607	$35,283	$19,591	$932,100	$932,100	$517,562	$8,700	$774,200	$782,900	$434,717	$372,000	$206,558	$901,400	$500,515	$100,000	$55,526	$294	$163	-$276,507	-$153,535	$4,197,469	$2,330,706
2024			$0	$0	$1,050,000	$300,000	$1,350,000	$720,776	$35,602	$19,008	$944,000	$944,000	$504,009	$8,800	$779,200	$788,000	$420,720	$377,000	$201,269	$901,400	$481,265	$100,000	$53,391	$241	$129	-$280,196	-$149,599	$4,216,047	$2,250,982
2025			$0	$0	$1,050,000	$300,000	$1,350,000	$693,054	$35,922	$18,441	$956,000	$956,000	$490,785	$8,900	$786,000	$794,900	$408,080	$382,000	$196,109	$901,400	$462,755	$100,000	$51,337	$228	$117	-$283,962	-$145,778	$4,236,467	$2,174,899
2026			$0	$0	$1,050,000	$300,000	$1,350,000	$666,398	$36,241	$17,890	$968,900	$968,900	$478,276	$9,000	$790,000	$799,000	$394,409	$387,000	$191,034	$901,400	$444,956	$100,000	$49,363	$174	$86	-$287,651	-$141,993	$4,255,064	$2,100,419
2027			$0	$0	$1,050,000	$300,000	$1,350,000	$640,767	$36,560	$17,353	$980,900	$980,900	$465,577	$9,100	$797,800	$806,900	$382,989	$392,000	$186,060	$901,400	$427,843	$100,000	$47,464	$162	$77	-$291,347	-$138,286	$4,276,575	$2,029,844
2028			$0	$0	$1,050,000	$300,000	$1,350,000	$616,122	$36,880	$16,831	$993,900	$993,900	$453,603	$9,200	$804,600	$813,800	$371,405	$397,000	$181,186	$901,400	$411,367	$100,000	$45,639	$150	$68	-$294,966	-$134,619	$4,298,163	$1,961,626
2029			$0	$0	$1,050,000	$300,000	$1,350,000	$592,425	$37,199	$16,324	$1,005,800	$1,005,800	$441,379	$9,400	$808,600	$818,000	$358,966	$402,000	$176,411	$901,400	$395,565	$100,000	$43,883	$97	$43	-$298,662	-$131,063	$4,315,835	$1,893,933
2030			$0	$0	$1,050,000	$300,000	$1,350,000	$569,640	$37,519	$15,831	$1,018,800	$1,018,800	$429,888	$9,500	$816,400	$825,900	$348,493	$407,000	$171,736	$901,400	$380,351	$100,000	$42,196	$84	$35	-$302,428	-$127,611	$4,338,274	$1,830,558
2031			$0	$0	$1,050,000	$300,000	$1,350,000	$547,731	$37,875	$15,367	$1,029,500	$1,029,500	$417,695	$9,600	$824,300	$833,900	$338,335	$411,000	$166,754	$901,400	$365,722	$100,000	$40,573	$80	$32	-$305,522	-$123,958	$4,358,233	$1,768,250
2032			$0	$0	$1,050,000	$300,000	$1,350,000	$526,664	$38,232	$14,915	$1,040,200	$1,040,200	$405,804	$9,700	$829,300	$839,000	$327,312	$415,000	$161,900	$901,400	$351,655	$100,000	$39,012	$34	$13	-$308,756	-$120,452	$4,375,110	$1,706,824
2033			$0	$0	$1,050,000	$300,000	$1,350,000	$506,408	$38,589	$14,475	$1,050,800	$1,050,800	$394,173	$9,800	$836,100	$845,900	$317,311	$419,000	$157,174	$901,400	$338,130	$100,000	$37,512	$30	$11	-$311,857	-$116,983	$4,393,862	$1,648,212
2034			$0	$0	$1,050,000	$300,000	$1,350,000	$486,930	$38,946	$14,047	$1,061,500	$1,061,500	$382,872	$9,900	$843,900	$853,800	$307,956	$424,000	$152,932	$901,400	$325,125	$100,000	$36,069	$27	$10	-$314,951	-$113,599	$4,414,722	$1,592,343
2035			$0	$0	$1,050,000	$300,000	$1,350,000	$468,202	$39,303	$13,631	$1,072,200	$1,072,200	$371,857	$10,000	$848,900	$858,900	$297,881	$428,000	$148,437	$901,400	$312,620	$100,000	$34,682	$19	$7	-$316,185	-$110,352	$4,431,599	$1,536,952
2036			$0	$0	$1,050,000	$300,000	$1,350,000	$450,195	$39,660	$13,226	$1,081,900	$1,081,900	$360,789	$10,100	$856,700	$866,800	$289,058	$432,000	$144,062	$901,400	$300,597	$100,000	$33,348	-$23	-$8	-$321,286	-$107,142	$4,450,451	$1,484,125
2037			$0	$0	$1,050,000	$300,000	$1,350,000	$432,879	$40,017	$12,831	$1,092,500	$1,092,500	$350,312	$10,200	$864,500	$874,700	$280,474	$436,000	$139,804	$901,400	$289,035	$100,000	$32,065	-$27	-$9	-$324,450	-$104,035	$4,470,139	$1,433,356
2038			$0	$0	$1,050,000	$300,000	$1,350,000	$416,230	$40,373	$12,448	$1,103,200	$1,103,200	$340,137	$10,300	$872,300	$882,600	$272,122	$440,000	$135,660	$901,400	$277,918	$100,000	$30,832	-$32	-$10	-$327,614	-$101,010	$4,489,928	$1,384,329
2039			$0	$0	$1,050,000	$300,000	$1,350,000	$400,221	$40,730	$12,075	$1,113,900	$1,113,900	$330,227	$10,300	$877,300	$887,600	$263,138	$445,000	$131,925	$901,400	$267,229	$100,000	$29,646	-$76	-$22	-$330,715	-$98,044	$4,507,840	$1,336,395
2040	$49,820,000		$49,820,000	$14,201,587	$1,050,000	$300,000	$1,350,000	$384,828	$41,087	$11,712	$1,124,500	$1,124,500	$320,548	$10,400	$885,100	$895,500	$255,269	$449,000	$127,991	$1,399,600	$398,967	$100,000	$28,506	-$80	-$23	-$333,879	-$95,175	$54,845,728	$15,634,210
2041			$0	$0	$1,050,000	$300,000	$1,350,000	$370,027	$41,444	$11,360	$1,135,200	$1,135,200	$311,152	$10,500	$891,900	$902,400	$247,343	$453,000	$124,165	$1,399,600	$383,622	$100,000	$27,409	-$84	-$23	-$336,973	-$92,362	$5,044,587	$1,382,692
2042			$0	$0	$1,050,000	$300,000	$1,350,000	$355,795	$41,801	$11,017	$1,145,900	$1,145,900	$302,004	$10,600	$896,900	$907,500	$239,174	$457,000	$120,443	$1,399,600	$368,868	$100,000	$26,355	-$130	-$34	-$340,214	-$89,664	$5,061,457	$1,333,958
2043			$0	$0	$1,050,000	$300,000	$1,350,000	$342,111	$42,158	$10,683	$1,156,600	$1,156,600	$293,100	$10,700	$904,700	$915,400	$231,977	$462,000	$117,078	$1,399,600	$354,680	$100,000	$25,342	-$133	-$34	-$343,308	-$87,000	$5,082,316	$1,287,938
2044			$0	$0	$1,050,000	$300,000	$1,350,000	$328,953	$42,515	$10,359	$1,167,200	$1,167,200	$284,416	$10,800	$912,500	$923,300	$224,979	$466,000	$113,550	$1,399,600	$341,039	$100,000	$24,367	-$139	-$34	-$346,542	-$84,441	$5,101,933	$1,243,182
