Durham/York Residual Waste Study

Evaluation of "Alternatives to" and Identification of the Preferred Residuals Processing System

Recommendations

REPORT

May 30, 2006

MacViro

Jacques Whitford

MacViro
Engineering and Environmental Science

May 30, 2006

Ms. Mirka Januszkiewicz,
Director, Waste Management Services
The Regional Municipality of Durham
Works Department
605 Rossland Rd. E.
Whitby, Ontario, L1N 6A3

and

Mr. Andrew Campbell
Director, Solid Waste Management Branch
York Region, Transportation and Works
Department
17250 Yonge Street
Newmarket, Ontario, L3Y 6Z1

Re: Durham/York Residual Waste Study
Report on Evaluation of "Alternatives To" and Identification of a Preferred Residuals Processing System – Recommendations

Dear Ms. Januszkiewicz and Mr. Campbell:

MacViro Consultants Inc., in association with Jacques Whitford Limited, is pleased to provide this report presenting the Consultant Teams' recommendations on the results of the evaluation of "Alternatives To". This is the first major step in the Durham/York Residual Waste Environmental Assessment (EA) Study completed subsequent to the Provincial approval of the Environmental Assessment (EA) Terms of Reference on March 31, 2006.

The result of this initial EA step – identification of a preferred long-term residuals processing system for Durham and York - is presented along with the background studies and supporting rationale in this main report and an accompanying series of annexes.

The evaluation of "Alternatives to" has been undertaken in accordance with Sections 4.1 and 6.1 of the approved EA Terms of Reference. In summary, the steps used in the evaluation of "Alternatives To" included:

- Evaluation of additional at-source diversion, in order to confirm the appropriateness of the diversion targets of 60% by year 2011 and 75% in future years for use in the planning of long-term processing capacity;
- Formulation of alternative disposal systems, wherein four (4) functionally different residuals processing systems were developed for evaluation (combining the alternative approaches identified in the approved EA Terms of Reference);
- Comparative evaluation of the alternative residuals processing systems; and
- Public consultation undertaken throughout the evaluation process.

Based on the comparative evaluation process we, the Consultant team, recommend that ***System 2(a) -Thermal Treatment of Mixed Solid Waste and Recovery of Energy followed by Recovery of Materials from Ash/Char*** - is the system that offers the preferred balance of advantages and disadvantages given the environmental priorities established by the study area communities and the Joint Waste Management Group. In reaching this recommendation, it is recognized that new technologies categorized in System 2(b) – Thermal Treatment of Solid Recovered Fuel may ultimately offer important benefits.

For some of the criteria where System 2(b) did not rank equivalent to 2 (a), (technical risks, costs and legal/contractual risks for example), the determination of the relative advantages and disadvantages was based upon the information that was readily available on both the mechanical and biological processes that are being used to recover solid fuel in other jurisdictions and on the thermal technologies that can process this fuel. Many of the technologies that would be used to thermally treat the solid recovered fuel (e.g. gasification) in System 2(b) are regarded as 'new technologies', with active research and development, but are much less proven than the technologies that are currently available to combust residual waste in System 2(a).

It is therefore recommended that, pending the approval of System 2(a) as the preferred residuals processing system, the competitive process used during the evaluation of "Alternative Methods" allow for the submission of proposals to implement both System 2(a) and System 2(b), and that the final decision on the technologies used to implement the preferred residuals processing system be based on the results of this competitive process.

Consultation on the Draft Report regarding the consultants conclusions on the preferred residuals processing system that were presented to the Joint Waste Management Group on April 18, 2006, indicates that the majority of the public (approximately 80%) within Durham and York that participated in the consultative process agree with the recommended residuals processing system. The results of the consultation process are presented in Annex F of the Report.

It is recommended that this report and the recommended preferred residuals processing system be forwarded to the Durham and York Public works committee and respective councils for approval.

Yours truly,

MacViro Consultants Inc.

D.O. Merriman, M.B.A., P.Eng.
Project Director

Jacques Whitford Limited

David Walmsley, MCIP, RPP
Environmental Assessment Lead

Executive Summary

The Minister of the Environment approved the Terms of Reference for the Durham/York Residual Waste Environmental Assessment Planning Study (the Study) on March 31, 2006. In Accordance with these Terms of Reference a number of alternatives were formulated and evaluated. Based on the evaluation of these "Alternatives To" it is concluded that the preferred system for managing the residual waste remaining after achieving 60% to 75% diversion is the thermal treatment of the residual waste with the recovery of materials from the ash or char (e.g., a mass burn incinerator). It is recognized that new material processing and thermal technologies (e.g., gasification of solid recovered fuels) may offer benefits in the terms of improved air emissions, energy conversion efficiency and costs. Unfortunately these technologies are not well proven as yet. Given this situation it is proposed that these new thermal technologies, along with proven thermal treatment technologies, be considered at the vendor selection step, as part of the evaluation of "Alternative Methods", in the Environmental Assessment process.

ES-1 Introduction and Background to the Report

The *Report on the Evaluation of "Alternatives to" and Identification of the Preferred Residuals Processing System* has been prepared to present the results of the first major step in the Study for public and agency review and comment. This is a report intended solely for the purpose of public and agency consultation.

The evaluation of "Alternatives To" the undertaking serves as the initial step in the Durham/York Residual Waste EA. "Alternatives to" are defined as fundamentally different ways of managing waste and achieving the purpose of the undertaking. The purpose of the undertaking as described in the approved EA Terms of Reference is:

> ***"To process - physically, biologically and/or thermally - the waste that remains after the application of both Regions' at-source waste diversion programs in order to recover resources - both material and energy - and to minimize the amount of material requiring landfill disposal.***
>
> ***In proceeding with this undertaking only those approaches that will meet or exceed all regulatory requirements will be considered."***

The results of the initial EA step – identification of a preferred long-term residuals processing system for Durham and York - are presented as a recommendation from the consultant team's consideration of alternative system advantages and disadvantages and environmental priorities. The environmental priorities are based on the results of public consultation.

This report incorporates input from the public and agencies, provided during a 30-day consultation period on the draft report that began on April 19, 2006 and ended on May 19, 2006. All parties reviewing the draft report were encouraged to submit their comments including those that are supportive or opposing and those that pose questions or make suggestions for modification to the results. As of the end of the consultative period, there were no substantive issues that had been identified which would have resulted in adjustments to the report or

supporting annexes and the majority of the public (approximately 80%) that participated in the consultative process agreed with the recommended residuals processing system.

ES-2 Methodology for Evaluation of Alternative Systems

To fully address the purpose of the undertaking, different waste management approaches capable of processing and recovering resources from post-diversion waste were combined into alternative residuals processing systems. The Study EA Terms of Reference established that alternative systems comprised of the following approaches and technologies would be formulated and evaluated:

- ✓ Mechanical Treatment;
- ✓ Biological Treatment; and
- ✓ Thermal Treatment.

Note: Thermal Treatment includes combustion, gasification and pyrolysis.

The following summarizes the seven (7) step methodology outlined in the Approved EA Terms of Reference that was applied to formulate and then comparatively evaluate alternative residuals processing systems.

Step 1 - Prior to initiation of the evaluation of "Alternatives to", the proposed evaluation methodology and criteria were reviewed in consultation with the public and agencies. This review sought additional input on the proposed evaluation steps and evaluation criteria presented in the EA Terms of Reference to establish and confirm the relative priorities to be considered during the evaluation.

Step 2 - The component alternatives were assembled into a range of alternative residuals processing systems with each system being capable of managing the entire projected residual waste stream.

Step 3 - Data collection was undertaken for the purpose of applying each of the comparative evaluation criteria to each of the alternative residuals processing systems. The proposed disposal system comparative evaluation criteria were included in Appendix "E" – Table E-1 of the approved EA Terms of Reference. There was provision for adjustment for suggested indicators and data sources at the initiation of the EA evaluation based on input received from agencies and the public at Step 1.

Step 4 - The comparative evaluation criteria were applied to each of the alternative residuals processing systems and potential effects identified.

Step 5 - Each of the potential effects identified at Step 4 were considered with respect to the availability of measures to mitigate (i.e., measures that may be applied to reduce or eliminate a negative potential effect) or enhance (measures that may be applied to improve or increase the magnitude of a benefit or positive effect) the effects, and identify the remaining or 'net effects'.

Step 6 - The net effects associated with each residuals processing system under each comparative criterion were compared and a list of relative advantages and

disadvantages associated with each alternative residuals processing system was developed.

Step 7 - The relative advantages and disadvantages of each alternative residuals processing system were considered in the context of priorities established in consultation with the public and agencies and the preferred system selected. The preferred system is the one exhibiting the preferred balance of advantages and disadvantages considering the priority of environmental categories and criteria established by the public and agencies.

As an initial task in the system development step, each municipality's at-source waste diversion program was reviewed to assess the suitability of the established sixty (60) percent at-source diversion targets. This review concluded that waste reduction and 'at-source' diversion approaches will continue to be preferred over disposal but that, given the current and projected diversion opportunities available to Durham and York, the targets of 60% diversion by 2011 and 75% diversion in future years are reasonable for use in the formulation and evaluation of alternative systems.

In determining the scope of alternative systems to be evaluated, the focus was on covering the range of options to recover resources, both materials and energy, from the residual waste stream rather than all possible combinations of the alternative approaches available for consideration. Resource recovery options included recovery of recyclable materials for sale to market, energy from biogas and energy from the thermal treatment of wastes or solid recovered fuel. The intent of the Study is to identify a preferred long-term alternative that maximizes the recovery of resources and minimizes the reliance on landfill as a primary method of disposal.

Landfill facilities will be assumed to continue to play a role for the disposal of certain materials that cannot be otherwise processed or diverted. A landfill only system, whereby a new landfill site capable of managing all waste that remains after at-source diversion would not meet the purpose of the undertaking, and thus was not considered in this study. Rationale for the exclusion of this option is provided in the approved EA Terms of Reference and the Report on Formulation of Alternative Residual Processing Systems (Annex C-2).

Once developed, the alternative residuals processing systems were evaluated by application of the established evaluation criteria and environmental priorities and using the net effects analysis outlined in Steps three (3) to seven (7) in the "Alternatives to" evaluation methodology. The preferred residuals processing system is that which offers the preferred balance of advantages and disadvantages given the environmental priorities established by the communities of Durham and York through the public consultation process.

ES-3 Consultation with the Public and Agencies, Preparation of the

Draft Report

On March 7th, 8th and 9th, the Regions of Durham and York held Public Information Sessions to discuss the "Alternatives to" and the proposed evaluation process. The four (4) alternative systems to be evaluated were presented, as well as at-source diversion measures and the potential for resource recovery that was considered with each system alternative. In addition, the evaluation methodology and evaluation priorities that were developed during the preparation of the EA Terms of Reference were presented for public review. To verify public agreement with the range of alternative systems to be evaluated and the evaluation priorities, attendees were asked to complete a questionnaire. In the questionnaire, respondents were asked for input on the range of alternatives to be evaluated to rank the five (5) categories of the environment as "Extremely Important", "Very Important", "Somewhat Important", "Not Very Important", or "Not at all Important". The environmental categories considered in the evaluation process included the Natural, Social/Cultural, Economic, Technical and Legal/Jurisdictional Environments. A total of 83 individuals completed the questionnaire.

In addition, the Joint Waste Management Group retained the services of the public polling firm Ipsos Reid. The firm conducted an online self-complete Internet survey, and received responses from a total of 449 Durham residents and 423 York residents. The sample was chosen to be representative of the population demographics of the two Regions. The format was similar to the open house questionnaire, and respondents were asked to assign priority levels to the same five (5) environmental categories listed above.

The results of the Public Information Sessions questionnaire and online public survey were combined to determine the priorities, pending approval by the Joint Waste Management Group, to be assigned to each of the environmental categories. The final ranking of the priorities is presented in Table ES-1 below.

The Regions of Durham and York also distributed the proposed evaluation criteria and copies of the open house display panels to the stakeholders and agencies that have been identified to date for review and comment. This list of stakeholders and agencies includes approximately 400 groups consisting of government agencies (Federal, Provincial, and Municipal), educational institutions, First Nations organizations, and environmental groups.

ES-4 Establishment of Priorities and Application in the Evaluation

An influential aspect of the evaluation process was the identification and application of priorities assigned to the various components of the environment by the public. A key characteristic of the Environmental Assessment Act, and most planning processes with a focus on sustainability, is the requirement to consider a broadly defined environment (i.e., more than just the natural environment). Accordingly, the different categories of the environment considered in this study and the relative priorities assigned by the communities of Durham and York were as follows:

Table ES-1 Environmental Considerations by Assigned Priorities

Environmental Category	Relative Priority
Natural Environmental Considerations	Most Important
Social / Cultural Considerations	Important
Economic / Financial Considerations	Important
Technical Considerations	Important
Legal Considerations	Least Important

ES-5 Formulation and Evaluation of Alternative System

The evaluation of "Alternatives to", as a first finding, concluded that the reduction and "at-source" diversion of municipal solid waste are and will remain the most preferred components of an integrated waste management system. With this in mind and given the current and projected diversion opportunities available to Durham and York, it was determined that the established percent at-source waste diversion targets of 60% by 2011 and 75% by 2045 are reasonably aggressive targets on which to base the planning of long-term residuals processing capacity.

The following four alternative systems were then formulated using the alternative processing approaches from the approved EA Terms of Reference:

System 1 - Mechanical and Biological Treatment with Biogas Recovery

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

System 2(b) - Thermal Treatment of Solid Recovered Fuel

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

Utilizing the seven (7) step alternative system evaluation methodology described above the relative advantages and disadvantages of the alternative residuals processing systems were identified and summarized below.

System 1 – Mechanical Biological Treatment with Biogas Recovery

System 1 involves mechanical processing to recover recyclable material from the waste, anaerobic digestion of the organic fraction to recover a relatively small amount of renewable energy, and the landfilling of the resulting residues. It is essentially a stabilized landfill alternative with 77% of the residual waste stream ultimately being exported to landfill.

Advantages of this system include:

- Lowest potential impacts on the air environment;
- More flexible to changes in waste quantities and composition;
- Potentially lower overall system costs provided low cost landfill capacity can be obtained from a third party;

- Potential to increase diversion through the recovery of additional recyclables – an advantage shared with Systems 2b and 2c.

Because this system is primarily a landfill alternative, it has a number of disadvantages including:

- Greatest potential impacts to water and land;
- Greatest potential to disrupt sensitive habitat;
- Lowest energy generation – both renewable and total;
- Greatest potential social impact on the landfill host community; and
- Least reliable due to dependence on export landfill contracts.

Systems 2a and 2b – Thermal Treatment of Municipal Solid Waste of Solid Recovered Fuel

Systems 2a and 2b are both based on the recovery of energy through thermal treatment. In 2a, recyclable metals are recovered following thermal treatment from the ash or char. In 2b, recyclable materials, including metals and some plastics, are recovered through mechanical treatment, moisture from the organic fraction in the remaining material is then reduced through biological treatment. The material (now considered a Solid Recovered Fuel) is then subjected to thermal treatment. In both cases, only a small proportion of the residual waste stream – typically 10-15% by volume – goes to landfill. If the bottom ash could be used as construction material as it is in Europe and is being studied in the United States, percent of waste to landfill to less than 5%.

In summary, the advantages associated with Systems 2a and 2b include:

- Lowest potential impacts to water and land;
- Least potential to disrupt sensitive habitats;
- Greatest energy generation – both renewable and total;
- Lowest potential social impact on landfill host community due to minimizing the quantities requiring landfill;
- Higher reliability due to minimum dependence on export to landfill; and
- Costs, although high, are comparable in the case of System 2a, with System 1.

The disadvantages of the thermal treatment systems include:

- Highest potential impacts on the air environment, although current technology has the proven ability to exceed all applicable air emissions standards;
- Less flexibility to changes in waste quantities and composition;
- Need to manage hazardous residues from the pollution control system. *(It can be argued that this is not really a disadvantage as the hazardous compounds – primarily heavy metals – are in the waste stream to begin with and simply landfilled in System 1. With the thermal systems, these contaminants are concentrated and removed for stabilization and/or management in a secure landfill.)*

When comparing Systems 2a and 2b, alternative 2a has the advantages of:

- More proven and reliable technology; and
- Lower costs – based on experience to-date.

Alternative 2b has the advantages of:

- The potential to recover more recyclables – some plastics as well as metals; and
- Potential improvements in air emissions, energy conversion efficiency and costs that may be provided by new technologies presently under development.

System 2c – Thermal Treatment of Solid Recovered Fuel With Biogas Recovery

System 2c includes the mechanical and biological treatment component of System 1 followed by the thermal treatment of a solid recovered fuel including the combustible portion of the residual waste, rather than the straight landfilling of all residues. Ultimately the inert non-recyclable materials, AD digestate and ash/char all require landfill disposal. Approximately 45% of the residual stream will require export landfill under this alternative versus the 77% for System 1.

The major advantage of the system includes:

- The ability to recover additional recyclable materials and also to make beneficial use of the post diversion waste stream.

It has the disadvantage of:

- Highest cost and lowest technical reliability due to the amount and complexity of the required processing equipment.

The attached Table ES-2 provides a more comprehensive overview of how each of the systems compares to one another in terms of their relative advantages and disadvantages when considering each of the evaluation criterion.

Table ES-2: Comparison of Alternative Systems – Major Advantages and Disadvantages

NATURAL ENVIRONMENTAL CONSIDERATIONS (Most Important Priority)

Criterion	*Indicator*	*System 1* *Mechanical, Biological Treatment with Biogas Recovery*	*System 2 (a)* *Thermal Treatment of MSW & Recovery of Materials from Ash/Char*	*System 2 (b)* *Thermal Treatment of Solid Recovered Fuel*	*System 2 (c)* *Thermal Treatment of Solid Recovered Fuel with Biogas Recovery*
Criterion 1: **Environmental burden at a global or macro-environmental scale, including impacts to air, land and water.**	**Predicted Emissions released to atmosphere by system (emissions form all systems will be within required limits)**	***MAJOR ADVANTAGE*** • Lowest net emissions of Greenhouse Gases • Lower net emissions of Acid Gases • Highest net emissions of Smog Precursors • Lowest net emissions of Heavy Metals & Organics to Air	***MAJOR DISADVANTAGE*** • Highest Net emissions of Greenhouse Gases • Highest net emissions of Acid Gases • Higher net emissions of Smog Precursors • Highest net emissions of Heavy Metals & Organics to Air	***DISADVANTAGE*** • Higher net emissions of Greenhouse Gases • Lower net emissions of Acid Gases • Lower net emissions of Smog Precursors • Higher net emissions of Heavy Metals & Organics to Air	***DISADVANTAGE*** • Higher net emissions of Greenhouse Gases • Lowest net emissions of Acid Gases • Lowest net emissions of Smog Precursors • Lower net emissions of Heavy Metals & Organics to Air
	Predicted pollutants released to water resources by system	***MAJOR DISADVANTAGE*** • Highest net emissions of Heavy Metals & Organics to Water.	***MAJOR ADVANTAGE*** • Lowest net emissions of Heavy Metals & Organics to Water.	***ADVANTAGE*** • Lower net emissions of Heavy Metals & Organics to Water	***NEUTRAL*** • Higher emissions of Heavy Metals & Organics to Water

Criterion	Indicator	System 1 Mechanical, Biological Treatment with Biogas Recovery	System 2 (a) Thermal Treatment of MSW & Recovery of Materials from Ash/Char	System 2 (b) Thermal Treatment of Solid Recovered Fuel	System 2 (c) Thermal Treatment of Solid Recovered Fuel with Biogas Recovery
Criterion 1: **Environmental burden at a global or macro-environmental scale, including impacts to air, land and water.** **(cont'd)**	**Need to manage residues classified as hazardous waste associated with system.**	• Hazardous elements remain in materials processed and/or landfilled and may be emitted by way of landfill emissions / collected by landfill pollution control systems. • No hazardous waste stream associated with residue from Facility Air Pollution Control Equipment.	• Approximately 15,500 tonnes per year of hazardous residue from pollution control equipment requires management at a licensed facility if the quantity of residual material managed by the facility is 400,000 TPY. • Costs to manage hazardous wastes at an approved facility have been included in estimated system costs.	• Approximately 8,500 tonnes per year of hazardous residue from pollution control equipment requires management at a licensed facility if the quantity of residual material managed by the facility is 400,000 TPY. • Costs to manage hazardous wastes at an approved facility have been included in estimated system costs.	• Approximately 5,500 tonnes per year of hazardous residue from pollution control equipment requires management at a licensed facility if the quantity of residual material managed by the facility is 400,000 TPY. • Costs to manage hazardous wastes at an approved facility have been included in estimated system costs.
		NEUTRAL • Opposing views of this consideration weigh segregation of hazardous materials and proper management versus discharging via mixed waste to landfill where they may or may not leach out of the disposed wastes.			

