



Durham/York Residual Waste Study

Annex E-4:

Supporting Technical Document on Financial Analysis and Cost Estimates

Report on Selection of Preferred Residuals Processing System

May 30, 2006





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Report on

Selection of Preferred
Residuals Processing System

May 30, 2006

prepared by:



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Appendix A

Annex E-4: Financial Analysis and Cost Estimates

Annex E-4 provides the estimated costs associated with the four (4) Durham/York Residual Waste Study residuals processing systems. Portions of this report are based on information and methodologies developed by the Niagara-Hamilton WastePlan Study. These costs are estimated in real terms (i.e. excluding inflation) at constant 2006 price levels. Two sets of estimates are provided for each item – one set prepared under a set of low cost assumption and the other set under a set of high cost assumption.

The key low cost assumptions are:

- Facility financing at a real cost of capital at 5%. With a 2% inflation assumption, this corresponds to a nominal public sector financing interest rate of 7%.
- Residual material, including bottom ash or char, disposal at a cost for haul and landfill disposal of \$70/tonne.
- Net energy from thermal treatment facilities sold at a price of \$85/MWh on the assumption that it is partially renewable and warrants a premium price.

The key high cost assumptions are:

- Facility financing at a real cost of capital at 10%. With a 2% inflation assumption, this corresponds to a nominal before tax private sector financing rate of 12%.
- Residual material, including bottom ash or char, disposal at a cost for haul and landfill disposal of \$100/tonne.
- Net energy from thermal treatment facilities sold at the estimated commodity price of \$60/MWh.

System Alternatives share a number of common assumptions as appropriate:

- Land costs of \$1,250,000 per hectare
- A planning and approvals cost of \$2,000,000 in additional to the Residual Waste Study costs.
- The following prices for recovered recyclable materials based on typical current prices, discounted by 20% to account for assumed lower quality – compared to source separated materials:

Material	Price per Tonne
Gable Top	50
Aseptic	50
PETE	360
HDPE	530
Aluminum	1500
Ferrous	100
Other Material	50

- An air pollution control system (APC) residual disposal cost of \$300 per tonne.

The disposal system cost estimates include all direct initial capital, annual operating costs, and revenues from the assumed sale of energy and recovered materials.

No collection or transfer/haul costs for the delivery of waste to the disposal system facilities have been assumed. In general, waste will be generated fairly uniformly across the study area relative to the potential locations for facilities. For the purpose of comparison of alternative systems, it is assumed that the effect of site location on collection or transfer haul would be generally the same for all systems. The potential costs associated with specific potential locations will be addressed in the evaluation of 'Alternatives Methods' (i.e., sites).

The inputs to this financial analysis include; the quantity estimates provided in Annex E-1, the site land requirements provided in Annex E-2, and the output electrical energy estimates provided in Annex E-3. Engineering estimates of the capital and operating costs for the various facilities required for each of the alternatives were developed. In addition, several technology vendors provided budgetary estimates of capital and operating costs. These estimates are provided on the various tables in Appendix A along with the other required unit price assumptions.

In the "*Report on Additional At-Source Diversion and Residual Quantities to be Managed*" (see Annex C-1), a range of waste quantity projections was provided. These projections were based on a variety of assumptions including diversion rates growing from 60% to 75%.

On the basis of this analysis, a facility with an initial capacity of 250,000 tonnes per year with the possibility of expansion to 400,000 tonnes per year was deemed to be reasonable.

With diversion holding constant at 60%, it was estimated that the quantities requiring management would grow to 400,000 tonnes per year by the 25th year of the planning period. If diversion rates prove to be higher, then the requirement to expand to 400,000 tonnes per year would be delayed. On the other hand, if diversion rates do not meet these levels, then a larger facility will be required sooner.

Based on this quantity analysis, the cost analysis of the system alternatives assumes the following:

- A facility with initial capacity of 250,000 tonnes, but flexibility to expand to 400,000 tonnes per year assumed.
- A 25-year financial life cycle planning period.
- An initial diversion rate of 60%, growing to 75% over the planning period.
- The landfilling of generated quantities in excess of the facility capacity.

The quantities resulting from these assumptions are presented tables in Appendix A.

The resulting cost estimates are deemed to be reasonably conservative, as they do not assume the economies of scale associated with a larger facility.

The tables in Appendix A illustrate the financial analysis of each of the alternatives under both the low and the high cost assumption. On the top portion of each table, the estimates of the capital and operating costs of the facilities along with any revenue estimates are provided. On the

mid portion, these costs are laid out over an assumed 25-year operating period and the present value of the life cycle costs associated with each alternative is provided.

