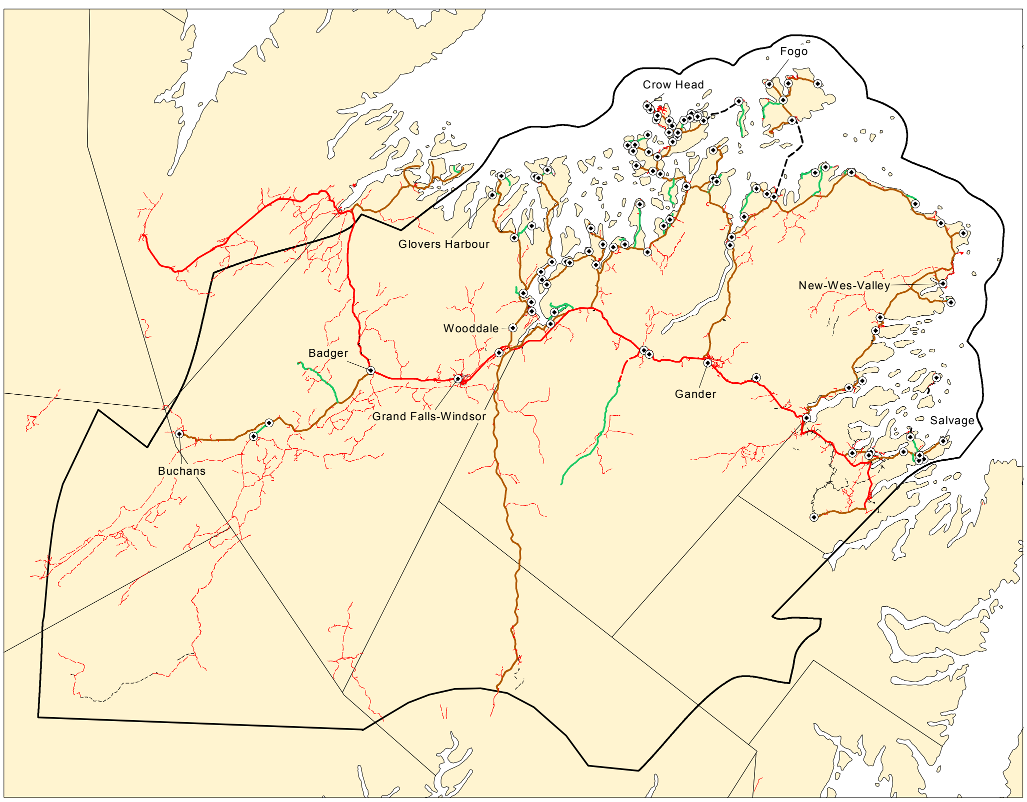
CENTRAL NEWFOUNDLAND SOLID WASTE MANAGEMENT PLAN

Phase I Report
Volume I

Final Report Submitted to

Central Newfoundland Waste Management Committee

BNG PROJECT # 721947



BAE ◆ NEWPLAN GROUP

CENTRAL NEWFOUNDLAND
SOLID WASTE MANAGEMENT PLAN

Phase I Report

Final Report Submitted to:

Central Newfoundland Waste Management Committee
c/o Town of Gander
P.O. Box 280
Gander, NF
A1V 1W6

Submitted by:

BAE-Newplan Group Limited
1133 Topsail Road, Mount Pearl
Newfoundland, Canada
A1N 5G2

October, 2002

Project No.: 721947

Title: CENTRAL NEWFOUNDLAND SOLID WASTE MANAGEMENT PLAN

Phase I Report - Final

Client: Central Newfoundland Waste Management Committee

C	02/10/02		Final Report	GW	WM	WM
B	02/09/18		Final Draft Report	GW/ZY	WM	WM
A	02/06/05		Issued for Review	GW/PH/ZY	WM	WM
Rev.	Date yyyy/mm/dd	Page No.	Description	Prepared By	Reviewed By	Approved By

TABLE OF CONTENTS

TABLES:

APPENDICES:

1.0 INTRODUCTION

1.1 BACKGROUND AND OBJECTIVES

The Province of Newfoundland and Labrador has developed a comprehensive strategy[1] with a goal of 50% diversion of materials currently going to landfills by the year 2010. The strategy includes a reduction in the number of disposal sites, the elimination of open burning, and the phase out of unlined landfills.

The Central Newfoundland Waste Management Committee is an umbrella organization made up of representative of the community councils within the Central Region of Newfoundland. In keeping with the goals of this strategy, the Central Newfoundland Waste Management Committee has undertaken the task to oversee the development of a Solid Waste Management Plan for the Central Newfoundland Region. BAE♦Newplan Group was retained in April 2002 to assist the committee with the development of the plan. The Central Newfoundland Waste Management Committee, under the direction of Allan Scott, has a mandate to:

> "To study and recommend a cost effective, environmentally acceptable solid waste management system for Central Newfoundland."

The guiding principles for this mandate are clearly documented in the Terms of Reference[2] provided to BAE♦Newplan Group by the Central Newfoundland Waste Management Committee. They include:

- Evaluate the solid waste management needs, including recycling programs;
- Identify existing problems and determine the most feasible means of improvement; and
- Provide the region with an acceptable solid waste management plan for a design period of 20 to 30 years.

The Work Plan for the development of the Solid Waste Management Plan is presented in accordance with the Terms of Reference provided to BAE♦Newplan Group by the Central Newfoundland Waste Management Committee[3].

---

[1] Government of Newfoundland and Labrador, Department of the Environment. *Newfoundland and Labrador Waste Management Strategy.* April 2002.
[2] Terms of Reference, Central Newfoundland Waste Management Study. February 22, 2002.
[3] Terms of Reference, Central Newfoundland Waste Management Study. February 22, 2002.

The Phase I – Solid Waste Management Study basically consists of completing a detailed Waste Audit of existing facilities in the study area, followed by a preliminary evaluation of alternatives, which may be appropriate for the study area. Objectives of the Phase I Report include:

- Determine the precise study boundary;
- Compile and review existing data and information;
- Review development plan for the region;
- Undertake a detailed waste audit;
- Review Waste Management Techniques;
- Evaluation of disposal site;
- Develop alternative waste management options;
- Provide cost analysis; and
- Provide findings and recommendations to the committee.

2.0 STUDY AREA BOUNDARY

The study area encompasses a large area of the Central Region of Newfoundland from Buchans in the west, to Salvage in the east, north to and including Fogo Island as outlined in the map below. There are a total of 108 communities located within the study area boundary. See Table 2.1 for list of communities included the study area.

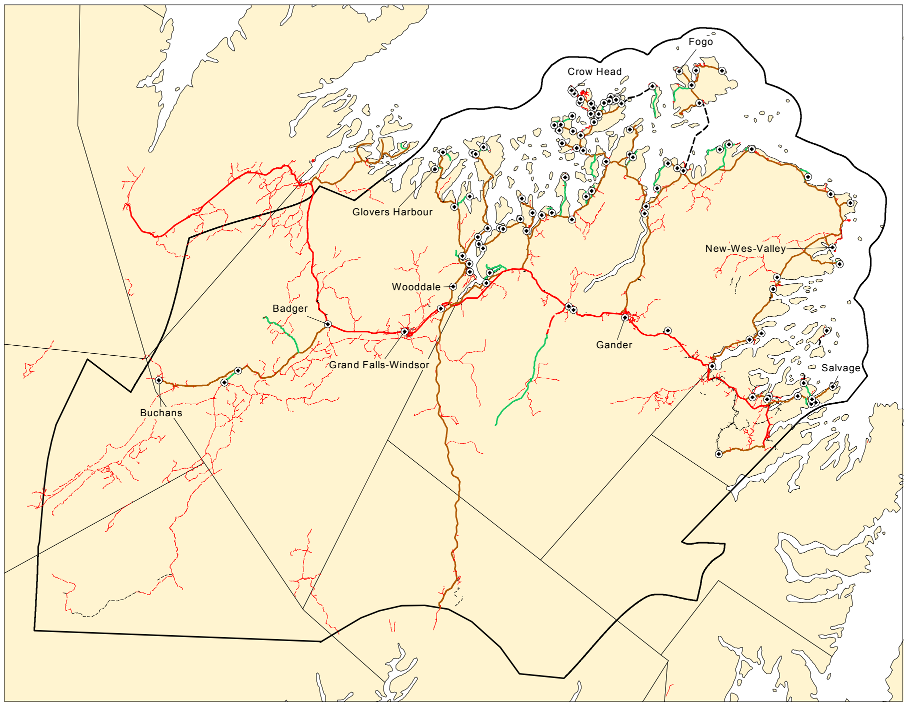


Figure 2.1: Central Region Waste Management Zone.

Table 2.1: List of Communities located within the Boundaries of the Study Area for the Central Newfoundland Waste Management Plan.

#	LEGAL NAME	LOCAL GOVERNMENT. ID	TYPE OF COMMUNITY
1	Appleton	85	Town
2	Aspen Cove	120	Local Service District
3	Badger	155	Town
4	Baytona	266	Town
5	Benton	345	Local Service District
6	Birchy Bay	375	Town
7	Bishop's Falls	405	Town
8	Botwood	550	Town
9	Boyd's Cove	560	Local Service District
10	Bridgeport	595	Local Service District
11	Brown's Arm	670	Local Service District
12	Buchans	685	Town
13	Buchans Junction	690	Local Service District
14	Burnside- St. Chards	745	Local Service District

#	LEGAL NAME	LOCAL GOVERNMENT. ID	TYPE OF COMMUNITY
15	Campbellton	830	Town
16	Cape Freels North	875	Local Service District
17	Carmanville	960	Town
18	Centreville-Wareham-Trinity	993	Town
19	Chanceport	1015	Local Service District
20	Change Islands	1020	Town
21	Charlottetown	1047	Local Service District
22	Cobbs Arm	1100	Local Service District
23	Comfort Cove-Newstead	1140	Town
24	Cottlesville	1205	Town
25	Cottrell's Cove	1210	Local Service District
26	Crow Head	1270	Town
27	Culls Harbour	1275	Unincorporated Community
28	Deadman's Bay	1350	Local Service District
29	Dover	1435	Town
30	Eastport	1490	Town
31	Embree	1515	Town
32	Fairbanks-Hillgrade	1552	Local Service District
33	Fogo	1630	Town
34	Fogo Island Region	1635	Region
35	Fortune Harbour	1655	Local Service District
36	Frederickton	1700	Unincorporated Community
37	Gambo	1755	Town
38	Gander	1760	Town
39	Gander Bay North	1765	Local Service District
40	Gander Bay South	1770	Local Service District
41	Glenwood	1855	Town
42	Glovers Harbour	1860	Unincorporated Community
43	Glovertown	1865	Town
44	Grand Falls-Windsor	1960	Town
45	Green Cove	2010	Unincorporated Community
46	Greenspond	2040	Town
47	Happy Adventure	2100	Town
48	Hare Bay	2165	Town
49	Hatchet Harbour	2202	Unincorporated Community
50	Herring Neck	2270	Local Service District
51	Horwood	2360	Local Service District
52	Indian Bay	2385	Town
53	Indian Cove	2390	Local Service District
54	Joe Batt's Arm-Barr'd Islands-Shoal Bay	2535	Town
55	Kettle Cove	2570	Unincorporated Community
56	Ladle Cove	2640	Unincorporated Community
57	Laurenceton	2740	Local Service District
58	Leading Tickles	2755	Town
59	Lewisporte	2775	Town
60	Little Burnt Bay	2825	Town
61	Little Harbour	2860	Unincorporated Community
62	Loon Bay	2985	Local Service District
63	Lumsden	3040	Town
64	Main Point-Davidsville	1335	Local Service District

#	LEGAL NAME	LOCAL GOVERNMENT. ID	TYPE OF COMMUNITY
65	Merritt's Harbour	3190	Local Service District
66	Michaels Harbour	3195	Local Service District
67	Millertown	3240	Town
68	Moore's Cove	3295	Unincorporated Community
69	Moreton's Harbour	3305	Local Service District
70	Musgrave Harbour	3380	Town
71	Newville	3463	Local Service District
72	New-Wes-Valley	165	Town
73	Noggin Cove	3490	Local Service District
74	Norris Arm	3505	Town
75	Norris Arm North	3510	Local Service District
76	Northern Arm	3560	Town
77	Paradise	3660	Unincorporated Community
78	Peterview	3735	Town
79	Phillips Head	3765	Local Service District
80	Pikes Arm	3781	Unincorporated Community
81	Pleasantview	3820	Local Service District
82	Point Leamington	3860	Town
83	Point of Bay	3870	Town
84	Port Albert	3910	Local Service District
85	Porterville	3985	Unincorporated Community
86	Purcell's Harbour	4055	Local Service District
87	Ragged Point	4090	Unincorporated Community
88	Salt Harbour	4555	Unincorporated Community
89	Salvage	4540	Town
90	Sandringham	4545	Town
91	Sandy Cove	4515	Town
92	Sandy Point	4570	Unincorporated Community
93	Seldom-Little Seldom	4630	Town
94	Shoal Cove	4695	Unincorporated Community
95	St. Brendan's	4340	Town
96	Stanhope	4930	Local Service District
97	Stoneville	4965	Local Service District
98	Summerford	4975	Town
99	Sunnyside	4995	Unincorporated Community
100	Terra Nova	5035	Town
101	Tilting	5095	Town
102	Tizzard's Harbour	5100	Local Service District
103	Too Good Arm	5115	Unincorporated Community
104	Traytown	5135	Town
105	Twillingate	5195	Town
106	Valley Pond	5220	Local Service District
107	Virgin Arm-Carter's Cove	5235	Local Service District
108	Wooddale	5460	Unincorporated Community

3.0 POPULATION PROJECTION

Estimating the future waste and resource quantities and composition is necessary to design a waste management system that is cost effective and will achieve the diversion targets established by the Province[4]. Projections of waste quantities are based upon population change, generation characteristics, and economic activities.

Residential waste generation is related closely to population. In contrast, IC&I waste generation rates are sensitive to economic growth and activity and are, therefore, less predictable. When IC&I generation rates are forecast based on economic growth, the projections become less reliable as the horizon becomes longer. Population projections are therefore used as an alternative.

The population projection is based on Statistics Canada's projections for Newfoundland, broken down by economic zones (see Appendix A for details of the projection). Statistics Canada provides a projection to the year 2016; for the years beyond 2016, the 2016 population growth rate was used as suggested by Statistics Canada. For a conservative approach, the high scenario was chosen. Under this population projection scenario, the population in Newfoundland and Labrador as a whole will increase by 2.4% over the next 50 years, with the population in the study area expected to decrease by 6.1% over the next 50 years. This 6.1% decrease, being the lowest rate of the three scenarios, is considered a conservative number. The medium and low scenarios could be investigated as well, if deemed necessary. Table 3-1 illustrates the population projections for the study area.

Table 3-1: Population Changes in 50 years – High, Medium and Low Scenarios

Scenario	Central Region	Province
High	-6.1%	2.4%
Medium	-11.4%	-3.8%
Low	-27.1%	-22.9%

The approach used in the population projection has a strong logical/scientific support. It was done with the cohort-component method, in which the components of population change (fertility, mortality, and net migration) are projected separately for each birth cohort (persons born in a given year). The base population is advanced each year by using projected survival rates and net migration.

[4] Government of Newfoundland and Labrador, Department of the Environment. *Newfoundland and Labrador Waste Management Strategy*. April 2002.

4.0 REVIEW OF WASTE GENERATION RATES AND WASTE CHARACTERISTICS IN OTHER JURISDICTIONS

The terms of reference for this study include a requirement to review waste and resource generation characteristics in other jurisdictions. Information on waste generation from other jurisdictions provides a source of comparison for the study area.

This section of the report documents waste and resource characteristics in other jurisdictions. The project team has collected data and waste characterization studies from a number of municipalities in Canada and has contacted several facilities directly. The research has illustrated that waste generation rates vary considerably from one area to another. There are also differences in how this data is collected and reported. Where possible, the information is presented in a comparable format; however, in some cases this was not possible.

4.1 WASTE GENERATION RATES IN ATLANTIC CANADA

4.1.1 Province of Nova Scotia

The Nova Scotia Department of the Environment and Labour conducts an annual survey of individual municipalities' waste generation and diversion rates[5]. The data for waste being landfilled in the province is presented in Table 4-1. The communities identified in the table are described as either urban or rural. It should be noted that this data does not represent the total waste generated in the communities, but rather the waste being disposed of in landfills only, including construction and demolition (C&D) landfills. Wastes that are currently diverted to recycling and other programs are not included in these numbers.

As shown in Table 4-1, the generation rates vary throughout the province. The rural rates range from 0.79 to 1.99 kg/person/day, and the urban rates range from 0.95 to 1.41 kg/person/day. The wide-ranging generation rates indicate the difficulty in characterizing the waste generation rate of one region based on the waste generation rates in another region.

[5] Personal Communication - Robert Kenny, Nova Scotia Department of the Environment and Labour.

Table 4-1: Summary of Population and Waste Generation, Nova Scotia (April 2000 - March 2001)[6]

Region	Community	Type	Population	Landfill*	
				(tonnes)	kg/person/day
1	Inverness County, Port Hawkesbury	rural	20,933	9,379	1.23
	Cape Breton Regional Municipality	urban	114,868	58,978	1.41
	Victoria County	rural	8,474	2,952	0.95
	Richmond County	rural	10,910	7,917	1.99
2	Pictou County	rural	49,325	22,742	1.26
	Antigonish County	rural	15,247	6,248	1.12
	Guysborough County	rural	10,443	3,012	0.79
	Antigonish Town	rural	4,850	3,496	1.98
3	Hants East	rural	22,708	6,781	0.82
	Colchester County	rural	51,025	24,144	1.30
	Cumberland County	rural	33,765	14,303	1.16
4	Halifax Regional Municipality	urban	367,502	127,200	0.95
5	Valley Region	rural	85,199	27,647	0.89
6	Lunenburg County	rural	38,243	11,908	0.85
	Chester	rural	10,820	4,451	1.13
	Hants West	rural	19,548	8,606	1.21
	Queens Regional Municipality	rural	12,046	3,877	0.88
	Shelburne (Municipal District)	rural	7,944	3,250	1.12
7	Yarmouth, Barrington	rural	36,460	12,394	0.93
	Digby County	rural	20,686	11,100	1.47
	Total for Province -->		**940,996**	**370,385**	1.08

* Includes disposal in all landfills including C&D, April 1, 2000 to March 31, 2001; does not include waste diverted at the disposal site (such as contaminated soils, organics, recyclables, white goods, metal, HHW, leaf and yard waste, etc.)

4.1.2 *Municipality of the District of Lunenburg, Nova Scotia*

The Municipality of the District of Lunenburg in Nova Scotia is a primarily rural area that includes some towns and has a population of 47,581. The Municipality has had a four-stream (garbage, paper, blue bag recyclables, organics) waste management program since 1994. In June 2001, a detailed waste audit of residential materials was conducted in the Municipality of the District of Lunenburg[7]. The data was obtained through a direct material sort using methodology prescribed by the *Recommended Waste Characterization Methodology for Direct Waste Analysis in Canada*, which was prepared for the Canadian Council of Ministers of the Environment (CCME) by SENES Consultants Limited in 1999[8]. Table 4-2 presents a detailed breakdown into ten main

[6] Information provided by Robert Kenny, Nova Scotia Department of the Environment and Labour, (Statistics Canada estimate).
[7] SNC-Lavalin. *Waste Characterization Study of Residual Solid Waste & Recyclables in the Municipality of the District of Lunenburg, Nova Scotia (Spring 2001).* SNC-Lavalin Inc. December 2001.
[8] SENES Consultants. *Recommended Waste Characterization Methodology for Direct Waste Analysis in Canada*. 1999.

categories for the residential materials collected by the Municipality. The generation rate for each category is reported in terms of kilograms per capita per year.

Table 4-2: Residential Waste Generation Rates by Category for the Municipality of the District of Lunenburg

Material Categories	Waste Generation Rate (kg/capita/year)	Percentage of Waste Generation
Paper & Paperboard	90.48	27.8%
Glass	10.10	3.1%
Ferrous	11.60	3.6%
Aluminum	3.29	1.0%
Plastic	31.91	9.8%
Multi-Material Wastes	9.33	2.9%
Textiles	13.39	4.1%
Organics	135.70	41.7%
Special-Care Wastes	10.69	3.3%
Other Wastes	8.93	2.7%
Total	**325.42**	**100.0%**

4.1.3 Westmoreland – Albert, New Brunswick

The Albert-Albert region in New Brunswick operates a wet-dry waste management system. Attempts were made to obtain recent data regarding waste generation rates and waste characteristics for this region. To date, only limited data has been received. The facility accepts a broad range of residential and commercial wastes. The residential waste stream consists of 30% wet bag waste and 70% dry bag waste. The residential waste is sorted and recyclable material recovered. The recovery rate for residential wet bag material was reported to be 60% (by weight); and the recovery rate for the dry bag stream was 38% (by weight). The overall recovery rate for residential waste stream is 43%. IC&I is not currently processed and directed to the landfill. It is understood IC&I recovery is planned in the future. The overall facility recovery rate is 24% [9]. Waste characterization information was not available from the facility.

4.2 WASTE GENERATION RATES AND WASTE CHARACTERISTICS IN ONTARIO

Municipalities in Ontario have completed a number of waste audits and studies. This section summarizes the results of these studies. Unless otherwise indicated, populations of the townships and overall compliance levels were not available.

[9] SNC-Lavalin site visit and interview. April 11, 2002

4.2.1 Township of Augusta

The Township of Augusta is a rural municipality in eastern Ontario. The municipality's waste management program includes recycling depots located throughout the municipality. There is no curbside collection; instead, residents take materials to landfills and depots (e.g. recycling, HHW). During a waste audit conducted over four days in August 2000[10], materials destined for the landfill were taken from 345 vehicles, with each vehicle assumed to represent one household. The results are summarized in Table 4-3.

Table 4-3: Characterization of Materials to be Landfilled for the Township of Augusta

Material categories	Total weight (kg)	Percent of total
Paper Fibers	606.4	8.3%
Plastics	401.3	5.5%
Metals	110.2	1.5%
Glass	134	1.8%
Household Special Wastes	0	0.0%
Compostables	5253.6	71.5%
Other Waste Materials	840.3	11.4%
TOTAL	7345.8	100.0%

4.2.2 Township of North Glengarry

The Township of North Glengarry in eastern Ontario is comprised of both rural and urban areas. A blue box recycling program was implemented in the township in 1990. Curbside collection in the township includes blue boxes (recyclable materials) and garbage (landfill waste). A four-week study of 60 homes (30 from rural, 30 from urban) was completed in the summer of 2000[11]. Materials were collected from the curbside and sorted into 7 categories and 57 subcategories. The results are summarized in Table 4-4.

[10] Corporation of the Township of Augusta. *Township of Augusta Waste Audit 2000*. January 2001.
[11] Township of North Glengarry. *Residential Curbside Waste Audit For North Glengarry*. August 24, 2000.

Table 4-4: Material Characterization in the Township of North Glengarry

Material categories	Blue Box Weight (kg)	Garbage Weight (kg)	TOTAL Weight (kg)	Percent Total
Paper Fibers	519.3	312.6	831.9	25.3%
Plastics	51.9	216	267.9	8.1%
Metals	61.6	49.7	111.3	3.4%
Glass	166.8	62.3	229.1	7.0%
Household Special Wastes	0	12.8	12.8	0.4%
Compostables	0	1315.1	1315.1	40.0%
Other Waste Materials	0	519.3	519.3	15.8%
TOTAL	**799.6**	**2487.8**	**3287.4**	**100.0%**
Percent by waste stream	*24%*	*76%*		

4.2.3 County of Simcoe

The County of Simcoe in north central Ontario contains urban and rural areas. Some of these areas include seasonal and multi-family residences. Curbside collection includes blue boxes (recyclables) and garbage (landfill waste). A waste audit completed in winter 2001 involved a sort of materials collected from the curbside of 125 homes, including urban, rural, seasonal, and multi-family residences[12]. As with the Township of North Glengarry study, the materials were sorted into 7 categories and 57 subcategories. The results are summarized in Table 4-5 and 4-6. The results indicate a difference in the diversion rate among the urban, rural, seasonal, and multi-residential areas.

Table 4-5: Residential Material Characterization in the County of Simcoe

Material categories	Blue Box Weight (kg)	Garbage Weight (kg)	TOTAL Weight (kg)	Percent Total
Paper Fibers	717.42	547.53	1264.95	31.9%
Plastics	47.75	312.39	360.14	9.1%
Metals	75.9	98.34	174.24	4.4%
Glass	169.48	70.22	239.7	6.0%
Household Special Wastes	0.8	28.5	29.3	0.7%
Compostables	5.06	1300.7	1305.76	32.9%
Other Waste Materials	1.6	589.6	591.2	14.9%
TOTAL	**1018.01**	**2947.28**	**3965.29**	**100.0%**
Percent by waste stream	*26%*	*74%*		

[12] County of Simcoe. *Seasonal Waste Composition Study for Streamed Programs*. March 2001.

Table 4-6: Residential Material Characterization by Area in the County of Simcoe

Area	Blue Box Weight (kg)	Garbage Weight (kg)	TOTAL Weight (kg)
Urban	389.7	922.4	1312.1
Percent of total	*30%*	*70%*	*100%*
Rural	236.7	908.4	1145.1
Percent of total	*21%*	*79%*	*100%*
Multi-residential	259.4	340.4	599.8
Percent of total	*43%*	*57%*	*100%*
Seasonal	132.3	774.7	907
Percent of total	*15%*	*85%*	*100%*
TOTAL	**1018.01**	**2947.28**	**3965.29**
Percent of total	*26%*	*74%*	*100%*

4.2.4 City of Peterborough

The City of Peterborough in Ontario is an urban area. Residential curbside collection includes garbage (landfill waste), blue bags (recyclables), and yard waste/organics. A waste audit completed in the summer and fall of 2000 involved two three-week studies of 30 middle-income homes[13]. The materials from each stream were sorted into three categories (recyclables, garbage, and organics). The results are summarized in Table 4-7. The capture rate describes what percentage of the waste stream is being diverted from landfill. The total capture rate for all waste streams is 53%.

Table 4-7: Material Characterization in the City of Peterborough, Ontario

Material categories	Diverted (kg/hhld/yr)	Landfill (kg/hhld/yr)	Total generated (kg/hhld/yr)	Percent of total waste	Capture rate
Recyclables	236	45	281	33%	84%
Garbage	0	166	166	20%	0%
Organics	209	191	399	47%	52%
TOTAL	**445**	**402**	**846**	**100%**	

4.2.5 Northumberland County

Northumberland County in central Ontario had a population of 79,120 in 1999. The county operates a wet-dry waste management system in which dry materials are taken to a material recovery facility (MRF). Composting of the wet stream does not yet occur. Curbside collection is offered to approximately 96% of the households in the county.

[13] REIC Perth. *Waste Composition Studies 2000 City of Peterborough*. November 2000.

Table 4-8 summarizes the results of a study completed in July 2000 of the materials sent to the MRF. Within the ICI category, 1,405 (44%) tonnes was clean cardboard (OCC). The Northumberland County MRF had a recovery rate of 66% for the residential dry stream. The county has a total diversion rate of 45%. Table 4-9 summarizes the composition of materials recovered and marketed after processing. A study completed in January 2001 found that 77% of the wet stream could be diverted. The wet stream comprises 48% of the county's municipal waste.

Table 4-8[14]: Materials Taken to the MRF in 1999

Residential (tonnes/year)	ICI (tonnes/year)	TOTAL (tonnes/year)
9653	3158	12811
75%	25%	100%

Table 4-9: Composition of Materials Recovered and Marketed after Processing (1999)

Material category	Residential (tonnes/year)	Percent of residential	ICI (tonnes/year)	Percent of ICI	TOTAL (tonnes/year)
Paper	4771	75%	2356	96%	7127
Plastics	383	6%	10	0%	393
Metals	643	10%	18	1%	661
Glass	537	8%	59	2%	596
Other	6	0%	0	0%	6
TOTAL	6340	100%	2443	100%	8784

4.2.6 Town of Markham

The Town of Markham is an urban area located close to Toronto, Ontario. The waste management system includes curbside collection of garbage, recyclables, and yard waste. Backyard composting of food waste is encouraged but food is not accepted in yard waste collection. From May 2000 to April 2001 the municipality conducted a pilot project of a three-stream collection system, which included garbage (landfill waste), recyclables, and kitchen organics. An average of 82% of households used blue bags, 21% used blue boxes, and 33% used green bags (organic food waste). During the pilot project 51.4 kg/household/year of kitchen organics and 390.6 kg/household/year of recyclables were collected. Ninety-four percent of the materials in the blue bags/boxes were acceptable for recycling[15].

[14] ENVIROS RIS. *Northumberland MRF Evaluation*. July 2000.
[15] ENVIROS RIS. *Markham "Bag It" Pilot: Summary of Collection Monitoring Results*. January 2002.

4.2.7 City of Guelph

The City of Guelph is an urban area in southern Ontario with a population of just over 100,000. The city's waste management program includes a wet-dry waste management system in which residents separate their waste into wet or dry materials. The municipality had a 58% diversion from landfill for 1996 to 1999. Table 4-10 illustrates the breakdown of materials.