Criterion	Indicator	System 1 Mechanical, Biological Treatment with Biogas Recovery	System 2 (a) Thermal Treatment of MSW & Recovery of Materials from Ash/Char	System 2 (b) Thermal Treatment of Solid Recovered Fuel	System 2 (c) Thermal Treatment of Solid Recovered Fuel with Biogas Recovery
Criterion 1: **Environmental burden at a global or macro-environmental scale, including impacts to air, land and water.** ***(cont'd)***	**Impacts to land by system.**	***MAJOR DISADVANTAGE*** • Siting process for a 11.4 ha Mechanical/Biological treatment facility in an urban/industrial setting will provide a high likelihood that facility location makes an appropriate use of land resources. • Primary facility site would likely be located within a designated urban boundary and/or on lands appropriately designated for the use. • Due to lack of approved landfill capacity within Durham and York, assumed that landfill capacity for residues would exist at a licensed municipal or private landfill. • A minimum of 287,000 cubic metres of landfill space will be required annually to dispose of system residues.	***MAJOR ADVANTAGE*** • Siting process for a 9.6 ha thermal facility in an urban/industrial setting will provide a high likelihood that facility location makes an appropriate use of land resources. • Primary facility site would likely be located within a designated urban boundary and/or on lands appropriately designated for the use. • Due to lack of approved landfill capacity within Durham and York, assumed that landfill capacity for residues would exist at a licensed municipal or private landfill. • A minimum of 50,000 cubic metres of landfill space will be required annually to dispose of system residues.	***ADVANTAGE*** • Siting process for a 14.6 ha MBT/ thermal facility in an urban/industrial setting will provide a high likelihood that facility location makes an appropriate use of land resources. • Primary facility site would likely be located within a designated urban boundary and/or on lands appropriately designated for the use. • Due to lack of approved landfill capacity within Durham and York, assumed that landfill capacity for residues would exist at a licensed municipal or private landfill. • A minimum of 81,000 cubic metres of landfill space will be required annually to dispose of system residues.	***NEUTRAL*** • Siting process for a 13.5 ha MBT/ thermal facility in an urban/industrial setting will provide a high likelihood that facility location makes an appropriate use of land resources. • Primary facility site would likely be located within a designated urban boundary and/or on lands appropriately designated for the use. • Due to lack of approved landfill capacity within Durham and York, assumed that landfill capacity for residues would exist at a licensed municipal or private landfill. • A minimum of 114,000 cubic metres of landfill space will be required annually to dispose of system residues.
Criterion 1:	**OVERALL**	**DISADVANTAGE**	**MAJOR ADVANTAGE**	**ADVANTAGE**	**NEUTRAL**

Criterion	Indicator	System 1 Mechanical, Biological Treatment with Biogas Recovery	System 2 (a) Thermal Treatment of MSW & Recovery of Materials from Ash/Char	System 2 (b) Thermal Treatment of Solid Recovered Fuel	System 2 (c) Thermal Treatment of Solid Recovered Fuel with Biogas Recovery
Criterion 2: **Consumption/preservation of non-renewable environmental resources.**	**Potential of system to consume non-renewable fossil fuel or displace non-renewable fossil fuel consumption for energy generation.**	***MAJOR DISADVANTAGE*** • Net lifecycle energy (i.e. electricity, heat, virgin material displacement credit, etc.) impact of 606,357 GJ conserved annually. • Net Electrical Energy Generation from renewable sources of 10,313 MWh	***MAJOR ADVANTAGE*** • Net lifecycle energy (i.e. electricity, heat, virgin material displacement credit, etc.) impact of 1,348,786 GJ conserved annually. • Net Electrical Energy Generation from renewable sources of 86,180 MWh	***MAJOR ADVANTAGE*** • Net lifecycle energy (i.e. electricity, heat, virgin material displacement credit, etc.) impact of 1,428,480 GJ conserved annually. • Net Electrical Energy Generation from renewable sources of 85,673 MWh	***ADVANTAGE*** • Net lifecycle energy (i.e. electricity, heat, virgin material displacement credit, etc.) impact of 1,230,067GJ conserved annually. • Net Electrical Energy Generation from renewable sources of 56,822 MWh
Criterion 3: **Potential for destruction or disruption of sensitive terrestrial and/or aquatic habitats at an eventual site.**	**Total Volume of Landfill Capacity Required to manage Post-Processing Residual Waste**	***MAJOR DISADVANTAGE*** • **Significant** requirement for landfill disposal of system residues increases potential for removal or disruption of sensitive natural habitats due to typically rural setting of landfill facilities.	***MAJOR ADVANTAGE*** • **Low** requirement for landfill disposal of system residues reduces potential for removal or disruption of sensitive natural habitats due to typically rural setting of landfill facilities.	***ADVANTAGE*** • **Low/Moderate** requirement for landfill disposal of system residues reduces potential for removal or disruption of sensitive natural habitats due to typically rural setting of landfill facilities.	***NEUTRAL*** • **Moderate** requirement for landfill disposal of system residues reduces potential for removal or disruption of sensitive natural habitats due to typically rural setting of landfill facilities.
	Land use setting typically associated with establishment of facilities comprising system.	• Estimated 11.4 ha. Site Requirement	• Estimated 9.6 ha. Site Requirement	• Estimated 14.6 ha. Site Requirement	• Estimated 13.5 ha. Site Requirement
		NEUTRAL • All facility(ies) site(s) can be located in designated urban area and on industrially designated lands with potential for impacts on sensitive habitats unlikely.			
Criterion 3:	**OVERALL**	**MAJOR DISADVANTAGE**	**MAJOR ADVANTAGE**	**ADVANTAGE**	**NEUTRAL**

Criterion	Indicator	System 1 Mechanical, Biological Treatment with Biogas Recovery	System 2 (a) Thermal Treatment of MSW & Recovery of Materials from Ash/Char	System 2 (b) Thermal Treatment of Solid Recovered Fuel	System 2 (c) Thermal Treatment of Solid Recovered Fuel with Biogas Recovery
Criterion 4: **Potential to increase diversion rate and/or make best use of residual (post-diversion) waste materials.**	**Potential of system facilities to remove any remaining materials in the post-diversion waste stream for use in a non-disposal manner.**	***MAJOR ADVANTAGE*** • System ensures achievement of 60% diversion target and offers potential 10% increase in rate of diversion from disposal to 70%.	***ADVANTAGE*** • System ensures achievement of 60% diversion target and in existing regulatory environment offers potential 2% increase in rate of diversion from disposal to 62%.	***MAJOR ADVANTAGE*** • System ensures achievement of 60% diversion target and in existing regulatory environment offers potential 8% increase in rate of diversion from disposal to 68%.	***MAJOR ADVANTAGE*** • System ensures achievement of 60% diversion target and in existing regulatory environment offers potential 10% increase in rate of diversion from disposal to 70%.
	Potential of system facilities to manage and make beneficial use of materials in the post-diversion waste stream including those materials for which diversion may decline or disappear in the future.	***ADVANTAGE*** • **Moderate** - If markets for compost and recycled paper fibres were to decline, this system could anaerobically digest these materials to recover energy. • If there were approved markets for Class B compost and use of some recovered materials as aggregate, diversion from landfill disposal could increase to 84%.	***MAJOR ADVANTAGE*** • **High** - If markets for recycled plastics, low-value paper etc. were to decline or disappear, this system could recover significant quantities of energy from these materials. • In addition, if European practice of curing and recycling bottom ash into aggregate materials was approved in Ontario, diversion from landfill disposal could increase to 95%.	***MAJOR ADVANTAGE*** • **High** - If markets for recycled plastics, low-value paper etc. were to decline or disappear, this system could recover significant quantities of energy from these materials. • In addition, if European practice of curing and recycling bottom ash into aggregate materials was approved in Ontario, diversion from landfill disposal could increase to 89%.	***MAJOR ADVANTAGE*** • **High** - If markets for recycled plastics, low-value paper etc. were to decline or disappear, this system could recover significant quantities of energy from these materials. • In addition, if European practice of curing and recycling bottom ash into aggregate materials was approved in Ontario, diversion from landfill disposal could increase to 87%.
Criterion 4:	**OVERALL**	**ADVANTAGE**	**ADVANTAGE**	**MAJOR ADVANTAGE**	**MAJOR ADVANTAGE**
NATURAL ENVIRONMENTAL CONSIDERATIONS	**OVERALL**	**DISADVANTAGE**	**MAJOR ADVANTAGE**	**MAJOR ADVANTAGE**	**ADVANTAGE**

SOCIAL / CULTURAL CONSIDERATIONS (Important Priority)

Criterion	*Indicator*	*System 1* *Mechanical, Biological Treatment with Biogas Recovery*	*System 2 (a)* *Thermal Treatment of MSW & Recovery of Materials from Ash/Char*	*System 2 (b)* *Thermal Treatment of Solid Recovered Fuel*	*System 2 (c)* *Thermal Treatment of Solid Recovered Fuel with Biogas Recovery*
Criterion 5: **Potential for land use conflicts from siting of facilities required for alternative.**	**Number of waste management facilities associated with alternative system.**	***NEUTRAL*** ▪ For comparative purposes it is assumed that all components of all of the alternative residuals processing systems would be located at a single location within Durham/York. As a result, all systems would have the same relative impact regarding the number of waste management facilities. The 'single facility, single site' system configuration represents the most efficient system configuration and would provide the economies of scale that are being sought in the Durham/York study. In general, a 'single facility, single site' configuration also represents the configuration which would be expected to have a lower potential for environmental and social impacts, as the total land area required and number of potential receptors that could be impacted by the systems, increases as the number of sites required for each system increases.			

Criterion	Indicator	System 1 Mechanical, Biological Treatment with Biogas Recovery	System 2 (a) Thermal Treatment of MSW & Recovery of Materials from Ash/Char	System 2 (b) Thermal Treatment of Solid Recovered Fuel	System 2 (c) Thermal Treatment of Solid Recovered Fuel with Biogas Recovery
Criterion 5: **Potential for land use conflicts from siting of facilities required for alternative.** **(cont'd)**	**Potential for land use conflicts considering location requirements of waste management facilities.**	***MAJOR DISADVANTAGE*** • For comparative purposes it is assumed that all components of the MBT System would be located at a single location within Durham/York. • MBT facility would likely be located within a designated urban boundary and/or on lands appropriately designated for the use. • Significant quantity of residual materials (30% of total waste stream) will require landfill disposal at a facility located outside of the study area, resulting in a higher potential for land use conflicts associated with export to waste in other communities. • Highest potential traffic related impacts, related to the haul of materials from the MBT facility to landfill.	***MAJOR ADVANTAGE*** • For comparative purposes it is assumed that all components of the Thermal System would be located at a single location within Durham/York. • Thermal facility would likely be located within a designated urban boundary and/or on lands appropriately designated for the use. • Small quantity of residual materials (9% of total waste stream) will require landfill disposal at a facility located outside of the study area, resulting in a low potential for land use conflicts associated with export to waste in other communities. • Lowest potential traffic related impacts, related to the haul of materials from the thermal facility to landfill.	***MAJOR ADVANTAGE*** • For comparative purposes it is assumed that all components of the MBT/Thermal System would be located at a single location within Durham/York. • MBT/Thermal facility would likely be located within a designated urban boundary and/or on lands appropriately designated for the use. • Small quantity of residual materials (13% of total waste stream) will require landfill disposal at a facility located outside of the study area, resulting in a low potential for land use conflicts associated with export to waste in other communities. • Low potential traffic related impacts, related to the haul of materials from the MBT/ thermal facility to landfill.	***NEUTRAL*** • For comparative purposes it is assumed that all components of the MBT/Thermal System would be located at a single location within Durham/York. • MBT/Thermal facility would likely be located within a designated urban boundary and/or on lands appropriately designated for the use. • Moderate quantity of residual materials (18% of total waste stream) will require landfill disposal at a facility located outside of the study area, resulting in some potential for land use conflicts associated with export to waste in other communities. • Low potential traffic related impacts, related to the haul of materials from the MBT/ thermal facility to landfill.

Criterion	Indicator	System 1 Mechanical, Biological Treatment with Biogas Recovery	System 2 (a) Thermal Treatment of MSW & Recovery of Materials from Ash/Char	System 2 (b) Thermal Treatment of Solid Recovered Fuel	System 2 (c) Thermal Treatment of Solid Recovered Fuel with Biogas Recovery
Criterion 5: **Potential for land use conflicts from siting of facilities required for alternative.** ***(cont'd)***	**Types and degree of Nuisance Impacts associated with waste management facilities based on Operational experience**	***MAJOR DISADVANTAGE*** • Relatively equivalent potential impacts for most nuisance related parameters (dust, noise, litter) • Higher potential for odour related impacts, due to biological component of the MBT system and as potential odorous materials will be hauled from the MBT facility to landfill for disposal.	***MAJOR ADVANTAGE*** • Relatively equivalent potential impacts for most nuisance related parameters (dust, noise, litter) • Lower potential for odour related impacts as there is no biological component of the Thermal system, and as the residue hauled to landfill is inert.	***ADVANTAGE*** • Relatively equivalent potential impacts for most nuisance related parameters (dust, noise, litter) • Higher potential for odour related impacts, due to biological component of the system, however, the residue hauled to landfill is inert as all biological residues are combusted.	***DISADVANTAGE*** • Relatively equivalent potential impacts for most nuisance related parameters (dust, noise, litter) • Higher potential for odour related impacts, due to biological component of the system and as potential odorous materials will be hauled from the MBT facility to landfill for disposal.
SOCIAL / CULTURAL CONSIDERATIONS	**OVERALL**	**MAJOR DISADVANTAGE**	**MAJOR ADVANTAGE**	**ADVANTAGE**	**DISADVANTAGE**

ECONOMIC / FINANCIAL CONSIDERATIONS (Important Priority)

Criterion	*Indicator*	*System 1* *Mechanical, Biological Treatment with Biogas Recovery*	*System 2 (a)* *Thermal Treatment of MSW & Recovery of Materials from Ash/Char*	*System 2 (b)* *Thermal Treatment of Solid Recovered Fuel*	*System 2 (c)* *Thermal Treatment of Solid Recovered Fuel with Biogas Recovery*
Criterion 6: **Net system costs per tonne of waste managed – in a systems context. Includes:** • Capital and operating costs over operational period of system (2011 to 2045). • Estimated costs associated with perpetual care of component facilities in accordance with current environmental and municipal accounting requirements. • Estimated revenues associated with system once fully implemented and operational. • Potential subsidies and revenues that may be realized during establishment and future operation of system.		***ADVANTAGE*** • Net System Cost per tonne ranges from $114 to $155, including capital, operating, financing, perpetual care, revenues and subsidies.	***ADVANTAGE*** • Net System Cost per tonne ranges from $97 to $160, including capital, operating, financing, perpetual care, revenues and subsidies.	***DISADVANTAGE*** • Net System Cost per tonne ranges from $116 to $188, including capital, operating, financing, perpetual care, revenues and subsidies.	***MAJOR DISADVANTAGE*** • Net System Cost per tonne ranges from $140 to $213, including capital, operating, financing, perpetual care, revenues and subsidies.

Criterion	Indicator	System 1 Mechanical, Biological Treatment with Biogas Recovery	System 2 (a) Thermal Treatment of MSW & Recovery of Materials from Ash/Char	System 2 (b) Thermal Treatment of Solid Recovered Fuel	System 2 (c) Thermal Treatment of Solid Recovered Fuel with Biogas Recovery
Criterion 7: **Sensitivity of system costs and affordability to external financial influences. Includes:** • Types of revenues and subsidies currently available to off-set system costs and predicted sustainability of these sources into the future. • Degree to which system affordability relies on revenues and subsidies during long-term operation of the system.		***MAJOR DISADVANTAGE*** • Net system cost assumes markets for recyclable materials recovered from mechanical component of MBT facility and biogas from anaerobic digester. Revenues offset in the range of 13 to 16% of average annual costs. • Revenue from sale of recyclables is likely least secure of all revenue streams. • System generates considerably more post-process residue that would require landfill disposal and therefore will be more susceptible to rising landfill disposal costs.	***NEUTRAL*** • Net system cost assumes markets for energy generated from thermal treatment of waste and for materials recovered from ash/char. Revenues off-set approximately 50 to 73% of average annual costs of facility. • Revenue from sale of electricity is likely most secure of all revenue streams. • System would have a minor influence related to the marketplace for disposal of APC residues / ashes / chars.	***NEUTRAL*** • Net system cost assumes markets for energy generated from thermal treatment of a solid recovered fuel and for materials recovered from the SRF facility. Revenues off-set approximately 43 to 63% of average annual costs. • Revenue from sale of electricity is likely most secure of all revenue streams. • System would have a minor influence related to the marketplace for disposal of APC residues / ashes / chars.	***DISADVANTAGE*** • Net system cost assumes markets for energy generated from thermal treatment of an solid recovered fuel and for materials and biogases recovered from facility that processes MSW into SRF. Revenues off-set approximately 32 to 47% of average annual costs. • Revenue from sale of electricity is likely most secure of all revenue streams. • System would be influenced by marketplace for disposal of APC residues / ashes / chars.
ECONOMIC / FINANCIAL CONSIDERATIONS	**OVERALL**	**DISADVANTAGE**	**ADVANTAGE**	**DISADVANTAGE**	**MAJOR DISADVANTAGE**

TECHNICAL (Important Priority)

Criterion	*Indicator*	*System 1* *Mechanical, Biological Treatment with Biogas Recovery*	*System 2 (a)* *Thermal Treatment of MSW & Recovery of Materials from Ash/Char*	*System 2 (b)* *Thermal Treatment of Solid Recovered Fuel*	*System 2 (c)* *Thermal Treatment of Solid Recovered Fuel with Biogas Recovery*
Criterion 8: **Technical risks associated with waste management alternative.**	**Flexibility of alternative system to changes in waste quantities, composition and availability of system diversion and disposal components.**	***ADVANTAGE*** • MBT component would be designed for a specified throughput and any quantities over that design capacity would have to be managed by way of extended operating hours or by-pass to a landfill.	***MAJOR DISADVANTAGE*** • Although changes to waste characteristics are not a significant issue, significant changes in quantity can be problematic. A reduction in quantity affects the assumed economics of the facility and may be corrected by way of alternate sourcing of feedstock. An increase may require MSW to bypass the facility.	***DISADVANTAGE*** • Incorporation of mechanical, biological and thermal components allows for adjustments in process line to accommodate some changes in waste types and quantities.	***DISADVANTAGE*** • Incorporation of mechanical, biological and thermal components allows for adjustments in process line to accommodate some changes in waste types and quantities.
Criterion 8: **Technical risks associated with waste management alternative.**	**Reliability of alternative system and component technologies and need for contingency landfill capacity.**	***MAJOR DISADVANTAGE*** • MBT component is considered reasonably reliable given past experience with mechanical component although experience with anaerobic digestion of mixed wastes is less common. • High Dependence on landfill capacity elsewhere in the Province results in lowest reliability.	***MAJOR ADVANTAGE*** • Operating experience with this technology has established a reasonable operating track record and a much-improved track record with regards to environmental protection. • Lowest dependence on landfill capacity elsewhere in Province.	***DISADVANTAGE*** • System is dependent on several different types of technologies and mechanical equipment that lends itself to the highest potential for breakdown or failure. • Moderate dependence on landfill capacity elsewhere in Province.	***DISADVANTAGE*** • System is highly dependent on several different types of technologies and mechanical equipment that lends itself to the highest potential for breakdown or failure. • Moderate dependence on landfill capacity elsewhere in Province.
TECHNICAL	**OVERALL**	**MAJOR DISADVANTAGE**	**NEUTRAL**	**DISADVANTAGE**	**DISADVANTAGE**

LEGAL CONSIDERATIONS (Less Important Priority)

Criterion	*Indicator*	*System 1* *Mechanical, Biological Treatment with Biogas Recovery*	*System 2 (a)* *Thermal Treatment of MSW & Recovery of Materials from Ash/Char*	*System 2 (b)* *Thermal Treatment of Solid Recovered Fuel*	*System 2 (c)* *Thermal Treatment of Solid Recovered Fuel with Biogas Recovery*
Criterion 9: **Legal / contractual risks associated with waste management alternative.**	**Types and complexity of approvals required to implement components of system.**	***DISADVANTAGE*** • System will require at a minimum, approval under the Ontario Environmental Assessment Act and Ontario Environmental Protection Act. • MBT facility would likely be located within a designated urban boundary and/or on lands appropriately designated for the use. Accordingly, potential for land use conflicts would be minimal and may facilitate obtaining the necessary approvals to implement and operate the facility. • System has higher landfill requirements, so that while MBT component may be more acceptable for approval within Durham and York, the use of a significant quantity of landfill space outside of the study area is likely to be less acceptable (particularly for the host community).	***NEUTRAL*** • System will require at a minimum, approval under the Ontario Environmental Assessment Act and Ontario Environmental Protection Act. • Thermal facility would likely be located within a designated urban boundary and/or on lands appropriately designated for the use. Accordingly, potential for land use conflicts would be minimal and may facilitate obtaining the necessary approvals to implement and operate the facility.	***NEUTRAL*** • System will require at a minimum, approval under the Ontario Environmental Assessment Act and Ontario Environmental Protection Act. • MBT / thermal facility would likely be located within a designated urban boundary and/or on lands appropriately designated for the use. Accordingly, potential for land use conflicts would be minimal and may facilitate obtaining the necessary approvals to implement and operate the facility.	***NEUTRAL*** • System will require at a minimum, approval under the Ontario Environmental Assessment Act and Ontario Environmental Protection Act. • MBT / thermal facility would likely be located within a designated urban boundary and/or on lands appropriately designated for the use. Accordingly, potential for land use conflicts would be minimal and may facilitate obtaining the necessary approvals to implement and operate the facility.

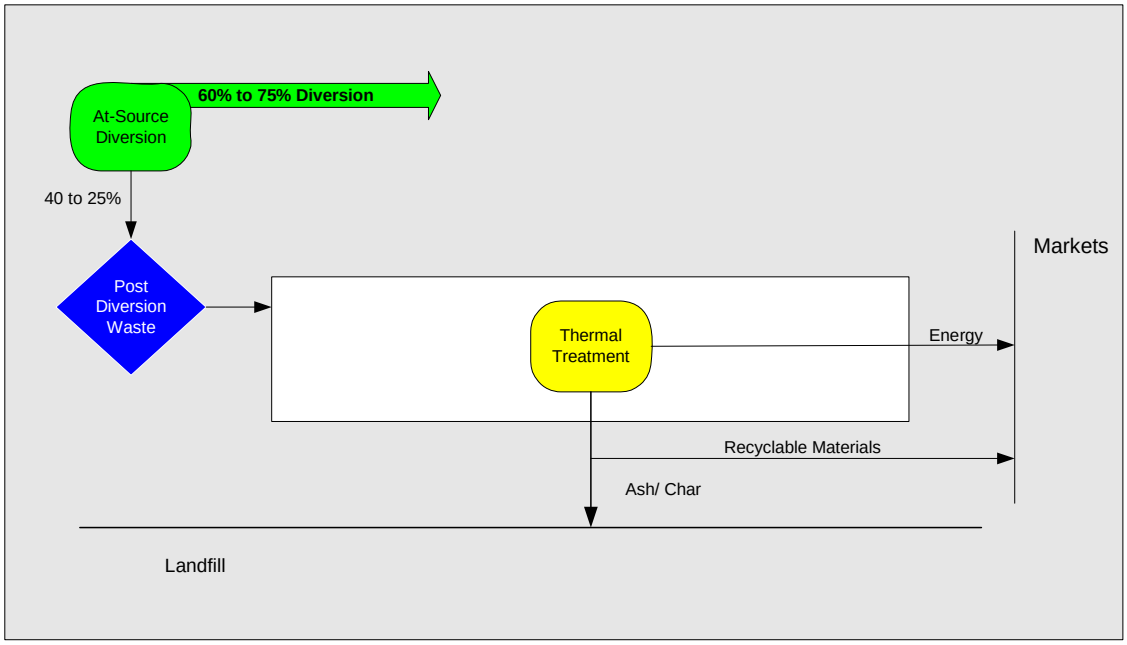
Criterion	*Indicator*	*System 1* *Mechanical, Biological Treatment with Biogas Recovery*	*System 2 (a)* *Thermal Treatment of MSW & Recovery of Materials from Ash/Char*	*System 2 (b)* *Thermal Treatment of Solid Recovered Fuel*	*System 2 (c)* *Thermal Treatment of Solid Recovered Fuel with Biogas Recovery*
Criterion 9: **Legal / contractual risks associated with waste management alternative.** ***(cont'd)***	**Degree to which system implementation and operation relies on private or public sector partnerships.**	***MAJOR DISADVANTAGE*** **Implementation:** • MBT technologies are largely proprietary and will likely require some form of contractual arrangement with the private sector vendor(s) for implementation. • System requires considerable landfill disposal capacity that must be obtained through contract with a third party. **Operation:** • Assumed in evaluation operation of MBT facilities is contracted out to the private sector. However, the respective municipalities could operate publicly if the necessary staff were retained and trained on facility operations.	***DISADVANTAGE*** Implementation**:** • Thermal technologies are largely proprietary and will likely require some form of contractual arrangement with the private sector vendor(s) for implementation. **Operation:** • Assumed in evaluation operation of thermal facilities is contracted out to the private sector. However, the respective municipalities could operate publicly if the necessary staff were retained and trained on facility operations.	***DISADVANTAGE*** Implementation: • Thermal and MBT technologies are largely proprietary and will likely require some form of contractual arrangement with the private sector vendor(s) for implementation. **Operation:** • Assumed in evaluation operation of MBT/ thermal facilities is contracted out to the private sector. However, the respective municipalities could operate publicly if the necessary staff were retained and trained on facility operations.	***DISADVANTAGE*** **Implementation**: • Thermal and MBT technologies are largely proprietary and will likely require some form of contractual arrangement with the private sector vendor(s) for implementation. **Operation:** • Assumed in evaluation operation of MBT/ thermal facilities is contracted out to the private sector. However, the respective municipalities could operate publicly if the necessary staff were retained and trained on facility operations.
LEGAL CONSIDERATIONS	**OVERALL**	**MAJOR DISADVANTAGE**	**DISADVANTAGE**	**DISADVANTAGE**	**DISADVANTAGE**

ES-6 Recommendation on the Preferred System

Based on the consideration of relative advantages and disadvantages and environmental priorities identified above, the preferred long-term residuals processing system identified to manage the post-diversion or residual wastes is *System 2(a) – Thermal Treatment of MSW and Recovery of Energy followed by Recovery of Materials from the Ash/Char*. More specifically, System 2(a) entails the establishment of thermal treatment capacity to process the residual waste stream and recover energy, followed by the removal of materials that may be sold to market from the ash/char residue, and finally the landfilling of all process residues (non-combustible materials removed prior to treatment and the ash/char).