To make the cost of each alternative more easily understood, a levelized cost per tonne is provided. This cost, if charged on every tonne managed, covers all the costs, capital, operating (net of revenues) and financing associated with the alternative.

This calculation is illustrated at the bottom of each table. The calculation assumes that the alternative is financed with a line of credit - or savings account - that changes interest when the account is in a deficit position and earns interest when the account has a surplus.

Over the project life cycle this financing account starts with a zero balance, goes into a deficit to cover the initial capital cost of the facilities, and ultimately closes with a zero balance at the end of the 25-year financial life cycle period. In each year, an amount equal to the cost per tonne multiplied by the quantity managed is paid into the account and an amount equal to the annual costs (operating net of revenues plus period capital) is withdrawn from the account. Annual deficits incur an interest expense, while annual surpluses earn interest.

The four (4) Durham/York Residual Waste Study System Alternatives are:

- 1 – Mechanical and Biological Treatment with Biogas Recovery
- 2a – Thermal Treatment of Mixed Waste with Recovery of Materials from the Ash/Char
- 2b – Thermal Treatment of Solid Recovered Fuel
- 2c – Thermal Treatment of Solid Recovered Fuel with Biogas Recovery

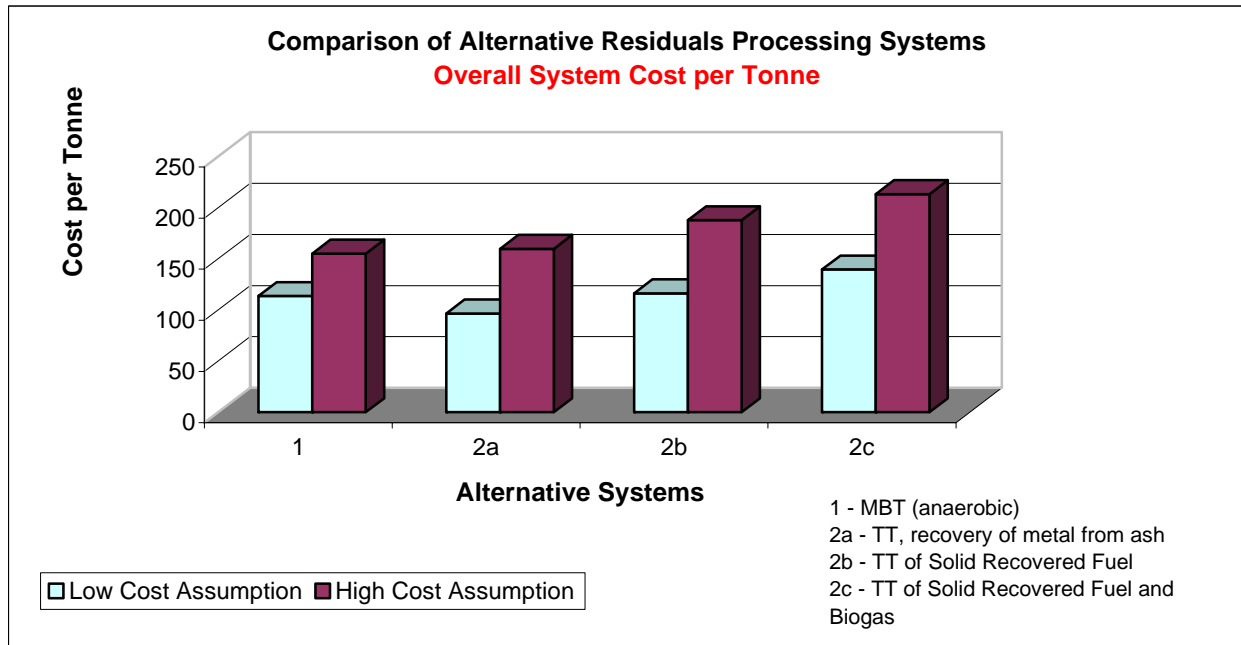
The levelized cost per tonne associated with these alternatives are summarized in Table 1 below.

Table 1 Range of Costs per Tonne

System Alternative	1	2a	2b	2c
Low Cost Assumptions (\$)	114	97	116	140
High Cost Assumptions (\$)	155	160	188	213

This range of costs is illustrated in the following graph.

Figure 1 Overall System Cost per Tonne



Additional cost estimates associated with these alternatives are summarized in Table 2. The costs associated with both the low and high cost assumptions are provided in each of the cells of this table.