Table 4-10[16]: Material Characterization in the City of Guelph, Ontario

Type of Material	Processed (tonnes)	Residue (tonnes)	Recovered (tonnes)	% Recovered (percent)
Material Recovery Facility				
Residential dry	10170	8206	1964	19%
Public drop off fiber	154	3	151	98%
Commingled containers, fiber, IC&I dry	18154	5384	12770	70%
TOTAL	28478	13593	14885	52%
Composter				
Residential wet	9160	2471	6689	73%
Other wet	1064	287	777	73%
Wood chip and yard waste amendment	2085	1876	209	10%
TOTAL	12309	4634	7675	62%

4.2.8 Summary of Ontario Studies

The data from these Ontario regions is useful in determining the breakdown among material categories, waste streams, and types of areas. The range of percent in each material category for the Township of Augusta, Township of North Glengarry, and the County of Simcoe combined is provided in Table 4-11. Other areas are not included in Table 3-11 because their waste audits did not use the same category breakdown.

[16] Cathy Smith, Geoff Rathbone, and Bob Graham. *Evaluating Guelph's Wet-Dry Recycling Program*. November 9, 2000.

Table 4-11: Material composition for three regions of Ontario

Material category	Augusta Percent of total	North Glengarry Percent of total	Simcoe Percent of total	Range of data (Percent)
Paper Fibers	8.3%	25.3%	31.9%	8.3%-31.9%
Plastics	5.5%	8.1%	9.1%	5.5%-9.1%%
Metals	1.5%	3.4%	4.4%	1.5%-4.4%
Glass	1.8%	7.0%	6.0%	1.5-7.0%
Household Special Wastes	0.0%	0.4%	0.7%	0%-0.74%
Compostables	71.5%	40.0%	32.9%	32.9%-71.5%
Other Waste Materials	11.4%	15.8%	14.9%	11.4%-15.8%
TOTAL	**100.0%**	**100.0%**	**100.0%**	

5.0 WASTE GENERATION RATES FOR CENTRAL NEWFOUNDLAND

5.1 DETERMINATION OF WASTE GENERATION RATES

A review of the data in various studies presented in Section 4 indicates that there is a wide discrepancy in waste generation rates. This is also evident in data presented in the Jacques Whitford draft report[17] which looked at waste generation rates for the province based upon a review of several recent studies.[18,19,20,21,22,23]

The Jacques Whitford draft report assumes a province-wide per capita waste generation rate of 2.05 kg/person/day. This generation rate was determined using Statistics Canada's estimated waste generation for the province in 1998 (407,208 tonnes) divided by the provincial population during the same year (545,362)[24]. This rate reflects a provincial waste generation rate of approximately 750 kg/person/year.

The Jacques study also quotes an accepted provincial per capita generation rate of 2.1 kg/person/day in urban areas and 1.3 kg/person/day in rural areas, resulting in a combined per capita rate of 1.84 kg/person/day. The primary reference source is not provided in the Jacques report. However, when the waste generation rates from other jurisdictions are compared (as presented in Section 4 of this report) these rural and urban generation rates appear reasonable and consistent.

The BNG report[25] calculated waste generation rates for the communities on Fogo Island. Average generation rates range from 0.75 kg/person/day to 2.16 kg/person/day. A high unit rate of 42 kg/person/day was reported for Fogo Centre. This is due to a small population (16) and the inclusion of the school garbage collection in the solid waste tonnage.

The CECON Ltd. report[26] calculated waste generation rates for Badger's Quay and areas. This study calculated an average total solid waste production rate of 0.66 kg/person/day.

---

[17] Jacques Whitford Environment Limited. *Assessment of the Economic Potential for Waste Diversion in Newfoundland and Labrador, Draft Report.* September 2001.
[18] Bae Newplan Group Limited. *Regional Solid Waste Site Selection Study for Fogo Island*. 2002
[19] Central Engineering Consultants of Newfoundland Limited (CECON). *Solid Waste Management Study: Badger's Quay and Area*. 1995
[20] Central Engineering Consultants of Newfoundland Limited (CECON). *Twillingate Solid Waste Management Study*. 1993
[21] Davis Engineering and Associates Limited. *Solid Waste Management Study: Alexander Bay – Eastport Peninsula Area*. 1995
[22] Newfoundland and Labrador Consulting Engineers LTD. *Regional Solid Waste Disposal for Botwood and Area*. 1986
[23] Proctor & Redfern Limited. *Report on Solid Waste Disposal for the Windsor, Bishop's Falls, Grand Falls Area*. 1982
[24] Town of Grand Falls – Windsor. *Regionalized Solid Waste Management for Central Newfoundland*. 1997
[25] BAE-Newplan Group Ltd. – Mt. Pearl. Regional Solid Waste Management for Fogo Island. 2002
[26] CECON Ltd., Gander. Solid Waste Management Study Badger's Quay and Area. 1995

The Davis Engineering & Associates Limited report[27] provided waste generation rates for the communities on the Eastport Peninsula. They assumed an average waste generation of 1.3 kg/person/day.

The Newfoundland and Labrador Consulting Engineers Ltd. report[28] provided waste generation rates for Botwood and area. This study estimated an average waste generation rate of 3.34 kg/person/day.

The Proctor & Redfern Limited report[29] provided waste generation rates for the Grand Falls Area. Generation rates range from 2.11 kg/person/day to 2.98 kg/person/day, with an average rate of 2.86 kg/person/day.

For the purpose of determining accurate waste generation rates for the study area, the data collected by others has been supplemented with scale data from the Robin Hood Bay Sanitary Landfill[25] and more recent scale data from the Harbour Grace incinerator site. No scale data was available for the Central Region. The rural estimated generation rate is based on the Jacques Whitford data, while the urban rate is based on the scale data from the Robin Hood Bay Sanitary Landfill. The assumed waste generation rates are:

Rural – 1.30 kg/person/day
Urban – 2.51 kg/person/day

Utilizing these waste generation rates and the population data from the last census, estimated waste generation for the study area was calculated and is presented in Table 5-1. The table provides the waste generation rates, by community, based upon the rural and urban generation rates provided above. For the purpose of this study, the communities in the study area were put into two distinct categories. The first category is all the communities that are considered to be urban and the second category includes all rural communities in the study area.

[27] Davis Engineering & Associates Limited, Port Blanford. Solid Waste Management Study Alexander Bay – Eastport Peninsula Area. 1995.
[28] Newfoundland & Labrador Consulting Engineers Ltd., St. John's. Report on Regional Solid Waste Disposal for Botwood & Area. 1986
[29] Proctor & Redfern Limited. Report on Solid Waste Disposal for the Windsor, Bishop's Falls, Grand Falls Area. 1982
[25] Robin Hood Bay Sanitary Landfill, City of St. John's. Scale Data, 2000 & 2001

Table 5-1: Summary of Study Area Estimated Waste Generation Rates[26]

Name	Type	Population (2001)	Waste Generation (kg/person/day)	Waste Generation (tonnes/year)
Urban				
Gander	Town	9,651	2.51	8,842
Grand Falls-Windsor	Town	13,340	2.51	12,221
Total Urban		22,991		21,063
Rural				
Appleton	Town	576	1.3	273
Badger	Town	906	1.3	430
Baytona	Town	325	1.3	154
Birchy Bay	Town	612	1.3	290
Bishop's Falls	Town	3,688	1.3	1,750
Botwood	Town	3,221	1.3	1,528
Buchans	Town	877	1.3	416
Campbellton	Town	565	1.3	268
Carmanville	Town	798	1.3	379
Centreville-Wareham-Trinity	Town	1,146	1.3	544
Change Islands	Town	360	1.3	171
Comfort Cove-Newstead	Town	510	1.3	242
Cottlesville	Town	297	1.3	141
Crow Head	Town	218	1.3	103
Dover	Town	730	1.3	346
Eastport	Town	509	1.3	242
Embree	Town	745	1.3	354
Fogo	Town	803	1.3	381
Fogo Island Region[1]	Region	564	1.3	268
Gambo	Town	2,084	1.3	989
Glenwood	Town	845	1.3	401
Glovertown	Town	2,163	1.3	1,026
Greenspond	Town	383	1.3	182
Happy Adventure	Town	245	1.3	116
Hare Bay	Town	1,065	1.3	505
Indian Bay	Town	214	1.3	102
Joe Batt's Arm - Barr'd Island - Shoal Bay	Town	889	1.3	422
Leading Tickles West	Town	453	1.3	215
Lewisporte	Town	3,312	1.3	1,572
Little Burnt Bay	Town	312	1.3	148
Lumsden	Town	622	1.3	295
Millertown	Town	118	1.3	56
Musgrave Harbour	Town	1,294	1.3	614
New-Wes-Valley	Town	2,832	1.3	1,344
Norris Arm	Town	843	1.3	400
Northern Arm	Town	375	1.3	178
Peterview	Town	811	1.3	385

[26] Population based on Statistics Canada 2001 Census.

Name	Type	Population (2001)	Waste Generation (kg/person/day)	Waste Generation (tonnes/year)
Point Leamington	Town	685	1.3	325
Point of Bay	Town	169	1.3	80
Salvage	Town	203	1.3	96
Sandringham	Town	262	1.3	124
Sandy Cove, B.B.	Town	152	1.3	72
Seldom-Little Seldom	Town	477	1.3	226
St. Brendan's	Town	251	1.3	119
Summerford	Town	1,010	1.3	479
Terra Nova	Town	30	1.3	14
Terra Nova National Park	Park	1028[2]	1.3	488
Tilting	Town	285	1.3	135
Traytown	Town	272	1.3	129
Twillingate	Town	2,611	1.3	1,239
Division No. 6, Subd. A* (Buchan's Junction)	Subd.	110	1.3	52
Division No. 6, Subd. C* (Philip's Head)	Subd.	328	1.3	156
Division No. 6, Subd. D* (Norris Arm North)	Subd.	337	1.3	160
Division No. 6, Subd. E* (Benton)	Subd.	182	1.3	86
Division No. 7, Subd. A* (Cape Freels North)	Subd.	161	1.3	76
Division No. 7, Subd. B* (No Community)	Subd.	5	1.3	2
Division No. 7, Subd. D*(Burnside – St. Chad's)	Subd.	224	1.3	106
Division No. 7, Subd. N* (No Community)	Subd.	15	1.3	7
Division No. 8, Subd. E* (Cottrell's Cove)	Subd.	692	1.3	328
Division No. 8, Subd. F* (Brown's Arm)	Subd.	973	1.3	462
Division No. 8, Subd. G* (Boyd's Cove)	Subd.	518	1.3	246
Division No. 8, Subd. H* (Virgin's Arm – Carters Cove)	Subd.	2,402	1.3	1,140
Division No. 8, Subd. I* (Purcell's Harbour)	Subd.	244	1.3	116
Division No. 8, Subd. L* (Gander Bay North)	Subd.	3,436	1.3	1,630
Division No. 8, Subd. M* (Deadman's Bay)	Subd.	220	1.3	104
Total Rural		52,564		25,427
TOTAL URBAN AND RURAL		**75,555**		**46,490**

*2001 Census Data is divided into Census Subdivisions, which include local service districts and unincorporated towns.
1 - Fogo Island Region consists of Deep Bay, Island Harbour, and Stag Harbour.
2 - An estimated population for the Terra Nova National Park was determined based on the annual amount of solid waste generated at the park divided by 1.3 kg/person/day. This population was not included in the total population for the study area.

As indicated in Table 5-1, the estimated annual waste generation for the study area is 46,490 metric tonnes.

5.2 DISTRIBUTION OF WASTES BETWEEN RESIDENTIAL AND IC&I SECTORS

The next step in this Phase I work is to characterize the waste stream utilizing the estimated annual waste generation. To characterize the waste generated, it is important to make a distinction between residentially generated waste and waste generated by the industrial, commercial and institutional (IC&I) sector. Waste generation and waste characteristics for these sectors will vary depending on where the materials are generated (urban or rural sources). This is especially true for the IC&I portion. Variations among regions are also expected because of cultural and/or regulatory differences.

5.2.1 Residential vs. ICI Ratio for Urban Communities

A study[27] conducted for Environment Canada estimated that 60% of the solid waste generated in the province in 1992 was IC&I generated waste, while the residential portion made up 34% and construction waste made up the balance of 6%. The Environment Canada study involved a detailed analysis of IC&I and C&D waste materials by incorporating regional information on waste disposal.

Since no actual residential vs. ICI ratio data for urban communities was available for the Central Region, data from the Robin Hood Bay Sanitary Landfill was incorporated into this section of the report. The residential vs. ICI ratio for urban areas was determined from this existing data that is provided in Table 5-2. The data in the table is separated into residential and IC&I waste streams. The entry for City Clean & Beautiful waste was placed with residential materials because it is mostly residential-type litter that is collected around the city. The entry for Leaves for Compost category were divided evenly between residential and IC&I. Useable fill, which accounted for 20,706 tonnes in 2001, was not included in Table 5-3 because this is considered as cover used at the landfill and does not represent generated waste.

The Robin Hood Bay data indicates that 34% of the waste received at the Sanitary Landfill is residential and 66% is IC&I. This is in agreement with the data from the Environment Canada study quoted above.

---

27 Resource Integration Systems Limited. *Environment Canada. An Assessment of the Physical, Economic and Energy Dimension of Waste Management in Canada, Volume 1.* 1996

Table 5-2: Waste Composition of Material Received at the Robin Hood Bay Sanitary Landfill[28]

Waste Stream	2000 Waste Amount (tonnes)	2001 Waste Amount (tonnes)
Residential		
Domestic	49,558	52,806
City Clean & Beautiful	83	154
Leaves for Compost	--	39
	49,641	**52,999**
IC&I		
Asbestos	543	259
Commercial/Domestic Mix	8,368	14,143
Construction Material	1,566	1,895
Commercial	61,173	60,122
Demolition Material	1,682	1,175
Fish Offal	--	0.25
Harbour Sludge *(no longer accepted)*	8	0
Hospital Waste	1,598	1,843
Leaves for Compost	--	39
Miscellaneous	6,077	4,190
*Road Base Material	645	5,237
Regatta	3	0.44
*Remediated Soil	--	12,780
Rubber Tires *(no longer accepted)*	357	337
*Reusable Asphalt	--	13
Trees/Wood	78	155
*Miscellaneous Water Waste	1,649	1,306
	83,746	**103,494**
Total Weight (kg)	**133,387**	**156,493**

* Recycled/reused
-- Not reported

5.2.2 Residential vs. ICI Ratio for Rural Communities

To determine the residential vs. IC&I ratios for rural communities, the study team looked at data from various communities in Newfoundland and Nova Scotia. Table 5-3 presents the Newfoundland data, while Table 5-4 summarizes the data for Nova Scotia. As the tables indicate, the IC&I generation rate tends to be higher in urban type areas than in the rural areas since the majority of IC&I establishments are located in urban areas. Based on a weighted average of the data in Table 5-3, a residential vs. IC&I ratio of 73% residential and 27% IC&I was calculated for urban communities.

[28] Robin Hood Bay Sanitary Landfill, City of St. John's. Scale Data, 2000 & 2001

Table 5-3: Residential vs. IC&I Waste Generation for Newfoundland Communities

Area/Region	Year of Data	Urban or Rural	Population	Total Waste Generation (tonnes)	Residential		IC&I		Per Capita (kg/person/day)	
					(tonnes)	%	(tonnes)	%	Residential	IC&I
Robin Hood Bay[29]	2001	Urban	170,848	177,199	52,806	30	124,393	70	0.85	1.99
Robin Hood Bay[30]	2000	Urban	170,848	159,213	49,558	31	109,655	69	0.79	1.75
Placentia[31]	1995	Urban	6,369	8,061	3,224	40	4,836	60	1.38	2.08
Bay Bulls[32]	1991	Rural	2,129	1,681	1,231	73	450	27	1.58	0.58
Holyrood[33]	1991	Rural	2,075	3,745	2,987	80	758	20	3.94	1.00
Avalon Isthmus – Southwest Arm Area[34]	1992	Urban	5,615	2,511	1,404	56	1,107	44	0.68	0.54
Town of Norman's Cove-Long Cove[35]	2001	Rural	852	2,600	2,340	90	260	10	7.5	0.08
Corner Brook/Bay of Islands/Humber Valley Region[36]	1994	Urban	45,762	36,843	14,737	40	22,105	60	0.88	1.32
Port Blandford – Winterbrook[37]	1994	Rural	6,694	2,701	1,890	70	811	30	0.77	0.33
Markland – Heart's Desire[38]	1993	Rural	7,815	3,619	2,497	69	1,121	31	0.87	0.39

29 Robin Hood Bay Sanitary Landfill, City of St. John's. Scale Data, 2000 & 2001
30 Robin Hood Bay Sanitary Landfill, City of St. John's. Scale Data, 2000 & 2001
31 BAE♦Newplan Group. *Regional Solid Waste Management Study Area for Placentia and Area.*1995.
32 Newplan Consultants Limited. *St. John's Urban Region Waste Management Study*. 1993.
33 Newplan Consultants Limited. *St. John's Urban Region Waste Management Study*. 1993.
34 Ms. Diane Hudson. *Municipal Report*. 2001.
35 Davis Engineering and Associates Limited. *Solid Waste Management Study, Avalon Isthmus – South West Arm*. 1992.
36 BAE-Newplan Group Limited. *Corner Brook/Bay of Islands/Humber Valley Region Waste Audit*. 1997.
37 Davis Engineering and Associates Limited. *Solid Waste Management Study Port Blandford - Winter Brook.* 1994.
38 Davis Engineering and Associates Limited. *Solid Waste Management Study, Markland – Heart's Desire*. 1993.

Table 5-4: Residential vs. IC&I Waste Generation for Nova Scotia Communities

Area/Region	Year of Data	Population	Total Waste Generation (tonnes)	Residential (tonnes)	Residential %	IC&I (tonnes)	IC&I %	Per Capita (kg/person/day) Residential	Per Capita (kg/person/day) IC&I
Cape Breton Island[39]	1994	160,161	96,340	46,243	48%	50,097	52%	0.79	0.86
Northern Region[40]	1994	184,291	123,660	77,906	63%	45,754	37%	1.16	0.68
Annapolis County[41]	1993/94		13,608	8,709	64%	4,899	36%		
Annapolis Valley/Southwestern Region[8]	1994	146,304	91,451	53,986	59%	37,465	41%	1.01	0.70
South Shore/Valley Region[42]	1994	155,671	96,279	48,140	50%	48,140	50%	0.85	0.85
Valley Region[43]	1997	84,205	52,468	24,253	46%	28,215	54%	0.79	0.92
Whynott's Settlement Landfill[44]	1990		12,769	6,012	47%	6,757	53%		

[39] Vaughan Environmental Consultants Limited in association with Resource Integration Systems Limited and Jacques Whitford Environment Limited. *Cape Breton Island Solid Waste Disposal and Household Hazardous Waste Management Options Study, Phase 1 Waste Audit Final Report.* April 1994.
[40] Vaughan Environmental Consultants Limited in association with Resource Integration Systems Limited and Jacques Whitford Environment Limited. *Northern Region Solid Waste Management Study, Phase 1 Waste Audit Final Report.* March 1994.
[41] Neill and Gunter (Nova Scotia) Limited and Angus Environmental Limited. Annapolis Valley/Southwestern Region Phase 1 Final Report Waste Audit. The Municipality of the District of Clare. 1994.
[42] Vaughan Environmental Consultants Limited in association with Resource Integration Systems Limited and Jacques Whitford Environment Limited. *South Shore/Valley Region Solid Waste Management Study, Phase 1 Waste Audit Final Report*. March 1994.
[43] Vaughan Environmental Consultants Limited. *Valley Region Resource/Solid Waste Management Plan, Valley Region Waste-Resource Management Committee.* January 1997.
[44] Acres International Limited. *Solid Waste Management Strategy, Whynott's Settlement*. May 1991.

When these ratios are applied to the Central Newfoundland Region, the total annual waste tonnage of 46,490 (determined from Table 4-1) can be broken down into residential and ICI sectors for urban and rural communities. This summary is presented in Table 5-5. The breakdown for the "urban" category is based on the total tonnage calculated for the urban areas (see Table 4-1) and applying the urban residential vs. ICI ratio of 34/66. The breakdown for the residential and IC&I for the rural areas is based on the total tonnage calculated for the rural areas (see Table 4-1) and applying the rural residential vs. ICI ratio of 73/27.

Table 5-5: Projected Annual Generation of Waste for the Central Newfoundland Region

Type of Community	Population	Waste Generation (tonnes/year)	
		Residential	**IC&I**
Urban	22,991	7161	13,902
Rural	52,564	18,562	6,865
Total:	75,555	25,723	20,767

From this break down, the unique characteristics within the waste stream can be estimated based upon either direct sort information for the residential waste or typical IC&I characterization data. This characterization is provided in Section 6.

6.0 WASTE CHARACTERISTICS FOR CENTRAL NEWFOUNDLAND

6.1 CHARACTERIZATION OF THE RESIDENTIAL WASTE STREAM

The residential waste stream for the urban and rural populations is not expected to vary greatly, so the residential characterization for both urban and rural populations has been estimated together. Each geographic region is unique in terms of the amount and characteristics of materials its residents generate; therefore, it is difficult to determine exactly what materials will be produced in one region based on the characteristics of the materials produced in other regions. Estimates can be made, however, that give an approximate breakdown of material types.

Residential waste characterization studies have been carried out for a number of communities in the past, several of which are presented in Section 4 of this report. Two directly relevant studies include the characterization of residential waste from the Green Bay waste management centre[45], and the direct waste sort characterization study in the Municipality of the District of Lunenburg, Nova Scotia[46], using the Canadian Council of Ministers of Environment protocols established in the SENES study[47].

The percentage of materials of each waste type in the Municipality of the District of Lunenburg study was used to estimate the amount and composition of residential materials that would be generated in the study area. The data from Lunenburg was judged to be the best to estimate the composition for the Central Newfoundland Region because the Lunenburg area would likely be more culturally and industrially similar to the Central Newfoundland Region than regions in Ontario. The data was also more detailed than the data from Green Bay and the Ontario regions. The percentages for categories were quite similar between the Municipality of the District of Lunenburg and the average of the Ontario regions.

Utilizing the annual residential generation data presented in Table 5-5 and characterization breakdown from the Lunenburg study, a projected residential waste characterization for each of the three residential categories was calculated.

---

[45] Green Bay Waste Management Centre. *Audit Results for Solid Waste Study*. June 2000.
[46] SNC-Lavalin. *Waste Characterization Study of Residual Solid Waste & Recyclables in the Municipality of the District of Lunenburg, Nova Scotia (Spring 2001).* SNC-Lavalin Inc. December 2001.
[47] SENES Consultants. *Recommended Waste Characterization Methodology for Direct Waste Analysis in Canada*. 1999.

Table 6-1: **Projected Residential Waste Composition for the Central Newfoundland Region**[48]

Waste Stream	Waste Generation Breakdown (%)	Residential Forecast Waste Characterization (tonnes/year)		
		Urban Areas	Rural Areas	Total for Study Area
Paper & Paperboard	27.8%	1,991	5,160	**7151**
Glass	3.1%	222	576	**798**
Ferrous	3.6%	258	668	**926**
Aluminum	1.0%	72	186	**258**
Plastic	9.8%	702	1,819	**2,521**
Multi-Material Wastes	2.9%	208	538	**746**
Textiles	4.1%	293	761	**1,054**
Organics	41.7%	2,986	7,740	**10,726**
Special-Care Wastes	3.3%	236	613	**849**
Other Wastes	2.7%	193	501	**694**
Total	100.0%	7,161	18,562	**25,723**

6.2 CHARACTERIZATION OF IC&I WASTE STREAM

Little direct characterization data is available for IC&I materials. It is difficult to characterize the ICI waste stream since it not only varies from urban to rural areas, but also varies based on the specific types of industries and institutions in a given region. Solid waste experts agree that it is not possible to utilize the IC&I waste characteristics of one region to project the IC&I waste stream of another unless the IC&I sector is defined in more detail.

IC&I waste will vary depending upon the generator. For example, the characteristics of hospital waste will be very much different than waste from a manufacturing source.

Without having a complete list of the type of IC&I generators and corresponding waste volumes for the study area, it was decided to utilize the characterization approach of the regional solid waste management studies[49] carried out in Nova Scotia in 1994. The approached utilized in these studies is as follows:

[48] SNC-Lavalin. *Waste Characterization Study of Residual Solid Waste & Recyclables in the Municipality of the District of Lunenburg, Nova Scotia (Spring 2001).* SNC-Lavalin Inc. December 2001.
[49] Vaughan Environmental Consultants Limited in association with Resource Integration Systems Limited and Jacques Whitford Environment Limited. *South Shore/Valley Region Solid Waste Management Study, Phase 1 Waste Audit Final Report*. March 1994.

"The ICI waste composition estimate for this study is based on the MSW sampling data from Metropolitan Toronto's Solid Waste Environmental Assessment Project (SWEAP) Waste Composition Study.[50]"[51]

"The breakdown for the Food and Accommodation Sector is based on the more detailed Ontario Waste Composition Study, Volume 2.[52] Primary and heavy industry is not included under the ICI composition tables due to the high variability of these wastes depending on the specific type of industry and local conditions. Information from other studies cannot be considered representative of local activities in this case. It is also common practice for most primary industrial generators (e.g., forestry, agriculture, fish processors) to treat and/or dispose of waste on site or nearby lands." [53]

The weighted average tabulation presented in Table 6-2 utilizes the waste composition estimates for each IC&I sector (as quoted above) and the Statistics Canada 1996 employment data for each of these sectors for the communities in the Central region. The last column of the table indicates an estimated typical waste characterization for the IC&I waste stream for the Central Newfoundland area.

---

[50] Proctor and Redfern Limited and SENES Consultants Limited. *Metropolitan Toronto Department of Works (MTO). SWEAP Solid Waste Environmental Assessment Plan Component 4: Solid Waste Management System Inventory.* 1991.

[51] Vaughan Environmental Consultants Limited in association with Resource Integration Systems Limited and Jacques Whitford Environment Limited. *South Shore/Valley Region Solid Waste Management Study, Phase 1 Waste Audit Final Report*. March 1994.

[52] Gore & Storrie Limited. *Ontario Ministry of the Environment. Commercial Waste Composition Study Volume II of the Ontario Waste Composition Study.* 1991

[53] Vaughan Environmental Consultants Limited in association with Resource Integration Systems Limited and Jacques Whitford Environment Limited. *South Shore/Valley Region Solid Waste Management Study, Phase 1 Waste Audit Final Report*. March 1994.

Table 6-2: Waste Characterization Presented as Weighted Percent for IC&I Sectors in Study Area.

ICI Sector / Waste Generated	Manufacturing	Construction	Transportation and Storage/ Communication and Other Utility	Retail/ Wholesale Trade	Finance, Real Estate and Other Services	Business and Public Administration	Food and Accommodation	Educational	Health	Weighted Average for Study Area
Paper	**31.10%**	**7.80%**	**52.60%**	**45.70%**	**61.00%**	**66.10%**	**42.42%**	**52.40%**	**58.60%**	**48.05%**
OCC	11.90%	3.60%	8.50%	26.20%	2.30%	6.40%	13.53%	5.10%	7.10%	11.04%
Fine	0.20%	0.10%	1.40%	1.90%	7.40%	13.20%	1.51%	0.80%	12.10%	5.02%
News	0.70%	0.40%	12.20%	3.50%	5.20%	4.50%	9.28%	8.60%	2.20%	4.77%
Magazines	0.60%	0.00%	0.80%	1.60%	3.10%	1.60%	0.26%	3.30%	1.50%	1.44%
Other	17.70%	3.70%	29.70%	12.50%	43.00%	40.40%	17.84%	34.60%	35.70%	25.78%
Plastic	**22.00%**	**2.50%**	**18.80%**	**8.30%**	**19.00%**	**7.80%**	**8.33%**	**10.10%**	**21.00%**	**12.17%**
Rigid (PET,HDPE,PS)	3.10%	0.20%	1.70%	1.10%	0.50%	0.70%	8.01%	0.80%		1.43%
Film	9.20%	0.70%	5.80%	3.10%	11.20%	3.60%	0.00%	6.10%		3.71%
Other	9.70%	1.60%	11.30%	4.10%	7.30%	3.50%	0.32%	3.20%		4.04%
Ferrous Metals	**6.10%**	**7.30%**	**4.60%**	**6.10%**	**1.30%**	**1.30%**	**3.28%**	**3.60%**	**1.20%**	**3.89%**
Food and beverage	0.10%	0.10%	2.30%	2.10%	0.25%	0.70%	3.02%	1.30%		1.13%
Other	6.00%	7.20%	2.30%	4.00%	1.05%	0.60%	0.26%	2.30%		2.59%
Non-Ferrous Metals	**0.50%**	**0.30%**	**2.50%**	**0.50%**	**0.60%**	**0.60%**	**1.03%**	**1.90%**	**1.70%**	**1.04%**
Food and beverage	0.10%	0.00%	2.30%	0.40%	0.50%	0.40%	0.87%	0.90%		0.54%
Other	0.40%	0.30%	0.20%	0.10%	0.10%	0.20%	0.16%	1.00%		0.26%
Organics	**14.10%**	**0.60%**	**9.40%**	**23.20%**	**2.60%**	**12.70%**	**32.42%**	**19.50%**	**12.30%**	**15.16%**
Glass	**0.30%**	**2.80%**	**4.20%**	**4.50%**	**2.70%**	**1.90%**	**6.97%**	**8.90%**	**2.60%**	**3.84%**
Food and beverage	0.30%	0.20%	4.20%	2.55%	1.90%	1.70%	6.60%	5.60%		2.37%
Other	0.00%	2.60%	0.00%	1.95%	0.80%	0.20%	0.37%	3.30%		1.09%
Wood	**18.40%**	**34.80%**	**0.10%**	**2.40%**	**0.00%**	**7.80%**	**0.63%**	**0.30%**		**6.66%**
Textiles/Rubber/Leather	**3.80%**	**1.30%**	**5.20%**	**1.70%**	**8.10%**	**0.00%**	**1.35%**	**1.90%**	**2.70%**	**2.26%**
Building Materials/Rubble	**3.20%**	**40.70%**	**0.60%**	**6.00%**	**1.70%**	**0.80%**	**0.08%**	**0.30%**		**5.58%**
Special	**0.10%**	**0.10%**	**0.00%**	**0.70%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**		**0.16%**
Other	**0.40%**	**1.90%**	**0.00%**	**0.90%**	**3.00%**	**0.80%**	**1.91%**	**1.00%**		**0.90%**

Table 6-3 provides a summary of the waste streams and utilizing the total annual waste generation rate for the ICI sector of 20,767 tonnes (see Table 5-5), provides the tonnage breakdown for each of the waste categories.

