



**REGIONAL ORGANIC WASTE
MANAGEMENT STRATEGY**
FINAL REPORT

REGIONAL DISTRICT OF OKANAGAN-SIMILKAMEEN
DECEMBER, 2010



CH2MHILL

The Regional District of Okanagan-Similkameen (RDOS) acknowledges the support of the following groups in funding this report:

- the B.C. Agricultural Research & Development Corporation (ARDCorp) Agriculture Environment & Wildlife Fund (AEWF)
- Canada-British Columbia-Union of British Columbia Municipalities Agreement on the Transfer of Federal Gas Tax Revenues (Gas Tax Fund) Regionally Significant Priorities Fund
- Regional District of Okanagan-Similkameen Campbell Mountain Landfill



1	Introduction	1-1
1.1	Project Approach	1-1
2	Organic Feedstocks and Amendments	2-1
2.1	Regional Wastesheds.....	2-1
2.2	Organic Wastes in the Municipal Solid Waste Stream	2-3
2.3	Organic Wastes from Construction, Demolition and Landclearing.....	2-10
2.4	Agricultural Wastes.....	2-13
2.5	Invasive Plants and Noxious Weeds.....	2-16
2.6	Wastewater Treatment Residuals.....	2-16
2.7	Other Organic Wastes	2-17
2.8	Existing Organic Waste Quantities	2-18
2.9	Projected Organic Waste Quantities	2-18
3	Existing Organics Management Infrastructure	3-1
3.1	Summary of Existing Composting Facilities within RDOS	3-1
3.2	Organics Processing in Adjacent Districts	3-4
4	Organic Waste Reduction Options	4-1
4.1	Reduction Options.....	4-1
4.2	Municipal Programs	4-5
5	Organic Waste Collection Options	5-1
5.1	Direct-Haul	5-1
5.2	Drop-off Depots	5-1
5.3	Community Collection Sites.....	5-3
5.4	At-source Collection Programs.....	5-4
6	Organic Waste Processing Options	6-1
6.1	Composting	6-1
6.2	Anaerobic Digestion.....	6-14
6.3	Mechanical-Biological Treatment	6-17
6.4	Mixed Municipal Solid Waste Composting	6-18
6.5	Land Application	6-18
6.6	Mulch Production	6-21
6.7	Biomass Production.....	6-21
6.8	Co-Digestion.....	6-22
6.9	Management Issues at Organic Waste Processing Facilities	6-23
7	Review of Compost Regulatory Requirements.....	7-1
7.1	Compost Facility Development and Operational Requirements.....	7-1
7.2	Compost Product Quality Requirements	7-1

8	Compost Uses and Markets	8-1
8.1	Summary of Compost Uses and Markets.....	8-1
8.2	Regulatory Product Quality Requirements.....	8-1
8.3	Analytical Testing of Products.....	8-2
8.4	End User Specifications	8-2
8.5	Market Demand	8-3
8.6	Market Value	8-5
8.7	Product Demand Curve.....	8-6
8.8	Challenges and Opportunities	8-7
9	Collection and Processing System Options	9-1
9.1	Initial Screening Process and Results.....	9-1
9.2	Program Assumptions	9-3
9.3	Organic Waste Management System Options	9-10
10	Analysis of Regional Organic Waste System Options.....	10-1
10.1	Land Requirements	10-1
10.2	Cost Estimates	10-2
10.3	Multi-Objective Decision Analysis.....	10-8
11	Conclusions.....	11-1
11.1	Recommendations	11-2

The Regional District of Okanagan-Similkameen (RDOS) is in the process of updating its Solid Waste Management Plan (SWMP), and has recognized that organic waste diversion and management is vital to meeting its overall waste management and reduction goals. Therefore, the RDOS commissioned a specific study and evaluation of organic waste management options that contained a greater level of detail than is normally done during the SWMP update processes. CH2M HILL was retained to assist with the identification and development of the strategy.

The overall project approach involved two phases. The first phase of this assignment involved establishing the framework for the organic waste management system. As part of this first phase, CH2M HILL prepared a number of background documents relating to:

- quantities and characteristics of organic wastes generated within RDOS;
- regulatory requirements related to organic waste processing and byproduct usage;
- existing solid and organic waste programs and facilities;
- organic waste reduction, collection and processing options; and
- uses and markets for compost in the Okanagan Valley.

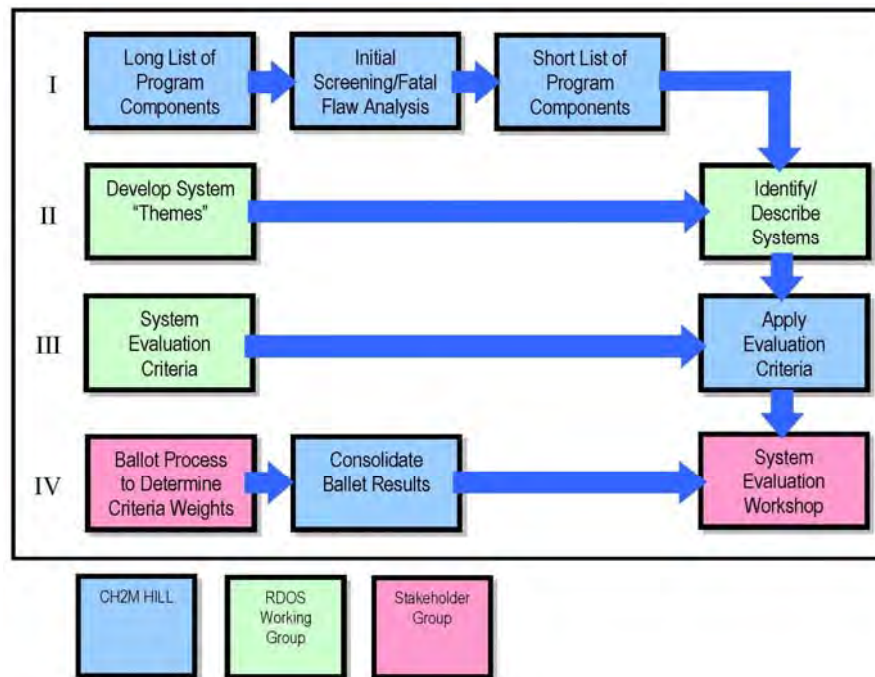
The second phase of the assignment involved identifying the specific program components that are suitable for use in RDOS, and combining these individual components into systems that reflect guiding principles, boundary conditions, and themes.

The analysis and decision process involved four “tracks” as outlined graphically in Exhibit ES-1 and outlined below.

- Track I involved CH2M HILL completing an initial screening and “fatal flaw” analysis of all the potential processing options identified, and eliminating those that are not practical or appropriate for implementation in RDOS. The end result was a short list of options that could be combined together to form the basis for regional systems.
- Track II involved RDOS’s core project staff and CH2M HILL jointly identifying “themes” that will guide the development of the regional systems, and provide the rationale for the selection of individual program components. The theme descriptions were relatively brief and direct, and were supported by key assumptions.
- Information and outcomes from Tracks I and II converged with the development of the five regional system options that were considered. A strategy table was used to identify the specific program components in each system, and once RDOS had verified these system options, CH2M HILL developed mass balances, costs (excluding land acquisition), and other detailed related to each system.
- As part of Track III, RDOS’s core staff and CH2M HILL developed a set of non-financial criteria and associated performance measures which were subsequently used to evaluate the regional system options.

- Track IV involved a “balloting” method with members of the stakeholder group to determine relative importance or weighting of each criterion developed as part of Track III. The ballot results were compiled by CH2M HILL, and the relative importance of each criterion determined by the average (geometric mean) of the ballots received (using a simple algebraic method).

EXHIBIT ES-1: SYSTEM DEVELOPMENT/ANALYSIS PROCESS



CH2M Hill subsequently used a multi-objective decision analysis (MODA) model developed internally, and used extensively on other infrastructure system projects to evaluate the system options. This approach is a practical and theoretically sound means of assessing the non-monetary aspects of different alternatives. CH2M HILL also performed a secondary evaluation to test the sensitivity of the analysis to specific non-monetary criteria.

Five system options were jointly developed by RDOS and CH2M HILL to test the implications of differing methods of material collection and processing, and different locations for material processing. In all options, facilities would accept material from residential and ICI sources, and agricultural wastes currently accepted at RDOS composting facilities. The key features of the five system options (highlighting residential collection methods) include:

- System Option 1:** Retain existing leaf and yard waste (L&YW) system with seasonal, bi-weekly collection, no separation of source separated organics (SSO), and centralized biosolids composting in the greater Penticton area.
- System Option 2:** Weekly collection of L&YW combined with SSO in a 240 L rolling cart, bi-weekly garbage collection, enclosed L&YW/SSO processing facilities in

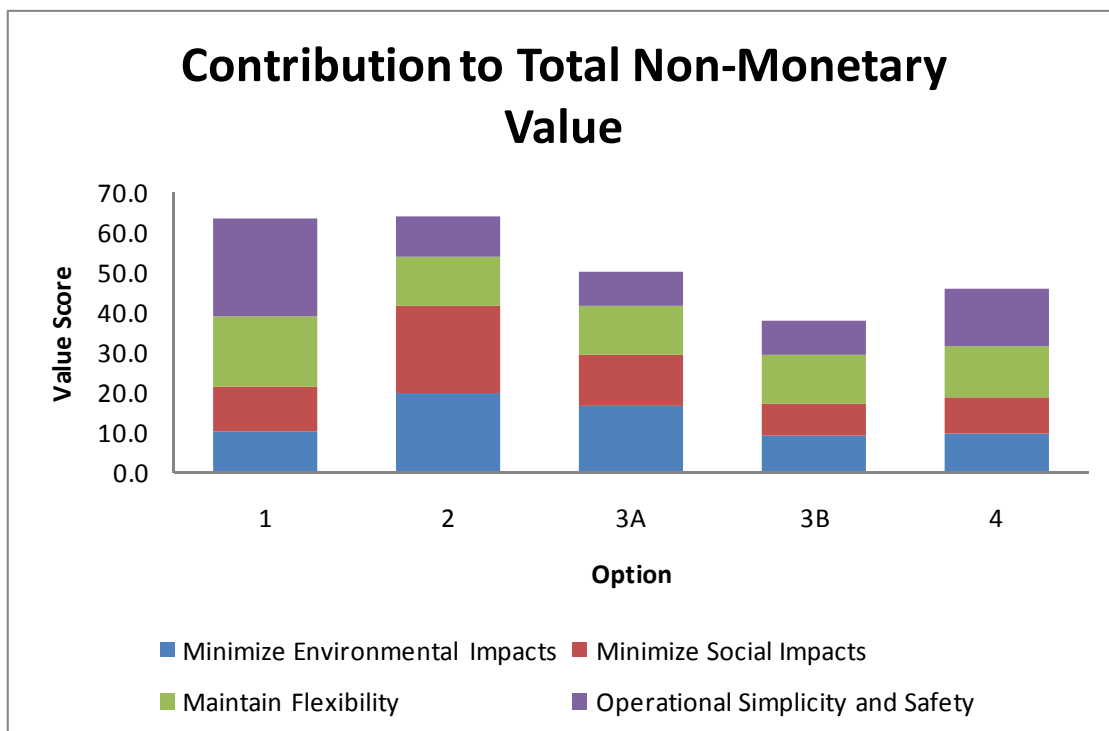
Oliver/Osoyoos and Princeton, and L&YW/SSO/biosolids composting in the greater Penticton area (which would also take material from Keremeos).

- **System Option 3A:** Seasonal bi-weekly collection of L&YW, weekly collection of SSO in a 45 L bin, and bi-weekly garbage collection. Windrow composting of L&YW and enclosed composting of SSO in Oliver/Osoyoos and Princeton. Windrow composting of L&YW and enclosed composting of SSO and biosolids in the greater Penticton area (which would also take material from Keremeos).
- **System Option 3B:** Same as Option 3A with windrow composting of L&YW and enclosed composting of SSO at Keremeos (rather than transporting that material to the Penticton facility)
- **System Option 4:** Same collection system as Option 3A. Windrow composting facilities for L&YW in Penticton, Keremeos, Oliver/Osoyoos, and Princeton. All SSO and biosolids would be transported to the Penticton facility, except for a small enclosed SSO composting facility in Princeton.

Through the non-monetary assessment of the MODA analysis (see Exhibit ES-2), Options 1 and 2 were found to have the highest “value”. System Option 1 provides a modest increase in organic waste diversion and continued biosolids composting, but scores well in the flexibility and operational simplicity criteria. The value of System Option 2 is derived primarily from environmental and social criteria. For example, the land requirements for the processing facilities are less than for other options, and the greater diversion of SSO from landfill lessens greenhouse gas emissions. Socially, all processing takes place indoors, which lessens the potential for odour and other nuisance impacts on the surrounding community.

EXHIBIT ES-2

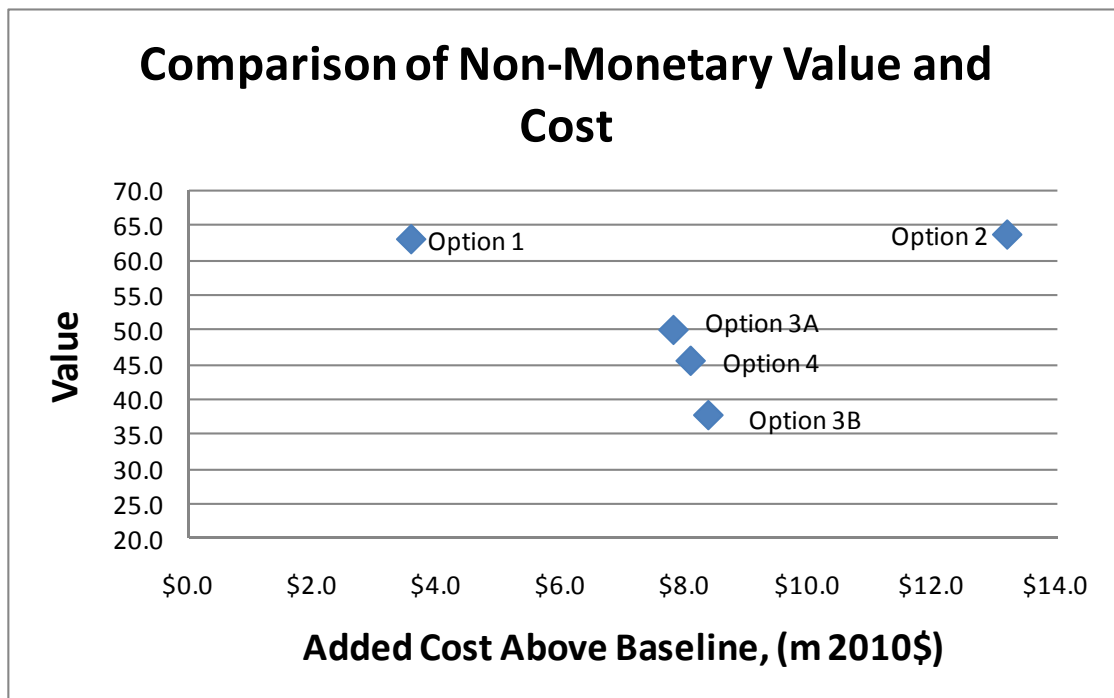
MODA Results – Total Non-Monetary Value of System Options



The system options were also viewed from the perspective of environmental and social factors and monetary criteria (i.e. a triple-bottom line evaluation). As shown in Exhibit ES-3, System Option 1 provides the highest value at the lowest cost of any of the options considered due to the simplicity, flexibility and relative lower cost compared to systems that collect and manage SSO.

Of the options that include SSO composting, Option 3A (i.e. separate collection of L&YW and SSO, with windrow composting of L&YW and enclosed composting of SSO at facilities in Oliver/Osoyoos, Princeton, and Penticton areas) is preferred. However, this option is followed closely by Option 4, which involves the same collection programs but consolidates SSO processing from Oliver/Osoyoos and Keremeos areas in Penticton. The relative similarity in the evaluation results for these two options indicates that there is some flexibility for RDOS to adapt a regional SSO processing system to the results of processing facility siting process.

EXHIBIT ES-3
MODA Results – Comparison of Non-Monetary Value and Cost



An analysis was conducted to test the sensitivity of the results to changes in weighting the flexibility and simplicity criteria to 0 (i.e. considering only the effects of environmental and social impacts). The results of this secondary analysis show that the relative importance of the criteria has little effect on the relative preference of the different options.

Recommendations

Options 1 and 2 were found to have the highest non-monetary “value” according to the evaluation criteria and weighting developed by the RDOS and its stakeholders. However, when financial aspects of the system options are considered, Option 2 has a relatively high cost whereas Option 1 provides the most value for the dollars spent (value-cost ratio) by a substantial margin compared to the other options. Therefore, based on this analysis, Option 1 would be the preferred system for implementation in the RDOS.

Although Option 1 is the preferred system, the Project Team recognizes that if environmental protection is more highly valued relative to other criteria or if additional factors not directly considered by the criteria established for the MODA analysis (e.g. availability of grant funding, future landfill airspace limitations, political influences), the RDOS may want to take a more aggressive approach to organic waste diversion, and implement a program for source-separated organics collection and processing.

Should this be the case, the selection of Option 3A or 4 would be the preferred approach to providing a regional SSO program. The overall value and value for the dollars spent provided by these two systems is similar (although Option 3A has improved environmental value while Option 4 provides more operational simplicity and safety). Practically speaking, the selection of which of the two systems to implement would be a function of the ability to site a processing facility in the Oliver/Osoyoos area.

From an overall implementation perspective, the initial upgrade of existing programs and facilities to allow for the implementation of Option 1, and potential subsequent expansion to Option 3A or 4, would provide a practical and staged approach to development of the regional organic waste management program.

1 Introduction

Like several other regional districts within British Columbia's Southern Interior region, the Regional District of Okanagan-Similkameen (RDOS) spans a diverse geographic area. It is also home to a diverse range of industries, including: tourism, agriculture, forestry, and retirement services. The RDOS's size and diversity can create challenges with respect to efficient waste management, and in particular, waste diversion programs.

RDOS is in the process of updating its Solid Waste Management Plan (SWMP), and has recognized that organic waste diversion and management is vital to meeting its overall waste management and reduction goals. The City of Penticton is also facing constraints with respect to the existing biosolids composting operations at the Campbell Mountain Landfill; the composting operation is in need of expansion to accommodate increased biosolids quantities, and at the same time, the existing location is slated for landfill development in the coming years.

These factors contributed to the RDOS developing the Terms of Reference for the development of a specific Regional Organic Waste Management Strategy. It was recognized that the development of the Strategy would require a greater level of investigation and assessment of organic waste quantities and reduction/collection/processing options than is normally done during the SWMP update processes. When complete, the Regional Organic Waste Management Strategy would become a key foundation for the SWMP update and help to establish policy and program direction for the next several years.

CH2M HILL was retained to assist with the identification and development of a strategy to manage organic wastes within the Regional District.

1.1 Project Approach

The overall project approach involved two phases. The first phase of this assignment involved establishing the framework for the organic waste management system. As part of this first phase, CH2M HILL prepared a number of background documents relating to:

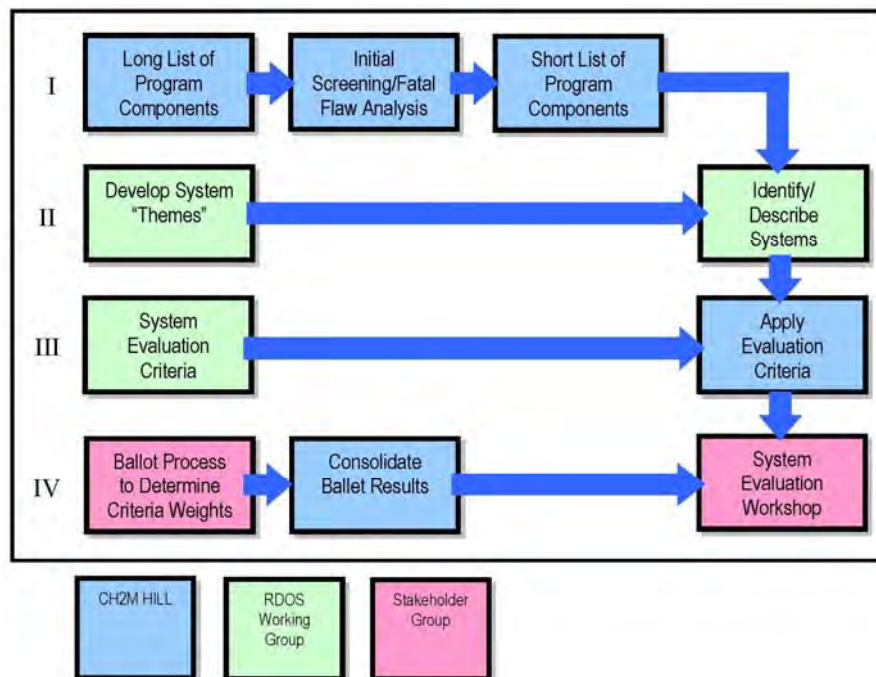
- quantities and characteristics of organic wastes generated within RDOS;
- regulatory requirements related to organic waste processing and byproduct usage;
- existing solid and organic waste programs and facilities;
- organic waste reduction, collection and processing options; and
- uses and markets for compost in the Okanagan Valley.

The second phase of the assignment involved identifying the specific program components that are suitable for use in RDOS, and combining these individual components into systems that reflect guiding principles, boundary conditions, and themes. During this second phase, CH2M HILL served as technical experts and facilitators, leading RDOS and a group of project stakeholders (i.e. Municipal representatives, BCMOE, BCMAL, BC Agricultural Council) through the analysis and decision process.

The analysis and decision process involved four "tracks" as outlined in the flow chart shown in Exhibit 1-1 and outlined below.

- Track I involved CH2M HILL completing an initial screening and “fatal flaw” analysis of all the potential processing options identified, and eliminating those that are not practical or appropriate for implementation in RDOS. The end result was a short list of options that could be combined together to form the basis for regional systems.
- Track II involved RDOS’s core project staff and CH2M HILL jointly identifying “themes” that will guide the development of the regional systems, and provide the rationale for the selection of individual program components. The theme descriptions were relatively brief and direct, and were supported by key assumptions.
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- As part of Track III, RDOS’s core staff and CH2M HILL developed a set of non-financial criteria and associated performance measures which were subsequently used to evaluate the regional system options.
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EXHIBIT 1-1: SYSTEM DEVELOPMENT/ANALYSIS PROCESS



CH2M Hill subsequently used a multi-objective decision analysis (MODA) model developed internally, and used extensively on other infrastructure system projects to evaluate the system options. This approach is a practical and theoretically sound means of assessing the non-monetary aspects of different alternatives. CH2M HILL also performed a secondary evaluation to test the sensitivity of the analysis to specific non-monetary criteria.

2 Organic Feedstocks and Amendments

A number of specific categories of organic wastes were considered during this review, originating from the three primary waste streams in the region: municipal solid wastes (MSW); demolition, landclearing and construction (DLC) debris; and agricultural waste. The primary categories of organic waste considered included:

- Food waste and leaf and yard wastes from residents and businesses;
- residuals from food and beverage processing operations;
- paper fibre and residuals from municipal recycling programs;
- wood wastes including “green wood” (i.e. unprocessed), dimensional lumber products and demolition and land clearing debris;
- agricultural wastes including manures, animal carcasses and abattoir waste, and orchard/vineyard waste; and
- wastewater treatment residuals.

2.1 Regional Wastesheds

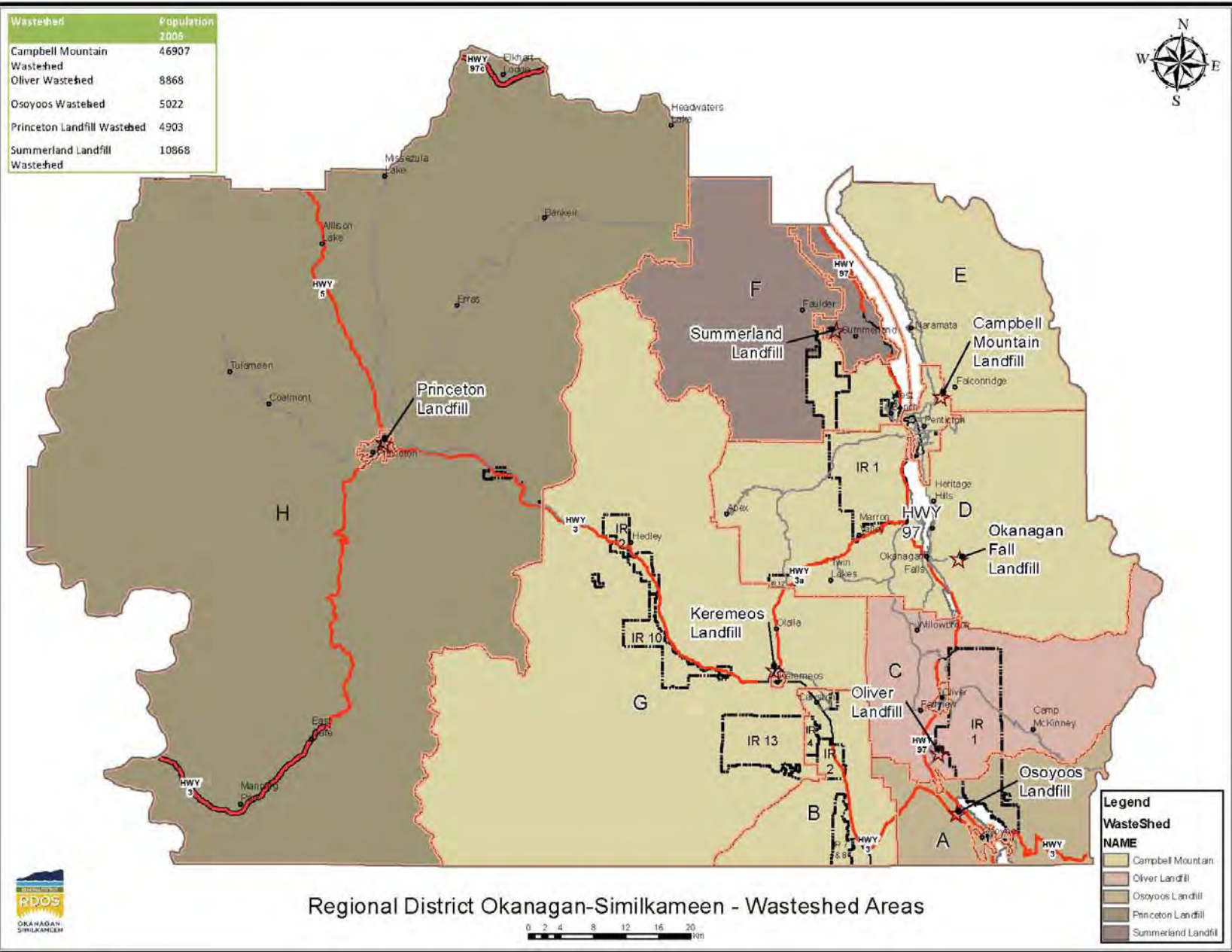
Organic and solid wastes generated within the RDOS tend to move within “wastesheds” that are based around disposal/processing facilities and municipal collection programs. This includes curbside and self-hauled residential waste, industrial, commercial, and institutional (ICI) Waste, and DLC waste. Wasteshed boundaries and the practices of waste generators are also influenced by consumer patterns and the relative location of urban centers.

A review of solid waste management and disposal infrastructure in the region is summarized below, and shown graphically in Exhibit 2-1.

- **Summerland Wasteshed:** The Summerland Sanitary Landfill (operated by the District of Summerland) accepts waste from the District of Summerland, as well as the portion of Electoral Area ‘F’ immediately to the west of the municipality.
- **Campbell Mountain/Okanagan Falls Wasteshed:** The Campbell Mountain Sanitary Landfill (CMSL), located in Penticton but operated by the RDOS, has the largest service area. It accepts waste from Penticton, as well as the Penticton Indian Band, Electoral Areas ‘D’ and ‘E’, and the balance of Electoral Area ‘F’ including the West Bench, Sage Mesa and Red Wing neighbourhoods. Waste from Keremeos and its outlying areas is also sent to the CMSL. This includes Electoral Areas ‘B’ and ‘G’ and several Indian Bands in the area. Curbside material is transported directly to the Campbell Mountain site, and many locals also use the local waste management site for self-haul.

The Keremeos Waste Management Facility operated by the RDOS is closed as a landfill, but continues to provide a transfer station for a minimal amount of waste, which is transported to the CMSL. It also accepts materials which can be diverted to recycling or reuse. Recyclables collected separately include curbside recyclables, white wood, yard and garden waste, metals, agricultural plastics, lead-acid batteries, propane tanks, concrete and masonry, asphalt shingles, ceramic fixtures, mattresses, E-waste and clean soil. There is also a soil remediation facility on site which accepts petrochemical contaminated soil to be rehabilitated to an Urban Park standard.

EXHIBIT 2-1
WASTESHEDS IN THE RDOS



The Okanagan Falls Sanitary Landfill, operated by the RDOS, provides service to the same geographic area as the CMSL, but primarily accepts waste from Demolition, Landclearing and Construction (DLC) activities. Due to wildlife concerns food waste is not accepted at this facility but recyclable products and yard waste are accepted.

- **Oliver Wasteshed:** The Oliver Sanitary Landfill, operated by the RDOS, services the Town of Oliver, Electoral Area 'C', and the Osoyoos Indian Band.
- **Osoyoos Wasteshed:** The landfill in Osoyoos is operated by the Town of Osoyoos. The Osoyoos Sanitary Landfill accepts waste from the Town of Osoyoos and Electoral Area 'A'.
- **Princeton Wasteshed:** The Princeton Landfill, operated by the Town of Princeton, serves the Town of Princeton and Electoral Area 'H'.

2.2 Organic Wastes in the Municipal Solid Waste Stream

The municipal solid waste (MSW) stream is quite diverse and contains a number of organic and inorganic materials. Typically, the identifiable organic fractions include food waste, leaf and yard waste, and wood. Leather and textiles are also sometimes included within the organic fraction of MSW, although this is not entirely accurate since some textiles (e.g. nylon) are synthetic.

At landfills, attendants categorize waste as it enters the facility. This helps in making management decisions as it provides detailed information on what is entering the site. However, the waste categories used for tracking differ amongst the various disposal facilities in the RDOS, reflecting the nature of the waste that enters a particular site and the information the manager wishes to obtain. In total, landfills in the RDOS use 95 different waste categories, which include several different categories for organic wastes, such as agricultural organics, carcasses, and garden and yard waste (broken down into curbside and self-haul subcategories).

Princeton presents a challenge for determination of waste quantities. Princeton has no curbside programs for recycling or yard waste collection, and the landfill contractor does not report the amounts of materials segregated onsite for recycling. The Princeton landfill also has no scale, and no reliable estimates of waste quantities and categories.

In order to gather useful data for quantification of organic waste streams from the Princeton area, the following measures were taken as part of this assessment:

- Existing white wood, green wood and yard waste stockpiles were physically measured on site and quantified.
- Annual buried waste has been recently estimated through a land survey conducted by Sperling Hansen Associates, as reported in their December 2009 study "Princeton Landfill Operations Update". According to this report, Princeton and Electoral Area 'H' residents generate 5,764 tonnes of MSW per year.
- CH2M HILL met with staff on site to visit landfill and sewage treatment areas and collect anecdotal information.
- Information was extrapolated from other communities when necessary.

A summary of the MSW quantities managed through municipal facilities within the RDOS is provided in Exhibit 2-2.

2.2.1 Determining Organic Waste Quantities

In order to plan organics diversion programs and design facilities properly, managers need as accurate as possible an estimate of organic waste quantities available for diversion. Material already separated and diverted can be quantified through direct measurement, but in the case of organics mixed with other waste types, solid waste professionals must extrapolate quantities from known values that represent their percentage of the incoming waste stream.

Determining the relative quantities of the different waste types in mixed municipal solid waste (MSW) is traditionally achieved by conducting a Waste Composition Study. During a waste composition study, representative samples of solid waste from various sources (e.g. residential, commercial, institutions) are obtained and manually sorted into major fractions (e.g. paper, plastic, food waste, textiles). The weights of the various fractions are tabulated, and the overall composition of the waste is calculated on a percentage basis.

Although a small-scale waste audit was conducted at the Campbell Mountain Landfill, no detailed waste composition studies have been undertaken in the RDOS. Fortunately, several studies have been undertaken in nearby districts, including a study for the Regional District of North Okanagan (RDNO) in 2005, and another for the Regional District of Central Okanagan (RDCO) in 2008. In the absence of comprehensive studies in the RDOS, it was considered appropriate to use data from the RDCO study for most organic waste types as the two regions have similar climates, and almost identical curbside collection programs.

Although the RDNO has a comparable urban/rural composition to the RDOS, and parallel quantities of industrial and commercial development, there is limited residential curbside collection of yard waste available, and the landfill charges customers (a reduced rate) for self-haul of yard trimmings. This is expected to result in less source separation, and a percentage of yard waste in the general waste stream that is significantly higher than in the RDOS situation.

North Okanagan data was applied however in the case of food waste (for which programs are identical to those in the RDOS), as the RDNO sorted 114 samples to generate their data, giving the numbers a higher level of statistical accuracy than the Central Okanagan study. RDNO data was also used for diapers which were not recorded as a separate category in the RDCO study.

The RDCO study was conducted between April 28 and June 2, 2008. Just over 14 metric tonnes of waste from DLC, ICI, residential curbside and residential self-haul sources was sorted into 19 categories and weighed. The data obtained is extremely useful, however some limitations should be noted:

- Although over 14 tonnes of waste was sorted, the waste originated from only 9 individual loads (although each residential self-haul “load” came from a bin that contained the contents of several pickup trucks and trailers).
- Samples were sorted during a single week, resulting in values that are not necessarily representative of seasonal variations in waste composition.
- Waste entering the Glenmore Landfill comes primarily from urban areas, and the study may not accurately reflect waste composition from RDOS rural/agricultural areas.

- The RDOS' small-scale waste audit suggests that a larger quantity of organic material may be present in local mixed waste than represented by the RDCO study.

EXHIBIT 2-2
MIXED (COMMINGLED) MSW DISPOSAL (2008)

Facility	Residential & ICI	DLC
Summerland Landfill	5,103	552
CMSL	27,916	565
OK Falls Landfill	9	3842
Oliver Landfill	4,540	580
Osoyoos Landfill	5,626	454
Keremeos Waste Mgmt Facility ¹	N/A	N/A
Princeton Landfill ²	5,764	346
Total	46,078	6339

Notes:

1. Commingled waste collected at the Keremeos facility is transferred to the CMSL for disposal.
2. Princeton Landfill quantities are based on estimates by Sperling Hansen Associates.

Based on direct measurement and extrapolation from known values, quantities of organic materials in the RDOS waste stream have been quantified for each wasteshed. Most data reported here was collected in 2008 as comprehensive data is available from this year. The exception is ground wood and green wood, where 2009 numbers have been used, as the 2008 quantities reported include some material that had accumulated in the previous year.

2.2.2 Food Waste

Food waste makes up a significant proportion of the municipal solid waste stream. It is generated primarily by the residential and ICI sectors, and can be either 'post-consumer', originating in residential and commercial kitchens (i.e. restaurants, hospitals etc.), or 'pre-consumer', coming from distribution and retail agents (i.e. transporters, supermarkets). Food waste usually enters landfills mixed with waxed corrugated cardboard and other materials, as a component of mixed waste.

Estimates of the amount of food wastes in the MSW stream from residential and commercial generators can be made using detailed data from solid waste composition studies in combination with waste generation data.

With respect to food waste quantities, the RDNO study found that food waste comprised 16.7% of the waste delivered to the Vernon Landfill, and 21.5% of the waste delivered to the Armstrong facility. Combining and considering the data from both sites together results in a food waste contribution of 18%, which corresponds to a generation rate of approximately 128 kg/capita/year. This number is consistent with information from other sources.

These per capita generation rates can be used with the RDOS' population to arrive at estimates of food waste in the MSW stream. A summary of these estimates is provided in Exhibit 2-3.

EXHIBIT 2-3
ESTIMATED FOOD WASTE QUANTITIES

Location	Population	Food Waste (tonnes per year)
Summerland Landfill	11,228	1,437
CMSL	46,122	5,904
OK Falls Landfill ¹	N/A	N/A
Oliver Landfill	8,269	1,058
Osoyoos Landfill	6,673	854
Keremeos Waste Mgmt Facility ²	N/A	N/A
Princeton Landfill	4,885	625
Total	77,177	9,877

1. OK Falls receives negligible amounts of food waste as it accepts primarily DLC waste. Mixed waste is transported to Campbell Mountain.
2. Keremeos transports all mixed waste to Campbell Mountain, thus quantities from this area are included in the CMSL data.

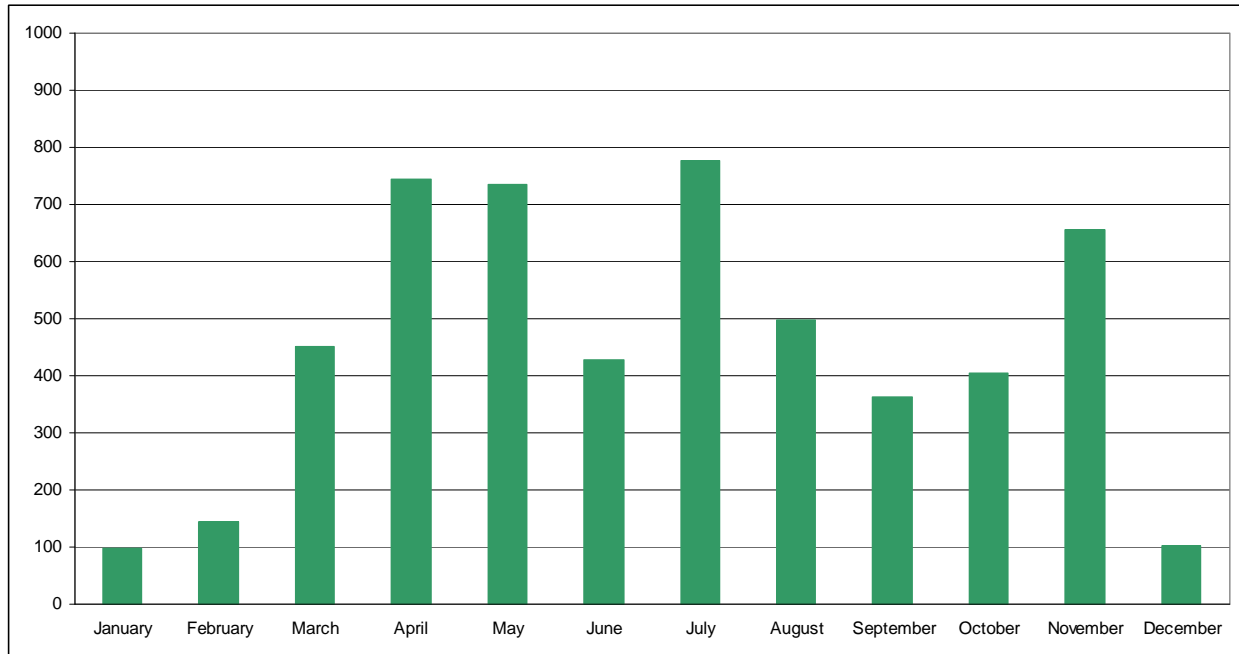
2.2.3 Leaf and Yard Waste

Leaf and yard waste (L&YW) is the term used to refer to a wide range of materials including grass clippings, leaves, flowers, weeds, pine needles and cones, and small prunings from bushes and trees. In some areas, Halloween pumpkins are also included in this category. L&YW is theoretically small enough that it does not require pre-processing (i.e. grinding) before inclusion in composting programs.