2045			$0	$0	$1,050,000	$300,000	$1,350,000	$316,301	$42,871	$10,045	$1,177,900	$1,177,900	$275,978	$10,900	$917,500	$928,400	$217,521	$470,000	$110,120	$1,399,600	$327,922	$100,000	$23,456	-$183	-$45	-$349,643	-$81,929	$5,118,945	$1,199,353
2046			$0	$0	$1,050,000	$300,000	$1,350,000	$304,135	$43,129	$9,716	$1,186,200	$1,186,200	$267,234	$11,000	$924,300	$935,300	$210,709	$473,000	$106,560	$1,399,600	$315,309	$100,000	$22,528	-$176	-$40	-$352,016	-$79,304	$5,135,037	$1,156,849
2047			$0	$0	$1,050,000	$300,000	$1,350,000	$292,438	$43,387	$9,398	$1,193,500	$1,193,500	$258,537	$11,100	$927,300	$938,400	$203,277	$476,000	$103,111	$1,399,600	$303,182	$100,000	$21,662	-$210	-$46	-$354,459	-$76,783	$5,146,217	$1,114,777
2048			$0	$0	$1,050,000	$300,000	$1,350,000	$281,190	$43,644	$9,091	$1,201,700	$1,201,700	$250,301	$11,200	$934,100	$945,300	$196,896	$480,000	$99,979	$1,399,600	$291,521	$100,000	$20,829	-$202	-$42	-$356,755	-$74,306	$5,163,287	$1,075,456
2049			$0	$0	$1,050,000	$300,000	$1,350,000	$270,375	$43,902	$8,793	$1,210,000	$1,210,000	$242,336	$11,300	$937,100	$948,400	$189,944	$483,000	$96,734	$1,399,600	$280,309	$100,000	$20,028	-$238	-$48	-$359,268	-$71,953	$5,175,396	$1,036,518
2050			$0	$0	$1,050,000	$300,000	$1,350,000	$259,976	$44,160	$8,504	$1,218,300	$1,218,300	$234,614	$11,300	$944,000	$955,300	$183,967	$486,000	$93,591	$1,399,600	$269,528	$100,000	$19,257	-$231	-$45	-$361,571	-$69,630	$5,191,557	$999,764
2051			$0	$0	$1,050,000	$300,000	$1,350,000	$249,977	$44,417	$8,225	$1,226,600	$1,226,600	$227,127	$11,400	$947,000	$958,400	$177,465	$489,000	$90,547	$1,399,600	$259,161	$100,000	$18,517	-$265	-$49	-$363,944	-$67,391	$5,203,809	$963,586
2052			$0	$0	$1,050,000	$300,000	$1,350,000	$240,363	$44,675	$7,954	$1,233,800	$1,233,800	$219,674	$11,500	$953,800	$965,300	$171,868	$493,000	$87,777	$1,399,600	$249,194	$100,000	$17,805	-$259	-$46	-$366,387	-$65,234	$5,219,729	$929,354
2053			$0	$0	$1,050,000	$300,000	$1,350,000	$231,116	$44,933	$7,692	$1,242,100	$1,242,100	$212,646	$11,600	$956,800	$968,400	$165,789	$496,000	$84,914	$1,399,600	$239,609	$100,000	$17,120	-$292	-$50	-$368,760	-$63,131	$5,231,980	$895,707
2054			$0	$0	$1,050,000	$300,000	$1,350,000	$222,229	$45,190	$7,439	$1,250,400	$1,250,400	$205,833	$11,700	$963,600	$975,300	$160,548	$499,000	$82,142	$1,399,600	$230,394	$100,000	$16,461	-$287	-$47	-$371,203	-$61,105	$5,248,001	$863,894
2055			$0	$0	$1,050,000	$300,000	$1,350,000	$213,681	$45,448	$7,194	$1,258,600	$1,258,600	$199,214	$11,700	$966,600	$978,300	$154,848	$502,000	$79,458	$1,399,600	$221,532	$100,000	$15,828	-$321	-$51	-$373,576	-$59,131	$5,260,051	$832,574
2056			$0	$0	$1,050,000	$300,000	$1,350,000	$205,463	$45,706	$6,956	$1,265,900	$1,265,900	$192,663	$11,700	$973,400	$985,100	$149,927	$505,000	$76,858	$1,399,600	$213,012	$100,000	$15,219	-$313	-$48	-$375,879	-$57,207	$5,275,114	$802,845
2057			$0	$0	$1,050,000	$300,000	$1,350,000	$197,561	$45,963	$6,726	$1,274,200	$1,274,200	$186,468	$11,800	$976,400	$988,200	$144,614	$509,000	$74,488	$1,399,600	$204,819	$100,000	$14,634	-$349	-$51	-$378,392	-$55,374	$5,288,223	$773,884
2058			$0	$0	$1,050,000	$300,000	$1,350,000	$189,962	$46,221	$6,504	$1,282,500	$1,282,500	$180,464	$11,900	$983,200	$995,100	$140,023	$512,000	$72,045	$1,399,600	$196,941	$100,000	$14,071	-$341	-$48	-$380,695	-$53,569	$5,304,385	$746,394
2059			$0	$0	$1,050,000	$300,000	$1,350,000	$182,656	$46,479	$6,288	$1,290,700	$1,290,700	$174,632	$12,000	$986,200	$998,200	$135,057	$515,000	$69,680	$1,399,600	$189,367	$100,000	$13,530	-$375	-$51	-$383,138	-$51,839	$5,316,465	$719,321
2060			$0	$0	$1,050,000	$300,000	$1,350,000	$175,831	$46,736	$6,080	$1,299,000	$1,299,000	$168,996	$12,000	$993,000	$1,005,000	$130,747	$518,000	$67,390	$1,399,600	$182,083	$100,000	$13,016	-$370	-$48	-$385,511	-$50,154	$5,332,455	$693,735
2061			$0	$0	$1,050,000	$300,000	$1,350,000	$168,876	$46,994	$5,879	$1,306,300	$1,306,300	$163,409	$12,100	$996,000	$1,008,100	$126,106	$521,000	$65,173	$1,399,600	$175,080	$100,000	$12,509	-$403	-$50	-$387,884	-$48,522	$5,343,707	$668,460
2062			$0	$0	$1,050,000	$300,000	$1,350,000	$162,380	$47,252	$5,684	$1,314,500	$1,314,500	$158,110	$12,200	$1,002,800	$1,015,000	$122,086	$525,000	$63,148	$1,399,600	$168,346	$100,000	$12,028	-$397	-$46	-$390,327	-$46,949	$5,360,627	$644,786
2063			$0	$0	$1,050,000	$300,000	$1,350,000	$156,135	$47,509	$5,495	$1,322,800	$1,322,800	$152,989	$12,300	$1,005,800	$1,018,100	$117,749	$528,000	$61,066	$1,399,600	$161,871	$100,000	$11,586	-$431	-$50	-$392,700	-$45,418	$5,372,879	$621,403
2064			$0	$0	$1,050,000	$300,000	$1,350,000	$150,130	$47,767	$5,312	$1,331,100	$1,331,100	$148,028	$12,400	$1,012,600	$1,025,000	$113,987	$531,000	$59,051	$1,399,600	$155,646	$100,000	$11,121	-$425	-$47	-$395,143	-$43,943	$5,388,899	$599,284
2065			$0	$0	$1,050,000	$300,000	$1,350,000	$144,356	$48,025	$5,135	$1,338,400	$1,338,400	$143,115	$12,400	$1,015,600	$1,028,000	$109,924	$534,000	$57,101	$1,399,600	$149,650	$100,000	$10,693	-$460	-$49	-$397,516	-$42,506	$5,400,049	$577,427
Total Capital =	$114,360,000	$25,600,000	$139,960,000																									
Total Net Present Value =				$82,700,578				$22,038,338		$628,399			$16,922,091				$13,782,324		$6,755,109		$17,075,679		$1,632,469		$1,360		-$5,023,440		**$156,512,907**

