City of Ottawa

Feasibility Study For Waste to Energy and Mixed Waste Processing

Prepared For:
City of Ottawa
110 Laurier Avenue West, Ottawa, Ontario K1P 1J1

Prepared By:
HDR Corporation
300 Richmond Road, Suite 200, Ottawa, Ontario K1Z 6X6

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Acronyms

Acronym	Definition
°C	Degrees Celsius
µg/Rm^3	Micrograms per reference cubic metre
APC	Air pollution control
C&D	Construction and demolition
CAC	Criteria air contaminants
CAD	Canadian dollars
CEA	Comprehensive Environmental Assessment
CH_4	Methane
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
CR	Curbside residential
CY	Cubic yards
DYEC	Durham York Energy Centre
EA	Environmental Assessment
EAA	Environmental Assessment Act
ECA	Environmental Compliance Approval
EOWHF	Eastern Ontario Waste Handling Facility
EPA	Environmental Protection Act
ESP	Environmental Screening Process
EU	European Union
GFL	Green For Life
GHG	Greenhouse gases
GTA	Greater Toronto Area
GWh	Gigawatts per hour
ha	Hectares
HDPE	High-density polyethylene
HSP	Hazardous and Special Products
ICI	Industrial, commercial, and institutional
kg	Kilograms
km	Kilometres
kPa	Kilopascals
kWh	Kilowatts per hour
LFG	Landfill gas
m^3	Cubic metres

Acronym	Definition
mg/Rm^3	Milligrams per reference cubic metre
MECP	Ministry of Environment, Conservation and Parks
MOVES	MOtor Vehicle Emission Simulator
MR/C	Multi-residential/containerized
MSW	Municipal solid waste
MW	Megawatts
MWe	Megawatts electric
MWh	Megawatt hour
MWt	Megawatts thermal
MWP	Mixed waste processing
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides
O&M	Operations and maintenance
OCC	Old corrugated containers
PEI	Prince Edward Island
PET	Polyethylene terephthalate
PFAS	Per- and polyfluoroalkyl chemicals
$PM_{2.5}$	Particulate Matter (< 2.5 micrometers)
RNG	Renewable natural gas
SO_2	Sulfur dioxide
SO_x	Sulfur oxides
SRF	Solid recovered fuel
SROI	Sustainable Return on Investment
SSO	Source-separated organics
Study	Feasibility Study
SWMP	Solid Waste Master Plan
T&D	Tipping and Disposal
TPD	Tonnes per day
TPH	Tonnes per hour
TPY	Tonnes per year
Trail	Trail Road Waste Facility
UK	United Kingdom
US	United States
VKT	Vehicle-Kilometres Travelled
VOC	Volatile Organic Compounds

Acronym	Definition
WA	Western Australia
WCEC	West Carleton Environmental Centre
WMS	Waste Management System
WTE	Waste-to-energy; waste-to-energy facility
WWTP	Wastewater treatment plant
YOE	Year of expenditure

Executive Summary

The City of Ottawa, the Nation's capital and sixth largest City in Canada, has developed and is in the process of implementing a 30-year Solid Waste Master Plan (SWMP) with the aim of decreasing the amount of waste managed by the City and diverting as much waste as possible from landfill. Furthermore, the City's current primary disposal option, the Trail Road Waste Facility (Trail) is nearing capacity in the next 10 to 15 years, which emphasizes the need to identify alternative long-term waste management options to process, recover, and divert the City's remaining residual waste. Trail (per the 2024 Annual Monitoring Report) is forecasted to reach capacity between 2034-2035, based on status quo disposal rates. For the purposes of this Study, HDR has used 2035 as the assumed closing date of Trail, which is in-line with the SWMP.

The City recognizes that there is no single solution to addressing future waste management challenges and developed the SWMP to address these issues through a multi-pronged approach, including looking for opportunities to maximize recovery of resources and energy in an environmentally sustainable manner.

The Waste Recovery and/or Treatment Facility Study Action Suite within the SWMP recommends the City advance a Feasibility Study and Business Case during the short-term to identify technology options that can reduce the amount of waste sent to landfill and potentially recover additional resources and energy. The City retained HDR Corporation (HDR) and KPMG to undertake the Feasibility Study and initiate the draft Business Case to evaluate the potential economic, environmental, and social impacts of implementing each of the long-term waste management options. The objective of these studies was to prepare a comprehensive, up-to-date, and substantiated comparison of the options for the future of residual waste management for the City of Ottawa. The City is also committed to managing residents' residual waste over the next 30 years and a guiding principle from the SWMP is "keeping waste local by treating residential waste within the City's boundaries, wherever operationally and economically feasible". These two points were considered throughout the preparation of the Feasibility Study.

The five options evaluated as part of the Feasibility Study are:

Option 1: Status Quo and Private Facilities. Under this option, the City would continue to dispose of non-diverted waste for final disposal at Trail until it reaches capacity (estimated to be in 2035) and then negotiate waste supply agreements for disposal with one or several regional third-party waste management facilities.

Option 2: WTE Facility. Under this option, the City would build a new WTE facility that can process all of their non-diverted waste with disposal of rejects and ash residue at a third-party waste management facility.

Option 3: MWP Facility. Under this option, the City builds a MWP Facility that can process all of the City's non-diverted waste, recover additional recyclables and dispose of the remaining process residuals at a private third-party waste management facility.

Option 4. WTE and MWP Facilities. Under this option, the City builds an MWP Facility to recover additional recyclables and builds a WTE facility to process and recover energy from the remaining residual waste. Reject and ash residue from WTE will be disposed of at a private third-party waste management facility.

Option 5. Construct a New Landfill. Under this option, the City builds a new greenfield landfill within the region to take all non-recyclable residuals after Trail reaches capacity.

To successfully implement any of the options above, the City will need to undertake a planning and siting process, identify a preferred procurement and delivery approach, consider funding availability and opportunities, obtain the necessary regulatory and environmental approvals, and ultimately construct, operate, and maintain a solid waste management facility. Prior to the development of this Feasibility Study, a series of technical memorandums were developed that provided detailed background information and analysis on the different technology options and the steps that would be required for successful implementation. These technical memorandums, provided in the appendix, and the information therein were used to support the evaluation of the five (5) options in the Feasibility Study.

A critical aspect of the Feasibility Study was summarizing the information compiled in the technical memorandums to perform a comparative evaluation of the five (5) solid waste management options. This included the development of key evaluation criteria subsets that were applied to each option, taking into consideration the potential environmental impacts, social impacts, economic impacts, and technical characteristics. A summary of the characteristics of the key evaluation criteria subsets are provided below:

i. The environmental criteria subsets assessed the nature of the potential impacts to the environment (e.g., air, water, land) that a technology or option may pose. Protection of the environment and public health was a key factor in evaluating whether the technology(ies) can be implemented in the City.

ii. The social criteria subsets assessed the potential impacts to the social environment, where the implementation of a specific technology could impact the way people live and interact in the area around the facility.

iii. The economical criteria subsets assessed the capital and operating costs of the technology or waste processing system, potential revenues produced by the option, and the overall financial feasibility.

iv. The technical criteria subsets assessed the commercial readiness of the technology, the technology's flexibility and suitability to handling the City's waste stream, and considered the operational history of all process steps, from waste receipt through energy conversion to management and recovery of material streams and handling of residuals.

Utilizing both quantitative and qualitative data and information, a weighting and scoring matrix was developed to evaluate, compare, and rank the five options being considered in this Feasibility Study. For each criterion, each option was rated as either most preferred, preferred, neutral, less preferred, or least preferred when compared against the other options. Furthermore, each of the grades were weighted to calculate a score for each criterion to support the ranking of each of the five options being considered. The criteria considered the triple bottom line analysis to identify the potential environmental, social, and financial contributions or impacts of each option versus performing an assessment based solely on a traditional technical or financial analysis.

Error! Reference source not found. presents the results of the scoring of the comparative evaluation for the five solid waste management options considered in the Study.

Table ES-1: Comparative Evaluation Scoring Results

	Status Quo and Private Facilities	WTE	MWP	MWP and WTE	New Landfill
Environmental Requirements					
Energy Recovery Potential	LEAST PREFERRED	MOST PREFERRED	LEAST PREFERRED	MOST PREFERRED	PREFERRED
Landfill Diversion Percentage	LEAST PREFERRED	MOST PREFERRED	LESS PREFERRED	MOST PREFERRED	LEAST PREFERRED
Opportunity to Recover Marketable Commodities	LEAST PREFERRED	PREFERRED	PREFERRED	MOST PREFERRED	LESS PREFERRED
Emissions-Discharges to Air, Land and Water	NEUTRAL	PREFERRED	NEUTRAL	PREFERRED	LEAST PREFERRED
Potential for GHG Impacts	LESS PREFERRED	NEUTRAL	PREFERRED	NEUTRAL	PREFERRED
Social Requirements					
Potential Visual Impacts	NEUTRAL	NEUTRAL	NEUTRAL	NEUTRAL	LEAST PREFERRED
Other Nuisance Impacts	NEUTRAL	PREFERRED	PREFERRED	PREFERRED	LEAST PREFERRED
System Transportation Impacts	MOST PREFERRED	PREFERRED	LESS PREFERRED	PREFERRED	MOST PREFERRED
Potential for Property Value Impacts	MOST PREFERRED	NEUTRAL	NEUTRAL	LESS PREFERRED	LEAST PREFERRED
Opportunity for Community Support	MOST PREFERRED	LESS PREFERRED	NEUTRAL	LESS PREFERRED	LEAST PREFERRED
Economic/Financial Requirements					
Capital Costs	MOST PREFERRED	LESS PREFERRED	PREFERRED	LESS PREFERRED	LESS PREFERRED
Operations and Maintenance Costs	NEUTRAL	NEUTRAL	LESS PREFERRED	LESS PREFERRED	PREFERRED
Revenue Generation Potential	LEAST PREFERRED	MOST PREFERRED	PREFERRED	MOST PREFERRED	PREFERRED
Overall Financial Feasibility	NEUTRAL	NEUTRAL	LESS PREFERRED	LESS PREFERRED	PREFERRED
Technical Requirements					
Technical Complexity	MOST PREFERRED	LESS PREFERRED	LESS PREFERRED	LEAST PREFERRED	PREFERRED
Timing/Schedule Requirements	MOST PREFERRED	LESS PREFERRED	LESS PREFERRED	LESS PREFERRED	LESS PREFERRED
Feedstock Flexibility	NEUTRAL	PREFERRED	LESS PREFERRED	PREFERRED	MOST PREFERRED
Scalability	LESS PREFERRED	LESS PREFERRED	PREFERRED	LESS PREFERRED	PREFERRED
Process Reliability (Risk Potential)	LESS PREFERRED	PREFERRED	LESS PREFERRED	PREFERRED	MOST PREFERRED
Siting Requirements	MOST PREFERRED	NEUTRAL	NEUTRAL	NEUTRAL	LEAST PREFERRED
Approvals/Permitting/Regulatory Requirements for Implementation	MOST PREFERRED	LESS PREFERRED	PREFERRED	LESS PREFERRED	LEAST PREFERRED
Number and Complexity of Contracts	NEUTRAL	LESS PREFERRED	LESS PREFERRED	LEAST PREFERRED	PREFERRED

Based on the results of the comparative evaluation, the five options are ranked below according to the most preferred option to the least preferred option:

1. **Option 2: WTE Facility (tie)**
1. **Option 1: Status Quo and Private Facilities (tie)**
3. **Option 4: WTE and MWP Facility**
4. **Option 3: MWP Facility**
5. **Option 5: New Landfill Facility**

The WTE facility option ranked in a tie for first as this option is assumed to offer significant environmental benefits, including a 77% landfill diversion rate and energy recovery, which aligns with the City's strategic priorities. However, the implementation of WTE technology presents substantial capital costs ($497 million – $862 million), a complex regulatory approval process, and potential public opposition. While WTE has the potential for long-term cost stabilization through energy revenue, its financial viability remains contingent on securing funding and identifying an appropriate delivery model that could potentially support some form of private investment in the facility.

The Status Quo and Private Facilities option also ranked first in the evaluation. Under this option, the City would continue disposing of non-diverted waste at Trail until it reaches capacity, after which waste would be sent to a regional third-party waste management facility for final disposal. This option ranked higher due to the minimal capital investment, regulatory simplicity, and ease of implementation. However, this option also exposes the City to long-term financial and environmental uncertainty and risks, because the City does not control the privately-owned solid waste management facility assets. The risks associated with the Status Quo and Private Facilities option include potential escalating landfill tipping fees, reducing airspace and/or capacity at regional waste facilities, limited control over disposal operations, and increased GHG emissions from waste transportation.

If the WTE facility option is ultimately selected as the preferred long-term approach for the City, the next steps in the implementation process will require detailed and careful planning. Based on changes to the Ontario Regulations (O.Reg. 101/07) since the implementation of the Durham York Energy Centre, specifically related to the Environmental Screening legislation, the approvals process could be shortened considerably from the timelines identified in the Study. A recent example of a WTE facility that has gone through the screening process is the planned redevelopment of the Emerald Energy from Waste Facility in Brampton, Ontario, which was completed early in 2025. At a minimum, the Environmental Screening process would allow the City to undertake a number of activities (including siting and some of the facility procurement) in advance; however, the City can decide to undertake, or the MECP has the option, to recommend a full EA status should the City or Minister deem it appropriate.

Depending on the preferred option selected, other preliminary next steps for the City would include performing a more detailed siting analysis, further refinement of design assumptions and the associated costs that will be used to finalize the Business Case. The refined design assumptions and criteria for the preferred option could also be used to perform a more in-depth market analysis for potential technology vendors, further evaluation of the risks and opportunities associated with different procurement and delivery models, funding options, and offtake agreements.

1 Introduction

1.1 Background

The City of Ottawa, the Nation's capital and sixth largest City in Canada, is in the process of implementing a 30-year Solid Waste Master Plan (SWMP) with the aim of decreasing the amount of waste managed by the City, diverting as much waste as possible from landfills, and looking for opportunities to maximize recovery of resources and energy in an environmentally sustainable manner. Furthermore, the City's current primary disposal option, the Trail Road Waste Facility (Trail) is nearing capacity in the next 10 to 12 years and waste management options to potentially extend the life of Trail will need to be determined. In addition, the current available and approved capacity for existing landfills within the Province is anticipated to be depleted within approximately 10 years. If there is no additional landfill capacity approved in Ontario during this period, the potential risks and competition for any remaining airspace could significantly drive up the cost of disposal for the City and other municipalities. This lack of available capacity and the potential risks associated further contribute to the City's objectives to divert as much waste as possible from final disposal at landfills.

The City recognizes that there is no single solution to addressing future waste management challenges and has developed the SWMP to address these issues through a multi-pronged approach. The recommendations outlined in the SWMP span the collection and management of waste from curbside-residential and multi-residential homes, parks and other public spaces, City facilities and operations, and existing partner programs. The key factors that were considered in developing the recommendations in the SWMP were the following: 1) the role of all three levels of government in Canada (i.e. federal, provincial, and municipal); 2) the impacts of climate change; 3) leveraging innovation and technology alternatives to traditional methods of waste processing and disposal; and 4) consideration of the waste management hierarchy with the aspirational goal of moving the City closer to its Zero Waste vision for the future.

Based on these considerations and key factors, the City identified 50 SWMP Actions that are laid out by short-term (0-5 years), medium-term (5-10 years), and long-term (>10 years) time frames. Five objectives were developed to present and measure how the recommended SWMP Actions would directly impact achieving the City's Zero Waste vision. The five SWMP objectives are:

1. **Maximize the Reduction and Reuse of Waste.** Actions under this objective are prioritized to begin in the short-term time frame to immediately decrease the waste generated and minimize the amount of waste that needs to be managed at a disposal facility.
2. **Maximize the Recycling of Waste.** Actions under this objective will have the biggest impact on diversion from landfill and potential reduction of greenhouse gases (GHGs) and will be prioritized in the short-term time frame.
3. **Maximize the Recovery of Waste and Energy and the Optimal Management of Remaining Residuals.** Actions under this objective will be assessed in the short-term and if deemed feasible, implemented over the medium and long-term time frames to address the immediate and future need to extend available landfill capacity and to extract maximum resources and energy from the remaining residual waste stream.

4. **Maximize Operational Advancements.** Actions within this objective support operational advancements through innovation and new technology to make operations more efficient and to reduce impacts on the environment.
5. **Develop a Zero Waste Culture Across the City.** Actions under this objective will educate residents on how they can contribute to the City's goal of a Zero Waste future, and influence industry and the wider community to reduce, reuse, and divert waste.

The Waste Recovery and/or Treatment Facility Study Action Suite within the SWMP recommends the City advance a Feasibility Study and Business Case during the short-term to identify a technology(ies) that can reduce the amount of waste sent to landfill and potentially recover additional resources and energy. As per the motion passed at the City's Environment and Climate Change Committee on November 21, 2023, and carried by Council on December 6, 2023, this project has been undertaken ahead of the timelines in the SWMP.

The City retained HDR Corporation (HDR) to conduct the Feasibility Study and draft Business Case to compare the Waste-to-Energy (WTE) and Mixed Waste Processing (MWP) scenarios identified in the SWMP as the preferred alternatives for extracting maximum resources and energy from the remaining residual waste stream and reducing reliance on landfilling.

1.2 Study Objective

The objective of this Feasibility Study (Study) is to prepare a comprehensive, up-to-date, and substantiated comparison of the options for the future of residual waste management for the City of Ottawa. The conclusions and recommendations within the Study will support the business case so City staff can make informed recommendations for a long-term strategy to present to Council. The requirements to establish a WTE, MWP and/or a new landfill will be clearly defined and the viability of each scenario will be fully assessed, explained and contrasted. The two alternative technologies being considered as part of this action, specifically WTE (i.e. mass burn incineration with energy recovery) and MWP, or a combination of these two technologies, will be compared to the existing disposal scenarios (the Status Quo and Private Facilities option) and a new landfill option for the future long-term processing and/or disposal of residual waste streams.

The City is committed to managing residents' residual waste over the next 30 years and a guiding principle from the SWMP is "k*eeping waste local by treating residential waste within the City's boundaries, wherever operationally and economically feasible".* These two points are considered throughout the Study and Business Case.

The five scenarios being considered in this Study are defined as the following:

- **Option 1: Status Quo and Private Facilities.** Under this option, the City would continue to dispose of non-diverted waste for final disposal at Trail until it reaches capacity (estimated to be in 2035) and then negotiate waste supply agreements for disposal with one or several regional third-party waste management facilities.
- **Option 2: WTE Facility.** Under this option, the City would build a new WTE facility that can process all their non-diverted waste with disposal of rejects and ash residue at a third-party waste management facility.

- **Option 3: MWP Facility.** Under this option, the City builds a MWP Facility that can process all of the City's non-diverted waste, recover additional recyclables, and dispose of the remaining process residuals at a private third-party waste management facility.
- **Option 4. WTE and MWP Facilities.** Under this option, the City builds a MWP Facility to recover additional recyclables and builds a WTE facility to process and recover energy from the remaining residual waste. Reject and ash residue from WTE will be disposed of at a private third-party waste management facility.
- **Option 5. Construct a New Landfill.** Under this option, the City builds a new greenfield landfill within the region to take all non-recyclable residuals after Trail reaches capacity.

The detailed scenario descriptions, assumptions, siting/approvals requirements, potential funding options, delivery models, and the evaluation methodology were outlined in the previously prepared Technical Memorandums 1 through 4, which can be found as attachments to this report. The detailed information provided in those referenced Technical Memos is also summarized in the body of this Study. The Study and Business Case will provide recommendations that will be presented to City Council for the processing of the City's residential residual waste for the next 30 years and beyond. The completed evaluation can assist the City with identifying and ranking the preferred technology scenario/options.

1.3 Feasibility Study Approach and Report Organization

A summary of the Study approach and report organization is shown in **Table 1-1**. As described in Section 1.2, the objective of this Study is to evaluate and prepare a comprehensive, up-to-date, and substantiated comparison of the five (5) possible scenarios identified to determine which option (or combinations of options) could be commercially deployed and successfully integrated into the City's future residual waste management system. To meet this objective, this Study uses a stepwise approach where each step in the process involves a greater level of detail to successively refine and rank the list of alternative residual waste management options. As noted above, the conclusions and recommendations within the Study will support the development of a draft and final business case so City staff can make informed recommendations for a long-term strategy to present to Council.

Table 1-1: Feasibility Study Approach and Report Organization

Report Section	Approach
Section 2.0: City-Generated Waste Characteristics	Presents waste and diverted materials quantity and composition estimates using data from existing City of Ottawa studies and plans, including the 30-year Solid Waste Master Plan. Identifies waste and diverted material classes that could be directly diverted or processed for use as a WTE and MWP technology feedstock.
Section 3.0: Overview of Scenarios and Background Summary	Presents a summary overview of the detailed information provided in standalone Technical Memo No.1 that describes each of the five (5) scenarios being evaluated, including the WTE and MWP technology options, plus best management practices, and current industry trends.
Section 4.0: Overview of Siting and Approvals Requirements	Presents a summary overview of the detailed information provided in standalone Technical Memo No. 2 that defines the general siting criteria and the varied planning and approvals requirements for each scenario. A site-specific review was not part of the scope of this Study.

Report Section	Approach
Section 5.0: Overview of Project Delivery Models and Funding Opportunities	Presents a summary overview of the detailed information provided in standalone Technical Memo No. 3 that focuses on the varied project delivery models and potential funding opportunities available to each scenario, as well as a summary of the independent market sounding that was performed to inform some of the conclusions in the technical memos and this Study.
Section 6.0: Evaluation Methodology and Approach	Presents a summary overview of the detailed information provided in standalone Technical Memo No. 4 that summarized the criteria and methodology that was used to evaluate each scenario and perform a triple bottom line analysis that included environmental, social, and financial considerations.
Section 7.0: Evaluation Summary, Conclusions, and Recommendations	Presents a summary of the evaluation, including how each scenario was ranked in comparison to each other, as well as provide conclusions, recommendations, potential risks, and potential next steps in pursuing one or a combination of solid waste management options.

2 City-Generated Waste Characteristics

Waste and diverted materials quantity and composition estimates (or waste characteristics) are key planning elements in development of long-term waste management projects. The planning elements are important in sizing waste management facilities to ensure that sufficient capacity is allowed for disposal, material handling, processing, energy generation (if applicable), and process by-product/residue management. The following elements can significantly affect design and operation of the scenarios being considered, adding to the importance of developing accurate estimates during the planning phase:

- Suitability of a particular choice of processing;
- Potential for impacts and needs for mitigation resulting from processing and/or landfill disposal;
- Energy content and recovery potential of the waste being processed; and,
- Quantity and nature of residues resulting from processing.

The methodology and results in estimating waste and diverted materials quantity and composition completed for this Study are described in the following sections. The existing waste generation and composition projections identified below were developed as part of the SWMP and evaluates influencing factors, such as regulation, legislation, and operational or programmatic changes that may impact these projections.

2.1 Waste Projections Methodology

Waste generation by households is closely linked to factors such as economic growth, job markets, household income, and others. Understanding waste projections and waste stream composition is a key element of the planning process, as it allows the City's decision makers and planners to identify the long-term needs of the system and effectively plan waste management programs. By understanding how the City's waste management needs may change in the short to long term, the City can make effective and efficient decisions about waste management programs and services and allow for the proper "right-sizing" of supporting infrastructure that will need to be developed and/or maintained.

Waste projection forecasting for the period between 2024 to 2053 was undertaken as part of the SWMP using data based on the City's current programs and policies alongside real waste data from 2019. The approach taken to develop the projections for the SWMP was to relate the annual curbside residential (CR) and multi-residential/containerized (MR/C) tonnage per household to annual socio-economic indicators specific to the City. This was observed over a 10-year period (2010 to 2019). A linear regression modeling approach was applied to historical data provided by the City that considered current and future socio-economic indicators to estimate future annual waste generation values for the SWMP planning period.

The waste projections and data described in this section were reviewed in detail by HDR as part of the standalone Technical Memo No. 1 to form the design basis for the five scenarios being considered for the Study.

2.2 Waste Generation Estimates

In 2021, the City's population was estimated to be just over 1,064,000 people based on the City of Ottawa's Official Plan (Section 3: Growth Management Framework). [1] The City's population is projected to grow to an estimated 1.5 million people by 2053. [2] The City may alter these population estimates based on additional information. The Ministry of Finance is forecasting an even higher population increase, and as a result, the City should consider updating the waste projections and Official Plan as required if the future projected population is underestimated.

Table 2-1 shows a breakdown of projected waste generation by source over the next 30-year planning period, as obtained from the SWMP.

Table 2-1: Projected Waste Generation by Source (tonnes)*

Year	Curbside-Residential	Multi-Residential	City Facilities	Parks & Public Spaces	Hazardous & Special Products (HSP)	Non-Residential Waste	Total Waste Generation
2024	268,800	69,000	25,100	1,900	700	37,400	403,000
2029	289,300	73,100	26,900	2,000	800	37,400	429,600
2034	308,600	76,500	28,700	2,100	800	37,400	454,200
2039	326,600	79,500	30,200	2,200	900	37,400	476,800
2044	342,200	82,200	31,600	2,300	900	37,400	496,600
2049	355,300	84,300	32,800	2,500	1,000	37,400	513,200
2053	367,400	86,300	33,900	2,600	1,000	37,400	528,600

* Tonnage represents all waste generated prior to any diversion.

Source: City of Ottawa SWMP (June 2024) – Table 3: Projected Waste Generation By Source (tonnes)
The City has a well-established green bin program that diverts curbside residential household organics, multi-residential household organics, City facility household organics, and leaf and yard waste (aggregately referred to as source-separated organics (SSO)). Therefore, the total tonnage projected for disposal at the Trail or alternate location is significantly less as shown in **Table 2-2** below.

[1] City of Ottawa – Official Plan - Section 3. Growth Management Framework.

[2] Solid Waste Master Plan June 2024 prepared by the City of Ottawa.

Table 2-2: Garbage and Bulky Waste Disposal Projections by Sector (tonnes)

Year	Curbside-residential	Multi-residential	City Facilities	Parks & Public Spaces	Total Waste Generation
2024	124,600	55,400	19,200	1,800	201,100
2029	134,100	58,700	20,600	2,000	215,400
2034	143,000	61,300	21,900	2,100	228,400
2039	151,400	63,600	23,100	2,200	240,300
2044	158,600	65,700	24,200	2,300	250,800
2049	164,700	67,400	25,100	2,400	259,500
2053	170,300	68,900	25,900	2,500	267,600

Source: SWMP – Table 3: Projected Waste Generation By Source (tonnes)

Table 2-3 provides a summary of the anticipated waste generation tonnages for the end of the -30-Year planning period in the SWMP (2053) that would require landfill disposal or processing by the WTE, MWP, or combination of the technology options. The 2053 projections of the waste generated in **Table 2-3** are divided into two parts: the “status quo” tonnage is based on the assumption that the current diversion programs within the City remain in place and that some of the impacts described in the SWMP are not successful in increasing diversion during the 30-year planning period; and, the “SWMP Diversion” tonnage assumes the City is successful implementing all of the diversion programs identified in the SWMP. For purposes of the Study, the ”status quo” tonnage of **267,600** tonnes per year was used to evaluate the technical, environmental, and financial impacts of each of the five scenarios. The status quo tonnage was selected as being more conservative for developing the facility sizes and the probable capital and operating cost estimates included in the standalone Technical Memos and the Study.

Table 2-3: Current and Anticipated Waste Generation Volumes

Type of Waste	2024 (Tonnes)	2053 (Tonnes) “Status Quo”	2053 (Tonnes) SWMP Diversion
Garbage and Bulky Waste	201,100	267,600	199,500

2.3 Waste Composition Estimates

The City performed an audit in 2019 to estimate the material composition of the waste stream after material was diverted by residents. The waste breakdown from the audit was provided in **Table 2-24** of Technical Memorandum No. 1. Separate audits were performed for the four sources identified earlier in **Table 2-2**. **Table 2-4**: Waste Composition Breakdown by Material Type

below shows the materials that were sorted from the waste stream during those audits and the percentage of each material that comprises the aggregated garbage and bulky waste streams. HDR used the material composition data from the 2019 Waste Audit presented in **Table 2-4** to estimate the tonnage of potentially recoverable material from a MWP facility, and to assess the potential energy content in the waste stream that will be considered in the design of the WTE facility scenario.

Table 2-4: Waste Composition Breakdown by Material Type

2019 Waste Audit Materials Grouped by Material Classification	2053 Tonnage Projections (Tonnes)	Percentage of Waste[1]
Fiber Material[2]	21,008	7.9%
Other Organics[3]	118,795	44.4%
Traditional Recyclables[4]	47,529	17.8%
Glass	7,461	2.8%
C&D Material[5]	23,797	8.9%
Mixed MSW[6]	49,009	18.3%
Total	**267,600**	**100.0%**

Notes:
[1] Based on material composition percentages from 2019 Waste Audit
[2] Old corrugated containers (OCC)/mixed paper
[3] Food waste/yard trimmings
[4] 1-7 plastics, metal
[5] Bricks, concrete, lumber
[6] Material determined to have no recoverable value at time of waste audit (i.e., diapers)

Based on the review of the projected City-generated waste characteristics, it was determined that the waste quantity and composition feedstock will be compatible with all five scenarios being considered in the Study.

3 Overview of Scenarios and Background Summary

This section provides a description of the five scenarios described in Section 1.2. A standalone technical memo (Technical Memo No. 1) was prepared that describes each scenario in more detail, including potential pros and cons, planning-level costs, and implementation considerations, and is provided in the Appendix. This section and the information provided in Technical Memo No. 1 is based on HDR's relevant industry experience and research into these types of technologies, including recent site tours and direct involvement in the planning, design, and implementation of similar projects. A jurisdictional scan of recent WTE and MWP projects in Canada, the United States (US), United Kingdom (UK), Europe, Australia, and some parts of Asia was also conducted to provide a broader context of some of the challenges, opportunities, and costs associated with these types of projects. It should be noted that due to evolving technological advances in the waste processing industry, not all new and/or evolving technologies in development now or in the near future could be included in this analysis.

It should be noted that Trail will eventually close and long-term post-closure management will be required regardless of the scenario. The environmental and financial benefits from collecting landfill gas that is captured from the closed Trail facility will be the same for each scenario, so it is not considered in the evaluation. The same is true for any post-closure financial costs for Trail and any environmental or social implications of having a closed landfill. These have not been included in the evaluation of scenarios.

3.1 Option 1: Status Quo and Private Facilities Scenario

As noted previously, under the Status Quo and Private Facilities scenario, the City would continue to dispose of non-diverted residual waste at Trail until it reaches capacity sometime in the next ten years. Sometime before Trail reaches capacity, this scenario assumes the City will negotiate long-term waste supply agreements with one or several regional third-party owned waste management facilities for disposal of City-generated wastes. If those facilities are at end of life, then the City will need to secure another third-party waste management facility to cover the balance of their waste disposal services over the next 30-year term.

3.1.1 Scenario Description

Trail is the second largest municipal landfill in Ontario and has been a key asset for the City since it first opened to receive waste in May 1980. Currently, all garbage collected by the City is brought to Trail for final disposal. Trail is permitted to accept solid, non-hazardous waste generated from within the boundaries of the City on a 153-hectare site, of which 85 hectares is currently approved for landfilling. The landfill operates above industry standards and includes a robust gas collection system to capture methane gas. According to the City, the gas collection system can capture up to 90 percent of the methane gas generated that is then converted into electricity using reciprocating engine generators that is operated by a private third-party company. The electricity generated from Trail's landfill gas-to-energy system is capable of powering up to 6,000 homes. According to the analysis performed as part of the SWMP, the Trail has a total approved capacity of 16.9 million cubic metres. As of 2022, it is estimated that there was only approximately 3.5 million cubic metres of air space remaining and that the Trail would reach full capacity sometime between 2034 and 2036 at the current rate of usage.[3] For the purposes of the Study, the Status Quo and Private Facilities scenario only considered the current permitted capacity of Trail and that the facility will reach capacity by 2035.

As a component of this option, waste would be transferred by the City starting in 2035 to a third-party waste management facility (whether currently in existence or a facility developed in the future (e.g. after 2035)) for processing to remove recyclable material and/or for final disposal within a landfill site approved to receive waste from the City of Ottawa (e.g. the Site's service area being the Province of Ontario). For this option, it is understood that the available landfill capacity in Ontario is expected to decrease and have extremely limited capacity (if not none) within the next 10 years unless additional airspace/capacity is approved by the Province.

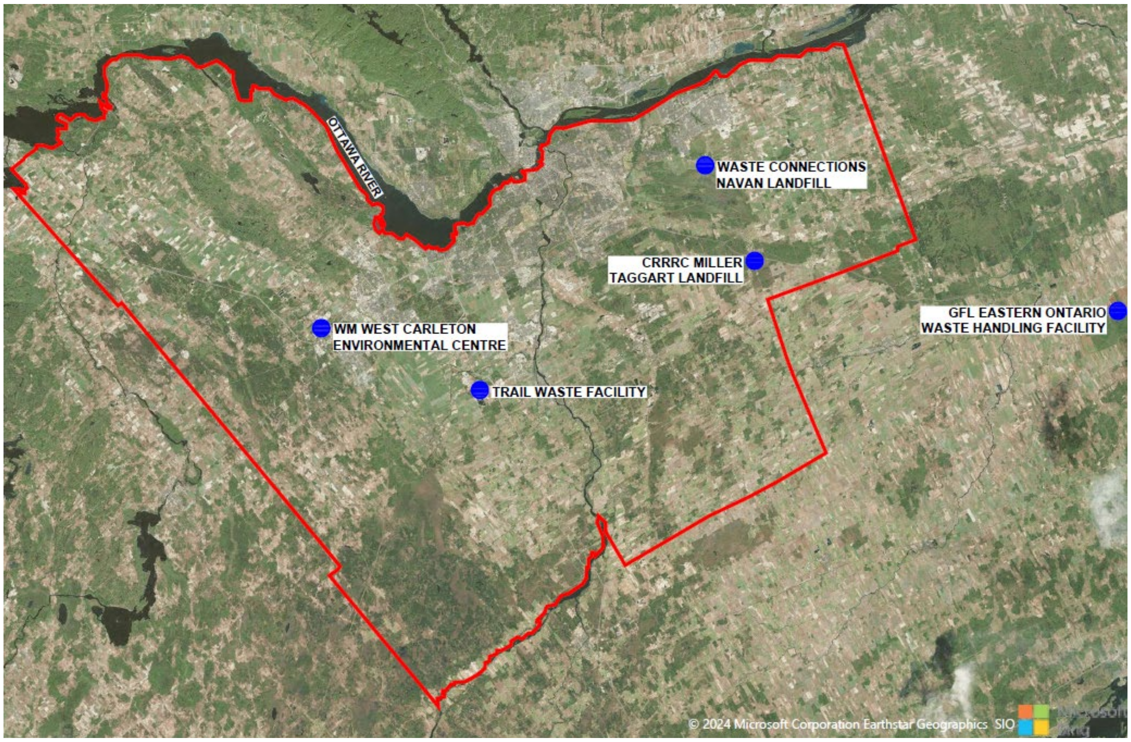
Currently, in addition to Trail, eastern Ontario has up to four (4) landfill waste management facility sites that are owned and operated by the private sector. Of the four private sector-owned landfills, only two (GFL's Eastern Ontario Waste Handling Facility and WM's Carleton Environmental Centre) have available capacity and are currently operational and approved to receive residential waste. These sites were both recently approved for expansion and have annual receiving rates of approximately 755,000 tonnes per year and 400,000 tonnes per year over an anticipated lifespan of 25 and 20 years, respectively. These sites have the potential to receive portions or all of the City's waste for the majority of the City's 30-year planning period. A third privately owned waste management facility (the Capital Region Resource Recovery Centre or Miller Taggart Landfill) received permission from the Ministry of Environment, Conservation, and Parks (MECP) to receive and landfill residential waste, but has not been constructed and is not operational at this time. When operational, the Miller Taggart Landfill site is anticipated to receive up to 450,000 tonnes per year over a 25-year lifespan. Waste Connections of Canada's Navan Landfill is currently permitted to only accept IC&I waste. Curbside waste is currently not approved for disposal at this site. The timeline for each of these sites is dependent on the remaining capacity, the approved receipt capacity, and the actual annual waste receipts. These sites are not governed by waste diversion; however, many facilities now include diversion facilities to maximize potential tipping/processing fees. These actions could potentially result in those sites lifespans being extended.

The City would need to enter into waste disposal agreements with one or more of these third-party waste management facilities for the disposal of City-generated waste after the closure of Trail landfill. It is important to consider that the current available and approved capacity for existing landfills within the Province is anticipated to be depleted within the next 10 years. As a result, there could be considerable competition from other communities and jurisdictions for the available landfill or other waste processing capacity in eastern Ontario given the shortage in available waste disposal capacity throughout the province. This could significantly impact the future disposal capacity that would be available to the City and will likely drive up the disposal costs offered by the private third-party owners. The City will also need to consider entering into third-party disposal agreements after the closure of Trail regardless of which one of the alternative scenarios is selected. Both the WTE and MWP options will require at least some future disposal capacity to handle by-product residual waste streams generated by both technologies.

[3] City of Ottawa, Solid Waste Master Plan, June 2024

An aerial photo showing the approximate location of the Trail and the other privately-owned regional waste facilities within the boundaries of Ottawa are shown in **Figure 3-1**.

Figure 3-1: Aerial Photo of Regional Waste Facility Options Near Ottawa



3.1.2 Scenario Costs

There is no additional capital costs anticipated under the Status Quo and Private Facilities scenario since this option only considers existing infrastructure. The volume of waste to be managed utilizes the assumptions shown in **Table 2-2**. If the City is successful in receiving approvals to expand Trail, there will be additional capital costs incurred to build a new cell, but this was not considered as part of the Study. The preliminary opinion of probable operation and maintenance (O&M) costs are based on the assumption that the private third-party waste management facilities will charge a minimum tipping fee of $150 per tonne by 2035. Given the anticipated competition for remaining disposal capacity in eastern Ontario over the next 10 years, a sensitivity analysis using tipping fees of $250/tonne was also evaluated, which is detailed at the end of Appendix A. Cost inflation/tipping fee increases were applied throughout the planning period as highlighted in the evaluation results in Section 7 and discussed in further detail in Appendices B and C.

The landfill gas-to-energy system at Trail is currently operated under a third-party agreement between the City and PowerTrail that expires in 2027. The City does receive a portion of the revenues generated by the Trail gas-to-energy system through the agreement with PowerTrail, but it is not anticipated that the City will receive any revenues for the gas generated from one of the private third-party waste management facilities that may receive the City's non-diverted waste after the closure of Trail. The revenue from the existing agreement between the City and PowerTrail is noted but not included in the evaluation of potential revenues for this scenario.

From a GHG perspective for the third-party waste management facilities, it is noted that the City tracks community and corporate GHG emissions through annual GHG inventories. A third-party waste management facility would fall under community GHG emissions.

3.2 Option 2: WTE Facility Scenario

As noted previously, under this option, the City would procure and construct a new WTE facility that can process all their post-recycled residual waste with disposal of rejects and ash residue to a third-party waste management facility. This scenario assumes that the WTE facility would be operational by 2035 to coincide with the projected closure of Trail.

3.2.1 Scenario Description

Mass burn incineration of municipal solid waste is still the dominant WTE technology used when developing new larger and medium-scale facilities. There are currently five (5) operating mass burn incineration WTE facilities operating in Canada, including two in Ontario. There are also approximately 70 operating WTE facilities in the United States, with the majority of these facilities employing mass burn incineration technologies. [4] European and Asian countries view mass burn WTE technology as a favourable alternative to landfilling, with over 2,000 operating units worldwide. There are two main types of traditional mass burn combustion facilities: grate-based with waterwall boiler tubes and modular-based design. Mass burn units with stoker grate furnaces and waterwall boilers are the most prevalent type of medium- and large-scale (processing between 200 TPD and 1,000 TPD per unit) WTE technology operating in North America and globally. Examples of this type of facility include the Durham York Energy Centre (DYEC) in Clarington, Ontario and the Metro Vancouver WTE Facility in Burnaby, British Columbia.

Figure 3-2 provides a typical cross section of a stoker grate-based waterwall mass burn WTE system.

[4] https://www.epa.gov/smm/energy-recovery-combustion-municipal-solid-waste-msw

Figure 3-2: Cross-Section of a Typical Grate-Based Mass Burn WTE Unit

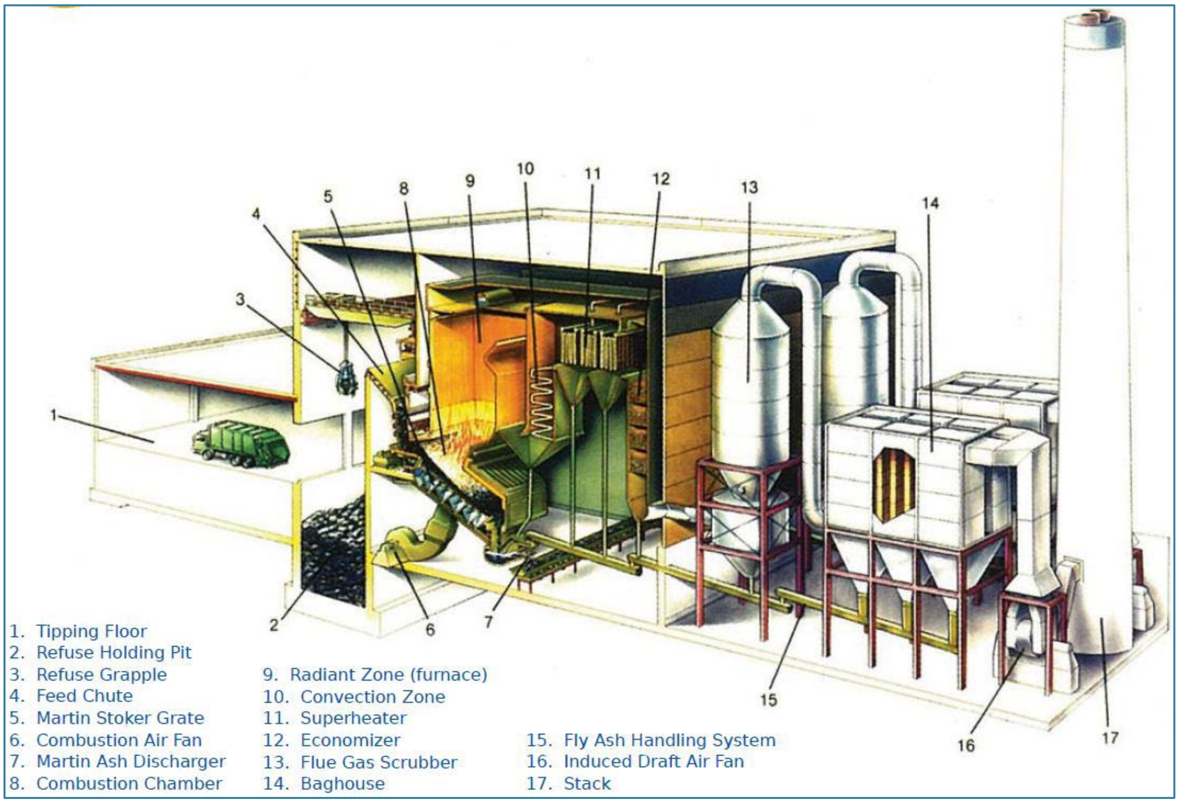


Photo Credit: Reworld™ (formerly Covanta Energy)

Modular-based mass burn WTE units are smaller in scale and typically designed to process between 50 to 100 TPD per unit. There are only a few remaining modular type WTE facilities processing MSW in North America. Examples include the Emerald Energy from Waste Facility in Brampton, Ontario and the Prince Edward Island (PEI) WTE Plant. However, the Study only focused on the stoker grate-based waterwall mass burn WTE technology since it is best suited for the City-generated waste amounts being considered.

WTE mass burn technologies operate by feeding waste using a large overhead crane directly into a hopper. An advantage of mass burn technology is that it requires little to no pre-processing or size reduction of the incoming waste, other than the removal of large bulky items. Waste leaves the hopper and feed chute where it is fed to the furnace and pushed onto a grate by a ram connected to hydraulic cylinders. Combustion air is drawn from the tipping floor and waste storage pit and enters under the grates to support the combustion process, as well as to help prevent odours from leaving the facility. The waste is burned on an inclined grate and the resulting flue gases are passed through the boiler where the energy from the heat of the gases is recovered in water-filled tubes to generate high energy steam. Steam is often sent directly to a steam turbine-generator set to generate electricity that can be sold directly to the grid. In addition, a portion or all of the steam can be used directly by an industrial user or sent to a hot water district energy system. If the WTE facility is designed to produce steam for both a district energy system and to sell electricity, this is called a co-generation facility.

After passing through the boiler, flue gases are sent through an air pollution control (APC) system designed to capture air emissions before being released into the atmosphere through the facility's stack. The APC systems in modern WTE facilities are capable of significantly reducing potential harmful air emissions from the combustion process, such as acid gases, dioxins/furans, metals, and some greenhouse gases. Some WTE facilities in Europe and North America are also incorporating carbon capture technology to further reduce the impacts of greenhouse gases generated during the combustion process. WTE facilities also generate incinerator bottom ash and fly ash residue that are collected at multiple locations throughout the system. The ash from each location is commonly processed separately. Incinerator bottom ash is collected under the inclined grate and is sent to landfill, or can be used as a construction base material, which is common in Europe and Asia but is not typically permitted for such use in Canada. The fly ash generated from the combustion of waste is collected separately throughout the boiler and APC system where it can be treated before being sent to a landfill for disposal. The combined incinerator bottom ash and fly ash make up only 25-30% by weight of the incoming waste processed by the system, which can help extend existing landfill life.

3.2.2 Scenario Costs

The preliminary opinion of probable construction costs for the Option 2 WTE Scenario is between roughly $497M and up to $862M for initial capital expenditures and an average of $38M annual direct O&M costs. The detailed breakdown of costs for the WTE scenario for the City's projected waste generation volumes (i.e. 267,600 tonnes per year) is included in the standalone Technical Memo 1, which is also included in Appendix D. It should be noted that a WTE facility capable of processing the City's projected waste volumes is technically and financially feasible, but a slightly larger facility capable of processing between 330,000-350,000 tonnes per year may be more financially viable from a purely economy of scale standpoint. The capital and operating cost implications of a larger WTE facility option were not evaluated in detail as part of this Study, but the costs on a per ton of waste processed basis would not be significant based on experience with similar projects.

Annual revenues from the WTE scenario in the form of electricity sales and the sale of ferrous and non-ferrous metals recovered post-combustion process are estimated to be on the order of approximately $19.4M annually, which could help offset some of the O&M expenditures. The WTE standalone option would also be capable of generating hot water that could be provided to the existing district energy network(s) in the City of Ottawa. Assuming the WTE facility is primarily designed for electricity generation and approximately 30 MW of thermal energy/hot water production, additional revenues as much as $20M annually as an upper limit of what could be possible given the project market rate for district energy in Ottawa. However, it should be noted that a detailed business case and feasibility analysis for this option would be required and, therefore, these revenues were not included in the financial evaluation for this Study.

There may also exist the opportunity for the City to receive additional revenue in the form of higher tipping fees from other regional municipalities outside of Ottawa and/or the IC&I sector that may lack their own disposal or processing capacity. As noted previously, a WTE facility sized for 330,000-350,000 tonnes per year could provide additional revenue to the City in the form of tipping fees if additional waste volumes could be procured through regional partnerships with municipalities or the IC&I sector.

3.3 Option 3: MWP Facility Scenario

As noted previously, under this option, the City builds a MWP Facility that can process all of the City's waste, recover additional recyclables and dispose of the remaining process residuals at one or more private third-party waste management facilities.

3.3.1 Scenario Description

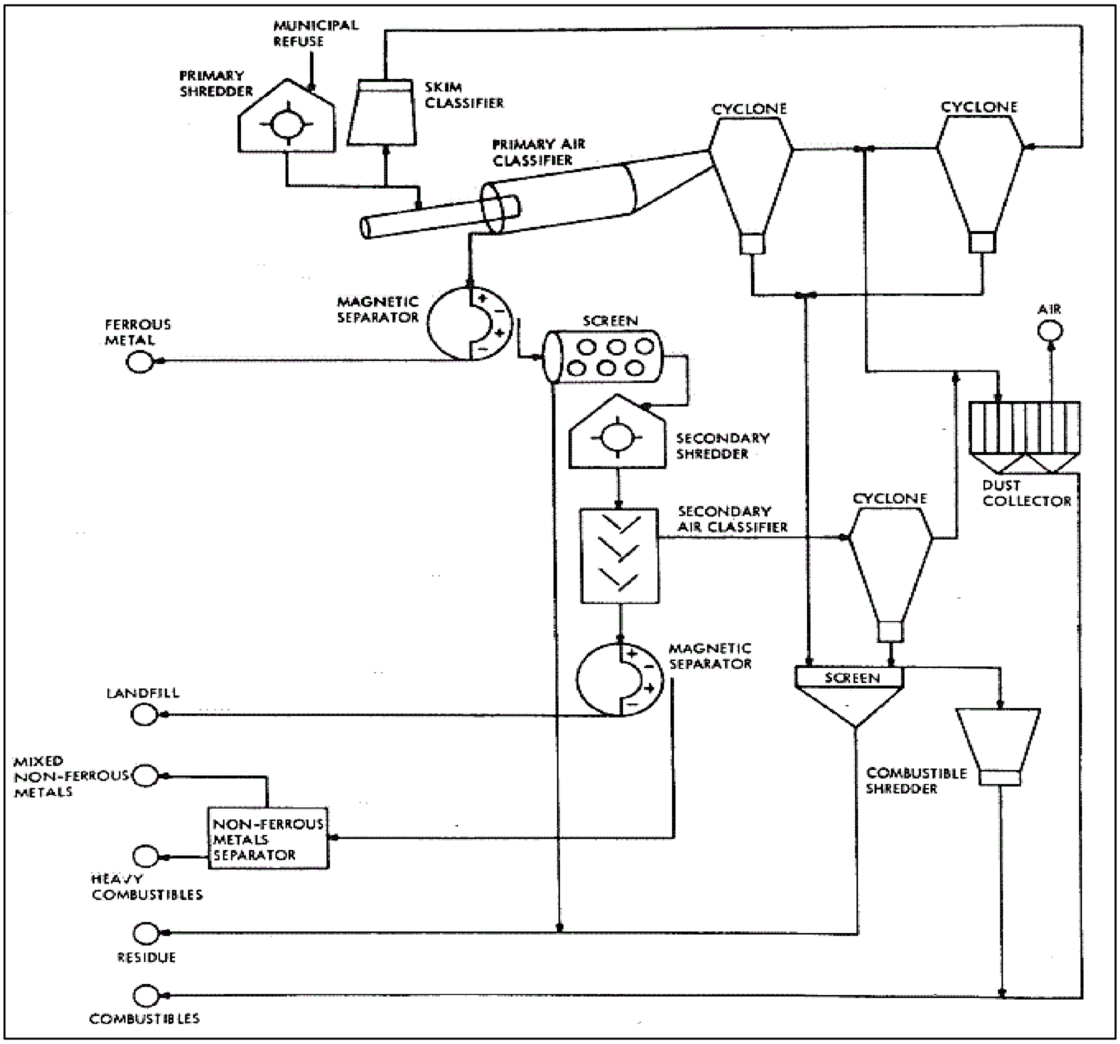
MWP Facilities are mechanical processing systems designed to recover recyclable commodities and, in some cases, organic waste from a mixed MSW stream. Various types of mechanical, optical, and density screening equipment, as well as manual labour, are used to open bags, sort materials by size and weight, and separate fiber, plastic, metal, and glass containers, organics, and other materials. The sorted materials are then baled (fiber, plastic, metal) or loaded (glass, wood, organics, scrap metal) into bins for transportation to recycling markets and the remaining residue is typically sent to the landfill for disposal. Some MWP facilities, particularly in the United Kingdom and Europe, will prepare the residual waste stream generated from this technology into a solid recovered fuel (or "SRF") that can further processed by a thermal process like a WTE facility. MWP Facilities operate successfully in North America, with a number of locations in the U.S. and at least one existing operating facility in Edmonton, Alberta. MWP uses commercially demonstrated technologies, including various mechanical, pneumatic, optical, and other automated and AI processes to capture the targeted commodities in the waste stream. MWP technology is often used as a pre-processing step in capturing specific fractions of the waste (e.g. plastics, organics, etc.) for use as a feedstock for other thermal, biological, and chemical conversion processes.

MWP technology vendors claim material recoveries of up to 80% of the targeted commodities in the mixed waste stream. As discussed in more detail in the jurisdictional scan of technologies performed as part of Technical Memorandum No. 1, experience with actual data reviewed from operating MWP facilities in North America and the UK, demonstrated material recoveries are more on the order of 10 to 25%, with some facilities achieving rates of up to and slightly greater than 40%. The reason for these lower recovery rates is largely due to the available equipment not being able to extract recyclables from the mixed waste stream that are clean enough to make them valuable in most recyclable material markets. In addition, recoveries also depend on the availability of the commodity materials in the mixed waste stream being processed. Therefore, recovery rates from a MWP facility can be impacted by the effectiveness of existing diversion programs as well as the value of the commodities recovered. The City of Ottawa has very well-established recycling programs, like the existing blue box materials and household organics collection, that are successful in separating and recovering a large portion of recyclable materials. This could impact the quantity of available commodities and potential recovery rates of the City's non-diverted waste that would be sent to an MWP facility.

MWP technology has been used to recover the organic fraction in mixed waste. Particularly in communities that lack source-separation and household organics collection programs. However, based on experience with MWP technologies in other jurisdictions (highlighted in more detail in standalone Technical Memo No. 1), the quantity and quality of the organic material recovered from a mixed waste stream through current MWP facilities varies significantly in quality and tends to contain contaminants that are difficult to remove (i.e. contaminated with bits of plastics and broken glass). The poorer quality organic material recovered by MWP can be harder to process through an AD system, and the resulting compost may have difficulty meeting Ontario's Compost Quality Standards.

Figure 3-3 represents the cross section of an MWP Facility that is designed to recover recyclable commodities and a solid recovered fuel (SRF) for further treatment by a WTE or thermal processing technology.

Figure 3-3: Section of a Typical MWP Facility



3.3.2 Scenario Costs

The preliminary opinion of probable construction costs for the Option 3 MWP Scenario is between roughly $96.8M and up to $167.7M for the initial capital expenditure and an average of $62.6M in direct annual O&M costs. The higher O&M costs account for the significant disposal costs for the process residuals that will likely need to be taken to a third-party private waste management facility. The detailed breakdown of costs for the MWP scenario are included in standalone Technical Memo 1, which is included in Appendix D.

Annual revenues from the MWP scenario in the form of sales from the recovered commodities are estimated to be approximately $4.7M annually, which could slightly offset some of the O&M expenditures.

3.4 Option 4: MWP and WTE Facilities Scenario

As noted previously, under this option, the City would build an MWP facility to recover additional recyclable materials and build a WTE facility at the same or an adjacent location. The WTE facility would take the process residuals from the MWP and combust it to recover energy. Process rejects and ash residue from the MWP and WTE facilities will be disposed of at a private third-party waste management facility.

3.4.1 Scenario Description

The fourth scenario considered is a combined MWP and WTE facility co-located on the same site or on a nearby adjacent site. The MWP and WTE scenario consists of the same technology components as the individual technologies described in Section 3.2.1 and 3.3.1. The benefits of this scenario are utilizing the MWP facility to maximize the recovery of commodities that still have market value and utilizing the WTE facility to maximize diversion from landfill. In this option, any material that is rejected from the MWP facility (process rejects) or not recovered as a commodity as part of the MWP process (process residuals) can be processed at a WTE facility instead of going directly to landfill. HDR has assumed that the WTE facility would be co-located on the same property as the MWP facility or on an adjacent site, which would minimize the transportation costs and emissions associated with transporting the MWP process residuals and process rejects to the WTE operation.

Waste would be delivered to a receiving and tipping building, and the small percentage of waste that is not acceptable for the MWP facility will be removed and sent to the WTE facility or transported off-site to a landfill. The remaining material stream will continue through the MWP processing train where the various mechanical separation and optical sorting equipment will remove recoverable commodities. The remaining process residuals stream (removed at the back end of the MWP facility) will be transported to the WTE waste storage pit to be processed and to recover energy. This is approximately 90% of the initial material stream by weight that was sent to the MWP, which means that the WTE would be designed for a slightly lower throughput capacity than the standalone facility described in Section 3.2. Consideration will be given to the design of the WTE to account for the fact that the characteristics and tonnage of what comes out of the MWP operation can vary depending on changes made to the separation process, variations in the incoming waste stream, and recycling market economics. For the purposes of sizing and costing the WTE portion of this combined scenario, HDR has assumed an 8% reduction in tonnage through the WTE facility to account for the recovery of materials at the MWP.

3.4.2 Scenario Costs

The preliminary opinion of probable construction costs for the Option 4 - MWP and WTE Facilities Scenario is between roughly $556M and up to $965M for initial capital expenditures and an average of $62M of direct annual O&M costs. As noted previously, a WTE facility sized to nominally process up to 330,000 to 340,000 tonnes per year would not significantly increase the expected capital and operating cost ranges and potentially improve the financial viability from an economy of scale basis. A facility sized to be larger could also provide a potential revenue source in the form of tipping fees for waste accepted beyond the City’s projected non-diverted tonnages. For purposes of the Study, the detailed breakdown of costs for the MWP with WTE scenario was only evaluated based on the projected quantity of the City non-diverted waste (i.e. 267,600 tonnes/year). The details of these estimates of probable cost for Option 4 were included in standalone Technical Memo 1, which is also included in Appendix D.

Annual revenues from the MWP and WTE scenario are in the form of recovered commodities, plus electricity sales and the sale of ferrous and non-ferrous metals recovered post-combustion process are estimated to be on the order of approximately $22.4M annually, which could help offset some of the O&M expenditures. This scenario, like the WTE standalone option, would be capable of generating electricity and hot water for district energy. Based on the current projected market rate for district energy in the Ottawa region, an additional revenue source of up to $20M annually as the upper limit of what may be possible. However, a detailed business case and feasibility analysis for this option would be recommended, and these revenues were not included in the financial evaluation for this Study. Like the standalone WTE scenario, there may also exist the opportunity for the City to receive additional revenue in the form of higher tipping fees from other regional municipalities outside of Ottawa and/or the IC&I sector that may lack their own disposal or processing capacity. However, the available design capacity of the WTE facility would need to be evaluated if non-City-generated waste were considered.

3.5 Option 5: Construct a New Landfill Scenario

As noted previously, under this option, the City would purchase a large enough parcel of land within the region to build and operate their own new greenfield landfill to take all non-recyclable residuals after Trail reaches capacity. The implementation of a new landfill was thoroughly assessed during the development of the SWMP. Although initially considered for deferral to future SWMP iterations, this option is being included for comparison purposes as part of this Study.

3.5.1 Scenario Description

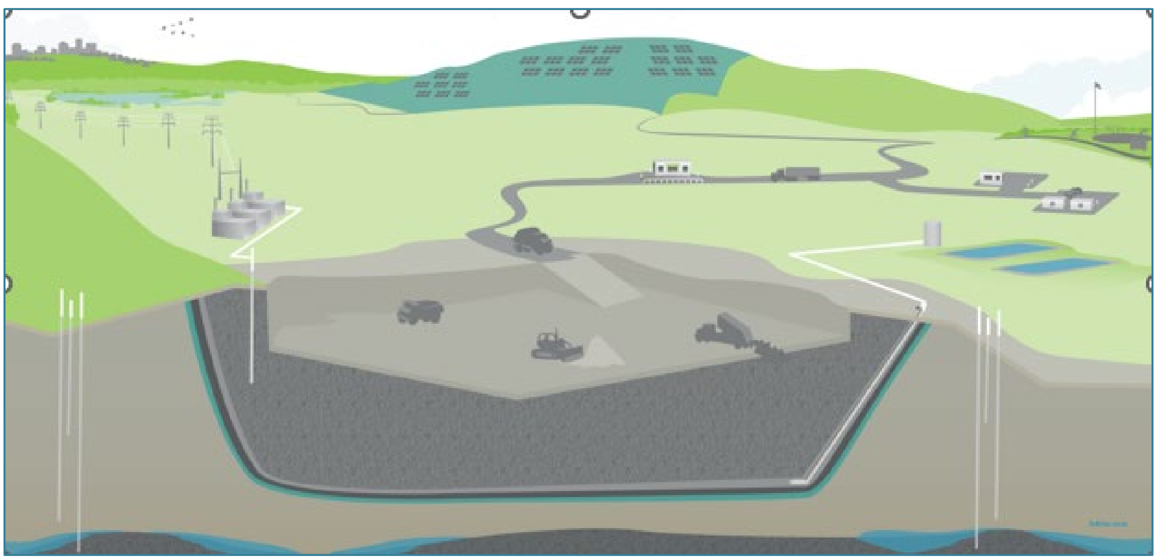
Landfilling of untreated solid waste is the most common commercially demonstrated method of waste disposal in the world. Landfilling involves the placement of waste into lined landfill cells, which provides hydraulic isolation from the groundwater below and provides daily cover material (e.g., dirt, sand, ash) to prevent the blowing of loose material and litter. Liner systems are also designed to prevent the uncontrolled migration of gases that are created during the decomposition of the organic fraction in the waste. To better manage the site and the cost expenditures needed to develop the site, the landfill is typically divided up into stages or cells, which allow for applicable systems of the landfill to be developed over time (e.g., liners, leachate collection systems and landfill gas collection systems). Landfilling is considered an established disposal technology and would be required in some capacity no matter which of the technology options, WTE and/or MWP, would be implemented by the City, since both technologies would generate some residual stream(s) requiring disposal (e.g., incinerator bottom ash, non-processible waste, etc.).

All new landfills are required to meet Ontario’s stringent landfill design requirements outlined in Ontario Regulation 232/98 – Landfill Sites made under the EPA. The regulation details the requirements for the design, operation, closure, and post-closure care of municipal (i.e., non-hazardous) waste landfilling sites (whether privately or publicly owned). The City would have to demonstrate that the design is protective of the environment and meets the intent of the regulation. New landfills must have a plan to manage leachate at the site that involves the installation and operation of a leachate collection system. Typically, the collection system simply consists of collecting and conveying leachate to on-site storage tanks where it is treated at an on-site leachate treatment facility. Leachate management must occur throughout the site’s contaminating lifespan, which is typically decades. Landfill gas (LFG) is generated from a landfill as the organic material in the landfill decomposes. Landfill gas is typically around 50% methane and 50% carbon dioxide and water vapor, by volume, and can be a significant contributor to greenhouse gas emissions if not properly collected. The new landfill site would be anticipated to have a volumetric capacity of greater than 1.5 million cubic metres, so it is assumed the site would be subject to the regulatory requirements for installing and operating a landfill gas collection system.

The amount and composition of the LFG produced varies greatly according to the characteristics of the waste placed in the landfill and the climate at the landfill location. Factors that have the greatest impact on the LFG produced include waste composition (e.g., organic content, age), oxygen levels, moisture content, and temperature, which can be influenced by climate. Emissions can be reduced through the installation of an efficient LFG collection system and then flaring the gas or combusting it in an internal combustion to produce electricity like what is done at Trail now. Recently, there has been a renewed interest in capturing the LFG for refinement and distribution directly into a gas transmission system. This form of LFG is known as renewable natural gas (RNG) and would require the installation of gas conditioning equipment to get the raw LFG to pipeline quality gas that can be marketed to a local utility like Enbridge.

Error! Reference source not found. provides a typical layout and cross section of a modern landfill.

Figure 3-4: Typical Cross Section of a Municipal Solid Waste Landfill



3.5.2 Scenario Costs

Including the RNG collection and condition system, the preliminary opinion of probable construction costs for the Option 5 Construct a New Landfill Scenario would be roughly \$439M to \$761M for the total capital expenditures and an average of \$12M annual direct O&M costs. The total capital costs include an RNG collection and conditioning system that added approximately \$53M in capital expenditures. It is estimated that the RNG system would also add another approximately \$2M in direct O&M costs. The detailed breakdown of costs for the new landfill scenario is included in standalone Technical Memo 1, which is included in Appendix D.

Annual revenues from the new landfill scenario could be in the form of either electricity sales from a LFG-to-electricity system, or from the sale of RNG for direct pipeline injection. The revenues for either the sale of electricity or RNG will vary depending on the market rates and the availability of other incentives. Based on a preliminary estimate of the potential LFG generation, it is estimated that the sale of electricity could yield an additional $1M-$2M in annual revenues versus an estimated $12M in potential annual revenues from the sale of RNG.

3.6 Summary of Scenarios

Table 3-1 provides a summary of the key background information compiled for each of the five scenarios being considered in the Study. The information in **Table 3-1** and key findings identified are presented in more detail in standalone Technical Memo No.1.

Table 3-1: Scenario Comparison Table at Design Capacity (2053)

	Option 1 Status Quo and Private Facilities	Option 2 WTE	Option 3 Mixed Waste Processing	Option 4 MWP and WTE	Option 5 New Landfill
Design Throughput (tonnes per year)	>260,000	267,600	267,600	267,600/227,500	>260,000
Feedstock Accepted	Mixed MSW	Mixed MSW	Mixed MSW	Mixed MSW	Mixed MSW
Site Area Required (hectares, ha)	None	3-5 ha	3-5 ha	5-10 ha	100-200 ha
Energy Recovery Potential [1] (MWt & MWe)	None	28 MWt (Gross) 12 MWe (Net)	None	23 MWt (Gross) 10 MWe (Net)	5-10 MWe
Potential for District Energy	No	Yes	No	Yes	No
Average Annual GHG Impacts (tonnes of CO_2 equivalent) [2]	12,000-16,500	7,300-10,000	10,300-14,100	6,000-8,200	12,000-16,500
Capital Costs (CAD)	Not Applicable	$497M–$862M	$97M–$168M	$556M–$965M	$439M– $761M
Direct Operating Costs (CAD per year) [3]	$44M	$47M	$70M	$73M	$16M
Potential Annual Revenues (CAD per year)	Not Available	$18M (does not include potential district energy revenues)	$5M	$21M (does not include potential district energy revenues)	$2M (for electricity) Up to $12M (for RNG)
Expected Implementation Timeline	Not Applicable	7-10 Years	5-7 Years	7-10 years	7-10 years

Notes:

1 Assumes a 70/30 split for electricity generation to thermal energy (in the form of hot water) based on available capacity of existing district energy networks in the City of Ottawa. Energy generation numbers are calculated based on an assumed waste calorific value of 13 MJ/kg, a net electric generation efficiency of 660kWh/tonne of waste processed, and a steam generation efficiency of 3,500 kg/tonne of waste processed.

[2] Results shown are taken from the Organic Waste Greenhouse Gas Calculator produced by Environment and Climate Change Canada, which excludes biogenic emissions and avoided emissions from recycled materials and calculates the average of annual lifecycle emissions over 30 years. The calculator includes waste that is processed/converted (e.g. incinerated) or recovered with a defined resale market (plastics, metals, some paper). The calculator does not include incinerator ash, process residues from MWP, recovered materials with no defined market in Ontario, Canada, which are assumed will be landfilled, or transportation emissions. Model assumptions also assume up to 90% capture of total LFG produced is used to produce electricity. Actual emissions will vary based on material specific decay rates and volume of waste disposed of annually. Due to the limitations of the tool, HDR will use a customized model that is able to incorporate lifecycle emissions estimates across more materials, in line with the USEPA's Waste Reduction Model (WARM), and will be able to track emissions based on varying waste volumes over time. This information is provided in more detail in Section 7.

[3] Based on direct operating costs, not including indirect costs such as debt service. Operating cost values are based on 2053 design year capacities, note that costs between 2035 and 2052 will be less than values shown.

[4] Annual numbers are based off the annual average of the lifecycle figures for the 30-year Study period (2035-2064) and may differ slightly from the annual figures shown in Table 5-1 in Technical Memo 1, which were based on the projected 2053 design capacity tonnage of 267,600 tonnes.

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4 Overview of Siting Requirements and Approvals

There are several approval and siting requirements for waste management facilities from a provincial, municipal, and federal perspective that may be applicable to a site depending on the technology and waste process. These include processes under the Provincial Environmental Assessment Act (EAA), Environmental Protection Act (EPA), and Municipal Act, and the Federal Fisheries Act. This section provides an overview of the siting requirements and necessary regulatory and environmental approvals that are anticipated to implement each of the five scenarios being considered in this Study. A standalone technical memo (Technical Memo No. 2) was prepared that describes the information provided in this section in more detail and is provided in Appendix E.

4.1 Siting Requirements

There are several considerations when identifying a potential location for a waste management facility. In general, for the five scenarios being evaluated by the City, the following were generic considerations for facility siting regardless of whether it is a WTE, MWP, combination of WTE and MWP, or new landfill:

- The site must meet local zoning and land use criteria, including local road weight limits and other limitations.
- The site must be easily accessible by solid waste vehicles in all weather conditions.
- The site design safely protects surface and groundwater quality.
- The site must meet applicable air emissions point of impingement (compliance point) for air emission contaminants and odours.
- For construction purposes, the site must have access to earth cover material that can be easily handled and compacted to support the infrastructure.
- Operations will not affect external environmentally sensitive areas.
- The site must have enough land and internal capacity to provide a buffer zone from neighbouring properties and can be expanded; and,
- Will be the most economic site available given haul distances and other economic considerations.
- Sites that have a reasonable chance to obtain regulatory site approval.

Public involvement early in the process will also be essential to the siting process to achieve a successful outcome when selecting a site. The search process can be used to educate the public about the difficult choices that must be made, and the degree of effort and expertise the City will be relying on to make the decisions. In addition, other considerations in selecting a site such as proximity to industrial or commercial business that may benefit from by-products generated by one or more of the scenarios (e.g. electricity, thermal energy, or biogas/RNG) will need to be considered. This will help support the City and key stakeholders with identifying a preferred site from the available alternatives which can reduce or mitigate concerns.

Table 4-1 provides a summary of the key siting characteristics and requirements that were considered in this evaluation for each of the five scenarios.

Table 4-1: Summary of Key Siting Requirements for Each Scenario

Options	Site Area Required	Infrastructure Needs	Utility Needs & Consumption	Road Requirements	Impacts to Nearby Receptors
Option 1:[1] **Status Quo and Private Facilities Scenario**	• N/A	• N/A	• N/A	• N/A	• N/A
Option 2: WTE Facility Scenario	• 3-5 hectares	• Major road & highway access. • Electrical substation and interconnection to import/ export power. • Access to District Energy network (if applicable).	• Potable Water, auxiliary fuel (gas), electricity, sewer.	• Designated truck route access or access zoned as industrial.	• Primarily air emissions and some noise. No set minimum distance. Odour will be controlled by drawing air into the WTE process.
Option 3: MWP Facility Scenario	• 3-5 hectares	• Major road & highway access. • Electrical substation access to import power.	• Potable Water, auxiliary fuel (gas), electricity, sewer.	• Designated truck route access or access zoned as industrial.	• Primarily odour emissions from stored materials and the process. Noise and dust also a possibility.
Option 4: WTE w/MWP Scenario	• 5-10+ hectares	• Major road & highway access. • Electrical substation and interconnection to import/ export power. • Access to District Energy network (if applicable).	• Potable Water, auxiliary fuel (gas), electricity, sewer.	• Designated truck route access or access zoned as industrial.	• Air emissions from WTE and some noise from MWP. Odour will be controlled by drawing air into the WTE process.

Options	Site Area Required	Infrastructure Needs	Utility Needs & Consumption	Road Requirements	Impacts to Nearby Receptors
Option 5: Construct a New Landfill Scenario	• 100-200 hectares	• Major road & highway access. • Electrical substation and interconnection to import or export power. • Access to natural gas pipeline for RNG.	• Potable Water, auxiliary fuel (gas for heating buildings), electricity, sewer (for buildings and leachate).	• Designated truck route access or access zoned as industrial.	• Primarily odour emissions from waste operations, potential groundwater impacts, dust, litter, and potentially noise from operations.

Notes:
1 N/A = Not Applicable since this option includes existing sites that already have all applicable permits and approvals.

4.2 Approvals Requirements

The MECP sets environmental standards and requirements for managing hazardous and non-hazardous waste to ensure that human health and the environment are protected. Depending on the operation or waste activities being undertaken, an environmental assessment is often required prior to obtaining the applicable environmental permission to operate. Waste facilities, landfills, and waste transportation systems require the owner and/or operator to get the appropriate environmental permission(s) to operate, unless they are exempt. Environmental permissions set out specific operating, monitoring, and reporting requirements that owners and operators must comply with.

Based on the five proposed waste management scenarios identified by the City, the applicable environmental assessment process and environmental approvals, which included waste, air, and wastewater approvals, were evaluated as part of Technical Memo No.2. Each of the five scenarios will have specific approvals and requirements based on regulatory thresholds and siting requirements. **Table 4-2-** provides a summary of the key items that were evaluated and considered for the key approvals and siting requirements for each option.

Table 4-2: Summary of Key Approvals and Requirements for Five Scenarios

Option	Approvals Requirements Summary
Option 1: Status Quo and Private Facilities Scenario	• Existing sites so no Environmental Assessment (EA) process triggered. • No anticipated new or amended Environmental Compliance Approvals (ECA) to allow for the continued use or transport of waste to third-party waste management facilities. • No specific siting requirements or other regulatory permits required for this option. • For GHG emissions, the City may request from the private third-party waste facilities for their landfill gas system collection efficiency. This will allow the City to verify that the GHGs are being sufficiently captured, and the action is meeting the community's GHG reduction goals. • Implementation Timeline: N/A (existing infrastructure)
Option 2: WTE Facility Scenario	• At minimum, the undertaking will trigger a streamlined EA process through the Environmental Screening Process (ESP). The Minister has the authority to "bump up" the process to a Comprehensive Environmental Assessment (CEA); however, it is not considered a common practice. • ECA requirements are waste, wastewater, and air/noise. • Impacts related to other Acts increase due to complexity of undertaking but can be mitigated in most circumstance. Risks to mitigations will vary depending on whether a greenfield or existing facility (e.g. existing industrial park). • Anticipated Implementation Timeline[1]: 7-10 years
Option 3: MWP Facility Scenario	• Estimated volumes are below EA trigger threshold, as a result no EA is anticipated for this undertaking. • ECA requirements are waste, wastewater, and air/noise (dependent on final operation). • Impacts related to other Acts will vary depending on whether a greenfield or existing facility (e.g. existing industrial park). • Anticipated Implementation Timeline[1]: 5-7 Years
Option 4: WTE w/MWP Scenario	• The approvals for this scenario are anticipated to follow the more conservative standalone Option 2 - WTE Facility requirements above. • Anticipated Implementation Timeline[1]: 7-10 Years
Option 5: Construct a New Landfill Scenario	• Estimated volumetric airspace required for disposal triggers the CEA process. • ECA requirements are waste, wastewater, and air/noise. • Impacts related to other Acts will play a role in the approvals and siting for a new landfill. Many of the same reports required for these permissions will be completed during the EA process. • Anticipated Implementation Timeline[1]: 7-10 Years

Notes:

[1] Anticipated Implementation Timeline includes time to obtain all applicable permits and approvals, plus design, construction, commissioning, and startup timing.

5 Overview of Project Delivery Models and Funding Opportunities

As part of the Study, it was critical to identify key considerations for the City with respect to assessing delivery and funding models for the five scenarios being evaluated, and the WTE or MWP options in particular. A standalone technical memo (Technical Memo No. 3) was prepared that describes the information provided in this section in more detail and is provided in Appendix F. As part of Technical Memo No. 3, KPMG led a market sounding, which involved engaging with seven industry stakeholders to explore various delivery models and funding mechanisms relevant to the City and these types of projects. The market sounding exercise was performed to provide key inputs to understanding relevant funding models seen across projects in Canada and internationally, with a focus on the commercial structuring of those projects and salient features for the City, such as the pros, cons, and risks of each model, as it assesses the viability of the project. Technical Memo No. 3 and the summary of the analysis presented herein is informed by both extensive desktop research and feedback obtained through a market sounding exercise.

5.1 Overview of Funding Requirements and Potential Funding Gaps

Pursuing the development of any of the scenarios, except for the Status Quo and Private Facilities option, requires substantial financial investment that may pose a significant challenge for the City of Ottawa. The substantial capital costs associated with constructing and maintaining the waste management facility options may pose a significant financial challenge for the City of Ottawa. These costs, which include both the initial construction and long-term operational expenditures, far exceed the City's projected capital budget of $199.7 million for 2021 to 2030. Moreover, with the City's solid waste capital and operating reserve funds currently in a deficit position, there are limited financial resources available to support this level of investment. To address this gap, it will be crucial for the City to explore and evaluate a range of potential funding solutions to ensure the feasibility and sustainability of these critical infrastructure developments.

Potential funding solutions were identified through desktop research and market sounding interviews performed as part of standalone Technical Memo No. 3, and included the following:

- **Government Funding Programs**: Leveraging opportunities such as CIB Green Infrastructure Financing, Green Municipal Fund (GMF), or Canada Growth Fund (CGF).
- **Private Sector Financing**: Considering concession models such as Build-Operate-Transfer (BOT) to involve private sector investment.
- **Alternative Revenue Sources**: Utilizing revenue streams from energy sales, material recovery, special material disposal fees, and carbon credits to reduce the overall funding requirement. Potential revenue from other sources, such as tipping fees from receiving waste generated from sources outside the City of Ottawa or from the IC&I sector could also be evaluated as potential revenue sources.

Each of the funding approaches identified above are explained in greater detail in Technical Memo No. 3. Each approach offers potential benefits, and a combination of these strategies will most likely be required to ensure the successful delivery of the scenarios being considered, particularly a WTE or MWP facility. Through a combined approach, the City can have a greater opportunity to create a more robust financial framework that will effectively address the funding requirements and support the long-term success of these critical waste management projects.