Table 6-3: **Estimated IC&I Composition for the Study Area**

Waste Generated	Weighted Average For Study Area	Forecast Generation (Tonnes)
Paper	48.19%	10,008
Plastic	12.20%	2,534
Ferrous Metals	3.90%	810
Non-Ferrous Metals	1.04%	216
Organics	15.21%	3,159
Glass	3.85%	799
Wood	6.68%	1,387
Textiles/Rubber/Leather	2.27%	471
Building Materials/Rubble	5.60%	1,163
Special	0.16%	33
Other	0.90%	187
Total	**100.00%**	**20,767**

Waste collected from international flights and vessels was not included in the calculation of IC&I waste generated by the study area because it is out of the scope of the waste management strategy. The international waste generated by commercial sources is the responsibility of the generator. Waste materials from international sources are regulated by the Canadian Food Inspection Agency (CFIA) and are included in the Federal Health of Animals Act (see Appendix B, Section 47). There are two acceptable disposal methods documented in the regulations, incineration and deep burial (to a minimum depth of 1.8 m). Any agreement/contract an individual municipality has to incinerate commercial waste is outside of our scope.

7.0 FIFTY YEAR WASTE GENERATION PROJECTION

Based on the high scenario population decrease of 6.1% (See Section 3.0) in the study area, BAE♦Newplan developed a waste generation projection over the next fifty (50) years. The waste generation projection is provided in Table 7-1. The table presents a 50% waste diversion scenario and a 60% waste diversion scenario and provides to total tonnage expected to be landfilled after fifty (50) years for each of these scenarios.

Table 7-1: **50-Year Waste Generation Projection Summary (6.1% decrease)**

	Total Waste Generated (Tonnes)	50% Diversion		60% Diversion	
		Landfill (Tonnes)	Diverted (Tonnes)	Landfill (Tonnes)	Diverted (Tonnes)
Base Year	46,490				
Year 1	46,348	23,174	23,174	18,539	27,809
Year 50	43,574	21,787	21,787	17,430	26,144
Cumulative Total	**2,321,677**	**1,160,838.5**	**1,160,838.5**	**928,671**	**1,393,006**

For comparison, Table 7-2 provides the same projection utilizing the medium population decrease scenario of 11.4% decrease for the study area. As can be seen from comparison of the totals at the bottom of the tables, the difference in waste generation projection between the two scenarios is only 4%.

Table 7-2: **50-Year Waste Generation Projection Summary (11.4% decrease)**

	Total Waste Generated (Tonnes)	50% Diversion		60% Diversion	
		Landfill (Tonnes)	Diverted (Tonnes)	Landfill (Tonnes)	Diverted (Tonnes)
Base Year	46,490				
Year 1	46,283	22,900	22,900	18,320	27,480
Year 50	40,956	20,295	20,295	16,236	24,354
Cumulative Total	**2,239,562**	**1,119,781**	**1,119,781**	**895,823**	**1,343,737**

8.0 MUNICIPAL SOLID WASTE MANAGEMENT SYSTEMS

There are many options available for managing municipal solid waste. The costs of operating the systems can vary significantly depending on a wide range of factors, such as the following:

- the collection of the wastes;
- the techniques and technologies used to process the wastes;
- waste composition;
- waste management promotion and public education;
- the local culture;
- the local economy; and
- the market demand for recovered waste.

The following section will provide a summary of options for managing municipal solid waste and present examples of system costs as experienced by other municipalities.

8.1 RECYCLABLE DROP-OFF CENTRES

Recyclable drop-off centres are an inexpensive way of collecting recyclables from residents and businesses. Numerous municipalities across Canada have implemented them. In a 1998 survey of 132 Canadian local governments by the University of Victoria, 16.7% said that they used recycling depots to collect recyclables, and 49.2% said they collect recyclables using both depot and curb side collection. The City of Calgary uses 44 recycling depots throughout the city to collect residential recyclables. In 2001, the depots collected 25,387 tonnes of newspaper, glass, metal, plastic milk jugs and mixed paper and cardboard. This amounts to approximately 0.03 tonnes per capita (using 1998 civic census data).

Recycling centres should be established where residents or waste haulers drop off their waste or in other convenient high-traffic areas, like near a supermarket or a shopping mall. Mobile drop-off trailers or permanent containers can be used to collect the materials in different locations, which are then transported, to a central location for processing. Drop-off recycling is less convenient than curb side recycling and usually results in lower recovery rates than curbside collection. There can also be significant contamination problems as there is no-one monitoring what is being put into the containers.

8.2 SINGLE STREAM, OR MIXED WASTE COLLECTION

This curbside collection option is perhaps the most convenient of all options, as it requires little change in the residents' disposal habits. Waste is collected unsorted in a collection vehicle and brought to a material recovery facility (MRF), where recyclables are then removed manually or mechanically. This option is convenient for residents, as they are not required to sort or transport waste and only minimal education efforts are needed. Additionally, for some types of businesses whose waste streams are dominated by a single waste type (for example, paper for offices or corrugated cardboard for supermarkets) mixed waste collection is convenient and can be successful.

Mixed waste processing can incorporate the production of compost or refuse-derived fuel (RDF). Recyclables are recovered at the front-end of the process. Organic matter such as leaf, yard and food waste and unrecyclable paper are separated from the stream and composted. The remainder of the mixed waste stream is either converted to RDF or landfilled.

While this option is convenient and easy to implement, it yields low recovery rates and is very labour and capital intensive. Approximately 25 percent (by weight) of recyclable material may be contaminated and therefore unmarketable. For instance, paper items may become soiled by food waste, or glass bottles may be prone to breaking. Compost produced from mixed waste may be highly contaminated by small particles of plastic and broken glass and require extensive screening.

The remainder of the waste stream will contain a significant amount of organics that was not removed for composting. If landfilled, the remaining organics will contribute to the production of leachate, odours and methane, a greenhouse gas.

Canadian experiences with mixed solid-waste processing have not met with much success. The Westmoreland-Albert Solid Waste Corporation in New Brunswick tried the mixed waste collection system, but the attempt was unsuccessful. The Corporation then moved to a Wet-Dry collection system.

---

[55] McDavid, James C. and Verna Laliberte. June 1999. The Efficiency of Residential Recycling Services in Canadian Local Governments: National Survey Report. http://web.uvic.ca/lgi/reports/recycle/recexec.html
[56] http://www.gov.calgary.ab.ca/sws/statistics.html
[57] http://www.gov.calgary.ab.ca/community/research/socialindicators/dpsize.html

8.3 WET-DRY COLLECTION

With Wet-Dry collection, waste is separated into two categories: Wet materials (yard trimmings, food scraps, diapers, soiled paper, animal waste, etc) and Dry materials (glass containers, tin and steel cans, plastics, etc). The Wet stream is composted while the materials within the Dry stream are separated for recycling. Because Wet materials are kept separate from the rest of the waste materials, recyclables are kept relatively uncontaminated and marketable.

In the City of Guelph, the focal point of the city's waste management system is the Wet-Dry Recycling Centre. A recent evaluation of the Wet-Dry recycling program conducted jointly by the City of Guelph, Corporations Supporting Recycling (CSR), and Enviro RIS found that the system had a residential flow diversion rate of 39.4%; that is, 39.4% of residential waste entering the facility was diverted from disposal. The residential waste diversion relative to the 1987 baseline was found to be 51.5%. Overall, the combined diversion rate for the Wet-Dry facility is 58%. The combined diversion rate includes all materials received at the Wet-Dry facility, including residential Wet and Dry waste, yard waste, public drop-off, IC&I waste, and other municipal recyclable or compostable material.

The Wet-Dry Recycling Program contributed 8,563 tonnes, or 22% of the waste by weight in the system, of material to Guelph's residential waste management system. Other contributors to diversion include HHW programs, yard waste programs, tires, white goods, wood, steel, and on-property initiatives such as grasscycling and backyard composting.

The Wet-Dry program was launched in 1995 after six years of pilot testing. The development of the Wet-Dry facility was $36-million, which included $24-million for the facility itself, $1 million for the land purchase, and $11 million for the approvals process, legal fees, public consultation, the annual monitoring program, design, and consulting fees. The gross cost for processing Dry waste was $130 per tonne in 1999, which includes both processing and administration costs. Dry processing net of administration was $89 per tonne. In 1997, the gross cost of collecting the Wet-Dry materials was $117/tonne. Costs for other components are shown in table 8-1.

[58] Smith, Cathy et. al. Evaluating Guelph's Wet-Dry Recycling Program. 2000.

Table 8-1: **Guelph Wet-Dry Recycling Centre Costs (1999)**

Component	Tonnes/ Year	Administration Costs	Process Costs	Total Costs (Gross)	Total Costs* (Net of Revenue)	Total Costs/ Tonne* (Net of Revenue)
Residential Dry	10,170	$609,290	$1,718,606	$2,327,896	$2,121,617	$209
Total Dry	28,923	$1,180,648	$2,580,047	$3,760,695	$1,648,404	$57
Total Wet	12,309	$557,752	$755,057	$1,312,809	$1,252,440	$102
HHW	128	$47,784	$121,112	$168,896	$167,826	$1311
Public Drop-Off	3,190	$85,959	$99,423	$185,382	$12,027	$4
Yard Waste	2,856	$69,850	$42,305	$112,155	$73,903	$26

Source: Smith, Cathy et. al. Evaluating Guelph's Wet-Dry Recycling Program. 2000.
*Total cost is administration costs plus process costs and does not include collection costs.

Guelph's Wet processing facility has a capacity of 44,000 tonnes per year. In 2000, 12,248 tonnes of Wet waste was processed at the facility. Of this, 65% was municipally collected Wet waste from residents and curbside businesses and 13% was yard waste and brush. Other sources of Wet waste included manure (for a carbon source), chipped wood (as an amendment), drop-off Wet-waste, and ICI Wet-waste. The Wet waste was either sold or transferred (34%), sent to landfill (21%), or placed in inventory or lost to evaporation (45%).

The Dry processing area is able to process up to 91,000 tonnes of Dry waste per year. In the year 2000, the facility processed 36,000 tonnes of Dry waste. Thirty-seven percent of the Dry waste was municipally collected Dry waste, and 15% came from private haulers. Other sources of Dry waste included the blue-box materials from a nearby county, the ICI sector, and city and township residents. Forty five percent of the Dry waste was sold, 49% sent to landfill, and 6% placed in inventory. The input of the pre-separated Dry materials into the Dry waste stream significantly decreases the stream's total costs (see table 1). Because the materials are pre-sorted, less processing time is required and a greater percentage of the materials are marketable.

[59] Smith, Cathy et. al. Evaluating Guelph's Wet-Dry Recycling Program. 2000.
[60] Kelleher, Maria. *Guelph's Wet-Dry System*. Solid Waste & Recycling. February/March 1998.
[61] Smith, Cathy et. al. Evaluating Guelph's Wet-Dry Recycling Program. 2000
[62] Kelleher, Maria. *Guelph's Wet-Dry System*. Solid Waste & Recycling. February/March 1998.
[63] City of Guelph Wet-Dry Recycling Centre Annual Report.
[64] City of Guelph Wet-Dry Recycling Centre Annual Report.

The facility also has a permanent HHW depot on site, which in 2000 safely disposed of or recycled 125,556 litres of hazardous waste, such as latex/alkyd paint, flammable solvents, acids, glycol, bases, batteries, pesticides, oxidizers, propane cylinders, propane tanks, car batteries, pharmaceuticals, oil filters, household motor oil, and sharps. The net cost of processing HHW in 1999 was $938/tonne.

The Westmoreland-Albert Solid Waste Corporation uses a voluntary Wet-Dry waste collection system to collect waste from 80,000 households in 14 New Brunswick communities. The program is supported by over 80 per cent of the residents.

The entire waste management facility, including the composting and recycling plants and the landfill, is contained on one site.

Residential Dry Waste, along with source-separated ICI Dry wastes, is sorted at the facility's Dry plant. The Dry waste is first dropped on the tipping floor, where staff does a quick pre-sort to remove bulky items. The see-through bags are then loaded into the automated bag opener. From there, wastes are moved along a conveyor belt where sorters pull out recyclable materials, which are then baled and stored for shipping. The remaining waste is run under a magnet to remove ferrous metals and then sent to the facility's secure landfill for disposal.

In the Wet plant, Wet waste is unloaded on the tipping floor and inspected for non-processable materials. The bags of Wet waste are then loaded onto a conveyor, which empty the waste into a bag opener. Materials such as wood chips or chipped cardboard are added to the Wet-waste mix for filler. This mixture is sent through a trommel screen to screen out large non-compostable items like plastic bags and diapers. The non-organic materials are then sent to landfill. The stream of organics then travels under a ferrous magnet to remove the ferrous metals. The organic material is shredded and then stored in one of five climate-controlled primary silos for approximately 21 days. Compost turners mix and move the organics daily until the material exits the primary silos and enters the secondary silos. After another 21 days, the organic matter has been converted to uncured compost. The compost is then sent to a maturing pad for three to six months until it is ready for distribution.

---

[65] City of Guelph Wet-Dry Recycling Centre Annual Report.
[66] Smith, Cathy et. al. Evaluating Guelph's Wet-Dry Recycling Program. 2000

The facility also houses a drop-off area for privately hauled ICI waste, appliances and white goods, old propane tanks and tires. Wood is brought to the facility through the C&D (construction and demolition) and the Christmas Tree Recycling programs. The wood is mulched and used as landfill cover during wet seasons or used as fuel for the facility's heating plant.

The Corporation also operates a Mobile HHW Unit. The Mobile HHW Unit circulates through the corporation's client communities from spring to Fall to accept HHW from residents free of charge.

To keep the Wet and Dry materials from being mixed, the Wet and Dry bags are usually different colours. For instance, the Wet-Dry program run by the Westmoreland-Albert Solid Waste Corporation in New Brunswick uses transparent blue bags for Dry waste and transparent green bags for Wet waste. The bags can be either collected together in one vehicle and separated at the waste facility, or collected separately in a dual collection vehicle. In Guelph, the city uses a co-collection system to pick up curbside Wet-Dry waste in a single pass. The trucks used have two compartments and have a capacity of 37 cubic yards. Wet waste, which is compacted, takes up 25% of the collection space, while the Dry, uncompacted waste takes up 75% . Prior to the adoption of the Wet-Dry program in 1996, the city used 13 trucks for blue box and garbage collection. With the Wet-Dry program, even after a 36% increase in the amount of residential waste collected between 1996 and 1999, only 11 vehicles are required for collection. In 1997, the net cost of collection per tonne in Guelph was $58 .

The Wet-Dry system requires promotion to encourage and train residents to sort their waste into Wet and Dry waste streams. The Albert-Albert Wet-Dry program is voluntary, and the key challenge to diversion is getting residents and businesses to participate. One of the advantages with the Wet-Dry system is that the message of separating waste into the two streams is relatively simple and easy to understand. Another advantage is the ease in which new materials can be recycled when markets become available. Because recyclables are separated out of the Dry waste stream at the processing facility, no new educational effort is required when markets are found for previously unrecycled materials. These materials can simply be pulled out on the sorting chain. As an example, when Westmoreland-Albert began recycling used sneakers, there was no need to educate their residents to sort the shoes. They sneakers were simply removed on the sorting line along with the cans, newspapers and other recyclables. Likewise, the City of Guelph recently began a polyurethane foam-recycling program by simply adding gaylords in a pre-sort area of the centre's MRF. Due to the Wet-Dry system, no large promotion or pilot was required.

While the Wet waste stream can be composted, it is sometimes significantly contaminated with plastics and other debris. This requires that the finished compost be finely screened.

Some of the advantages with a Wet-Dry system include:

- efficient single-pass collection;
- control of recovery rates occurs at the facility instead of in the home or curb, providing the flexibility to respond to market demands;
- the production of compost;
- the stabilization of Wet waste residue;
- the inability to hide unacceptable wastes (e.g. HHW, yard waste) in transparent bags.

Wet-Dry bags

- use of bags reduce capital costs (in comparison to using carts or bins);
- the familiarity of bags to residents;
- the ease of loading bags into the collection vehicles.

Some disadvantages of the Wet-Dry system include:

- increase of plastics residue and other contaminants in compost;
- higher screening costs;
- greater composting capacity needed to process non-organic Wet waste;
- medical waste such as sharps on the sorting line;
- recyclables in the Dry stream can become tangled in clumps with waste and remain unsorted;
- the composition of waste, such as hidden medical waste or other undesirable material, can discourage sorters;
- contamination or breakage of waste (e.g. contamination of paper with broken glass or unrinsed containers);
- bags may be prone to tearing or puncturing.
- bags of waste may be torn open by dogs, raccoons, crows, seagulls, or other animals
- higher consumption of plastic

[67]Kelleher, Maria. *Guelph's Wet-Dry System*. Solid Waste & Recycling. February/March 1998.
[68] Smith, Cathy et. al. Evaluating Guelph's Wet-Dry Recycling Program. 2000.
[69] Kelleher, Maria. *Guelph's Wet-Dry System*. Solid Waste & Recycling. February/March 1998.

Also, in a voluntary Wet-Dry program, diversion rates may be lower due to the amount of unprocessed Wet waste or contaminated Dry waste provided by unparticipating households.

If the program is voluntary, residents may maintain the status quo and continue to put their waste into opaque garbage bags, with the following potential undesirable outcomes:

- the hiding of unacceptable wastes, such as HHW
- the contamination of recyclable materials by food waste
- unprocessed and unstabilized organics entering the landfill

With a mandatory system, waste that is not separated properly into Wet and Dry can be subject to enforcement procedures, such as the refusal of the municipality to collect the waste or, in recurring cases, a fine.

8.4 THREE OR FOUR STREAM WASTE COLLECTION

Three Stream Waste Collection typically involves the source-separation of recyclables, organics and refuse by the waste producer. In Four Stream Waste Collection systems, recyclables are further divided into paper recyclables and containers. For residents, waste is collected in carts, bags or bins. Collection of the different streams is usually performed with conventional packer trucks or specialized collection vehicles with separate compartments.

With this option, recyclables are taken to a Material Recycling Facility for sorting and processing. This process requires more effort in the Three-Stream Waste Collection option than in the Four Stream option because paper products and containers arrive at the facility commingled and must then be sorted. In the Four-Stream option, the material arrives at the facility pre-sorted, and therefore less sorting is required. Similarly, both the three and four stream waste collection option require less sorting than with either the Wet-Dry or the single stream system because the work required to sort has already been performed by residents and businesses. A MRF capable of processing 25,000 tonnes per year of recyclables would be in the range of $6 million to $8 million with an operating cost of $80 to $120 per tonne (not including revenues from the sale of the recyclables).

The organics stream is taken to a composting facility. Because the organics are separated at the source of the waste stream, there are typically fewer contaminants in the compostables and therefore a higher grade of compost might be achievable with less time devoted to screening.

Most of the municipalities in Nova Scotia have chosen three or four stream systems to manage their municipal solid waste. The county of Lunenburg, comprised of four municipal units (three towns and the rural area), uses a four-stream program to service its 37,000 residents. Curbside collection of the four units is provided every two weeks to over 13,500 households. Recyclables and paper are collected in separate blue bags, refuse is collected in regular garbage bags, and organics are collected in aerated carts. The materials are taken to the Lunenburg Regional Recycling and Composting Facility (LRRCF), a fully integrated waste management facility that houses a HHW depot, a first generation landfill, a MRF, an in-vessel composting plant, a C&D waste collection and processing area, and sewage treatment facilities. The approximate capital cost for the facility was $10 million dollars and, according to a recent waste characterization study, has a diversion rate of 64.8% .

In fiscal 2001, the LRRCF diverted 5,657 tonnes of organics and 3,485 tonnes of recyclables from being landfilled. The total cost of operating the MRF, including amortization and revenues, was $711,449, or $198 per tonne. The total cost of operating the composting facility was $463,481, or $70 per tonne. The total cost of the Lunenburg County system, including collection, disposal, recycling, composting, administration and education for fiscal 2001 was $2,760,414 (before revenues), or $204 per household . A list of system costs is found in Table 8-2.

[70] Propane tanks hidden in garbage bags have been known to pose a danger to both workers and equipment, especially in lines that use automated bag breakers.

Table 8-2: **Annual operating costs for the Lunenburg Regional Recycling and Composting Facility (Fiscal 2001)**

Facility Component	Cost (tip fees not included)	Cost (tip fees included)
Disposal Site Cost	$419,727	$181,205
Collection Cost	$1,018,837	$1,018,837
Materials Recycling	$752,246	$711,449
Composting	$471,244	$463,481
HHW	$55,253	$55253
Administration	$248,800	$248,800
Education	$80,969	$80,969
Total Cost	$3,047,496	$2,760,414
Number of Households Serviced	13,500	13,500
Total Cost/Household	$226	$204
Number of Stops (HH & ICI)	14,500	14,500
Total Cost/Household & ICI Unit	$210	$190
Total Tonnage Handled	27,234	27,234
Cost/Tonne	$112	$101
Population	38,181	38,181
Cost/Person	$80	$72

Source: Nova Scotia Environment and Labour

The Halifax Regional Municipality (HRM) operates a similar four-stream waste management system. Refuse is collected in regular garbage bags, recyclable containers in blue bags, newspapers in grocery bags, and organics in aerated carts. In HRM, there are two composting facilities to process the municipality's organic waste. Both are in-vessel, but one uses bin technology and the other uses rectangular agitated beds. In fiscal 2001, about 42,000 tonnes of organic waste was processed.

Recyclables in the municipality are handled through a Material Recycling Facility (primarily residential recyclables) or through private recyclers (mostly ICI recyclables). In fiscal 2001, an estimated 93,000 tonnes of solid waste was recycled in HRM. Table 8-3 summarizes HRM diversion rates and Table 8.4 lists the costs associated with the HRM waste management system.

The programs in both municipalities are mandatory, which allows the municipalities to focus communication efforts on educating residents on how to participate in the program correctly instead of convincing them to do it.

Table 8-3: **HRM Diversion Rates (Fiscal 00-01)**

Item	Value
Residential Diversion Rate	50.8%
Residential Diversion Tonnage	58,542 tonnes
ICI Diversion Rate	60.0%
ICI Diversion Tonnage	131,690 tonnes
Total Diversion Rate	56.8%
Total Diversion Tonnage	190,232 tonnes

Source: Halifax Regional Municipality
*Mass balance for the Halifax Regional Municipality

The main advantage of the three and four stream collection options is that the materials arrive at the facility pre-sorted. This reduces the amount of time and effort required by the facilities to sort and process the recyclables.

Essentially, the sorting process is done in the households and businesses rather than at the processing plant. Also, because the materials are pre-sorted, contamination of recyclables is greatly reduced and a greater amount of the waste stream is recoverable. However, the success of the program relies on significant promotion and education efforts to ensure the correct participation of residents and businesses in the community.

Table 8-4: **Annual operating costs for the Halifax Regional Municipality Waste Management System (Fiscal 2001)**

Facility Component	Cost	Cost (net of tip fee revenue)
Disposal Site Cost	$18,804,748	$9,539,070
Collection Cost	$8,620,298	$8,620,298
Materials Recycling	$1,555,567	$1,555,567
Composting	$3,401,957	$3,401,957
HHW	$320,000	$320,000
Administration	$696,050	$696,050
Education	$281,675	$281,675
Total Cost	$33,680,295	$23,483,697
Number of Households Serviced	119,000	119,000
Total Cost/Household	$283	$197
Total Number of Households	155,000	155,000
Cost/Household	$217	$152
Total Tonnage*	204,454	204,454
Cost/Tonne	$165	$115
Population	367,502	367,502
Cost/Person	$92	$64

Source: Nova Scotia Environment and Labour
*Does not include waste handled by private recyclers or through source reduction

[71] SNC-Lavalin. Waste Characterization Study of Residual Solid Waste & Recyclables in the Municipality of the District of Lunenburg, Nova Scotia (Spring 2001). 2001.
[72] Nova Scotia Environment and Labour

Some advantages of the three/four stream waste collection system include:

- the production of compost
- recyclable or compostable material is pre-sorted
- less contamination of materials in the organics and recyclables streams
- the refuse stream can go straight to landfill without being sorted

Some disadvantages of the three/four stream system include:

- separating garbage into three or four waste streams can initially be confusing for residents and businesses
- a greater level of public education is required to get the residents and businesses separating their waste correctly

The costs of starting up the system and the collection of waste will vary greatly depending on the containers used to prepare the waste for collection. For instance, if aerated carts are used to collect the organics, then collection costs are reduced as waste can be picked up every two weeks. However, the start-up costs associated with carts can be high, as each cart can cost between $80 and $100. Approximately $1.56 million was spent on carts for 13,500 households in Lunenburg County. If bags are used, then organics should be collected every week to minimize odours from anaerobic food waste. Table 8-5 describes some of the advantages and disadvantages associated with using carts and bags to collect household waste.

Table 8-5: **The advantages and disadvantages of carts and bags**

	Advantages	Disadvantages
Bags	• No first-time capital cost • Bags are familiar to residents • Less space required in the home for storing waste between collections • Bag usage relates directly to amount of waste generated • Collection of bags by haulers easy and quick • Residents do not have to worry about cleaning containers • Easy to view contamination or unacceptable items through transparent bags	• Bags can tear or rip • Animals can open bags and get into garbage • Bags create anaerobic conditions for organic waste • Increase in use of plastic • Plastic residue in compost • Weekly collection required to collect bagged organics • Opaque garbage bags can hide recyclable waste in regular refuse

	Advantages	Disadvantages
Carts	• Carts are tidy • Carts are animal proof • Carts allow food waste to be picked up every two weeks • Reduced levels of plastic entering waste stream • Potential for weigh-on-board user pay system • Haulers are not required to lift heavy bags (mechanical lifter does work) • Contaminates can be sorted out when waste is dumped into trucks	• High start-up costs • Residents may not have space on property for storage of carts • Residents may not want carts on property • Carts require occasional cleaning • Using mechanical lifter to empty cart is slower than tossing bags • Carts can be snowed in • Pushing carts down long, unpaved driveways can be difficult • Carts may be difficult to handle or intimidating for the elderly

8.5 COMBINED WASTE COLLECTION

Some communities combine curbside and drop-off collection. For instance, most of the residents in Nova Scotia have the choice of either recycling some materials at an Enviro-Depot or at curbside. Most beverage containers in Nova Scotia (with the exception of milk products) have a deposit associated with them. Residents can either return them to the Enviro-Depot for a refund, or place the materials in their blue bags for recycling at curbside.

8.6 WASTE MINIMIZATION

Waste minimization, or source reduction, is reducing the amount of waste generated at the source instead of putting it into the waste stream. Promoting waste minimization techniques, such as backyard composting, grasscycling, leaf mulching, or precycling, can be added to any waste management system to increase waste diversion and save municipalities money on collection and processing costs. For instance, it is estimated that the Central Region produces 10,578 tonnes of organic waste per year, which is primarily yard and food waste. If 10% of the yard and food waste is reduced at source by residents and businesses through backyard composting, grasscycling and leaf mulching, then the potential savings through waste minimization of yard and food waste could be in the range of $105,780 to $158,670 .

8.7 BACKYARD COMPOSTING

Many municipalities across Canada actively encourage their residents to compost their food and yard waste in their own back yard. Through backyard composting, municipalities:

- reduce the amount of waste material collected in their communities, and thus reduce transportation and processing costs and, environmental impacts
- divert organics from landfill, thereby reducing the amount of methane and leachate produced from landfills
- encourage active living, especially where backyard composting leads to an increased participation in gardening
- though the residents' use of home-made compost, potentially reduces the amount of chemical fertilizers and pesticides used and released in communities

There are many different ways in which municipalities can encourage residents to backyard compost. Many municipalities sell composters to residents free or at a subsidized price. Other municipalities include a door-to-door canvassing campaign to educate residents on how to backyard compost and the benefits of doing so. The canvassers provide solutions to backyard composting issues residents may have. Other municipalities hold workshops periodically, often in partnership with gardening clubs and businesses.