A more detailed description of the system, its individual components, and the need for a waste management hierarchy to support the continued improvement of waste reduction and at-source diversion performance prior to processing is provided in the main report. The flow of materials through System 2(a) is represented in Figure ES-1 below.

Figure ES-1 System 2(a) – Thermal Treatment of Mixed Waste with Recovery of Materials from the Ash / Char



Although System 2(a) has been recommended as the Preferred Long Term Residual Processing System, it is important to note that System 2(b) also exhibits an acceptable range of advantages and disadvantages.

For some of the criteria where System 2(b) did not rank equivalent to 2(a), (technical risks, costs and legal/contractual risks for example), the determination of the relative advantages and disadvantages was based upon the information that was readily available on both the mechanical and biological processes that are being used to recover solid fuel in other jurisdictions and on the thermal technologies that can process this fuel. Many of the technologies that could be used to thermally treat the solid recovered fuel (e.g., gasification) in System 2(b) are regarded as 'new

technologies', with active research and development, but are less proven than the technologies that are currently available to combust residual waste in System 2(a).

Should Durham and York Regions not meet their projected waste diversion targets within the currently planned timeframe, System 2(b) could be utilized to capture additional recyclables and compostables in the waste stream that have not been source separated by residents. This will contribute to the Regions' overall respective waste diversion rates.

It is therefore recommended that, pending the approval of System 2(a) as the preferred residuals processing system, the competitive process used during the evaluation of "Alternative Methods" (Sites) allow for the submission of proposals to implement both System 2(a) and System 2(b), and that the final decision on the technologies used to implement the preferred residuals processing system be based on the results of this competitive process.

ES-7 Results of Consultation on the Draft Report

With the receipt of the draft report by the Joint Waste Management Group on April 18, 2006 the following activities were undertaken prior to finalization of the report:

- The report was released to the public and government review agencies for a period of 30 days starting on April 19th, 2006 and ending on May 19, 2006.
- Notification was issued of the availability of the draft report by way of direct contact with the established public and government review agency list and by way of the website and local media for the general public.
- Copies of the draft documentation were forwarded to the public and government agencies in the established contact lists and copies were placed in the local libraries, municipal offices and on the study website for public review.
- Concurrent Public Information Sessions were held in both Durham and York during the evening of May 9, 10 and11th, 2006.
- A telephone poll was conducted by Ipsos Reid during the week of May 15th, 2006, reaching 200 individuals in Durham and 200 individuals in York to determine their support for the recommended residuals processing approach.
- The Joint Waste Management Group scheduled, advertised and held concurrent special meetings in both Durham and York during the day and evening of May 17th, 2006 to receive delegations from interested parties on the draft report and its results.
- Comments received during the draft report review period were documented and included in this final report in Annex F and comments received were considered and addressed, as appropriate, during finalization of this report.

The results of the consultative process indicate that:

- A significant majority (approximately 80%) of the public that participated in the consultative process agreed with the consultant's recommendation the preferred system is *System 2(a) – Thermal Treatment of MSW and Recovery of Energy followed by Recovery of Materials from the Ash/Char.* It was recognized that new technologies categorized in System 2(b) – Thermal

Treatment of Solid Recovered Fuel may ultimately offer important benefits and as a result the competitive process used during the evaluation of "Alternative Methods" should allow for the submission of proposals to implement both System 2(a) and System 2(b), with the final decision on the technologies used to implement the preferred residuals processing system being based on the results of this competitive process.

- Those that did not agree with the recommended preferred system generally supported increased diversion activities, including extended producer responsibility and expansion of the municipal diversion system. It is recommended that Durham and York continue to support a hierarchy of waste management practices whereby diversion is the priority and continues to manage an increasing percentage of the municipal waste stream over time with a diversion targets of 60% at the beginning of the planning period escalating to 75% towards the latter end of the planning period.

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1. Introduction

This report entitled ***Evaluation of "Alternatives To" and Identification of a Preferred Residuals Processing System*** has been prepared as part of the Durham-York Residual Waste Study and is intended to provide the results of this key and initial EA study task for consideration by the public, government agencies, other stakeholders and the Joint Waste Management Group. Portions of this report and the accompanying annexes are based on information and methodologies developed in the Niagara-Hamilton WastePlan Study.

1.1 Background

1.1.1 Durham and York Regions Waste Diversion Programs

The Region of Durham has programs in place for the source separation and diversion of both "Blue Box" recyclables and household organics. The Blue Box program is being expanded over the next few years to collect a wider range of materials and the source separated organics collection/composting program is being expanded to service the entire Region. In its December 1999 Solid Waste Master Plan, the Region adopted a diversion target for residential waste of at least 50% by 2007 or earlier. On April 14, 2004, Durham Regional Council adopted the position to increase waste diversion beyond 50%. In light of the province's policy initiative of "60% diversion by 2008" the Region will likely refine its diversion target to align with that proposed by the Province.

York Region has programs in place for the source separation and diversion of "Blue Box" recyclables and household organics. In July 2005, the Region opened a single-stream Blue Box recycling facility located in East Gwillimbury. This facility enables residents to put all recyclables into one Blue Box, eliminating the need for separating containers and fibres. The facility also allows residents to recycle approximately 25 items, including #1 to #7 rigid plastic containers, empty paint cans, and milk containers. Household collection of food waste began, as a pilot project in September of 2004, and is currently provided to approximately 67,000 households. Full implementation of household organics programs is expected to be completed by 2008. In light of the province's policy initiative of "60% diversion by 2008", York Region also anticipates aligning its diversion target with that proposed by the Province.

Despite expanded source separated diversion efforts, Durham and York continue to face the challenges of managing residual waste and require increased processing capacity in the near future.

1.1.2 Durham/York Residual Waste Study

Durham and York Regions have agreed to undertake a joint Residual Waste Planning Study. Both municipalities are in need of a local solution to manage the remaining solid waste after diversion (residual or post-diversion waste). The Regions are working to address the social, economic, and environmental concerns of residents through an Environmental Assessment (EA) Study, which will examine potential residuals processing alternatives.

Even with expansion of source separated diversion programs, Durham and York continue to face the challenges of managing residual waste. Both Regions face a shortage of available landfill capacity over the long term. In response to the closing of existing landfill sites and the inability to develop new landfill capacity in the GTA, Durham and York Regions, along with other GTA municipalities, were forced to enter into contracts for the "export" of their residential waste primarily to Michigan.

In response to this situation, the Regions want to implement, as quickly as possible, a Durham/York based solution that is socially and environmentally acceptable to both communities, that maximizes environmental protection and that fosters the wise management of potential resources, such as the recovery of additional recyclable materials from the residual waste which are currently lost by way of landfill in Michigan.

During the later half of 2005, the United States government initiated the process of passing legislation that, if successful, would prevent or severely inhibit Durham and York's current disposal arrangements with landfill sites in the State of Michigan. There is a reasonable likelihood that this legislation will be passed in 2006.

Durham and York recognize that the Province of Ontario doesn't have sufficient energy to meet its growing needs. Both Regions recognize that there is opportunity associated with the utilization of the waste stream as a fuel source to produce energy and have identified this opportunity as a key part of the subject EA Study.

1.1.3 Environmental Assessment (EA)

Since the adoption of the Environmental Assessment Act (EA Act) in the 1970s, the EA process has evolved into a study or decision-making process undertaken in consultation with interested parties including the public and other parties, that evaluates alternatives considering potential effects on the environment, the availability of mitigative measures that address, in whole or in part, these effects and the comparison of the advantages and disadvantages of the remaining or "net" effects. The result of this process is to provide the planning rationale and support for a preferred solution.

The EA Study provides a planning approach where environmental constraints or opportunities are considered in the context of the broadly defined environment (i.e., the natural environment as well as the social, economic and heritage "environments") and potential effects are understood and addressed before development occurs.

All public sector (i.e., provincial or municipal) undertakings that have the potential for significant effects in terms of their scope are generally subject to the EA Act and must apply for approval from Ontario's Minister of the Environment. With respect to waste management, certain types of waste management undertakings require approval under the EAA. In general, approval under the EAA is required for the establishment or the expansion of a waste disposal or processing facility.

Under the EA Act, an Environmental Assessment (EA) Terms of Reference must be prepared and submitted to the Minister of the Environment for approval before an EA Study can be undertaken. The purpose of the EA Terms of Reference is to describe in a clear and concise manner the purpose of the proposed undertaking and how the proponent intends to carry out an environmental assessment in respect of the proposed undertaking. The EA Terms of Reference, once finalized and approved by the Minister of the Environment, becomes the guiding document for the completion of the environmental assessment study and the EA documentation.

On March 31, 2006, the Durham/York Residual Waste EA Terms of Reference was approved by the Minister of the Environment. The approved EA Terms of Reference identifies a process, consistent with the requirements of the EAA that will be followed by Durham and York to identify a long-term residual waste processing system and site(s). The EA Terms of Reference describes the following key elements related to the EA study:

- the proponents completing the EA study;
- the purpose and description of the undertaking that will result from the EA study;
- the range of alternatives to be evaluated as part of the EA study;
- the environment that may potentially be affected by the undertaking;
- the step-by-step methodology and an initial set of criteria to be applied to evaluate the alternatives; and
- a plan for consulting with the public and other stakeholders during the EA study.

Durham and York are following the process described in the approved EA Terms of Reference. A copy of the approved EA Terms of Reference document may be obtained from the study website, www.durhamyorkwaste.ca and is included as Annex A of this document.

1.1.4 Purpose of the Undertaking

An 'Undertaking' is a project or facility that is subject to an environmental assessment.

The purpose of the Durham/York Residual Waste Study Undertaking is:

> *To process - physically, biologically and/or thermally - the waste that remains after the application of both Regions' at-source waste diversion programs in order to recover resources - both material and energy - and to minimize the amount of material requiring landfill disposal.*
>
> *In proceeding with this undertaking only those approaches that will meet or exceed all regulatory requirements will be considered.*

1.1.5 Consideration of Alternatives

The Residual Waste Study EA Terms of Reference identifies two types of alternatives to be evaluated during the EA study. The first are referenced as **"Alternatives To"** the undertaking and include fundamentally different approaches to managing post-diversion waste.

Recognizing the priority afforded by both communities to waste diversion, additional at-source diversion has been evaluated separately and preceding the evaluation of other alternatives to confirm the quantity and types of waste requiring management by a future Durham / York residual waste processing system.

During development of the EA Terms of Reference, consideration was given to a range of reasonably available alternatives with regards to suitability and applicability to Durham and York resulting in identification of the following system components:

- Mechanical Treatment;
- Biological Treatment; and
- Thermal Treatment.

As part of the Residual Waste Study, alternative processing systems comprised of these components were formulated and evaluated.

The second type of alternative to be evaluated are referenced as **"Alternative Methods"** and include alternative ways or methods of implementing the preferred "Alternative to", in this case, the preferred alternative residuals processing system. With waste management related undertakings, the consideration of "Alternative Methods" typically involves an evaluation of alternative sites for establishing waste management facilities. Depending on the scope and types of sites being considered, some EA studies may also evaluate alternative facility design and operational aspects.

The approved EA Terms of Reference provides a proposed site selection process for facilities required as part of the preferred long-term processing system. The site selection process will evaluate a range of siting opportunities identified in areas considered suitable for the establishment of a waste management facility. The types of opportunities considered and the nature of areas considered suitable for the siting of a waste management facility will depend on a number of factors, including the types of technologies being sited.

1.1.6 Rationale for Excluding Landfill Only Systems from Further Consideration

The intent of the Durham York Residual Waste EA is to identify a preferred long-term alternative that maximizes the recovery of resources and minimizes the reliance on landfill as a primary method of disposal. Landfill facilities will be assumed to continue to play a role for the disposal of certain materials that cannot be otherwise processed or diverted. It is anticipated that landfill capacity will be provided via a partnership with a neighbouring municipality or purchased from the private sector. The acquisition of this disposal capacity is outside the scope of this Environmental Assessment.

A landfill only system, whereby a new landfill site capable of managing all waste that remains after at-source diversion would not meet the proposed purpose of the undertaking, and thus will not be considered in this EA Study. Rationale for the exclusion of this option was provided in Background Document 2-1[1] for the EA Terms of Reference and is expanded upon as follows:

- Historically both Durham and York were hosts to large landfill sites, Brock West in Durham and Keele Valley in York. These facilities created nuisance effects and significant social impacts within their host communities. As a result of this negative experience there is a very strong opposition to landfill in certain parts of Durham and York.

- Durham and York Regions have had the experience over the past 20 to 25 years, of being responsible for or being the subject of various landfill siting initiatives, including (but not limited to) contingency landfill siting (in the late 1990's), the Toronto SWEAP and the Provincial IWA processes. None of these initiatives resulted in the successful approval of landfill capacity located within either regional jurisdiction.

- During the landfill siting initiatives noted above, there was well-organized opposition throughout all phases of the siting process. The identification of landfill sites within the rural agricultural land-use areas of both Durham and York has met with this opposition due to well-developed concerns from the landowners and ratepayers that could be affected by the proposed sites.

- Over the past few years, given concerns regarding the use of land within the GTA at a provincial level, two different initiatives have resulted in the development of barriers within both Durham and York to the siting of landfills.

  Firstly, the Oak Ridges Moraine (ORM) Conservation Act, 2001, establishes the regulatory basis for the Oak Ridges Moraine Conservation Plan. The purpose of this Plan is to provide direction to agencies, municipalities and other stakeholders regarding land use planning and resource management initiatives within the defined ORM area. The Plan divides the ORM area into four land use designations: "Natural Core Areas", "Natural Linkage Areas", "Countryside Areas" and "Settlement Areas". The ORM affects land use planning within a large portion of both Durham and York Regions, the net effect of which in landfill facility siting would be to largely exclude the area affected by the ORM from consideration.

  Secondly, the Greenbelt Protection Act, 2003, provides the legislative context for the Greenbelt Plan, which was released in February 2005. The Plan defines the limits of and articulates policies for a "greenbelt area" within the Greater Golden Horseshoe of southern Ontario. The Plan identifies where urbanization should occur so as to protect agricultural lands and ecological features within the defined area. The Plan, in part, establishes a "Protected Countryside" designation that is intended to enhance the spatial extent of protected agricultural and ecological lands currently defined within the Oak Ridges Moraine Conservation Plan (ORMCP) and the Niagara Escarpment Plan (NEP) while establishing improved linkages between these two policy areas and the surrounding major lake systems

[1] Background Document 2-1 Purpose and Need for the Undertaking, Durham/York Residual Waste Study, December, 2005

and watersheds. The majority of the land area within Durham and York that lies outside of existing urban boundaries for both municipal jurisdictions is located within the "greenbelt area". While the act includes exemptions for necessary infrastructure, in reality it would be extremely difficult to consider lands within the "Protected Countryside" for landfill siting.

- Durham and York Regions are both currently dependent on the export of waste outside the Province of Ontario, to landfill facilities located in the U.S. for the disposal of most of the landfill capacity required by both jurisdictions. Due to the current political environment in Michigan and increasing resistance in the USA to accept out-of-country waste, it has been increasingly apparent that continued dependence on waste export to landfills outside Ontario is not a sustainable practice. Various restrictions have been put in place by the State of Michigan in the past three years to reduce the flow of waste across the Canada/USA border. Legislation has been developed in the USA to further limit waste imports from Canada by requiring that the EPA implement and enforce the Bilateral Agreement both countries signed in 1992, and to give the State Governments the authority to regulate foreign waste imports until US EPA regulations have been implemented. The State of Michigan has legislation in place that could close the border to Canadian waste if the federal legislation giving them the required power is enacted.

- There is insufficient landfill capacity within the province of Ontario for disposal of residual waste managed by municipalities and the Industrial, Commercial & Institutional waste stream (IC&I waste) that is largely managed by the private sector in the province. Recent reports issued by the Ontario Waste Management Association have projected a significant and continued deficit over time in the amount of annual landfill capacity required to manage all of the waste generated in the province and the amount of landfill capacity available at current approved sites and that could be made available through proposed site expansions.

- The results of consultation in both Durham and York during the preparation of the EA Terms of Reference (see EA Terms of Reference Consultation Record, Summary of Consultation on "Alternatives To") and consultation undertaken in regards to the formulation of alternative systems (see Annex B of the Report on Evaluation of Alternatives to and Identification of a Preferred Disposal System) indicate public support for minimizing the role of landfill in future disposal systems, and the need or preference to recover resources that remain in the residual waste stream.

- In Europe the negative effects of landfilling untreated residual wastes have been recognized. The EU Landfill Directive calls for a phasing out of the landfill of untreated waste in member countries. Under the directive, acceptable treatment approaches include both biological and thermal treatment. In some northern European nations, such as Sweden, waste management policy has been integrated with renewable energy policy and the landfilling of combustible material is banned. Significant environmental analysis underlies these policies and provides a further rationale for excluding a landfill only alternative.

Given the above, the focus of this EA as expressed in the purpose of the undertaking, is to minimize the reliance on landfill within the waste disposal system for both municipalities, and

recover both material and energy resources from the residual waste stream that remains after diversion.

However, it is recognized that each of the component alternatives will generate to some degree process residues that will require landfill disposal. The key in the identification of viable system outputs and system configurations is to minimize this landfill requirement. Landfill as it pertains to the development and siting of a facility, will not be considered as a component in the systems, rather the need for the landfill disposal of process residuals will be identified and considered in system evaluation.

1.2 Purpose of this Report

This report has been prepared to present the results of the evaluation of "Alternatives To", which is the first major step in the Durham/York Residual Waste Study. "Alternatives to" are defined as fundamentally different ways of managing waste and achieving the purpose of the undertaking or study. The purpose of the undertaking from the approved EA Terms of Reference is:

> ***"To process - physically, biologically and/or thermally - the waste that remains after the application of both Regions' at-source waste diversion programs in order to recover resources - both material and energy - and to minimize the amount of material requiring landfill disposal.***
>
> ***In proceeding with this undertaking only those approaches that will meet or exceed all regulatory requirements will be considered."***

The result of the initial EA step – identification of a preferred long-term residuals processing system for Durham and York - is presented as a recommendation from the consultant team's consideration of each systems advantages and disadvantages and environmental priorities established by the communities of Durham and York and is supported by the results of public and agency consultation.

1.3 Overview of Report Content

This report provides the relevant background and the step-by-step results of the "Alternatives to" evaluation process leading up to the identification and description of the preferred long-term residuals processing system for Durham and York Regions'. The report has been structured such that, depending on the needs or interests of the reader, the entire process can be reviewed at varying levels of detail. The following are the key components comprising this report:

Executive Summary

An executive summary has been prepared which presents the highlights and key findings of the evaluation process and which culminates with the presentation of next steps. The executive summary is included at the front of the report and has also been prepared as a separate document for wider distribution.

Main Report

The main report contains the detailed documentation of the process flowing from start to finish. It includes the following sections:

- **Section 1** provides relevant background and an overview of the report purpose, structure and content.
- **Section 2** describes the seven-step methodology and public and agency consultation program followed to evaluate "Alternatives to".
- **Section 3** provides the results of Step 1 of the evaluation methodology – confirmation of evaluation methodology and criteria. This section describes the outcomes of public workshops and polling applied to confirm the scope of comparative considerations and the environmental priorities of the study area community.
- **Section 4** describes how alternative disposal systems were developed at Step 2, the systems developed, and the results of consultation confirming the scope of systems to be evaluated. Also included in this section is an overview of the assessment of potential additional at-source diversion, which was undertaken prior to determining the extent of disposal system requirements.
- **Section 5** overviews the scope of baseline studies completed at Step 3 to define the existing environment in the study area that may be impacted by an undertaking.
- **Section 6** describes the results of Steps 4, 5 and 6, which entailed applying the comparative criteria to the alternative systems, considering the availability of mitigation to off-set identified effects and identification of residual or net effects upon which the systems would be compared.
- **Section 7** describes the advantages and disadvantages for each system identified from the comparison of net effects at Step 7, and describes the results of public consultation confirming the scope of system advantages and disadvantages to be considered in selection of a preferred system.
- **Section 8** describes in more detail the preferred system, the roles of its various components and some initial considerations for implementation of the system.
- **Section 9** describes the results of the consultative process used to seek input on the draft report issued on April 18th, 2006 that described the consultant's conclusion on the preferred residuals processing system.
- **Section 10** describes the steps that would be followed to seek approval from the Councils from Durham and York Regions for the recommended alternative residuals processing system and for proceeding with the next major step in the EA process being the evaluation of "Alternative Methods".

Also included with the main report are a series of appendices (**Appendices 1 to 3**) that provide additional background, detail and data directly related to the materials discussed in Sections 1 through 9.

Annexes

Under separate cover from the main report are a series of annexes, which are referenced throughout the discussion of the "Alternatives to" evaluation results. The materials in the annexes are primarily reports prepared containing background studies, which provide the detailed calculations, and rationale for certain results or assumptions applied in the evaluation process. The subject matter covered by the various annexes is summarized as follows:

- **Annex A** includes the provincially approved Environmental Assessment Terms of Reference.
- **Annex B** includes reports on the results of Step 1 (evaluation methodology and criteria) consultation with the public and review agencies.
- **Annex C** includes detailed reports related to the results of Step 2 (alternative system development) and on the results of consultation at that step.
- **Annex D** includes the detailed background reports on the various components of the environment potentially affected (Step 3).
- **Annex E** includes detailed supporting technical documents related to the alternative system 'net effects analysis' (Steps 4, 5 and 6).
- **Annex F** Includes a report on the results of Step 7 (identification of preferred system – draft report) consultation with the public and review agencies.