5.2 Summary of Applicable Delivery Models

As part of the assessment of delivery models performed in Technical Memo No. 3, a comprehensive market sounding exercise was undertaken to gather insights from industry stakeholders regarding the most suitable project delivery models for the two waste management technologies: the WTE or MWP facility options. The feedback from market participants helped identify potential challenges and opportunities across a range of delivery models analyzed. Based on these discussions, several models were assessed for their applicability to this type of project:

- **Design-Bid-Build (DBB) Model**: The market considered this model unsuitable due to limited interest. Participants highlighted key challenges associated with constructing a WTE or MWP facility, including extended timelines and elevated construction costs. The lack of integration between the design and construction phases contributes to delays and inefficiencies in the delivery of these technologies.
- **Design-Build (DB)/Engineering, Procurement, and Construction (EPC) Model**: The DB/EPC model emerged as a viable option, with market participants highlighting its ability to streamline design and construction phases.
- **Design-Build-Operate-Maintain (DBOM) Model**: Participants favored the DBOM model, where private operators manage operations and maintenance under long-term agreements. It was discussed that this operating model is well-suited for complex assets like MWP and WTE, where private partners can leverage their expertise to optimize operations, driven by performance-based incentives.
- **Integrated Project Delivery (IPD) Model**: The IPD model was identified as a flexible option, allowing for collaborative design and transparent, open-book costing. This approach is particularly suited for complex, multi-phase projects like WTE or MWP facilities, where collaboration, adaptability, and ongoing coordination are critical to success.
- **Design-Build-Finance (DBF) Model**: The DBF model was deemed unsuitable due to limited opportunities for private sector innovation and market interest in raising finance for a project that they will not be operating.
- **Design-Build-Finance-Operate-Maintain (DBFOM) Model**: This model garnered interest from market participants, offering the private sector greater control over the project. However, its viability depends on the willingness of the private sector to assume most project risks, particularly as they relate to revenues. The majority of DBFOM contracts in Canada are based on an availability payment structure where the asset owner (i.e., the City) would make monthly payments to the private partner to support the repayment of debt and O&M costs. If the private partner were required to take on risks associated with earned revenues at the facility, it is likely that a significant premium would be added to the cost of the facility.

- **Concession Model (Build-Operate-Transfer - BOT)**: The BOT model was highlighted by private sector participants as a feasible approach and one that has been used to varying levels of success internationally. Under this model, the private sector assumes responsibility for financing, designing, building, operating, and eventually transferring the facility back to the municipality, typically under a 25-year contract.

5.3 Summary of Key Considerations

The intent of this section and the detailed information in Technical Memo No. 3 was to present valuable insights from private sector stakeholders and owners, but not to identify a preferred delivery approach at this time.

The results of this analysis underscored the complexity of WTE and MWP project scenarios, highlighting the critical role of unique project parameters in determining the optimal delivery model and helped to eliminate a few delivery models from further consideration. Factors such as partnership structures, financial capacity, and risk appetite will significantly influence the suitability of various procurement models. Considering these findings, the level of detail available currently does not allow for a direct recommendation for a specific delivery model. Rather, it presents a series of critical considerations that will guide the City in selecting the most appropriate procurement strategy tailored to its specific needs and circumstances. These key considerations include:

- **Collaborative Approach**: A collaborative process that integrates input from both public and private sectors can help to ensure that the selected model is mutually beneficial.
- **Funding and Financing**: The City must consider a variety of funding sources and financing structures, understanding that long-term financial commitments will need to align with the City's projected financial position and capacity.
- **Risk Allocation**: Defining clear lines of responsibility for risk is critical. The City should seek to allocate risks to the parties best equipped to manage them.
- **Project Readiness**: It is essential that the City presents a well-prepared proposal to the private sector. This includes not only financial and technical plans but also a clear vision of the project's long-term objectives, the City's role, and the potential benefits to private partners.

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6 Evaluation Methodology and Approach

A critical aspect of the feasibility study is the development of an evaluation criteria, weighting and scoring system that can be applied to the five (5) scenarios. To accomplish this task, HDR utilized our experience with similar studies, the information obtained during the development of Technical Memorandums 1, 2, and 3, and our collaboration with City staff with the initial development of this evaluation approach. This information was incorporated into the development of the evaluation criteria and a scoring matrix to rank the five waste management scenarios being considered in this Study. The criteria considered the triple bottom line analysis to identify the potential environmental, social, and financial contributions or impacts of each option versus performing an assessment based on just a traditional technical or financial analysis. The evaluation criteria and scoring matrix was applied in the overall analysis summarized in Section 7 and was intended to assist the City with identifying and ranking the preferred technology scenario/options.

A standalone technical memo (Technical Memo No. 4) was prepared that describes the information provided in this section in more detail and is provided in Appendix G.

6.1 Summary of Evaluation Criteria

The evaluation criteria were developed and were divided into four primary factors that will be critical in the selection of the preferred long-term waste management scenario(s). The four primary factors were selected with consideration to the goals identified in the City's 30-year SWMP, as well as the objectives of this Study. Each of the primary criterion was developed with consideration of specific subset factors that we believe will be valuable for the City's assessment of the five scenarios. These factors are summarized in **Table 6-1-** and described in further detail in Technical Memo No. 4.

Table 6-1: Summary of Evaluation Criteria Subsets and Definitions

Criteria Subset	Type of Criteria	Definition
Environmental Evaluation Criteria		
Energy Recovery Potential	Quantitative	The amount of potential energy (in GWh) that can be harnessed from the scenario over the 30-year planning period, as well as the ability to generate different types of energy (e.g., district heating or RNG).
Landfill Diversion Percentage	Quantitative	The percentage of the incoming waste stream that is diverted from landfill disposal by either recovery of marketable materials or through thermal conversion.
Opportunity to Recover Marketable Commodities	Quantitative	The ability of a specific scenario to recover materials with a known/defined market, plus the type and quantity of those materials recovered over the 30-year life cycle.
Emission – Discharges to Air, Land, and Water	Qualitative	Potential to emit pollutant emissions/discharges to the air, land, or water, including those from odours.

Criteria Subset	Type of Criteria	Definition
Potential for GHG Impacts	Quantitative	The type and quantity of greenhouse gas (GHG) emissions generated from the scenario over its life cycle.
Social Evaluation Criteria		
Potential Visual Impacts	Qualitative	Potential for scenario to create visual impacts to neighbouring properties due to the size and associated equipment/operations of the scenario(s).
Other Nuisances	Qualitative	Potential for scenario to create other nuisance impacts (e.g., noise, litter/debris, vectors) to neighbouring properties due to the size and associated equipment/operations of the scenario(s).
System Transportation Impacts	Quantitative	Potential impacts to local traffic volumes along potential haul routes, including transportation impacts in areas near city owned facilities and third-party waste management facilities that may receive waste as a result of the scenario, if required.
Potential for Property Value Impacts	Qualitative	Potential for scenario to negatively impact adjacent property values due to the activities associated with an active waste management site.
Opportunity for Community Support	Qualitative	Potential for the local community to support the project, as well as for the scenario to provide additional educational and social benefits for the community.
Financial Evaluation Criteria		
Capital Costs	Quantitative	Capital Costs, including land acquisition costs.
Operating and Maintenance Costs	Quantitative	Operating costs, including but not limited to potential long-term major maintenance costs, (this will depend in part on the ownership structure).
Revenue Generation Potential	Quantitative	The potential revenues generated by the scenario through existing markets for recovered materials and energy produced by the technology.
Overall Financial Feasibility	Quantitative	The potential for the scenario to generate positive cashflow and meet the City's other long-term financial objectives.
Technical Evaluation Criteria		
Technical Complexity	Qualitative	The number and type of complex systems that make up the technology, and the skillsets required to operate and maintain the technology efficiently and reliably.
Timing/Schedule Requirements	Qualitative	The amount of time and effort to procure, site, permit, design, and construct a facility ready for operation.

Criteria Subset	Type of Criteria	Definition
Feedstock Flexibility	Qualitative	The ability of a scenario to receive and efficiently process a variety of wastes of differing quantities, compositions, and quality (i.e., energy content) that may be found in the City's waste stream.
Scalability	Qualitative	Ability of the scenario to adjust to significant changes in waste throughput and expanded/derated should additional or reduced capacity be required.
Process Reliability (Risk Potential)	Qualitative	Risks associated with overall system reliability and resiliency, including the amount of time the scenario is available to accept and process waste versus downtime for scheduled and unscheduled maintenance.
Siting Requirements	Qualitative	The overall area of the site required, plus the required infrastructure and utilities required, and proximity to major roads and highways required to accommodate the scenario.
Approvals/Permitting/ Regulatory Requirements for Implementation	Qualitative	The number and complexity of regulatory approvals and permits that will be required to implement the scenario, as well as operate the facility.
Number and Complexity of Required Contracts	Qualitative	The amount of complex contractual arrangements required to implement and operate the scenario, including the timing of negotiations and administrative requirements.

6.2 Summary of Comparative Evaluation Methodology

There are different methods (qualitative or quantitative or a combination of both) that can be used to evaluate the potential technologies and systems. The methodology and approach utilized in the Feasibility Study were selected with consideration to the goals identified in the City's 30-year SWMP. Each of the primary criterion in **Table 6-1** were developed with consideration of specific subset factors that would be valuable for the City's assessment of the five scenarios. The proposed evaluation methodology includes a primarily qualitative approach, comparing each system based on its relative strengths and weaknesses. As identified in **Table 6-1**, for some criterion, quantitative data was also used to compare each scenario to a calculated value (e.g., \$/tonne, $MTCO_2e$, \$/year, etc.). The qualitative and quantitative information for each criteria subset was then used to grade each scenario to determine whether it is most preferred, preferred, neutral, less preferred or least preferred. Furthermore, each of the grades are weighted to calculate a score for each criterion to support the ranking of each of the five options being considered. There could be a scenario in this evaluation where a criteria subset for one or more options receives the same grade. In this scenario, the options would both receive the same grade and weighting for that subset of criteria.

Table 6-26-2 provides guidance on how the grades and weightings were assigned in the evaluation and what would constitute a preferred outcome or not.

Table 6-2: Comparative Evaluation Methodology Scoring/Weighting Guidance

Grade (Weighting)	Description	Example
Most Preferred (+2)	The Technology/System would have minimal impact based on the criteria/indicator being applied and could potentially result in a net benefit because of the facility's development.	A facility that could be developed and offer low-cost thermal energy (i.e., steam and/or hot water) that would attract new industry to the area would be considered most preferred over a system that does not provide the same economic benefit.
Preferred (+1)	Development of the Technology/Scenario would have manageable impacts based on the criteria/indicator being applied and, in some cases, a net benefit could potentially result from facility development.	In comparison to the above example, a Technology/System that produces thermal energy, but in much smaller quantities, would still be considered preferred; however, when compared to another system with a greater thermal or electrical output to market, it would not be considered most preferred.
Neutral (0)	The Technology/System development would have no potential impacts (positive or negative) based on the criteria/indicator being applied.	A situation where all facilities would require obtaining the same permits and the same permitting risk would be considered neutral in that there is no substantial difference between any of the Technology/System options.
Less Preferred (-1)	Development of the Technology/System would have some negative impacts based on the criteria/indicator being applied and would likely require some mitigation measures to reduce the potential impact.	In comparison to the below example, a Technology/System that produces a wastewater discharge, but in much smaller quantities, would still be considered less preferred (when compared to a zero wastewater discharge facility); however, when compared to another system with a relatively greater wastewater discharge, it would not be considered least preferred.
Least Preferred (-2)	Development of the Technology/System would have a significant negative impact based on the criteria/indicator being applied and would require extensive mitigation measures to reduce the potential impact.	A Technology/System with a relatively large wastewater discharge would be considered least preferred over a system with a minimal or no wastewater discharge.

6.3 Overview of Sustainable Return on Investment Model (SROI)

This section briefly describes HDR's proprietary Sustainable Return on Investment (SROI) decision-making tool and how, utilizing the available data for each scenario compiled in the Technical Memos, this tool was used to generate the quantitative outputs for some of the criteria described in **Table 6-1**. The intent of the SROI process is to help the City understand and communicate investment strategies from an objective and transparent perspective that is linked to their 'triple bottom line'. The SROI process weighs the project costs against public benefits.

The quantitative results from the SROI model are aligned to the applicable criteria subsets identified in **Table 6-3** to support the comparative evaluation, excluding impacts from infrastructure anticipated to be owned and operated by third parties (i.e. private regional waste facilities). **Table 6-3** provides a summary of the quantitative outputs from the SROI model that will be applied to some of the sub-criteria identified in Section 6 to support the grading and scoring for the Comparative Evaluation.

Monetary outputs from the SROI model are escalated with a 2% annual inflation rate. The inflation rate arises from the Bank of Canada's inflation control target, which states the aim for the price of goods and services in Canada to increase, on average, by 2% yearly. All cost and revenue estimates are initially presented in real value terms, based in dollars in 2024 (base year) terms. We apply inflation to account for the time between when the cost/revenue is incurred and the base year (2024) to estimate impacts in year-of-expenditure (YOE) dollars. Inflation applied to revenues and costs further in the future will have a compounding effect. Year-of-expenditure dollars, when summed across years, will provide the undiscounted impacts of a particular cost or revenue line item.

Furthermore, all monetary outputs from the SROI model are also discounted with a 5% annual discount rate. The discount rate represents the time value of money, a concept which means greater value is placed on money today compared to money in the future. As such, future cash flows are weighted less than near-term cash flows. Once the discount factor is applied to the year-of-expenditure dollars across each time period, these values can be summed to provide the discounted value (present value) of the cost or revenue item. Monetary outputs from the SROI are presented in present values unless otherwise stated. [5]

Non-monetary quantitative outputs such as energy recovery potential, tonnes of material recovered, or vehicle kilometres travelled, are neither inflated nor discounted. These values are presented as the totals over the project lifecycle.

A detailed explanation of the SROI model, key assumptions used to develop the model, and the results that were incorporated in the final Comparative Evaluation Summary are provided in Appendix C.

[5] Discounted (present) value refers to the value of a cost/revenue stream that is weighted by a discount factor to account for the time value of money, which typically represent an opportunity cost.

Undiscounted value refers to the total value of cost/revenue over time without factoring in the time value of money.

Real value refers to the cost/revenue stream that are in constant terms, excluding the growth in prices from inflation.

Table 6-3: SROI Analysis Outputs Used in the Evaluation

Criteria/Sub-Criteria	SROI Output
Environmental Requirements	
Energy Recovery Potential	GWh of Energy Produced – Annual GWh of Energy Produced – Lifecycle
Landfill Diversion Percentage	Tonnes of Material Avoided Being Landfilled - Annual Tonnes of Material Avoided Being Landfilled - Lifecycle (Millions)
Opportunity to Recover Marketable Commodities	Tonnes of Materials Recovered - Annual Tonnes of Materials Recovered - Lifecycle (Millions)
Potential for GHG Impacts	Tonnes of GHG Emitted – Annual Tonnes of GHG Emitted - Lifecycle (Millions) *Includes Corporate Anthropogenic Emissions, Community Anthropogenic Emissions, and Biogenic Emissions*
Social Requirements	
System Transportation Impacts	Total Truck Kilometers Travelled - Annual Total Truck Kilometers Travelled - Lifecycle (Millions)
Financial Requirements	
Capital Costs	Total Capital Costs - Lifecycle (Millions 2024$) *Presented as Real Values (Undiscounted 2024$)*
Operation and Maintenance Costs	Total Facility O&M Costs (2024$) - Annual Total Facility O&M Costs - Lifecycle (Millions 2024$) *Presented as Real Values (Undiscounted 2024$)*
Revenue Generation Potential	Total Revenues from Energy + Material Recovery (2024$) - Annual Total Revenues from Energy + Material Recovery - Lifecycle (Millions 2024$) *Presented as Real Values (Undiscounted 2024$)*
Overall Financial Feasibility	Total Cash Outflow (2024$) – Annual Total Cash Outflow - Lifecycle (Millions 2024$) *Presented as Present Values (Discounted), and as Real Values (Undiscounted 2024$)*

7 Evaluations Summary, Conclusions and Recommendations

7.1 Evaluation Summary

The City of Ottawa is in the process of implementing a 30-Year Solid Waste Master Plan (SWMP) with the aim of decreasing the amount of waste managed by the City through actions such as diverting as much waste as possible from landfill and to look for opportunities to maximize recovery of resources and energy in an environmentally sustainable manner. One of the key components of the City's existing solid waste management system is the Trail landfill, which only has an estimated remaining waste fill capacity of approximately 10 years under its current ECA. The City recognizes that there is no single solution to addressing future waste management challenges and developed recommendations in the SWMP to address these issues through a multi-pronged approach over a 30-year planning cycle. One of the recommended actions in the SWMP was to advance a Feasibility Study and Business Case during the short-term (i.e. within the next five years) to identify a technology(ies) that can reduce the amount of waste sent to landfill and potentially recover additional resources and energy. The objective of this Study was to prepare a comprehensive, up-to-date, and substantiated comparison of the options for the future of residual waste management for the City of Ottawa.

To begin the Study, City-generated waste characteristics were assessed, including quantity and composition. These characteristics are key planning elements in development of long-term waste management projects. Once waste characteristics were estimated, the following waste processing and conversion scenarios were evaluated:

- **Option 1: Status Quo and Private Facilities.** Under this option, the City would continue to dispose of non-diverted waste for final disposal at Trail until it reaches capacity (estimated to be in 2035) and then negotiate waste supply agreements for disposal with one or several regional third-party waste management facilities.
- **Option 2: WTE Facility.** Under this option, the City would build a new WTE facility that can process all their post-recycled residual waste with disposal of rejects and ash residue at a third-party waste management facility.
- **Option 3: MWP Facility.** Under this option, the City builds a MWP Facility that can process all of the City's waste, recover additional recyclables and dispose of the remaining process residuals at a private third-party waste management facility.
- **Option 4. WTE and MWP Facilities.** Under this option, the City builds a MWP Facility to recover additional recyclables and builds a WTE facility to process and recover energy from the remaining residual waste. Reject and ash residue from WTE will be disposed of at a private third-party waste management facility.
- **Option 5. Construct a New Landfill.** Under this option, the City builds a new greenfield landfill within the region to take all non-recyclable residuals after Trail reaches capacity.

As part of the evaluation of the five scenarios, the technical characteristics, potential environmental impacts, siting needs/requirements, associated challenges and opportunities, and estimates of probable costs were identified.

In addition, the regulatory and environmental approvals and timelines required for implementation of each of the five scenarios were reviewed, as well as the potential funding opportunities and project delivery models. The information gathered from this analysis was summarized in standalone Technical Memos No. 1 through No. 4 that are included in Appendices C-F.

A comparative evaluation methodology was developed that utilized both quantitative and qualitative criteria to compare each of the five scenarios to each other based on their relative strengths and weaknesses. The background information gathered from Technical Memos No. 1 through No. 4 was applied to the evaluation to inform some of the quantitative and qualitative criteria. Each criterion was developed to evaluate and grade each scenario to determine whether they are most preferred, preferred, less preferred or least preferred when compared against the other scenarios. Furthermore, each of the grades were weighted to calculate a score for each criterion to support the ranking of each of the five scenarios being considered. There were instances in this evaluation where the grade for a specific criterion for one or more scenarios received the same grade. For example, the WTE and MWP and WTE scenarios both received a “Most Preferred” grade for the Revenue Generating Potential criterion since both offered equally greater revenue amounts on an annual and life cycle basis for the sale of electricity and recovered commodities.

HDR utilized its proprietary Sustainable Return on Investment (SROI) decision-making tool used to assist with alternatives evaluation and selection using available data. The SROI model was applied to the comparative evaluation criteria to provide the specific quantitative outputs identified in **Table 6-3**. A detailed description of the SROI model, the assumptions used to generate the model outputs, and the results is provided in Appendix A. The general economic parameters and assumptions used to develop the SROI are included in Appendix B.

Table 7-1 provides a summary of the Comparative Evaluation for the five scenarios that were assessed as part of the Study. **Table 7-2** presents the summary of the total score for each alternative based on the evaluation table ratings, along with the score breakdown by category (environmental, social, economic/financial, and technical requirements).

Table 7-1: Comparative Evaluation

<table>
<tr><th colspan="6">Environmental Requirements</th></tr>
<tr><th></th><th>Status Quo and Private Facilities</th><th>WTE[1]</th><th>MWP[2]</th><th>MWP and WTE[3]</th><th>New Landfill</th></tr>
<tr><td rowspan="2">Energy Recovery Potential
GWh of Energy Produced Over Facility Lifecycle (30 years)</td><td>LEAST PREFERRED</td><td>MOST PREFERRED</td><td>LEAST PREFERRED</td><td>MOST PREFERRED</td><td>PREFERRED</td></tr>
<tr><td>• SROI Analysis: City will not benefit from energy recovery at third party site.</td><td>• WTE facilities generate steam from the combustion of waste which can be used in a district heating loop and/or run through a turbine to generate electricity.
• SROI Analysis: Capable of generating up to 5,543 GWh of electricity over 30 years of operations (or approximately 185 GWh/yr on average).
• Scenario also has the option to produce both electricity plus thermal energy that could be directed to the local district energy network. Assuming a 70/30 electricity to thermal energy split would result in up to 12 MWe (net) and 28 MWt, respectively.</td><td>• SROI Analysis: Technology does not have the ability to produce energy and requires significant power to operate.</td><td>• WTE facilities generate steam from the combustion of waste which can be used in a district heating loop or run through a turbine to generate electricity. Slightly less than WTE only option due to power needs of MWP facility and lower waste throughput.
• SROI Analysis: Capable of generating up to 5,136 GWh of electricity over 30 years of operations (or approximately 171 GWh/yr on average).
• Scenario also has the option to produce both electricity plus thermal energy that could be directed to the local district energy network. Assuming a 50/50 electricity to thermal energy split would result in up to 10 MWe (net) and 23 MWt respectively.</td><td>• New landfill will be designed with the ability to generate electricity from landfill gas and/or ability to generate RNG from landfill gas.
• SROI Analysis: Potential to generate and capture landfill gas for use as up to approximately 618 GWh of electricity over 30 years of operations (or approximately 21 GWh/yr on average).
• Variability will depend on type and actual tonnage of waste and will be impacted by potential restrictions provincial policy on organic and food waste going to landfills.</td></tr>
<tr><td rowspan="2">Landfill Diversion Percentage
Percentage of Waste Generated by City that is Diverted Away from Landfills</td><td>LEAST PREFERRED</td><td>MOST PREFERRED</td><td>LESS PREFERRED</td><td>MOST PREFERRED</td><td>LEAST PREFERRED</td></tr>
<tr><td>• Diversion percentage would be 0% since all residual waste generated by the City is assumed to be directed to third-party waste management facilities.</td><td>• Up to 77% of the City-generated waste will be converted or recovered (e.g. metals) by the process and diverted away from disposal. The remaining 23% will be ash residue and a small amount of unprocessible waste, which is assumed to be disposed of at a third-party waste management facility.</td><td>• Only 8% of incoming waste is estimated to be recoverable materials that will be diverted from third-party waste management facilities and/or disposal sites.
• The remaining 92% of the incoming waste stream will require further processing or will end up being disposed. This percentage could be reduced if more processing equipment is installed or additional markets develop for lower quality/valuable materials.</td><td>• 79% of incoming waste is estimated to be diverted from third-party waste management facilities and/or disposal sites. Slightly higher than WTE option due to materials recovered from MWP process.
• Estimated 21% of incoming waste stream will end up at third-party waste management facilities and/or disposal sites in the form of ash residue and process rejects. Slightly less than WTE option due to recovered materials from the MWP process on the front end.</td><td>• Approximately 0% diversion is assumed since most of the residual waste generated by the City will be landfilled and limited amount of materials will be recovered at the landfill.</td></tr>
<tr><td rowspan="2">Opportunity to Recover Marketable Commodities
Potential Tonnes of Marketable Material Recovered Over Lifecycle (Millions)</td><td>LEAST PREFERRED</td><td>PREFERRED</td><td>PREFERRED</td><td>MOST PREFERRED</td><td>LESS PREFERRED</td></tr>
<tr><td>• No diversion. Disposal only option with the assumption that no additional recovery will occur at the third-party waste management facilities.</td><td>• Ferrous and non-ferrous metals can be captured post-combustion (est. 3% of incoming waste stream).
• SROI Analysis: Opportunity to recover post combustion metals estimated to be 0.26 Mt (8,635 tonnes annually) over the 30-year lifecycle of the facility.</td><td>• Opportunity to recover recyclable materials such as OCC, mixed paper, #1, #2, and mixed metals).
• SROI Analysis: Opportunity to recover recyclable materials estimated to be 0.64 Mt (21,170 tonnes annually) over the 30-year lifecycle of the facility.</td><td>• Opportunity to recover recyclable materials (OCC, mixed paper,#1, #2, mixed metals) and post combustion recyclable materials.
• SROI Analysis: Opportunity to recover recyclable material and post combustion metals estimated to be 0.87 Mt (29,091 tonnes annually) over the 30-year lifecycle of the facility.</td><td>• Disposal only option but assumes new landfill will be designed with some ability to recover select recoverable materials at landfill. Quantity is considered small and may vary by year so no detailed recovery quantities were estimated.</td></tr>
</table>

Environmental Requirements	Status Quo and Private Facilities	WTE[1]	MWP[2]	MWP and WTE[3]	New Landfill
	NEUTRAL	**PREFERRED**	**NEUTRAL**	**PREFERRED**	**LEAST PREFERRED**
Emissions-Discharges to Air, Land and Water Impacts to Air, Land and Water Quality	• It is anticipated that there will be some increase in truck vehicle emissions for transport to third-party waste management facilities.	• Combustion process can yield air pollutant emissions, but there is a greater opportunity to significantly reduce these emissions through implementing advanced air pollution control systems. • Minor impacts to land due to significantly less reliance or need on third-party disposal sites for handling the lower amounts of ash generated. • Facility can be designed as a zero discharge facility for wastewater.	• The process itself yields no actual emissions to air, outside of waste collection vehicles and on-site mobile equipment. • Some potential to emit to land from ash residue generated and potential deposition of air emissions, but at a much lower quantity compared to most scenarios. • The process itself may produce some leachate and wastewater that will need to be managed/treated, but minimal amounts.	• WTE facility has the potential to produce higher emissions, but the total quantity would be less with the inclusion of the MWP component. • Least potential to emit to land from ash residue generated compared to other options due to MWP component, plus lower potential for deposition of air. emissions scenarios inclusion of the MWP component. • Minimal potential impacts to surface and ground waters, but the combined options will produce a combination of the stand-alone WTE and MWP options and is slightly higher.	• Landfill gas emissions, specifically methane, that are not captured by the gas recovery system. • Potential impacts to groundwater and surface water from leachate (including the potential impacts from the presence of PFAS). • Impacts to land from the construction and operation as a result from the landfill.
	LESS PREFERRED	**NEUTRAL**	**PREFERRED**	**NEUTRAL**	**PREFERRED**
Potential for GHG Impacts [4] Tonnes of GHG Emitted, Emissions Over Lifecycle (Millions)	• City would not have to manage any new disposal emissions as they will be managed by a third party waste facility. Emissions associated with 3rd party waste disposal cannot be quantified with certainty, and depending on disposal method and specifications, may be greater than the emissions projected on the other alternatives. Emissions from third party facilities would fall under community emissions and not the City of Ottawa corporate emissions. This alternative has a reduced score due to the potential risk of greater community emission impacts. • SROI Analysis: ○ Corporate Emissions: 0.0086 Mt of anthropogenic emissions from waste transported during the Study period (0.3k tonnes/year). ○ Community Emissions: Future emissions unknown due to uncertainty of 3rd party waste disposal facility. ○ Biogenic Emissions: Future biogenic emissions unknown due to uncertainty of 3rd party waste disposal facility. ○ Further community emissions will be released for over 100 years after the Study period due to the decomposition of waste disposed during that period.	• WTE facilities can emit indirect forms of GHG in the form of NOx and SOx. However, these emissions can be significantly reduced via advanced air pollution control equipment. • SROI Analysis: ○ Corporate Emissions: 4.1 Mt of anthropogenic emissions from waste transported, recycled, and combusted during the Study period (138k tonnes/year). ○ Community Emissions: 0.019 Mt of anthropogenic emissions from waste disposed in the third party waste facility (0.6k tonnes a year). ○ Biogenic Emissions: 5.5 Mt emitted (182k tonnes a year), 96% come from corporate emissions and 4% come from community emissions. ○ Community emissions released for over 100 years after the Study period due to the decomposition of waste disposed are negligible since there is typically >1% organic material remaining in the ash residue after the combustion process.	• The majority of GHG emissions from the MWP scenario comes from the disposing of process residuals and generation of methane (CH4) once those residuals are in a landfill. • SROI Analysis: ○ Corporate Emissions: 0.107 Mt of anthropogenic emissions from waste transported, and recycled, during the Study period (4k tonnes/year). ○ Community Emissions: 1.2 Mt of anthropogenic emissions from waste disposed in the third party waste facility (41k tonnes a year). ○ Biogenic Emissions: 14.6 Mt emitted (488k tonnes a year), all of which come from community emissions. ○ Almost all of emissions from the MWP scenario are attributable to community emissions from third-party waste management facilities that will need to take the residual waste stream remaining. These additional emissions will be released for over 100 years after the Study period due to the decomposition of waste disposed during that period.	• GHG impacts from this option would be from NOx and SOx emissions but would be slightly less than the stand alone WTE option due to less material being combusted. • SROI Analysis: ○ Corporate Emissions: 3.7 Mt of anthropogenic emissions from waste transported, recycled, and combusted during Study the period (125k tonnes/year). ○ Community Emissions: 0.018 Mt of anthropogenic emissions from waste disposed in the third party waste facility (0.6k tonnes a year). ○ Biogenic Emissions: 5.2 Mt emitted (175k tonnes a year), 96% come from corporate emissions and 4% come from community emissions. ○ Community emissions released for over 100 years after the Study period due to the decomposition of waste disposed are negligible since there is typically >1% organic material remaining in the ash residue after the combustion process.	• Landfills can emit GHG such as methane. The landfill gas capture system is estimated to capture 85-90% of these emissions. • SROI Analysis: ○ Corporate Emissions: 1.3 Mt of anthropogenic emissions from waste disposed in the third party waste facility (44k tonnes a year) ○ All emissions are corporate in the new landfill case. ○ Biogenic Emissions: 16.0 Mt emitted (532k tonnes a year), all of which come from corporate emissions. ○ Additional corporate emissions will be released for over 100 years after the Study period due to the decomposition of waste landfilled during that period.

SOCIAL REQUIREMENTS	Status Quo and Private Facilities	WTE[1]	MWP[2]	MWP and WTE[3]	New Landfill
	NEUTRAL	NEUTRAL	NEUTRAL	NEUTRAL	LEAST PREFERRED
Potential Visual Impacts Negative aesthetics associated with operations and structures required for the scenario	• Third-party waste management facilities are existing facilities and are located in fairly remote areas so new visual impacts are not anticipated.	• Operation can mostly be contained inside the processing building and there is opportunity for architectural enhancements to approve aesthetics. Stack will create visual impacts depending on site location.	• Operation can mostly be contained inside the processing building and there is opportunity for architectural enhancements to approve aesthetics.	• Most potential for visual impacts for technology options due to the size of the buildings needed for the MWP and WTE facilities, plus the stack visual impacts.	• The size and outdoor nature of the operations at an active landfill site creates the worst potential visual impact.
	NEUTRAL	PREFERRED	PREFERRED	PREFERRED	LEAST PREFERRED
Other Nuisance Impacts Impacts associated with odour, dust, litter, and other nuisances that could be part of the scenario's operation.	• Potential City vehicles transporting waste to third-party waste management facilities would still cause odour, dust and litter. Although City does not own/operate the third-party locations there still be indirect negative potential impacts associated with odours, dust, and debris from City delivering waste to these locations.	• Operation will be contained within building to reduce/eliminate nuisance impacts, and odours will be controlled/eliminated by the combustion process.	• Operation can mostly be contained indoors, but there is the risk of odour impacts from the operation. These impacts could be mitigated with mechanical controls.	• Operation will be contained within building to reduce/eliminate nuisance impacts, and odours will be controlled/eliminated by the combustion process.	• The largest potential impact for odour, loose debris/litter, dust, and potential for vectors.
	MOST PREFERRED	PREFERRED	LESS PREFERRED	PREFERRED	MOST PREFERRED
System Transportation Impacts (5) Total Vehicle-Kilometres Travelled (Millions)	• Waste will be hauled directly to third-party waste management facility. • SROI Analysis: 11.2M VKT for existing condition (Approximately 373k VKT / year, over a 30-year Study period).	• Waste will be hauled directly to WTE facility; bypassed waste and ash will be hauled to a third-party waste management facility. • SROI Analysis: 13.5M VKT to haul process rejects to third-party waste management facility (Approximately 450k VKT / year, over a 30-year Study period).	• Waste will be hauled directly to MWP facility, bypassed waste and process residuals will be hauled to a third-party waste management facility. • SROI Analysis: 21.3M VKT to haul process rejects and bypassed waste (est. @ 15% of incoming waste stream) to third-party waste management facility (Approximately 701k VKT / year, over a 30-year Study period).	• Waste will be hauled directly to MWP and WTE facility, bypassed waste and process residuals will be hauled to a third-party waste management facility. • SROI Analysis: 13.3M VKT to haul ash and process rejects to a third-party waste management facility (Approximately 444k VKT / year, over a 30-year Study period).	• Waste will be hauled directly to the new landfill. • SROI Analysis: SROI Analysis: 11.2M VKT to haul waste to new City-owned landfill (Approximately 373k VKT / year, over a 30-year Study period).
	MOST PREFERRED	NEUTRAL	NEUTRAL	LESS PREFERRED	LEAST PREFERRED
Potential for Property Value Impacts Effects of Value of Properties in the Vicinity of the Facilities	• Existing facilities so no change over current property values would be anticipated, but future opportunities for commercial or residential development may be limited on closed third-party waste management facility/waste disposal sites.	• No significant impacts to property values are anticipated based on experience with existing facilities. Perceived environmental concerns could deter some home buyers.	• No significant impacts to property values are anticipated based on experience with existing facilities, but local resident concerns about an active waste processing site could deter some home buyers.	• No significant impacts to property values are anticipated based on experience with existing facilities. Perceived environmental concerns could deter some home buyers. • The MWP and WTE option will have the most number of vehicles entering and exiting the site, which will add to the negative perception and potential property value impacts.	• Highest potential to negatively impact property values versus other options. The large land size required for a landfill means there are more neighbouring properties that could be impacted.
	MOST PREFERRED	LESS PREFERRED	NEUTRAL	LESS PREFERRED	LEAST PREFERRED
Opportunity for Community Support Level of Acceptance in the Community, and Possibility of NIMBY Opposition	• The third-party waste management facility would already exist and community opposition is not expected to be a new issue.	• Higher potential for community/social risks associated with opposition to project and potential (or perceived) health risks to the community. High potential for NIMBY opposition.	• Low potential to result in community/social risks. Technology is relatively accepted. Still chance for NIMBY opposition to a new solid waste facility.	• Potential for community/social risks associated with opposition to project and potential (or perceived) health risks to the community, but slightly less than WTE only option since there is more upfront recovery of recyclables. Still high potential for NIMBY opposition.	• Highest potential for community/social risks associated with opposition to project and potential (or perceived) health risks to the community. Significantly higher NIMBY opposition.

Economic/Financial Requirements	Status Quo and Private Facilities	WTE[1]	MWP[2]	MWP and WTE[3]	New Landfill
	MOST PREFERRED	**LESS PREFERRED**	**PREFERRED**	**LESS PREFERRED**	**LESS PREFERRED**
Capital Costs (Millions 2024$)	• Existing site with infrastructure already in place. No capital costs (e.g. $0). Any new or additional capital costs for modifications to the site will fall upon third-party waste management facility receiving the waste.	• Real Value (Undiscounted 2024$): $663.5 M. Range anticipated to between $497 M - $862 M. • Includes construction, engineering, design, and land acquisition costs.	• Real Value (Undiscounted 2024$): $129.4 M. Range anticipated to between $97 M - $168 M. • Includes construction, engineering, design, and land acquisition costs.	• Real Value (Undiscounted 2024$): $742.5 M. Range anticipated to between $556 M - $965 M. • Includes construction, engineering, design, and land acquisition costs.	• Real Value (Undiscounted 2024$): $592.6 M. Range anticipated to between $439 M - $761 M. • Includes construction, engineering, design, and land acquisition costs. • Factors in capital costs for infrastructure (pipeline and connections) and gas conditioning requirements for converting landfill gas to RNG, which could be on the order of $45M-$60M installed costs if City was to own/operate.
	NEUTRAL	**NEUTRAL**	**LESS PREFERRED**	**LESS PREFERRED**	**PREFERRED**
Operations and Maintenance Costs [(6),(7)] (Millions 2024$)	• Real Value (Undiscounted 2024$): $1,314 M (Estimated $43.8 M / year). • Solely comprises of hauling & disposal costs. Facility O&M costs for waste will fall upon third-party waste management facility owner/operator receiving the waste.	• Real Value (Undiscounted 2024$): $1,405.2 M (Estimated $46.8 M / year). • Captures hauling & disposal costs, and facility O&M of new WTE facility, during the 30-year Study period. • Does not include indirect costs related to financing and debt service costs, which would add up to an additional $40 M annually.	• Real Value (Undiscounted 2024$): $2,104.2 M (Estimated $70.1 M / year). • Captures hauling & disposal costs, and facility O&M of new MWP facility, during the 30-year Study period. • Does not include indirect costs related to financing and debt service costs, which would add up to an additional $8 M annually.	• Real Value (Undiscounted 2024$): $2,184.6 M (Estimated $72.8 M / year). • Captures hauling & disposal costs, and facility O&M at the new MWP and WTE facilities, during 30-year Study period. • Does not include indirect costs related to financing and debt service costs, which would add up to an additional $44 M annually.	• Real Value (Undiscounted 2024$): $469.3M (Estimated $15.6 M / year). • Captures hauling & disposal costs, and facility O&M at new landfill with a RNG system, during the 30-year Study period. • Does not include indirect costs related to financing and debt service costs, which would add up to an additional $35 M annually. • Includes additional operating costs associated with operating and gas conditioning systems to convert landfill gas to RNG, estimated to be on the order of an additional $2M/yr if City was to own/operate.
	LEAST PREFERRED	**MOST PREFERRED**	**PREFERRED**	**MOST PREFERRED**	**PREFERRED**
Revenue Generation Potential Total Revenue from Energy & Material Recovery (Millions 2024$)	• Third-party waste management facility will benefit from the revenue generated due to LFG utilization, not the City.	• Real Value (Undiscounted 2024$): $537.4 M (Estimated $17.9 M / year). • Established markets in Ottawa/Province for electricity and thermal energy generated, as well as established markets for post-combustion metals in Ontario. • The option to sell the thermal energy generated could result in up to $20M in additional revenues annually, plus up to an additional $5M-$6.5M in electrical revenues depending on the agreed upon energy pricing arrangements for the project.	• Real Value (Undiscounted 2024$): $133.4 M (Estimated $4.4 M / year). • Assumes recycled materials can be sold on secondary markets.	• Real Value (Undiscounted 2024$): $631.0 M (Estimated $21.0 M / year). • Established markets in Ottawa/Province for electricity and thermal energy generated, as well as established markets for post-combustion metals in Ontario. • The option to sell thermal energy generated could result in up to $20M in additional revenues annually, plus up to an additional $5M-$6.5M in electrical revenues depending on the agreed upon energy pricing arrangements for the project.	• Real Value (Undiscounted 2024$): $56.0 M (Estimated $1.9 M / year). • Revenue generating potential from LFG collected and use for electricity generation, but may be less beneficial if operated/controlled by a third party. • Potential for revenue generation for converting landfill gas to RNG (as much as $12M per year per the City). Detailed impacts on the quantity of gas available (and impacts of potential ban on landfilling organics) and capital and operating costs will need to be further evaluated if scenario is advanced beyond feasibility phase.

Economic/Financial Requirements	Status Quo and Private Facilities	WTE[1]	MWP[2]	MWP and WTE[3]	New Landfill
	NEUTRAL	NEUTRAL	LESS PREFERRED	LESS PREFERRED	PREFERRED
Overall Financial Feasibility [(6),(8),(9)] *Total Cash Outflow (Millions 2024$)*	• Present Value (Discounted): $606.1 M (Estimated $20.2 M / year, $77.6 / tonne). • Real Value (Undiscounted 2024$): $1,314 M (Estimated $43.8 M / year, $160.0 / tonne). • Most susceptible to changes in tipping fees for third-party waste management facilities. If the tip fee increases by $100 per tonne, net present cash outflow increases by 62.5%.	• Present Value (Discounted): $933.4 M (Estimated $31.1 M / year, $119.5 / tonne). • Real Value (Undiscounted 2024$): $1,531.3 M (Estimated $51.0 M / year, $196.0 / tonne). • Minimal risk to changes in tipping fees for third-party waste management facilities due to lower amounts of waste generated requiring disposal. If the tip fee increases by $100 per tonne, net present cash outflow increases by 9.6%.	• Present Value (Discounted): $1,035.6 M (Estimated $34.5 M / year, $132.6 / tonne). • Real Value (Undiscounted 2024$): $2,100.1 M (Estimated $70.0 M / year, $268.9 / tonne). • Highly susceptible to changes in tipping fees for third party waste facilities. If the tip fee increases by $100 per tonne, net present cash outflow increases by 34.3%.	• Present Value (Discounted): $1,307.0 M (Estimated $43.6 M / year, $167.3 / tonne). • Real Value (Undiscounted 2024$): $2,296.1 M (Estimated $76.5 M / year, $294.0 / tonne). • Minimal risk to changes in tipping fees for third-party waste management facilities due to least amount of remaining waste that would require disposal. If the tip fee increases by $100 per tonne, net present cash outflow increases by 6.3%.	• Present Value (Discounted): $576.4 M (Estimated $19.2 M / year, $73.8 / tonne). • Real Value (Undiscounted 2024$): $1,005.9 M (Estimated $33.5 M / year, $128.8 / tonne).$1,005.9 M (Estimated $33.5 M / year, $128.8 / tonne). • Not susceptible to changes in tipping fees for third party waste facilities.

Technical Requirements	Status Quo and Private Facilities	WTE1	MWP2	MWP and WTE3	New Landfill
	MOST PREFERRED	LESS PREFERRED	LESS PREFERRED	LEAST PREFERRED	PREFERRED
Technical Complexity Amount and Complexity of Technology Required	• The City's waste will be going to third-party waste management facilities. No technical effort required by the City. • Note that all technology scenarios will require at least some third-party waste management/disposal facility(ies).	• Amount of equipment, technology and the high-level of skill/education required to operate this scenario makes the level of complexity high.	• Amount of equipment, technology and the higher level of skill required to operate technology makes the level of complexity high.	• Requires integration of the two most technologically complex options.	• Technical complexity is very low compared to other technological processing options.
	MOST PREFERRED	LESS PREFERRED	LESS PREFERRED	LESS PREFERRED	LESS PREFERRED
Timing/Schedule Requirements Length of Time from Project Concept to Commercial Operations	No significant timing or schedule requirements anticipated since no new infrastructure will be developed. Contracts for waste disposal to be coordinated prior sending waste to third-party waste management facilities.	• The need to identify a site, complete the regulatory approval process, and the design and construction of the facility results in a longer implementation timeline (i.e. 7-10 years).	• The need to identify a site, complete the regulatory approval process, and design and construct the facility results in a longer implementation timeline; however, approval process and design/construction process could be faster than WTE or MWP and WTE options (i.e. 5-7 years).	• The need to identify a site, complete the regulatory approval process, and design and construct the facility results in a longer implementation timeline (i.e. 7-10 years).	• The need to identify a site large enough to accommodate the area to meet the landfill operational requirements, complete the regulatory approval process, and design and construct the facility results in a longer implementation timeline. Could range from 7-10 years.
	NEUTRAL	PREFERRED	LESS PREFERRED	PREFERRED	MOST PREFERRED
Feedstock Flexibility Restrictions on Types of Waste Accepted	• Little to no restrictions beyond unacceptable wastes by permit. City would be subject to third-party waste management facility's waste receiving and acceptance restrictions.	• Technology estimated to be able to process close to 99% of incoming material.	• Technology is able to accept a wide variety of materials, but a higher percentage (estimated at 15%) of incoming materials will need to be diverted from the process. • City's existing and future recycling and recovery efforts will inhibit the available materials that can be recovered and marketed by technology requiring much of the incoming materials to be directed to third-party waste management facilities.	• Technology estimated to be able to process close to 99% of incoming material based on the assumption that whatever cannot be passed through the MWP component will be sent directly to the WTE to be processed.	• Least amount of restrictions to accepting various materials as long as permitted/approved.

Technical Requirements	Status Quo and Private Facilities	WTE1	MWP2	MWP and WTE3	New Landfill
Scalability Flexibility to either Increase or Decrease Capacity	**LESS PREFERRED** Existing locations with finite capacity (assuming additional expansion is not feasible). • Potential for competition with other jurisdictions for third-party waste management facility sites, which could limit the available capacity to receive all of the City's waste and will require future expansion that may impact City's long term plans.	**LESS PREFERRED** • Some flexibility can be built into the design to accommodate changes to waste stream (either a 10-15% reduction or increase in capacity as required) and to take different materials if allowed by permit (e.g. sludge, other materials). Initial design can also take future expansion in mind (i.e. DYEC). Facility capacity could be reduced by taking one or more units offline or reducing unit throughput.	**PREFERRED** • Would require upgrades if waste levels increase significantly, or if the City requires additional materials to be recovered (e.g. organics, specific commodities). The technology is less affected by drop in waste capacity. Some flexibility to easily add equipment to recover more or different materials assuming building was designed to accommodate future expansion.	**LESS PREFERRED** • Scalability would be comparable to both the stand-alone WTE and MWP.	**PREFERRED** • New cell construction and addition would be less restrictive than other options. • City will have greater control over the asset and the ability to accept additional waste.
Process Reliability (Risk Potential) Reliability of Operations and Potential of Experiencing Downtime	**LESS PREFERRED** • City would have limited control of waste disposal operations and would need to rely on third-party waste management facility owner/operators with finite capacity without future expansion. • Limited available waste facility disposal capacity throughout the Province which is predicted to be further restricted by 2035, plus competition for disposal facility space with other jurisdictions (e.g. the GTA) could limit future third-party waste management facility availability for the disposal of City's waste, and higher market rates for disposal (e.g. tipping fees) will be likely.	**PREFERRED** • Technology has a high industry average reliability in North America (i.e. >90% available to process waste). • Technology does have scheduled and unscheduled downtime for maintenance, but the impacts on the waste processing/disposal can be mitigated if multiple units are constructed and the timing of outages and waste deliveries are coordinated with the operator. Depending on ownership model, the City would have greater control of asset and tipping fees.	**LESS PREFERRED** • Changes to commodity pricing may impact which materials are removed from the process vs. sent to disposal as process residuals. • Technology includes high wear equipment (shredders, trommels, etc.) that requires frequent maintenance and can result in extended downtime. Could be mitigated by installing multiple processing lines. • Given the expected amount of process residuals from the technology that will require disposal or further processing, City would still be heavily dependent on third-party waste management facility disposal contracts.	**PREFERRED** • Scenario would be similar to WTE option since MWP facility on the front end could be bypassed if that component is having maintenance issues.	**MOST PREFERRED** • Operations are relatively simple and does not rely on complex processing equipment and systems to process waste materials that requires a lot of maintenance (other than mobile equipment and gas recovery systems). Shutdown periods for maintenance would be anticipated to have less of an impact than the technology options (WTE and MWP). • City is assumed to own the asset and would have greater control over available capacity.
Siting Requirements Overall Area Requirements, Necessary Infrastructure and Utilities, Proximity to Major Highways	**MOST PREFERRED** • Third-party waste management facilities will be responsible for site capacity or additional infrastructure required on existing sites.	**NEUTRAL** • Will require approximately 3-5 hectare (ha) site at a minimum and would require significant infrastructure upgrades for utilities (water, sewer, electric, potentially natural gas), as well as proximity to local power delivery centre for electrical interconnect.	**NEUTRAL** • Will require 3-5 ha site at a minimum to build facility and for infrastructure and setbacks, and would require significant infrastructure upgrades for utilities (water, sewer, electric, potentially natural gas) .	**NEUTRAL** • Will require approximately 8 ha site at a minimum to build the facility, slightly more land than the WTE or MWP due to the two operations and would require significant infrastructure upgrades for utilities (water, sewer, electric, potentially natural gas) as well as proximity to local power delivery centre for electrical interconnect.	**LEAST PREFERRED** • Requires the most land acquisition within the boundaries of the City of any of the options (approximately 200 ha).
Approvals/Permitting/Regulatory Requirements For Implementation Number and Complexity of the Approvals Required to Implement the Process	**MOST PREFERRED** • None. Third-party waste management facilities will have approvals and permits already in place. (e.g. only facilities that are approved to accept the waste will be considered).	**LESS PREFERRED** • Scenario would require a number of complex approvals and permitting requirements, including streamlined EA, approvals for air, water, and waste, as well as building permits, electrical interconnect, as well as testing requirements for stack emissions and ash testing that will be required throughout the operational life of the facility.	**PREFERRED** • Process would require a complex approvals process, but the permitting and long-term testing requirements would be far less complex than the WTE scenario. Some factors that impact permits will be whether a new build or existing building.	**LESS PREFERRED** • WTE component within scenario will require a number of complex approvals and permitting requirements, including streamlined EA, approvals for air, water, and waste as well as other permits such as building permits, electrical interconnect, as well as testing requirements for stack emissions and ash testing that will be required for the life of the facility.	**LEAST PREFERRED** • The approvals and permitting requirements for this option are anticipated to be onerous (e.g. Comprehensive EA and ECA approvals for waste, air, wastewater) as there exists specific regulations (e.g. O.Reg. 232/98) that spells out the standards for landfill design and stormwater management. In addition, additional permits from other agencies may be required.

Technical Requirements	Status Quo and Private Facilities	WTE[1]	MWP[2]	MWP and WTE[3]	New Landfill
	NEUTRAL	LESS PREFERRED	LESS PREFERRED	LEAST PREFERRED	PREFERRED
Number and Complexity of Contracts Amount and Sophistication of Agreements Needed to be Made for the Operation of the Facility	• Waste disposal agreements will need to be negotiated and re-negotiated for third-party waste management facilities.	• Scenario will require a number of complex contracts, including an O&M Agreement with a third party, residue disposal agreements, and the electrical interconnect and power purchase agreement.	• Scenario will require complex contracts, including recovered materials off-taker agreements, possibly an O&M Agreement with a third party, and a residue disposal agreement(s).	• This scenario will have the greatest number of complex contracts as it will combine the number of contracts required for the stand-alone WTE and MWP options (including residual disposal agreements).	• Scenario will require minimal contracting if owned and operated by the City. The most complex contract may be related to obtaining or leasing the land required for the landfill.

FOOTNOTES

General Note: Numbers included from the SROI analysis are shown as lifecycle amounts based on a 30-year Study period starting in 2035 (after the presumed closure of Trail). Annualized numbers will be shown in parenthesis. Annual numbers are based off the annual average of the lifecycle figures for the 30-year Study period (2035-2064) and may differ slightly from the annual figures from Technical Memo 1, which were based on the projected 2053 design capacity tonnage of 267,600 tonnes.

[1] This option also includes the need for a landfill to accept the ash produced from the combustion process (estimated to be 23% of the incoming tonnage by weight).

[2] This option also includes the need for a landfill to accept the unrecovered materials (estimated to be 92% of the incoming tonnage by weight).

[3] This option also includes the need for a landfill to accept the ash produced from the combustion process (estimated to be 21% of the incoming tonnage by weight).

[4] The City tracks community and corporate GHG emissions through annual GHG inventories and potential GHG emissions are scored including both community and corporate GHG emissions. A third-party waste management facility would fall under community GHG emissions. Third party waste facilities are assumed to be landfills in the emission modelling, unless otherwise stated. Emissions are reported as biogenic and anthropogenic terms, however only anthropogenic emissions are evaluated in the scoring.

[5] Comparison performed using quantitative results from SROI Analysis.

[6] Closure and Post Closure Costs at Trail are incurred in all scenarios and not included in the evaluation.

[7] Total O&M Costs includes hauling costs of $150 / tonne, and transportation costs of $10 / tonne. Values are escalated in line with inflation (assumed 2% per year).

[8] Rankings are based off present values of cash outflow, and sensitivity to tipping fee increases. Detailed results of discounted costs, discounted revenues, and the sensitivity analysis for the $250 tip fee are shown in Appendix A of the feasibility study.

[9] Total Cash Outflow = Capital Cost + Operations and Maintenance Costs – Revenue Generating Potential

Table 7-2: Summary of Final Scenario Rankings

		Status Quo and Private Facilities	WTE	MWP	MWP and WTE	New Landfill
Environmental Requirements	Score	-7	+6	-1	+7	-3
	Subcriteria Ranking	5	2	3	1	4
Social Requirements	Score	+6	+1	0	0	-6
	Subcriteria Ranking	1	2	3	3	5
Economic/Financial Requirements	Score	0	+1	0	-1	+2
	Subcriteria Ranking	3	2	3	5	1
Technical Requirements	Score	+6	-3	-3	-5	+2
	Subcriteria Ranking	1	3	3	5	2
Total (Score)		+5	+5	-4	+1	-5
Overall Final Scenario Ranking		1	1	4	3	5

7.2 Risk Analysis

This section examines the key risk considerations for each waste management option, identifying critical risk factors that could introduce uncertainty and impact successful implementation. The risk analysis was informed by the findings presented in the technical memos.

The key risk factors evaluated in these technical memos include, but are not limited to:

- **Process Reliability Risks:** Risks related to system reliability and resilience, including operational consistency and long-term performance.
- **Environmental Risks:** Potential negative environmental impacts, including risks to public and ecological health.
- **Social Risks:** Risks associated with site selection, host community considerations, public consultation, and overall social acceptance.
- **Economic/Financial Risks:** Financial implications of implementation, covering capital and operational costs, market risks for by-products (e.g., energy, recovered materials), risks associated with construction, operations and maintenance, ability to secure financing, and residuals management requirements.
- **Approval Risks:** Risks that impact ECA approvals.

The following subsections discuss these risk factors across the five waste management options, excluding the WTE and MWP combination, as its risks would largely reflect a combination of those identified for each individual technology. While each option presents unique risk considerations, some may be more exposed to specific risks than others. This risk analysis highlights these variations and their potential implications.

7.2.1 Status Quo and Private Facilities

The Status Quo and Private Facilities option, which involves allowing the landfill to reach capacity and then entering into a third-party agreement for waste disposal, presents several key risks:

7.2.1.1 PROCESS RELIABILITY RISKS

- The City would have limited control over waste disposal operations, relying entirely on third-party landfill owners and operators.
- Finite landfill capacity within the province, particularly with competition from other jurisdictions (e.g., GTA), creates uncertainty around long-term disposal availability. Current landfill capacity in the Ottawa area would not cover the full 30-year study period.
- Potential service disruptions due to third-party operational changes, regulatory constraints, or closure of landfill sites.

7.2.1.2 ENVIRONMENTAL RISKS

- While the third-party landfill already exists, transporting waste to these locations would contribute to GHG emissions from hauling activities.

- Odour, dust, and debris could be generated from waste transportation, creating localized environmental impacts.
- The City does not have direct control over third-party landfill environmental compliance, which could potentially expose it to indirect reputational risks by contributing to community or environmental impacts.

7.2.1.3 SOCIAL RISKS

- Continuous use of landfills is a solution that is known to residents, therefore there is some social acceptance with this approach given its familiarity. However, the City may face resistance from local residents due to concerns over environmental impact, air quality, and potential health risks. Shifting to a third-party could further escalate public dissatisfaction, raising concerns about long-term waste management planning.

7.2.1.4 ECONOMIC/FINANCIAL RISKS

- The City would be highly susceptible to market fluctuations in tipping fees, making long-term cost predictability challenging.
- With there being a limited amount of landfill space available in the region, bidding against private organizations and neighbouring municipalities could lead to higher than anticipated tipping fees for the City.

While the Status Quo and Private Facilities option avoids the complexities of implementing new waste management technologies, it exposes the City to moderate financial risks due to unpredictable tipping fee increases and long-term disposal capacity constraints. Additionally, reliance on third-party landfills reduces operational control, potentially leading to service disruptions. Although ECA approvals are not a concern, the environmental and social risks associated with increased waste transportation (GHG emissions, odour, dust, and litter) remain notable considerations.

7.2.2 WTE Facility

The development of a WTE facility presents a distinct set of risks across multiple categories, including technical feasibility, social acceptance, financial exposure, and regulatory approvals.

7.2.2.1 PROCESS RELIABILITY RISKS

- The facility must meet Ontario’s stringent air emissions standards, requiring robust air modeling and adjacent property uses that can support the air emissions (e.g., away from sensitive land uses).
- WTE facilities require high technical expertise to maintain consistent performance and emissions compliance.
- A portion of waste (~10–20%) remains as ash, necessitating a third-party landfill agreement for disposal.

7.2.2.2 ENVIRONMENTAL RISKS

- **Air quality concerns:** While modern WTE technologies meet strict emissions standards, public skepticism around air pollution and health impacts remains a key challenge.

- **GHG emissions:** While WTE can reduce landfill methane emissions, it still generates CO_2 and other pollutants, requiring mitigation strategies.
- **Proximity risks:** The site must be adequately distanced from sensitive land uses to minimize exposure to emissions and avoid conflicts with local zoning.
- **Carbon tax impact:** WTE facilities face the highest potential impact from Canada's carbon tax, driven by the carbon emissions attributed to the combustion process.

7.2.2.3 SOCIAL & COMMUNITY RISKS

- High likelihood of NIMBY (Not In My Backyard) opposition, as WTE facilities often face public resistance due to perceived health risks.
- Public opposition - the project would be subject to Ontario's Environmental Assessment process, which includes:
    - Public and Indigenous consultation, potentially leading to delays or opposition.
    - Risk of Part II Order or Elevation Request, which could escalate the project to an Individual Environmental Assessment (IEA), prolonging approvals.
    - Ministerial discretion in determining whether objections are valid, adding an element of regulatory uncertainty.

7.2.2.4 ECONOMIC/FINANCIAL RISKS

- The significant capital costs make it one of the most expensive options evaluated.
- Possible offsets from energy generation and sale of by-products, though market viability is uncertain.
- During the construction phase, WTE facilities may be exposed to a financial risk from cost overruns, particularly if led by an inexperienced or unqualified developer. Potential to transfer the cost overrun risks depending on the project delivery approach undertaken by the City (i.e., public-private partnership or similar innovative model could transfer construction cost overruns to developer).

7.2.2.5 APPROVAL RISKS

- Regulatory approvals are a key challenge due to Ontario's strict environmental standards for air emissions.
- The ESP must be elevated to a comprehensive EA.
- MECP regulatory consistency: If the Ministry issues a Part II Order, it would contradict the intent of the ESP's streamlined approach, making this a low but not negligible risk.

The WTE facility presents significant financial, social, and regulatory risks, despite its potential long-term benefits in waste reduction and energy generation. The high cost (capital costs estimated to range between $497 million to $862 million plus annual O&M costs of $46.8 million), strong potential for public opposition, and stringent air emissions requirements make this a high-risk investment. However, if the technology is proven and the EA process is navigated successfully, WTE could offer a long-term waste management solution with reduced landfill reliance.

7.2.3 MWP Facility

A MWP facility involves advanced sorting technologies to recover recyclable and reusable materials from mixed municipal waste. While this approach enhances diversion rates, it introduces significant financial, operational, and market risks, particularly due to its reliance on third-party landfills for residual waste disposal.

7.2.3.1 PROCESS RELIABILITY RISKS

- Technologies such as shredders, trommels, and sorting systems require frequent maintenance, potentially leading to downtime or extended shutdowns.
- A significant portion of waste remains as process residuals, requiring ongoing third-party landfill disposal, leaving the City vulnerable to capacity constraints and price fluctuations.
- Changes in market demand for recovered materials could affect what is economically viable to divert, impacting landfill disposal rates.

7.2.3.2 ENVIRONMENTAL RISKS

- While operations are primarily indoors, odours remain a key risk factor, requiring mechanical controls and proper site setbacks from residential and sensitive land uses.
- Given the continued reliance on third-party landfills, emissions from hauling residuals will contribute to the facility's environmental footprint.

7.2.3.3 SOCIAL & COMMUNITY RISKS

- Lowest social risk among options, as MWP is a relatively accepted technology. However, potential for NIMBY opposition still exists, particularly if odours or truck traffic become an issue.
- Site selection considerations - the facility must be appropriately located with:
    - Adequate road access to support waste transportation.
    - Proper buffer zones to mitigate potential nuisance factors (e.g., odour, noise, traffic).

7.2.3.4 ECONOMIC/FINANCIAL RISKS

- Highly susceptible to third-party landfill tipping fee fluctuations, as the facility will still require long-term landfill agreements for process residuals.
- Contractors may face financial instability during construction, leading to project delays.
- Higher-than-expected maintenance costs could drive up operational expenses.
- Revenues from recovered materials depend on fluctuating commodity prices and market demand.
- During the construction phase, MWP facilities may be exposed to a financial risk from cost overruns, particularly if led by an inexperienced or unqualified developer. Potential to transfer these cost overrun risks depending on the project delivery approach undertaken by the City (i.e., public-private partnership or similar innovative model could transfer construction cost overruns to developer).
- During the operational phase, MWP facilities may face revenue risks due to downturns in commodity markets, equipment malfunctions, or required system upgrades.

- High sensitivity to external factors like inflation, commodity pricing, and increased diversion efforts that could impact economics.

7.2.3.5 APPROVAL RISKS

- Moderate risk related to zoning and environmental approvals.
- Facility must be appropriately sized for waste storage and processing.
- Odour management plans are a critical requirement for approval.
- Low risk of regulatory barriers if siting and design factors are properly addressed.

While MWP offers the lowest social risk, it presents significant financial, operational, and market risks due to its reliance on third-party landfills, fluctuating tipping fees, and unstable commodity markets for recovered materials. The high capital and operational costs (capital costs estimated to range between $97 million to $168 million plus annual O&M costs of $70.1 million) coupled with potential maintenance and performance challenges, make long-term viability a concern. Successful implementation would require careful site selection, odour mitigation strategies, and securing long-term disposal agreements to mitigate cost risks.

7.2.4 New Landfill

Developing a new landfill presents significant regulatory, environmental, social, and financial risks. While landfills are a well-established waste management option, securing ECA is highly complex due to hydrogeological concerns, land ownership requirements, and leachate management. Additionally, public opposition is expected to be substantial, given the perceived health and environmental risks.

7.2.4.1 PROCESS RELIABILITY RISKS

- The City will have to clearly demonstrate an understanding of the hydrogeological conditions at the site so that it can be effectively monitored. There have been cases when ECA applications have been refused due to a proponent not being able to demonstrate a clear understanding of the hydrogeologic conditions at the site (e.g., situated in a highly sensitive hydrogeological and complex area).
- A key regulatory requirement for landfills is that the proponent must own all the land in which waste is placed and the buffer area (O.Reg. 232/98). Given the large area of land required for a greenfield site, this potentially could be a financial burden.
- The City must develop a comprehensive leachate treatment plan, with options including:
    - Off-site treatment at a wastewater treatment plant (WWTP), which depends on existing WWTP capacity.
    - On-site WWTP construction, which is costly and complex to operate.
    - If neither option is feasible, the probability of obtaining approval decreases significantly.

7.2.4.2 ENVIRONMENTAL RISKS

- New landfills produce odours, attract vectors (e.g., birds, rodents), and generate airborne debris, impacting surrounding areas such as haulage routes.

- Landfills generate methane (a potent GHG), requiring a gas collection system for mitigation.

7.2.4.3 SOCIAL & COMMUNITY RISKS

- Significant NIMBY resistance, making public consultation and engagement a major challenge.
- The landfill must be sufficiently distant from sensitive land uses (e.g., residential areas, schools, water bodies) to reduce opposition, but this could limit available locations.

7.2.4.4 ECONOMIC/FINANCIAL RISKS

- A new landfill requires substantial land acquisition, permitting, infrastructure, and long-term monitoring.
- The City is responsible for the post-closure care of the landfill for decades after its operational life ends, adding long-term financial burdens.

7.2.4.5 APPROVAL RISKS

- Strong public opposition could trigger legal challenges, political pushback, or extended delays.
- Municipal, and provincial coordination required, adding complexity to approvals.

A new landfill presents high regulatory, social, environmental, and economic/financial risks, particularly due to hydrogeological uncertainty, land acquisition requirements, and leachate management challenges. Public opposition is expected to be the strongest among all waste management options, increasing the risk of political intervention or legal challenges. While landfill technology is well-established, securing approvals, managing long-term liabilities, and mitigating social resistance make this a highly challenging option for the City.

7.3 Conclusions and Recommendations

The comparative results indicated that of the two waste management technologies being assessed, the WTE option had the highest ranking, and the MWP options have lower rankings. Error! Reference source not found.**Error! Reference source not found. 7-2** above summarizes the scores by category, while **Table C-1** in Appendix C provides a detailed summary of the final grades and rankings for each scenario by sub-criteria (i.e. Environmental, Social, Financial, and Technical). The options are ranked from highest to lowest below:

1. **Option 2: WTE Facility (tie)**
1. **Option 1: Status Quo and Private Facilities (tie)**
3. **Option 4: WTE and MWP Facility**
4. **Option 3: MWP Facility**
5. **Option 5: New Landfill Facility**

Through comparative evaluation, the WTE option's greatest strengths are in the environmental requirements which are due to the significant amount of waste diverted from disposal facilities (thereby reducing emissions), the opportunity to recover marketable material, the lower system transportation impacts, and a primarily indoor operation which will eliminate or minimize nuisance impacts. While a new landfill is one of the least expensive options, the significant social and environmental disbenefits resulted in being the least preferred option from the comparative evaluation. Given that the City's current and future planned curbside recycling and diversion programs have been successful in capturing a large portion of the available commodities and recoverable materials in the waste stream, a new MWP facility would divert a relatively small proportion of remaining materials (approximately 8.3%). As a result, a large portion of the non-diverted City generated waste that could not be recovered or marketed from the MWP option would require landfill disposal or additional processing at a third-party waste management facility and would offer minimal opportunities for cost savings and little change in the environmental considerations relative to the Status Quo and Private Facilities option. A combination of the WTE and MWP facility does gain the benefits of both facilities and maximize diversion from landfill disposal, resulting in the greatest environmental score; however, this option also has the greatest additional cost and technical complexity of constructing and operating both facilities which impacted the overall score and ranking for the option.

Overall, while the WTE and Status Quo and Private Facilities options score the highest, the Status Quo and Private Facilities option is also susceptible to greater risk as there needs to be enough space for private waste facilities to accept waste and the fees charged could increase above what has been assumed in this analysis. The WTE option also has associated risks related to the construction and operating costs and the impacts of tariffs and inflation, as well as changes in environmental regulations that could impact costs. However, the WTE option also presents the City with more revenue-generating opportunities in the form of energy (i.e. electricity and district heating) and recovered commodities (e.g. metals) to offset some of the capital and operating expenditure.

If the WTE option is ultimately selected as the preferred long-term approach for the City, the next steps in the implementation process will require detailed and careful planning. Based on changes to the Ontario Regulations (O.Reg. 101/07) since the implementation of the Durham York Energy Centre, specifically related to the Environmental Screening legislation, the approvals process could be shortened considerably from the timelines identified in the Study. A recent example of a WTE facility that has gone through the screening process is the planned redevelopment of the Emerald Energy from Waste Facility in Brampton, Ontario, which was completed early in 2025. At a minimum, the Environmental Screening process would allow the City to undertake a number of activities (including siting and some of the facility procurement) in advance; however, the MECP would still have the ability to recommend a full EA status should they deem appropriate.

Depending on the preferred option selected, other preliminary next steps for the City would include refining the design assumptions and associated costs that were used to develop the draft Business Case. The refined design assumptions and criteria for the preferred option could also be used to perform a more in-depth market analysis for potential technology vendors, funding options, and offtaker agreements.

Appendix A

Sustainable Return on Investment (SROI) Detailed Analysis

Sustainable Return on Investment (SROI) Detailed Analysis

Sustainable Return on Investment (SROI) Results

The results presented in this section are based on measuring all costs and benefits from the handling, processing, and disposal of all waste over the 30-year Study period (2035-2064), regardless of whether the infrastructure is owned by the City. These impacts will affect the community and accounts for all options on a level playing field. Details of the analysis, including waste flows, greenhouse gas emission figures, and cash flow statements, are discussed in this appendix. Assumptions of general economic parameters used in the economic analysis can be found in Appendix B. Analysis of environmental effects include both anthropogenic and biogenic emissions. Total emissions are reported in two separate cases, one including both anthropogenic and biogenic emissions (*Including Biogenic Emissions*), and another with just anthropogenic emissions (*Excluding Biogenic Emissions*). Analysis of costs, benefits and cash flows are presented in both discounted (present value) and undiscounted (nominal value) terms. The assumptions and parameters used for each of these impacts are discussed in detail in Appendix B.

Table A-1 illustrates the discounted capital, facility operations and maintenance (O&M), and hauling and disposal costs that are incurred for each alternative. Costs for WTE and MWP facilities are mainly driven by facility O&M costs, and hauling and disposal costs, which combined account for around 57 percent and 91 percent of total discounted costs, depending on the alternative. As opposed to a conventional landfill, the WTE facilities have substantially higher capital and O&M costs associated with them. Thus, the total cost per tonne attached to each facility are significantly higher than the tipping fees saved from using the private landfill in the Status Quo and Private Facilities case. The MWP facility has substantial O&M costs, and since only a small proportion of waste is diverted, the alternative has similar hauling and disposal costs when compared to the Status Quo and Private Facilities option. Thus, the MWP also has a high total cost per tonne, similar to the WTE facility. Costs are exacerbated in scenario 4, where costs of both facilities are combined, albeit some savings from synergies in joint operations.

Meanwhile, the projected lowered hauling and disposal costs of the new landfill compared to the tipping fees charged by the private landfill in the Status Quo and Private Facilities scenario, offsets the alternative's capital costs, and result in a cost decrease of only $0.7 per tonne (discounted) when compared to the Status Quo and Private Facilities option.

Table A-2 illustrates the undiscounted, year-of-expenditure costs that are incurred for each alternative. Since discounting places more weight to near-term costs, removing the discount factor will result in alternatives with more long-term costs (i.e. Facility O&M, and Hauling and Disposal Costs) having a larger increase than alternatives with more near-term costs (i.e. Capital Costs). Consequently, alternatives with high reliance on 3rd party waste facility disposal, such as the Status Quo and Private Facilities and the MWP facility scenario, experience the largest change when focusing on total cost, ignoring the time value of money.

Table A-1: Monetized Costs from SROI Analysis, Discounted

Present Value of Costs, 2024$	Status Quo and Private Facilities	Mass Burn WTE Facility	Mixed Waste Processing	WTE and MWP Facility	New Landfill
Capital Costs (Millions)	-	$511.3	$98.3	$570.7	$372.3
Facility O&M Costs (Millions)	-	$503.4	$408.3	$874.4	$190.1
Hauling and Disposal Costs (Millions)	$606.1	$180.5	$594.0	$169.2	$37.9
Total Costs (Millions)	**$606.1**	**$1,195.2**	**$1,100.6**	**$1,614.4**	**$600.3**
Total Costs per Tonne Processed (per Tonne)	**$77.6**	**$153.0**	**$140.9**	**$206.7**	**$76.9**

Table A-2: Monetized Costs from SROI Analysis, Undiscounted

Nominal Value of Costs, 2024$	Status Quo and Private Facilities	Mass Burn WTE Facility	Mixed Waste Processing	WTE and MWP Facility	New Landfill
Capital Costs (Millions)	-	$793.0	$156.2	$889.0	$840.8
Facility O&M Costs (Millions)	-	$1,738.7	$1,545.2	$3,154.2	$663.6
Hauling and Disposal Costs (Millions)	$2,123.7	$643.6	$2,081.9	$604.5	$132.7
Total Costs (Millions)	**$2,123.7**	**$3,175.4**	**$3,783.3**	**$4,647.7**	**$1,637.2**
Total Costs per Tonne Processed (per Tonne)	**$271.9**	**$406.5**	**$484.4**	**$595.0**	**$209.6**

Table A-3 presents the waste flows and material recovery from different waste facilities, which feed into cost, revenue, and emissions calculations. Although the MWP facility can recover the greatest amount of recyclables, much of the waste still end up in landfill, with an overall waste diversion rate of only eight percent. Since WTE facilities can incinerate most of the waste, most materials landfilled are ash residuals from incineration, resulting a waste diversion rate of 77% for the standalone facility and a marginally higher rate of 78% for the combined WTE and MWP facility.

Table A-3: Waste Flows and Recovery Rates, 2035-2064

Waste Flows and Recovery Rates	Unit	Status Quo and Private Facilities	Mass Burn WTE Facility	MWP Facility	WTE and MWP Facility	New Landfill Facility
Total Incoming Waste	metric tons (millions)	7.81	7.81	7.81	7.81	7.81
Waste Processed by MWP Facility	metric tons (millions)	-	-	7.69	7.69	-
Waste Processed by WTE Facility	metric tons (millions)	-	7.70	-	7.06	-
Materials Recovered by MWP	metric tons (millions)	-	-	0.64	0.64	-
Materials Recovered by WTE	metric tons (millions)	-	0.26	-	0.24	-
Residuals Generated	metric tons (millions)	-	1.75	7.05	1.61	-
Materials Landfilled	metric tons (millions)	7.81	1.87	7.18	1.72	7.81
Materials Avoided being Landfilled	metric tons (millions)	-	5.94	0.64	6.09	-
Waste Diversion Rate	percent (%)	-	77%	8%	78%	-

Table A-4 presents the energy production and transportation impacts between alternatives. The renewable natural gas system at the New Landfill Facility is estimated to produce about 618 GWh of electricity over the study period. The non-landfill has higher vehicle-kilometers travelled (VKT) when compared to the Status Quo and Private Facilities scenario due to extra transportation required to ensure all waste and associated byproducts can be properly disposed of. Due to lower diversion rates, the standalone MWP facility experiences the highest VKT at 21.3 million kilometres. This is followed by the New Landfill Facility, which has a 35 percent higher VKT when compared to the Status Quo and Private Facilities scenario, as it is assumed to be marginally further from the city than the existing Trail facility.

Table A-4: Other Quantified Impacts for Emissions Estimation, 2035-2064

Other Quantified Impacts	Unit	Status Quo and Private Facilities	Mass Burn WTE Facility	MWP Facility	WTE and MWP Facility	New Landfill Facility
Electricity Production	GWh	-	5,542.8	-	5,136.3	618.3
Total Truck Kilometres Travelled	VKT (millions)	11.2	13.5	21.3	13.3	11.2

Figure A-1 examines the total anthropogenic and biogenic greenhouse gas (GHG) emissions for each alternative, with a detailed breakdown for total criteria air contaminants (CAC), anthropogenic and biogenic emissions shown by **Table A-5**. Biogenic emissions occur when carbon contained within organic materials is released and includes the decomposition and combustion of these materials. Biogenic emissions include carbon dioxide released from disposed materials with organic carbon. An example of this occurs when organic material decays at a landfill and releases carbon dioxide as a component of landfill gas. Anthropogenic emissions arise from human activities. Examples include the emission from the decomposition and combustion of non-biological materials, tailpipe emissions from transportation vehicles, and emissions from energy generation. Methane from landfill gas is considered anthropogenic.

As shown, the major source of greenhouse gas emission variances between alternatives arises from differences in emissions from waste management. Due to waste diversion, MWP facilities are anticipated to produce roughly eight percent less greenhouse gas emissions when compared to both landfill options. As WTE facilities could generate net benefits from electricity generation and reduce the emissions generated from landfills, the standalone WTE facility is expected to generate around 44% less greenhouse gas emissions when combined with the Status Quo and Private Facilities scenario. Combining the two benefits in the WTE and MWP facility leads to a 48% greenhouse gas reduction against the Status Quo and Private Facilities Scenario.