8.8 GRASSCYCLING

Grass clippings needlessly make up a significant portion of the waste stream collected by municipalities. Recognizing this, many municipalities are encouraging their residents to grasscycle. Grasscycling is simply leaving grass clippings on the lawn and letting them decompose back into the soil. To prevent clippings from laying on the grass in clumps, residents are encouraged to mow their lawn once a week during the growing season, cut less than one third off the top of the grass, and leave the blades of grass at least 2 inches long.

As with backyard composting, grasscycling reduces the amount of waste material requiring transport and processing. Grasscycling also reduces the need for artificial fertilizers and pesticides by returning nutrients to the soil naturally.

8.9 LEAF MULCHING

The fall and spring seasons result in a large influx of leaf waste into municipal refuse and composting facilities. Like food waste and grass clippings, leaves can be used by the resident right on their own property. If a resident owns or has access to a lawnmower, he or she can use the mower to mulch the leaves. If the mower is a mulching mower, then the leaves can be mulched into fine pieces and left on the lawn. Otherwise, the mulched leaves can be used on flower and garden beds or put into the backyard composter.

8.10 PRECYCLING

Precycling is preventing waste before it happens. Residents and businesses can prevent waste by reducing, reusing, and buying consciously. When people precycle, they think about the products they are buying and the packaging that the product comes in.

Table 8-6 describes actions associated with precycling.

Table 8-6: **Precycling Actions**

List of Precycling Actions
Avoid buying disposable items
Buy durable and repairable goods
Purchase products with recycled content
Buy in bulk
Avoid over-packaging
Use refillable containers
Buy solutions in concentrate
Use reusable or recyclable packaging

8.11 MUNICIPAL COMPOSTING

The recovery and composting of biodegradable solid waste can play an important role in helping municipalities reach high diversion rates. Besides the conservation of landfill volume, removing organics from landfills reduces methane generation and decreases the amount of food, which would attract pests and vectors like seagulls and rats. Diverting organics from landfills also helps to reduce the amount of landfill leachate.

A key step in planning a municipal composting program is to identify what organic waste will be composted. Potential compost feedstocks available in municipal solid waste include:

- leaves, brush and yard trimmings
- grass clippings
- food waste
- bio-solids and sewage sludge
- soiled or contaminated paper
- food processing waste
- organic industrial wastes and by-products (soiled paper, pulp and paper sludge)
- agricultural waste

The most common portion of the organic waste stream that is composted is leaf and yard waste. Unlike food waste or biosolids, leaf and yard waste is relatively easy to collect and process, with less concern for health issues. This allows the waste to be composted with low-tech, low-cost composting methods, often outdoors in piles known as windrows.

The composting of food and yard waste in central locations has been adopted by many Canadian municipalities. Many municipalities in Nova Scotia collect residential and commercial organic waste and transport it to centralized facilities for composting. In New Brunswick, the Westmoreland Albert Solid Waste Corporation collects food waste from residents in their Wet-Dry program. Similarly, the City of Edmonton collects and compost food waste as well.

An issue that can cause serious concerns for municipal composting is that of capacity. Capacity demand can fluctuate with each season, especially in the spring and fall. Also, capacity demand can fluctuate with economic conditions. Typically, as the economy improves, the amount of waste improves also. To accommodate this, it is important that the expansion of the facilities is included in the planning process.

To adequately deal with these issues and others, it is extremely beneficial to have an experienced composting facility operator managing the facility. Composting facilities are complex and unexpected problems can quickly arise. An experienced operator can prevent the problems from occurring, or keep the situations that do arise from becoming a public relations issue.

8.12 COMPOSTING METHODS

There are four main technologies used in composting municipal organic solid waste. These include:

- open piles
- turned windrows
- aerated static piles
- in-vessel systems

The four technologies are described below.

Open Piles

Open piles, also referred to as heap composting, is one of the simplest of all composting methods, and one of the slowest. Heap composting is the decomposition of organics in small, open piles, and is most commonly seen in use by home composters. The open piles take advantage of the natural air movement through the heap. As decomposition occurs, the inside portion of the pile becomes active and heats. Warm air rises up and out of the pile, drawing cooler air in. While wind currents can help move air through the pile, larger heaps experience compaction and therefore are more difficult to aerate sufficiently.

Open pile composting is typically used for small amounts of organics, like backyard composting operations, and not in centralized operations. Therefore, this operation is not a recommended option for the study area.

Open Air Turned Windrows

Windrow composting involves placing the organic matter in long windrows or piles that are agitated or mixed for aeration on a regular basis. The sizes of windrows vary and depend on the size of the equipment used to turn the organics. For small windrows, a front-end loader can be used to agitate the pile, while larger or longer windrows may require a windrow turner. While they are regularly turned, windrows receive their aeration primarily through natural or passive air movement. If windrows are too large, anaerobic areas can be created within the pile, which can result in strong odours being released when the windrow is turned. Alternatively, windrows that are too small may not be able to achieve temperatures high enough for satisfactory composting. Because windrows are operated in the open, provisions must be made to control drainage and wind-blown debris.

This method of composting is very common for composting separately collected yard waste – such as leaves, brush, etc. – but because of odour and pest issues is not very common for composting food waste. In Europe, the German Government has banned open windrowing of organics that includes food wastes.

One of the advantages to windrow composting is that it is low-tech and can be built and operated at a relatively low cost. Because turned windrows are operated outdoors, fewer structures are required to be built. However, because of this, the potential for odours escaping is greater with a windrow than with a contained system. If a windrow is not properly cared for or is experiencing problems, odours can become a serious problem, especially when high-nitrogen feedstocks such as food waste or grass clippings are used.

Another advantage of windrow composting is the ability to handle fluctuations in waste flow. When a large influx of material enters the facility, such as grass clippings or yard trimmings in the spring or leaves in the fall, the windrow can be extended or another windrow constructed.

Capital costs are associated with the cost of the land (in order of 10 acres for 25,000 tonnes per year), preparation of the operating base for the windrows (i.e. impermeable), surface water drainage and treatment system, site works (i.e. grading, road construction and landscaping). Other major capital cost is the turning equipment, compost screening and brush shredding equipment.

Operating costs involve the operating and maintenance costs of a loader, turning equipment, a brush shredder, a compost screen, site management, surface water treatment chemicals, and the environmental testing of compost and the composting site.

For 25,000 tonnes per year of yard waste this type of compost facility the capital cost would be in the range of $1 million to $2.5 million with an operating cost in the range of $40 to $80 per tonne. Overall cost (i.e. capital and operating) on a per tonne basis is not very sensitive to capacity of the facility – larger capacity sites do not reduce the per tonne costs significantly.

Enclosed Turned Windrow

This involves the same composting approach as above but the first 1 to 2 weeks of the windrow composting process being housed in an agricultural-style building (i.e. pole barn or fabric structure) with the building exhausted through a biofilter for odour treatment. This approach will enable a mixture of food waste and yard waste to be processed in a basically low-tech approach. After 2 weeks composting in the building, the compost would be windrowed outside, but not turned, for an additional 2 to 3 months. This approach can solve the odour issues with turned windrows operated in the open air when processing yard waste and food wastes.

Overall capital costs for a 25,000 tonne per year facility using this approach would be in the order of $3 to $5 million with operating costs in the order of $60 to $90 per tonne.

Aerated Static Piles or Windrows

Organics composted in aerated static piles are shaped in windrows but are more heavily managed than the turned pile. The pile is not agitated, but instead air is blown into the pile to keep them aerated. Air is forced through pipes located below the compost pile to create either a negative or positive pressure within the windrow and thus encouraging airflow. Because the porosity of the material is crucial in keeping the pile uniformly aerated, amendments such as wood chips or brush are added to the material. To contain odours, absorb moisture and insulate the pile, a layer of finished compost is often used to cover the pile. Alternatively, the windrows can be covered with a fabric, which enables the piles to breathe but sheds any rain that falls on the pile.

This approach is common in Europe but it is not very common in North America. The size of the site can be reduced because there is no space required between windrows for the turning equipment and the aeration process will reduce the time required to produce finished compost.

Capital costs associated with this process are similar to turned windrows except for the aeration pipe work and fans and the turning equipment. Overall capital costs for a 25,000 tonne per year facility would be in the range of $1 to $2 million with operating costs of $40 to $80 per tonne.

In-Vessel Systems

In-vessel composting systems are the most management and capital intensive of the four technologies. With these systems, organics (i.e. yard waste, food waste, food processing waste, agricultural wastes) are composted within a closed building or container. Typically, in-vessel composting systems use forced aeration and a mechanical turning process to speed up the composting process and reduce costs. The organics are processed for between 1 and 4 weeks following which the material is cured outside in windrows for an additional 8 to 12 weeks.

In-vessel systems offer efficient control over the general management of the composting process, including odours, system biology, aeration, agitation, moisture and particle size. This control makes them highly suitable for composting mixed municipal organics and biosolids, even within urban areas. For instance, Miller Composting operates an in-vessel composting system in Halifax Regional Municipality's busy Burnside Industrial Park and has experienced few odour complaints.

Because of extra capital costs associated with in-vessel composting, capacity must be very carefully planned and accounted for. Loads can peak during the spring and fall as residents send large loads of grass clippings, brush or leaves to the facilities. When planning its waste management system, the Halifax Regional Municipality carefully charted waste streams in order to determine the maximum capacity required by the composting facilities. However, spring and fall loads have been more than expected and have at times exceeded capacity. To reduce the load, the municipality is required to temporarily export organics to composting facilities in other municipalities.

There are a small number of composting systems that can be described as being in-vessel, in particular bin composting, rectangular agitated beds, silos, and rotating drums.

Bin composting is one of the more simpler forms of in-vessel composting. With this system, organics are contained within one or more large containers that are force-aerated. Climate conditions within the bin – like pH, temperature and moisture – are carefully controlled. Little or no turning is required. Because the organics are compartmentalized, the size of the system can be tailored to either large or small operations. If the facility experiences an increase in load, then the operator can increase the facility's capacity by adding additional compartments. In doing so, however, the operator must also increase the size of the curing area. The New Era Farms composting facility in Halifax Regional Municipality encountered a similar problem in an attempt to expand the capacity of the facility. The composting facility first had to increase the size of its curing pad to handle the quantity of compost processed there. When the flow of organics increased, the facility was unable to add additional composting units because the curing pad addition had taken up the additional space.

There are a number of companies marketing these types of technologies in North America and Europe. Typically the process involves mixing food waste and yard waste on an enclosed tipping floor and then loading the mixed organics into a fully enclosed bin with a forced aeration system and process instrumentation and controls. Exhaust from the bin is treated in an odour treatment system prior to discharge to the environment.

The principal benefit of this type of system is that it can process a mixture of food wastes and yard wastes with minimal odour effects. The footprint of the facility is significantly less than a turned windrows system, reducing land costs. However these facilities require expertise in the operation of mechanical systems and biological processes to avoid the potential for odours.

Capital costs of a bin system rated at 25,000 tonnes per year would be in the range of $10 to $15 million with an operating cost of $30 to $50 per tonne. Examples of this technology can be found in Halifax, Truro and the Region of Peel.

Rectangular agitated beds technologies are being used in Halifax and Guelph and many locations in the US and Europe to process a mixtures of food wastes, yard wastes, food processing wastes and bio solids. A number of technology suppliers sell this type of composting technology.

The facilities involve concrete channels with an under floor aeration system with a mechanical turning machine with travels along rails installed along the top of the channel walls. Organics are loaded into the channel from one end and discharged out of the other end by means of the turning machine, which travels down the channel on a daily basis. Typically the waste is processed in the channels for a 1 to 3 week period.

The channels are installed within a building, which is provided with a building exhaust system and odour treatment system. The forced aeration system is designed to improve the performance of the biological composting process.

The overall capital costs of these types of facility for 25,000 tonne per year capacity are in the range of $10 to $15 million with an operating cost in the range of $50 to $80 per tonne. This type of technology is particularly sensitive to the capacity of the facility, with overall per unit costs increasing with lower capacities and reducing with higher capacities. However, the technology is being used at a number of small livestock operations in Ontario to compost manures

Silos are another in-vessel composting system. Similar in configuration to a bottom-unloading agricultural silo, raw materials are added to the top of the silo, and an auger removes finished compost from the bottom. Air is forced up through the silo from the bottom and can be filtered at the top for odour control.

The vertical stacking action of composting silos can minimize the land area needed for composting, but this can lead to problems with compacting, temperature control and airflow which in turn reduce the efficiency of the composting process and can create malodorous conditions. The compost is turned very little during the process, meaning that the feedstock must be very well mixed before entering the silo.

The silo type of composting facility is being used at a number of locations in North America to compost dewatered bio solids from sewage treatment plants. As far as we are aware this type of process is not being used for composting a mixture of food wastes and yard wastes. It is therefore not recommended as technology option for the study area.

Rotating drums use a horizontal vessel to mix, aerate and move composting material through the system. Raw materials are added at the front of the drum and are supplied with air through the discharge end. The length of the drum, its rotation speed and the inclination of the drum determine how long the material is in the system. To more carefully control the process, some drums are partitioned into two or three compartments. When compost reaches the end of the drum and is finished, the discharge end is opened and the finished compost removed.

The rotating drum composting technology was developed in the 70's to process and compost mixed solid wastes collected from residences and businesses. This type of process is being utilized at the new composting facility in Edmonton. At this facility the mixed waste is processed and composted utilizing rotating drums and other mechanical processes, which separate out non-organics from the mixed waste stream. The quality of the compost produced from this process is not critical in Edmonton since the compost will be used for the reclamation of open pit mines. It is generally recognized that the quality of compost produced from mixed waste is not good enough for the use of the product in agriculture or horticulture.

This technology is not appropriate for the composting of source-separated organics and yard waste.

Table 8-7 ranks the various composting methods described here according to their cost and diversion potential. The rankings are low, medium or high and are relative to the other programs in the chart.

Table 8-7: **Estimated costs of potential composting options**

Composting Method	Material Composted	Capital Cost*	Operating Cost per Tonne*
Open Air Turned Windrow	Yard Waste	$1 million to $2.5 million	$40 to $80
Enclosed Turned Windrow	Yard Wastes Food Wastes	$3 million to $5 million	$60 to $90
Aerated Static Piles	Yard Wastes	$1 million to $2 million	$40 to $80
Bin (In-Vessel) Composting	Yard Waste Food Waste	$10 million to $15 million	$30 to $50
Rectangular Agitated Beds	Yard Wastes Food Wastes Bio Solids	$10 million to $15 million	$50 to $80

*25,000 tonnes per year capacity

9.0 EXISTING RECYCLING AND COMPOSTING

9.1 RECYCLING

Multi-Material Stewardship Board (MMSB)

MMSB is a Crown Agency established by the Department of Environment to develop, implement and, where appropriate, manage a variety of waste diversion programs in Newfoundland and Labrador. It is currently responsible for the beverage container recycling program and the administration of the Newfoundland and Labrador Waste Management Trust Fund.

The Beverage Recycling Program, implemented in January 1997, is a province-wide deposit refund system for all beverage containers five litres or less, excluding milk, infant formulas, refillable bottles, and medicinal nutritional supplements. The program operates under a halfback system where the consumers pay a deposit on their beverage containers and receive a refund when they return their containers to a green depot.

Green Depots

A questionnaire was developed by the study team and distributed to all green depots located within the study area presented in Table 9-1. The purpose of the questionnaire was to obtain information regarding the size of the operation, collection method, processing methods, storage, transportation, number of employees, service area, operating costs, and revenue. As well, each companies ability and willingness to expand operations for an increased market and/or for different types of materials was assessed.

Table 9-1: **Recycling Depots located in Central Newfoundland.**

Recycling Depot	Location
Nova Recycling (Gander & Grand Falls-Windsor)	20 McCurdy Drive, Gander 32 Hardy Ave., Grand Falls-Windsor
Calypso Recycling	45 Centennial Drive, Lewisporte
Ernest Guy & Sons Ltd.	Main Highway, Twillingate
Sheppard Investments Ltd.	Main Street, Stag Harbour, Fogo Island
Glovertown & Area Recycling	198 Main Street South, Glovertown
Botwood Recycling Depot	1 Circular Road, Botwood
Lester Spurrell Ltd.	83-85 Quay Road/Main St., Badger's Quay
Perry's Wholesale Ltd.	Main Highway, St. Alban's
Robert's Arm Volunteer Fire Department	Main Highway, Robert's Arm
Green Bay Wholesalers Ltd.	381 Little Bay Road, Springdale

All green depots were contacted via telephone between May 13 – 14, 2002 and faxed a questionnaire to fill out and return to BAE♦Newplan Group Ltd. All depots within the study area that did not respond within a two-week period were contacted via telephone and faxed an additional copy of the questionnaire to fill out and return. Despite the effort put forward, only five of the ten green depots companies listed in Table 9-1 responded to the questionnaire.

All depots that responded to the questionnaire expressed their willingness to expand operations for an increased market and/or for different types of materials. Results of the recycling depot survey are provided in Volume 2 of the report.

Information regarding the total volume of beverage containers recycled within the study area and the total revenue generated was provided by the MMSB head office in St. John's, Newfoundland. Each year there is on average 16,812,144 beverage containers recycled in the green depots listed in Table 9-1. Operating revenue for the green depots within the study area is approximately $504, 364.

9.2 COMPOSTING

Little information was available on composting within the study area. Genesis Organic Incorporated, located at Corner Brook and Wild Cove, Newfoundland, operates the largest dedicated composting site in Canada. However, this company makes its own compost with soft wood bark from the local paper mill and fish waste from local fish processing plants.

10.0 TRANSPORTATION ANALYSIS

Transportation is a fundamental component of the waste management system. Transportation will influence the location of infrastructure, levels of service, and overall cost of the waste management system. As part of the work program a transportation model has been developed to assist in the design of the final waste management system. The model will be used to determine the costs of various scenarios related to the sitting of transfer stations and the waste processing and disposal facility.

This section of the report provides a preliminary analysis of transportation cost for optimizing the landfill site in the Region. The waste management system has not yet been selected, so the model evaluated both the 2 stream (wet/dry) and 3 stream (organics / blue bags / garbage) collection options.

The purpose of presenting the transportation cost modelling is to illustrate the impacts on the overall system that result from transportation related constraints. The model also provides an initial cost estimate for the transportation system based on transfer / staging station Scenario I. The transportation modelling result was used to determining the optimal landfill location. The optimal landfill location is the one that minimize the total transportation (travel time, or distance, or tonnage-travelling time) from communities / transfer stations to the landfill site. It could also be applied to optimize transfer station locations.

The transportation model consists of a GIS module (MapInfo Professional 6.5) and a database module (Microsoft Access 2000). The GIS module provides inputs to the database module. The model will optimize the transportation routes from communities / transfer stations to a potential landfill site. The database module contains waste generation data and functions for transportation cost analysis.

10.1 ROAD NETWORK

The transportation road network in the Central Newfoundland Region was prepared based on the 1:50,000 scale topographic maps, and highway information from provincial Department of Works, Services and Transportation. The road was classified into six (6) categories regarding travelling speed of Hauler:

1. Trans Canada Highway, average speed – 90 km/hr.
2. Other major highway, average speed – 90 km/hr.
3. Secondary highway, average speed – 70 km/hr.
4. Other secondary highway, average speed – 60 km/hr.
5. Road, average speed – 50 km/hr.
6. Community access road, average speed – 45 km/hr

The distance from a community to the reference point, Gander, was measured, breaking down to the above six (6) road categories for the purpose of calculating travel time. As the route might be different from a community to different landfill location, all possible route scenarios were compiled.

The transportation road network is shown in Figure 10-1.

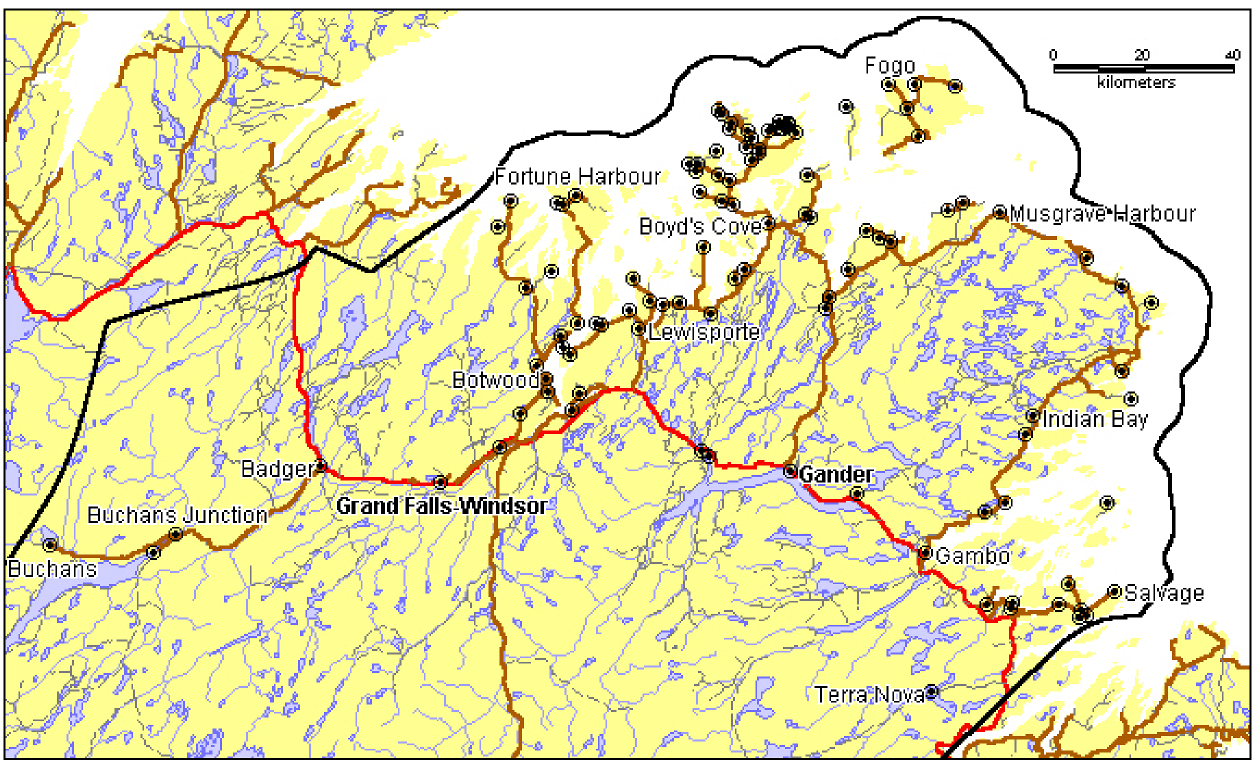


Figure 10-1: Transportation Road Network in the Central Newfoundland Region.

10.2 CENTROID OF WASTE GENERATION.

Based on the transportation road network and the waste generation data, the waste generation centroid by road distance was calculated. The waste generation centroid by road distance is defined as a point of which the waste tonnage-distances from both side of it are same.

The waste generation centroid of the Central Newfoundland Region is calculated to be 34.7 km west of Gander (Figure 10-2).

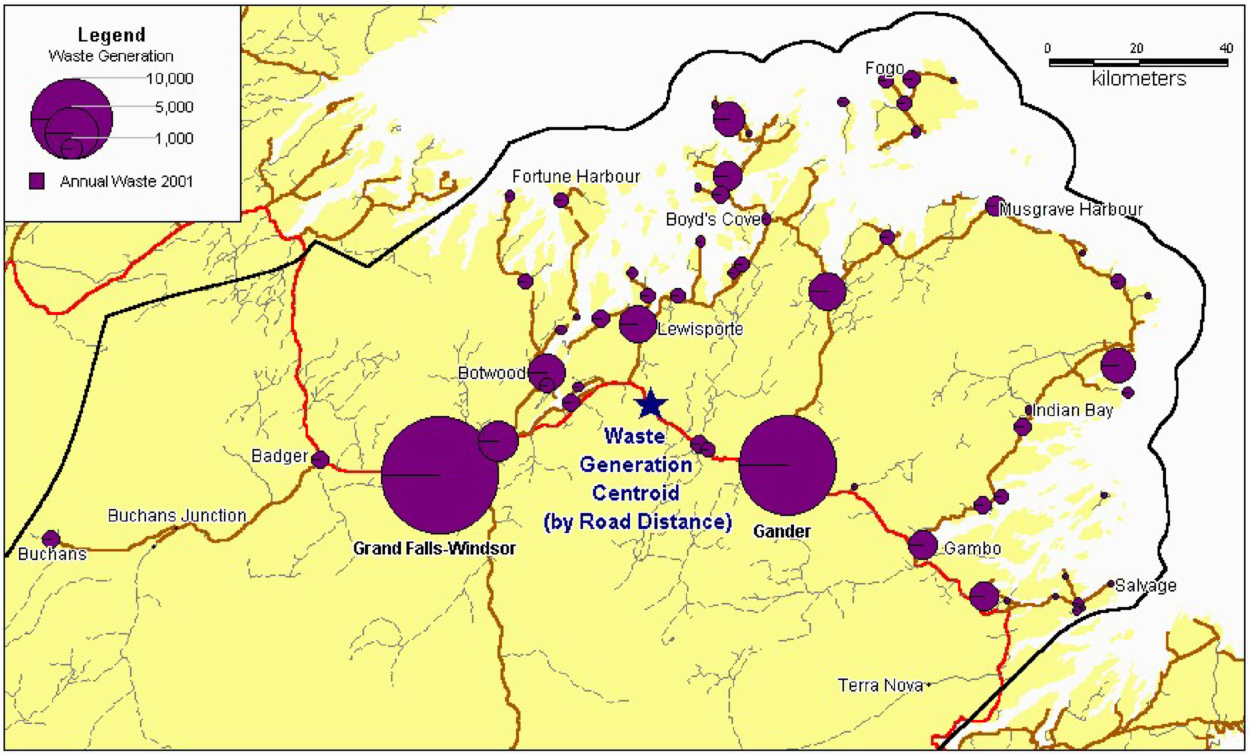


Figure 10-2: Waste Generation Distribution and Centroid

Note: 46% of the waste in the Central Newfoundland region is generated in the two major towns – Grand Fall / Windsor and Gander.

10.3 TRUCK COST AND LOAD CAPACITY

A survey of collection vehicles used by communities had been done through out the Central Newfoundland Region. Table 10-1 summarized the types of vehicles and their volume. The load capacity depends on the waste density and compacting ability of the vehicle.

In the future, waste transportation from transfer stations to the landfill will utilize large transfer trailers or boxes. Contractors in New Brunswick and Nova Scotia are presently using 45 ft and 53 ft top loading containers with a moving floor conveyor system for off loading. The containers are loaded and compacted by small excavators, which achieve a compaction density of approximately 260 kg/m^3. Based on the information provided, the hourly rate and capacity of each container for mixed waste is presented in Table 10-2.

Table 10-1: **Collection Vehicles Currently Used in the Central Newfoundland.**

Truck Type	Volume (m^3)	Typical Cost ($/Hour)
Pick-up	6.0	30.00
5 ton dump truck	16.0	40.00
1 ¼ ton stake body	13.0	30.00
3 ton stake body	20.0	35.00
5 ton stake body	36.0	40.00
16 yd compactor	12.5	60.00
20 yd compactor	15.6	60.00
29 yd compactor	22.6	90.00

Table 10-2: **Hourly Rates and Capacities of Hauling Containers.**

Hauling Container Type	Volume (m3)	Typical Cost ($/hour)
53 ft Container (Nova Scotia)	101.0 (132 cubic yards)	131.00
45 ft Container (New Brunswick)	82.6 (108 cubic yards)	183.00

It is worth noting that a local waste disposal contractor estimated that the cost of providing the same transportation service with 40 cubic yards (10 tonne) stationary compaction units would be $129.00/hr. It also appears that down size containers to suit specific transfer station quantities will only result in minimal transportation cost savings.

10.4 LANDFILL LOCATION OPTIMIZATION FOR TRANSPORTATION COST

The optimal landfill location is the one that minimizes the total transportation (travel time, or distance, or tonnage-travelling time) from communities / transfer stations to the landfill site. The centroid of the waste generation is not necessarily the optimal location for landfill site. This can be illustrated with a simple case of 2 communities. If community A generates more waste than community B, the least transportation landfill site is in downtown community A, while the centroid of waste generation is located between the 2 communities. If the two communities generate the same amount of waste, the waste generation centroid will be in the midway, but the landfill could be anywhere between the two communities and the transportation cost remains same.

To find the optimal landfill site for transportation cost, the total tonnage-travelling time to various location along the Trans Canada Highway was calculated (Figure 10-3) for transfer / staging stations Scenarios I. The optimal transportation route from a community / transfer station / staging station to a particular landfill location is determined by the Transportation Modelling System.