Although L&YW is often discussed separately from green wood, for the purposes of this report, these two categories have been combined under the L&YW category, to harmonize with RDOS programs. These materials are tracked together, and managed as a single category. Green wood is not distinguished separately by the RDOS when measuring and tracking waste quantities.

L&YW generation rates vary significantly during the course of the year; they are lowest during the winter, and highest during the spring and late fall. The magnitude of this variation is shown graphically in Exhibit 2-4 which shows the month-by-month variation in L&YW tonnages received from various sources (curbside collection, self-haul) at the CMSL during 2008. The spike in July quantities corresponds to a curbside yard waste collection event during that month.

EXHIBIT 2-4
SEASONAL VARIATIONS IN L&YW TONNES RECEIVED AT CMSL (2008)



L&YW generation also varies somewhat from year to year in the same area due to differences in growing conditions (e.g. rain, sunshine). The impacts of climate on L&YW generation rates are mitigated to some extent in urban areas by irrigation and fertilization practices. For example, the effects of a dry summer season on residential lawns can be offset by watering on a regular basis.

The type of grass, shrubs and trees used in landscaping applications, and the types of native trees can also affect L&YW quantities. For example, deciduous trees can contribute more to L&YW quantities than many coniferous trees, although Ponderosa pine needles and cones provide a significant contribution to L&YW quantities in the Okanagan Valley. The maturity of the plantings is also a factor, with more established plantings in older neighbourhoods contributing a larger amount of L&YW than plantings in newer areas.

Estimating the quantities of L&YW generated is complicated by seasonal and year-to-year variations, as well as the fact that a significant amount of the L&YW that is generated is managed onsite by residents and businesses through such means as mulching and backyard composting. As a result, L&YW quantities can only be estimated on an “as disposed” basis, which represents that material which is managed through municipal programs and facilities.

L&YW quantities managed at each of the RDOS facilities are summarized in Exhibit 2-5. Based on the results from the RDCO waste composition study, it is estimated that approximately 2% of the MSW being disposed of in these landfills consists of L&YW. Estimates of the L&YW quantities being disposed of as waste in each site are also contained in Exhibit 2-5.

EXHIBIT 2-5
L&YW DIVERSION AND DISPOSAL ESTIMATES (2009)

Facility	Diverted (tonnes)	Disposed as MSW (tonnes)	Total (tonnes)
Summerland Landfill	2327	306	2633
CMSL	9431	2968	12,399
OK Falls Landfill	1290 ¹	1	1291
Oliver Landfill	3352	448	3800
Osoyoos Landfill	881	338	1219
Keremeos Waste Mgmt Facility	1088	N/A ²	1088
Princeton Landfill	130	267	397
Total	18,499	4,328	22,827

1. OK Falls Landfill operates primarily as a DLC waste management facility and most L&YW arriving on site is source-separated.
2. Waste from the Keremeos facility is transferred to Campbell Mountain; L&YW is ground on site.

2.2.4 Food Processing Waste

Food processing wastes in the RDOS are generated primarily by wineries, and packing houses that receive fruit from the various orchards and sort and forward it to distributors and processing facilities.

There are currently over eighty wineries in the RDOS, with more starting up every year. The primary waste product from these operations is a mixture of skins, stems, seeds and pulp called "pomace". Typically, the wine industry produces one tonne of pomace each year for every 0.8 to 2 ha (2 to 5 acres) of land used for grape production. With approximately 2,500 ha of land in the RDOS used for grape cultivation, this could potentially result in up to 3,100 tonnes of pomace production annually.

Packing houses receive large volumes of fruits (e.g. apples, peaches, pears, cherries) from the various orchards in the Okanagan Valley, and further inspect and sort them before sending them on to wholesalers and processing facilities. It has been reported that very little fruit is rejected by the packing houses, since they normally charge the costs of managing culls back to individual orchard growers; this charge is a very effective means of compelling orchardists to inspect products prior to shipment. Despite the efforts of orchard operators and packing houses, some fruit is invariably damaged or rendered unsalable. This material is reportedly sent to cattle feedlots as a feed supplement, and does not enter the local waste stream.

Most landfills in the RDOS track food processing waste separately, making it possible to estimate quantities. In 2008, 550 tonnes of food processing waste was delivered to the Oliver, Campbell Mountain and Osoyoos landfills combined. The Summerland Landfill does not track food processing wastes separately; instead these quantities are reported as part of the municipal solid waste or leaf and yard waste categories.

The estimated quantities of winery and fruit processing wastes are significantly greater than amounts being handled at landfills in the region. Discussions with various industry contacts from wineries in the region indicate that the majority of wineries (twelve of the thirteen

contacted) are managing the pomace onsite through composting, or at privately operated composting facilities. One notable program includes the Mission Hill Winery at their Paradise Ranch and Oliver vineyards, where staff combine pomace with ground yard waste and cow manure to produce a high quality compost. Tinhorn Creek Winery also composts pomace on site, and incorporates the finished product back into their vineyards.

2.2.5 Recyclable Materials and Residuals from Recycling Programs

Within the RDOS, there are established recycling programs for residents and businesses. Through a combination of curbside collection and drop-off depots, the following materials are collected:

- A range of paper products including cardboard, boxboard, newsprint, magazines and catalogues, office paper, envelopes, and phone books;
- Glass bottles and jars;
- Tin and aluminum food containers; and
- Plastic containers and plastic bags.

Curbside materials collected through these programs are transported to a materials recovery facility (MRF) in Kelowna for further sorting and processing, and subsequent marketing. When they arrive at the MRF, commingled recyclables are dumped onto a conveyor where workers hand sort various recyclables from the belt as they pass by. Paper is left on the belt, to be collected in an uncontaminated state as it drops into a bin at the end.

Inorganic materials (glass, metals and plastics) are typically not suitable for use/management within an organic waste system. However, paper fibres collected through these programs (e.g. newsprint, cardboard, mixed paper) are of interest as they may provide an alternative source of amendments for composting facilities, or it may be possible to incorporate these materials into the feedstocks for anaerobic digestion systems.

A summary of paper fibre (paper, boxboard, cardboard) materials recovered through recycling programs in the RDOS during 2008 are provided in Exhibit 2-6.

Despite the fact that paper and cardboard provide a good source of carbon for composting nitrogen-rich feedstocks such as food waste, these materials are not listed as acceptable feedstocks in British Columbia's Organic Matter Recycling Regulation, Schedule 12 "Organic Matter Suitable for Composting". Thus, clarification and consent may be required from the Ministry of the Environment prior to including these materials in any type of organic waste collection/processing program. Initial communication with the Ministry indicates that changes to the regulation to allow paper fibre are currently in the works.

When the economics are good, it makes sense to market recyclable fibre rather than process it with organics. But depending upon fluctuations in markets for recyclable commodities, MRFs may be left with materials that are not economically viable to sell. For example, in 2008 market prices for cardboard dropped significantly, and many MRFs were left with stockpiles that could not be easily sold.

EXHIBIT 2-6
QUANTITIES OF RECYCLABLE FIBRE (2009)

Facility	Diverted (tonnes) ¹	Disposed as MSW (tonnes)	Total (tonnes)
Summerland Landfill	783 ²	543	1326
CMSL	1956	2826	4782
OK Falls Landfill	10	231	241
Oliver Landfill	331	489	820
Osoyoos Landfill	331	590	921
Keremeos Waste Mgmt Facility	20	n/a	20
Princeton Landfill	n/a	292	292
Total	3431	4971	8402

1. Includes material from curbside collection, drop-off depots and commercial bins.
2. In 2009, the Summerland recycling depot moved from a downtown location to the landfill, and discouraged deposit of material by ICI users. Current quantities will be lower due to reduced volumes of depot fibre.

During the course of sorting and processing the recyclables, non-marketable residuals are generated in the MRF. These mainly consist of garbage and other non-recyclable materials included by participants in collection programs. Residuals can also include dropped or spilled materials cleaned from MRF floors or around processing equipment, and recyclable materials that were “contaminated” by garbage or other materials, and which no longer meet market specifications. A common example of the latter is paper fibre contaminated by broken glass, or cardboard contaminated with wax-coated cardboard.

MRF residuals contaminated with metals, glass, and plastics are generally not suitable for co-management with organic wastes due to both operational issues (e.g. equipment damage or clogging) and potential impacts on the quality of products manufactured from the organic wastes (e.g. compost). However, residuals that consist exclusively of paper fibre can be incorporated subject to Ministry of Environment clarification and operational issues (e.g. material handling, litter).

2.3 Organic Wastes from Construction, Demolition and Landclearing

Wastes from construction, renovations, and demolition projects primarily consist of concrete, asphalt, wood, plastic, insulation, roofing materials, metal and gypsum. Waste from land clearing activities is primarily wood-based. Collectively, these wastes are referred to as demolition, land clearing, and construction (DLC) wastes.

Although DLC waste quantities fluctuate over time based on various economical and demographic factors, wastes from these activities contribute significantly to the overall solid waste stream in the RDOS.

2.3.1 Wood Waste

Wood waste is a significant component of the DLC waste stream. For the purposes of this assessment, wood wastes are categorized into two groups: “green wood” and “white wood”.

Green wood consists of prunings, brush, limbs, trunks and stumps. It is usually generated as a result of land clearing and development activities, but also from gardening and landscaping, and clearing of overhead utility lines. Significant quantities of green waste can also be generated by wind and ice storms. This material has already been addressed as “leaf and yard waste” in Section 3.3.

White wood consists of dimensional lumber and other “processed” wood products. It is often further broken down into “clean” (i.e. unpainted, untreated) and “unclean” (i.e. treated or painted). White wood is generally generated by construction, renovation and demolition projects activities, but can also include discarded furniture and shipping pallets. One log home manufacturer in the Penticton area generates approximately 50 tonnes per year of wood waste.

White wood waste quantities are summarized in Exhibit 2-7.

EXHIBIT 2-7
WHITE WOOD DIVERSION AND DISPOSAL ESTIMATES (2009)

Facility	Diverted (tonnes)	Disposed as MSW (tonnes)	Total
Summerland Landfill	1,425	972	2,397
CMSL	13,990	4,853	18,843
OK Falls Landfill	1,158	732	1,890
Oliver Landfill	3,374	882	4,256
Osoyoos Landfill	787	1,043	1,830
Keremeos Waste Mgmt Facility	1,291	N/A ¹	1,291
Princeton Landfill	140	526	666
Total	22,165	9,008	31,173

1. Waste collected at the Keremeos Waste Management Facility is transferred to CMSL.

2.3.2 Diseased Wood

Diseased wood is a special sub-category of the wood waste stream that is unique to some jurisdictions. In areas of BC’s interior, impacts on forests from the spread Mountain Pine Beetle are the primary concern.

Experts agree that the Mountain Pine Beetle will soon start to have a significant impact on forests within the Okanagan Valley. Forest entomologists estimate that the beetle infestation will peak in 2010 and 2011, and dead and dying trees will need to be managed in greatest number between 2011 and 2013. This represents an accelerated time frame compared to earlier estimates, and can be attributed to the particularly mild winter of 2009/10.

The Pine Beetle infestation in the Kamloops area peaked in 2007, and resulting wood waste volumes have since declined. The City of Kamloops managed 2,477 tonnes of beetle-killed wood in 2007, and the amount dropped to about half this number in 2009. In its peak year, this represents approximately 28 kg of pine beetle waste per resident.

Based on the Kamloops experience, the order-of-magnitude amount of beetle-killed wood in the RDOS is estimated to be approximately 2,100 tonnes in its peak year, dropping to about half this

amount two years later, and falling off severely after that. Because projected wood volumes are dependent on the activity of a biological entity, there is some unpredictability involved in its behaviour, which can be affected by numerous factors over which we have no control. The insect will affect areas with more pine trees to a higher degree. For instance, Princeton area residents will probably suffer a greater impact than those in Osoyoos.

Another forest pest that is expected to damage or kill mature trees in the Okanagan Valley is the Douglas Fir Tussock Moth. Although not as damaging as the Mountain Pine Beetle, this pest is expected to add to the volume of wood waste in the RDOS.

2.3.3 Gypsum

Segregated gypsum drywall is being accepted at landfills in the RDOS and diverted to recycling programs. Efforts are made to divert this material because it contributes to the production of hydrogen sulphide gas in landfill cells. Currently landfill customers pay between \$75 and \$150 per tonne to deposit drywall at RDOS landfills, which offsets the costs of handling, transportation and processing. A summary of gypsum drywall quantities diverted through recycling programs at landfills in the RDOS is provided in Exhibit 2-8.

Gypsum contains plant nutrients including calcium, phosphorus and potassium, and has successfully been ground and processed for use as a soil supplement and as an additive to compost. However, gypsum can also contain significant amounts of boron (which is toxic to plants at higher concentrations), and drywall from construction, renovation and demolition projects can contain fiberglass, glue, fire retardants, antifungal agents, vinyl, paraffin, and aluminum foil, depending on the type of wallboard.

EXHIBIT 2-8
GYPSUM DIVERSION (2008)

Facility	Tonnes
Summerland Landfill	250
CMSL	6,822
OK Falls Landfill	440
Oliver Landfill	129
Osoyoos Landfill	0
Keremeos Waste Mgmt Facility	N/A
Princeton Landfill	N/A
Total	7,641

Gypsum is not included on the list of materials acceptable for composting under Schedule 12 of the Organic Matter Recycling Regulation, and at present there are no plans to include it, according to the BC Ministry of Environment.

2.4 Agricultural Wastes

2.4.1 Animal Carcasses

Animal carcasses and mortalities are generated at farming and ranching operations, at intensive livestock and poultry operations, by veterinary practitioners, and as a result of vehicle collisions on roadways. The majority of mortalities in the RDOS are expected to be produced by intensive livestock and poultry operations.

According to agricultural census data from Statistics Canada, there were in the order of 25,000 head of cattle and 13,000 poultry reported in the RDOS in 2006. The majority of the cattle are raised as part of the region's beef industry; dairy production in the RDOS is insignificant. Hog production in RDOS is also insignificant.

The exact quantities of animal carcasses is difficult to quantify since much of this material is managed on-farm or via methods outside of the municipal solid waste management system. Discussions with one large cattle feedlot operator indicate that he loses in the order of 10 to 15 head per year, from a herd of approximately 4,000. Extrapolating this ratio to the entire region suggests there are in the order of 60 to 100 cattle mortalities per year.

A small amount of carcasses were reported as being disposed of at landfills in the RDOS in 2008 (see Exhibit 2-9). This is significantly less than the estimated quantity of mortalities expected in the region, because most livestock carcasses are managed through composting or burial onsite at farms and ranches, or are left to predators in remote areas of the animals' summer range. The tonnages reported include carcasses that originate from all the sources described above.

EXHIBIT 2-9
ANIMAL CARCASS DISPOSAL (2008)

Facility	Carcasses (tonnes)
Summerland Landfill	0
CMSL	3.3
OKF Landfill	0
Oliver Landfill	3.3
Osoyoos Landfill	0
Keremeos Waste Mgmt Facility	0
Princeton Landfill	N/A
Total	6.6

2.4.2 Abattoir Wastes

In BC, abattoirs are required to be registered either with the Canadian Food Inspection Agency (CFIA) or the Province. Abattoirs registered with CFIA are permitted to export products outside of BC, while provincially licensed facilities can only sell their product within the province.

A review of CFIA and provincial databases shows that the only abattoir located within RDOS boundaries is associated with a poultry operation in Keremeos. Wastes from this abattoir operation were estimated by the operator to be in the order of 3.5 tonnes per year, and are reported as being composted onsite.

2.4.3 Specified Risk Materials

Specified risk materials (SRM) refers to the brain, spinal cord, eyes, distal ileum and other parts of a ruminant that could be infected with the prion that causes Bovine Spongiform Encephalopathy (BSE). SRM wastes are generated primarily by abattoir operations, but cattle mortalities from feedlots and farming operations can also be categorized as SRM.

Facilities wishing to accept this material for destruction or disposal must possess a permit as issued by the Canadian Food Inspection Agency. Likewise, generators of this waste, including animal mortalities that contain this material, also require a permit.

SRM can be composted, but because the composting process does not destroy the prion, this compost must not leave the property, and must be applied to land on which ruminants will never graze.

Other than dealing with their own wastes on-site, there are few alternatives for generators of SRM materials. One business in BC that collects and processes SRM waste is prohibitively expensive for RDOS customers. Thus this material is generally managed through on-farm methods including burial and composting.

2.4.4 Animal Manures

Animal manures and used livestock/poultry bedding is produced at small and large farming operations and intensive cattle and poultry operations. Typically these materials are managed on-farm through land application or composting.

Animal manures and bedding quantities are difficult to quantify as volumes are not typically tracked or reported to municipal/provincial authorities, and there are variations in animal bedding and manure handling practices. However, quantities can be estimated based on livestock numbers and typical waste volumes reported in the literature. A summary of estimated manure quantities is provided in Exhibit 2-10.

Insight into manure management practices in the RDOS can be gained from Statistics Canada's agricultural census data from 2006. More farmers in the RDOS reported using composted manure on their field crops and pastures than uncomposted manures (i.e. 263 vs. 138). However, the land base on which composted manures were applied was reported as being 1,077 ha, compared to 1,366 ha for uncomposted manures. This suggests that the practice of composting manures is more common at small farming operations than at larger operations.

While liquid manure management through irrigation and liquid application/injection was reported by farmers in the RDOS, the numbers were insignificant relative to solid manures, which is reflective of the small number of dairy cattle and hog operations in the region.

EXHIBIT 2-10
ESTIMATED MANURE QUANTITIES

Livestock Type	# of Animals ¹	Estimated Manure Generation ³ (tonnes/animal/year)	Manure Quantities (tonnes/year)
Cattle	24,825	1.8	44,685
Chickens/Turkeys	>12741 ²	0.02	255
Sheep/Lamb	1397	0.6	838
Horse/Pony	1899	5.0	9,495
Pig	202	0.8	162

Notes:

1. Statistics Canada 2006 Census of Agriculture (<http://www.statcan.ca/english/agcensus2006/index.htm>)
2. Turkey # not reported by Statistics Canada for business confidentiality reasons.
3. Manure Characteristics and Land Base Code 1st Edition, Alberta Agricultural and Rural Development, September 2006.

2.4.5 Wood Waste from Orchards and Vineyards

Significant volumes of wood waste are produced by orchards and vineyards in the RDOS. This wood waste originates mainly from seasonal pruning of plants. However, complete removal or replacement of orchards is also common.

Apart from quantities recorded for source-separated materials at landfills, agricultural wood waste is difficult to quantify as much of this material is been managed onsite by orchard/vineyard operators. Burning has been a historically popular practice. More recently, and with the assistance of RDOS staff, orchard/vineyard operators are using alternative practices including:

- onsite grinding where chips are left between the rows for weed suppression;
- onsite grinding where ground material is composted on site;
- collection and use as firewood;
- use in furniture manufacturing (larger trunks); and
- collection and use in food smokers and wood-fired ovens.
- transport to RDOS landfill where agricultural organics are accepted free of charge.

The volume of agricultural organics arriving at landfills is indicated in Exhibit 2-11. Based on feedback from orchard/vineyard operators and wood grinding contractors in the region, it appears that there is minimal need for alternative options to manage these materials.

2.4.6 Fruit Waste from Orchards and Vineyards

In addition to wood wastes, orchards and vineyards also generate waste in the form of fruit culls during spring/summer thinning and pruning and losses due to wind. Fruit culls are also generated in the orchards during the picking process.

EXHIBIT 2-11
AGRICULTURAL ORGANICS DISPOSAL (2008)

Facility	Agricultural Wood (Tonnes)	Agricultural Organics (Tonnes)
Summerland Landfill	N/A	N/A
CMSL	365	164
OK Falls Landfill	15	0
Oliver Landfill	883	0
Osoyoos Landfill	N/A	6
Keremeos Waste Mgmt Facility	N/A	N/A
Princeton Landfill	N/A	N/A
Total	1263	170

It is reportedly a standard practice that fruit culls are managed within the orchard; the materials are left on the ground and subsequently mowed and mulched back into the soil. Fruit culls that enter local landfills are usually ground as L&YW, and may be reported separately or as L&YW when deposited.

2.5 Invasive Plants and Noxious Weeds

Invasive plants are non-native species that have been introduced to the region, and for which there are no insect predators, plant pathogens or other control measures to limit their growth and spread. Invasive plants have the potential to outcompete and displace native plant species, crops, or ornamental plant species.

The most harmful invasive plants are labeled "noxious weeds" by the Provincial Ministry of Agriculture and Lands. Among these are Dalmatian Toadflax, Hound's Tongue, Leafy Spurge, Orange Hawkweed, Puncturevine, Purple Loosestrife, Spotted Knapweed, and Tansy Ragwort.

The RDOS assists with the management of invasive plants on a regional basis by providing guidance to landowners and local weed managers and developing and distributing educational materials.

Invasive plants and noxious weeds that are collected through the various programs are currently disposed of at landfills in the region. A summary of the quantities of materials disposed of during 2008 is provided in Exhibit 2-12.

2.6 Wastewater Treatment Residuals

Many large communities in the Okanagan region rely upon mechanical/biological wastewater treatment plants (WWTPs) to manage the community's sanitary sewer waste. There are WWTPs in Summerland, Penticton, Okanagan Falls and Keremeos. A byproduct of these treatment processes is a nutrient rich, but unstable sludge material called biosolids. WWTPs also generate smaller quantities of "screenings" which are solids removed from the wastewater at the front of the process.

EXHIBIT 2-12
INVASIVE PLANT DISPOSAL (2008)

Facility	Tonnes
Summerland Landfill	2.5
CMSL	14.5
OK Falls Landfill	2.2
Oliver Landfill	19.7
Osoyoos Landfill	5.1
Keremeos Waste Mgmt Facility	N/A
Princeton Landfill	N/A
Total	45.0

Communities which do not have a population base that is sufficiently large to warrant a mechanical/biological treatment plant may instead rely on treatment lagoons. This includes the Towns of Oliver, Osoyoos and Princeton. Although lagoons also result in the generation of a solid residual stream (i.e. the solids that settle to the bottom of the lagoon), the solids are not generated continuously as in a WWTP. Typically, lagoon sediments are removed once every few years.

WWTP residuals and lagoon sediments are not generally considered to be part of the municipal solid waste stream, and are often managed through separate infrastructure (and in many jurisdictions by a different municipal department). However, there are potential synergistic opportunities for co-managing solid organic wastes and biosolids/lagoon sediments, and thus the latter should be considered in the context of a regional organic waste strategy.

A summary of the wastewater treatment system within the RDOS, and nearby facilities in the Regional District of Central Okanagan, is provided in Exhibit 2-13.

A new WWTP is scheduled to come online in Okanagan Falls in 2010, and biosolids production in this area is expected to increase from 148 to 280 tonnes per year (tpy at that time, as the new facility employs dewatering processes more similar to those used by the Penticton and Summerland plants.

The City of Penticton and District of Summerland currently sell biosolids compost at the Campbell Mountain and Summerland Landfills, respectively. As such their operations meet Provincial and Federal standards. All other jurisdictions composting bio-solids do not sell the products generated and the standards of compost generation and the uses of the product created vary between facilities.

2.7 Other Organic Wastes

Like contaminated MRF residuals as discussed above in Section 3.5, the materials in this section are usually considered unsuitable for composting.

2.7.1 Textiles

Some textiles such as wool, cotton, linen and leather come from organic sources, and as such have the potential to be composted. Many clothing items however contain synthetic fibres such

as polyester and nylon. Many garments made of 100% natural fibre contain inorganic components such as zippers, interfacing, polyester thread and buttons, which would be difficult to separate from the compostable portion of the article. Again because of contamination of the final compost product, textiles are not recommended for composting.

EXHIBIT 2-13
WASTEWATER TREATMENT SYSTEMS AND RESIDUALS

Municipality	Treatment System Type	Solid Residual Types/Quantities (wet tpy)	Current Disposal/ Management Practices
City of Penticton	WWTP (Primary/Secondary/Tertiary)	5,000	Compost
District of Summerland	WWTP (Primary/Secondary/Tertiary)	1,066	Compost
RDOS – Okanagan Falls	WWTP (Primary/Secondary)	145 ¹	Compost
Town of Oliver	Lagoon	30	Compost
Town of Osoyoos	Lagoon	300	Compost
Town of Princeton	Lagoon	20	Land application
Village of Keremeos	WWTP (Primary/Secondary)	110	Compost
RDCO – West Kelowna	WWTP (Primary/Secondary/Tertiary)	5,000	Landfill (Kelowna)

1. Annual quantity calculated to 20% solid.

2.7.2 Diapers and Hygiene Products

Diapers and hygiene products contain paper fibre, but also contain significant amounts of plastic and “super absorbent polymer”. Although the polymer will break down slowly, the plastic (25% of diaper dry weight) contaminates the end product. Again the contamination issue rules out this waste category as a compost feedstock. There are communities which recycle used disposable diapers and this avenue may bear further investigation.

2.8 Existing Organic Waste Quantities

In order to provide a comprehensive snapshot of the current annual quantities of the organic feedstocks recommended for inclusion in composting programs, data from the tables in this memo have been consolidated in Exhibit 2-14. Materials not recommended for inclusion in composting programs (such as diapers and gypsum) have been omitted, as have those materials which currently don’t enter the municipal waste stream, such as livestock manure.

2.9 Projected Organic Waste Quantities

Projected increases or decreases in solid waste quantities are affected by a number of factors including population changes, changes to the economic climate, and introduction of extended producer responsibility programs. In general, the size of the population has the highest correlation with the quantity of organic waste generated.

Exhibit 2-15 shows a projection of organic waste quantities based on the current situation and increased relative to projected population growth. Projections are shown graphically in Exhibit 2-16. Other factors, such as beetle kill of ponderosa pine have been taken into account in this model. In addition, the start-up of the new WWTP in Okanagan Falls in 2012 will increase biosolids production somewhat, and this too has been incorporated into the projections.

EXHIBIT 2-14
CURRENT ANNUAL QUANTITIES OF ORGANIC FEEDSTOCKS (TONNES)

Facility	White Wood	L&YW; Green Wood	Food Waste	Food Processing Waste	Recyclable Fibre	Biosolids	Carcasses	Total
Summerland Landfill	2,397	2,633	1,437	N/A	1,326	1,066	0	8,859
CMSL	18,843	12,399	5,904	96	4,782	5,000	3	47,027
OK Falls Landfill	1,890	1,291	0	0	241	145	0	3,567
Oliver Landfill	4,256	3,800	1,058	10	820	30	3	9,977
Osoyoos Landfill	1,830	1,219	854	0	921	300	0	5,124
Keremeos Waste Mgmt Facility ¹	1,291	1,088	N/A	N/A	20	110	0	2,509
Princeton Landfill	666	397	625	N/A	292	20	N/A	2,000
Total	31,173	22,827	9,878	106	8,402	6,671	6	79,063

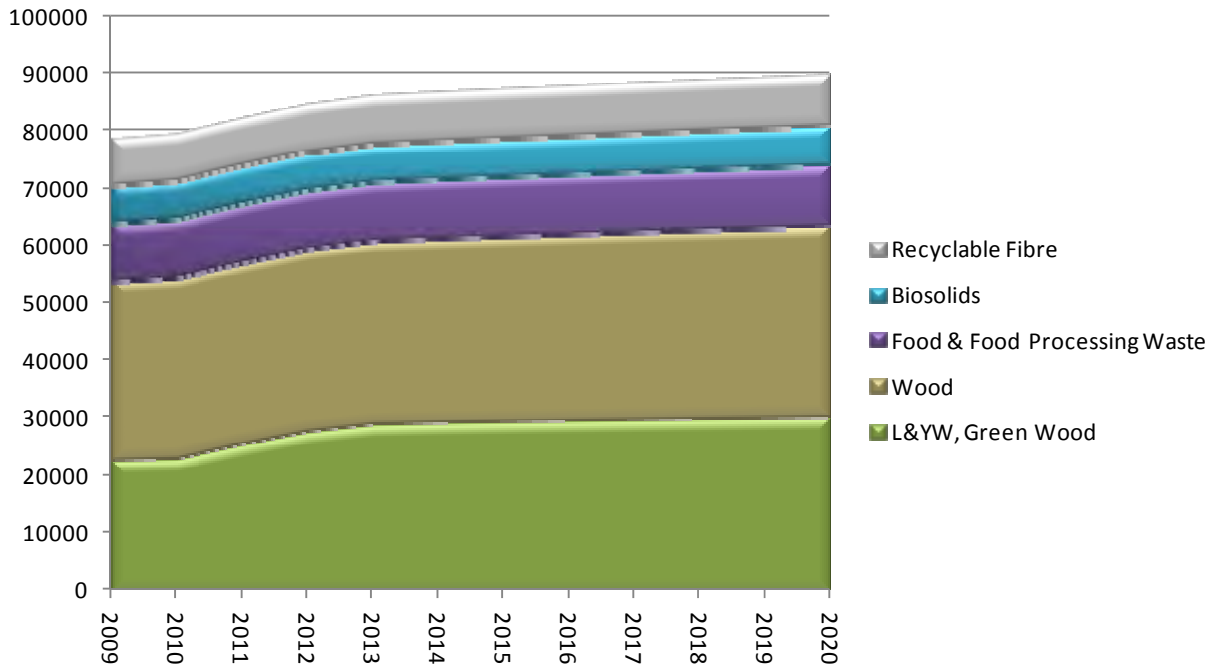
1. Keremeos data does not include any L&YW from local curbside collection, or quantities of any organics found in mixed waste, both of which are transported to Campbell Mountain, and reported in CMSL totals.

EXHIBIT 2-15
PROJECTED QUANTITIES OF MAJOR ORGANIC FEEDSTOCKS IN THE RDOS (TONNES)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Population ¹	83,430	83,801	84,201	84,589	85,003	85,465	85,950	86,443	86,927	87,379	87,831
L&YW & Green Wood	23,102	25,551	25,357	24,525	23,659	23,707	23,800	23,937	24,071	24,196	24,321
Wood	31,549	31,689	31,840	31,987	32,144	32,318	32,502	32,688	32,871	33,042	33,213
Food /Food Proc.Waste	9,997	10,042	10,089	10,136	10,186	10,241	10,299	10,358	10,416	10,470	10,524
Biosolids	6,751	6,781	7,081	7,114	7,148	7,187	7,228	7,270	7,310	7,348	7,386
Recyclable Fibre	8,503	8,541	8,582	8,621	8,664	8,711	8,760	8,810	8,860	8,906	8,952
Total	79,903	82,604	82,950	82,383	81,800	82,164	82,589	83,063	83,528	83,962	84,397

1. Population projections obtained from the Province of BC: www.bcstats.gov.bc.ca

EXHIBIT 2-16
PROJECTED ORGANIC FEEDSTOCK QUANTITIES IN THE RDOS (TONNES)



3 Existing Organics Management Infrastructure

As part of the larger project CH2M HILL undertook a review of the existing organics management infrastructure within the Regional District and in adjacent communities. The specific scope of work for this aspect of the project includes compiling a list of known organics management facilities within the area, including their location, processing method and annual capacity.

This approach was intended to provide a snapshot of the existing situation, and will allow for the location and size of additional processing facilities to be identified along with the order-of-magnitude costs associated with developing this additional processing capacity.

In addition, it will provide information on potential opportunities for the Regional District, to process material from adjacent communities.

3.1 Summary of Existing Composting Facilities within RDOS

A listing of organics processing facilities within the RDOS was obtained from discussion with RDOS personnel. This list was supplemented with the Project Team's personal knowledge of facilities within the Regional District, and the results from a survey of selected facility managers and operators.

The consolidated listing of facilities is provided in Exhibit 3-1. The locations of these facilities within RDOS are shown graphically in Exhibit 3-2.

The Town of Princeton landfill has large stockpiles of ground wood waste and leaf and yard waste on site, but because they are not actively composting at the present time, their landfill has not been included in the list of facilities in Exhibit 3-1.

3.1.1 Feedstocks Composted

Feedstocks composted most frequently include Leaf and Yard Waste (L&YW), ground wood waste, livestock manure, biosolids from the wastewater treatment process, winery waste (skins, seeds and stems), and straw. In one operation, spent brewery grain is occasionally added to the mixture. Inorganic amendments include gypsum, and in one case, sand and soil.

Slightly over half of the facilities in the RDOS are municipal operations. The municipalities compost L&YW, ground wood waste, and often biosolids. The amount of biosolids processed varies depending on the sewage treatment process employed and the size of the population serviced by the system. The Town of Osoyoos incorporates biosolids into their compost only on an occasional basis, when accumulated material is dredged from aerated lagoons.

Municipalities with Wastewater Treatment Plants, including Penticton, Summerland, Okanagan Falls and Keremeos have a more consistent output of biosolids. In Oliver and Princeton, several years pass between each dredging of sewage lagoons.

The private composting facilities in the RDOS tend to handle different organic feedstocks than municipal operations. In addition to L&YW and wood waste, private operations incorporate manure, and often winery and brewery waste into their compost.

EXHIBIT 3-1
ACTIVE COMPOSTING FACILITIES WITHIN THE RDOS

Facility	Location	Technology Type	Feedstocks	tpy	Size Range
District of Summerland compost, Summerland Landfill	Summerland	Turned windrow	L&YW, Biosolids	500	Small
City of Penticton compost, Campbell Mountain Landfill	Penticton	Aerated static pile	L&YW, Biosolids	15,000	Large
RDOS compost, Campbell Mountain Landfill	Penticton	Turned windrow	L&YW	6,000	Medium
RDOS compost, Okanagan Falls Landfill	Okanagan Falls	Static pile	Wood Waste, Biosolids	50	Very Small
Town of Oliver compost	Oliver	Turned windrow	L&YW	300	Very Small
Town of Osoyoos compost, Osoyoos Landfill	Osoyoos	Turned windrow	Wood Waste, L&YW, Biosolids	725	Small
Village of Keremeos compost	Keremeos	Static pile	L&YW, Biosolids, Sand and Soil	200	Very Small
Mission Hill Winery compost, Indian Rock Vineyard	Naramata	Turned windrow	Wood Waste, L&YW, Manure, Winery Waste, Spent Brewery Grain	30	Very Small
Private composting operation	Okanagan Falls	Turned windrow	Wood Waste, Manure	500	Small
Mission Hill Winery compost, Oliver Vineyard	Oliver	Turned windrow	Wood Waste, L&YW, Manure, Winery Waste	150	Very Small
Southern Plus Feedlots	Oliver	Static pile	Wood Waste, L&YW, Manure, Winery Waste	4,000	Medium
Private mushroom compost facility	Princeton	Aerated static piles	Straw, Manure, Gypsum	Confidential	Very Large
Private mushroom compost facility	East Gate	Turned windrow	Straw, Manure, Gypsum	Confidential	Very Large

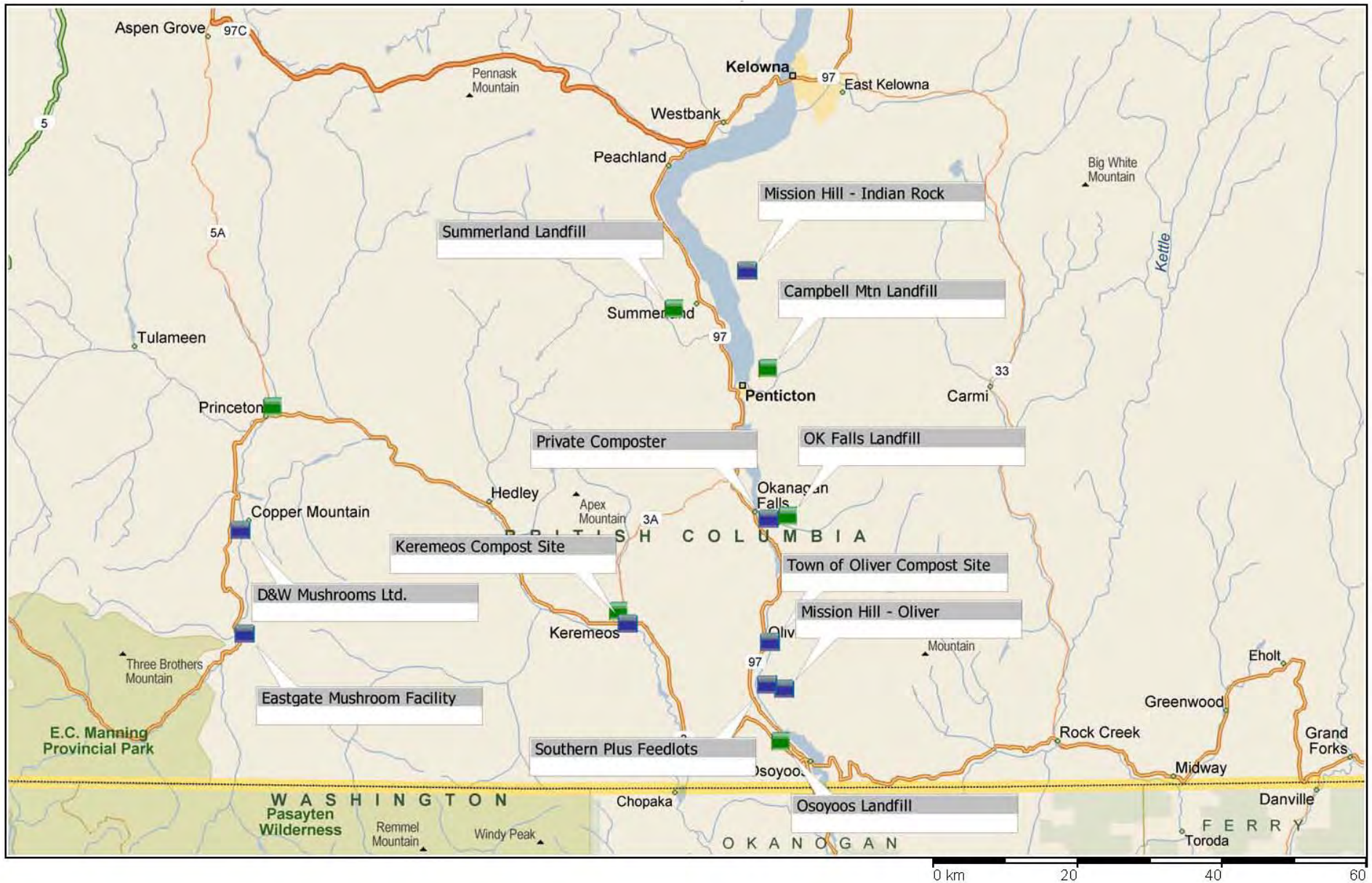


EXHIBIT3- 2
COMPOSTING FACILITIES IN THE RDOS

There are two private composting operations west of Princeton that produce compost specifically for the mushroom growing industry. They receive their feedstocks from outside the Regional District and transport their finished compost product to markets in the lower mainland. Because they have no impact on the organic fraction of the RDOS waste stream, they have been exempted from further consideration in this study.