Figure A-1: Quantifiable Greenhouse Gases (GHG) Emissions, 2024-2064 (Thousands of Metric Tonnes)

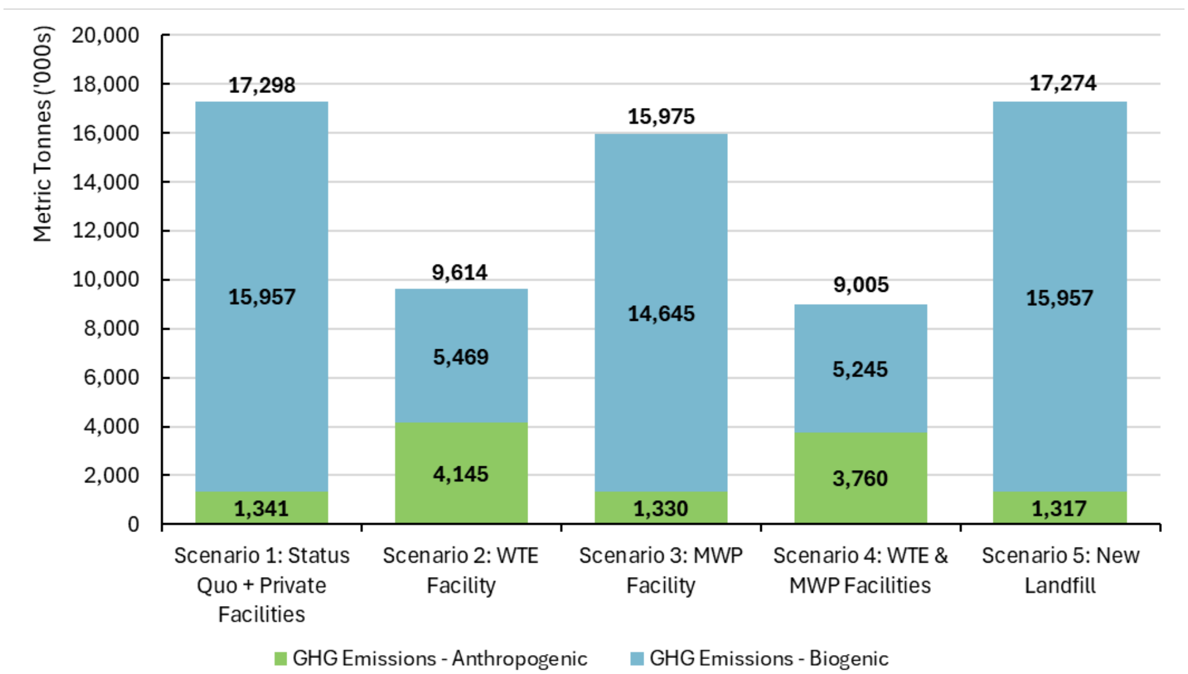

Table A-5: Metric Tonnes of Quantifiable Greenhouse Gases (GHG) and Criteria Air Contaminants (CAC), 2035-2064, Including Biogenic Emissions

Total Metric Tonnes of Emissions (Thousands)	Status Quo and Private Facilities	Mass Burn WTE Facility	MWP Facility	WTE and MWP Facility	New Landfill Facility
GHG Emissions Avoided from Electricity Production	-	166	-	154	-
CAC Emissions Avoided from Electricity Production	-	0.316	-	0.293	-
GHG Emissions Generated from Electricity Production	-	30	-	28	-
CAC Emissions Generated from Electricity Production	-	0.057	-	0.053	-
GHG Emissions Avoided from RNG Use	-	-	-	-	24
GHG Emissions from Waste Management	17,289	9,740	15,959	9,121	17,289
GHG Emissions - Truck	9	10	16	10	9
CAC Emissions - Truck	0.014	0.017	0.027	0.017	0.014
Total GHG Emissions	**17,298**	**9,614**	**15,975**	**9,005**	**17,273**
Total CAC Emissions	**0.014**	**-0.242**	**0.027**	**-0.223**	**0.014**

Table A-6: Metric Tonnes of Quantifiable Greenhouse Gases (GHG) and Criteria Air Contaminants (CAC), 2035-2064, Excluding Biogenic Emissions

Total Metric Tonnes of Emissions (Thousands)	Status Quo and Private Facilities	Mass Burn WTE Facility	MWP Facility	WTE and MWP Facility	New Landfill Facility
GHG Emissions Avoided from Electricity Production	-	166	-	154	-
CAC Emissions Avoided from Electricity Production	-	0.316	-	0.293	-
GHG Emissions Generated from Electricity Production	-	30	-	28	-
CAC Emissions Generated from Electricity Production	-	0.057	-	0.053	-
GHG Emissions Avoided from RNG Use	-	-	-	-	24
GHG Emissions from Waste Management	1,332	4,271	1,313	3,876	1,332
GHG Emissions - Truck	9	10	16	10	9
CAC Emissions - Truck	0.014	0.017	0.027	0.017	0.014

Total Metric Tonnes of Emissions (Thousands)	Status Quo and Private Facilities	Mass Burn WTE Facility	MWP Facility	WTE and MWP Facility	New Landfill Facility
Total GHG Emissions	**1,341**	**4,145**	**1,330**	**3,760**	**1,317**
Total CAC Emissions	**0.014**	**-0.242**	**0.027**	**-0.223**	**0.014**

Table A-7 provides the present (discounted) value of a high-level cash flow analysis, excluding any financing costs. The comparative analysis examines cash outflows for each alternative, calculated by the total costs incurred under each option (outflows) and the incremental revenues received from new facilities, such as selling recovered materials on secondary markets, or energy revenues through net metering (inflows). Due to having two facilities to construct and maintain, the combined WTE and MWP facility has the highest cash outflows, despite having the highest cash inflow. From the analysis performed, the WTE and MWP facility has the highest financial burden, followed by the MWP facility, WTE facility, the Status Quo and Private Facilities and the New Landfill facility.

Table A-7: High-Level Cash Flow Analysis, 2035-2064, $150 Tip Fee, Discounted

Present Value of Net Cash Outflow, 2024 CAD$	Status Quo and Private Facilities	Mass Burn WTE Facility	MWP Facility	WTE and MWP Facility	New Landfill Facility
Capital Costs (Millions)	-	$511.3	$98.3	$570.7	$372.3
Facility O&M Costs (Millions)	-	$503.4	$408.3	$874.4	$190.1
Hauling & Disposal Costs (Millions)	$606.1	$180.5	$594.0	$169.2	$37.9
Less: Economic Cash Inflows (Millions)	-	$261.7	$65.0	$307.3	$24.0
Net Energy Benefits (Millions)	-	$243.1	-	$225.3	$24.0
Recovered Materials - Ferrous/Non-Ferrous (Millions)	-	$18.6	$65.0	$82.1	-
Net Cash Outflow (Millions)	**$606.1**	**$933.4**	**$1,035.6**	**$1,307.0**	**$576.4**
Net Cash Outflow per Tonne Processed (per Tonne)	**$77.6**	**$119.5**	**$132.6**	**$167.3**	**$73.8**

Table A-8 provides the nominal (undiscounted) value of a high-level cash flow analysis, excluding financing costs. Removing discounting places equal weight between current and future spending, resulting in alternatives with a greater proportion of future spending to have relatively higher net cash flows when compared to their associated discounted figures.

Table A-8: High-Level Cash Flow Analysis, 2035-2064, $150 Tip Fee, Undiscounted

Nominal Value of Net Cash Outflow, 2024 CAD$	Status Quo and Private Facilities	Mass Burn WTE Facility	MWP Facility	WTE and MWP Facility	New Landfill Facility
Capital Costs (Millions)	-	$793.0	$156.2	$889.0	$840.8
Facility O&M Costs (Millions)	-	$1,738.7	$1,545.2	$3,154.2	$663.6
Hauling & Disposal Costs (Millions)	$2,123.7	$643.6	$2,081.9	$604.5	$132.7
Less: Economic Cash Inflows (Millions)	-	$910.2	$225.9	$1,068.8	$102.4
Net Energy Benefits (Millions)	-	$845.4	-	$783.4	$102.4
Recovered Materials - Ferrous/Non-Ferrous (Millions)	-	$64.8	$225.9	$285.4	-
Net Cash Outflow (Millions)	**$2,123.7**	**$2,265.2**	**$3,557.3**	**$3,578.9**	**$1,534.7**
Net Cash Outflow per Tonne Processed (per Tonne)	**$271.9**	**$290.0**	**$455.4**	**$458.2**	**$196.5**

Table A-9 and **Table** A-10 provides the sensitivity of the present (discounted) and nominal (undiscounted) value of a high-level cash flow analysis, respectively, excluding financing costs, following an assumed $100 increase in tip fees from $150 to $250. As the Status Quo and Private Facilities scenario completely relies on third-party waste management facilities for all waste flows, the scenario experiences the largest increase in present cash outflow of over 62.5%. Following that, the MWP has the second largest increase in present cash outflow at around 34.3% due to the heavy reliance on third-party waste management facilities from low landfill diversion rates. Although the WTE facilities utilize third-party waste facilities for ash and non-processable waste, the high diversion rates from the process means that the WTE alternatives are fairly robust against tip fee increases, with present cash flow increases of 9.6% for the standalone WTE facility, and 6.3% for the WTE and MWP facility. Since the New Landfill Facility does not require disposal at third party waste facilities, increases in tip fees for these facilities have no effect on the cash outflow for the alternative. Changes in nominal cash outflows among alternatives follow a similar manner, albeit at greater magnitudes for the WTE, MWP, WTE and MWP facilities.

Table A-9: High-Level Cash Flow Analysis, 2035-2064, $250 Tip Fee, Discounted

Present Value of Net Cash Outflow, 2024 CAD$	Status Quo and Private Facilities	Mass Burn WTE Facility	MWP Facility	WTE and MWP Facility	New Landfill Facility
Capital Costs (Millions)	-	$511.3	$98.3	$570.7	$372.3
Facility O&M Costs (Millions)	-	$503.4	$415.2	$874.4	$190.1
Hauling & Disposal Costs (Millions)	$984.9	$269.8	$941.9	$251.5	$37.9
Less: Economic Cash Inflows (Millions)	-	$261.7	$65.0	$307.3	$24.0
Net Energy Benefits (Millions)	-	$243.1	-	$225.3	$24.0
Recovered Materials - Ferrous/Non-Ferrous (Millions)	-	$18.6	$65.0	$82.1	-
Net Cash Outflow (Millions)	**$984.9**	**$1,022.8**	**$1,390.3**	**$1,389.4**	**$576.4**
Net Cash Outflow per Tonne Processed (per Tonne)	**$126.1**	**$130.9**	**$178.0**	**$177.9**	**$73.8**
Net Cash Outflow Increase Compared to $150 Tip Fee Scenario (%)	**62.5%**	**9.6%**	**34.3%**	**6.3%**	**0.0%**

Table A-10: High-Level Cash Flow Analysis, 2035-2064, $250 Tip Fee, Undiscounted

Nominal Value of Net Cash Outflow, 2024 CAD$	Status Quo and Private Facilities	Mass Burn WTE Facility	MWP Facility	WTE and MWP Facility	New Landfill Facility
Capital Costs (Millions)	-	$793.0	$156.2	$889.0	$840.8
Facility O&M Costs (Millions)	-	$1,738.7	$1,569.1	$3,154.2	$663.6
Hauling & Disposal Costs (Millions)	$3,451.1	$964.4	$3,301.7	$900.9	$132.7
Less: Economic Cash Inflows (Millions)	-	$910.2	$225.9	$1,068.8	$102.4
Net Energy Benefits (Millions)	-	$845.4	-	$783.4	$102.4
Recovered Materials - Ferrous/Non-Ferrous (Millions)	-	$64.8	$225.9	$285.4	-
Net Cash Outflow (Millions)	**$3,451.1**	**$2,586.0**	**$4,801.0**	**$3,875.3**	**$1,534.7**
Net Cash Outflow per Tonne Processed (per Tonne)	**$441.8**	**$331.1**	**$614.7**	**$496.1**	**$196.5**
Net Cash Outflow Increase Compared to $150 Tip Fee Scenario (%)	**62.5%**	**14.2%**	**35.0%**	**8.3%**	**0.0%**

Appendix B

General Economic Parameters

General Economic Parameters

The SROI analysis is predicated on general assumptions to define the framework of the analysis. These parameters include defining the study period and a discount rate representing the opportunity cost of capital, typically estimated as the average borrowing rate for new capital investments. This study is set to examine the implementation of waste solution scenarios which begin construction as early as 2032 to be operational by 2035. Impacts are accrued over a 30-year period (2035-2064), and once operational, the facilities are expected to run at least through the analysis period. All future costs and benefits are discounted to 2024, in 2024 dollars (2024$).

Discounting is weighting future net impacts against current net impacts to reflect society's general preference for the present and reflect the opportunity cost of not investing these funds in another project. The conversion ensures a meaningful comparison of benefit and cost streams over the project life cycle.

Table B-1: General Economic Assumptions

General Assumptions	Value	Source
Base Date	2024	All results are presented in 2024 terms (e.g., all life cycle economic costs and benefits are discounted back to a Present Value estimate in 2024$.
First Year of Operations (WTE and MWP, WTE, and MWP facilities)	2035	Assuming all waste diversion facilities are operational in 2035, with all solutions accruing impacts simultaneously.
First Year of Operations (new landfill)	2035	Assuming the new landfill is operational in 2035, accruing impacts simultaneously.
Study Period Length	30 years	2035 – 2064
Nominal Discount Rate	5.0%	The assumption to represent the opportunity cost of capital is based on provincial government guidance and used to discount all future costs and benefits to a present value total.
General Inflation	2.0%	Midpoint of Bank of Canada's long term inflation target.

Assumptions required for specific impacts are explained below.

Economic Impacts

This section outlines the economic impacts on society in the SROI analysis. These include user costs of material handling, revenues from material handling byproducts, the cost of electricity purchased, and the revenue from excess electricity exported to the grid.

User Costs of Material Handling

The user cost of material handling represents the cost associated with handling and disposing of waste. The benefit is calculated from two inputs: the tonnage of material landfilled and the landfill tipping fee.

Table B-2: User Costs of Material Handling Assumptions

General Assumptions	Value	Source
Transportation Cost (Hauling Fee) – City Centre to MWP/WTE/Landfills	$10/tonne	HDR calculations including cost of labour, fuel, maintenance, consumables and contingency. Distance assumed to be 28.6 kilometres one-way at an average speed of 77.2 km/h.
Transportation Cost (Hauling Fee) – MWP/WTE to Landfills	$10/tonne	HDR calculations including cost of labour, fuel, maintenance, consumables and contingency. Distance assumed to be 28.6 kilometres one-way at an average speed of 77.2 km/h.
Transportation Cost (Hauling Fee) – MWP to WTE	$0/tonne	(Option 4 only) Facilities built adjacent to each other, incremental transportation fees.
Tipping Fee – Private Regional Waste Facilities	$150/tonne	HDR assumption. A sensitivity analysis of $250/tonne is also performed.

Tonnage of material landfilled

The tonnage of waste landfilled varies in the waste solution scenarios depending on the diversion and recovery of products. The waste composition projections were based on the 2019 Solid Waste Master Plan and assumed to maintain the same overall composition throughout the study period. Landfilled materials included single family, multi-residential, city facility and parks waste.

Table B-3: Waste Composition Assumptions

General Assumptions	Value	Source
Corrugated Containers	1.3%	2053 Projections, based on the 2019 Solid Waste Master Plan
Mixed Paper (general)	6.6%	2053 Projections, based on the 2019 Solid Waste Master Plan
Green Bin Waste	42.7%	2053 Projections, based on the 2019 Solid Waste Master Plan
Yard Trimmings	1.7%	2053 Projections, based on the 2019 Solid Waste Master Plan
HDPE	0.8%	2053 Projections, based on the 2019 Solid Waste Master Plan
PET	2.7%	2053 Projections, based on the 2019 Solid Waste Master Plan
Mixed Plastics	11.1%	2053 Projections, based on the 2019 Solid Waste Master Plan
Aluminum Cans	0.4%	2053 Projections, based on the 2019 Solid Waste Master Plan
Steel Cans	0.8%	2053 Projections, based on the 2019 Solid Waste Master Plan
Mixed Metals	2.0%	2053 Projections, based on the 2019 Solid Waste Master Plan
Glass	2.8%	2053 Projections, based on the 2019 Solid Waste Master Plan
Clay Bricks	3.0%	2053 Projections, based on the 2019 Solid Waste Master Plan

General Assumptions	Value	Source
Concrete	3.0%	2053 Projections, based on the 2019 Solid Waste Master Plan
Dimensional Lumber	3.0%	2053 Projections, based on the 2019 Solid Waste Master Plan
Mixed MSW	18.3%	2053 Projections, based on the 2019 Solid Waste Master Plan

Revenues from Material Handling Byproducts

Revenues from material handling byproducts captures revenue streams from material handling, including recovered cardboard, metals and plastics, and glass. All revenue stream assumptions and recovery rates were developed as part of the scenarios.

Table B-4: Material Byproduct Revenue Assumptions, 2024$

General Assumptions	Value	Source
Value of ferrous material from WTE	$208/tonne	HDR industry experience.
Value of non-ferrous material from WTE	$949/tonne	HDR industry experience.
Value of corrugated containers recovered from MWP	$77/tonne	HDR industry experience. Based on 70% of market price.
Value of mixed papers recovered from MWP	$46/tonne	HDR industry experience. Based on 70% of market price.
Value of HDPE recovered from MWP	$725/tonne	HDR industry experience. Average of natural and color HDPE, based on 70% of market price.
Value of PET recovered from MWP	$370/tonne	HDR industry experience. Based on 70% of market price.
Value of mixed plastics recovered from MWP	$31/tonne	HDR industry experience.
Value of aluminum cans recovered from MWP	$1,265/tonne	HDR industry experience.
Value of steel cans recovered from MWP	$278/tonne	HDR industry experience.
Value of mixed metals recovered from MWP	$231/tonne	HDR industry experience.
Value of glass recovered from MWP	-$77/tonne	HDR industry experience.

Cost of Electricity Purchased

The cost of electricity purchased captures the electricity demand at the various buildings in the scenarios.

Table B-5: Electricity Cost Assumptions, 2024$

General Assumptions	Value	Source
Electricity Usage Rate	$0.13/kWh	Ontario Energy Board
Electricity Price Escalation Rate	2%/year	Bank of Canada inflation target

Revenue from Excess Electricity Exported to the Grid

The revenue from electricity generated on site from waste-to-energy facilities or renewable natural gas (RNG) is assumed to be exported back to the grid at a buyback rate. The buyback rate is assumed to be significantly less than the cost of electricity and was derived as part of the cost estimates for the scenarios.

Table B-6: Electricity Buyback and Generation Assumptions, 2024$

General Assumptions	Value	Source
Electricity Buyback Rate	$0.13/kWh	Ontario Energy Board
Electricity Price Escalation Rate	2%/year	Bank of Canada inflation target
RNG Production Rate	455 Btu/ft^3	U.S. EPA LFGcost-Web Model (Version 3.6)
Fuel Use Rate	13,000 Btu/kWh	U.S. EPA LFGcost-Web Model (Version 3.6)
Landfill Gas Heat Content	506 Btu/ft^3	U.S. EPA LFGcost-Web Model (Version 3.6)

Environmental Impacts

This section outlines the environmental impacts on society in the SROI analysis. Environmental impacts capture the environmental damages from greenhouse gas emissions and criteria air contaminants. The net impacts of emissions from material handling, waste transportation, and the production and generation of electricity are captured as environmental impacts.

GHG Emissions from Material Handling

Greenhouse gas (GHG) emissions from the material handling represent the impacts of landfilling and waste diversion for each waste solution.

A customized version of *LandGEM* 3.03 model, based on capture rate of the Ottawa landfills and the Environment and Climate Change Canada *Greenhouse Gas Calculator for Organic Waste Management*, was used to calculate landfill emissions. Recycling emission factors were sourced from the Table 9 of the *2025 GHG Emission Factors Hub* by the United States Environmental Protection Agency's (EPA), excluding the emissions generated by the transportation of waste. Combustion emission factors were based on actual 2021 emissions from the Durham-York Energy Centre data from the *Greenhouse Gas Emissions Reporting By Facility* report by the Ontario Ministry of the Environment, Conservation and Parks.

Except for combustion, emission factors are available for various material types, defined by EPA's GHG Emissions Factors Hub. Each material part of the Ottawa waste stream was mapped to a material in the GHG Emission Factors Hub, and emission factors were applied based on the tonnage of waste and the method used to handle the waste. Further analysis estimated the impacts of landfill gas recovery and flaring to appropriately estimate emissions released from landfill.

For combustion, actual emissions from the Durham-York Energy Centre in 2021 were extracted, and an average emission factor per tonne was calculated by dividing the figure with the 2021 tonnage of waste incinerated by the centre. Emissions from Ottawa were then estimated by multiplying the forecasted amount of waste incinerated by the WTE facility with the above average emission factor.

Table B-7: Material Handling Emissions Assumptions

Assumption	Unit	Value	Source
Landfill Gas Capture Efficiency Rate – City of Ottawa	%	90%	City of Ottawa
Landfill Gas Capture Efficiency Rate – Other Landfills	%	85%	HDR Assumption
Methane Destruction Rate from Landfill Gas Capture	%	99%	Environment and Climate Change Canada's Calculator for Organic Waste Management
Methane Generation Rate	%	4%	Environment and Climate Change Canada's Calculator for Organic Waste Management
Potential Methane Generation Capacity	m^3/tonne	96	Environment and Climate Change Canada's Calculator for Organic Waste Management
Methane by Volume	%	50%	US EPA LandGEM v3.03.
Methane Global Warming Potential	CO_2e	29.8	IPCC Sixth Assessment Report, https://report.ipcc.ch/ar6/wg1/IPCC_AR6_WGI_FullReport.pdf; EPA, GHG Emissions. https://www.epa.gov/ghgemissions/understanding-global-warming-potentials.

Emissions from the Transportation of Waste

Emissions from the transportation of waste capture GHG and CAC emissions from trucks hauling waste to landfills or processing facilities. Emissions from heavy-duty diesel trucks were simulated from the EPA's Motor Vehicle Emissions Simulator (MOVES) for St. Lawrence County, Upstate New York and Crittenden County, Vermont, representative counties nearby Ottawa with similar climates. MOVES produces emissions by vehicle speed and year. The output was interpolated to construct emission factors for every year at each 5-mile per hour increments. Each emission factor is multiplied by the distance traveled to estimate the total annual emissions for carbon dioxide, nitrogen oxides, sulfur dioxide, particulate matter, and volatile organic compounds.

Table B-8: Emission Factors for Transportation of Waste

Vehicle Type	NO_X	VOC	SO_2	CO_2	$PM_{2.5}$
Heavy Duty Truck (g/km)	3.19-6.93	0.04-0.32	0.007-0.008	1,970-2,343	0.01-0.21

Notes: Trucks are assumed to travel on average between 72 - 80 km/h.

Emissions from the Production and Generation of Electricity

Emissions from the production and generation of electricity capture the net impact of GHG and CAC emissions from the electricity demand at the facilities. The emissions are offset by any electricity generation by the waste solution. GHG emissions from the electric grid were estimated based on emission factors and reference values from Environment & Climate Change Canada 2023 National Inventory Report. CAC emissions from the electrical grid are calculated from Canada's National 2024 Air Pollutant Emission Inventory and Canada national electricity generation. Weighted average Ontario emissions constructed using fuel mix based on 2023 year-end data are applied to estimated emissions per MWh for each fuel type.

Table B-9: Emission Factors for Average Electricity Generation in Ontario, g/MWh

Emission	NO_X	SO_2	CO_2	$PM_{2.5}$
Ontario Average Emissions	44.282	9.719	29,995	1.132

Other assumptions used in the model can be found below in **Table B-10.**

Table B-10: Other Assumptions Used in the Analysis

Category	Variable	Unit	Value	Source
Schedule	Base Year of Analysis	year	2024	Current year of model development
Schedule	Study Period	years	30	Calculated based on end year of analysis
Schedule	End year	year	2064	Calculated based on study period length
MWP	Processable Waste - MWP	%	90%	SWMP - WTE and MWP Calcs
MWP	Non-Processable Waste – MWP	%	10%	Calculated
MWP	Throughput Capacity	tonnes/year	267,000	HDR Assumption
MWP	Capital Cost - Construction Subtotal	2024$	$116,200,000	HDR Assumption
MWP	Capital Cost - Engineering/Design Subtotal - without WTE	2024$	$12,782,000	HDR Assumption
MWP	Capital Cost - Engineering/Design Subtotal - without WTE	%	12%	HDR Assumption
MWP	Capital Cost - Land Acquisition - with WTE	2024$	$300,000	City of Ottawa
MWP	Capital Cost - Land Acquisition - without WTE	2024$	$400,000	City of Ottawa
MWP	Capital Cost - with WTE	2024$	$126,540,000	HDR Assumption
MWP	Capital Cost - without WTE	2024$	$129,400,000	HDR Assumption

Category	Variable	Unit	Value	Source
MWP	Capital Cost Savings when Built Together with WTE Facility	%	3%	HDR Assumption
MWP	Cyclical Cost - Process Equipment	2024$	$53,200,000	HDR Assumption
MWP	Cyclical Cost - Building Replacement	2024$	$63,700,000	HDR Assumption
MWP	Cyclical Cost - Operating Cash Reserve	%	2%	HDR Assumption
MWP	Cyclical Timeframe - Process Equipment	years	15	HDR Assumption
MWP	Cyclical Timeframe - Building Replacement	years	30	HDR Assumption
MWP	Cyclical Timeframe - Operating Cash Reserve	years	1	HDR Assumption
MWP	Disposal Cost of Residual Waste	2024$/tonne	$150	HDR Assumption
MWP	Variable O&M Cost	2024$/tonne	$77	HDR Assumption
MWP	Fixed O&M Cost	2024$	$2,700,000	HDR Assumption
MWP	Recyclables Captured by Facility	%	8.26%	HDR Assumption
MWP	Construction Start	year	2033	HDR Assumption
MWP	Construction Duration	years	2	HDR Assumption
MWP	Construction End	year	2034	HDR Assumption
MWP	Useful Life	years	50	HDR Assumption
MWP	Electricity Demand	kWh/year	1,950,000	HDR Assumption
WTE	Ash Generated from Processable Waste Handled	%	22%	HDR Assumption
WTE	Ferrous Waste Recovered from Ash	%	3%	HDR Assumption
WTE	Non-Ferrous Waste Recovered from Ash	%	0.40%	HDR Assumption
WTE	Processable Waste - WTE	%	99%	SWMP - WTE and MWP Calcs
WTE	Non-Processable Waste - WTE	%	1%	Calculated
WTE	Throughput Capacity - with MWP	tonnes/year	245,500	HDR Assumption
WTE	Capital Cost - Construction Subtotal - with MWP	2024$	$566,700,000	HDR Assumption
WTE	Capital Cost - Engineering/Design Subtotal - with MWP	%Construction Subtotal	12%	HDR Assumption
WTE	Capital Cost - Land Acquisition Cost - with MWP	2024$	$300,000	City of Ottawa
WTE	Capital Cost - with MWP	2024$	$615,960,000	HDR Assumption

Category	Variable	Unit	Value	Source
WTE	Capital Cost Savings when Built Together with MWP Facility	%	3%	HDR Assumption
WTE	Cyclical Costs - with MWP	2024$	$6,631,000	1% of CAPEX
WTE	Cyclical Timeframe - with MWP	years	1	Annual average spend amount
WTE	Fixed O&M Cost - with MWP	2024$	$5,874,000	HDR Assumption
WTE	Distribution Cost of Residual Waste (Ash Only) - with MWP	2024$/tonne	$150	HDR Assumption
WTE	Variable O&M Cost - with MWP	2024$/tonne	$85	HDR Assumption
WTE	Construction Start - with MWP	year	2032	HDR Assumption
WTE	Construction Duration	years	3	HDR Assumption
WTE	Construction End - with MWP	year	2034	HDR Assumption
WTE	Useful Life	years	50	HDR Assumption
WTE	Throughput Capacity - without MWP	tonnes/year	267,600	HDR Assumption
WTE	Capital Cost - Construction/Engineering/Design Subtotal - without MWP	2024$	$663,100,000	HDR Assumption
WTE	Capital Cost - Land Acquisition Cost - without MWP	2024$	$400,000	HDR Assumption
WTE	Capital Cost - without MWP	2024$	$663,500,000	HDR Assumption
WTE	Cyclical Costs - without MWP	2024$	$6,631,000	1% of CAPEX
WTE	Cyclical Timeframe - without MWP	years	1	Annual average spend amount
WTE	Fixed O&M Cost - without MWP	2024$	$5,874,000	HDR Assumption
WTE	Distribution Cost of Residual Waste (Ash Only) - Without MWP	2024$/tonne	$150	HDR Assumption
WTE	Variable O&M Cost - without MWP	2024$/tonne	$85	HDR Assumption
WTE	Construction Start - without MWP	year	2032	HDR Assumption
WTE	Construction Duration	years	3	HDR Assumption
WTE	Construction End - without MWP	year	2034	HDR Assumption
WTE	Useful Life	years	50	HDR Assumption
New Landfill	Capital Costs (Near-Term)	2024$	$320,808,350	Tech Memo No. 1. Includes $52.6 million for a RNG system at the new landfill.

Category	Variable	Unit	Value	Source
New Landfill	Capital Costs (Long-Term)	2024$	$269,756,650	Tech Memo No. 1. Captures additional excavation, cell construction and cell closure.
New Landfill	O&M Cost	$/tonne	$44	Tech Memo No. 1
New Landfill	Start of Construction	year	2033	HDR Assumption
New Landfill	Construction Duration	years	2	HDR Assumption
New Landfill	End of Construction	year	2034	HDR Assumption
New Landfill	Capacity Volume	cubic metres	12,000,000	HDR Assumption
New Landfill	Useful Life	years	30	HDR Assumption
New Landfill	Cyclical Costs – RNG Operating Costs	2024$	$1,954,600	HDR Assumption
New Landfill	Cyclical Timeframe	years	1	HDR Assumption
Waste	Landfill Gas Capture Efficiency Rate - City of Ottawa	%	90%	HDR Assumption
Waste	Landfill Gas Capture Efficiency Rate - Other Landfills	%	85%	HDR Assumption
Waste	Tipping Fee - Private Landfill	$/tonne	$150	HDR Assumption
Energy Use	WTE Gross Generation Rate	kWh/tonne	704	HDR Assumption
Energy Use	In-House Power Demand	%	15%	HDR Assumption
Energy Use	Energy Use Growth Rate	%	0%	HDR Assumption
Energy Use	City Energy Revenue Share - Contingency	%	82%	HDR Assumption
Energy Use	Capacity Factor	%	90%	HDR Assumption
Energy Use	Cost of Power Year Percentage	%	10%	HDR Assumption
Energy Use	Grid loss	%	2.0%	IESO Transmission Planning Guide Version 1.0, June 2023.
VMT	Return Factor from Landfill	%	100%	% vehicles returning from private landfill
VMT	Percentage of Waste Delivered by Third Party Haulers	%	0%	% waste hauled by private entities
VMT	Distance from City to MWP	kilometres	28.43	HDR Assumption
VMT	Distance from City to WTE	kilometres	28.43	HDR Assumption
VMT	Distance from MWP to WTE	kilometres	0.00	HDR Assumption
VMT	Distance from City to Private Regional Landfill	kilometres	28.43	HDR Assumption

Category	Variable	Unit	Value	Source
VMT	Distance from MWP to Private Regional Landfill	kilometres	28.43	HDR Assumption
VMT	Distance from WTE to Private Regional Landfill	kilometres	28.43	HDR Assumption
VMT	Truck Capacity (non ash)	tonnes/vehicle	24.3	Average 10 tonnes per load from 2024 Jan-July curbside summary report
VMT	Truck Capacity (ash)	tonnes/vehicle	26.5	Based on existing truck size
VMT	Truck Speed	km/h	76.8	HDR Assumption
VMT	City Share of Recovered Revenues - WTE	%	50%	HDR Assumption
VMT	City Share of Recovered Revenues - MWP	%	100%	HDR Assumption

Appendix C

Detailed Summary of Results

Table C-1: Summary of Scenario Grades and Rankings

	Status Quo and Private Facilities	WTE	MWP	MWP and WTE	New Landfill
Environmental Requirements					
MOST PREFERRED	0	2	0	3	0
PREFERRED	0	3	1	2	1
NEUTRAL	1	0	1	0	0
LESS PREFERRED	1	0	2	0	2
LEAST PREFERRED	3	0	1	0	2
Social Requirements					
MOST PREFERRED	3	0	0	0	0
PREFERRED	0	2	1	2	1
NEUTRAL	2	2	3	1	0
LESS PREFERRED	0	1	1	2	0
LEAST PREFERRED	0	0	0	0	4
Economic/Financial Requirements					
MOST PREFERRED	1	1	0	1	0
PREFERRED	0	0	2	0	3
NEUTRAL	2	2	0	0	0
LESS PREFERRED	0	1	2	3	1
LEAST PREFERRED	1	0	0	0	0
Technical Requirements					
MOST PREFERRED	4	0	0	0	2
PREFERRED	0	2	2	2	3
NEUTRAL	2	1	1	1	0
LESS PREFERRED	2	5	5	3	1
LEAST PREFERRED	0	0	0	2	2

Total (Count)	**22**
Environmental Requirements	5
Social Requirements	5
Economic/Financial Requirements	4
Technical Requirements	8

Appendix D

Technical Memorandum No. 1

City of Ottawa

Feasibility Study For Waste to Energy and Mixed Waste Processing

Technical Memorandum No. 1
Technology & Background Summary

June 2, 2025

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Appendix A: Jurisdictional Scan Details

Acronyms and Abbreviations

Acronym	Definition
°C	Degrees Celsius
µg/Rm^3	Micrograms per reference cubic metre
AACE	Association for the Advancement of Cost Engineering
AB	Assembly Bill (California, United States)
AD	Anaerobic digestion
APC	Air pollution control
C&D	Construction and demolition
CAC	Criteria air contaminants
CAD	Canadian dollars
CEA	Comprehensive Environmental Assessment
CH_4	Methane
CO_2	Carbon dioxide
CO_{2e}	Carbon dioxide equivalent
CR	Curbside residential
CY	Cubic yards
DES	District energy system
DPS	District energy piping
DYEC	Durham York Energy Centre
EA	Environmental Assessment
EAA	Environmental Assessment Act
EASR	Environmental Activity and Sector Registry
ECA	Environmental Compliance Approval
ECCC	Environment and Climate Change Canada
EFW	Energy from waste
EFWP	Energy from waste plant
EOWHF	Eastern Ontario Waste Handling Facility
EPA	Environmental Protection Act
EPR	Extended producer responsibility
ESP	Electrostatic precipitator
EU	European Union
FIT	Feed-in-tariff
GFL	Green For Life
GHG	Greenhouse gases
GTA	Greater Toronto Area
HCl	Hydrogen chloride
HDPE	High-density polyethylene
HHV	Higher heating value

Acronym	Definition
HSP	Hazardous and Special Products
ICI	Industrial, commercial, and institutional
kg	Kilograms
km	Kilometres
kPa	Kilopascals
kWh	Kilowatts per hour
LFG	Landfill gas
m^3	Cubic metres
MBT	Mechanical biological treatment
mg/Rm^3	Milligrams per reference cubic metre
MEA	Monoethanolamine
MECP	Ministry of Environment, Conservation and Parks
MR/C	Multi-residential/containerized
MSW	Municipal solid waste
MSWLF	Modern sanitary municipal solid waste landfill
MW	Megawatts
MWe	Megawatts electric
MWh	Megawatt hour
MWt	Megawatts thermal
MWP	Mixed waste processing
MWP, OR	Mixed waste processing with organics recovery
MWP, OR+SRF	Mixed waste processing with organics recovery and solid recovered fuel (or equivalent)
MWP, SRF, WTE	Mixed waste processing to create solid recovered fuel and combustion of remaining materials
MWPF	Mixed waste processing facility
ng/g	Nanograms per gram
ng/L	Nanograms per litre
ng/Rm^3	Nanograms per reference cubic metre
NMOC	Non-methane organic compounds
N_2O	Nitrous oxide
NOx	Nitrogen oxide
O&M	Operations and maintenance
OCC	Old corrugated containers
ORWA	Ontario Water Resources Act
pa/m	Pascals per metre
PEI	Prince Edward Island
PET	Polyethylene terephthalate
PFAS	Per- and polyfluoroalkyl chemicals
ppm	Parts per million
ppmdv	Parts per million dry volume

Acronym	Definition
PURPA	Public Utilities Regulatory Policies Act
PVC	Polyvinyl chlorides
RDF	Refuse derived fuel
RFP	Request for proposal
RNG	Renewable natural gas
RRCEA	Resource Recovery and Circular Economy Act
SB	Senate Bill (California, United States)
SNCR	Selective non-catalytic reduction
SO_2	Sulfur dioxide
SRF	Solid recovered fuel
SSO	Source-separated organics
SWANA	Solid Waste Association of North America
SWMP	Solid Waste Master Plan
T&D	Tipping and Disposal
tm	Trench Metre
TPD	Tonnes per day
TPH	Tonnes per hour
TPY	Tonnes per year
Trail	Trail Waste Facility
UAE	United Arab Emirates
UK	United Kingdom
UNEP	United Nations Environment Program
US	United States
USEPA	United States Environmental Protection Agency
WA	Western Australia
WCEC	West Carleton Environmental Centre
WMS	Waste Management System
WTE	Waste-to-energy; waste-to-energy facility
WTE, CC	Mass burn waste-to-energy facility with carbon capture
WTE, DE	Mass burn waste-to-energy facility with district heating
WWTP	Wastewater treatment plant

1 Introduction

The City of Ottawa, the Nation's capital and sixth largest city in Canada, is in the process of implementing a 30-year Solid Waste Master Plan (SWMP) with the aim of decreasing the amount of waste managed by the City, diverting as much waste as possible from landfill, and looking for opportunities to maximize recovery of resources and energy in an environmentally sustainable manner. Furthermore, the City's current primary disposal option, the Trail Waste Facility (Trail) is nearing capacity in the next 10 to 15 years, and waste management options to potentially extend the life of Trail need to be determined.

From the SWMP the City is committed to managing residents' residual waste over the next 30 years and a guiding principal from the SWMP is "k*eeping waste local by treating residential waste within the City's boundaries, wherever operationally and economically feasible".* These two points are considered throughout the Study and Business Case.

The City recognizes that there is no single solution to addressing future waste management challenges and has developed the SWMP to address these issues through a multi-pronged approach. The recommendations outlined in the SWMP span the collection and management of waste from curbside-residential and multi-residential homes, parks, and other public spaces; City facilities and operations; and existing partner programs. The key factors that were considered in developing the recommendations in the SWMP were the following: 1) the role of all three levels of government in Canada (i.e. federal, provincial, and municipal), 2) the impacts of climate change, 3) leveraging innovation and technology alternatives to traditional methods of waste processing and disposal, and 4) consideration of the waste management hierarchy with the aspirational goal of moving the City closer to its zero-waste vision for the future.

Based on these considerations and key factors, the City identified 50 recommended SWMP Actions that are laid out by short-term (0-5 years), medium-term (5-10 years), and long-term (>10 years) time frames. Five objectives were developed to present and measure how the recommended SWMP Actions would directly impact achieving the City's zero-waste vision. The five SWMP objectives are the following:

- **Maximize the reduction and reuse of waste.** Actions under this objective are prioritized to begin in the short-term time frame to immediately decrease the waste generated and minimize the amount of waste that needs to be managed at a disposal facility.

- **Maximize the recycling of waste.** Actions under this objective will have the biggest impact on diversion from landfill and potential reduction of greenhouse gases (GHGs) and will be prioritized in the short-term time frame.

- **Maximize the recovery of waste and energy and the optimally manage remaining residuals.** Actions under this objective will be assessed in the short term and, if deemed feasible, implemented over the medium- and long-term timeframes to address the immediate and future need to extend available landfill capacity and to extract maximum resources and energy from the remaining residual waste stream.

- **Maximize operational advancements.** Actions within this objective support operational advancements through innovation and new technology to make operations more efficient and to reduce impacts on the environment.

- **Develop a zero-waste culture across the city.** Actions under this objective will educate residents on how they can contribute to the City's goal of a zero-waste future and influence industry and the wider community to reduce, reuse, and divert waste.

The Waste Recovery and/or Treatment Facility Study Action Suite within the SWMP recommends the City advance a Feasibility Study and Business Case during the short term to identify technological solutions that can reduce the amount of waste sent to landfill and potentially recover additional resources and energy. The two alternative technologies being considered as part of this action are waste-to-energy (WTE) (specifically mass burn incineration with energy recovery) and mixed waste processing (MWP), or a combination of these two technologies. In addition to the WTE and MWP technology options, the Feasibility Study will consider existing and new landfill options for the future disposal of residual waste streams.

The City retained HDR Corporation (HDR) to conduct a Feasibility Study and draft Business Case on WTE and MWP in comparison to landfilling. This study will support the development of a business case to present recommendations to City Council for the processing of the City's residential residual waste for the next 30-years and beyond. The first step in this Feasibility Study and the purpose of Technical Memorandum #1 is to review the waste generation and composition projections developed in the SWMP, provide a technology overview of the WTE and MWP options, and gather relevant information from internal and external sources by completing a jurisdictional scan of recent similar projects for the following five options being considered as part of the Feasibility Study:

- **Option 1: Status Quo and Private Facilities.** Under this option, the City would continue to dispose of non-diverted waste for final disposal at Trail until it reaches capacity (estimated to be in 2035) and then negotiate waste supply agreements for disposal with one or several regional third-party waste management facilities.

- **Option 2: WTE Facility.** Under this option, the City would build a new WTE facility that can process all of their non-diverted waste with disposal of rejects and ash residue at a third-party waste management facility.

- **Option 3: MWP Facility.** Under this option, the City builds a MWP Facility that can process all of the City's non-diverted waste, recover additional recyclables and dispose of the remaining process residuals at a private third-party waste management facility.

- **Option 4: WTE and MWP Facilities.** Under this option, the City builds a MWP Facility to recover additional recyclables and builds a WTE facility to process and recover energy from the remaining residual waste. Reject and ash residue from WTE will be disposed of at a private third-party waste management facility.

- **Option 5: Construct a New Landfill.** Under this option, the City builds a new greenfield landfill within the region to take all non-recyclable residuals after Trail reaches capacity.

It is noted that the implementation of a new landfill was thoroughly assessed during the development of the SWMP. Although initially considered for deferral to future SWMP iterations, this option is being included for comparison purposes.

The findings in Technical Memorandum #1 will be used to further define the next steps in the Feasibility Study, including identifying the siting and regulatory approval requirements for each option; the potential project delivery models and funding opportunities available for each option; and the evaluation criteria, scoring, and weightings that will be used to assess the feasibility of each of the five options.

2 Review of waste projections and composition analysis

This section summarizes the existing waste generation and composition projections developed as part of the SWMP and evaluates influencing factors such as regulation, legislation, and operational or programmatic changes that may impact these projections.

2.1 Waste Projections Methodology

Waste generation by households is closely linked to factors such as economic growth, job markets, household income, and others. Understanding waste projections and waste stream composition is a key element of the planning process, as it allows the City's decision makers and planners to identify the long-term needs of the system and effectively plan waste management programs. By understanding how the City's waste management needs may change in the short to long term, the City can make effective and efficient decisions about waste management programs and services and allow for the proper "right-sizing" of supporting infrastructure that will need to be developed and/or maintained.

Waste projection forecasting for the period between 2024 to 2053 was undertaken as part of the SWMP using data based on the City's status quo/existing programs and policies alongside real waste data from 2019. The approach taken to develop the projections for the SWMP was to relate the annual curbside residential (CR) and multi-residential/containerized (MR/C) tonnage per household to annual socio-economic indicators specific to the City. This was observed over a 10-year period (2010 to 2019). A linear regression modeling approach was applied to historical data provided by the City that considered current and future socio-economic indicators to estimate future annual waste generation values for the SWMP planning period. In addition, the City provided HDR with updated tonnage data for Trail for 2023 and through August 2024 that was also reviewed for consistency with the waste projections developed in the SWMP.

The waste projections and data described in this section were reviewed in detail by HDR as part of this Technical Memorandum to form the design basis for the five options being considered for the Feasibility Study.

2.2 Waste Composition Analysis

The City categorizes the tonnes of materials collected as CR and MR/C. These two categories are further broken down by the City for the collection of materials according to the following:

CR includes materials collected from:

- Single family residences – garbage, recyclables, green bin organics, leaf and yard waste, and bulky items;
- Schools – green bin organics;
- Small businesses (yellow bag program only) - garbage, recycling, green bin organics;

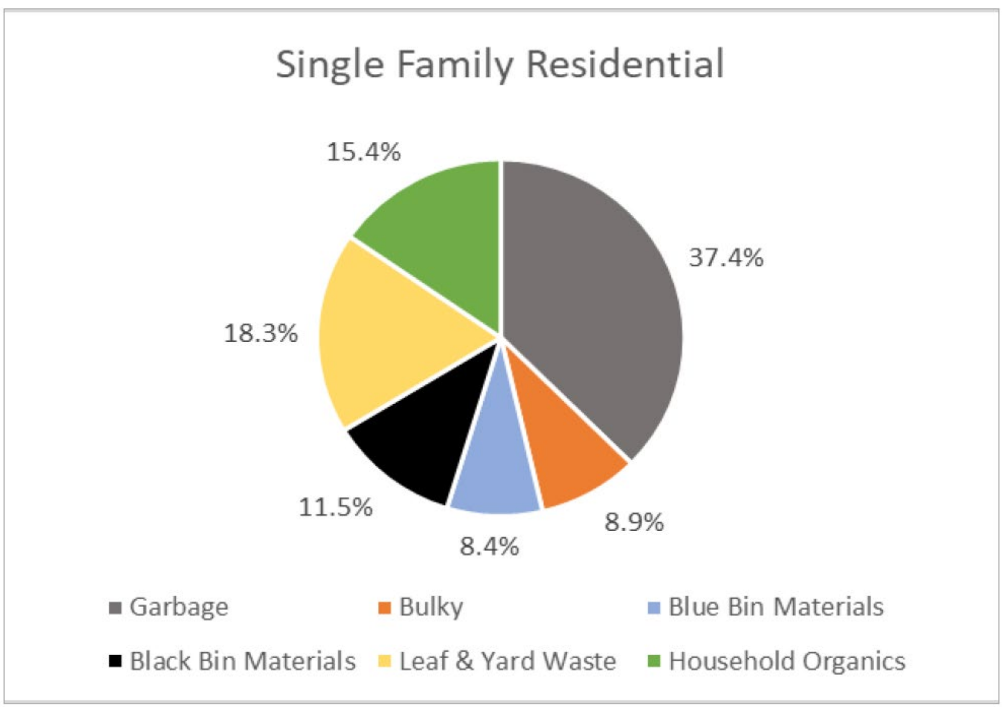
- City facilities – recyclables and green bin organics placed out in bags and bins; and,
- Multi-residential buildings – garbage and recyclables placed out in bags and bins, green bin organics placed out in carts, and bulky items (regardless of how other materials are collected).

MR/C includes materials collected from:

- Multi-residential buildings – garbage and recyclables placed out in front end load containers and carts; and,
- City facilities – garbage, recyclables, and leaf and yard waste placed in front-end load containers.

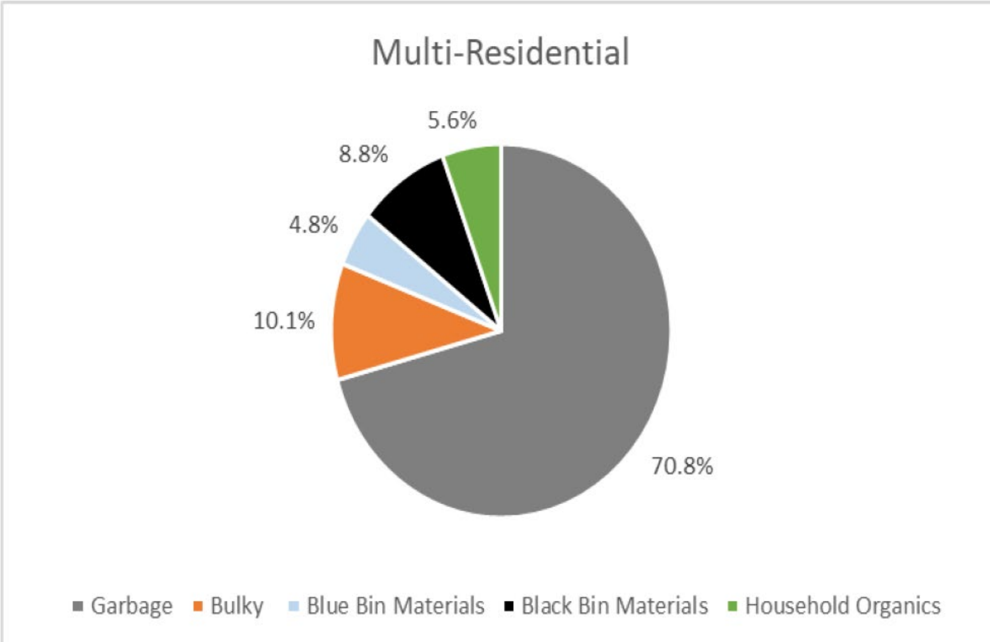
For the SWMP, the tonnage information collected from the CR and MR/C contracts were allocated to either single family, multi-residential, or City facilities, and by waste stream (i.e. garbage, black bin materials, blue bin materials, bulky items, leaf and yard waste, and green bin organics). Based on the data used to develop the SWMP, the single-family sector accounts for almost 91% of waste collected under the CR contracts, with the City facilities and multi-residential sectors accounting for approximately 7% and 2%, respectively. According to the SWMP, the multi-residential sector consisting primarily of garbage accounts for almost 95% of the tonnes collected through the MR/C contract, with City facilities accounting for the remaining 5%. Overall, for the three sectors analyzed in the SWMP and reviewed for Technical Memorandum #1, single family, multi-residential, and City facilities generate 73%, 20%, and 7% of the total annual waste, respectively. **Figure 2-1**, **Figure 2-2**, and **Figure 2-3** shows the percentage breakdown by sector and waste stream based on the allocation scheme developed in the SWMP that were assumed to remain constant over the duration of the planning period (2023 to 2053).

Figure 2-1: Single Family Residential Percent Allocation by Waste Stream



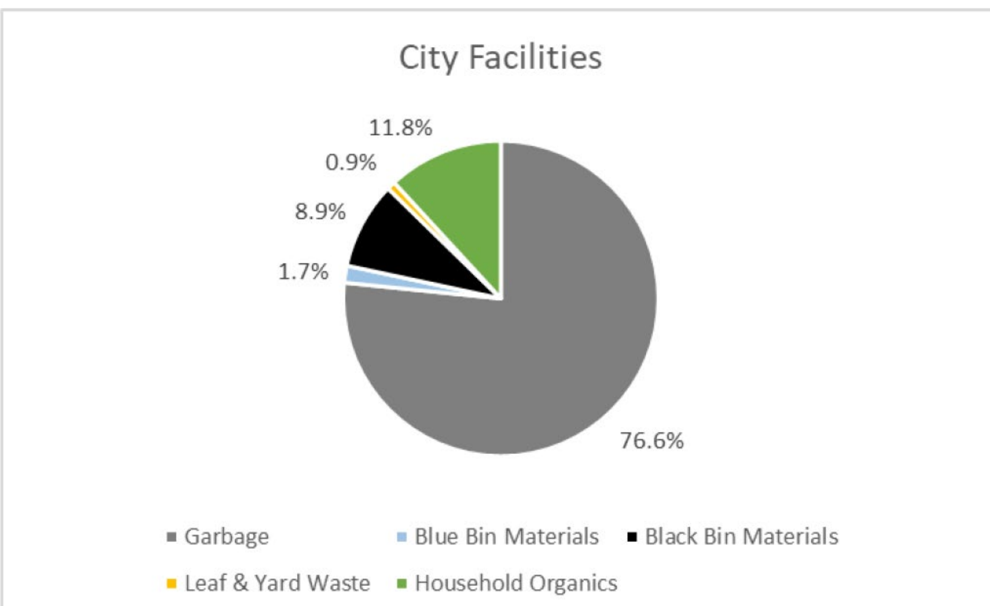
Source: City of Ottawa Solid Waste Master Plan, June 2024

Figure 2-2: Multi-Residential Percent Allocation by Waste Stream



Source: City of Ottawa Solid Waste Master Plan, June 2024

Figure 2-3: City Facilities Percent Allocation by Waste Stream



Source: City of Ottawa Solid Waste Master Plan, June 2024

2.3 Projected Quantities of Waste Volumes Available

2.3.1 Summary of Existing Volumes

In 2023, the City of Ottawa provided waste management services to and for approximately:

- 310,700 curbside-residential households;
- 2,300 multi-residential households;
- 750 on-street waste bins (garbage and recycling);
- 5,400 waste bins in City parks;
- 500 City facilities;
- 300 small businesses and places of worship through the Yellow Bag Program for small businesses; and,
- 300 schools through the Green Bins in Schools program.

In 2023, the City collected and managed a total of 345,900 tonnes of waste, which included approximately:

- 183,000 tonnes of curbside waste;
- 99,400 tonnes of organics and leaf and yard waste; and
- 63,400 tonnes of recyclables.

Based on these volumes, the City's estimated diversion rate in 2023 was 47% based on curbside waste. The actual amount of waste received through the scales at Trail was 220,000 tonnes, which included both curbside waste and non-curbside waste. The diversion rate is calculated based on the quantity of material collected for diversion and the total quantity of waste collected (i.e., for disposal and diversion). Organics, leaf and yard waste, and recyclables are considered materials that were diverted from final disposal.

The City has noted that trends show curbside households continue to divert more waste than multi-residential households. The 2023 diversion rate for curbside households was 54% and the 2023 diversion rate for multi-residential households was 17%. As a result, there are still opportunities for further diversion in both categories of households. Further education and awareness programs can support increasing the diversion rates.

Based on the 2023 data, it is estimated that the average Ottawa household generates approximately one tonne of garbage per year.

2.3.2 Projected Waste Volumes

In 2021, the City's population was estimated to be just over 1,064,000 people based on the City of Ottawa's Official Plan (Section 3: Growth Management Framework).[1] The City's population is projected to grow to an estimated 1.5 million people by 2053.[2] The City may alter these population estimates based on additional information. The Ministry of Finance is forecasting an even higher population increase, and as a result, the City should consider updating the waste projections and Official Plan as required if the future projected population is underestimated.

[1] City of Ottawa – Official Plan - Section 3. Growth Management Framework.

[2] Solid Waste Master Plan June 2024 prepared by the City of Ottawa

Table 2-1 shows a breakdown of projected waste generation by source, as obtained from the current SWMP over the next 30-year planning period.

Table 2-1: Projected Waste Generation by Source (tonnes)*

Year	Curbside-Residential	Multi-Residential	City Facilities	Parks & Public Spaces	Hazardous & Special Products (HSP)	Non-Residential Waste	Total Waste Generation
2024	268,800	69,000	25,100	1,900	700	37,400	403,000
2029	289,300	73,100	26,900	2,000	800	37,400	429,600
2034	308,600	76,500	28,700	2,100	800	37,400	454,200
2039	326,600	79,500	30,200	2,200	900	37,400	476,800
2044	342,200	82,200	31,600	2,300	900	37,400	496,600
2049	355,300	84,300	32,800	2,500	1,000	37,400	513,200
2053	367,400	86,300	33,900	2,600	1,000	37,400	528,600

*Tonnage represents all waste generated prior to any diversion.
Source: City of Ottawa SWMP – Table 3: Projected Waste Generation By Source (tonnes)

The City has a well-established green bin program that diverts curbside residential household organics, multi-residential household organics, City facility household organics, and leaf and yard waste (aggregately referred to as source-separated organics (SSO). The total tonnage projected for disposal at Trail or alternate location is significantly less as shown in **Table 2-2** below.

Table 2-2: Garbage and Bulky Waste Disposal Projections by Sector (tonnes)

Year	Curbside-residential	Multi-residential	City Facilities	Parks & Public Spaces	Total Waste Generation
2024	124,600	55,400	19,200	1,800	201,100
2029	134,100	58,700	20,600	2,000	215,400
2034	143,000	61,300	21,900	2,100	228,400
2039	151,400	63,600	23,100	2,200	240,300
2044	158,600	65,700	24,200	2,300	250,800
2049	164,700	67,400	25,100	2,400	259,500
2053	170,300	68,900	25,900	2,500	267,600

Source: SWMP – Table 3: Projected Waste Generation By Source (tonnes)

Based on the City's projections, **Table 2-3** provides a summary of the anticipated waste generation tonnages broken down by waste, bulky waste, and SSO. These projections assume that the diversion impacts described in Section 8 of the SWMP are not successful in increasing diversion during the 30-year planning period.

Table 2-3: Current and Anticipated Waste Volumes Without Implementation of Additional SWMP Diversion Initiatives (Status Quo)

Type of Waste	2024 (Tonnes)	2053 (Tonnes)
Overall Waste Generation Volume	403,000	528,600
Garbage and Bulky Waste	201,100	267,600
Source-Separated Organics (SSO)	98,100	134,000

The SWMP estimates that through the implementation of a number of diversion programs, the City will only need to dispose of 199,500 tonnes of waste at a landfill or alternative location.

2.3.3 2019 Waste Audit Composition Results

An audit was performed in 2019 to estimate the material composition of the waste stream after material was diverted by residents. Separate audits were performed for the four sources identified earlier in **Table 2-2**. **Table 2-4** below shows the materials that were sorted from the waste stream during those audits and the percentage of each material that comprised the aggregated garbage and bulky waste streams.

Table 2-4: Waste Composition Breakdown

2019 Waste Audit Material Categories	2019 Waste Audit Results (Tonnes)	2053 Tonnage Projections from SWMP	Percentage of Waste
Corrugated Containers	2,135	3,363	1.26%
Mixed Paper (general)	10,663	17,645	6.59%
Green Bin Waste	66,722	114,378	42.74%
Yard Trimmings	2,500	4,417	1.65%
High-Density Polyethylene (HDPE)	1,413	2,206	0.82%
Polyethylene Terephthalate (PET)	4,641	7,157	2.67%
Mixed Plastics	17,297	29,629	11.07%
Aluminum Cans	684	1,102	0.41%
Steel Cans	1,379	2,145	0.80%
Mixed Metals	3,182	5,290	1.98%
Glass	4,503	7,461	2.79%
Clay Bricks	4,482	7,932	2.97%
Concrete	4,482	7,932	2.97%
Dimensional Lumber	4,482	7,932	2.97%
Mixed Municipal Solid Waste (MSW)	29,910	49,009	18.31%
Total	**158,474**	**267,600**	**100.00%**

Table 2-5 displays this same data but grouped by material type.

Table 2-5: Waste Composition Grouped by Material Type

2019 Waste Audit Materials Grouped by Material Classification	2053 Tonnage Projections (Tonnes)	Percentage of Waste[1]
Fiber Material[2]	21,008	7.9%
Other Organics[3]	118,795	44.4%
Traditional Recyclables[4]	47,529	17.8%
Glass	7,461	2.8%
C&D Material[5]	23,797	8.9%
Mixed MSW[6]	49,009	18.3%
Total	**267,600**	**100.0%**

Notes:
[1] Based on material composition percentages from 2019 Waste Audit
[2] Old corrugated containers (OCC)/mixed paper
[3] Food waste/yard trimmings
[4] 1-7 plastics, metal
[5] Bricks, concrete, lumber
[6] Material determined to have no recoverable value at time of waste audit (i.e., diapers)

HDR used the material composition data from the 2019 Waste Audit to estimate the tonnage of potentially recoverable material from a WTE or MWP Facility. This is discussed in more detail in **Section 3.3**.

2.3.4 Feedstock Considerations

Based on the review of the existing and projected waste volumes and composition in the SWMP, HDR has evaluated the City's potential feedstock for compatibility with the two technology options being considered in the Feasibility Study.

2.3.4.1 Waste-to-Energy (WTE)

- One of the main benefits of a mass burn WTE facility is its ability to accept a wide variety of MSW (all material) and waste considered bulky waste, with minimal pre-processing requirements. Bulky materials delivered to the facility are broken down into a smaller size by a front-end loader, grapple crane, and in some instances a dedicated sheer shredder that is installed above the waste pit. No modifications would be required to the current feedstock to process current waste streams at a new mass burn WTE facility.

- The projected heating value of the feedstock is an important factor when sizing a new facility. The heating value can be affected by its composition and moisture content. The greater the heating value of the feedstock, the less material you need to generate the same amount of heat (and resultant steam and electricity). A study evaluated the implementation of Metro Vancouver's food waste diversion program on the impacts of waste heating value. The study estimated that diversion of 25% of the food waste from the existing waste stream would result in a reduction in total waste quantity by 7.3% and an increase in the overall heating value by

4.1%.[3] Plans for future organic diversion from the waste stream should be considered as it relates to WTE facility sizing and design capacity.

- The MWP and the WTE facility are intended for residential and curbside waste materials with potential options to increase diversion and reduce materials going to landfills. The City of Ottawa is not intending on processing construction and demolition (C&D) materials at these facilities currently. The City may decide to further explore potential opportunities for C&D diversion as they arise, and recycling markets become available or evolve for those materials. With those opportunities, it should be noted that C&D as a feedstock has its benefits and challenges. C&D can include a wide range of materials, such as roofing shingles, concrete, asphalt, construction wood, pallets, and sheetrock or gypsum board. The HHV is typically higher than that of MSW, as the material stream tends to have lower moisture content. However, certain C&D materials can generate acidic gases such as sulfur oxides and hydrochloric acid, which results in the need to use a greater quantity of hydrated lime to neutralize these compounds. Materials containing chlorine (i.e., polyvinyl chlorides [PVC]) can also adhere to boiler tubes and accelerate tube wear.

- There are occasions where non-approved waste or waste that may require further processing to be managed may be received at a site. These may include items such as hazardous waste or explosive materials (e.g., propane tanks). These materials should be sorted and removed from the waste prior to entering the waste processing or thermal treatment operation. The materials should be stored in a designated area for removal from the site for proper treatment and processing. If the approval permits, materials requiring further processing could be completed on site where appropriate. Typically, as a component of the site's Design and Operation Plan incorporated into a site's Environmental Compliance Approval (ECA) for waste, the report will clearly identify waste screening, receiving, and separation procedures for unapproved waste. These requirements are considered standard and are important for compliance and operations.

- A WTE facility capable of processing the City's projected waste volumes in 2053 of is technically feasible. However, a slightly larger facility capable of processing between 330,000-350,000 tonnes per year may be more financially viable from a purely economy of scale standpoint. Furthermore, there may also exist the opportunity for the City to receive additional revenue in the form of higher tipping fees from other regional municipalities outside of Ottawa and/or the IC&I sector that may lack their own disposal or processing capacity. However, the capital and operating cost implications of a larger WTE facility option are not evaluated in detail as part of the Feasibility Study.

2.3.4.2 Mixed Waste Processing (MWP)

- MWP facilities require some pre-screening of incoming MSW and are less robust and accepting of different waste streams when compared to mass burn WTE. Typically, all incoming material is fed over an in-feed conveyor and a grapple crane is used to remove non-processible materials from the system. Non-processible material can vary from facility to facility but typically consists of bulky items such as furniture, carpet, and mattresses. An optimal

[3] Lore, A., Harder, S. (2012), "The Effect of Food Diversion on Waste Heating Vale and WTE Capacity", Proceedings of the National Waste to Energy Conference (NAWTEC20-7041).

feedstock for a MWP facility will in theory consist of a material stream that has been pre-processed or pre-sorted (e.g., site waste screening procedures) to grind or remove these items prior to arrival at the facility. In addition, explosive items such as propane tanks need to be removed from the process up front as well.

- Organics content in the waste stream, more organic material present in the waste stream coming into the facility means a greater quantity of organic materials that can be recovered from the process. Recovered organic materials (typically this is organics fines of a 2” (approximately 5 cm) minus fraction that is removed by a trommel and not considered viable in other uses) (e.g. too contaminated for use within the compost process) can be used as a feedstock in a thermal treatment process (e.g., gasification), marketed as a solid recovered fuel (SRF), or further cleaned up and used in an anaerobic digestion (AD) process to generate a biogas. However, the City of Ottawa has an established green bin program, so there will be a lower fraction of organic waste in the MSW stream. It will likely not make economic sense to recover this organic stream. The likely destination for the material is a landfill. The City will make program decisions based on the success of the diversion programs proposed in the SWMP.

- Recyclables in the waste stream, the ideal MWP feedstock typically comes from a waste system that has no established recycling collection system. In this setting, the MWP affords the ability to recover a portion of recyclable material that would otherwise end up in a landfill. However, the City of Ottawa has an established and mature recycling program, and as a result, it is anticipated there will be a lower fraction of recoverable recyclables in the waste stream. The recyclable materials that are able to be recovered are expected to be of lower quality and would likely be discarded in the waste stream because they are contaminated with food residue (i.e., a peanut butter jar that has not been washed out or a greasy pizza box) or comingled with other MSW by the generator; hence the reason it was not placed in the recycling stream to begin with. Should the material not be salvageable for further diversion, it would lower the potential amount of revenue the City could generate through the sale of recovered materials. The success of a facility would depend on the metrics of the facilities (e.g., financial profitability or reducing the amount of waste that goes for final disposal).

2.3.5 Impact of SWMP Diversion Initiatives on Triple Bottom Line Analysis

Considering the wide range of potential tonnages that may require disposal by the year 2053, **Section 3** of this memo will display estimates for WTE and MWP facility size, throughput, and capital and operating costs for both:

1) a “status quo” scenario, in which the recommended SWMP diversion programs are not implemented or not effective in increasing the current diversion rates in the City (resulting in a need to dispose of 267,600 tonnes of waste at a landfill or one of the alternative processing technologies); and,

2) a scenario in which the recommended SWMP diversion impacts are implemented to the fullest effect (resulting in a need to dispose of 199,500 tonnes of waste at a landfill or alternative processing facility).

The specific tonnage number to use when estimating facility size, throughput, capital and operating costs, GHG emissions, and developing the triple bottom line analysis for both the WTE and MWP options will require additional analysis and input from the City. However, for the purposes of this Technical Memorandum and the Feasibility Study, HDR will assume the most conservative tonnage estimate of 267,600 tonnes of waste and bulky waste projected for 2053, which is approximately 890 tonnes per day (based on 300 operating day per year). The status quo tonnage was selected as being more conservative for developing the facility sizes and the probable capital and operating cost estimates included in the standalone Technical Memos and the Study.

3 Overview of options

This section provides a detailed description of the five options being considered as part of the Feasibility Study, including the WTE and MWP technologies options. This section evaluates the risks, opportunities, planning-level costs, and implementation considerations associated with both of these technologies.

3.1 Status Quo and Private Facilities

3.1.1 Trail Waste Facility and Regional Landfills

The Trail Waste Facility (Trail) is the second largest municipal landfill in Ontario and has been a key asset for the City since it first opened to receive waste in May 1980. Currently, all garbage collected by the City is brought to Trail for final disposal. Trail is permitted to accept solid, non-hazardous waste generated from within the boundaries of the City on a 153-hectare site, of which 85 hectares is currently approved for landfilling. According to the analysis performed as part of the SWMP, Trail has a total approved capacity of 16.9 million cubic metres. As of 2022, it is estimated that there was only approximately 3.5 million cubic metres of air space remaining and that Trail would reach full capacity sometime between 2034 and 2036 at the current rate of usage.[4] The City is currently evaluating a separate Environmental Assessment to determine if the use of some of the active 85 hectares site or part of the remaining 68 hectares can be used to expand the allowable landfilling space on Trail. For the purposes of the Feasibility Study, HDR will only consider the current permitted capacity of Trail as part of the Status Quo and Private Facilities option.

The landfill operates above industry standards and includes a robust gas collection system to capture methane gas. According to the City, the gas collection system can capture up to 90 percent of the methane gas generated that is then converted into electricity using reciprocating engine generators. The electricity generated from Trail's landfill gas-to-energy system can power up to 6,000 homes. The landfill gas-to-energy system is operated under a 3rd party agreement between the City and PowerTrail that expires in 2027.

An aerial photo of Trail is shown in **Figure 3-1**

[4] City of Ottawa, Solid Waste Master Plan, June 2024

Figure 3-1: Aerial Photo of Trail Waste Facility (Trail) Landfill

3.1.2 Regional Landfill Options

In addition to Trail, eastern Ontario has a number of landfill sites that are owned and operated by the private sector. The existing privately owned and operated landfills in Eastern Ontario that the City could consider as alternative disposal facilities are the following:

- The **Green For Life (GFL) Eastern Ontario Waste Handling Facility (EOWHF)** is located in Moose Creek, Ontario, approximately 50 km east of Ottawa. The facility recently received approval for an expansion after completing an environmental assessment (EA). The approval is for 15.1 million cubic metres of landfill disposal capacity, and it is anticipated this will provide 20 years of capacity at the approved annual fill rate of 755,000 tonnes per year. The facility has an Ontario service area and is permitted to receive residential waste.

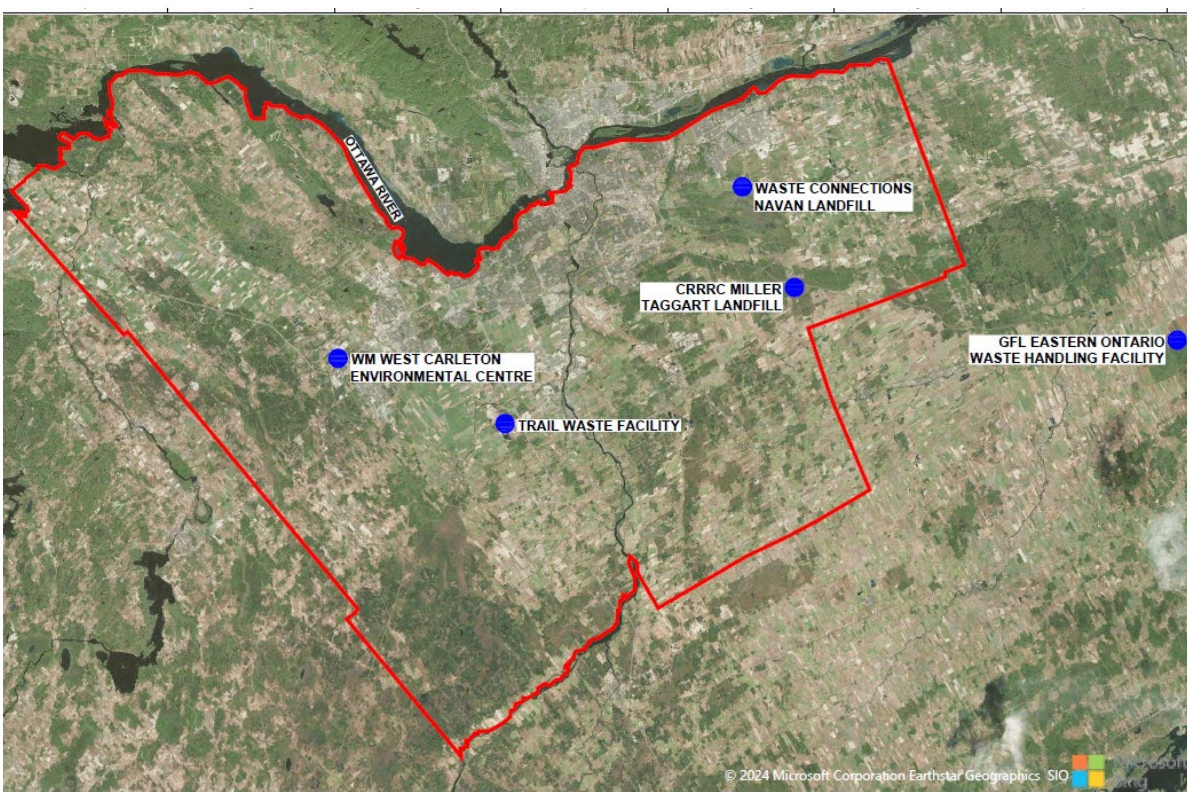
- The **Waste Connections Navan Landfill** is located in the east end of Ottawa (Navan). It is permitted to receive 234,750 tonnes of solid non-hazardous waste (excluding putrescible waste) per year. Based on publicly available information, the Navan Landfill has less than 10 years of capacity remaining. Given the restrictions on the type of waste accepted, it would limit the City to only a portion of the City's waste (e.g., industrial, commercial, and institutional [ICI] waste or post-processed waste).

- The **Waste Management West Carleton Environmental Centre (WCEC)**, located in the west end of Ottawa (West Carleton/Stittsville) received EA approval in September 2013. This approval included the expansion of an existing (now closed) landfill site. The approval is for a volume of 6.5 million m³ based on receiving 400,000 tonnes annually over an approximate 10-year planning period. The facility (expansion) opened in November 2024.

- The **Capital Region Resource Recovery Centre (or the Miller Taggart landfill)**, located on Boundary Road in eastern Ottawa, received EA approval in May 2017 for a new landfill with capacity of approximately 10.17 million cubic metres. This capacity is based on a fill rate of 450,000 tonnes annually over a 30-year planning period. On May 24, 2024, the Ministry of Environment, Conservation, and Parks (MECP) amended the ECA (Waste) to permit the site to receive and landfill MSW. At this point in time, the landfill has not been constructed and is not operational.

The City would need to enter into a long-term waste disposal agreement with one or more of the regional landfills identified above for disposal of City-managed waste after the closure of Trail. It should also be noted that the WTE and MWP options being considered as part of this Feasibility Study would also require some disposal capacity to handle residual waste streams generated by both technologies. An aerial photo of the regional landfill options near Ottawa is shown in **Figure 3-2**.

Figure 3-2: Aerial Photo of Regional Landfill Options Near Ottawa



3.1.3 Environmental Considerations

This option will utilize Trail until available capacity is exhausted, after which the City would utilize local third-party waste management facilities. This option has minimal environmental considerations for approvals for the landfill operation (except for any future amendments) and for waste management systems for transportation. For the waste management system (WMS) option, the City can utilize their existing waste management collection vehicles. As a recommendation, the City should ensure their waste transportation vehicles that transport waste to a third-party site have the proper environmental permissions (e.g., for WMS that may not meet the Environmental Activity and Sector Registry (EASR) registry requirement and would require an ECA). Similarly, for third-party transportation vehicles, the City should have a component in the service contract that the contractor's vehicles will have the proper environmental permissions.

From a third-party waste management facility perspective, when considering a third-party site, the landfill could consider the site's environmental record. The following aspects can be considered when assessing sites.

- **Landfill gas collection efficiency.** Landfill gas collection systems are typically designed to collect 85% of the expected landfill gas to be generated at a site. Not all sites with landfill gas collection system achieve that collection efficiency. Identifying a site that meets or exceeds the collection efficiency to meet GHG reduction goals can be a factor in the City's assessment.

- **Leachate management.** Managing leachate is an effective manner that will minimize the potential environmental impacts at the site. Identifying sites that adequately manage leachate can potentially reduce risks to the City should the site have to reduce or cease accepting waste.

- **Site Compliance.** Identification of a site that is compliant with the site's applicable permissions. Identifying a site in compliance with their approvals can reduce the environmental risk to the City should the landfill have to reduce or cease accepting waste to manage the non-compliance situation (e.g., reduced waste acceptance may result in the City having issues collecting curbside waste should vehicles not be able to empty in a timely manner).

3.1.4 Financial Implications

After 2035, the Status Quo and Private Facilities option will send waste to one or several third-party waste management facilities.

There is no additional capital costs anticipated under the Status Quo and Private Facilities scenario for such as land acquisition, operational cost or construction costs since this option only considers existing infrastructure. If the City is successful in receiving approvals to expand Trail there will be additional capital costs incurred to build a new cell, but this was not considered as part of this study. The operating costs incurred by the City under this scenario will solely be attributed to the transportation and disposal costs for the waste delivered to the private third-party waste management facilities. It is anticipated the third-party waste management sites will charge a tipping fee of at least $150 per tonne (not including hauling costs). In addition, the long-term closure and maintenance costs associated with Trail after it reaches capacity is anticipated to continue during the 30-year planning period and would exceed roughly $1M annually. **Table 3-1** provides a summary of the expected operating costs under the Status Quo and Private Facilities option. Given the anticipated competition for remaining disposal capacity in eastern Ontario over the next 10 to 13 years, tipping fees in excess of $200/tonne could also be possible.

The landfill gas-to-energy system is operated under a 3rd party agreement between the City and PowerTrail that expires in 2027. The City does receive a portion of the revenues generated by Trail gas-to-energy system through the agreement with PowerTrail, but it is not anticipated that the City will receive any revenues for the gas generated in the private third-party waste management facilities.

The City will not receive any revenues from the third-party waste management facilities for electricity or RNG generated from landfill gas.

Table 3-1: Status Quo and Private Facilities Operating Costs (2053)

Operating Cost	Estimated Annual Operating Costs (CAD)	Cost per Tonne of MSW Processed (CAD)
Hauling and Disposal Costs[1]	$42,816,000	$160
Trail Closure Costs	$1,000,000	$4
Estimated Annual O&M Costs[2]	**$43,816,000**	**$164**

Notes:

1. Based on a $150 per tonne tipping fee plus an additional $10 per tonne hauling cost.
2. Estimated O&M costs are based on a disposing the equivalent amount of the design capacity of alternate facilities of 267,600 tonnes/year in 2053.

3.2 Mass Burn Waste to Energy (WTE) Option

3.2.1 Overview

Globally, mass burn incineration of MSW is still the dominant WTE technology used when developing new larger and medium-scale WTE facilities. There are currently five operating mass burn incineration WTE facilities operating in Canada, including two in Ontario. There are also approximately 75 operating WTE facilities in the United States, with most of these facilities employing mass burn incineration technologies.[5] European and Asian countries view mass burn WTE technology as a favorable alternative to landfilling, with over 2,000 operating units worldwide. In addition to Europe and Asia, there has been some development of WTE technology in Africa, including the 1,400 tonnes per day (TPD) Reppie WTE Facility, which commenced operation in Ethiopia in 2018, and the Kwinana WTE Facility in Western Australia, which is nearing construction completion and commissioning. In the Middle East, Abu Dhabi is also in the planning stages to construct a 3,000 TPD facility using this same technology.

In a traditional mass burn process, MSW is fed into a hopper or feed chute where it enters the furnace and is combusted using excess air to generate heat and reduce the volume of waste by up to 90% (or up to 75% by weight). The latent heat generated from the combustion process is recovered in a boiler to generate steam, which can be used directly for heating and industrial purposes or passed through a steam turbine-generator to create electricity. These facilities are fitted with extensive flue gas treatment systems to capture and reduce emissions from air pollutants to meet the stringent environmental and regulatory standards that are typically required for their operation.

[5] https://www.epa.gov/smm/energy-recovery-combustion-municipal-solid-waste-msw

These facilities are typically operated 24 hours per day, 365 days per year with scheduled boiler downtime twice per year to perform maintenance. In North America, the availability of WTE mass burn units, which is the hours a unit is available to process waste in a year, typically ranges from 91% and 94%. The high availabilities for a well operated and maintained mass burn WTE unit puts this technology at the higher end of the reliability scale compared to other fossil fuel and renewable power generating technologies. As an example, the boiler availability at the Durham York Energy Centre (DYEC) facility is designed to be at 90%; however, the facility has operated at a higher rate depending on planned or unplanned outages and maintenance plans for the facility.