Notes:
1. Excludes CO2e off-sets of commerical fertilizers by non-CRD end users (i.e. assumes that the CRD would not be able to sell these "credits").
2. Assumes disposal in a purpose built landfill.
3. Includes **diesel fuel,** driver, maintenance costs.
5. Includes only SW organics electrical cost. Electricity produced by WW sludge FBC considered in note 6.
6. Not a saleable product; overall revenue neutral.

Capital Regional District - Core Area Wastewater Management Strategy: Program Development Phase, Integrated Resource Management Strategy - Biosolids Management / Organic Residuals Energy and Resource Recovery

File: 20062935.04.E.03.01
Prepared: D. Shiskowski, D. Forgie
Last Revision: November 28, 2008
Last Revision By: D. Shiskowski

Subject: Strategy 5b (cement kiln)
No Digestion and
Balanced Energy / Beneficial Reuse
Material Flows
and GHG Emissions

Note: Coloured cells contain data linked to external spreadsheets

Year	Materials									GHG Sources			GHG Offsets		Total GHG Emissions
	Electricity			Diesel Fuel			Natural Gas	Dried WW Sludges	Land Applied SW Organics	Electricity Purchased	Natural Gas Combusted	Diesel Fuel Combusted	Avoided Commercial Fertilizer Use via SW Compost3	Avoided Coal Use via Dried WW Sludges	
	WW Sludges (kWh/yr)	SW Organics (kWh/yr)	Total (kWh/yr)	WW Sludges (L/yr)	SW Organics (L/yr)	Total (L/yr)	WW Sludges (GJ/yr)	(dry t/yr)	(wet t/yr)	(t CO2e/yr)	(t CO2e/yr)	(t CO2e/yr)	(t CO2e/yr)	(t CO2e/yr)	(t CO2e/yr)
2008															
2009															
2010															
2011															
2012															
2013															
2014															
2015															
2016	1,588,100	472,098	2,060,198	27,400	126,282	153,682	78,660	8,884	33,629	148	4,424	424	-504	-15,576	-11,084
2017	1,591,400	476,661	2,068,061	27,400	127,548	154,948	79,820	9,015	33,954	149	4,489	427	-509	-15,805	-11,249
2018	1,594,600	481,224	2,075,824	27,400	127,838	155,238	80,980	9,146	34,279	149	4,555	428	-514	-16,035	-11,417
2019	1,597,900	485,787	2,083,687	27,400	129,104	156,504	82,140	9,277	34,604	150	4,620	431	-519	-16,264	-11,582
2020	1,601,100	490,350	2,091,450	27,400	130,369	157,769	83,300	9,408	34,929	151	4,685	435	-524	-16,494	-11,747
2021	1,604,300	494,913	2,099,213	27,400	130,660	158,060	84,460	9,539	35,254	151	4,750	436	-529	-16,723	-11,915
2022	1,607,600	499,476	2,107,076	27,400	131,925	159,325	85,620	9,670	35,579	152	4,816	439	-534	-16,953	-12,080
2023	1,610,800	504,039	2,114,839	27,400	133,191	160,591	86,780	9,801	35,904	152	4,881	443	-539	-17,183	-12,245
2024	1,614,100	508,602	2,122,702	27,400	133,481	160,881	87,940	9,931	36,229	153	4,946	443	-543	-17,412	-12,413
2025	1,617,300	513,165	2,130,465	27,400	134,747	162,147	89,100	10,062	36,554	153	5,011	447	-548	-17,642	-12,578
2026	1,620,600	517,728	2,138,328	27,400	135,037	162,437	90,260	10,193	36,879	154	5,077	448	-553	-17,871	-12,746
2027	1,623,800	522,291	2,146,091	31,300	136,303	167,603	91,420	10,324	37,204	155	5,142	462	-558	-18,101	-12,900
2028	1,627,100	526,854	2,153,954	31,300	137,568	168,868	92,580	10,455	37,529	155	5,207	466	-563	-18,330	-13,066
2029	1,630,300	531,417	2,161,717	31,300	137,859	169,159	93,730	10,586	37,854	156	5,272	466	-568	-18,560	-13,234
2030	1,633,500	535,980	2,169,480	31,300	139,124	170,424	94,890	10,717	38,179	156	5,337	470	-573	-18,789	-13,399
2031	1,636,300	541,078	2,177,378	31,300	140,424	171,724	95,880	10,829	38,543	157	5,393	473	-578	-18,985	-13,540
2032	1,639,100	546,176	2,185,276	31,300	140,749	172,049	96,870	10,940	38,906	157	5,448	474	-584	-19,181	-13,684
2033	1,641,800	551,274	2,193,074	31,300	142,048	173,348	97,860	11,052	39,269	158	5,504	478	-589	-19,377	-13,826
2034	1,644,600	556,372	2,200,972	31,300	143,348	174,648	98,850	11,164	39,632	158	5,560	481	-594	-19,572	-13,967
2035	1,647,400	561,470	2,208,870	31,300	143,672	174,972	99,840	11,275	39,995	159	5,615	482	-600	-19,768	-14,111
2036	1,650,100	566,568	2,216,668	31,300	144,972	176,272	100,820	11,387	40,358	160	5,671	486	-605	-19,964	-14,253