3.1.2 Technology

Most of the existing composting facilities use simple “low-tech” processes to produce the compost, building windrows from organic feedstocks, and turning them periodically with front-end loaders.

The exception is the City of Penticton facility at the Campbell Mountain Landfill, with a system of extended aerated static piles, where a series of mechanical blowers delivers air to compost windrows through perforated pipes. Temperature is monitored by electronic compost probes inserted into the piles, and blowers are turned on and off in response to readings.

3.2 Organics Processing in Adjacent Districts

Organics processing facilities in adjacent districts were identified, again through communication with municipal managers, and through the Project Team’s personal knowledge of these facilities. This was done in part to place the RDOS infrastructure into perspective within the interregional framework, and also to identify possible deficits in processing capacity in nearby areas that could result in opportunities for the RDOS to capture additional organics. This information will be useful should the RDOS decide to develop additional processing capacity within its own boundaries. The list of facilities is shown in Exhibit 3-3.

EXHIBIT 3-3
 ORGANICS PROCESSING FACILITIES IN ADJACENT DISTRICTS

Operation	Location	Tech type	Feedstocks	tpy	Size Range
District of Peachland	Peachland	Static pile	L&YW	400	Very Small
Bylands Nurseries	Westbank	Turned windrow	L&YW	10,000	Large
Dean the Lawnmower Man	Kelowna	Turned windrow	L&YW, Manure, Alfalfa, Rock Dust	1,200	Small
City of Kelowna - Brandt's Creek Tradewaste Treatment Plant	Kelowna	Land application	Food Processing Waste	20,000	Small*
City of Kelowna, Glenmore Landfill, Glenmore Grow	Kelowna	Turned windrow	L&YW	22,000	Very Large
City of Kelowna/City of Vernon site on Commonage Rd, Vernon	Vernon	Aerated static pile	Wood Waste, L&YW, Biosolids	20,000	Very Large
McLeods By-Products	Grindrod	Turned windrow	Grain, Food Waste	250	Very Small
RDKB, Grand Forks Landfill	Grand Forks	Turned windrow	L&YW	2000	Small
RDKB, McKelvey Creek Landfill	Trail	Turned windrow	L&YW	4600	Medium

*Considered a small amount because at 2.5% solid, BCTTP biosolids are very dilute. Amount of solids is equivalent to 900 tpy of L&YW.

4 Organic Waste Reduction Options

CH2M HILL has prepared this summary of practical “at source” organic waste reduction and recycling strategies to help local government determine how to proceed with existing programs, and decide upon any new programs they may wish to implement.

4.1 Reduction Options

Sometimes considered “soft” programs, most organic waste reduction options involve outreach and public education. The intent is to reduce the amount of organic waste entering municipal programs, reducing infrastructure needs. In reality, many of these programs don’t result in a significant waste reduction, but they do make residents more aware of the waste they produce so that they are compelled to reduce waste generation in other ways as well.

Additionally, this mind-set may be taken from the home to the work environment. A greater percentage of total municipal solid waste is generated by the IC&I sector, and people who engage in waste reduction activities at home are more likely to do so in the workplace.

An informed public is engaged. Educating the public and encouraging residents to more actively participate in organic waste reduction strategies also leads to greater public support of more ambitious organic waste programs such as introduction of curbside organics collection programs and construction of centralized processing facilities.

A number of strategies exist for reducing the amount of organic waste generated, with the most effective of those targeting the organic waste types present in greatest quantity in the waste stream: wood waste, yard waste and food waste.

4.1.1 Landfill Disposal Bans

Landfill disposal bans are an effective way to reduce the volume of resources that is buried. A ban is a way of decreeing that a particular material (such as yard waste or wood waste) will no longer be accepted for disposal. It is written into bylaw, with penalties defined, and can be enforced by anyone specified to do so within the bylaw, including enforcement officers, landfill staff and contractors.

Whenever a disposal ban is put into place, there must be alternative options for residents to dispose of the material addressed by the ban. If no viable management option is provided, studies have shown that enactment of the ban results in an increase in illegal dumping instances and public backlash.

Disposal bans are often introduced slowly, with the first several months serving as a transition period, where warnings are issued but no real penalties exacted. This allows the public to get ‘up to speed’. Often extra resources are required to educate the public during this period, but the effort pays off down the line with greater awareness and acceptance of the change.



4.1.2 Green Yardcare

Many communities have implemented organic waste reduction measures that fall within the Green Yardcare arena. The RDOS is involved in many initiatives already, as are many other local municipal governments. Some of these strategies include promotion of backyard composting, grasscycling, and to a minor extent xeriscaping.

Some RDOS programs that promote sustainable yard care are described in examples below. In addition, there are many other programs conducted by local governments. For instance, the Regional District of Central Okanagan offers “Go Natural Garden Parties”, similar to other home parties, but without a sales component. RDCO staff teaches attendees about composting, grasscycling, and xeriscaping. Hosts are provided with gift packages that include items that support sustainable yard care, and guests win door prizes. This is a free service and it allows district staff to explain sustainable principles more effectively to residents. Personal communication has been shown by research to be far more effective at promoting sustainable behaviours than simply providing information.

In Alameda County California, on the San Francisco Bay, local governments have banded together to form a coalition that encourages waste reduction. Through this they have developed the Bay Friendly Landscaping and Gardening program, a comprehensive program for homeowners, professional landscapers, business and industry, schools, and public agencies. They have spearheaded initiatives such as informative publications, workshops, ‘green’ landscape design assistance, composter sales, gardening workshops, garden tours, plant sales, and certification of ‘green’ landscapers, to name a few.

Below we describe some specific practices and methods that are being used to promote Green Yardcare, or that can be used to promote them.

4.1.2.1 Backyard Composting

Backyard composting is often seen as the low hanging fruit of organic waste diversion programs. Programs are generally inexpensive, and have the potential to divert approximately 5% of MSW from RDOS landfills, with 100% residential participation.

Compost is considered a ‘green’ process for more than effective waste reduction. Use of compost reduces the need for chemical fertilizers and pesticides, and contributes to water conservation goals, as soils amended with compost retain more moisture between waterings.

Many communities, the RDOS included, make information on composting available to the public. Explanation of ‘How to Compost’ and construction plans for backyard composters can be found on the Regional District website, as paper handouts, and in the District’s annual Curbside Calendar. Staff is also available to help residents who phone in with questions about various waste issues including composting.



The Regional District also offers compost education to kids through school programs, and to adults through the Master Composter program, described below. Staff might also consider offering a short afternoon workshop to interested adults as a way to teach basic composting principles to those who do not wish to invest the time and effort required of a Master Composter course.

4.1.2.2 Master Composter Program

Master Composter Programs are a common outreach tool used by many municipalities to raise awareness and increase participation in waste reduction and diversion programs. Through periodic “train-the-trainer” style workshops, volunteers from the community are trained on successful backyard composting practices which they can use themselves and can also help implement in their neighbours’ yards. With volunteer hours often being a requirement for Master Composter certification, volunteers are often also “groomed” to become ambassadors for broader waste management initiatives, and provide a volunteer-base which Waste Managers can tap into for assistance with promotional events.

The RDOS has recently initiated a Master Composter Program with good success. Examples of other successful programs include those operated by the Regional District of Central Okanagan, the City of Edmonton, Seattle Public Utilities, and the Alameda County Waste Management Authority.

As part of the organic waste strategy, RDNO would continue to develop their Master Composter program, possibly in conjunction with adjacent regional districts (e.g. RDCO where similar programs operate), holding annual workshops.

4.1.2.3 Composter Sales

Like many municipalities in Canada and the United States, the RDOS provides subsidized backyard composting bins and vermicomposting bins to residents as part of its outreach programs. Although this does not normally result in a significant degree of waste reduction, it does help to promote the concept of generators being responsible for their own wastes.



The actual amount of kitchen and yard waste diverted to home composting is unclear. The RDOS should undertake a targeted survey of prior participants in the subsidized bin program to gauge the impact and success of the program. Specific questions would be asked to determine, for example, how many of the subsidized bins are still being used and how much and what types of materials are being diverted. This information can then be used to demonstrate the effectiveness of the existing program, or to refine it as necessary.

4.1.2.4 Compost Demonstration Garden

In cooperation with the Penticton Community Gardens Association and a nearby bistro, the RDOS is developing a Compost Demonstration Site where residents can go to see different examples of composters in operation and learn about composters and composting.

At the time of writing, this site is still very rough, and because it is located in a locked enclosure, it serves more to provide compost to the Community Gardens, than to educate the public. Further development of the site might include making it more accessible to the public, and installing interpretive signage, similar to the signage explaining the native plantings elsewhere on site. Also, composters with open sides (wire and pallets) might be upgraded to retain moisture better in the dry Okanagan climate.

A Compost Demonstration site also provides a good practical demonstration when holding composting workshops. It allows participants a hands-on illustration of successful composters in action. It is helpful for both a short afternoon workshop to explain composting basics, or a full Master Composter course.



4.1.2.5 Grasscycling

Grass clippings are generated by homeowners once or twice per week during the peak growing season from April through September. If yard waste collection events occur less frequently than this, clippings often end up in the garbage, regardless of bans in place.

Grasscycling is a process where grass clippings are not bagged, but chopped up finely and left on the lawn to provide nutrients and organic matter to growing grass. It can improve the appearance of a lawn without the use of pesticides and fertilizers, and increase the water holding capacity of the soil, reducing the need for irrigation.

The RDOS already makes some basic information on grasscycling available through handouts and their website. The annual curbside calendar and utility billing provide additional venues for distribution of 'green' information.

In addition to educating residents, landscapers could also be targeted. Information can be prepared specifically for landscape professionals. Guides produced by Alameda County in California describe practical ways for professionals to reduce waste and water use, and use testimonials from respected local practitioners to help make their point. Obtaining testimonials from landscapers who use sustainable practices not only gives credibility to waste reduction programs, but promotes the landscaper, resulting in a win-win situation.

Municipal parks and grounds maintenance crews have a visible profile within the community. Municipal governments could be approached to make a commitment to use sustainable landscaping methods such as grasscycling as much as possible. This can provide residents with practical examples of how a beautiful landscape can be achieved with sustainable techniques.

The RDOS could also launch a new program similar to the successful wood stove change-out program that promotes replacement of old bag mowers with new mulching mowers. Subsidies or rebates could be offered for new mowers that meet the required criteria. Old mowers could be accepted as an additional bulky item during the annual collection event, over and above the two-item limit.

4.1.2.6 Low-Growing Grass Species

There are new “low-mow” or “no-mow” grass species on the market that are gaining in popularity. They require much less mowing than traditional ryegrass and bluegrass species and have drought tolerant characteristics as well. After the initial capital investment, homeowners are reported to require much less time, effort and expenditure in maintaining their lawns. The City of Kelowna has installed a demonstration lawn using no-mow grass near the public library. The RDOS could investigate this option for residents and provide information and guidance as appropriate to those wishing to try out this alternative.

4.1.2.7 Xeriscaping

Xeriscaping refers to gardening using drought tolerant plants. Xeriscape gardens often produce less yard waste, but not always. There are drought tolerant plantings that appear lush, and require just as much trimming as their thirsty counterparts. As a waste reduction tactic, xeriscaping is less useful, but it remains an extremely important gardening practice for water conservation, and should be encouraged along with other strategies.

Some sources will encourage planting of evergreen tree species over deciduous for waste reduction. However, as many Okanagan homeowners will attest, native pine trees produce just as much yard waste in the form of dropped pine needles, and because needles are acidic and slow to compost, they are usually put into municipal compost programs, rather than backyard bins. Deciduous trees also have other environmental benefits by letting in more light in winter months, reducing heating and lighting needs, while shading homes in the hot summer months, reducing air conditioning requirements. It is not clear that one type of tree should be promoted over another. In addition, most pine tree species are affected by the mountain pine beetle, which is just about to become a significant problem in the RDOS.

4.1.3 Pine Beetle Education

The Mountain Pine Beetle is coming to the Okanagan Valley, and reports from areas already affected suggest that 90% of pine trees within the area will be killed. This has the potential to result in an enormous volume of wood waste over the next few years.

Municipalities should make an effort to educate people now about how to protect their trees from pine beetle infestation to reduce the volume of beetle damaged wood that needs to be managed later.

4.2 Municipal Programs

For residential waste, many components of yard waste such as pine needles and cones and large branches don't break down readily in a backyard composter. Also many household and commercial organic wastes such as cooked foods, meat and dairy products, fats oils and grease and pet waste are not recommended for inclusion in back yard composting.

The ICI sector contributes significantly more to the solid waste stream than the Residential sector. Composters are difficult to operate on ICI properties due to space constraints, and often the sheer volume of feedstocks and the associated logistics required to maintain a system prevent a commercial composter from being a viable option.

Despite the importance of municipal organic waste reduction programs, there will always be a need for municipal management of organic waste.

5 Organic Waste Collection Options

5.1 Direct-Haul

Since all of the work is delegated to waste generators, direct-haul of materials to processing facilities is the most cost-effective collection method available to a municipality. From the generator's perspective, the hauling of materials can either be done using internal staff and equipment, or it can be outsourced to a contractor. Collection from institutional and commercial sources and from multi-family dwellings (e.g. apartment and condominium complexes) is generally outsourced to waste contractors. Larger industrial and agricultural generators and wastewater treatment plants are more likely to have the resources and equipment that would allow them to haul materials themselves.

While there are definite cost advantages to implementing a direct-haul program, there are also disadvantages. The major disadvantage is the increased infrastructure required at the processing facility to manage the higher traffic levels that can be expected. Due to a greater variety of collection vehicle types, there might also be a need to alter facility designs (e.g. increased building interior clearances, larger turning radii for roadways) to accommodate all vehicle types.

It is also reasonable to expect that direct-haul will result in a greater number of smaller loads being received at the processing facility. This can further increase traffic loads, and potentially cause noise and other disruptions in the community surrounding the processing facility.

Typically, residential customers are not as experienced at navigating the hazards at waste facilities, or driving and backing up in close proximity to large trucks and site equipment. As a result, at facilities where direct-haul loads are accepted from residential customers, it is recommended that they be provided with an unloading area that is separate from the area used by commercial traffic. While this will add to the overall cost of the facility, it allows potential safety issues to be avoided. It also improves the flow and speed of commercial traffic through the facility, which helps to reduce transportation costs for those customers.

5.2 Drop-off Depots

Where collection services are provided, centralized drop-off depots are generally the most cost-effective collection method available on a per tonne basis. However, this type of program has a lower level of convenience relative to



Exhibit 5- 1: Residential customers dropping of material at a compost facility.



Exhibit 5- 2: Typical depot consisting of yard waste stockpiled in an open area.

“at-source” collection programs, and therefore they rarely collect more than 50% of the available materials (diversion rates in the range of 10% to 25% are more common). Also, due to the likelihood of attracting birds and animals, and the high potential for odours, traditional drop-off depots are not well suited to putrescible organic materials such as food wastes. Centralized depots make the most sense when the materials collected are limited to leaf and yard debris, and woody materials such as brush, clean white wood and Christmas trees.

Participation rates in drop-off programs are dependent upon a number of factors. One of the main factors is the number and location of the depots (i.e. their proximity to the generator’s location). Others include the amount and quality of educational/awareness programming undertaken by the municipality, and the physical accessibility of the drop-off site (e.g. layout, driving surfaces) and its overall cleanliness and level of housekeeping. It is not unheard of for residents to avoid using drop-off sites if they are smelly, muddy or crowded.

Depots can vary widely in their level of sophistication. At the lower end of the spectrum are depots that simply consist of an open area where materials are dumped in a single large pile. At the opposite end of the spectrum are paved areas that contain designated containers or bunkers for different materials (e.g. grass and leaves, shrubs and branches, large branches, logs and stumps), and have specific traffic flow patterns. The latter style of depot tends to be used at sites which experience higher traffic volumes.

When piles and bunkers are used, no special collection truck is required. More often, dump trucks (which are owned by most municipalities) can be used to transfer material from the drop-off site to the processing facility. For larger programs, or where the hauling distances are longer (e.g. > 50 km round trip), it may be more economical to use a walking floor trailer which has a payload capacity of 20 or more tonnes (compared to the 5 to 10 tonne payload of a dump truck). However, depending upon the size of the wheel loader used to load material at the depot, it may be necessary to construct an earth ramp to allow the walking floor trailer to be loaded.

Bunkers generally help to maintain a cleaner looking site and piles. The back wall of the bunker also serves as a convenient push-wall for wheel loaders or skid-steer loaders used to empty the depot. Bunkers are commonly constructed from a range of materials including wooden timbers, railway ties, old telephone poles, jersey barriers and cast-in-place concrete. The use of pre-cast concrete “ecology-blocks” is also very common and is often the most convenient.

Ecology-blocks can generally be purchased from concrete plants for between \$100 and \$150 each, and can be placed using skid-steers, front-end loaders or trucks with picker-cranes. If available, “off-spec” ecology blocks, or blocks made from leftover concrete from other pre-cast jobs can be purchased for as little as \$50 each.



Exhibit 5- 3: Typical bunker-style depot constructed from ecology-blocks.

A typical drop-off depot with two bunkers, limited earthwork requirements, and without a concrete base pad can be constructed from 45 to 50 ecology-blocks for a cost of approximately \$7,500. This cost will increase as the distance from the block supplier (and thus delivery costs) increases, or if there is a substantial amount of grading and compaction required.

The use of low-sided roll-off containers at drop-off depots is also common, and equally functional. Roll-off containers eliminate the double-handling associated with loading materials from the ground or in a bunker into a dump truck. Containers also provide a much higher level of containment of liquids and rainwater that run off the feedstock piles, which in turn helps control odours associated with standing water and potential groundwater quality impacts.

However, roll-off containers do require that a specialized bin-truck be purchased, or that the transfer service be contracted out. Also, stairways/walkways or retaining walls are normally required so that site users can safely lift and deposit materials into the container without risking back injuries.

The cost of a 30 yd³ open-topped roll-off container is in the range of \$7,500. Depending on whether it is made from wood or steel, stairs and walkways could cost between \$500 and \$2,500 per bin. If a retaining walls system is constructed, the cost of the drop-off depot can easily exceed \$25,000.



Exhibit 5- 4: Typical use of roll-off containers at yard waste depot.

5.3 Community Collection Sites

Rather than providing one or two larger centralized drop-off locations, some municipalities have opted to instead provide several smaller drop-off sites located throughout their community. This allows sites to be located closer to generators, making them more convenient to use and thus boosting participation.

These “neighbourhood” sites typically consist of some form of waste container, such as a commercial front-end bin, oversized wheeled carts, or a Haul-All semi-automated container. Since the containers are small, they must be emptied frequently to prevent them from overflowing and becoming unsightly. However,

this higher collection frequency also means that community depots may be suitable for collection of food wastes. If food waste is included, the collection container must be animal proof.

Depending upon the style of container, community depot sites can be located in parking lots at municipal facilities (e.g. parks, sports fields, skating arena, swimming pools) or even at roadside pull offs. Because of traffic and odour potential, siting on roadways in residential areas



Exhibit 5- 5: Community collection bins for food waste in Banff, AB.

may result in complaints from nearby homeowners.

For certain styles of container, there may be little to no site preparation required for a community collection site. Thus costs are generally limited to the cost of the container. This can range from a few hundred dollars for wheeled carts, to \$7,000 for Haul-All's semi-automated bin. Depending upon the type of container, specialized collection trucks may have to be purchased, or the service contracted out.

5.4 At-source Collection Programs

Collection of organic wastes from the generator's location can significantly increase diversion rates by driving up program participation. For example, in established residential curbside collection programs with supporting education programs, participation rates of 80 to 90% are not uncommon.

At-source collection programs offered by municipalities are generally limited to residential generators, and in particular to single-family homes and row-houses. Most municipalities do not provide collection services to apartments and condominiums. Instead, these types of dwellings are normally serviced by private waste contractors in the same manner as commercial businesses. Similarly, municipalities do not normally service commercial customers.

One of the key decisions involved with the planning of a curbside collection program for residents is the type of collection container that will be used. The most common choices are plastic bags (regular and compostable), paper bags, or wheeled carts.



Exhibit 5- 6: Bag-based yard waste collection program.

Historically, many leaf and yard waste collection programs allowed residents to set out materials in plastic garbage bags. However, it soon became apparent that allowing the use of garbage bags lead to a number of problems, one of which was higher contamination levels resulting from generators "hiding" unacceptable wastes in the bags (to avoid disposal charges or garbage bag limits).

Overtime, programs have evolved to only allow the use of clear or translucent green garbage bags. This allows the bag's contents to be inspected at the curb, and left behind if contamination levels are unacceptable. However, this does not eliminate another problem associated with plastic bags; separating the bag from its contents prior to processing.



Exhibit 5- 7: Plastic wrapped around the flails on a windrow turner.

If not removed, the plastic bags can become tangled around the rotating parts of processing equipment and either reduce productivity or cause damage. The plastic can also be shredded into smaller pieces during processing operations, which in turn can lead to clogging of

processing equipment or contamination of products produced from the organic feedstocks (e.g. compost).

The labour and cost involved with separating plastic bags from organic feedstocks can be significant. The only method that is truly reliable is to have one or more workers open bags with knives and empty them by hand. If quantities are large enough (e.g. > 100 tonnes per day), the investment in dedicated mechanical bag-opening equipment may be warranted. For moderately sized programs that have a dedicated trommel screen at their processing operation, it may be feasible to retrofit the trommel to act as a bag opener.

A further downside to plastic bag-based programs is that bags of wet green grass or food waste can be heavier than bags of garbage. As a result, collection vehicle workers are subjected to a higher risk of back strains and injuries.

Despite these problems, plastic bag-based programs continue to be popular because of their convenience to both residents and municipalities. For the resident, the bags are readily available at retail stores and are inexpensive. For municipalities, bag-based programs mean that special collection vehicles, or modifications to existing vehicles, are not necessary as the bags can be collected using the same trucks that are used for regular garbage collection. This allows a municipality to integrate organic waste into existing waste collection programs without having to change or purchase additional collection trucks.

As an alternative to regular plastic bags, a new generation of “compostable” plastic bags has become available over the past two to three years. These bags are produced from resins that will break down under ideal composting conditions, and are certified in accordance with international standards. However, experiences with these bags at composting facilities in Ontario have shown that they do not completely break down in the normal timeline of municipal composting operations (i.e. 4 to 8 weeks) and they can still affect processing equipment used in the early stages of the process.

Large Kraft paper bags are allowed in curbside collection programs operated by many municipalities. These bags have the benefit that they can be incorporated into many processing operations without the risk of damaging equipment or affecting product quality. Paper bags are generally available for roughly the same cost as a large clear plastic bags (e.g. €50/bag), although they may not be as readily available at retail stores.

Collection of organic wastes, garbage and recyclables using wheeled carts and automated or semi-automated trucks has been popular in the Ontario and Atlantic Canada for many years, and is gaining in popularity in the West. Carts-based collection programs eliminate the need for, and the problems caused by plastic bags.

Carts are available in a number of sizes ranging from 50 L (13 gallons) to 360 L (95 gallon). This variability allows municipalities to select a size(s) that matches the types or waste being collected (e.g. just yard waste, or yard and food



Exhibit 5- 8: Kraft paper bags used for yard waste collection.

waste) and collection frequency (i.e. weekly or biweekly), and manage seasonal variations. Choosing the appropriate cart size is based on waste statistics and resident surveys, and often involved limited pilot trials. Guidance from the experiences of similar communities is also extremely valuable.

Popular cart sizes for residential collection programs that include both food and waste are 120 L, 245 L and 360 L. Programs that collect only food waste can opt for a smaller cart in the 50 to 75 L size range.

Regardless of whether they are based on bags or carts, curbside collection programs are not suited to collection of bulky or heavy wastes due to the limitations of compactor trucks and the risk of back injuries for collections personnel.

These materials are normally banned from collection programs, or strict limitations are put in place. In the case of organic wastes, this often means that items such as large tree limbs, logs, and stumps are banned, and there are limits on smaller limbs and brush (e.g. maximum diameter and length of tree limbs, requiring limbs to be tied in bundles). It is normal practice that when bans or limits on bulky yard waste materials are put in place, at least one centralized drop-off location is established where residents can bring these materials, or direct-haul to the processing site is permitted.



Exhibit 5- 9: Small 50L green cart being unloaded by a Toronto collections program worker.

Although curbside programs can increase diversion rates, it comes at a substantially higher cost than maintaining and operating a network of drop-off sites. Prices for collection are typically in the \$4 to \$6 per household per month range, although this does vary depending on the frequency of collection (weekly versus biweekly), the number of households, and the distance to/from processing facilities. To provide a balance between higher diversion rates



Exhibit 5- 10: Typical fully automated collection vehicle.

and higher costs, some communities opt to provide curbside collection on periodic basis (i.e. spring and/or fall) rather than throughout the spring, summer and fall. Another approach is to provide curbside collection on “subscription” basis, where households voluntarily sign up for collection service and pay an additional monthly or annual cost. Anecdotal information indicates that the collection costs of spring/fall and subscription programs are similar to full season programs.

6 Organic Waste Processing Options

There are numerous technologies that can be used to process organic waste. In order to help establish the framework for an organic waste management system, this technical memorandum has been prepared to identify processing methods and technologies which are appropriate for application in RDOS.

6.1 Composting

Composting of organic wastes can be carried using various methods and technologies at sizes ranging from simple backyard operations, to large central facilities that process tens of thousands of tonnes each year. Compost methods and technologies are generally divided into home or backyard composting, mid-scale or on-site composting, and centralized composting.

6.1.1 Composting Process Overview

Composting is the controlled biological process in which microbes decompose organic material in the presence of oxygen, converting it into a biologically stable product that can subsequently be used as a soil amendment. A wide variety of organic waste streams can be converted into soil amendments through the composting process. Leaf and yard waste is the most common feedstock treated, but composting has also been used effectively to manage pre and post consumer food waste (with and without soiled paper products), biosolids from waste water treatment facilities, animal manures and bedding, animal mortalities and slaughterhouse waste, and organic waste for food processing plants, breweries and dairies.

As an alternative to producing a soil amendment, composting can also be used as a treatment step for organic wastes prior to disposal. In several jurisdictions, composting is used to stabilize and reduce the volume of municipal solid wastes prior to their being landfilled. The composting process can also be used to treat soils contaminated with hydrocarbon or other organic compounds; the type of contaminant(s) present and the final treatment efficiency will determine if and how the treated soils can be reused.

During the composting process, several key parameters are monitored and controlled during the various stages of the composting process. Nutrient ratios, moisture content, temperature and oxygen are the most closely monitored. Porosity and particle size, and pH are generally only managed at the start of the composting process.

The “conventional” composting process (i.e. where production of a soil amendment product is the goal) is often broken down into distinct steps as shown in Exhibit 6- 1.

Feedstock Recovery involves removing materials from containers or bags, and inspecting them for non-compostable materials and other contaminants. When found, these contaminants are removed to improve the quality of the final product, and to prevent damage to subsequent processing equipment.

Feedstock Preparation involves changing the physical and/or chemical characteristics of the feedstock in order to provide the most optimal conditions for microbes during the composting process. Preparation may include grinding to set particle size, mixing in amendments to increase porosity, blending together various feedstocks to optimize nutrient ratios or pH, adding water, or inoculating the feedstock with beneficial microbes by recycling compost.

Prepared feedstocks are then placed into the pile, windrow or vessel where the **Composting** process begins. The composting process is often described as having two stages: high rate and stabilization. In reality this distinction is theoretical as the transition between stages is gradual enough that it is indistinguishable.

The initial high rate stage of the composting process involves the rapid decomposition of the most readily degradable material. It is characterized by the generation of a significant amount of heat; enough to raise the temperature of the feedstocks into the 55°C to 65°C range.

Once the more readily degradable chemical compounds in the feedstock are consumed and the compost is “stable”, the biological process slows down and enters the **Curing** or “maturation” phase. During curing, microbes convert extra carbon into carbon dioxide and humus, and extra nitrogen into nitrates. Curing can take anywhere from a few weeks to several months to complete.

Screening and refining is done to remove oversized materials such as large compost particles, stones, contaminants, and uncomposted bulking agents, and create a product suitable for the selected end use.

Storage of the finished product is the final stage of the process. In some cases, it is mixed with other products (e.g. topsoil, peat, sand) to produce soil blends, and at some larger facilities the compost or blends may be bagged for distribution through the retail market.

6.1.2 Composting Methods

As mentioned, composting is carried out at scales ranging from backyard operations to large centralized facilities. The composting principles are the same at each level even though differences occur in the composting rates, control methods, and the composting vessels.

Home composting is a common component of municipal waste reduction strategies across North America, and a wide variety of backyard compost containers are available. However the volume of material that can be effectively managed at the household level is small (i.e. < 100 kg per year), and the potential for odours and other nuisances is high when food waste is handled. Introduction of food waste into a home composting pile also increase the risk of attracting animals.

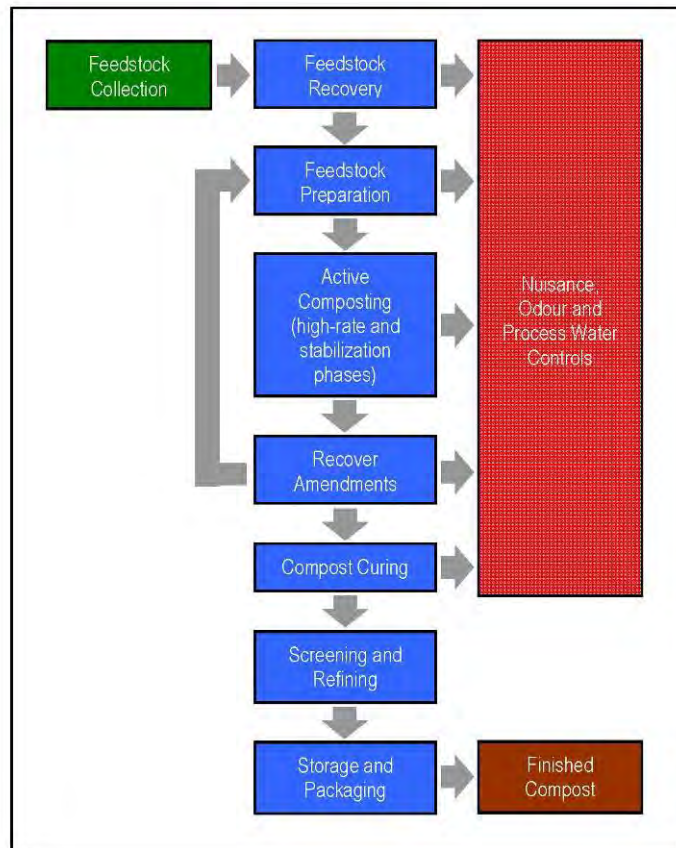


Exhibit 6- 1: Compost Unit Processes

Mid-scale composting typically refers to the composting of moderate quantities (i.e. less than one tonne per day) of organic waste by large waste generators on their own site, thus allowing for a de-centralized approach to managing organic wastes. Examples of applications where on-site composting is appropriate include hospitals, apartment buildings, airports, shopping malls, office buildings, schools, and university/college campuses. The benefit of on-site composting is the avoidance of the costs incurred to transport organic wastes off-site for disposal or processing. However, in situations where there is insufficient space at the site, it may be necessary to transfer the compost to an offsite location once it has gone through the active compost process so it can be fully cured.

Centralized composting involves the collection of larger volumes of organic wastes from several different generators, and processing at a single facility. These facilities are generally large, with capacities ranging from a few tonnes per day up to several hundreds of tonnes per day. Centralized composting has been practiced in Europe and North America for several years. As a result, a wide range of technologies and techniques have been developed, ranging from simple and inexpensive, to complex and costly.

The following sections provide a brief overview of specific mid-scale and centralized composting options and technologies.

6.1.2.1 Static Pile Composting

This method of composting is the simplest and generally the least expensive option available. It is appropriate for leaves and other woody feedstocks, and when there is an abundance of space, and time are available. The static pile method of composting involves forming the collected organics materials into large windrows or piles which are then allowed to decompose over an extended period (i.e. 2 to 3 years) with little or no mixing. Static pile composting takes much longer to complete than other methods due to the lack of agitation and the resulting lower aeration rate. A longer residence time also means that a greater amount of space is required relative to other methods which compost materials more quickly.

Static piles are normally built using front-end loaders, skid-steers, farm tractors or excavators. It is good practice to separate piles with roads or aisles to allow for fire equipment access in the event of spontaneous ignition.

Once they are built, the windrows or piles are expected to be passively aerated via convection and diffusion. Therefore it is very important that materials initially be mixed with enough amendment to provide sufficient porosity.

Despite the passive aeration, static piles are often largely anaerobic with the exception of the pile exterior. Since anaerobic conditions can prevail, odours generate quickly and can affect the surrounding community. Release of odours often takes place when the piles are mixed or moved. The higher potential for odours increased the need for buffer zones between the compost site and adjacent properties, which in turn increases land requirements.



Exhibit 6-2: Typical example of static pile method being used to process yard waste.

Occasional remixing and reformation of the static pile is helpful in re-establishing porosity which is lost over time as the materials degrade. Without periodic mixing, there will be areas in the pile which do not attain the required composting temperatures and thus a proportion of the material will not be adequately composted. The outer layer may not undergo composting at all.

A properly managed static windrow can be effective at minimizing runoff issues. The larger piles typical of this composting method have less exposed surface area which reduces the overall amount of rain and snow melt that infiltrates the pile.

Historically, static pile composting has been used to process yard waste and bark mixtures, biosolids and sawdust mixtures. However, the system is generally not suited for use in urban areas where odours can be constantly emitted from the pile and agitation of older material releases odours as the aerobic process is re-started.

6.1.2.2 Bunker Composting

Composting smaller quantities of materials can be done quite simply using a static pile approach in small bunkers. The bunkers can be constructed from cast-in-place concrete, concrete lock-blocks, jersey barriers, and even wood. Depending upon the installation location and climate, the bunkers can be located outdoors, covered by a simple roof structure, or contained within a building.



Exhibit 6- 3: Small bunker composting system used to process animal manures.

A typical installation consists of three separate bunkers. The first bunker is used for receiving fresh materials on a daily basis. When this bunker is filled (typically after one to two weeks), the third bunker is emptied, and refilled with material from the second bunker. The material from the first bunker is then moved into the second bunker to make room for fresh materials. Active composting occurs in the second and third bunkers.

Depending upon the size of the composting operation, materials can be moved from bunker to bunker manually, or using a skid steer or small front-end loader.

Due to their simplicity, bunker systems can be custom designed to match a specific application and rate of feedstock generation. Individual bunkers can range in size from 2 to 3 m³, to as much as 20 m³. Larger bunkers can be equipped with aeration systems (similar to those used in aerated static pile systems) to provide better process control and control over odours.

6.1.2.3 Windrow Composting

Windrow composting is the most common composting method in North America. It generally requires little in the way of infrastructure and has low operating costs compared to other composting methods.

The materials being processed are formed into long low piles (a.k.a. windrows). The windrows are regularly moved or “turned” to re-establish porosity in the material, to chop it up, and to blend it. Turning can be done using mobile equipment (e.g. front-end loader, skid steer, excavator), a farm tractor and manure spreader, or a specially designed windrow “turner”.

The turning process also reintroduces oxygen into the windrow. However, in this oxygen is quickly consumed; in some cases, oxygen is consumed so fast that anaerobic conditions become established in as little as 30 minutes. Thus, aeration of the windrows is largely passive and depends on the porosity of the pile.

Windrows are typically 1.5 to 3 m (4 to 10 ft) high and 3 to 6 m (10 to 20 ft) wide. The size of the windrow is dictated in part by the type of equipment used to turn it. It is also a balance between keeping a small enough cross section to maintain aerobic conditions (through passive aeration), and a large enough pile to hold in heat and achieve temperatures high enough to evaporate moisture and kill pathogens.

Windrow composting is almost always done outdoors where it is exposed to precipitation. This can lead to runoff management problems. Any runoff created must be collected and treated, or added to a batch of incoming feedstock to increase its moisture content. To avoid problems with runoff, piles can be placed under a roof or in a building, although this adds to the capital costs of the facility.

The windrows are usually situated on a firm working surface, or “pad” which is constructed to support the weight of delivery vehicles and turning equipment without rutting. The pad is normally sloped (0.5 to 2%) to direct drain run-off towards a collection ditch or detention pond. The most common types of composting pad surfaces are concrete, asphalt, cement treated base, and compacted gravel.



Exhibit 6- 4: Typical windrow operation with a specialized turner mounted on a front-end loader.

Every time a windrow is turned, heat, water vapor, and gases trapped in the pore spaces are released into the atmosphere. If the facility is outdoors, there is little that can be done to capture the water vapour and gases, and as a result this method of composting has the potential to affect adjacent neighbouring properties. Windrow turning should therefore always be done at times when they will have the least impact on neighbours.

A properly managed windrow composting facility can be inexpensive but it does require land and buffer areas to minimize impacts from potential odours. The solution to odour prevention and control is to ensure that experienced facility design and management expertise are used, and that on-site staff are well trained in the principles of composting and troubleshooting solutions when problems arise. Most turned windrows are situated in non-urban settings surrounded by a large buffer zones. Often, they are placed at the landfill which offers ample land, berms, and buffer areas.