Table 2 Summary of System Costs (\$ X 1,000)

System Alternative		1	2a	2b	2c
Initial Capital Costs	Low	109,000	245,000	274,100	283,900
	High	111,600	251,000	280,800	290,800
Average Annual Operating Costs	Low	24,900	20,300	24,400	26,800
	High	30,800	22,500	26,900	30,200
Average Annual Revenue	Low	(3,890)	(14,780)	(15,350)	(12,600)
	High	(3,890)	(11,000)	(11,700)	(9,700)
Average Annual Costs Net of Revenues	Low	21,000	5,600	9,000	14,100
	High	26,900	11,500	15,200	20,500
Present Value of Lifecycle System Costs	Low	381,200	324,100	390,000	468,200
	High	319,800	329,600	387,300	440,100
Revenue as % of Annual Costs	Low	16%	73%	63%	47%
	High	13%	49%	43%	32%

The details associated with the development of with these estimates for each system are provided below.

1. Mechanical and Biological Treatment

1.1 System 1 Mechanical Biological Treatment (MBT) with Biogas Recovery

In this system, incoming post diversion waste is assumed to be received on a tipping floor and materials that are unacceptable for mechanical processing (e.g., mattresses) are removed. Some of these unacceptable materials such as large metal parts may be set aside for recycling, but most of the materials are assumed to be sent directly to landfill disposal.

The balance of the post diversion waste stream is assumed to be processed – mechanically treated - to remove recyclables, primarily metal and plastic containers. A relatively small quantity of these recyclable materials remain in the post diversion waste as the vast majority of these materials are assumed to be recovered through at-source diversion programs (e.g., blue box recycling). Mechanical treatment separates the waste stream into a number of fractions, from which some recyclables are removed. A large portion of the material is sent to landfill after removal of recyclables. A portion of the material is sent to biological treatment.

The portion of the remaining material stream that contains the highest percentage of organic materials (heavy, fines) is biologically treated via anaerobic digestion (AD) to breakdown organic materials. This process converts carbon-containing compounds to biogas (primarily methane and carbon dioxide), which in turn can be used to produce energy for in-plant consumption and sold to external users.

The residual materials, including stabilized organic material – digestate from the AD process – are assumed to be landfilled.

The estimated cost for the MBT facility and the landfill site under the low and high cost assumptions are provided in Tables 1 – i and ii of Appendix A. The additional key assumptions used in developing these estimates are as follows:

- Renewable energy produced from the biogas is sold at a premium price of \$110/MWh.
- It is not possible to market compost from biological processing or inert materials; this is landfilled.
- Biological treatment component includes in-vessel anaerobic digestion with biogas recovery and energy generation, digestate is landfilled.

2. Thermal Treatment

2.1 System 2a) Thermal Treatment of Mixed Waste with Recovery of Materials from Ash/Char

There are two main types of commercially available thermal treatment technologies: combustion and gasification. Depending on the technology, incoming waste may be received on either a flat tipping floor or into a receiving pit. The waste is inspected and any unacceptable items are removed.

In combustion technologies, hydrocarbons in the waste stream are converted to thermal energy, carbon dioxide, and water. Ash is discharged from the bottom of the grate and is quenched.

Exhaust gases from combustion are cleaned prior to being emitted to the atmosphere. The process is exothermic (i.e., requires little to no external energy once combustion has been initiated).

Gasification technologies involve the thermal breakdown of solid materials into a synthetic gas (syngas) and a solid char residue. The process is endothermic (i.e., requires external energy). The syngas (mainly comprised of hydrogen, carbon monoxide, carbon dioxide, and nitrogen) must undergo a cleaning process before it is utilized. After cleaning, the syngas may be used as fuel for reciprocating engines or gas turbines, or it can be combusted in a steam boiler to generate steam.

After thermal treatment, mechanical treatment is utilized to recover metals (aluminium and ferrous) from the ash or char.

The residual materials, including materials unacceptable for thermal processing and ash or char, are assumed to be landfilled. In addition, residue from the flue gas or syngas cleanup process also requires management.

For costing purposes, a combustion facility is assumed as there is more information available on the cost of this technology. The estimated costs for the assumed incineration facility under the low and high cost assumptions are provided in Tables 2a – i and ii of Appendix A.

2.2 System 2b) Thermal Treatment of Solid Recovered Fuel

This system combines mechanical, biological (aerobic), and thermal treatment.

After removal of some unacceptable materials (similar to 2a) the incoming post diversion waste is processed and a portion of the material is separated into “large, dry, light” streams of plastic and paper materials. The other portion of the material includes more “small, wet, heavy” material including food waste residue, which is sent to biological treatment (aerobic composting) for bio-drying.

The waste is then processed mechanically to remove non-combustable materials and to recover some recyclable resources. A solid fuel is recovered and is fed into the thermal process to produce energy.