Based on HDR's recent experience in Canada and the United States, the planning, permitting, design, and construction process for a new "Greenfield" mass burn WTE facility is estimated to take approximately eight to ten years. Technical Memorandum #2 will provide an overview of key environmental regulations, permits, and estimated time requirements for WTE facilities in Ontario.

3.2.2 Technology Description

There are two main types of traditional mass burn combustion facilities: grate-based with waterwall boiler tubes and modular-based design.

Mass burn units with stoker grate furnaces and waterwall boilers are the most prevalent type of medium- and large-scale (processing between 200 TPD and 1,000 TPD per unit) WTE technology operating in North America and globally. Many facilities have two or more units with overall facility waste throughputs in the range of 400 TPD to as much as 3,000 TPD or more. Examples of this type of facility include the Baltimore Resource Recovery Facility in Baltimore, Maryland; the Montgomery County Resource Recovery Facility in Dickerson, Maryland; and the Durham York Energy Centre (DYEC) in Ontario. H-Power Unit #3 is a mass burn facility located in Honolulu, Hawaii that has been in operation since 2013 with a processing capacity of 900 TPD. This facility has a steam-driven turbine-generator rated to produce 32 megawatts (MW) of energy and an average net electrical generation of over 200,000 megawatt-hours (MWh) per year, which is estimated to provide enough energy to power 20,000 homes annually.

Figure 3-3 provides a typical cross section of a stoker grate-based waterwall mass burn WTE system.

Figure 3-3: Grate-Based Mass Burn WTE Unit Overview

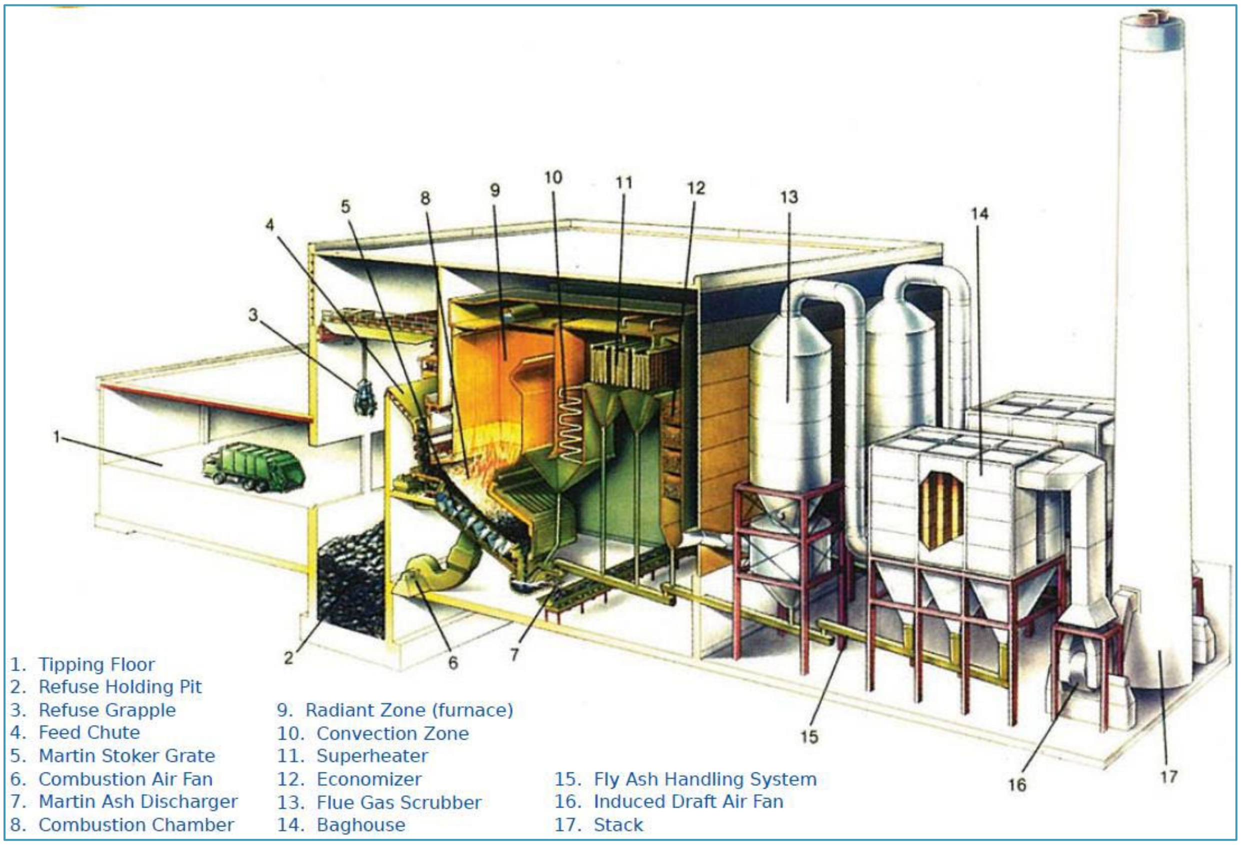
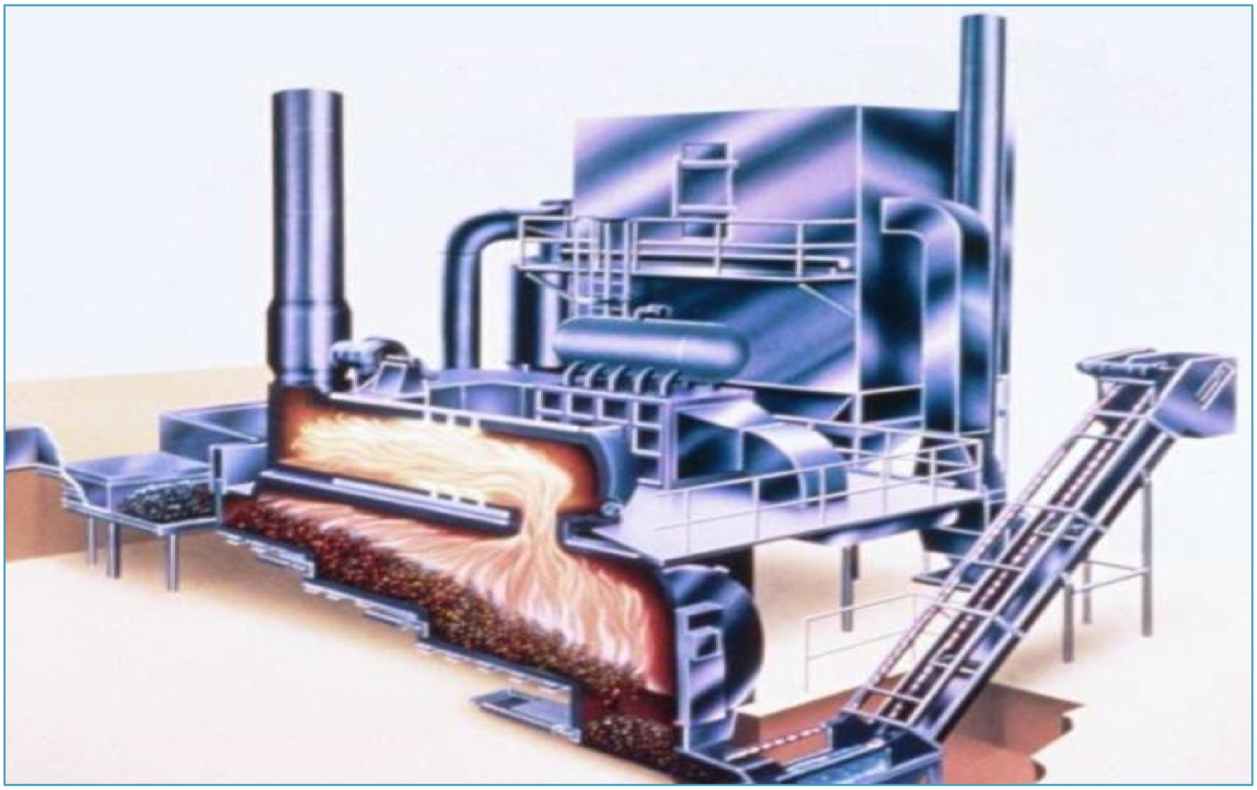


Photo Credit: Reworld™ (formerly Covanta Energy)

Modular-based design units are smaller in scale and typically designed to process 50 to 100 TPD per unit. These modular units can use either starved air or excess air combustion systems. There are only a few modular type WTE facilities processing MSW in North America. Examples include the Emerald Energy from Waste Facility in Brampton, Ontario and the Prince Edward Island (PEI) WTE Plant in PEI.

Figure 3-4 provides a typical cross section of a modular mass burn WTE system.

Figure 3-4: Typical Modular Mass Burn WTE Unit Cross Section



Source: Consutech Systems LLC

Both types of technologies feed MSW directly into a boiler system with little to no pre-processing, other than the removal of large bulky items such as furniture and white goods (e.g., refrigerators, washing machines, and dishwashers). MSW is managed with either a grate-based system or a modular system. The two systems differ based on how the waste is fed into the system. In a grate-based system, MSW is pushed onto a grate by a ram connected to hydraulic cylinders where air enters under the grates to complete combustion. In modular units, MSW is fed into a refractory lined combustor where the waste is combusted on refractory lined hearths.

When waste is burned in both types of systems, the resulting flue gases from each unit pass through the boiler and the energy from the heat of the gases is recovered in the boiler tubes to generate steam. The waste combustion creates three streams of material: steam, flue gases, and ash. Steam is often sent to a steam turbine-generator onsite, generating electricity to run the facility and to be sold to other local end markets. Prior to passing through the boiler, the flue gas passes through the air pollution control (APC) system to capture additional fly ash and common air pollutants (SO_2, NOx, HCl). Emissions from the boiler are eventually discharged through the emission stacks. Ash is collected at multiple locations throughout the system. The ash from each location is commonly processed separately. Bottom ash, collected under the grates (if applicable) or at the end of the combustion line, can be used as a construction base material (common in European end markets but not typically permitted for such use in Canada unless it meets an exemption in Regulation 347 (site specific/process specific))) or sent to a landfill. Fly ash, collected separately throughout the APC system, is then treated and typically combined with bottom ash.

3.2.3 Facility Layout

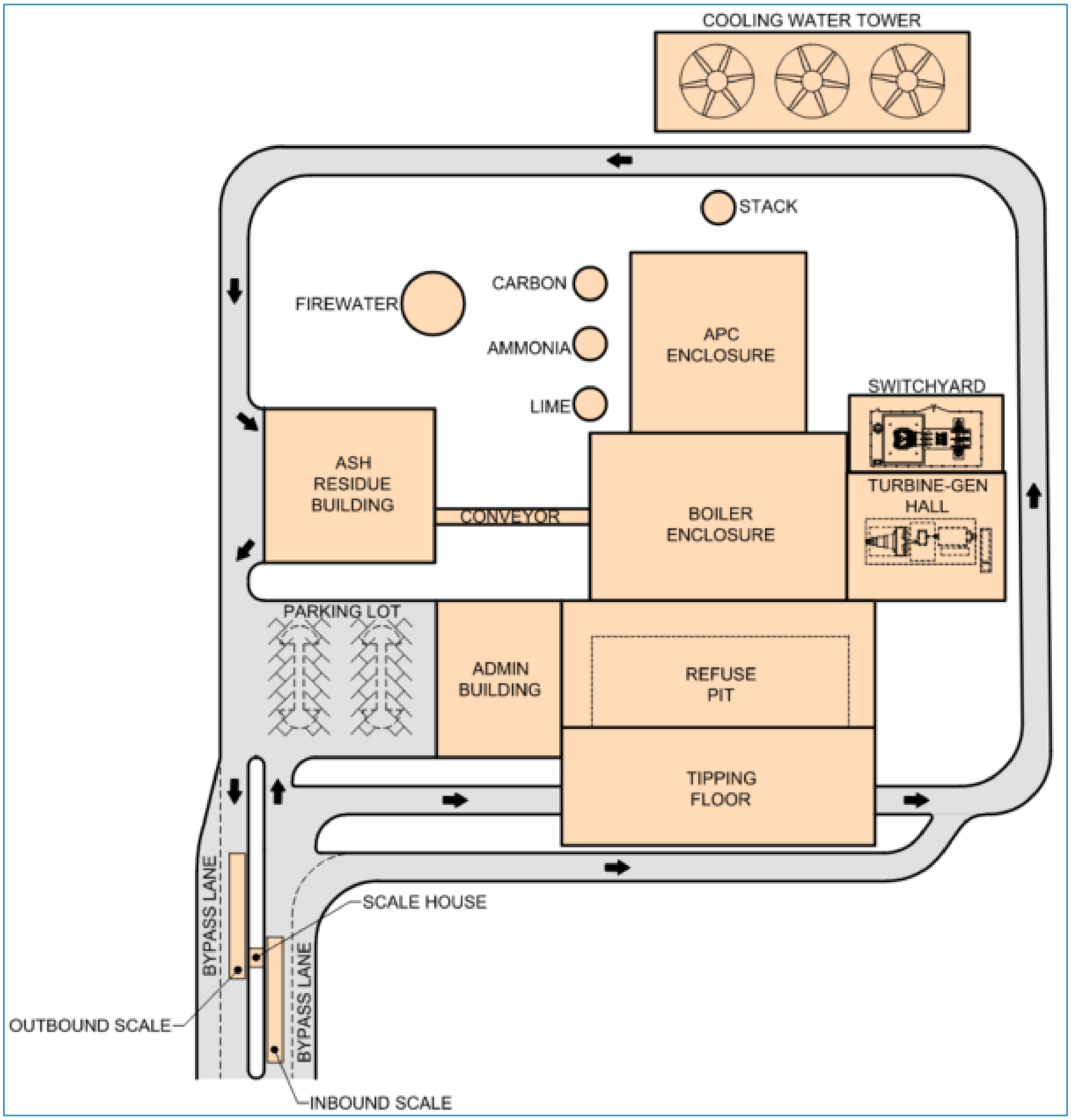
The following provides brief descriptions of each component of mass burn waste-to-energy technology and process flow diagram:

- **Waste receiving area.** Area where waste is received, screened and unapproved or large objects are removed for removal from the site.
- **Waste-handling equipment.** Equipment that feeds MSW directly into a boiler system with little to no pre-processing.
- **Boilers.** Mass burn combustion units with stoker grate furnaces and waterwall boilers are the most prevalent type of large scale (processing between 200 TPD up to 1,000 TPD per unit). Many facilities have two to four units with overall facility throughputs in the range of 400 TPD to 3,000 TPD or more.
- **Steam cycle**. The resulting flue gases from each unit pass through the boiler and the energy from the heat of the gases is recovered in the boiler tubes to generate steam.
- **Turbine generator.** Steam is often sent to a steam turbine-generator onsite, generating electricity to run the facility and to be sold to other local end markets.
- **Air pollution control (APC) (Including selective catalytic reduction [SCR]).** The flue gas passes through the APC system to capture additional fly ash and common air pollutants (SO_2, NO_x, HCl & particulate matter).
- **Ash-processing equipment.** Ash is collected at multiple locations throughout the system. The ash from each location is commonly processed separately. Bottom ash, collected under the grates (if applicable) or at the end of the combustion line, can be used as a construction base material (common in European end markets but not typically permitted for such use in the United States or Canada) or sent to a landfill. In Ontario, the waste management regulatory framework considers exemptions for waste material that could potentially be used to manage residual ash generated during operation. These exemptions are generally provided in Regulation 347 – General Waste Management (Section 3). If the material meets the exemption, then the material for that use is not regulated as a waste. (These scenarios are site- and operation-specific where the risks have been assessed by the MECP. Potential options can be assessed on a case-by-case basis). Fly ash, collected separately throughout the APC system, is then treated and typically combined with bottom ash.

Mass burn WTE facilities require the following buildings on their campus, displayed in **Figure 3-5.**

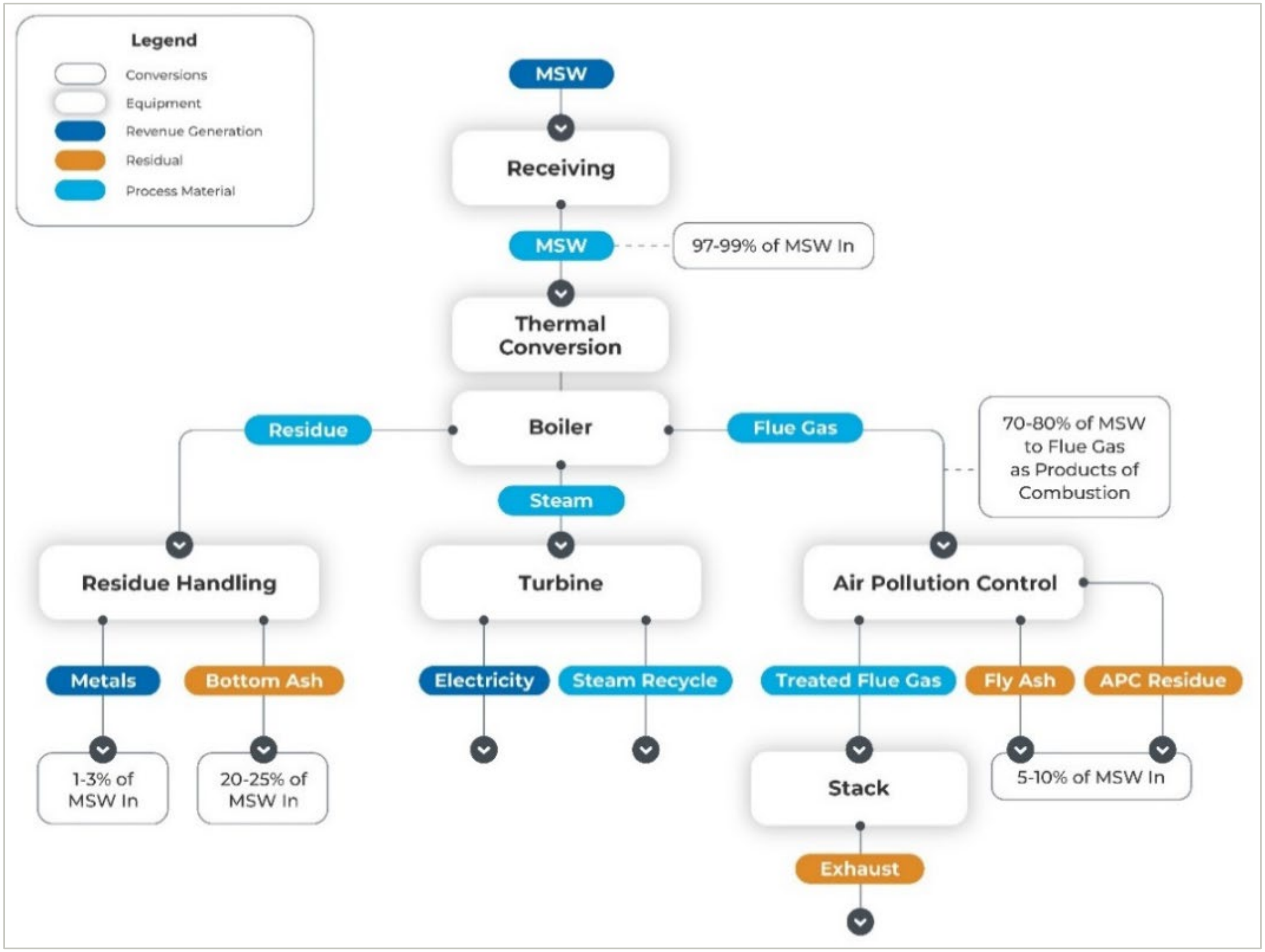
- Scale House
- Administration Building
- Tipping Floor
- Refuse Pit
- Boiler Building
- Turbine Generator Hall
- APC Building
- Ash Building
- Cooling Tower

Figure 3-5: Typical Mass Burn WTE Facility Layout



The process flow for a typical Mass Burn waste-to-energy facility is shown in Figure 3-6**.**

Figure 3-6: Typical WTE Process Flow



It is expected that a WTE facility of this size would require a minimum of three (3) to five (5) hectares of land. Development of this site would take approximately five years. Generally, the timelines for environmental approvals and siting for a new WTE project will be on the order of eight to ten years based on our experience with similar projects. The detailed approvals and permitting requirements and anticipated timing are discussed in greater detail in Technical Memo #2.

3.2.4 Facility Throughput & Diversion Potential

Depending on the success of the implementation of the diversion initiatives outlined in the SWMP, there is a range of waste tonnage that will need to be disposed of either by landfill or alternative option. **Table 3-2** presents the estimated waste generation rates, and the corresponding design throughput estimation, based on these two bookend scenarios.

Table 3-2: Mass Burn WTE Throughput

Category	Unit	No SWMP Diversion Impacts Realized	All SWMP Diversion Impacts Realized
Total Projected Waste Generation Rate[1]	Tonnes per year (TPY)	267,600	199,500
Initial Rejects[2]	TPY	2,700	2,000
Annual Design Throughput	TPY	264,900	197,500
Availability[3]	Percent	90%	90%
Daily Design Throughput Capacity [4]	Tonnes per day (TPD)	806	601
Hourly Design Throughput Capacity	Tonnes per hour (TPH)	34	25

Notes:

1. Garbage and Bulky Waste tonnage projections for 2053 per the SWMP, no SSO waste included.
2. Assumes around 1% of incoming material will be rejected.
3. Availability is the percentage of time a unit is online and processing waste at full capacity.
4. Based on 365 days/year and 24 hours/day operation multiplied by the assumed availability.

Table 3-3 below displays the estimated diversion potential of a WTE option.

Table 3-3: Mass Burn WTE Diversion Potential

Category	Unit	No SWMP Diversion Impacts Realized	All SWMP Diversion Impacts Realized
Incoming Material[1]	Tonnes per year (TPY)	267,600	199,500
Initial Rejects[2]	TPY	2,700	2,000
Processible Waste	TPY	264,900	197,500
Ash Generation[3]	TPY	58,300	43,500
Ferrous Metal Recovery[4]	TPY	7,900	5,900
Non-Ferrous Metal Recovery[5]	TPY	1,100	800
Total Tonnes to LF	TPY	61,000	45,500
Total Tonnes Diverted	TPY	206,600	154,000
Diversion Percentage	Percent (%)	77%	77%

Notes
1. Garbage and Bulky Waste tonnage projections for 2053 per the SWMP, no SSO waste included.
2. Assumes around 1% of incoming material will be rejected.
3. Estimated at 22% of the processed tonnage amount (264,900 tonnes).
4. Estimated at 3% of processed tonnage amount (264,900 tonnes).
5. Estimated at 0.4% of the processed tonnage amount (264,900 tonnes).

The anticipated minimum throughout through the option is 199,500 tonnes of waste. This amount is still above the minimum tonnage required to make the mass burn WTE option technical feasible. This is supported by the fact that the DYEC employs this same mass burn technology and has been operating successfully for more than a decade processing around 140,000 tonnes per year of MSW. However, 199,500 tonnes per year is on the smaller side for the ideal economy of scale for developing a WTE facility.

3.2.5 Environmental Considerations

While WTE facilities offer benefits, such as reducing waste in landfills and generating energy, they also raise several environmental considerations related to land, air, and water. The Environmental Protection Act (EPA) requires that a proponent of a facility that thermally treats municipal waste apply for environmental compliance approval (ECA) to install and operate the facility. These will include ECAs for air, waste, and wastewater. The ECA requirements are outlined in HDR's Technical Memorandum #2 – Approvals and Siting. In summary, the facility shall require ECAs under Section 9 of the EPA (air approval) for air and noise emissions and an ECA under Part V of the EPA (waste approval) for the waste receiving, handling, storage, and other waste management issues (as well as financial assurance for the facility, if privately owned) and for wastewater under the Ontario Water Resource Act (OWRA).

For air approvals, facilities that thermally treat municipal waste are expected to demonstrate that the /facility can meet the emission limits in the stack. Many WTE facilities have an advanced APC system that captures fly ash and harmful air pollutants; however, some emissions still occur. Facilities are tested on an annual or biannual (twice per year) basis to ensure their emissions are compliant with provincial and federal regulations. In addition, WTE facilities have continuous emissions monitoring (CEM) systems to ensure all regulations are being met in real time. Many provinces in Canada have implemented extended producer responsibility programs to collect batteries and other hazardous household waste to remove products from the MSW feedstock stream that can contain mercury and other harmful pollutants.

Land use considerations include a large footprint for WTE facilities for the facility itself and to store waste. There are several factors that are considered when siting a new facility, such as the impacts to the environment and society, technical suitability, and financial and commercial impacts. Noise generation from WTE facility operations (e.g. equipment and vehicles) must also be considered, and land buffers are generally required to mitigate any noise between the facility and nearby receptors as these facilities are generally smaller in size (e.g. compared to landfills) and main operations are located closer to the nearest receptors (e.g. other businesses)

From a waste management perspective, thermal treatment facilities will result in remaining solid residues that will require proper management. For conventional combustion systems, typical residue will include metals and two types of ash: bottom ash and fly ash. All residual materials must be sent to an appropriate facility for disposal. The operations may require additional utilities for the operation that may require other permits or place impact on the local environment (e.g., water taking permits). For the anticipated facility size, **Table 3-4** provides an overview of some operational requirement for the facility:

Table 3-4: WTE Estimated Utility Volume Needs

Utility Type	Potable Water Usage	Sewage	Boiler/Natural Gas Usage
Estimated Annual Volume Requirement	40,000-50,000 cubic metres	6,000-10,000 cubic metres	500,000-1,800,000 cubic metres

3.2.5.1 Greenhouse Gas Impacts

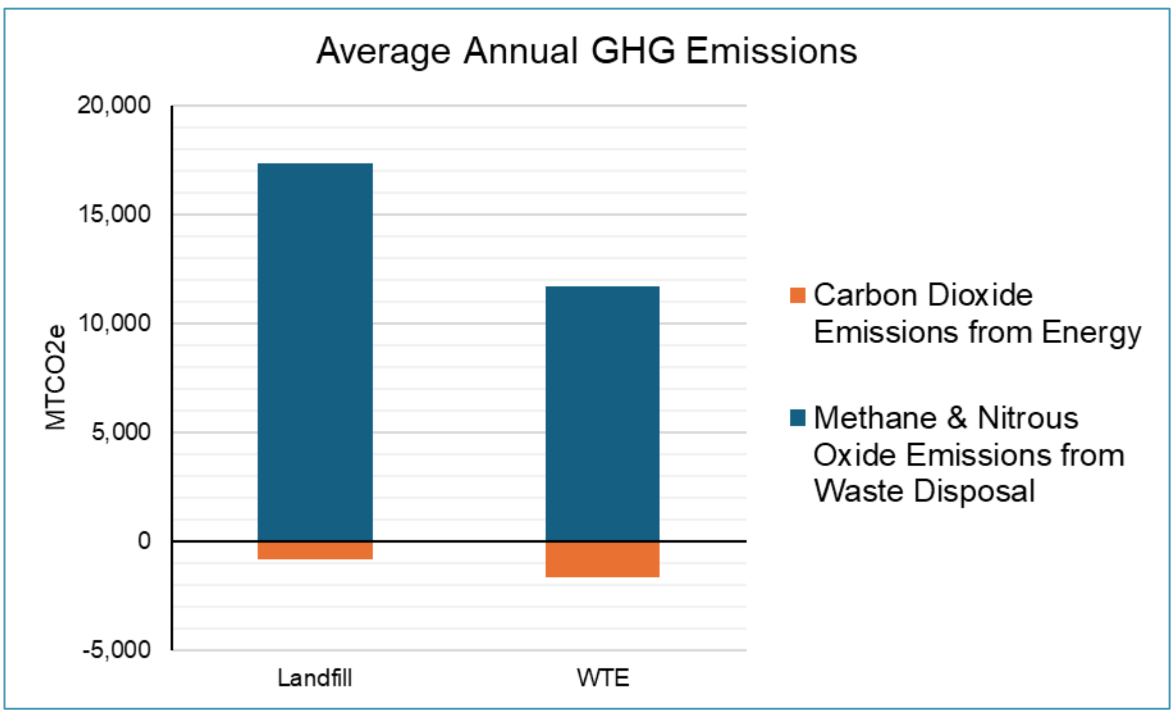
The carbon (biogenic and anthropogenic) in MSW is converted to carbon dioxide (CO_2) when combusted in WTE facilities. In addition, the combustion process generates other greenhouse gases (GHG), such as methane (CH_4) and nitrogen oxides (in the form of N_2O), that also contribute to the technology's carbon and GHG footprint. CO_2 emissions are also indirectly generated from WTE facilities from the consumption of reagents used in the process, such as ammonia and lime, that are accounted for when looking at the overall carbon and GHG impacts. When evaluating the GHG impact of the WTE option, it is typical to look at the sum of the emissions less any savings compared to other options. For the WTE option, the comparison is based on power generation and landfilling waste. The combustion process reduces the volume of waste that would normally require landfilling by up to 90% (or approximately 75% by weight), with the remaining residual ash stream going to landfill if there are no beneficial reuse options for that material. The electricity generated from a WTE facility also offsets the need to combust fossil fuels.

As part of a preliminary screening, HDR used the Environment and Climate Change Canada's (ECCC) Organic Waste GHG Calculator to estimate emissions for the WTE option to compare against landfilling and MWP solutions. The following key assumptions were used to inform the preliminary analysis:

- Due to the limitations of the tool, preliminary GHG emission results calculated from Environment and Climate Change Canada's Organic Waste GHG Calculator, Version 1.1 (February 2023) only includes direct anthropogenic emissions and avoided energy emissions.
- The current composition of total MSW stream is representative of future waste composition.
- WTE is able to incinerate roughly 99% of the MSW stream.
- No additional emissions from travel are included for transporting waste to newly constructed WTE facility or in transporting ash to landfill.
- Annual figures are representative of the average lifecycle emissions of producing the same quantity of waste over 30 years, and do not reflect actual year-to-year variance resulting from estimated decay rates of materials or growth in waste volumes.

From initial review, a WTE facility is anticipated to reduce annual GHG emissions by roughly 40% relative to landfilling. Further refinement of the estimations will be undertaken as a component of the feasibility study.

Figure 3-7: Average Annual Greenhouse Gas (GHG) Emissions for WTE



3.2.6 WTE Implementation

Compared to other technology options like MWP, a WTE facility will have the highest level of complexity to develop and operate. Therefore, a traditional design, bid, build approach is not a common delivery model for implementing a WTE project in North America. Over the past 40 years, the facility development, operation, and sometimes ownership of WTE facilities is more commonly managed through a public-private partnership or a completely privatized process. Private operators and developers can perform the detailed design, equipment procurement, construction, and operate and maintain WTE facilities much more effectively than an individual municipality due to the limitations of both the presence of a workforce with the necessary technical skills to operate and maintain the facility and the municipal procurement processes (e.g., requirements to evaluate multiple bids for ongoing maintenance). While some WTE facilities in the past have been developed and operated entirely by the public sector, it is not common due to the project level of complexity. The DYEC in Clarington, Ontario is a recent example in Canada where a municipal entity entered into a public-private partnership with a third-party to design, build, operate, and maintain a WTE facility. This example and others will be explained in more detail in **Section 4** of this technical memorandum, Jurisdictional Scan.

Even though the financial requirements for a WTE facility are typically higher than other alternative waste management technologies, there are long-term financial benefits to developing local disposal capacity. The increase in regional disposal capacity would have a downward price pressure on disposal costs over time as private and municipal waste facilities reach the end of their useful lives. If the City could utilize a WTE facility, it may not be subject to transfer and disposal pricing increases driven by macro-economic factors that are out of the City's control.

A key consideration when assessing the potential to implement a waste-to-energy facility is the greenhouse gas emission reduction compared to transfer and landfill disposal. Emissions associated with transportation and fugitive methane emissions to disposal sites where City materials are managed may result in significantly higher greenhouse gas emissions than the local disposal options provided by waste-to-energy. Every tonne of waste processed in a WTE facility rather than landfill (without an LFG collection system) avoids a tonne of carbon dioxide equivalent emissions (when the emissions savings from recycling recovered metals is included).[6] However, in Ontario, the collection of landfill gas for large sites is regulated. The avoidance of the carbon dioxide equivalent emissions at a landfill with an LFG collection system will depend on operation of the system and the accuracy of the model to predict the landfill gas generation rate. Additionally, WTE technology captures the energy potential of the waste stream much more efficiently than landfill gas systems and eliminates the point source methane emissions that are present at landfills. Further analysis is required to estimate annual emissions reductions specific to the City's SWMP.

3.2.7 Land Acquisition Costs

The City provided HDR with a high-level estimate for rural land values in support of a feasibility study for a proposed waste-to-energy facility. The valuation is subject to the following assumptions:

[6] Castaldi, Marco. "Scientific Truth About Waste-To-Energy." WTE-REPORT7603.pdf (ccnyeec.org)

- The land in question is located in a rural setting outside of the outer urban area of Ottawa, with average-to-good access from major highways (416/417/7).

- The land would be serviced with private water and sewer services.

Based on these assumptions, a market value of $50,000 per hectare was determined for a roughly 10-hectare site. The value refers only to the market value of land and therefore does not include any other costs associated with preliminary site investigations and due diligence and land acquisition (e.g., real estate commissions, legal fees, land transfer taxes, environmental studies, etc.). Therefore, HDR has increased this unit cost to account for those additional costs.

Table 3-5 shows the estimated land acquisition costs for a four-hectare site, which is a reasonably sized site for this size WTE facility.

Table 3-5: Mass Burn WTE Land Acquisition Costs

Land Acquisition Costs	Estimate # of Hectares	Estimated $ per Hectare (CAD)	Total Cost (CAD)
Land Acquisition	4	$100,000	$400,000

Note:

1. Estimate based on assumption of $50,000 CAD per hectare provided for a 4 ha site local in a rural area outside the City of Ottawa with average or better access to major highways and with private water and sewer service, increased to account for preliminary site investigations and due diligence, real estate commissions, legal fees, or land transfer taxes.

3.2.8 Construction and Operating Costs

This section presents the estimated capital and operating costs and revenues for the conceptual WTE facility options.

3.2.8.1 Capital Construction Costs

There have not been any new WTE facilities in this size range developed in the past 30 years in North America, therefore it is difficult to accurately predict material and labour costs for this type of development. To estimate the capital construction costs, HDR developed a capital cost curve by plotting the construction costs of the three most recent WTE developments in North America (West Palm Beach County, FL [$2011], Durham-York Energy Centre [$2009], and H-Power Unit #3 Expansion [$2008]). The cost curve was created by normalizing the construction costs of each facility, then escalating these costs to $2024 using a three percent annual inflation rate. The cost curve was used to determine an appropriate cost per tonne per day to multiply by the estimated tonnage per day processing capacity of the conceptual Ottawa WTE facility to estimate its construction costs in $2024. The cost estimate prepared by HDR is considered an Association for the Advancement of Cost Engineering (AACE) Class 5 (-25% to +30% contingency) level estimate. **Table 3-6** presents these construction, engineering, and design costs for a facility sized to process 267,600 tonnes of waste per year. The cost estimate does not include the cost for the land, which was shown previously in **Table 3-5**.

Table 3-6: Mass Burn WTE Capital Construction Costs

Capital Costs	Percent of Total Construction Cost (%)	Estimated Construction Costs (CAD)
Construction Costs		
Waste Handling Equipment and Boilers[1]	34	$200,000,000
Turbine Generator	11	$67,500,000
Air Pollution Control[2]	19	$109,900,000
Electrical, Instrument, and Controls	7	$40,000,000
Mechanical Equipment[3]	7	$40,000,000
Sitework[4]	8	$50,000,000
Building and Structures	14	$84,700,000
Construction Subtotal	**89.3**	**$592,100,000**
Engineering and Design		
Engineering, Design, and Permitting	6	$35,526,000
Construction Development Documents	5	$29,605,000
Construction Administration and Construction Quality Assurance (CQA)	1	$5,921,000
Engineering and Design Subtotal[5]	**10.7**	**$71,000,000**
Total Construction Cost[6]	**100**	**$663,100,000**
Total with Low Contingency Range (-25%)		**$497,300,000**
Total with High Contingency Range (+30%)		**$862,000,000**

Notes:

1. Includes steam cycle, cooling tower, and circulation system.
2. Includes Selective Catalytic Reduction (SCR) for NOx control.
3. Includes metals recovery, compressor air, fire suppression systems, water, mobile equipment, and other equipment costs.
4. Includes clearing, grubbing, excavation, grading, roadways, and utilities installation.
5. Estimated construction costs are based on a facility sized to accept 267,600 tonnes per year in 2053.
6. Rounded to the nearest 100,000.

3.2.8.2 Operation & Maintenance Costs

The conceptual operation and maintenance (O&M) costs for the WTE facility options are shown in the below table. Note that the typical operational lifespan for a WTE is 30 years. However, with regular maintenance, a facility can exceed the typical lifespan.

O&M expenses consider subcategories of costs, including but not limited to operator payment, labour and supplies, utilities, and other pass-through costs, such as reagents, environmental testing, and insurance. O&M expenses do not typically include debt service, amortized capital costs, or capital reserve funding; however, they can contribute quite significantly to the cost of owning the facility, and HDR has included them in **Table 3-7** below as potential "Indirect Annual Operating Costs".

Table 3-7: Mass Burn WTE Annual Operating Costs

Operating Cost	Estimated Annual Operating Costs (CAD)	Cost per Tonne of MSW Processed (CAD)
Operator's Base Service Fee[1]	$22,700,000	$85
Pass-Through Costs and Utilities[2]	$4,100,000	$15
Other City Operating Costs[3]	$1,800,000	$7
Ash Hauling and Disposal[4]	$9,400,000	$35
Direct Annual Operating Costs	**$38,000,000**	**$142**
Annual Debt Service[5]	$39,500,000	$148
Indirect Annual Operating Costs	**$39,500,000**	**$148**
Estimated Annual O&M Costs[6]	**$77,500,000**	**$300**

Notes:

1. Assumes a base Operator Service Fee of $85 per tonne in first year based on similar size WTE facilities in North America and recent operating experience.
2. Costs include reagents such as hydrated lime, phosphoric acid, activated carbon, aqueous ammonia, and environmental testing and utilities such as purchased electricity, natural gas, water, and wastewater.
3. Costs include property and liability insurance and miscellaneous City costs such as labour, office supplies, permits, etc.
4. Based on 267,600 tonnes per year, approximately 22% ash generation rate and 1-2% rejected waste, and Tipping Fee & Disposal (T&D) of $150/tonne, plus an additional $10/tonne for hauling costs.
5. Assumes City will finance the project with a 30-year loan at an interest rate of 4.25% interest. Loan includes land acquisition costs.
7. Estimated O&M costs are based on a facility designed to accept and process 267,600 tonnes/year in 2053.

The cost to purchase electricity is typically offset by the sale of electricity. Revenues from the sale of electricity and other materials, namely ferrous and non-ferrous metal, are discussed in **Section 3.2.8.3**.

Unless the City chooses to self-operate this facility, most operating costs will likely be spent as a service fee payment to a private operator to operate and maintain the facility. This is similar to the DYEC, where the Region of Durham and Region of York currently pay Covanta Energy to operate the plant under a long-term service agreement. In this arrangement, the operator is typically responsible for all routine and major maintenance work and may also be responsible for a portion or all of any capital refurbishment or improvement work that is required, depending on the specific contract.

The City will also need to pay for reagents such as hydrated lime, activated carbon, and aqueous ammonia for emissions control. These items are typically paid for by the operator and submitted as a pass-through cost to the City.

The City will also need to pay for site utilities such as electricity used internally to run equipment and systems, water and sewer costs for makeup water, potentially cooling costs for the boilers and process equipment, and auxiliary fuel consumed during unit start up, shutdown, and the occasional upset conditions.

Transportation costs related to ash hauling have also been included in this estimate and assumes ash trailers will have a payload capacity of 24 tonnes. These costs can be affected depending on whether the City intends to self-haul recovered ash or pay a third-party to provide this service.

Property and liability insurance is a major cost that has increased significantly for WTE facilities in recent years. Phones, plant radios, internet, administrative supplies, and similar costs fall under the category of 'Other City Operating Costs'.

3.2.8.3 Revenues

Mass burn WTE facilities generate revenue from tipping fees, sale of excess electricity, and sale of recovered materials, typically ferrous and non-ferrous metals.

The tipping fees are the primary revenue sources for WTE facilities. For this study, the tipping fee was set to achieve a breakeven cost of operation. The WTE option could consider accepting waste from the IC&I sector or other sources at a higher tipping fee to help provide potential additional sources of revenue. A slightly larger facility capable of processing between 330,000-350,000 tonnes per year could also improve the financial viability of the project from a purely economy of scale standpoint. This is a common practice in the U.S. and U.K. but will not be considered as part of the proposed scenario for the purposes of this assessment.

A secondary revenue source for these facilities is the sale of recovered electricity. For purposes of this study, HDR estimates a gross power generation rate of 776 kilowatt hours (kWh) per tonne of waste processed and that 15% of that power will be used internally to self-power the facility. This results in approximately 660 kWh of energy per tonne of waste processed that can be exported to the grid. Depending on the negotiated price for electricity that the City can get from the Independent Electricity System Operator (IESO), this electrical revenue can provide a significant revenue source and offset some of the operating costs. The WTE option would also be capable of generating hot water that could be provided to the existing district energy network(s) in the City of Ottawa. Assuming the WTE facility is primarily designed for electricity generation and approximately 30 MW of thermal energy/hot water production, additional revenues as much as $20M annually as an upper limit of what could be possible given the project market rate for district energy in Ottawa. The possibilities for tying the WTE into a regional district energy system is explained in more detail in **Section 3.6.2**.

Recovery of ferrous and non-ferrous metals provides a tertiary revenue source. These metals can be recovered after the combustion process to be sold to end markets. Ferrous recovery is typically 3% to 4% of inbound tonnes (including metal recovery from pre-processing), and non-ferrous recovery is typically 0.3% to 0.5% of inbound tonnes. Potential revenues from the mass burn WTE options are shown in **Table 3-8**.

Table 3-8: Mass Burn WTE Annual Revenues

Revenue Stream	Estimated Annual Revenues (CAD)	Revenue per Tonne of MSW Processed (CAD)
Tipping Fees[1]	$0	$0
Ferrous Metals Recovery[2]	$830,000	$3
Non-Ferrous Metals Recovery[3]	$500,000	$2
Electricity [4]	$18,100,000	$68
Total Revenue[5]	**$19,430,000**	**$73**

Notes:

1. Assumes no revenue from tipping fees due to municipal collection.
2. Estimated $208 per tonne for ferrous metal and assumes 3% of processed tonnage is captured as ferrous metal. Assumes 50/50 split with Operator.
3. Estimated $949 per tonne for non-ferrous metal and assumes 0.4% of processed tonnage is captured non-ferrous. Assumes 50/50 split with Operator.
4. Total annual Electrical revenue is based on the City receiving 82% of the energy revenue, with a cost of purchased power at $0.125 per kWh and the sale of electricity at $0.125 per kWh.
5. Estimated revenues are based on a facility designed to accept up to 267,600 tonnes per year in 2053.

3.2.8.4 Summary of Net Operating Costs

Table 3-9 shows estimated net operating costs.

Table 3-9: Mass Burn WTE Net Operating Costs

Description	Estimated Annual Net Operating Costs (CAD)	Net Cost per Tonne of MSW Processed (CAD)
Revenue from Sale of Recovered Metals	($1,330,000)	($5)
Revenue from Sale of Electricity	($18,100,000)	($68)
Direct Operating Costs	$38,000,000	$142
Indirect Operating Costs	$39,500,000	$148
Total Annual Net Operating Cost	**$58,070,000**	**$227**

3.3 Mixed Waste Processing

3.3.1 Overview

MWP Facilities operate successfully in North America, with a more concentrated presence in California, USA and some examples in Canada (e.g. Edmonton, Alberta). Mixed waste processing facilities (MWPFs) are a well-proven technology, and various mechanical, pneumatic, optical, and automated processes are updated continually. This technology is being used more and more as a pre-processing step in preparing feedstock for other thermal, biological, and chemical processes. These facilities gained popularity to help combat low public participation rates of traditional recycling programs and minimize collection costs, such as collection of curbside source-separated recyclables and source-separated organics. MWPFs are now also being used as a pre-sorting operation prior to more advanced conversion technologies. MWPFs aim to capture specific materials based on the feedstock and market demand. Although MWPFs are well known and commercially available in the United States and parts of Canada, their financial viability is influenced by existing jurisdictional regulations (e.g. Resource Recovery Circular Economy Act [RRCEA]), existing recycling programs and, commodity recovery rates. In most cases, a high percentage of the inbound material ends up at process residuals and still requires disposal.

For the Ottawa area, a key component of the MWP consideration is that the City has an existing green bin program and leaf and yard program in place, but also that its blue box program will be transitioning over to the extended producer responsibility (EPR) model in 2026 where producers will be responsible for the recovery of their products. These existing successful programs remove a significant amount of the recoverable recyclables and organic waste that would normally be recovered by a MWP technology. Any collected and separated materials considered to be EPR material, compost, or leaf and yard waste should be transported to one of the City's approved facilities or an approved location disposal or for further processing. The MWP can address any remaining materials that either were not placed in the blue bin or captured in the green bin programs, but the potential return on investment and increase in recycling will need to be further analyzed compared to the capital and operating expense associated with the MWP facility. That analysis will be performed in the Feasibility Study and Business Case development and is not the focus of this technical memorandum. Further discussion with the EPR producers on cost recovery and transportation of collected blue box waste would be a discussion between the City and producers.

3.3.2 Technology Description

MWPFs are mechanical processing systems designed to recover recyclable commodities and, in some cases, organic waste from a mixed MSW stream. Various types of mechanical, optical, and density screening equipment, as well as manual labour, are used to open bags, sort materials by size and weight, and separate fiber, plastic, metal, and glass containers, organics, and other materials. The sorted materials are then baled (fiber, plastic, metal) or loaded (glass, wood, organics, scrap metal) into bins for transportation to recycling markets and the remaining residue is typically sent to the landfill, where in certain locations in the U.S. and Canada, it is used as alternative daily cover.

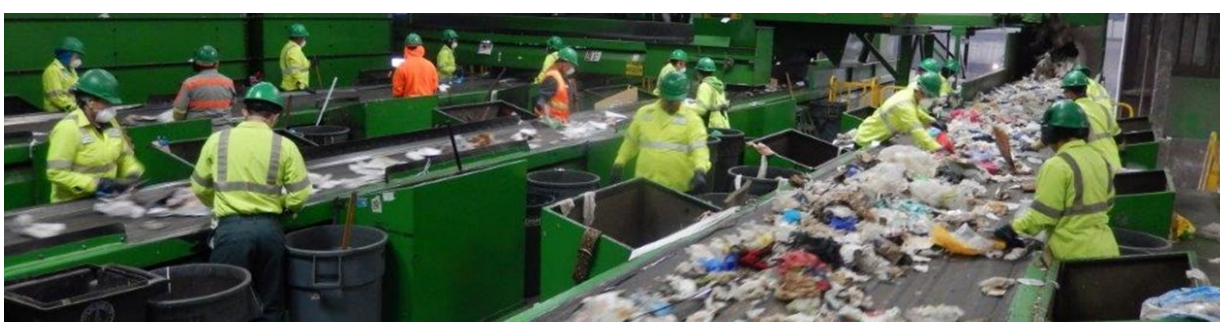
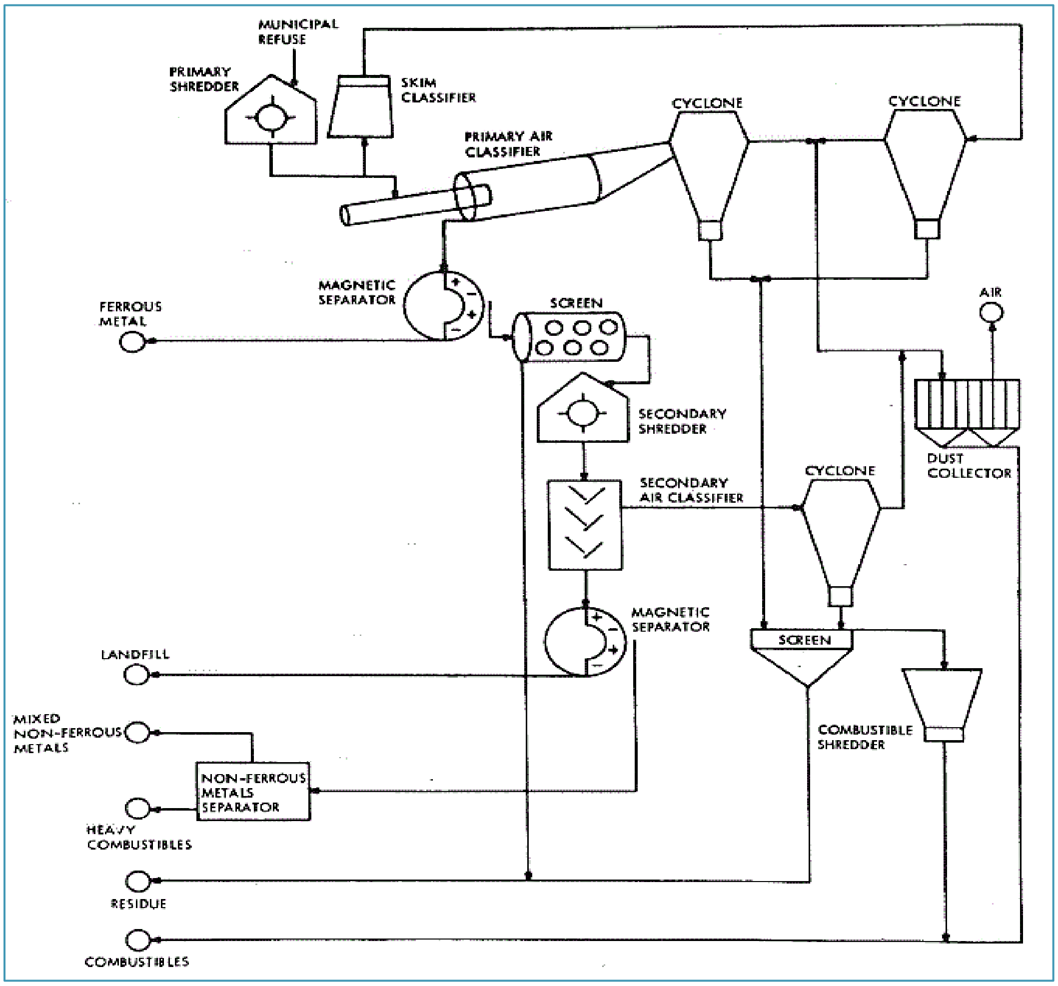


Photo: Manual Sorting Line, Greenwaste Materials Recovery Facility, San Jose, California, USA.

Table 3-7 represent the cross section of a MWPF that is designed to recover recyclable commodities and a solid recovered fuel (SRF) for further treatment by a WTE or thermal processing technology.

Figure 3-8: Section of a Typical MWPF



MWPFs were first introduced in the 1970s to capture higher calorific elements of MSW for use of combustion-based energy recovery systems, such as converted coal-fired facilities or dedicated WTE facilities. Today, MWP has gained interest as a means to address low participation rates for source-separated recycling collection systems and/or as a method to recover additional commodities and organics in the waste stream. In some cases, particularly in Europe, MWP is used to prepare feedstocks into a solid recovered fuel (or "SRF") for traditional WTE systems or alternative thermal conversion technologies. In theory, MWPF can give communities with lower recycling participation rates, the opportunity to divert additional commodities than has been demonstrated by the local curbside collection systems. Advances in technology, including the use of robots and artificial intelligence, has improved the amount and types of materials that can be recovered at modern MWPFs when compared to older versions of the technology.

Some MWPF vendors claim that their technology can recover up to 80% of the targeted commodities in the mixed MSW stream. However, in HDR's experience, most commercially operating MWPFs typically recover around 10 to 25% of materials for communities where source separation has not occurred and without considering organics, with some facilities achieving rates greater than 40% if there are suitable markets for products such as organics, lower value plastics, and recovered glass.

The reason for this very low recovery rate is largely due to the available equipment not being able to extract recyclables from the MSW stream and provide a clean enough product for recyclable markets. This anticipated recovery is usually from single waste streams without source separated recyclables. The typical capacity for MWPFs ranges from 200 to 1,500 TPD, and their lifespan can be 20 to 30 years with proper maintenance.

3.3.3 Facility Layout

The following provides brief descriptions of each component of a typical mixed waste processing facility technology and process flow diagram. Different equipment suppliers may alter the facility arrangement based upon their equipment offerings as well as the specific project needs.

- **Waste receiving equipment.** Mixed waste is received on the tipping floor and scanned for non-processible waste, usually consisting of oversized bulky waste and wastes that might damage or otherwise negatively impact downstream equipment and sorters. These non-processible waste can include large timbers, tree trunks, furniture, large metal objects, cables, and unacceptable waste. These materials are then pushed with a frontend loader onto a conveyor or to a temporary floor storage pile until it can be processed.

- **Bag opening and sizing.** Depending on the equipment supplier's preference, bag openers, shredders, or various types of screens, sometimes in combination, will be used to open and expose the contents of garbage bags and otherwise reduce the size of larger materials such as carboard boxes and containers. This step allows the contents of containers to be available for sorting and recovery and helps to protect downstream equipment from damage and plugging. In addition, smaller materials less than about five centimetres in size are generally separated to clean up the larger material. These smaller materials are rich in organics and may be sent to an organics recovery system or recovered at some facilities in other ways, such as alternative daily cover.

- **Organics processing equipment.** Some MWPFs, particularly on the west coast of the U.S., include equipment to target organics-rich materials, which may be as much as half of the feedstock by weight. These materials may be sent to an anaerobic digestion system or composting system, which is installed as a complementary part of the MWPF or as a standalone facility. The anaerobic digestion system may consist of a large drum or other vessel that slowly rotates or otherwise mixes the material providing retention time for generation of a biogas rich in methane in the contained environment that can be cleaned and sold as renewable natural gas or otherwise utilized. The remaining feedstock after gas generation can be converted into compost and made available as a soil amendment for non-agricultural and low contact applications or alternative daily cover at a landfill. The composting operation will require a high percentage of the site area due to the volume of material and time required to mature the compost. Glass and small metal or plastic objects, which may become separate products, are sometimes removed from the compost to increase its usability for soil amendment applications.

- **Sorting equipment.** The larger material from the sizing step is then sorted with various types of mechanical screens, optical sorters, robots, manual sorters, and other separation devices. Much of the paper and cardboard materials are likely too wet and contaminated for traditional recycling and can be sent to the organics processing system for recovery in the compost product. Some optical scanners may have the capability to distinguish and separate higher quality paper for recycling. Most of the recycled materials will consist of metals and plastics. These items are sorted with combinations of magnets, optical sorters, eddy current separators, robots, and possibly with manual sorters. The metals are usually sorted into magnet ferrous metals consisting of tin cans and small magnet metal items and nonferrous metals such as used beverage cans, aluminum foil, copper, and brass objects. Used beverage cans consist of a special grade of aluminum that commands a higher price if kept separate from other non-ferrous metals. Depending on the effectiveness of area recycling programs, the quantity of recyclables may be limited, but a high percentage of the available materials may be recovered.

- **Storage.** Storage occurs in three different areas of the facility. As noted above, materials are received in the tipping floor and unprocessed materials may be stored there until they can be processed. Captured recyclables are collected and stored in various types of bins until such time as enough of any one material has been collected to warrant baling. Recyclables may be conveyed to the bins or in some cases pneumatically blown to storage. Bins may be vertical expanded metal, bunkers, live bottom horizontal bins, and/or other types depending on the material contained and quantity recovered. Baled materials are stacked and stored until enough bales of a particular commodity are collected to allow for a full shipment as a truck or train carload of bales to the respective processing mill.

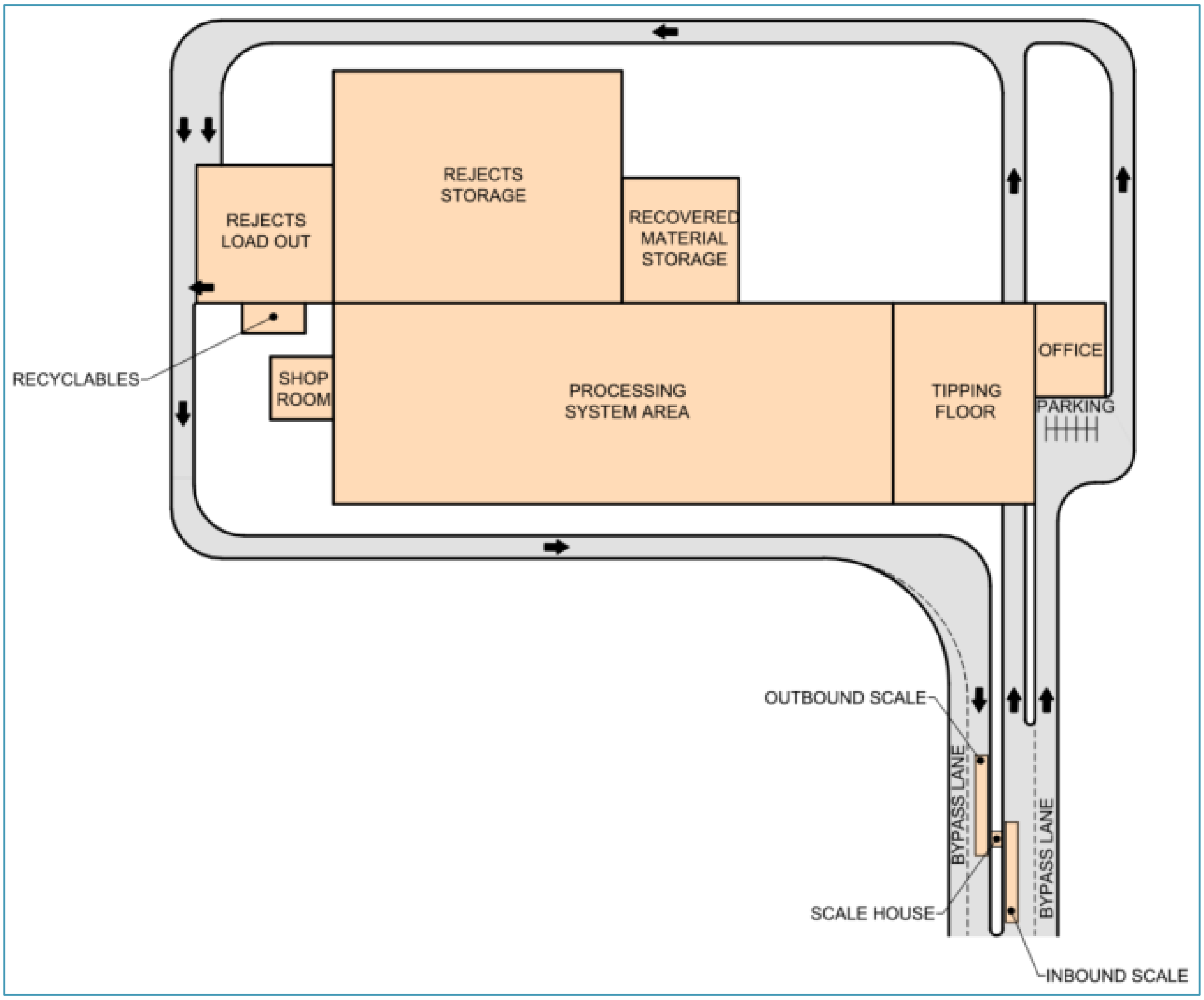
- **Baling.** Most of the recycled materials will be baled into large, compacted cubes to maximize density for shipping. Belt conveyors are arranged to individually allow any commodity to be fed onto the belt from the various bins. The baler will compress the commodity and will tie the bale that is formed with wires, plastic straps, or shrink wrap. Some products such as glass, compost, and sometimes scrap metal may be shipped in bulk without baling.

- **Residue Handling.** For a MWPF, significant material will remain after processing and recovery of commodities. Without organics recovery or use of the fines for landfill daily cover or similar uses, recovery may be limited to around 10 to 20% for a well-run facility. Organics processing can increase recovery to potentially 50% or more if composting markets are available. The remaining residue material may be stored in compactor bins, open top bins, bunkers, or loaded directly into trailers for removal from the facility. The residue may ultimately be taken to a WTE facility or landfill for management.

MWPFs require the following buildings on their campus, displayed in **Figure 3-8.**

- Scale House
- Administration Building/Office
- Tipping Floor
- Processing System Area
- Recovered Material Storage
- Rejects Storage
- Rejects Load Out Building
- Recyclables Building
- Shop Room

Figure 3-9: Typical MWPF Layout

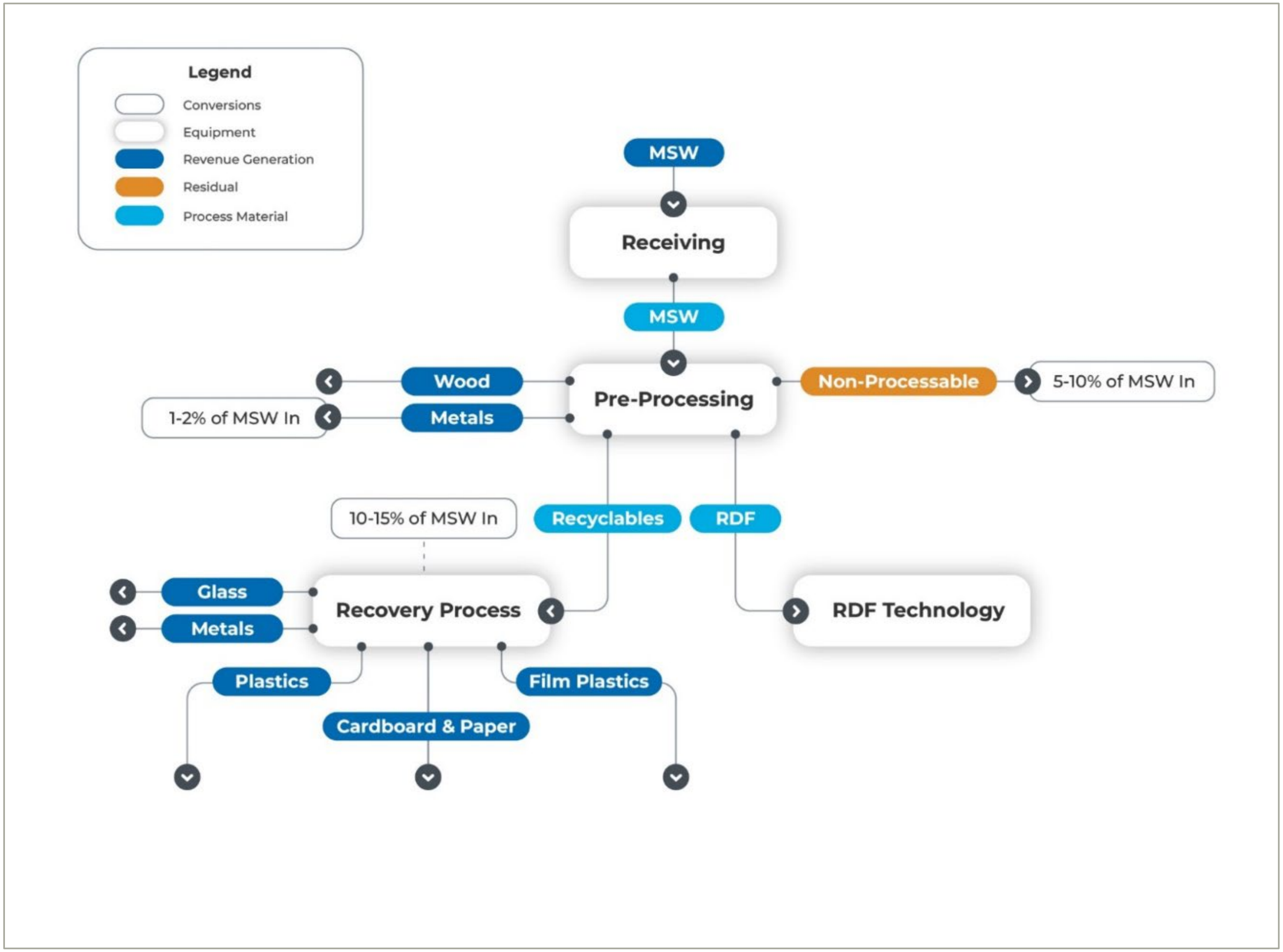


It is expected that a MWPF of this size would require between three (3) to five (5) hectares of land. Development of this site would take approximately five years. It is anticipated that the approvals, permitting, and siting process will require less time to implement the MWPF versus a WTE facility. The permit requirements and anticipated timing are discussed in more detail in Tech Memorandum #2.

The process in a MWPF involves receiving materials on a tipping floor, removing larger items manually or with equipment, and conveying the material to sort lines for separation. The facility can accept single stream recycling materials and prepare the recyclables for external end markets. The facility can process mixed paper, plastic, and metals and prepare the recyclables with the use of conveyor belts, sorting screens, optical sorters, and balers. Organics, which are typically a large fraction of incoming waste, can be processed and sold to organic processing facilities to further utilize waste received at the facility.

Figure 3-10 provides the typical process flow of a MWPF that is designed to develop a SRF or refuse derived fuel (RDF) for use in a thermal treatment plant like a WTE facility.

Figure 3-10: Flow Process of a MWPF



3.3.4 Facility Throughput and Diversion Potential

Depending on the success of the implementation of the diversion initiatives outlined in the SWMP, there is a range of waste tonnage that will need to be disposed of either by landfill or alternative option. **Table 3-10** presents the estimated waste generation rates and the corresponding design throughput estimation, based on these two bookend scenarios.

Table 3-10: MWP Waste Throughput

Category	Unit	No SWMP Diversion Impacts Realized	All SWMP Diversion Impacts Realized
Total Projected Waste Generation Rate[1]	Tonnes per year (TPY)	267,600	199,500
Initial Rejects[2]	TPY	26,800	19,950
Annual Design Throughput	TPY	240,800	179,550
Daily Design Throughput Capacity[3]	Tonnes per day (TPD)	800	600
Hourly Design Throughput Capacity[4]	Tonnes per hour (TPH)	63	47

Notes:

1. Waste and bulky waste tonnage projections for 2053 per the SWMP, no SSO waste included.
2. Assumes 10% of incoming material will be rejected. This will predominantly consist of construction and demolition materials.
3. Assumes 306 days per year operation.
4. Based on 2 shift operation and 7 processing hours per shift, plus 10% increase in sizing capacity.

Table 2-4 and **Table 2-5** within **Section 2.3.3** describe the different materials that were sorted and recorded during the 2019 Waste Audit. HDR applied those percentage breakdowns to the projected tonnage amount of 267,600 tonnes per year in 2053 to estimate the tonnage of recoverable material in the waste stream in 2053. These tonnages, as well as the assumed recovery rate, are displayed in **Table 3-11** below.

Table 3-11: MWP Recovery Potential – All Audit Categories

Commodity	Recovered Commodity (tonnes)	Estimated Recovery percentage of Commodity from Waste Stream	Percent of Waste Stream per 2019 Waste Audit	Recovery Rate Assumption[1]
Corrugated Containers	2,020	0.8%	1.3%	60.0%
Mixed Paper (general)	5,290	2.0%	6.6%	30.0%
Green Bin Waste[2]	0	0.0%	42.7%	0.0%
Yard Trimmings[2]	0	0.0%	1.6%	0.0%
HDPE	1,100	0.4%	0.8%	50.0%
PET	3,570	1.3%	2.7%	50.0%
Mixed Plastics[3]	0	0.0%	11.1%	0.0%
Aluminum Cans	820	0.3%	0.4%	75.0%
Steel Cans	1,610	0.6%	0.8%	75.0%
Mixed Metals	3,970	1.5%	2.0%	75.0%
Glass[4]	3,730	1.4%	2.8%	50.0%
Clay Bricks[5]	0	0.0%	3.0%	0.0%
Concrete[5]	0	0.0%	3.0%	0.0%
Dimensional Lumber[5]	0	0.0%	3.0%	0.0%
Mixed MSW[6]	0	0.0%	18.2%	0.0%
Diversion - Recyclables, TPY[7]	**22,100**	**8.3%**	**100.0%**	

Notes:
1 Based on HDR estimates and findings from jurisdictional scan.
2 Assumes no organic recovery; organic material will be treated as process residuals.
3 Assumes no market for mixed plastics (#3-#7); mixed plastics will be treated as process residuals.
4 Assumes 50% of glass will be recovered and diverted from a landfill.
5 Assumes C&D material received by this facility will be transferred to a landfill.
6 Assumes no recovery of the "mixed MSW" fraction of the waste stream.
7 Based on projected throughput of 267,600 tonnes in 2053, rounded to the nearest hundred.

As noted in the footnotes of **Table 3-11**, the assumption is being made that no residual organic materials in the waste stream will be removed at the MWP facility. Organics are generally small (less than 15 centimetres in diameter), so some form of screening would be necessary to extract the organic fraction out of the mixed waste. With appropriate additional screening equipment installed, the City may be able to recover 20% to 30% of these residual organics; however, there are limited markets for its reuse and even if 30% recovery was achieved, it would only increase the overall facility diversion to 20%.

The City has inquired if the organic materials recovered from a MWPF could be used as a supplemental feedstock for an anaerobic digestion (AD) facility. The organics recovered from a MWP system often contain tiny fragments of residue and other contaminants that make the biological conversion in an AD facility and reuse of the solid by-product (a.k.a. digestate) difficult to manage. The viability of using organics recovered from a MWP as a feedstock for an AD facility often depends on a lot of factors, including the type of digester, what is being done with the digestate, and what type of feedstock the digester is designed to accept. If the digester is dry or a plug flow type, then the organic stream pulled out of the MWP would have less impacts on the process and the contamination of the digestate and may be able to be added into the AD process. Others have found outlets for this product in agriculture and transportation applications, so there may be alternatives to using it as a feedstock for an AD facility, but it will be dependent on local markets.

Regarding mixed plastics, there is an increasing market for #5 plastics, and it could be reasonable to assume a percentage of that plastic type can be separated out using optical sorters. However, if there was a local market for it, it would not improve the economics of the MWP option in any significant way.

Regarding construction and demolition (C&D) material, this comprised approximately 9% of the garbage and bulky waste stream based on the 2019 waste audit results, with most of those materials being generated from residential households, likely from home improvement projects. We have assumed this material will be sorted out of the process on the front end of the system to the extent possible, as aggregate and gritty materials are quite abrasive and will wear down the process equipment and increase maintenance and repair costs. It is possible to add additional sorting equipment to pulverize the diverted C&D material for volume reduction or potential reclamation for C&D reuse initiatives, but it would not improve the economics of the MWP option in any significant way.

Regarding glass, this is a material that would make sense to remove from the process to the greatest extent possible, as there are alternative disposal outlets for recovered glass that would cost less than the assumed tonnage and disposal cost of $160 per tonne at a landfill. In the event there is a lack of a glass outlet, then the City would have to incur the full disposal costs. In addition, similar to C&D material, glass is extremely abrasive and will accelerate wear and tear on the equipment if left in the process.

Table 3-12 provides additional detail for the information provided in **Table 3-12** by grouping the individual waste constituents by material type.

Table 3-12: MWP Recovery Potential - Grouped by Commodity Type

Commodity	2053 Tonnage Projections (Tonnes)[1]	Percent of Waste	MWP Recovery Rate Assumption	Total Recovered Materials (Tonnes)
Fiber (Old Corrugated Containers [OCC] and /Mixed Paper)	21,008	7.9%	34.8%	7,314
Other Organics	118,795	44.4%	0.0%	0
Traditional Recyclables (#1 and #2 Plastics, Metals)	47,529	17.8%	23.3%	11,072
Glass	7,461	2.8%	50.0%	3,733
C&D Materials (Bricks, Concrete, Lumber)	23,797	8.9%	0.0%	0
Mixed MSW	49,009	18.3%	0.0%	0
Total[2]	**267,600**	**100.0%**	**-**	**22,100**

Notes:
1 Estimated tonnage of material based on 2019 waste audit composition, applied to a projected tonnage of 267,600 tonnes.

2 Rounded to the nearest hundred.

Table 3-13 summarizes the material flow through a conceptual MWP facility, based on the assumed recovery rates for the materials in the waste stream.

Table 3-13: MWP Summary of Material Flow

Category	Unit	No SWMP Diversion Impacts Realized
Incoming Material[1]	Tonnes per year (TPY)	267,600
Initial Rejects[2]	TPY	26,800
Processible Waste	TPY	240,800
Recovered Commodities[3]	TPY	22,110
Process Residue - (Total Tonnes to LF)[4]	TPY	245,490
Total Tonnes Diverted	TPY	22,110
Diversion Percentage	Percent (%)	8%

Notes:

1. Waste and bulky waste tonnage projections for 2053 per the SWMP, no SSO waste included.
2. Assumes around 10% of incoming material will be rejected, primarily C&D materials.
3. This tonnage will be variable based on changes in commodities pricing and local market opportunities.
4. Any material not recovered from the process and disposed at a landfill at an estimated transportation and disposal cost of $150 per tonne, plus a $10 per tonne hauling fee.

The City of Ottawa has well-established recycling programs for the separation and recovery of recyclable materials like blue box materials or household organics. For other types of waste, such as mixed waste, organics, mixed plastics, and C&D materials, there are fewer recycling facilities or markets that accept them for re-use and recycling. Furthermore, in HDR's experience, the quality of recovered organics tends to be a concern, as they can become contaminated; Ontario's Compost Quality Standards have stringent requirements that such organic materials may not meet.

Without a long-term viable option and end market for these materials, they inevitably end up at a landfill site for final disposal. As a result, the recovery of these materials at the MWP are not proposed, and an anticipated hauling and disposal rate of $160 per tonne is used to manage these materials.

Table 3-14 provides a breakdown of what comprises the process residual stream of the conceptual MWP. This material will be transported to a landfill for disposal at an assumed tonnage and disposal cost of $150 per tonne, plus an additional $10 per tonne for hauling costs.

Table 3-14: MWP Process Residue Breakdown

Process Waste	Tonnes Per Year	Assumed Residuals Percentage[1]
Contaminated or Unrecoverable Fiber	13,693	5%
Food Waste and Yard Trimmings	118,788	44%
Unrecovered Plastics	34,293	13%
Unrecovered Metals	2,134	1%
Glass	3,733	1%
C&D Material	23,763	9%
Mixed MSW	48,998	18%
Other	89	0%
Process Residue	245,490	92%

Notes:
1. Calculated as a percentage of the projected throughput of 267,600 tonnes per year in 2053.

3.3.5 Environmental Considerations

MWP facilities that transfer and process waste (without associated thermal treatment facilities) are subject to the Environmental Assessment Act (EAA), Environmental Protection Act (EPA), and Ontario Water Resources Act (OWRA) and their applicable regulations. These requirements are outlined in Technical Memorandum #2. A brief overview is provided below.

Under O. Regulation 50/24 of the EAA, a waste management facility that handles, transfers, or processes over 1,000 tonnes of waste per day on an annual average for final disposal would trigger an Environmental Screening Process (ESP), which is a streamlined environmental assessment process. Any material separated for recycling or further waste processing would not be counted within the amount of waste sent for final disposal. Based on the City of Ottawa's waste generation volumes and recycling rate, it is not expected that a MWP would trigger an environmental assessment process.

From an EPA perspective, a MWP would be required to apply and receive approval for an environmental compliance approval (ECA) for waste (transfer/processing) and sewage works (OWRA Section 53). Based on the air assessment for the site, the City may need to install an environmental control system for air emissions, which would require an ECA for air/noise under Section 9 of the EPA.

There are no specific regulations with design standards for MWP facilities that would apply. There are regulations with provisions (e.g., O.Reg. 347) that discuss general operations for the site that will need to be considered during operation. These are standard for all sites.

A more detailed description of the permissions required for the facility is outlined in HDR's Technical Memorandum #2 – Approvals and Siting.

3.3.5.1 Greenhouse Gas Impacts

MWP facilities separate MSW that has been collected by residents into materials that can be diverted and materials that can be landfilled. A recovered material stream, in general can be used in additional processes, though these are not addressed in this analysis since it has been assumed that the organics would go to landfill".

As part of a preliminary screening, HDR used the Environment and Climate Change Canada's (ECCC) Organic Waste GHG Calculator to estimate emissions for the MWP option to compare against landfilling and WTE solutions. The following key assumptions were used to inform the preliminary analysis:

- Due to the limitations of the tool, preliminary GHG emission results calculated from Environment and Climate Change Canada's Organic Waste GHG Calculator, Version 1.1 (February 2023) only includes direct anthropogenic emissions and avoided energy emissions. Avoided emissions from recycled materials are not captured, which underestimates the full lifecycle emissions for MWP.

- The current composition of total MSW stream is representative of future waste composition.