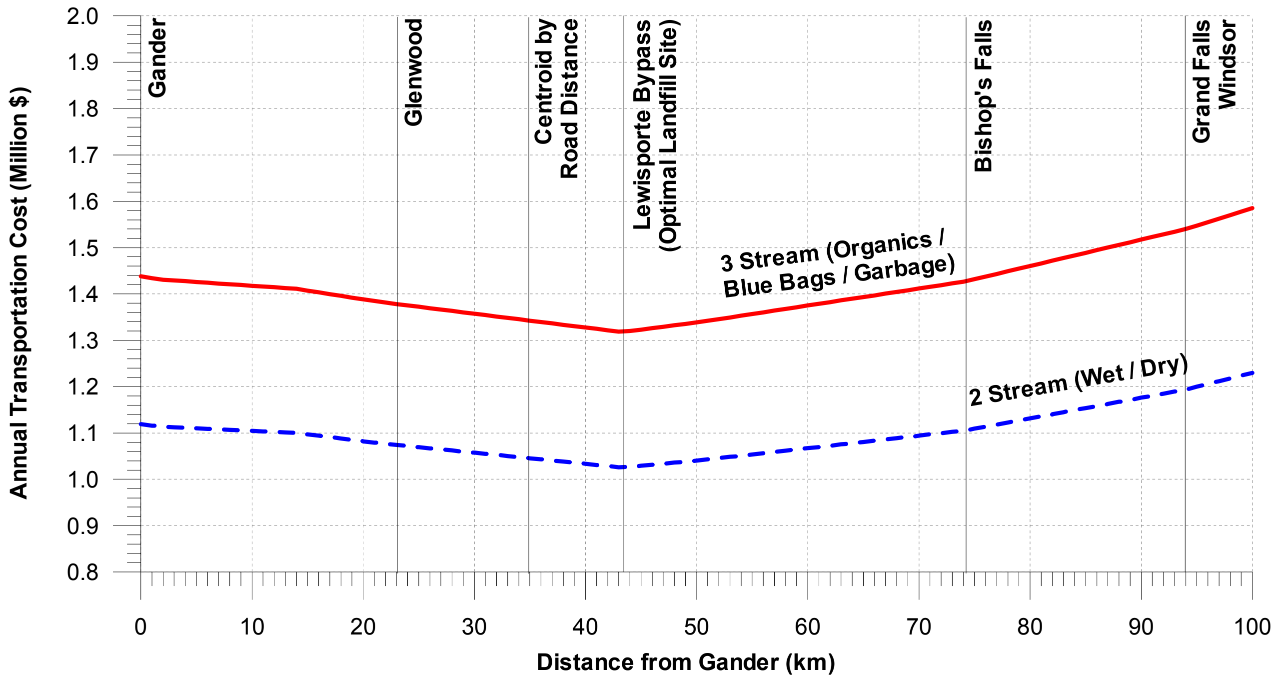


Figure 10-3: Landfill Location and Corresponding Total Annual Transportation Cost.(Transfer / Staging Stations Scenario I)

The above transportation cost includes:

1. Transportation cost of domestic waste from communities to transfer stations or staging station or directly to landfill site.
2. Long hauling cost from transfer stations and staging stations of domestic waste and part of IC&I waste (wet or organics/garbage) dropped at the transfer stations and staging stations.

From the analysis it can be seen that the least transportation cost landfill site situates near the Lewisporte Bypass.

11.0 TRANSFER STATIONS

Transfer stations are centralized facilities where waste is unloaded from several collection vehicles into a large transfer trailer or box. The primary reason for establishing a transfer station is to economize on haul costs. One transfer trailer can haul as much as three to five waste collection (packer) trucks or as much as 40 pickup loads. Transfer stations can also serve as collection points for recyclable materials, special wastes, and household hazardous wastes. There are many different methods and combinations of methods for solid waste transfer.

Ideally, a transfer station should be sited as close as possible to the centroid of the population served, in order to minimize collection costs, or some distance along the haul route to the landfill. The transfer station should be sited and operated so as to create no environmental or health hazard, and no nuisance.

11.1 TRANSFER STATION SYSTEMS

Common types of transfer stations include:

- direct dumping to trailers,
- tipping floor dumping,
- pit dumping,
- compactor,
- roll-off box, and
- drop-off box stations;
- dedicated truck.

Several variations and combinations of these six primary types also exist.

<u>Direct Dumping</u>

A direct dumping transfer station allows the waste collection trucks (packer trucks) and other vehicles to dump directly into a transfer trailer. Transfer trailers typically hold about 100 cubic yards and thus can accommodate three to five packer loads or many pickup loads. The direct dumping station has the disadvantage of requiring a transfer trailer on site and thus it may require a second transfer trailer while the first is enroute to the landfill.

Tipping Floor Dumping Transfer Station

A tipping floor dumping transfer station is similar to a direct dumping station except it has additional space for trucks to discharge their waste on a concrete tipping floor for inspection and emergency storage. A front loader with a bucket is required to push the waste from the floor into the transfer trailer. The primary disadvantage of the floor dumping system is the cost of the tipping floor and a tractor to push the waste from the floor into the transfer trailer. Because of the risk of someone falling into the transfer trailer, some communities require all small vehicles to dump on the tipping floor.

Pit-Dumping Station

A pit-dumping station has a large pit into which several trucks can unload simultaneously. Some stations have tractors in the pit to push the waste into transfer trailers. The pit-dumping transfer station has the advantage of allowing several trucks to dump simultaneously, allowing waste to be stored temporarily during peak hours, and having a tractor in the pit to crush the waste and maximize trailer loads. The primary disadvantages are the cost of a large concrete pit and a tractor or walking floor to move the waste from the pit to a transfer trailer, high operating costs, and the liability associated with people falling into the pit. A large volume of waste is required to justify this cost.

With these first three transfer stations, open-top/uncompacted trailers are used to haul the waste to the landfill. They normally have a net-type cover which prevents debris from being blown out of the trailer during travel. They also have a walking floor or a push blade to unload the waste. A clamshell or backhoe is desirable, but not mandatory, to attain maximum payload, level the load, and extract undesirable material.

Compactor Station

Using the compactor station, the waste is unloaded or pushed into the hopper of a stationary compactor and then into a completely enclosed transfer trailer or roll-off container. The compactor station's advantages are:

1. it minimizes wind-blown litter during dumping and
2. it allows a smaller transfer trailer to be used.

The primary disadvantages are the lack of alternative loading when the compactor fails, and the limited hopper capacity, which may cause a backup of vehicles waiting to unload.

Roll-Off Box Station

The roll-off box station is a relatively low capital cost transfer station and can service communities of up to about 1,000 people. Major components consist of a 40 cubic yard steel box, an unloading ramp that slopes up to the top of the box and a concrete pad to support the box. To reduce wind blown litter, the boxes can be covered with lids and hatches. A truck with a special hydraulic hoist is required to remove the box and haul it to a landfill. The primary advantage to the roll-off type of transfer station is its low capital cost. The primary disadvantage is that it is limited to rather small amounts of household wastes.

Drop-Off Box Station

The drop-off box station is similar to the roll-off box transfer station except that it has one or several six or eight cubic yard boxes. The boxes can be lifted and emptied by a large packer truck. Boxes are generally located on a surfaced parking area. A contract hauler normally provides the boxes and hauling services. Although economical in terms of capital cost, the relatively small bins are unable to accommodate large items such as furniture and demolition/land clearing/construction (DLC) waste, as well as being awkward to use because waste must be lifted up to be dumped.

Dedicated Compaction Waste Collection Truck

A dedicated compaction waste collection truck would be available at a specified location, on a regular schedule, for an advertised time period, usually once per week. Waste collectors would bring their waste to the truck, and are charged a prearranged rate per bag or can by the truck driver. Although this system is not a "transfer station" it can be a substitute for one, and has the advantages of requiring no capital cost, assuming a collection contractor is available, only minimal operating cost for a subsidy and advertising, and users pay much of the cost directly for the service. The major disadvantages are that it is relatively expensive, and that service can usually only be afforded for limited periods, say one day per week or less.

The preferred type of transfer station for a community depends on:

- the estimated amount of waste to be transferred;
- the nature of the waste;
- the desire to separate recyclable materials at the transfer station.

An analysis of alternatives that examines economics, engineering issues, and community goals should be made to help determine which type of transfer station is best for each specific site.

11.2 SITTING GUIDELINES

11.2.1 General Location

It is desirable that a transfer station be located near the centroid of the population to be served, and near a major haul route to the destination landfill. The location of solid waste management facilities, including transfer stations, in relation to the presence of indigenous and migratory wildlife, is an issue of increasing importance as the activities of human beings intrude more heavily into the traditional habitat of bears and other wildlife. It is important that attention be paid to avoiding areas of high concentration of wildlife, such as migratory paths and other high use/high presence locales, in the siting of transfer stations and other solid waste management facilities.

Location has a strong influence on the cost of operating a transfer station, on its convenience to the public and on operational problems associated with wildlife such as bears. Notwithstanding these issues, suitable land may not always be available in the best general location or may not be acceptable to the public.

11.2.2 Area Requirement

Sufficient area should be provided for existing needs and buffers, but also for potential future expansion. The planning horizon for the provision of transfer services at a particular site, or at an alternative site, should be a minimum of twenty years.

11.2.3 Zoning

The selected site should conform to local zoning bylaws relative to land use, and building heights and setbacks. Appropriate land use designations include industrial, commercial, institutional, and agricultural. Residential zoning may be appropriate in areas where the lots are large, and where the station is accepted by the local residents.

11.2.4 Buffer

A vegetated or landscaped buffer zone of at least 15 metres should be left around the perimeter of the active transfer area, in order to minimize any potential nuisance associated with noise, dust, or odours, or any objections based on visual aesthetics. For small, unmanned, rural stations adjacent to forested areas, and where there is a threat of fires being set in the waste containers, an additional buffer zone may be desirable. In this situation, it would be appropriate to provide a cleared firebreak of 35 metres between the waste bins and the vegetated buffer.

Some flexibility should be allowed, based on local conditions and adjacent land use.

11.2.5 Site Servicing

Consideration should be given to the availability of utilities, including water, sewer, and electricity, particularly for stations accepting more than 1,000 tonnes per year.

Mid-size to large transfer stations need to provide water for firefighting and washdown of floors, need electrical power for machinery and lighting, and need to provide for staff amenities such as showers and toilets. The proximity of services can have a strong impact on capital and operating costs.

11.3 DESIGN GUIDELINES

11.3.1 Quantity Estimation

Solid waste quantities anticipated at a transfer station should be based on estimates for the area to be served.

11.3.2 Storage Volume

A transfer station must provide sufficient volume, between one waste pickup and the next, to ensure that the bins or transfer trailer provided do not fill to overflowing. A direct dump station must provide sufficient tipping area to accommodate the numbers and types of vehicles arriving, their unloading times, and any waste sorting or processing that is to be done. Sufficient volume must be provided to accommodate peak waste periods, statutory holidays, and long weekends. Storage volume provided and pick-up frequency are essentially a trade-off. For a given population served (or waste generation rate), the larger the storage volume provided, the less frequent the waste pickups.

11.3.3 Bulky Goods

In some cases, acceptance of bulky goods such as appliances, autohulks, furniture and wood wastes at transfer stations may provide the most convenient and practical method to the public for handling these types of wastes. Volume (space) provisions should be made for storing these wastes, if they are accepted at the site. Failure to provide bulky goods services may result in these items being placed in transfer station bins, resulting in inefficient use of bin space, premature filling of the bins to the point of over-flowing, more frequent hauling and an associated increase in operating and haulage costs. For transfer station sites in remote locations, the option of requiring the public to haul bulky items to a regional landfill site may be too onerous.

If bulky items are accepted at a transfer station site, they should be segregated to dedicated storage piles/containers. The piles, if kept properly clean of contaminants, could be allowed to build-up until economical loads are available for transport. The time period before economical loads are available for transport could be several months to several years.

11.3.4 Access Roads

Roads to a transfer station site and within the site should be designed to provide all season, all weather access. Designs must be in accordance with standard practice for the anticipated traffic volume and speeds. Sufficient space should be provided for queuing, such that vehicles need not stop on a public road or highway when entering the site. Traffic flow through the site should be considered. Gravelled surfaces may be acceptable, depending on the local context, but if dust or mud is a problem, asphalt paving should be provided.

11.3.5 Surface and Groundwater Quality

Provision should be made to prevent stormwater and runoff from contacting waste. All waste containers should be leak proof, or should provide for the collection of contaminated water and illegally dumped liquids. Tipping floors should provide drains and sumps to collect washdown water and illegally dumped liquids. Proper disposal of contaminated water should be ensured.

11.3.6 Weigh Scales

Transfer stations serving populations of 5,000 or more, or receiving 5,000 tonnes/year or more should install weigh scales. Smaller stations should consider installing weigh scales or using an alternative method of measuring waste quantities received, or instituting charges per vehicle or waste container, as a means of allowing the collection of tipping fees and thus of paying the costs of staffing and operating the station.

11.3.7 Wildlife Control

Perimeter fencing, such as the chain link variety, is the first defence against wildlife intrusion. Careful attention must be paid to gate design, on the one hand to promote responsible use by humans (including both easy access and after use closure) while at the same time to prevent wildlife from entering the site.

Containers intended to receive organic waste should have lids, screens, or covers that will prevent access by wildlife. Alternatively, containers may be placed inside predator-proof enclosures that provide both easy access to users and promote closure after use (e.g.: garage door type designs). Consideration should also be given to washing out containers between uses, either at the transfer station or at the landfill. Only sturdy, easily cleanable, animal-proof containers should be used. Buildings at direct dump facilities should be designed to minimize areas/spaces that afford a harbour for rats and other small mammals, and to be predator-proof.

11.3.8 Site Security

Fencing should be provided around the perimeter of the site, with a lockable gate at any entrance point. The type of fencing may vary with the natural site features.

11.3.9 Signs

Transfer stations should be provided with a sign (or signs), posted prominently at the entrance, that contains the following information:

- Facility name
- Owner/operator with phone number and address
- Emergency phone numbers for fire, police and medical assistance
- Hours of operation (if applicable)
- Prohibited materials
- Materials accepted for recycling
- Tipping fee schedule (if applicable)

11.3.10 Water Supply

For facilities with buildings, employing staff during operating hours, water for fire protection should be provided. For these larger stations, washdown water should also be provided.

11.3.11 Safety Features

Most transfer stations involve the dropping or pushing of waste down into a bin or trailer. It is important that safety features such as guardrails be incorporated to prevent people from falling into a bin, and stop logs or bars to prevent vehicle accidents. Transfer buildings should be designed with sufficient ceiling clearance to accommodate the vehicles that may enter and dump. It is desirable that transfer buildings have clear spans, without central columns to impede traffic.

11.3.12 Emergency Procedures

Transfer station staff should be familiar with procedures involving fire prevention and control. A "FIRE HAZARD - NO SMOKING" sign should be posted at the entrance or at the weigh scales. Fire extinguishers should be available inside all buildings and vehicles. Stations receiving 5,000 tonnes/year or more, or with permanent staff, should have telephone communications available to enable the fire department, police, or medical services to be contacted. Staff serving small stations should have a cellular telephone in their vehicle.

11.3.12 Nuisance Control

The generation of dust can cause unsightly conditions, and may be irritating to transfer station staff and users. Dust may arise from roads, and from some refuse, such as concrete, demolition waste, ashes, and plaster. Consideration should be given to paving, watering, or brine sealing unsurfaced roads, and sweeping surfaced roads. If dust problems arise from the handling of waste, consideration should be given to wetting the waste, or if within a building, to installing proper ventilation and dust collection.

Operational practices for reducing odours are the prompt removal of waste and the regular washing of floors, equipment and bins.

If noise is a cause for complaint by neighbours, it may be necessary to limit the operating hours of the station, and/or to provide better noise suppression on equipment and vehicles.

11.4 SELECTION OF TRANSFER STATION AND STAGING AREA LOCATIONS

The geographic and waste generation characteristics of the Region support a conclusion that transfer stations and staging areas will form an important component of the overall waste management system. As part of the transportation analysis, the project team has developed several potential transfer station/staging area system options. This section of the report provides a description of these systems.

Locations of the transfer stations and staging areas were selected based on aspects such as geographical location, geographical centroid, centre of waste generation, siting the facilities in areas of current landfills or incinerators, as well as the cost of transportation. This ensured each zone had a centralized location that would minimize cost, reduce travel times for communities, and reduce backtracking. It is inevitable that some communities have longer haul distances than others to their respective transfer stations. This limitation is due to the road network and geography of the study area. Four scenarios have been developed to illustrate potential locations for transfer stations and staging areas throughout the Central Newfoundland Region. The scenarios included 3 transfer stations and 2 staging areas, 2 transfer stations and 3 staging areas, 1 transfer station and 4 staging areas, and 7 staging areas for the Central Newfoundland Region.

In all four scenarios, areas in the vicinity of the proposed location of the waste management facility (landfill) were excluded from the transfer station zones. Communities in this area can deliver their waste directly to the waste management facility.

Selecting a potential location for transfer facilities under each model presents many challenges. As mentioned, the geography and road network and the geography of the study area make it difficult to totally eliminate negative aspects such as transportation backtracking and lengthy haul distances. Also, it is difficult to determine optimum locations for transfer facilities without a site selected for the waste management facility.

The selected final location of the waste disposal facility may alter these models. For example, some communities that are assigned a transfer facility under the current models may be in close enough proximity to the waste management facility to transport waste directly to the site.

11.4.1 Three Transfer Station and Two Staging Area Model

The proposed locations for transfer stations include Gambo, Boyd's Cove, and Grand Falls-Windsor. Staging areas will also be located on Fogo Island and in Botwood. The Landfill will be located in close proximity to Lewisporte Junction. Table 11-1 provides the proposed transfer station and staging area locations and the estimated waste volumes for the Three Transfer Station and Two Staging Area Model.

Table 11-1: **Proposed transfer station and staging area locations and the estimated waste volumes for the Three Transfer Station and Two Staging Area Model.**

Proposed Transfer Station and Staging Area Locations	Zone	Population Served 2001	Estimated Amount of Waste per Zone (Tonnes) 2001
Gambo	1	12,785	6,065
Boyd's Cove	2	14,191	6,733
* Fogo Island	2	3,018	1,432
* Botwood	3	6,734	3,195
Grand Falls-Windsor	4	15,351	13,175

* Staging Areas

Gambo (Zone 1)

Under the three-transfer station and two staging area model, Gambo was selected as the potential location for the transfer station in Zone 1 (see Appendix C, Figure 11-1). The location is not the geographic centroid but it reduces backtracking for communities within the zone.

A limitation that must be considered for this site is that the waste generated from St. Brendan's has to be transported to Burnside – St. Chad's by ferry.

Boyd's Cove (Zone 2)

Boyd's Cove was selected as the potential location for the transfer station in Zone 2 (see Appendix C, Figure 11-1). This location is not the geographic centroid but it reduces backtracking for communities within the zone. This site was selected because it provided a centralized location with minimal backtracking for all communities in that zone. Although Division 8, Subd. L (Gander Bay North) produces the majority of waste for Zone 2, travel time and backtracking would be increased for the majority of communities.

Division 8, Subd. I (Boyd's Cove) is within one hour of Division 8, Subd. L (Gander Bay North) and appears to be the best location for all communities in Zone 2.

A limitation that must be considered for this site is the long haul distances for communities north and east of Boyd's Cove.

Fogo Island (Zone 3)

The waste generated from Fogo Island has to be transported to Port Albert by ferry. A staging area is proposed for Fogo Island (Stag Harbour) to collect all solid waste generated on the island for transportation to the landfill site located in close proximity to the Lewisporte Junction.

A limitation that must be considered for this location is the solid waste generated from the Island has to be transported to Port Albert by ferry.

Botwood (Zone 4)

Botwood was selected as the potential location for the facility in Zone 3 (see Appendix C, Figure 11-1). This location was chosen as the most appropriate to reduce the amount of backtracking. Due to the volume of waste generated in Zone 3 a staging area is proposed for this location.

Limitations that must be considered include:

- Long haul distances for several communities north of Botwood; and
- Short backhaul distances for Peterview and Wooddale.

Grand Falls – Windsor (Zone 5)

Grand Falls – Windsor was selected as the potential location for the facility in Zone 4 (see Appendix C, Figure 11-1). This location is the geographic centroid and reduces backtracking for communities within the zone. This site was selected due to its proximity to the centroid and centre of waste generation for this zone, increasing its cost efficiency while reducing backtracking.

Due to the geographic location of Buchans and the proposed transfer station in Grand Falls – Windsor, the project team recommends one contractor collect the waste generated from all communities located outside Grand Falls – Windsor.

11.4.2 Two Transfer Station and Three Staging Area Model

The proposed locations for transfer stations include Boyd's Cove and Gambo. Staging areas will also be located in Buchan's Junction, Botwood, and on Fogo Island. The Landfill will be located in close proximity to the Lewisporte Junction. Table 11-2 provides the proposed transfer station and staging area locations and the estimated waste volumes for the Two Transfer Station and Three Staging Area Model.

Table 11-2: **Proposed transfer station and staging area locations and the estimated waste volumes for the Two Transfer Station Three Staging Area Model.**

Proposed Transfer Station and Staging Area Locations	Zone	Population Served	Estimated Amount of Waste per Zone (Tonnes)
		2001	2001
*Buchan's Junction	1	1,105	524
*Botwood	2	6,734	3,195
Boyd's Cove	3	14,191	6,733
*Fogo Island	4	3,018	1,432
Gambo	5	12,785	6,065

* Staging Area

Buchan's Junction (Zone 1)

Under the two-transfer station and three staging area model, Buchan's Junction was selected as the potential location for a staging area in Zone 1 (see Appendix C, Figure 11-2). The location is not the geographic centroid but it reduces backtracking for communities within the zone.

Limitations that must be considered include:

The location is not the waste generation centroid, but it reduces backtracking for communities in the zone; and

- The proposed staging area site (Buchan's Junction) is located on a slow road (45 km/h).
- The appropriateness of this road would have to be considered.

Botwood (Zone 2)

Botwood was selected as the potential location for a staging area in Zone 2 (see Appendix C, Figure 11-2). This location is not the geographic centroid but it reduces backtracking for communities within the zone.

Limitations that must be considered include:

- Long haul distances for several communities north of Botwood; and
- Short backhaul distances for Peterview and Wooddale.

Boyd's Cove (Zone 3)

Boyd's Cove was selected as the potential location for a Transfer Station in Zone 3 (see Appendix C, Figure 11-2). This location was chosen as the most appropriate to reduce the amount of backtracking.

A limitation that must be considered for this location is the long haul distances for communities north and east of Boyd's Cove.

Fogo Island (Zone 4)

Fogo Island (Stag Harbour) was selected as the potential location for a staging area in Zone 4 (see Appendix C, Figure 11-2). This location was chosen as the most appropriate to reduce the amount of backtracking for this zone.

A limitation that must be considered for this location is the solid waste generated from the Island has to be transported to Port Harbour by ferry.

Gambo (Zone 5)

Under the two-transfer station and three staging area model, Gambo was selected as the potential location for the transfer station in Zone 5 (see Appendix C, Figure 11-2). The location is not the geographic centroid but it reduces backtracking for communities within the zone.

A limitation that must be considered for this site is that the waste generated from St. Brendan's has to be transported to Burnside – St. Chad's by ferry.

11.4.3 One Transfer Station and Four Staging Area Model

The proposed location for a transfer station is Gander. Staging areas will also be located in Buchan's Junction, Norris Arm North, Boyd's Cove, and on Fogo Island. The Landfill will be located in the Exploits Regional Disposal Site, Grand Falls. Table 11-3 provides the proposed transfer station and staging area locations and the estimated waste volumes for the One Transfer Station and Four Staging Area Model.

Table 11-3: **Transfer station and staging area locations and the estimated waste volumes using a One Transfer Station and Four Staging Area Model.**

Proposed Transfer Station and Staging Area Locations	Zone	Population Served	Estimated Amount of Waste per Zone (Tonnes)
		2001	2001
Buchan's Junction*	1	1,105	524
Norris Arm North*	2	9,018	4,280
Boyd's Cove*	3	8,594	4,079
Fogo Island*	4	3,018	1,432
Gander	5	29,149	18,091

*Staging Area

Buchan's Junction (Zone 1)

Under the one transfer station and four staging area model, Buchan's Junction was selected as the potential location for a staging area in Zone 1 (see Appendix C, Figure 11-3). The location is not the geographic centroid but it reduces backtracking for communities within the zone.

Limitations that must be considered include:

- The location is not the waste generation centroid, but it reduces backtracking for communities in the zone; and
- The proposed staging area site (Buchan's Junction) is located on a slow road (45 km/h). The appropriateness of this road would have to be considered.

Norris Arm North (Zone 2)

Norris Arm North was selected as the potential location for a staging area in Zone 3 (see Appendix C, Figure 11-3). This location is not the geographic centroid but it reduces backtracking for communities within the zone. This site was selected due to its proximity to the centroid and centre of waste generation for this zone, increasing its cost efficiency while reducing backtracking.

Boyd's Cove (Zone 3)

Boyd's Cove was selected as the potential location for the staging area in Zone 4 (see Appendix C, Figure 11-3). This location is not the geographic centroid but it reduces backtracking for communities within the zone. This site was selected because it provided a centralized location with minimal backtracking for all communities in that zone.

A limitation that must be considered for this location is the long haul distances for communities north of Boyd's Cove.

Fogo Island (Zone 4)

Fogo Island (Stag Harbour) was selected as the potential location for a staging area in Zone 5 (see Appendix C, Figure 11-4). This location was chosen as the most appropriate to reduce the amount of backtracking for this zone.

A limitation that must be considered for this location is the solid waste generated from the Island has to be transported to Port Harbour by ferry.

Gander (Zone 5)

Gander was selected as the potential location for the transfer station in Zone 6 (see Appendix C, Figure 11-3). This location was chosen as the most appropriate to reduce the amount of backtracking. Due to the volume of waste generated in Zone 6 a staging area is proposed for this location.

A limitation that must be considered for this location is the long haul distances for communities east of Gander.

11.4.4 Seven Staging Area Model

The proposed locations for staging areas include Buchan's Junction, Botwood, Virgin's Arm – Carter's Cove, Fogo Island (Seldom – Little Seldom), Gander Bay South, Indian Bay, and Terra Nova Regional Landfill. The Landfill will be located in Lewisporte Junction. Table 11-4 provides the proposed staging area locations and the estimated waste volumes for the Seven Staging Area Model.

Table 11-4: **Proposed staging area locations and the estimated waste volumes for the Seven Staging Area Model.**

Proposed Staging Area Locations	Zone	Population Served	Estimated Amount of Waste per Zone (Tonnes)
		2001	2001
Buchan's Junction*	1	1,105	524
Botwood*	2	6,734	3,195
Virgin Arm – Carter's Cove*	3	7,660	3.635
Fogo Island*	4	3,018	1,432
Gander Bay South*	5	5,748	2,727
Indian Bay*	6	7,158	3,396
Terra Nova Regional Landfill*	7	6,410	3,040

*Staging Area

<u>*Buchan's Junction (Zone 1)*</u>

Under the seven staging area model, Buchan's Junction was selected as the potential location for a staging area in Zone 1 (see Appendix C, Figure 11-4). The location is not the geographic centroid but it reduces backtracking for communities within the zone.

Limitations that must be considered include:

- The location is not the waste generation centroid, but it reduces backtracking for communities in the zone; and
- The proposed staging area site (Buchan's Junction) is located on a slow road (45 km/h). The appropriateness of this road would have to be considered.

<u>*Botwood (Zone 2)*</u>

Botwood was selected as the potential location for a staging area in Zone 2 (see Appendix C, Figure 11-4). This location is not the geographic centroid but it reduces backtracking for communities within the zone.

Limitations that must be considered include:

- Long haul distances for several communities north of Botwood; and
- Short backhaul distances for Peterview and Wooddale.

Virgin Arm – Carter's Cove (Zone 3)

Virgin Arm – Carter's Cove was selected as the potential location for a staging area in Zone 3 (see Appendix C, Figure 11-4). This location was chosen as the most appropriate to reduce the amount of backtracking.

A limitations that must be considered for this location is short backhaul distances for communities south of Virgin Arm – Carter's Cove.

Fogo Island (Zone 4)

Fogo Island (Stag Harbour) was selected as the potential location for a staging area in Zone 4 (see Appendix C, Figure 11-4). This location was chosen as the most appropriate to reduce the amount of backtracking for Fogo Island.

A limitation that must be considered for this location is the solid waste generated from the Island has to be transported to Port Albert by ferry.

Indian Bay (Zone 5)

Indian Bay was selected as the potential location for the staging area in Zone 5 (see Appendix C, Figure 11-4). This location is not the geographic centroid but it reduces backtracking for communities within the zone.

A limitation that must be considered for this site is that Hare Bay and Dover are located within half of an hour from the staging area. Therefore, they will have a minimal amount of backtracking to reach the landfill.

Terra Nova Regional Landfill (Zone 6)

Terra Nova Regional Landfill was selected as a potential location for the staging area in Zone 6 (see Appendix C, Figure 11-4). This location is not the geographic centroid but it reduces backtracking for communities within zone 6.