As mentioned under System 2a, the main thermal technologies are combustion or gasification. Combustion is an exothermic reaction in which hydrocarbons in the waste stream are converted to thermal energy, carbon dioxide, and water. The exhaust gases are cleaned prior to release into the atmosphere and the ash is discharged and quenched. Gasification is an endothermic reaction in which solid material is thermally broken down into syngas and a solid char residue. The syngas is cleaned before it is utilized for the generation of energy.

The materials requiring landfill disposal include the residuals from the recovery of solid fuel, the unacceptable waste and the ash/char from the thermal treatment. In addition, residue from the flue gas or syngas cleanup process also requires management.

The estimated costs for this facility under the low and high cost assumptions are provided in Tables 2b – i and ii of Appendix A.

2.3 System 2c) Thermal Treatment of Solid Recovered Fuel with Biogas Recovery

This system is a variation of System 2b that involves the separation of the organic material (e.g., food waste) from the rest of the post diversion waste and the subsequent anaerobic digestion of this organic fraction of the waste stream to produce biogas. Energy is thus produced from both the solid recovered fuel and the biogas.

The residuals from anaerobic digestion, ash/char from the thermal treatment process and the residues from the mechanical treatment process all require landfilling. A small amount of waste from the air pollution control/gas clean-up system also requires management.

The estimated costs for the facility assumed under this alternative are provided in Tables 2c – i (low cost assumptions) and 2c – ii (high cost assumption) of Appendix A.

Appendix A

Annex E-4: Table 1 - i																										
System 1: Mechanical, Biological (Anaerobic Digestion) Treatment with Biogas Recovery and Landfill of Stabilized Residuals																										
Low Cost Estimate at Constant 2006 Price Levels																										
Initial Capital Costs 250,000 tpy Facility (\$ X 1,000)																										
Planning & Approvals	2,000	(in addition to Residual Waste Study)																								
Land (site & large buffer)	14,250	(11.4 Ha of land @ \$1,250,000 / Ha)																								
General Site Works	3,800																									
Buildings	17,750																									
Mechanical Process Equipment	12,350																									
Biological Process Equipment	15,800																									
Biogas Recovery & Utilization	5,750																									
Odour Control	1,750																									
Rolling Equipment	900																									
Sub Total	74,350																									
Contingency @ 30%	22,305																									
Engineering @ 13%	9,666																									
Interest During Const @ 2.5%	2,658																									
Total Initial Capital	108,979																									
		Average Price per Tonne																								
		\$ 256																								
Annual Operating Costs & Prices																										
Labour	1,800																									
Fuel & Utilities	90																									
Maintenance & Operations	6,000																									
Other	620																									
Sub total Annual Operating	8,510																									
Contingency @ 30%	2,553																									
Annual Operating Cost	11,063	(\$ X 1,000)																								
Electricity Sales	\$ 110	per Mwh	(Renewable Energy)																							
Recovered Recyclables Sales	\$ 256	per tonne																								
Landfill Residue Disposal	\$ 70	per tonne																								
Interest Rate/Cost of Capital	5%	0.0058333																								
System Cost per Tonne	\$ 114																									
	Time 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	