2037	1,652,900	571,665	2,224,565	31,300	146,271	177,571	101,810	11,498	40,721	160	5,726	490	-611	-20,159	-14,394
2038	1,655,700	576,763	2,232,463	31,300	147,571	178,871	102,800	11,610	41,085	161	5,782	493	-616	-20,355	-14,536
2039	1,658,400	581,861	2,240,261	31,300	147,896	179,196	103,790	11,722	41,448	161	5,838	494	-622	-20,551	-14,680
2040	1,661,200	586,959	2,248,159	35,200	149,195	184,395	104,780	11,833	41,811	162	5,893	508	-627	-20,747	-14,810
2041	1,664,000	592,057	2,256,057	35,200	150,495	185,695	105,770	11,945	42,174	162	5,949	512	-633	-20,942	-14,952
2042	1,666,700	597,155	2,263,855	35,200	150,819	186,019	106,750	12,057	42,537	163	6,004	513	-638	-21,138	-15,096
2043	1,669,500	602,253	2,271,753	35,200	152,119	187,319	107,740	12,168	42,900	164	6,060	516	-644	-21,334	-15,237
2044	1,672,300	607,351	2,279,651	35,200	153,418	188,618	108,730	12,280	43,263	164	6,115	520	-649	-21,529	-15,379
2045	1,675,000	612,449	2,287,449	35,200	153,743	188,943	109,720	12,391	43,626	165	6,171	521	-654	-21,725	-15,523
2046	1,677,100	616,129	2,293,229	35,200	154,952	190,152	110,470	12,476	43,889	165	6,213	524	-658	-21,874	-15,629
2047	1,679,200	619,810	2,299,010	35,200	155,187	190,387	111,220	12,561	44,151	166	6,256	525	-662	-22,022	-15,739
2048	1,681,400	623,491	2,304,891	35,200	156,396	191,596	111,970	12,646	44,413	166	6,298	528	-666	-22,171	-15,845
2049	1,683,500	627,172	2,310,672	35,200	156,630	191,830	112,720	12,731	44,675	166	6,340	529	-670	-22,320	-15,955
2050	1,685,600	630,853	2,316,453	35,200	157,840	193,040	113,470	12,815	44,937	167	6,382	532	-674	-22,468	-16,062
2051	1,687,700	634,534	2,322,234	35,200	158,074	193,274	114,220	12,900	45,200	167	6,424	533	-678	-22,617	-16,171
2052	1,689,800	638,214	2,328,014	35,200	159,283	194,483	114,970	12,985	45,462	168	6,466	536	-682	-22,766	-16,278
2053	1,691,900	641,895	2,333,795	35,200	159,518	194,718	115,730	13,070	45,724	168	6,509	537	-686	-22,915	-16,386
2054	1,694,000	645,576	2,339,576	35,200	160,727	195,927	116,480	13,155	45,986	168	6,551	540	-690	-23,063	-16,493
2055	1,696,100	649,257	2,345,357	35,200	160,962	196,162	117,230	13,239	46,248	169	6,594	541	-694	-23,212	-16,602
2056	1,698,200	652,938	2,351,138	39,100	162,171	201,271	117,980	13,324	46,511	169	6,636	555	-698	-23,361	-16,698
2057	1,700,300	656,619	2,356,919	39,100	162,405	201,505	118,730	13,409	46,773	170	6,678	555	-702	-23,509	-16,808
2058	1,702,400	660,299	2,362,699	39,100	163,615	202,715	119,480	13,494	47,035	170	6,720	559	-706	-23,658	-16,914
2059	1,704,500	663,980	2,368,480	39,100	163,849	202,949	120,230	13,579	47,297	171	6,762	559	-709	-23,807	-17,024
2060	1,706,600	667,661	2,374,261	39,100	165,058	204,158	120,980	13,663	47,559	171	6,804	563	-713	-23,955	-17,130
2061	1,708,700	671,342	2,380,042	39,100	165,293	204,393	121,730	13,748	47,822	171	6,847	563	-717	-24,104	-17,240
2062	1,710,800	675,023	2,385,823	39,100	166,502	205,602	122,480	13,833	48,084	172	6,889	567	-721	-24,253	-17,346
2063	1,712,900	678,704	2,391,604	39,100	166,736	205,836	123,230	13,918	48,346	172	6,931	567	-725	-24,401	-17,456
2064	1,715,000	682,384	2,397,384	39,100	167,946	207,046	123,980	14,003	48,608	173	6,973	571	-729	-24,550	-17,562
2065	1,717,100	686,065	2,403,165	39,100	168,180	207,280	124,740	14,087	48,870	173	7,016	571	-733	-24,699	-17,671
Totals =	82,940,300	29,233,984	112,174,284	1,662,500	7,429,102	9,091,602	5,195,730	586,796	2,082,421	8,077	292,232	25,063	-31,236	-1,028,789	**-734,655**

Capital Regional District - Core Area Wastewater Management Strategy: Program Development Phase, Integrated Resource Management Strategy - Biosolids Management / Organic Residuals Energy and Resource Recovery

File: 20062935.04.E.03.01
Prepared: D. Shiskowski, D. Forgie
Last Revision: November 28, 2008
Last Revision By: D. Shiskowski

Subject: Strategy 5b (cement kiln)
No Digestion and
Balanced Energy / Beneficial Reuse
Discount Rate Base
Life-Cycle Analysis

Yellow-shaded cell denotes assumed/input values
Note: Other coloured cells contain data linked to external spreadsheets