1.4 Glossary of Terms

A glossary of terms and abbreviations that are expected to be frequently used over the course of the EA Study is included in Appendix 1. This glossary will be continually updated over the course of the study.

2. Overview of Approach for "Alternatives to" Evaluation

2.1 Evaluation Methodology

The evaluation of alternatives to manage the waste remaining after diversion ("alternatives to" the undertaking) involved a comparison of the advantages and disadvantages associated with each alternative, which were defined using a net effects analysis. Specifically, the seven (7) step methodology identified in the approved EA Terms of Reference and used in the Durham/York EA study are described as follows:

Step 1 Prior to initiation of the evaluation of "Alternatives To", the proposed evaluation methodology and criteria were reviewed in consultation with the public and agencies. This review sought additional input on the proposed evaluation steps and evaluation criteria presented in the EA Terms of Reference and sought to confirm the relative priorities to be considered during the evaluation.

Step 2 The component alternatives were assembled into alternative residuals processing systems with each system being capable of managing the entire projected residual waste stream.

Step 3 Data collection was undertaken for the purpose of applying each of the comparative evaluation criteria to each of the alternative residuals processing systems. The proposed system comparative evaluation criteria were included in Appendix "E" – Table E-1 of the approved EA Terms of Reference and confirmed in Step 1 above.

Step 4 The comparative evaluation criteria were applied to each of the alternative residual processing systems and potential effects were identified.

Step 5 Each of the potential effects identified at Step 4 were considered with respect to the availability of measures to mitigate (i.e., measures that may be applied to reduce or eliminate a negative potential effect) or enhance (measures that may be applied to improve or increase the magnitude of a benefit or positive effect) the effects, resulting in the identification of the remaining effects or 'net effects'.

Step 6 The net effects associated with each residuals processing system under each comparative criterion were compared and a list of relative advantages and disadvantages associated with each alternative processing system developed.

Step 7 The relative advantages and disadvantages of each alternative residuals processing system were considered in the context of priorities established in consultation with the public and agencies and the preferred system selected. The preferred system is the one exhibiting the preferred balance of advantages and disadvantages accounting for the significance of environmental categories and criteria established in consultation with the public and agencies.

The results of these seven (7) steps are presented in Sections 3 through 8 of this report with additional detail provided in Annexes B through E to this report.

2.2 Public and Agency Consultation, Preparation of Draft Report

The approved EA Terms of Reference includes a consultation plan that identifies points in the study where the public and agencies are to be contacted for consultation, as well as who will be contacted and how consultation will be approached. With regards to the evaluation of "Alternatives to", the following project milestones involved public and/or agency consultation.

- EA study initiation and review of evaluation methodology and criteria (Step 1);
- Evaluation of "alternatives to" the undertaking including development of the alternative processing systems (Step 2); and,
- Identification of the preferred residual waste processing system (Step 7).

At Step 1 of the evaluation of "Alternatives to": *Confirmation of Evaluation Methodology & Criteria*, public and agency input was requested in order to review and confirm the environmental priorities and the range of alternative systems to be evaluated. This step involved the following activities:

- Distribution of a questionnaire at Public Open House Events, with a total of 83 respondents;
- Distribution of an online public opinion survey, with a total of 892 respondents (conducted by Ipsos Reid); and,
- Circulation of the draft criteria, along with indicators to be used in the application of criteria to review agencies in March 2006 with a request to review and provide comment if necessary.

The Public Open House events were held on March 7th, 8th and 9th in both Durham and York. The purpose of these events was two-fold. The first objective was to present for consultation the four (4) alternative systems to be evaluated, as well as the opportunity for additional at-source diversion measures and potential for resource recovery that will be considered with each. The second objective was to confirm public agreement with the range of alternative systems, and the evaluation methodology and priorities to be utilized in the evaluation of these four (4) systems. Open House attendees were requested to complete a questionnaire where they were asked whether they agreed with the range of alternatives systems, as well as to provide priority rankings for the five (5) environmental considerations.

Eighty-three (83) Open House attendees completed the questionnaire, all of which agreed with the range of alternative systems to be evaluated. Further detail on the open houses and results from the questionnaire are provided in Annex B to this report.

The public polling firm, Ipsos Reid, was retained to conduct an online public opinion survey of Durham and York residents. Public polling was conducted with the objective of including a broader population base in order that results could be considered representative of the full cross-section of the Durham and York populations. Similar to the open house questionnaire, the

survey asked respondents to rate the importance of the five (5) environmental categories. Overall, responses were received from 449 Durham residents and 423 York residents. The specifics of the public opinion survey and detailed results are provided in Annex B to this report.

The results of the open house questionnaire and public polling were combined to establish the relative priorities of each of the categories of the environment. Table 3-1 shows the priorities allocated to each of the five (5) environmental categories.

The Regions of Durham and York also distributed the proposed evaluation criteria and copies of the open house display panels to the Government Review Team (identified in consultation with the MOE during the review of the EA Terms of Reference) for review and comment.

3. Step 1- Confirmation of Evaluation Methodology & Criteria

3.1 Development of Methodology & Criteria

During the development of the evaluation methodology and criteria for "Alternatives to" the undertaking, the focus was on addressing the approval requirements of the Environmental Assessment Act. Accordingly, the following objectives needed to be achieved:

- Consideration of a broadly defined environment including aspects such as social/cultural, economic, and legal considerations in addition to the natural environment;
- Incorporation of a net effects analysis allowing for the consideration of mitigative and/or enhancement measures, if available, in the assessment of the range of alternatives;
- Identification of advantages and disadvantages to the environment to provide the basis for a decision on the preferred undertaking;
- Incorporation of meaningful opportunities for public consultation in the decision-making process;
- Results that reflect the priorities and address the significant issues of the study area community; and,
- Generation of results in a rationale, traceable and replicable manner.

The initial content of the "Alternatives to" evaluation methodology and criteria was developed early in the process of developing the EA Terms of Reference and has been refined since that time to reflect the input of the public and review agencies.

3.2 Establishment of Environmental Priorities

The environmental priorities, representative of the Durham and York communities were established in order to guide the evaluation of the alternative systems and were derived from the following three activities:

- Public Workshops held in the two communities on February 15th, 16th and 17th, 2005, which asked attendees for their opinions on priorities that should be considered in identification of a long-term processing system, during the development of the EA Terms of Reference;
- The results of questionnaires that were filled out by attendees of the Public Open Houses held during the evenings of March 7th, 8th and 9th, 2006, which asked attendees to rank the priority of each of five (5) environmental considerations as part of Step 1 of the Evaluation of "Alternatives to"; and,
- The results of an online public opinion poll conducted by a public polling firm in March 2006, which asked a representative sample of both Durham and York residents to rank the priority of each of five (5) environmental considerations.

The results of the above activities were combined in order to determine the overall relative importance of the environmental categories to be to be considered in the evaluation of "Alternatives to". These have translated to the assigned priorities presented in Table 3-1 below.

Table 3-1: Environmental Categories by Assigned Priorities

Environmental Category	Priority
Natural Environmental Considerations	Most Important
Social / Cultural Considerations	Important
Economic / Financial Considerations	Important
Technical Considerations	Important
Legal Considerations	Least Important

4. Development of Alternative Residuals Processing Systems

The Durham/York EA Terms of Reference determined that alternative systems would be established – each capable of managing all wastes requiring processing – and that the following approaches and technologies would be considered in the development of these systems:

- Mechanical Treatment;
- Biological Treatment; and,
- Thermal Treatment.

Additional at-source diversion was assumed to apply to all of the alternative systems examined in the Durham/York EA Study and was addressed through the development of a "Draft Report on Additional "At-Source" Diversion and Residual Quantities to be Managed" (Annex C-1).

Through the development of a report "Draft Report on Formulation of Alternative Residuals Processing Systems" (Annex C-2), the three technological approaches were reviewed for their potential to manage and recover resources from the waste that remains after at-source diversion. These three approaches were then assembled into functionally different processing systems. In total, four (4) alternative residual processing systems were developed for detailed evaluation.

4.1 Consideration of Additional "At-Source" Diversion

The "Draft Report on Additional "At-Source" Diversion" (Annex C-1) addressed:

- the examination of additional at-source diversion; and
- the projection of future waste quantities, waste diversion program performance and the composition of waste requiring management and disposal over the 35-year planning period from 2011 to 2045.

As noted above, additional at-source diversion applies to all of the alternative systems, such that only the remaining residual waste will require management by the alternative residuals processing systems. The purpose of preparing this report was to:

- Provide an update on current waste diversion performance (as of 2004) for Durham and York;
- Review diversion practices from higher performing waste diversion programs around the world, including what is being achieved and the measures in place to achieve their diversion rates;
- Examine the concept/philosophy of "Zero Waste", what it means, and its applicability to Durham and York;
- Consider additional at-source diversion on a quantitative basis for Durham and York, based on municipal measures and policies, and examine the overall waste diversion potential for the two municipalities;

- Project recovery rates and the overall at-source diversion rate for both Durham and York reflecting the implementation of both municipalities' approved waste management plans that have been designed to achieve 60% diversion by 2011;
- Confirm the appropriateness of assuming increases in diversion targets over the planning period; and
- Project the quantities of materials generated, diverted and requiring disposal over the planning period for both municipalities on a material-by-material basis.

4.2 Overview of System Components

The three technological approaches capable of managing materials in the residual or post-diversion waste stream and used to formulate the alternative residuals processing systems include:

- **Mechanical Treatment,** which involves the physical processing of waste materials using equipment such as screens, conveyors and magnets to recover recyclable materials and prepare waste for further treatment or disposal.
- **Biological Treatment**, which involves the use of microorganisms such as aerobic or anaerobic bacteria to change the properties of the organic constituents of the waste stream. Essentially, biological treatment breaks down and stabilizes organic matter such as food waste and waste paper – both of which are predicted to remain in the residual waste stream but to a substantially lesser degree after curbside organics collection.
- **Thermal Treatment,** which includes approaches traditionally referenced as combustion, incineration, energy-from-waste (EFW), waste-to-energy (WTE), etc. or more contemporary /emerging technologies such as gasification or pyrolysis, in which the hydrocarbons in the waste stream are converted to thermal energy, carbon dioxide (CO_2) and water.

4.3 Approach to System Development

The systems development report in Annex C-2 expands on the information presented in the EA Terms of Reference and provides detailed information on the three technological components or 'building blocks' considered.

Those systems considered capable of addressing the purpose of the undertaking in a reasonable manner, as described in the approved EA Terms of Reference and which are functionally different from the other systems, are recommended for further consideration.

To address the purpose of the undertaking, the systems must:

- Recover materials from the residual waste stream;
- Recover energy from the residual waste stream; and,
- Minimize the amount of material requiring landfill disposal.

Descriptions of the following are provided:

- **Input materials** (i.e. what goes into the component). The input materials include the total post-diversion residual waste stream (see Draft Report on Additional At-Source Diversion), and/or the outputs from another process component depending on the process configuration.
- **Process description** (i.e. what goes on inside the component). The process description describes the different technologies that comprise the range of options for managing materials within the process.
- **Recovery of Resources** (i.e. the potential to recover resources). Resources include both recyclable materials and energy.
- **Outputs** (i.e. what comes out of the component). The outputs considered include:
  - Products, Resources and Materials (to be fed into other treatment approaches);
  - Air Emissions;
  - Water Discharges (Storm and Sanitary);
  - Solid Residues requiring disposal; and
  - Nuisance Effects.

These components, and the technologies that they comprise, could be combined in a multitude of different ways. Basing the system alternatives on specific combinations of these process components had the potential to lead to many system alternatives (i.e. too many systems to be considered functionally different). A more general approach was therefore adopted.

Different technologies can be used to recover different resources from the waste stream. These resources were identified and their viability was considered in the systems development report included in Annex C-2. Conclusions were reached regarding the viability of the identified resource recovery options. The resulting viable resource recovery options included the following products, resources and materials:

- Recyclable Materials for Markets;
- Energy (Heat and/or Electricity) produced from Biogas;
- Energy (Heat and/or Electricity) produced from a Solid Recovered Fuel; and
- Energy (Heat and/or Electricity) produced from Mixed Waste.

What followed was the development of alternative systems formulated on the basis of using the three specific technological components to recover various combinations of the resources identified above.

Some of the identified alternative systems were very similar and others offered minimal benefit. Based on the principal of "reasonableness" established during the preparation of the EA Terms of Reference, conclusions were reached regarding combining some of these alternatives as well as not considering other alternatives any further in the evaluation process.

Section 4.4 below describes the resulting four (4) functionally different system alternatives that were considered for detailed evaluation.

4.4 Description of Disposal Systems Evaluated

The resulting four (4) functionally different system alternatives carried forward for detailed evaluation are illustrated in the following Figures 4-1 to 4-4 and summarized in Table 4-1.

Figure 4-1: System 1 - Mechanical and Biological Treatment with Biogas Recovery

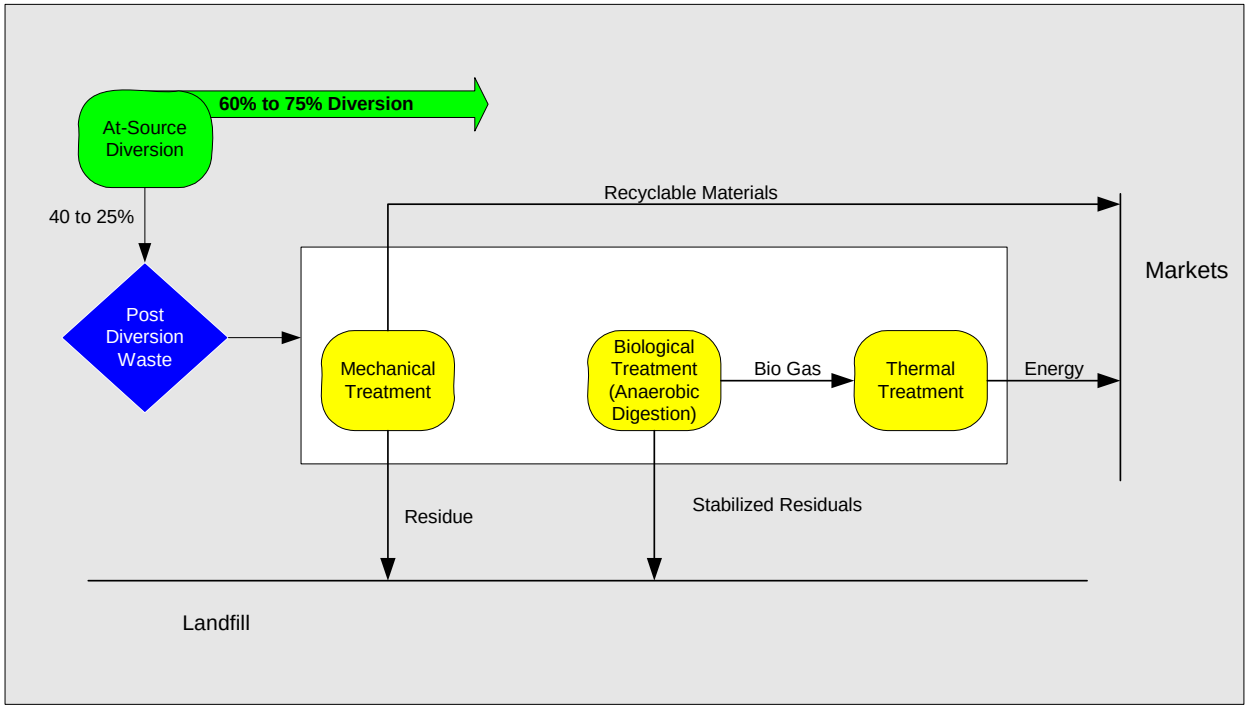


Figure 4-2: System 2(a) - Thermal Treatment of Mixed Waste with Recovery of Materials from the Ash / Char

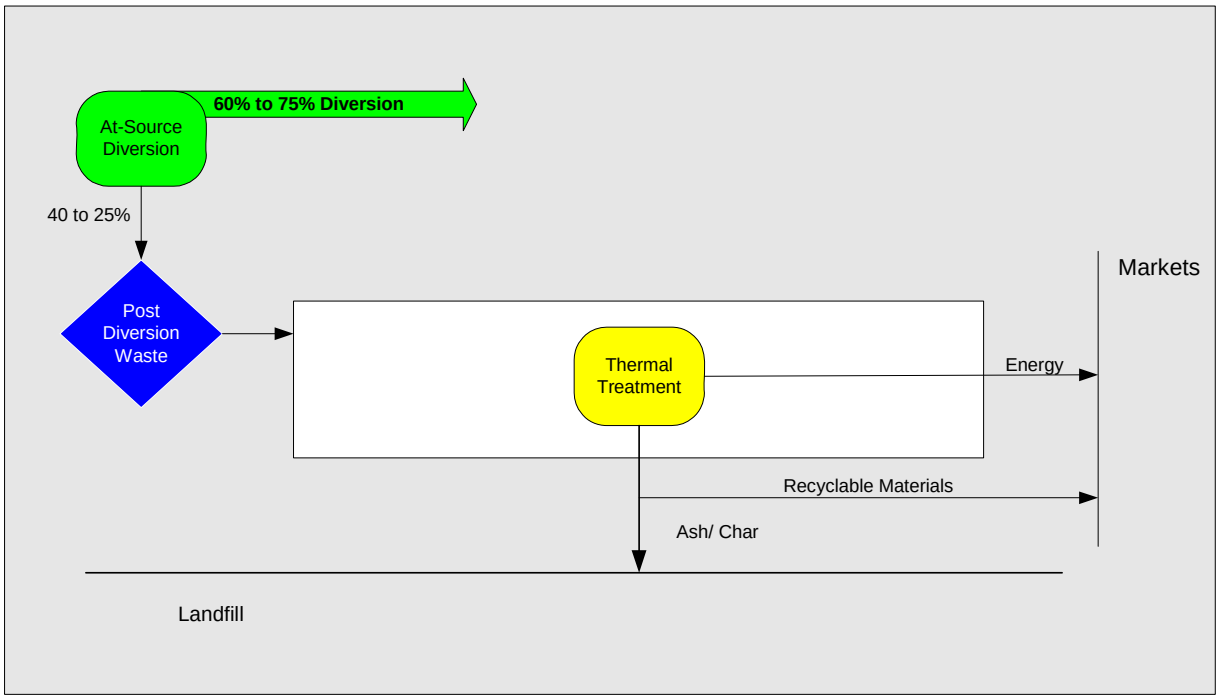


Figure 4-3: System 2(b) - Thermal Treatment of Solid Recovered Fuel

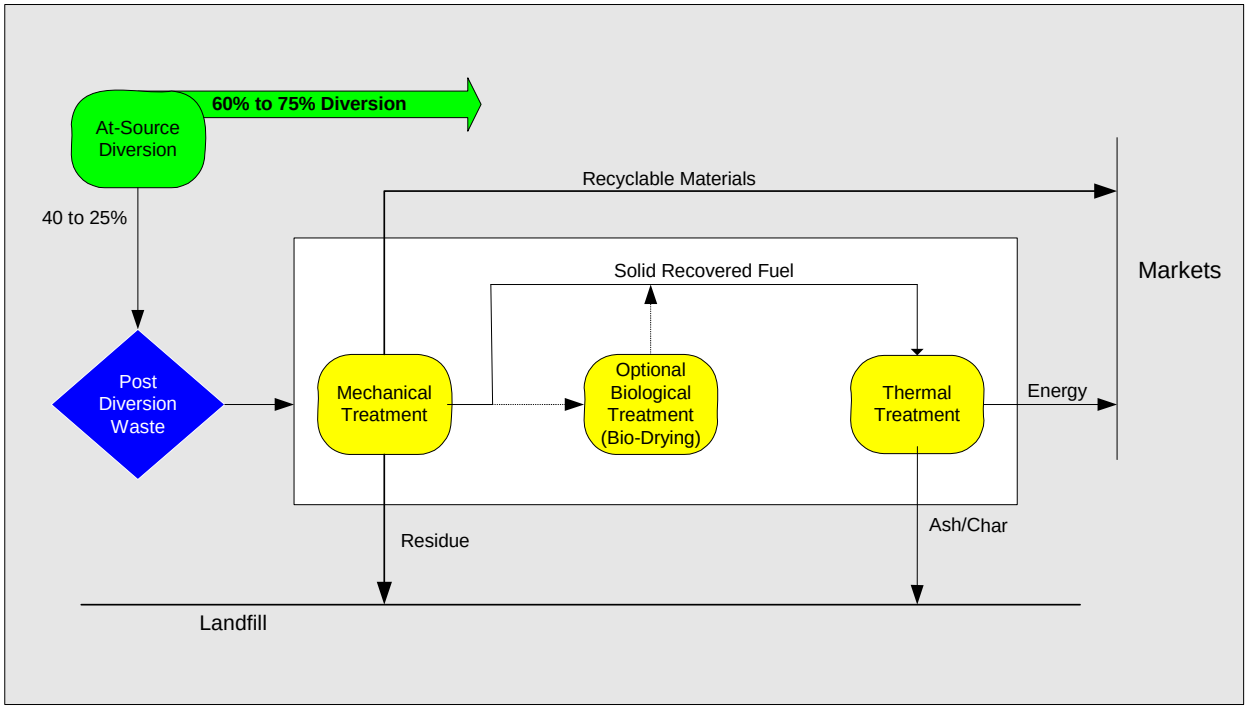


Figure 4-4: System 2(c) - Thermal Treatment of Solid Recovered Fuel with Biogas Recovery

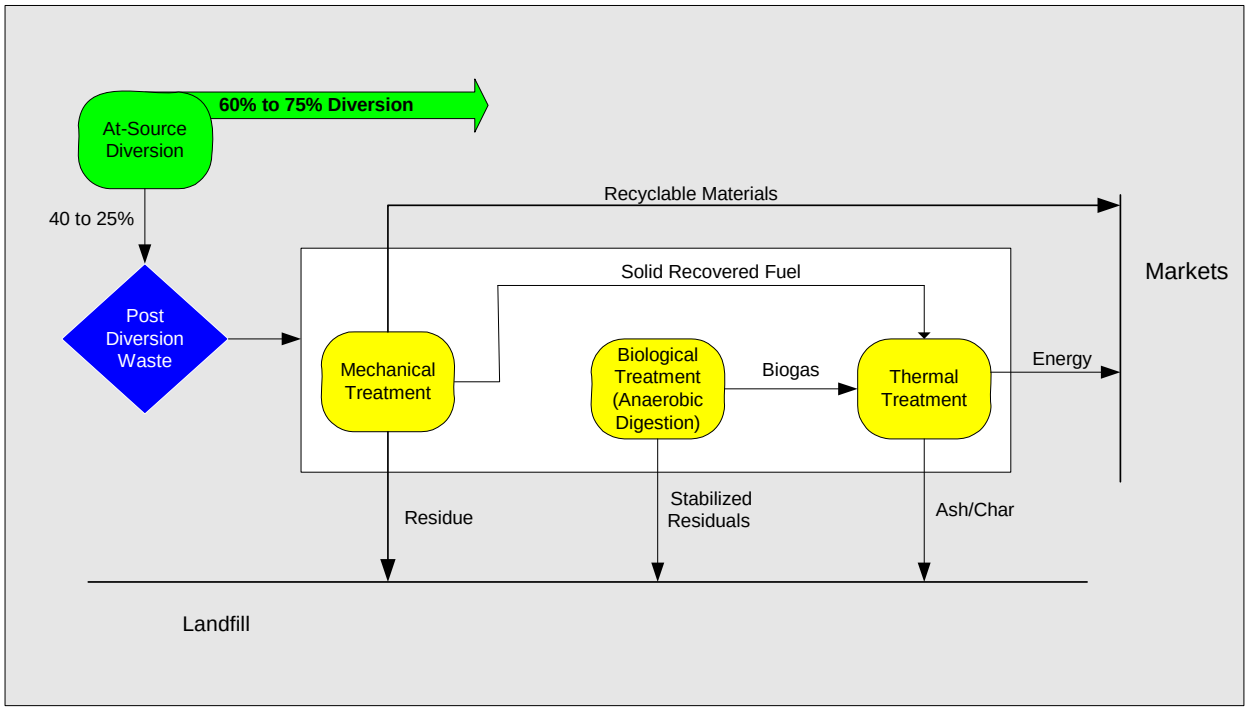


Table 4-1: Description of Alternative Systems Evaluated

Alternative Systems	System Reference	Potentially Recovered Resources				Residuals Management
		Recyclable Materials for Markets	Energy Produced from Biogas	Energy Produced from Solid Recovered Fuel	Energy Produced from Mixed Waste	Landfilling of Residuals
Mechanical Biological Treatment (MBT) with Biogas Recovery	**1**	●	●			●
Thermal Treatment of Mixed Waste with Recovery of Materials from the Ash/Char	**2(a)**	●			●	●
Thermal Treatment of Solid Recovered Fuel	**2(b)**	●		●		●
Thermal Treatment of Solid Recovered Fuel with Biogas Recovery	**2(c)**	●	●	●		●

5. Step 3: Data Collection on the Environment Potentially Affected and Technical Components of Alternative Systems

Step 3 of the "Alternatives to" evaluation methodology involved the collection of data to support the application of the established comparative criteria to the alternative systems. This included studies on both the environment potentially affected by the undertaking and on the technical components of the alternative systems. The following sections provide brief overviews of these studies.