Annual Quantities (tonnes)																										
Total Material Generated	637,300	652,392	667,841	683,657	699,847	708,800	723,967	739,465	755,301	771,482	780,900	796,241	811,901	827,889	844,211	855,400	871,215	887,346	903,801	920,584	924,500	939,031	953,805	968,828	984,103	
At-Source Diversion Rate	60.0%	60.6%	61.2%	61.8%	62.3%	62.9%	63.5%	64.1%	64.7%	65.3%	65.8%	66.4%	67.0%	67.6%	68.2%	68.8%	69.3%	69.9%	70.5%	71.1%	71.7%	72.3%	72.8%	73.4%	74.0%	
Portion to Disposal	40.0%	39.4%	38.8%	38.3%	37.7%	37.1%	36.5%	35.9%	35.3%	34.8%	34.2%	33.6%	33.0%	32.4%	31.8%	31.3%	30.7%	30.1%	29.5%	28.9%	28.3%	27.8%	27.2%	26.6%	26.0%	
Total Material for Disposal	254,920	257,151	259,345	261,499	263,609	262,847	264,248	265,591	266,873	268,090	266,808	267,404	267,927	268,374	268,741	267,313	267,173	266,943	266,621	266,202	261,942	260,581	259,117	257,547	255,867	
Total Material to Facility	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	
Surplus Material to Landfill	4,920	7,151	9,345	11,499	13,609	12,847	14,248	15,591	16,873	18,090	16,807	17,404	17,927	18,374	18,741	17,312	17,173	16,943	16,621	16,202	11,942	10,581	9,117	7,547	5,867	
Total Waste to Facility (tonnes)	-	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	
Recovered Materials	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	
Facility Residue to Landfill	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	
Total Residue to Landfill	197,285	199,516	201,710	203,864	205,974	205,212	206,613	207,956	209,238	210,455	209,173	209,769	210,292	210,739	211,106	209,678	209,538	209,308	208,986	208,567	204,307	202,946	201,482	199,912	198,232	
Electricity Output Mwh	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	
Life Cycle Costs (X 1,000)																										
Initial Capital	108,979																									
Net Electricity Sales Revenue	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	
Recovered Recyclables Sales Revenue	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	
Facility Operating Costs	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	
Residue Disposal Cost	13,810	13,466	13,466	13,466	13,466	13,466	13,466	13,466	13,466	13,466	13,466	13,466	13,466	13,466	13,466	13,466	13,466	13,466	13,466	13,466	13,466	13,466	13,466	13,466	13,466	
Total Annual Cost	108,979	20,985	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	
PV Costs	381,151																									
Levelized Quantity	3,356																									
Total All Costs	625,328																									
Total Quantity	6,250																									
Average Cost per Tonne	\$ 100																									
	Time 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25
Annual Quantity	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	
Annual Tip Fee Revenue	114	28,396	28,396	28,396	28,396	28,396	28,396	28,396	28,396	28,396	28,396	28,396	28,396	28,396	28,396	28,396	28,396	28,396	28,396	28,396	28,396	28,396	28,396	28,396	28,396	
Levelized Cost Calculation (X 1,000)																										
Open Balance	-	108,979	107,016	104,612	102,087	99,435	96,651	93,728	90,659	87,437	84,053	80,500	76,770	72,852	68,740	64,421	59,886	55,125	50,126	44,877	39,365	33,578	27,501	21,120	14,421	7,386
Annual Net Costs	108,979	20,985	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	20,640	
Annual Tip Fee Revenue	(28,396)	(28,396)	(28,396)	(28,396)	(28,396)	(28,396)	(28,396)	(28,396)	(28,396)	(28,396)	(28,396)	(28,396)	(28,396)	(28,396)	(28,396)	(28,396)	(28,396)	(28,396)	(28,396)	(28,396)	(28,396)	(28,396)	(28,396)	(28,396)	(28,396)	
Annual Interest	-	5,449	5,351	5,231	5,104	4,972	4,833	4,686	4,533	4,372	4,203	4,025	3,838	3,643	3,437	3,221	2,994	2,756	2,506	2,244	1,968	1,679	1,375	1,056	721	
Closing Balance	108,979	107,016	104,612	102,087	99,435	96,651	93,728	90,659	87,437	84,053	80,500	76,770	72,852	68,740	64,421	59,886	55,125	50,126	44,877	39,365	33,578	27,501	21,120	14,421	7,386	