12.0 EXISTING DISPOSAL SITES EVALUATIONS

A site survey form and municipal questionnaire was developed by the study group to assess each of the existing waste disposal sites within the study area presented in Table 12-1. The assessment will identify ownership, site controls, existing conditions, disposal methods, waste types, number of users, solid waste haulers, source and type of cover material, environmental considerations, and operating and maintenance cost associated with the disposal site. Information on the cost of operating and maintaining the existing disposal sites were collected from the municipalities responsible for the sites. An SNC-Lavalin Technician visited each disposal site, interviewed the individual(s) responsible for the site (if present), documented current site conditions, and collected a photographic record for each site. The landfill/Incinerator site visit checklists and municipal questionnaires are provided in Volume 2 of the report.

Table 12-1: **Disposal Sites located within the Study Area.**

Landfill Sites	
New- Wes-Valley	Gander Bay
Indian Bay	Gambo
Terra Nova Site	Cottrell's Cove
Terra Nova Regional Waste Disposal Site	Comfort Cove – Newstead
Stoneville	Carmanville
St. Brendan's	Cape Freels
Point of Bay	Campbellton
Point Leamington	Buchan's Junction
Peterview	Boyd's Cove
Norris Arm	Botwood
Musgrave Harbour	Birchy Bay
Millertown	Benton
Lumsden	Badger
Little Burnt Bay	Gander
Laurenceton	Leading Tickles
Aspen Cove	Main Point
Horwood	Buchans
Glenwood	Fogo Island (Metallic Waste Disposal Site)
Incinerator Sites	
Twillingate	Brown's Arm
New World Island	Change Islands
Lewisporte	Exploits Region
Fogo Island	

All disposal sites located within the boundaries of the study area were visited during the assessment with the exception of the Terra Nova and Fogo Island sites. Information on the Fogo Island disposal sites was obtained from the *Regional Solid Waste Site Selection Study for Fogo Island published by BAE Newplan Group Limited in 2002.* The Terra Nova landfill site was not visited because it is no longer in operation.

13.0 ANALYSIS OF WASTE MANAGEMENT SYSTEM ALTERNATIVES

This section of the report provides a cost analysis of the two waste management systems under consideration for the Central Newfoundland Region. The systems are (1) wet/dry system, and (2). three stream system.

It is inherently difficult to compare solid waste management systems of different municipalities. Each of the facilities used within the various systems may use a significantly different process than its counterpart in another municipality. For instance, one facility may favour mechanical rather than manual sorting to a greater degree than another or may accept a greater amount of IC&I waste. Also, the local economic climate may contribute to the disparity between process costs; the cost of labour, materials and utilities may be more or less expensive in certain municipalities, and the markets for recyclable materials may be more or less lucrative. There are many variables at play.

Another significant challenge in comparing waste management systems is the inconsistency in how cost and process information is reported. A thorough accounting of the cost and process data would be required to ensure that the costs reported are categorized and defined similarly across the systems. Such an analysis would be lengthy and involve a high level of cooperation from the municipal waste managers whose systems are being studied. This level of research analysis is beyond the scope of this report.

The analysis presented in this report is based on the best data available to the study group. The information used in this study has been gathered from the literature and, where possible, through direct discussion with municipal waste managers. It is intended that the process cost per units may be helpful in **estimating cost ranges** for comparable potential waste systems in the Central Newfoundland Region. However, it is stressed that these can only be ballpark estimates and would be based on municipal systems whose local conditions may or may not be similar to that of the Central Newfoundland Region.

Three examples have been used for each system. Examples of wet/dry systems used are from Guelph (Ontario), Edmonton (Alberta), and Northumberland (Ontario). The three/four stream systems examined are from Colchester County, the Annapolis Valley, Halifax Regional Municipality (HRM). All are four stream systems from Nova Scotia.

The observations from the analysis are incorporated in six tables. Table 12.1 presents an overview of the waste systems reviewed. Table 12.2 presents a summary of the quantities of waste processed at the municipal waste facilities. Table 12.3 and 12.4 reviews the processing abilities and costs of the municipal recycling and composting facilities. Table 5 examines collection costs and Table 6 provides a summary of the total system costs.

13.1 COMPARABLE MUNICIPAL WASTE SYSTEMS

The City of Guelph

Guelph was the first municipality to collect and process all waste in a Wet/Dry system. The program has achieved significant diversion from its inception, and has proven to be both effective and economical. As can be seen, Guelph's system costs are low compared to other municipalities. An important factor in this low system cost is the amount of revenue that the municipality receives from the sale of recyclable materials that are delivered, pre-sorted, to the plant by the IC&I sector. Requiring no processing, this material is a source of significant revenue, offsetting the costs of processing the entire residential waste stream.

Guelph's approach to the IC&I sector is something that should be considered by all municipalities. However, this approach may not be possible in municipalities where private recyclers already exist. Established private sector recyclers would be very upset to find themselves in competition with a tax-funded municipal recycling program.

The City of Edmonton

Edmonton has a collection program that resembles a Wet/Dry program, but differs significantly. Edmonton collects recyclables ONLY in its dry stream, and everything else in its wet stream. In fact, Edmonton simply pulls non-compostable material out of its garbage stream and composts the rest. The system also composts significant amounts of sewage sludge.

The Edmonton program addresses only the residential waste stream. At a capital cost of $99 million, Edmonton's program stands out not only for its 70% residential diversion rate, but also for its cost.

Northumberland County

Although Northumberland collects their waste in a Wet/Dry stream, they do not compost the organic portion. To date, the composting facility has not been built.

Halifax Regional Municipality

Halifax's system includes a four-stream collection system. Recyclables are collected in two separate streams: fibre and containers. Organics are collected separately and the fourth stream is the garbage that is left.

Halifax, as well as all other Nova Scotia Municipalities, benefits from the fact that their program is mandatory. Residences and businesses alike must separate their waste. Recyclable and compostable material is banned from disposal in Nova Scotia.

Halifax's recycling numbers appear to be lower than others. That is primarily because of the many private recyclers that provide collection and recycling services to businesses. The municipality handles very little commercial recyclables at the recycling plant. The City has made a decision not to compete with private recyclers.

The Municipality of Colchester

Colchester's Waste Management Program has benefited from economies of scale. When designing their facility, Colchester decided to build excess capacity to be able to process recyclables from other municipalities. They import recyclable material collected in the Annapolis Valley and other jurisdictions and recycle it for a per tonne fee. The bottom-line benefits from having the tipping fee from the Valley as well as the revenue from the sale of the recyclable materials. In fact, the Colchester facility operates at a profit, which is unheard of in municipal recycling circles.

Annapolis Valley

The Annapolis Valley system is unique in that they do not have a recycling facility or a composting facility. Instead of building such facilities, the Valley sends its source-separated materials to other municipalities for processing. The Valley has built two transfer stations where the collected material is gathered and then sent off for processing.

Analysis

The tables and associated discussion points are found in the following pages.

Table 13-1: Municipal Waste Systems Reviewed.

System Type	Wet/Dry			Four Stream		
Municipality	Guelph, ON	Edmonton, AB	Northumberland, ON	HRM, NS	Colchester, NS	Annapolis Valley, NS
Population	157,405	650,000	79,120	367,502	51,025	84,565
# of Households	44,000	257,000	33,141	119,000	16,987	32,329
Diversion Rate (%)	43% (2001 total historical diversion relative to 1987) 51.5% (1999 GAP historic res. diversion relative to 1987) 39.4% (1999 GAP res. flow diversion)	70% (residential waste stream).	38% (1999 GAP res. flow diversion)	57% (2001 total diversion) 56.6% (1999 GAP residential diversion)	36.7% (2001 diversion of recyclables and organics from disposal for municipal facility)	50% (total diversion)

Analysis

One of the main challenges in comparing diversion rates between municipalities is that they are often measured differently, and thus have different meanings. For instance, it is common knowledge that municipalities within Nova Scotia have achieved the target of diverting more than 50% of their waste from disposal. In the table above, the Halifax Regional Municipality and the Annapolis Valley are reporting diversion rates of 57% and 50%, respectively. Many have also heard that the City of Edmonton is now diverting 70% of its solid waste. Initially, it appears that Edmonton has surpassed the Nova Scotia municipalities by 13% and 20%. However, Edmonton's diversion rate deals only with residential municipal solid waste, while the HRM and Annapolis Valley rates include the diversion and disposal of IC&I waste.

When comparing diversion rates, it is important to consider the methodologies used in their calculations. Some points to consider include:

- Does the diversion rate include materials not handled by the municipality, such as some IC&I waste or backyard composted organics?
- Is the diversion rate calculated using per capita waste generation amounts or total tonnage?
- Is the diversion rate calculated relative to a baseline year or is it a direct comparison of refuse to diverted materials?

Given these differences, caution must be employed when comparing one diversion rate with another. However, when used with understanding, diversion rates can be helpful in evaluating the success and the opportunities for improvement in any waste management program.

Table 13-2: Waste Quantities Processed

		Wet/Dry			Four Stream		
	Municipality	Guelph, ON (2000)	Edmonton, AB (2001)	Northumberland, ON (1999)	HRM, NS (2001)	Colchester, NS (2001)	Annapolis Valley, NS (2001)
Residential	Organics Processed (tonnes/year)	10,200	180,000*	0✚	28,500	2,400	4,500
	Organics Processed (kg/capita/year)	65	280*	0✚	80	50	50
	Recyclables Processed (tonnes/year)	29,000	40,000	9,700	14,200	9,800	2,800
	Recyclables Processed (kg/capita/year)	180	60	120	40	190	30
	Refuse Disposed (tonnes/year)	15,700	90,000	13,700	55,500	6,100	23,500
	Refuse Disposed (kg/capita/year)	100	300	170	150	10	280
IC&I	Organics Processed (tonnes/year)	1,200✚✚	0**	0✚	13,700✚✚	1,000✚✚	2,400
	Organics Processed (kg/capita/year)	8✚✚	0**	0✚	40✚✚	20✚✚	30
	Recyclables Processed (tonnes/year)	7,200✚✚	0**	3,200✚✚	3,400✚✚	620✚✚	1,500✚✚
	Recyclables Processed (kg/capita/year)	46✚✚	0**	40✚✚	10✚✚	10✚✚	20✚✚
	Refuse Disposed (tonnes/year)	113,000	Unknown**	No data available. About 23% of the IC&I dry stream is sent to disposal.	164,000✚✚✚	14,700★	Information not available
	Refuse Disposed (kg/capita/year)	720	Unknown**	Unable to calculate.	440	290	Unable to calculate.
Total	Organics Processed (tonnes/year)	12,200	Unknown	0✚	42,200	3,500	6,900
	Organics Processed (kg/capita/year)	78	Unknown	0✚	120	70	80
	Recyclables Processed (tonnes/year)	36,200	Unknown	12,800	17,500	10,400	4,400
	Recyclables Processed (kg/capita/year)	230	Unknown	160	50	200	50
	Refuse Disposed (tonnes/year)	129,000	Unknown	Unable to calculate.	127,000	20,900	23,500
	Refuse Disposed (kg/capita/year)	820	Unknown	Unable to calculate.	340	410	280
Total Annual System Tonnage (Recovery and Disposal)		157,000	Unknown	Unknown	204,000	41,500	

The figures in Table 13.2 indicate the amount of waste and recoverable material that is handled by the selected municipalities. In many cases, IC&I organics or recyclables may be processed through private recyclers or composters. For instance, the Halifax Regional Municipality estimates that in fiscal year 2000-2001, about 118,000 tonnes of IC&I solid waste was recycled through the private sector. However, because most of the landfills in this study are municipally owned, the final disposition of most IC&I refuse is handled - and therefore documented - by the municipalities.

It is expected that the amount of materials received for processing at a dry-stream MRF will be higher per capita than it will be with a three/four stream MRF. This is because the dry-stream MRF is required to process a proportion of the refuse stream that is commingled with the recyclables. For example, table 13.2 shows that the MRFs in Guelph and Northumberland receive 180 and 120 kg/person/year, respectively, for residential recyclable processing, while HRM and the Annapolis Valley receive only 40 and 30 kg/person/year, respectively. The recyclables waste stream entering the HRM and Valley MRFs arrive pre-sorted and with out significant amounts of refuse or contamination, and thus less processing capacity is used. The Colchester MRF is an exception in this case, possibly because it receives recyclables from other jurisdictions.

Table 13-3: Recyclables Processing Facilities

	Wet/Dry			Four Stream		
Municipality	Guelph, ON (1999)	Edmonton, AB (2001)	Northumberland, ON (1999)	HRM, NS (2001)	Colchester, NS (2001)	Annapolis Valley, NS✚✚✚ (2001)
Annual Capacity (tonnes)	91,000	40,000	30,000	28,000	12,000	
Annual Capacity per Person (kg)	580	60	380	76	235	
Capital Costs	$12,100,000	$12,000,000	$6,800,000	$4,500,000**	$4,746,000✚	$816,000★
Capital Costs per Capacity	$132	$300	$230	$160	$395	
Capital Costs per Person	$77	$18	$86	$12	93	$10
Annual Gross Operating Costs✓	$3,760,000 (2000: $4,879,215)		$2,110,000	$2,410,000	$843,000	$465,000
Annual Tonnage Received		40,000	12,800	17,500	10,400	4,400
Annual Gross Operating Costs per Tonne	$130 (2000: $165)		$165	$138	$81	$107
Annual Revenues	$2,112,000		$892,000*	$1,349,000***	$1,611,000✚✚	$142,000
Annual Net Operating Costs✓✓	$1,648,000		$1,219,000	$1,062,000	-$768,000	$323,000
Annual Net Operating Cost per Tonne	$57	$100	$95	$61	-$74	$73
Annual Net Operating Cost per Person	$11		$15	$3	-$15	$4

Table 13.3 illustrates how the addition of high-value, pre-sorted ICI recyclables into the recyclable processing stream can decrease the MRF per tonne operating costs. In Guelph, the cost per tonne of processing residential dry waste in 1999 was $130 (including administration). Introducing source-separated old corrugated cardboard, newsprint, fine paper, commingled containers, and mixed recycling material reduced the processing cost to $57 per tonne.

Table 13-4: Organics Processing Facilities

	Wet/Dry			Four Stream		
Municipality	Guelph, ON (1999)	Edmonton, AB* (2001)	Northumberland, ON	HRM, NS (2001)	Colchester, NS (2001)	Annapolis Valley, NS✓✓ (2001)
Annual Capacity (tonnes)	44,000	300,000	The Northumberland Wet/Dry program currently does not compost its Wet waste stream. The organics composted at the Canada Composting Inc. facility in Newmarket, Ontario for the County's organics composting trials are not included in these calculations.	50,000 (25,000 per facility)	6,000	
Annual Capacity per Person (kg)	280	460		140	120	
Capital Costs	$7,000,000	$97,000,000**		Data not available✚	$1,939,000 ✚✚✚	$1,293,000✓✓✓
Capital Costs per Capacity	$159	$323			$323	
Capital Costs per Person	$44	$149			$38	$15
Annual Gross Operating Costs ☒	$1,313,000 (2000: $1,398,000)			$3,499,000✚	$185,000	$661,000
Annual Tonnage Received	12,300 (2000: 10,700)	180,000		42,200	3,500	6,900
Annual Gross Operating Costs per Tonne	$107 (2000: $131)	MSW: $60 (projected)*** Sewage biosolids: $183 (projected)***		$83	$53	$96
Annual Revenues	$60,400			$1,028,000✚✚	$48,000✓	$300,000
Annual Net Operating Costs ☒☒	$1,252,000			$2,471,000	$137,000	$361,000
Annual Net Operating Cost per Tonne	$102	$85		$59	$39	$52
Annual Net Operating Cost per Person	$8			$7	$3	$4

In this review, the costs of processing the compostable waste streams (organics in a three/four stream system or wet in a wet/dry system) are shown to be considerably less expensive per tonne in the three/four stream system than in the wet/dry system. This is likely because the wet stream is processing refuse in addition to compostables; thus, the compostables are highly contaminated and will require extra processing, in particular pre-sorting and screening.

Table 13-5: Collection

	Wet/Dry			Four Stream		
Municipality	Guelph, ON (2000)	Edmonton, AB (2001)	Northumberland, ON (2001)	HRM, NS (2001)	Colchester, NS (2001)	Annapolis Valley, NS (2001)
Methodology	Weekly co-collection of wet and dry wastes.	Waste is collected weekly April to October and bi-weekly November to March.	Co-collection of wet (refuse) and dry wastes.	Bi-weekly collection of refuse and organics on alternating weeks. Recyclables collected weekly in urban, bi-weekly in rural.	Bi-weekly collection. Refuse and organics collected one week; paper and container recyclables are collected the next.	Bi-weekly, single pass 4-stream collection.
Number of stops			30,300	155,000	17,000	35,300
Annual Cost	$2,556,000		$1,389,000	$8,620,000*	$1,500,000 **	$1,719,000***
Annual Cost per Tonne	$50 - $55	$60	$82	$42		
Annual Cost per Person	$16		$18	$23	$29	$20
Annual Cost per Stop	$58 per household		$46	$56	$88	$49

Table 13-6: System Summary

	Wet/Dry			Four Stream		
Municipality	Guelph, ON (2000)	Edmonton, AB (2001)	Northumberland, ON (1999)	HRM, NS (2001)	Colchester, NS (2001)	Annapolis Valley, NS (2001)
Total System Annual Gross Cost (not including revenues or tipping fees)	$11,199,000	$31,000,000	Data not available	$35,236,000	$5,404,000	$7,927,000
Total System Annual Gross Cost per Tonne	$71	$160		$172	$130	$213
Total System Annual Gross Cost per Person	$71	$48		$96	$106	$94
Total System Annual Gross Cost per Household	$255	$120		$296	$318	$245
Annual Revenues (including sales and tip fees)	$8,000,000	3,300,000		$11,655,000	$2,706,000	$2,781,000
Annual Revenues per Person	$51	$5		$32	$53	$32
Annual Revenues per Tonne	$51	$17		$57	$65	$75
Annual Revenues per Household	$182	$13		$98	$159	$86
Net System Annual Costs (after revenues)	$3,000,000	27,500,000	$3,188,000	$23,484,000	$2,697,000	$5,145,000
Net System Annual Costs per Tonne	$19	$139	Data not available	$115	$65	$138
Net System Annual Costs per Person	$19	$42	$40	$64	$53	$61
Net System Annual Costs per Household	$68	$107	$96	$152	$159	$159

13.2 ANALYSIS OF COLLECTION SYSTEMS AND COSTS

Collection systems vary significantly before and after system change. In most cases researched, the method of collection of waste differed significantly after the implementation of a new waste management system. The new collection system was configured to integrate with the new processing system. Usually, collection frequency, number of vehicles, types of vehicles, and routing has all been changed in the implementation of the new system. Appendix D provides flow charts of typical wet/dry and three stream systems.

The only anomaly is in Edmonton, where there is no separate organic collection. In Edmonton, the organics are extracted from the garbage stream. In effect, they did not change collection methodology, but instead started treating their garbage stream like a Wet stream in a Wet/Dry Collection program.

Wet/Dry Collection can cost less than recycling and garbage collection. In Guelph, Wet/Dry collection is done in single-pass split trucks. Prior to the implementation of the Wet/Dry collection, recyclables were picked up every week in a separate vehicle than the garbage. The recycling collection included curbside sorting where paper, cans, glass and plastic are all kept separate in different compartments. That collection system meant that there was a requirement for two different types of vehicles and that each home had to be visited by two vehicles every week.

The Wet/Dry system allows all material to be picked up in one vehicle, reducing the need to send two trucks. The system has proven to be more cost-efficient than the old, employing fewer vehicles and driving fewer miles.

Collection Costs: Before and After Comparison

System Type	Municipality	Period	Cost per Tonne	Description of Collection System
Wet/Dry	Guelph	Before (c. 1995)	$60/tonne (Garbage: $52/tonne Blue Box: $87/tonne)	Refuse & Blue Box. Municipally collected. 13 trucks used to collect waste: 8 garbage trucks and 5 recycling trucks
		After	$50-$55/tonne	Wet/Dry Collection. Municipally collected. 9 co-collection trucks used. Split capacity trucks: 70% Dry & 30% wet
	Edmonton	Before (c.1995)	$60/tonne	Refuse & Blue Box. Collected using municipal and contract staff. Blue Box collected by contractors. Waste collected using 50 city trucks and 35 contractor trucks.
		After	$60/tonne	Two Stream (Refuse and Recyclables)Recyclables collected in blue bags and blue box. Refuse stream collected by combination of city and contract staff using mostly side loaders. Multi-family waste is collected by the city using contractors with front load trucks. Recyclables are collected in compacting side loaders by both city and contract staff. The city and the contractors each use approximately 30 trucks for refuse and 15 trucks for recyclables. Collection from multi-family units uses approximately 10 front loaders for refuse.
Four Stream	HRM	Before (c.1997)	$45	Two Stream (Refuse and Recyclables). Recyclables in Blue Bags. Large variety of contractors and trucks under contract to 4 municipalities prior to amalgamation.
		After	$42	Four stream collection. Organics one week, garbage next. Recyclable containers in Blue Bags, paper in grocery bags, cardboard bundled, organics in carts, and garbage. Urban areas receive recyclable collection every week, rural areas every second week.
	Annapolis Valley	Before (c.1996)	$18	Refuse and Recyclables (blue box or blue bag). The towns and the municipalities each managed their own waste and recyclable collection. Except for the Municipality of Kings County, all use private contractors for collection.
		After	$46	Bi-weekly, single-pass 4 stream collection. Labrie top-loader. Cart tipper on the side of truck. Four streams are organics, recyclable fibre, recyclable containers, and garbage.

The study team has completed a model to determine the costs for collection and transportation from the study area. The model uses actual data from the study in the analysis. The following tables summarize the results.

Collection Cost

System	Wet/Dry Option
Population	75,555
Number of Households	35,959
Annual Residential Waste* (tons)	25,725
Annual Collection Cost** ($)	1,225,328
Annual Cost per Person ($)	16
Annual Cost per Ton ($)	48
Annual Cost per Household*** ($)	34

Note: * Include the waste generated by tourists in Terra Nova Park, which is equivalent to 1,025 residents in Year 2001.

*** * Collection cost estimation is based on $16/person/year which is determined from the information from towns with reference to Avalon Peninsula and other region in Canada.**

***** Adjusted for Tourism in Terra Nova Park.**

Transportation Cost

System Type	Wet/Dry Option
Population	75,555
Number of Households	35,959
Annual Waste Generation (tons)	46,490
Annual Waste to the Facility* (tons)	43,017
Transportation Cost from Communities to Transfer/Central Facilities (to community) ($)	775,407
Transportation Cost from Transfer Stations to Central Facilities (to Waste Management Authority)** ($)	582,961
Total Transportation Cost of Residential Waste*** ($)	1,124,029
Annual Cost per Person ($)	15
Annual Cost per Ton ($)	44
Annual Cost per Household ($)	31

Note: * Waste to the facility include 100% of residential waste, 100% of rural IC&I waste and 75% of urban IC&I waste..

*** * Hauling cost of waste (residential and IC&I) from transfer/staging stations to the central facility by 53 ft container. The hauling cost is estimated based on the trucking time (round trip plus half an hour unloading time) and hourly truck rate ($150/hour) and weekly trip numbers from each transfer /staging stations.**

14.0 ANALYSIS OF RECYCLABLE PROCESSING OPTIONS

Recyclables Processing

Once municipally collected recyclable materials are collected from householders and businesses, they are then sent to a Materials Recycling Facility (MRF) for sorting, processing and shipping to market. The process used for sorting and separating recyclable materials can be primarily manual, automated, or a blend of automation and manual labour.

There are three common approaches to processing recyclable materials: single-stream processing, two-stream processing, and multi-stream processing. The choice of system is tied to the type of collection system used to collect the recyclable materials.

Single-stream processing is used when all recyclables are collected together and fully commingled. The City of Edmonton, for example, uses the single-stream collection method.

Some advantages of the single-stream collection and processing of recyclables include convenience for the householder and simplified collection. One of the key disadvantages of single-stream processing is that the sorting and separating process at the MRF is more complicated, in particular the separation of container recyclables and fibres (papers). Also, single-stream processing has a more contamination and residue – and thus a lower recovery rate – than two-stream or multi-stream processing. Broken glass is a common contaminant that is difficult to separate from mixed papers. Because the materials are collected in one container, it is more difficult to employ behaviour correction techniques with residents who include contaminants.

Two-stream processing is used when recyclable materials are collected in two-streams, such as fibres (papers) and mixed containers (plastics, steel and tin cans, and glass jars). For example, in the Halifax Regional Municipality, newspapers and flyers are collected in plastic grocery bags and mixed container recyclables are collected in transparent blue bags. In this approach, basic sorting and processing is used to separate the different materials and prepare them for transport.

Two main advantages of the two-stream processing are reduced contamination rates and reduced processing requirements. Essentially, the householders are providing the municipality with a free sort by separating their fibre and container recyclables. Disadvantages of two-stream processing include that is slightly more complicated to explain and less convenient for householders.

The multi-stream processing approach is used when recyclable materials are kept highly segregated during collection. For instance, materials may be pre-sorted into fibres, glass containers, plastics, and metals containers. This approach is more common in drop-off programs but can be used with curbside collection (e.g. blue box recycling). Blue box collection systems is convenient for householders, as all they have to do is put the materials in the blue box and place the box by the curb. Collection staff collects the materials and put them in the appropriate compartments on the truck. Contaminants are left in the blue box. When materials arrive at the MRF, they require minimal sorting and processing. The MRF is mainly used as a transfer station where the materials are baled and shipped to market.

This approach can be cumbersome to collect. A common collection problem, in particular with blue box recycling, is "cubing-out". Materials are collected into separate compartments on the collection truck. Once one compartment is filled, even if the others are not, the truck must leave the route and empty its load.

Once the materials have gone through single-stream, two-stream, or multi-stream processing, they can be compacted using balers or densifiers before being stored or shipped to market. Glass products can be crushed and placed in transport tubs.

Processing Technologies

Many technologies can be used to process recyclables and are described in table 14-1.

Table 14-1: **Recycling Facility Technologies**

Technology	Function	Description
Bag Breaker: slitters	Open bags	Bags are forced between cutting blades that rotate in opposite directions. As the bags are ripped open, the materials spill onto a conveyor belt below. The plastic bag residue is removed manually along the conveyor line.
Bag Breakers: augers	Open bags	Bags are moved through a cylinder that contains a rotating screw auger. The auger rips the bags open against the inside of the cylinder wall. Plastic bag residue is removed manually.
Bag Breakers: trommels	Open bags	Bag-breaking trommels are specially equipped with triangular cutters or spikes on the inside of the rotating drum. The cutters tear open the bags as they are tumbled in the drum, and the recyclable materials then come out. Plastic bag residue is removed manually later in the process.
Air Classifiers: blowers	Separate materials based on weight	Lighter materials (e.g. aluminum) are separated from heavier materials (e.g. steel cans) by using forced air. The lighter materials are blown to another conveyor, while the heavier materials remain.
Air Classifiers: suction	Separate materials based on weight	A vacuum above a mixed container stream on a conveyor picks up the lighter material, which is then deposited on another conveyor. Vacuum pressure can be adjusted to assist in sorting materials of different weight.
Inclined Conveyors	Separate materials based on weight	Light containers are directed along the conveyor and discharged off the end. Heavier containers slide down the slope of the conveyor and onto a second conveyor, which then moves the heavier containers to another sorting area. Inclined conveyors can also use a series of chain curtains moving in the same direction as the conveyor to improve the sorting.
Trommel Screens	Separate materials based on size	Trommel screens are long, rotating drums that are inclined to help move materials along the drum. The drum is covered in holes of various diameters, which are used to separate containers and debris based on their size. As the drum rotates, the materials tumble in the drum and exit through the holes. Larger materials work their way down toward the end of the drum.
Trommel-Magnets	Remove ferrous materials	A magnet can be added to a trommel screen to separate ferrous materials from the others. A stainless steel tube is welded on one end of the trommel. The tube is magnetized to attract the ferrous materials. As the trommel rotates, the tube brings the materials to the top of the trommel. The magnetic field is then weakened, and the ferrous materials are dropped into a chute or onto a conveyor.
Star/Disc Screens	Separate materials based on size	The star/disc screens consist of a number of rotating axles, and each have a number of star-shaped discs spaced along them. The spacing between the axles and the stars is adjustable to accommodate the sorting function, as is the diameter of the discs. The materials are directed over the discs so that oversized material is passed over the screen while smaller materials are able to fall through the spaces.
Colour Glass Sorters	Separate glass based on colour	Mechanical glass sorters that differentiate using colours are a new technology. The sorters air-classify the unders and then optically sorts the glass into clear, opaque, and two coloured glasses.
Plastics Sorters: transmission	Separate plastics based on resins and colours	The colours or resin-types of plastics are detected with transmission identification sensors (using x-rays or visible light). This is best used where there are low levels of contaminants in the stream.
Plastics Sorters: reflective	Separate plastics based on resins and colours	Reflective near infra-red (NIR) sensors are used to detect the colours of resin-types of plastics. The NIR sensors can be used in 'dirty' MRFs where the stream is mixed.
Eddy Current Separators	Separate aluminum cans using conductivity	An oscillating magnetic field is used to separate conductive but non-ferrous materials from the waste stream. The field moves the materials (typically aluminum cans) onto another conveyor or into a chute. The separators work best when the stream has already received some sorting and the conductive material is the dominant item in the stream. This prevents other items from being moved with, or preventing the movement of, the conductive materials.