5.1 Environment Potentially Affected

The definition of existing conditions originated during development of the EA Terms of Reference, which included a brief overview of the study area environment (see Section 5 of the EA Terms of Reference). The Definition of the "Environment Potentially Affected" expanded on this base of information to consider the scope of considerations for the alternative systems. Accordingly, the following studies were completed at Step 3 and are included in Annex D to this report:

Annex D-1 Report on Air Environment

This report discusses factors affecting ambient air quality; profiles emissions of contaminants of concern identified by various regulatory authorities; provides air quality monitoring results for contaminants of concern (where available) discusses some of the primary sources of air contaminants in the study area; and, compares ambient air quality in the study area to other areas in Ontario.

Annex D-2 Report on Terrestrial / Aquatic Environment

This report describes the physical and biological settings in the study area including descriptions of the geology and physiography, soils, hydrology, and climate characteristics. Terrestrial and aquatic biological features are also presented including information regarding vegetation, flora and wildlife. Areas with special natural heritage designations (e.g. Oak Ridges Moraine) are also identified.

Annex D-3 Report on Agricultural Environment

This report provides an overview of the agricultural land use patterns in the study area including conditions supporting farming operations and provides detailed information on farm characteristics, the types of commodities produced and the economic value of the agricultural sector. In addition, Durham and York's land use planning strategies for agricultural lands is described as is the Provincial Greenbelt Plan and its policies related to agricultural lands.

Annex D-4 Report on Social/Cultural Environment

This report discusses existing settlement and land use patterns in the study area as well as designations and policies in place to guide future development and growth patterns. Major land

uses and transportation corridors are defined both in terms of area, capacity and distribution. Population statistics and projections are also provided along with relevant demographic and employment data.

Annex D-5 Report on Legal/Jurisdictional Environment

This report describes the government structures associated with the two study area municipalities and explains how each manages the responsibility for and provision of waste management services. Relevant to the Durham/York EA study, an overview of the joint disposal study partnership agreement is provided as well as a description of applicable legislation and approval requirements.

5.2 Consideration of Environment Potentially Affected at "Alternatives To" Evaluation stage

Given that the evaluation of "Alternatives to" in the Durham/York study did not involve any siting considerations (at this point in the study), as is the case for many municipal waste management environmental assessments, and that most of the descriptive information is related to geography, the relevance of these studies tends to be limited to some very general considerations. The screening of the three (3) waste management technologies for feasibility, environmental suitability, and approvability occurred during the development of the EA Terms of Reference. The identification, therefore, of any existing background conditions that would preclude or severely disadvantage the establishment of any of the alternatives under consideration in the EA study was not expected. Notwithstanding, where possible, the studies were utilized during application of the comparative criteria at Steps 4 and 5.

The studies were completed with recognition that the next major step will focus on siting for the preferred system. With the selection of the preferred system and the confirmation of facility siting criteria, these studies will continue to be developed to a greater level of detail and will become much more relevant at this step.

5.3 Technical Components of Alternative Systems

In addition to the background studies defining the existing environment potentially affected, a series of technical background studies were undertaken to facilitate the application of several comparative evaluation criteria. These technical background studies are included in Annex E to this report and are briefly overviewed as follows:

Annex E-1 System Mass Balance and Diversion Estimates

This Report quantified the flow of materials into, through and out of each system and allowed for an estimate of diversion from disposal and diversion from landfill rates that could be achieved by each system. The diversion estimates were prepared based on current regulatory and market conditions in Ontario and likely trends to develop in the future. The results of this study were used directly to apply the Natural Environmental Criterion 4 (estimated diversion potential) and also factored into the life cycle environmental analysis and the estimation of land requirements completed for each system. They were also used in the preparation of cost estimates related to facility throughputs, revenues from recyclable materials, etc.

Annex E-2 Facility Land Requirements

This Report identifies the estimated area of land that would be displaced and potentially disrupted by each system. These estimates considered predicted throughput quantities associated with each system and assumed buffer requirements based on current waste management facility approval regulations, policies, guidelines and practices of the Province. The results of this study were used to apply Natural Environmental Criterion 1 and 3 and Social/Cultural Criterion 5 related to impacts on lands and land uses.

Annex E-3 Electrical Energy Balances

This Report provides the electrical energy balances associated with each of the alternative systems including:

- the gross electricity produced for those systems that produce electricity;
- the electrical energy consumed within the system facilities; and,
- the electrical energy available – both renewable and total - to be sold assuming that an electrical interconnection between the facility and the grid can readily be provided.

This information was used to apply the energy consumption / generation aspects of Natural Environmental Criterion 2 and to calculate energy revenues for consideration in applying Economic/Financial Criterion 7. Broader life-cycle considerations with regards to energy are addressed below in Annex E-5.

Annex E-4 System Financial Analysis and Cost Estimates

This Report provided the estimated costs of each alternative system on a cost/tonne-managed basis. The cost/tonne estimates include capital, operating and financing costs as well as revenues received from the sale of energy and recyclable materials. The costs are estimated in real terms (i.e. excluding inflation) at constant 2005 price levels. Two sets of estimates are provided for each item – one set prepared under a set of low cost assumptions and the other set under a set of higher cost assumptions. This information was used to apply Economic/Financial Criterion 7 (cost/tonne). The information on revenue amounts and sources was used to apply Economic/Financial Criterion 8.

Annex E-5 Environmental Life Cycle Analysis

This Report provided the estimated life cycle implications related to air, water and energy associated with the alternative waste disposal systems. The estimated life-cycle implications were primarily determined using the Integrated Waste Management (IWM) model developed by the University of Waterloo, on behalf of, the Corporation Supporting Recycling (CSR) and the Environmental and Plastics Industry Council (EPIC). All assumptions, inputs and outputs related to the model run for this study are rationalized and documented in the report. Estimates of greenhouse gas emissions were developed using a report prepared for Environment Canada by ICF Consulting entitled *"Determination of the Impact of Waste Management Activities on Greenhouse Gas Emissions: 2005 Update, Final Report"*. The results of this study were used to apply Natural Environmental Criterion 1 (global environmental burden) and the life-cycle energy aspects of Criterion 2.

Annex E-6 Generic Air Dispersion Modelling

This report provides a generic analysis of the impact of air emissions from a Municipal Solid Waste (MSW) thermal treatment facility (e.g., mass burn incinerator) on the air quality in the area surrounding the facility. This analysis is based on the possible emissions from a modern thermal treatment process with a state-of-the-art air pollution control system, designed to meet all Ontario regulatory requirements. In order to quantify the possible emissions from the facility, the facility is sized based on the envisaged Durham-York ultimate needs (400,000 tonnes per year capacity) and emission data obtained from thermal treatment technologies manufacturers.

The assessment of potential air quality impacts associated with the potential Durham-York MSW thermal treatment facility was conducted in accordance with the current Ontario Regulation 419/05. This report identifies the total expected air emissions of critical contaminants from a thermal treatment facility exhaust stack and compares the predicted ground level concentrations around a facility to applicable Ontario criteria. The results of this study were used in addressing issues raised during the consultative process on potential impacts of air emissions and to supporting discussions regarding the health risk assessments that will be undertaken later in the EA Study during the evaluation of "Alternative Methods".

6. Steps 4, 5 & 6 – Application of Evaluation Criteria

Steps 4, 5 and 6 of the evaluation methodology involved a 'net effects analysis' of the alternative residuals processing systems. A 'net effects analysis', which is a requirement of the Environmental Assessment Act, was identified in the step-by-step methodology (see Section 2.1 of this report) included in the approved EA Terms of Reference and involves the following:

- First, the comparative evaluation criteria (identified in Table 6-1 below) are applied to the alternatives and the range of potential effects resulting from this application are identified.
- Second, each potential effect is reviewed and a determination made as whether or not mitigative measures exist that could be applied to offset or eliminate the potential effect. In the case of a positive effect, enhancement measures may be considered to increase the benefit.
- Finally, the remaining, or 'net' effects are tabulated for consideration further in the evaluation process.

The intent of this exercise is to ensure that all alternatives are being reviewed in the context of best practices or best available technology – provided these measures are reasonably available and can be reasonably applied to the undertaking.

Table 6-1: Comparative Evaluation Criteria for "Alternatives to" the Undertaking

Evaluation Criteria	Indicators or Measures for Criteria Application
Natural Environmental Considerations	
Environmental burden at a global or macro-environmental scale, including impacts to air, land and water.	• Predicted emissions released to atmosphere by system
	• Predicted pollutants released to water resources by system
	• Need to manage residues classified as hazardous waste associated with system.
	• Impacts to land by system.
Consumption /preservation of non-renewable environmental resources.	• Potential of system to consume non-renewable fossil fuel or displace non-renewable fossil fuel consumption for energy generation.
Potential for destruction or disruption of sensitive	• Total Volume of Landfill Capacity Required to manage Post-Processing Residual Waste

Evaluation Criteria	Indicators or Measures for Criteria Application
terrestrial and/or aquatic habitats at an eventual site.	• Land use setting typically associated with establishment of facilities comprising system.
Potential to increase waste diversion rate and/or make best use of residual (post-diversion) waste materials.	• Potential of system facilities to remove any remaining materials in the post-diversion waste stream for use in a non-disposal manner.
	• Potential of system facilities to manage and make beneficial use of materials in the post-diversion waste stream including those materials for which diversion may decline or disappear in the future.
Social Cultural Considerations	
Potential for land use conflicts from siting of facilities required for alternative.	• Number of waste management facilities associated with alternative system.
	• Potential for land use conflicts considering location requirements of waste management facilities.
	• Types and degree of Nuisance Impacts associated with waste management facilities based on operational experience
Economic/Financial Considerations	
Net system costs per tonne of waste managed – in a systems context.	• Capital and operating costs over operational period of system (2011 to 2045). • Estimated costs associated with perpetual care of component facilities in accordance with current environmental and municipal accounting requirements. • Estimated revenues associated with system once fully implemented and operational. • Potential subsidies and revenues that may be realized during establishment and future operation of system.
Sensitivity of system costs and affordability to external financial influences.	• Types of revenues and subsidies currently available to offset system costs and predicted sustainability of these sources into the future. • Degree to which system affordability relies on revenues and subsidies during long-term operation of the system.

Evaluation Criteria	Indicators or Measures for Criteria Application
Technical Considerations	
Technical risks associated with waste management alternative.	• Flexibility of alternative system to changes in waste quantities, composition and availability of system diversion and disposal components.
	• Reliability of alternative system and component technologies and need for contingency landfill capacity.
Legal Considerations	
Legal/Contractual risks associated with waste management alternative.	• Types and complexity of approvals required implementing components of system.
	• Degree to which system implementation and operation relies on private or public sector partnerships.

6.1 Consideration of Potential Effects, Mitigation and Net Effects

The results of applying the comparative evaluation criteria and indicators are included in Appendix 3 of this report. The results included in the tables of Appendix 3 incorporate the consideration of mitigation and therefore can be considered net effects for the purpose of moving forward to Step 6 in the evaluation process.

As discussed at the beginning of this section, the intent of considering mitigation and enhancement measures is to ensure that alternatives are compared on the basis of best practices and best available technology. Given the systems-related nature of the current comparative exercise and the background associated with the identification of alternative system components and formulation of systems, all of the systems being considered and accordingly, all of the identified effects, are assumed to innately include all reasonably available mitigative measures. In particular:

- The screening of alternative waste management approaches for environmental suitability during development of the EA Terms of Reference established that any of the alternatives being considered at this point in the study must ***be able to meet or exceed all regulatory requirements*** and therefore be approvable under Ontario's stringent environmental legislation and standards;
- Similarly, sufficient operational data is available for existing state-of-the-art facilities and from that information this study was able to incorporate observed net or post-mitigation effects directly into the comparison;

- The cost estimates carried forward in the evaluation of alternative systems included unit costs associated with state-of-the-art facilities equipped with the best available pollution control equipment required to address Ontario's approval requirements; and,
- In considering the potential siting impacts of system facilities, appropriate buffer zones and land use preferences were incorporated into the comparative process.

Because the process of applying the evaluation criteria and identifying potential effects inherently incorporated mitigation (best practices and best available technology), the presentation of net effects in this comparative process did not warrant and did not include an effect-by-effect consideration of available mitigation.

6.2 Comparative Analysis of Alternative Systems Net Effects

Step 6 of the evaluation process focussed on the identification of relative advantages and disadvantages for each of the four (4) systems. These were identified based on the net effects for each system identified at Step 5 and a comparison of these net effects is intended to, in essence, establish a ranking of systems under each comparative consideration.

Where appropriate and to assist in understanding how the systems compared under the various evaluation criteria, a series of graphs have been prepared and are presented in Figures 6-1 to 6-7 following this section. Graphs were prepared for only those considerations that could be represented numerically. These include net life cycle air and water emissions, diversion from disposal and landfill, net system costs, life cycle energy conservation and generation, and area of land required for facilities. The process of establishing the rankings and respective graphs is described in the technical and background studies included in Annex E to this report.

It should be noted that in Figures 6-1 and 6-2, there are no units shown on the y-axis. This is because the graphs amalgamate the consideration of several different parameters using a range of units and orders of magnitude. The intent of the graphs is to show how the systems comparatively rank (e.g. best (lower) worse (higher) etc.). They should not be interpreted as a measure of the level of impact on the air or water environment.

For the remaining considerations that were more qualitative in nature (e.g. legal considerations), the relative system advantages and disadvantages are identified and discussed as part of the comparative evaluation presented in Section 7.