Annex E-4: Table 1 - ii																										
System 1: Mechanical, Biological (Anaerobic Digestion) Treatment with Biogas Recovery and Landfill of Stabilized Residuals																										
High Cost Estimate at Constant 2006 Price Levels																										
Initial Capital Costs 250,000 tpy Facility (\$ X 1,000)																										
Planning & Approvals	2,000	(in addition to Residual Waste Study)																								
Land (site & large buffer)	14,250	(11.4 Ha of land @ \$1,250,000 / Ha)																								
General Site Works	3,800																									
Buildings	17,750																									
Mechanical Process Equipment	12,350																									
Biological Process Equipment	15,800																									
Biogas Recovery & Utilization	5,750																									
Odour Control	1,750																									
Rolling Equipment	900																									
Sub Total	74,350																									
Contingency @ 30%	22,305																									
Engineering @ 13%	9,666																									
Interest During Const @ 5%	5,316																									
Total Initial Capital	111,637																									
		Average Price per Tonne																								
			\$ 256																							
Annual Operating Costs & Prices																										
Labour	1,800																									
Fuel & Utilities	90																									
Maintenance & Operations	6,000																									
Other	620																									
Sub total Annual Operating	8,510																									
Contingency @ 30%	2,553																									
Annual Operating Cost	11,063	(\$ X 1,000)																								
Electricity Sales	\$ 110	per Mwh	(Renewable Energy)																							
Recovered Recyclables Sales	\$ 256	per tonne																								
Landfill Residue Disposal	\$ 100	per tonne																								
Interest Rate/Cost of Capital	10%	0.0058333																								
System Cost per Tonne	\$ 155																									
	Time 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	
Annual Quantities (tonnes)																										
Total Material Generated	637,300	652,392	667,841	683,657	699,847	708,800	723,967	739,465	755,301	771,482	780,900	796,241	811,901	827,889	844,211	855,400	871,215	887,346	903,801	920,584	924,500	939,031	953,805	968,828	984,103	
At-Source Diversion Rate	60.0%	60.6%	61.2%	61.8%	62.3%	62.9%	63.5%	64.1%	64.7%	65.3%	65.8%	66.4%	67.0%	67.6%	68.2%	68.8%	69.3%	69.9%	70.5%	71.1%	71.7%	72.3%	72.8%	73.4%	74.0%	
Portion to Disposal	40.0%	39.4%	38.8%	38.3%	37.7%	37.1%	36.5%	35.9%	35.3%	34.8%	34.2%	33.6%	33.0%	32.4%	31.8%	31.3%	30.7%	30.1%	29.5%	28.9%	28.3%	27.8%	27.2%	26.6%	26.0%	
Total Material for Disposal	254,920	257,151	259,345	261,499	263,609	262,847	264,248	265,591	266,873	268,090	266,808	267,404	267,927	268,374	268,741	267,313	267,173	266,943	266,621	266,202	261,942	260,581	259,117	257,547	255,867	
Total Material to Facility	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	
Surplus Material to Landfill	4,920	7,151	9,345	11,499	13,609	12,847	14,248	15,591	16,873	18,090	16,807	17,404	17,927	18,374	18,741	17,312	17,173	16,943	16,621	16,202	11,942	10,581	9,117	7,547	5,867	
Total Waste to Facility (tonnes)	-	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	
Recovered Materials	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	10,775	
Facility Residue to Landfill	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	192,365	
Total Residue to Landfill	197,285	199,516	201,710	203,864	205,974	205,212	206,613	207,956	209,238	210,455	209,173	209,769	210,292	210,739	211,106	209,678	209,538	209,308	208,986	208,567	204,307	202,946	201,482	199,912	198,232	
Electricity Output Mwh	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	10,313	
Life Cycle Costs (X 1,000)																										
Initial Capital	111,637																									
Net Electricity Sales Revenue	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	(1,134)	
Recovered Recyclables Sales Revenue	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	(2,754)	
Facility Operating Costs	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	11,063	
Residue Disposal Cost	19,729	19,237	19,237	19,237	19,237	19,237	19,237	19,237	19,237	19,237	19,237	19,237	19,237	19,237	19,237	19,237	19,237	19,237	19,237	19,237	19,237	19,237	19,237	19,237	19,237	
Total Annual Cost	111,637	26,903	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	
PV Costs	319,835																									
Levelized Quantity	2,063																									
Total All Costs	772,407																									
Total Quantity	6,250																									
Average Cost per Tonne	\$ 124																									
	Time 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25
Annual Quantity	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	
Annual Tip Fee Revenue	155	38,759	38,759	38,759	38,759	38,759	38,759	38,759	38,759	38,759	38,759	38,759	38,759	38,759	38,759	38,759	38,759	38,759	38,759	38,759	38,759	38,759	38,759	38,759	38,759	
Levelized Cost Calculation (X 1,000)																										
Open Balance	-	111,637	110,944	109,690	108,311	106,795	105,126	103,291	101,271	99,051	96,608	93,920	90,964	87,713	84,136	80,201	75,873	71,113	65,876	60,116	53,779	46,809	39,142	30,708	21,431	11,226
Annual Net Costs	111,637	26,903	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	26,411	
Annual Tip Fee Revenue	(38,759)	(38,759)	(38,759)	(38,759)	(38,759)	(38,759)	(38,759)	(38,759)	(38,759)	(38,759)	(38,759)	(38,759)	(38,759)	(38,759)	(38,759)	(38,759)	(38,759)	(38,759)	(38,759)	(38,759)	(38,759)	(38,759)	(38,759)	(38,759)	(38,759)	
Annual Interest	-	11,164	11,094	10,969	10,831	10,679	10,513	10,329	10,127	9,905	9,661	9,392	9,096	8,771	8,414	8,020	7,587	7,111	6,588	6,012	5,378	4,681	3,914	3,071	2,143	
Closing Balance	111,637	110,944	109,690	108,311	106,795	105,126	103,291	101,271	99,051	96,608	93,920	90,964	87,713	84,136	80,201	75,873	71,113	65,876	60,116	53,779	46,809	39,142	30,708	21,431	11,226	