Processing times for L&YW using windrow composting can be as low as three to four months if the site is aggressively managed, but six to twelve months is more common in the colder climates of north central and northeast United States.

Because processing times are reduced, the same amount of material can be processed on a smaller footprint by using the windrow method rather than static piles. The amount of space required for windrow composting is also influenced by the type of equipment used to turn the windrows, which determines the windrow size and spacing. Generally, sites that use large

straddle-type windrow turners can manage more material in the same amount of space than a site that uses front-end loaders or manure spreaders. However, front-end loaders can be used to create and turn larger piles than small towed windrow turners, and are thus more efficient in terms of space requirements.

6.1.2.4 Aerated Static Pile Composting

This method of composting was developed in the early 1970's, and has since been used successfully for leaf and yard waste, food waste, animal mortalities, animal manures, biosolids, and industrial composting. Aerated static pile (ASP) composting offers less exposed pile surface, less agitation, and, if designed to operate using negative aeration, it allows for a higher level of odour control than static pile and windrow composting.

Feedstocks are mixed and piled to depths of between 1.5 and 3.5 m (5 and 12 ft) depending upon the feedstock characteristics and site design. In more extensively engineered systems, pile heights of up to 8 m (25 ft) are possible. There is no standard width or length for aerated static piles; it is often dependent of site specific situations and land availability.

The air is distributed through the pile via a network of solid and perforated pipes in the base of the pile. The perforated sections of the pipe are normally embedded in a porous layer of wood chips or straw. The perforated pipes and the porous base layer are also constructed such that they are 2 to 3 m (6 to 10 ft) from the edges of the pile. This prevents air from “short circuiting” out the ends and sides of the pile, and forces it to pass through the material being composted.

In larger facilities, below-grade air systems (e.g. covered trenches, pipe and spigot arrangements) are often used instead of above ground perforated pipes. These systems are more costly to construct, but allow for quicker pile construction and tear-down. They also eliminate the risk of damaging aeration piping and the need to replace pipe. Often, below-grade systems provide more efficient air delivery, which translates to reduced electrical consumption by aeration fans.

Two forms of ASP systems are commonly used: single and extended piles. Single piles are the most common and are normally used in smaller applications where material is composted in batches. Materials received within a short period of time (e.g. 3 to 5 days) are used to form the pile. Since the material is approximately the same age and has the same demand for air throughout, a simple aeration control system can be used.

Extended piles are used when materials are generated daily and each day's intake is sufficient for a single “cell”. The cells are built against each other as the material arrives. This results in better use of the available area since there are no aisles between piles. Cell widths are usually equal to the pile height, and each cell has its own aeration piping and aeration control.



Exhibit 6- 5: Typical ASP system with above-ground piping. Block walls are used to separate batches and better utilize available space.

If positive airflow is used (i.e. air is forced through the aeration system and up into the pile), the piles are normally covered with an outer layer of finished compost which helps to manage odours and retain moisture. When negative aeration is used (i.e. air is sucked down through the pile and into the aeration system) the concentration of odourous compounds in the air removed from the pile will be much higher and some form of treatment is needed. The most common practice is to exhaust the air from the pile through a biofilter.

Air flow can be continuous or intermittent. Continuous operation allows for lower air flow rates but excessive cooling may result if the system is not carefully design and managed. Over cooling piles can prevent the temperatures needed for pathogen destruction from being reached, and can lengthen the time required to stabilize materials.

Intermittent fan operation is more common. Aeration fans are typically controlled by a timer, or by a system that measures temperatures in the piles and turns the fans on and off much like a home thermostat.

Fans are usually of the centrifugal axial blade type. The size of the fan depends on a number of factors including the type and porosity of material in the pile, the size of the pile, and air flow characteristics of the air distribution system. Sizing and selection of the fan is normally done by an experienced designer

When the composting process nears its third or fourth week, the piles are broken up for the first time since their construction. The materials are then further composted in aerated static piles, or possibly using the windrow method.

Since ASP's are not turned regularly, care must be taken during the blending of feedstocks with structural amendments to ensure adequate porosity is maintained throughout the composting period. It is important to achieve a homogeneous mixture and not compact the material with machinery while constructing the pile, so that air distribution is even and no anaerobic areas develop causing sections of uncomposted material.

Fully matured compost can be produced using this technology in as little as 10 to 12 weeks during the warmer months of the year. Typically, material is kept within the aerated piles for 6 to 8 weeks.

Advantages of aerated static pile (ASP) composting compared to windrow composting include the management of odourous materials in an undisturbed mass, until such time as they have stabilized. This is one reason that it has been popular in the processing of biosolids.

The infrastructure necessary for ASP systems usually increases capital costs, but manpower and material handling needs are generally lower than at a comparably sized windrow system as the piles do not need turning.

Due to the pile sizes and configurations, lack of aisles between adjacent piles, and quicker processing times, land requirements for aerated static pile composting is normally less than for windrow systems.

6.1.2.5 Passively Aerated Windrow Composting

This method of composting is a cross between the static pile and aerated static pile methods. The mixture of materials to be composted is placed in long, low windrows which are

constructed over a network of perforated and open-ended pipes. The pipes are placed every 0.5m (2 ft) along the length of the windrow, and are covered with a 25cm (12") base layer of finished compost, straw or wood chips. The pipes and base layer allow air to naturally diffuse through the material without the use of aeration fans.

HDPE or PVC pipe (4" or 6" diameter) is normally used when constructing passively aerated windrows. If perforated pipe is unavailable, standard sewer pipe can be purchased and 1/2" diameter holes can be drilled manually.

A 25cm (12") layer of finished compost is normally placed overtop of surface of the windrow to discourage insects and help with the retention of moisture. The outer layer also helps to manage odours.

The increased amount of aeration relative to traditional static pile method should theoretically allow for quicker processing times. However there is limited experience with this method from which to confirm this. Processing times are therefore generally estimated to be between one and two years.

As with static piles and ASP systems, particular attention must be given to the moisture and porosity of the material when constructing the windrow so that adequate aeration can be maintained.

6.1.2.6 Turned Mass Bed Composting

Mass bed composting is an improvement upon the traditional windrow method. It is a continuous flow system (as opposed to traditional windrows which are batch systems) which relies on a specialized windrow turner originally designed by SCAT Engineering (now sold by Vermeer) and the use of windrows that are normally 20 m wide or more.

The original towed and self propelled windrow turners designed by SCAT Engineering were, and still are, used for processing individual windrows. Rather than the rotating drum with flails used by most other windrow turners, they use an inclined conveyor to lift and throw the compost. As the turner travels down the length of a windrow, the inclined conveyor moves through the material, lifts it up, and throws it backwards off the top of the conveyor.

The self propelled turner design was subsequently modified, and a horizontal "cross conveyor" was added behind the incline conveyor. As the modified unit travels down

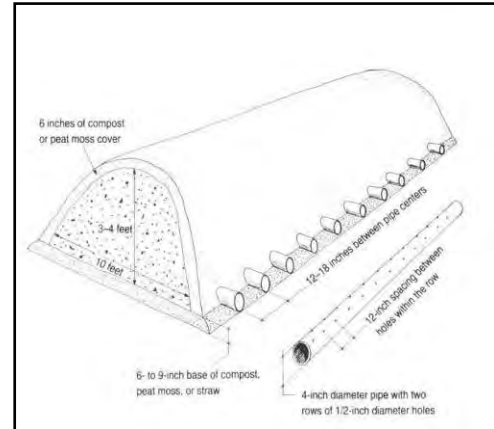


Exhibit 6- 6: Schematic of a passively aerated windrow system. (Source: On-farm Composting Handbook)



Exhibit 6- 7: A Vermeer towed windrow turner used to turn individual windrows.

the length of the windrow, the material is still lifted up and thrown backwards by the incline conveyor. However, rather than falling back on the ground directly behind the turner, the horizontal conveyor catches the material and throws it to the side of the turner opposite the inclined conveyor.



Exhibit 6- 8: A self-propelled Vermeer windrow turner equipped with a horizontal cross conveyor.

The side throwing action of the modified turner allows it to work sequentially from one side of the mass bed to the other. Each time the turner passes through the bed, it picks up the material to its right and throws it to the left, and in the process creates a new drive aisle to the right. The unit then back up, moves to the right and repeats the process down the newly created aisle. Once the mass bed has been completely turned, it will have been physically relocated 3 to 4 m (10 to 13ft) to the left.

Mass bed composting can be done indoors or outdoors. It can also be further improved by combining it with an infloor forced aeration system. With forced aeration, processing times can be much quicker than traditional windrow composting. For example, a processing time of between 6 and 10 weeks can be achieved with L&YW feedstocks.

The primary benefit of the mass bed approach is that it allows for a much larger amount of material to be processed in a smaller footprint compared to windrow composting using a large straddle turner or a front end loader. Thus, even though the cost of the turning equipment is 50% to 100% higher than large straddle-type turners, the smaller working pad and reduced construction costs can make this approach very cost-effective.

The downside to using mass beds is that there is a greater potential for reduced oxygen levels in the piles which can lead to nuisance odours. This drives the need for more frequent turning and higher management, and thus higher operational costs relative to a windrow system.

6.1.2.7 Enclosed Aerated Static Pile Composting

While outdoor composting is a well-established composting technique for managing leaf and yard waste and small amounts of source separated food waste, it is not typically an appropriate technique for managing large volumes of food waste, biosolids, or liquid manures.

Enclosed aerated static pile composting is simply a variation of the outdoor technology. The process is identical but it includes walls and a ceiling. Enclosed aerated static pile systems can take the form of tunnels, enclosed bays, bunkers, or large windrows. Most typically, the piles are trapezoidal blocks with push walls.



Exhibit 6- 9: Aerated static pile composting being done inside an enclosed concrete "tunnel".

The interior environment and materials used to construct the buildings and enclosures are critically important for sustaining safety and building integrity. Some enclosed facilities have proved to be inadequate with regard to corrosion protection, interior visibility, and indoor air quality. These problems are all related to low air exchange rates for the building interior. The composting process releases large amounts of heat, dust, and water vapour. Under these conditions the building interior will be a rain forest-like environment with interior fog obscuring visibility and condensation dripping off the ceiling interior. These operating conditions are a particular concern for composting facilities in locations where winters are very cold.

6.1.2.8 Channel Composting Systems

Enclosed channel systems are essentially turned windrow piles which are placed inside of buildings. The windrow is situated between two long, parallel concrete walls that are 1.8 to 2.4m (6 to 8 ft) high and 3 to 6m (10 to 20 ft) apart.

The raw materials are loaded into one end of the channel, and are moved down its length over a period of one to three weeks by a turning machine that rides along the tops of the concrete walls. The turning machine has a conveyor or rotating drum that hangs below it that physically lifts and throws the compost backwards, and agitates it in the process. As the turning mechanism makes repeated passes down the channel over time, it moves the mass of material from the feed end of the channel to its discharge end.

Oxygen and temperature control within each channel is provided by a forced aeration system in the floor of the channel, similar to that used with aerated static pile systems.

Channel systems are normally designed so that the primary composting process is largely completed by the time that the waste is discharged from the end of the channel. The compost material is then typically placed in outdoor windrows or aerated static piles to complete the maturation process.



Exhibit 6- 10: Channel composting system used to process animal manures.

Organic waste can be only added to the channel system once and, consequently, must be in a perfectly-proportioned blend with each application. This requires skilled Operators to work with different loads and types of wastes to ensure the proper blend is achieved.

Although costs vary among different technologies, enclosed channel systems are generally less costly than similarly sized in-vessel systems. Since most of the technology associated with the turning system is suspended over the biomass, servicing and repair of equipment tends to be straightforward.

6.1.2.9 In-Vessel Composting

The differentiator between in-vessel and other composting systems is that the composting process itself is conducted inside some type of sealed container, chamber or vessel. This enables the composting process and odours to be more highly controlled.

Generally, in-vessel systems are equipped with forced aeration and mechanical mixing devices and equipment used to feed raw waste into the vessel and remove compost from it. The units include some type of monitoring system for at least temperature and oxygen content within the vessel.

In-vessel composting systems tend to be more capital-intensive than the composting approaches previously described. However, these systems tend to take up less space, can be automated, and may be viable where others are not.

A key consideration for most in-vessel systems is that they have retention times in the range of 2 to 4 weeks, and are therefore only designed to stabilize organic wastes. The material that is discharged from the systems will need to be further matured in outdoor windrows or aerated static piles prior to being used as a soil amendment. The curing time can take several months, depending on the material, the level of management, and external conditions.

6.1.2.10 Containerized Systems (In-vessel)

One type of in-vessel composting systems uses a number of modular composting vessels which are portable and can be moved around the facility. These containers are very similar to 40 yd³ roll-off waste containers used in North America for handling commercial solid wastes.

The containers are filled through sealable doors in the rear or roof of the container. Once filled, the containers are connected to a stationary aeration system that is capable of providing air to multiple bins. After two to four weeks of composting, the containers are emptied by hoisting them on a truck with a specialized lifting system, and tipping the material out the rear doors much like a dump truck. This same truck is used to move empty and full containers around the site.



Exhibit 6- 11: Containerized composting system manufactured by Engineered Compost Systems.

Containerized composting system vendors include Engineering Compost Systems, Green Mountain Technologies, Stinnes, and NatureTech.

6.1.2.11 Rotating Drum Systems (In-vessel)

Several small-scale horizontal rotating drums systems have been developed during the past decade, modeled on the large-scale drum systems made popular for mixed municipal solid waste composting by Bedminster Bioconversion in the 1990's.

The small-scale drum systems typically consist of a steel drum with a diameter of between 1.5 and 4.5 m (5 and 15 ft) and a length of up to 10 m (30 ft). Large scale Bedminster installations have drums that are 4m (13 ft) or 5m (16 ft) in diameter and over 30m (100 ft) long

The drums are positioned on a slight incline (<5%) so that gravity assists material injected into the drum's



Exhibit 6- 12: Small-scale drum composting system.

upper end in travelling to the lower end where it is removed. Depending on the size of the drums, they are driven by large ring-gears, rubber trunions, or sprockets and chains.

Manufacturers of small drum composting systems include Transform Compost Systems, X.Act Systems, and International Composting Corporation.

6.1.2.12 Wright Composting System (In-vessel)

The composting system manufactured by Wright Environmental is a stationary container-type system that relies on a moving floor system to slowly walk materials from the unit's inlet end to its discharge end. One or more sets of "spinners" are located along the length of the unit to agitate materials and break up clumps.

The systems are available in a wide range of sizes, from 450 kg (1000 lbs) per day, to several tonnes per day, and the desired processing capacity can be achieved by using multiple units in parallel. The size of the units vary based on capacity; smaller units can fit inside a single parking stall while larger units are typically 3 to 5m (10 to 15ft) wide and have lengths exceeding 7m (25 ft).



Exhibit 6- 13: Wright composting system installed at a university campus.

Installations of this system are commonly designed with a retention time of 14 days, however longer retention times are possible by lengthening the unit.

6.1.2.13 Hot Rot Composting System (In-vessel)

The Hot Rot Composting System is a continuous flow system similar in concept to the Wright system; feedstocks are injected into on end of the process and are slowly moved to the discharge end. The difference is that rather than a moving floor, the Hot Rot system uses an auger that runs along the length of the vessel to move materials towards the unit's discharge end. The auger is driven by a motor and gear-box that is situated outside of the processing chamber and therefore readily accessible for maintenance.



Exhibit 6- 14: Hot Rot's mid-sized composting unit.

The Hot Rot system is available in four different sizes with capacities ranging from 500 kg (1,100 lbs) per day to 10 tonnes per day. Higher capacities can be obtained by operating multiple units in parallel. The smallest unit is approximately 8m (25ft) long and 1.5m (5 ft) wide while the largest unit is almost 22m (75 ft) long and 5m (15 ft) wide.

Hot Rot units are manufactured in New Zealand, and have been installed in wholesale garden markets, zoos, and municipal applications.

6.1.2.14 Green Mountain EarthTub and Earth Bin (In-vessel)

Earth Tubs and Earth Bins are small-scale systems manufactured specifically for onsite composting applications by Green Mountain Technologies. They are typically used at schools, college or university campuses, hospitals, and other locations with large cafeterias.

The Earth Tub system is the smaller of the two systems, and has a capacity of about 3 yd³. Feedstocks are manually loaded into the unit through a hatchway in the cover. Wood chips, shredded paper or shavings are also added to provide appropriate composting conditions. Once the unit is filled, the materials are composted for 3 to 4 weeks, and then manually removed for further curing in a windrow or static pile. During the 3 to 4 week composting period, materials are periodically mixed by manually turning the auger/lid assembly in a counter-clockwise direction. Mixing is recommended two to three times per week.



Exhibit 6- 15: Schematic of Green Mountain's Earth Tub system.

Due to the batch-type operations, multiple units are required to provide continuous service. The number of units is a function of the rate at which organic wastes are generated.

The Earth Bin system is capable of handling larger volumes of feedstocks than the Earth Tubs, and also operates on a continuous basis. The units are built around industry-standard open-topped roll-off containers, and are available in two sizes: 20 yd³ and 30 yd³. The smaller unit has a processing capacity of 500 kg (1,000 lbs) per day, and the large can process up to 1 tonne

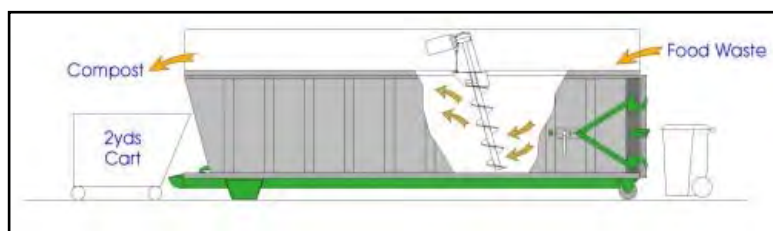


Exhibit 6- 16: Schematic of Green Mountain's Earth Bin system.

per day. Both systems use an inclined auger to mix and move material from the inlet end of the bin to the discharge end.

Both the Earth Tub and Earth Bin are designed to be attached to a biofilter to capture and treat odourous process air.

6.1.2.15 GoMixer (In-vessel)

The GoMixer system is a small scale unit that is design for onsite applications in commercial kitchens, supermarkets, and restaurants. The units are available in a range of sizes from 8 kg (18 lbs) to 725 kg (1,600 lbs) per day.

Feedstocks are manually loaded into the GoMixer unit, and amended with structural materials such as paper or cardboard. The materials are slowly degraded within the unit, and leachate is given off which is directed to a sanitary sewer connection.

The system is advertised as being able to accept materials on a continuous basis.



Exhibit 6- 17: Small GoMixer installation.

6.1.2.16 Big Hanna Composting System (In-vessel)

The Big Hanna onsite composting system is manufactured in Sweden and distributed in Canada by Vertal Inc of Quebec. The units are available in five sizes ranging from 75 kg (165 lbs) to 1,200 kg (2,600 lbs) per week. An optional shredder attachment is available for the inlet of larger units, as is an automated cart tipper.

Once inside the system, materials are slowly mixed and agitated by the rotation of the internal drum chamber, and ventilation is provided to meet oxygen demands. A pre-heater system on the inlet air of the ventilation system allows the unit to be installed in outdoor locations.



Exhibit 6- 18: Big Hanna composting system.

Depending on the installation location, the units can be vented directly to atmosphere, or odourous process air can be redirected to a biofilter.

6.1.2.17 Gore™ Cover System

This composting system was originally developed in Germany, but has since been marketed worldwide by WL Gore and Associates, Inc., and is used in a wide range of applications, including yard wastes, biosolids, and food wastes.

The Gore™ Cover System is based on an aerated static pile composting system. Depending upon the installation, it uses in-ground aeration trenches, or aboveground aeration piping to push air through the composting pile, and the aeration fan is controlled by an oxygen sensor and control computer. What differentiates this system from traditional aerated static piles is that the material being composted is covered by a large Gore-Tex tarp (up to 10m wide and 50m long). The Gore-Tex membrane within the tarp helps to treat odourous process air as it diffuses through the tarp. Weights are used to seal the edges of the tarp on the ground and prevent process air from short-circuiting. The composting process below the Gore-Tex tarp also takes place at a much higher temperature: 80 to 90°C rather than 55 to 60 °C that most other composting system operate at.



Exhibit 6- 19: Gore Cover system processing biosolids in Atlantic Canada.

Another differentiator of this composting system is its low energy requirement relative to aerated static pile and other in-vessel systems. A typical full-scale pile (900 m³) utilizes only a 2hp aeration fan which operates intermittently (i.e. 5 to 10 minutes per hour).

6.2 Anaerobic Digestion

The anaerobic digestion process is used to decompose organic materials in an anaerobic (i.e. without oxygen) environment, and allows the recovery of the energy value on the organic material in the form of “biogas”.

Anaerobic digestion is well established in North America as a means of treating wastewater treatment plant residuals, dairy manures, and other sources of relatively homogenous organic material. The application of anaerobic digestion to organic solid waste is a more recent development and one that has become popular in Europe during the past decade as a result of bans on disposal of organics in landfills. However, while there is significant interest in applying anaerobic digestion to organic solid wastes in North America, there are relatively few operating facilities.

In addition to biogas, the anaerobic digestion process results in liquid and solid byproducts, some of which may have a high nutrient value and is suitable for beneficial reuse as a soil amendment. In some cases, byproducts can be land-applied directly, although there is increasing trend towards some type of further processing (e.g. composting or drying) prior to land-application. If composting or drying is the selected downstream technology, these processes are typically integrated into the process and facility designs.

Anaerobic digestion systems generally consist of four different steps:

- pretreatment
- liquid makeup and recirculation
- acid-phase digestion
- methane-phase digestion (gas conversion)

The **pretreatment** step involves the removal of any contaminants from the feedstock, and preparing the remainder for the digestion process. Depending upon the feedstock, pretreatment may involve manual or mechanical sorting of feedstocks, particle size reduction, and mixing. The general intent is to remove contaminants that will affect equipment operation and byproduct quality, and increase the available surface area of the feedstock to allow for more rapid decomposition.

The efficiency of an anaerobic digestion facility can be optimized by closely managing the solids-water balance in the digestion process. This is done through **liquid makeup and recirculation**. In “wet” digestion systems, feedstocks must be converted into a slurry mixture with less than 5% solids content to allow for efficient pumping, mixing, and heating. This normally involves recirculating and mixing a significant portion of the liquid byproducts from the digestion process back into fresh feedstocks. An external water supply may also be needed to manage the balance of internal mineral concentrations. In “dry” digestion systems, the target solids content is generally in the range of 15% to 25%. At these levels, the materials can be handled more like a solid and front-end loaders can be used.

Once the feedstocks are prepared and suitable moistened, the **digestion** process can commence. In wet systems, the moist and relatively dense waste slurry is typically fed into an acid reactor where the sedimentation of heavy objects such as bones and shells occurs together with the acidification of organic materials. Material within the reactor is mildly agitated and heated to ensure mixing and optimum biological degradation. In this step, uniformly suspended food wastes are hydrolyzed and degraded to organic acids in the acid reactor.

In dry anaerobic digestion systems, the materials are loaded into an enclosed concrete tunnel that closely resembles a tunnel composting system. The tunnel digester has a sealable door, and systems for collecting and recycling leachate back into the material.

Once the acid phase of digestion (also known as acidogenesis) is complete, the feedstock contains a high concentration of organic acids. In wet systems, this mixture can be pumped into a separate reactor where the acids are converted to biogas primarily through the activity of methane-forming bacteria. In dry systems, the material is retained within the same tunnel for both stages.

Biogas generation is commonly used at wastewater treatment plants, and as a result the process is well understood by practitioners. When the material starts degrading, it produces biogas primarily through biochemical reactions known as methanogenesis. If the vessel or tank is kept warm and mixed, it will produce a significant amount of biogas, with most of the conversion occurring in the first two weeks. This biogas is a mixture of methane (the same molecule as natural gas for home heating and cooking), carbon dioxide, and various trace gases. The amount of gas produced depends upon the biodegradability of the material in the digester, how many calories are in the material being digested, and how efficiently the digester operates.

The biogas that is collected from the reactor can be further processed and refined into a fuel source for industrial engines, vehicles or in a generator to create electricity for local use or distribution to through the electrical grid.

The residual solid/liquid mixture from the biogas reactor is known as “digestate”. This material is typically very odourous and often requires special handling.

The digestate from a wet digestion system may be suitable for land application. However, more often some means of solid-liquid separation is used to reduce the moisture content of the digestate (and thus the overall volume that requires further handling), and the digestate is converted to a soil amendment through drying or composting. Some or all of the liquid separated from the digestate is usually recycled back to the front of the process, with any surplus liquid being discharged to sanitary sewer.

In dry digestion systems, the digestate can typically be further processed (e.g. drying or composting) without any need for dewatering.

6.2.1 Anaerobic Digestion Technologies

Although anaerobic digestion is commonly used at wastewater treatment plants, most anaerobic digestion system use to handle non-biosolids waste streams are proprietary in nature and are provided as a technology package by vendors.

These packages vary in terms of the pretreatment steps involved, the amount of moisture added to the feedstock prior to digestion, the means of controlling specific process variables. Some systems also incorporate secondary treatment of digestate and/or refining of biogas into value-added products.

Some anaerobic digestion vendors include:

- BTA (licensed in North America to Canada Composting Inc.)
- Arrow-Bio
- Kompogas
- Kreig and Fisher
- Bekon (licensed in North America to Harvest Power)
- Schmack Bioenergy

There are a number of vendors of proprietary digestion systems, but many systems have not been applied successfully at full scale. Due diligence must be performed when evaluating and selecting anaerobic digestion systems, for they are mechanically complex and require many safety features.

6.3 Mechanical-Biological Treatment

Mechanical-biological treatment (MBT) generally refers to the integration of municipal solid waste (MSW) treatment processes normally found in material recycling facilities, refuse derived fuel plants, and composting plants. A key feature of MBT facilities is the use of mechanical separation to remove and recover non-organic components of the MSW stream, and biological treatment to stabilize the organic fraction of the MSW stream.

MBT facilities involve waste input and control, mechanical preparation, biological treatment, and product conditioning. Waste input and control normally consists of manually removing oversized and hazardous materials. Mechanical processing can include minimal separation or shredding, or sophisticated sorting of the inbound waste into biodegradable material, recyclables, and contaminant streams. Sorting is usually done with dry processes but it can also involve wet processes, such as flotation and hydro-pulping. Hand-sorting systems have also been implemented at some facilities, but this increases health and safety requirements for staff. Depending on the quality and market demand, the recyclables are typically sold, but paper fibers, textiles, rubber, plastics, and residual organics can also be used as refuse derived fuel (RDF).

MBT systems can be classified into three general groups:

- biological treatment used to produce RDF for combustion;
- anaerobic digestion to recover energy ; and
- composting to stabilize organic wastes or to produce a soil amendment.

Use of biological treatment to produce an RDF product for combustion is a popular approach in Europe, but is much less common in North America.

The anaerobic digestion process is used to break down organic materials in an anaerobic (i.e. without oxygen) environment and allows the recovery of the energy from the organic materials in the form of “biogas” that can be refined into a fuel source. In addition to biogas, the process results in liquid and solid byproducts, some of which may have a high nutrient value. In some cases, byproducts can be applied directly to land, although there is an increasing trend towards some type of further processing (e.g. composting or drying) prior to land-application. If

composting or drying is the selected secondary processing technology, these processes are typically integrated into the process and facility designs.

Using composting as the biological treatment component is the most common approach at MBT plants currently operating in North America. Composting is a controlled aerobic biological process in which microorganisms decompose organic material, converting it into a biologically stable product. If implemented in its entirety, the composting process results in the production of “compost” which is stabilized enough to use as a soil supplement. However, at some facilities the composting process is cut short, and instead of being used to create compost, is used only to stabilize organic wastes prior to disposal.

6.4 Mixed Municipal Solid Waste Composting

Mixed municipal solid waste (MMSW) composting has been implemented in nearly a dozen jurisdictions in the United States and Canada. The first generation of MMSW composting facilities were developed in the 1980s and early 1990s, and involved short-term (i.e. 1 to 3 days) biological treatment in a large rotating drum similar to a cement kiln, following by composting.

Data from operating MMSW facilities indicates that, relative to facilities that compost source-separated organic wastes, they are subject to higher costs, more frequent equipment breakdowns, and require a steady market for the compost end-products. For example, the latest MMSW composting plant built in North America (Edmonton, Alberta) has faced a number of challenges related to equipment failures and maintenance since it opened in 2000. Over the past five years, the City of Edmonton, which owns the facility, has implemented several costly modifications to improve the performance of the facility.



Exhibit 6- 20: Aerial view of Edmonton's mixed MSW composting facility. (Source: City of Edmonton)

The quality of the compost produced from an MMSW composting facility depends on the specific processes used, the quality of the feedstock, and the ability to separate metals, plastics, glass fragments, and toxic materials from the organic fraction. In general, the quality of the compost produced at an MMSW facility is lower than that produced at a composting facility that processes source-separated organic material such as green waste or food waste. In some cases the product is not saleable.

6.5 Land Application

Land application of biosolids and manures to complement fertilizer requirements is one of the most widely established practices in North America for managing these organic wastes streams. As a partial replacement for commercial fertilizer, biosolids and manures are a valuable source of nitrogen and phosphate for plants, and also provide small amounts of potassium, as well as many trace elements required by plants. They are also good soil conditioner for soils with a low

organic content, facilitating nutrient uptake, increasing water retention, permitting easier root penetration and improving soil texture.

Biosolids and manures may contain elements that are not desirable for agricultural crops, such as certain metals and pathogens. However, based on long-term experience from many years of biosolids application on land, the risk to human and animal health is minimal when biosolids are processed and applied on land, in accordance with existing guidelines and regulations.

Direct land application of solid organic wastes (e.g. food waste, grass) is not a generally accepted practice.

6.5.1 Agricultural Land Application

Biosolids and manures can generally be applied on agricultural land between April and December, when the weather permits and at the convenience of the farmer. They generally cannot be applied on frozen or snow-covered ground due to risks of runoff during thaw periods. Similarly, they cannot be applied during wet weather periods due to risks from runoff, and the fact that spreading equipment may not be able to access the land.

Liquid biosolids and manures can be applied by surface spreading vehicles or subsurface injector vehicles equipped with flotation type tires. Spray irrigation can also be used for apply liquid biosolids and manures. Dewatered biosolids and solid manures are more typically spreading using vehicles with flotation-type tires, and subsequently incorporated into the soil using applicable equipment



Exhibit 6- 21: Liquid manure injection system

The equipment and facilities needed for handling and applying liquid or dewatered biosolids include application vehicles, portable roadside storage tanks, road tankers or dump trucks. Biosolids application vehicles are generally used only to apply the biosolids on the agricultural land. Road tanker trucks for liquid biosolids and dump trucks for dewatered biosolids are used to transport the biosolids from the treatment plant or biosolids storage facility to the agricultural utilization site. Portable roadside storage tanks for liquid biosolids or front-end loaders for dewatered biosolids are used to transfer biosolids from the road tankers or dump trucks to the application vehicles.

6.5.2 Forested Land Application

As with agricultural crops, forests can benefit from the application of biosolids and manures. Nitrogen, phosphorus, organic matter, and micronutrients in biosolids are utilized by trees as they are by agricultural crops. The biosolids may also improve the texture of the soil. Extensive brush growth generally takes place after biosolids application. This is generally beneficial for the wildlife habitats.

Typical forest soils have high infiltration rates that reduce the risks of runoff and ponding. Odour is generally not a problem when stabilized biosolids are applied and there is sufficient distance from residences.

The primary environmental and public health concern when applying manures and stabilized biosolids to forested land is contamination of water supplies. The high infiltration rates and low nutrient uptake rates typical of forest soils can result in groundwater supplies being contaminated by nitrates. Studies conducted in the United States indicate that nitrate contamination of the groundwater can be prevented by limiting the biosolids application rates on typical forest soils. Successive biosolids applications on forested land are controlled by the nutrient requirements of the trees and the frequency with which the trees are harvested.

Unlike agricultural land, forested lands are generally rough in terrain, requiring special application vehicles and the construction of a road system. Application to recently cleared forest sites is easier than for established forest sites because of increased accessibility for application equipment. However, many tree seedlings grown on sites with recent biosolids applications have poor survival rates due to competition with weeds and brush growth. Also, seedlings have lower nutrient uptake rates. Application in established forests often requires the cutting and clearing of 3-metre-wide trails for the application vehicles to access the land.

6.5.3 Land Reclamation

Application of biosolids and manures can be used to turn land disturbed by mines, quarries and sand and gravel pits into productive land. If not reclaimed, these sites can be unsightly, and can also be a source of acid runoff and be subject to high erosion rates.

High application rates are necessary to introduce sufficient organic matter and nutrients into the soil to support vegetation and create a self-sustaining productive soil. Biosolids application rates in as high as 450 dry tonnes/ha have been reported, but 100 dry tonnes/ha are more typical.

Some contamination of ground and surface waters can occur after application (i.e. nitrate contamination of groundwater). However, with good site management, contamination is minimized and, generally, the contamination is negligible compared to the problems before reclamation. Good site management includes prompt revegetation after application and site leveling to reduce slopes.

6.5.4 Land Application in Public Contact Sites

Use of biosolids products on public contact sites, such as recreational parks, ball fields, golf courses, as well as road embankments, has many of the same advantages as application on agricultural land. To protect the public, a higher degree of stabilization and pathogen destruction is required than necessary for application on agricultural land. Stabilization processes, such as composting, thermal drying, and advanced alkaline stabilization, are examples of acceptable stabilization processes.

Application of biosolids on home lawns and gardens is not permitted unless strict requirements are met. The reason is that the application rate cannot be controlled as it is in large-scale application programs. Also, to protect public health, biosolids application on vegetables grown for human consumption is not recommended due to the potential risk of transmission of human pathogens that may be present in low levels in the biosolids.

6.6 Mulch Production

Mulch is a protective layer that is applied over soils, usually early in the growing season, to reduce the amount of soil moisture lost to evaporation, buffer fluctuations in soil temperature during the day and night, and to control weed growth.

Mulches are commonly produced from organic materials, and thus they will degrade over time and need to be replaced. The most common organic materials used for mulch include straw, shredded wood and bark. Shredded cardboard and newspaper, grass, leaves, and pine needles can also be used as mulch, but this is a less common practice in residential and commercial landscaping applications.

Mulch produced from shredded wood and bark has become particularly popular for landscaping applications, due mainly to its durability and consistency. Often the mulch is “coloured” with pigments make is a consistent shade of brown or red.



Exhibit 6- 22: Producing coloured mulch from ground wood waste.

The demand for coloured mulches in some areas has spurred the expansion of programs that collect and grind of clean “white wood” (e.g. from pallets and dimensional lumber), tree limbs, logs, and stumps.

6.7 Biomass Production

Biomass is the broad term applied to renewable energy sources which are produced from biological material and are burned to generate electricity or heat. Biomass can also be used as a feedstock to produce other forms of energy such as biogas and biodiesel.

Common biomass sources include wood waste from land clearing and forestry operations, wood from urban sources (e.g. construction, landscaping), municipal solid waste, and agricultural crop residuals. In the southeastern United States, storm debris from hurricanes is a significant source of biomass.

Producing biomass from wood debris typically involves drying the material, shredding it to the appropriate size, and removing contaminants.

The moisture content of the biomass is typically one of the most important characteristics that end users monitor. It is not uncommon for supply contracts to contain moisture specifications. This is due both to the implications on trucking costs, and on combustion efficiency.

The particle size is related to the design of the end user’s feed system for their combustion units, and therefore will vary from user to user. Particle size is also related to combustion efficiency; large particles may not completely burn and will increase the amount of bottom ash. Contaminants can cause significant problems for biomass energy facilities. Physical contaminants such as rocks, nails, and tramp metal can damage equipment. Plastic contaminants can affect the composition of exhaust gases and drive the need for costly

emissions treatment systems. It is often necessary to producers to “clean up” wood sources to removed these contaminants, through some combination of magnetic separation, screening, and visual inspection/sorting.

6.8 Co-Digestion

Co-digestion is a relatively recent development in the organic waste management field. It generally refers to the process whereby two or more types of organic wastes are mixed together and digested. The mixture of waste streams considered for co-digestion commonly includes some combination of wastewater treatment plant solids, animal manures, and food wastes.

Co-digestion is often considered for implementation at existing wastewater treatment plants (WWTP's). This approach takes advantage of a municipality's existing infrastructure at their WWTP, and potentially allows them to reduce overall capital investments. This is particularly true if the WWTP has surplus digestion capacity, as is often the case in its early years before wastewater loads approach design capacities.

Co-digestion offers some potential advantages including improved nutrient balance, increased gas production, maintenance of biomass inventory in digester, and dilution of the waste streams (thereby reducing the potential impacts of toxic compounds such as free ammonia and hydrogen sulfide). On the other hand, co-digestion requires the addition of new waste receiving and pre-processing/feeding facilities; handling of additional waste in dewatering systems; handling and treatment of additional gas; and additional treatment of the recycle stream.

Increased biogas production and revenues from tipping fees can compensate for the additional investment needed for modifications and upgrades to the existing plant.

Anaerobic digestion is a well-established process for stabilization of WWTP solids and animal manures, and producing biogas. During anaerobic digestion, complex organic material is hydrolyzed and fermented to form short-chain volatile fatty acids (SCVFAs), alcohols, and hydrogen, which are consequently converted to methane and carbon dioxide.

Carbohydrate- and protein-rich food wastes are also relatively easy to digest since they tend to be more amenable to simpler catabolic reactions. Fat- and oil-containing foods require more retention time for proper breakdown, but more energy and gas production per unit weight can be gained from these sources.

The amount of food waste that can be co-digested with biosolids or manure depends on factors such as the occurrence of inhibitory metabolites (e.g. H₂S, free ammonia, and volatile fatty acids) and digester conditions (i.e. scum layer, sediments, mixing). At centralized biogas plants in Denmark, 80% manure and 20% food waste mixtures have been reported. The Danish Institute of Technology reported good digester performance when operated with 72% manure and 28% food waste mixture. Based on these and other literature findings, food waste percentages of 5 to 30 percent appear to be feasible for co-digestion applications.

Although adding food waste to existing manure and WWTP digesters can be beneficial, the business case and logistics for full-scale implementation should be closely reviewed. Addition of more food waste may require more holding tank capacity, or cause significant increases in truck traffic at a particular site.