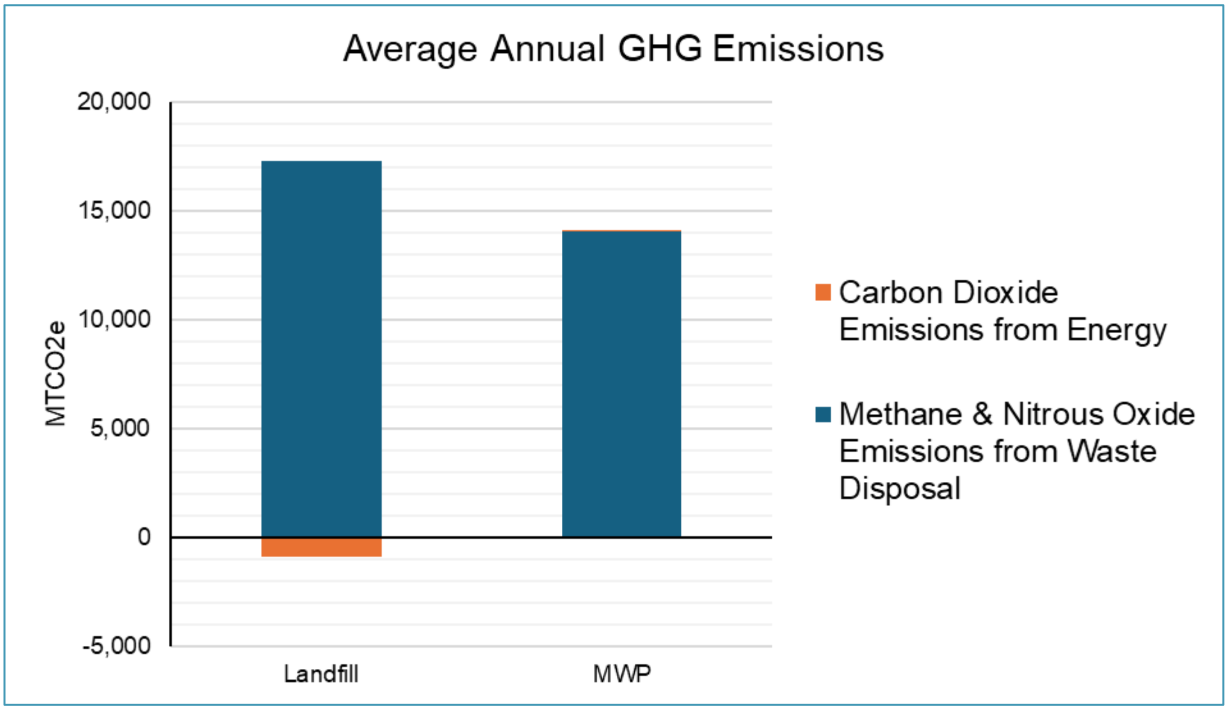
- MWP is able to divert roughly 8.3% of the MSW stream to recycling.

- No additional emissions from travel are included for transporting waste to newly constructed MWP facility, transporting process residue to landfill, or transporting recovered materials to end markets.

- Annual figures are representative of the average lifecycle emissions of producing the same quantity of waste over 30 years and do not reflect actual year-to-year variance resulting from estimated decay rates of materials or growth in waste volumes.

From initial review, a MWP facility is anticipated to reduce annual GHG emissions by roughly 15% relative to landfilling the City's remaining post-diverted waste.

Figure 3-11: Average Annual Greenhouse Gas (GHG) Emissions for MWP



3.3.6 MWP Implementation

A MWPF has a higher level of complexity to develop and operate than a transfer station and a standard material recovery facility but depending on the type of mechanical equipment and automated systems incorporated in the design, this type of facility would be expected to have a lower level of complexity than a WTE facility. Therefore, a MWPF could be owned and operated by the City, but the technical expertise, staffing, and equipment maintenance required to manage a facility of this size may be better suited for a private third-party operator. It should also be noted that the quality (i.e. contamination) of the recovered recyclables may impact the marketability of the recovered materials from a MWPF. As mentioned, the City has an existing blue box program that will be transitioned to the EPR program under the Resource Recovery and Circular Economy Act (RRCEA) and an existing green bin and leaf and yard program.

Since these programs are in place, HDR's analysis does not account for processing of source-separated curbside collected recycling, yard waste, or construction and demolition (C&D) at the MWPF. The feedstock may contain limited quantities of these materials, but if large quantities of any of these material flow there in the future, there would be a significant impact on the operations and cost due to limitations on tip floor and storage space, equipment design and layout, and additional hauling costs.

The level of complexity regarding siting and permitting is similar to a WTE facility and there would not need to be significant changes to the City's by-law. However, there may be challenges related to siting a facility from public or private sector stakeholders. In the past, MWPFs have been met with significant public resistance and private hauler objections due to concerns from local residences about traffic, noise, odours, and other concerns thought to impact property values and quality of life.

Similar to a transfer station, there are risks associated with the rising costs of transfer and disposal due to competition with existing longer-term hauling and disposal agreements from generators in the area (e.g., private haulers). Without a long-term offtake agreement for processed material, the same impact of tightening disposal capacity may drive the operational costs up significantly over time. Further analysis would be required to evaluate the long-term impact of rising disposal prices over the useful life of the facility.

Given the existing recycling program (blue box, green bin, and leaf and yard waste) in the City and expected capacity through the extended producer responsibility regime, the additional diversion benefits of a MWPF could be achieved through increased education, outreach, and compliance efforts as part of the existing recycling program. The City could realize an increased capture rate that is consistent with the amount of recyclables and diversion of waste that could be extracted by developing and operating a MWPF through sustained program compliance and by leveraging future EPR programs that are established.

3.3.7 Land Acquisition Costs

The City provided HDR with a high-level estimate for rural land values in support of a feasibility study for a proposed MWP facility. The valuation is subject to the following assumptions:

- The land in question is located in a rural setting outside of the outer urban area of Ottawa, with average-to-good access from major highways (416/417/7).
- The land would be serviced with private water and sewer services.

Based on these assumptions, a market value of $50,000 per hectare was determined for a roughly three (3) to five (5) hectare site. The value refers only to the market value of land and therefore does not include any other costs associated with preliminary site investigations and due diligence and land acquisition (e.g., real estate commissions, legal fees, land transfer taxes, environmental studies, etc.). Therefore, HDR has factored in these costs to the unit cost to account for those additional costs.

Table 3-15 shows the estimated land acquisition costs for a four-hectare site, which is a reasonably sized site for this size MWP facility.

Table 3-15: MWP Land Acquisition Costs

Land Acquisition Costs	Estimate # of Hectares	Estimated $ per Hectare (CAD)	Total Cost (CAD)
Land Acquisition	4	$100,000	$400,000

Note:

1. Estimate based on assumption of $50,000 CAD per hectare provided for a 4 ha site local in a rural area outside City of Ottawa with average or better access to major highways and with private water and sewer service, increased to account for preliminary site investigations and due diligence, real estate commissions, legal fees, or land transfer taxes.

3.3.8 Construction and Operating Costs

MWPFs typically have higher capital and operating costs than landfilling. However, other benefits such as increased landfill diversion and greenhouse gas impacts should be considered. In addition, a MWPF is expected to require a lower capital investment than a WTE Facility. This section presents the estimated capital and operating costs for a MWPF facility.

3.3.8.1 Capital Construction Costs

Table 3-16 presents the construction, engineering, and design costs prepared following an AACE Class 5 estimate with a contingency range of -25% to +30%.

Table 3-16: MWP Capital Construction Costs

Capital Cost	Percent of Total Construction Cost (%)	Estimated Capital Construction Costs (CAD)
Construction		
MWP Building[1]	35	$45,500,000
Equipment: Processing System[2]	26	$33,600,000
Equipment AI or Optical Sorters, Robotics[3]	15	$19,600,000
Equipment: Install and Start-Up[4]	8	$10,640,000
Dust Collection System	2	$2,800,000
Site Investigations	0.3	$350,000
Site Work[5]	1.3	$1,696,100
Site Utilities[6]	1.3	$1,680,000
Surveying	0.05	$56,000
Screening, Landscaping, Signage	0.1	$140,000
Fencing and Gates	0.1	$156,800
Construction Subtotal[10]	**90.1**	**$116,200,000**
Engineering and Design		
Engineering, Design, and Permitting	5	$6,400,000
Construction Development Documents	4.1	$5,340,000
Construction Administration and Construction Quality Assurance (CQA)[7]	1	$1,060,000
Engineering/Design Subtotal[9]	**9.9**	**$12,800,000**
Total Construction Cost	**100**	**$129,000,000**
Total Cost with Low Contingency Range (-25%)		**$96,800,000**
Total Cost with High Contingency Range (+30%)		**$167,700,000**

Notes:
1. Includes building, foundations, floors, HVAC.
2. Includes screens, magnets, eddy current, balers, etc.
3. 6-10 optical sorters & robotics.
4. 20% of vendor equipment cost.
5. Includes clearing, grubbing, excavation, grading, roadways, and drainage and erosion control.
6. Includes electricity, water, sewer, natur al gas and heating fuel, phone and internet.
7. 10% of construction costs.
8. 1% of construction costs.
9. Estimated construction costs are based on a facility sized to accept 267,600 tonnes per year in 2053.
10. Rounded to the nearest 100,000.

3.3.8.2 Operation & Maintenance Costs

The operation and maintenance costs for a MWP facility are shown in **Table 3-17**. It is assumed the facility would operate six days per week with a two-shift operation. Operational costs include a service fee paid to the company contracted to operate the facility, any pass-through and utility costs, and other costs such as City labour, permits, consulting fees, and property and liability insurance.

Table 3-17: MWP Annual Operating Costs

Operating Cost	Estimated Annual Costs (CAD)	Cost per Tonne of MSW Processed (CAD)
Operator Base Service Fee[1]	$20,640,000	$77
Pass-Through Costs and Utilities[2]	$729,000	$3
Other City Operating Costs[3]	$1,970,000	$7
Disposal of Process Residuals[4]	$39,280,000	$147
Direct Annual Operating Costs	**$62,620,000**	**$234**
Annual Debt Service[5]	$7,710,000	$29
Indirect Annual Operating Costs	**$7,710,000**	**$29**
Estimated Total Annual Operating Costs[7]	**$77,230,000**	**$263**

Notes:

1. Assumes a base operator fee of $77 per tonne waste received.
2. Estimated pass through costs and utilities such as electricity, water, sewer, natural gas and heating fuel, and phone and internet.
3. Costs include property and liability insurance, City labour, office supplies, consulting fees, permits, etc.
4. Based on the disposal of 245,490 T&D of process residuals at a T&D cost of $150 per tonne, plus an additional $10/tonne for hauling costs.
5. Assumes City will finance the project with a 30-year loan at an interest rate of 4.25% interest. Loan includes land acquisition costs.
6. Annual reserve calculated based on a 15-year replacement life of processing equipment, 30-year replacement life of building, and 2% of direct operating costs.
7. Estimated annual operations and maintenance costs based on operating at full capacity at a design throughput of 267,600 tonnes per year.

3.3.8.3 Revenues

MWPFs generate revenue from tipping fees and the sale of recovered materials, typically ferrous and non-ferrous metals, and recyclables.

The tipping fees are the primary revenue sources for MWPFs. For this study, the tipping fee was set to achieve a breakeven cost of operation.

Recovery of materials provides a secondary revenue source. The sorting process can recover recycled materials from the municipal solid waste to be sold to end markets. Recovery rates will vary by material type.

Potential revenues from the MWPF options are shown in **Table 3-18**.

Table 3-18: MWP Potential Annual Revenues From Sale of Recovered Commodities

Recovered Recyclables	Quantity Recovered (Tonnes)	Unit Price (CAD)	Annual Revenue (CAD)
Corrugated Containers	2,020	$77	$157,000
Mixed Paper (General)	5290	$46	$245,000
Green Bin Waste[1]	0	$0	$0
Yard Trimmings[1]	0	$0	$0
HDPE	1,100	$725	$797,000
PET	3570	$370	$1,324,000
Mixed Plastics[2]	0	$31	$0
Aluminum Cans	820	$1,265	$1,044,000
Steel Cans	1,610	$278	$447,000
Mixed Metals	3970	$231	$920,000
Glass[3]	3,730	($77)	($288,000)
Clay Bricks[4]	0	$0	$0
Concrete[4]	0	$0	$0
Dimensional Lumber[4]	0	$0	$0
Mixed MSW[5]	0	$0	$0
Total Revenue from Recovered Commodities[6]	**22,100**	**$210**	**$4,650,000**

Notes:
1. Assumes no organic recovery; organic material will be treated as process residuals.
2. Assumes no market for mixed plastics (#3 through #7); mixed plastics will be treated as process residuals.
3. Assumes 50% of glass will be recovered and diverted from a landfill.
4. Assumes C&D material received by this facility will be transferred to a landfill.
5. Assumes no recovery of the "mixed MSW" fraction of the waste stream.
6. Based on projected design throughput of 267,600 tonnes in 2053, annual revenue rounded to the nearest 10,000.

Table 3-19 displays the total annual revenues from a MWP facility.

Table 3-19: MWP Annual Revenues

Category	Estimated Annual Revenues (CAD)	Revenue per Tonne of MSW Processed (CAD)
Tipping Fees[1]	$0	$0
Annual Revenue from Sale of Commodities	$4,650,000	$17
Total Annual Revenue	**$4,650,000**	**$17**

Note:
1. Assumes no revenue from tipping fees due to municipal collection

3.3.8.4 Summary of Net Operating Costs

Table 3-20 shows estimated Net Operating Costs.

Table 3-20: MWP Net Operating Costs

Description	Estimated Annual Net Operating Costs (CAD)	Net Cost per Tonne of MSW Processed (CAD)
Revenue from Sale of Commodities	($4,650,000)	($17)
Direct Operating Costs	$62,620,000	$234
Indirect Operating Costs	$7,700,000	$29
Total Annual Net Operating Cost	**$65,670,000**	**$246**

3.4 MWP and WTE

HDR evaluated a fourth option that consisted of a combined MWP and WTE facility co-located on the same site. The main benefit of this option is to maximize recovery of commodities that still have market value, as well as maximizing diversion from landfill. In this option, any material that is rejected from the MWP facility (process rejects) or not recovered as a commodity as part of the MWP process (process residuals) will be processed at a WTE facility instead of the landfill. HDR has assumed that the WTE facility would be co-located on the same property as the MWP facility, which would minimize the transportation costs and emissions associated with transporting the MWP process residuals and process rejects to the WTE operation.

Please refer to **Section 3.1** and **Section 3.3** for more details on the technical and environmental considerations of the MWP and WTE technologies.

In this option, waste would be delivered to a receiving and tipping building, and waste that is not acceptable for the MWP (predominantly bulky waste and residential C&D materials) will be removed and sent to the WTE facility or transported off-site to a landfill. The remaining material stream will continue through the processing train, and various mechanical and optical sorting equipment will remove recoverable commodities. Please refer to **Table 3-11** and **Table 3-12** for a breakdown of the commodities and commodity recovery rates that were estimated from a MWP operation, as they remain the same for this option.

The non-processible waste from the MWP facility (removed at the front end) and the process residuals stream (removed at the back end) make up the feedstock for the WTE process. This is approximately 92% of the initial material stream by weight, which means that the WTE could be designed for a slightly lower throughput capacity. However, consideration should be given to the fact that the characteristics and tonnage of what comes out of the MWP operation can vary depending on changes made to the MWP process, incoming waste stream, and recycling market economics. For the purposes of sizing and costing the WTE portion of this facility, HDR has assumed an 8% reduction in tonnage through the WTE facility.

Table 3-21 displays the tonnage flow and diversion potential of a combined MWP and WTE facility.

Table 3-21: MWP and WTE Material Flow and Diversion Potential

Category	Unit	Diversion Impacts Realized
Incoming Material[1]	Tonnes per year (TPY)	267,600
MWP Recovered Materials[2]	TPY	22,100
MWP Process Residuals to WTE[3]	**TPY**	**245,500**
WTE Process Rejects[4]	TPY	2,500
WTE Processible Waste	**TPY**	**243,000**
WTE Ferrous Metal Recovery[5]	TPY	7,300
WTE Non-Ferrous Metal Recovery[6]	TPY	1,000
Total Material Recovered	**TPY**	**30,400**
WTE Ash Generation[7]	TPY	53,500
Total Tonnes to Landfill	TPY	56,000
Total Tonnes Diverted[8]	**TPY**	**212,000**
Diversion Percentage	**Percent (%)**	**79%**

Notes:
1. Garbage and bulky waste tonnage projections for 2053 per the SWMP, no SSO waste included.
2. Refer to Table 3-10 through 3-13 for more detail on MWP commodities.
3. Includes around 10% of incoming waste diverted from MWP as non-processible for the MWP operation (mainly consisting of bulky waste and residential C&D materials).
4. Assumes around 1% of material incoming to the WTE facility will be rejected.
5. Estimated at 3% of WTE Processible Waste tonnage.
6. Estimated at 0.4% of WTE Processible Waste tonnage.
7. Calculated based on 22% ash generation rate on portion of waste that is processed at the WTE facility.
8. Rounded to nearest thousand.

The following five tables (**Table 3-22** through **Table 3-26**) display the estimated capital and annual operating costs of a combined MWP and WTE facility.

Table 3-22: MWP and WTE Land Acquisition Costs

Land Acquisition Costs	Estimate # of Hectares	Estimated $ per Hectare	Total Cost
Land Acquisition	8	$100,000	$800,000

Note:
1. Estimate based on assumption of $50,000 CAD per hectare provided for a 8 ha site local in a rural area outside City of Ottawa with average or better access to major highways and with private water and sewer service, increased to account for preliminary site investigations and due diligence, real estate commissions, legal fees, or land transfer taxes.

Table 3-23: MWP and WTE Capital Construction Costs

Capital Cost	Percent of Total Construction Cost (%)	Estimated Capital Construction Costs (CAD)
Construction		
MWP Facility Construction[1]	15.7	$116,200,000
WTE Facility Construction[2]	76.4	$566,700,000
3% discount to account for cost savings from development of combined infrastructure/shared equipment/systems	-2.8	($20,487,000)
Construction Subtotal	**89.3**	**$662,410,000**
Engineering and Design		
Engineering, Design, and Permitting	5.4	$39,750,000
Construction Development Documents	4.5	$33,140,000
Construction Administration and Construction Quality Assurance (CQA)	0.9	$6,600,000
Engineering/Design Subtotal	**10.7**	**$79,490,000**
Total Construction Cost	**100**	**$741,900,000**
Total Cost with Low Contingency Range (-25%)		**$556,400,000**
Total Cost with High Contingency Range (+30%)		**$964,500,000**

Notes:
1. See Table 3-16 for detailed breakdown of costs.
2. Capital construction costs reduced as a result of 9% decrease in throughput from MWP diversion.
3. 12% of construction subtotal.

Table 3-24: MWP and WTE Annual Operating Costs

Operating Cost	Estimated Annual Costs (CAD)	Cost per Tonne of MSW Processed[11]
MWP Operator Base Service Fee[1]	$21,440,000	$80
MWP Pass-Through Costs & Utilities[2]	$730,000	$3
Other City Operating Costs for MWP Operation[3]	$1,970,000	$7
Direct Annual Operating Costs for MWP[4]	**$24,140,000**	**$90**
WTE Operator Base Service Fee[5]	$22,750,000	$85
Pass-Through Costs & Utilities[6]	$4,010,000	$15
Ash Disposal and Hauling[7]	$9,370,000	$35
Other City Operating Costs for WTE Operation[8]	$1,870,000	$7
Direct Annual Operating Costs for WTE[4]	**$38,000,000**	**$142**
Annual Debt Service[9]	$43,800,000	$164
Indirect Annual Operating Costs	**$43,800,000**	**$164**
Estimated Total Annual Operating Costs[10]	**$105,940,000**	**$396**

Notes:
1. Assumes a base operator fee of $80 per tonne waste received, increased slightly compared to MWP option to account for transportation of MWP rejects and process residuals to co-located WTE facility.

2. Estimated pass-through costs and utilities such as electricity, water and sewer, natural gas and heating fuel, and phone and internet.
3. Costs include property and liability insurance, City labour, office supplies, consulting fees, permits, etc.
4. Assumes MWP and WTE are co-located on same site.
5. Assumes a base Operator Service Fee of $85 per tonne of waste processed in first year.
6. Costs include reagents such as hydrated lime, phosphoric acid, activated carbon, aqueous ammonia, and environmental testing and utilities such as purchased electricity, natural gas, water, and wastewater.
7. Based on 243,000 tonnes per year processed at WTE facility with a 22% ash generation rate and T&D of $150 per tonne, plus an additional $10/tonne for hauling.
8. Costs include property and liability insurance, City labour, office supplies, consulting fees, permits, etc.
9. Assumes City will finance the project with a 30-year loan at an interest rate of 4.25% interest. Loan includes land acquisition costs.
10. Estimated annual operations and maintenance costs based on full capacity throughput of 267,600 tonnes/year. Rounded to the nearest 100,000.
11. Cost per tonne of MSW processed is based on a total facility throughput of 267,600 TPY in 2053.

Table 3-25: MWP and WTE Annual Revenues

Description	Estimated Annual Revenues (CAD)	Revenue per Tonne of MSW Processed (CAD)
Tipping Fees[1]	$0	$0
Revenue from Sale of MWP Commodities[2]	$4,650,000	$17
Ferrous Metals Recovery[3]	$760,000	$3
Non-Ferrous Metals Recovery[4]	$470,000	$2
Sale of Electricity[5]	$16,530,000	$62
Total Revenue	**$22,410,000**	**$84**

Notes:
1. Assumes no revenue from tipping fees due to municipal collection.
2. Refer to Table 3-18 for MWP commodity revenue assumptions.
3. Estimated $208/tonne for ferrous metal and assumes 3% of processed tonnage is captured as ferrous metal. Assumes 50/50 split with Operator.
4. Estimated $949/tonne for non-ferrous metal and assumes 0.4% of processed tonnage is captured non-ferrous. Assumes 50/50 split with Operator.
5. Total annual Electrical revenue based on the County receiving 82% of the energy revenue, with a cost of purchased power at $0.125/kWh and the sale of electricity at $0.125/kWh

Table 3-26: MWP and WTE Net Operating Costs

Description	Estimated Annual Net Operating Costs (CAD)	Net Costs per Tonne of MSW Processed (CAD)
Revenue from Sale of Recovered MWP Commodities	($4,650,000)	($17)
Revenue from Sale of Recovered Metals	($1,230,000)	($5)
Revenue from Sale of Electricity	($16,530,000)	($62)
Direct Operating Costs	$62,140,000	$232
Indirect Operating Costs	$43,800,000	$164
Total Annual Net Operating Cost	**$83,530,000**	**$312**

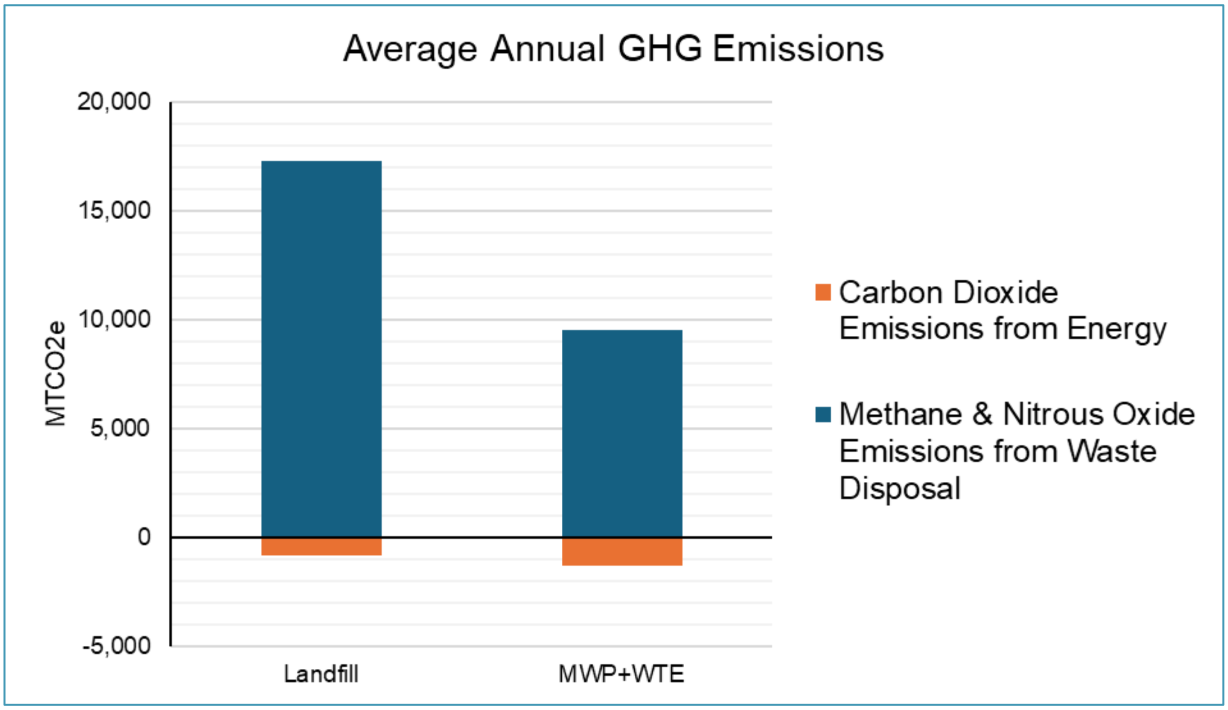
3.4.1 GHG Impacts

As part of a preliminary screening, HDR used the Environment and Climate Change Canada's (ECCC) Organic Waste GHG Calculator to estimate emissions for the MWP and WTE option to compare against landfilling, MWP-only, and WTE-only solutions. The following key assumptions were used to inform the preliminary analysis:

- Due to the limitations of the tool, preliminary GHG emission results calculated from Environment and Climate Change Canada's Organic Waste GHG Calculator, Version 1.1 (February 2023) only includes direct anthropogenic emissions and avoided energy emissions. Avoided emissions from recycled materials are not captured, which underestimates the full lifecycle emissions for MWP.
- The current composition of total Municipal Solid Waste (MSW) stream is representative of future waste composition.
- MWP can divert roughly 8.3% of the MSW stream to recycling. Of the remaining volumes, 99% is incinerated by the WTE facility. Waste volumes not recycled or incinerated are landfilled.
- No additional emissions from travel are included for transporting waste to newly constructed MWP facility, transporting process residue or ash to landfill, or transporting recovered materials to end markets.
- Annual figures are representative of the average lifecycle emissions of producing the same quantity of waste over 30 years, and do not reflect actual year-to-year variance resulting from estimated decay rates of materials or growth in waste volumes.

From initial review, the MWP plus WTE facility option is anticipated to reduce annual GHG emissions by roughly 50% relative to landfilling the City's remaining post-diversion waste. Further refinement of the estimations will be undertaken as a component of the Feasibility Study.

Figure 3-12: Average Annual Greenhouse Gas (GHG) Emissions for WTE and MWP



3.5 New MSW Landfill

This section is intended to provide a general overview of landfilling technology and the general requirements and costs associated with constructing a new MSW landfill within the City of Ottawa. Landfill options were evaluated as part of the SWMP and will be further evaluated as part of the final Feasibility Study. As noted previously, the five options being considered by the Feasibility Study will all require some landfill disposal component, whether for residual non-processible wastes, rejects, or incinerator bottom ash.

3.5.1 Overview

Landfilling of untreated solid wastes is the most common commercially demonstrated method of waste disposal in the world. Landfilling involves the placement of waste into lined landfill cells, which provides hydraulic isolation from the groundwater below and provides daily cover material (e.g., dirt, sand, ash) to prevent the blowing of loose material and litter. Liner systems are also designed to prevent the uncontrolled migration of gases that are created during the decomposition of the organic fraction in the MSW. Landfilling is considered an established disposal technology and would be required in some capacity no matter which of the technology options, WTE and/or MWP, would be implemented by the City, since both technologies would generate some residual stream(s) requiring disposal (e.g., incinerator bottom ash, non-processible waste, etc.).

All new landfills and expanding landfills are required to meet Ontario's stringent landfill design requirements outlined in O.Reg. 232.98 – Landfill Sites made under the EPA. The regulation details the requirements for the design, operation, closure, and post-closure care of municipal (i.e., non-hazardous) waste landfilling sites (whether privately or publicly owned). The regulation sets requirements for the following:

- Design specifications for groundwater protection, including a site-specific design option and two generic design options;
- Mandatory air emissions control for landfill gas collection for sites larger than 1.5 million cubic metres;
- The assessment of groundwater and surface water conditions;
- Design requirements for buffer areas, final cover design, surface water, and landfill gas control, and the preparation of a site design report;
- Operation and monitoring requirements for site preparation, groundwater and surface water monitoring, daily cover, record keeping, and reporting;
- Requirements for a leachate contingency plan;
- Site closure and post-closure care provisions; and
- Financial assurance requirements for private sector landfills.

The regulation does not specific any one approach for landfill design, as the regulation allows for site-specific designs (e.g., engineered or natural attenuation) or one of the two generic design concepts outlined in the regulation. It can be summarized that the goals of the regulation are to:

- Ensure landfills are designed for groundwater and surface water protection;
- Minimize impacts to the environment from site operations; and
- To facilitate site closure and post-closure care.

As a general overview, there are some components that are key for consideration:

With regards to the base of the landfill, the regulation outlines the design criteria for the engineered landfill and generic site designs. In general, clay liners are typical for engineered landfills. However, there have been movements towards accepting alternative clay liners (geosynthetic clay liners). The City would have to demonstrate that the design is protective of the environment. Key concepts within the regulation are understanding the hydrogeology behind the groundwater that will allow for environmental monitoring and a realistic contingency plan should the landfill discharge to the natural environment.

New landfills or expanding landfills (as outlined in O. Reg. 232/98 - Landfill Sites) must have a plan to manage leachate at the site. For engineered sites, this involves the installation and operation of a leachate collection system. Typically, leachate is collected and conveyed to on-site storage tanks where it is treated at an on-site leachate treatment facility. Leachate management must occur throughout the site's contaminating lifespan which is typically decades.

A requirement for new landfill sites is the collection of landfill gas for any new sites with a volumetric capacity greater than 1.5 million cubic metres. Landfill gas is typically around 50% methane and 50% carbon dioxide and water vapor, by volume. Trace amounts of nitrogen, oxygen, hydrogen, non-methane organic compounds (NMOCs), and inorganic compounds are also present. Some of these compounds are the source of odours.

Landfill gas (LFG) is generated from a landfill as the organic material in the landfill decomposes. The amount and composition of the LFG produced varies greatly according to the characteristics of the waste placed in the landfill and the climate at the landfill location. Factors that have the greatest impact on the LFG produced include waste composition (e.g., organic content, age), oxygen levels, moisture content, and temperature, which can be influenced by climate. Emissions can be reduced through the installation of an efficient LFG collection system and then flaring the LFG or combusting it in an internal combustion to produce energy in the form of electricity. Whereas the regulations (Reg. 347 and O.Reg. 232) imply all LFG should be captured, for design purposes, proponents generally design LFG treatment facilities to manage 85% of the peak landfill gas generation rate (due to losses in the system). Trail has typically been able to capture over 90% anticipated /modelled generation rates for landfill gas. In Ontario, there are approximately 30 sites that are regulated to have LFG collection systems. Recently, there has been a renewed interest in capturing the LFG for refinement and distribution directly into a gas transmission system. This form of LFG is known as renewable natural gas (RNG).

3.5.2 Typical Layout

The following provides brief descriptions of each component of a typical solid waste landfill disposal site and process flow diagram:

Waste receiving and scale house. Waste is received and weighed at the scale house where the truck weight is recorded. Most facilities include both inbound and outbound scales which can either include scale attendants or automated systems to record truck loads and tare weights. Many landfills also include radioactive monitors to detect if the waste load contains any low-level radioactive materials.

- **Stage** – The stage, is the development of a portion of the landfill site that includes a distinct landfill base and final closure grades and may consist of one, two, or many more cells. A landfill may be developed in stages over time with separation between each phase, or in some cases the stages can be contiguous.

- **Cell** – The cell is a discreet portion of a stage of development with its own lined boundary and leachate collection and removal system to provide operational separation from adjacent cells. Cells are typically constructed independent of one another and abut and tie in to adjoining cells. Cell sizes can range from roughly two to 10 hectares and are based on the volume and life that each provides, what can reasonably be constructed in a single season, and leachate and stormwater management considerations. Some landfills may include cells that are dedicated to specific waste materials, such as C&D waste or ash residue.

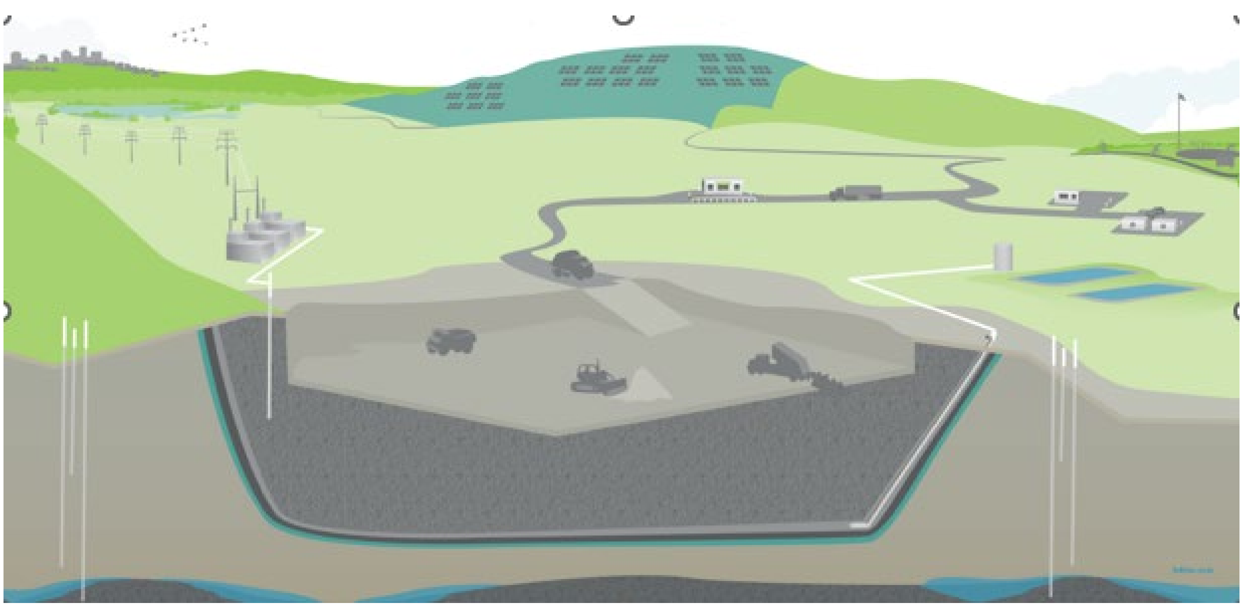
- **Liner system** – O. Regulation 232/98 sets out the stringent design standards for landfills. Landfills must clearly demonstrate that the design requirements can be achieved, and that environment and human health will be protected. In Ontario, the regulation permits for natural attenuation landfills and engineered landfills. Natural attenuation landfills utilize the capacities of the existing soils and environment to limit and manage leachate that will be generated at the site. Typically, there are no engineered controls for natural attenuation sites. For engineered landfills, typically a clay base liner system is utilized to ensure that the concentration values of certain parameters listed in the regulations will not be exceeded in the uppermost aquifer at the relevant point of compliance. Liner systems need to be completed with a composite liner and include a leachate collection system that is designed to limit the amount of leachate over the liner. Most composite liners consist of two main components: the upper component and the lower component.

- **Liquids management system.** Leachate is generated because of the percolation of water through the waste and the compression of the waste under its own load. The leachate management system includes all facilities, either existing or proposed, that are required for the collection, storage, treatment, and disposal of leachate generated within the Landfill. The collection and removal of leachate within the cell is accomplished by a system of perforated high-density polyethylene (HDPE) pipes installed within gravel-filled trenches.

- **Landfill gas collection and management system.** LFG is generated from a landfill as the organic material in the landfill decomposes. LFG emissions are controlled through the installation of a collection system, and then by either flaring (burning) the LFG or combusting the gas directly in an internal combustion engine generator system to produce electricity. A typical modern landfill gas collection system that collects over 85% of the generated landfill gas at a site is considered a well-operated system.

Figure 3-13 provides a typical layout and cross section of a modern sanitary landfill.

Figure 3-13: Typical Cross Section of a MSW Sanitary Landfill



3.5.3 Facility Sizing

In Ontario, waste management planning plays a significant role in estimating the size of a landfill. Generally, 25 years is considered the appropriate planning period for municipalities when planning their long-term waste management options. An estimated long term waste management estimate is calculated by assessing the population (including growth over that 25-year period), the volume of waste per person typically generated, and any potential diversion programs that may be implemented within that time. Based on these factors, a realistic estimate of the waste management needs on a yearly basis and throughout the planning period can be estimated.

In Ontario, the application of daily cover is a key approach to manage litter, odours, and leachate generation. Typically, available soil is utilized as daily cover. For the purposes of estimating the amount of daily cover required throughout the planning period, the MECP generally accepts that 20% of the landfill airspace will be daily cover (a 4:1 ratio of waste to daily cover).

To estimate the volumetric airspace required for the landfill, the municipality will take the sum of the waste and daily cover.

The land requirements for a landfill vary, but based on recent landfill approvals in Ontario, the land requirements are expected to be between 100 and 200 hectares.

To better manage the site and the cost expenditures needed to develop the site, the landfill is typically divided up into stages, which allow for applicable systems of the landfill to be developed over time (e.g., liners, leachate collection systems and landfill gas collection systems). The costs for this will then be amortized over a longer period, and tipping fees collected during each stage can support the costs of construction for the next stage.

The remaining life of existing active stages is typically calculated by comparing three surfaces to each other: the top of the protective cover (if not already filled over), existing topography, and the proposed final intermediate filling grades. Once the remaining capacity of existing and proposed cells is determined, the remaining and projected life can be calculated.

Airspace utilization factor or waste density is determined or estimated on the volume consumed by waste and soil cover materials per tonne of waste disposed in that volume. Waste placement in areas with appreciable waste depths can reduce the airspace consumed due to consolidation of the underlying waste materials. The available waste capacity is calculated from the total airspace for each development area less the estimated volumes of base liner and final cover systems.

3.5.4 Environmental Considerations

New landfills are subject to the EAA, EPA, and the OWRA and their applicable regulations (e.g., O.Reg. 232/98 – Landfill Sites). These requirements are outlined in Technical Memorandum #2. A brief overview is provided below,

Under Section 50/24 under the EAA, a new landfill with a volumetric capacity of over 100,000 cubic metres would trigger a Comprehensive Environmental Assessment (CEA) process.

From an EPA perspective, the new landfill would be required to apply and receive approval for an ECA for waste (disposal) (air emissions both under the EPA and sewage works under the OWRA. The air approval would be required for destruction unit (flare) for the landfill gas collection system.

Any new landfill would have to demonstrate that a site would meet Ontario's stringent landfill standards (as outlined in O.Reg. 232 – Landfills). The standards apply to all new or expanding municipal (non-hazardous) waste landfilling sites larger than 40,000 cubic metres. Key aspects of the regulation include:

- design specifications for groundwater protection, including a site-specific design option and two generic design options;
- mandatory air emissions control for landfill gas collection systems for sites larger than 1.5 million cubic metres;
- the assessment of groundwater and surface water conditions, which need to be clearly understood and a have a realistic contingency plan should the groundwater protection system fail;
- design requirements for buffer areas, final cover design, surface water, leachate management, and landfill gas control, and the preparation of a site design report;
- operation and monitoring requirements for site preparation, groundwater and surface water monitoring, daily cover, record keeping, and reporting;
- requirements for a leachate contingency plan; and,
- site closure and post-closure care provisions.

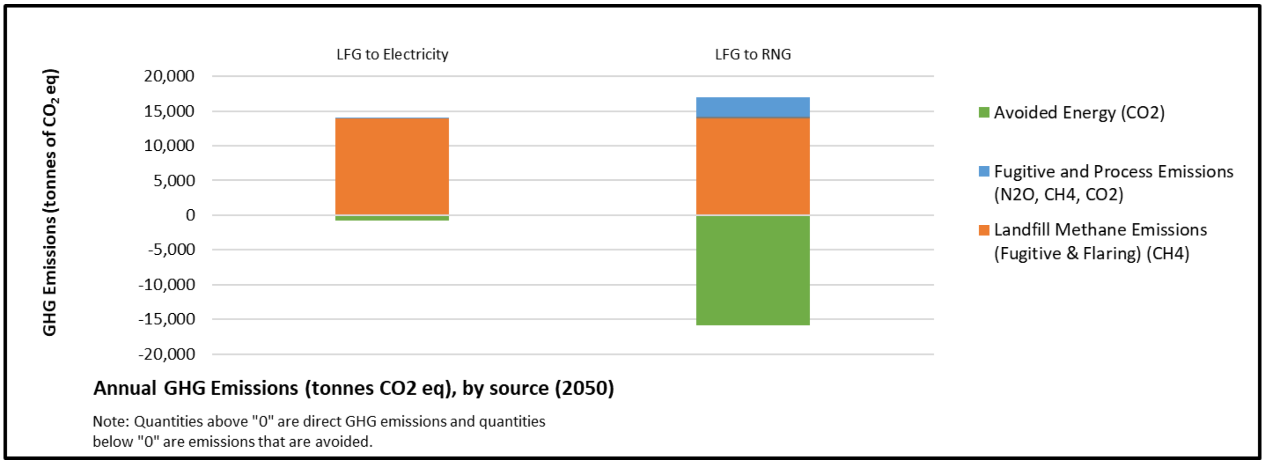
A more detailed description of the permissions required for the facility is outlined in HDR's Technical Memorandum #2 – Siting and Approvals.

3.5.4.1 Greenhouse Gas Impacts

GHG emissions can be reduced through improvements and on-going maintenance of the landfill gas collection system. Typically, a site that collects approximately 85% of the landfill gas generated is considered a well-run landfill system. Capturing the LFG for cleanup and distribution directly into a gas transmission system (for renewable natural gas [RNG]) is becoming more common in modern day landfills. RNG has the potential to reduce GHG emissions because it offsets or displaces the need for and use of natural gas.

The ECCC's Organic Waste GHG Calculator was used to determine if collecting LFG for electricity or RNG can offset GHG emissions. As shown in **Figure 3-14**, it is estimated that LFG collection does not result in a reduction of GHG. Incorporating the avoided energy from the LFG captured for electricity and RNG, it was calculated that landfills will still emit approximately 12,000 and 16,500 tonnes of CO_{2e} per year by 2050, respectively.

Figure 3-14: Annual GHG Emissions for LFG Collection Scenarios (2050)



3.5.5 Implementation

Construction of a greenfield MSW landfill was evaluated in detail during the development of the SWMP. While at the time of the SWMP it was decided to be deferred, this option is being provided in this Study for comparison purposes. The main reasons the option was deferred during the SWMP stems from the anticipated difficulties related to the permitting process, the current municipal consent approach required in the EAA, and that the National Capital Region has at least four private landfills within the area that could support the Region's waste disposal needs. At a minimum, developing a new landfill would require an EA and ECA (waste, air, and industrial sewage). The EA process is comprehensive and can take many years to complete. Other approvals, such as ECA and municipal approvals, including land use planning, zoning, and site approvals, will also take several years to complete for a new landfill. Overall, the new landfill option would be expected to take seven to more than ten years based on recent experience in Ontario.

HDR will be performing a triple bottom line analysis that includes the development of a greenfield landfill as Option #5. This option is anticipated to have constraints to being implemented within the City boundaries and is not consistent with the recommendations in the SWMP.

3.5.6 Capacity Requirements

For a new landfill development, it was assumed that additional capacity would be needed beginning in 2034 so that operations of Trail could wind down and the new landfill could receive select MSW for initial placement in its first landfill cell in a way that protects the base liner system. The tonnage requiring disposal in 2034, as summarized in the SWMP in **Table 2-2**, was 228,400 tonnes. Projected annual disposal rates from the SWMP were provided through the year 2053. For this evaluation and a 30-year operating life, we projected the tonnes to be received through 2063 using the same growth estimated for the years 2048 to 2053. A total of 7,764,825 tonnes of waste is estimated to require disposal for the 30-year operating period of 2034 through 2063.

Using an airspace utilization factor of 0.750 metric tonnes per cubic metre, it is calculated that the landfill would require a capacity of at least 10.35 million cubic metres. A conceptual landfill, assuming on average six metres of soil excavation below ground surface with three-to-one base liner side slopes and four-to-one final fill slopes, would require an approximate footprint of just over 71 hectares. For simplistic planning purposes, we have assumed that the landfill could be developed with two phases of construction, each consisting of three cells 11.83 hectares in size. This is a reasonable cell size for the purposes of a single season of construction for the liner system and infrastructure and for the management of leachate with a single sump and side slope riser pump station.

A landfill of 71 hectares would require approximately 200 hectares of property to provide locations for administration and maintenance activities, stormwater, leachate and landfill gas management infrastructure, soil borrow areas, perimeter roadways, and buffers from property lines and residential development.

3.5.7 Land Acquisition Costs

The City provided HDR with a high-level estimate for rural land values in support of a feasibility study for a proposed landfill facility. The valuation is subject to the following assumptions:

- The land in question is in a rural setting outside of the outer urban area of Ottawa, with average-to-good access from major highways (416/417/7).
- The land would be serviced with private water and sewer services.

Based on these assumptions, a market value of $35,000 per hectare was determined for a site that that is roughly 200 hectares. The value refers only to the market value of land and therefore does not include any other costs associated with land acquisition (e.g., preliminary site investigations and due diligence, real estate commissions, legal fees, land transfer taxes, environmental studies, etc.). Therefore, HDR has increased this unit cost slightly to account for those additional costs.

Table 3-27 shows the estimated land acquisition costs for a 100 to 200-hectare site, which is a reasonably sized site for this size landfill facility.

Table 3-27: Landfill Land Acquisition Costs

Land Acquisition Costs	Estimate # of Hectares	Estimated $ per Hectare (CAD)	Total Cost (CAD)
Land Acquisition	200	$35,000	$7,000,000

Note:

1. Estimate based on assumption of $35,000 CAD per hectare provided for a 200 ha site local in a rural area outside City of Ottawa with average or better access to major highways and with private water and sewer service, increased to account for preliminary site investigations and due diligence, real estate commissions, legal fees, or land transfer taxes.

3.5.8 Construction and Operating Costs

Landfills have longer-term (over the planning period) capital and operating costs (even after the site ceases accepting waste) compared to WTE and MWP related to post-closure environmental monitoring and site maintenance. These capital costs can be accounted for upfront or spread over a set period (e.g. 30 years). For landfills, the annual costs must include funding for the future post-closure costs, which in some cases can last for decades after the site closes.

For the development of a greenfield landfill, substantial permitting and initial site development costs are incurred before the first landfill cell is constructed. The initial site development includes the construction of an entrance and access roadways, administration and maintenance areas, truck scales, leachate, and stormwater storage infrastructure prior to or concurrent with construction of the first landfill cell. After initial operations, a landfill gas collection and control system would need to be implemented to comply with regulatory requirements for greenhouse gas impacts. The development of each landfill cell is based on airspace utilization, how much existing capacity is remaining, and at least a 12-month period for construction and regulatory approvals to operate the cell. The capital costs are heavily weighted early in the life of the landfill for the initial site development and construction of the first two cells. The disposal capacity of these first cells is limited since there is little overlap onto previous filled wastes over a preceding cell footprint. The construction of the subsequent cells are spaced out over the remaining operating life. For the conceptual landfill comprised of six cells of the same size, we have calculated the airspace and life for each would total just under 29 years of capacity, as summarized in **Table 3-28**.

Table 3-28: Landfill Capacity and Life Calculations

Cell	Cell Area (Hectare)	Waste Capacity (Cubic Metres [m^3])[1]	Cumulative Waste Capacity (m^3)	Life (Yrs)[2]	Fill Complete
A-1	11.83	812,722	812,722	1.6	8/24/2035
A-2	11.83	1,410,172	2,222,894	4.4	1/27/2040
A-3	11.83	1,459,082	3,681,976	4.4	6/23/2044
B-1	11.83	1,033,253	4,715,229	3.0	7/7/2047
B-2	11.83	2,596,641	7,311,870	7.4	11/10/2054
B-3	11.83	2,906,519	10,218,389	7.8	8/18/2062
Total	**71.00**	**10,218,389**		**28.6**	

Notes:
1. Assumes an airspace utilization factor of 0.750 tonnes per m^3 for disposal of waste and placement of cover soils.
2. Assumes annual tonnages as projected in SWMP for 2034 to 2053 and similar projections for 2054 to 2064.

3.5.8.1 Capital Construction Costs

For the capital costs, HDR developed cost estimates for cell construction and closure construction on a per hectare basis, using recent experience with construction projects as a guide. HDR estimates, in 2024 dollars, an average base liner cost of $1,746,269 per hectare and an average closure construction cost of $1,012,054 per hectare. The capital costs also include survey, permitting, design and construction engineering services, site development and compliance costs, soil excavation and filling, leachate management, and landfill gas management. The costs for these activities occur at different periods based on the development of the landfill expansions and closures. For ease of comparison to other alternatives, the total capital costs are summarized in 2024 dollars (without the benefit of present value analysis) in **Table 3-29** below.

Table 3-29: Landfill Capital Costs

Capital Cost	Percent of Total Construction Cost (%)	Estimated Capital Construction Costs (CAD)
Construction		
Site Development and Compliance[1]	30.5	$178,400,000
Excavation and Fill[2]	11.3	$66,438,400
Leachate Management[3]	5.4	$31,520,000
LFG Management[4]	6.0	$35,000,000
Cell Construction[5]	21.2	$123,985,000
Closure Construction[6]	12.3	$71,856,000
RNG System[7]	9.0	$52,648,000
Construction Subtotal	**95.6**	**$559,847,000**
Expansion Engineering, Design, Construction Administration, and CQA[8]	2.1	$12,088,000
Closure Engineering, Design, Construction Administration, and CQA[9]	1.2	$7,278,000
Permitting (Local & Provincial)	0.9	$5,000,000
Survey	0.2	$1,400,000
Engineering and Design Subtotal	**4.4**	**$25,766,000**
Total Construction Cost	**100.0**	**$585,613,000**
Total Cost with Low Contingency Range (-25%)		**$439,209,750**
Total Cost with High Contingency Range (+30%)		**$761,296,900**

Notes:

1. Includes administration and maintenance building, scales and scalehouse, entrance roadway, groundwater monitoring system, stormwater management ponds, and access roadways.
2. Includes clearing and grubbing, topsoil recovery, and 200,000 m^3 of excavation to landfill subgrade and 150,000 m^3 of structural berm filling over time.
3. Includes leachate storage tanks, loadout facility, forcemains, six leachate side riser pump stations, and electrical connections.
4. Includes construction of landfill gas blower, flare station, and periodic expansions of the gas collection and control system.
5. Includes construction of six 11.83-hectare landfill cells with single composite liner systems, contractor general conditions and mobilization, subgrade installation, geosynthetic clay liners, geomembrane, and leachate collection systems.
6. Includes construction of an average of 11.83-hectare closure systems with topsoil and protective cover soils, geocomposite and geomembrane liners, and stormwater management systems.
7. Based on the EPA LMOP LFGCostWeb model, which uses values based on recent market research and forecasts. Calculations are generated from a design project size of approximately 1,600-SCFM.
8. 9.75% of cell construction costs.
9. 10.13% of closure construction costs.

3.5.8.2 Operation and Maintenance Costs

The operation and maintenance costs can vary for a site. Key tasks for the operation and maintenance could include:

- Site staffing for landfill and LFG collection system operations;
- Equipment;
- Repairs and maintenance;
- Property taxes;
- Leachate disposal;
- Electricity costs;
- Environmental monitoring;
- Reporting; and
- Post-closure care funding.

- The following three tables (**Table 3-30** through Notes:

1. Assumes no revenue from tipping fees due to municipal collection.
2. Based on the current electricity rate and revenue for the Trail LFG to electricity system.
3. Based on estimate for the LFG generation and potential market from RNG in Ottawa Region using USEPA Landfill Gas Energy Cost Model (LFGCostWeb). Potential revenues provided by the City.
4. Total Revenue Potential for the New Landfill option is shown as the sum of both potential revenue sources.

Table 3-32) display the estimated capital and annual operating costs of a combined MWP and WTE facility.

Table 3-30: Landfill Annual Operating Costs

Operating Cost	Estimated Annual Costs (CAD)	Cost per Tonne of MSW Disposed (CAD)
Landfill Operations[1]	$10,773,860	$40
LFG Operations[2]	$600,000	$2
Landfill Post Closure Care Fund[3]	$583,720	$2
LFG Reuse Operations[4]	$1,954,600	$7
Direct Annual Operating Costs	**$13,912,180**	**$51**
Annual Debt Service[5]	$35,000,000	$131
Indirect Annual Operating Costs	**$35,000,000**	**$131**
Estimated Total Annual Operating Costs[6]	**$48,912,180**	**$182**

Notes:

1. Estimated operating costs from Solid Waste Association of North America (SWANA) 2017 Benchmarking Study for 800 tonnes per day, adjusted for 2024 CAD and including labour, equipment, operations, maintenance, and reporting costs.
2. Estimated from United States Environmental Protection Agency (USEPA) LFG Cost Model V3.6 for landfill with 267,600 tonnes per year, including labour, equipment, maintenance, and reporting.
3. Post-closure care fund estimated to require $550,000 CAD for 30 years of post-closure care.
4. Estimated for LFG to electricity or RNG recovery from United States Environmental Protection Agency (USEPA) LFG Cost Model V3.6 for landfill with 267,600 tonnes per year, including labour, equipment, maintenance, and reporting.
5. Assumes City will finance the project with a 30-year loan at an interest rate of 4.25% interest. Loan includes land acquisition costs.
6. Cost per tonne of MSW processed is based on a total facility design throughput of 267,600 TPY.

3.5.8.3 Revenues

Landfills generate revenue from tipping fees and either the sale of electricity from combusting landfill gas, or from the sale of recovered renewable natural gas (RNG).

The tipping fees are the primary revenue sources for landfills. For this study, the tipping fee was set to achieve a breakeven cost of operation. Similar to the other options, the City could consider accepting waste from the IC&I sector or other sources at a higher tipping fee to help provide potential additional sources of revenue. However, this would need to be approved by the MECP as part of the ECA process.

A secondary revenue source for landfills is the sale of recovered electricity generated from the combustion of natural gas. For purposes of this Study, HDR estimates based on the projected annual quantity of waste that these revenues would be up to $1.9M per year. Alternatively, there is the potential for revenue generation for converting landfill gas to RNG. Based on current projections of waste generated and the current market for RNG in Ontario, the revenues from selling RNG directing to Enbridge or similar utility could be as much as $12M per year. For the New Landfill option, it is assumed that revenues would only be available from either the sale of electricity or from RNG, but not both. A more detailed evaluation, of the quantity of gas available from the New Landfill option, including assessing the potential impacts of bans on landfilling organics, as well as the capital and operating costs will need to be further evaluated if this scenario is advanced beyond feasibility phase.

Table 3-31: New Landfill Annual Revenues

Description	Estimated Annual Revenues (CAD)	Revenue per Tonne of MSW Processed (CAD)
Tipping Fees[1]	$0	$0
Sale of electricity[2]	$1,900,000	$7
Sale of RNG[3]	$12,000,000	$45
Total Revenue Potential[4]	**$13,900,000**	**$52**

Notes:

1. Assumes no revenue from tipping fees due to municipal collection.
2. Based on the current electricity rate and revenue for the Trail LFG to electricity system.
3. Based on estimate for the LFG generation and potential market from RNG in Ottawa Region using USEPA Landfill Gas Energy Cost Model (LFGCostWeb). Potential revenues provided by the City.
4. Total Revenue Potential for the New Landfill option is shown as the sum of both potential revenue sources.

Table 3-32: New Landfill Net Operating Costs

Description	Estimated Annual Net Operating Costs (CAD)	Net Costs per Tonne of MSW Processed (CAD)
Revenue from Sale of Electricity[1]	($1,900,000)	($7)
Direct Operating Costs	$13,912,180	$51
Indirect Operating Costs	$35,000,000	$131
Total Annual Net Operating Cost	**$47,012,180**	**$175**

Notes:
1. Electricity revenues used based on electricity revenues as a conservative estimate, and due to need for a more detailed feasibility and market analysis required for RNG recovery.

3.6 Other Considerations

This section provides background information on other considerations that may impact the City's evaluation of the five options being considered as part of this study.

3.6.1 Per- and Polyfluoroalkyl Chemicals (PFAS)

PFAS are a large class of man-made synthetic chemicals that were created in the 1930s and 1940s for use in many industrial and manufacturing applications. There are over 10,000 known compounds of PFAS that have been widely used for their unique properties that make products repel water, grease, stains; reduce friction; and resist heat. Because of their unique chemical structure, PFAS readily dissolve in water and are mobile, are highly persistent in the environment, and bioaccumulate in living organisms over time. PFAS are referred to as "forever chemicals" because they do not readily break down when exposed to air, water, or sunlight. The primary means of distribution of PFAS throughout the environment has been through the air, water, biosolids, food, landfill leachate, and fire-fighting activities. Exposure to these chemicals is known to cause adverse health effects in laboratory animals and in humans. Exposure can occur when fish caught in waters contaminated with PFAS are eaten, foods packaged in PFAS-coated materials are consumed, soil and dust polluted with PFAS are unintentionally ingested, or products made with PFAS chemicals are handled.[7]

3.6.1.1 PFAS in Municipal Solid Waste

The PFAS content of MSW is reported to vary widely. One reason for this variance is that there is no standard methodology for obtaining representative MSW samples and establishing their PFAS content. PFAS concentrations for individual solid waste fractions have been found to range from 0 to more than 1,000 nanograms per gram of sample (ng/g). A value of 10 ng/g (0.01 parts per million [ppm]) is considered a representative figure characterizing the overall MSW PFAS content.[8] This value compares well with the findings of a study conducted by Sanborn Head and Associates, Inc. for the

[7] https://www.dep.pa.gov/Business/Water/BureauSafeDrinkingWater/DrinkingWaterMgmt/Regulations/Pages/PFAS-MCL-Rule.aspx

[8] Kremen, A. "Leachate is the Driving Force for PFAS Sequestration in Landfills", WasteAdvantage Magazine, Nov 2, 2020.

New England Waste Services of Vermont, Inc.,[9] which estimated that 23 grams per day of PFAS is included in the approximately 2,025 tons per day received at the Coventry Landfill.[10] This amount is equivalent to 12.5 ng/g or 0.0125 ppm. While these findings agree, it should be noted that the PFAS samples were taken from specific waste streams that included sludges from municipal wastewater treatment plants and other industrial sources, sewer grit, contaminated soil, textiles from bulky waste, carpeting and other C&D waste, and targeted waste from commercial customers (such as food packaging). MSW from residential sources was not included in the sampling program.

Another method that can be used to estimate the PFAS content of MSW is to multiply the PFAS content of certain types of MSW (i.e., carpet) by their reported PFAS concentrations. As an example, the EPA reported that carpets and rugs represented 1.7% of the MSW disposed in 2018.[11] Assuming that 40% of the weight of the carpet consisted of carpet fibers, carpet fibers would therefore represent 0.7% of the MSW disposed that year.[12]

3.6.1.2 Opportunity for PFAS Destruction by Thermal Treatment

Thermal treatment of PFAS has been identified by the United Nations Environment Program (UNEP) as the most appropriate method of destroying PFAS chemicals from halogenated waste streams. However, the effectiveness of mass burn WTE technologies, specifically, in generating and/or destroying all of the possible PFAS compounds in an MSW stream, particularly those compounds that require higher temperature destruction, remains to be accepted in the U.S. While Canada is aware of the concerns of PFAS, Ontario does not currently regulate the thermal treatment of PFAS-impacted waste. The USEPA has expressed concerns regarding the efficacy of high-temperature combustion in destroying PFAS compounds and whether fluorinated or mixed halogenated organic byproducts are formed during the incineration process. USEPA did work with the University of Dayton (Ohio) Research Institute in 2013 to determine whether municipal and/or medical waste incineration of commercial PFAS compounds is a potential source that may contribute to environmental and human health exposures. The findings of this study concluded that incineration of PFAS compounds would not be expected to be a significant source of PFAS in the environment if the process temperatures were maintained at 1,000ºC for two seconds or greater. Most WTE technologies, including mass burn systems, can meet this process temperature and the two second residence time in the furnace.

HDR is aware of several facilities within the U.S. that have performed or are currently performing PFAS destruction testing. Although specific facility names cannot be shared, HDR is aware of one facility in Minnesota that has completed testing and three more that were scheduled to undergo testing in the

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9 Sanborn Head and Associate, Inc. PFAS Waste Source Testing Report: New England Waste Services of Vermont, Inc., October 2019.

10 Email from Samuel Nicolai of Casella Waste Systems, Inc. to Jeremy O'Brien, SWANA's Director of Applied Research, February 4,2021.

11 US EPA. Advancing Sustainable Materials Management: 2016 and 2017 Tables and Figures, November 2019.

12 To determine the face weight (carpet fiber weight) of the total weight of the carpet, the total weight should be divided by 2.5. Some manufacturers, Mohawk for example, list both the face weight and total weight on the display cards. For example, 22 ounce nylon Mainstreet type commercial carpet equals 54.08–55.28 ounces of total weight.

fall of 2024. EPA Method OTM-45 will be used to evaluate removal efficiency. Inbound PFAS will be estimated by multiplying the PFAS content of certain types of MSW by their reported PFAS concentrations, using recent waste composition results to estimate the percentage of these various materials in the waste stream. The State of Pennsylvania passed a ruling requiring WTE facilities to test for PFAS destruction, and HDR is aware of two facilities that will be performing that testing within the next year. In addition, some testing is occurring at WTE facilities in Florida, yet no information has been released on the findings. HDR anticipates that in the next one to two years, data on the reduction and destruction of PFAS compounds at several of the WTE facilities currently operating in the United States will be made publicly available.

There has also been research and testing performed in the European Union on PFAS emissions from WTE facilities, including in Sweden, Germany, and Denmark. In 2018, a study was performed by Karlsruhe Institute of Technology in Germany that included a pilot scale study under typical WTE combustion conditions. This study concluded that municipal incineration of PFAS using best available WTE technology was not a significant source of the compounds studied and should be considered an acceptable form of waste treatment. A commercial scale study and long-term sampling of a “state of the art” WTE facility in the Netherlands between 2015 and 2017 found the presence of PFAS emissions in the flue gas from the WTE plant over the period studied. However, the average emission rate of the PFAS compounds studied during the sampling period was reported to be only 0.3% of the 70 parts per trillion health advisory limit for PFAS in drinking water (or 0.00000018 milligrams per kilogram of waste processed).

3.6.1.3 PFAS Removal from Landfill Leachate - Canada

The primary pathway for PFAS chemicals potentially entering the environment through landfilling is through the PFAS-impacted groundwater and the leachate generated during the composition of the waste materials containing these chemicals. In February 2023, Health Canada posted a consultation document on a treatment-based drinking water objective for PFAS using an approach similar to that used in Ontario. The proposed Health Canada objective is 30 nanograms per litre (ng/L) for the sum of at least 18 different PFAS. The MECP has developed interim advice with regards to PFAS, which is to minimize PFAS levels in drinking water to the lowest level reasonably achievable with available technology. The MECP will review the final Health Canada objective to assess how it would inform Ontario’s drinking water programs. These assessments will include landfills.

The MECP has plans to continue to undertake PFAS monitoring programs. The focus of these programs is to better understand the presence and prevalence of PFAS in the province. One project is a study of municipal landfills across Ontario. There are approximately 805 active landfills and over 5,000 closed municipal landfills across Ontario. Recent studies funded under the Canada-Ontario Agreement on Great Lakes Water Quality and Ecosystem Health suggest landfills are likely sources of PFAS and that PFAS-impacted groundwater has the potential to contaminate drinking and irrigation water wells. The MECP is sampling PFAS at approximately 20 landfills across Ontario, and the study will provide information on PFAS across a range of site conditions and landfill types.

In addition to sampling within the boundaries of landfills, samples of private well water, groundwater, and, where possible, surface water in the vicinity of landfill locations were also obtained. The information collected is shared with the municipalities and health units where the landfill is located and will inform our response to PFAS in the environment.

As a component of future planning, the City should continue to monitor for any potential regulatory requirements related to PFAS and leachate management. The City should consider the implementation of technologies that can address PFAS in the leachate as a precautionary and planning approach for potential future landfill expansions. Pre-planning can assist in reducing future costs during the life expectancy and during post-closure landfilling activities.

3.6.2 District Heating

The WTE facility option provides the ability to recover energy in the form of steam or hot water that can be directed to a district energy system. In the European Union, WTE plants account for around 10% of the energy provided to district heating networks in Europe.[1] In some examples, the WTE plants in Malmö, Sweden and Brescia, Italy cover 50% or more of the heating needs of those communities. Although using mass burn WTE technology in a district energy system is far more common in the European Union, there are less examples of this approach currently in North America. In the US, the current examples of mass burn WTE plants providing energy to district energy or heating systems are more associated with providing lower energy steam to an industrial user or government installation or infrastructure. Some US examples include the Baltimore (Maryland) WTE Facility that provides steam to a local district heating and cooling system, the Lancaster County (Pennsylvania) WTE Facility that provides steam to a nearby soybean drying/processing facility, and the Huntsville (Alabama) WTE Facility that currently provides steam to an adjacent US Army Base (Redstone Arsenal). In Canada, the Prince Edward Island WTE Facility provides energy to a local district heating system, and recently in British Columbia, a district energy network has been approved that will be supplied by the Metro Vancouver WTE Facility located in Burnaby.

The City of Ottawa currently has a few existing district energy systems operating that could feasibly be tied into and supplied by a mass burn WTE facility. The details and availability of these networks will be described in more detail in the sections below. The exact location of the WTE Facility for the City is unknown at this time; therefore, this memorandum provides general cost metrics for distribution piping that can be used in the study. The costs provided include only the distribution piping and do not include the costs of the WTE facility or any costs associated with building connections or building upgrades. It is assumed the distribution piping system will be using hot water, with a supply temperature of 95°C and return temperature of 65°C.

The higher supply temperature allows for the connection of existing buildings. It is unknown which buildings or existing district energy network could feasibly be connected, so this assessment uses the "95/65 supply/return" temperature information to establish pipe sizing. The current pipe sizing allows for a maximum of 150 pascals per metre (pa/m) pressure drop. This approach is considered consistent with the existing district energy systems within the Ottawa region.

HDR has provided four thermal capacity scenarios to review as shown in **Table 3-33** below. For each scenario, HDR calculated the resulting pipe sizes and estimated cost per trench metre to install. These pipe sizes can be considered average "mains" sizes and do not represent sizes for typical building connections.

Table 3-33: Summary of District Heating Thermal Capacity Scenarios

		Scenario 1 (Higher Fuel Volume, 100% Thermal Generation	Scenario 2 (Lower Fuel Volume, 100% Thermal Generation	Scenario 3 (Higher Fuel Volume, 50% Thermal Generation)	Scenario 4 (Lower Fuel Volume, 50% Thermal Generation)
% thermal	%	100% thermal generation	100% thermal generation	50% thermal, 50% electricity generation	50% thermal, 50% electricity generation
Fuel Input	tonnes/ yr	375,000	195,000	375,000	195,000
Gross Thermal Capacity	MW	129	67	64	33
Estimated Pipe Size	ON	600	500	500	400
Estimated $/trench metre	$	$26,000.00	$22,000.00	$22,000.00	$18,000.00

Based on the scenarios, it is estimated that the cost could potentially range from $18,000 to $26,000 per trench metre (tm).

Table 3-34 below provides a summary of the potential energy outputs for the WTE options for the different processing capacities being considered for the City of Ottawa Feasibility Study.

Table 3-34: Summary of Potential WTE Energy Outputs

	Scenario A= 267,600 tonnes/yr		Scenario B =199,500 tonnes/yr	
	English Units	SI Units	English Units	SI Units
Hourly Throughput	37 tons/hr	34 tonne/hr	32 tons/hr	24.6 tonne/hr
Daily Throughput	898 tons/day	815 tonne/day	763 tons/day	591 tonne/day
Steam Production	261,830 lbs/hr	118,766 kg/hr	222.594 lbs/hr	85,886 kg/hr
	2,293,629 lbs/yr	1,040,390 Mg/yr	1,949,928 1000 lbs/yr	752,358 Mg/yr
Thermal Generation (100%)				
Gross Thermal	92 MWt	92 MWt	78 MWt	78 MWt
Gross Electric	- MW	- MW	- MW	- MW
Net Electric	(4) MW	(4) MW	(3) MW	(3) MW
Electricity Generation (100%)				
Gross Thermal	- MWt	- MWt	MWt	
Gross Electric	26 MW	26 MW	22 MW	22 MW
Net Electric	22 MW	22 MW	19 MW	19 MW
Combined Heat & Power (70/30 Electricity to Thermal (Hot Water))				
Gross Thermal	28 MWt	28 MWt	23 MWt	23 MWt
Gross Electric	16 MW	16 MW	13 MW	13 MW
Net Electric	12 MW	12 MW	10 MW	10 MW

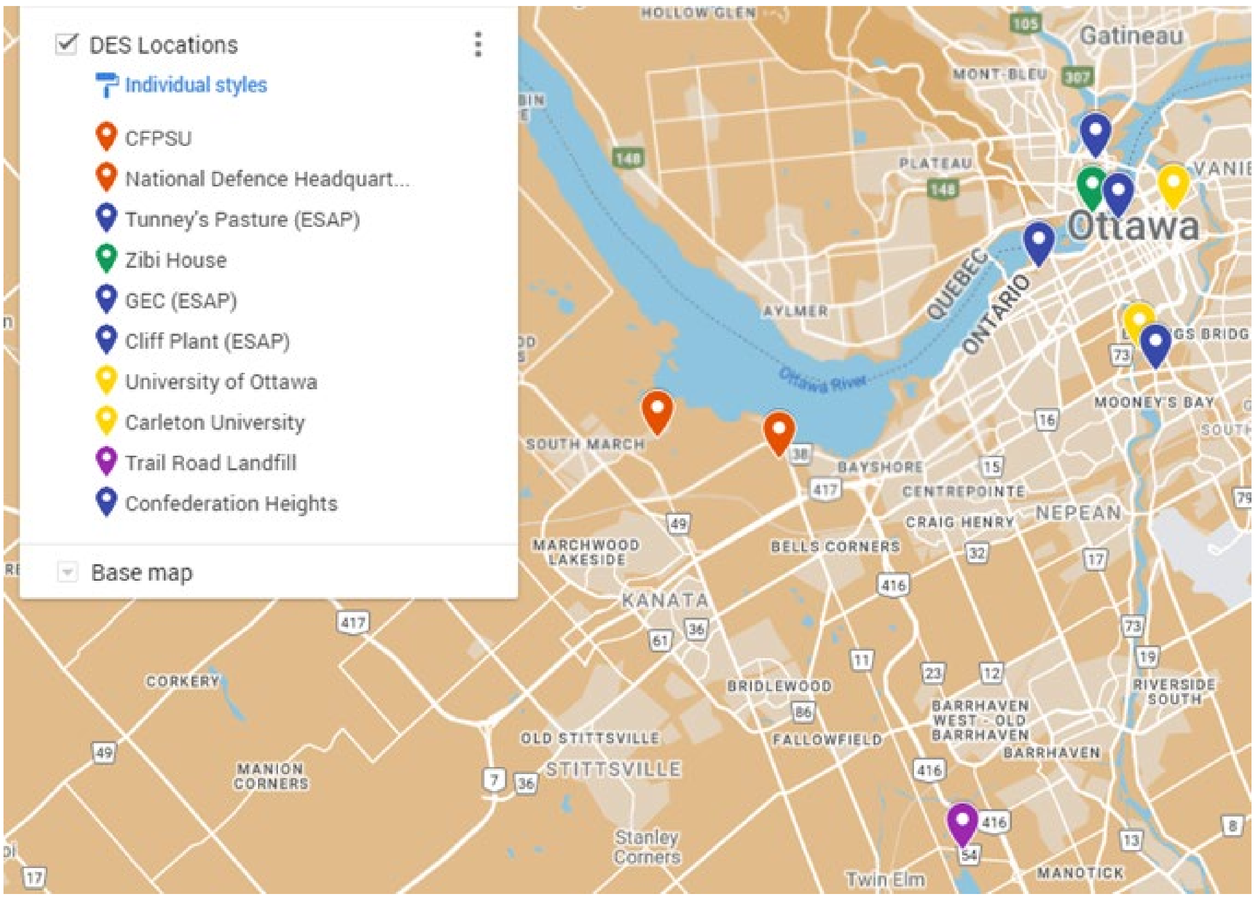
Assumptions

1. Unit Availability = 90%
2. Steam Generation Efficiency = 7000 lbs/ton of MSW processed (3500 kg/tonne)
3. Net Electric Generation Efficiency = 800 kWh/ton of MSW of1.15W processed (660 kWh/tonne)
4. Parasitic load is 15% of gross electoral generation
5. Waste HHV = 13 MJ/kg
6. Boiler efficiency - 75%

3.6.2.1 Examples of District Heating Options in the City of Ottawa

There are a few district energy systems operating in Ottawa today, as listed below and shown in **Figure 3-15**. Trail is also indicated as a reference point.

Figure 3-15: Overview of District Energy Systems within Ottawa



1. Energy Service Acquisition Program (ESAP):
    a. Interconnected network of 14km of underground piping, approximately 150 megawatts (MW) for heating, owned by the Federal Government of Canada. Currently under a major public-private partnership project for modernization.
    b. Renewable heating energy provided via Gatineau plant which utilizes 30 MW electric boilers. The current remainder of heating energy is provided by natural gas boilers.

   c. Cooling energy is provided by electric chillers.
   d. System is considered inclusive, as heating network operates at temperatures high enough (95°C) for the existing built environment to connect.
2. Zibi:
   a. The Zibi system is privately owned development with 50% ownership by Hydro Ottawa. System demand is approximately 10 MW with primarily residential buildings. The district network utilizes waste heat from an industrial plant located in Gatineau, Quebec, making the heating and cooling energy largely renewable.
   b. The Zibi system is considered exclusive, as supply temperatures are low (48°C) and typically require new buildings that can use low supply temperatures to connect.
3. Ottawa University:
   a. System is privately owned and operated by the University, with peak heating demands of approximately 30 MW. The system utilizes natural gas boilers for heating and electric chillers for cooling. The owner has issued a request for interest for a system modernization, but no request for proposals (RFP) has been issued yet.
4. Carleton University:
   a. University owns and operates its own district energy network. Latest university master energy plan (2022) indicates a system heating demand of approximately 29 MW. The report details plans to expand and upgrade the existing system before 2030, with the goal of reducing greenhouse gas intensity.
5. Shirley's Bay:
   a. Existing heating and cooling district network at the Communications Research Centre for Canada. The system uses natural gas boilers for steam heating (1.9 MW peak demand) and electric chillers for cooling. The system was built in 1977, and the only major replacement project was a boiler replacement in 1996.
6. Carling Campus:
   a. Campus has a mix of standalone buildings and a single district energy network of three buildings. The building maintenance contractor has had multiple studies reviewing expansion of the district energy system, with the target of achieving net zero building heating.
   b. Estimated total heating demand for the whole campus is 12.5 MW.

3.6.2.2 Other Examples of District Energy Sites

Vancouver, British Columbia (BC)

The Metro Vancouver WTE Facility, operational since 1988 in Burnaby, BC, processes approximately 250,000 tonnes of MSW annually and generates around 180,000 megawatt hours (MWh) of electricity. In response to evolving energy needs and sustainability goals, Metro Vancouver is developing a district energy system (DES) to utilize a portion of the steam from the WTE plant for heating and domestic hot water in neighbouring facilities. This initiative aims to enhance overall performance and reduce GHG emissions by approximately 70,000 tonnes per year. The primary objective of the DES project is to improve energy efficiency and reduce GHG emissions by leveraging waste heat.

In the first phase of the project, scheduled from 2025 to 2027, the construction will focus on establishing the energy center and installing six kilometres of district energy piping (DPS). The second phase will involve extending the DPS to connect with the forthcoming district energy utility, which will be tasked with delivering 95°C thermal energy to buildings in the South Burnaby neighbourhood. Areas with a significant potential to expand the DES have been identified and are currently in the project concept phase. Phase 1 connects to River District Energy and will deliver about 10 MW of thermal heat to the River District development, located in Vancouver. The first delivery of thermal energy is anticipated for 2026.

For buildings located within the Burnaby District Utility service area (Phase 2), the initial thermal energy delivery will be directed to new buildings with a minimum size of 100,000 square feet, for which connection to the system is mandatory. However, the City of Burnaby's District Energy Policy, effective from 2024, outlines the opportunity for existing buildings to connect to the system, based on compatibility and costing. New buildings above the minimum space requirement located in an area identified with future district energy potential must be designed to be compatible to connect to the DES as the system expands.

Charlottetown, Prince Edward Island

The system was initially constructed by a crown corporation of the provincial government (PEI Energy Corp) between 1981-1989, with three separate heating plants. In 1995, the system was purchased by Trigen Energy Canada, Inc., and the three heating plants were interconnected, with major upgrades including the addition of a biomass plant, a heat recovery boiler, a 1.2-megawatts-electric (MWe) electrical turbine, and installation of an emissions control system. Further upgrades were completed in 2004 to install hot water storage tanks and economizers. A more recent major system modernization project was proposed in 2023 by the current system operator, Enwave. The 2023 modernization project is currently on hold.

The current Charlottetown district system demand is over 40 megawatts thermal (MWt) for heating, and the thermal network is approximately 17km long with 125 customer buildings. The system heating is supplied by the following three plants:

- University of PEI (UPEI) Facility
- Prince Edward Home (PEH) Facility
- Energy From Waste Plant (EFWP)

The UPEI and PEH facilities are fuel oil-based boilers; the UPEI facility is used for peaking and backup, whereas the PEH facility is rarely used. The largest facility is the EFWP, which is the base heating load facility. The EFWP facility has a solid waste system to produce steam and contains a biomass-fueled boiler system and fuel oil boilers. The biomass boiler uses chipped woody biomass as a fuel source. Steam is used directly by the Queen Elizabeth Hospital and is used for heating, sterilization, and cooling through an absorption chiller. The EFWP can produce 1.2 MW of electricity, some of which is used by the plant, with the excess being sold to the local utility.

The system has recently been under analysis for expansion and upgrades. Studies and proposals are taking place to increase the capacity of the WTE facility with other modernization upgrades.