Annex E-4: Table 2a - i																											
System 2a: Thermal Treatment of Mixed Waste With Recovery of Metals from Ash / Char																											
Low Cost Estimate at Constant 2006 Price Levels																											
Initial Capital Costs 250,000 tpy Facility (\$ X 1,000)														Recycling Material Revenue													
Planning & Approvals														2,000 (in addition to Residual Waste Study)													
Land (site & large buffer)														12,000 (9.6 Ha of land @ \$1,250,000 / Ha)													
Thermal Process Facility														225,000													
														Tonnes Price /Tonne Revenue													
														Gable Top - 50 -													
														Aseptic - 50 -													
														PETE - 360 -													
														HDPE - 530 -													
Sub Total														239,000													
														Aluminum 858 1500 1,287,000													
														Ferrous 6,905 100 690,500													
														Other Mat - 50 -													
Contingency (Included)																											
Engineering (included)																											
Interest During Const @ 2.5%														5,975													
Total Initial Capital														244,975													
														Totals 7,763 1,977,500													
														Average Price per Tonne \$ 255													
Annual Operating Costs & Prices																											
Annual Operating Cost														13,500 (\$ X 1,000)													
Electricity Sales														\$ 85 per Mwh													
Recovered Recyclables Sales														\$ 255 per tonne													
Landfill Residue Disposal														\$ 75 per tonne													
APC Residue Disposal														\$ 300 per tonne													
Interest Rate/Cost of Capital														5% 0.0058333													
System Cost per Tonne														\$ 97													
Time 0	Year 1 2011	Year 2 2012	Year 3 2013	Year 4 2014	Year 5 2015	Year 6 2016	Year 7 2017	Year 8 2018	Year 9 2019	Year 10 2020	Year 11 2021	Year 12 2022	Year 13 2023	Year 14 2024	Year 15 2025	Year 16 2026	Year 17 2027	Year 18 2028	Year 19 2029	Year 20 2030	Year 21 2031	Year 22 2032	Year 23 2033	Year 24 2034	Year 25 2035		
Annual Quantities (tonnes)																											
Total Material Generated	637,300	652,392	667,841	683,657	699,847	708,800	723,967	739,465	755,301	771,482	780,900	796,241	811,901	827,889	844,211	855,400	871,215	887,346	903,801	920,584	924,500	939,031	953,805	968,828	984,103		
At-Source Diversion Rate	60.0%	60.6%	61.2%	61.8%	62.3%	62.9%	63.5%	64.1%	64.7%	65.3%	65.8%	66.4%	67.0%	67.6%	68.2%	68.8%	69.3%	69.9%	70.5%	71.1%	71.7%	72.3%	72.8%	73.4%	74.0%		
Portion to Disposal	40.0%	39.4%	38.8%	38.3%	37.7%	37.1%	36.5%	35.9%	35.3%	34.8%	34.2%	33.6%	33.0%	32.4%	31.8%	31.3%	30.7%	30.1%	29.5%	28.9%	28.3%	27.8%	27.2%	26.6%	26.0%		
Total Material for Disposal	254,920	257,151	259,345	261,499	263,609	262,847	264,248	265,591	266,873	268,090	266,808	267,404	267,927	268,374	268,741	267,313	267,173	266,943	266,621	266,202	261,942	260,581	259,117	257,547	255,867		
Total Material to Facility	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000		
Surplus Material to Landfill	4,920	7,151	9,345	11,499	13,609	12,847	14,248	15,591	16,873	18,090	16,807	17,404	17,927	18,374	18,741	17,312	17,173	16,943	16,621	16,202	11,942	10,581	9,117	7,547	5,867		
Total Waste to Facility (tonnes)	-	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000		
Recovered Materials	7,763	7,763	7,763	7,763	7,763	7,763	7,763	7,763	7,763	7,763	7,763	7,763	7,763	7,763	7,763	7,763	7,763	7,763	7,763	7,763	7,763	7,763	7,763	7,763	7,763		
Facility Residue to Landfill	56,131	56,131	56,131	56,131	56,131	56,131	56,131	56,131	56,131	56,131	56,131	56,131	56,131	56,131	56,131	56,131	56,131	56,131	56,131	56,131	56,131	56,131	56,131	56,131	56,131		
APC Residue to Disposal	7,500	7,500	9,700	9,700	9,700	9,700	9,700	9,700	9,700	9,700	9,700	9,700	9,700	9,700	9,700	9,700	9,700	9,700	9,700	9,700	9,700	9,700	9,700	9,700	9,700		