6.9 Management Issues at Organic Waste Processing Facilities

6.9.1 Odour Control

Odour is perhaps the most common nuisance issue associated with organic waste treatment facilities. Failure to sufficiently address odour issues has led to unpleasant relationships with neighbours and, in several instances, litigation or closure of facilities in North America.

Although a well-constructed and well-operated organic waste facility will not be odour-free, it should not produce offensive odours. Some odour control techniques, such as good housekeeping and eliminating sources of odour like wet feedstocks and/or stagnant water, cost very little and can be extremely effective in preventing odour production. Sound management practices, careful site selection, and communication with your neighbours may be the best and least expensive prevention for odour complaints.

Generally, enclosed or in-vessel systems have a much greater ability to capture odourous emissions and treat them prior to release. There are a number of available methods to treat odours from composting facilities including wet scrubbers, biofiltration, and carbon adsorption. The choice of which treatment methods is appropriate is dependent on air volumes, type of odour compounds, and concentration levels.

“Fugitive odours” is a term that is used to describe any of a range of small point sources of odour that can be present at an organics processing facility. They can include odours from leachate spills, stagnant water, leakage of odourous process air from tanks and vessels, from feedstock stockpiles, and from open or faulty overhead doors. Because they tend to be smaller and more dispersed throughout a facility, it is often times more difficult to manage these fugitive odours than to collect and manage odourous process gases.

6.9.2 Maintenance

Within the solid waste industry, organic waste facilities are known as having technically challenging working environments. One of the primary technical challenges is corrosion resulting from sustained exposure of equipment and infrastructure to humidity and process gases, and biological corrosion processes. Concrete and stainless steel buildings have been demonstrated to be the most durable types of structures for this type of corrosive environment. However, the initial capital costs associated with these types of structures are not acceptable to some Owners. For steel or other metal structures, a range of coating types (e.g. galvanizing, epoxy, foam) and building liner systems have been tried with moderate success. As a compromise between initial capital cost and long-term durability, many newer facilities combine negative aeration and extensive source capture or heating, ventilation, and air conditioning (HVAC) systems with coatings and liners.

Humidity and dust within an enclosed composting facility generally result in high maintenance costs for both fixed and mobile equipment. To mitigate the resulting negative effects on equipment, preventative or predictive maintenance is required which typically includes:

- More frequent greasing of bearings
- Replacing worn parts on a more frequent schedule
- Increased frequency of fluid and filter changes

- Flushing of aeration and leachate pipes
- Particulate removal from HVAC ducting
- Changing odour control system media
- General cleaning and housekeeping

The required maintenance and the associated costs required to operate an organic waste facility is similar to what is required at food processing or manufacturing facilities, chemical manufacturing plants, and wastewater treatment plants. Owners that are new to the organic waste industry, and even those who have been previously involved with outdoor composting operations, may not be familiar with these types of mitigation measures, and may not be prepared for the resources and costs required to sustain operations.

In some cases these requirements have been underestimated during the feasibility study or during the project budgeting processes, resulting in insufficient allocation of funds and resources. Experience at several organic waste facilities has demonstrated that the failure to allocate proper resources for facility maintenance has had significant impacts on the lifespan of the asset. For municipal facilities, inadequate maintenance and the resulting issues (higher than anticipated operating costs, fugitive emissions, etc.) can also have an impact on public or political support for the project.

7 Review of Compost Regulatory Requirements

As part of a broader project by the Regional District of Okanagan Similkameen (RDOS) to update their Solid Waste Management Plan, CH2M HILL was retained to assist with the identification and development of a strategy to manage organic wastes within the Regional District.

In order to help establish the framework for an organic waste management system, CH2M HILL has prepared this review of regulatory requirements and voluntary initiatives related to composting operations and compost product utilization.

7.1 Compost Facility Development and Operational Requirements

7.1.1 Organic Matter Recycling Regulation (OMRR)

Municipal composting facilities in British Columbia are regulated primarily by the provincial Ministry of Environment under the requirements of the *Organic Matter Recycling Regulation* (OMRR). The regulation has a broad focus, as it governs not only the construction and operation of composting facilities, but the production, distribution, storage, sale and use or land application of biosolids and compost as well.

In Part 5 of the regulation, OMRR sets out requirements for construction or expansion of composting facilities with an existing or proposed production capacity of 20,000 tonnes or more. The regulation also includes the requirement that a Qualified Professional (QP) prepare and submit Environmental Impact Studies, Odour and Leachate Management Plans, and Operating and Closure Plans and Specifications.

The regulation does not apply to the composting of agricultural wastes on farms, the operation of a mushroom composting facility (both of which are governed by other regulations), backyard composting or compost demonstration gardens.

A companion document, *Compost Facility Requirements Guideline*, has been prepared to support OMRR by providing further insight and clarification to Part 5 of the document. It explains the regulation and identifies best management practices which can be used to comply with OMRR requirements.

7.2 Compost Product Quality Requirements

Quality criteria for finished compost products are necessary to protect human health and prevent environmental degradation. Criteria are also beneficial in that they help ensure product satisfaction and maintain consumer confidence. For these reasons, development of science-based standards, and documented adherence to these standards by producers, is fundamental to the continued expansion and strengthening of the composting industry in Canada.

Criteria generally fall into the categories of public health/environmental protection, fertility, and aesthetics. Regulatory standards are generally limited to the protection of public health and the environment and fertility criteria. Aesthetic criteria, which address the texture, color, composition, and aroma of the product, are more often industry-developed and voluntary in nature.

In British Columbia, compost product quality criteria for health and safety and environmental factors are mandated by the Province's Ministry of the Environment, and the Canadian Food Inspection Agency (CFIA). Provincial requirements are contained in OMRR, while CFIA requirements are outlined in the *Fertilizer Act* and associated regulations and trade memoranda. The CFIA also ensures consumer protection through its enforcement of the product labeling requirements of the *Fertilizer Act* and associated regulations.

7.2.1 OMRR Requirements

Compost producers in BC must follow Ministry of Environment's *Organic Matter Recycling Regulation* (OMRR) under the *Environmental Management Act* and the *Health Act*. This regulation replaced the *Production and Use of Compost Regulation* in 2002 to provide guidance for local governments and other compost and biosolids producers to protect the environment and public health, and to support waste reduction through the beneficial use of organic material.

As outlined previously, OMRR is not applicable to on-farm agricultural waste composting, mushroom composting facilities, backyard composting, or compost demonstration gardens.

OMRR was reviewed and updated in 2007 with the assistance of significant stakeholder input, to reflect changes in law and in knowledge surrounding the management of organic matter.

In addition to governing the construction and operation of composting facilities, and most other activities associated with biosolids and compost, OMRR contains quantitative criteria for maximum concentrations of trace elements, foreign matter and sharp foreign matter, minimum maturity and stability requirements, and pathogen reduction requirements. Sampling and analysis protocols, and record keeping requirements are also specified.

The regulation also defines the organic matter that is suitable for composting. This includes animal bedding, biosolids, brewery and winery wastes, domestic septic tank sludge, fish and hatchery wastes, food waste, manure, milk processing waste and whey, plant matter derived from fruit and vegetable processing plants, poultry carcasses, red meat waste, untreated and unprocessed wood residuals, and yard waste. Note that paper fibre products are not listed as an allowable feedstock under OMRR.

If minimum quality requirements are not met, the compost must be disposed of at an approved waste management facility, as compostable materials and recyclable materials continue to be a waste until dealt with in accordance with this regulation.

In developing minimum acceptable standards, the Ministry of Environment has in part adopted the requirements laid out by the Canadian Council of Ministers of the Environment (CCME) Guidelines for Compost Quality (described later in this document), although some requirements do vary. This differs from other provinces, many of which have adopted CCME standards verbatim. However, OMRR does specify that producers must also comply with the requirements set out in the CFIA Trade Memorandum T-4-93.

7.2.2 Canadian Food Inspection Agency Requirements

The Canadian Food Inspection Agency (CFIA) was created in 1997 through the amalgamation of inspection and related services provided by the departments of Agriculture and Agri-Food Canada, Fisheries and Oceans Canada, Health Canada and Industry Canada. This restructuring

consolidated the delivery of all federal food, animal and plant health inspection programs into one organization.

The CFIA's role is to enforce food safety and nutritional quality standards established by Health Canada. It is also responsible for setting standards and carrying out enforcement and inspections related to animal health and plant protection. The CFIA delivers over a dozen specific inspection programs related to foods, plants and animals across Canada.

The CFIA is responsible for the administration and enforcement of the Fertilizer Act, Fertilizer Regulation and associated Trade Memoranda. As part of this, CFIA staff routinely sample fertilizers, fertilizer-pesticides and soil supplements to verify that products meet standards for safety. This is done through random inspections and product sampling at blending plants, manufacturing plants, processing plants, retail outlets and warehouses. The samples are tested for contaminants including heavy metals, pesticides and pathogens such as salmonella.

In accordance with the Fertilizer Regulation, the CFIA classifies compost as a "soil supplement" and all compost product sold are subject to certain minimum quality requirements. The quality requirements are outlined in Trade Memoranda that have been issued by the CFIA, most notably T-4-93 which establishes cumulative loading rates of trace element in soils (a copy of the memorandum is provided in the appendices). The CFIA has also set criteria for organic matter, moisture content, pathogens and compost maturity, however these criteria have not been published in the form of trade memoranda and are not well known. Similarly, the sampling and analytical methods used by CFIA in enforcing these criteria are not published and this has lead to regulatory enforcement problems at facilities in the past. Both these issues have been acknowledged by the CFIA, and they are working with the CCME to harmonize the two standards.

The Fertilizer Regulation also specifies labeling requirements for compost products that are sold. The labeling requirements include "guaranteed analysis" for organic matter and moisture content, instructions for use, and producer information. There are protocols for label sizes and fonts, as well as an extensive set of rules surrounding what claims can and can not be made on the label. While the CFIA's labeling requirements are extensive, they are not well documented or known, and as a result, not fully adhered too. Also, the requirements are not fully enforced by CFIA across all soil supplement industries, which leads to further confusion amongst producers and consumers.

It is well known by producers within the industry that the CFIA's regulations and requirements only apply to products that are sold. Thus, if a producer gives their product away, they do not have to meet any of the Fertilizer Regulation requirements for testing and labeling. In recent years the CFIA has broadened the application of the concept of "sold" to include any transaction where money changes hands. This eliminates the potential for a producer to circumvent the requirements by giving the compost away to a user, but charging them a monetary amount for "loading" the product or an inflated amount for transportation. Again this policy is not well documented in the public domain by the CFIA.

In response to requests from the composting industry for clarification of regulation and policy surrounding compost products under the Fertilizers Act, the Fertilizer Section and Fertilizer Safety Office of CFIA have developed a specific Trade Memorandum (T-4-120) for compost products. The CFIA also released information in 2007 on requirements for fertilizers and

supplements in the context of the new program for animal health protection from BSE. Some of these requirements, which came into force on July 12, 2007, affect all compost products, but most are targeted to compost that contains so-called “prohibited materials”¹. The new requirements include lot numbering, labeling, recall procedures, and record keeping.

7.2.3 Voluntary Product Standards and Programs

In several jurisdictions, voluntary standards have evolved to complement the regulatory standards. In most cases, this is because regulatory standards do not address agronomic issues that are important to compost users. In Canada, the Composting Council of Canada has developed a voluntary initiative called the Compost Quality Alliance. Through this program, compost producers participate in standardized testing and reporting of their product characteristics, and can provide comparisons with generally accepted agronomic criteria (e.g. EC, pH, soluble salt levels, etc.) for specific compost uses. A voluntary national standard has also been published by the Bureau de Normalisation du Quebec.

7.2.3.1 Canadian Council of Ministers of the Environment

The finished compost quality requirements contained in OMRR are based in part upon national guidelines developed by the Canadian Council of Ministers of the Environment (CCME). CCME is an “intergovernmental forum” of federal and provincial/territorial government representatives that work together to discuss and take joint action on environmental issues that have national implications. The CCME’s goal is to encourage consistent standards, practices and legislation across Canada.

The CCME’s Guidelines for Compost Quality were first published in 1996 following discussion and collaboration by the Provinces, Environment Canada, and Agriculture Canada (a CFIA predecessor). An updated version of the guidelines was published in 2005 following consultations amongst these groups and industry representatives.

The CCME guidelines include specific criteria for trace elements, pathogen levels, maturity, foreign matter (including “sharps”), and organic compounds. Two sets of criteria exist within the guidelines, which allow compost to be classified as either “Category A” or “Category B”². The distinction between the two lies in differing criteria for trace elements and sharp foreign matter. Criteria for pathogens levels, maturity and organic compounds are the same for both categories.

The trace element and sharps criteria for Category A are more stringent than Category B, the intent of which is to allow for more flexibility in using Category A products. The trace element criteria for Category B are derived from (and are thus harmonized with) the federally mandated criteria contained in the Fertilizer Regulation administered by the Canadian Food Inspection Agency.

¹ Prohibited material includes animal protein, including meat and bone meal, derived from animals that are mammals except horses and swine, poultry and fish. Blood meal, milk and gelatine from any mammal, ruminant tallow with less than 0.15% impurities, and manures and solids from municipal wastewater plants that do not receive SRM are specifically exempted.

² The terms “Category A” and “Category B” are specifically used in the CCME documentation. They should not be confused with, or used interchangeably with the terms “Class A” or “Class B” which are used to reference pathogen treatment levels for biosolids.

7.2.3.2 Compost Quality Alliance

The Compost Quality Alliance (CQA) is a voluntary program developed and managed by the Composting Council of Canada. The program's goal is to improve consumer confidence in compost products through the use of standardized testing and reporting of product characteristics. The program has the benefit of helping consumers select the "right compost" for the intended use and will support regulatory compliance within the industry.

The CQA program is open to all compost producers, and focuses on final product quality instead of the process used to make the product. CQA participants follow prescribed sampling frequencies (based on annual production levels) and reporting methods, and through an annual licensing arrangement, use the CQA logo on packaging and product promotion.

Products marketed under the CQA banner are tested to ensure they meet the appropriate provincial quality guidelines (i.e. CCME criteria in Alberta) as well as certain key agronomic characteristics. The agronomic criteria include pH, carbon to nitrogen ratio, moisture, particle size, soluble salts (i.e. electrical conductivity), and sodium.

Product testing is completed by CQA recognized labs in Canada or the United States who are involved in the Compost Analysis Proficiency (CAP) program. CAP is a laboratory quality assurance program to calibrate procedures and evaluate inter-lab method performance, and is administered by Dr. Robert Miller of Colorado State University. The Test Methods for Examination of Composting and Compost forms the basis of the analytical test methods used in the CQA and CAP programs.

The Composting Council of Canada is also working with CFIA on a process for streamlining regulatory inspections and reporting for CQA members. Conceptually, as a result of the testing and reporting aspects built-in to the CQA program, the CFIA would place less emphasis on field inspections of CQA members, and focus more on non-CQA members. This may require regular voluntary reporting of final product quality to CFIA.

7.2.4 Bureau de Normalisation du Quebec

The Bureau de Normalisation du Quebec (BNQ) is an affiliated "daughter" organization of the Standards Council of Canada (SCC) that was established in 1961. As part of its mandate within the SCC framework, the BNQ is the organization responsible for establishing national standards for organic soil supplements.

The first national standard (CAN/BNQ -413-200 Organic Soil Conditioners - Composts) was published by the BNQ in 1997. This was developed through a consensus-based approach that involved product manufacturers, users, government agencies and interested parties. Minor amendments were made to the standard in 1997 and 1999. A major review and amendment was commenced in 2003 and an updated standard was published in 2005.

The national standard establishes three categories of compost (AA, A and B), and includes criteria for physical characteristics (moisture, organic matter, foreign matter, sharps), chemical characteristics (trace elements, maturity) and biological characteristics (fecal coliform, salmonella). Detailed sampling methods, and references to analytical method standards published by other standard setting agencies (e.g. USEPA, ASTM) are also included in the standard.

In addition to publishing the national standard, the BNQ also runs a voluntary certification program for producers. However, this program is quite expensive to participate in and is not well known or marketed by BNQ. As a result, it is not used by producers outside of Quebec, and only by a few producers within that province.

8 Compost Uses and Markets

To assist with establishing the framework for the organic waste management system, CH2M HILL has prepared this review of uses and markets for compost in the Okanagan Valley, and a summary of associated challenges and requirements.

8.1 Summary of Compost Uses and Markets

Compost is the soil amendment product that results from the composting of organic feedstocks such as leaf and yard waste, ground wood, food residuals and biosolids. In British Columbia, the production and use of compost by municipal facilities is regulated by the Ministry of the Environment. Sale of compost in British Columbia is also regulated by the Canadian Food Inspection Agency (CFIA).

Compost products are typified by their dark colour and fine grained, friable texture. Besides visual appeal, attributes include a high organic matter content (typically >30%) and presence of slow release nutrients.

Traditionally, compost is used in residential and commercial landscaping (e.g. flower, vegetable and shrub beds, turf establishment, tree planting), turf top dressing (e.g. residential lawns, sports fields, parks), reclamation of industrial sites and mines, and incorporation into manufactured top soils (e.g. triple mix). Compost is also used in agricultural applications (mulching and replanting in orchards) and to a lesser extent in horticulture and silviculture.

Compost used in these “traditional” applications is typically screened so that it has a particle size of ½” or less. Product is sold primarily in bulk, but bagged product sold through retail outlets (e.g. hardware stores, garden centres) is also common.

Additional uses take advantage of the absorbent characteristics and microbial content of compost products, and are described more fully in Section 6.

There is a significant volume of literature available outlining the usage of compost in these applications, and the performance results from differing application rates and methods.

8.2 Regulatory Product Quality Requirements

Quality criteria for finished compost products are necessary to protect human health and prevent environmental degradation. Criteria are also beneficial in that they help ensure product satisfaction and maintain consumer confidence. For these reasons, development of science-based standards, and documented adherence to these standards by producers, is fundamental to the continued expansion and strengthening of the composting industry in Canada.

In British Columbia, quality criteria for health, safety and environmental factors related to compost are mandated by the Province’s Ministry of the Environment, and the Canadian Food Inspection Agency (CFIA). Provincial requirements are contained in OMRR, while CFIA requirements are outlined in the *Fertilizer Act* and associated regulations and trade memoranda. The CFIA also ensures consumer protection through its enforcement of the product labeling requirements of the *Fertilizer Act* and associated regulations.

Specific requirements of OMRR and CFIA were outlined in a previously submitted Technical Memorandum entitled “Review of Compost Regulatory Requirements”.

8.3 Analytical Testing of Products

One of the challenges faced by the composting industry is related to the variability of analytical testing methods used by compost producers. Compost has several unique characteristics that can cause interferences in traditional soil analytical methods. As a result, use of these methods can cause confusion among end users.

As a means of addressing this issue, the composting industry, with support from the US Department of Agriculture, developed an analytical methods manual that is specific to composting and compost products. The Test Methods for the Evaluation of Compost and Composting (TMECC) are based on methods from the following sources:

- USEPA Report SW-846, Test Methods for Evaluating Solid Waste, 3rd Edition, November 1990.
- Association of Official Analytical Chemists (AOAC) Official Methods of Analysis, 1990, 15th edition.
- Methods of Soil Analysis, Parts I, II and III. Soil Science Society of America. 1996
- North Central Regional (NCR) Publication No. 221 (Revised). Recommended Chemical Soil Test Procedures for the North Central Region Bulletin No. 499 (Revised) October 1988 "Recommended Test Procedures for Greenhouse Growth Media".
- Standard Methods for the Examination of Water and Wastewater, 18th Edition, 1992.
- The American Society for Testing and Materials (ASTM) Standard Test Methods, 1988.

TMECC has become widely adopted by producers and end users, as well as by some regulatory agencies. The TMECC methods also provide the basis for the Compost Council of Canada's Compost Quality Alliance (CQA) program, which is a national product quality monitoring and declaration program adopted by several large-scale producers throughout Canada.

8.4 End User Specifications

8.4.1 Qualitative Parameters

Consistency of products is a key requirement of a successful compost marketing program. Developing and maintaining a consistently good product is imperative for the compost product's reputation, and this obviously has a direct effect on product sales. A negative impression or bad experience with a product or service will be relayed several orders of magnitude more quickly and to a significantly wider audience than a neutral or positive experience. First impressions count, and the appearance of a soil amendment is at least as important in selling it as the results of laboratory testing.

For traditional uses, customers are looking for a product with specific characteristics, including:

- Dark colour, preferably black
- Damp but not moist
- Fine, friable texture
- Free from inorganic contaminants (particularly plastic, but including small rocks)

- Earthy-smelling
- Weed seed free
- Pathogen free
- Containing plant macro- and micro-nutrients

8.4.2 Quantitative Parameters

In addition to meeting regulatory quality criteria (e.g. OMRR, CFIA) and aesthetic properties, there are several additional parameters (commonly referred to as “agronomic criteria”) which are often of interest to end users, and which should be measured and reported by producers. These additional parameters generally include:

- Electrical Conductivity
- Organic Matter
- Moisture Content
- Bulk Density
- Particle size
- Calcium
- Magnesium
- Sodium
- Potassium
- Chloride
- Sulphate
- Total Kjeldahl Nitrogen
- Ammonia-N
- Nitrate-N
- Available Nitrate-N
- Available Phosphate-P
- Available Potassium
- Potassium as K₂O
- Phosphorous as P₂O₅
- Hot Water Extractable Boron
- pH

Specific requirements for agronomic criteria can vary from application to application. In some cases these requirements are well documented through written specifications developed by producers or end users, but more often they are not. Two of the major compost producers in the Okanagan Valley (City of Kelowna and City of Penticton) do not have specific product or end use specifications other than insisting that product be dark-coloured and free from contaminants. These parameters are however measured and the information is provided to customers who wish to have it.

At a provincial level, there is ongoing work on the development of specifications by the Ministry of Transportation for material to be used in their projects, but at this time no specifications have been formally adopted.

8.5 Market Demand

8.5.1 Traditional Markets

The traditional use for compost is as a soil amendment in horticultural applications. Purchasers of Okanagan municipal compost products report digging it into gardens, mixing it with soil

when planting trees and shrubs, topdressing lawns, mulching shrub beds, and combining it with soilless mix in containers.

Municipal compost is also purchased by one value-added customer who further refines the compost and blends it to create new soil and soil amendment products for the bulk and bagged market.

Municipal compost is also used in agricultural applications. Okanagan soils tend to be coarse and well-draining with high (basic or alkaline) pH. Compost helps retain valuable irrigation water, stores nutrients for slow release over the growing season and buffers pH levels.

Research carried out at the Agriculture and Agri-Food Canada Pacific Agricultural Research Centre in Summerland has shown the effectiveness of municipal compost products with more vigorous growth and disease resistance in plants grown in soil amended with this product over soil modified with other amendments. In addition, municipal compost has been shown to have value as a mulch in orchard rows, providing nutrients and suppressing weed growth. Finally, studies have also shown that this product aids in the amelioration of apple replant disease.

One area of research that is receiving particular attention in the scientific and industry literature is the use of compost to control or eliminate certain types of plant pathogens, where the beneficial microbes present in compost are thought to not only outcompete the pathogens, but actually assist the plants in fighting them off.

The above notwithstanding, many users prefer not to use compost containing biosolids on vegetable plots, despite assurances regarding product safety, and regulatory limits. This is due partly to the feedstock origins, and partly to a belief that any heavy metals present will accumulate in soils with repeated applications.

8.5.2 Emerging Markets

Over the past several years, a number of new uses for compost products have been developed, primarily through the work of Filtrexx International and its network of certified installation contractors. Filtrexx has pioneered the use of compost in erosion control and slope stabilization applications, where the product is pneumatically applied either on its own or as a mixture with seed or fertilizer. Filtrexx has also done significant work in the use of compost-filled “socks” in storm water management, sediment management applications, and retaining wall applications. The compost typically used in Filtrexx installations is a coarser grained product, typically with a particle size range of up to 1½”.

Other uses for compost include bioswale and strip filters to treat/remove contaminants in storm water run-off, use in landfill capping systems to passively treat landfill gas, and as a component of the media used in green roofs. These uses have been proven in a small number of projects, but are generally not widely adopted or publicized. As a result they are referred to as “emerging markets”.

8.5.3 Non-traditional uses

In addition to being used as a soil supplement, compost also has several “alternative uses”. One of the more common alternative uses is as bedding material for cattle and poultry. Another alternative is to intentionally dry the compost product to less than 25% moisture, and use it as an alternative to sawdust or peat for absorbing spills and cleaning up sludge pits.

8.6 Market Value

A number of compost producers in the Okanagan Valley were contacted as part of this assignment. Several producers indicated that their compost products are used only internally within the organization. However, a number of producers also sell products either at wholesale rates to distributors or value-added companies, or at retail rates directly to landscapers and homeowners.



Quantities of soil and soil amendment products are generally measured in cubic yards, rather than cubic meters, as loader buckets are calibrated in cubic yards, and the information provided here reflects that. Information collected shows that wholesale pricing for truckload quantities of screened compost in the Okanagan Valley ranges from \$5 to \$20 per yd³. Retail prices for compost product start at \$30, but can be as high as \$75 per cubic yard for finely screened product.

The City of Kelowna/City of Vernon joint Ogotrow production facility uses a sliding price scale for wholesale purchases, with purchasers of larger annual volumes charged a lower price than those who simply buy the occasional truckload. In 2008, the City sold 40,000 yd³ of product, generating over \$400,000 in revenue. The average price per cubic yard was \$11.61, however this takes into account the purchase of approximately half the partnership's production by a single customer at \$7.75 per cubic yard.

In the RDOS, seven vendors of bulk organic soil amendment were identified, including the City of Penticton. Four of these seven suppliers are also the producers, selling their own product. Only three of the retail locations contacted sell bulk organic soil amendment on behalf of other producers.

EXHIBIT 8-2
BULK ORGANIC SOIL AMENDMENT PRICES IN THE OKANAGAN VALLEY

Bulk Product	Bulk Retail Price (\$/yd³)	Wholesale Price (\$/yd³)
Ogotrow™	\$30 to \$70	\$8 to \$20
City of Penticton Compost	\$24	\$15
District of Summerland Compost	\$5	N/A
Southern Plus Feedlots Compost	\$25 to \$30	N/A
Nature's Gold* Mulch	\$42	\$21
Nature's Gold* Premium Fertilizer	\$75	\$37
Mushroom Manure	\$37 to \$56	\$18 to \$28
Year-Old Steer Manure	\$24	\$12
Peat Moss	\$50 to \$75	\$28 to \$37
Bark Mulch	\$30 to \$70	\$15 to \$35

Conversely, bagged soil amendment was available in numerous locations throughout the RDOS, from small garden centres to large outlets such as Canadian Tire and Home Depot. Bagged product currently on the market includes peat moss, manures, worm castings, and Nature's Gold products, which are made from the municipal compost product Odogrow™. One bagged soil amendment with a trade name of "Claybuster" contains a mixture of compost, sphagnum peat moss, gypsum and zeolite.

When calculated at dollars per cubic yard, the price for bagged soil amendment is significantly more than for the equivalent product in bulk. For instance, composted steer manure that costs \$24 per cubic yard from a bulk bin is sold for \$2.79 for a 20 litre bag. This is equivalent to a price of \$107 per cubic yard, a 446% increase in price. However, this is somewhat misleading as a significant portion of the retail price for bagged products can be attributed to handling and packaging, transportation, and marketing.

Exhibit 8- 2 provides a price comparison for bagged products currently on the market in the Okanagan. In general nurseries add a 100% markup to products they sell.

It is rare that the revenue from sale of compost products is sufficient to offset all of the costs associated with compost production. This is true even at facilities with very successful marketing programs. Most often, sales revenues are sufficient to offset marketing and sales costs, lab testing costs, product screening, and a small portion of product manufacturing costs.

The City of Kelowna reports that it is significantly less expensive to compost biosolids and generate revenue from sales than to landfill this material and pay tipping fees. With the added benefits of avoiding methane production by burying organic material, and creating a rich soil amendment, it becomes a "win-win" situation.

EXHIBIT 8-2

BAGGED ORGANIC SOIL AMENDMENT PRICES IN THE OKANAGAN VALLEY

Bagged Product	Retail Price (\$/bag)	Bulk Retail Price (\$/yd³)	Wholesale Price (\$/yd³)
Steer Manure	\$2.79 (20L)	\$107	\$53
Composted Steer Manure	\$3.99 (40L)	\$76	\$38
Mushroom Manure	\$2.79 (20L)	\$107	\$53
Sheep Manure	\$2.99 (20L)	\$114	\$57
Worm Castings	\$10.99 (32L)	\$263	\$131
Claybuster	\$6.99 (33L)	\$162	\$81
Peat Moss	\$11 – 16 (4ft ³)	\$74 to \$108	\$37 to \$54
Nature's Gold* Fertilizer	\$10.99 (40L)	\$137	\$69
Nature's Gold* Mulch	\$7.99 (40L)	\$153	\$77
Nature's Gold* Blended Potting Soil	\$5.99 (15L)	\$305	\$153

8.7 Product Demand Curve

Compost markets in the Okanagan Valley are cyclical based on the region's growing season; most compost is purchased and applied by end users between April and October. The peak demand period is typically in April and May.

As a result of this demand curve, production facilities are typically designed with sufficient space for storage of product produced during the months of November through March. At larger processing facilities, it may be necessary that product finishing operations be enclosed or otherwise designed to allow continued operation through the winter months so that the high demand for product in the spring can be met.

Inventories of finished compost must be handled and stored in a manner that preserves the product quality (e.g. prevents weed propagation and pathogen reintroduction), and prevents it from becoming saturated by snowmelt and rainfall. Stockpiling finished compost in 6 to 10m high "cones" built with stacking conveyors is a common practice at medium to large facilities.

8.8 Challenges and Opportunities

There are many examples of compost programs and production facilities that have been developed based on the assumption that all of the products produced will be sold directly to homeowners. While the homeowner market is important, it is certainly not the only market, and typically medium to large sized production operations do not sell significant volumes of product directly to homeowners. More often homeowners purchase bulk compost from landscape or garden supply centers, or in bagged form through garden centres and larger retail outlets (e.g. Home Depot, Rona, Canadian Tire). Depending on local availability of similar products, both of these markets can potentially be difficult to penetrate, however the City of Penticton compost is already well established as a bulk product, and sales of new or additional material can build on this success.



In the case of retail "bag" markets, the investment required in equipment, marketing and QA/QC can be significant (>\$1,000,000). However, the return on investment can be good if a large volume of bags (e.g. >1,000,000) can be packaged and sold. Besides the initial investment, entry into bagged markets can be challenging as there are numerous bagged products already available, and customers tend to stick with brands they are familiar with and have used before. With greater returns comes greater risk, and municipal staff must become adept at sales and marketing in order to compete with existing products.

One of the keys to a sustainable composting program is the ability to transform the wide range of uses for compost products into paying markets. This ability is based on a clear understanding of product characteristics and limitations, and product consistency. Completing actual market research on known markets and competing products is also imperative.

Within the composting industry, it can take as long as five years to realize consistent results from product marketing plans. This is particularly true in areas where compost production and use is not prevalent: in these areas, the "first-in" producers will often have to make higher investments than those that come into the market area in later years. However, purchasers of organic products tend to be loyal and stick to a particular brand, which means that the first-in

producers have the opportunity to maintain a larger market share in the long term, and have to worry less about competing solely on price.

Many composting facilities overlook the background requirements and research needed to establish sustainable markets. It is not uncommon to see producers refer to a “marketing plan” which is actually little more than a “sales plan” which simply outlines the tools used to sell products to consumers (i.e. lead generation, cold calls, literature, product samples). A true marketing plan covers a much broader scope and range of activities that are undertaken, from the initial concept development to the point at which there are consistent return sales. It includes product research and development, market research and needs analysis, planning and positioning, distribution, promotion, and sales.

A challenge that is often encountered in municipal composting operations is the lack of knowledge of sales personnel. Often, facility supervisors or other public works/waste management staff are responsible for sales, and these personnel typically have only a cursory knowledge of the technical aspects of their products (e.g. application rates, agronomic characteristics). This can hamper their ability to sell product into markets where customers themselves are very educated (e.g. horticultural, silviculture, golf courses), or to compete against producers with more technically astute sales personnel. For this reason, it is often recommended that those personnel assigned with sales responsibilities be given specific training on compost utilization, basic soil science, and basic sales techniques, and that these personnel then become the points of contact for the marketing program, taking referrals from each municipal office as well as generating and following up on sales leads.

One of the keys to satisfying and retaining customers is to ensure that products produced are consistent and meet any required or advertised specifications. Variable products that do not produce consistent results can damage market perceptions of products and/or brand(s). Development of an appropriate quality assurance and quality control (QA/QC) program is one of the primary tools used in manufacturing industries to maintain the desired level of quality in their products. A QA/QC program is simply the combination of various tools, measures and proactive management methods that allow control of inputs, processes, and outputs to meet customer requirements. A typical QA/QC program at a compost facility consists of process controls and finished product testing.

9 Collection and Processing System Options

The second phase of this project involved identifying the specific program components that are suitable for use in RDOS, and combining these individual components into management systems that reflect guiding principles, boundary conditions, and themes. The management systems were subsequently evaluated through a multi-objective decision analysis process.

This chapter outlines the results of the process used by CH2M HILL to identify organic waste processing options that are suitable for application in RDOS. It outlines the collection and processing systems that were developed jointly by RDOS and CH2M HILL, and the specific details of each system.

9.1 Initial Screening Process and Results

An initial list of potential processing options that could be applied in RDOS was developed by CH2M HILL, and is shown in Exhibit 9-1. This “long list” was developed based on the Team’s experience as well as the research conducted for this and other solid waste management projects in British Columbia and elsewhere.

Each of the options included in the long list was subjected to an initial screening and “fatal flaw” analysis using criteria developed by CH2M HILL and RDOS. These criteria included:

- The land requirements for the processing option;
- The option’s inherent level of odour control;
- The amount of water consumed;
- The amount of leachate/effluent generated;
- Whether there is sufficient amount of suitable land available within RDOS;
- Appropriateness of the option to RDOS’s climate;
- Whether there is sufficient feedstock available within in RDOS to make an option viable;
- Whether the option has operated reliably for at least five years at a commercial level; and
- The ability of the option to meet provincial regulatory requirements.

The assessment of each potential program component based on these criteria is summarized in Exhibit 9-1. Based on the assessment, a number of processing options were excluded from further consideration. The rationale for excluding these options is summarized below:

- Static pile and passively aerated static pile composting were excluded due to low level of odour control;
- Wet anaerobic digestion was excluded due to water requirements and effluent quantities, and the resulting impact of the latter on WWTP capacities;
- Landfill bioreactor and co-digestion at area WWTP’s were excluded due to limited commercial experience with these options;

Exhibit 9-1

Initial Screening of Organic Waste Processing Options

Technology	Space Requirements	Inherent Odour Control	Water Consumption	Leachate/ Effluent Generation	Suitable Available Land Base in RDOS	Appropriate for RDOS Climate	Sufficient Feedstock Available in RDOS	5 Years of Reliable Commercial Operation	Ability to Meet Prov. Regs
Composting									
Static Pile	Large	Low	Low- Moderate	Low	Yes	Yes	Yes	Yes	Yes
Passively Aerated Static Pile	Large	Low	Low- Moderate	Low	Yes	Yes	Yes	Yes	Yes
Turned Windrow	Large	Low to Moderate	Low- Moderate	Low	Yes	Yes	Yes	Yes	Yes
Mass Bed (unaerated, outdoor)	Large	Low to Moderate	Low- Moderate	Low	Yes	Yes	Yes	Yes	Yes
Aerated Static Pile (outdoor)	Moderate to Low	Moderate to High	Low- Moderate	Low to Moderate	Yes	Yes	Yes	Yes	Yes
Covered Aerated Static Pile (outdoor)	Moderate	High	Low	Low	Yes	Yes	Yes	Yes	Yes
Aerated Static Pile (enclosed)	Moderate to Low	High	Low	Low to Moderate	Yes	Yes	Yes	Yes	Yes
Channel	Moderate to Low	High	Low	Low to Moderate	Yes	Yes	Yes	Yes	Yes
Mass Bed (aerated, indoor)	Moderate to Low	High	Low	Low to Moderate	Yes	Yes	Yes	Yes	Yes
Agitated Bed	Moderate to Low	High	Low	Low to Moderate	Yes	Yes	Yes	Yes	Yes
Static Containers/Vessels	Moderate to Low	High	Low	Low to Moderate	Yes	Yes	Yes	Yes	Yes
Agitated Containers/Vessels	Moderate to Low	High	Low	Low to Moderate	Yes	Yes	Yes	Yes	Yes
Tunnel	Moderate to Low	High	Low	Low to Moderate	Yes	Yes	Yes	Yes	Yes
Rotating Drum	Moderate to Low	High	Low	Low	Yes	Yes	Yes	Yes	Yes
Anaerobic Digestion									
Wet Anaerobic Digestion	Moderate to Low	High	Very High	Very High	Yes	Yes	Yes	Yes	Yes
Dry Anaerobic Digestion	Moderate to Low	High	Low	Low to Moderate	Yes	Yes	Yes	Yes	Yes
Landfill Bioreactor	Large	Low to Moderate	Low	Low to Moderate	Yes	Yes	Yes	No	Yes
Co-Digestion using WWTP Infrastructure	Moderate to Low	High	Low	High	Yes	Yes	Yes	No	Yes
Land Application									
Surface application - Ag Land	Very Large	Low	N/A	N/A	No	Yes	Yes	Yes	Yes
Surface application - Forestry Land	Very Large	Low	N/A	N/A	Yes	Yes	Yes	Unknown	Unknown
Subsurface application - Ag Land	Very Large	Low to Moderate	N/A	N/A	No	Yes	Yes	Yes	Yes
Other									
Mulch Production	Moderate to Low	Low	N/A	Low	Yes	Yes	Yes	Yes	Yes
Biomass Production	Moderate to Low	Low to Moderate	N/A	Low	Yes	Yes	Yes	Yes	Yes

- Surface and subsurface land application was excluded due to odour generating potential, and the lack of sufficient agricultural land in the RDOS.

Those options that are appropriate for application in RDOS, and which were considered further are summarized in Exhibit 9-2. Exhibit 9-2 also provides a summary of the appropriateness of each short-listed options to the various organic wastes produced in the RDOS.

9.2 Program Assumptions

The purpose of this section is to document the common assumptions on which the system options outlined in this chapter are based.