Figure 6-1: Relative Overall Emissions to Air including GHG

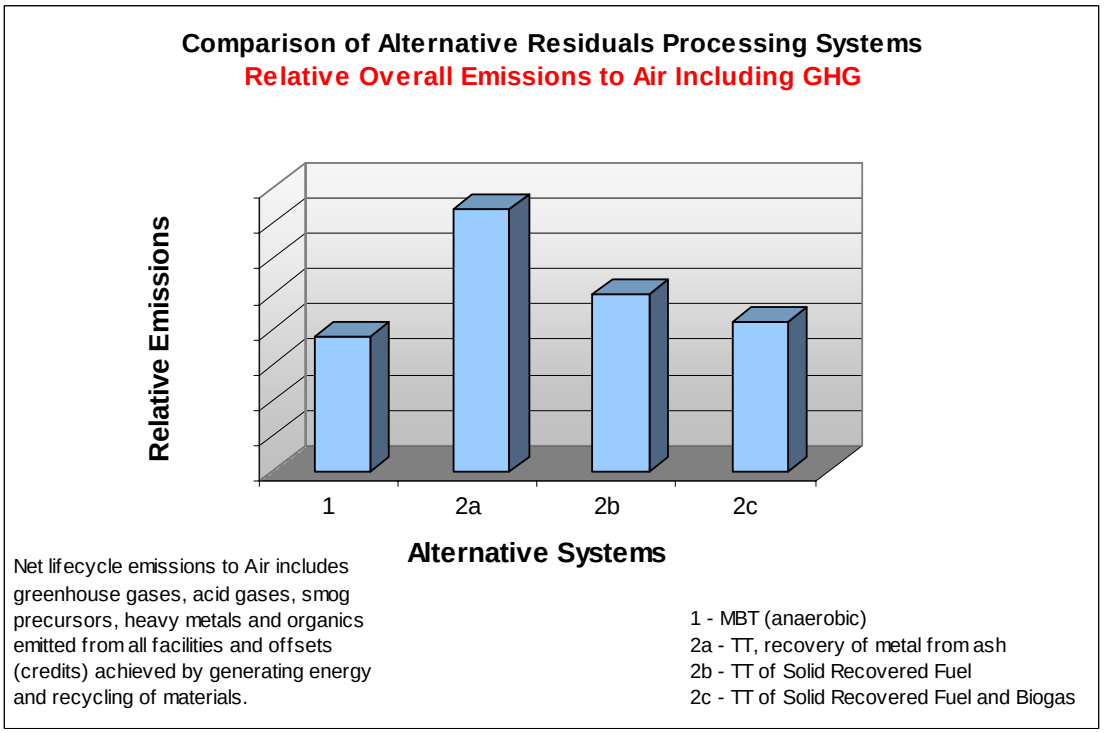


Figure 6-2: Relative Emissions to Water

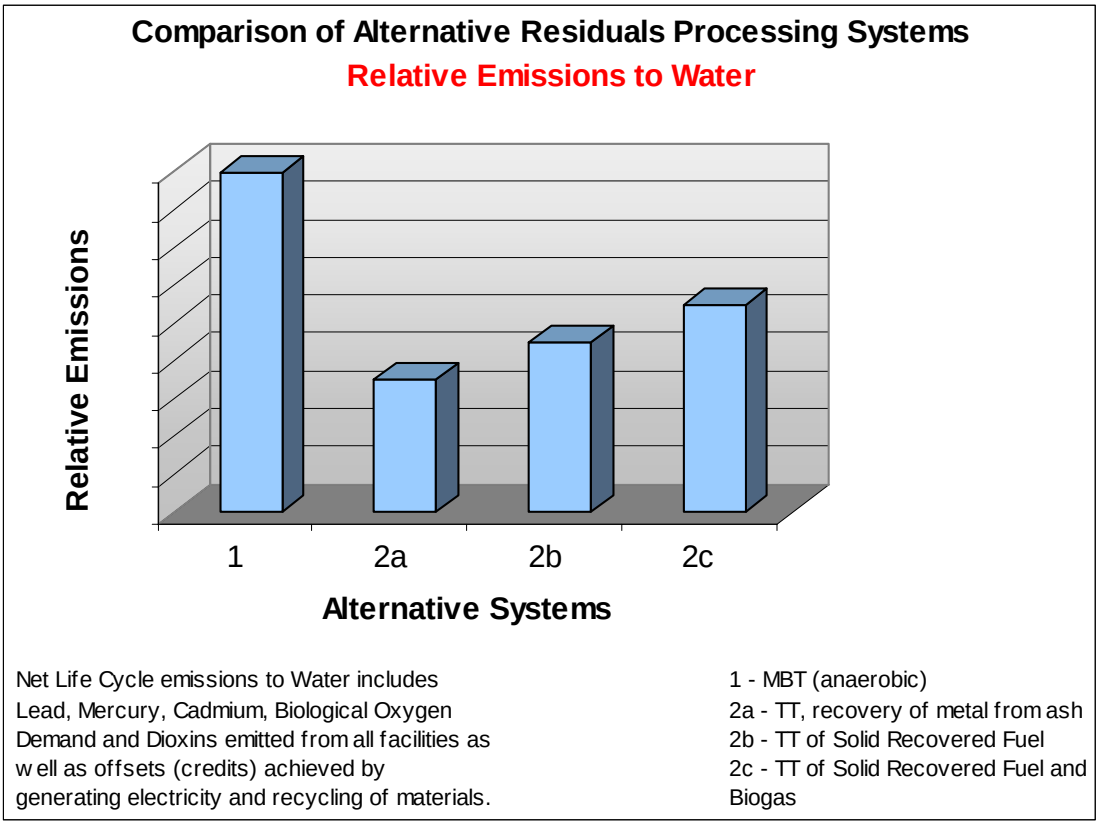


Figure 6-3: Land Air Space Requirements

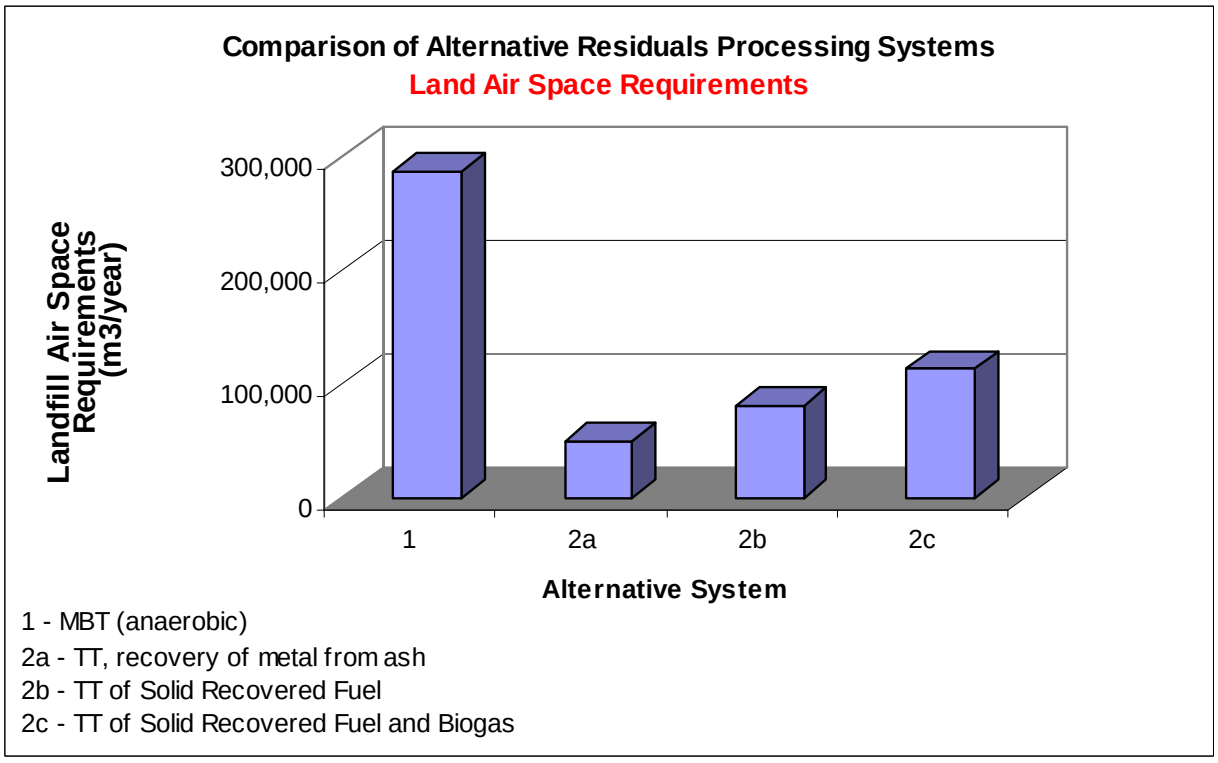


Figure 6-4: Net Life Cycle Energy Generation

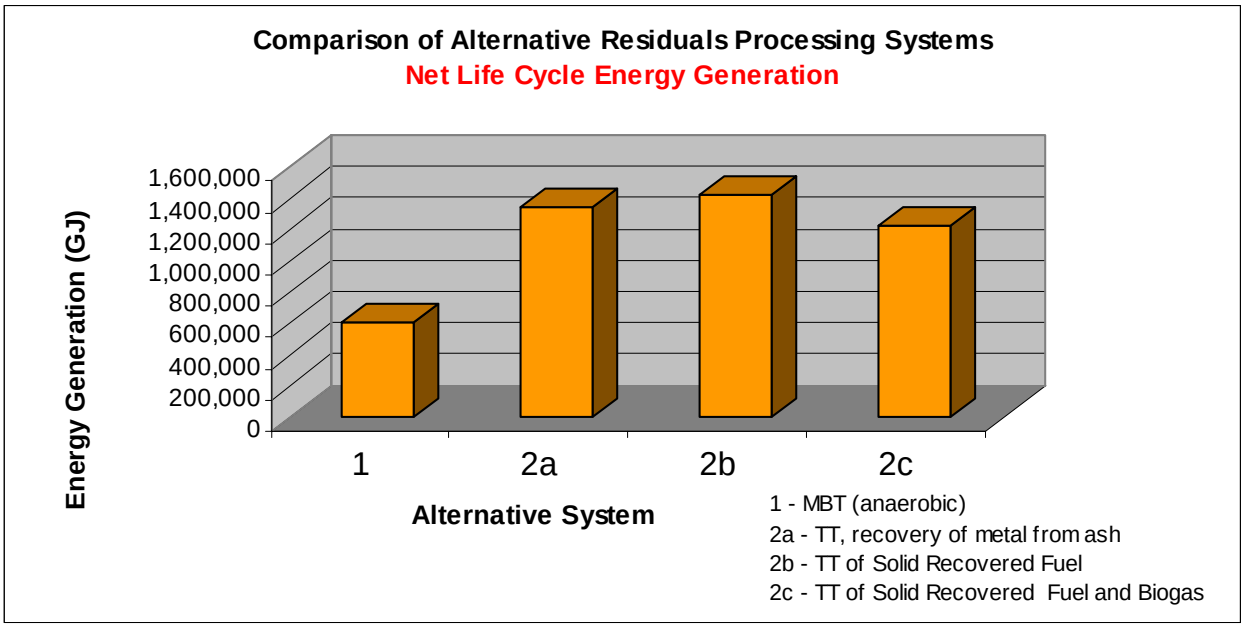


Figure 6-5: Household Energy Equivalencies

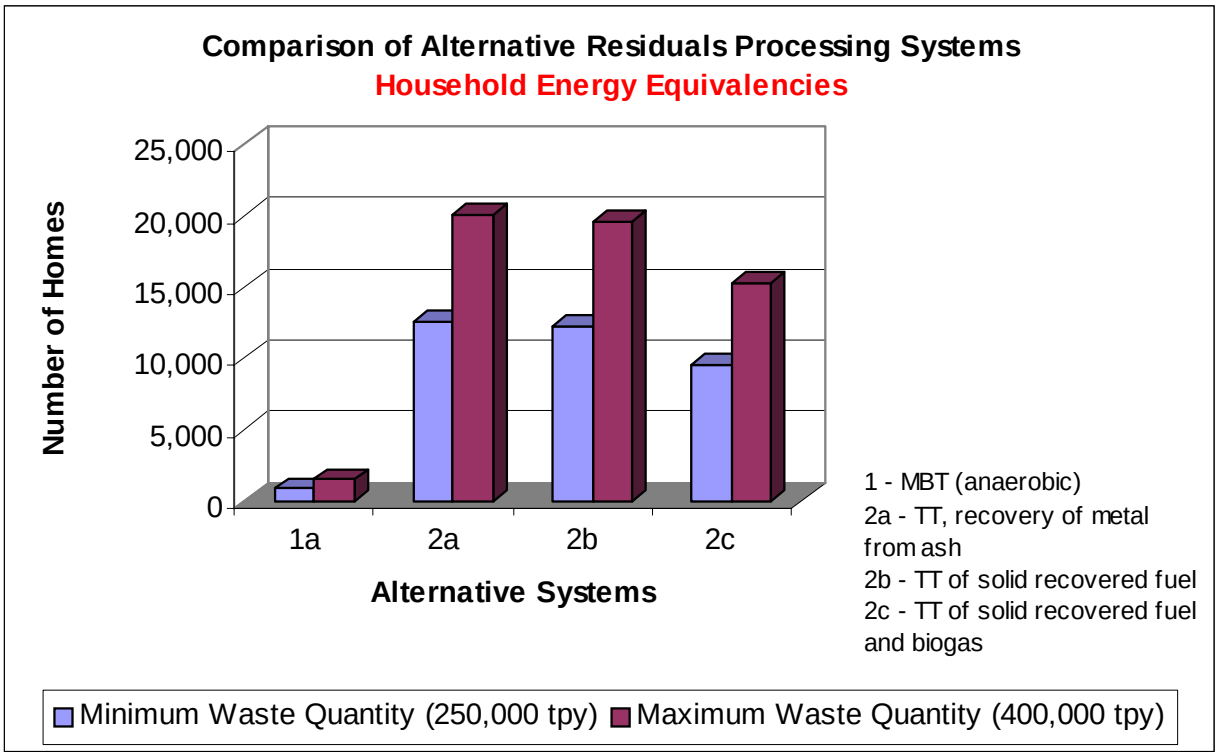


Figure 6-6: Diversion from Disposal

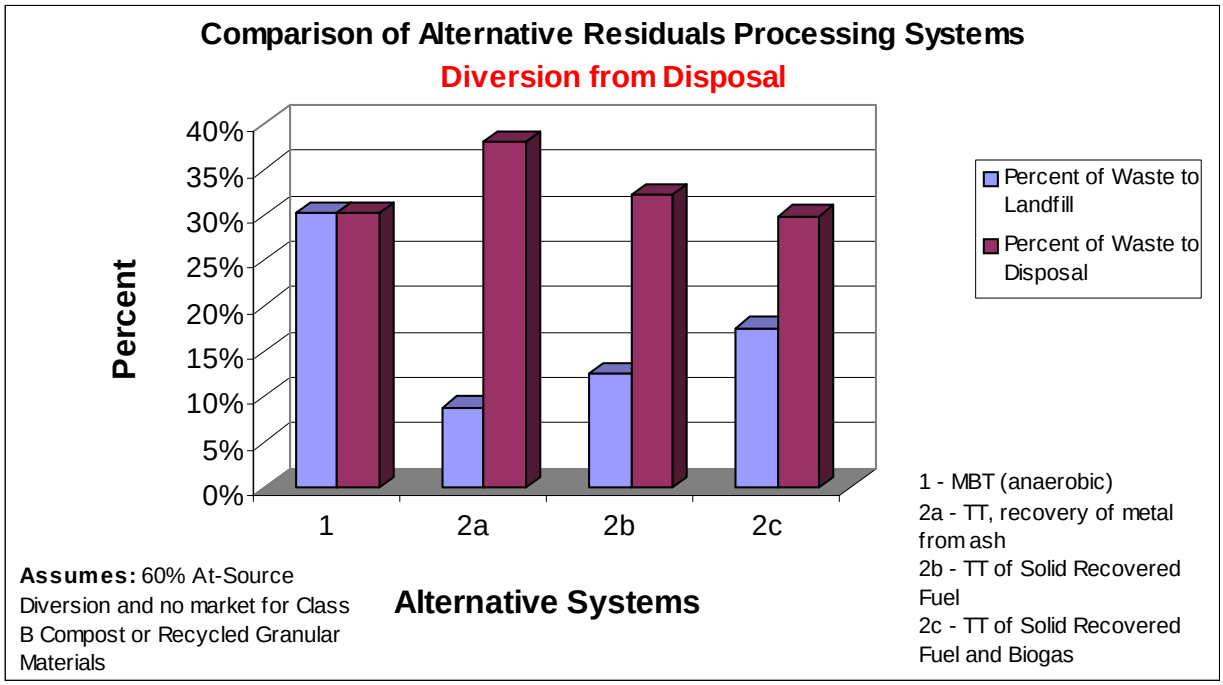
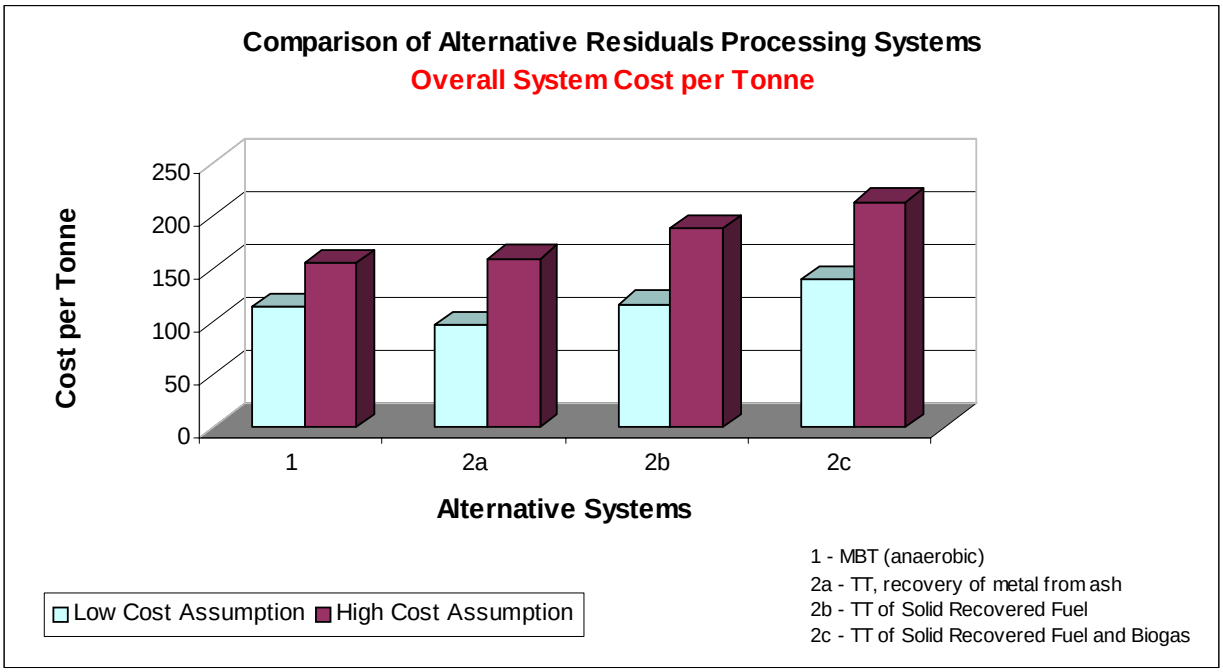


Figure 6-7: Overall System Cost per Tonne



7. Step 7 - Identification of Preferred Residuals Processing System

Step 7 of the "Alternatives to" comparative evaluation process involved the consideration of the relative system advantages and disadvantages and identification of a preferred system. The preferred system was determined to exhibit the preferred balance of advantages and disadvantages factoring in the environmental priorities identified by way of the Step 1 public and agency consultation process.

7.1 Approach to Preferred System Identification

The identification of the preferred system followed a qualitative comparative evaluation methodology, with consideration of the four (4) alternative residual processing systems and the results of Steps 1 to 6.

Application of a System Advantages and Disadvantages Comparison Approach

Identification of the preferred residuals disposal system involved the consideration of the system advantages and disadvantages identified at Step 6. The comparison was undertaken using a methodology that compared each of the alternative systems, based on their relative advantages and disadvantages, for each of the five (5) categories of the environment. This comparison of advantages and disadvantages was completed at two-levels as follows:

- **Level 1**, which involved the comparison of all four systems with respect to each of the criteria within a particular category of the environment (See Section 7.2 and Table 7-2). At this level, each system was assigned a relative Major Advantage, Advantage, Neutral (where the impact is neither an advantage nor a disadvantage), Disadvantage or Major Disadvantage; and,
- **Level 2**, which involved the review of each systems advantages and disadvantages identified in level 1 at the criteria stage to determine the relative advantages and disadvantages at the broader category stage (See Section 7.3).

It was determined that the application of advantages and disadvantages alone did not completely reflect the differences between systems in terms of the potential range of impacts associated with each of the systems. In order to overcome this issue and still maintain a qualitative approach to the evaluation, it was determined that the application of advantages and disadvantages would include: Major Advantages; Advantages; Neutral; Disadvantages; and, Major Disadvantages to better represent the significance of some of the impacts and therefore the significant differences between the systems.

Qualitative Approach Selected

A qualitative assessment approach was employed to consider and compare system advantages and disadvantages, identify trade-offs, and decide on preferences. Selection of a qualitative versus quantitative approach recognized the ability of the qualitative approach to focus on the provision of a descriptive rationale for certain choices and the consideration of priorities, and an

ability of the broader public to understand the decision-making process. Although much of the analysis relies on the professional skills of the consultant team, staff and municipal authorities, to assemble the relevant information, it was recognized throughout the evaluation that all decisions and/or trade-offs would need to be clearly documented, defensible, and appropriately linked to the results of public and agency consultation.

Although it can be easier for reviewers, with appropriate training, to follow the results of a quantitative evaluation approach, this feature is outweighed by the respective drawbacks related to broader environmental assessment concerns and in particular, the need to document a process that is traceable to all potentially impacted or with concerns and not just those that can understand the math. First, it should be noted that in developing and applying the methodology and respective data sets that much of the same professional skills used in qualitative approaches is required for quantitative approaches. The challenge tends to arise in translating that qualitative information to data sets or numbers with defined limits representing the scope of a particular impact and further, in determining the numeric point at which different impacts are distinguished (e.g. high versus moderate versus low impact or significance).

Experience with complex quantitative approaches has shown that these processes often revert to a focus on numeric orders, magnitudes and equations that are usually difficult to link to advantages and disadvantages in terms that the general public can understand. Inevitably, these processes lead to debate among those with a background or qualifications in statistics or mathematics and these debates usually become narrowly focussed on minute detail such as a percentage point up or down which may mathematically change the final conclusion. In doing so, these approaches present the risk of losing the human side of what 'makes sense' and is considered reasonable and understandable to the general public.

Experience has shown that a well documented and rational qualitative approach can overcome the above deficiencies associated with quantitative approaches and therefore was selected as the appropriate approach for use throughout the Durham/York Residual Waste Study. The use of any quantitative approaches or methodologies will be limited to testing the sensitivity of decisions, if deemed appropriate, by Durham and York.

Use of Environmental Priorities

Section 3.2 of this report outlines the process that was followed in establishing the environmental priorities of the Durham/York EA study area. For the purpose of considering the system advantages and disadvantages identified at Step 6, the following priorities were applied:

Table 7-1: Environmental Priorities

Environmental Category	Priority
Natural Environmental Considerations	Most Important
Social / Cultural Considerations	Important
Economic / Financial Considerations	Important
Technical Considerations	Important

Legal Considerations	Least Important

Accordingly, during the comparison of systems, the advantages and disadvantages identified were organized under each of the above categories along with their relative priority. In doing so, the selection of which system would move forward in the evaluation process considered both the scope of advantages and disadvantages and the priority associated with each.

7.2 Comparison of Alternative Systems

The comparative evaluation of system advantages and disadvantages was completed as outlined in Section 7.1 above and is summarized in Table 7-2 below.

Table 7-2: Comparison of Alternative Systems - Major Advantages and Disadvantages

NATURAL ENVIRONMENTAL CONSIDERATIONS (Most Important Priority)

Criterion	*Indicator*	*System 1* *Mechanical, Biological Treatment with Biogas Recovery*	*System 2 (a)* *Thermal Treatment of MSW & Recovery of Materials from Ash/Char*	*System 2 (b)* *Thermal Treatment of Solid Recovered Fuel*	*System 2 (c)* *Thermal Treatment of Solid Recovered Fuel with Biogas Recovery*
Criterion 1: **Environmental burden at a global or macro-environmental scale, including impacts to air, land and water.**	**Predicted Emissions released to atmosphere by system (emissions form all systems will be within required limits)**	***MAJOR ADVANTAGE*** • Lowest net emissions of Greenhouse Gases • Lower net emissions of Acid Gases • Highest net emissions of Smog Precursors • Lowest net emissions of Heavy Metals & Organics to Air	***MAJOR DISADVANTAGE*** • Highest Net emissions of Greenhouse Gases • Highest net emissions of Acid Gases • Higher net emissions of Smog Precursors • Highest net emissions of Heavy Metals & Organics to Air	***DISADVANTAGE*** • Higher net emissions of Greenhouse Gases • Lower net emissions of Acid Gases • Lower net emissions of Smog Precursors • Higher net emissions of Heavy Metals & Organics to Air	***DISADVANTAGE*** • Higher net emissions of Greenhouse Gases • Lowest net emissions of Acid Gases • Lowest net emissions of Smog Precursors • Lower net emissions of Heavy Metals & Organics to Air
	Predicted pollutants released to water resources by system	***MAJOR DISADVANTAGE*** • Highest net emissions of Heavy Metals & Organics to Water.	***MAJOR ADVANTAGE*** • Lowest net emissions of Heavy Metals & Organics to Water.	***ADVANTAGE*** • Lower net emissions of Heavy Metals & Organics to Water	***NEUTRAL*** • Higher emissions of Heavy Metals & Organics to Water

Criterion	Indicator	System 1 Mechanical, Biological Treatment with Biogas Recovery	System 2 (a) Thermal Treatment of MSW & Recovery of Materials from Ash/Char	System 2 (b) Thermal Treatment of Solid Recovered Fuel	System 2 (c) Thermal Treatment of Solid Recovered Fuel with Biogas Recovery
Criterion 1: **Environmental burden at a global or macro-environmental scale, including impacts to air, land and water.** **(cont'd)**	**Need to manage residues classified as hazardous waste associated with system.**	• Hazardous elements remain in materials processed and/or landfilled and may be emitted by way of landfill emissions / collected by landfill pollution control systems. • No hazardous waste stream associated with residue from Facility Air Pollution Control Equipment.	• Approximately 15,500 tonnes per year of hazardous residue from pollution control equipment requires management at a licensed facility if the quantity of residual material managed by the facility is 400,000 TPY. • Costs to manage hazardous wastes at an approved facility have been included in estimated system costs.	• Approximately 8,500 tonnes per year of hazardous residue from pollution control equipment requires management at a licensed facility if the quantity of residual material managed by the facility is 400,000 TPY. • Costs to manage hazardous wastes at an approved facility have been included in estimated system costs.	• Approximately 5,500 tonnes per year of hazardous residue from pollution control equipment requires management at a licensed facility if the quantity of residual material managed by the facility is 400,000 TPY. • Costs to manage hazardous wastes at an approved facility have been included in estimated system costs.
		NEUTRAL • Opposing views of this consideration weigh segregation of hazardous materials and proper management versus discharging via mixed waste to landfill where they may or may not leach out of the disposed wastes.			