3.6.3 Carbon Capture

3.6.3.1 Waste-to-Energy (WTE)

There are a wide range of carbon capture technologies being developed for WTE facilities. These include absorption-based technologies, such as amine scrubbing and molten alkali metal borates. There also exists adsorption-based technologies, which can use physical (using activated carbon or zeolites) or chemical (using metal-organic frameworks [MOFs]) media, as well as membrane-based technologies (i.e., polymeric and mixed matrix). Other technologies still in development include cryogenic separation, oxy-fuel combustion, hydrate formation, ionic liquids, pressure swing adsorption, and chemical looping combustion.

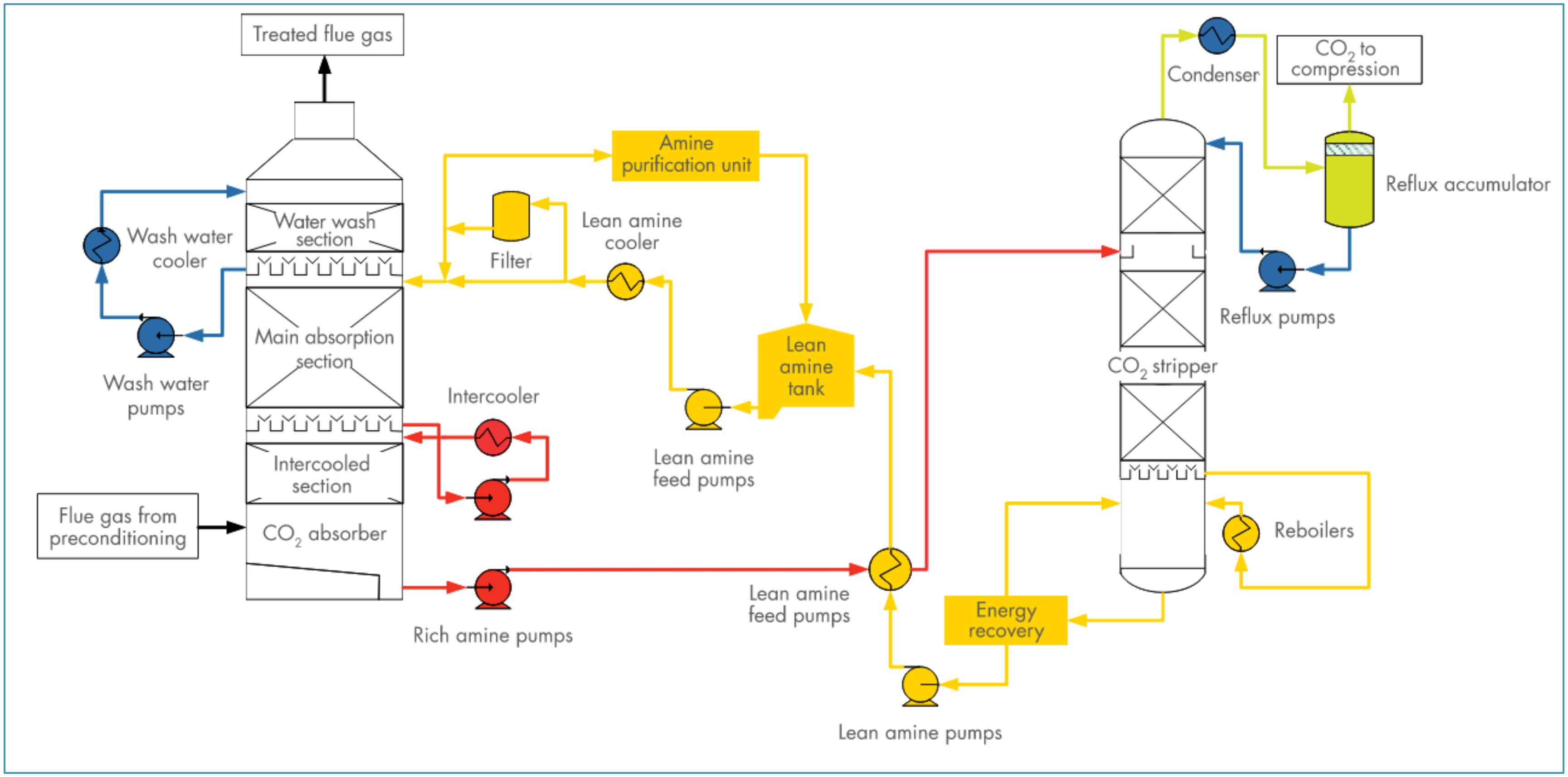
From HDR's high level review, the most commercially available technology for carbon capture in a waste combustion process is the CANSOLV® CO_2 Capture System offered by Shell Global that uses an aqueous monoethanolamine (MEA) solution in a process referred to as "amine scrubbing". This is a post-combustion CO_2 capture system that can be retrofitted onto an existing facility in a lower-temperature region of the flue gas path, around 29°C to 41°C at atmospheric pressure. The CO_2-rich flue gas is fed into a CO_2 absorber, where the CO_2 is washed out of the flue gas using the aqueous MEA solution. During amine scrubbing, up to 85 to 90% of the CO_2 contained in the flue gas can be captured. The CO_2-rich solvent is loaded into a desorber, in which the CO_2 is dissolved from the solvent with the addition of heat. The resulting mixture of water vapor and CO_2 is cooled, condensing the water before returning to the desorber. The regenerated solvent (low in CO_2) is cooled by cross-heat exchange with the CO_2-loaded solvent and returned to the CO_2 absorber. The CO_2 is compressed and cooled, making it available for storage, transport, and further use.

HDR also spoke with a company based out of Boston, Massachusetts, USA called Mantel Capture. This company is focusing on developing a system that captures CO_2 from the higher-temperature regions of a boiler unit and is looking specifically at WTE applications as part of its target demographic. This technology uses molten alkali metal borates to absorb CO_2 in the first pass of the boiler. The claim is that this process is less energy intensive because the scrubbing occurs in a higher-temperature region, allowing that energy to be put back into the process, resulting in less of an ultimate energy demand to operate the system. Mantel is currently testing its system in a prototype processing 500kg per day at 90% efficiency. The technology could be installed as a retrofit to an existing facility or installed during a facility expansion and tied into the existing operating units. By Mantel's own timeline, commercially available systems will not be ready until 2028. In addition, the longevity of the tube bundles placed into the high-temperature and corrosive regions of the boiler remains to be seen.

There is established infrastructure for capture and subsurface storage of CO_2 in western Canada, specifically in Alberta, Saskatchewan, Manitoba, and B.C. Currently, Ontario lacks the infrastructure for geological storage of CO_2 but has established regulations to allow for demonstration projects and is working on a framework to allow for commercial-scale carbon storage projects. As the market for storage and future reuse of the captured CO_2 becomes more established, the combustion of waste could be categorized as a CO_2-negative process.

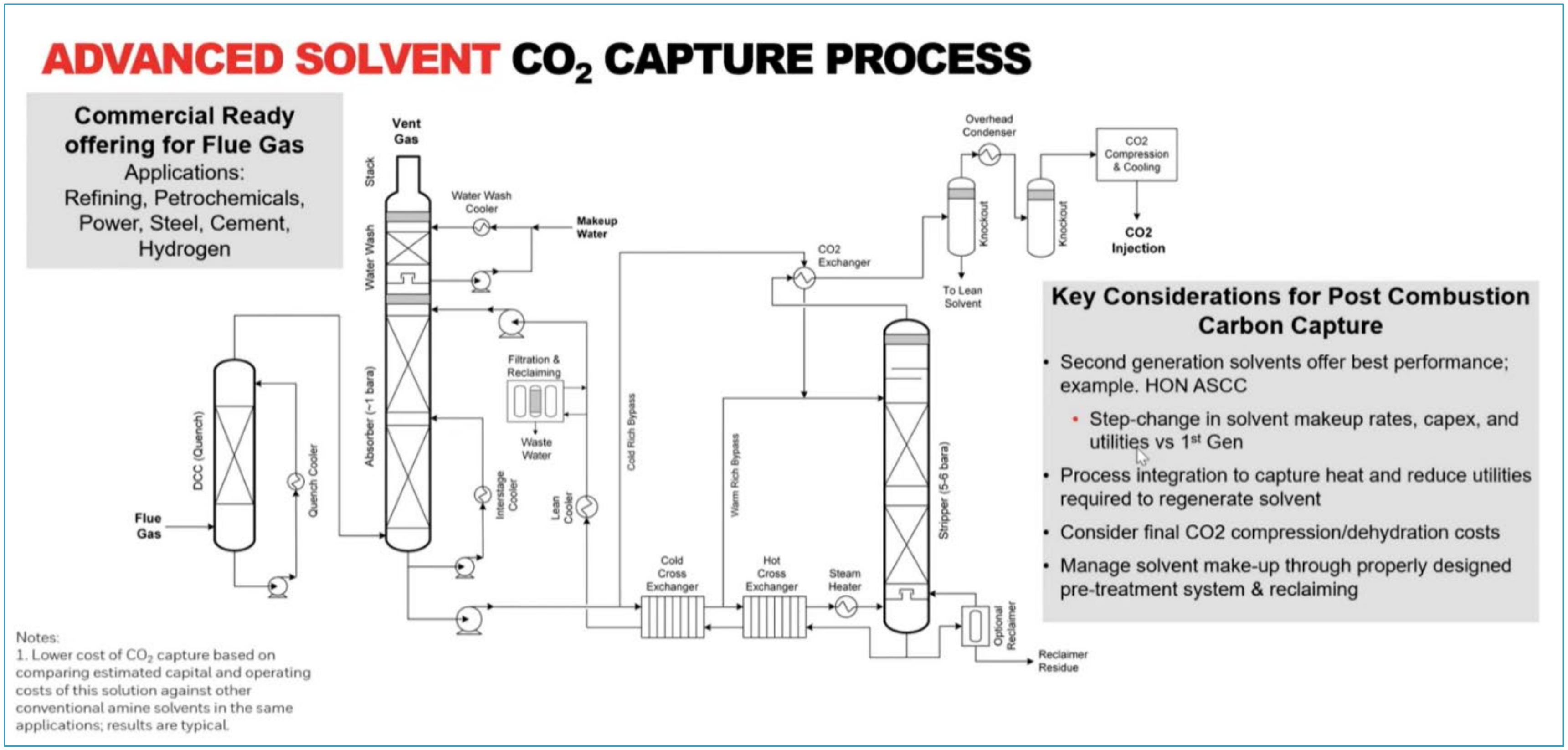
Figure 3-15 and **Figure 3-16** provide process flow diagrams of the Shell Global CANSOLV® CO_2 Capture System and the Mantel Capture system, respectively. In addition to these technologies, the U.S.-based company, Babcock & Wilcox, recently contracted with a WTE facility in Sweden to do a full-scale feasibility study for their SolveBright™ CO_2 capture technology with the goal of capturing up to 400,000 tonnes of CO_2 annually. Similar to the CANSOLV® and Mantel technologies, the system SolveBright™ is a post-combustion technology that uses a solvent to absorb the CO_2 in the flue gas.

Figure 3-16: Proposed Layout of the Shell Global CANSOLV® CO_2 Capture System



Source of Diagram: Shell Global

Figure 3-17: Proposed Layout of the Mantel Carbon Capture System



Source of Diagram: Mantel

In Canada, the Norwegian-based company Varme Energy is developing mass burn modular WTE projects that will incorporate their carbon capture technology. The exact details of how the carbon capture component works are not publicly available, but in general the process uses special filters to capture CO_2 from the WTE plant. Once captured, the CO_2 is compressed to reduce its volume and then transported via pipeline and/or by truck or rail to a storage site. The CO_2 is then injected deep underground into secure geological formations, like depleted oil fields or saline aquifers. This method of carbon capture is also commercially available and is being considered for some WTE plants in the UK that are exploring deep underground injection in the North Sea. This process claims to ensure the CO_2 remains safely stored and doesn't contribute to atmospheric greenhouse gases, helping to combat climate change. Varme has two projects under development in Canada, both in Alberta, and another project in development in the UK. As part of the jurisdictional scan in this memorandum, HDR has provided more details on the project being developed in conjunction with the City of Edmonton in Industrial Heartlands, Alberta.

The robust incentives available to fund carbon capture technologies in Canada and the U.S. will make many projects economically viable, allowing for the technology to continue to improve and become more cost effective. There are incentives available in the form of tax credits, including direct pay options, voluntary and involuntary carbon markets, and the CO_2 offset market.

The cost of transportation also needs to be considered after the CO_2 is captured. Upon capture, the CO_2 is compressed and dehydrated to prepare for shipping. If transporting via pipeline over a short distance, it can be transported as a gas, but longer distance transportation via pipeline requires higher pressure to achieve supercritical conditions. If transported via truck or ship, it is required to be liquified at temperature and pressure conditions of about -40ºC and approximately 690 kPa. Ultimate use and destination and cost to transport it would need to be considered to estimate transportation costs and tax credits for end use. The Varme projects in Alberta, as well as the projects in the UK, will have the advantage of the availability of existing pipelines and infrastructure to accommodate their CO_2 capture system making it more economically viable versus if that infrastructure was not established.

Although technically and commercially feasible, due to the current lack of established infrastructure for carbon capture in Ontario, HDR will not include this technology as part of the initial design or cost assumptions of a new WTE facility for this Feasibility Study. The use of absorption-based carbon technologies is still not in wide-scale commercial development, but pilot studies in the U.S. on some WTE facilities is underway and may be available commercially in the near future.

3.6.3.2 Global Carbon Capture Examples

Although the application of the carbon capture technology on commercially operating WTE facilities is still in development in North America, there are some examples in Europe and Japan. **Table 3-35** provides some examples of WTE facilities that have incorporated carbon capture, usage, and storage (CCUS).

Table 3-35: Summary of Global Carbon Capture, Usage, and Storage Applications

Country	Plant	Total Waste Processed [t/y]	Total CO_2 Produced [t/y]	CO_2 Capture Plant Type	CO_2 Capture Plant Status	Total CO_2 Captured	CO_2 % mol conc. In flue	Removal Target[1]	CCU/CCS Technology
Netherlands	HVC-Alkmaar Project 1	682,412	673,882	Amine technology	Ongoing	4,000	N.A.	N.A.	Liquified CO_2 for greenhouse horticulture
Netherlands	HVC-Alkmaar Project 2	"	"	Amine technology	Feasibility study	75,000	N.A.	60%	Liquified CO_2 for greenhouse horticulture
Netherlands	AEB Amsterdam	1,284,164	1,268,112	Amine technology (MEA based)	Feasibility study	450,000	N.A.	90%	Feasibility Study
Netherlands	AVR-Duiven	360,635	400,000 (reported)	Amino technology (MEA based)	Plant Start-up	50.000-64000	10%	90%	Liquified CO_2 for greenhouse horticulture
Netherlands	AVR Rozenburg	N.A.	1,153,319	N.A.	N.A.	800,000	N.A.	N.A.	FEED Study ongoing based on the operator's experience in Duiven
Netherlands	Twence-Hengelo	608,000	600,000 (estimated)	Amine Absorption by Aker solutions	Full-scale project under engineering study	100,000	10-11%	N.A.	Liquified CO^2 for greenhouse OR for the production of formic acid OR to be mineralized into construction materials
Norway	Fortum-Klemetsrud	375,000-400,000 (reported)	430,000-460,000 (reported)	Shell Consolv engineered and built by Technip (reported)	Concept study completed. Pilot tests ongoing since Feb 2019 FEED ongoing	414,000	10-12%	90%	CO_2 to be delivered by truck to the Oslo harbor where it is liquefied and sent by ship to long term storage in the North Sea (logistics under study)
Japan	Saga City-Japan	74,010	54,000 (220 t/day reported)	Chemical absorption based on specific amine solvent	Full-sale plant in operation since 2016	2,500 (10 t/day reported)	8-18%	80-90%	Gaseous CO_2 stored in a 100 m^3 buffer and delivered via pipeline to nearby algae cultivation

Note:
[1] Removal target refers to the removal of the CO; content of the stream to be treated.

3.6.3.3 Landfill Methane Recovery and Destruction

In Canada, the federal government has implemented a Landfill Methane Recovery and Destruction protocol that is intended for use by landfill owners that are undertaking a project to actively recover and destroy LFG to generate offset credits under the Canadian Greenhouse Gas Offset Credit System Regulations (the Regulations). The federal government has established requirements that are outlined in the Regulations to guide landfill owners.

The landfill owner is required to follow the methodology and requirements set out in this protocol, including those to quantify and report GHG emission reductions generated by their sites. The federal government developed the protocol in accordance with the principles of the International Organization for Standardization (ISO) 14064-2:2019. GHG emission reductions generated at a landfill under this protocol can only result from avoided CH_4 emissions achieved through the active recovery of LFG from within the project site and its destruction in an eligible destruction device, which can include open and enclosed flares, boilers, turbines, internal combustion engines, stations for the direct injection of upgraded LFG into a natural gas network, or stations for the compression or liquefaction of upgraded LFG prior to its transport and injection into a natural gas network.

Projects that use the recovered LFG to generate energy or heat may reduce their GHG emissions from fossil fuel combustion. GHG emission reductions from fossil fuel displacement (i.e., fuel switching) are not additional, as the emission sources are subject to carbon pollution pricing; therefore, they are not included in the quantification of GHG emission reductions under this protocol. Landfill owners may be able to generate credits for this activity under other crediting mechanisms, such as the Clean Fuel Regulations.

Landfill owners are responsible for ensuring that any GHG emission reductions credited under the Regulations are unique; that is, they are not credited under another offset program or another GHG reduction mechanism. The landfill owner must ensure they meet all the site-specific criteria to be able to participate in this program.

4 Jurisdictional scan

As part of Technical Memorandum #1, HDR conducted a jurisdictional and municipal scan to gather relevant information on similar projects that have implemented one or more of the five options being considered. The objectives of this initial scan were the following:

- Consult with current and past staff that are or were engaged with existing similar waste management facilities in Canada, the United States (US), and the United Kingdom (UK);
- Identify what were the major risks and opportunities with each project;
- Identify any challenges that were encountered in the planning and implementation phases of the project, as well as any current challenges;
- Provide high-level financial information, such as the cost to implement, the financing model used, operating costs, the ownership model, and other financial metrics, as available;
- Identify the projects' experience with GHG reduction or mitigation;
- Identify the projects' experience with carbon capture technology, if applicable; and,
- Identify the impacts of the project on waste diversion and reduction.

The following sections present the approach and results of the initial Jurisdictional Scan. The results of the jurisdictional scan include consideration of the drivers for use of landfill disposal, mass burn WTE, and MWP options and information on facilities in Canada, the US, the UK, and the European Union (EU).

4.1 Jurisdictional Scan Approach

The intention of this exercise was to summarize the key drivers and potential approaches of implementing MWP and WTE installations in North America, the UK, and the EU. The projects selected for this scan were identified based on the technological, environmental, and economic attributes that are similar to the scenarios being considered by the City of Ottawa.

The following approach was used when generating a summary of projects and facilities to include in the scan:

- Key facility information (location, operator, input material streams, general technology, design capacity etc.);
- Demographic information regarding the host jurisdiction to allow for comparison to the City of Ottawa (population, households, and climate), as available;
- Municipal waste program information to allow for a general comparison of the similarities between the City of Ottawa waste streams and that of the host jurisdiction (tonnes of waste generated, diversion programs, per capita waste generation, types of waste handled);

- Whether a landfill is used for residual management and tonnes landfilled;
- Recovered energy and other commodity streams at each facility;
- Process used to procure and finance the project, as available;
- Reported capital and operating costs, as available;
- Processing capacity greater than 150,000 tonnes per year (TPY), with some exceptions if the project was considered relevant or similar to the City of Ottawa's objectives; and,
- Facilities that have been operating for less than 10 years, or that have had a major upgrade in the past 10 years were preferred, as older facilities and/or technologies would be less relevant for consideration by the City. Some exceptions were made if the project was deemed relevant to the objectives of this study.

Technologies used by facilities were organized into the following categories:

- Mass Burn WTE Facility (WTE)
- Mass Burn WTE Facility with District Heating (WTE, DE)
- Mass Burn WTE Facility with Carbon Capture (WTE, CC)
- Mixed Waste Processing with Organics Recovery (MWP, OR)
- Mixed Waste Processing with Organics Recovery and SRF (MSW, OR+SRF)
- Mixed Waste Processing to create a SRF + combustion of remaining materials (MWP, SRF, WTE)

When applying the criteria above, the approach was to screen through to the jurisdictions and facilities that most closely align with most of the categories. It was found that in many cases that, although one or more of the screening criteria were not met (e.g., similarity of jurisdiction, similarity of programs), there were still valuable lessons learned associated with many of projects screened during the scan that made it relevant to include in the City's assessment.

4.2 Jurisdictional Scan Considerations

4.2.1 Drivers for Use of Landfill, MWP, or WTE

The following are some observations about the drivers that determined why some of the jurisdictions investigated either use MWP, WTE, or some combination of one or more of these options, and the general findings from the expanded research.

4.2.1.1 European Union (EU)/United Kingdom (UK) and North America

In general, for the EU/UK and North America, the use of either MWP and WTE processes are prevalent in areas where: 1) there is limited to no landfill capacity available or there are incentives in place to promote increased diversion, recovery of commodities, and energy from the mixed MSW stream; 2) landfilling is banned outright; or 3) where landfilling costs are prohibitively expensive (often as a result of landfill taxes applied to gate fees) to incentivize other disposal or recovery options. Additionally, where WTE technologies are considered a renewable source of energy and can contribute to a jurisdiction's diversion rate, WTE can have an advantage over landfilling and MWP.

EU and UK

The EU and UK have developed a range of legislation for waste management, intended to reduce landfilling and support a circular economy. One of the most significant pieces of legislation related to thermal treatment is the EU Landfill Directive, implemented in 2001 (Council Directive 1999/31/EC). This legislation was introduced to move waste recovery up the waste hierarchy and reduce the amount of biodegradable material in MSW being disposed of in landfills. EU members (which then included the UK) also looked to other technologies, such as MWP for waste management to recover organic waste and reduce the biodegradable content in the waste stream. In general, MWP and WTE processes were chosen as the preferred alternative to landfilling residual materials.

Another significant piece of legislation in the EU is the Waste Framework Directive (2008/98/EC), which set a target of 50% of municipal waste to be recycled by 2020. In 2018, higher targets were adopted to increase the recycling targets to 55% by 2025, to 60% by 2030, and to 65% by 2035 (applicable to most countries in the EU). This legislation encouraged investment in programs and technologies to recover the recyclable fractions in the mixed waste stream (which has shrunk over time based on the success of source-separation programs), and to recover recyclables that previously had limited market value.

Individual countries also developed legislation intended to divert waste from landfill, which included total landfill bans and/or high landfill levies or taxes. The following **Table 4-1** presents some examples of landfill taxes and bans that are currently in effect in EU nations and the UK.

Table 4-1: Examples of EU Landfill Taxes and Bans (2020)

Country	Landfill Tax	Landfill Tax (in CAD)	Landfill Ban
France	A: €152 per tonne in 'non-authorized' landfills.	$238 per tonne	Yes
France	B: €25 per tonne in 'authorized' landfills with 75% energy recovery from captured biogas	$39 per tonne	Yes
France	C: €35 per tonne in 'authorized' bioreactor landfill cells with biogas recovery	$55 per tonne	Yes
France	B + C - €18 per tonne	$28 per tonne	Yes
France	Other 'authorized' landfills: €42 per tonne	$66 per tonne	Yes
Germany	No		Yes. Exceptions for some waste with a certain calorific value.
Hungary	6,000 HUF per tonne (€19.35)	$30 per tonne	Yes
Poland	200 PLN per tonne (46€)	$72 per tonne	Yes
Spain	(Varies from region to region) e.g. Valencia - €7.50 per tonne for non-hazardous waste	$12 per tonne	No national ban, but some regions have implemented bans on biodegradable or non-treated waste.
UK	£94.15 per tonne (standard rate)	$162 per tonne	Partial; Scotland and Northern Ireland have bans.

Source: https://www.cewep.eu/wp-content/uploads/2017/12/Landfill-taxes-and-bans-overview.pdf

In some jurisdictions within the EU and UK, decreasing municipal and public sector landfill capacity and reducing reliance on external (private) landfills appears to be the main driver for the development of MWP and/or the use WTE. For the UK and EU-member countries, the EU Landfill Directive was the biggest factor in discontinuing or reducing the use of landfill disposal and driving the implementation of both MWP and WTE projects. In addition, limited natural resources and higher energy costs make the electricity and thermal energy recovered from a WTE facility more valuable. It was also noted in some cases that the use of MWP facilities in the UK and EU was driven by the need to improve the uniformity and calorific value of the incoming mixed waste stream so that it can be more efficiently processed in a WTE plant.

In addition to financial disincentives on landfill disposal, the EU has historically provided financial incentives for the development of WTE technologies to promote environmental protection and resource efficiency as part of its EU Cohesion Fund, particularly in the newer members to the EU from former Soviet Bloc countries. As an example, funding of more than €100 million ($157 million CAD) was approved for the development of two new WTE plants in Poland, which came on-line between 2022 and 2023. However, there has been limited new development of WTE plants due to amount of existing built-out processing capacity in many western and northern EU states and the drive to develop more carbon-neutral forms of energy generation. Some countries, such as Wales and Scotland, have gone as far as to put a moratorium on new WTE development.

United States

In the US, drivers for the use of WTE technologies can vary from region-to-region and state-to-state. Although the USEPA recognizes the role of WTE and energy recovery as part of the greater waste hierarchy, there is no national directive or legislation similar to the EU that discourages landfill disposal. The Public Utility Regulatory Policies Act of 1978 (PURPA) was put in place following the energy crisis in the US during the 1970s to encourage cogeneration and renewable resources and to promote competition for electric generation. The WTE industry in the US was seen as a reliable method of waste processing and extending landfill life, while also generating renewable electricity and/or steam. The promulgation of PURPA promoted the construction of many of the existing WTE facilities operating in the US today by incentivizing publicly and privately owned electric utilities to buy the electricity generated from these facilities at a premium.

Currently, there are approximately 70 WTE facilities in operation in 20 states in the US. Facilities are predominantly located on the east coast of the US, particularly in Florida and the northeastern US, where landfill capacity is at a premium due to limited space and/or the difficulty associated with building new or expanding existing landfills. Renewable energy credits (RECs) and/or recycling credits are also offered in 23 states to increase the market value of electricity. However, there has been recent legislation in some of US states that removed WTE as being eligible for RECs and/or recycling credits that has negatively impacted the financials of facilities in these locations. The following provides a summary of some of the drivers and challenges to WTE in the US market:

- There are 12 WTE facilities in Florida alone, which manage 12% of Florida's MSW. Use of WTE (considered as renewable energy) contributes to Florida's goal of 75% recycling by 2020, as recycling credits are allowed for each megawatt of energy produced. As of 2018, Florida's recycling rate was 49%, well below the state goal of 75%. [13] Florida has been the most active in exploring and developing new WTE capacity in the US. The Lee County WTE Facility in Fort Myers was one of the first existing WTE facilities in North America to add a new mass burn WTE unit in 2007. The Hillsborough County WTE Facility in Tampa added a fourth mass burn unit shortly after the Lee County expansion was completed. Renewable Energy Facility No. 2 in Palm Beach County, a one million tonne per year mass burn WTE facility, was constructed adjacent to an existing WTE facility in 2016. The Pasco County WTE Facility also recently started construction on a fourth mass burn unit at the existing facility, and there are other counties in the state exploring new or expanded WTE capacity.

- The State of New York currently has ten operating mass burn WTE facilities. Many of these facilities were designed and built in the late 1980s and early 1990s. WTE is not considered a renewable source of energy in the state, and the New York State Department of Environmental Conservation recently issued a Statewide Solid Waste Master Plan that may further inhibit future WTE development. The statewide SWMP has proposed levies on in-state and out-of-state landfill disposal and WTE (combustion). These levies will be used to fund waste reduction and recycling programs in the state. Although public and private WTE owners are opposing

[13] https://floridadep.gov/sites/default/files/Final%20Strategic_Plan_2019%2012-13-2019_1.pdf

this provision in the SWMP, it remains to be seen what the future impacts will be on the industry.

- In California, there are several pieces of legislation that are driving the use of alternative technologies, particularly for organics management. These include Assembly Bill (AB) 341 (75% recycling goal by 2020), AB 1826 (mandatory commercial composting), AB 32 (reduction of GHG emissions) and Senate Bill (SB) 1383 (targets for statewide organic disposal reductions). This legislation and incentivizing increased diversion from landfilling has promoted the construction and implementation of MWP facilities throughout the state. This legislation and the removal of the recycling credit that was historically granted to the two remaining operating mass burn WTE facilities in the state. As a result, the two remaining WTE plants in the City of Long Beach and Stanislaus County will close due to the associated economic burden. [14]

- Minnesota considers WTE as a renewable energy source and has nine WTE plants. [15] Minnesota has a goal of recycling and composting 75% of the state's solid waste by 2030. WTE facilities have been supported with flow control laws (i.e., legal provisions that allow state and local governments to designate the places where MSW is taken for processing, treatment, or disposal) and subsidies for haulers to bring waste to the facilities, rather than to less-expensive landfills. Minnesota currently has nine operating WTE facilities, but the largest mass burn WTE facility in the state located in downtown Minneapolis will be closing due to increased economic pressure and opposition from environmental groups.

The challenge to WTE and MWP in the US is that landfill capacity is plentiful in most states outside of the northeast states and California, and that landfill tipping fees are generally less expensive compared to WTE and MWP facilities. The incentives for developing WTE capacity that were granted initially under PURPA are no longer in place for many of the WTE facilities whose 20-year power purchase agreements with electric utilities expired. This has left most WTE owners and operators with no option but to receive only current market rates for the electricity generated by their facilities, which are not always favourable or able to sustain operating costs. Furthermore, environmental advocates and non-governmental organizations have put increased pressure on mass burn WTE plants to close. For this reason, the development of new WTE capacity in the US over the last two decades has been limited to Florida or states that have limited landfill capacity and/or have incentives in the form of renewable energy credits. That said, there are still many WTE facility owners and operators in the US who are continuing to invest significant capital money to perform replacements and upgrades of key facility equipment to extend the operating life of their existing assets.

Canada

Like the EU/UK and US, all provinces and territories in Canada have adopted a similar waste hierarchy, where the recovery of energy and resources is considered the fourth most desirable option above landfilling. However, conventional mass burn WTE technologies are not considered a renewable source of energy and are not typically part of circular economy strategies. The federal

[14] https://www.calrecycle.ca.gov/Laws/Regulations/ Accessed November 11, 2020.

[15] https://energynews.us/2016/04/26/midwest/in-minnesota-waste-to-energy-debate-firing-up-once-again/

government and all provinces have also adopted some form of GHG reduction targets and climate action plans to reduce carbon emissions, including the Government of Canada's commitment to achieve net-zero emissions by 2050 (known as the *Canadian Net-Zero Emissions Accountability Act*). Some provinces, such as Quebec and Manitoba, have enacted regulations that require landfill levies similar to the EU and UK, but in both cases, these levies also apply to WTE mass burn incineration. Similarly, some other provinces are also considering landfill levies to help fund waste reduction and diversion efforts, but it is not clear if these levies will also be applied to mass burn WTE technologies.

The drivers that have prompted some municipalities to develop MWP or WTE technologies can be very localized and were often driven by the lack of or limited landfill capacity in a particular region. For example, in Durham Region, the symbolic closure of the border with Michigan to allowing MSW from Ontario municipalities coupled with the lack of available landfill capacity in the Greater Toronto Area were the primary drivers behind the development of the Durham York Energy Centre. Other factors in provinces and municipalities in Canada that are driving interest in MWP technologies include looking for ways to increase the recovery of commodities and additional organic wastes that are not being captured using current diversion programs. As noted above, interest in alternative fuels and non-fossil sources of energy has driven interest in using LFG or AD biogas as a source of RNG, and even thermal energy from mass burn WTE as a source for district energy systems in Vancouver and PEI.

4.2.1.2 Global Context

Australia

Australia has an action plan to meet the National Waste Policy 2018 to move the country to a circular economy. The action plan, which implements the National Waste Policy, includes national targets of halving the amount of organic waste sent to landfill by 2030 and to achieve an average 80% recovery rate from all waste streams by 2030. Most states in Australia, including but not limited to Western Australia (WA), Victoria, New South Wales (NSW), and Queensland, have adopted some form of landfill levies and WTE frameworks. In 2013, it was reported that there were 13 alternative waste treatment facilities (which includes Mechanical Biological Treatment [a form of MWP] and aerobic and anaerobic facilities) and three thermal waste management facilities (non-mass burn WTE technologies). In comparison, there are 39 large (more than 100,000 TPY) landfills which receive approximately 75% of Australia's waste. [16] Australia's first mass burn WTE facility, the Kwinana Energy Recovery project in WA, is currently in construction and is expected to be in operation by the end of 2024, however it does not appear to be in operation as off January 2025. There are also several WTE facilities in the planning stage in Victoria.

Asia

Asia is the largest and most populated continent, with 60% of the world's current population and a population density of 150 people per square kilometre. [17] Many countries are urbanizing rapidly, which is causing changes in lifestyles, consumption, and waste generation. Traditionally, many communities in Asia have relied on open dumping and use of landfill disposal for waste management. There is an

[16] https://www.environment.gov.au/system/files/resources/0a517ed7-74cb-418b-9319-624491e4921/files/factsheet-infrastructure.pdf

[17] Population of Asia (2021) - Worldometer (worldometers.info)

increasing awareness of the detrimental effects of these practices on both human and environmental health and a shift towards a greater use of controlled (i.e., fenced to control access, staffed, and waste is covered daily) and sanitary landfills to manage waste. The choice of disposal technology is heavily dependent on several factors, including income levels, land availability, socio-economic factors, climate, waste generation and composition, the rate of urbanization, and the degree of industrialization.

Some of the differences impacting the development and use of thermal treatment facilities include:

- Climate and seasonal variations that impact the quality and quantity of waste. Many countries are in a tropical or sub-tropical zone with a long, wet season. Heat and humidity increase the moisture content of MSW and can cause the organic portion of the waste to decompose quickly, which causes issues with handling and disposal. There is a need to pretreat waste directed to WTE (e.g., drying).

- Some thermal treatment facilities have implemented technology such as circulating fluidized beds to increase calorific content by reducing moisture to address the high proportion of organics in the waste stream.

- Scavenging and waste picking infrastructure is in place, resulting in the removal of high value or marketable materials from the waste stream before disposal.

- Many countries struggle with the enforcement of policies, programs, strategies, and projects in place for waste management.

- The high cost of development, operation, and maintenance of thermal treatment facilities can be prohibitive.

- There is a lack of integration and collaboration of intergovernmental agencies.

- There is limited technology manufacturing and servicing capacity and a lack of skilled technicians to operate and maintain facilities.

In many Asian cities, the biggest constraint in using landfill as a disposal method is land availability. As urbanization of cities increases, it is increasingly difficult to find space for a landfill with sufficient capacity to manage the waste generated. WTE (including gasification) facilities require a smaller footprint than a processing facility and can generate heat or power as required.

There are many countries in Asia where WTE technologies are developing or emerging, as well as others where mass burn WTE is firmly established.

The following list presents some examples of the use of landfills and WTE facilities in Asia. [18]

[18] Renewable Waste-to-Energy in Southeast Asia: Status, Challenges, Opportunities and Selection of Waste-to-Energy Technologies. Appl. Sci. 2020,010,7312. Accessed November 11, 2020

- China – 286 WTE plants in 2017[19] (expected to grow to 600 plants by 2020[20]) and 654 landfills. In 2014, it was reported that approximately 60% of MSW was managed in a landfill, 8% in open dump, and around 30% incinerated[21]

- Indonesia – 12 WTE facilities expected to be complete in 2022, 70 controlled landfills.

- Japan – 1,162 WTE facilities (29% are equipped with power generation facilities, and 71% use residual heat to produce power).[22]

- Malaysia – one incinerator, one landfill gas-to-energy facility, eight sanitary landfills, 10 controlled landfills.[23]

- Pakistan – at least two WTE facilities in development.

- Philippines – 273 controlled landfills, future WTE infrastructure being planned for.

- Singapore – four WTE facilities, one sanitary landfill.

- Thailand – three WTE plants (incineration and gasification), 91 sanitary landfills, 20 controlled landfills.

- Vietnam – 17 sanitary landfills, 91 controlled landfills, at least one WTE facility in development.

Increasingly, Asian countries are developing policies and guidelines for solid waste management to improve how waste is handled. As an example, Japan has a Waste Disposal Law that requires plastic waste to undergo thermal treatment before being disposed into landfills, which has resulted in gasification becoming a common practice for plastic disposal in Japan. Many countries are also providing economic incentives that are encouraging a move away from landfill disposal. In China and Thailand, the development of WTE infrastructure is encouraged through Feed-in-Tariff (FIT) programs, and local municipalities also provide fiscal support through low-cost loans and waste disposal fees. In India, energy from waste (EFW) is increasing with financial incentives such as subsidized tipping fees,

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[19] https://www.bbc.com/news/world-asia-50429119#:~:text=In%202017%2C%20China%20collected%20215,no%20figures%20have%20been%20released Accessed November 11, 2020

[20] https://chinadialogue.net/en/energy/11093-waste-to-energy-a-renewable-opportunity-for-southeast-asia/ Accessed November 11, 2020

[21] https://wedocs.unep.org/bitstream/handle/20.500.11822/27289/Asia_WMO.pdf?sequence=1&isAllowed=y (page 215) Accessed November 11, 2020

[22] https://wedocs.unep.org/bitstream/handle/20.500.11822/27289/Asia_WMO.pdf?sequence=1&isAllowed=y#page=195 Accessed November 11, 2020

[23] Sanitary landfills are engineered and have landfill gas collection systems, controlled landfills are engineered but the presence of landfill gas collection system is unknown or does not exist.

tax incentives and procurement policies which stipulate that states should procure electricity from EFW facilities. [24]

Middle East

Information about waste management facilities and policies was not readily available to the public. The United Arab Emirates (UAE) has a National Agenda to reduce materials disposed at landfills by 75% by 2021. Several very large WTE facilities are in the process of being constructed or have been constructed in the UAE. There is a planned facility in Dubai that aims to treat 1.82 million tonnes of solid waste annually, reported to be the world's largest WTE facility. While information available states the facility is planned to be operational in 2020, there is no information on how the development of this facility is progressing.

Beyond land availability, other key policy drivers for increased use of WTE include:

- A global movement to green and sustainable cities, resulting in changes to government policies and regulations;
- Regionalized cooperation and coordination amongst governments; and
- Cooperation with international organizations to assist with facility development.

4.3 Jurisdictional Scan – List of Facilities

The tables in **Appendix A** provide a summary of the detailed information that was compiled for each of the WTE and MWP facilities that were evaluated as part of the Jurisdictional Scan.

4.4 Outcome of the Jurisdictional Scan Analysis

4.4.1 General Findings Related to Geographic Location

The WTE and MWP facilities reviewed as part of the Jurisdictional Scan manage similar MSW feedstocks to the City of Ottawa. This is due to similar approaches to diversion and well-established recycling programs, as well as similar organics/food waste collection practices in some jurisdictions. The waste streams managed by communities in the US vary greatly depending on geography and geopolitics, but the MWP facilities reviewed in California and Minnesota as part of the scan were carried forward for having similar diversion and recycling programs to the City. Facilities located in Asia, Australia, and the Middle East, as well as some parts of southern Europe (e.g., Spain) may manage a different feedstock, due to differences in cultural (e.g., consumer behavior) and climatic conditions, so these locations were excluded from the scan since technologies and equipment are usually selected to best manage the feedstock generated locally.

[24] https://niti.gov.in/sites/default/files/2020-01/IEA-India%202020-In-depth-EnergyPolicy.pdf Accessed November 11, 2020

The following highlights some general findings and differences between the locations and projects considered as part of the jurisdictional scan:

- It is anticipated that the significant differences in climate (i.e., arid/desert, rainy seasons), cultures, and legislation and policies would impact the composition of waste feedstock materials and processes at waste management facilities in Asia, Australia, and the Middle East. As an example, outdoor windrow composting is used frequently in Australia and the Middle East where higher temperatures accelerate the composting process.

- A larger site on the order of five to greater than ten hectares would be required if the residual stream or SRF generated by the MWP was to be connected to an on-site WTE technology.

- It is possible that feedstock managed in some countries does not contain significant amounts of recyclable materials to facilitate recyclables recovery as part of MWP, as there are different methods of waste collection, including small scale door-to-door collection and scavenging of materials such as plastics and metals that would remove these materials from MSW. In the case of Canada, and specifically in Ontario, the success of the already well-established curbside recycling programs in many communities may not justify the expense of building a MWPF when considering the lower quantity and quality of the additional recyclable materials that may be recovered.

- In Canada, there are a limited number of mass burn WTE facilities. In Ontario, there are currently two operational WTE facilities managing large amounts of MSW. The Durham York Energy Centre located in Clarington, Ontario and the Emerald Energy from Waste Facility located in Brampton. The Emerald facility recently and successfully went through an environmental screening process for replacing their existing modular mass burn units with larger modern mass burn units. Other WTE facilities in Canada include British Columbia, which has a WTE mass burn facility in Burnaby, and Quebec and PEI, which each have WTE mass burn facilities. Alberta has as many as two facilities planned that are expected to be operational by 2028.

4.4.2 Financial and Contractual Observations

Both WTE and MWP facilities, particularly those projects that include both MWP with an on-site or integrated WTE facility, are expensive to develop and operate compared to traditional landfilling. Many of the facilities evaluated in the UK and EU, particularly those utilizing a WTE and/or that depend in part on the ability to market the SRF, have complex, long-term contracts in place that spread costs over a longer period. Similarly, in Canada and the US, the term length for project agreements between municipalities and private third-party operators were/are typically 20 years with one or more multi-year extensions. Contracts with large, multi-national service providers often cover collection, processing, and disposal of waste, along with development and operation of a MWP or WTE facility. In the EU, funding is being provided to member states to offset the high costs of development of facilities, such as WTE facilities, particularly in some countries that are newer to the EU and have not yet met the goals of the Landfill Directive.

Although most of the projects scanned were successfully implemented with minimal or no problems, some information related to contractual issues with WTE and MWP were identified. These issues/challenges, included but were not limited to vendors not meeting their performance guarantees (e.g., electricity generation or diversion targets), contractors that went into administration or solvency during construction/development of projects, facilities not operating properly (mostly MWP technologies), higher maintenance costs, risks from increased costs of marketing SRF (for MWP facilities) that impact costs and revenues, lower energy revenues than forecasted, and reduced markets for SRF (where applicable).

As there were a greater number of MWP facilities in the UK that also supply SRF to WTE plants, more examples of contractual and financial issues were identified in that jurisdiction, including:

- Many of the facilities reviewed were developed as part of long-term contracts with large service providers. Some MWP facilities, particularly those in the UK, appear to have experienced financial and operational issues, which is not uncommon in developing complex integrated waste management facilities.

- Waste management in the UK is under pressure, including tighter markets for SRF and higher costs for disposing this material in the EU due to Brexit, as well as concerns in the EU about managing waste materials from another jurisdiction and demand on capacity from local sources. The tax on SRF imports from the UK was imposed by other EU member states to achieve national climate targets and to create more resource-efficient and non-toxic waste management.

- The taxes on waste and SRF imports had driven the UK market to develop more WTE and thermal treatment facilities. However, UK contractors appear to have had a greater frequency of issues with construction of WTE plants for various reasons, including but not limited to the following: lack of expertise; bearing a large burden of the technical and financial risk; complicated and onerous client requirements; and issues with Private Finance Initiatives and Public Private Partnerships.

- Recently, both Durham Region and Peel Region in Canada developed procurements to retain a private third-party to design, build, and operate a MWP facility to recover additional organics that would be processed by an integrated AD facility. In both cases, the pricing associated with the projects was significantly higher than anticipated, resulting in both procurements being canceled. Some of the reasons behind the higher than anticipated pricing were the effects of the war in Ukraine, inflation, and the vendors and contractors monetizing the risks associated with the Regions' desired contractual guarantees. The inclusion of the MWPF in both procurements versus focusing the AD process solely on the SSP collected in those jurisdictions may also have contributed to the higher-than-expected capital costs

- The lack of available expertise for WTE can present issues during construction, making project implementation longer and more costly. This has been the experience in the UK and was also a contributing factor to the delays and early commissioning issues experienced during the construction of the Durham York Energy Centre. As noted, there have been several firms in the UK that have gone into insolvency/administration citing poor profit from WTE projects caused by a lack of experience that resulted in design and construction issues.

4.4.3 Landfill Disposal Considerations

- As noted in **Section 3.3**, there are several potential landfill disposal options available to the City, including expanding Trail and setting up disposal agreements with one or more existing private waste management facilities currently operating within eastern Ontario. Regardless of which of the five scenarios is selected by the City, there will be a need to have at least some landfill disposal capacity available to accommodate non-recyclable residual waste.

- If the WTE option is determined to be the preferred long-term solution for the City, it will need to be confirmed with the receiving site that the MECP has not imposed any conditions (e.g., only materials that cannot be recycled or reused further) that may restrict the site from receiving bottom ash residue. Based on existing sites in the Ontario, this is considered a low risk. Otherwise, the landfill may receive the waste.

- The flue gas treatment and boiler fly ash generated by the mass burn WTE facility (typically 3% to 4% of the incoming waste by weight) will be considered hazardous unless treated. The two operating WTE facilities in Ontario take different approaches to fly ash disposal. The Emerald Energy from Waste Facility collects the fly ash separately and disposes that material as a hazardous waste. The Durham York Energy Centre collects the fly ash separately but treats and stabilizes the material onsite using Portland cement and pozzolan so that it can be disposed of in a non-hazardous landfill. Both processes can be expensive, but the City will need to assess the best approach(es) if the WTE option is selected.

- Depending on the equipment selected and facility arrangement, the MWP option could generate a significant residual stream (as much as 50% of the incoming waste stream by weight) that would still require additional processing or landfill disposal.

4.4.4 WTE Considerations

- In the development of a WTE facility, economy of scale is an important factor. Many of the recent projects reviewed as part of this jurisdictional scan process greater than 300,000 tonnes of waste per year. The potential waste capacity available for the City's WTE option (i.e. 267,600 TPY) is technically feasible for this technology but is slightly below the typical "sweetspot" for the economy of scale factor (i.e. 330,000 to 350,000 TPY and higher). That being noted, there are exceptions, such as in the case of the Durham York Energy Centre. There are also design options that could be considered further, such as a single unit, that could help project economics.

- Based on the scan of existing WTE facilities, particularly in North America, the typical approach to implementing these projects is to rely on the experience of a private third-party to prepare the detailed design, construct the facility, and operate and maintain the facility under a long-term agreement. In some cases, in North America and the UK, the private third-party has also financed the project and retained ownership of the facility. Given the complexity of the development and operations of a WTE facility, it would require significant effort for the City to implement this type of project through a traditional design, bid, build (DBB) model and then self-operate the facility. Typically, municipally owned WTE facilities have an operator contracted to operate the facility like the Durham-York Energy Centre. The municipality would typically provide staff to operate the scale house, manage waste deliveries, and communicate with the facility operator to ensure the facility is operating in compliance with the terms and conditions in the Operator Agreement.

- For the level of complexity and financial impact of developing this type of facility, the City could engage with other municipalities to achieve long-term financial and environmental benefits. The short-term financial impact of developing a waste-to-energy facility challenges the ability for the City to pursue independently. However, longer design life, increased local disposal capacity, and volume reduction minimize the risk of rising disposal prices across the Region as regional landfills reach the end of their useful lives.

- The annual operating expenses for a waste-to-energy facility are driven primarily by the operator service fee. These costs represent between 60% and 70% of the annual operating costs. The fee structure to equitably support a waste-to-energy operation could be a combination of an increase to the solid waste fee and implementation of an impact fee on commercial entities for solid waste (in addition to the existing impact fees for roads, schools, and safety). If a facility is developed through a multi-jurisdictional approach, less of the operating cost burden would be borne by the City.

- Waste-to-energy is the becoming more acceptable in Ontario as an alternative to landfilling, but the level of complexity regarding siting and permitting is significant, which may factor in this option being selected by municipalities. There may be higher local emissions of particulate matter and other carcinogens (NO_x, SO_2, etc.) that make the level of complexity regarding siting and permitting more challenging due to public opposition regarding potential health concerns. Although tightening emissions regulations are a challenge, proactive planning and public engagement to communicate the social and environmental benefits of waste-to-energy are essential. For these reasons, effective planning and engagement to design and develop a new WTE facility is expected to take between seven and 10 years before construction begins to communicate the social, environmental, and financial advantages of developing this type of local disposal capacity.

4.4.5 MWP Considerations

- A MWPF could be operated by the City, like a regular MRF. However, due to the technical complexity, staffing expertise, and equipment maintenance required to manage a MWPF of this size, some facility owners choose to hire a private third-party operator under a negotiated long-term operations and maintenance agreement.

- The annual costs to develop and operate a MWPF are driven primarily by the labour, hauling, and disposal operations. These costs represent 75% of annual operating costs. These costs may vary depending on any opportunities to increase technology and automate operations (e.g., optical sorters) to reduce the number of required quality control sorters and process operators. Additionally, reducing truck hauling distance or achieving a more competitive disposal cost could reduce operational expenses. As advances in recovery technology and the use of artificial intelligence and robots continues at MWPF, the costs associated with maintenance and upgrading this equipment will also be a potentially larger contributor to operating costs.

- A number of the existing MWPFs constructed in the US were developed in jurisdictions that did not have an existing MRF and had limited curbside recycling programs. In these cases, the benefits of the MWPF allowed for minimized collection costs because garbage and recycling could be co-collected, and material can be brought to a centralized location. Given the existing recycling programs in the City, the additional diversion benefits of a MWPF are minimal and would need to be achieved through increased education, outreach, and compliance through the existing recycling program while still yielding a very high residual process stream (50%+), which will require hauling to a landfill or WTE.

An evaluation of the MWP options shows the following:

- MWPFs would be capable of recovering metals, typically with a recovery rate that is at or over 75%. Typically, ferrous metals are recovered at a rate of 85% to 90%, and aluminum at a rate of 75% to 90%. End-market specifications for metals differ between North American and UK/European markets, particularly when it comes to quality (percent residue) and the ability to market a 'blended' metals stream.

- MWPFs would be capable of recovering HDPE and PET, typically with recovery rates over 40%. Reported recovery rates in the US typically range up to 60% and are more than 40% in the UK/European context. In Canada, these recovery rates vary depending on provincial regulations. In Ontario, there are new regulatory requirements for specific materials (including blue box materials) under the RRCEA that require producers to establish programs to recover their materials.

- MWPFs would not generally recover polypropylene. Recovery of this material is limited by a lack of secondary markets.

- MWPFs would recover OCC, but typically at or under 30% recovery due to the difficulties of removing clean, marketable OCC from mixed solid waste.

- MWPFs often recover a range of other materials, such as wood and electronic waste materials.

- The City would need to apply quality control measures to achieve similar quality standards for recyclables as those applied to materials recovered from a single stream material recovery facility. As a result of China's National Sword initiative, European re-processors of plastic materials are more sensitive to material quality standards. They will often direct plastics to secondary processing to shred, wash, and flake the polymers for sale to the plastics industry.

- MWPFs typically recover over 50% of the organics present in the mixed waste stream, usually as part of the undersized fraction of materials, if desired. Note that due to the City's green bin program, there will be significantly less organic waste present in the mixed waste stream and therefore a much lower overall recovery rate.

- MWPFs typically have a range of inorganic contaminants in the recovered organic fraction, which can make up as much as 40% by weight of this material. This necessitates either on-site or off-site refinement to remove inorganic materials, based on the quality standards applicable to the final organic product. Long-term viable end-uses for the stabilized high-organics fraction (post-AD and/or composting) are often soft landscaping, industrial site rehabilitation, and landfill cover. There are some (limited) examples of higher value beneficial markets for products derived from recovered organics.

- The organics fraction recovered from MWP would need to be directed to a robust pre-treatment system capable of removing the higher inorganic contamination in the material to make it suitable for AD processing (should the City consider an organic processing facility as part of the MWP) and to produce a marketable end-product. Further analysis of separation technologies would be required to assess the feasibility of managing the organics fraction that could be recovered by a MWPF. This analysis is not part of the objectives for this Feasibility Study for the City.

- Higher heat value materials could be recovered from the residual mixed waste through MWP as a RDF/SRF. Recovery of RDF/SRF could substantially increase the recovery of materials through a MWPF and would be a consideration for the MWP and WTE option being considered by the City. If RDF/SRF recovery was a consideration, a solid fuel analysis of the residual remaining, or unrecyclable fraction would need to be performed to determine the potential fuel quality and marketability of this material.

4.4.6 Consideration of MWP with WTE Option

There were several examples of UK-based MWPFs that provided process residues or an RDF/SRF material to a mass burn WTE plant. In addition, a large part of the diversion rate associated with MWPFs in those UK jurisdictions was associated with the recovery and marketing of RDF/SRF and not solely on the recovered commodities.

- The City is considering the development of a MWPF that produces RDF to divert additional materials from Trail. As documented in this technical memorandum, RDF/SRF could be derived from the residual waste that would remain following the separation of the waste (mixed materials that may fall under the equipment that generally are most of the organics fraction, as well as glass, grit, and other materials) and removal of marketable blue bin recyclables. Recovery of RDF/SRF could result in a 4% to 10% change in the quantity of material diverted from landfilling.

- Under current Ontario legislation, the production of RDF/SRF does not count towards diversion. It is possible that this could change in the future, but the timing is unknown. However, regardless of whether it's diversion, there would still be physically less material being sent to the landfill if the RDF/SRF could be further processed or marketed.

- The potential range in tonnage for RDF/SRF as identified in **Table 3-20** would be at the lower end of typical thermal treatment design capacities. As noted previously, WTE technology is technically feasible at lower waste quantities, but this could affect the economy of scale and price for development of a purpose-built facility intended to use RDF from the City as a fuel. It is anticipated that the development of a MWPF with a WTE Facility would involve a more intense and time-consuming siting and approvals process.

4.5 Summary of Jurisdictional Scan

The outcome of the Jurisdictional Scan analysis indicates that:

- WTE facility design and operation is complex and has been primarily implemented via a public-private partnership with a qualified private third-party contractor or operator. In most of the recent WTE projects evaluated as part of this scan, the municipal entity entered into a long-term agreement with a private entity to perform the detailed design, construction, operation, and maintenance, and even to finance and own the facility in some cases (particularly in the UK). Ownership and project delivery models are evaluated in more detail in Technical Memorandum #3.

- GHG reduction technologies implemented in WTE facilities, such as selective non-catalytic reduction and selective catalytic reduction, are primarily focused on the reduction of NO_x emissions. Carbon capture applications for WTE facilities are in development and have been applied to some WTE facilities in Japan, the EU, and the UK, but data and cost information is limited. The Varme projects under development in Alberta will be some of the first in North America to apply carbon capture technology on a commercial scale to a mass burn WTE facility. There have been some pilot studies on WTE plants in the U.S., specifically the Hillsborough County WTE Facility in the Tampa, Florida area, but data is not yet available.

- SRF recovery was a significant factor in diversion performance for most of the UK/EU facilities and the Ramsey/Washington facility in Minnesota. For many facilities, SRF made up the bulk of materials recovered from the MSW. This finding highlights the connection between many MWP applications and WTE or thermal treatment, with a ready market for SRF at off-site applications or the use of on-site WTE as a component of a MWP facility or adjacent facility being a necessity to achieve higher diversion from landfill disposal.

- There are few examples of MWP facilities in Canada that could be applicable in the City of Ottawa context. Some facilities are not in continuous full-time operation, while others were built for a different purpose. For example, the Waste Stabilization Facility at Otter Lake Landfill near Halifax, Nova Scotia was implemented due to public concern related to the landfilling of untreated waste. [25] While the Edmonton Waste Management Centre was brought into the Jurisdictional Scan (as it was thought that the City could benefit from the lessons learned in the development of this Canadian facility), it should be noted that the MWP facility is operational and still produces an RDF/SRF that is marketed to local cement kilns. However, the Enerkem waste-to-fuel facility that was originally the primary receiver of the RDF/SRF is no longer in operation. The costs associated with the operation and maintenance of the RDF/SRF facility are significant and Edmonton may not continue to operate that process now that they have signed an agreement to take their waste to the Varme WTE facility being planned in the region.

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[25] http://www.otterlakecmc.ca/?page_id=572

- There are MWP facilities in the US where the primary focus of the facilities is the diversion of recyclables and recovered organics, many of them in California. The technology applied at those facilities may be reasonable in the Ottawa context in that the scale of the facilities is similar in scope. The range of source-separation and diversion programs in place within some of the municipalities that use MWPFs vary greatly and don't always align exactly the City. The difference in recycling programs compared to the City may include factors, such as fewer materials accepted in the municipal source-separation and diversion programs, the programs are offered to fewer users, and there are differences in the availability or convenience of diversion programs. These factors can result in a different mixed waste input stream that may contain more high-value recyclable materials for potential recovery versus a jurisdiction, like the City of Ottawa that has a more established recycling program.

- There are a wide range of MWP approaches applied in the UK and Europe, some of which could be applicable to the City. Most facilities are in jurisdictions of a similar scale to Ottawa, recover organics to some extents have a comparable mixed waste feedstock resulting from generally similar curbside collection and source-separation programs, meet the sizing criteria, and are relatively "new" facilities (commissioned within the last 10 years).

- Regarding landfill disposal, most jurisdictions in Europe and North America use traditional engineered landfills for disposal of residual materials. As described in **Section 3.3,** there are several potential landfill options within eastern Ontario that could be considered for disposal of MSW, MWP process residuals, or WTE ash.

- Solid waste technological solutions like WTE and MWP implemented in Europe have developed in response to circumstances including the specific fiscal and regulatory regime in those jurisdictions and available material markets that make direct comparisons to the City of Ottawa, and North America in general, challenging. Furthermore, the financial incentives and drivers in place in the EU and UK that help promote WTE and MWP implementation, like landfill bans and levies, do not currently exist in North America. However, the lessons learned, and technical experience gained from the EU and UK experience in the WTE and MWP markets are still valuable to the City for the purposes of the Feasibility Study.

- Experience in the UK and EU indicates that achieving substantial reduction in tonnes sent to landfill in most jurisdictions has required SRF recovery as a primary offtake for MWPFs, with recovery of recyclables and/or organics having more limited markets or end-market sustainability issues. The viability of SRF recovery from a MWPF is tied to the availability of end markets that can use this material (e.g., thermal treatment plants, industries such as cement kilns).

- Although not within the scope of this Study, using MWP technology to achieve diversion targets for organics will require finding a solution that can take a highly contaminated organic material stream (e.g., remaining residuals from initial mixed waste screening with approximately 50% organic content) and turn it into an organic feedstock or product that is marketable. Very few of the facilities identified appear to recover a product that could be broadly marketed in Ottawa under the Ontario Compost Quality Standards or other federal fertilizer standards. Most facilities (mainly those in Australia) that extract and process an organics stream generate a compost-like material with limited or restricted markets based on quality that is used as alternative daily cover for land rehabilitation or other similar restricted uses.

- Markets for the recyclable material recovered from MWP has been challenging, particularly due to stricter contamination requirements in some Asian markets that had traditional taken these materials. As a result, the recovered materials in some locations like California have had to find other markets or even landfill the recyclable materials recovered by the MWPF. Some plants are focusing on producing higher purity outputs, which is requiring additional capital investment for alternative sorting technologies (e.g., robotics, plastic washing). Re-processing options within Canada for low-quality materials may help support recovery plants processing MSW, but the MWP design will need to build in more flexibility to allow for future technology and equipment advances.

- SRF recovery has been a focus of many MWP facilities in the UK and Europe and is linked to the availability of local markets. In some cases, the evaluated MWP facilities have been purpose-built to prepare SRF for an adjacent or regional WTE application.

- In North America, particularly in California, the recovery of additional recyclables and the organics fraction of MSW has been a primary focus for most existing MWP facilities identified in the scan of that jurisdiction. For those facilities that do recover the organics stream, the products resulting from organics processing may not be marketable in the Ottawa context. This is a critical issue: the analysis completed as part of this technical memorandum indicates that recovery of organics (and marketable products derived from organic processing) will be essential to achieving greater MWP diversion performance.

- Many of the examined MWP facilities experienced some or many issues in commissioning and operating the full range of component technologies that are part of the facilities. In many cases, inadequate data was available to assess recovery rates, material quality, operational uptime and downtime, etc.

5 Summary and conclusions

Technical Memorandum #1 was prepared as the first step in the City's Feasibility Study for the development of WTE and/or MWP facilities. The purpose of this memorandum was to review the waste generation and composition projections developed in the City's 30-year SWMP and provide an overview of the landfill disposal and WTE and MWP technology options. A jurisdictional scan of recent similar projects for each of the options was also undertaken to gather relevant information from internal and external sources across North America and globally. The information gathered for each of the five options was reviewed and validated and will help to inform further evaluation through a triple bottom line analysis in the next steps of the Feasibility Study.

Based on our review of pertinent information for the City's projected waste generation and composition and the outcome of the jurisdictional scan, the following preliminary conclusions and recommendations were identified for each of the options being considered:

- **Option 1: Status Quo and Private Facilities – Trail with Third-Party Disposal.** Regardless of what option is ultimately selected, the City will continue to need disposal capacity at Trail until it reaches capacity and then will need to utilize disposal at one of the regional waste management facilities. Both the WTE and MWP options can reduce the amount of waste requiring disposal, but both technologies will generate some residual stream that will require landfilling (e.g., non-processables, fines, incinerator ash, etc.). The City is pursuing approvals to expand Trail and has entered into waste disposal agreements with one or more of the private waste management facilities in the Region, which could help extend the life of Trail. Given the need for reliable disposal for the next 30-year planning window, the Status Quo and Private Facilities option will be required and evaluated in more detail as part of the triple bottom line analysis.

- **Option 2: WTE Facility.** The WTE option provides a commercially proven and effective method of reducing the amount of waste requiring landfill (up to 90% by volume and 75% by weight). WTE technology has been the preferred approach to processing residual waste in the EU, parts of Asia, and more recently in the UK. The energy recovered from a WTE facility is used to generate electricity and thermal energy for district heating and cooling that can provide the City with an additional revenue source. Based on the composition data reviewed in the SWMP, WTE technology has the flexibility to efficiently process the City's waste. Developing a WTE facility for the City would be considered technically complex. However, there are recent examples in Canada and the US that make the WTE option a viable option to the City. The WTE option will be evaluated further and in more detail as part of the triple bottom line analysis.

- **Option 3: MWP Facility.** MWP facilities operate successfully in North America, with a more concentrated presence in the western US, as well as in the UK and EU, and some examples in Canada. MWPFs use proven technology, including various mechanical, pneumatic, optical, and automated sorting processes are updated continually. A MWPF could process all the City's projected waste to recover additional recyclables and organics. Based on the findings in the jurisdictional scan, the quantity and quality of the recovered materials could affect the ability to market these materials, particularly the recovered organics stream given the City's existing green bin program and the expected levels of non-organic contamination. Recent MWP procurement examples in Ontario found the costs associated with a MWP that included organics recovery, and an adjacent AD facility were canceled due to higher-than-anticipated capital and operating costs. However, the MWP option can still be a viable option to the City and will be evaluated further as part of the triple bottom line analysis.

- **Option 4. WTE and MWP Facilities.** A MWPF coupled with an adjacent mass burn WTE facility was evaluated as part of the jurisdictional scan. There are a wide range of MWP approaches applied in the UK and EU that are applicable to the City. Most facilities are in jurisdictions of a similar scale to Ottawa, recover organics to some extent, and have a comparable mixed waste feedstock due to similar curbside collection and source separation program. This approach would be the most technically complex and likely most expensive of the five options being evaluated. The upside of this option could be the potential for the highest diversion from landfill and recovery of energy and commodities when compared to the WTE or MWP options alone. Therefore, the MWP and WTE combination option is still a viable option at this point in the study and will be evaluated further as part of the triple bottom line analysis.

- **Option 5. Construct a New Landfill.** Construction of a new landfill was evaluated in detail as part of the SWMP. Although this option would provide the City with a secure long-term solution and known approach after the closure of Trail, the potential change in the waste management landscape associated with the technical complexity and issues management associated with siting, EA process, timing, and ultimate costs could make this option the least feasible of the five being considered during the matrix review. The new landfill option will still be carried forward as part of the triple bottom line analysis in the next steps of the study for comparison purposes.

Table 5-1 provides a summary of the key background information compiled for each of the five scenarios being considered in this evaluation. The information in **Table 5-1** and key findings identified in Technical Memorandum #1 will be used to further define the next steps in the Feasibility Study, including identifying the siting and regulatory approval requirements for each option, the potential project delivery models and funding opportunities available for each option, and the evaluation criteria, scoring, and weightings that will be used to assess the final feasibility of each of the five options.

Table 5-1: Scenario Comparison Table

	Option 1 Status Quo and Private Facilities	Option 2 WTE	Option 3 Mixed Waste Processing	Option 4 MWP and WTE	Option 5 New Landfill
Design Throughput (tonnes per year)	>260,000	267,600	267,600	267,600/227,500	>260,000
Feedstock Accepted (1)	Mixed MSW	Mixed MSW	Mixed MSW	Mixed MSW	Mixed MSW
Site Area Required (hectares, ha)	None	3-5 ha	3-5 ha	5-10 ha	100-200 ha
Energy Recovery Potential (MWt & MWe)	None	89 MWt (Gross) 22 MWe (Net)	None	80 MWt (Gross) 18 MWe (Net)	5-10 MWe
Potential for District Energy	No	Yes	No	Yes	No
Diversion Potential (percent of tonnes of material diverted from landfill per year) (2)	0%	77%	8%	79%	0%
Average Annual GHG Impacts (tonnes of CO_2 equivalent)[26] (3)	12,000-16,500	7,300-10,000	10,300-14,100	6,000-8,200	12,000-16,500
Capital Costs (CAD)	Not Applicable	\$497M–\$862M	\$97M–\$168M	\$556M–\$965M	\$439M–\$761M
Direct Operating Costs (CAD per year) (4)	\$43M	\$38M	\$63M	\$62M	\$14M
Potential Annual Revenues (CAD per year)	Not Available	\$19.4M	\$4.7M	\$22.4M	\$1M-\$2M (for electricity) Up to \$12M (for RNG)
Expected Implementation Timeline (5)	Not Applicable	8-10 Years	5-7 Years	8-10 years	7-10 years

Notes:
(1) Other feedstocks such as commercial MSW, ICI, or specialty waste could be considered for each of these options, but they are not anticipated to be included at this time.

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(2) Includes waste that is processed/converted (e.g. incinerated) or recovered with a defined resale market (plastics, metals, some paper). These values do not include incinerator ash, process residues from MWP, or recovered materials with no defined market in Ontario, Canada, which are assumed will be landfilled.

(3) Results are taken from the Organic Waste Greenhouse Gas Calculator produced by Environment and Climate Change Canada, which excludes biogenic emissions and avoided emissions from recycled materials. Values exclude transportation emissions and are the average of annual lifecycle emissions over 30 years. Model assumptions also assume up to 90% capture of total LFG produced is used to produce electricity. Actual emissions will vary based on material specific decay rates and volume of waste disposed of annually. Due to the limitations of the tool, HDR will use a customized model that is able to incorporate lifecycle emissions estimates across more materials, in line with the USEPA's Waste Reduction Model (WARM), and will be able to track emissions based on varying waste volumes over time.

(4) Based on direct operating costs, not including indirect costs such as financing and Debt Service costs. Operating cost values are based on 2053 design year capacities, note that costs between 2035 and 2052 will be less than values shown.

(5) Based on recent experience with similar projects and on evaluation performed in more detail for Technical Memo No. 2.

Appendix A

Jurisdictional Scan Details

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Table A-1: 2024 North America, UK, and Ireland, EU WTE Project Jurisdictional Scan

Name of Project:	Durham York Energy Centre	Varme Energy Inc.	Metro Vancouver WTE Facility	Dublin WTE Facility	Rookery South Energy Recovery Facility	Newhurst Energy Recovery facility	Earl's Gate Energy Centre	Protos Energy Recovery Facility
Location	1835 Energy Dr Courtice, Ontario	Industrial Heartland Fort Saskatchewan, AB	5150 Riverbend Dr Burnaby, BC	Poolbeg Peninsula, Dublin, Ireland	Green Lane, Stewartby, Bedford MK43 9LY, UK	Shepshed, Loughborough LE12 9BU, UK	Green Ln, Stewartby, Bedford MK43 9LY, UK	ERF Limited, Generation Road, Ince, Protos CH2 4FJ, UK
Website	Durham York Energy Centre (durhamyorkwaste.ca)	Industrial Heartland, Alberta, Canada — Varme Energy	Waste-to-Energy Facility | Metro Vancouver	https://www.dublinwastetoenergy.ie/	https://www.rookerysoutherf.co.uk/	https://www.newhursterf.co.uk/	https://egecl.com/	https://www.protoserf.co.uk/about-the-facility/
Feedstock (mixed MSW, RDF or SRF, etc.)	Mixed MSW	Mixed MSW	Mixed MSW	Mixed MSW	Mixed MSW	Mixed MSW	Mixed MSW	Mixed MSW
Technology Grouping	WTE – Mass Burn	WTE - Modular Mass Burn	WTE – Mass Burn	WTE – Mass Burn	WTE – Mass Burn	WTE – Mass Burn	WTE – Mass Burn	WTE – Mass Burn
Capacity (TPY or TPD)	140,000 tonnes/year	150k-205k tonnes/year	310,000 tonnes/year	690,000 tonnes/year	657,000 tonnes/year	450,000 tonnes/year	274,000 tonnes/year	500,000 tonnes/year
Energy Output	20 MWe Gross/Up to 7 MWt (not connected)	Up to 15 Mwe	23 MWe Gross (developing district energy)	60 MWe Net (plus up to 90 MWt for district heating)	60 MWe Net (plus district heating being developed)	42 MWe Net	21.5 MWe Net (plus steam sales)	49 MWe Net
Years of Project	Initial Planning - 2004 Startup - January 2016	Under Development (expected 2027/2028)	March 1988	October 2017	January 2022	Spring 2023	Winter 2024	Fall 2024
What were the opportunities / major accomplishments?	First True Greenfield mass burn WTE Facility in North America in two decades.	First "industrial scale" WTE with carbon capture in Canada	One of the first WTE Facilities to be constructed in Canada	Greenfield project that provides 100 jobs (over 300 during construction)	Reduces landfill and generates baseload electricity for 112,500 households	First facility in UK to use hydrogenated vegetable oil (HVO) to replace diesel fuel	Supports Scottish initiative to ban MSW from landfills by 2025	Part of Peel NRE's strategic energy and resource hub at Ellesmere Port
What were the Risks?	• Contractor (Reworld and GC) lacked WTE construction experience in Canada • Inexperience within MECP with technology	• Engineering, structuring, and costing • Securing enough quality waste to make the project sustainable	• Technology risks – a lot of parts/systems that came from outside N. America • Quality issues during design and construction – design issues with ash pit	• Fly ash must be transferred to Norway as hazardous waste driving up O&M costs • Brownfield site challenges – contaminated soils	• Crane manufacturer was inexperienced which caused issues • COVID-19 impacts on schedule and costs	• Largest single combustion unit manufacturer (HZI) ever built – issues during operation • Endangered species concerns – rare type of newt found near site	• Contaminated brownfield site challenges • Permit required odour control technology to be implemented on the tipping floor • Small single unit	• Contaminated brownfield site on a port site • Heavily unionized labour force drove up project costs and delays
What were/are the Challenges?	• Opposition Schedule delays during construction.	• Understanding the feedstock & gathering all pertinent information	• Equipment manufacturers were from Europe with no local reps	• Cost overruns & construction challenges – leaks in waste storage bunker	• Quality control issues during design and construction process	• Grate length for large single combustion stoker warped during startup operations	• Original EPC Contractor (CNIM) went bankrupt during project	• Quality of soil at port site required lots of piles when constructing the foundation
Capital Costs / Operating Costs (CAD)	$255M (2011) / $15M (2011)	~$300M / TBD	~$210M (2024) /	$820-$850M / $70-$75M	$800-$845M / $25-$30M	$575-$625M / $28-$32M	$625-$715M / $30-$34M	$715-$800M / $34-$36M
Delivery model	Design-Build-Operate-Maintain (DBOM)	Design-Build-Finance-Operate-Maintain (DBFOM)	Design-Build-Operate-Maintain (DBOM)	Engineer-Procure-Construct (EPC)	Engineer-Procure-Construct (EPC)	Engineer-Procure-Construct (EPC)	Engineer-Procure-Construct (EPC)	Engineer-Procure-Construct (EPC)

Name of Project:	Durham York Energy Centre	Varme Energy Inc.	Metro Vancouver WTE Facility	Dublin WTE Facility	Rookery South Energy Recovery Facility	Newhurst Energy Recovery facility	Earl's Gate Energy Centre	Protos Energy Recovery Facility
How was it Financed	Gas Tax	Private and $2.8M Grant from Emissions Reduction Alberta	Debt Financed	Debt Financed (25-30% Equity)	Debt Financed (30% Equity)	Debt Financed (30% Equity)	Debt Financed (25% Equity)	Debt Financed (30% Equity)
Current Ownership Structure	Owned by Durham Region and York Region, operated by Reworld under a 20-year operating agreement	Public private partnership (PPP) between Edmonton and Varme	Owned by Metro Vancouver, operated by Reworld under operating agreement (expires in March 2025)	Public private partnership (PPP) between Dublin City Council three private entities: Encyclis; DIF Capital Partners, and PG	Private Ownership, Partnership between Encyclis and Veolia	JV between Encyclis and Biffa, Hitachi Zosen Innova constructed under EPC contract	Partnership between Encyclis and Brockwell Energy	Partnership between Encyclis and Biffa
Any GHG reduction technology incorporated?	Dry with Enhanced SNCR for NOx control.	TBD	Dynamic SNCR for NOx control.	Dry and wet scrubber with SNCR for NOx control.	Dry scrubber with SNCR for NOx control.	Dry scrubber with SNCR for NOx control.	Dry scrubber with SNCR for NOx control.	Dry scrubber with SNCR for NOx control.
Carbon capture?	No	Yes (claims 130k tonnes/yr CO_2 captured)	No	No	No	No	Funding to capture carbon emissions being explored	First in UK - currently under planning and permitting.
Impacts on Diversion	• 100k-105k tonnes/yr of waste diverted from landfill • ~4k tonnes of ferrous and non-ferrous metals recovered	• Up to 150k tonnes/yr of waste diverted from landfill	• ~200k tonnes/yr of waste diverted from landfill, plus 5k of ferrous and non-ferrous metals recovered	• ~500k tonnes/yr of waste diverted from landfill, ~170k bottom ash recycled • Avoids up to 250k tonnes of fossil fuels	Up to 657,000 tonnes/yr of waste diverted from landfill, plus incinerator bottom ash is recycled into construction aggregate	Diverts up to 350,000 tonnes of waste from landfill, plus recover metals and incinerator bottom ash for reuse	Will divert up to 274,000 tonnes/yr of waste from landfill, plus ferrous and non-ferrous metals recovery	Diverts up to 500,000 tonnes of waste from landfill, plus recover metals and incinerator bottom ash for reuse

Table A-1: 2024 North America, UK, and Ireland, EU WTE Project Jurisdictional Scan (Continued)

Name of Project:	Four Ashes Energy Recovery Facility	Ardley Energy Recovery Facility	Dunbar Energy Recovery Facility	Cardiff Energy Recovery Facility	Amager Bakke WTE Plant (aka CopenHill)
Location	Staffordshire, UK	Bicester, UK	Dunbar, UK	Cardiff, UK	Copenhagen, Denmark
Website	https://www.veolia.co.uk/four-ashes-energy-recovery-facility-erf	https://www.viridor.co.uk/energy/energy-recovery-facilities/ardley-erf/ https://www.varme.ca/projects/industrial-heartland	https://www.viridor.co.uk/energy/energy-recovery-facilities/dunbar-erf/	https://www.viridor.co.uk/energy/energy-recovery-facilities/cardiff-erf/	https://a-r-c.dk/amager-bakke/from-waste-to-energy/
Feedstock (mixed MSW, RDF or SRF, etc.)	Residential MSW	MSW	MSW	Mixed MSW and SRF	MSW
Technology Grouping	WTE – Mass Burn	WTE - Mass Burn	WTE – Mass Burn	WTE – Mass Burn	WTE – Mass Burn
Capacity (TPY or TPD)	340,000 TPY	378,000 TPY	390,000 TPY	400,000	400,000
Energy Output	29 MWe (Gross)	24 MWe (Gross)	36 MWe/10 MWt	30 MWe	63 MWe/250 MWt
Years of Project	Initial planning 2009/10 Construction commenced 2011 Commissioned 2014	Initial planning 2009 -2011 Construction commenced 2011 Commissioned 2014	Planning permission 2013 Construction commenced 2014 Commissioned 2019	Planning granted 2010 Construction started 2012 Commissioned 2014	Construction commenced 2013 - Construction Completed 2016 Commissioned - 2017
What were the opportunities / major accomplishments?	Energy prices - Government 'green' policy (taxes etc.) - General construction opportunities	Energy prices - Government 'green' policy (taxes etc.) - General construction opportunities	Energy prices - Government 'green' policy (taxes etc.) - General construction opportunities	Energy prices - Government 'green' policy (taxes etc.) - General construction opportunities	• Plant is constructed in downtown Copenhagen and includes a ski slope and climbing wall.
What were the Risks?	• Council planning challenges - Labour/expertise shortages - Supply chain issues - Energy prices - Government 'green' policy (taxes, emissions etc.)	• Council planning challenges - Labour/expertise shortages - Supply chain issues - Energy prices - Government 'green' policy (taxes, emissions etc.)	• Council planning challenges - Labour/expertise shortages - Supply chain issues - Energy prices - Government 'green' policy (taxes, emissions etc.)	• Council planning challenges - Labour/expertise shortages - Supply chain issues - Energy prices - Government 'green' policy (taxes, emissions etc.)	• Plant was sized to be too large (560,000 tonne capacity vs 350,000 tonne waste forecast) requiring import of waste to be financially viable, • Controversy over burning of recyclable materials and biomatter to meet demand,
What were/are the Challenges?	• Initial planning proposal required some amendments (reduced height of building and stack)	• Council and planning requirements for ~2 years • Air pollution fears among locals	• Local resistance to plant, controversy over construction wages, Interserve (construction JV) went into administration shortly after administration with low profit EfW contracts being blamed	• Questions over whether there was enough waste to meet demands of the planned size of plant	• Funding issues from outset • Opposition between local municipalities regarding if facility met Denmark's climate plan • Controversy involving minister stepping in to ensure project went ahead to help company in his constituency avoid significant losses • Several technical issues
Capital Costs / Operating Costs (CAD)	~$317M/~$70M	~360M//~$70M	~312M/Not Available	~$325M/Not Available	~$700M-$750M
Delivery model	Private Finance Initiative (PFI) between Staffordshire County Council (SCC) and Veolia	PPP between Oxfordshire Council and Viridor, construction by CNIM-Clugston	B&W Volund/Interserve JV - engineering, procure and construct (EPC) contract	Part of 'Project Green' a PPP between a consortium of Welsh regional councils and Viridor	Owned and operated by ARC a public company comprising 5 local municipalities

Name of Project:	Four Ashes Energy Recovery Facility	Ardley Energy Recovery Facility	Dunbar Energy Recovery Facility	Cardiff Energy Recovery Facility	Amager Bakke WTE Plant (aka CopenHill)
How was it financed?	Private Equity	Mix of Public Funding & Private Equity	Private Equity	Mix of Public Funding & Private Equity	30-year public loan
Any GHG reduction technology incorporated?	Dry scrubber with SNCR for NOx control.	Dry scrubber with SNCR for NOx control.	Dry scrubber with SNCR for NOx control.	Dry scrubber with SNCR for NOx control.	Wet scrubbers, electrostatic precipitators, fabric filters, SCR (DeNOx)
Carbon capture?	No	No	No	No	Pilot CC plant installed 2022 with plans to scale up
Impacts on Diversion	• Over 10 years since commissioning diverted 2,750,000 tonnes, 1% sent to landfill (~275k TPY diverted)	• Roughly 95%' of incoming waste is diverted (~359kTPY at capacity)	• Roughly 95%' of incoming waste is diverted (~370kTPY at capacity)	• Roughly 95%' of incoming waste is diverted (~380kTPY at capacity)	• Roughly 95%' of incoming waste is diverted (~380kTPY at capacity)

Table A-2: 2024 North America and UK Project Jurisdictional Scan for MWP and MWP/WTE

Name of Project:	Sunnyvale Materials Recovery & Transfer Station (SmaRT)	Santa Barbara ReSource Center	Ramsey-Washington Recycling & Energy Center	Edmonton Waste Management Centre	Avonmouth Resource Recovery Centre	Beddington Energy Recovery Facility	Greatmoor Energy from Waste Facility	Allerton Waste Recovery Park
Location	301 Carl Road, Sunnyvale, California, USA	14470 Calle Real Goleta, CA 93117-9732	100 Red Rock Rd Newport, Minnesota, USA	250 Aurum Road NE, Edmonton, Alberta	Avonmouth, UK	Beddington, UK	Aylesbury, UK	North Yorkshire, UK
Website	https://www.sunnyvale.ca.gov/homes-streets-and-property/recycling-and-garbage/smart-station-recycling-center	https://www.countyofsb.org/1298/ReSource-Center	recyclingandenergy.org	https://www.edmonton.ca/programs_services/garbage_waste/refuse-derived-fuels	https://www.viridor.co.uk/energy/energy-recovery-facilities/avonmouth-rrc	https://www.viridor.co.uk/energy/energy-recovery-facilities/beddington-erf/	https://www.greatmoor.co.uk/	https://www.northyorks.gov.uk/bins-recycling-and-waste/allerton-waste-recovery-park
Feedstock (mixed MSW, RDF or SRF, etc.)	Mixed MSW	Mixed MSW/SSO/Mixed Recyclables	Mixed MSW (converted to RDF)	Mixed MSW (converted to RDF)	Mixed MSW (converted to RDF)	Mixed MSW (converted to RDF)	Mixed MSW (converted to RDF)	Mixed MSW (converted to RDF)
Technology Grouping	MWP/AD	MWP/AD	MWP and WTE (Mass Burn)	MWP and WTE (Gasification)	MWP and WTE	MWP and WTE	MWP and WTE	MWP/AD and WTE
Capacity (TPY or TPD)	~142,780 TPY (2022/23)	225,000 TPY MSW 36,000 TPY Recyclables 66,000 TOY SSO	360,000 TPY	100,000 TPY	427,000 TPY	347,000 TPY	345,000 TPY	320,000 TPY
Years of Project	Original - 1993/1994 Renovated in 2009	Operations - 2021	Original – 1987 Renovated in 2016	Original – 1999/2000 Renovated in 2021/22	Initial planning 2009 - Planning approved 2011 Commissioned 2020	Initial planning - 2012-2013 Construction - 2015-2019 Commissioned - 2019	Initial Planning - 2011 High Court Decision - 2013 Construction – 2013-2016 Commissioned - 2016	Initial Planning - 2013 Commissioned - 2018
What were the opportunities / major accomplishments?	• One of the first mixed waste processing and material recovery facilities in the U.S. • Establishing facility improved material recovery and diversion	• Implemented to increase the overall community's diversion rate to 85% • At the time of construction, the facility claimed to be one of the largest MWP in the world	• Added a food scrap bag sorting line that uses AI and robots to remove food scraps in compostable bags • Upgraded the recyclable recovery line to recover metals, PET and HDPE, corrugated cardboard & organic-rich materials	• Currently producing 30k-60k YPY of RDF to cement kiln • Recently signed an agreement with Varme Energy to provide 150,000 tonnes/yr to a future mass burn WTE plant.	• Energy prices - Government 'green' policy (taxes etc.) - General construction opportunities	• Energy prices - Government 'green' policy (taxes etc.) - General construction opportunities	• Energy prices - Government 'green' policy (taxes etc.) - General construction opportunities	• Energy prices - Government 'green' policy (taxes etc.) - General construction opportunities
What were the Risks?	• New technology at the time of construction	• AD/compost quality risks from organic stream captured by mixed MSW	• End market user risks for RDF if current buyer (Xcel Energy) goes away • New technology	• New technology risks associated with the waste-to-fuel technology (Enerkem)	• Council planning challenges - Labour/expertise shortages - Supply chain issues - COVID related issues - Energy prices - Government 'green' policy (taxes, emissions etc.)	• Council planning challenges - Labour/expertise shortages - Supply chain issues - COVID related issues - Energy prices - Government 'green' policy (taxes, emissions etc.)	• Council planning challenges - Labour/expertise shortages - Supply chain issues - COVID related issues - Energy prices - Government 'green' policy (taxes, emissions etc.)	• Council planning challenges - Labour/expertise shortages - Supply chain issues - COVID related issues - Energy prices - Government 'green' policy (taxes, emissions etc.)