9.2.1 Collection Programs and Policies

The quantities of organic wastes from residential and industrial/commercial/institutional (ICI) sources that can be diverted for processing depend on the type of collection system and the mix of policies adopted to encourage and enforce participation in the organics program. Policies that have shown to be effective in maximizing diversion of organics from landfill are shown in Exhibit 9-3. In order to achieve the diversion from landfill projected in this memorandum, these types of policies would be required, particularly for source separated organic waste (SSO) diversion programs.

9.2.2 Processing Technologies

In addition to regulatory and siting drivers, the choice of organic waste processing technology is also highly dependent on the quantity and type of feedstocks to be processed. For example, windrow composting may be appropriate for processing small quantities of leaf and yard waste (L&YW), whereas other more sophisticated technologies, such as aerated static piles, may be appropriate for larger quantities. Still more sophistication may be appropriate or required when biosolids and/or SSO are added to the operation.

9.2.3 Organic Waste Quantities

There are several streams of organic waste materials generated within the RDOS that could potentially be diverted. Estimates of the quantities of organic material currently being disposed and diverted in the RDOS are provided in the technical memorandum entitled "Organics Feedstocks and Amendments". As noted in that memorandum, Agricultural sources of organics in the RDOS have primarily been diverted into on-site uses such as composting or chipping or been incorporated into this study through the current volumes of organic waste received at landfills.

For the purpose of facility sizing, the amount of material that can be reasonably expected to be diverted from disposal were prepared using the following information:

- **Leaf and Yard Waste:** the estimates in the Organics Feedstocks and TM suggest that approximately 18,500 of 22,800 tonnes (81 percent) of L&YW were diverted in 2008 by existing programs in the regional district. Based on experiences elsewhere (such as long-term, routine waste composition studies from Seattle, WA.), it is estimated that moving to bi-weekly collection might increase the amount diverted to 21,340 tonnes (93 percent), and that moving to weekly collection could result in 22,480 tonnes (98 percent) diverted.

Exhibit 9-2

Initial Screening Results/Appropriateness to Various Feedstocks

Technology	Wood Waste	L&YW	ICI Food Waste	Residential Food Waste	Mixed MSW	Biosolids	Manure	Fruit Waste	Non-SRM Carcass/Slaughter Waste	SRM
Composting										
Turned Windrow	✓	✓	✓	✓	x	✓	✓	✓	✓	x
Mass Bed (unaerated, outdoor)	✓	✓	✓	✓	x	x	✓	✓	x	x
Aerated Static Pile (outdoor)	✓	✓	✓	✓	x	✓	✓	✓	x	x
Covered Aerated Static Pile (outdoor)	✓	✓	✓	✓	x	✓	✓	✓	✓	x
Aerated Static Pile (enclosed)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Channel	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mass Bed (aerated, indoor)	✓	✓	✓	✓	x	x	x	✓	x	x
Agitated Bed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Static Containers/Vessels	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Agitated Containers/Vessels	✓	✓	✓	✓	x	✓	✓	✓	✓	✓
Tunnel	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Rotating Drum	✓	✓	✓	✓	✓	x	x	✓	✓	✓
Anaerobic Digestion										
Dry Anaerobic Digestion	x	x	✓	✓	✓	✓	✓	✓	✓	x
Other										
Mulch Production	✓	x	x	x	x	x	x		x	x
Biomass Production	✓	x	x	x	✓	x	x	x	x	x

- **Source Separated Organics (SSO):** With aggressive programmatic support (as discussed in Exhibit 9-3), data from Ontario and Nanaimo suggest that SSO diversion of 130 kg/hh is achievable from the residential sector. Data from Nanaimo and Seattle suggest that a mature ICI SSO program can divert approximately 10 percent of the total waste stream.
- **Biosolids:** Existing quantities (wet tonnes at 20 percent assumed solids) were assumed to continue in the future, and those quantities would increase proportional to forecast population growth.

EXHIBIT 9-3

Residential and ICI Organics for System Options, 2030

Material/Program	Policies Which Would Support
Residential L&YW	Mandatory source separation program Curbside collection through growing season Leaf and yard waste ban in garbage Bag limits for garbage Pay as you throw for garbage
Residential SSO	Mandatory source separation Curbside collection of SSO weekly Bi-weekly garbage collection Pay as you throw for garbage
ICI L&YW	Mandatory program Landfill ban on ICI landscaping waste High tipping fees Low composting fees
ICI SSO	Landfill ban on ICI food waste High landfill tip fees Less expensive composting fees Mandatory source separation ordinance Enforcement of mandatory source separation ordinance and landfill ban

In order to project the quantities of organic materials forwarded to the processing facilities in each system option, organic quantities were broken down into smaller wastesheds using population, household and labour force data from BC Stats. Growth in material quantities were forecast using population growth for Health Areas from B.C. Stats (which include Summerland, Penticton, Keremeos, Southern Okanagan (Oliver/Osoyoos), Princeton, and Central Okanagan (used to project biosolids quantities from the West Kelowna WWTP)).

Estimated quantities of material diverted to processing facilities in 2020 and 2030 are shown in Exhibit 9-4. Material is shown for residential only (applicable in Scenario 1) and for residential plus ICI. Residential L&YW is shown for both bi-weekly seasonal collection (Scenarios 1, 3, 4, 5) and weekly collection (Scenario 2).

9.2.4 Compost Product Quality and Use Assumptions

The quantities and proposed uses of the final product(s) produced by a composting facility should be reflected in the facility's design. This is necessary to ensure that suitable allowances are made for post-processing operations and equipment and storage space.

In British Columbia, compost product quality criteria for health and safety and environmental factors are mandated by the Province's Ministry of the Environment, and the Canadian Food Inspection Agency (CFIA). Provincial requirements are contained in OMRR, while CFIA requirements are outlined in the *Fertilizer Act* and associated regulations and trade memoranda. The CFIA also ensures consumer protection through its enforcement of the product labeling requirements of the *Fertilizer Act* and associated regulations.

EXHIBIT 9-4

Forecast Tonnes to Processing Facilities

Wastashed	Tonnes to Processing Facilities , 2020				Tonnes to Processing Facilities , 2030			
	L&YW (Bi- Weekly)	L&YW (Weekly)	SSO	Biosolids (wet)	L&YW (Bi- Weekly)	L&YW (Weekly)	SSO	Biosolids (wet)
Residential Only								
Summerland	2,410	2,580	590	1,160	2,590	2,760	640	1,250
CMSL/OKF	9,830	10,510	1,940	5,640	10,530	11,250	2,080	6,040
Keremeos	1,110	1,180	300	120	1,120	1,200	300	120
Osoyoos	910	970	460	330	930	990	470	330
Oliver	3,460	3,700	430	30	3,540	3,780	440	30
Princeton	430	460	210	20	390	410	200	20
West Kelowna WWTP				6,180				7,010
Subtotal	18,150	19,400	3,930	13,480	19,100	20,390	4,130	14,800
Residential + ICI								
Summerland	3,120	3,290	860	1,160	3,350	3,530	920	1,250
CMSL/OKF	12,600	13,270	3,540	5,640	13,500	14,220	3,790	6,040
Keremeos	1,410	1,480	460	120	1,420	1,500	470	120
Osoyoos	1,240	1,300	810	330	1,260	1,330	830	330
Oliver	4,240	4,470	720	30	4,340	4,580	730	30
Princeton	600	630	560	20	540	570	510	20
West Kelowna WWTP				6,180				7,010
Subtotal	23,210	24,440	6,950	13,480	24,410	25,730	7,250	14,800

The primary markets envisioned for the compost produced at the composting facility are internal uses in municipal parks, boulevards and sports fields; professional landscapers and retail landscape supply companies; and to soil blenders for use in manufactured topsoils and garden soil blends. Where feasible, the RDOS will work with the Ministry of Agriculture and Agricultural organizations to develop strategies to help utilize compost produced from this facility in local agricultural operations.

On the basis of these expectations, it will be necessary to produce compost products that are both stable and mature. Stability is a measure of the stage of decomposition of the organic material and is measured by tests such as reheating (e.g. Dewar Flask) or carbon dioxide respirometry. Maturity is affected by stability, but also measures the compost's impacts to plant germination and development. Germination and growth tests with cucumbers or other species, and ammonia concentration tests are commonly used to measure maturity. The stability and maturity requirements in Exhibit 9-5 have been adopted and used to guide the conceptual design of composting facilities included within the system scenarios.

EXHIBIT 9-5
Product Stability/Maturity Criteria

Criteria	Method	Criteria
Stability Criteria:		
Reheat	TMECC 5.08-D	<10°C
CO ₂ Respiration	TMECC 5.08-B	<4 mg CO ₂ /g OM/day
Maturity Criteria:		
Emergence/Growth (Cucumber)	TMECC 5.05-A	90%
Ammonia Concentration	TMECC 4.02-C	<500 ppm (dry wt)

9.2.5 Processing Facility Design Basis Assumptions

A number of design and performance criteria have been outlined which form the basis for the conceptual designs of processing facilities considered in the systems. These criteria are based on regulatory requirements and guidelines outlined by BCMOE, as well as industry best management practices.

9.2.5.1 Design Life

Based on the magnitude of infrastructure investment required, and considering the rate at which solid waste management technologies are advancing, a minimum design life of 20 years is recommended for the major components of facilities, including buildings.

Secondary components, including mobile equipment and some mechanical pre- and post-processing equipment, will have a shorter lifespan and will require replacement during a facility's lifespan. For example, mobile equipment used in organic waste facilities can be expected to have a lifespan of 5 to 7 years, and processing equipment from 5 to 10 years.

9.2.5.2 Building Design

It has been assumed that building systems used for the processing facilities will combine custom and pre-engineered steel buildings with metal cladding. Regardless of type, close attention is required to the selection and design of building systems due to the potential for chemical and biological corrosion. Generally, organic waste processing facilities are also subject to an increased rate of wear and tear from operations.

To provide protection from corrosion, it has been assumed that the interiors of organic waste processing buildings would be coated with a protective coating. While a range of coatings are available, a spray-applied polyurethane foam system with a polymer composite shell has been

used as the basis for conceptual designs. This system has been used in several composting facilities in the North America and has been shown as effective.

Interior floors within the waste receiving, storage, and processing areas will be sloped so that any leachate or other liquid escaping from feedstocks is fully contained within the building. Floor surfaces in these areas would also be coated or otherwise constructed to withstand the normal wear and tear from scraping wear edges of wheel-loader buckets.

9.2.5.3 Fire Protection

The facility will be designed in accordance with the requirements of the provincial fire code as it related to industrial occupancies, including egress requirements, hose and extinguisher stations, and alarms. Additionally, a sprinkler system would be installed in material receiving and storage areas which, in combination with operational practices and the use of concrete walls and bunkers in these areas, would reduce damage caused by any minor fires that might occur.

9.2.5.4 Building Ventilation and Odour Control Systems

The ventilation and odour control systems at waste processing facilities should be highly integrated. This is necessary to ensure that both process air and odourous building air is captured and conveyed to the odour treatment system. The ventilation system should also be used to keep buildings and enclosures under a slight negative pressure, which will help to reduce fugitive releases of untreated building air to the atmosphere.

The basis of design for the ventilation system would be an air flow rate in the order of six air changes per hour to control fugitive emissions and provide a safe working environment. This will be augmented with source capture systems in key locations (such as over material storage areas, shredders, and screens). Generally, building air from each area within the facility will be collected through ducting at roof level and transferred to the odour treatment system, which consists of a wet scrubber and biofilter.

The biofilters would consist of a traditional design, comprising a 1.5-m layer of coarse wood chip overlying a layer of 25 mm+ washed rock. Aeration pipes would be embedded in the base layer. Each biofilter would be designed with distinct cells, each with a capacity of 40 percent of the required total. This allows for 1 cell to be taken offline (that is, for media changes) while providing 80 percent of the required treatment capacity. Each cell would be designed with an empty-bed residence time (EBRT) of 45 seconds

Wet scrubbers installed immediately upstream of the biofilter(s) would be used to reduce particulate levels in the airstream, which could otherwise affect the biofilter media's performance. The wet scrubber would also help to reduce ammonia levels in the airstream, which would result from processing of green grass and/or biosolids.

In outdoor operating areas, the degree of odour control is more limited than within enclosed operating areas. Odour control in outdoor areas would be achieved primarily through the use of good operating practices. However, basic design features, such as sloped working surfaces, would also be incorporated into outdoor areas.

9.2.5.5 Dust and Litter Controls

Dust and litter would be managed through the implementation of good operating practices. However, design features, such as: hard-surfaced roadways, permanent litter fences, and

enclosures around residual storage areas that are incorporated into the design of the facility, will complement operational practices.

9.2.5.6 Bird and Wildlife Control

Bird controls will be limited to traditional, non-auditory “scares” around the buildings and facility. Building designs will also consider bird controls by minimizing potential perches, using mist netting or other barriers, and installing coils or spikes on selected horizontal surfaces.

Wildlife and vermin control would primarily be maintained with good housekeeping and maintenance practices to minimize opportunities for infestation.

9.2.5.7 Stormwater Management

Stormwater that has come in contact with feedstocks, or which has been contaminated by run-off from receiving, composting, and curing areas, can be high in biochemical oxygen demand (BOD), suspended solids, and/or nutrients.

To minimize the potential for contamination of surface waters (which, in turn, increases leachate management requirements), stormwater from non-operating areas outside of the processing facilities would be diverted around or away from the facility through ditches, swales, berms, or other conveyance methods. Similarly, drainage from building roofs will be controlled/diverted so that it does not enter or impede access to processing areas and buildings.

9.2.5.8 Leachate Management

It is necessary to manage surface water and leachate to prevent uncontrolled releases to the environment that will result in adverse effects. Surface water that has come into contact with organic waste feedstocks, or that has been contaminated by run-off from receiving and processing areas, will be managed as leachate.

Leachate from processing systems would be collected and transferred via above-grade piping to one or more leachate tanks. With some technologies (such as in-vessel composting, wet AD), leachate from the tank(s) can be reused to moisten feedstocks as part of pre-processing and processing stages.

Surplus leachate that cannot be recycled and reused within the process would either be discharged to the sanitary sewer system or hauled directly to a WWTP. Analytical testing would be necessary to confirm compliance with the sewer-use criteria.

Run-off from outdoor operating areas would be captured using ditches and swales, and transferred to one or more onsite retention ponds. The retention ponds would be designed to manage the run-off from a 1-in-25-year, 24-hour storm event. Working surfaces in these operating areas will be constructed to withstand expected wear and tear from site equipment and customer vehicles, and will be underlain by a 0.5-m-thick clay liner (hydraulic conductivity of 1×10^{-9} metres per second [m/s]) to prevent downward and lateral migration of leachate into groundwater. The retention pond would be underlain with a synthetic liner.

Depending upon the levels of nutrients and contaminants, management options for surplus leachate in the retention pond would include reuse within the processing technology, spray-irrigation on adjacent lands, onsite pretreatment (i.e. aeration or wetlands treatment) and release to nearby surface water bodies, and offsite disposal via the sanitary sewer system.

9.2.5.9 Roadways

A geometric design of access roadways and maneuvering areas would accommodate anticipated vehicle types, which include single- and tandem-axle waste collection trucks, single- and tandem-axle dump trucks, and tandem- or tri-axle semi-trailers up to 25 m in length. Roadways would be constructed of asphalt, concrete, or equivalent materials that are capable of withstanding the weight of vehicles and site equipment.

9.2.5.10 Staff, Administrative, and Maintenance Facilities

A typical facility would include a combined staff and administrative building that houses a staff break room; male and female washrooms, locker rooms, and shower facilities; a dedicated control room; a laboratory appropriately equipped for process control analysis purposes; and offices and meeting spaces.

An allowance for maintenance and warehouse storage is also included. The maintenance facility is intended for servicing of mobile equipment and completion of small repairs. Critical spare parts, tools, and consumable supplies would be stored in the warehouse area.

9.2.5.11 Compost Product Storage

For facilities that produce compost, the cured product resulting from the composting and curing process must be stored in a manner that preserves the product's quality (that is, prevents weed propagation and pathogen reintroduction). This generally means that product stockpiles are stored on prepared surfaces and are kept free of vegetation (such as from windblown seeds) and litter. There must also be sufficient space to store the compost that accumulates during months when product shipments are low (such as during winters).

A storage capacity large enough to accommodate 4 to 6 months of product is necessary once markets are fully developed. During the initial 1 to 2 years of a facility's operation (before markets are fully developed), additional temporary capacity may also be necessary.

9.3 Organic Waste Management System Options

When analyzing potential organic waste diversion processing methods, it is important to take a "systems" approach that considers diversion policies, collection programs, facility locations, and feedstock types and quantities. The interaction of these factors must be considered to make reasoned programmatic decisions about organics processing technology. They will also determine the quantity of residual waste (e.g. contaminants, off-spec products) that is generated by the processing facility and which must be disposed of or otherwise managed.

In consultation with RDOS personnel and other stakeholders, CH2M HILL has developed five system options that are targeted to investigate different possible ways of managing the diversion of organic waste diverted through the residential and commercial collection programs. All of the scenarios assume aggressive policies to drive organics diversion as outlined in Exhibit 9-3. A summary of the assumed collection methods for each system option is provided in Exhibit 9-6. Other features of each system including assumed processing methods are outlined in the following sections.

In developing the systems, two time horizons were considered: an initial period of seven to ten years (represented by 2020) and a twenty year period (i.e. 2030). Consideration of the two time lines is necessary to assess potential changes in organic waste tonnages and the resulting impacts of processing facility design. For example, if there is a significant difference in organic

waste quantities between the 2020 and 2030 milestones, this may direct the selection process for processing technology to one that more readily allows for staged construction or “modular” additions of capacity.

EXHIBIT 9-6

Assumed Collection Methods for System Options

System Option	Residential Collection				
	L&YW	SSO	Garbage	Recycling	ICI Collection
Existing System	Bags, 6 times/year	Not separated	Weekly	No change	No change
1 Bi-weekly L&YW Collection	Bags, Biweekly, Apr-Oct	Not separated	Weekly	No change	Separate SSO Routes
2 Combined L&YW/SSO Collection, Multiple (3) SSO Facilities ^a	240-L cart for combined L&YW/SSO, Weekly, year round		Bi-weekly ^a	Bi-weekly ^a	Separate SSO Routes
3A Separate L&YW/SSO Collection, Multiple (3) SSO Facilities ^a	Bags, Biweekly, Apr-Oct	45-L cart, weekly, year round	Bi-weekly ^b	Bi-weekly ^a	Separate SSO Routes
3B Separate L&YW/SSO Collection, Multiple (4) SSO Facilities ^a	Bags, Biweekly, Apr-Oct	45-L cart, weekly, year round	Bi-weekly ^b	Bi-weekly ^a	Separate SSO Routes
4 Separate L&YW/SSO Collection, Single Regional SSO Facility ^a	Bags, Biweekly, Apr-Oct	45-L cart, weekly, year round	Bi-weekly ^b	Bi-weekly ^a	Separate SSO Routes

^aAssumes two trucks: one for L&YW/SSO and a second that collects garbage one week and recycling the next week. Penticton would change to bi-weekly recycling or add additional collection capacity.

^bAssumes two trucks: one split truck collecting SSO weekly in one compartment with garbage one week and recycling the next week in the other compartment. A second truck would be used for seasonal L&YW collection. Penticton would change to bi-weekly recycling or add additional collection capacity.

9.3.1 System Option 1

9.3.1.1 L&YW and SSO

This system is an expansion and improvement upon the existing residential L&YW collection program in the region. It assumes that bag-based curbside L&YW service would be provided on a bi-weekly basis to residents in all areas of the RDOS from April through October.

There would be no specific programs included in this system that promote the diversion of L&YW from ICI sources. However, L&YW drop-off points at disposal facilities in the RDOS would continue to be open to use by ICI generators.

9.3.1.2 Biosolids

In addition to collection and processing of L&YW, this system would include a single centralized composting facility for processing of biosolids from the four WWTP's in the RDOS as well as from the West Kelowna WWTP in the adjacent Regional District of Central Okanagan (RDCO). It has been assumed that biosolids would be dewatered at each of the WWTP's prior to being transferred to the composting facility. The biosolids composting operation would be co-located with the L&YW composting facility in the Penticton area.

9.3.1.3 Wood Waste from DLC Sources

The existing practice of separating wood waste at disposal sites in the RDOS for grinding and subsequent, beneficial reuse allows a significant volume of landfill airspace to be conserved. It is assumed that in this system, the existing wood waste diversion programs would continue, and participation/diversion would be increased through education, promotion and policy tools.

The operation of the diversion programs would be further enhanced to be consistent with wood waste management initiatives being undertaken in RDCO and RDNO. Specifically, wood wastes would be segregated into the four categories as shown in Exhibit 9-7. This degree of segregation allows for greater flexibility in directing the waste into beneficial reuse opportunities that currently exist or which expected to be developed over the coming years.

EXHIBIT 9-7
Wood Waste Segregation Categories

Categories	Recommended Uses
Dimensional wood –treated/painted	Grind for use at landfills for roads and working surfaces Grind for use as alternative daily cover in landfill operations
Dimensional wood – untreated/unpainted	Grind for use at co-generation facility in Armstrong Grind for use as amendment in yard waste or biosolids composting operations grind for use/sale as mulch
Large branches (more than 1.5" diameter), and logs and stumps	Grind for use at co-generation facility grind for use as amendment in yard waste or biosolids composting operation
Small branches and tree prunings less than 1.5" diameter	Incorporate directly into yard waste composting operation

By adopting consistent collection programs, and producing ground materials to common specifications, RDOS, RDCO, and RDNO would be better able to oversee reuse opportunities within the southern interior region, and manage stockpiles more effectively.

9.3.1.4 Agricultural Waste

Agricultural wastes managed through this system would be limited to the small amounts of wood waste from orchards and vineyards, and manures that are currently accepted at disposal facilities in the RDOS. No animal carcasses, abattoir wastes, or Specified Risk Materials (SRM) would be accepted. The RDOS, in partnership with Provincial and existing Agricultural organizations, would encourage on-site composting, chipping or re-use of materials where possible rather than removal to an off-site facility.

9.3.1.5 Processing Facility Locations

The materials collected and diverted would be transferred to one of four composting facilities for processing. The composting facilities would be distributed on a "wasteshed basis" (i.e. they would be geographically located close to concentrations of organic waste generators within the RDOS's major wastesheds as a means of minimizing transportation costs. This approach drives the development of a larger number of smaller processing facilities.

9.3.1.6 Material Quantities and System Flow Diagram

A diagram that illustrates how organic waste would flow through this system, and the estimated tonnages, is provided in Exhibit 9-8.

9.3.1.7 Processing Technologies

The quantities of organic wastes that are diverted to the processing facilities in this system are relatively small. At all facilities except the Penticton area site, the feedstocks consist of only L&YW. Due to the size of the facilities required in the Oliver/Osoyoos, Keremeos and Princeton areas, it is most appropriate and cost effective to use a windrow composting approach. The difference in the size of facility required to manage anticipated L&YW quantities diverted in 2020 and 2030 is not significantly different, and therefore the initial build out would be to the full (i.e. 2030) capacity.

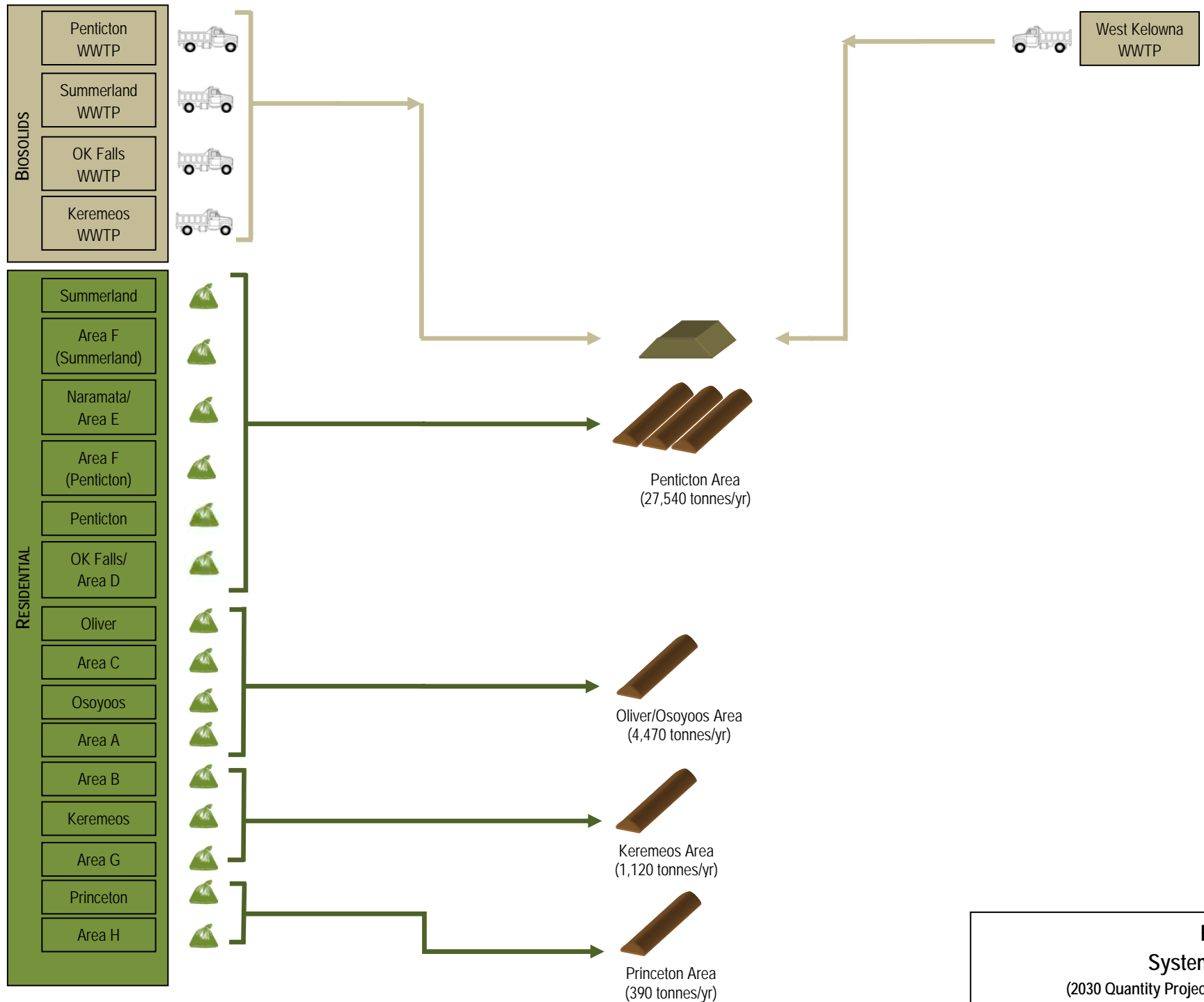
Feedstocks at the Penticton area facility consist of L&YW and dewatered biosolids. However, the materials are collected and delivered to the site separately, which allows for the opportunity to utilize two separate processing technologies. In the case of L&YW, the quantities are such that windrow composting would be appropriate, although an outdoor aerated static pile system could also be used if there are space limitations at the facility. Once again, the initial build out would be based on the required capacity in 2030.

Windrow composting is not generally appropriate for managing biosolids due to the higher potential for odours. Negatively aerated static pile composting (with or without a cover), combined with a biofilter for treating process air, would be the minimum acceptable technology for use with this feedstock. A positively aerated static pile (ASP) system with a cover system would also be a suitable technology provided the odour control properties of the cover system can be demonstrated. Positively aerated static pile composting is feasible but not recommended due to the reduced odour control capabilities of this method (as compared to negative ASP system and biofilter).

Depending on the site location and the proximity of adjacent landowners, it may be necessary to enclose the ASP composting operation inside a building to achieve a higher level of odour and nuisance control. Enclosing the composting process as a result of climate is not expected to be necessary in the Penticton area.

In terms of the size of the biosolids composting operation, an initial build out based on 15,000 wet tonnes of materials per year (288 tonnes/wk) would be appropriate. Future increases in biosolids quantities could subsequently be managed through increased ASP pipe heights (which may require modifications to aeration systems and fans), and/or construction of additional infrastructure to allow for more composting piles. An outdoor system, both these options can be easily accommodated provided suitable allowances are incorporated into the initial facility design. Expansion of an enclosed ASP system with more piles would be more difficult as building modifications would be required.

Due to the requirements for amendments, a portion of the wood wastes accepted through the system would be ground and used in the biosolids composting process. The surplus wood waste would be ground and managed through the beneficial reuse options previously outlined in Exhibit 9-7.



Surplus L&YW self-hauled to closest processing facility.

Exhibit 9-8
System Option 1
 (2030 Quantity Projections Shown)

9.3.2 System Option 2

9.3.2.1 L&YW and SSO

The second system option is based on a regional source-separated organic (SSO) waste collection program being provided to residents throughout the region on a year-round basis. The residential collection program would consist of weekly automated collection of L&YW combined with SSO in a common cart. It is envisioned that residents would be given the choice of two to three cart sizes ranging between 240 L (65 gal) and 360 L (96 gal) in size, allowing them to match collection service to their household size and habits. Providing a weekly SSO collection would allow municipalities to reduce the frequency of waste collection to bi-weekly, and alternate the schedule for garbage collection with recyclables collection. (Note that in Penticton, this would presume that recyclables would be collected bi-weekly instead of weekly; alternatively weekly service could be retained with an associated increase in costs.) Changing to bi-weekly collection of garbage would require significant up-front education and promotion.

Diversion of L&YW from ICI sources would be actively targeted through promotion of existing programs and differential tipping fee structures. Similarly, RDOS staff would work with targeted ICI generators (e.g. grocery stores, food and fruit wholesalers and processing operations) to divert clean source separated organic wastes to the regional processing facilities outlined below.

9.3.2.2 Biosolids

As in System Option 1, biosolids from WWTPs in RDOS and West Kelowna would be dewatered at the WWTP's, and transferred to a single centralized composting facility in the Penticton area.

9.3.2.3 Wood Waste from DLC

Wood waste from DLC sources would be managed on a regional basis in a consistent manner as in RDCO and RDNO as outlined in System Option 1. Participation in programs, and diversion of wood waste would be increased through education, promotion and policy tools.

9.3.2.4 Agricultural Waste

The quantity of wood waste from orchards and vineyard generated in the region is large, but the amount that would be managed through this system is expected to be small. Much of this material is managed onsite (e.g. through grinding or composting) and there is little financial incentive for growers to divert this material to regional collection points. Similarly, significant volumes of cattle manures are generated in RDOS, as are lesser volumes of manures from horses, sheep and poultry. However, much of this manure is managed at the farm/ranch level, and is unlikely to be diverted to a local or regional organic waste processing facility operated by RDOS.

Therefore, this system has been designed to meet capacity to manage the relatively small amounts of animal carcasses and orchard/vineyard wood wastes that are currently diverted through RDOS programs. The RDOS, in partnership with Provincial and existing Agricultural organizations, would encourage on-site composting, chipping or re-use of materials where possible rather than removal to an off-site facility. No abattoir wastes, or Specified Risk Materials (SRM) would be accepted.

9.3.2.5 Processing Facility Locations

The various materials diverted would be transferred to one of three composting facilities for processing. The facilities would be distributed on a regional basis (as opposed to on a watershed basis) with facilities located in the Penticton area, Oliver/Osoyoos area, and Princeton area. This approach means that organic materials from some areas will have to be transported further, and thus the associated collection/transfer costs would be higher. However, these costs would be offset in part through the economies of scale encountered with the construction of fewer and larger processing facilities, and higher operational efficiencies.

9.3.2.6 Material Quantities and System Flow Diagram

A diagram that illustrates how organic waste would flow through this system, and the estimated quantities, is provided in Exhibit 9-9.

9.3.2.7 Processing Technologies

The inclusion of SSO and other putrescible materials in the organic waste stream significantly increases the potential for odours, nuisances, and wildlife attraction at the processing facilities. These facilities must also be capable of operating on a year-round basis, without interruption by weather (i.e. low temperatures, snow, heavy rain). For these reasons, windrow composting would not be appropriate at any of the three facilities except as a means curing materials stabilized through another composting system.

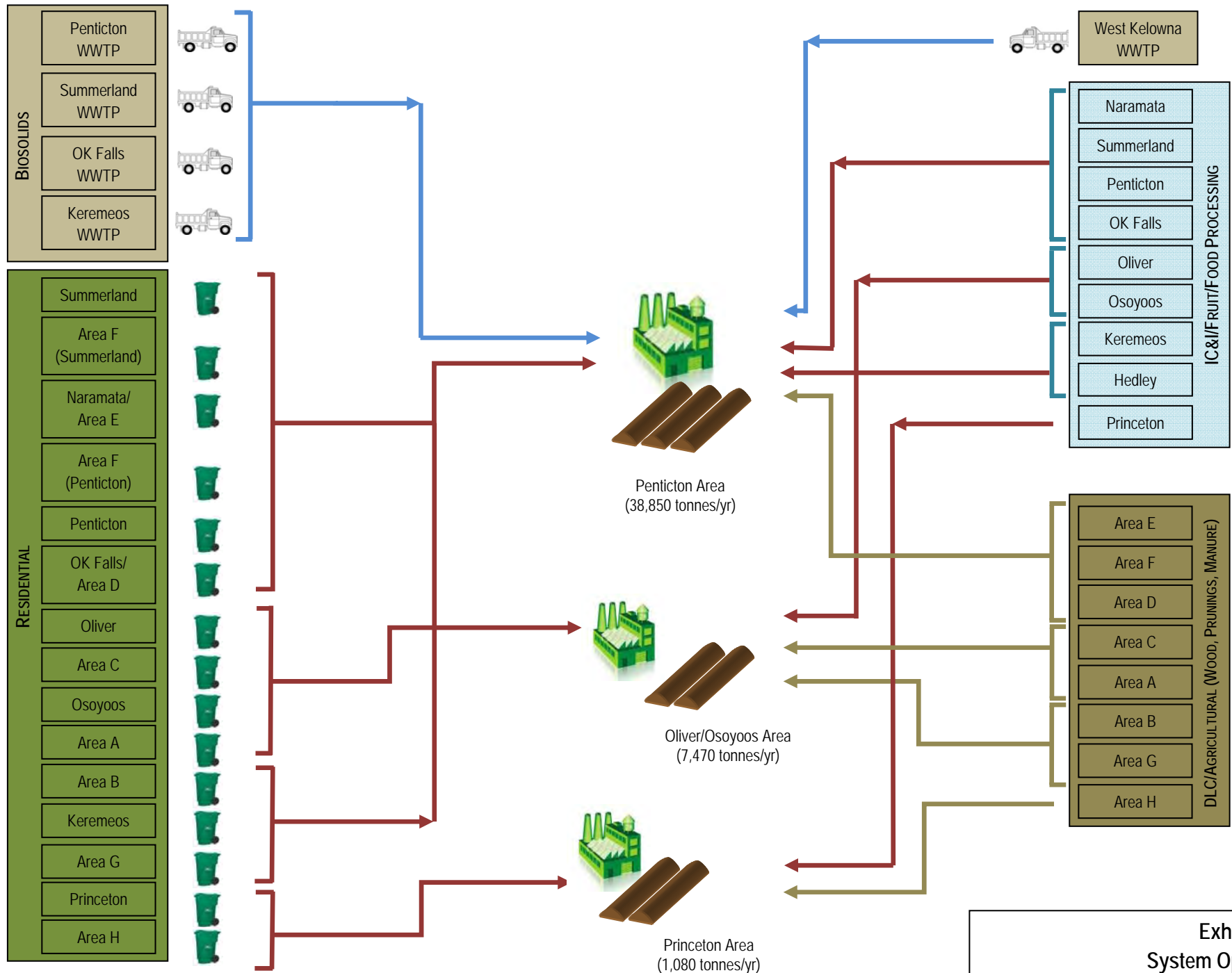
Another key consideration in the selection of technology for this system is the seasonal variation in the quantities of SSO. The projections of waste quantities indicate that L&YW in the Penticton, Oliver and Osoyoos areas is three times the quantity of SSO. Since L&YW is not generated in the winter months, this would result in a significant portion of the processing facility's capacity being unused between November and April.

The amount of space needed at the three facilities to manage the anticipated organic waste quantities diverted is not appreciably different in 2020 compared to 2030. Therefore, all of the processing facilities would be designed based on receiving and processing the quantities of feedstocks anticipated in 2030.

In the case of Penticton, the combined quantities of SSO and biosolids are significant, and a high degree of odour and nuisance control would be required. A number of composting technologies are feasible for processing materials in these quantities including covered ASP systems, outdoor or enclosed negative ASP systems, channels, and tunnels. The size of the operation is beyond the logistical and material handling capabilities of static container/vessels systems. It is also very likely to be below the threshold of economic feasibility for agitated bed and rotating drum system.

Given the higher population density in the Penticton area, the use of covered ASP and outdoor ASP systems may be limited due to the need for a higher level of control. This would be a decision that would need to be made in the context of the specific host site for this facility, and the type and proximity of adjacent land uses.

Of the remaining technologies, there is no clear technical basis to choose between an enclosed ASP, tunnel, or an agitated container/vessel system. It is expected that a facility employing any of these technologies would be capable of meeting technical requirements developed by the RDOS for odour and nuisance controls, production capacity, product quality and leachate



Surplus L&YW self-hauled to closest processing facility.

Exhibit 9-9
System Option 2
 (2030 Quantity Projections Shown)

management. In a situation such as this, it would be beneficial to develop a detailed specification (including process requirements) and solicit firm cost estimates from technology vendors. The vendor claims and cost quotes could then be evaluated on a life-cycle basis to identify the preferred processing system using a triple-bottom line approach.

For the purposes of comparative evaluations of the system options, an enclosed ASP system with a capacity of 1,020 tonnes/wk has been chosen as the technology basis for the Penticton facility in this system option.

The quantities of SSO managed at the Oliver/Osoyoos facility would be significantly less than at the Penticton facility, but are still substantial and would require a high degree of control over nuisances, odours and wildlife issues. The composting technologies that are feasible for processing materials at an Oliver/Osoyoos location include outdoor negative ASP or covered ASP systems, and enclosed ASP system, static container systems, and smaller agitated container/vessel systems. However, as in Penticton, the specific choice of site might preclude the use of an outdoor ASP or covered ASP system. For evaluation purposes, an enclosed ASP system with a capacity of 230 tonnes/wk has been chosen as the basis for the facility.

In the Princeton area, where the relative quantities of L&YW and other SSO components are likely to be similar and the overall quantities of SSO are low, the impact of seasonal variations on technology selection is less of an issue. However, the relatively low quantities of SSO overall eliminate a number of technologies (i.e. drums, tunnels, agitated bed, channel) from the perspective of financial feasibility.