Year	Capital Costs				Operations & Maintenance Costs																		GHG CO_2e[1]		Dried WW Sludge Revenues		Total	
					Labour				Electricity		Natural Gas		Chemicals			Trucking/Equipment[2]			Maintenance		Administration							
	WW Sludges	SW Organics	Total Cost	Net Present Value	WW Sludges Annual Cost	SW Organics Annual Cost	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	WW Sludges Annual Cost	SW Organics Annual Cost	Total Annual Cost	Net Present Value	WW Sludges Annual Cost	SW Organics Annual Cost	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Cost	Net Present Value	Total Annual Rev	Net Present Value	Total Annual Cost	Net Present Value
2008																												
2009																												
2010																												
2011																												
2012																												
2013																												
2014																												
2015	$54,010,000	$25,600,000	$79,610,000	$60,497,057																							$79,610,000	$60,497,057
2016			$0	$0	$900,000	$300,000	$1,200,000	$876,828	$144,214	$105,376	$786,600	$574,761	$844,300	$844,300	$616,922	$436,800	$730,200	$1,167,000	$852,715	$796,100	$581,702	$100,000	$73,069	-$160,206	-$117,061	-$300,690	-$219,711	$4,577,318	$3,344,601
2017			$0	$0	$900,000	$300,000	$1,200,000	$843,104	$144,764	$101,709	$798,200	$560,805	$857,300	$857,300	$602,328	$436,800	$737,000	$1,173,800	$824,696	$796,100	$559,329	$100,000	$70,259	-$162,625	-$114,258	-$305,121	-$214,374	$4,602,418	$3,233,598
2018			$0	$0	$900,000	$300,000	$1,200,000	$810,677	$145,308	$98,165	$809,800	$547,072	$869,200	$869,200	$587,200	$436,800	$741,000	$1,177,800	$795,679	$796,100	$537,817	$100,000	$67,556	-$165,084	-$111,525	-$309,553	-$209,123	$4,623,571	$3,123,519
2019			$0	$0	$900,000	$300,000	$1,200,000	$779,497	$145,858	$94,747	$821,400	$533,566	$882,200	$882,200	$573,060	$436,800	$746,800	$1,185,600	$770,143	$796,100	$517,131	$100,000	$64,958	-$167,502	-$108,806	-$313,984	-$203,958	$4,649,672	$3,020,338
2020			$0	$0	$900,000	$300,000	$1,200,000	$749,516	$146,402	$91,442	$833,000	$520,289	$894,200	$894,200	$558,515	$436,800	$755,600	$1,192,400	$744,770	$796,100	$497,242	$100,000	$62,460	-$169,921	-$106,132	-$318,416	-$198,881	$4,673,765	$2,919,220
2021			$0	$0	$900,000	$300,000	$1,200,000	$720,689	$146,945	$88,251	$844,600	$507,245	$907,100	$907,100	$544,781	$436,800	$759,600	$1,196,400	$718,527	$796,100	$478,117	$100,000	$60,057	-$172,379	-$103,527	-$322,847	-$193,894	$4,695,919	$2,820,247
2022			$0	$0	$900,000	$300,000	$1,200,000	$692,970	$147,495	$85,175	$856,200	$494,434	$919,100	$919,100	$530,757	$436,800	$767,400	$1,204,200	$695,395	$796,100	$459,726	$100,000	$57,748	-$174,798	-$100,941	-$327,278	-$188,995	$4,721,019	$2,726,271
2023			$0	$0	$900,000	$300,000	$1,200,000	$666,317	$148,039	$82,201	$867,800	$481,859	$932,100	$932,100	$517,562	$436,800	$774,200	$1,211,000	$672,425	$796,100	$442,046	$100,000	$55,526	-$177,216	-$98,402	-$331,710	-$184,187	$4,746,113	$2,635,348
2024			$0	$0	$900,000	$300,000	$1,200,000	$640,690	$148,589	$79,333	$879,400	$469,519	$944,000	$944,000	$504,009	$436,800	$779,200	$1,216,000	$649,232	$796,100	$425,044	$100,000	$53,391	-$179,675	-$95,930	-$336,141	-$179,469	$4,768,273	$2,545,820
2025			$0	$0	$900,000	$300,000	$1,200,000	$616,048	$149,133	$76,561	$891,000	$457,416	$956,000	$956,000	$490,785	$436,800	$786,000	$1,222,800	$627,753	$796,100	$408,696	$100,000	$51,337	-$182,093	-$93,482	-$340,573	-$174,841	$4,792,366	$2,460,273
2026			$0	$0	$900,000	$300,000	$1,200,000	$592,354	$149,683	$73,888	$902,600	$445,549	$968,900	$968,900	$478,276	$436,800	$790,000	$1,226,800	$605,583	$796,100	$392,977	$100,000	$49,363	-$184,552	-$91,100	-$345,004	-$170,304	$4,814,527	$2,376,586
2027			$0	$0	$900,000	$300,000	$1,200,000	$569,571	$150,226	$71,304	$914,200	$433,916	$980,900	$980,900	$465,577	$499,200	$797,800	$1,297,000	$615,611	$796,100	$377,863	$100,000	$47,464	-$186,809	-$88,668	-$349,436	-$165,857	$4,902,181	$2,326,783
2028			$0	$0	$900,000	$300,000	$1,200,000	$547,664	$150,777	$68,813	$925,800	$422,523	$993,900	$993,900	$453,603	$499,200	$804,600	$1,303,800	$595,037	$796,100	$363,330	$100,000	$45,639	-$189,228	-$86,361	-$353,867	-$161,500	$4,927,282	$2,248,747
2029			$0	$0	$900,000	$300,000	$1,200,000	$526,600	$151,320	$66,404	$937,300	$411,319	$1,005,800	$1,005,800	$441,379	$499,200	$808,600	$1,307,800	$573,907	$796,100	$349,355	$100,000	$43,883	-$191,695	-$84,122	-$358,299	-$157,233	$4,948,327	$2,171,492
2030			$0	$0	$900,000	$300,000	$1,200,000	$506,346	$151,864	$64,080	$948,900	$400,393	$1,018,800	$1,018,800	$429,888	$499,200	$816,400	$1,315,600	$555,125	$796,100	$335,919	$100,000	$42,196	-$194,113	-$81,907	-$362,730	-$153,056	$4,974,420	$2,098,983