Name of Project:	Sunnyvale Materials Recovery & Transfer Station (SmaRT)	Santa Barbara ReSource Center	Ramsey-Washington Recycling & Energy Center	Edmonton Waste Management Centre	Avonmouth Resource Recovery Centre	Beddington Energy Recovery Facility	Greatmoor Energy from Waste Facility	Allerton Waste Recovery Park
What were/are the Challenges?	• California regulations imposed organic waste separation and material recovery requiring the installation of a food waste receiving and pre-processing system. • Market conditions and China SWORD policy impacted the resale value for the recyclables being recovered by the facility and many were landfilled.	• Project goals were not fully met - goal of the facility was to divert an additional 15-20% of recyclables from mixed MSW stream – actual diversion is closer to 2.5% • AD/compost operation had commissioning issues - the County eventually terminated the agreement with the original operator and took over operation.	• Added a food scrap bag sorting line that uses AI and robots to remove food scraps in compostable bags	• Challenges with getting feedstock to meet the waste-to-fuel technology (Enerkem) specifications and design/reliability issues with the technology • High cost associated with processing and making RDF/SRF	• Sister plastic recycling plant closing due to 'challenging market conditions', unclear how this will affect EFW if at all (it remains open) • Initial plans were rejected by Bristol Council in 2010 - Permission upheld by the High Court • Labour shortages during construction due to concurrent major project in region • Clugston (civils contractor) lost money on this and other EfW projects and has since filed for administration	• Council objection to increased capacity application • Council rejection of initial planning citing 'air quality' concerns. As a result, Viridor committed ~£1,000,000 over 25 years for local education centre, live on-line air quality monitoring, local complaints forum, local landscaping, restoration of existing landfill site. • Lagan Construction Group had 4 companies go into administration but no significant impact in project	• Significant outages totalling 41 days 6 hours as a result of bottom ash conveyor, 'non- conforming waste, grate damage due to significant slag fall, and other issues. • Disputes between Buckinghamshire Council (BCC) and FCC over payments • Local resistance to planning on grounds of nature preservation and flood risk	• Failure to meet recycling targets, concern over urban creep • Local resistance and concern over impact on green/rural space
Capital Costs	Original: $45M (1992 to 2024) Upgrades: $13M-$16M (2021)	$224M (2021)	$236M (Replacement Cost)	Original: ~$100M Retrofit (2022): ~$16M	~$560M	~$350M	$370M	~$322M
Operating Costs (CAD)	$38.5M	Detailed operational cost data was not available	~$69M/year (2023, includes ~$2M for equipment replacement & repairs)	~$240/tonne to produce RDF (looking for ways to reduce costs)	~$100M/year	~$85M/year	~$80M/year	~$100M/year
Energy Recovery	• Not Applicable	• Plans to produce enough energy from biogas to power 3,000 homes and power the campus	• Sells RDF to local utility (Xcel Energy) as fuel for two of their regional WTE facilities	• Sells RDF to local cement kilns and business. Recently signed partnership with Varme to build a WTE	25-30 MWe	25 MWe	25 MWe	24 MWe
Impacts on Diversion	• 36% MSW Diverted (2022/23)	• Up to 60% diversion from landfill • Claims to have helped the community reach a total diversion of 85% (originally was only ~50%)	• Up to 90% diversion from landfill (~326k tonnes/yr in 2022) • ~12k tonnes/yr metals recovered (2023) • 99,500 tonnes of CO_2 avoided versus landfilling waste (2023)	• ~21-36% tonnes/yr diverted from landfill (2021)	• Almost 100% waste diversion (320kTPY at commissioning, rising to 427kTPY, unclear if closing of recycling facility will impact), Viridor claims recycling of bottom ash and air pollution control residue but couldn't find figures on this	• Up to 95%' of waste delivered diverted from landfill, ~330kTPY if operating at capacity, Viridor claims recycling of bottom ash and air pollution control residue but couldn't find figures on this	• 2023/24: 263,843 tonnes treated, 73,266 tonnes ash sent to landfill, 2 tonnes non-conforming waste. Near 100% 'waste' diversion, but 27.8% of wastes mass ends up in landfill as ash	• At least 90%' so ~288kTPY at capacity

Appendix E

Technical Memorandum No. 2

City of Ottawa

Feasibility Study For Waste to Energy and Mixed Waste Processing

Technical Memorandum No. 2

Prepared For:
City of Ottawa
110 Laurier Avenue West, Ottawa, Ontario K1P 1J1

Prepared By:
HDR Corporation
300 Richmond Road, Suite 200, Ottawa, Ontario K1Z 6X6

June 2, 2025

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Acronyms

CRN	Canadian Registration Number
CWA	Clean Water Act
CEA	Comprehensive Environmental Assessment
ESA	Endangered Species Act
EFW	Energy from Waste
EA	Environmental Assessment
EAA	Environmental Assessment Act
EAPD	Environmental Assessment and Permissions Division
ECA	Environmental Compliance Approvals
EPA	Environmental Protection Act
ESP	Environmental Screening Process
IEA	Individual Environmental Assessment
IPZ	Intake Protection Zone
LRIA	Lakes and Rivers Improvement Act
LAHJ	Local Authority Having Jurisdiction
MMAH	Ministry of Municipal Affairs and Housing
MNR	Ministry of Natural Resources
MECP	Ministry of the Environment, Conservation and Parks
MWP	Mixed Waste Processing
OWRA	Ontario Water Resources Act
POR	Points of Reception
PM	Project Manager
REA	Renewable Energy Approvals
RU	Rural Countryside Zone
RH	Rural Heavy Industrial Zone
SWMP	Solid Waste Management Plan
TSSA	Technical Standards and Safety Authority
Trail	Trail Waste Facility
WTE	Waste-to-Energy
WHPA	Wellhead Protection Area

1 Introduction

The City of Ottawa, the Nation’s capital and sixth largest City in Canada, is in the process of implementing a 30-Year Solid Waste Master Plan (SWMP) with the aim of decreasing the amount of waste managed by the City, diverting as much waste as possible from landfill, and looking for opportunities to maximize recovery of resources and energy in an environmentally sustainable manner. Furthermore, the City’s current primary disposal option, the Trail Waste Facility (Trail) is nearing capacity in the next 10 to 15 years and waste management options to potentially extend the life of Trail needs to be determined. The City recognizes that there is no single solution to addressing future waste management challenges and has developed the SWMP to address these issues through a multi-pronged approach. The recommendations outlined in the SWMP span the collection and management of waste from curbside-residential and multi-residential homes, parks and other public spaces, City facilities and operations, and existing partner programs. The key factors that were considered in developing the recommendations in the SWMP were the following: 1) the role of all three levels of government in Canada (i.e. federal, provincial, and municipal); 2) the impacts of climate change; 3) leveraging innovation and technology alternatives to traditional methods of waste processing and disposal; and 4) consideration of the waste management hierarchy with the aspirational goal of moving the City closer to its Zero Waste vision for the future.

Based on these considerations and key factors, the City identified 50 recommended SWMP Actions that are laid out by short-term (0-5 years), medium-term (5-10 years), and long-term (>10 years) time frames. Five objectives were developed to present and measure how the recommended SWMP Actions would directly impact achieving the City’s Zero Waste vision. The five SWMP objectives are the following:

1. **Maximize the Reduction and Reuse of Waste.** Actions under this objective are prioritized to begin in the short-term time frame to immediately decrease the waste generated and minimize the amount of waste that needs to be managed at a disposal facility.

2. **Maximize the Recycling of Waste.** Actions under this objective will have the biggest impact on diversion from landfill and potential reduction of greenhouse gases (GHGs) and will be prioritized in the short-term time frame.

3. **Maximize the Recovery of Waste and Energy and the Optimal Management of Remaining Residuals.** Actions under this objective will be assessed in the short-term and if deemed feasible, implemented over the medium and long-term time frames to address the immediate and future need to extend available landfill capacity and to extract maximum resources and energy from the remaining residual waste stream.

4. **Maximize Operational Advancements.** Actions within this objective support operational advancements through innovation and new technology to make operations more efficient and to reduce impacts on the environment.

5. **Develop a Zero Waste Culture Across the City.** Actions under this objective will educate residents on how they can contribute to the City’s goal of a Zero Waste future, and influence industry and the wider community to reduce, reuse, and divert waste.

The Waste Recovery and/or Treatment Facility Study Action Suite within the SWMP recommends the City advance a Feasibility Study and Business Case during the short-term to identify a technology(ies) that can reduce the amount of waste sent to landfill and potentially recover additional resources and energy. The two alternative technologies being considered as part of this action are Waste-to-Energy (WTE) (specifically mass burn incineration with energy recovery) and Mixed Waste Processing (MWP), or a combination of these two technologies. In addition to the WTE and MWP technology options, the Feasibility Study will consider existing and new landfill options for the future disposal of residual waste streams.

From the SWMP the City is committed to managing residents' residual waste over the next 30 years and a guiding principle from the SWMP is "k*eeping waste local by treating residential waste within the City's boundaries, wherever operationally and economically feasible".* These two points will be considered throughout the Study and Business Case.

The five scenarios being considered in this Study are defined as the following:

- **Option 1: Status Quo and Private Facilities.** Under this option, the City would continue to dispose of non-diverted waste for final disposal at Trail until it reaches capacity (estimated to be in 2035) and then negotiate waste supply agreements for disposal with one or several regional third-party waste management facilities.
- **Option 2: WTE Facility.** Under this option, the City would build a new WTE facility that can process all of their non-diverted waste with disposal of rejects and ash residue at a third-party waste management facility.
- **Option 3: MWP Facility.** Under this option, the City builds a MWP Facility that can process all of the City's non-diverted waste, recover additional recyclables and dispose of the remaining process residuals at a private third-party waste management facility.
- **Option 4. WTE and MWP Facilities.** Under this option, the City builds a MWP Facility to recover additional recyclables and builds a WTE facility to process and recover energy from the remaining residual waste. Reject and ash residue from WTE will be disposed of at a private third-party waste management facility.
- **Option 5. Construct a New Landfill.** Under this option, the City builds a new greenfield landfill within the region to take all non-recyclable residuals after Trail reaches capacity.

It is noted that the implementation of a new landfill was thoroughly assessed during the development of the SWMP. Although initially considered for deferral to future SWMP iterations, this option is being included for comparison purposes.

As a component of the Feasibility Study and the purpose of Technical Memorandum No. 2, HDR will review the approvals and siting requirements for the options described in Technical Memorandum No. 1 and outlined below. The findings in Technical Memorandum No. 2 will be used to further assist in the next steps in the Feasibility Study which include evaluation criteria, scoring, and weightings that will be used to assess the feasibility of each of the five scenarios.

The matrix will be provided in Technical Memorandum No. 4.

2 Understanding of Objectives – Technical Memorandum No. 2

2.1 Project Understanding

A critical aspect of the Feasibility Study is the implementation of the technology(ies) options and understanding the approvals and siting requirements/limitations. This memorandum will look at factors the City will need to consider when assessing applicable siting requirements and applicable environmental permissions/permits that would have to be obtained for each option the City identified in their SWMP.

To further support this review, our team held a pre-consultation meeting with staff from the Ministry of the Environment, Conservation and Parks (MECP) on August 21, 2024, to better understand the current operational requirements and potential policy direction (e.g., currently under consideration) that the City may need to address/face. Key MECP divisions in attendance included the Environmental Assessment and Permissions Branch and the Climate Change and Resiliency Division. Based on these discussions, several risks were identified that shall be considered/included in the Risk Matrix. A high-level discussion of those risks is summarized below in this technical memorandum. In addition, the formal meeting agenda and minutes are attached to this memorandum as Appendix A.

2.2 Key Considerations for Permits and Siting

There are several approval and siting processes/requirements for waste management facilities from a provincial, municipal, and federal perspective that may be applicable to a site depending on the technology and waste process. These include processes under the Provincial Environmental Assessment Act, Environmental Protection Act (EPA), and Municipal Act, and the Federal Fisheries Act.

For the study, HDR reviewed the permits and siting requirements for the five scenarios defined in Section 1.

When considering the various options, HDR based the assessment on the anticipated waste volumes that would have to be managed by the City after diversion activities (e.g., Blue box, organics, and leaf and yard waste recycling). The City identified the volumes in **Table 4** of the Solid Waste Master Plan.[1] The following table estimates the anticipated waste volume that the City will have to manage. These volumes are discussed further in Technical Memorandum No. 1:

[1] Solid Waste Master Plan June 2024 prepared by the City of Ottawa

Table 1.1 Anticipated Waste Volumes, Table 4 from Solid Waste Master Plan

Year	Curbside-residential	Multi-residential	City Facilities	Parks & Public Spaces	Total Waste Generation
2024	124,600	55,400	19,200	1,800	201,100
2029	134,100	58,700	20,600	2,000	215,400
2034	143,000	61,300	21,900	2,100	228,400
2039	151,400	63,600	23,100	2,200	240,300
2044	158,600	65,700	24,200	2,300	250,800
2049	164,700	67,400	25,100	2,400	259,500
2053	170,300	68,900	25,900	2,500	267,600

3 Approvals

The MECP sets environmental standards and requirements for managing hazardous and non-hazardous waste to ensure that human health and the environment are protected.

Depending on the operation or waste activities like establishing or expanding a new landfill, these undertakings often require an environmental assessment prior to obtaining the applicable environmental permission to operate.

For permissions, waste facilities, landfills, and waste transportation systems it is required to get appropriate environmental permission(s) to operate, unless they are exempt. Environmental permissions set out specific operating, monitoring, and reporting requirements that owners and operators must comply with.

Based on the proposed waste management options identified by the City, further discussions on the applicable environmental assessment process and environmental approvals, which will include waste, air, and wastewater approvals, are provided below. The information is intended to assist the City in understanding the process and factors in the risk matrix.

3.1 Environmental Assessment Act

Waste management projects are subject to the Ontario Environmental Assessment Act (EAA). Under the EAA, waste management projects, regardless of whether the proponent is public or private sector, are designated under the EAA. As a result, there are no differences in the process. In February 2024, the MECP amended the EAA and its regulations. Previously, waste management projects were regulated under O. Reg. 101/07 – Waste Management Projects under the EAA. Waste management projects are now captured under O. Regulation 50/24 – Part II.3 PROJECTS - DESIGNATIONS AND EXEMPTIONS. As a result, Reg. 101/07 has been revoked.

Key studies required for an EA process include the following technical, social, and economic aspects:

1. Surface and Ground Water (e.g., will the undertaking cause negative effects on surface water or groundwater quality, quantities, or flow)
2. Land (is the undertaking consistent with the Provincial Policy Statement, provincial land use or resource management plans)
3. Traffic impacts (e.g., traffic flow and impacts to the community)
4. Air and Noise (e.g., any negative effects on air quality due to emissions)
5. Natural Environment (e.g., any negative effects on protected natural areas such as ANSIs, ESAs, or other significant natural areas)
6. Resources (e.g., does it result in generation of energy that cannot be captured and utilized)
7. Socio-economic (e.g., any negative effects on neighbourhood or community character)
8. Heritage and Culture (e.g., any negative effects on heritage buildings, structures or sites, archeological sites or areas of archeological importance, or cultural heritage landscapes)
9. Indigenous (e.g., any potential negative effects on land, resources, traditional activities, or other interests of Indigenous communities)

3.1.1 Comprehensive Environmental Assessment

The Comprehensive Environmental Assessment (CEA) process is a planning and decision-making process used to promote environmentally responsible decision-making. The EAA provides for the protection, conservation, and wise management of Ontario's environment. The undertakings subject to the CEA are considered higher risk undertakings with less known outcomes. The intent is for proponents to make responsible environmental decisions considering different factors such as natural, social, economic, cultural, and built environments. The EA process can be broken down into several processes including the development and approval of a Terms of Reference (ToR) and then the main Environmental Assessment (EA) study. These processes both require consultation/engagement and approval by the Minister. For CEA projects, the Crown (which for these undertakings means the MECP) has a constitutional duty to consult with an Indigenous community. The MECP will download this requirement onto the City to complete.

The MECP does not consider the EA process to be a consensus building exercise, but a mechanism to allow interested people to be involved in the decision-making process. The typical timeline for an EA process is **three to ten years**.

The MECP's Environmental Assessment Branch within the Environmental Assessment and Permissions Division (EAPD) is highly involved. The decision to approve or reject the EA is ultimately made by the Minister.

Given the lengthy time to complete a CEA, the City could consider undertaking a simultaneous EAA and EPA review process. The City would achieve this task by submitting complete Environmental Compliance Approvals applications and supporting documentation for Air, Waste and Wastewater at the same time the EA is submitted to the Minister for their consideration; however, this option is only recommended if the City has a level of comfort that the undertaking will receive Minister approval. Whereas there is no regulatory restriction when EPA applications can be submitted, the EPA approvals will not be approved until the Minister has approved the EA.

3.1.2 Environmental Screening Process

The Environmental Screening Process (ESP) is a proponent driven self-assessment process, which requires the completion of the applicable studies and public consultation, including indigenous community(ies) consultations (outlined in MECP's Guidelines entitled "Preparing Environmental Assessments" and "Guide to Environmental Assessment Requirements for Waste Management Projects". Subject matter for the studies are similar to those for the CEA. The guideline provides a streamlined overview of the anticipated contents/issues that the reports should address.

The ESP are used for routine projects that have predictable and manageable environmental effects. Proponents of these types of projects follow a self-assessment and decision-making process that is streamlined. For the ESP process, the proponent must:

- Follow the streamlined process
- Consult with public, Indigenous communities and government agencies
- Assess potential environmental effects (reports/studies)
- Prepare documentation specified in the streamlined process

- Send their notices and project information form to the region where the project is located

The reports that proponents prepare under the ESP do not require approval by the Minister or MECP staff, specifically the Environmental Assessment Branch of the (EAPD). However, as the proponent, the City would be required to consult with affected government agencies (similar to a Comprehensive EA), including the appropriate regional office of the MECP, during the course of the review under the ESP. The MECP, as a key affected government agency, may provide comments or advice to proponents to address the MECP's concerns.

It will be the City's decision to determine when to formally commence the process. The MECP has suggested that proponents may wish to conduct preliminary consultation and undertake scoping of the projects prior to commencing the ESP, which falls under the responsibility of the City. It would be the City's decision to determine the time required to adequately conduct the ESP with sufficient consultation and when it is able to issue an ESP for review by government agencies, interested persons, including Indigenous communities. For EA projects the Crown (which for these undertakings means the MECP) has a constitutional duty to consult with an Indigenous community. The community or members of it may be interested people or concerned people for the purposes of consultation in the ESP. The Crown will download this responsibility onto the City.

As the ESP is a streamlined process, the MECP encourages and supports proponents to conduct the ESP concurrently with applications for other approvals. If an environmental effect or issue identified in the ESP is also being addressed under another environmental approval (e.g., an environmental compliance approval under the EPA), proponents should describe the other approvals required and should provide sufficient information in their reports under the ESP to demonstrate that the project is feasible and that the subsequent approvals are attainable. The proponent may decide to prepare more detailed technical information and studies in cases where there are concerns from government agencies or interested persons, including Indigenous communities, about a potential environmental effect. Provision of sufficiently detailed information can help assure government agencies and interested persons, including Indigenous communities that environmental effects have been adequately addressed, and may reduce the likelihood of a request to elevate the project.

With regards to the ESP time frame, it is noted that in the MECP's Guide to Environmental Assessment Requirements for Waste Management Projects in Section B – Environmental Screening Process it indicated that:

> *"Proponents are encouraged to conduct the Environmental Screening Process concurrently with applications for other approvals. If an environmental effect or issue identified in the Environmental Screening Process is also being addressed under another environmental approval (e.g., an approval under the Environmental Protection Act), proponents should describe the other approvals required and should provide sufficient information in their reports under the Environmental Screening Process to demonstrate that the project is feasible and that the subsequent approvals are attainable. The proponent may decide to prepare more detailed technical information and studies in cases where there are concerns from government agencies or interested persons, including Aboriginal communities, about a potential environmental effect. Provision of sufficiently detailed information can help assure government agencies and interested persons, including Aboriginal communities that environmental*

effects have been adequately addressed, and may reduce the likelihood of a request to elevate the project."

Undertaking the ESP and Environmental Compliance Approvals (ECA) processes simultaneously can effectively and efficiently allow projects to commence; however, there is a risk should the outcome or mitigation measures identified change or terminate the project. The MECP has indicated that the overall approval process could be completed within **six to 24 months (about two years)** if a complete application is submitted; however, based on HDR's experience, the typical minimal time period is approximately nine months.

For projects that are subject to the ESP process, a proponent may voluntarily choose to undertake a CEA rather than the ESP process, or the Minister may designate the undertaking and require a CEA. If either occurs, then the undertaking will be required to undertake the CEA process. This process as mentioned above is anticipated to take three to ten years to complete.

For any streamlined EA process, there is a potential risk that a member of the public may request the Minister to require a proponent to complete the CEA process for the undertaking rather than the streamlined process (e.g. ESP process). This is considered a potential risk as it can result in delays in the process (MECP approval of documents compared to proponent driven) and results in higher costs for the City (e.g., preparation of more detailed reports, responding to ministry review comments, and additional consultation requirements). This could potentially result in a delay in implementation. However, the outcomes for WTE are known and can be mitigated, which reduces the risk of the minister agreeing to a bump up request. In addition, other WTE facilities have successfully gone through the ESP process (e.g. Emerald Energy) without being "bumped up" to a CEA. Notwithstanding, there are no set requirements for the minister to assess the request, so it is at the discretion of the Minister. Potential approval risks are provided in Table 6-1.

For this "bump up" request, the public would have to make a formal submission which would include information such as:

- Details about the individual's concerns about potential adverse impacts on constitutionally protected Indigenous or treaty rights and how the proposed Order may prevent, mitigate, or remedy the identified adverse impacts.
- Whether the person belongs to, represent or have spoken with an Indigenous community who's constitutionally protected Indigenous, or treaty rights may be adversely impacted by the proposed project.
- Whether you have raised your concerns with the proponent, the proponent's response (if any) and why the concerns could not be resolved with the proponent.
- Any other information that should be considered to support the request.

3.1.3 City's Options - EA Process

There are different thresholds to trigger the environmental assessment process for the City's options. To assist in the assessment, the anticipated waste volumes/management requirements identified by the City in their SWMP will be the basis for the assessment. These volumes were included in Technical Memorandum No. 1.

In 2023, the City collected and managed a total of 345,900 tonnes of waste, which included approximately:

- 183,000 tonnes of garbage.
- 99,400 tonnes of organic, leaf and yard waste; and
- 63 ,400 tonnes of recyclables.

It is assumed that only the volume of garbage will be managed by WTE, MWP and/or a new landfill. On average, a facility may operate 300 days per year, which would allow for management of approximately 610 tonnes of waste per day.

The following potential environmental assessment process summary table is provided for the City's options. It is noted that the final technology and processes will have a significant impact on the outcome. For the options, the following is a general overview:

Table 3.1: Environmental Assessment Requirements for Options

Option	Description
Status-Quo and Private Facilities	There are no EA triggers resulting from the City transporting waste to a private landfill or processing facility. Any EA triggers would fall to the owner/operator of the private facility.
WTE	For waste management facilities where some of the energy may be used for other purposes other than waste disposal, the City may utilize an environmental screening process (ESP) under the EAA. There are no waste volume restrictions. The ESP process may save the City a significant amount of time in their approvals process. The ESP takes approximately six to 24 months (about two years) to complete. There have been only a few proponents that have utilized the ESP to date. The timelines have generally fluctuated. Given the complex nature of it, it is reasonable to estimate the time frame for the ESP would be closer to 24 months (about two years). Should the City voluntarily undertake the CEA process for the undertaking, or the Minister designates the undertake, then the undertaking will need to follow the CEA process, and the timeframe would be amended to three to ten years.
MWP	For waste management facilities that process waste, the EA trigger threshold for waste processing sites (e.g., MWP or composting) are waste management sites that send more than 1,000 tonnes/day of residual waste (material not separated for recycling or further recycling) for final disposal. It is anticipated that the average waste receipt will be approximately 610 tonnes per day. Only the residual material after processing will be considered when assessing the EA trigger for waste processing/transfer. As a result, the waste processing/transfer operations without any thermal treatment will not trigger the EA process. Only the ECA process is required.
WTE with MWP	The trigger provisions will dictate the EAA Process. The MWP process will have to be considered in the various EA assessments, but it is not the focus or purpose of the undertaking. The estimated time frame would be similar to the WTE time frame.

Option	Description
New Landfill	For planning purposes, landfill capacity for a 30-year period is considered good planning. Ottawa generated approximately 220,000 tonnes of residual waste for disposal in 2023. Factoring in density/compaction/daily cover when placed in a landfill (0.78 tonnes/m3), it is estimated that that is approximately 283,000 cubic metres. This results in an anticipated long-term waste management volumetric airspace need of approximately 7,100,000 cubic metres. For new landfills, the EA trigger for a CEA is a site that seeks a volumetric airspace capacity greater than 100,000 cubic metres. Based on the City's existing yearly disposal requirements and 30-year planning period, any new City landfill to meet the long-term needs would be required to undertake a Comprehensive EA. There are no applicable exemptions for additional volumetric airspace that the City may appear to utilize at this time. It is noted that the last "new" landfill site approved in the Province was the Capital Region Resource Recovery Centre (CRRRC). In the last 25 years, there have only been a handful (if any) new sites approved. The typical CEA process is approximately three to ten years.

The City will have to assess risk and timing when considering their options. During the Feasibility Study discussions, the City has indicated that they are using the Durham York Energy Centre as a reference for the anticipated timeframe for an EA process undertaking option. The City should be aware that the Region of Durham and Region of York had an opportunity to complete the ESP but decided to undertake the Comprehensive EA process which added a significant amount of time to the approvals process. The Region of Durham and Region of York made the determination to undertake an Individual Environmental Assessment (IEA) for their Energy from Waste (EFW) Centre rather than the ESP to ensure a thorough evaluation of the potential environmental impacts of the project were undertaken. This was to ensure the preferred alternative for managing residual waste considered social, environmental, and economic factors, and to ensure there was public confidence and participation in the decision-making process given the historical concerns that the general public had with the burning of waste at the time.

There were very limited facilities in operation in Ontario at that time and there were a lot of public concerns/perceptions around burning of waste. In recent years, perceptions around thermal treatment and energy generation have changed since the DYEC facility underwent the EA process.

Public confidence and alternative approaches to landfilling have become more acceptable and people recognize the potential benefits from alternative energy generation. Based on HDR's experience, there has been an increase in discussions with other municipalities and the private sector that have considered opportunities. Public perception has not been the reason for those municipalities and private sector proponents utilizing thermal treatment technologies, but more related to the uncertainty of the new or emerging technology they were considering. The mass incineration processes the City is considering is well understood and known, which minimizes those concerns. As an example of the changing acceptance of facilities, it should be noted that Emerald Energy located in Brampton, Ontario has completed an ESP to upgrade and expand their facility.

For reference, a CEA typically takes three to ten years to complete, and an ESP generally takes six months to two years to complete. Engaging the public early in the process can assist the City in addressing those concerns and further support the decision to undertake an ESP process rather than a CEA similar to the Region of Durham and Region of York.

3.2 Environmental Protection Act

3.2.1 Overview

Under Part II.1 of the EPA, proponents are required to obtain the appropriate ECA for their undertakings. An ECA is a permission that allows proponents to operate their facility or site with environmental controls that protect human health and the natural environment. Proponents who plan to carry out activities that have the potential to impact the public or natural environment must get an ECA before they can construct, operate, or upgrade a facility or site in Ontario. These activities are described under the EPA (1990) and Ontario Water Resources Act, 1990 (OWRA). The applicable sections under the EPA and OWRA include:

- Section 27 of the EPA requires an ECA for transportation, management, and/or disposal of certain types of waste.
- Section 53 of the OWRA requires an ECA for sewage works.
- Section 9 of the EPA requires an ECA for activities with emissions related to air, noise, and/or vibrations.

Unless exempt, these requirements will apply to most waste management sites, including for waste management facilities that operate indoors. Unless the site meets an exemption (O. Reg. 525/98 – exemptions) under the OWRA, indoor waste management facilities still require an OWRA approval for the site. For the EPA and OWRA, there does not appear to be any exceptions available to the City's proposed options, so applicable approvals will be required.

Based on the MECP's current service standard, the MECP has indicated that proponents will receive their ECA in less than one year. Based on HDR's experience, there is significant variability in the turnaround times for ECA reviews. The ECA reviews for new sites or those considered complex have generally taken the MECP longer than a year to approve. Further discussion on potential risks and timelines for ECA turnaround times is discussed in Section 6.0. In recent years, the MECP has not consistently achieved the one-year service standard on technically complex applications which WTE, MWP and Landfills may be considered.

3.2.2 Waste Approvals (EPA)

Section 27 in the EPA states that "…no person shall use, operate, establish, alter, enlarge or extend a waste management system or a waste disposal site except under and in accordance with an environmental compliance approval." Depending on the waste operations/process, there are different application submission requirements, which are outlined in **Table 3.2** below.

Under the EPA, there are regulations that assist in guiding the design and implementation of certain waste sites. For example, for landfill Regulation 347 – General Waste Management and O. Reg. 232/98 Landfilling Sites. O. Reg. 232/98 provided details on design and operations requirements for new or expanding landfills. There are no specific regulations for waste processing or thermal treatment under the EPA.

Table 3.2: Application Requirements for Waste Facilities

Waste Disposal Site	Design & Operations Report	Stormwater Management Report (if site includes outside storage of waste)	Hydro-geological Report or Assessment or Physical and Water Use Conditions	Waste Analysis Plan	Odour Impact Assessment (OIA)	Odour Management and Control Plan
Landfill site	Required	N/A	Required	N/A	An Odour Impact Assessment (OIA) and Odour Management and Control Plan should be considered for any waste disposal site. If it is decided that odour is not an issue and it is decided that an assessment and plan are not necessary, a description of the reasoning for the decision is required in the application.	An OIA and Odour Management and Control Plan should be considered for any waste disposal site. If it is decided that odour is not an issue and it is believed an assessment and plan are not necessary, a description of the reasoning for the decision is required in the application.
(Thermal treatment sites)	Required	N/A	N/A	N/A	An OIA and Odour Management and Control Plan should be considered for any waste disposal site. If it is decided that odour is not an issue and it is believed an assessment and plan are not necessary, a description of the reasoning for the decision is required in the application.	An OIA and Odour Management and Control Plan should be considered for any waste disposal site. If it is decided that odour is not an issue and you believe an assessment and plan are not necessary, a description of the reasoning for the decision is required in the application.

Waste Disposal Site	Design & Operations Report	Stormwater Management Report (if site includes outside storage of waste)	Hydro-geological Report or Assessment or Physical and Water Use Conditions	Waste Analysis Plan	Odour Impact Assessment (OIA)	Odour Management and Control Plan
MWP (Waste processing sites)	Required	Required	N/A	Required	An OIA and Odour Management and Control Plan should be considered for any waste disposal site. If you decide odour is not an issue and you believe an assessment and plan are not necessary, a description of the reasoning for the decision is required in the application.	An OIA and Odour Management and Control Plan should be considered for any waste disposal site. If it is decided odour is not an issue and it is believed that an assessment and plan are not necessary, a description of the reasoning for the decision is required in the application.

The MWP and other non-thermal processing options would fall under the waste processing category. The landfill and thermal treatment (including) would fall under their respective categories. It is not anticipated that there will be any new approvals or permits for the Status Quo and Private Facilities option (continued use of Trail and disposal at a third-party waste management facility) unless new vehicles or systems are obtained/purchased by the City.

3.2.3 Sewage Works Approvals (OWRA)

The OWRA, Section 53 states "…no person shall use, operate, establish, alter, extend or replace new or existing sewage works except under and in accordance with an environmental compliance approval." Sewage works in this context refer to collecting, transmitting, treating, and/or disposing of stormwater. For waste management facilities, a new or amended ECA from the MECP for 'sewage works' will be required for new or proposed modifications to the stormwater management works associated with the facility or for on-site treatment of leachate or wastewater that may be discharged into the natural environment. The options for WTE, MWP, and landfill all have a stormwater management component (surface water runoff) and potentially based on the final design potentially leachate/wastewater discharge potential.

Depending on the operation and who owns or operates the facility, an Industrial Sewage Works or Municipal Sewage works will be required. Industrial sewage works are any works involving the collection, transmission, treatment, or disposal of sewage generated from industrial activities. This could include projects to handle storm runoff, domestic sewage, and process sewage from industrial sites (e.g. non municipal sites). All other sewage works are referred to either as Municipal Sewage Works or Private Sewage Works. In Ontario, as a comparison, the Emerald Energy WTE facility has an Industrial Sewage Approval, while the Durham York Energy Centre WTE facility has a Municipal Sewage Works Approval. These approvals were granted in the multimedia ECAs for the two facilities.

The ECA application must be supported by a document assessing potential impacts on the environment and relevant environmental standards that must be met. As mentioned, unless eligible for an exemption, the proponent would require an appropriate ECA, even if the operations occur indoors. The submission requirements are summarized in **Table 3-3**. These requirements can apply to all waste management options. There are no separate requirements for each facility.

Table 3.3: OWRA Submission Requirements

Technical Requirement	Industrial Sewage Works	Municipal Sewage Works
Pipe Data Form	If applicable	If applicable
Municipal responsibility agreement	Not applicable	Not applicable
Design Report	Required (the SWM plan and report can suffice as the Design Report if there is no sanitary sewage or process water)	Required
Stormwater Management Plan	Required	Required
Stormwater Management Report	Required	Required
Preliminary Engineering Report	Not applicable	As included in the Design Report
Environmental Impact Analysis	If applicable	If applicable
Site Plan	Required	Required (see section Final Plans)
Final Plans	Not applicable	Required
Engineering Drawings and Specifications / Sewage Works – Specifications	Required	Required (either included in Final Plans or as separate section)
Detailed Description of proposed works (in addition to the detailed project and process description)	Required	Required

3.2.4 Air/Noise Approvals (EPA)

For waste management projects that are subject to Section 9 of the EPA, which are sites that have emissions to air, the proponents must prepare appropriate models and assessments. Waste management sites registered to a technical standard under *Ontario Regulation 419/05* may be required to submit information demonstrating compliance with the technical standard, as part of the ECA application. This standard will be required to be demonstrated for any of the managed options the City is considering.

For waste management facilities with point sources or systems that manage air emissions, such as a landfill gas flare, building dust or odour controls for a MWP facility that collect and discharge air emissions, or for any WTE facility, an air approval will be required. In summary, if a proponent has a system or apparatus that may collect air emissions that may discharge a contaminant into any part of the natural environment other than water, then an ECA Air/Noise requirement will be triggered

For the Status Quo and Private Facilities option, there are no anticipated permissions/approvals required for transporting waste to third-party waste management facilities within the area.

For the WTE option (that thermally treats municipal waste) it will be expected to demonstrate that the facility is able to meet the emission limits in the exhaust stack (or as otherwise specified) as set in the MECP's Guideline entitled "Guideline A-7: Air Pollution Control, Design and Operation Guidelines for Municipal Waste Thermal".

Key parameters for air quality testing are outlined in Guideline A-7. Key emission parameters for typical WTE facilities are provided in **Table 3-4**. As an example, these parameters are included as part of the DYEC's source testing parameter list.

Table 3.4: In-Stack Emission Limits for Thermal Treatment Facilities

Parameter	In-Stack Emission Limit	Verification of Compliance
particulate matter (PM)	14 mg/Rm^3	Results from compliance source testing or calculated as the rolling arithmetic average of four hours of data before dilution with any other gaseous stream, measured by a continuous emission monitoring system that provides data at least once every 15 minutes.
cadmium	7 µg/Rm^3	Results from compliance source testing.
lead	60 µg/Rm^3	Results from compliance source testing.
mercury	20 µg/Rm^3	Results from compliance source testing or calculated as the rolling arithmetic average of 24 hours of data measured by a continuous emission monitoring system that provides data at least once every 15 minutes.
dioxins and furans	80 pg/Rm^3	Results from compliance source testing; results expressed as I-TEQ.
hydrochloric acid (HCl)	18 ppmdv (27 mg/Rm^3) or an HCl removal efficiency of not less than 95%	Results from standard (compliance) stack testing or calculated as the arithmetic average of 24 hours of data (daily block average) measured by a continuous emission monitoring system that provides data at least once every 15 minutes.
sulphur dioxide (SO2)	21 ppmdv (56 mg/Rm^3)	Results from standard (compliance) stack testing or calculated as the arithmetic average of 24 hours of data (daily block average) measured by a continuous emission monitoring system that provides data at least once every 15 minutes.
nitrogen oxides (NOx)	105 ppmdv (198 mg/Rm^3)	Results from standard (compliance) stack testing or calculated as the arithmetic average of 24 hours of data (daily block average) measured by a continuous emission monitoring system that provides data at least once every 15 minutes.

Parameter	In-Stack Emission Limit	Verification of Compliance
organic matter (undiluted, expressed as equivalent methane)	50 ppmdv (33 mg/Rm^3)	Results from compliance source testing or calculated as the rolling arithmetic average of 10 minutes of data at the outlet of the piece of equipment where combustion of the gas stream resulting from thermal treatment of waste is completed but before dilution with any other gaseous stream takes place, measured by a continuous emission monitoring system that provides data at least once every minute.

For MWP facilities, the requirement for an air/noise approval will depend on whether the facilities have any air environmental controls to manage air emissions. There are several factors that will determine the requirements; however, the City should expect that air emission controls will be included as part of the overall site design due to the anticipated size and volumes of materials. Other factors such as adjacent land uses and distance to receptors will factor into the air emissions design component/requirements.

For a new landfill, O. Reg. 232/98 requires the collection of landfill gas at landfills with a volumetric airspace capacity of 1.5M cubic metres or greater. Based on the City's disposal needs for a 30-year planning period, a new landfill for the city would be greater than 1.5M cubic metres. The landfill gas collection system would require a landfill flare, at a minimum, which would require the appropriate ECA for air emissions.

For the noise component for any of the waste management facilities, the City will need to assess the noise and/or vibrations from the facility unless it meets an exemption.

3.2.5 Summary of Expected ECA Approval Requirements

Table 3-5 provides a summary of the anticipated ECA requirements/needs for each of the options:

Table 3.5: ECA Approval Requirements for Each Option

Option	Waste Approval	Air/Noise Approval	Wastewater Approval
Status Quo and Private Facilities	Yes (1)	No	No
WTE	Yes	Yes	Yes
MWP	Yes	Dependent on Environmental Control Requirements (2)	Yes
WTE with MWP	Yes	Yes	Yes
Landfill (New)	Yes	Yes (for landfill gas destruction)	Yes

Note:

(1) The City's has existing approvals in place that will need to be maintained. No new approvals are anticipated.

(2) For MWP, the air approval will depend on the site-specific conditions and whether environmental controls are required for the building. If environmental controls are required, there will be an air discharge point that will require an ECA Air. Generally, for MWP located in urban areas, environmental controls are encouraged.

3.3 Risk Discussion for Approvals

Each specific waste facility option has its own risk or areas of limitations that may impact the decision by the City, whereas each item can be mitigated, allowing the ECA application to proceed. The following are the key risks or limitations for each option.

3.3.1 Status Quo and Private Facilities Considerations

There are no significant limitations for ECA approvals for the Status Quo and Private Facilities. The City has existing approvals in place for waste management systems (e.g. trucks) for the transportation of waste. and an existing ECA for Trail. Permissions for waste management systems and sites (non-expansion) are common and no concerns were identified for the City to obtain the necessary approvals or amendments.

3.3.2 WTE Considerations

As discussed in Section 4 of this memorandum, these facilities can require a significant amount of land and infrastructure to operate. The land and supporting infrastructure are important factors when considering air modelling and adjacent land uses. As discussed below in Section 4.0 SITING CONSIDERATIONS, there are specific requirements for setbacks and considerations for adjacent land uses that must be considered in modelling.

The most significant limitation for the WTE facility option is the ability to demonstrate the technology is proven and can meet the stringent air standards within Ontario Guideline A-7 or better. Along with the modelling, the site must have adequate area, and adjacent property uses that can support air emissions (e.g., away from sensitive land uses).

Mass burn incineration is a common technology that has enough actual emissions and operating data available that can be used to model and predict potential air emissions and assess potential risks to surrounding land uses.

An ECA cannot be issued until the applicable EA review process is complete. A common potential risk for any undertaking subject to an EA is the potential for stricter standards being enforced as a result of the review process that require alterations to the design or operations of the WTE (regardless of ESP or CEA). In the event of such a change, a proponent would have to update the supporting document for the ECA application. Depending on the severity of the change and impact on the WTE facility design, this risk could potentially cause delays in the review of the ECA application, additional costs for updating the supporting ECA documents, and potential increases to capital and operating costs for the WTE. For example, during the ECA application process for the Durham York Energy Centre, the EA review process resulted in more stringent standards for some emissions and operating parameters that resulted in slight changes to the WTE facility design and operation. The additional capital and operating cost impacts due to these changes were relatively minor but resulted in slight delays to the ECA being finalized in Durham. This is a greater risk for ECA applications that have being reviewed concurrently with EA reviews (as described in Section 3.1.2)

As noted previously, the MECP minister has the jurisdiction to “bump” up the ESP process to a CEA. The risks associated with this scenario are similar to those previously described for the EA review process and would likely result in a delay from the ECA being issued. The primary risk under the “bump up” scenario is a longer timeline for the reviews under the CEA process. Under this scenario, the ECA application could still be reviewed concurrently, but could not be issued until the EA review process is complete. As discussed above, there is a risk associated with concurrent EA and ECA reviews if the technical details are not well defined, or additional information is requested by the MECP. However, from a technical document requirements perspective, there is no change in the amount or type of documents that are needed to support the ECA application, whether a proponent undertakes an ESP or CEA process.

In summary, the key risks associated with approvals for the WTE option are delays to the EA process timelines if the type of review process is changed, and the potential changes to the design or operation of the WTE facility in the ESP process (if undertaking simultaneous reviews) that could impact timelines and project costs. These risks are discussed in more detail in Section 6.0

3.3.3 MWP Considerations

The limitations for the MWP as it relates to approvals is demonstrating that the site is sized for the appropriate capacity (indoor storage and processing), and that the site has appropriate plans to address odours, which is the most significant concern for these types of facilities. The facility should have an appropriate setback from property boundaries and environmental controls in place to manage odours related to the transfer and processing operations. These can be addressed by having a reasonable distance between the facility and both residential and sensitive land uses (e.g., schools, daycares etc.). Zoning requirements for the City require certain road types and construction to address access, and service requirements are discussed in the siting requirements.

Key risk considerations required for these facilities are ensuring the operations will occur indoors (not mandatory) to help minimize environmental issues and potential impacts on nearby receptors.

The other approval factors would be considered a low risk and can be mitigated appropriately on a site-specific case.

3.3.4 Landfill Considerations

For the City’s landfill options, there are several limitations that the City will need to consider for the ECA application assessment, specifically limitations related to the hydrogeological and the design and operations reports.

With regards to the hydrogeological report, the City will have to clearly demonstrate an understanding of the hydrogeological conditions at the site so that it can be effectively monitored. There have been cases when ECA applications have been refused due to a proponent not being able to demonstrate a clear understanding of the hydrogeologic conditions at the site (e.g., situated in a highly sensitive hydrogeological and complex area).

The City will have to demonstrate a clear understanding of the area, specifically the geology, groundwater flow direction, and that realistic contingency and monitoring plans can be implemented to assess potential off-site discharges. If the City is not able to demonstrate those items, then the limitation of this option increases.

With regards to the Design and Operations Plan for the landfill option, a key regulatory requirement for landfills is that the proponent must own all the land in which waste is placed and for the buffer area (O.Reg. 232/98). Given the large area of land required for a greenfield site, this potentially could be a financial burden.

Another aspect of the Design and Operations Plan is the requirement for the management of landfill leachate. The City must have a clear plan on the process to manage leachate generated from the site. Leachate is typically managed either through off-site treatment (e.g. WWTP), on-site WWTP, or a combination of both options. The limitations for these options are the WWTP capacity available within the area and/or the cost of building a site-specific plant and its long-term operation. The City will need to clearly have these plans in place or assess the available capacity. If the capacity does not exist and building a WWTP is not feasible, the probability of obtaining an approval decreases. Based on these limitations, this is considered high risk for the City.

The other items within the ECA application for landfills are considered well-known and established (e.g., gas collection, site operations, cover material) and can be mitigated, resulting in a low risk.

3.4 Permissions for District Energy

The City is considering a District Energy scenario for the WTE option. Similar to the environmental and other permissions related to the waste management component, the potential implementation of a district energy component would also require applicable approvals and studies to be completed. In Ontario, the approval requirements for district energy projects typically fall under the broader category of renewable energy approvals (REA). REAs are required under O. Reg. 359/09 of the EPA. The REA process involves several steps, including conducting site assessments (similar to EA requirements including air and noise assessments), preparing detailed plans and reports, and consulting with municipalities, Indigenous communities, and the public.

The limitations for District Energy facilities are similar to the WTE, where the air quality emissions standards need to be achieved and met in relation to adjacent property uses.

Prior to obtaining permissions, several other studies and work to support the application must be completed. These include:

- Determination of whether the design will be registered with the Technical Standards and Safety Authority (TSSA in Ontario). For example, in Ontario, the owners, users, agents, manufacturers, and contractors of boilers or pressurized equipment must register equipment designs with the TSSA. This is to obtain a Canadian Registration Number (CRN), which is necessary before the equipment can be used. The design must undergo an engineering review to ensure compliance with the Technical Standards and Safety Act, 2000, Ontario Regulation 220/01: Boilers & Pressure Vessels.

- Coordinating the overall proposed plan with the local authority having jurisdiction (TSSA) and obtain all necessary base maps and guidelines pertaining to buried services and necessary separations of buried services. It is important to note that some services may be private (e.g. gas, power, communications, etc.) and can require additional requests and processes to be followed. This will also include obtaining a relevant topographical survey or the preparation of one, if necessary, for the design process.

- Engage the TSSA to discuss key design parameters. For example, stress relief approaches should be discussed that may impact services. The design parameters can affect layouts, flushing and testing during construction, and startup (water sources and draining impacts sewers).

- Engagement with the City departments to establish “line assignment” with the TSSA.

- Prepare and review preliminary design reports which will include layout and profiles, plus initial separations and offsets. Where applicable, discuss the designs with the TSSA and with private utilities.

- Prepare and review detailed design including below ground and above ground impacts and engage with the local authority having jurisdiction (LAHJ) over those impacts (e.g. conservation authority).

4 Siting Considerations

There are several considerations when identifying a potential location for a waste management facility. In general, for the City's options, the following are generic considerations for facility siting regardless of whether it is a MWP or new landfill:

1. The site will meet local zoning and land use criteria, including local road weight limits and other limitations.

2. The site can be easily accessible by solid waste vehicles in all weather conditions.

3. Safely protects surface and groundwater quality.

4. Will meet applicable air emissions point of impingement (compliance point) for air emission contaminants and odours.

5. For construction purposes, it has access to earth cover material that can be easily handled and compacted to support the infrastructure. Whereas it is important for the applicable infrastructure and building for each option, it is important for landfills from a landfill liner geotechnical perspective and final cover. Operations will not affect external environmentally sensitive areas.

6. Comprises enough land and internal capacity to provide a buffer zone from neighbouring properties and can be expanded; and,

7. Will be the most economic site available given haul distances to user communities and other economic considerations.

Notwithstanding the siting goals, from the City's planning perspective, key siting goals should include the following regardless of whether, WTE, MWP or a new landfill:

- Establish goals and gather community and political support for the undertaking.
- Identify facility design basis and need to assist with the site selection process.
- Identify potential sites within the City to determine if it is feasible.
- Select best site for development.
- Sites that have a reasonable chance to obtain regulatory site approval.

Public involvement early in the process is essential to identifying a preferred site and achieving a successful outcome. The search process can be used to educate the public about the difficult choices that must be made, and the degree of effort and expertise the City will be relying on to make the decisions. This can help to support the public in identifying a site from the available alternatives which can reduce or mitigate concerns.

4.1 Estimated Facility Needs

Understanding the general needs for waste management facilities will assist the City in understanding their initial needs when identifying potential site options. To assist the City, based on the waste management options and volume of waste processing needed, the following is provided to give an indication of the area and infrastructure that may be required for the options. For the purpose of this analysis, we have utilized the estimated waste volume requirements that the City anticipates currently and in the future. These volumes are estimated to be up to 267,000 tonnes of waste per year by 2053 as described in Technical Memorandum No. 1.

4.1.1 Status Quo and Private Facilities

The proposed continued use of Trail and existing third-party waste management facilities within the eastern Ontario region would not require the City to invest in or consider any additional land siting features.

4.1.2 WTE

These facilities require substantial space due to the amount of process equipment and distance required to comply with air emissions discharges at the compliance point (POI – Point of Impingement) for O.Reg. 419/06.

In addition, these facilities require a significant amount of supporting infrastructure to operate as noted by the following considerations:

- **Site area.** A mass burn facility is expected to require between 2-4 hectares of land for the buildings. In general, the entire facility is expected to require 3-5 hectares for infrastructure, buffer, and other auxiliary activities (e.g., parking). There is no regulatory requirement for the City to own the land that the facility is located; however, it is recommended for better operational control and long-term stability.
- **Infrastructure requirements.** Electrical substation and connection to main grid for power importation and exportation, access to major highways. Anticipated sizing required for net electrical generation is estimated to be between 16-20 MW.
- **Utility needs and consumption.** Water source, sewer, electricity interconnections, auxiliary fuel for combustion control, and gas line connections are significant utility requirements for the on-going operation of the facility. Unlike the MWP and landfill options, their operations required a significant amount of clean water, natural gas, and sewer discharge capabilities. The utility needs are outlines in **Table 4.1.** WTE Estimated Utility Volume Needs.
- **Roads:** The zoning requirements for waste facilities are restricted to having either direct access to a designated truck route or access through a City identified- or RH- zoned industrial subdivision leading directly to a designated truck route.
- **Impacts on nearby receptors.** Air emissions/odour from stored materials. (Distance from receptors is very dependent on the type of receptor as outlined in **Section 4.2** (e.g. sensitive

receptors such as schools, daycare etc. that are outlined in Guideline A-7) and area topography and barriers (e.g. trees). There is no minimum distance that is set for WTE facilities).

Table 4.1 WTE Estimated Utility Volume Needs

Utility Type	Potable Water Usage	Sewage	Boiler/Natural Gas Usage
Estimated Annual Volume Requirement	40,000-50,000 m^3	6,000-10,000 m^3	500,000-1,800,000 m^3

4.1.3 MWP

These facilities require substantial space, but less supporting infrastructure when compared to WTE facilities as noted by the following considerations:

- **Site area.** MWP facility typically would require between 2-4 hectares of land for the buildings. Similar to the WTE option, there is no regulatory requirement for the City to own the land where the facility is located; however, it is recommended that the City own the land for operational flexibility and long-term stability (e.g. risk of lease not being extended). To assist potential impacts to neighbours, it is anticipated the facility will require 3-5 hectares in total. This is dependent in part on how much storage area is allocated for recovered material storage. In general, processed waste remains on site longer until it is removed from the site. If processed waste is removed at a higher frequency, the area for storage will be less and can reduce the facility footprint. It is noted that additional space can be used for additional capacity should the downstream receiver of the waste operated is disrupted and the City may require short-term storage capacity.
- **Infrastructure requirements.** Electrical substation and connection to main grid for power importation, access to major highways.
- **Roads:** The zoning requirements for waste facilities are restricted to having either direct access to a designated truck route or access through an RG- or RH- zoned industrial subdivision leading directly to a designated truck route.
- **Utility needs and consumption.** Water source, electricity, sewer connection, gas line connection.
- **Impacts on nearby receptors.** Odour from stored materials.

4.1.4 New Landfill

These facilities require substantial land area, but less supporting infrastructure as noted by the following considerations:

- **Site area.** The City must own the land as per O. Regulation 232/98 and based on recent landfills approvals, it is expected that new landfills would require between 100-200 hectares of land for landfilling, buffer, and contaminant attenuation zone.
- **Infrastructure requirements:** Electrical substation and connection to main grid for power importation, access to major highways. In addition, the facility may require a connection to the

sanitary sewer or WWTP for leachate treatment. Alternatively, the leachate will have to be shipped off-site which increases GHG emissions.

- **Roads** - The zoning requirements for waste facilities are restricted to having either direct access to a designated truck route or access through an RG- or RH- zoned industrial subdivision leading directly to a designated truck route.

- **Utility needs and consumption.** Water source, electricity interconnections, sewer connection, and gas line connection (for potential RNG production). The main item that needs to be considered is the sewer connection or WWTP capacity (off-site).

- **Geotechnical –** The geotechnical capacity will impact the design. The site must demonstrate that it can maintain the weight of the waste. Mitigation approaches can be implemented to adjust the site footprint, height, and geometry accordingly to support a landfill. The site must be demonstrated to meet the requirements of O. Regulation 232/98, which allows for generic designs (G1 or G2) or site-specific designs.

- **Impacts on nearby receptors.** Odour from landfill materials, potential impacts to groundwater wells, potential impacts to surface water if discharges occur, or containment features of the landfill fail.

4.2 General Air Emission Siting Requirements

The MECP has identified several sensitive receptors that should be considered when selecting a site. These sites include the following areas:

- permanent, seasonal, or rental residences
- hotels/motels
- nursing/retirement homes
- hospitals
- campgrounds
- noise-sensitive buildings such as schools, day-care facilities, and some places of worship

These receptors potentially could limit the number of sites that may be considered for any of the options during the assessment.

5 Other Considerations for Siting and Regulatory Approvals/Permissions

The EAA and EPA permission processes described above are the key permissions that proponents require before they can proceed with the planning, construction, and operations of waste management facilities. However, all applicable approvals must be obtained before a site can operate. In general, the other approval considerations are considered low risk for the MWP and WTE options, as there are appropriate mitigation measures that can be implemented to address concerns. For the new landfill option, due to the size of the area, the approval and permission requirements are considered a higher risk. To obtain the other applicable approvals you may take additional work and require additional mitigation measures to be considered to address any potential risks that have been identified for those permissions.

In summary, all options can meet the regulatory requirements through implementation of mitigation measures. The landfill option and any greenfield site for WTE and MWP would have an increased risk due to the nature, size, and long-term requirements.

5.1 Other Provincial and Federal Acts

The following section describes the additional approvals that will or may be required for the options process.

5.1.1 Planning Act

Depending on the facility's location, it is expected that re-zoning of the land that the facility is located on or amendments to the official plan may be required. This will require a municipal application and applicable supporting documentation.

For waste processing and transfer facilities in rural areas, the facility must be in a Rural Heavy Industrial (RH) Zone. In addition, the facilities are restricted to having either direct access to a designated truck route or access through an RG or RH zoned industrial subdivision leading directly to a designated truck route. This would apply to MWP facilities.

For urban areas, waste processing and transfer facilities are permitted under the General Industrial Zone and Heavy Industrial Zone designations.

The City will have to clarify whether they consider WTE facilities to fall under the waste processing category. Should the City consider a WTE facility to fall within the waste processing zoning category, then they will be covered under the current official plan. If it is determined that it is not waste processing, then the land will have to be zoned accordingly to permit the undertaking.

The City’s zoning by-law does not address landfill zoning. Notwithstanding, the City’s zoning map for the location of the Trail Road Waste Facility is identified as RU (Rural Countryside Zone). Any new landfill would have to be zoned, which involves amending the official plan and re-zoning activities.

In Ottawa, an application for a zoning by-law amendment involves public consultation, including providing notice to all property owners within 120 metres of the subject site. The City Council must approve any amendment to the zoning by-law, which is subject to an appeal process. The Planning Act has a provision whereby the City Council must decide on any zoning by-law amendment application within 90 days of receiving a complete application. If the City Council does not make a decision within this time frame, the applicant can appeal to the Ontario Land Tribunal on the basis that a decision has not been made within the allotted time.

For the waste management options, for the preferred locations, the City has the authority to amend the zoning to allow the undertakings to proceed should the lands not meet the proper zoning requirements. This is considered a low-risk approval requirement.

5.1.2 Planning Act – Provincial Policy Statement (Provincial)

In June 2024, the Ministry of Municipal Affairs and Housing (MMAH) released its updated provincial policy statement on planning. In the policy statement it contained the following:

> *“Waste management systems need to be planned for and provided that are of an appropriate size, type, and location to accommodate present and future requirements, and facilitate integrated* waste management.”

The MMAH realized the important role that waste management plays in the planning of our communities, and that waste management facilities should be included as an integral part of a community.

As the City reviews and updates its Official Plan, consideration can be given to expanding potential land use options for these facilities.

From a waste management option perspective, the policy statement provides a general overall acceptance and acknowledgement for the options; however, the City will still have to undertake their due diligence for assessing, WTE, MWP, and new landfills.

There is no indication that the release of the policy statement will have any immediate impact on the site selection unless the City makes amendments to their Official Plan. Currently, there is a low risk of impact on the various options.

5.1.3 Clean Water Act

The Clean Water Act, (CWA) 2006 was introduced on December 5, 2005, and received Royal Assent on October 19, 2006. The Act will ensure that communities are able to identify potential risks to their supplies of drinking water and take action to reduce or eliminate these risks. Municipalities, conservation authorities, landowners, farmers, industry, community groups, and interested people will all work together to meet common goals.

CWA created source protection areas and source protection regions. A source protection region can have one or more source protection areas. The Act also created a local multi-stakeholder source protection committee for each region. These committees identify significant existing and future threats to their municipal drinking water sources and develop plans to address those threats.

There are two source protection regions covering the City of Ottawa. These source protection areas include the Mississippi-Rideau Source Protection Region and the Raisin-South Nation Source Protection Region. Each region has their own source protection plan that identifies risks to local drinking water sources and develops strategies to reduce or eliminate these risks.

Future waste sites will not be permitted in areas that pose a significant threat to drinking water. Existing sites have a set of rules depending on the activity. For landfilling of municipal waste, for both source water regions, the activity is a significant threat (Intake Protection Zone (IPZ) and Wellhead Protection Area (WHPA)) based on the vulnerable area and the fill area of the landfill disposal site in **Table 5-1**:

Table 5.1: Summary of Source Protection Requirements

Vulnerable Area	Score	Area
WHPA	10	Any Size
	8	> 10 ha
IPZ	10	> 1 ha
	9	> 10 ha

Sites with the scores as indicated could limit the potential of the landfill being approved.

When identifying sites, the City will have to identify whether the source water protection plans permit or have mitigation measure requirements to allow an undertaking to take place. Depending on the zone, if the activity is not permitted, then the City would not be able to utilize that site for their undertaking.

In general, the restrictions are related to the final disposal of waste. The CWA will have to be considered for any greenfield landfill site. This is considered a medium to high risk depending on the area. From a waste processing perspective, the CWA may have requirements but do not restrict/prevent the operation. The impact is considered low to medium, depending on the actual site.

5.1.4 Ontario Heritage Act

Any form of real property can be identified and protected in a designation by-law, including buildings, structures, open space, landscape features, trees, and plantings. There are two types of municipal heritage registers:

- Designated properties
- Non-designated properties

Designated properties are heritage properties legally designated by a municipal by-law, registered on title to the property. Once designated, an owner will require a heritage permit to alter or demolish a designated property.

Non-designated properties are properties that have been identified as having some cultural heritage value or interest but have not been legally designated under the Ontario Heritage Act by a municipal by-law.

Under the Ontario Heritage Act, municipalities are empowered to add non-designated properties of cultural heritage value or interest to their heritage registers. Listing on the register is one step short of designation under the Act and constrains property rights by requiring the owner of a non-designated property to give the municipality 60 days notice before demolishing the property. This notice period is essentially a trigger, allowing a municipality time to consider protecting the property from demolition by designating it under Part IV of the Act.

Ottawa has one of the largest registries in the province, with nearly 4,600 properties identified as non-designated. If a site is designated and it is considered as a subject site, it can result in the proponent (e.g., the City) having to undertake an archaeological and cultural heritage study. The report would then have to be submitted to the Ministry of Heritage, Sport, Tourism and Culture Industries, and they will review and evaluate the report against relevant standards and ensure mitigation recommendations are included. These actions can take time and potentially could lead to delays in a project while the report is being reviewed, or potentially not allowing changes to the site.

In general, this Act is not expected to impact approvals or sitings. For new landfills, and processing facilities, it is anticipated that they will either be sited at a greenfield site (without buildings) or existing industrial locations where a heritage designation is not anticipated. The City has the authority to designate a property with a heritage designation. The City has control over the designation process, and as a result, the City should not be designating a property they are considering for one of these facilities.

As part of their due diligence in site selection, the City should reference the list to identify any potential sites that may be identified within the City's designated and non-designated properties.

5.1.5 Endangered Species Act (Provincial)

To protect the natural environment, studies will have to be undertaken to assess species at risk. The undertakings will require review and determination of permitting requirements under the Endangered Species Act (ESA). Direct loss and/or damage to an endangered species' habitat will have to be addressed.

It is possible that mitigation can be put in place to avoid or minimize the effects on the species. Consultation with the MECP will determine if the proposed works require a Notice of Activity or Overall Benefit Permit.

This approval is a site-specific approval and not necessarily dependent on the specific waste management option. The City will have to assess each location that is being considered during that phase of the project to assess the potential impacts. As the City is in the preliminary Feasibility Study stages, the potential impacts to deciding on the facility will have to be deferred until potential site locations are identified.

5.1.6 Conservation Authorities Act (Provincial)

Depending on the location of the facilities, they may fall under the Regulation Limits of the Rideau Valley Conservation Authority. It will be prudent for the City to engage the local CA in discussions to determine the potential requirements for an applicable permit under the Conservation Authorities Act and its regulations as it relates to the Ottawa area.

From a siting perspective, to reduce the potential risk to concerns from the CA, the City should consider keeping sites away from any flood protection areas where the CA may have authority.

For developed areas, these are considered a low risk. For greenfield sites for any of the options, this will be considered a low to medium risk due to the potential unknowns.

5.1.7 Lakes and Rivers Improvement Act

The Lakes and Rivers Improvement Act (LRIA) regulates the construction, repair, and use of a dam on any lake or river, including the diversions of streams, and is administered by the Ministry of Natural Resources (MNR). “Dam,” “lake” and “river” are very broadly defined in the LRIA. Construction, alteration, improvement, and repair of a dam in circumstances set out in the regulations require approval from MNR.

It is not anticipated that the facilities will be located near a lake or a dam due to the potential environmental impacts; therefore, the requirements of the LRIA will likely not be applicable.

5.1.8 Public Lands Act

Waste management projects may be subject to the Public Lands Act administered by the Ministry of Natural Resources. The "rules" governing the administration of Crown land are laid out in the Public Lands Act. In this statute, the term "public land" means Crown land. Section 2 of the Public Lands Act grants the Minister of Natural Resources the authority to manage, sell, and dispose of public lands.

This Act is considered a low risk for the City. Any undertaking will occur on existing or newly purchased lands by the City.

5.1.9 Fisheries Act

The federal Fisheries Act provides protection for fish and fish habitat. Under the habitat provisions of the Act, no person shall carry out any work or undertaking that harmfully alters, disrupts, or destroys fish habitat, unless authorized by the Minister of Fisheries and Oceans Canada. An authorization under section 35(2) of the Fisheries Act protects an individual from prosecution under the Act, provided the conditions of the authorization are met. A section 35(2) Fisheries Act authorization is a regulatory trigger for an environmental assessment under the EAA.

Contact with the Conservation Authority and Ministry of Natural Resources should determine the need to contact Fisheries and Oceans Canada. These government agency contacts should be made early in the planning process. Information on the Fisheries Act and Fisheries and Oceans Canada’s Policy for the Management of Fish Habitat is available on the Fisheries and Oceans Canada website.

Given the potential location of the facilities within the City of Ottawa, this Act is considered low risk; however, it should have a risk matrix assessment associated as a pre-cautionary approach.

5.1.10 Navigable Waters Protection Act

Any project that could affect the navigability of a navigable waterway requires a permit under the Navigable Waters Protection Act. This in turn would trigger the requirement for an assessment in accordance with the Canadian Environmental Assessment Act. To ascertain whether a waterway or watercourse is navigable, Transport Canada’s Navigable Waters Protection Program would have to be contacted to assist in the determination.

Given the location and probable location of a facility, this Act is considered a low risk.

5.1.11 Migratory Birds Convention Act

The Migratory Birds Convention Act, 1994, deals with the conservation and protection of listed species of migratory birds and their nests. The Act, administered by Environment Canada, regulates the release of harmful substances into any waters or other areas frequented by migratory birds, the “incidental take” of migratory birds and the disturbance, destruction or taking pursuant to sections 35(1) and 6, respectively, of Migratory Birds Regulations. “Incidental take” is the killing or harming of migratory birds due to actions, such as economic development, which are not primarily focused on taking migratory birds.

For the WTE option, given the existence of a stack, there may be a low to medium concern given and potential impact to birds. MWP facilities are considered low risk and would likely not be regulated under this Act. Due to the size of the landfill and the potential attraction that landfills have with birds and the greater potential for habitat loss, this regulation is considered medium to high risk, and the City would have to consider the Act in their EAA and Design and Operations Report.

5.1.12 Species at Risk Act

The Species at Risk Act, 2003, is intended to provide protection for individuals of wildlife species at risk listed under Schedule 1, Parts 1-3 of the Act, their residences (dwelling places, such as a den or nest or other similar area that is occupied or habitually occupied by one or more individuals during part or all of its life cycle) and their critical habitat. Critical habitat, as it is or will be identified in species specific recovery strategies or action plans, is the part of areas used or formerly used by listed species to carry out their life processes that are deemed essential for survival or recovery. Prohibitions under the Species at Risk Act apply to federally regulated migratory birds and aquatic species, and all species on federal lands.

Depending on the site selection process, this Act is a greater risk for greenfield sites that may apply to new facilities (e.g. new landfill) compared to a facility that may have already been developed (e.g. industrial park). It is anticipated that the WTE and MWP will occur within an existing industrial area where the concerns for this Act are considered low.

5.1.13 Municipal Permits

For any building or changes to an existing building, the proponent will have to obtain necessary and applicable building permits to construct a facility. Under the Building Code Act, a building permit is required for the construction of a new building, an addition, or alteration of any building or structure with a building area of over ten square metres (approximately 108 square feet). In order to get a building permit, site plan approval must first be required. This requires several supporting studies and investigations; however, the information for these studies is typically addressed during the environmental assessment (if applicable).

Permits can be delayed due to the volume of permits under review. Adequate lag time should be given to account for potential delays.

This will be a factor for any new facility that requires a structure or an amendment to an existing building.

5.2 Summary of Potential Impacts to Site

The following is a summary and expected level of risk associated with the applicable act/policy statement as it relates to each option. As part of planning and development the city should review reach item below to determine whether the item is applicable. There are other factors such as a greenfield and established area that would have to factored into the assessment. The following only gives an initial indication.

Table 5.2: Potential Act Requirements Risks

Act	Status Quo and Private Facilities	WTE	MWP	WTE with MWP	New Landfill
Planning Act	Low	Med	Med to Low	Med to Low	High
Provincial Policy Statement	Low	Low to Med	Low	Low	Med to high
Clean Water Act	Low	Med	Med	Med	High
Ontario Heritage Act	Low	Low	Low	Low	Low
Endangered Species Act	Low	Low	Low	Low	Med
Conservation Act	Low	Low	Low	Low	Med
Public Lands Act	Low	Low	Low	Low	Low
Fisheries Act	Low	Low	Low	Low	Med
Navigable Water Protection Act	Low	Low	Low	Low	Low
Migratory Birds Convention Act	Low	Med	Low	Med	Med to High

Act	Status Quo and Private Facilities	WTE	MWP	WTE with MWP	New Landfill
Species at Risk	Low	Low	Low	Low	Med
Municipal Permits	Low	Med to High	Low	Med to High	High

6 Approvals/Siting Identified Risks

The risks identified previously were supported by the discussion with the MECP on August 21, 2024. Further potential risks and concerns were subsequently identified that may pose a risk to the City in a timely and effective project implementation step to address or mitigated by the City should the MECP not address the issue.

Table 6-1 below provides a general overview of the risks for approvals and siting, and further in-depth discussion on the key factors that may cause the risk.

Table 6.1: Key Risks

Item	Risk	Mitigation
Delay/Change in Environmental Assessment Process	The risk that the EA process is delayed due to review delays, or the Ministry designates the undertaking, or receives and agrees to a request from the public, for a bump up request (e.g. CEA be undertaken). The bump up request is realistically applicable towards the WTE and the ESP process. The new landfill undertaking would be considered a risk of delay due to complexity and the number of stakeholders involved in reviewing and commenting on the undertaking The MWP and Status Quo and Private Facilities Options are not considered a risk for the EA process Delaying or having the process change could result in costs for the City (e.g., higher financing costs, or construction price inflation during the period of delay). The risk that proper community and indigenous engagement/consultation is not carried out.	Early engagement with Minister's Office staff, MECP, and local residents to proactively address concerns. Have regularly scheduled project meetings with the MECP to identify and proactively address concerns as they arise. Development of a comprehensive consultation and engagement plan. Ensure a good understanding of the project and subject area to demonstrate that the undertaking has a predictable outcome.
Increase in Costs	The risk that Environmental Assessment and/or ECA approvals require changes to the project which require changes in design, construction, and/or operations prior to financial close / notice to proceed thereby causing a scope change outside of the competitive tension of the procurement process, thereby increasing costs. This can be applicable to each of the options based on site-specific information and any feedback received from agencies or the public.	Early engagement with Minister's Office Staff, MECP, and local residents to proactively address concerns. Have regularly scheduled project meetings with the MECP to identify and proactively address concerns as they arise. Have a strong project plan in place that allows for adaptability and change.

Item	Risk	Mitigation
Delay in Environmental Permission Approvals	The risk that ECAs are delayed or are awarded based on conditions imposed on the City which impact the project schedule, and which may delay the time to reach financial close. Delaying the process could result in costs to the City (e.g., higher financing costs, or construction price inflation during the period of delay). This risk applies to all site options.	Ensure complete applications are prepared and submitted. This can be accomplished through pre-consultation meetings with the MECP. The City PM can request to have regularly scheduled project meetings with MECP to identify and proactively address concerns as they arise to ensure timely review responses from the City. Where not typically assigned by the MECP, the City could file a specific request to the Regional Director or EAPD Director to assign a dedicated project manager (PM) or issues coordinator (typically at the regional level) to be the one-window contact and that can provide oversight and project controls to address internal MECP reviews, inquiries and feedback. Although it is uncommon, certain high profile/high contentious files within the MECP have had dedicated PMs assigned. Ensure a complete application is submitted and have an ECA pre-consultation meeting to further understand the specific undertaking requirements.
Failure to Obtain Approvals	The risk that the required ECA and EA approvals are not obtained.	Have adequate contingency plans to address short-term needs until a longer-term sustainable plan can be identified and implemented. (e.g., long, or short haul transport to private third-party waste management facilities).
Site Availability (Acquisition Delay or Failure)	The risk that, in the case that the private sector provides its own site, the site is not obtained when required, leading to either delays in the process or changes to the project which can result in additional costs to the project.	Have contract contingencies in place for penalties and requirements for the contractor to absorb the cost of waste management until the facility is operational. Reduce potential liability to the City.