An enclosed ASP composting system, or one that uses static or agitated containers/vessels would provide the most appropriate balance of odour and nuisance controls, operational simplicity and cost for the Princeton area. Once again, developing a detailed specification and obtaining vendor quotes would be appropriate means of finalizing the choice of technology. For the purposes of the evaluation of systems, an agitated container system similar to that used by the University of British Columbia has been selected for this processing facility. The facility would have a capacity of 30 tonnes/wk.

9.3.3 System Option 3A

9.3.3.1 L&YW and SSO

This system option would have the same processing locations as Option 2 with the fundamental difference in that the L&YW would be collected separately from SSO. This would result in the benefit of allowing L&YW to be processed separately from SSO. This separate processing can be done at a different location and/or using a different technology (e.g. outdoor windrow), both of which may allow for significant cost savings (i.e. compared to processing the L&YW along with SSO through an indoor or in-vessel system).

For collection, this system is a combination of the bi-weekly L&YW collection program outlined in System Option 1 (i.e. bag-based bi-weekly collection from April through October), and the year-round, cart-based collection program outlined in System Option 2. In the case of the latter, the cart size would be reduced to approximately 45 L (12 gal), and collection would be provided manually rather than on an automated basis. Weekly SSO collection would still allow municipalities to reduce the frequency of waste collection to bi-weekly, and alternate that service with the bi-weekly collection of recyclables. Changing to bi-weekly collection of garbage

would require significant up-front education and promotion. A second truck would be used for the seasonal yard waste program.

As outlined in System Option 2, RDOS staff would target the diversion of L&YW and clean source separated SSO from ICI generators through promotion, differential tipping fees, and direct contact.

9.3.3.2 Biosolids

As in the previous two options, dewatered biosolids from the WWTP's in the RDOS and West Kelowna would be transferred to the composting facility in the Penticton area for processing.

9.3.3.3 Wood Waste from DLC

As in the previous two system options, wood waste from DLC sources would be managed in a consistent manner with RDCO and RDNO, and participation/diversion would be increased through education, promotion and policy tools.

9.3.3.4 Agricultural Waste

As with System Option 2, processing capacity would be provided to manage the relatively small amounts of animal carcasses and orchard/vineyard wood wastes that are currently diverted through RDOS programs. The RDOS, in partnership with Provincial and existing Agricultural organizations, would encourage on-site composting, chipping or re-use of materials where possible rather than removal to an off-site facility. No abattoir wastes, or Specified Risk Materials (SRM) would be accepted.

9.3.3.5 Processing Facility Locations

As in the preceding option, materials would be transferred to one of three regionally-located composting facilities (i.e. Penticton area, Oliver/Osoyoos area, and Princeton area).

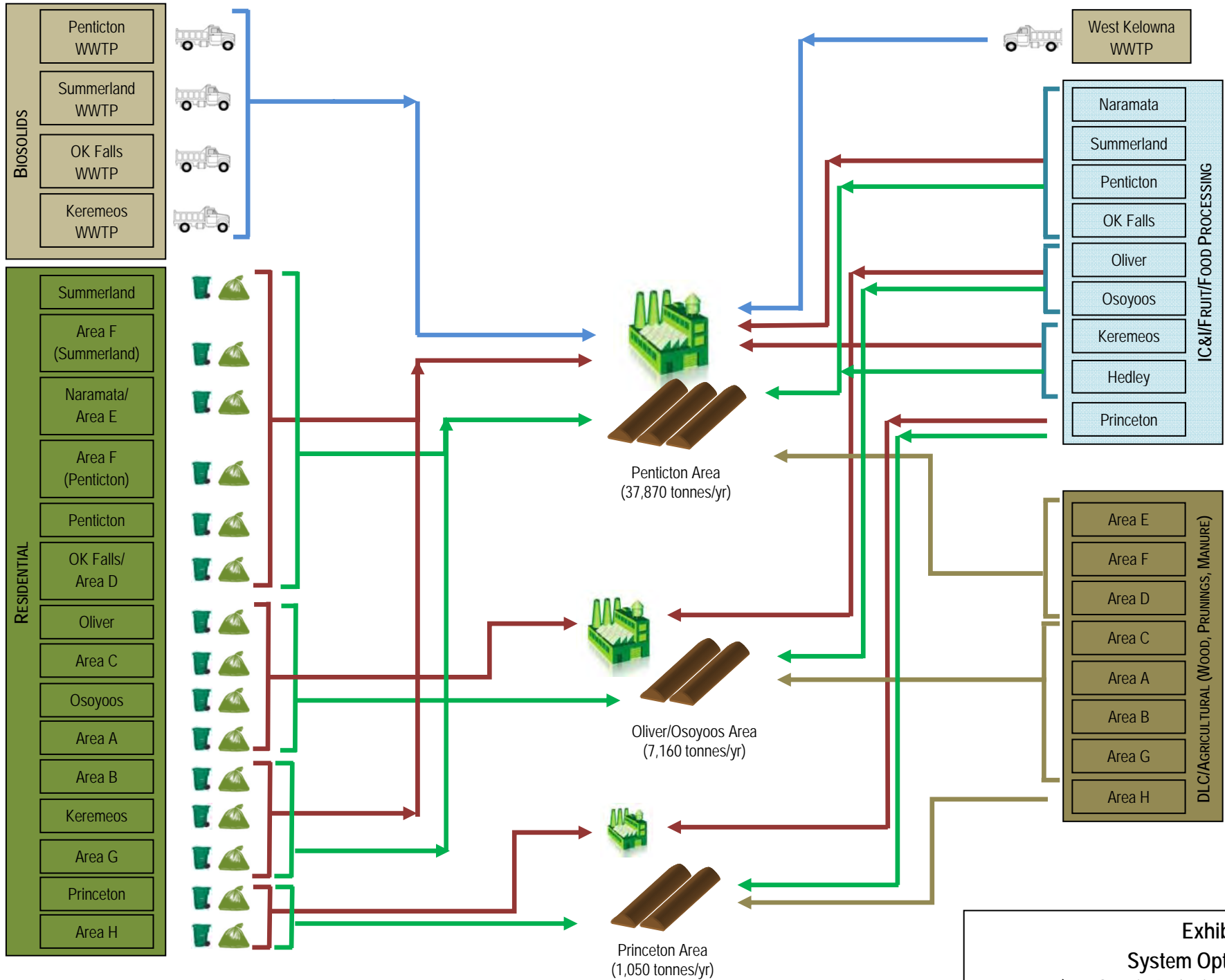
9.3.3.6 Material Quantities and System Flow Diagram

A diagram that illustrates how organic waste would flow through this system is provided in Exhibit 9-10. The estimated material quantities that would be managed through this system are also shown in Exhibit 9-10.

9.3.3.7 Processing Technologies

As in the previous system option, the use of windrow composting to process SSO and biosolids is not acceptable due to the potential for odours, nuisances, and wildlife attraction at the processing facilities, and climatic consideration. However, windrow composting would be an acceptable means of processing the L&YW materials that are collected separately from the SSO and other source separated organic wastes. In the case of the Penticton area facility, the quantities of L&YW may be sufficient to justify the use of a mass bed composting approach if space constraints are an issue at the selected site.

For all three processing facilities, it has been assumed that the L&YW windrow composting facility would be co-located with the SSO composting facility. This allows the windrow curing operation associated with the SSO composting facility to be operating in tandem with the L&YW windrow composting operation, thereby eliminating the duplication of manpower and equipment.



Surplus L&YW self-hauled to closest processing facility.

Exhibit 9-10
System Option 3A
 (2030 Quantity Projections Shown)

The capacity of the SSO and biosolids processing facility in Penticton required by this system would be substantially less than that required by System Option 2, due almost entirely to the separate collection and processing of L&YW. In this system, a processing capacity of 375 tonnes/wk would be necessary at the Penticton facility. From a technology perspective, all of the systems identified in System Option 2 would be appropriate in this situation. For the purposes of the evaluation, it has been assumed the facility would be based around the use of an enclosed ASP system.

Capacity requirements and technology for the processing facility in the Oliver/Osoyoos area would be the same as those outlined for the Princeton location in System Option 2. An agitated vessel system with a capacity of 30 tonnes/wk has been used as the basis for this facility.

The requirements for the processing facility in the Princeton area are similar to those in System Option 2, although the facility would be smaller (i.e. 10 tonnes/wk) since L&YW would be collected separately and processed in outdoor windrows.

As in System Options 1 and 2, the difference in capacity requirements between 2020 and 2030 are relatively similar, and thus all processing facilities are based on the anticipated 2030 feedstock quantities.

9.3.4 System Option 3B

9.3.4.1 L&YW and SSO

The organic waste collection and diversion programs for the residential and ICI sectors would be the same as those outlined for System Option 3A except that the materials would be directed to differing processing locations within the region as outlined below.

9.3.4.2 Biosolids

Biosolids from WWTPs in RDOS and West Kelowna would be dewatered at the respective WWTP's, and transferred to the centralized composting facility located in the Penticton area.

9.3.4.3 Wood Waste from DLC

Management programs for wood waste from DLC sources would be the same as outlined in the previous system options, including the cooperation with RDCO and RDNO. Materials would be used for a range of beneficial use options, including use as the source of amendment for composting operations.

9.3.4.4 Agricultural Waste

As with previous systems, processing capacity would be provided to manage the relatively small amounts of animal carcasses and orchard/vineyard wood wastes that are currently diverted through RDOS programs. The RDOS, in partnership with Provincial and existing Agricultural organizations, would encourage on-site composting, chipping or re-use of materials where possible rather than removal to an off-site facility. No abattoir wastes, or Specified Risk Materials (SRM) would be accepted.

9.3.4.5 Processing Facility Locations

As in the first system option, materials would be transferred to one of four composting facilities (i.e. Penticton area, Oliver/Osoyoos area, Keremeos area, and Princeton area) which are located on a "wasteshed basis close to generators.

9.3.4.6 Material Quantities and System Flow Diagram

A diagram that illustrates how organic waste would flow through this system is provided in Exhibit 9-11 along with estimated material quantities.

9.3.4.7 Processing Technologies

As outlined earlier, windrow composting is not appropriate for processing SSO and biosolids due to potential odours, nuisances, and wildlife issues. However, windrow composting would be an acceptable means of processing the L&YW materials that are collected separately from SSO.

At all four processing facilities, it has been assumed that the L&YW windrow composting facility would be co-located with the composting facilities for SSO and biosolids. This allows the windrow curing operation associated with the SSO composting facility to be operating in tandem with the L&YW windrow composting operation, thereby eliminating the duplication of manpower and equipment.

The capacity requirements and technology selection criteria for the processing facility in Penticton would be the same as those outlined for this location in System Option 3A. An enclosed ASP system with a capacity of 375 tonnes/wk has been used as the basis for this facility.

The capacity requirements and technology selection for the Oliver/Osoyoos area facility would be the same as those outlined for Princeton location in System Option 2. An agitated vessel system with a capacity of 30 tonnes/wk has been used as the basis for this facility.

The size and technology for the processing facility located in Princeton would be the same as those outlined in System Option 3A. An agitated vessel system with a capacity of 10 tonnes/wk has been used as the basis for this facility.

The capacity requirements of the processing facility in Keremeos are similar to those of the Princeton facility. However, the addition of biosolids to the feedstocks does affect the choice of technologies; the agitated vessel system assumed for Princeton cannot be used for biosolids because of the potential for the biosolids to form into balls as a result of the frequent agitation. Therefore, for the purposes of comparison, a static container system (similar to that used in Okotoks, Alberta) with a capacity of 12 tonnes/wk has been assumed as the basis for this facility.

The differences in the anticipated quantities of feedstocks diverted through this system in 2020 and 2030 are not significant. Therefore, the capacity of each of the processing facilities has been based on the anticipated feedstock quantities in 2030.

9.3.5 System Option 4

9.3.5.1 L&YW and SSO

The organic waste collection and diversion programs for the residential and ICI sectors would be the same as those outlined for System Options 3A and 3B, except that the material would be directed to differing processing locations within the region as outlined below.

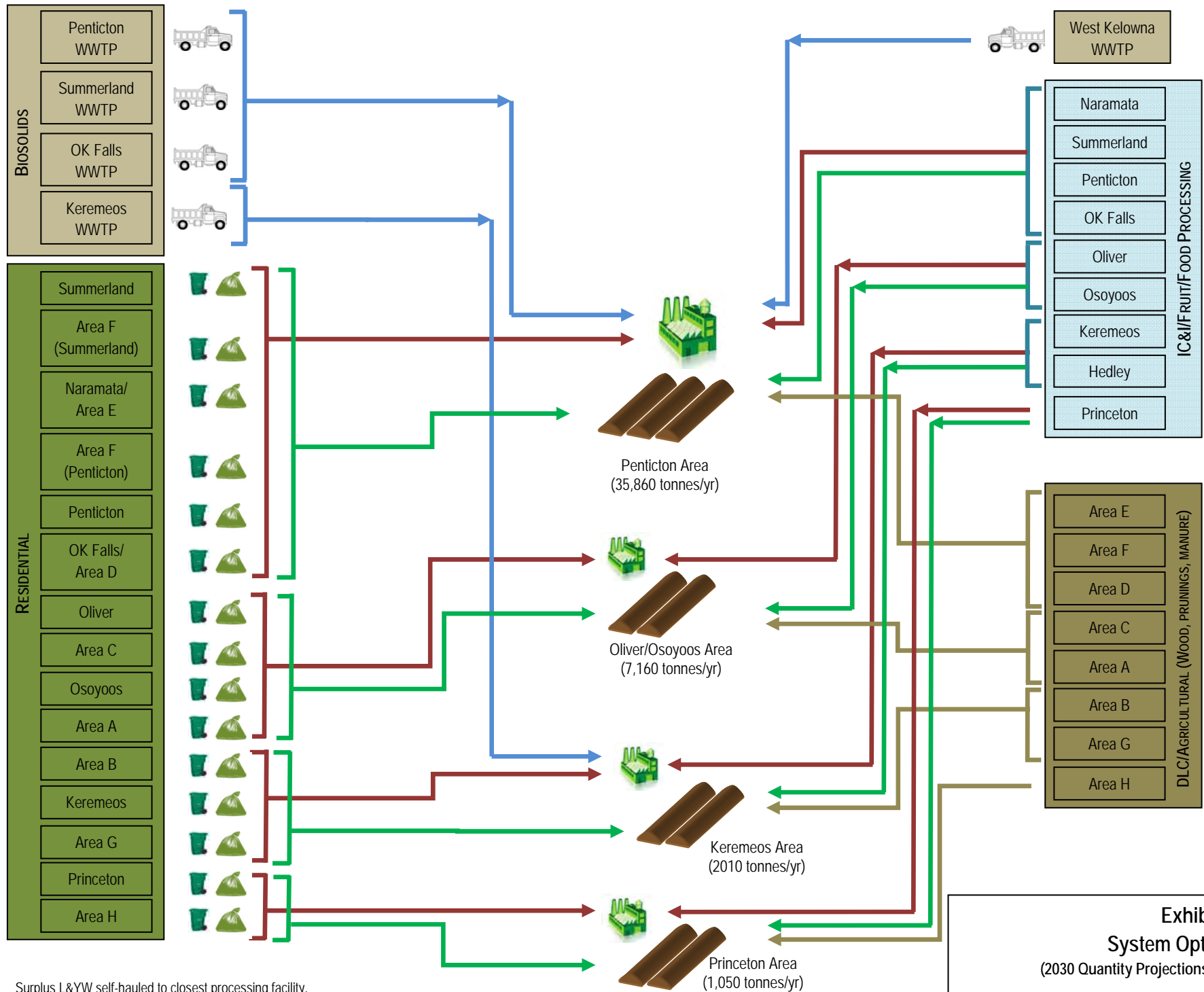


Exhibit 9-11
System Option 3B
 (2030 Quantity Projections Shown)

9.3.5.2 Biosolids

Dewatered biosolids from the WWTP's in the RDOS and West Kelowna would be transferred to the composting facility in the Penticton area for processing.

9.3.5.3 Wood Waste from DLC

As outlined previously, management programs for wood waste from DLC sources would be done in cooperation with RDCO and RDNO, and diversion would be increased through education, promotion and policy tools. Materials would be used for a range of beneficial use options, including use as the source of amendment for composting operations.

9.3.5.4 Agricultural Waste

As with previous systems, processing capacity would be provided to manage the relatively small amounts of animal carcasses and orchard/vineyard wood wastes that are currently diverted through RDOS programs. The RDOS, in partnership with Provincial and existing Agricultural organizations, would encourage on-site composting, chipping or re-use of materials where possible rather than removal to an off-site facility. No abattoir wastes, or Specified Risk Materials (SRM) would be accepted.

9.3.5.5 Processing Facility Locations

As in System Option 1, L&YW would be transferred to one of four composting facilities located close to generators (i.e. Penticton area, Oliver/Osoyoos area, Keremeos area, and Princeton area). However, SSO material from residential and ICI sources would all be transferred to a large centralized composting facility in the Penticton area where it would be co-processed with biosolids with a higher degree of control and greater operational efficiencies.

9.3.5.6 Material Quantities and System Flow Diagram

A diagram that illustrates how organic waste would flow through this system is provided in Exhibit 9-12. Exhibit 9-12 also contains the assumed material quantities that would be managed through this system.

9.3.5.7 Processing Technologies

Windrow composting is not appropriate for processing SSO and biosolids due to potential odours, nuisances, and wildlife issues. However, windrow composting would be an acceptable means of processing the L&YW materials that are collected separately from the SSO. Therefore, at all four processing facilities, it has been assumed that the L&YW would be composted in windrows.

In the case of the Penticton and Princeton facilities, it has been further assumed that the windrow composting facility would be co-located with the SSO/biosolids composting facilities to **allow** for sharing of manpower and equipment.

The requirements and the choice of processing technology for the Penticton processing facility would be similar to those outlined in System Option 3A. The only significant difference is that the processing facility's capacity would be slightly larger (i.e. 410 tonnes/wk) to account for it accepting SSO from the Oliver and Osoyoos area.

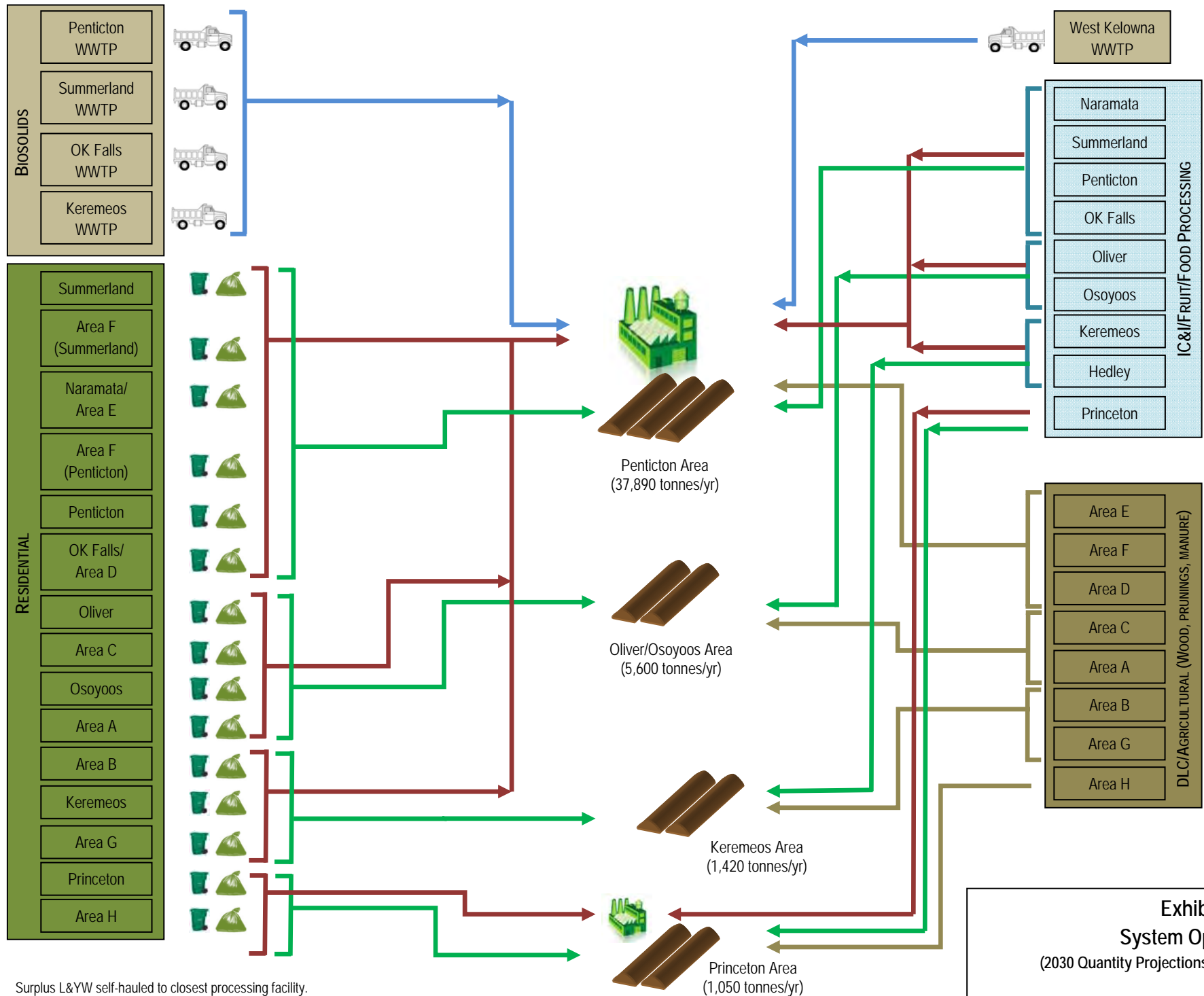


Exhibit 9-12
System Option 4
 (2030 Quantity Projections Shown)

The capacity and technology selection for the processing facility in Princeton would be the same as those outlined for this location in System Option 3A (i.e. agitated vessel system with a capacity of 10 tonnes/wk).

As in all of the preceding systems, the differences in processing capacity requirements at each location between 2020 and 2030 are insignificant. Thus the size of all processing facilities has been based on the anticipated 2030 feedstock quantities.

10 Analysis of Regional Organic Waste System Options

The five system options outlined in the previous chapter were jointly developed by RDOS and CH2M HILL to test the implications of various different methods of material collection and processing, and different locations for material processing. In all options, facilities would accept material from residential and ICI sources, and agricultural wastes currently accepted at RDOS composting facilities.

The key features of the five system options (highlighting residential collection methods) include:

- **System Option 1:** Retain existing leaf and yard waste (L&YW) system, increasing collection frequency to seasonal, bi-weekly collection and establishment of centralized outdoor biosolids composting in the greater Penticton area; no collection of source separated organics (SSO).
- **System Option 2:** Weekly collection of L&YW combined with SSO in a 240 L rolling cart, bi-weekly garbage collection, enclosed L&YW/SSO processing facilities in Oliver/Osoyoos and Princeton, and L&YW/SSO/biosolids composting in the greater Penticton area (which would also take material from Keremeos).
- **System Option 3A:** Seasonal bi-weekly collection of L&YW, weekly collection of SSO in a 45 L bin, and bi-weekly garbage collection. Windrow composting of L&YW and enclosed composting of SSO in Oliver/Osoyoos and Princeton. Windrow composting of L&YW and enclosed composting of SSO and biosolids in the greater Penticton area (which would also take material from Keremeos).
- **System Option 3B:** Same as Option 3A with an additional facility for windrow composting of L&YW and enclosed composting of SSO and biosolids at Keremeos (rather than transporting that material to the Penticton facility)
- **System Option 4:** Same collection system as Option 3A. Windrow composting facilities for L&YW in Penticton, Keremeos, Oliver/Osoyoos, and Princeton. All SSO and biosolids would be transported to the Penticton facility, except for a small enclosed SSO composting facility in Princeton.

The system options were evaluated by CH2M HILL using a multi-objective decision analysis (MODA) process to determine the most appropriate option(s). This chapter presents the results of the MODA analysis.

10.1 Land Requirements

Each of the system options considered in the analysis consists of three or more processing facilities of varying sizes. In many cases, the processing facilities consist of both enclosed composting operations for biosolids and SSO, and outdoor windrow operations for L&YW. One of the assumptions in this project was that the enclosed and outdoor facilities would be co-located on the same property to allow for efficiencies in equipment utilization and site development.

The land requirements for the various processing facilities will affect the evaluation of the systems. A summary of the land requirements are contained in Exhibit 10-1.

EXHIBIT 10-1
Processing Facility Land Requirements (m²)

	Penticton	Oliver/ Osoyoos	Keremeos	Princeton	Total
System Option 1					
Biosolids (No SSO)	27,000				
L&YW	60,000	34,000	9,300	4,200	
Total	87,000	34,000	9,300	4,200	134,500
System Option 2					
SSO, Biosolids and L&YW	55,000	23,000		9,000	
Total	55,000	23,000		9,000	87,000
System Option 3A					
SSO & Biosolids	30,000	7,200		5,500	
L&YW	81,750	42,000		5,200	
Total	111,750	49,200		10,700	171,650
System Option 3B					
SSO & Biosolids	30,000	7,200	300	5,500	
L&YW	75,000	42,000	11,000	5,200	
Total	105,000	49,200	11,300	10,700	176,200
System Option 4					
SSO & Biosolids	30,000			5,500	
L&YW	75,000	42,000	11,000	5,200	
Total	105,000	42,000	11,000	10,700	168,700

Note:

A. Does not include buffer zones or setback areas as required by OMRR and industry best-management practices.

10.2 Cost Estimates

Each of the organic waste systems developed for this study include the organic waste collection and processing components. Order-of-magnitude cost estimates for facility development and operations, and collection programs, have been developed for each of the system options. Unless specifically noted, it has been assumed that waste collection and recycling services, and landfill operations, will continue to be operated as they are currently.

10.2.1 Summary Costs

The estimated annual cost of the system options is shown in Exhibit 10-2. The per-tonne cost of processing materials is shown in Exhibit 10-3.

The costs shown in Exhibit 10-2 include three main components: Construction and equipment costs (annualized at a 5% interest rate and 15-year term), annual facility operations and maintenance costs, and added material collection costs. They do not include the costs associated with acquisition of land to host the processing facilities.

EXHIBIT 10-2
Summary Cost Estimates of System Options

	Total Facility Capital Cost	Annualized Capital Cost	Annual O&M Cost	Added Annual Collection Cost	Total Annual Cost
System Option 1					
Biosolids (No SSO)	\$7,500,000	\$722,600	\$366,000	n.a.	n.a.
L&YW	\$9,780,000	\$942,200	\$355,000	n.a.	n.a.
Total	\$17,280,000	\$1,664,800	\$721,000	\$1,200,000	\$3,585,800
System Option 2					
SSO, Biosolids and L&YW	\$54,750,000	\$5,274,700	\$2,105,000	\$5,800,000	\$13,179,700
System Option 3A					
SSO & Biosolids	\$27,175,000	\$2,618,100	\$916,000	n.a.	n.a.
L&YW	\$11,435,000	\$1,101,700	\$272,000	n.a.	n.a.
Total	\$38,610,000	\$3,719,800	\$1,188,000	\$2,900,000	\$7,807,800
System Option 3B					
SSO & Biosolids	\$30,175,000	\$2,907,100	\$1,075,000	n.a.	n.a.
L&YW	\$11,825,000	\$1,139,200	\$348,000	n.a.	n.a.
Total	\$42,000,000	\$4,046,300	\$1,423,000	\$2,900,000	\$8,369,300
System Option 4					
SSO & Biosolids	\$30,175,000	\$2,907,100	\$765,000	n.a.	n.a.
L&YW	\$11,825,000	\$1,139,200	\$373,000	n.a.	n.a.
Total	\$42,000,000	\$4,046,300	\$1,138,000	\$2,900,000	\$8,084,300

Facility capital costs based on 2030 design year. All costs shown are in 2010 dollars.

Does not include the cost of transporting biosolids to a central facility, estimated to be \$197,000 for Options 1,2,3A,4 and \$187,000 for Option 3B.

Source: CH2M HILL

There are two financial benefits associated with the system options that may occur that are outside the scope of this study: extending the life of RDOS landfills; and the potential for lower landfill operations costs.

Because the system options would divert waste from landfills, implementing them would extend landfill capacity in the RDOS beyond what it would be if an option was not implemented. Extending the life of landfills has two main financial benefits: first, it can reduce the amount of funds that must be set aside for landfill closure and post-closure. This would result in lower costs to the RDOS assuming the RDOS can invest closure and post-closure funds at an interest rate that is higher than the rate of inflation: if so, extending costs into the future lowers what must be collected today to pay for future closure and post-closure costs. Second, it extends the date at which landfills must be expanded or waste must be trucked to more distant landfills, which are fairly certain to be more expensive options than sending waste to existing landfills in the RDOS.

EXHIBIT 10-3
Estimated Annual Processing Costs, 2010\$ per tonne

	Annualized Capital	O&M	Total
System Option 1			
Biosolids (No SSO)	\$60.32	\$30.55	\$90.87
L&YW	\$54.37	\$20.48	\$74.85
Total	\$56.80	\$24.60	\$81.40
System Option 2			
SSO, Biosolids and L&YW	\$125.02	\$49.89	\$174.92
System Option 3A			
SSO & Biosolids	\$139.93	\$48.96	\$188.89
L&YW	\$49.43	\$12.20	\$61.63
Total	\$90.73	\$28.98	\$119.70
System Option 3B			
SSO & Biosolids	\$155.46	\$57.49	\$212.95
L&YW	\$51.11	\$15.61	\$66.72
Total	\$98.71	\$34.72	\$133.43
System Option 4			
SSO & Biosolids	\$155.46	\$40.91	\$196.37
L&YW	\$51.11	\$16.73	\$67.84
Total	\$98.71	\$27.76	\$126.48

Facility capital costs based on 2030 design year. All costs shown are in 2010 dollars.

Source: CH2M HILL

There can be opportunity to lower annual landfill operations costs by composting waste organics. However, most landfill operations and maintenance costs don't change substantially with relatively small reductions in input tonnages. The quantity of waste diverted from landfill in the system options would probably result in very small landfill operations and maintenance costs savings, if any savings at all could be achieved.

10.2.2 Compost Facility Capital Cost Estimates

The capital costs of the organics waste processing facilities and the processing technology used as a basis for costing of the system options are presented in Exhibit 10-4. The costs shown are summaries of order-of-magnitude opinions of cost (Class 5 estimates) for each facility. As indicated the facilities are designed for 2030 tonnes and all costs are in 2010 dollars.

Operations and maintenance costs for each facility (based on 2010 tonnes and in 2010 dollars) are shown in Exhibit 10-5. These costs are based on actual operating costs of similar facilities, adjusted for specific conditions likely to be encountered in the RDOS.

The capital and operating costs could vary significantly from those shown depending on a variety of factors such as competitive bidding climate, material price inflation, contractual details, and risk sharing provisions.

EXHIBIT 10-4
System Option Capital Cost Estimates

	Penticton	Oliver/ Osoyoos	Keremeos	Princeton	Total
System Option 1					
Biosolids (No SSO)	Outdoor ASP \$7,500,000				\$7,500,000
L&YW	Windrow \$5,600,000	Windrow \$3,000,000	Windrow \$800,000	Windrow \$380,000	\$9,780,000
Total	\$13,100,000	\$3,000,000	\$800,000	\$380,000	\$17,280,000
System Option 2					
SSO, Biosolids and L&YW	Enclosed ASP	Enclosed ASP	n.a.	Agitated Vessel	
Total	\$36,000,000	\$12,500,000		\$6,250,000	\$54,750,000
System Option 3A					
SSO & Biosolids	Enclosed ASP \$17,300,000	Agitated Vessel \$6,250,000	n.a.	Agitated Vessel \$3,625,000	\$27,175,000
L&YW	Windrow \$7,300,000	Windrow \$3,675,000	n.a.	Windrow \$460,000	\$11,435,000
Total	\$24,600,000	\$9,925,000	\$0	\$4,085,000	\$38,610,000
System Option 3B					
SSO & Biosolids	Enclosed ASP \$17,300,000	Agitated Vessel \$6,250,000	Static Container \$3,000,000	Agitated Vessel \$3,625,000	\$30,175,000
L&YW	Windrow \$6,775,000	Windrow \$3,675,000	Windrow \$915,000	Windrow \$460,000	\$11,825,000
Total	\$24,075,000	\$9,925,000	\$3,915,000	\$4,085,000	\$42,000,000
System Option 4					
SSO & Biosolids	Enclosed ASP \$17,300,000	n.a.	n.a.	Agitated Vessel \$3,625,000	\$20,925,000
L&YW	Windrow \$6,775,000	Windrow \$3,675,000	Windrow \$915,000	Windrow \$460,000	\$11,825,000
Total	\$24,075,000	\$3,675,000	\$915,000	\$4,085,000	\$32,750,000

Order of magnitude (Class 5) opinions of cost for construction and equipment, 2030 design year, 2010\$
Source: CH2M HILL.

EXHIBIT 10-5
System Option Operations and Maintenance Cost Estimates

	Penticton	Oliver/ Osoyoos	Keremeos	Princeton	Total
System Option 1					
Biosolids (No SSO)	\$366,000				\$366,000
L&YW	\$115,000	\$89,000	\$92,000	\$59,000	\$355,000
Total	\$481,000	\$89,000	\$92,000	\$59,000	\$721,000
System Option 2					
SSO, Biosolids and L&YW					
Total	\$1,412,000	\$457,000		\$236,000	\$2,105,000
System Option 3A					
SSO & Biosolids	\$618,000	\$151,000		\$147,000	\$916,000
L&YW	\$146,000	\$71,000		\$55,000	\$272,000
Total	\$764,000	\$222,000	\$0	\$202,000	\$1,188,000
System Option 3B					
SSO & Biosolids	\$618,000	\$151,000	\$159,000	\$147,000	\$1,075,000
L&YW	\$137,000	\$71,000	\$85,000	\$55,000	\$348,000
Total	\$755,000	\$222,000	\$244,000	\$202,000	\$1,423,000
System Option 4					
SSO & Biosolids	\$618,000			\$147,000	\$765,000
L&YW	\$137,000	\$89,000	\$92,000	\$55,000	\$373,000
Total	\$755,000	\$89,000	\$92,000	\$202,000	\$1,138,000

Based on actual operating costs of similar facilities, adjusted for specific conditions likely to be encountered in the RDOS, with estimated 2010 tonnes with costs in 2010\$.

Does not include the cost of transporting biosolids to a central facility, estimated to be \$ 197,000 for Options 1,2,3A,4 and \$187,000 for Option 3B.

Source: CH2M HILL.

10.2.3 Collection Cost Estimates

Implementing any of the organic waste options will require policy changes to encourage, perhaps mandate, and enforce behavioural change and will result in increased collection costs. While a detailed analysis of collection programs in the RDOS is beyond the scope of this analysis, a high-level investigation of collection costs was conducted to provide a general indication of the magnitude of impacts to collection systems in the region and to residential households. The added collection cost that would be experienced by ICI waste sector establishments was not estimated.

Estimated increases in residential collection costs that would be required to implement the system options are shown in Exhibit 10-6. Costs are shown as annual costs and on the basis of \$ per household per month. Assumptions and observations about these estimates include:

- The collection methods and frequencies shown are just one way to collect material for each option. Other arrangements are certainly possible. Existing collection operations and factors affecting collection in the RDOS were considered when preparing these estimates.

EXHIBIT 10-6

Estimated Collection Cost for System Options (2010\$)

Background Data							
Residential collection cost per stop ^a	\$1.55						
Number of singlefamily households ^b	35,100						
Total Residential Collection Cost (\$m)	\$2.8						
Estimated annualized cost per cart per stop ^c							
45-litre	\$0.10						
240-litre	\$0.24	System Option					
		1. Bi-Weekly L&YW Collection, No SSO Facilities	2. Combined Collection, Multiple SSO Facilities	3A. Slip Stream Collection, Multiple SSO Facilities	3B. Option 3A Plus SSO Facility in Keremeos	4. Slip Stream Collection, Regional SSO Facility in Penticton	
	Existing System						
L&YW							
Receptacle	Bags	Bags	n.a.	Bags	Bags	Bags	
Frequency (stops per year)	6	15	n.a.	15	15	15	
SSO							
Receptacle	n.a.	n.a.	n.a.	45-l cart	45-l cart	45-l cart	
Frequency (stops per year)	n.a.	n.a.	n.a.	52	52	52	
Combined L&YW/SSO							
Receptacle	n.a.	n.a.	240-l cart	n.a.	n.a.	n.a.	
Frequency (stops per year)	n.a.	n.a.	52	n.a.	n.a.	n.a.	
Added stops beyond existing system	0	9	46	9	9	9	
Percent of current per-stop cost for added stops	n.a.	100%	80%	100%	100%	100%	
Added cost of existing split-truck routes ^d	n.a.	n.a.	n.a.	20%	20%	20%	
Annual Cost							
Collection (\$m)	\$0.0	\$0.5	\$2.0	\$1.1	\$1.1	\$1.1	
Carts (\$m)	\$0.0	\$0.0	\$0.4	\$0.2	\$0.2	\$0.2	
Total Annual Cost (\$million)	\$0.0	\$0.5	\$2.4	\$1.2	\$1.2	\$1.2	
Total Cost per household per month	\$0.00	\$1.20	\$5.80	\$2.90	\$2.90	\$2.90	

^aCH2M HILL analysis of data provided by RDO-S.

^bSource: BC Stats.

^cFrom recent bids, adjusted for specific RDOS conditions.

^dCurrently recycling is bi-weekly; add 20% to Options 3A, 3B, and 4 because both compartments of split-truck would be filled weekly.

n.a. means not applicable.

Source: CH2M HILL unless otherwise noted.

- The estimated increase in collection costs was estimated by calculating the number of additional stops per year, then multiplying the number of stops times the current cost per stop times a percent of the current cost per stop that considers whether or not the new stops would be likely to be more or less costly than current stops. Added to this is the estimated cost for carts, amortized over 7 years at 5 percent interest.
- Option 2 assumes that two trucks would be required: one for combined L&YW/SSO and a second that collects garbage one week and recycling the next week. Penticton would either change to bi-weekly recycling or add additional collection capacity.
- Options 3 and 4 assume two trucks: one split truck collecting SSO weekly in one compartment with garbage one week and recycling the next week in the other compartment. A second truck would be used for seasonal L&YW collection. Penticton would change to bi-weekly recycling or add additional collection capacity.