2031			$0	$0	$900,000	$300,000	$1,200,000	$486,872	$152,416	$61,839	$958,800	$389,010	$1,029,500	$1,029,500	$417,695	$499,200	$824,300	$1,323,500	$536,979	$796,100	$322,999	$100,000	$40,573	-$196,168	-$79,590	-$366,508	-$148,702	$4,997,640	$2,027,674
2032			$0	$0	$900,000	$300,000	$1,200,000	$468,146	$152,969	$59,677	$968,700	$377,911	$1,040,200	$1,040,200	$405,804	$499,200	$829,300	$1,328,500	$518,276	$796,100	$310,576	$100,000	$39,012	-$198,283	-$77,347	-$370,286	-$144,457	$5,017,920	$1,957,598
2033			$0	$0	$900,000	$300,000	$1,200,000	$450,140	$153,515	$57,586	$978,600	$367,089	$1,050,800	$1,050,800	$394,173	$499,200	$836,100	$1,335,300	$500,893	$796,100	$298,630	$100,000	$37,512	-$200,317	-$75,142	-$374,065	-$140,318	$5,039,933	$1,890,564
2034			$0	$0	$900,000	$300,000	$1,200,000	$432,827	$154,068	$55,571	$988,500	$356,541	$1,061,500	$1,061,500	$382,872	$499,200	$843,900	$1,343,100	$484,442	$796,100	$287,145	$100,000	$36,069	-$202,372	-$72,993	-$377,843	-$136,284	$5,063,053	$1,826,189
2035			$0	$0	$900,000	$300,000	$1,200,000	$416,180	$154,621	$53,625	$998,400	$346,262	$1,072,200	$1,072,200	$371,857	$499,200	$848,900	$1,348,100	$467,543	$796,100	$276,101	$100,000	$34,682	-$204,467	-$70,912	-$381,621	-$132,353	$5,083,333	$1,762,984
2036			$0	$0	$900,000	$300,000	$1,200,000	$400,173	$155,167	$51,745	$1,008,200	$336,212	$1,081,900	$1,081,900	$360,789	$499,200	$856,700	$1,355,900	$452,162	$796,100	$265,481	$100,000	$33,348	-$206,530	-$68,873	-$385,399	-$128,522	$5,105,338	$1,702,515
2037			$0	$0	$900,000	$300,000	$1,200,000	$384,782	$155,720	$49,932	$1,018,100	$326,455	$1,092,500	$1,092,500	$350,312	$499,200	$864,500	$1,363,700	$437,272	$796,100	$255,271	$100,000	$32,065	-$208,584	-$66,883	-$389,178	-$124,790	$5,128,358	$1,644,415
2038			$0	$0	$900,000	$300,000	$1,200,000	$369,982	$156,272	$48,182	$1,028,000	$316,952	$1,103,200	$1,103,200	$340,137	$499,200	$872,300	$1,371,500	$422,859	$796,100	$245,452	$100,000	$30,832	-$210,639	-$64,944	-$392,956	-$121,156	$5,151,478	$1,588,297
2039			$0	$0	$900,000	$300,000	$1,200,000	$355,752	$156,816	$46,490	$1,037,900	$307,696	$1,113,900	$1,113,900	$330,227	$499,200	$877,300	$1,376,500	$408,078	$796,100	$236,012	$100,000	$29,646	-$212,734	-$63,067	-$396,734	-$117,616	$5,171,750	$1,533,218
2040	$37,130,000		$37,130,000	$10,584,201	$900,000	$300,000	$1,200,000	$342,070	$157,371	$44,860	$1,047,800	$298,684	$1,124,500	$1,124,500	$320,548	$561,600	$885,100	$1,446,700	$412,393	$1,167,400	$332,777	$100,000	$28,506	-$214,627	-$61,181	-$400,512	-$114,169	$42,758,632	$12,188,688
2041			$0	$0	$900,000	$300,000	$1,200,000	$328,913	$157,924	$43,286	$1,057,700	$289,909	$1,135,200	$1,135,200	$311,152	$561,600	$891,900	$1,453,500	$398,396	$1,167,400	$319,978	$100,000	$27,409	-$216,682	-$59,391	-$404,290	-$110,814	$5,650,752	$1,548,838
2042			$0	$0	$900,000	$300,000	$1,200,000	$316,263	$158,470	$41,765	$1,067,500	$281,342	$1,145,900	$1,145,900	$302,004	$561,600	$896,900	$1,458,500	$384,391	$1,167,400	$307,671	$100,000	$26,355	-$218,785	-$57,661	-$408,069	-$107,547	$5,670,916	$1,494,589
2043			$0	$0	$900,000	$300,000	$1,200,000	$304,099	$159,023	$40,299	$1,077,400	$273,030	$1,156,600	$1,156,600	$293,100	$561,600	$904,700	$1,466,300	$371,583	$1,167,400	$295,837	$100,000	$25,342	-$220,840	-$55,964	-$411,847	-$104,368	$5,694,036	$1,442,957
2044			$0	$0	$900,000	$300,000	$1,200,000	$292,402	$159,576	$38,884	$1,087,300	$264,941	$1,167,200	$1,167,200	$284,410	$561,600	$912,500	$1,474,100	$359,192	$1,167,400	$284,459	$100,000	$24,367	-$222,894	-$54,312	-$415,625	-$101,275	$5,717,056	$1,393,068
2045			$0	$0	$900,000	$300,000	$1,200,000	$281,156	$160,121	$37,516	$1,097,200	$257,071	$1,177,900	$1,177,900	$275,978	$561,600	$917,500	$1,479,100	$346,546	$1,167,400	$273,518	$100,000	$23,430	-$224,989	-$52,714	-$419,403	-$98,265	$5,737,329	$1,344,238
2046			$0	$0	$900,000	$300,000	$1,200,000	$270,343	$160,526	$36,164	$1,104,700	$248,673	$1,186,200	$1,186,200	$267,234	$561,600	$924,300	$1,485,900	$334,752	$1,167,400	$262,998	$100,000	$22,529	-$226,542	-$51,037	-$422,274	-$95,132	$5,755,911	$1,296,723
2047			$0	$0	$900,000	$300,000	$1,200,000	$259,945	$160,931	$34,861	$1,112,200	$240,925	$1,193,500	$1,193,500	$258,537	$561,600	$927,300	$1,488,900	$322,526	$1,167,400	$252,883	$100,000	$21,662	-$228,135	-$49,419	-$425,144	-$92,095	$5,769,652	$1,249,825
2048			$0	$0	$900,000	$300,000	$1,200,000	$249,947	$161,342	$33,606	$1,119,700	$233,221	$1,201,700	$1,201,700	$250,301	$561,600	$934,100	$1,495,700	$311,538	$1,167,400	$243,157	$100,000	$20,829	-$229,688	-$47,841	-$428,014	-$89,151	$5,788,140	$1,205,606