Criterion	Indicator	System 1 Mechanical, Biological Treatment with Biogas Recovery	System 2 (a) Thermal Treatment of MSW & Recovery of Materials from Ash/Char	System 2 (b) Thermal Treatment of Solid Recovered Fuel	System 2 (c) Thermal Treatment of Solid Recovered Fuel with Biogas Recovery
Criterion 1: **Environmental burden at a global or macro-environmental scale, including impacts to air, land and water.** ***(cont'd)***	**Impacts to land by system.**	***MAJOR DISADVANTAGE*** • Siting process for a 11.4 ha Mechanical/Biological treatment facility in an urban/industrial setting will provide a high likelihood that facility location makes an appropriate use of land resources. • Primary facility site would likely be located within a designated urban boundary and/or on lands appropriately designated for the use. • Due to lack of approved landfill capacity within Durham and York, assumed that landfill capacity for residues would exist at a licensed municipal or private landfill. • A minimum of 287,000 cubic metres of landfill space will be required annually to dispose of system residues.	***MAJOR ADVANTAGE*** • Siting process for a 9.6 ha thermal facility in an urban/industrial setting will provide a high likelihood that facility location makes an appropriate use of land resources. • Primary facility site would likely be located within a designated urban boundary and/or on lands appropriately designated for the use. • Due to lack of approved landfill capacity within Durham and York, assumed that landfill capacity for residues would exist at a licensed municipal or private landfill. • A minimum of 50,000 cubic metres of landfill space will be required annually to dispose of system residues.	***ADVANTAGE*** • Siting process for a 14.6 ha MBT/ thermal facility in an urban/industrial setting will provide a high likelihood that facility location makes an appropriate use of land resources. • Primary facility site would likely be located within a designated urban boundary and/or on lands appropriately designated for the use. • Due to lack of approved landfill capacity within Durham and York, assumed that landfill capacity for residues would exist at a licensed municipal or private landfill. • A minimum of 81,000 cubic metres of landfill space will be required annually to dispose of system residues.	***NEUTRAL*** • Siting process for a 13.5 ha MBT/ thermal facility in an urban/industrial setting will provide a high likelihood that facility location makes an appropriate use of land resources. • Primary facility site would likely be located within a designated urban boundary and/or on lands appropriately designated for the use. • Due to lack of approved landfill capacity within Durham and York, assumed that landfill capacity for residues would exist at a licensed municipal or private landfill. • A minimum of 114,000 cubic metres of landfill space will be required annually to dispose of system residues.
Criterion 1:	**OVERALL**	**DISADVANTAGE**	**MAJOR ADVANTAGE**	**ADVANTAGE**	**NEUTRAL**

Criterion	Indicator	System 1 Mechanical, Biological Treatment with Biogas Recovery	System 2 (a) Thermal Treatment of MSW & Recovery of Materials from Ash/Char	System 2 (b) Thermal Treatment of Solid Recovered Fuel	System 2 (c) Thermal Treatment of Solid Recovered Fuel with Biogas Recovery
Criterion 2: **Consumption/preservation of non-renewable environmental resources.**	**Potential of system to consume non-renewable fossil fuel or displace non-renewable fossil fuel consumption for energy generation.**	***MAJOR DISADVANTAGE*** • Net lifecycle energy (i.e. electricity, heat, virgin material displacement credit, etc.) impact of 606,357 GJ conserved annually. • Net Electrical Energy Generation from renewable sources of 10,313 MWh	***MAJOR ADVANTAGE*** • Net lifecycle energy (i.e. electricity, heat, virgin material displacement credit, etc.) impact of 1,348,786 GJ conserved annually. • Net Electrical Energy Generation from renewable sources of 86,180 MWh	***MAJOR ADVANTAGE*** • Net lifecycle energy (i.e. electricity, heat, virgin material displacement credit, etc.) impact of 1,428,480 GJ conserved annually. • Net Electrical Energy Generation from renewable sources of 85,673 MWh	***ADVANTAGE*** • Net lifecycle energy (i.e. electricity, heat, virgin material displacement credit, etc.) impact of 1,230,067GJ conserved annually. • Net Electrical Energy Generation from renewable sources of 56,822 MWh
Criterion 3: **Potential for destruction or disruption of sensitive terrestrial and/or aquatic habitats at an eventual site.**	**Total Volume of Landfill Capacity Required to manage Post-Processing Residual Waste**	***MAJOR DISADVANTAGE*** • **Significant** requirement for landfill disposal of system residues increases potential for removal or disruption of sensitive natural habitats due to typically rural setting of landfill facilities.	***MAJOR ADVANTAGE*** • **Low** requirement for landfill disposal of system residues reduces potential for removal or disruption of sensitive natural habitats due to typically rural setting of landfill facilities.	***ADVANTAGE*** • **Low/Moderate** requirement for landfill disposal of system residues reduces potential for removal or disruption of sensitive natural habitats due to typically rural setting of landfill facilities.	***NEUTRAL*** • **Moderate** requirement for landfill disposal of system residues reduces potential for removal or disruption of sensitive natural habitats due to typically rural setting of landfill facilities.
	Land use setting typically associated with establishment of facilities comprising system.	• Estimated 11.4 ha. Site Requirement	• Estimated 9.6 ha. Site Requirement	• Estimated 14.6 ha. Site Requirement	• Estimated 13.5 ha. Site Requirement
		NEUTRAL • All facility(ies) site(s) can be located in designated urban area and on industrially designated lands with potential for impacts on sensitive habitats unlikely.			
Criterion 3:	**OVERALL**	**MAJOR DISADVANTAGE**	**MAJOR ADVANTAGE**	**ADVANTAGE**	**NEUTRAL**

Criterion	Indicator	System 1 Mechanical, Biological Treatment with Biogas Recovery	System 2 (a) Thermal Treatment of MSW & Recovery of Materials from Ash/Char	System 2 (b) Thermal Treatment of Solid Recovered Fuel	System 2 (c) Thermal Treatment of Solid Recovered Fuel with Biogas Recovery
Criterion 4: **Potential to increase diversion rate and/or make best use of residual (post-diversion) waste materials.**	**Potential of system facilities to remove any remaining materials in the post-diversion waste stream for use in a non-disposal manner.**	***MAJOR ADVANTAGE*** • System ensures achievement of 60% diversion target and offers potential 10% increase in rate of diversion from disposal to 70%.	***ADVANTAGE*** • System ensures achievement of 60% diversion target and in existing regulatory environment offers potential 2% increase in rate of diversion from disposal to 62%.	***MAJOR ADVANTAGE*** • System ensures achievement of 60% diversion target and in existing regulatory environment offers potential 8% increase in rate of diversion from disposal to 68%.	***MAJOR ADVANTAGE*** • System ensures achievement of 60% diversion target and in existing regulatory environment offers potential 10% increase in rate of diversion from disposal to 70%.
	Potential of system facilities to manage and make beneficial use of materials in the post-diversion waste stream including those materials for which diversion may decline or disappear in the future.	***ADVANTAGE*** • **Moderate** - If markets for compost and recycled paper fibres were to decline, this system could anaerobically digest these materials to recover energy. • If there were approved markets for Class B compost and use of some recovered materials as aggregate, diversion from landfill disposal could increase to 84%.	***MAJOR ADVANTAGE*** • **High** - If markets for recycled plastics, low-value paper etc. were to decline or disappear, this system could recover significant quantities of energy from these materials. • In addition, if European practice of curing and recycling bottom ash into aggregate materials was approved in Ontario, diversion from landfill disposal could increase to 95%.	***MAJOR ADVANTAGE*** • **High** - If markets for recycled plastics, low-value paper etc. were to decline or disappear, this system could recover significant quantities of energy from these materials. • In addition, if European practice of curing and recycling bottom ash into aggregate materials was approved in Ontario, diversion from landfill disposal could increase to 89%.	***MAJOR ADVANTAGE*** • **High** - If markets for recycled plastics, low-value paper etc. were to decline or disappear, this system could recover significant quantities of energy from these materials. • In addition, if European practice of curing and recycling bottom ash into aggregate materials was approved in Ontario, diversion from landfill disposal could increase to 87%.
Criterion 4:	**OVERALL**	**ADVANTAGE**	**ADVANTAGE**	**MAJOR ADVANTAGE**	**MAJOR ADVANTAGE**
NATURAL ENVIRONMENTAL CONSIDERATIONS	**OVERALL**	**DISADVANTAGE**	**MAJOR ADVANTAGE**	**MAJOR ADVANTAGE**	**ADVANTAGE**

SOCIAL / CULTURAL CONSIDERATIONS (Important Priority)

Criterion	*Indicator*	*System 1* *Mechanical, Biological Treatment with Biogas Recovery*	*System 2 (a)* *Thermal Treatment of MSW & Recovery of Materials from Ash/Char*	*System 2 (b)* *Thermal Treatment of Solid Recovered Fuel*	*System 2 (c)* *Thermal Treatment of Solid Recovered Fuel with Biogas Recovery*
Criterion 5: **Potential for land use conflicts from siting of facilities required for alternative.**	**Number of waste management facilities associated with alternative system.**	***NEUTRAL*** ▪ For comparative purposes it is assumed that all components of all of the alternative residuals processing systems would be located at a single location within Durham/York. As a result, all systems would have the same relative impact regarding the number of waste management facilities. The 'single facility, single site' system configuration represents the most efficient system configuration and would provide the economies of scale that are being sought in the Durham/York study. In general, a 'single facility, single site' configuration also represents the configuration which would be expected to have a lower potential for environmental and social impacts, as the total land area required and number of potential receptors that could be impacted by the systems, increases as the number of sites required for each system increases.			

Criterion	Indicator	System 1 Mechanical, Biological Treatment with Biogas Recovery	System 2 (a) Thermal Treatment of MSW & Recovery of Materials from Ash/Char	System 2 (b) Thermal Treatment of Solid Recovered Fuel	System 2 (c) Thermal Treatment of Solid Recovered Fuel with Biogas Recovery
Criterion 5: **Potential for land use conflicts from siting of facilities required for alternative.** **(cont'd)**	**Potential for land use conflicts considering location requirements of waste management facilities.**	***MAJOR DISADVANTAGE*** • For comparative purposes it is assumed that all components of the MBT System would be located at a single location within Durham/York. • MBT facility would likely be located within a designated urban boundary and/or on lands appropriately designated for the use. • Significant quantity of residual materials (30% of total waste stream) will require landfill disposal at a facility located outside of the study area, resulting in a higher potential for land use conflicts associated with export to waste in other communities. • Highest potential traffic related impacts, related to the haul of materials from the MBT facility to landfill.	***MAJOR ADVANTAGE*** • For comparative purposes it is assumed that all components of the Thermal System would be located at a single location within Durham/York. • Thermal facility would likely be located within a designated urban boundary and/or on lands appropriately designated for the use. • Small quantity of residual materials (9% of total waste stream) will require landfill disposal at a facility located outside of the study area, resulting in a low potential for land use conflicts associated with export to waste in other communities. • Lowest potential traffic related impacts, related to the haul of materials from the thermal facility to landfill.	***MAJOR ADVANTAGE*** • For comparative purposes it is assumed that all components of the MBT/Thermal System would be located at a single location within Durham/York. • MBT/Thermal facility would likely be located within a designated urban boundary and/or on lands appropriately designated for the use. • Small quantity of residual materials (13% of total waste stream) will require landfill disposal at a facility located outside of the study area, resulting in a low potential for land use conflicts associated with export to waste in other communities. • Low potential traffic related impacts, related to the haul of materials from the MBT/thermal facility to landfill.	***NEUTRAL*** • For comparative purposes it is assumed that all components of the MBT/Thermal System would be located at a single location within Durham/York. • MBT/Thermal facility would likely be located within a designated urban boundary and/or on lands appropriately designated for the use. • Moderate quantity of residual materials (18% of total waste stream) will require landfill disposal at a facility located outside of the study area, resulting in some potential for land use conflicts associated with export to waste in other communities. • Low potential traffic related impacts, related to the haul of materials from the MBT/ thermal facility to landfill.

Criterion	Indicator	System 1 Mechanical, Biological Treatment with Biogas Recovery	System 2 (a) Thermal Treatment of MSW & Recovery of Materials from Ash/Char	System 2 (b) Thermal Treatment of Solid Recovered Fuel	System 2 (c) Thermal Treatment of Solid Recovered Fuel with Biogas Recovery
Criterion 5: **Potential for land use conflicts from siting of facilities required for alternative.** ***(cont'd)***	**Types and degree of Nuisance Impacts associated with waste management facilities based on Operational experience**	***MAJOR DISADVANTAGE*** • Relatively equivalent potential impacts for most nuisance related parameters (dust, noise, litter) • Higher potential for odour related impacts, due to biological component of the MBT system and as potential odorous materials will be hauled from the MBT facility to landfill for disposal.	***MAJOR ADVANTAGE*** • Relatively equivalent potential impacts for most nuisance related parameters (dust, noise, litter) • Lower potential for odour related impacts as there is no biological component of the Thermal system, and as the residue hauled to landfill is inert.	***ADVANTAGE*** • Relatively equivalent potential impacts for most nuisance related parameters (dust, noise, litter) • Higher potential for odour related impacts, due to biological component of the system, however, the residue hauled to landfill is inert as all biological residues are combusted.	***DISADVANTAGE*** • Relatively equivalent potential impacts for most nuisance related parameters (dust, noise, litter) • Higher potential for odour related impacts, due to biological component of the system and as potential odorous materials will be hauled from the MBT facility to landfill for disposal.
SOCIAL / CULTURAL CONSIDERATIONS	**OVERALL**	**MAJOR DISADVANTAGE**	**MAJOR ADVANTAGE**	**ADVANTAGE**	**DISADVANTAGE**

ECONOMIC / FINANCIAL CONSIDERATIONS (Important Priority)

Criterion	*Indicator*	*System 1* *Mechanical, Biological Treatment with Biogas Recovery*	*System 2 (a)* *Thermal Treatment of MSW & Recovery of Materials from Ash/Char*	*System 2 (b)* *Thermal Treatment of Solid Recovered Fuel*	*System 2 (c)* *Thermal Treatment of Solid Recovered Fuel with Biogas Recovery*
Criterion 6: **Net system costs per tonne of waste managed – in a systems context. Includes:** • Capital and operating costs over operational period of system (2011 to 2045). • Estimated costs associated with perpetual care of component facilities in accordance with current environmental and municipal accounting requirements. • Estimated revenues associated with system once fully implemented and operational. • Potential subsidies and revenues that may be realized during establishment and future operation of system.		***ADVANTAGE*** • Net System Cost per tonne ranges from $114 to $155, including capital, operating, financing, perpetual care, revenues and subsidies.	***ADVANTAGE*** • Net System Cost per tonne ranges from $97 to $160, including capital, operating, financing, perpetual care, revenues and subsidies.	***DISADVANTAGE*** • Net System Cost per tonne ranges from $116 to $188, including capital, operating, financing, perpetual care, revenues and subsidies.	***MAJOR DISADVANTAGE*** • Net System Cost per tonne ranges from $140 to $213, including capital, operating, financing, perpetual care, revenues and subsidies.

Criterion	Indicator	System 1 Mechanical, Biological Treatment with Biogas Recovery	System 2 (a) Thermal Treatment of MSW & Recovery of Materials from Ash/Char	System 2 (b) Thermal Treatment of Solid Recovered Fuel	System 2 (c) Thermal Treatment of Solid Recovered Fuel with Biogas Recovery
Criterion 7: **Sensitivity of system costs and affordability to external financial influences. Includes:** • Types of revenues and subsidies currently available to offset system costs and predicted sustainability of these sources into the future. • Degree to which system affordability relies on revenues and subsidies during long-term operation of the system.		***MAJOR DISADVANTAGE*** • Net system cost assumes markets for recyclable materials recovered from mechanical component of MBT facility and biogas from anaerobic digester. Revenues offset in the range of 13 to 16% of average annual costs. • Revenue from sale of recyclables is likely least secure of all revenue streams. • System generates considerably more post-process residue that would require landfill disposal and therefore will be more susceptible to rising landfill disposal costs.	***NEUTRAL*** • Net system cost assumes markets for energy generated from thermal treatment of waste and for materials recovered from ash/char. Revenues offset approximately 50 to 73% of average annual costs of facility. • Revenue from sale of electricity is likely most secure of all revenue streams. • System would have a minor influence related to the marketplace for disposal of APC residues / ashes / chars.	***NEUTRAL*** • Net system cost assumes markets for energy generated from thermal treatment of a solid recovered fuel and for materials recovered from the SRF facility. Revenues offset approximately 43 to 63% of average annual costs. • Revenue from sale of electricity is likely most secure of all revenue streams. • System would have a minor influence related to the marketplace for disposal of APC residues / ashes / chars.	***DISADVANTAGE*** • Net system cost assumes markets for energy generated from thermal treatment of an solid recovered fuel and for materials and biogases recovered from facility that processes MSW into SRF. Revenues offset approximately 32 to 47% of average annual costs. • Revenue from sale of electricity is likely most secure of all revenue streams. • System would be influenced by marketplace for disposal of APC residues / ashes / chars.
ECONOMIC / FINANCIAL CONSIDERATIONS	**OVERALL**	**DISADVANTAGE**	**ADVANTAGE**	**DISADVANTAGE**	**MAJOR DISADVANTAGE**

TECHNICAL (Important Priority)

Criterion	*Indicator*	*System 1* *Mechanical, Biological Treatment with Biogas Recovery*	*System 2 (a)* *Thermal Treatment of MSW & Recovery of Materials from Ash/Char*	*System 2 (b)* *Thermal Treatment of Solid Recovered Fuel*	*System 2 (c)* *Thermal Treatment of Solid Recovered Fuel with Biogas Recovery*
Criterion 8: **Technical risks associated with waste management alternative.**	**Flexibility of alternative system to changes in waste quantities, composition and availability of system diversion and disposal components.**	***ADVANTAGE*** • MBT component would be designed for a specified throughput and any quantities over that design capacity would have to be managed by way of extended operating hours or by-pass to a landfill.	***MAJOR DISADVANTAGE*** • Although changes to waste characteristics are not a significant issue, significant changes in quantity can be problematic. A reduction in quantity affects the assumed economics of the facility and may be corrected by way of alternate sourcing of feedstock. An increase may require MSW to bypass the facility.	***DISADVANTAGE*** • Incorporation of mechanical, biological and thermal components allows for adjustments in process line to accommodate some changes in waste types and quantities.	***DISADVANTAGE*** • Incorporation of mechanical, biological and thermal components allows for adjustments in process line to accommodate some changes in waste types and quantities.
Criterion 8: **Technical risks associated with waste management alternative.**	**Reliability of alternative system and component technologies and need for contingency landfill capacity.**	***MAJOR DISADVANTAGE*** • MBT component is considered reasonably reliable given past experience with mechanical component although experience with anaerobic digestion of mixed wastes is less common. • High Dependence on landfill capacity elsewhere in the Province results in lowest reliability.	***MAJOR ADVANTAGE*** • Operating experience with this technology has established a reasonable operating track record and a much-improved track record with regards to environmental protection. • Lowest dependence on landfill capacity elsewhere in Province.	***DISADVANTAGE*** • System is dependent on several different types of technologies and mechanical equipment that lends itself to the highest potential for breakdown or failure. • Moderate dependence on landfill capacity elsewhere in Province.	***DISADVANTAGE*** • System is highly dependent on several different types of technologies and mechanical equipment that lends itself to the highest potential for breakdown or failure. • Moderate dependence on landfill capacity elsewhere in Province.
TECHNICAL	**OVERALL**	**MAJOR DISADVANTAGE**	**NEUTRAL**	**DISADVANTAGE**	**DISADVANTAGE**

LEGAL CONSIDERATIONS (Less Important Priority)

Criterion	*Indicator*	*System 1* *Mechanical, Biological Treatment with Biogas Recovery*	*System 2 (a)* *Thermal Treatment of MSW & Recovery of Materials from Ash/Char*	*System 2 (b)* *Thermal Treatment of Solid Recovered Fuel*	*System 2 (c)* *Thermal Treatment of Solid Recovered Fuel with Biogas Recovery*
Criterion 9: **Legal / contractual risks associated with waste management alternative.**	**Types and complexity of approvals required to implement components of system.**	***DISADVANTAGE*** • System will require at a minimum, approval under the Ontario Environmental Assessment Act and Ontario Environmental Protection Act. • MBT facility would likely be located within a designated urban boundary and/or on lands appropriately designated for the use. Accordingly, potential for land use conflicts would be minimal and may facilitate obtaining the necessary approvals to implement and operate the facility. • System has higher landfill requirements, so that while MBT component may be more acceptable for approval within Durham and York, the use of a significant quantity of landfill space outside of the study area is likely to be less acceptable (particularly for the host community).	***NEUTRAL*** • System will require at a minimum, approval under the Ontario Environmental Assessment Act and Ontario Environmental Protection Act. • MBT/ thermal facility would likely be located within a designated urban boundary and/or on lands appropriately designated for the use. Accordingly, potential for land use conflicts would be minimal and may facilitate obtaining the necessary approvals to implement and operate the facility.	***NEUTRAL*** • System will require at a minimum, approval under the Ontario Environmental Assessment Act and Ontario Environmental Protection Act. • MBT/ thermal facility would likely be located within a designated urban boundary and/or on lands appropriately designated for the use. Accordingly, potential for land use conflicts would be minimal and may facilitate obtaining the necessary approvals to implement and operate the facility.	***NEUTRAL*** • System will require at a minimum, approval under the Ontario Environmental Assessment Act and Ontario Environmental Protection Act. • Thermal facility would likely be located within a designated urban boundary and/or on lands appropriately designated for the use. Accordingly, potential for land use conflicts would be minimal and may facilitate obtaining the necessary approvals to implement and operate the facility.

Criterion	*Indicator*	*System 1* *Mechanical, Biological Treatment with Biogas Recovery*	*System 2 (a)* *Thermal Treatment of MSW & Recovery of Materials from Ash/Char*	*System 2 (b)* *Thermal Treatment of Solid Recovered Fuel*	*System 2 (c)* *Thermal Treatment of Solid Recovered Fuel with Biogas Recovery*
Criterion 9: **Legal / contractual risks associated with waste management alternative.** ***(cont'd)***	**Degree to which system implementation and operation relies on private or public sector partnerships.**	***MAJOR DISADVANTAGE*** **Implementation:** • MBT technologies are largely proprietary and will likely require some form of contractual arrangement with the private sector vendor(s) for implementation. • System requires considerable landfill disposal capacity that must be obtained through contract with a third party. **Operation:** • Assumed in evaluation operation of MBT facilities is contracted out to the private sector. However, the respective municipalities could operate publicly if the necessary staff were retained and trained on facility operations.	***DISADVANTAGE*** Implementation: • Thermal technologies are largely proprietary and will likely require some form of contractual arrangement with the private sector vendor(s) for implementation. **Operation:** • Assumed in evaluation operation of thermal facilities is contracted out to the private sector. However, the respective municipalities could operate publicly if the necessary staff were retained and trained on facility operations.	***DISADVANTAGE*** Implementation: • Thermal and MBT technologies are largely proprietary and will likely require some form of contractual arrangement with the private sector vendor(s) for implementation. **Operation:** • Assumed in evaluation operation of MBT/ thermal facilities is contracted out to the private sector. However, the respective municipalities could operate publicly if the necessary staff were retained and trained on facility operations.	***DISADVANTAGE*** **Implementation**: • Thermal and MBT technologies are largely proprietary and will likely require some form of contractual arrangement with the private sector vendor(s) for implementation. **Operation:** • Assumed in evaluation operation of MBT/ thermal facilities is contracted out to the private sector. However, the respective municipalities could operate publicly if the necessary staff were retained and trained on facility operations.
LEGAL CONSIDERATIONS	**OVERALL**	**MAJOR DISADVANTAGE**	**DISADVANTAGE**	**DISADVANTAGE**	**DISADVANTAGE**

7.3 Identification of Significant System Advantages and Disadvantages

For each of the four (4) alternative systems, a set of significant advantages and disadvantages were identified. A significant advantage or disadvantage was considered to be one that represented the best or worst of all systems considered. For example, the system with the lowest net cost per tonne was considered to have a significant advantage under this consideration.

The purpose of this exercise was to give an initial indication of the relative strengths and weaknesses of the four (4) alternative systems being evaluated. Accordingly, a system with a longer list of significant advantages or disadvantages under a particular category was considered to be an outlier (i.e. significantly advantaged or disadvantaged) in that regard whereas, a system with no or few advantages or disadvantages under a particular category was considered to reside somewhere in the midrange of effects for that consideration.

As noted in Section 6 of this report, when the actual comparative evaluation of the alternative systems was undertaken, the methodology used accounted for the relative placement of net effects for each system from best to worst. At that point in the evaluation process examining, the full range of net effects, advantages and disadvantages were the key contributors to the results of the comparative evaluation and the significant advantages and disadvantages originally publicized for each system were noted as additional information.

The following summarizes the significant advantages and disadvantages associated with each of the alternative systems.

System 1 - Mechanical and Biological Treatment with Biogas Recovery

System 1 involves mechanical processing to recover recyclable material from the waste, anaerobic digestion of the organic fraction in the waste to recover a relatively small amount of renewable energy and the landfilling of the resulting residuals. It is essentially a stabilized landfill alternative with 77% of the residual waste stream ultimately exported to landfill.

In summary, the advantages of this system include:

- Lowest potential impacts on the air environment;
- More flexible to changes in waste quantities and composition;
- Potentially lower overall system costs provided low cost landfill capacity can be obtained from a third party;
- Potential to increase diversion through the recovery of additional recyclables – an advantage shared with Systems 2b and 2c.