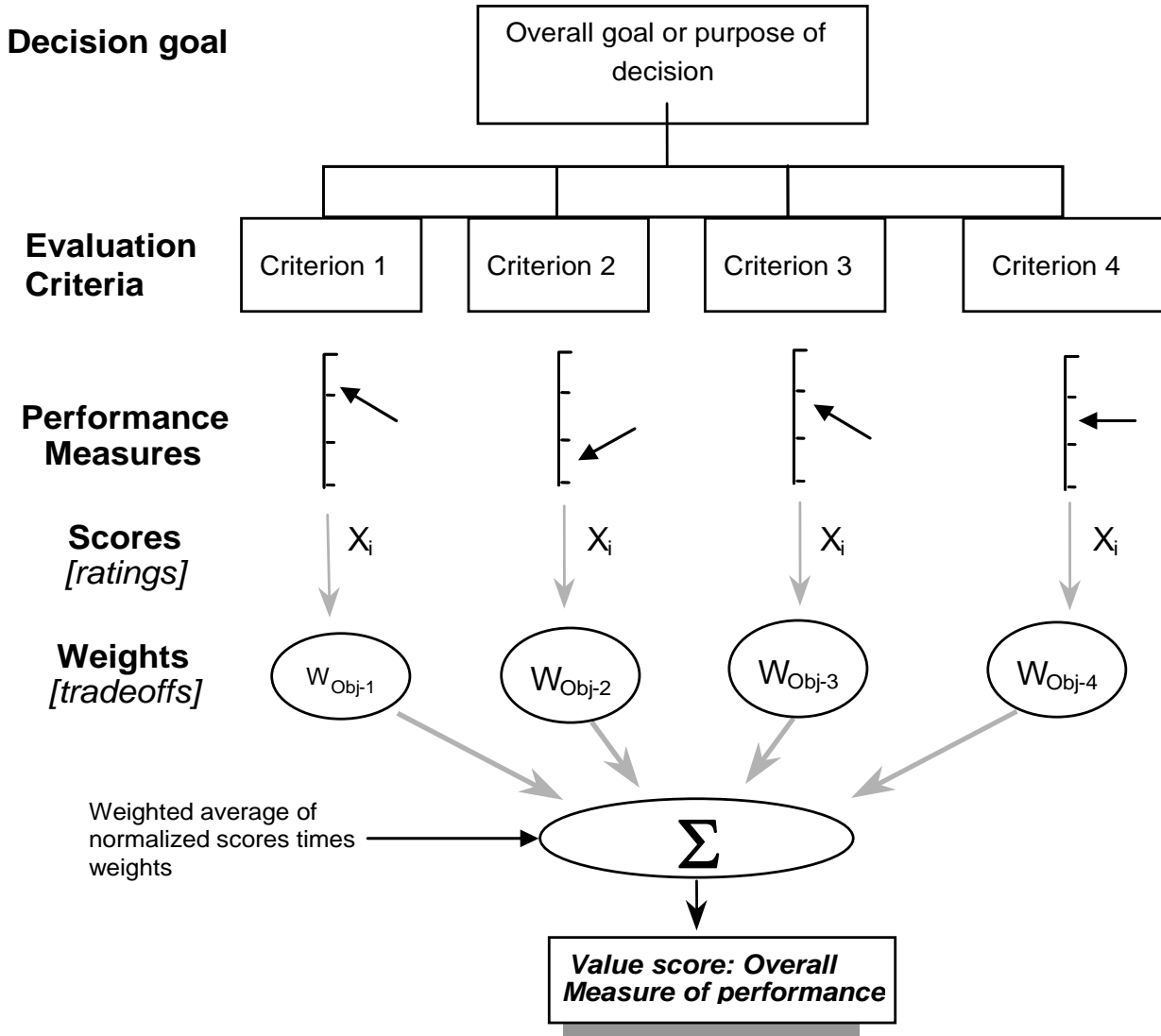
10.3 Multi-Objective Decision Analysis

The triple bottom line (environment, social, and financial) of the system options was assessed using multi-objective decision analysis (MODA), which is also known as multi-criteria decision analysis. The specific technique used is called SMARTS, the Simple Multi-Attribute Rating Technique with Swings. This quantitative technique supports decision-making that involves multiple financial, environmental, and social objectives and is based on the principles of multi-attribute utility theory (Keeney, et al, 1976). MODA proceeds through a series of defined steps, illustrated in Exhibit 10-7, and include:

1. Establish the decision goal.
2. Identify and specify objectives (evaluation criteria).
3. Develop performance measures to assess project performance against objectives.
4. Add technical detail to the performance measures, and assign scores to the performance measures.
5. Assign weights to the objectives.
6. Score options.
7. Normalize scores and weights to calculate total value scores.
8. Conduct sensitivity analysis.

These steps are discussed in further detail in the following sections.

EXHIBIT 10-7
Generalized Representation of Multi-Objective Decision Analysis



(See text for discussion of the figure. X_i represents the score of alternative "i" on the given objective. Weights are the relative importance assigned to each objective. Σ is the rule for aggregating scores.)

10.3.1 Decision Goal

The decision goal is the overall purpose of this evaluation, or the decision that is to be made. In this analysis, the decision goal is to:

Recommend a regional organic waste management system for the RDOS that: improves diversion of organic wastes from area landfills and thereby reduces associated green house gas emissions and leachate, increases the value of organic waste, and creates quality soil amendments for local agriculturists and home owners.

10.3.2 Evaluation Criteria

There are typically a series of criteria that must be met to achieve the decision goal. Those criteria, or objectives, can be classified into a hierarchical structure where a main criterion might have a series of subcriteria. The main criteria are the singular factors that are most important to achieving the decision goal. Then, there are attributes of each main criterion that define or operationalize that criterion and are referred to as subcriteria. The set of criteria and subcriteria are then combined into a set of evaluation criteria for the analysis. Exhibit 10-8 presents the evaluation criteria for this analysis.

The evaluation criteria for this project were initially proposed by the consultant team, and then refined during a workshop and subsequent discussions with RDOS staff and members of the stakeholder committee.

10.3.2.1 Performance Measures and Scoring

Once the criteria are fully developed, performance measures are required to determine how well alternatives perform against the objectives. Performance measures may be quantitative or qualitative, depending upon the objective and the availability of data for each measure. For this analysis, a mix of quantitative and qualitative measures was used, as shown in Exhibit 10-9. The scores assigned to each criterion for each option is shown in Exhibit 10-10, and the rationale for the qualitative scores is shown in Exhibit 10-11.

Rating or scoring alternatives is the process by which the performance scales are applied to the alternatives. Each alternative is scored to determine the extent to which that alternative meets each objective. After scoring, each performance measure is normalized to a scale of 0 to 1 by a linear transformation of each score according to its distance from the scale endpoints. For example, to normalize a criterion with a “worst” outcome of 1 and a “best” outcome of 5 to a 0-to-1 scale, the 5 outcome would be assigned a score of 1 on the normalized scale; 1 would be assigned a score of 0; and 3 would be assigned a score of 0.5. This means that increasing a score from 1 to 3 is as important as increasing a score from 3 to 5: both incremental changes are of equivalent value. (Note that scales can also be nonlinear when changes along the scale have different degrees of importance; however, in this analysis, all of the scales were assumed to be linear.)

EXHIBIT 10-8
Evaluation Criteria for System Options

I. Minimize Long-term Life Cycle Cost (including capital, maintenance, replacement, operating, and revenues from compost)

II. Maximize non-monetary value resulting from alternatives

A. Minimize Environmental Impacts or Benefits

1. Protect air from pollution
 - a. Minimize air pollution from vehicles and equipment (PM10, NOx) or other sources
 - b. Minimize greenhouse gas emissions (CO2e) generated from collection, process/operation, or end use materials
2. Protect water resources
 - a. Minimize the use of clean water as a process input
 - b. Maximize process water reuse
 - c. Maximize the quality of effluents
3. Protect and enhance land resources
 - a. Minimize the amount of land required for processing facilities
 - b. Preserve greenfields
 - c. Protect sensitive habitats
 - d. Preserve ALR zoning

B. Minimize Socioeconomic Impacts on RDOS Residents and Businesses

1. Minimize the negative effects of traffic
2. Minimize the proximity impacts of processing infrastructure on neighbours (noise, vectors/animals, odours, litter, dust)
3. Minimize the visual impacts of process infrastructure on neighbours
4. Minimize the traffic impacts of process infrastructure on neighbours
5. Ease of use for customers

C. Maintain Flexibility

1. Adaptability of system to change (modularity, staged development, expansion, future technologies, regulatory change)
2. Promotes operational resilience (e.g., if one component breaks down, you can still operate, speed of repairs)
3. Maximum product diversification
4. Maximizes Class A compost

D. Achieve Simplicity and Safety during Operations and Maintenance

1. Relatively easy to operate, thus ensuring operating labour continuity and a "clean house"
 2. Relatively easy to maintain, thus ensuring maintenance labour continuity
 3. System's inherent operational safety (i.e. are there more inherent risks in one system that you have to control through administrative/operation controls (vs engineering controls)
-

EXHIBIT 10-9
Performance Measures

Evaluation Criteria	Performance Measures
I. Minimize Long-term Life Cycle Cost (including capital, maintenance, replacement, operating, and revenues from compost)	Estimated annual costs in 2010 dollars
II. Maximize non-monetary value resulting from alternatives	
A. Minimize Environmental Impacts or Benefits	
1. Protect air from pollution a. Minimize air pollution from vehicles and equipment (PM10, NOx) or other sources	1-5 scale for minimizing air pollution
b. Minimize greenhouse gas emissions (CO ₂ e) generated from collection, process/operation, or end use materials	1-5 scale for minimizing greenhouse gas emissions
2. Protect water resources	
a. Minimize the use of clean water as a process input	1-5 scale for added process water requirements
b. Maximize process water reuse	1-5 scale for economical water reuse
c. Maximize the quality of effluents	1-5 scale for changes in effluent water quality
3. Protect and enhance land resources	
a. Minimize the amount of land required for processing facilities	Additional land required (hectares)
b. Preserve greenfields	Additional greenfield land required (hectares)
c. Protect sensitive habitats	Number of new greenfield sites required
d. Preserve ALR zoning	Number of new greenfield sites required
B. Minimize Socioeconomic Impacts on RDOS Residents and Businesses	
1. Minimize the negative effects of traffic	1-5 scale reflecting additional trucking of material on roads within the RDOS
2. Minimize the proximity impacts of processing infrastructure on neighbours (noise, vectors/animals, odours, litter, dust)	1-5 scale for extent of sensitive receptors near sites and the nature of on-site activities
3. Minimize the visual impacts of process infrastructure on neighbours	1-5 scale for likelihood of visual impacts from facilities
4. Minimize the traffic impacts of process infrastructure on neighbours	Number of new facilities
5. Ease of use for customers	1-5 scale reflecting ease of use for residential and ICI customers
C. Maintain Flexibility	
1. Adaptability of system to change (modularity, staged development, expansion, future technologies, regulatory change)	1-5 scale for adaptability to change
2. Promotes operational resilience (e.g., if one component breaks down, you can still operate, speed of repairs)	1-5 scale for reducing likelihood of major failure or difficulty in obtaining parts
3. Maximum product diversification	1-5 scale for the ability to produce many types of products
4. Maximizes Class A compost	1-5 scale for ability to produce Class A compost
D. Achieve Simplicity and Safety during Operations and Maintenance	
1. Relatively easy to operate, thus ensuring operating labour continuity and a "clean house"	1-5 scale for operational ease
2. Relatively easy to maintain, thus ensuring maintenance labour continuity	1-5 scale for maintenance ease
3. System's inherent operational safety (i.e. are there more inherent risks in one system that you have to control through administrative/operation controls (vs engineering controls)	1-5 scale for inherent operational safety

EXHIBIT 10-10
Scores for Criteria

		Scores				
		1	2	3A	3B	4
Evaluation Criteria	Performance Measure	Bi-Weekly L&YW Collection, No SSO Facilities	Combined Collection, Multiple SSO Facilities	Slip Stream Collection, Multiple SSO Facilities	Option 3A Plus SSO Facility in Keremeos	Slip Stream Collection, Regional SSO Facility in Penticton
I. Minimize Long-term Life Cycle Cost (including capital, maintenance, replacement, operating, and revenues from compost)	Estimated annual costs in millions of 2010 dollars	\$3.586	\$13.180	\$7.808	\$8.369	\$8.084
II. Maximize non-monetary value resulting from alternatives						
A. Minimize Environmental Impacts or Benefits						
1. Protect air from pollution						
	a. Minimize air pollution from vehicles and equipment (PM10, NOx) or other sources	1-5 scale for minimizing air pollution	5	1	2	2
	b. Minimize greenhouse gas emissions (CO2e) generated from collection, process/operation, or end use materials	1-5 scale for minimizing greenhouse gas emissions	1	5	5	5
2. Protect water resources						
	a. Minimize the use of clean water as a process input	1-5 scale for added process water requirements	2	4	4	4
	b. Maximize process water reuse	1-5 scale for economical water reuse	3	3	3	3
	c. Maximize the quality of effluents	1-5 scale for changes in effluent water quality	4	2	2	2
3. Protect and enhance land resources						
	a. Minimize the amount of land required for processing facilities	Additional land required (hectares)	13.5	8.7	17.1	17.6
	b. Preserve greenfields	Additional greenfield land required (hectares)	9.3	7.8	16	16.5
	c. Protect sensitive habitats	Number of new greenfield sites required	3	2	2	3
	d. Preserve ALR zoning	Number of new greenfield sites required	3	2	2	3
B. Minimize Socioeconomic Impacts on RDOS Residents and Businesses						
	1. Minimize the negative effects of traffic	1-5 scale reflecting additional trucking of material on roads within the RDOS	3	3	3	3
	2. Minimize the proximity impacts of processing infrastructure on neighbours (noise, vectors/animals, odours, litter, dust)	1-5 scale for extent of sensitive receptors near sites and the nature of on-site activities	2	5	3	3
	3. Minimize the visual impacts of process infrastructure on neighbours	1-5 scale for likelihood of visual impacts from facilities	2	5	3	3
	4. Minimize the traffic impacts of process infrastructure on neighbours	Number of new facilities	4	3	3	4
	5. Ease of use for customers	1-5 scale reflecting ease of use for residential and ICI customers	5	3	1	1
C. Maintain Flexibility						
	1. Adaptability of system to change (modularity, staged development, expansion, future technologies, regulatory change)	1-5 scale for adaptability to change	5	2	2	2
	2. Promotes operational resilience (e.g., if one component breaks down, you can still operate, speed of repairs)	1-5 scale for reducing likelihood of major failure or difficulty in obtaining parts	5	4	4	4
	3. Maximum product diversification	1-5 scale for the ability to produce many types of products	3	3	5	5
	4. Maximizes Class A compost	1-5 scale for ability to produce Class A compost	2	4	2	2
D. Achieve Simplicity and Safety during Operations and Maintenance						
	1. Relatively easy to operate, thus ensuring operating labour continuity and a "clean house"	1-5 scale for operational ease	5	2.5	2	2
	2. Relatively easy to maintain, thus ensuring maintenance labour continuity	1-5 scale for maintenance ease	5	2.5	2	2
	3. System's inherent operational safety (i.e. are there more inherent risks in one system that you have to control through administrative/operation controls (vs engineering controls)	1-5 scale for inherent operational safety	5	3	3	3

EXHIBIT 10-11
Rationale for Scores

Evaluation Criteria	Rationale				
	1	2	3A	3B	4
	Bi-Weekly L&YW Collection, No SSO Facilities	Combined Collection, Multiple SSO Facilities	Slip Stream Collection, Multiple SSO Facilities	Option 3A Plus SSO Facility in Keremeos	Slip Stream Collection, Regional SSO Facility in Penticton
I. Minimize Long-term Life Cycle Cost (including capital, maintenance, replacement, operating, and revenues from compost)					
II. Maximize non-monetary value resulting from alternatives					
A. Minimize Environmental Impacts or Benefits					
1. Protect air from pollution					
a. Minimize air pollution from vehicles and equipment (PM10, NOx) or other sources	Only 9 new yard waste stops per hh per year	The most added fuel use of all options because of combined L&YW/food collection	9 new yard waste stops per hh per year and some added miles to existing split truck routes	9 new yard waste stops per hh per year and some added miles to existing split truck routes	9 new yard waste stops per hh per year and some added miles to existing split truck routes
b. Minimize greenhouse gas emissions (CO2e) generated from collection, process/operation, or end use materials	No new food waste diversion	Food waste compost provides significant benefits - substantially more than the added GHG emission from required collection	Food waste compost provides significant benefits - substantially more than the added GHG emission from required collection	Food waste compost provides significant benefits - substantially more than the added GHG emission from required collection	Food waste compost provides significant benefits - substantially more than the added GHG emission from required collection
2. Protect water resources					
a. Minimize the use of clean water as a process input	Small increase from current system because of added L&YW composting	Small reduction compared to Option 1 because of the moisture included in food	Small reduction compared to Option 1 because of the moisture included in food	Small reduction compared to Option 1 because of the moisture included in food	Small reduction compared to Option 1 because of the moisture included in food
b. Maximize process water reuse	No significant difference between alternatives	No significant difference between alternatives	No significant difference between alternatives	No significant difference between alternatives	No significant difference between alternatives
c. Maximize the quality of effluents	L&YW results in lower strength effluent than SSO	SSO results in higher strength effluent than L&YW	SSO results in higher strength effluent than L&YW	SSO results in higher strength effluent than L&YW	SSO results in higher strength effluent than L&YW
3. Protect and enhance land resources					
a. Minimize the amount of land required for processing facilities	n.a.	n.a.	n.a.	n.a.	n.a.
b. Preserve greenfields	n.a.	n.a.	n.a.	n.a.	n.a.
c. Protect sensitive habitats	n.a.	n.a.	n.a.	n.a.	n.a.
d. Preserve ALR zoning	n.a.	n.a.	n.a.	n.a.	n.a.
B. Minimize Socioeconomic Impacts on RDOS Residents and Businesses					
1. Minimize the negative effects of traffic	Insignificant number of new trucks on road in RDOS				
2. Minimize the proximity impacts of processing infrastructure on neighbours (noise, vectors/animals, odours, litter, dust)	Biosolids and all L&YW processed outdoors	All processing is indoors	L&YW processed outdoors and multiple SSO facilities	L&YW processed outdoors and multiple SSO facilities	L&YW processed outdoors; only one SSO facility
3. Minimize the visual impacts of process infrastructure on neighbours	Outdoor processing activities considered to be the most likely for negative visual impacts and fewer enclosed SSO facilities is preferred (scored same as B.2.)				
4. Minimize the traffic impacts of process infrastructure on neighbours	Prior to identifying sites, potential for traffic impacts assumed to be related to number of facilities required				
5. Ease of use for customers	Same as existing with added weeks of yard waste collection	Move to bi-weekly garbage will require behaviour change; rolling cart likely to be positively received by most	Move to bi-weekly garbage and separate food collection will require behaviour change	Combined easier than separate. Option 1 is easiest	Combined easier than separate. Option 1 is easiest
C. Maintain Flexibility					
1. Adaptability of system to change (modularity, staged development, expansion, future technologies, regulatory change)	Relatively little capital investment, thus highly adaptable and modular	Commitment made to sophisticated indoor processing facilities could preclude move to anaerobic digestion or other technologies for SSO	Commitment made to sophisticated indoor processing facilities could preclude move to anaerobic digestion or other technologies for SSO	Commitment made to sophisticated indoor processing facilities could preclude move to anaerobic digestion or other technologies for SSO	Commitment made to sophisticated indoor processing facilities could preclude move to anaerobic digestion or other technologies for SSO
2. Promotes operational resilience (e.g., if one component breaks down, you can still operate, speed of repairs)	Very few moving parts beyond front end loader	Very few moving parts that could be difficult to replace and very unlikely that major failure would result	Very few moving parts that could be difficult to replace and very unlikely that major failure would result	Very few moving parts that could be difficult to replace and very unlikely that major failure would result	Very few moving parts that could be difficult to replace and very unlikely that major failure would result
3. Maximum product diversification	Potential for biosolids and L&YW product	Potential for biosolids and mixed L&YW/SSO product	Potential for biosolids, L&YW, and SSO products	Potential for biosolids, L&YW, and SSO products	Potential for biosolids, L&YW, and SSO products
4. Maximizes Class A compost	Pathogens, metals, maturity, organic compounds a function of feedstock not processing method	Fewer plastic bags than other options; Pathogens, metals, maturity, organic compounds a function of feedstock not processing method	Pathogens, metals, maturity, organic compounds a function of feedstock not processing method	Pathogens, metals, maturity, organic compounds a function of feedstock not processing method	Pathogens, metals, maturity, organic compounds a function of feedstock not processing method
D. Achieve Simplicity and Safety during Operations and Maintenance					
1. Relatively easy to operate, thus ensuring operating labour continuity and a "clean house"	Relatively simple windrow operation	Three SSO operations, but no plastic bags	Multiple SSO facilities and L&YW in plastic bags	Option 1 is easiest. Option 4 next, then Option 2 is next b/c no bags. 3A/B slightly harder	Only one SSO facility; L&YW in plastic bags
2. Relatively easy to maintain, thus ensuring maintenance labour continuity	Scored the same as criterion D1.				
3. System's inherent operational safety (i.e. are there more inherent risks in one system that you have to control through administrative/operation controls (vs engineering controls)	No facilities operating indoors	Three SSO operations requiring management of indoor air quality	Three SSO operations requiring management of indoor air quality	Three SSO operations requiring management of indoor air quality	Two SSO operations requiring management of indoor air quality

10.3.2.2 Weighting

Some criteria may be more or less important than others. Different stakeholders faced with the same problem may have different underlying value systems; therefore, there may be a different sense of what is most important in the given problem. This leads to the concept of weighting objectives.

Assigning weights to objectives is a subjective exercise based on the values of the stakeholder(s). This was accomplished by issuing ballots in an internal weighting exercise to RDOS staff and stakeholders who participated in the initial workshop where criteria were discussed. The weights used for this evaluation were the average (geometric mean) of the 15 responses received.

Weighting was done after the performance measures were developed, so project team members could include in their consideration the extent to which the full set of alternatives vary in performance. The weight assigned to an objective is a measure of that criteria's relative contribution to the decision goal as it is varied from the lower end of its measurement scale to the upper end of that scale. Exhibit 10-12 presents the weights developed for the evaluation criteria.

Weights were assigned in a two-step process. First, weights were assigned to establish the relative importance of the sub-criteria within each of the six main criteria. The most important sub-criterion was assigned an importance weight of 100, and the other sub-criteria were assigned weights proportional to the highest rated criterion. For example, when evaluating the sub-criteria within criterion B., Minimize Socioeconomic Impacts, the group felt that sub-criterion B.2 was the most important so it was assigned a weight of 100. The group felt that sub-criterion B.1 was about half as important, so it was assigned a weight of 50.

After all sub-criteria were scored, the group assigned weights to the main criteria. Again, the most important criterion (A. Minimize Environmental Impacts) was assigned a weight of 100, and the other criteria were assigned weights proportional to that criterion.

Finally, all weights were converted to a 0 to 1 scale, resulting in a percentage weight for each sub-criterion. This was done through a weighted averaging process where each sub-criterion weight was multiplied by the percent of the total weight assigned to the main criteria. For example, in Exhibit 10-12, the 4 main criteria add to a total weight of 375 (100+100+85+90). The 3 sub-criteria for item D. add to 270 (85+85+100). Thus, the percentage weight for sub-criteria D.1 is 7.6 percent, calculated as $(85/270) \times (90/375)$.

Note that the weights shown in Exhibit 10-12 have been assigned only to the non-monetary objectives. Rather than try and assess the relative importance of cost compared to the other objectives, it was decided to compare the non-monetary value achieved against the cost of each alternative.

EXHIBIT 10-11

Relative Importance Weights for Criteria

Criteria	Relative Importance Weight	% of Total
II. Maximize non-monetary value resulting from alternatives		
A. Minimize Environmental Impacts or Benefits	100	27%
1. Protect air from pollution	100	
a. Minimize air pollution from vehicles and equipment (PM10, NOx) or other sources	90	6%
b. Minimize greenhouse gas emissions (CO2e) generated from collection, process/operation, or end use materials	100	7%
2. Protect water resources	10	
a. Minimize the use of clean water as a process input	100	1%
b. Maximize process water reuse	100	1%
c. Maximize the quality of effluents	100	1%
3. Protect and enhance land resources	70	
a. Minimize the amount of land required for processing facilities	40	2%
b. Preserve greenfields	60	3%
c. Protect sensitive habitats	100	5%
d. Preserve ALR zoning	50	2%
B. Minimize Socioeconomic Impacts on RDOS Residents and Businesses	100	27%
1. Minimize the negative effects of traffic	50	4%
2. Minimize the proximity impacts of processing infrastructure on neighbours (noise, vectors/animals, odours, litter, dust)	100	8%
3. Minimize the visual impacts of process infrastructure on neighbours	55	4%
4. Minimize the traffic impacts of process infrastructure on neighbours	65	5%
5. Ease of use for customers	80	6%
C. Maintain Flexibility	85	23%
1. Adaptability of system to change (modularity, staged development, expansion, future technologies, regulatory change)	95	7%
2. Promotes operational resilience (e.g., if one component breaks down, you can still operate, speed of repairs)	100	8%
3. Maximum product diversification	50	4%
4. Maximizes Class A compost	50	4%
D. Achieve Simplicity and Safety during Operations and Maintenance	90	24%
1. Relatively easy to operate, thus ensuring operating labour continuity and a "clean house"	85	8%
2. Relatively easy to maintain, thus ensuring maintenance labour continuity	85	8%
3. System's inherent operational safety (i.e. are there more inherent risks in one system that you have to control through administrative/operation controls (vs engineering controls)	100	9%

10.3.3 MODA Results

The total value score for each alternative was calculated using a weighted averaging process in which the total value score is calculated as the sum of the percentage-weighted, normalized scores of each subcriteria, times 100. Exhibit 10-13 and 14 show the results of the analysis.

Exhibit 10-13 shows the scores for each alternative in a stacked bar chart where each bar represents the contribution to total value from each objective. As shown, Options 1 and 2 provide the highest overall value, but for different reasons. Option 1 scores well in the flexibility and operational simplicity criteria: this option includes a modest increase in L&YW composting and continued biosolids composting, but does not divert additional SSO from landfills. Option 2 which includes SSO collected at the same time and in the same container with L&YW provides roughly equivalent value, but the value comes from high scores in the environmental and social criteria: diverting SSO from landfill lessens greenhouse gas emissions and provides other benefits. On social impacts, Option 2 scores better than Option 1 because all composting takes place indoors, which would lessen the likelihood of odour or visual impacts resulting from facility operations.

Exhibit 10-14 shows a scatter diagram of value to cost. As shown, Option 1 provides the highest value at the lowest cost of any option using baseline weights. Again, this is because adding SSO composting costs more money and adds complexity. Of the options that include SSO composting, Option 3A is preferred, followed close behind by Option 4. Option 3B has similar cost, but somewhat less value. Option 2, which has the highest value of the options that include SSO processing would cost approximately \$5 million per year more than the other SSO options, because of relatively high relative costs for both collection and processing. For collection, Option 2 would have added collection stops and would require providing 240 litre rolling carts to all single family households. For processing, Option 2 would be more expensive because L&YW would be composted together with SSO in enclosed buildings, whereas in Options 3A, 3B, and 4 L&YW would be composted in windrows outdoors which is less expensive.

A sensitivity analysis was conducted to test the sensitivity of the results to changes in weights. The results of the analysis are shown in Exhibit 10-15. The sensitivity analysis tests the effect of setting the weights on flexibility and simplicity to 0 and testing only the effects of environmental and social impacts. The results show that the results are relatively insensitive to changes in weights i.e., the relative importance of the criteria has little effect on the relative preference of the different options.

EXHIBIT 10-13
 MODA Results – Total Non-Monetary Value of System Options

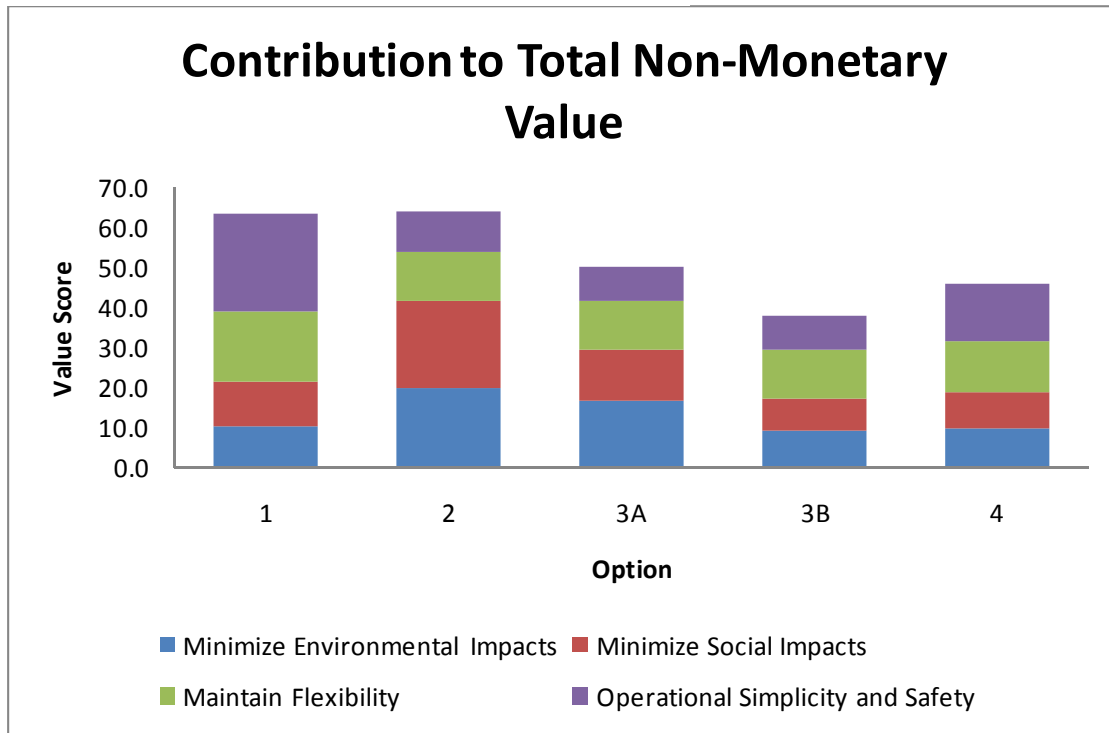


EXHIBIT 10-14
 MODA Results – Comparison of Non-Monetary Value and Cost

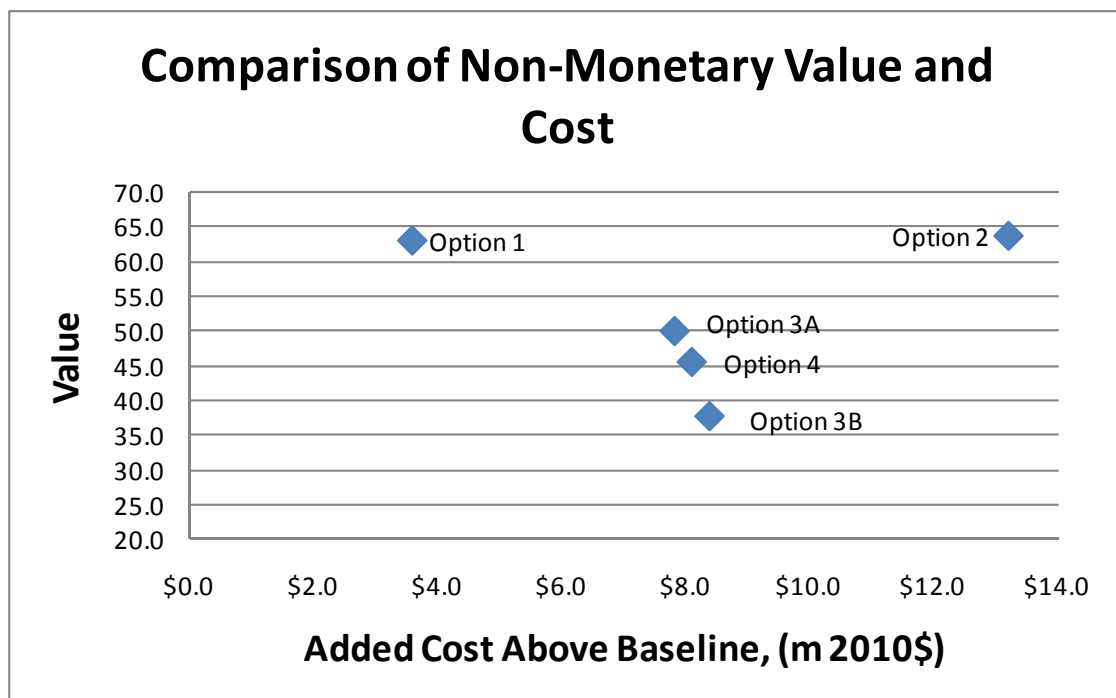


EXHIBIT 10-15
Sensitivity Analysis of Changes in Importance Weights

	System Option				
	1	2	3A	3B	4
	Bi-Weekly L&YW Collection, No SSO Facilities	Combined Collection, Multiple SSO Facilities	Slip Stream Collection, Multiple SSO Facilities	Option 3A Plus SSO Facility in Keremeos	Slip Stream Collection, Regional SSO Facility in Penticton
Scores					
Base Model, RDOS Average Weights	63.1	63.8	50.0	37.7	45.6
Environment is 50%, Social is 50%, Others 0%	39.9	77.4	55.1	32.0	35.5
Environment is 70%, Social is 30%, Others 0%	39.4	75.8	58.0	33.2	35.8
Rank, Highest Valued Option = 1					
Base Model, RDOS Average Weights	2	1	3	5	4
Environment is 50%, Social is 50%, Others 0%	3	1	2	5	4
Environment is 70%, Social is 30%, Others 0%	3	1	2	5	4

11 Conclusions & Recommendations

In updating their Solid Waste Master Plan, the RDOS recognized that organic waste diversion and management would be crucial to meeting their overall waste management and reduction goals. Therefore, the RDOS commissioned a specific study and evaluation of organic waste management options that contained a greater level of detail than is normally done during the SWMP update processes.

The overall project approach involved two phases. The first phase of this assignment involved establishing the framework for the organic waste management system by providing information on organic waste characteristics in the RDOS, reduction and collection options, processing options and regulations. The second phase of the project involved identifying specific program components suitable for use in RDOS, and combining these into systems that reflect guiding principles, boundary conditions, and themes.

Five system options were developed and used to test the implications of various methods of material collection and processing, and different locations for material processing. In all options, facilities would accept material from residential and ICI sources, and agricultural wastes currently accepted at RDOS composting facilities.

A set of non-monetary evaluation criteria were developed for use in the evaluation of the systems, and the relative importance of these criteria was determined by a group of stakeholders consisting of staff from the RDOS and from municipalities in the RDOS, BCMAL, and the BC Agricultural Council.

The evaluation criteria were used in conjunction with estimated capital and operating costs to assess the total value score of each system. The total value score for each alternative was calculated using a weighted averaging process.

The two systems which were found to have the highest “value” were Options 1 and 2.

System Option 1 is an expansion of the existing L&YW collection program to a full season (i.e. April to November) program with bi-weekly collection, and centralized biosolids composting in the Penticton area. Although this option provides a modest increase in organic waste diversion and continued biosolids composting, it scores well in the flexibility and operational simplicity criteria.

System Option 2 involves weekly combined collection of L&YW and SSO on a year-round basis, and processing in one of three enclosed facilities. Biosolids would be co-composted or processed in parallel with L&YW/SSO at the Penticton area facility. This value of this option is derived primarily from environmental and social criteria. For example, the land requirements for the processing facilities are less than for other options, and the greater diversion of SSO from landfill lessens greenhouse gas emissions. Socially, all processing takes place indoors, which lessens the potential for odour and other nuisance impacts on the surrounding community.

The systems were also viewed from the perspective of environmental and social factors and monetary criteria (i.e. a triple-bottom line evaluation). From this perspective, System Option 1 provides the highest value at the lowest cost of any of the options considered due to the simplicity, flexibility and relative lower cost compared to systems that collect and manage SSO.

Of the options that include SSO composting, Option 3A (i.e. separate collection of L&YW and SSO, with windrow composting of L&YW and enclosed composting of SSO at facilities in Oliver/Osoyoos, Princeton, and Penticton areas) is preferred. However, this option is followed closely by Option 4, which involves the same collection programs but consolidates SSO processing from Oliver/Osoyoos and Keremeos areas in Penticton. The relative similarity in the evaluation results for these two options indicates that there is some flexibility for RDOS to adapt a regional SSO processing system to the results of processing facility siting process.

Option 2 has the highest overall value of the options that include SSO processing, but would cost approximately \$5 million more per year than the other SSO options. This is due to the higher costs for both collection and processing operations.

An analysis was conducted to test the sensitivity of the results to changes in weighting the flexibility and simplicity criteria to 0 (i.e. considering only the effects of environmental and social impacts). The results of this secondary analysis show that the relative importance of the criteria has little effect on the relative preference of the different options.

11.1 Recommendations

Options 1 and 2 were found to have the highest non-monetary “value” according to the evaluation criteria and weighting developed by the RDOS and its stakeholders. However, when financial aspects of the system options are considered, Option 2 has a relatively high cost whereas Option 1 provides the most value for the dollars spent (value-cost ratio) by a substantial margin compared to the other options. Therefore, based on this analysis, Option 1 would be the preferred system for implementation in the RDOS.

Although Option 1 is the preferred system, the Project Team recognizes that if environmental protection is more highly valued relative to other criteria or if additional factors not directly considered by the criteria established for the MODA analysis (e.g. availability of grant funding, future landfill airspace limitations, political influences), the RDOS may want to take a more aggressive approach to organic waste diversion, and implement a program for source-separated organics collection and processing.

Should this be the case, the selection of Option 3A or 4 would be the preferred approach to providing a regional SSO program. The overall value and value for the dollars spent provided by these two systems is similar (although Option 3A has improved environmental value while Option 4 provides more operational simplicity and safety). Practically speaking, the selection of which of the two systems to implement would be a function of the ability to site a processing facility in the Oliver/Osoyoos area.

From an overall implementation perspective, the initial upgrade of existing programs and facilities to allow for the implementation of Option 1, and potential subsequent expansion to Option 3A or 4, would provide a practical and staged approach to development of the regional organic waste management program.