The selection of the appropriate processing technology will depend upon the collection system selected, the desired recovery rate, equipment and servicing availability, cost and finally, from experience with similar systems.

15.0 ALTERNATIVE APPROACHES TO ENGINEERED LANDFILL

This section of the report provides a discussion on alternative approaches to engineering landfill including such factors as amount of land needed for a 50 year capacity, high water table, cover material, bale fill or in-cell compaction, and other designs, construction and operational parameters. Appendix E provides information gathered from suppliers and manufacturers on technologies being applied to landfill operations.

15.1 LANDFILL DESIGN ALTERNATIVES

Landfills are designed to maximize the volume of refuse and minimize the landfill area. This is accomplished by maximizing the density of the refuse, minimizing the cover systems, and optimizing the design of the landfill to utilize site-specific topographic conditions. Conventional fill and compact landfill are the most common approaches. The compaction of refuse may be achieved by the normal traffic over the site, or by compaction equipment designed for this purpose. Compaction equipment includes rollers fitted with sheep foot or pad compactors. Mechanical compaction is effective and typically increases refuse density to approximately 700-kg/cubic meter[54].

The alternative to on-site compaction of refuse is to bale the refuse using hydraulic presses. The baled refuse is then placed in the landfill as blocks. The density of the baled refuse is similar to that of compacted in place refuse[55]. Bale-fills may result in reduced handling costs, easier handling and storage, reduction of leachate and landfill gas generation, and reduction of odour and vector problems. The following section provides a brief summary of landfill design alternatives.

15.2 BALE-FILL LANDFILLING

Conventional landfills require large land areas to accommodate the volume requirements associated with uncompacted waste. In addition, these landfills have historically been associated with odour problems, fire risk, and unacceptable environmental conditions. Bale-fill landfills can reduce and/or eliminate many of these problems.

Bale-filling systems can process waste from all three waste streams. Bale-fill landfills offer the potential of volume and cost reduction through compression of solid waste into a fraction of the original volume. In a typical bale system, the waste is compressed into airtight bales and wrapped with stretch film. The film lowers oxygen and water intake into solid waste, thereby reducing the potential for leachate production within the landfill from fermentation and degradation. Other advantages of bale-fill landfills include:

[54] Per. Com. Otter Lake Landfill Operations.
[55] Per. Com. Colcherster Bale-fill.

- Preservation of waste material properties;
- Reduction of odour and landfill gas;
- Less fire risk;
- Reduction of landfill leachate generation;
- Easy handling and storage; and
- No landfill compaction equipment required.

15.3 ALTERNATIVE DAILY COVER SYSTEMS

Synthetic cover systems offer significant volume reduction compared to conventional soil cover. These system save valuable airspace to extend the life of the landfill and offer potential cost savings. Typical synthetic cover alternatives include slurries and tarping.

Slurries are typically composed of cellulose fiber mulch and form a cementous binder when applied as a daily cover. Typically, the slurry is water-based and applied with a portable hydro-mulch vehicle. Many slurry systems include odour and dust control materials while offering a reduction in infiltration.

Tarping systems utilize a self-contained tarping unit, which attaches to heavy machinery such as the blades of bulldozers. The tarping unit unrolls and retrieves synthetic fabric, which is used to cover solid waste and reduce infiltration. The associated tarp is weighted with cable pockets and/or ballast chains to prevent dislodgement.

15.4 LINER SYSTEMS

A containment landfill will be required for the Central Region[56]. A containment landfill is designed to control the discharge of effluent. The design requires the installation of one or more impermeable liners. The design of the liner system is an engineering function. The liner system may be designed with leachate collection, a leak detection layer, and a second liner to serve as a contingency against failure. The cost of the liner system will vary depending upon the complexity and the risk management factors built into the system.

Site conditions will impact engineering designs. A containment landfill requires the collection and management of leachate. The leachate will be collected in a piping network and directed to a treatment system. There are no alternatives to leachate collection, however there are alternatives in the methods used to collect leachate.

[56] Newfoundland and Labrador Waste Management Strategy. Department of the Environment 2002.

16.0 COST FOR WASTE MANAGEMENT FACILITIES

This section of the report provides a description and cost of the proposed waste-resource management facility options as well as providing alternatives based upon overall system costing.

Broad-spectrum costing for these facilities, based on annual tonnages received, is provided below. These include:

- Less than 1000 T/year;
- 1000 T/year – 2000 T/year;
- 2000 T/year to 3000 T/year;
- 3000 T/year to 4500 T/year;
- 6000 T/year to 7000 T/year;
- Greater than 10,000 T/year.

The following section describes each of the proposed waste-resource management centres, including the location, conceptual site layouts, and design. Each facility will also incorporate storage areas for construction and demolition debris, hazardous materials, and white goods.

Several assumptions were made in costing these facilities. The assumptions include:

- Access road is approximately 500 m. Cost may increase if access road is greater than 500 m or decrease if access road is less than 500 m;
- Costing is based on a wet-dry collection system. Cost may vary slightly with a 3 or 4 waste stream collection system;
- Power supply is located adjacent to main road.

16.1 LESS THAN 1000 T/YEAR WASTE-RESOURCE MANAGEMENT CENTRE (i.e., BUCHAN'S JUNCTION)

Based on the volume of waste, costing was presented for a combination of roll off bins and green bins.

The conceptual design demonstrates that the entire site is enclosed with an approximate 50 m x 25 m fence. A 12 m scale and associated scale house are located at the gated entrance. The site design accommodates two roll-off bins and two green bins within the enclosed site. A separate area for construction/demolition materials, hazardous materials, and metal/white goods storage is provided.

Assuming 70% dry waste and 30% wet waste will be delivered to the waste management facility, one 30 m^3 compaction rolloff bin, two 4.6 m3 green bins, and one open top rolloff bin would be required. The dry waste can be compacted to a density of 250 kg/m^3. Based on a weekly collection schedule, one 30 m^3 compaction roll off bin is required. Due to the small volumes of the wet waste as well as a weekly collection schedule, two 4.6 m^3 green bins would be required. One 30 m^3 open top rolloff bin will be supplied for unusual waste.

Capital Costs

Item	Cost ($)
Land Purchase - Assumed Central Solid Waste Management Commission would not have to purchase land.	$0
Site Preparation - Site grading, excavation, clearing, grubbing, etc. Assumed size of site would be 50 m x 25 m. Assumed an average of 0.25 m excavation and backfill for the site at $10/$m^3$.	$3,125
Access Road - The site is located on a 500 m gravel access road. It was assumed the access road would have to be upgraded and paved. The assumed cost of the upgrade would be $100/m	$50,000
Onsite Paving - It was assumed approximately 200 m^2 of the site would require paving, at a cost of $20/$m^2$	$4,000
Retaining Wall - Requires 63.5 m^2 of reinforced concrete, 0.3 m thick, at a cost of $450/$m^3$.	$8,573
Concrete Pad - The total concrete pad area is estimated to be 36m^2, 0.15 m thick, at a cost of $450/$m^3$.	$2,430
Rolloff Bins - One 30 m^3 compactor rolloff bin at a cost of $16,000, one 30 m^3 open top rolloff bin at a cost of $6,000 and two 4.6 m^3 green bins at a cost of $1,000/unit.	$24,000
Rolloff Bin Covers - Steel covers with rolling doors and animal resistant mesh screen (open bin only), at a cost of $16,000.	$16,000
Weigh Scales - Inbound 40 ft scales	$50,000
Water Supply - A water supply will be needed for employee use, washroom facilities, and facility washdown. An artesian well is proposed. The cost of drilling an artesian well is $100/m to a depth of 100m. It was assumed that water storage would not be required.	$10,000
Power Supply – It was assumed power the supply could be extended from the main road (500 m). The cost to extend the power supply was assumed at $25/m.	$3,750
Septic Tank and Tile Field	$10,000
Fencing and Gates - 3m fence around perimeter of site (approx. 150m) at $55/m. $2000 was assumed for the cost of gates and $300 was assumed for signage.	$10,550
Landscaping	$5,000
Sub-Total	$197,428
Contingency (10%)	$19,743
Engineering (15%)	$32,576
TOTAL	$249,746

Operational Costs

ITEM	COST ($/year)
Staffing - One part-time employee (20 hr/week) @ $15/hour + 35% payroll burden	$21,060
Maintenance	$2,000
Snow Clearing	$2,000
Power Lighting, misc	$1,000
TOTAL	$26,060

16.2 1000 T/YEAR TO 2000 T/YEAR WASTE RESOURCE MANAGEMENT CENTRE (i.e., FOGO)

Based on the annual volume of waste delivered to the waste resource management centre, costing was presented for rolloff bins.

The conceptual design demonstrates that the entire site is enclosed with an approximate 50 m x 40 m fence. A 12 m scale and associated scale house are located at the gated entrance. The site design accommodates four roll-off bins. A separate area for construction/demolition materials, hazardous materials, and metal/white goods storage is provided.

Assuming 70% dry waste and 30% wet waste will be delivered to the waste management facility, three 30 m^3 compaction roll off bins and one open top rolloff bin would be required. The dry waste can be compacted to a density of 250 kg/m^3. Based on a collection schedule of twice/week, two 30 m^3 compaction rolloff bins will be required. The wet waste can be compacted to a density of 900 kg/m^3. Based on a collection schedule of once every two weeks one 20 m^3 compaction rolloff bin will be required. One 30 m^3 open top rolloff bin will be supplied for unusual waste.

Capital Costs

Item	Cost ($)
Land Purchase - Assumed Central Solid Waste Management Commission would not have to purchase land.	$0
Site Preparation - Site grading, excavation, clearing, grubbing, etc. Assumed size of site would be 40m x 50m. Assumed an average of 0.25 m excavation and backfill for the site at $10/m.	$5,000
Access Road - The site is located on a 500 m gravel access road. It was assumed the access road would have to be upgraded and paved. The assumed cost of the upgrade would be $100/m	$50,000
Onsite Paving - It was assumes approximately 500 m^2 of the site would require paving, at a cost of $20/$m^2$	$10,000
Retaining Wall – Requires 115 m^2 of reinforced concrete, 0.3 m thick, at a cost of $450/$m^3$.	$15,525
Concrete Pad - The total concrete pad area is estimated to be 72 m^2, 0.15 m thick, at a cost of $450/$m^3$.	$4,860

Item	Cost ($)
Rolloff Bins - Three 30 m^3 compactor rolloff bins at a cost of $16,000/unit, one 30 m^3 non-compactor rolloff bin at a cost of $6,000.	$54,000
Rolloff Bin Covers - Steel covers with rolling doors and animal resistant mesh screen (open bin only), at a cost of $16,000.	$16,000
Weigh Scales - Inbound 40 ft scales	$50,000
Water Supply - A water supply will be needed for employee use, washroom facilities, and facility washdown. An artesian well is proposed. The cost of drilling an artesian well is $100/m to a depth of 100m. It was assumed that water storage would not be required.	$10,000
Power Supply – It was assumed power the supply could be extended from the main road (500 m). The cost to extend the power supply was assumed at $25/m.	$12,500
Septic Tank and Tile Field	$10,000
Fencing and Gates - 3m fence around perimeter of site (approx. 180m) at $55/m. $2000 was assumed for the cost of gates and $300 was assumed for signage.	$12,200
Landscaping	$5,000
Sub-Total	$255,085
Contingency (10%)	$25,509
Engineering (15%)	$42,089
TOTAL	$322,683

Operational Costs

ITEM	COST ($/year)
Staffing - One part-time employee (20 hr/wk) @ $15/hour + 35% payroll burden	$21,060
Maintenance	$5,000
Snow Clearing	$5,000
Power Lighting, misc	$1,000
TOTAL	$32,060

16.3 2000 T/YEAR TO 3000 T/YEAR WASTE RESOURCE MANAGEMENT CENTRE (i.e., GANDER BAY SOUTH)

Based on the annual volume of waste delivered to the waste resource management centre, costing was presented for rolloff bins.

The conceptual design demonstrates that the entire site is enclosed with an approximate 50 m x 40 m fence. A 12 m scale and associated scale house are located at the gated entrance. The site design accommodates four roll-off bins. A separate area for construction/demolition materials, hazardous materials, and metal/white goods storage is provided.

Assuming 70% dry waste and 30% wet waste will be delivered to the waste management facility, three 30 m^3 compaction roll off bins and one 30 m^3 open top rolloff bin would be required. The dry waste can be compacted to a density of 250 kg/m^3. Based on a daily collection schedule, two 30 m^3 compaction roll off bins will be required. The wet waste can be compacted to a density of 900 kg/m^3. Based on a weekly collection schedule, one 20 m^3 compaction rolloff bin will be required. One 30 m^3 open top rolloff bin will be supplied for unusual waste.

<u>Capital Costs</u>
The estimated capital costs are comparable to the 1000 T/year to 2000 T/year waste management facility.

<u>Operational Costs</u>
The estimated operational costs are comparable to the 1000 T/year to 2000 T/year waste management facility.

16.4 3000 T/YEAR TO 4500 T/YEAR WASTE RESOURCE MANAGEMENT CENTRE (i.e., BOTWOOD)

Based on the annual volume of waste delivered to the waste resource management centre, costing was presented for roll off bins.

The conceptual design demonstrates that the entire site is enclosed with an approximate 50 m x 40 m fence. A 12 m scale and associated scale house are located at the gated entrance. The site design accommodates four roll-off bins. A separate area for construction/demolition materials, hazardous materials, and metal/white goods storage is provided.

Assuming 70% dry waste and 30% wet waste will be delivered to the waste management facility, three 30 m^3 compaction roll off bins and one open top rolloff bin would be required. The dry waste can be compacted to a density of 250 kg/m^3. Based on a daily collection schedule, two 30 m^3 compaction rolloff bins will be required. The wet waste can be compacted to a density of 900 kg/m^3. Based on a weekly collection schedule, one 30 m^3 compaction rolloff bin will be required. One 30 m^3 open top rolloff bin will be supplied for unusual waste.

<u>Capital Costs</u>
The estimated capital costs are comparable to the 1000 T/year to 2000 T/year waste management facility.

Operational Costs

ITEM	COST ($/year)
Staffing - One full-time employee @ $15/hour + 35% payroll burden	$42,120
Maintenance	$5,000
Snow Clearing	$5,000
Power Lighting, misc	$1,000
TOTAL	$53,120

16.5 6000 T/YEAR TO 7000 T/YEAR WASTE RESOURCE MANAGEMENT CENTRE (i.e., GAMBO)

Based on the annual volume of waste delivered to the waste resource management centre, costing was presented for roll off bins.

The conceptual design demonstrates that the entire site is enclosed with an approximate 70 m x 70 m fence. A 12 m scale and associated scale house are located at the gated entrance. The site design accommodates six roll-off bins. A separate area for construction/demolition materials, hazardous materials, and metal/white goods storage is provided.

Assuming 70% dry waste and 30% wet waste will be delivered to the waste management facility, five 30 m^3 compaction roll off bins and one open top rolloff bin would be required. The dry waste can be compacted to a density of 250 kg/m^3. Based on a daily collection schedule, three 30 m^3 compaction roll off bins will be required. The wet waste can be compacted to a density of 900 kg/m^3. Based on a weekly collection schedule, two 30 m^3 compaction rolloff bins will be required. One 30 m^3 open top rolloff bin will be supplied for unusual waste.

Capital Costs

Item	Cost ($)
Land Purchase - Assumed Central Solid Waste Management Commission would not have to purchase land.	$0
Site Preparation - Site grading, excavation, clearing, grubbing, etc. Assumed size of site would be 70m x 70m. Assumed an average of 0.25 m excavation and backfill for the site at $10/m.	$12,250
Access Road - The site is located on a 500 m gravel access road. It was assumed the access road would have to be upgraded and paved. The assumed cost of the upgrade would be $100/m	$50,000
Onsite Paving - It was assumes approximately 500 m^2 of the site would require paving, at a cost of $20/$m^2$	$10,000
Retaining Wall - Requires 172.5 m^2 of reinforced concrete, 0.3 m thick, @ a cost of $450/$m^3$.	$23,288
Concrete Pad - The total concrete pad area is estimated to be 108 m^2 , 0.15 m thick, @ a cost of $450/$m^3$.	$7,290

Item	Cost ($)
Rolloff Bins - Five 30 m^3 compactor rolloff bins at a cost of $16,000/unit, one 30 m^3 non-compactor at a cost of $6,000.	$86,000
Rolloff Bin Covers - Steel covers with rolling doors and animal resistant mesh screen (open bins only), at a cost of $16,000.	$16,000
Weigh Scales - Inbound 40 ft scales	$50,000
Water Supply - A water supply will be needed for employee use, washroom facilities, and facility washdown. An artesian well and reservoir system is proposed. The cost of drilling an artesian well is $100/m to a depth of 100m. This cost also includes the onsite piping, storage tanks, and pumps.	$60,000
Power Supply - The assumed power supply could be obtained at the main road (500 m). The cost to extend the power supply was assumed at $25/m. Onsite electrical distribution was assumed to a lump sum of $2000.	$14,500
Septic Tank and Tile Field	$10,000
Fencing and Gates - 3m fence around perimeter of site (approx. 280m) at $55/m. $2000 was assumed for the cost of gates and $300 was assumed for signage.	$17,700
Landscaping	$5,000
Sub-Total	$362,028
Contingency (10%)	$36,203
Engineering (15%)	$59,735
TOTAL	$457,965

Operational Costs

ITEM	COST ($/year)
Staffing - Two permanent employees @ $15/hour + 35% payroll burden	$84,240
Maintenance	$10,000
Snow Clearing	$10,000
Power Lighting, misc	$2,000
TOTAL	$106,240

16.6 GREATER THAN 10,000 T/YEAR WASTE RESOURCE MANAGEMENT CENTRE (i.e., GRAND FALLS - WINDSOR)

Based on the volume of waste, costing for an enclosed transfer station with one loading bay and a tipping floor are presented.

The conceptual design demonstrates that the entire site is enclosed within an approximate 150 m x 150 m fenced area. A scale and associated scale house are located at the gated entrance. The site design accommodates a 16 m long transport and a semi dump truck circling the site and accessing the loading bay. Municipal collectors can access and dump waste on the wet/dry tipping floor for loading and shipment to the final facility.

Within the fenced facility, a separate area (containing bins) will be designated for public dumping. A separate area is also designed for construction/demolition materials, hazardous materials, and metal/white goods storage.

Capital Costs

Item	Cost ($)
Land Purchase - Assumed Central Solid Waste Management Commission would not have to purchase land.	$0
Site Preparation - Site grading, excavation, clearing, grubbing, etc. Assumed size of site would be 150m x 150m. Assumed an average of 0.25 m excavation and backfill for the site at $10/m.	$56,250
Access Road – Assumed site is located on a 500 m gravel access road. It was assumed the access road would require upgrading and paving, at an assumed cost of $100/m	$50,000
Onsite Paving - It was assumed approximately 1000 m^2 of the site would require paving, at a cost of $20/$m^2$	$20,000
Transfer Station Building - To accommodate a tipping floor, loading bay, and loader operations it was assumed the building would have to be approximately 30m x 36m. The unit cost of the metal pre-fab building, including concrete bi-level is $800/$m^2$. This includes an attached office.	$864,000
Weigh Scales - Inbound 40 ft scales	$50,000
Water Supply - A water supply will be needed for employee use, washroom facilities, and facility washdown. Due to the location of the current incinerator, an artesian well and reservoir system is proposed. The cost of drilling an artesian well is $100/m to a depth of 100m. This cost also includes the onsite piping, storage tanks, and pumps.	$70,000
Power Supply - The assumed power supply could be obtained at the main road (500 m). The cost to extend the power supply was assumed at $25/m. Onsite electrical distribution was assumed to a lump sum of $2000.	$14,500
Septic Tank and Tile Field	$10,000
Compactor - The uncompacted density of dry waste is approximately 150 kg/m^3. The dry stream can be compacted to a density of approximately 250 kg/m^3. Compaction of wet waste is not necessary due to the transportation limitation of 25MT. Therefore only dry was needs to be compacted. The cost of the compactor includes installation.	$190,000
Loader	$150,000
Fencing and Gates - 3m fence around perimeter of site (approx. 600m) at $55/m. $2000 was assumed for the cost of gates and $300 was assumed for signage.	$35,300
Landscaping	$10,000
Sub-Total	$1,520,050
Contingency (10%)	$152,005
Engineering (15%)	$250,808
TOTAL	$1,922,863

BAE • NEWPLAN GROUP

Operational Costs

ITEM	COST ($/year)
Staffing - Four permanent employees @ $15/hour + 35% payroll burden	$168,480
Maintenance	$10,000
Loader Operation - 5 hr/day @ 5 days/week@ 52 weeks/year @ $40/hr	$52,000
Snow Clearing	$10,000
Power Lighting, misc	$1,500
TOTAL	$241,980

17.0 IDENTIFICATION OF POTENTIAL LOCATIONS FOR WASTE MANAGEMENT FACILITY

17.1 INTRODUCTION

The following section provides the results of the initial phase of the site selection process. The Terms of Reference required the project team to consider existing sites for future use and, to undertake a site selection process for a new Regional Waste-Resource Management Facility.

The project team has reviewed all existing waste management facility site locations in the context of the new regional management plan. For example, the study team has applied the committee generated constraint criteria to existing waste disposal and incinerator sites.

The proposed regional facility will include:

- construction and demolition recycling depot
- disposal site,
- public HHW drop-off area,
- centralized composting facility, and
- material recovery facility.

The site selection process is well understood by the regulators, it applies regulatory and community based constraints to a GIS model. The short listed sites then under go an ever-increasing level of investigation until the most desirable site is selected.

The proposed process involves a phased assessment of site suitability:

1. Phase 1 - Preliminary Identification (Constraint Mapping)
2. Phase 2 - Site Screening (Ranking)
3. Phase 3 - Financial Investigation
4. Phase 4 - Detailed Investigations

The first two phases of the site selection process included a comprehensive multi-disciplinary review of site characteristics. The assessment has focused on “avoidance criteria”, which include any characteristic and/or condition that would preclude development of the site for the intended purpose. Avoidance criteria may include specific restrictions established under municipal planning and zoning classifications, areas protected under provincial statute, areas restricted due to unique or protected habitat, registered archaeological sites, and sites determined to be unsuitable for a access or constructability stand-point. Access restrictions may include unsuitable all weather roadway or roadways with under capacity bridge structures.

Constructability may include areas with steep slopes, watercourse or groundwater problems. Most constructability restrictions will not be considered restrictions, and not preclude construction but may have a significant impact on cost.

The site selection process applied regulatory and community based constraints to a GIS model. Topographic maps (1:50,000) and the Department of Government Services and Lands provincial land use atlas were used in conjunction with site selection criteria and constraints. Each constraint and criteria were layered on a base map in the GIS model. The selection criteria and constraints are discussed in the methodology section.

A GIS map consists of several superimposed layers (i.e., a road network overlaid on a landmass). Figure 17-1 below outlines an example of the road network layer.

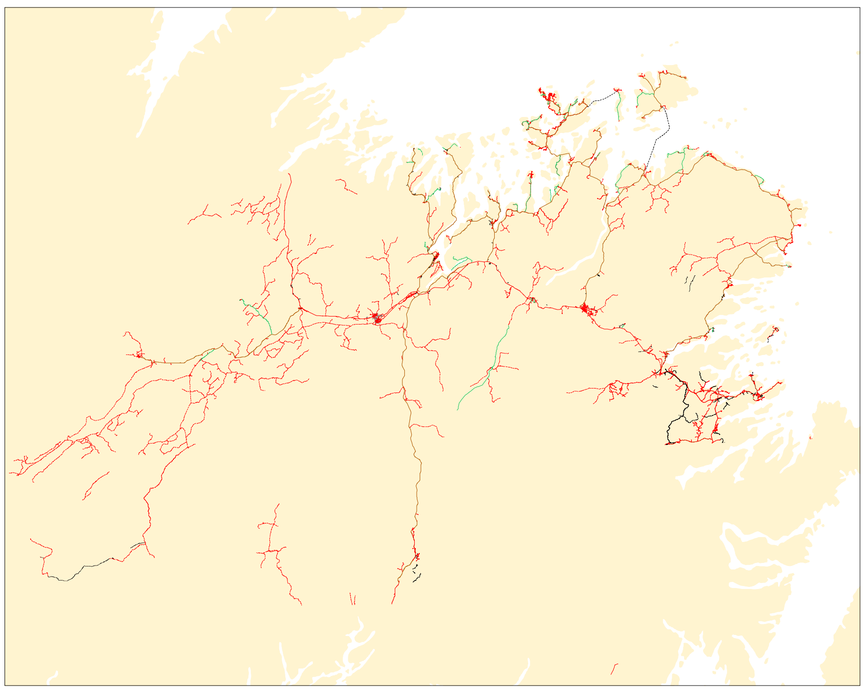


Figure 17-1: Example of Road Network Layer.

17.2 METHODOLOGY

In an effort to site the proposed waste management facility information and mapping was gathered from several government departments. These included:

1. **Government Services and Lands – Land Use Atlas**. Included data for agricultural zones, forestry zones, private lands, crown lands, non development areas, municipal boundaries, watersheds, water supplies (current and proposed), provincial and private parks, and wildlife reserves;

2. **Crown Lands – Cadastral mapping for each proposed site**. No site plans and property descriptions were available for the proposed sites;

3. **Department of Tourism, Culture, and Recreation**
   - Contacted sensitive wildlife division. Information requested but is still pending;

4. **Department of Forest Resources and Agrifoods**
   - Discussed use of proposed sites with Charlie Butler (Policy Co-ordinator). The department will advise of any encroachments on their property;

5. **Department of Government Services and Lands**
   - Topographic maps (1:50,000) for Central Region;
   - Contacted department of Works, Services, and Transportation on if there were any new road systems that were not included in the topographic maps. Information for road systems was requested but is pending.

To site the proposed waste management facility the following constraints were followed:

1. The site should be located 150 meters from the nearest water body or watercourse. Bodies of standing water located in wetlands were not considered as part of this constraint;
2. Site location should be located 300 m from the nearest public road and screened from view. Where possible, there should be a tree screen of 120 m or more maintained between the site and the road;
3. Site location should not be closer than 1.6 km from the nearest residences or other structure where person work or are lodged 24 hours a day;
4. Site should not be located within 2 km of an airport;
5. Site should not be closer than 1 km from residential wells, which are used as a drinking water supply. It was assumed that all residential wells would be within the 1.6 km residential buffer zone;
6. Site should not be within 1 km of all Municipal/Provincial/Federal parks. This included sanctuaries, protected areas, and wildlife reserves;
7. Site should not be located on land that has a slope greater than 12%;

8. Site should not located within an existing (or proposed) municipal water supply watershed area;
9. Site should not be located within 1 km of the coastline;
10. The site should be located 1 km from native land claims. There are no known native land claims located in the Central Region; and
11. Site should avoid endangered species habitat. It was assumed that endangered species habitat would be included in the parks buffer zone.

Based on the above constraints the following map was generated. Figure 17-2 below provides the constraint and opportunity criteria map

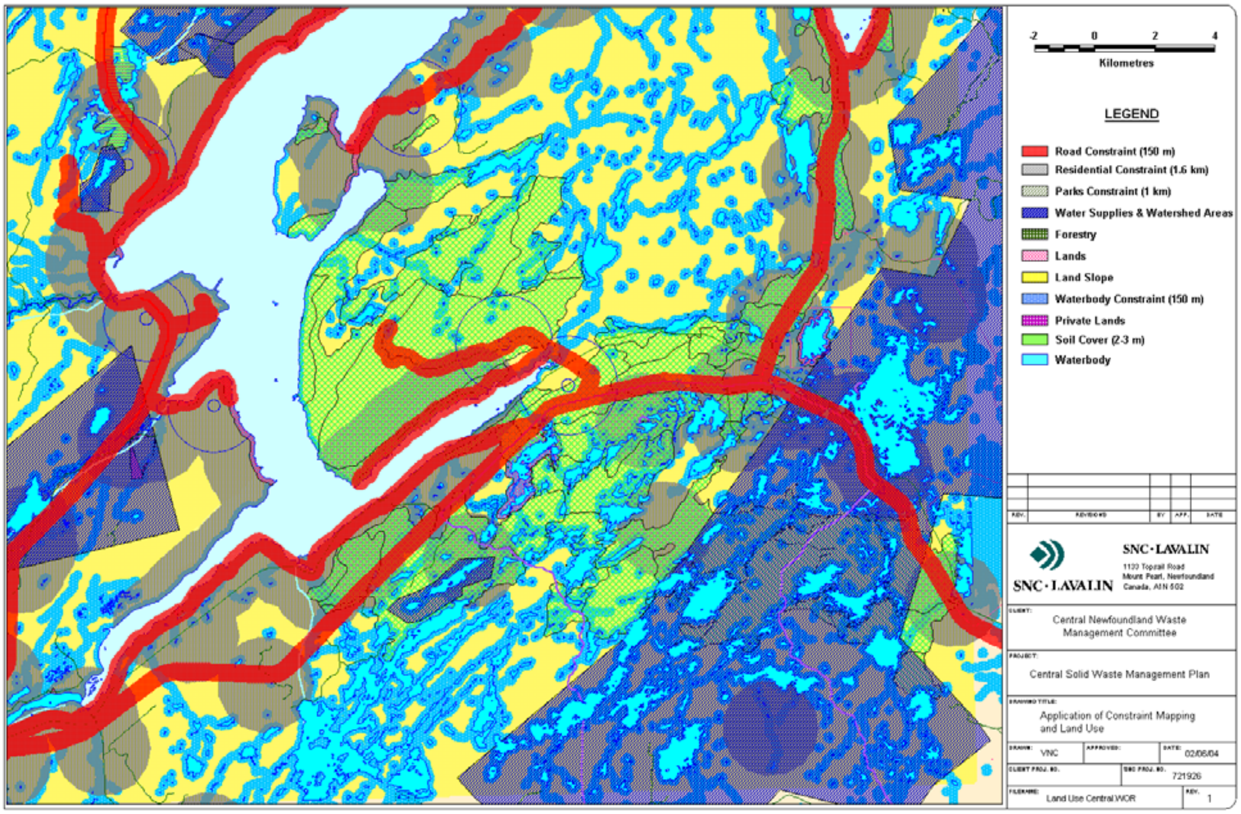


Figure 17-2: Application of Constraint Mapping and Land Use.