On the other hand, it has a number of disadvantages including:

- Greatest impacts to water and land;
- Greatest potential to disrupt sensitive habitat;
- Lowest energy generation – both renewable and total;
- Greatest social impact on the landfill host community; and

- Least reliable due to dependence on export landfill contracts.

System 2a - Thermal Treatment of Mixed Waste with Recovery of Materials from the Ash / Char and System 2b - Thermal Treatment of Solid Recovered Fuel

Systems 2a and 2b are both based on the recovery of energy through thermal treatment. In 2a, recyclable metals are recovered following thermal treatment from the ash or char. In 2b, recyclable materials, including metals and some plastics, are recovered through mechanical treatment, moisture from the organic fraction in the remaining material is then reduced through biological treatment. The material (now considered a Solid Recovered Fuel) is then subjected to thermal treatment. In both cases, only a small proportion of the residual waste stream – typically 10-15% by volume – exported to landfill. If the bottom ash could be used as construction material as it is in Europe, the percentage of waste to landfill 5%.

In summary, the advantages associated with Systems 2a and 2b include:

- Lowest impacts to water and land;
- Least potential to disrupt sensitive habitat;
- Greatest energy generation – both renewable and total;
- Lowest social impact on landfill host community due to minimizing the quantities requiring landfill;
- Higher reliability due to minimum dependence on to export landfill; and
- Costs, although high, are comparable in the case of System 2a, with System 1.

The disadvantages of the thermal treatment systems include:

- Highest impacts on the air environment, although current technology has the proven ability to exceed all applicable air emission standards;
- Less flexibility to changes in waste quantities and composition;
- Need to manage hazardous residues from the pollution control system. *(It can be argued that this is not really a disadvantage as the hazardous compounds – primarily heavy metals – are in the waste stream to begin with and simply landfilled in System 1. With the thermal systems, these contaminants are concentrated and removed for stabilization and/or management in a secure landfill.)*

When comparing Systems 2a and 2b, alternative 2a has the advantages of:

- More proven and reliable technology; and
- Lower costs – based on experience to-date.

Alternative 2b has the advantages of:

- The potential to recover more recyclables – some plastics as well as metals; and
- Potential improvements in air emissions, energy conversion efficiency and costs that may be provided by new technologies presently under development.

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

System 2c includes the mechanical and biological treatment of System 1 followed by the thermal treatment of a solid recovered fuel including the combustion portion of the residual waste, rather than the straight landfilling of all residues. Ultimately the inert non-recyclable materials, AD digestate and ash/char all require landfill disposal. Ultimately, 45% of the residual stream will require export landfill under this alternative versus the 77% from System 1.

The advantages and disadvantages associated with this alternative fall between these identified for the two sets of previous systems.

The major advantage of the system includes:

- The ability to recover additional recyclable materials and also to make beneficial use of the post diversion waste stream.

It has the disadvantage of:

- Highest cost and lowest technical reliability due to the amount and complexity of the required processing equipment.

A more detailed description of the significant advantages and disadvantages is provided in Appendix 3 of this report.

Table 7-3 below identifies how each system compared within each of the established priorities at the Category level.

Table 7-3: Comparison of Alternative Systems

Criterion	System 1 Mechanical, Biological Treatment with Biogas Recovery	System 2 (a) Thermal Treatment of MSW & Recovery of Materials from Ash/Char	System 2 (b) Thermal Treatment of Solid Recovered Fuel	System 2 (c) Thermal Treatment of Solid Recovered Fuel with Biogas Recovery
MOST IMPORTANT PRIORITY				
NATURAL ENVIRONMENTAL CONSIDERATIONS	**DISADVANTAGE**	**MAJOR ADVANTAGE**	**MAJOR ADVANTAGE**	**ADVANTAGE**
IMPORTANT PRIORITY				
SOCIAL / CULTURAL CONSIDERATIONS	**MAJOR DISADVANTAGE**	**MAJOR ADVANTAGE**	**ADVANTAGE**	**DISADVANTAGE**
ECONOMIC / FINANCIAL CONSIDERATIONS	**DISADVANTAGE**	**ADVANTAGE**	**DISADVANTAGE**	**MAJOR DISADVANTAGE**
TECHNICAL	**MAJOR DISADVANTAGE**	**NEUTRAL**	**DISADVANTAGE**	**DISADVANTAGE**
LESS IMPORTANT PRIORITY				
LEGAL CONSIDERATIONS	**MAJOR DISADVANTAGE**	**DISADVANTAGE**	**DISADVANTAGE**	**DISADVANTAGE**

Based on the consideration of the advantages and disadvantages and the priorities of the environmental considerations noted above in Table 7-3, the preferred system to manage the post-diversion or residual wastes is ***System 2A – Thermal Treatment of MSW and Recovery of Energy followed by the Recovery of Materials from the Ash/Char***.

8. Description of Preferred Residuals Processing System

8.1 Overview

The undertaking that is the subject of this EA Study in accordance with the approved EA Terms of Reference is a residual waste processing system capable of managing the post-diversion residual wastes projected to remain for disposal over the 35-year planning period after achievement of the 60% waste diversion targets by 2011 and up to 75% waste diversion in future years.

Inherent to this undertaking should be the adoption of a hierarchy of integrated waste management system approaches wherein the first priority for Durham and York is the diversion of waste through at-source diversion programs which are expected to manage the majority of the waste generated by both municipalities over the long-term. The second priority is the management of the post-diversion residual waste stream first by thermal treatment and followed by landfill for remaining materials.

The projected quantities of waste that would be managed over the long-term by the integrated waste management system were updated at Step 2 as part of the review of additional at-source diversion (see draft report in Annex C-2) and are summarized in Table 8-1.

Table 8-1: Projected Long-Term Management of Wastes by Durham and York Integrated Waste Management Systems

For the 2011 to 2045 Period	2011 (tonnes)	2045 (tonnes)
Estimated Total Material Generation (Residential)	637,300	1,159,600
Estimated Annual Quantity Diverted At-Source	382,400	869,700
Diversion Rate (%)	60%	75%
Estimated Annual Residual Quantity Requiring Management	254,900	289,900
Average Monthly Residual Quantity Requiring Management	21,200	24,200
Approximate Average Daily Residual Quantity Requiring Management (1)	1,020	1,160
35 Year Total Residual Wastes Quantity Requiring Management	Approximately 11,142,000	

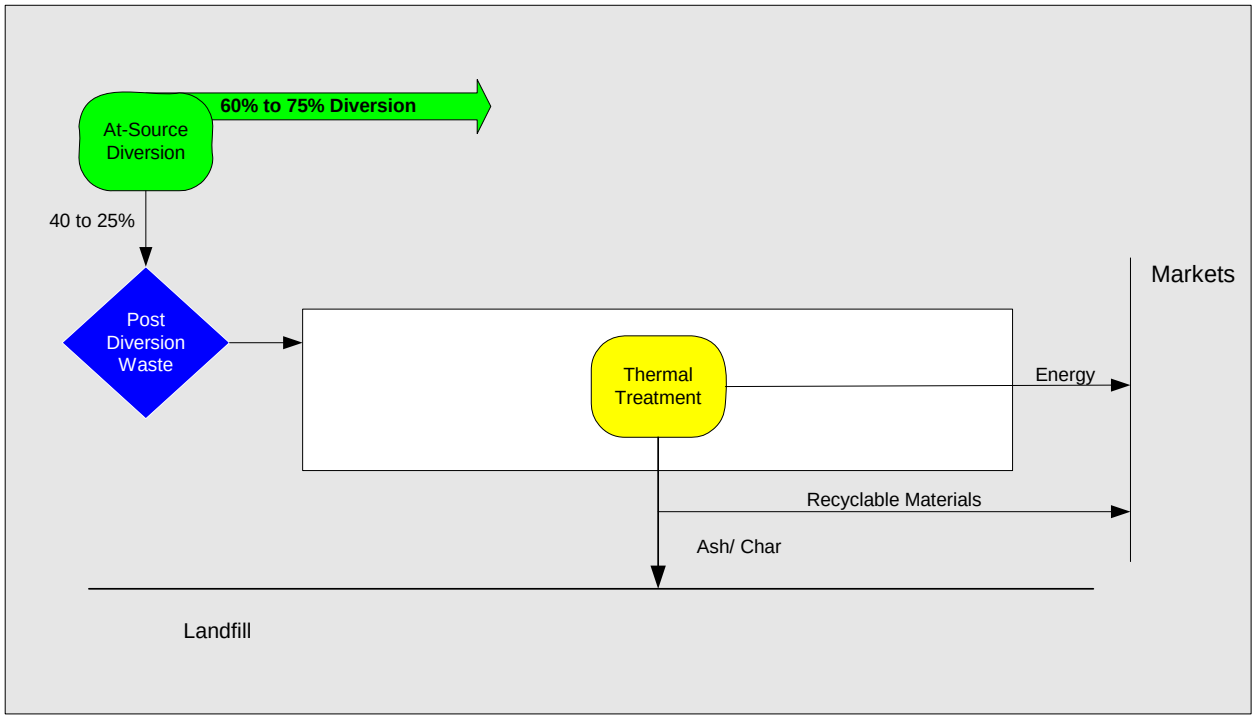
(1) Annual quantity divided by 250 days per year

The preferred long-term waste disposal system identified as a result of the evaluation of alternatives to manage the post-diversion or residual wastes is ***System 2A – Thermal Treatment of MSW and Recovery of Energy followed by the Recovery of Materials from the Ash/Char***.

More specifically, System 2A entails:

- The establishment of thermal treatment capacity to process the residual waste stream and to recover energy;
- Followed by the removal of materials that may be sold to market from the ash/char residue; and,
- The landfilling of all process residues (non-combustible materials removed prior to treatment and the ash/char).

Figure 8-1: System 2(a) - Thermal Treatment of Mixed Waste with Recovery of Materials from the Ash / Char



A summary of the material quantities managed by this system is provided in Table 8-2.

Table 8-2: Summary of Estimated 2011 Material Quantities (tonnes) to be Managed by Preferred Disposal System 2(a)

Approach to Management	Estimated Quantity / Proportion (2011)
Quantity of Post-Diversion Residual Waste (tonnes)	**250,000**
Quantity of Waste Processed Thermally (tonnes)	**242,500**
Percent of Total Waste Stream Thermally Processed	38%
Moisture & Mass Loss at Thermal Treatment (Primarily H_2O and CO_2) (tonnes)	186,100
Additional Materials Recovered and Recycled (tonnes)	7,800
Quantity of Residue and Ash/Char Landfilled (tonnes)	**56,100**

Although System 2(a) has been identified as the Preferred Long Term Residual Processing System, it is important to note that ***System 2(b) Thermal Treatment of Solid Recovered Fuel*** also exhibits an acceptable range of advantages and disadvantages.

For some of the criteria where System 2(b) did not rank equivalent to 2 (a), (technical risks, costs and legal/contractual risks for example), the determination of the relative advantages and disadvantages was based upon the information that was readily available on both the mechanical and biological processes that are being used to recover solid fuel in other jurisdictions and on the thermal technologies that can process this fuel. Many of the technologies that would be used to thermally treat the solid recovered fuel (e.g. gasification) in System 2(b) are regarded as 'new technologies', with active research and development, but much less of a track record than the technologies that are currently available to combust residual waste in System 2(a).

Should Durham and York Regions not meet their projected waste diversion targets within the currently planned timeframe, System 2(b) could be utilized to capture additional recyclables and compostables in the waste stream that have not been source separated by residents. This will, contribute to the Regions' overall respective waste diversion rates.

It is therefore recommended that, pending the approval of System 2(a) as the preferred residuals processing system, the competitive process used during the evaluation of "Alternative Methods" allow for the submission of proposals to implement both System 2(a) and System 2(b), and that the final decision on the technologies used to implement the preferred residuals processing system be based on the results of this competitive process.

8.2 Role of "At–Source" Diversion

The Report on Additional "At-Source" Diversion, included as Annex C-1, examined the potential for additional at-source diversion and provided projections of future waste quantities, diversion performance and composition of materials requiring management and disposal over the 35-year planning period from 2011 to 2045.

The projected recovery rates and the overall at-source diversion rate for both Durham and York reflect the implementation of both municipalities' approved waste management plans that have been designed to achieve a 60% diversion target by 2011.

Considering Durham and York Regions' policies and, proposed provincial policies, in combination with a review of the current waste characterization and the diversion potential of various waste management programs (i.e., combining the at-source reduction, curbside and depot collection programs), it was concluded that it was reasonable to assume for the purpose of waste quantity projections and assessing disposal alternatives that both municipalities would achieve a 60% at-source diversion rate over the planning period. In the longer term it is difficult to predict what will be achieved but diversion rates may well increase beyond 60%. For planning purposes it is assumed that the diversion rate will increase from 60% to 75% over the course of the study period.

Achievement of 60% at-source diversion will require significant improvements in the participation and capture rates for materials that can be diverted by the sectors serviced by existing and planned municipal diversion programs. The material recovery rates used in the analysis of the role of at-source diversion were reasonably aggressive, assuming high participation and capture rates, and full implementation of both Durham and York's planned waste diversion systems. This includes the assumption that both municipalities would implement various measures to maximize diversion system performance, such as:

- Incentives and/or disincentives for all sectors to ensure appropriate behaviour by the users of the system (e.g. container limits, user fees, by-law enforcement); and
- Promotion and education campaigns, using a variety of mediums to reach the target audience.

Future initiatives that may still be required to achieve 60% diversion and that would be required to increase diversion to 75% include the following:

- Disposal taxes/advance disposal fees to support diversion initiatives and/or create a disincentive to dispose;
- Stewardship programs that promote increased container recovery rates (i.e., deposit-return programs);
- Extended Producer Responsibility programs that promote systemic changes in the production of products and packaging, which reduce the overall municipal requirements to manage residual materials; and
- The transition from a consumer to a conserver society.

It must be noted that this later grouping of initiatives fall primarily outside of municipal jurisdiction and control. The potential for additional at-source diversion associated with such initiatives will be considered during the determination of the optimal size and potential throughput of the thermal treatment component of the system to be undertaken as an initial step in the evaluation of "Alternative Methods" (siting).

8.3 Role of Thermal Processing and Energy Recovery

The role of thermal processing is to manage the majority of the post-diversion residual waste, and to recover energy from the combustible portion of the residual waste stream.

The main type of commercially available thermal treatment technologies is combustion. A detailed description of this technology is included in Annex C-2. This type of thermal treatment option has been developed and operates on a commercial scale in North America and elsewhere, and is capable of meeting the requirements of Ontario's regulatory environment. In addition, new technologies such as gasification may be capable of meeting the requirements of Ontario's regulatory environment.

In combustion technologies, hydrocarbons in the waste stream are converted to thermal energy, carbon dioxide, and water. Thermal energy is used to generate steam, which can then be used to generate electrical energy. If the facility is located within reasonable proximity to a suitable load; heat (e.g., steam or hot water) as well as electricity can be sold. If such a co-generation opportunity can be found; the overall thermal efficiency of the process is significantly improved.

Ash is discharged from the bottom of the grate and is quenched. Exhaust gases from combustion, primarily water and carbon dioxide, are cleaned prior to being emitted to the atmosphere.

Gasification technologies involve the thermal breakdown of solid materials into a synthetic gas (syngas) and a solid char residue. 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. As with the combustion technologies discussed above, electricity, heat, or both electricity and heat can be produced and sold.

The decision on the specific thermal treatment technology that would be used for implementation of the preferred disposal system will be made through a competitive procurement process undertaken as part of the evaluation of "Alternative Methods" of implementing the undertaking.

8.4 Role of Material Recovery

After thermal treatment, mechanical treatment will be utilized to recover metals (primarily ferrous metal and some aluminium metal) from the ash or char. Mechanical treatment processes are capable of recovering the majority of the metals found in the residual waste stream that remain in the bottom ash/char.

The selection of an appropriate thermal treatment technology undertaken through the competitive procurement process during the evaluation of "Alternative Methods", will address the requirement to maximise recovery of materials from the ash/char that remains after thermal processing.

It should be noted that in some jurisdictions, the ash/char that remains after the removal of metals is stabilized and marketed as a granular construction material increasing the recovery of materials through thermal treatment processes and further minimizing landfill requirements. However, the evaluation of "Alternatives to" has assumed in all cases that it would not be viable to produce and market any Granular "B" products derived from waste that would result from any

alternative systems, given that the current regulatory environment in Ontario does not encourage this practice. In the event Ontario perspectives were to change and the marketing of ash amended Granular "B" construction material were accepted, the diversion achieved under this alternative would increase.

8.5 Role of Landfill

As noted in Section 8.1, it is assumed that in the order of 56,100 tonnes of residual materials would remain after thermal processing on an annual basis, which would require landfill disposal. This material will include:

- Unacceptable materials removed prior to thermal treatment (e.g. construction and demolition waste, some bulky goods that are either non-combustible or cannot be physically managed by the thermal treatment equipment); and
- Ash/Char remaining after material recovery.

These materials will be largely inert, and thus would not have the characteristics of MSW that typically result in nuisance impacts and require management measures when landfilled (e.g. odours, landfill gas generation, leachate generation, etc.). These materials will be denser than MSW and thus could be used as landfill cover and would occupy significantly less space than an equivalent amount of MSW, further minimizing landfill capacity requirements.

In regards to the landfilling of thermal treatment residues, Section 3.2 of the EA Terms of Reference describes the Durham/York inter-municipal agreement which recognizes that if a processing facility(s) is selected as the preferred disposal alternative, that each municipality would be responsible for managing their own share of process residues (e.g. ash, char or stabilized waste stream) and would be responsible for any EA(s) (or arrangements) required to establish disposal capacity for such process residues.

Section 4.1.2 of the EA Terms of Reference notes that each of the proposed processing alternatives will require landfill disposal capacity for process residues. The landfill component will be identified following the identification of the preferred "Alternative To". Options to address that landfill component, depending on the amount of capacity required, may include:

- Contracting to use private sector landfill capacity;
- Identification of new capacity; and/or,
- Establishment of Waste Supply/Residuals Supply Agreements with neighbouring municipalities outside the Greater Toronto Area (GTA).

However, the actual identification of existing landfill capacity and/or siting of new landfill capacity to manage these process residues is outside the scope of this EA Study. During the EA Study, Durham and York will decide whether to pursue this capacity jointly or individually.

8.6 Preliminary Review of Implementation Requirements

Based on the description of the elements of the preferred disposal system, as set out above, an initial indication of the issues/actions that require consideration during the implementation of the preferred system are summarized as follows:

1. Adoption of a formal hierarchy of the integrated waste management system components to reflect the purpose of the undertaking, as follows:
   - At-source Diversion;
   - Thermal Processing (including energy and materials recovery);
   - Landfill Disposal of Residue.
2. Initiation of a review and update of planned diversion strategies, and development of a protocol for future review and continuous improvement.
3. Determination of optimal facility size and throughput and resulting site size requirements, taking into account:
   - The potential future at-source diversion rate;
   - Contingency capacity requirements (as noted in Section 3.3 of the EA Terms of Reference);
   - Opportunities for the provision of disposal capacity beyond that required by Durham and York which may provide an overall environmental and economic benefit to the undertaking and the proponents (also as noted in Section 3.3 of the EA Terms of Reference); and,
   - Undertake waste audits to confirm the composition of the post-diversion residual waste stream.
4. Initiation of a formal competitive procurement process as part of evaluation of "Alternative Methods" of implementing the preferred undertaking. This process will allow for the identification of vendors of the preferred "alternative to" and allow for the confirmation of System 2(a) versus System 2(b) as the preferred approach.
5. Determination of the approach that will be used by Durham and York to secure long-term landfill capacity for the disposal of residues, which will remain after thermal treatment and material recovery. This review will be completed in parallel to the Durham/York Residual Waste Study and falls outside the scope of the approved EA Terms of Reference.

9. Public and Agency Consultation on the Preferred System

With the receipt of the draft report by the Joint Waste Management Group on April 18, 2006 the following activities were undertaken prior to preparation of this final report on the identification of the preferred long-term residuals processing system:

- The report was released to the public and government review agencies for a period of 30 days starting on April 19th, 2006 and ending on May 19, 2006.
- Notification was issued of the availability of the draft report by way of direct contact with the established public and government review agency list and by way of the website and local media for the general public.
- Copies of the draft documentation were forwarded to the public and government agencies in the established contact lists and copies were placed in the local libraries, municipal offices and on the study website for public review.
- Concurrent Public Information Sessions were held in both Durham and York during the evening of May 9, 10 and11th, 2006. These sessions were attended by a total of 303 individuals, and 110 attendees completed and returned a questionnaire providing input on the draft report. The majority of attendees indicated that they strongly or somewhat agreed with the recommended residuals processing system.
- A telephone poll was conducted by Ipsos Reid during the week of May 15th, 2006, reaching 200 individuals in Durham and 200 individuals in York to determine their support for the recommended residuals processing approach. The results of the survey indicated that approximately 80% of the residents of Durham and York agree with building a Thermal Treatment Facility.
- The Joint Waste Management Group scheduled, advertised and held concurrent special meetings in both Durham and York during the day and evening of May 17th, 2006 to receive delegations from interested parties on the draft report and its results. A total of 18 delegations were received in Durham and 16 in York. The majority of delegations supported the recommended residuals processing system, and those that did not were highly supportive of increased diversion efforts in both municipalities.
- Comments received during the draft report review period were documented and included in this final report in Annex F. Comments received were considered and addressed, as appropriate, during finalization of this report.

The results of the consultative process indicate that:

- A significant majority of the public (approximately 80%) that participated in the consultative process agreed with the consultants' recommendation the preferred system is *System 2(a) – Thermal Treatment of MSW and Recovery of Energy followed by Recovery of Materials from the Ash/Char.* It was recognized that new technologies categorized in System 2(b) – Thermal Treatment of Solid Recovered Fuel may ultimately offer important benefits and as a result

the competitive process used during the evaluation of "Alternative Methods" should allow for the submission of proposals to implement both System 2(a) and System 2(b), with the final decision on the technologies used to implement the preferred residuals processing system being based on the results of this competitive process.

- The majority of those (57%) that did not agree with the recommended preferred system generally supported increased diversion activities, including extended producer responsibility and expansion of the municipal diversion system. It is recommended that Durham and York continue to support a hierarchy of waste management practices whereby diversion is the priority and continues to manage an increasing percentage of the municipal waste stream over time with a diversion targets of 60% at the beginning of the planning period escalating to 75% towards the latter end of the planning period.

  A minority (29%) of those that did not agree with the recommended system, preferred to continue to export waste to landfill sites outside of the Regions.

10. Next Steps

A copy of the resolution presented and approved by the Durham York Joint Waste Management Group, regarding the preferred residuals processing system is presented in Annex G.

With the approval of the recommended preferred system by the Joint Waste Management Group on May 30th, 2006 the following steps will be undertaken:

- Presentation of recommendations for approval to Durham and York Public Works Committees and councils during June 2006;
- Pending approval of this recommendation, proceeding with the evaluation of "Alternative Methods of Carrying out the Undertaking" as set out in the approved EA terms of Reference (Annex A).