Total Residue to Landfill	61,051	63,282	65,476	67,630	69,740	68,978	70,379	71,722	73,004	74,221	72,938	73,535	74,058	74,505	74,872	73,443	73,304	73,074	72,752	72,333	68,073	66,712	65,248	63,678	61,998		
Electricity Output Mwh	150,570	150,570	150,570	150,570	150,570	150,570	150,570	150,570	150,570	150,570	150,570	150,570	150,570	150,570	150,570	150,570	150,570	150,570	150,570	150,570	150,570	150,570	150,570	150,570	150,570		
Life Cycle Costs (X 1,000)																											
Initial Capital	244,975																										
Net Electricity Sales Revenue	(12,798)	(12,798)	(12,798)	(12,798)	(12,798)	(12,798)	(12,798)	(12,798)	(12,798)	(12,798)	(12,798)	(12,798)	(12,798)	(12,798)	(12,798)	(12,798)	(12,798)	(12,798)	(12,798)	(12,798)	(12,798)	(12,798)	(12,798)	(12,798)	(12,798)		
Recovered Recyclables Sales Revenue	(1,978)	(1,978)	(1,978)	(1,978)	(1,978)	(1,978)	(1,978)	(1,978)	(1,978)	(1,978)	(1,978)	(1,978)	(1,978)	(1,978)	(1,978)	(1,978)	(1,978)	(1,978)	(1,978)	(1,978)	(1,978)	(1,978)	(1,978)	(1,978)	(1,978)		
Facility Operating Costs	13,500	13,500	13,500	13,500	13,500	13,500	13,500	13,500	13,500	13,500	13,500	13,500	13,500	13,500	13,500	13,500	13,500	13,500	13,500	13,500	13,500	13,500	13,500	13,500	13,500		
Residue Disposal Cost Including APC	6,829	6,996	7,821	7,982	8,141	8,083	8,188	8,289	8,385	8,477	8,380	8,425	8,464	8,498	8,525	8,418	8,408	8,391	8,366	8,335	8,015	7,913	7,804	7,686	7,560		
Total Annual Cost	244,975	5,553	5,720	6,545	6,706	6,865	6,807	6,912	7,013	7,109	7,201	7,104	7,149	7,188	7,222	7,249	7,142	7,132	7,115	7,090	7,059	6,739	6,637	6,528	6,410		
PV Costs	324,084																										
Levelized Quantity	3,356																										
Total All Costs	415,457																										
Total Quantity	6,250																										
Average Cost per Tonne	\$ 66																										
Time 0	Year 1 2011	Year 2 2012	Year 3 2013	Year 4 2014	Year 5 2015	Year 6 2016	Year 7 2017	Year 8 2018	Year 9 2019	Year 10 2020	Year 11 2021	Year 12 2022	Year 13 2023	Year 14 2024	Year 15 2025	Year 16 2026	Year 17 2027	Year 18 2028	Year 19 2029	Year 20 2030	Year 21 2031	Year 22 2032	Year 23 2033	Year 24 2034	Year 25 2035		
Annual Quantity	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000		
Annual Tip Fee Revenue	97	24,144	24,144	24,144	24,144	24,144	24,144	24,144	24,144	24,144	24,144	24,144	24,144	24,144	24,144	24,144	24,144	24,144	24,144	24,144	24,144	24,144	24,144	24,144	24,144		
Levelized Cost Calculation (X 1,000)																											
Open Balance	-	244,975	238,632	232,140	226,147	220,017	213,738	207,088	200,210	193,090	185,709	178,051	169,914	161,415	152,530	143,234	133,501	123,174	112,320	100,906	88,898	76,257	62,665	48,292	33,090	17,010	
Annual Net Costs	244,975	5,553	5,720	6,545	6,706	6,865	6,807	6,912	7,013	7,109	7,201	7,104	7,149	7,188	7,222	7,249	7,142	7,132	7,115	7,090	7,059	6,739	6,637	6,528	6,410		
Annual Tip Fee Revenue	(24,144)	(24,144)	(24,144)	(24,144)	(24,144)	(24,144)	(24,144)	(24,144)	(24,144)	(24,144)	(24,144)	(24,144)	(24,144)	(24,144)	(24,144)	(24,144)	(24,144)	(24,144)	(24,144)	(24,144)	(24,144)	(24,144)	(24,144)	(24,144)	(24,144)		
Annual Interest	-	12,249	11,932	11,607	11,307	11,001	10,687	10,354	10,011	9,654	9,285	8,903	8,496	8,071	7,626	7,162	6,675	6,159	5,616	5,045	4,445	3,813	3,133	2,415	1,654		
Closing Balance	244,975	238,632	232,140	226,147	220,017	213,738	207,088	200,210	193,090	185,709	178,051	169,914	161,415	152,530	143,234	133,501	123,174	112,320	100,906	88,898	76,257	62,665	48,292	33,090	17,010		

Annex E-4: Table 2c - ii

System 2c: Thermal Treatment of Solid Recovered Fuel with Biogas Recovery

High Cost Estimate at Constant 2006 Price Levels

Initial Capital Costs 250,000 tpy Facility (\$ X 1,000)		Recycling Material Revenue																											
Planning & Approvals	2,000	(in addition to Residual Waste Study)																											
Land (site & large buffer)	16,875	(13.5 Ha of land @ \$1,250,000 / Ha)																											
Thermal Process Facility	220,500																												
Mechanical Process Facility	14,250																												
Biological Process Facility	23,310																												