Locations that fell within the constraint areas were excluded form the site selection process. Only the areas that fell within the less than 12 percent land slope and soil covered criteria were considered as suitable sites for the waste management facility. This process identified five possible locations where the waste management facility could be located. Figure 17-3 below highlights these locations.

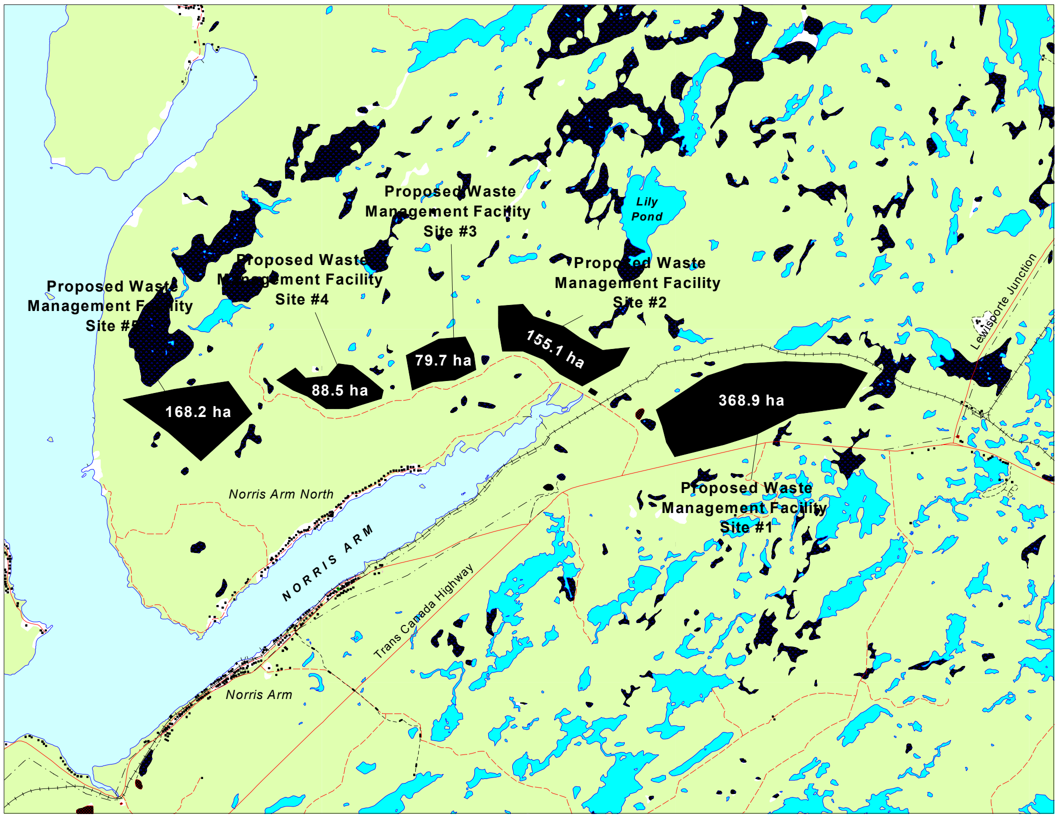


Figure 17-3: Five Proposed Waste Management Facility Locations

17.3 PROPOSED WASTE MANAGEMENT FACILITY SITES

17.3.1 Proposed Waste Management Facility Site #1

Site #1 is located approximately 2.0 km east of Norris Arm Harbour. The site covers an area of approximately 368.9 ha. Aerial photography of the site is provided in Appendix F.

Access Road

The site can be accessed using three possible routes. These include:

- Gravel road from the Trans Canada Highway to Norris Arm North. The road is approximately 1.5 km west of the proposed area. With upgrades to the gravel road and construction of 0.5 km of new road it could potential be used as access to the site.
- A paved road from the TCH to Lewisporte. The road is approximately 2.5 km east of the site. Approximately 2.0 km of this road would have to be constructed.
- A paved road from the TCH to the proposed area. Approximately 0.5 km of road would have to be constructed to access the site.

Utilities

Three-phase power is potentially available at Norris Arm, Norris Arm North, and Lewisporte, which are approximately 8 km, 4.0 km, and 10 km from the site respectively.

Land Use

The current land use of the potential site includes:

- Constraint mapping identified the site as having a 2 m – 3 m of soil cover.
- The remaining area is undeveloped wilderness area.

Adjacent Land

The land adjacent to this site is mainly agricultural land. This includes:

- Indian Arm Pond protected water supply for the Campbellton area is approximately 4.0 km E of the site.
- N of the area approximately 0.5 km from the site is the Trans Canada Trail.
- The communities of Norris Arm and Norris Arm North are located 8 km and 6 km west of the area respectively.
- Lewisporte Junction is located 2.0 km east of the proposed area.
- The Norris Arm North access road is located approximately 0.5 km west of the site.
- The remaining area is undeveloped wilderness area.

The proposed waste management facility sites #1 is shown in Figure 17-4 below.

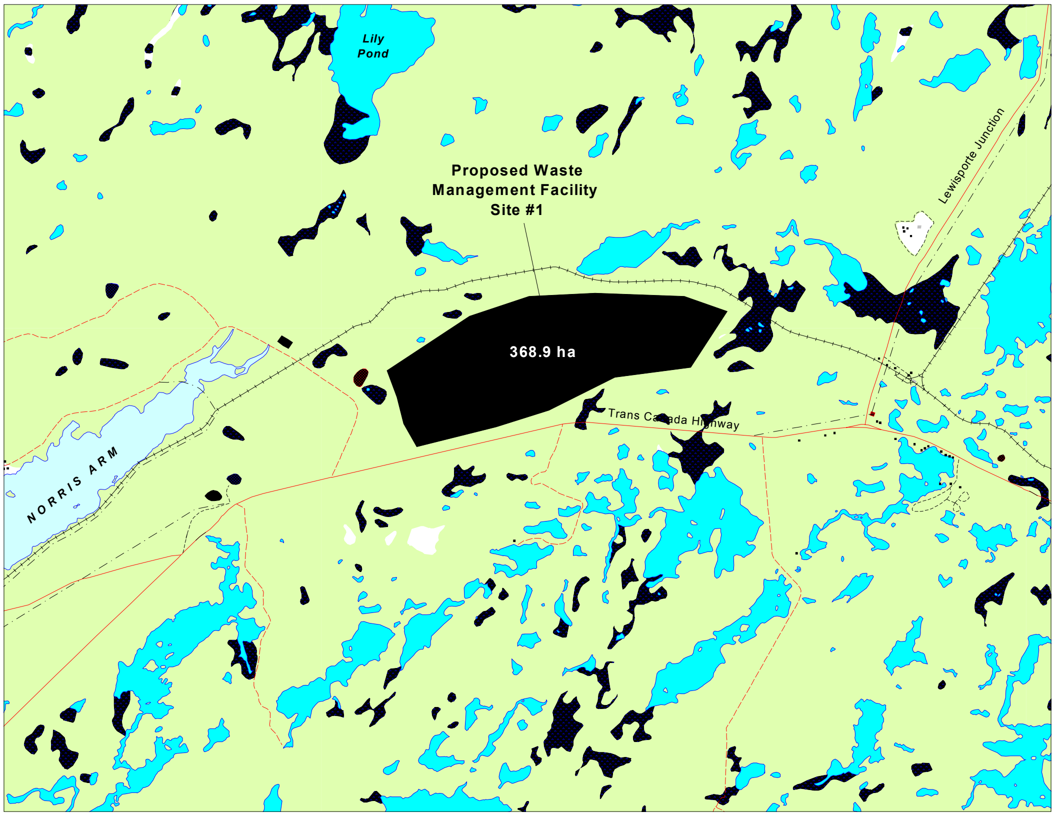


Figure 17-4: Proposed Waste Management Facility Site #1.

17.3.2 Proposed Waste Management Facility Site #2

Site #2 is located approximately 1.0 km north of Norris Arm Harbour. The site covers an area of approximately 155.1 ha. Aerial photography of the site is provided in Appendix F.

<u>Access Road</u>
The site can be accessed using two possible routes. These include:

- Gravel road from the Trans Canada Highway to Norris Arm North. The road is approximately 2.8 km south of the proposed area. With upgrades to the gravel road and construction of 0.2 km of new road it could potential be used as access to the site.

<u>Utilities</u>
Three-phase power is potentially available at Norris Arm, Norris Arm North, and Lewisporte, which are approximately 6.5 km, 3.2 km, and 14 km from the site respectively.

<u>Land Use</u>

The current land use of the potential site includes:

- Constraint mapping identified the site as having a 2 m – 3 m of soil cover.
- The remaining area is undeveloped wilderness area.

<u>Adjacent Land</u>

The land adjacent to this site is mainly agricultural land. This includes:

- Indian Arm Pond protected water supply for the Campbellton area is approximately 9.0 km E of the site.
- N of the area approximately 0.5 km from the site is the Trans Canada Trail.
- The communities of Norris Arm and Norris Arm North are located 3.5 km and 5.5 km south of the area respectively.
- Lewisporte Junction is located 6.5 km east of the proposed area.
- The Norris Arm North access road is located approximately 0.2 km south of the site.
- The remaining area is undeveloped wilderness area.

The proposed waste management facility sites #2 is shown in Figure 17-5 below.

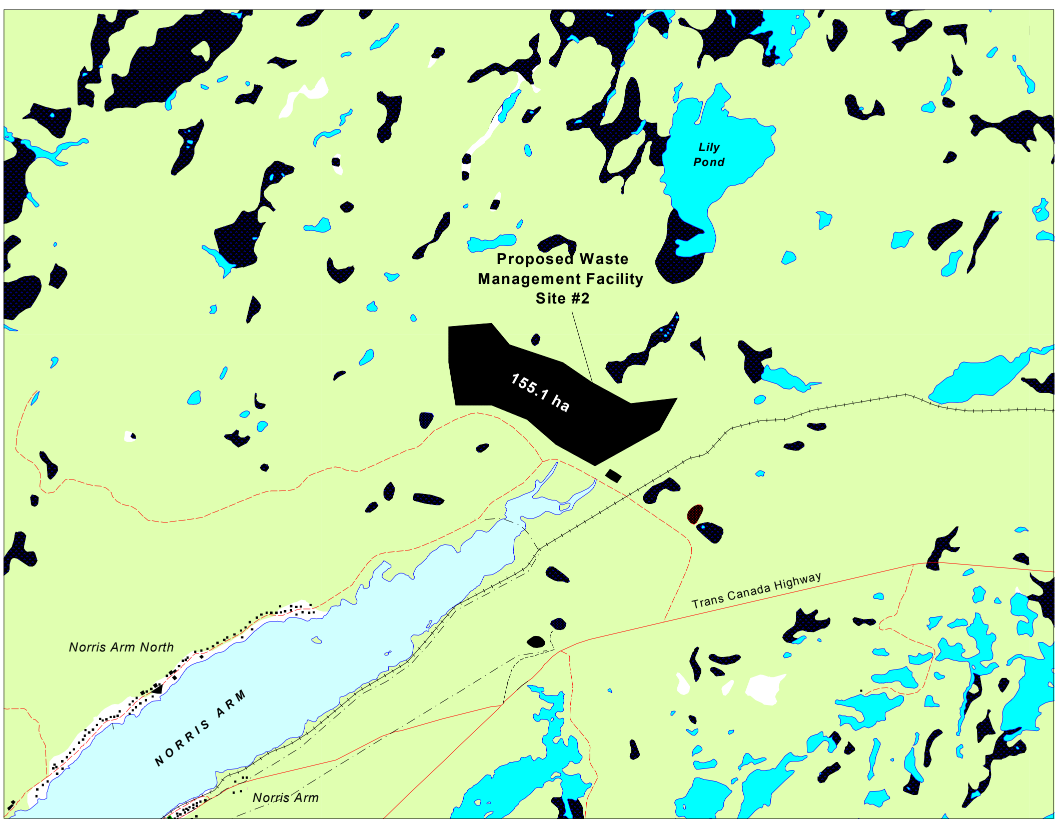


Figure 17-5: Proposed Waste Management Facility Site #2.

17.3.3 Proposed Waste Management Facility Site #3

Site #3 is located approximately 1.5 km north of Norris Arm Harbour. The site covers an area of approximately 79.7 ha. Aerial photography of the site is provided in Appendix F.

Access Road
The site can be accessed using two possible routes. These include:

- Gravel road from the Trans Canada Highway to Norris Arm North. The road is approximately 4.5 km southeast of the proposed area. With upgrades to the gravel road and construction of 0.15 km of new road it could potential be used as access to the site.

Utilities
Three-phase power is potentially available at Norris Arm, Norris Arm North, and Lewisporte, which are approximately 7.0 km, 2.0 km, and 14 km from the site respectively.

Land Use
The current land use of the potential site includes:

- Constraint mapping identified the site as having a 2 m – 3 m of soil cover.
- The remaining area is undeveloped wilderness area.

Adjacent Land
The land adjacent to this site is mainly agricultural land. This includes:

- Indian Arm Pond protected water supply for the Campbellton area is approximately 11.5 km E of the site.
- E of the area approximately 3.3 km from the site is the Trans Canada Trail.
- The communities of Norris Arm and Norris Arm North are located 3.5 km and 2.0 km south of the area respectively.
- Lewisporte Junction is located 8.5 km east of the proposed area.
- The Norris Arm North access road is located approximately 0.15 km south of the site.
- The remaining area is undeveloped wilderness area.

The proposed waste management facility site #3 is shown in Figure 17-6.

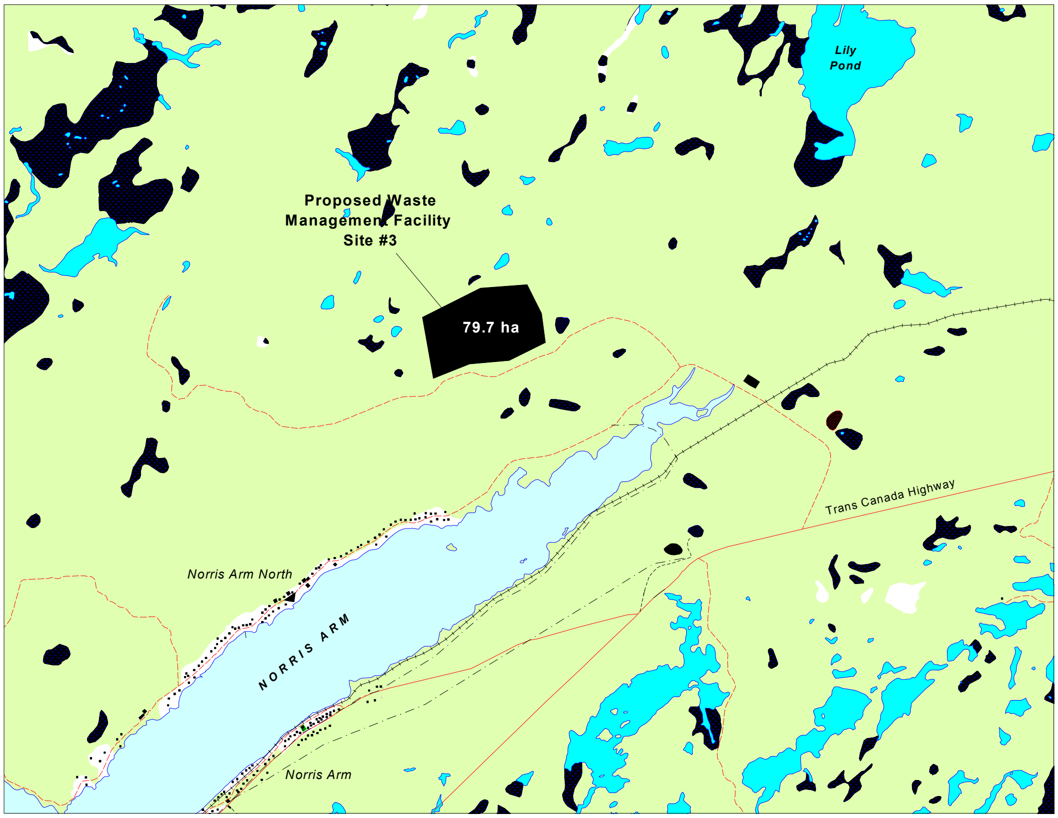


Figure 17-6: Proposed Waste Management Facility Site #3.

17.3.4 Proposed Waste Management Facility Site #4

Site #4 is located approximately 2.0 km north of Norris Arm Harbour. The site covers an area of approximately 88.5 ha. Aerial photography of the site is provided in Appendix F.

Access Road

The site can be accessed using two possible routes. These include:

- Gravel road from the Trans Canada Highway to Norris Arm North. The road is approximately 6.3 km southeast of the proposed area. With upgrades to the gravel road and construction of 0.23 km of new road it could potential be used as access to the site.

Utilities

Three-phase power is potentially available at Norris Arm, Norris Arm North, and Lewisporte, which are approximately 9.5 km, 1.5 km, and 16.5 km from the site respectively.

<u>Land Use</u>
The current land use of the potential site includes:

- Constraint mapping identified the site as having a 2 m – 3 m of soil cover.
- The remaining area is undeveloped wilderness area.

<u>Adjacent Land</u>
The land adjacent to this site is mainly agricultural land. This includes:

- Indian Arm Pond protected water supply for the Campbellton area is approximately 13.5 km E of the site.
- E of the area approximately 5.0 km from the site is the Trans Canada Trail.
- The communities of Norris Arm and Norris Arm North are located 3.5 km and 1.8 km south of the area respectively.
- Lewisporte Junction is located 10.5 km east of the proposed area.
- The Norris Arm North access road is located approximately 0.2 km south of the site.
- The remaining area is undeveloped wilderness area.

The proposed waste management facility site #4 is shown in Figure 17-7 below.

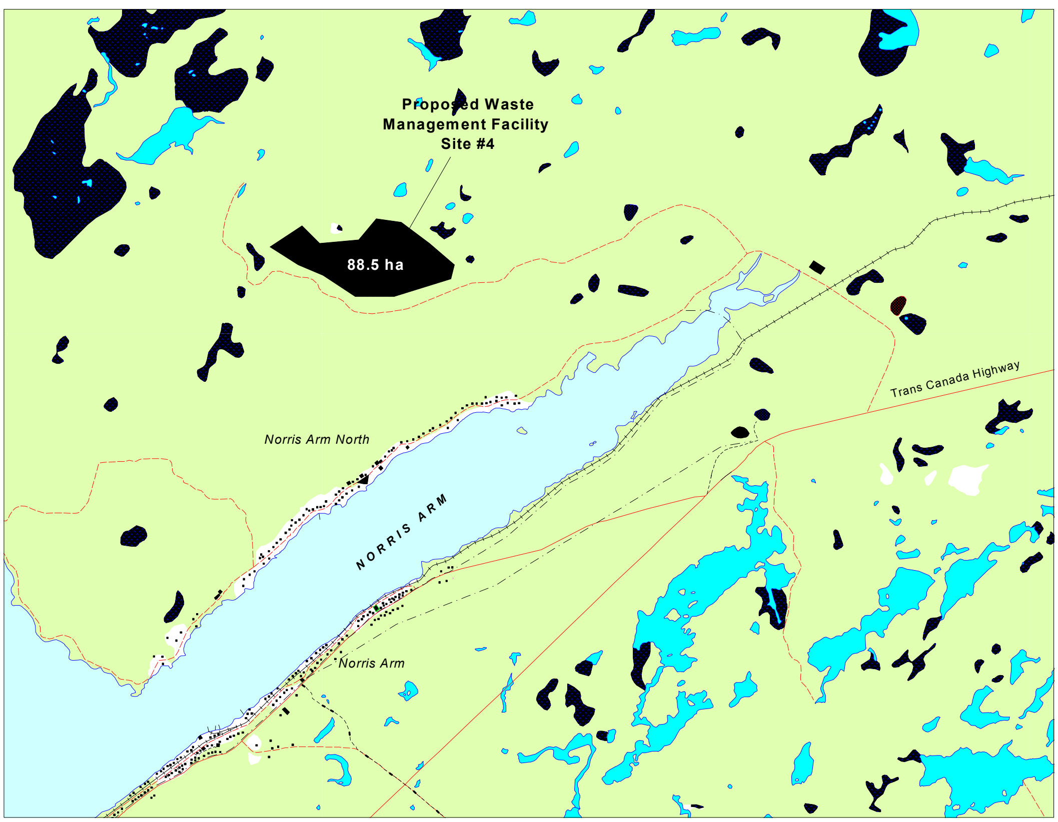


Figure 17-7: Proposed Waste Management Facility Site #4.

17.3.5 Proposed Waste Management Facility Site #5

Site #4 is located approximately 3.5 km north of Norris Arm Harbour. The site covers an area of approximately 168.2 ha. Aerial photography of the site is provided in Appendix F.

Access Road
The site can be accessed using two possible routes. These include:

- Gravel road from the Trans Canada Highway to Norris Arm North. The road is approximately 7.0km southeast of the proposed area. With upgrades to the gravel road and construction of 0.5 km of new road it could potential be used as access to the site.

Utilities
Three-phase power is potentially available at Norris Arm, Norris Arm North, and Lewisporte, which are approximately 12.8 km, 2.2 km, and 19.0 km from the site respectively.

Land Use
The current land use of the potential site includes:

- Constraint mapping identified the site as having a 2 m – 3 m of soil cover.
- The remaining area is undeveloped wilderness area.

Adjacent Land
The land adjacent to this site is mainly agricultural land. This includes:

- Indian Arm Pond protected water supply for the Campbellton area is approximately 16.5 km E of the site.
- E of the area approximately 6.7 km from the site is the Trans Canada Trail.
- The communities of Norris Arm and Norris Arm North are located 4.5 km and 2.5 km south of the area respectively.
- Lewisporte Junction is located 12.8 km east of the proposed area.
- The Norris Arm North access road is located approximately 0.5 km south of the site.
- The remaining area is undeveloped wilderness area.

The proposed waste management facility site #5 is shown in Figure 17-8 below.

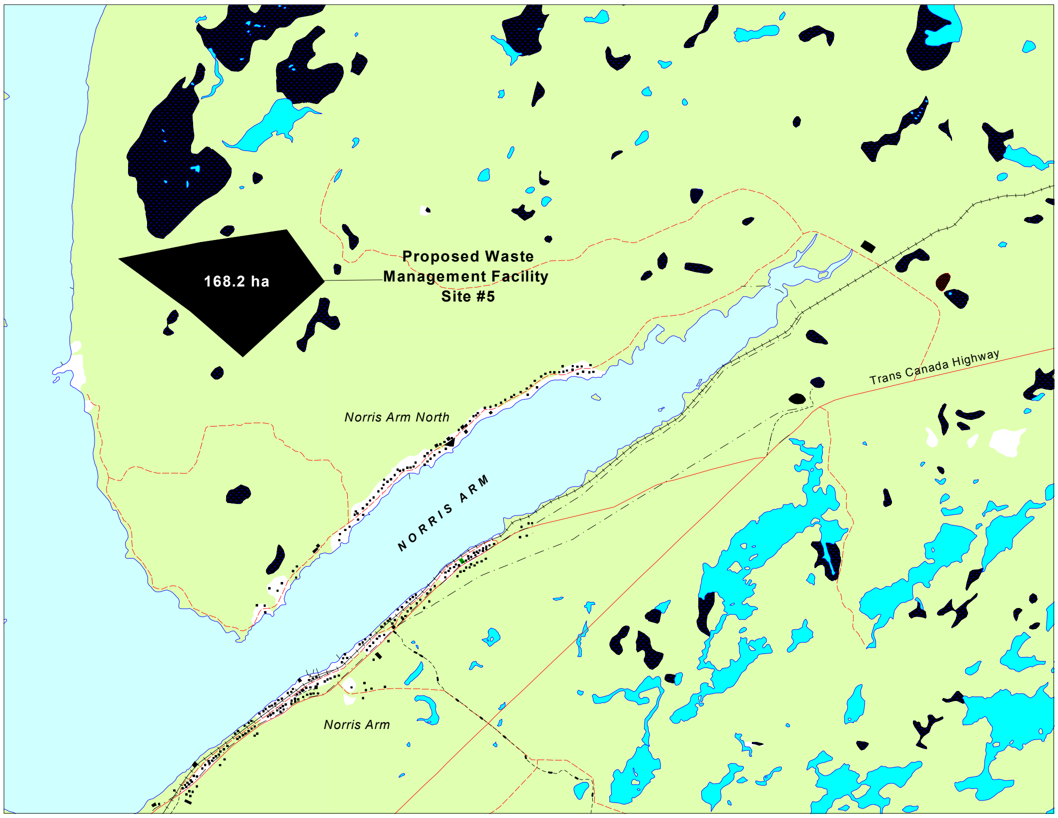


Figure 17-8: Proposed Waste Management Facility Site #5.

18.0 GLOSSARY[57]

Backyard composting – The transformation of organic kitchen and yard waste into a beneficial soil amendment on the property of the generating resident. Traditionally, backyard composting has been undertaken by allowing a pile of organic wastes to naturally degrade. However, backyard compost units are now commercially available.

Compostables – Materials that can undergo microbiological decomposition, resulting in a humus-like end product that is primarily used for soil conditioning.

Construction and demolition (C&D) debris – Waste materials from the construction and/or demolition of buildings, usually including wood and metal scrap, brick, block and concrete rubble, wire, and packaging.

Hazardous waste – Waste materials that may cause a threat to human health or the environment. Federal and provincial laws regulate Handling and disposal of hazardous wastes.

Household hazardous waste (HHW) – Materials commonly found in the home that may cause harm to human health or the environment. These materials are often banned from municipal waste disposal facilities.

Industrial, commercial, and institutional (IC&I) sector – Includes industries (e.g. manufacturing), businesses, and institutions such as schools and hospitals. Municipal waste is often categorized according to whether it is generated by the IC&I sector or residential sector.

Materials recovery facility (MRF) – A facility where materials are processed to separate and recover recyclable materials from the waste stream.

Multi-material waste – Waste that is composed of more than one main category (e.g. paper, glass) of material. An example is a material that is comprised of both paper and plastic.

Municipal solid waste (MSW) – Commonly referred top as garbage, this material is handled by municipal collection and/or disposal services. It includes two main types of solid waste: residential or domestic and industrial, commercial and institutional waste.

[57] The Community Stakeholder Committee (CSC). *An Integrated ~~Waste~~ Resource Management Strategy for Halifax County/Halifax/Dartmouth/Bedford*. March 25, 1995

Organics – Carbon- and hydrogen-based materials that can be transformed into humus-like materials through microbiological processes.

Recyclables – Materials that can be separated from municipal solid waste and reprocessed into new products.

Residential sector – Householders, including those who live in detached dwellings, row housing, condominiums, and apartments.

Source separation – Classifying and segregating waste/resource materials by category, usually separating various classes of recyclable vs. non-recyclable items, usually done as the collection or pick-up point (e.g. residences, offices, commercial facilities).

Waste audit – A method of assessing the amount and type of waste generated by a specific organization or sector.

Waste diversion – A term used to refer to the diversion of wastes from disposal. Diversion depends on the 3Rs of waste management as part of a strategy to divert used materials from disposal.

White goods – Large bulky metal items, usually durable household appliances such as refrigerators, stoves, washing machines, and dryers.

Yard waste – Discarded materials from residential yards and gardens, such as lawn clippings, leaves, and prunings. These materials are primarily compostable and have been banned from disposal facilities in many North American jurisdictions.

APPENDIX A

Population Projection

APPENDIX B

Health of Animals Act

APPENDIX C

Transfer Station Location Options

APPENDIX D

Flow Charts of Waste Collection Systems

APPENDIX E

Alternative Technologies Being Applied to Landfill Operation

Alternative Daily Cover

Waste Handling and Storage

Alternative Daily Cover (Tarpomatic)

APPENDIX F

Aerial Photography

Central Newfoundland Solid Waste Management Plan

Volume 2

Questionnaires

Green Depot Questionnaires
Municipal Questionnaires
Landfill Incinerator Checklists