2049			$0	$0	$900,000	$300,000	$1,200,000	$240,334	$161,747	$32,394	$1,127,200	$225,753	$1,210,000	$1,210,000	$242,336	$561,600	$937,100	$1,498,700	$300,157	$1,167,400	$233,804	$100,000	$20,028	-$231,281	-$46,321	-$430,884	-$86,297	$5,802,882	$1,162,189
2050			$0	$0	$900,000	$300,000	$1,200,000	$231,090	$162,152	$31,226	$1,134,700	$218,515	$1,218,300	$1,218,300	$234,614	$561,600	$944,000	$1,505,600	$289,941	$1,167,400	$224,812	$100,000	$19,257	-$232,834	-$44,838	-$433,754	-$83,530	$5,821,563	$1,121,087
2051			$0	$0	$900,000	$300,000	$1,200,000	$222,202	$162,556	$30,100	$1,142,200	$211,499	$1,226,600	$1,226,600	$227,127	$561,600	$947,000	$1,508,600	$279,345	$1,167,400	$216,165	$100,000	$18,517	-$234,427	-$43,409	-$436,625	-$80,840	$5,836,304	$1,080,698
2052			$0	$0	$900,000	$300,000	$1,200,000	$213,656	$162,961	$29,015	$1,149,700	$204,700	$1,233,800	$1,233,800	$219,674	$561,600	$953,800	$1,515,400	$269,811	$1,167,400	$207,851	$100,000	$17,805	-$235,980	-$42,015	-$439,495	-$78,250	$5,853,786	$1,042,245
2053			$0	$0	$900,000	$300,000	$1,200,000	$205,438	$163,366	$27,966	$1,157,300	$198,126	$1,242,100	$1,242,100	$212,646	$561,600	$956,800	$1,518,400	$259,948	$1,167,400	$199,857	$100,000	$17,120	-$237,565	-$40,671	-$442,365	-$75,732	$5,868,635	$1,004,701
2054			$0	$0	$900,000	$300,000	$1,200,000	$197,537	$163,770	$26,959	$1,164,800	$191,742	$1,250,400	$1,250,400	$205,833	$561,600	$963,600	$1,525,200	$251,069	$1,167,400	$192,170	$100,000	$16,461	-$239,118	-$39,362	-$445,235	-$73,292	$5,887,217	$969,117
2055			$0	$0	$900,000	$300,000	$1,200,000	$189,939	$164,175	$25,986	$1,172,300	$185,555	$1,258,600	$1,258,600	$199,214	$561,600	$966,600	$1,528,200	$241,887	$1,167,400	$184,779	$100,000	$15,828	-$240,711	-$38,100	-$448,105	-$70,927	$5,901,858	$934,161
2056			$0	$0	$900,000	$300,000	$1,200,000	$182,634	$164,580	$25,046	$1,179,800	$179,559	$1,265,900	$1,265,900	$192,663	$624,000	$973,400	$1,597,400	$243,116	$1,167,400	$177,672	$100,000	$15,219	-$242,103	-$36,847	-$450,976	-$68,636	$5,982,001	$910,429
2057			$0	$0	$900,000	$300,000	$1,200,000	$175,609	$164,984	$24,144	$1,187,300	$173,751	$1,274,200	$1,274,200	$186,468	$624,000	$976,400	$1,600,400	$234,204	$1,167,400	$170,839	$100,000	$14,634	-$243,696	-$35,663	-$453,846	-$66,416	$5,996,742	$877,570
2058			$0	$0	$900,000	$300,000	$1,200,000	$168,855	$165,389	$23,272	$1,194,800	$168,123	$1,282,500	$1,282,500	$180,464	$624,000	$983,200	$1,607,200	$226,153	$1,167,400	$164,268	$100,000	$14,071	-$245,249	-$34,510	-$456,716	-$64,266	$6,015,324	$846,432
2059			$0	$0	$900,000	$300,000	$1,200,000	$162,361	$165,794	$22,432	$1,202,300	$162,672	$1,290,700	$1,290,700	$174,632	$624,000	$986,200	$1,610,200	$217,861	$1,167,400	$157,950	$100,000	$13,530	-$246,843	-$33,398	-$459,586	-$62,182	$6,029,965	$815,858
2060			$0	$0	$900,000	$300,000	$1,200,000	$156,116	$166,198	$21,622	$1,209,800	$157,391	$1,299,000	$1,299,000	$168,996	$624,000	$993,000	$1,617,000	$210,366	$1,167,400	$151,875	$100,000	$13,010	-$248,396	-$32,315	-$462,456	-$60,164	$6,048,546	$786,896
2061			$0	$0	$900,000	$300,000	$1,200,000	$150,112	$166,603	$20,841	$1,217,300	$152,276	$1,306,300	$1,306,300	$163,409	$624,000	$996,000	$1,620,000	$202,651	$1,167,400	$146,034	$100,000	$12,509	-$249,989	-$31,272	-$465,327	-$58,209	$6,062,288	$758,350
2062			$0	$0	$900,000	$300,000	$1,200,000	$144,338	$167,008	$20,088	$1,224,800	$147,321	$1,314,500	$1,314,500	$158,110	$624,000	$1,002,800	$1,626,800	$195,674	$1,167,400	$140,417	$100,000	$12,028	-$251,542	-$30,256	-$468,197	-$56,316	$6,080,768	$731,405
2063			$0	$0	$900,000	$300,000	$1,200,000	$138,787	$167,412	$19,362	$1,232,300	$142,522	$1,322,800	$1,322,800	$152,989	$624,000	$1,005,800	$1,629,800	$188,495	$1,167,400	$135,016	$100,000	$11,566	-$253,135	-$29,276	-$471,067	-$54,481	$6,095,510	$704,979
2064			$0	$0	$900,000	$300,000	$1,200,000	$133,449	$167,817	$18,662	$1,239,800	$137,675	$1,331,100	$1,331,100	$148,028	$624,000	$1,012,600	$1,636,600	$182,002	$1,167,400	$129,823	$100,000	$11,121	-$254,688	-$28,323	-$473,937	-$52,705	$6,114,092	$679,931
2065			$0	$0	$900,000	$300,000	$1,200,000	$128,316	$168,222	$17,988	$1,247,400	$133,385	$1,338,400	$1,338,400	$143,115	$624,000	$1,015,600	$1,639,600	$175,322	$1,167,400	$124,830	$100,000	$10,693	-$256,273	-$27,403	-$476,807	-$50,985	$6,127,941	$655,261
Total Capital =	$91,140,000	$25,600,000	$116,740,000																									
Total Net Present Value =				$71,081,258				$19,589,634		$2,500,442		$15,763,557			$16,922,091				$21,734,427		$14,755,404		$1,632,469		-$3,225,474		-$6,025,634		**$154,728,174**

Notes:
1. Excludes CO_2e off-sets of commerical fertilizers by non-CRD end users (i.e. assumes that the CRD would not be able to sell these "credits"). Assumes CRD can "sell" credits from dried WW sludges.
2. Includes **diesel fuel**, driver, maintenance costs.

APPENDIX B - Sustainability Assessment Framework Material

Table B-1. Objectives Hierarchy, Performance Measures and Scales

Objectives Hierarchy	Performance Scales		
	5	3	1
1. Minimize Net Present Value of Life Cycle Cost (includes accounting for revenues)	Lowest NPV from LCA		Highest NPV from LCA
2. Minimize Environmental Impacts			
Non-CO2e emissions (PM10, NOx) from vehicles	Lowest fuel consumption from LCA/CFA		Highest fuel consumption from LCA/CFA
GHG emissions generated from energy, process, end use and transportation	Lowest total GHG emissions from CFA		Highest total GHG emissions from CFA
Localized odours from LW/SW infrastructure	No noticeable odours likely	Odour potential with sensitive receptors at more than one site	Odour potential with sensitive receptors at five or more sites
Chemical demand	Lowest chemical use from LCA		Highest chemical use from LCA
3. Minimize Socioeconomic Impacts			
Community disruption	WW solids or SW organics being trucked only to and from existing locations		End use products hauled to new reuse locations
Potential siting concerns such as cultural and terrestial resource protection (historic, cultural, archaeologically signifcant resources, endangered species, etc).	Extremely unlikely that cultural and/or terrestrial resources will be affected	Cultural and/or terrestrial resources may be affected, but effects can likely be mitigated	Unmitigatable cultural and/or terrestrial resource effects likely
Economic development opportunities	WTE brings the potential for industial development and beneficial use of steam and electricity		No WTE
4. Maintain Flexibility			
Consistent with implementation schedules for both wastewater and solid waste programs	No foreseeable impact on implementation schedule of either program	Potential delay of up to two years in implementing one program	Highly likely result in 2 or more year delay in implementation of one program
Maintains the abiltity to adapt to beneficial future technologies and opportunities	No thermal destruction at CRD facility		Thermal destruction at CRD facility limits future options
Ability to respond to future regulatory change	No land application of biosolids and no WTE (emission requirements)		Land application of biosolids and WTE
5. Ease and Safety of Operations and Maintenance	No WTE or WW/SW digestors		WTE and WW/SW digestors (pressure, steam)

Others considered but not explicity included:

Maximize resource recovery, biogas recovery or minimize energy - should be captured in CO2e measurement
Technological flexibility is relevant for wastewater treatment but less so for biosolids and organics. Also, see risks.
Economic development not likely to help us distinguish between alternatives
Waste diversion - all alternatives assumed to divert similar quantities of organics from landfill
Public process / education - won't distinguish between alternatives
Politically implementable - a means to an end

Table B-2. Objectives Hierarchy Weights

Objectives Hierarchy		Relative Importance Weight	% of Total
1. Minimize Net Present Value of Life Cycle Cost (includes accounting for revenues)		100.0	26.3
2. Minimize Environmental Impacts			
	2a. Non-CO2e emissions (PM10, NOx) from vehicles	31.3	8.2
	2b. GHG emissions generated from energy, process, or end use	31.3	8.2
	2c. Localized odours from LW/SW infrastructure	31.3	8.2
	2d. Chemical demand	6.3	1.6
3. Minimize Socioeconomic Impacts			
	3a. Community disruption	36.8	9.7
	3b. Cultural and terrestrial resource protection (historic, cultural, archaeologically signifcant resources including endangered species)	22.1	5.8
	3c. Economic development opportunities	11.1	2.9
4. Maintain Flexibility			
	4a. Consistent with implementation schedules for both wastewater and solid waste programs	15.0	3.9
	4b. Maintains the abiltity to adapt to beneficial future technologies and opportunities	15.0	3.9
	4c. Ability to respond to future regulatory change	30.0	7.9
5. Ease and Safety of Operations and Maintenance		50.0	13.2

Table B-3. Risk Assessment Matrix

Likelihood	Impact				
	Insignificant	Minor	Moderate	Major	Extreme
Almost Certain	M	M	H	C	C
Likely	M	M	H	C	C
Possible	L	M	M	H	H
Unlikely	L	L	M	H	H
Rare	L	L	M	M	M

L	low risk
M	medium risk
H	high risk
C	critical risk

Table B-4. Risk Impacts

Public Acceptability Risk Impacts

Any new wastewater or solid waste project is likely to result in opposition. The risk of adverse public perception, including political risks, is evaluated in the context of whether an activity is likely to run counter to public expectations. If the opposition is strong enough, experience has shown that the project might fail to be implemented as planned.

Rating	Impacts / consequence
Insignificant	• Project enjoys broad support with no organized opposition. • No news coverage • Media call but no follow up story
Minor	• Pockets of isolated opposition to the project. • Negative letter(s) to the editor
Moderate	• Substantial proportions of the public are against the project. • Public opinion survey results in a below average / unsatisfactory rating • A negative news story
Major	• Public opinion negative. Project would fail in a public vote. Intervention from city political leadership; city legislation • Negative news storiesm
Extreme	• Public opinion strongly aligned against project. Project would soundly fail in a public vote. • Daily local negative news stories • Negative national news coverage • Vote of no confidence by elected representatives

Technologic and Financial Risk Impacts

The risk exists that a new process or technology will not work as planned, thus resulting in unbudgeted costs and political embarrassment to correct the deficiencies. Such unanticipated changes in costs have the potential to trigger unplanned rates increases or decreases.

Rating	Impacts / consequence
Insignificant	• Does not require budget revisions • No rate or financial performance impacts • Some staff time to correct errors
Minor	• Small but noticeable impact on short-term financial performance, with no noticeable impact on medium to long term rate path(s)
Moderate	• small short-term rate impact with small rate impact on medium and long-term rate path
Major	• moderate short-term rate impact with moderate rate impact on medium and long-term rate path
Extreme	• High short-term rate impact with high rate impact on medium and long-term rate path

Climate Change Risk Impacts

The risk exists that climate change will result in unanticipated sea level rise and/or a substantial increase in the volatility of weather patterns and extreme events. Such changes have the potential to require costly retrofits to parts of the wastewater or solid waste system.

Rating	Impacts / consequence
Insignificant	• Does not require budget revisions • No rate or financial performance impacts • Some staff time to correct errors
Minor	• Small but noticeable impact on short-term financial performance, with no noticeable impact on medium to long term rate path(s)
Moderate	• small short-term rate impact with small rate impact on medium and long-term rate path
Major	• moderate short-term rate impact with moderate rate impact on medium and long-term rate path
Extreme	• High short-term rate impact with high rate impact on medium and long-term rate path