Item	Risk	Mitigation
Land Use Planning and Zoning	The risk that all planning approvals required are not in place to support the project. This applies to all site options.	Work proactively with other City partners to address concerns and actively address issues as they arise.
Agency Approvals and Permits (Other than EA and ECA)	The risk that the agency approvals of permits and other authorizations delay the beginning of construction and any eventual operation.	Have regularly scheduled project meetings/contact with agencies to identify and proactively address concerns as they arise. Outline project management plan tasks for follow-up with agencies.

These examples are not an inclusive list, but based on experience, are the typical items that contribute to delays. For each approval/permit required, the findings could conclude that a selected site may not be appropriate (e.g. archeological reasons or endangered species). However, considerations to the implementation of risk the mitigation measures could be implemented to reduce or eliminate the risk.

6.1 Considerations for Root Causes to Approvals Risk Considerations

There are several root causes that can contribute to the risk. The root causes are generally in the control of other government agencies in which the City must apply and obtain the appropriate approvals. As discussed above, key approvals must come from the MECP. Based on a meeting on August 21, 2024, the following factors were identified that may contribute to delays or refusal of approvals.

1. Project Management Plans and Quality Assurance Plans – the MECP does not have any set project management/quality assurance processes similar to those typically aligned with Project Management Professional organizations. This potential lack of controls can present an unknown level of uncertainty to reviews and the timeline for reviews. In many cases, it has been these unknowns and potential lack of plans that can and have led to considerable time delays in projects.

   The City should have a proactive PM that actively engages with MECP staff at EAPD and the local district office to ensure open communications, information sharing and having the MECP confirm expected deliverables and timeframes.

   From a City perspective, an additional approach is for the City to request a priority review of all or any of the waste management applications the City is considering. Having a priority review will bump the application near or at the top of the reviewer's review pile. This will provide a level of assurance to the City that the final submission will be reviewed in a timely manner.

The MECP will make the final decision on whether the applications can receive a priority review based on their criteria. This includes files that may have received provincial or federal funding, emergency, or health situations, meet provincial priorities, or other factors the MECP identify.

2. ECA Conditions – ECA conditions can have both operational and financial implications for proponents. The MECP is focused on protecting the public interest, supporting economic growth in Ontario; however, in recent years the MECP has been imposing conditions in ECAs that are considered non-environmental compliance related and non-enforceable. These conditions can cause proponents significant costs to comply with those conditions.

   As MWP facilities are considered significant environmental undertakings, it is anticipated that the MECP may impose unnecessary and burdensome conditions on the City for their proposed waste management options. This will increase the financial cost to operate the facilities for the City.

   It is important to understand the ECA review process and the various stages to assess the potential risk. The terms and conditions of an ECA are not provided to a proponent until the end of the review, which can be problematic as it puts undue pressure on a proponent to accept the conditions, especially those non-environmental related conditions that have financial impacts.

   To potentially address these concerns, the City should engage the MECP early in the review process to discuss the conditions to gain an understanding of the MECP approach and have discussions on typical conditions. In addition, the City could also take a proactive approach and draft potential ECA conditions for the MECP's consideration. Being familiar with the site and the technology allows the City to draft conditions that better reflect the site operations. This has been completed in the past for proponent consideration.

   In general, the MECP sharing information earlier in the process can assist with compliance and approval timelines.

   This approach can be applied to all the waste management options the City is considering as a project control measure, and to ensure delays are minimized because of a negotiation over conditions in the ECA.

3. Subject Matter Expertise Thermal Treatment – Similar to other organizations, the MECP has undergone staff changes over time due to changing demands and financial constraints, which has resulted in the merger of divisions and/or reallocation of staff. In recent years, key positions related to waste management, energy from waste and new technologies have been left empty and/or positions removed. This includes positions related to air emissions standards and reviewers of new waste technologies. The removal of these positions has left a significant gap in the MECP's review process.

   This is considered a potential risk for the option. as it can lead to delays in approvals as they become familiar with the technology. Whereas the MECP has plans/aspirations on educating staff on the new technologies the probability of staff turnover and data knowledge loss is expected due to retirement is considered high, which can pose a risk for future reviews.

To mitigate this particular concern, the City can actively engage the reviewer, including requesting regularly scheduled meetings (MECP may decline) to ensure they have the most current information regarding the project during the ESP and the ECA application review.

Where possible, the City can arrange potential site tours of other comparable facilities to allow the reviewers to visit and better understand the operations and the inside workings of a WTE facility. A key component of the undertaking is to educate the public where necessary and the applicable government agencies to reduce concerns that can lead to contentious issues due to misconceptions. Subject Matter Expertise on Reg. 347 – Regulation 347 – General Waste Management is a key regulation for waste. Regulation 347 is considered by many to be a very complex and intertwined regulation that can be difficult to interpret at times. Similar to the above, there has been a significant change in staff at the MECP for those who would be considered subject matter experts and those who may be familiar with Regulation 347. The Ministry acknowledged at the August 21, 2024, meeting that new staff are getting up to speed with the regulation; however, this implies that they are not subject matter experts now. This can potentially impact review timelines as reviewers review and assess applications. These concerns can impact both the MWP and new landfill reviews, depending on the site-specific concerns.

There are several steps/approaches the City can take to offset this issue. The primary approach should be that the City should engage the MECP in a pre-consultation early in the process. This should be completed once the preferred facilities are identified and inquire whether there are any regulatory aspects of the undertaking that the MECP would require additional studies or further information. It can also allow for more detailed discussion on the subject matter in Reg. 347 and allow for the sharing of ideas and interpretation. This can strongly reduce the development of concerns later in the review.

Another approach to consider is informal education. This can be accomplished through site visits to existing facilities to walk the MECP through the facility such that they can understand the internal workings of a site. This will allow for questions to be answered and better understand the supporting documentation and the discussion within (e.g., correlate the site operations to regulatory requirements).

4. Service Standard for Reviews – The MECP has a service standard for returning communications and a one-year service standard on ECA applications.

   The MECP has a one-year service standard for ECA application. HDR has requested information from the MECP pertaining to service standard achievement. This information would be useful for the City to understand and assess risk on actual MECP turnaround timelines and potential impacts on all the City’s potential options. Currently, the MECP has not provided the information. As a result, the MECP meeting the service standard turnaround times for ECA applications can be considered a medium to high risk for all the options. Based on HDR’s experience, high complex files at the MECP have not met the one-year service standard in recent years, which delays projects and adds financial burdens to proponents. The reason for these files not meeting the service standard is file dependent. Some reasons included incomplete applications, higher priority files, or complexity of files.

Timelines for reviews are outside the City control; however, meeting regularly with the MECP for updates, open communication and transparency can assist in responding to issues or concerns that may arise during the reviews. This approach can be applied to all the waste management options and are not limited to any option.

5. Zoning – It has been the MECP position to not approve an application without the proper zoning in place. It is important to note that they will not refuse an application based solely on improper zoning. They will hold onto the approval until such a time the zoning is in place. To mitigate this issue, it is important for the city to ensure all the zoning or processes to obtain the zoning are in place when making the ECA application for any of the options. It will minimize any potential delays in ECA approvals. The zoning does not need to be in place for the EA process.

To summarize, there are several factors outside the City's direct control that can delay or impede approvals or siting a waste management facility. These are related to the implementation of the regulatory framework, project management controls and facility knowledge to deliver these services. The MECP, municipalities and other government organizations plays a significant role in the approvals process for the potential facilities. The MECP and other organizations are facing some challenging times due to staff reductions, reduced technical knowledge around waste management and core competencies to deliver on projects in a timely and effective manner. Other organizations face similar challenges but play a less involved role in approvals.

To minimize the risk, there may be opportunities for the City to engage the MECP early on to discuss processes, goals, and deliverables to identifying opportunities to streamline approaches and reduce burdens where duplication exists. The City may suggest potential delivery approaches that the MECP may consider or implement for the City's projects, including opportunities for simultaneous EA and ECA reviews for applicable files (e.g.), site visit to existing waste management facilities for education purposes to enhance MECP knowledge and understanding and request for priority reviews to ensure timely deliverables. These concepts can further be discussed as options during the planning stages of the project.

7 Summary

For the five options that the City are considering, each have specific approvals (based on regulatory thresholds, and siting requirements.

The following provides a summary of key items to consider for approvals and siting requirements for each option:

Table 7.1 – Summary of Key Approvals and Siting Requirements for the Options

Option	Approval and Siting Requirement Summary
Status Quo and Private Facilities	• No EA process triggered. • No anticipated new or amended ECAs to allow for the continued use or transport of waste to third-party waste management facilities. • No specific siting requirements or other regulatory permits are required for this option. • For GHG emissions, the City does not have any control over the management of third-party landfill gas collection systems, which would contribute to overall community emissions.
MWP	• Estimated volumes are below EA trigger threshold, as a result no EA is anticipated for this undertaking. • ECA requirements are waste, wastewater, and air/noise (dependent on final operation). • Impacts related to other Acts will vary depending on whether a greenfield or existing facility (e.g. existing industrial park). • Land requirements are anticipated to be approximately 3-5 ha for the site. • Typical utility requirements are anticipated (water, sewer etc.).
WTE	• At minimum, the undertaking will trigger a streamlined EA process (ESP). The Minister has the authority to “bump up” the process to an CEA; however, it is not considered a common practice. • ECA requirements are waste, wastewater, and air/noise • Impacts related to other Acts increase due to complexity of undertaking but can be mitigated in most circumstances. Risks to mitigation will vary depending on whether a greenfield or existing facility (e.g. existing industrial park) • Land requirements are anticipated to be approximately 3-5 ha for the site. • Utility requirements are significant for this option. There are specific requirements for electrical stations, gas requirements, sewer and water sources. These items are anticipated to play a role in the matrix to assess risk and potential site selection.

Option	Approval and Siting Requirement Summary
WTE with MWP	• The WTE option summary applies to this option. • Land requirements are anticipated to be approximately 5-10 ha for the site. • Utility requirements are significant for this option and are anticipated to be similar to a combination of the MWP and WTE options. These items are also anticipated to play a role in the matrix to assess risk and potential site selection.
New Landfill	• Estimated volumetric airspace required for disposal triggers the CEA process. • ECA requirements are waste, wastewater, and air/noise. • Impacts related to other Acts will play a role in the approvals and siting for a new landfill. Many of the same reports required for these permissions will be completed during the EA process. • Land requirements are anticipated to be approximately 100-200 ha for the site. • A key utility requirement for landfills is a sewer connection or capacity or capacity at receiving WWTP to accept leachate.

When developing a scoring matrix to assess the feasibility of the options, the approval and siting requirements discussed in this technical memorandum can be factored into the scoring to assist the City determine the preferred option.

Once a preferred option(s) has been established, there are opportunities to streamline or better manage the approvals process. An example that can be utilized includes for any undertaking that triggers an ESP process, the City can undertake the EA and EPA process simultaneously to reduce burdens and achieve a timely outcome.

For any of the processes there are also opportunities to manage the project to receive your permissions in a timely manner.

Recommended actions that the City can consider include:

1. Request a priority review for ECA applications.
2. Ensure a complete application is prepared and submitted to the EAPD for approval.
3. For applicable ESP processes (option), undertake simultaneous ESP and ECA processes to reduce timelines.
4. Engage early in the process with the MECP to identify the dedicated reviewers. Have the MECP identify whom the point of contact for the EA and ECA process will be to ensure timely

responses and deliverables will be achieved. Ensuring the City's PM works directly with the MECP's point of contact will reduce the potential for misinterpretations on the City' s end.

5. Maintain contact with other organizations for their awareness of upcoming applications from the City and the anticipated time frames and deliverables to minimize delays and allow those organizations to plan accordingly.

Appendix A

August 21, 2024, Meeting with MECP Pre-Consultation Meeting Agenda and Meeting Minutes

Agenda

Project:	City of Ottawa: Feasibility Study for Waste to Energy and Mixed Waste Processing
Subject:	MECP/CH Concerns June 28 Correspondence and Correspondence
Date:	Wednesday, August 21, 2024
Location:	Microsoft Teams
Attendees from MECP:	Mary Ianni (MI) Eugene Macchione (EM) Tracey Hart (TH) Bonnie Wilkinson (BW) Sherif Hegazy (SH) Yuefeng Zhang (YZ) John Maiorano (JM) Jon Orpana (JO) Shelly Bonte Gelok (SBG) Ian Drew (ID) Bijal Shah (BS) Miroslav Ubovic (MU) Pierre Godbout (PG) Mohsen Keyvani (MK) Margaret Wojcik (MW)
Attendees from HDR and City of Ottawa:	Bruce Howie (BP) Dale Gable (DG) Megan Farnel (MF) Brandon. Maynard (BM) (Optional) Andrea Gay Farley (AGF) Nichole Bienasz (NB) (Optional) Heidi Scott (HS) Shelley McDonald (SM)

1. Introduction - All
2. Land acknowledgement – DG
3. Overview of the Meeting – DG
    a. Overview of SWMP
        i. Maximize the Reduction and Reuse of Waste
        ii. Maximize the Recycling of Waste
        iii. Maximize the Recovery of Waste and Energy and the Optimal Management of Remaining Residuals
        iv. Maximize Operational Advancements
        v. Developing a Zero Waste Culture Across the City
    b. Update on regulatory changes, expectations, and known challenges

   c. Obtain a clear understanding of regulatory requirements/interpretation
   d. Gather information to assess potential risk (decision/risk matrix)

4. Policy Discussion with RRPB – DG, SBG, ID
   a. Update/direction related to current policy or potential new policy matters related to thermal treatment and energy from waste.
   b. Update/direction on mixed waste processing policy (e.g. bans, incentives)
   c. Roles of thermal treatment (not destruction of thermal applications) in waste processing (non-thermal treatment)
   d. Updates and discussions on environmental plans and the role of energy recovery as a component of the province waste management strategy and updates to policy around recycling (e.g. 5Rs compared to 4Rs)
   e. Sharing of information (Landfill Operations Improvement Project (LOIP) information on landfill gas collection)
   f. ARAP – Environmental Racism (Background for EAA/EPA Discussion)

   Meeting Summary:
   - MECP does not have any direction to amend regulations or policy related to thermal treatment undertakings. The MECP focus currently on ERP (e.g. blue box)
   - MECP provided clarification on status of organics ban
   - Requested information on landfill gas collection. MECP Action Item to review requests and get back to HDR
   - Subject Matter Expertise – Inquired on staffing experience on Reg. 347. MECP indicated staff on getting up to speed. HDR raised concerns that some staff doing roles of 5 former positions and more staff are waste generalist. Main concern was it may take longer to review and comment on files comments compared to SMEs.

5. Climate Change and Greenhouse Gas Reduction Goals – JM, DG,
   a. Discussion on MECP approved/preferred GHG models and GHG opportunities to assess project with respect to climate change and GHG reduction
   b. Regulatory update/changes that may factor decision matrix

Meeting Summary:
- No new regulations anticipated that may impact undertakings
- Indicated they use ECCC models.

6. EAA Regulatory Discussion – DG, ZR, TH, BW, MI:
   a. Update/Recap of new regulation O. Reg. 50/24 under the EAA and current EA requirements for thermal treatment sites with an energy from waste component.
   b. Current MECP and government perspective on the primary issues/risks/components that will need to be considered as part of an EA.
   c. Mixed Waste Processing with thermal component

Meeting Summary:
- No direct changes to waste management project component
- Confirm would consider the concurrent reviews that can be completed for ESP and EPA applications
- No new specific requirement on anti-racism for currently being contemplated (e.g. no stand-alone separate reports from a social report)

7. MECP Project Control – DG, ZR, MK, MU, SH, BS, others

a. MECP approach to project risk management, project management planning, quality assurance control and other matters for environmental assessments and environment compliance approvals to reduce project risk, meet government mandates and achieve timely deliverables.
b. Fundamentals of regulatory and subject matter expertise within MECP.
c. Regulatory interpretation of emissions from processing and thermal treatment and other waste management operations.
d. Compliance related interpretations

Meeting Summary

- The ministry supports proponents through various approaches including pre-consultation meetings. MECP can provide additional information once timelines from the City are identified.
- No specific project controls were identified in the meeting. HDR followed up with MECP (EM) to inquire on management platforms, SharePoint and potential discussion opportunities on dedicated MECP project managers.
- MECP confirmed that they do not consider biogas/landfill gas from MSW to be a hazardous waste. The processing of that gaseous waste would need waste approval. Further discussion on how gaseous waste can be exempted within Reg. 347 will be required as currently no regulatory exemptions from the waste framework (e.g. any gaseous waste turned into an RNG would still be considered a waste without an exemption).
- MECP confirmed that industrial facilities such as waste transfer and processing facilities would require an OWRA approval.
- MECP confirmed that A5 and A7 should be reviewed and considered for WTE facilities.

8. Recap and Summary

Appendix B

Example of Risk Matrix for Approvals/Siting

3.00	Property Acquisition, Approvals and Site Condition					
	Risk	**Description**	**Relevant?**	**Vary for Site?**	**Vary for Technology?**	**Vary for Size?**
Site Conditions						
3.06	**Archaeological**	The risk that archaeological findings at the proposed site result in delays and increased costs, due to measures required to comply with relevant government authorities.				
3.07	**Construction Activity Results in Contamination**	The risk that construction activity results in contamination of the proposed site. This could result in temporary closure of the site and delay in commissioning.				
3.08	**On-site restrictions**	The risk of any on-site restrictions, such as on-site watercourse, easement etc. that could cause a delay in the process and lead to increased costs due to remediation efforts required.				
Approvals						
3.09	**Agency Approvals & Permits (Other than EA and ECA)**	The risk that the agency approvals with respect to permits and other authorizations delay the beginning of construction and any eventual operation.				
3.10	**PPA Risk**	The risk that the a PPA cannot be obtained from the Ontario Power Authority for sale of electricity to the Province or PPA offered to City is not enough to make the project financially viable.				
3.11	**Generation License (Electricity, Heat, and Fuel)**	The risk of being unable to obtain approval (if required) from Ontario's Independent Electricity System Operator for PPA approval, even it not initially connected to the grid, or relevant approval for other energy products (e.g. heat, fuel)				

Appendix F

Technical Memorandum No. 3

Technical Memo #3 – Project Delivery Models and Funding Opportunities

Final Report

City of Ottawa

—

June 02, 2025

Disclaimer

This document has been prepared by KPMG LLP (“KPMG”) for HDR Corporation (“the Client” or “HDR”) pursuant to the terms of our subconsultant agreement dated July 22, 2024 (the “Engagement Agreement”).

KPMG neither warrants nor represents that the information contained in this document is accurate, complete, sufficient, or appropriate for use by any person or entity other than the Client or for any purpose other than set out in the Engagement Agreement. This document may not be relied upon by any person or entity other than the Client, and KPMG hereby expressly disclaims all responsibility or liability to any person or entity other than the Client in connection with their use of this document.

Our assessment was based on research and analysis of Client-provided data and input from market sounding participants (i.e., owners and operators of WTE and MWP facilities). We express no opinion or any form of assurance on the information presented in this document and make no representations concerning its accuracy or completeness.

Actual results achieved as a result of implementing the opportunities identified are dependent upon the Client’s management decisions and actions, and variations may be material. The Client is responsible for its decisions to implement any opportunities/options and for considering their impact. Implementation will require the Client to plan and test any changes to ensure that the Client will realize satisfactory results.

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1. Executive Summary

1.1 Project Background

The City of Ottawa ("the City") has a new Solid Waste Master Plan (SWMP) to guide its approach to sustainable waste management over the next 30 years. The SWMP was approved by Council in June 2024. With the Trail Waste Facility (“Trail”) landfill approaching capacity, it is crucial to identify strategies that will extend the life of the landfill. As part of the SWMP, the City will be undertaking the development of a business case to evaluate waste recovery technologies aimed at increasing diversion rates and/or reducing the volume of waste that requires landfilling over the longer term (10+ years).

Specifically, the SWMP has highlighted two key technologies, Waste-to-Energy (WTE) through mass-burn incineration and Mixed Waste Processing (MWP), that align with the City's objectives of extending the Trail landfill’s lifespan while addressing long-term solid waste management and diversion needs. These technologies, while offering significant benefits, come at a considerably higher cost compared to traditional landfilling. As such, the SWMP recommends conducting a detailed business case to ensure comprehensive information is made available for Council to make informed decisions about whether to proceed with either technology.

To support this decision-making process, the City has engaged a consulting team led by HDR and KPMG to develop a feasibility study and support the development of the business case. The goal is to provide a thorough, up-to-date comparison of WTE and MWP technologies, ensuring that recommendations for a long-term residual waste management strategy are well-founded. The business case will clearly define the requirements for implementing a WTE facility, MWP facility, or a new landfill, with a focus on evaluating the viability, costs, and benefits of each option.

Each alternative will require the City to navigate a range of processes, including planning, site selection, procurement, approvals, and the implementation, operation, and maintenance of a new facility. The business case will outline key dependencies and constraints associated with these solutions. To support this study, four technical memos are in development, providing detailed insights and analysis to guide the decision-making process.

Table 1: Description of Technical Memos

Memo #	Description of Memo	Responsible Party
#1: Technology and Background Summary	Provides a definition for WTE, MWP and landfill options, gathering insights from similar facilities in Canada and the U.S. The memo also assesses feedstock requirements, end markets for by-products, and district energy opportunities for WTE.	HDR

Memo #	Description of Memo	Responsible Party
#2: Siting and Approvals	Presents a denotation on the siting criteria and requirements for scenarios identified in Technical Memo #1. Additionally, all of the required approvals and associated timelines will be identified for each type of facility being considered.	HDR
#3: Project Delivery Models and Funding Opportunities	Assesses various project delivery models and funding opportunities for the options under consideration with a focus on how similar projects have previously been delivered in Canada and internationally, the commercial structuring of those projects and key considerations for the City as it assesses the viability of the project.	KPMG
#4: Evaluation Criteria, Scoring Matrix and Weightings	Evaluates WTE, MWP and landfill options by collaboratively working with City staff to develop the evaluation criteria, scoring matrix and a weighting system.	HDR

The technical memos will play a critical role in providing the City with a detailed, structured approach, to assess the best waste management solution for the future. This Technical Memo #3 focuses on evaluating project delivery models and identifying funding opportunities to support the delivery of the City's future waste management solution. It provides an in-depth analysis of contracting approaches (i.e., delivery models), risks and, potential government and private sector funding sources. By gathering insights from the market along with providing an overview of the City's current financial position, the memo provides key considerations that the City should weigh in assessing the merits of a WTE or MWP facility. This evidence-based analysis is intended to support City Council in making an informed decision on the most suitable sustainable waste management strategy. Additionally, a brief overview of new landfill development is also provided, highlighting key costs and considerations. This high-level overview enables a comparison between the advanced technologies and a traditional landfill solution, while the in-depth delivery model analysis is specific to the WTE and MWP facilities.

1.2 Overview of Funding Requirements and Potential Funding Gap

Pursuing the development of a WTE or MWP facility requires substantial financial investment. For a WTE-Mass Burn facility, capital construction costs can range between $497 million and 862 million, with ongoing operating and maintenance (O&M) costs representing a significant portion of that capital spend on an annual basis, estimated at $46.8 million. While MWP facilities present a relatively lower cost alternative, they still require significant funding. Capital construction costs for an MWP facility can range between $97 million to $168 million, with annual O&M costs amounting to approximately $70.1 million. Constructing a new landfill is almost as expensive as a WTE facility. Construction costs can range between $439 million to $761 million, with annual operating costs anticipated to be $15.6 million. A financial implication of this magnitude highlights the critical need for robust financial planning and well-structured funding strategies to ensure long-term feasibility and sustainability for these waste management solutions.

The substantial capital costs associated with constructing and maintaining WTE and MWP facilities, as outlined, pose a significant financial challenge for the City of Ottawa. These costs, which include both the initial construction and long-term operational expenditures, far exceed the City's projected capital budget of $199.7 million for 2021 to 2030. Moreover, with the City's solid waste capital and operating reserve funds currently in a deficit position, there are limited financial resources available to support this level of investment. To address this gap, it will be crucial for the City to explore and evaluate a range of potential funding solutions to ensure the feasibility and sustainability of these critical infrastructure developments. Potential funding solutions identified through desktop research and market sounding interviews include:

- **Government Funding Programs:** Leveraging opportunities such as CIB Green Infrastructure Financing, Green Municipal Fund (GMF), or Canada Growth Fund (CGF).
- **Private Sector Financing:** Considering concession models such as Build-Operate-Transfer (BOT) to involve private sector investment.
- **Alternative Revenue Sources:** Utilizing revenue streams from energy sales, material recovery, special material disposal fees, and carbon credits to reduce the overall funding requirement.

Overall, while each funding approach offers potential benefits, a combination of these strategies will most likely be required to ensure the successful delivery of a WTE or MWP facility. Through a combined approach, the City can have a greater opportunity to create a more robust financial framework that will effectively address the funding requirements and support the long-term success of these critical waste management projects.

1.3 Summary of Applicable Delivery Models

As part of the assessment of delivery models, a comprehensive market sounding exercise was undertaken to gather insights from industry stakeholders regarding the most suitable project delivery models for a WTE or MWP facility. The feedback from market participants helped identify potential challenges and opportunities across a range of delivery models analyzed. Based on these discussions, several models were assessed for their applicability to this type of project:

Design-Bid-Build (DBB) Model: The market considered this model unsuitable due to limited interest. Participants highlighted key challenges associated with constructing a WTE or MWP facility, including extended timelines and elevated construction costs. The lack of integration between the design and construction phases contributes to delays and inefficiencies in the delivery of these technologies.

Design-Build (DB)/Engineering, Procurement, and Construction (EPC) Model: The DB/EPC model emerged as a viable option, with market participants highlighting its ability to streamline design and construction phases.

Design-Build-Operate-Maintain (DBOM) Model: Participants favored the DBOM model, where private operators manage operations and maintenance under long-term agreements. It was discussed that this operating model is well-suited for complex assets like MWP and WTE, where private partners can leverage their expertise to optimize operations, driven by performance-based incentives.

Integrated Project Delivery (IPD) Model: The IPD model was identified as a flexible option, allowing for collaborative design and transparent, open-book costing. This approach is particularly suited for complex, multi-phase projects like WTE or MWP facilities, where collaboration, adaptability and ongoing coordination are critical to success.

Design-Build-Finance (DBF) Model: The DBF model was deemed unsuitable due to limited opportunities for private sector innovation and market interest in raising finance for a project that they will not be operating.

Design-Build-Finance-Operate-Maintain (DBFOM) Model: This model garnered interest from market participants, offering the private sector greater control over the project. However, its viability depends on the willingness of the private sector to assume most project risks, particularly as they relate to revenues. The majority of DBFOM contracts in Canada are based on an availability payment structure where the asset owner (i.e., the City) would make monthly payments to the private partner to support the repayment of debt and O&M costs. If the private partner were required to take on risks associated with earned revenues at the facility, it is likely that a significant premium would be added to the cost of the facility.

Concession Model (Build-Operate-Transfer - BOT): The BOT model was highlighted by private sector participants as a feasible approach and one that has been used to varying levels of success internationally. Under this model, the private sector assumes responsibility for financing, designing, building, operating, and eventually transferring the facility back to the municipality, typically under a 25-year contract.

1.4 Key Considerations

While Technical Memo #3 presents valuable insights from private sector stakeholders and owners, the initial analysis did not identify a preferred delivery approach.

Instead, the results underscored the complexity of WTE and MWP projects, highlighting the critical role of unique project parameters in determining the optimal delivery model and also helped to eliminate a few delivery models from further consideration. Factors such as partnership structures, financial capacity, and risk appetite will significantly influence the suitability of various procurement models. In light of these findings, this memo does not provide a direct recommendation for a specific delivery model. Rather, it presents a series of critical considerations that will guide the City in selecting the most appropriate procurement strategy tailored to its specific needs and circumstances. These considerations include:

- **Collaborative Approach:** A collaborative process that integrates input from both public and private sectors can help to ensure that the selected model is mutually beneficial.
- **Funding and Financing:** The City must consider a variety of funding sources and financing structures, understanding that long-term financial commitments will need to align with the City's projected financial position and capacity.
- **Risk Allocation:** Defining clear lines of responsibility for risk is critical. The City should seek to allocate risks to the parties best equipped to manage them.
- **Project Readiness:** It is essential that the City presents a well-prepared proposal to the private sector. This includes not only financial and technical plans but also a clear vision of the project's long-term objectives, the City's role, and the potential benefits to private partners.

2. Introduction

2.1 Project Background and Overview of Memo

As outlined in the SWMP, the City is undertaking the development of a Feasibility Study to support the development of a business case to evaluate WTE and MWP technologies. These technologies are being considered to enhance diversion rates and reduce long-term landfill needs. To facilitate informed decision-making, the City has engaged HDR, with KPMG as a subcontractor, to develop a series of technical memos that are intended to provide detailed insights and analysis to support the City's decision-making process. This Technical Memo #3 focuses on identifying key considerations for the City with respect to assessing delivery and funding models for a WTE or MWP facility. It achieves this through the exploration of relevant funding models seen across projects in Canada and internationally, with a focus on the commercial structuring of those projects and salient features for the City, such as the pros, cons, and risks of each model, as it assesses the viability of the project. Also included in Technical Memo #3 is an overview of the more traditional landfill development, highlighting the technical and funding requirements and enabling a comprehensive evaluation of WTE or MWP facilities against this conventional waste management approach.

The analysis presented herein is informed by both extensive desktop research and feedback obtained through a market sounding exercise. KPMG led the market sounding, which involved engaging with seven industry stakeholders to explore various delivery models and funding mechanisms relevant to the City and these types of projects. The market sounding exercise was a key input to Technical Memo #3 and was designed to address the following key objectives, as outlined by the City in its scope of work for this project:

- **Assess Private Sector Interest:** Gauge the level of private sector interest in delivering a WTE or MWP project for the City.
- **Transaction Structures and Procurement Models:** Identify and discuss potential transaction structures and procurement models that can support the City in achieving its objectives.
- **Market Expertise and Experience:** Gain a deeper understanding of the market's expertise and experience in delivering WTE and MWP projects.
- **Lessons Learned:** Identify key lessons learned from precedent projects and procurement processes to inform the current project.
- **Owner's Perspective:** Highlight key considerations from an owner's perspective relating to procurement, construction, operations, financing, and funding of WTE and MWP facilities.
- **Risk Assessment:** Identify key risks or considerations that could impact the City's ability to deliver the project or the private sector's willingness to participate.

The following section outlines the methodology and process KPMG undertook to effectively conduct the market sounding.

2.2 Market Sounding Methodology

The market sounding process was intended to identify and engage with both owners and operators of WTE and MWP facilities with the highest potential to bring relevant insights. The process is categorized into the following two stages:

2.2.1 Identification of Market Participants

The market sounding process began with the development of two tailored sets of questions – one for asset owners and one for operators. These questions were carefully aligned with the objectives of Technical Memo #3, ensuring that the responses would address the specific objectives of the City from an owner and operator perspective. To capture a wide range of perspectives, participants were divided into two distinct groups:

Public Sector: Comprising municipalities with experience in waste management and infrastructure procurement (typically owners).

Private Sector: Consisting of private sector companies with expertise in delivering WTE and / or MWP technologies (typically operators).

This categorization was essential to reflect the complex and collaborative nature of delivering WTE and MWP projects, ensuring that all relevant stakeholders were engaged.

An initial longlist of 18 potential stakeholders was identified through desktop research and the professional networks of KPMG and HDR, focusing on organizations involved in similar projects. This list included a mix of municipalities and private sector companies. The longlist was then refined to a target group of 9 key stakeholders: 4 municipalities, and 5 private sector companies. The selection was based on criteria such as alignment with the City's requirements, relevance to the targeted technologies, and expertise in WTE and MWP.

2.2.2 Formal Engagement and Interviews

The shortlisted participants were engaged through formal outreach via email. Follow-up emails were sent as needed to ensure engagement. Once participants confirmed their interest, they were provided with a market sounding package that outlined the key objectives and included two distinct sets of questions (refer to Appendix A for the market sounding package).

The outreach effort generated a strong response, with 7 participants agreeing to schedule interviews, comprising 3 municipalities and 4 industry contacts. One participant declined, and another did not respond. The complete list of market sounding participants is provided in Table 2.

Table 2: List of Market Sounding Participants.

Industry Stakeholder	Role	Date of Interview (2024)
Durham Region	Municipality	Friday September 6th
Varme Energy	Industry	Monday September 9th
Peel Region	Municipality	Wednesday September 11th
Veolia	Industry	Friday September 13th
Reworld	Industry	Monday September 16th
Metro Vancouver	Municipality	Monday September 23rd
John Laing	Industry	Tuesday September 24th

Feedback from these market sounding participants supplemented our desktop research and the collective expertise and experience of our consulting team to support the analysis and subsequent findings presented in this report. The report's structure and content are outlined below.

2.3 Structure of this Report

This report is organized by multiple sections, each exploring various considerations related to establishing a new WTE or MWP facility in the City of Ottawa.

Section 3 – Funding Requirements: This section provides a comprehensive overview of the City's existing funding model and outlines potential future funding requirements. It is intended to provide an overview of the financial needs of the project and the associated financial considerations for the City.

Section 4 – Funding Opportunities: This section explores various funding opportunities available for the project. It includes a detailed analysis of government funding programs, a private financing approach, and alternative revenue sources. The aim is to identify and analyze potential sources of funding that could be leveraged for the project.

Section 5 – Delivery Models: This section presents an overview of potential project delivery models. The objective is to assess the applicability of the delivery models for the implementation of a WTE or MWP facility in the City of Ottawa, as informed by desktop research and market sounding findings.

Section 6 – Key Considerations: This section of the report outlines the key considerations the City must address in selecting the appropriate delivery and funding approach for a new WTE or MWP facility.

3. Funding Requirements

This section details the City's current funding model for delivering solid waste services, including an overview of operating costs and revenue streams, such as user fees and the general tax levy. It also outlines the City's updated approach to funding waste services through the newly approved fully recoverable fee model. Furthermore, this section provides an estimate of the potential capital and operating costs associated with implementing a WTE or MWP facility, or constructing a new landfill, illustrating the potential funding gap given the City's current financial position.

3.1 Overview of Current Funding Model

In 2005, the City of Ottawa's Solid Waste Services received City Council approval to implement a hybrid funding model for solid waste management services. The primary goals of this model were to enhance cost transparency, ensure fair distribution of program costs, and provide stronger incentives for customers to divert waste from landfills.

Under the hybrid model, customers are charged based on the value of their property using rates set through the City's Solid Waste By-law 2012-370 and through a uniform flat fee. The model is structured such that:

- Property taxes (i.e., assessment-based tax bill/general tax levy) fund collection and processing costs related to waste diversion and recycling services; and,
- Rate-based uniform flat fees (i.e., the Solid Waste Curbside Service Fee) fund garbage collection and landfill disposal services (charged to each single-family home or multi-residential unit).

With the recent introduction of the Individual Producer Responsibility (IPR) for recycling, it becomes necessary to reassess the existing hybrid model to ensure its goals are still met. The reasons for reassessment include but are not limited to:

- Shift in Responsibility: Under IPR, producers are responsible for managing and funding the recycling of their products. This changes the financial burden and potentially reduces the City's costs for recycling services.
- Redundant Funding Mechanism: The hybrid model currently allocates property tax revenue to fund recycling services, which may no longer be necessary under IPR. This requires a reassessment of how those funds are allocated to avoid double-charging residents, while also ensuring that any adjustments sufficiently recover the costs of delivering services.
- Incentive Alignment: With producers now taking on responsibility for recycling, the City may need to adjust its fee structure to align with new waste management goals, such as focusing more on landfill diversion or garbage reduction strategies.

3.1.1 Current Funding for Operating and Capital Costs

Ottawa's Solid Waste Services' 2024 operating budget[1] includes approximately $121.3 million in operating costs and $80.7 million in revenues. The City's $121.3 million operating costs are primarily (73%) attributable to diversion/recycling and waste collection. The remaining costs are driven by landfill operations and disposal services, long-term planning, director's office, and other costs.

The net balance of $34.1 million in operating costs was funded from the tax supported budget which includes:

- $6 million of which is an allocation from corporate common revenues; and,
- $28.1 million funded from the general tax levy.

Table 3 below provides a breakdown of the costs by program type.

[1] Adopted Budget 2024 (ottawa.ca)

Table 3: Breakdown of Costs by Program Type.

Expenditure by Program	2024 Program Costs ($ million)
Diversion/Recycling	$60.3
Garbage Collection	$28.7
Solid Waste Non-Departmental	$17.0
Landfill Operations/Disposal	$10.3
City Space Waste Operations	$2.4
Long-term Planning	$1.1
Soil Management	$0.8
Director's Office	$0.7
Total	$121.3
Recoveries and Allocations	($6.5)
Revenue	($80.7)
Net Requirement	$34.1

The City generates revenues from its solid waste operations through provincial subsidies[2], tipping fees, and user fees, totaling $80.7 million, as well as recoveries from other departments of $6.5 million.

Regarding capital costs, the City's Solid Waste Services 2024 budget allocates a total of $34.6 million, which includes $28.1 million for regulatory projects, such as landfill capping, $4.5 million for service enhancements, including long-term planning services, and $2.0 million in renewal projects.

Table 4 highlights that the total capital budget requirement from 2021 to 2030 is projected to be $199.7 million. This figure primarily reflects the anticipated costs associated with regulatory-required upgrades to the Leachate Treatment Facility and the expansion of key services, such as the gas collection system and groundwater management at the Trail Waste Facility and the construction of a horizontal landfill cell.

[2]Provincial subsidies refer to Stewardship Funding received for administering the Blue Box program. As Ontario moves to Individual Producer Responsibility beginning in 2023, the City's Blue Box program administration costs as well as the amount of Stewardship Funding received by the City will be impacted.

Table 4: 2021 to 2023 Capital Budget ($ millions)[3].

Period	Renewal Projects	Growth Projects	Facilities Upgrade Regulatory	Landfill Expansion Program	Strategic Projects	Capital Budget
Actual						
2021			$0.4	$18.3	$1.2	$19.9
2022	$5.0	$0.6	$2.0	$19.0	$1.9	$28.5
2023	$1.0	$0.7		$31.9	$2.3	$35.9
2024	$2.0		$16.0	$12.1	$4.5	$34.6
Projected						
2025			$5.0	$3.4	$0.2	$8.6
2026				$28.4		$28.4
2027				$28.4		$28.4
2028				$12.3	$0.2	$12.5
2029				$1.3	$0.2	$1.5
Total	**$8.0**	**$1.3**	**$23.4**	**$156.5**	**$10.5**	**$198.3**

While the City has allocated a capital budget for solid waste services, it is important to note that the development of a large-scale waste management facility, such as WTE or MWP, is not accounted for within this budget. Given the capital-intensive nature of such projects and the current deficit position of the solid waste capital reserve fund, it is likely that the City will need to explore alternative funding mechanisms to ensure the successful funding of a major waste management infrastructure project (refer to section 4 for additional details on the reserve fund).

3.1.2 Uniform Flat Fees and General Tax Levy

As highlighted in section 3.1.1, the City utilizes a hybrid funding model for waste management services, combining uniform flat fees and the general tax levy. This structure ensures that residential customers contribute to the cost of waste collection and land fill services, while general tax revenues fund broader waste diversion efforts. Refer to sections 3.1.2.1 and 3.1.2.2 for further detail regarding uniform flat fees and the general tax levy.

3.1.2.1 Uniform Flat Fee

The uniform flat fee for garbage collection is included on residential customers' property tax bills and allows curbside customers to dispose of up to six items (a combination of garbage bags, bins, and bulky items) every other week. For multi-residential buildings, a flat fee is charged per unit for garbage collection. If a building exceeds the allocated collection limit, the building

[3]City of Ottawa Solid Waste Services 2020_2030 Capital Budget

management is responsible for covering the cost of any additional garbage collection services provided by the City.

The user fee structure for both curbside and multi-residential garbage collection services is detailed in Table 5 below.

Table 5: 2023 to 2024 Solid Waste – Uniform Flat Flees Capital Budget.

Solid Waste – Uniform Flat Fees	2023 Rate $	2024 Rate $	% Change over 2023
Single Family Household	$130.00	$145.00	11.50%
Multi-Residential Household	$83.50	$91.00	9.00%
Yellow Bag per bag fee	$4.20	$4.40	2.30%

The uniform flat fees charged to residential customers for garbage collection services are designed to cover the costs of residual garbage collection and landfill disposal fees.

3.1.2.2 General Tax Levy for Waste Diversion and Other Revenue Sources

The City's waste diversion program for blue, black and green bins are currently funded by the general tax levy. This allowed for costs to be spread across all properties that pay property taxes (including industrial, commercial and institutional properties). The amount charged to properties is dependent on the value of the property and property class. In 2024, an average single residential property owner pays $56 for waste diversion services[4].

In addition to the unfirm flat fees and general tax levy, the City collects revenue from other sources to support the delivery of solid waste services. These sources include:

- Landfill tipping fees at the Trail Waste Facility, which accepts most non-hazardous and non- liquid waste including residential, construction and leaf and yard waste;
- The soil management program, where customers can dispose of non-hazardous soil that is later used for landfill cover/capping projects;
- A royalty from the conversion of landfill gas to electricity;
- The Yellow Bag program[5] that is offered to small businesses; and
- Sale of scrap metal and potting soil.

3.1.3 Future Funding Plan[6]

In June 2024, the City of Ottawa's Finance and Corporate Services department submitted the Solid Waste Long Range Financial Plan (2025-2053) (LRFP) to address the current and future capital and operating requirements for Solid Waste Services. This plan aims to ensure adequate funding while maintaining financial stability for residents and ratepayers. The LRFP support this goal by analyzing the costs associated with investing in a residual waste management strategy such as a future landfill, MWP facility, or WTE technology. However, the plan relies on

[4]City of Ottawa

[5]Registration-based curbside collection service or garbage, recyclables and organics for small businesses that generate less than 16 bags of garbage every two weeks. Participating small businesses are required to purchase special yellow garbage bags at a cost of $4.40 per bag.

[6]2024 Solid Waste Services Long Range Financial Plan (2025 – 2053)

extending the life of the Trail landfill by approximately 14 years, allowing sufficient time to replenish the Solid Waste reserve. This will enable investment in a new residual waste management system, expected to be operational by 2050.

The report outlines key recommendations and a funding strategy to support both immediate capital needs and the strategic actions identified in the SWMP. The recommendations approved by City Council included:

1) Approving the transition to a fully recoverable fee model to fund Solid Waste Services for both waste diversion and garbage, replacing the current hybrid model, where waste diversion is tax-funded, and garbage is fee-based. This new model would be implemented, with a phased-in approach if necessary, as part of the 2025 budget process.
2) Approving the establishment of a Solid Waste debt service limit of 15%, aligning with Rate Supported services, while maintaining the 8.5% limit for combined tax- and rate-supported services, as previously set by Council.
3) Direct staff to assess the feasibility of incorporating Solid Waste Services as a separate development charge in the upcoming Development Charge Background Study.

This memo focuses on the recommendations related to the fully recoverable fee model and establishment of a Solid Waste debt service limit.

Fully Recoverable Fee Model

Implementing a fully recoverable fee model, with only a minimal percentage remaining on the tax bill for citywide solid waste services, such as the collection and processing of waste from public garbage bins, provides a more equitable, flexible, transparent, and sustainable approach compared to the current hybrid model. According to the LRFP, the benefits of this approach are outlined in more detail below:

- **Equitable**: Currently, 30% of the solid waste budget is funded through property taxes and citywide revenues, meaning all property taxpayers, including commercial properties, contribute. Under a fully recoverable fee model, only the properties directly receiving the service would be charged. This addresses the issue where properties with higher assessments are currently paying more for the same service.
- **Flexible:** A fully recoverable fee model offers greater flexibility by aligning costs with service needs, much like a utility model. This approach avoids dependency on citywide tax increases and reduces competition for funding with other city services.
- **Clarity**: The costs associated with delivering solid waste services become more transparent, with fees directly tied to the service provided, offering greater clarity to ratepayers.
- **Sustainable**: Fee increases can be strategically planned over an extended time horizon. The LRFP includes a 28-year outlook, ensuring capital needs are factored into the funding strategy, resulting in smoother and more predictable fee increases. Additionally, a cost-recovery model can leverage alternative revenue sources or service fees, helping to offset residential service fees.

In the LRFP, the City indicated that transitioning from the current partially tax-funded model to a fully recoverable fee model will result in a modest increase for single-family residential properties. The cost for an average home assessed at $415,000 would rise from $201 annually to a flat fee of $227 annually, representing an increase of approximately $2 per month. This adjustment better aligns fees with the costs to deliver the services.

Use of Debt

Debt is an appropriate financing tool for assets that provide long-term benefits, such as solid waste management, as it allows future generations to share in the costs. Municipalities, however, are restricted to using debt solely for capital projects, as it cannot be applied to operating expenditures. The City’s rate-supported services have a debt servicing limit set at 15% of own-source revenue, that is meant to recognize the capital-intensive nature of these services. Given the recommendation to transition solid waste services to a utility-style funding model and to implement a fully cost-recoverable fee, staff propose establishing a dedicated debt servicing limit of 15% for solid waste, aligning with rate-supported services, while maintaining the 8.5% limit for all other services combined.

Based on current capital projections in the LRFP, it is estimated that approximately 55% of the $1.53 billion capital required over the next 28 years or $797 million can be financed through debt while remaining within the 15% limit. Additionally, with an estimated $40 million in development charge revenue expected, the City will need to contribute $690 million from cash reserves over the 2025-2053 period to cover the remaining funding gap identified in the LRFP.

Overall, while debt remains a viable financing tool for long-term capital projects such as solid waste management, the City's ability to proceed with high-cost initiatives, like a WTE, or MWP, is currently limited due to immediate funding constraints. These concerns extend to the development of a new landfill, as it still represents a significant financial commitment that poses a challenge to the City's financial capacity. The LRFP, being a long-term financial strategy, cannot provide immediate funding for these projects but may offer a pathway for financing in the future.

3.2 Potential Funding Requirements

As indicated previously, the SWMP recommended an assessment of the following for implementation:

- - WTE Facility;
- - MWP Facility;
- - WTE and MWP Facilities; or,
- - Construct a New Landfill.

The adoption of these technologies will significantly enhance waste diversion efforts and reduce the volume of waste requiring landfilling in the long term (i.e., 10+ years). While these solutions offer the added benefit of extending the lifespan of the Trail Waste Facility landfill, along with other advantages, they come with substantial capital and operational costs. The City's 2025-2053 financial plan estimates a $791 million investment for a residual waste management system (e.g., landfill, WTE, or MWP facility)[7]. However, as highlighted in section 3.1.3, challenges related to debt financing reveal a considerable funding gap for a project of this scale.

The following subsections provide a detailed overview of the technology options, including high-level estimates of the capital and operating cost requirements, as well as the existing funding gap that must be addressed to realize the WTE or MWP project.

3.2.1 Overview of Technology Options

This section presents an overview of the options considered by the City to enhance the SWMP and divert waste from the Trail Waste Landfill Facility.

3.2.1.1 Waste to Energy (WTE)[8]

WTE technologies used for processing municipal solid waste (MSW) encompass a range of options, including anaerobic digestion and gasification. However, the mass-burn technology remains the most widely adopted solution globally for large-scale WTE facilities. Therefore, this section of the memo focuses on mass-burn technology.

In a mass-burn facility, MSW is combusted to produce heat, which is then recovered in a boiler to generate steam. This high-pressure steam can either be utilized directly for industrial heating or converted into electricity through a steam turbine-generator.

Mass-burn WTE facilities are designed for continuous operation, with an availability rate of 92%. This allows them to function 24/7, with only minimal downtime for scheduled maintenance or unplanned repairs. However, their operation requires substantial physical and technical infrastructure to ensure efficient processing. Below are the primary considerations:

- **Site Requirements**: A typical mass-burn WTE facility requires between 2 to 4 hectares of land to accommodate its infrastructure and operational needs.

[7] Solid Waste Services Long Range Financial Plan 2025-2053
[8] Refer to Technical Memo 1 for more detailed information on WTE-mass burn technology, including a breakdown of capital construction and O&M costs.

- **Infrastructure**: Key infrastructure needs include a dedicated electrical substation, access to the main power grid for both import and export, and proximity to major transportation routes, such as highways.
- **Utility Consumption**: Facilities require reliable access to water for steam generation, consistent electricity supply, and auxiliary fuel for combustion management.
- **Environmental and Community Impact**: Considerations must be made regarding emissions from the APC system, as well as odor management from the storage of solid waste materials.

Based on these operational requirements and performance metrics, the permitting, design, and construction phases for a new mass-burn WTE facility are projected to span approximately 8-10 years. Should a private vendor manage both the development and ownership of the facility, there is potential to reduce this timeline by streamlining the decision-making and implementation processes.

From a costing perspective, the estimated capital and operating costs associated with a WTE facility are substantial, particularly when factoring in the considerations mentioned. A high-level overview of these costs is provided in the sections below.

Capital Construction and Operations and Maintenance (O&M) Costs

HDR has developed cost estimates for the capital construction, operation, and maintenance of a WTE facility in the City of Ottawa. HDR has extensive experience with this technology and have prepared cost estimates for similar facilities across North America. Their expertise offers a reliable benchmark for financial planning.

The results of HDR's analysis revealed the following:

- Capital construction costs: Amounts to approximately $663.5 million (real, undiscounted $2024) which is inclusive of construction, and engineering and design costs. This total has been applied with a contingency of (-25% to +30%) resulting in the following capital cost range: $497.6 million - $862.6 million.
- O&M costs: Comprise of direct (e.g., operator’s base service fees, ash hauling and disposal, etc.), in addition to indirect (i.e., required maintenance) costs for which the estimated annual total is $46.8 million (real, undiscounted $2024).

These estimates highlight the substantial financial commitment required for a WTE facility. They underscore the need for thorough financial planning and the identification of potential funding strategies to ensure the long-term feasibility and sustainability of the project.

3.2.1.2 Mixed-Waste-Processing (MWP)[9]

MWP facilities are well-established technologies in North America, especially in Canada and the U.S. These facilities are designed to handle mixed waste streams, using various mechanical, optical, and density screening equipment to sort and separate materials such as fibre, plastic, metal, and glass. The sorted materials are then baled or loaded for transportation to recycling markets, with the remaining residue typically sent to landfills. MWP facilities generally recover 10% to 25% of materials, with higher rates possible depending on market demand for products

[9]Refer to Technical Memo 1 for more detailed information on MWP technology, including a breakdown of capital construction and O&M costs.

like low-value plastics and glass. The relatively low recovery rates are attributed to the equipment's limitations in extracting recyclables from mixed streams.

The financial performance of MWP facilities is closely tied to commodity prices, with a significant portion of incoming material still requiring disposal. With a processing capacity ranging from 200 to 1,500 tons (imperial) per day (TPD) and a lifespan of 20 to 30 years, MWP facilities can provide a viable waste recovery option. While MWP facilities require a substantial real estate footprint, the supporting infrastructure and land requirement is typically less than what is required for WTE facilities. Hence, the construction and operating costs associated with a MWP facility is significantly less however, these costs remain substantial. The sections below discuss these costs at a high-level.

Capital Construction and O&M Costs

Similar to a WTE-mass burn facility, HDR has also prepared cost estimates for MWP facilities across North America. While MWP facilities typically involve lower capital expenditures, the costs are still significant. The results of HDR's analysis revealed the following:

- Capital construction costs: Amounts to approximately $129.4 million (real, undiscounted $2024) which is inclusive of construction, and engineering and design costs. This total has been applied with a contingency of (-25% to +30%) resulting in the following capital cost range: $97.1 million - $168.2 million.
- O&M costs: Comprises direct (e.g., operator's base service fees, disposal of process residuals, etc.), in addition to indirect (i.e., required maintenance) for which the estimated annual total is $70.1 million (real, undiscounted $2024).

Despite being a more affordable alternative to WTE, MWP facilities also require substantial financial commitment and careful long-term planning to ensure sustainable operations.

3.2.1.3 Construct a New Landfill[10]

The implementation of a new landfill remains a potential solution under consideration by the City. This option involves obtaining the land, designing, constructing, and operating a new landfill facility to provide a long-term waste disposal solution. While this approach would provide a disposal option for the City, it will involve a number of challenges.

It is anticipated that the new landfill option will have high upfront capital costs compared to some of other options being considered, primarily due to land acquisition and site preparation requirements. Additionally, even modern landfills are a source of greenhouse gas emissions, specifically methane, when compared to the net emissions generated by the alternative waste management solutions being considered. Furthermore, new landfill developments often face strong public opposition, particularly from nearby communities, which can lead to lengthy and complex approval processes. The planning and approval process for a new landfill is anticipated to be lengthy, involving environmental assessments, siting, and land acquisition. This option also does not contribute to increasing the City's waste diversion rates, which is an important consideration for the City's waste management strategy.

[10]Refer to Technical Memo 1 for more detailed information on the construction of a new landfill, including a breakdown of capital construction and O&M costs.

Despite these challenges, developing a new landfill remains a viable option for addressing the City's waste disposal needs, and its relative technical simplicity compared to WTE or MWP facilities, is a factor in its favor.

Capital Construction and O&M Costs

HDR has provided cost estimates for the implementation of a new landfill for the City. Highly dependent on land acquisition costs, these capital costs are expected to fall within a range of $439 million to $761 million. Additionally, the operation and maintenance costs of such a facility amounts to approximately $15.6 million per year.

3.2.2 Potential Funding Gap

The substantial capital costs associated with constructing and maintaining WTE and MWP facilities, as highlighted in Section 3.2.1, present a significant financial challenge for the City. These costs, which include both the initial construction cost and the long-term operational and maintenance expenditures, exceed what the city's current operating budget and 2021 to 2030 capital budget ($199.7 million) can support. Additionally, with the City's capital and operating reserve fund in a deficit position, there are limited financial resources available to fund the waste management facilities in question without a significant increase to current rates to support the build-up of a reserve to pay for future costs.

To bridge this funding gap, it is necessary for the City to evaluate several potential funding solutions. One option is to pursue government funding at the provincial and federal levels, leveraging grants or infrastructure programs aimed at supporting environmental sustainability and waste management innovations. The challenge with trying to access these types of programs is that it can be a time-consuming process with no guarantee of receiving funds at the end of the process. Securing funding through some of these programs could come with stipulations on the City’s future cash flows, which could also limit the City’s financial flexibility in the future.

Alternatively, the City may explore innovative financing models such as public-private-partnerships ("P3s”) and private approaches including, a concession model. There are different approaches to leveraging private capital that are discussed in more detail in the following sections.

Given the scale of the capital and operational costs, it is likely that a combination of these strategies will be required to ensure the successful development and financial sustainability of the WTE or MWP facility. At this stage, it is essential to further progress the evaluation and planning of either a WTE or MWP facility to gain greater clarity on the specific requirements, financial commitments, and potential benefits. This information is critical and will allow the City to make a well-informed decision on the most viable and sustainable strategy for its future waste management.

4. Funding Opportunities

Solid Waste Services operates with a combined capital and operating reserve fund to manage annual pressures and fund capital investments. However, this reserve over the past 10 years has been in a deficit, currently at $25 million, despite efforts to improve financial sustainability through fee increases. With significant capital requirements identified for 2021-2030 (including a WTE or MWP facility currently unfunded in the 10-year capital plan), it is not expected that the existing reserve contributions will be sufficient to cover the capital costs over this period. As such, the City will need to explore additional funding sources or alternative delivery models to meet these critical capital demands.

Following extensive market research and stakeholder engagement, this memo presents a selection of potential funding models for WTE and MWP facilities.

4.1 Potential Funding Models

This section provides an overview of a range of funding mechanisms identified through our research including government programs, alternative rate structures, additional revenue streams, and private financing approaches that can be considered by the City in order to fund the development of a WTE or MWP facility. Three categories of government funding programs are outlined, including the Green Infrastructure Fund, the Green Municipal Fund, and the Canada Growth Fund. Additionally, a concession-based model is explored with respect to private financing approaches, as directly suggested in market sounding discussions. Finally, four additional revenue streams are outlined, including material recovery, carbon credits, special material disposal, and energy sales.

4.1.1 Government Funding Programs

The following key elements are discussed for each government funding mechanism:

- **Overview**: description of the funding mechanism, including the source, quantity and eligibility requirements;
- **Use of Funding and Applicability to the City of Ottawa**: description of the challenges and benefits of the funding mechanism in the context of implementation by the City; and
- **Case Studies**: A relevant example of a project similar in nature to Ottawa's envisioned WTE or MWP facility that has leveraged the government program.

Table 6: Green Infrastructure Financing – Canada Infrastructure Bank (CIB)

<table>
<tr><th colspan="2">Overview</th></tr>
<tr><td>Description</td><td>The Canada Infrastructure Bank (CIB) is a Crown corporation mandated to invest in infrastructure which benefits Canadians.

The CIB are impact investors, who focus on new infrastructure to deliver results such as economic growth, climate change action and connected communities. CIB makes repayable investments in impactful projects that are revenue generating, in the public interest and delivered in partnership with the public and private sectors. CIB was specifically highlighted during recent market sounding discussions as a key funding opportunity.

The Green Infrastructure stream is particularly relevant, with $10 billion allocated to support initiatives such as energy-efficient building retrofits, water and wastewater management, carbon capture, clean fuels, hydrogen, and zero-emission vehicle charging[2]. CIB provides financial support through loans, equity investments, and other instruments, covering up to 50% of project financing, net of other government incentives.

• Support Type: Can vary depending on project need (e.g., senior debt, subordinated debt, equity) over 15-25 years with a concessional base interest rate.
• Interest Rates: Interest rates range around GOC +/- 200 bps, with higher premiums for merchant risk and lower rates for firm offtakes.
• Merchant Risk: CIB may accept merchant revenue-based repayment risk supported by application submitted.
• Maximum financing: Up to $1B for single project.</td></tr>
<tr><td>Applicability and Use of Funding</td><td>The CIB funding program is highly applicable to the City of Ottawa's SWMP. The CIB's focus on green infrastructure and clean power sectors aligns well with the SWMP's exploration of WTE and MWP technologies. While the CIB offers flexible funding arrangements, the typical investment range is between 10% - 50% of total project costs, with the remaining funds sourced from other avenues such as municipal bonds, or private sector investments.

The CIB's acceptance of merchant revenue-based repayment risk enhances its suitability as a funding source. Once operational, the WTE facility could generate revenue by selling the energy produced to the local power grid. This revenue could be used to repay the CIB's investment, as well as any other loans or investments used to fund the project.</td></tr>
</table>

Overview	
Case Study	The Green Infrastructure Stream provided critical support to Project Varennes Carbon Recycling[11], an innovative WTE initiative. This project is a joint venture between industry leaders Shell, Suncor, and Proman, in partnership with the Government of Québec. Project Varennes Carbon Recycling transforms waste into valuable biofuels and circular chemicals, promoting a more circular economy. Through the Green Infrastructure Stream, the CIB invested $277 million in the project, providing flexible financing terms carefully tailored to the project's risk profile.

Table 7: Green Municipal Fund (GMF) – Federation of Canadian Municipalities (FCM)

Overview	
Description	The GMF is one of the main funding sources administered by FCM to enhance the quality of life for people in Canada by accelerating a transformation to resilient, net-zero communities. It does this by providing grants, loans, innovative financing, leveraged investments, capacity building, and strategic support. Notably, the GMF was specifically highlighted during recent market sounding discussions as a key funding opportunity for sustainable waste management initiatives, underscoring its potential to drive meaningful environmental impact and community development. The GMF offers grants for municipal environmental projects. Loans are also available to municipalities at competitive rates, and most recipients receive an additional grant of up to 15 percent of their loan amount. Municipal partners may also apply for competitive, long-term financing.

[11] project Varennes Carbon Recycling

Overview	
Applicability and Use of Funding	The GMF is a good resource for supporting the SWMP. The fund offers streams that can help municipalities accelerate their waste management technologies and contribute to a more sustainable Canadian energy landscape. With its flexible funding model, GMF can provide financial assistance to projects that align with its focus on sustainable communities. **Key Funding Opportunities:** • **Organic WTE:** This funding stream supports projects that generate energy from landfill gas, anaerobic digestion, or aerobic composting with heat recovery, resulting in net GHG emissions reduction and energy benefits. While MWP and WTE technologies would be ineligible for this opportunity, there is potential funding should the City pursue a landfill with gas capture. • **Net-Zero Transformation:** This funding stream supports innovative projects with significant GHG reduction potential, resilience, equity considerations, and multi-solving benefits for the environment, communities, and local economies. MWP and WTE facilities can be eligible if they incorporate advanced technologies, carbon capture and storage, or demonstrate innovative applications of existing technology that significantly enhance performance. To be eligible for GMF funding, projects must meet specific criteria, including innovation, significant GHG reduction potential, and climate resilience. The GMF can fund up to 50% of project costs, to a maximum of $10 million, with remaining funds sourced from other avenues such as municipal bonds or government grants. Once operational, the WTE or MWP facility revenue generated from the facilities can be used to repay the GMF investment and other loans or investments.
Case Study	Dufferin County[12] received funding from the GMF to explore a WTE facility utilizing plasma gasification technology to convert waste into electricity. After evaluating two options, the ~77,100-tons per year capacity was deemed feasible, reducing landfill waste by 220-275 tons daily. This solution offers numerous benefits, including diverting up to 90% of waste from landfills, providing stable long-term pricing for municipal waste disposal, and feeding electricity into the power grid.

[12] Dufferin - Energy from Waste Facility

Overview	
Case Study continued	The GMF supported a business case study for the Lac-Saint-Jean region[13] in Quebec. Similar to the City of Ottawa, the municipality faced limited landfill capacity and increasing GHG emissions from waste management. To address this issue, stakeholders collaborated to establish Réemploi+, an organization dedicated to developing a comprehensive waste diversion and reuse system. The GMF funding enabled the organization to conduct thorough research, engage stakeholders, and establish effective infrastructure for waste management. Once finished, the project is expected to divert ~5,500 tons per year from landfill, and reduce GHG emissions by 20% within three years.

Table 8: Canada Growth Fund (CGF)

Overview	
Description	The CGF is a $15 billion independent public fund dedicated to accelerating Canada's transition to a low-carbon economy by deploying technologies that reduce emissions. To achieve its mandate, the CGF concentrates its investments in three primary sectors: • **Projects**: Investing in projects leveraging less mature technologies to reduce emissions, including carbon capture and storage, hydrogen, and biofuels. • **Clean Technology**: Supporting clean technology companies, including small and medium enterprises (SMEs), in demonstrating and commercializing innovative technologies. • **Low-Carbon Supply Chains**: Financing projects and companies involved in low-carbon or climate technology value chains, including low-carbon natural resource development. The fund partners with the private sector through direct investments, co-investments, and anchor investments in other funds. The CGF can fund up to 40% of project costs, with the intention of transforming and growing Canada's economy while achieving net-zero emissions.
Applicability and Use of Funding	The CGF aims to reduce emissions and achieve Canada's Climate Targets, which resonates with the City's focus on WTE and MWP facilities. To increase the likelihood of securing investment from the CGF, project proponents should highlight innovative technologies or approaches that set their project apart. Additionally, demonstrating significant greenhouse gas reductions, waste diversion from landfills, and emphasizing alignment with Canada's climate goals will be crucial. A strong business case, showcasing robust project economics and scalability, will also be essential to attract CGF investment.

[13] Lac-Saint-Jean Region - Waste Diversion

Overview	
Case Study	On June 11th, 2024, CGF announced a strategic partnership with Varme and Gibson Energy to develop Canada's first waste-to-energy project with carbon capture and sequestration[14]. CGF committed $2.7 million to a development loan, which will be used to partially finance the furtherance of the front-end engineering and design activities. During the quarter, an amount of $0.7 million was paid by CGF to Varme for that purpose.

4.1.2 Private Financing Approach

The pursuit of a viable WTE or MWP facility for Ottawa necessitates a thorough examination of a private financing option. The municipality's infrastructure needs, combined with its negative capital reserve, require innovative financing solutions. In response, this overview examines the concession-based model, which was suggested in direct conversations with industry stakeholders. Table 9 highlights this model's definition, characteristics, benefits, considerations and applicability to the City of Ottawa.

[14] Canada Growth Fund, Gibson Energy and Varme Energy – WTE Project

Table 9: Concession Model.

Concession Model	
Definition	P3 where the private sector finances, designs, builds, and operates infrastructure projects, transferring risks and responsibilities from the municipality.
Key Characteristics	Majority private sector financing, private sector control and operational responsibility during concession period, expertise-based delivery, and potential for higher life-cycle costs with no upfront municipal expenses. This differs from the commonly understood Design-Build-Finance-Operate-Maintain (DBFOM) approach where the owner would retain revenue risk and make availability payments to the private partner for operating and maintaining the facility to a set of defined performance specifications. This model is explored further in section 5.1.6.
Benefits	Offloads financial risks, leverages private sector expertise and efficiency, faster project delivery, and potential for innovative solutions.
Considerations	Concession period length, risk allocation, service level agreements, reputational risks, and potential impact on municipal control.
Applicability to the City of Ottawa	High, particularly suitable for municipalities with limited capital reserves or fiscal constraints for major infrastructure investment.

4.1.4 Alternative Revenue Sources

Alternative revenue streams can significantly impact project viability, financial sustainability, and return on investment. Effective revenue strategies can mitigate financial risks, enhance project bankability, and attract investors. Table 10 highlights key alternative revenue streams to consider for WTE and MWP facilities, as identified through conversations with industry stakeholders.

Table 10: Alternative Revenue Sources.

Alternative Revenue Sources	
Energy Sales	Selling electricity generated from waste-to-energy processes to the grid or third-party off-takers through Power Purchase Agreements (PPAs), which can provide stable, long-term revenue. Municipalities may leverage their position to secure favorable PPAs, de-risking power sales.
Material Recovery	Recovering valuable materials from waste streams, potentially offsetting up to 10% of operating fees, as reported by industry stakeholders.

Alternative Revenue Sources	
Special Material Disposal	Disposing of specialized materials, such as medical waste, at premium rates. WTE operators have noted that these materials can command higher disposal fees.
Carbon Credits	Generating and selling carbon credits through GHG reductions, achieved by diverting waste from landfills, producing renewable energy, or implementing energy-efficient technologies.

These alternative revenue sources have the potential to reduce the funding requirement during the operating period and can help to offset long-term financing costs. It is not expected that these alternative revenue sources would be sufficient to fully offset operating costs.

5. Delivery Models

This section provides an overview of potential delivery models for the MWP and WTE facility under consideration, including examples from precedent projects where these models have been successfully implemented. Additionally, it includes a summary of the market sounding feedback shared by participants to help with presenting market insights, highlighting recurring themes and key takeaways from the discussions.

5.1 Overview of Potential Delivery Models

For major capital projects, a broad range of delivery models is typically considered. Given the scope of this initiative, which involves the development and operation of either a WTE or MWP facility, and to assist City Council in selecting the most appropriate option, the following 7 procurement models are presented for consideration. These models ensure that all potential delivery models that could provide value to the City are evaluated.

- Design-Bid-Build (DBB);
- Design-Build (DB) or Engineering, Procurement and Construction (EPC);
- Integrated Project Delivery (IPD);
- Design-Build-Finance (DBF);
- Design-Build-Finance-Maintain (DBFM);
- Design-Build-Finance-Operate-Maintain (DBFOM); and,
- Concession Model

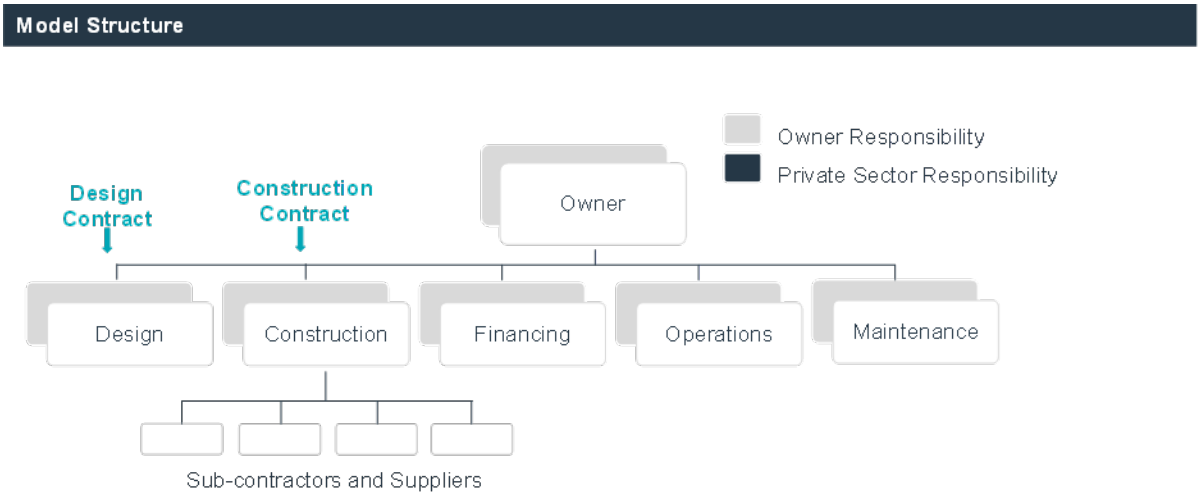
The aforementioned procurement options have been considered through a combination of desktop research, specialist input from KPMG, and insights gathered from market sounding participants. This approach ensures that the delivery models are assessed against their ability to optimize risk allocation, streamline delivery, and potentially address operations and maintenance considerations, ultimately enhancing market acceptance and feasibility. While a preferred delivery model is not identified in this memo, some of the delivery models can be removed from consideration based on the findings of our research and feedback from the market.

The following sub-sections provide a high-level overview of the procurement models under consideration, outlining their respective benefits and limitations, along with their applicability for a WTE and MWP facility. Furthermore, the section on market sounding will distill the feedback and insights gathered, emphasizing recurring themes from the responses. This analysis can help inform the selection of the most suitable delivery models for assessment in the business case, ensuring balance between cost, efficiency, and long-term value.

5.1.1 Design-Bid-Build (DBB)

An illustration of the DBB procurement model is shown in Figure 1 below:

Figure 1: DBB Procurement Model.



The DBB is a traditional procurement option in which the Owner awards two distinct and sequential contracts for the design and construction work:

- The first contract is with a design firm to develop a full detailed design and to assist the Owner in putting the construction of the project out to tender; and
- The second contract is with a general contractor to build that design.

Under the DBB model, the operations, maintenance, and financing of the project would remain the responsibility of the Owner. Throughout the detailed design process, the designs are reviewed by the Owner. After the design is complete, the Owner would procure the construction works based on the completed design. It would do so by hiring a general contractor to complete the project in accordance with the design firm's plans and specifications. During construction, the Owner, with support from consultants, would manage and oversee the general contractor.

The Owner would pay for the construction project typically through monthly progress payments to the general contractor(s) during the construction period, based on work completed. Following completion, the assets are turned over to the Owner. The Owner assumes full responsibility for operations and maintenance, including continuously monitoring the condition of the assets to determine how frequent maintenance is required.

Table 11 below includes a summary of the benefits and limitations of the DBB model as deployed in the development of a MWP or WTE facility.

Table 11: Benefits and limitations for the DBB model.

Benefits	Limitations
• **Significant Market Experience**: Well understood and commonly used approach by the public sector • **Control**: Significant degree of Owner control of project • **Flexibility:** Flexibility to respond to changing conditions and citizen concerns	• **Limited Collaboration**: Requires complete design before construction contract award, providing clarity but limiting collaborative flexibility during construction in comparison to other models where design and construction are bundled together.

Benefits	Limitations
• **Less Upfront Time and Resources:** Less upfront time and resources spent on projecting future operational requirements and risks	• **Constructability Considerations**: Limited direct contractor-designer collaboration, but constructability issues can be mitigated through GC advocacy, reviews, and experienced design teams. • **Minimal Risk Transfer:** Owner retains the majority of the project risks (e.g., cost/schedule overruns) • **Lacks a Holistic Lifecycle Approach:** Requires the Owner to consider optimization of long-term quality / performance in developing the specifications due to the retention of O&M responsibilities by the Owner • **No Performance Guarantee:** Other than typical warranty provisions within the contract, there are no performance guarantees provided, with the owner responsible for asset performance and quality. • **Less Opportunity for Innovation:** Less opportunity for private sector innovation, particularly for WTE of MWP facilities where sophisticated technologies are being deployed • **Technical Operational Requirements:** Lack of O&M element requires the City to operate and manage unfamiliar technology, which can be resource intensive for training and operating the facility

Applicability of DBB Model

The DBB model is not considered suitable for the WTE or MWP facility, as market participants have indicated limited interest in this approach. For this type of project, the use of the DBB model is likely to present the following challenges:

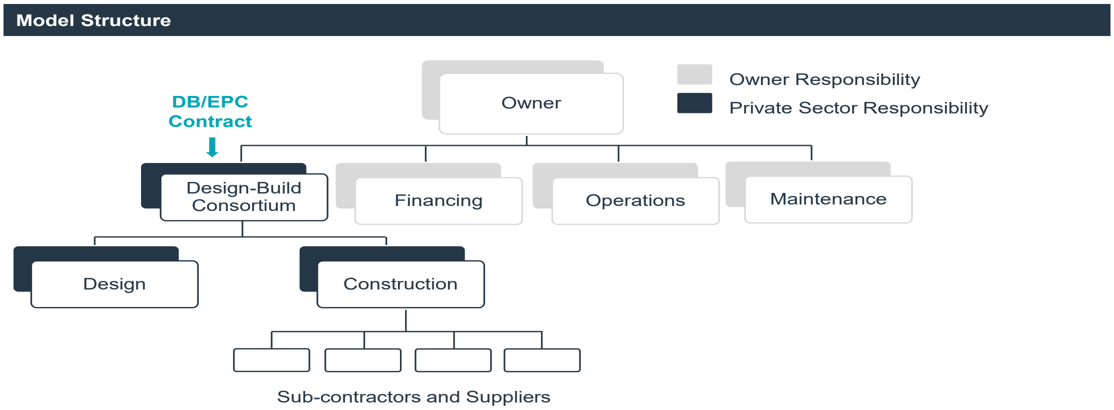
- The overall process tends to be lengthier compared to other procurement models.
- The construction phase may also extend longer, as the absence of collaboration between the contractor and designer may restrict the integration of constructability considerations into the design, potentially resulting in schedule delays caused by design issues (e.g., delays due to inadequate or late design). Mitigation strategies are available through GC advocacy, reviews, and experienced design teams.
- While DBB offers cost control advantages, the model's sequential approach can still lead to increased construction costs. This is due to the contractor not being involved in the design phase, and the construction budget remains unclear until design finalization.

- This approach would require the City to operate a specialized technology that it does not have prior experience delivering.

5.1.2 Design-Build (DB) or Engineering, Procurement and Construction (EPC)

An illustration of the DB/EPC procurement model is shown in Figure 2 below:

Figure 2: DB Procurement Model.



The DB/EPC model consolidates the design and construction work under a single contract, whereas the DBB model separates these phases into distinct contracts that are awarded sequentially. Consortiums, joint ventures and/or subcontracting arrangements may be established between two or more companies to pool the resources and expertise necessary to deliver a DB/EPC project. Under a DB/EPC contract, the Owner is responsible for financing the entire project. Furthermore, the Owner continues to operate, maintain, and refurbish the asset after project delivery.

During the construction period, the Owner would typically make monthly progress payments or milestone payments to the contractor based on the value of work completed. With this method of payment, the contractor does not have to arrange significant amounts of private financing. The tender of the DB/EPC is not based upon a detailed design but rather the project requirements are defined in the form of performance specifications by the Owner, which states what the project needs to achieve in terms of functional requirements, rather than how to achieve it. The General Contractor is typically the lead in this arrangement as the majority of the cost, schedule and quality risk relate to the construction.

The characteristics of a DB/EPC model and the issues associated with it depend upon the unique characteristics of the project. Table 12 includes a summary of the benefits and limitations of the DB model.

Table 12: Benefits and Limitations for the DB/EPC model.

Benefits	Limitations
• **Greater Efficiency and Cost Savings Potential than DBB:** Integration of design and construction creates efficiencies and cost savings	• **Lacks a Holistic Lifecycle Approach:** Requires the Owner to consider optimization of long-term quality / performance in developing the specifications due to the retention of O&M responsibilities by the Owner

Benefits	Limitations
• **Cost and Schedule Certainty:** More certainty on final construction price and completion than DBB • **Enhanced Constructability:** Enhanced constructability of design plans compared to DBB due to integration of contractor • **Accelerated Delivery Schedule:** Can accelerate project delivery schedule compared to DBB • **Reduced Risk:** Reduced design and construction risk for the Owner compared to DBB	• **No Performance Guarantee:** Other than typical warranty provisions within the contract, there are no performance guarantees provided, with the owner responsible for asset performance and quality • **Less Opportunity for Innovation:** Less opportunity for private sector innovation, particularly for WTE of MWP facilities where sophisticated technologies are being deployed • **Technical Operational Requirements:** Lack of O&M element requires the City to operate and manage unfamiliar technology, which can be resource intensive for training and operating the facility

Applicability of DB/EPC Model

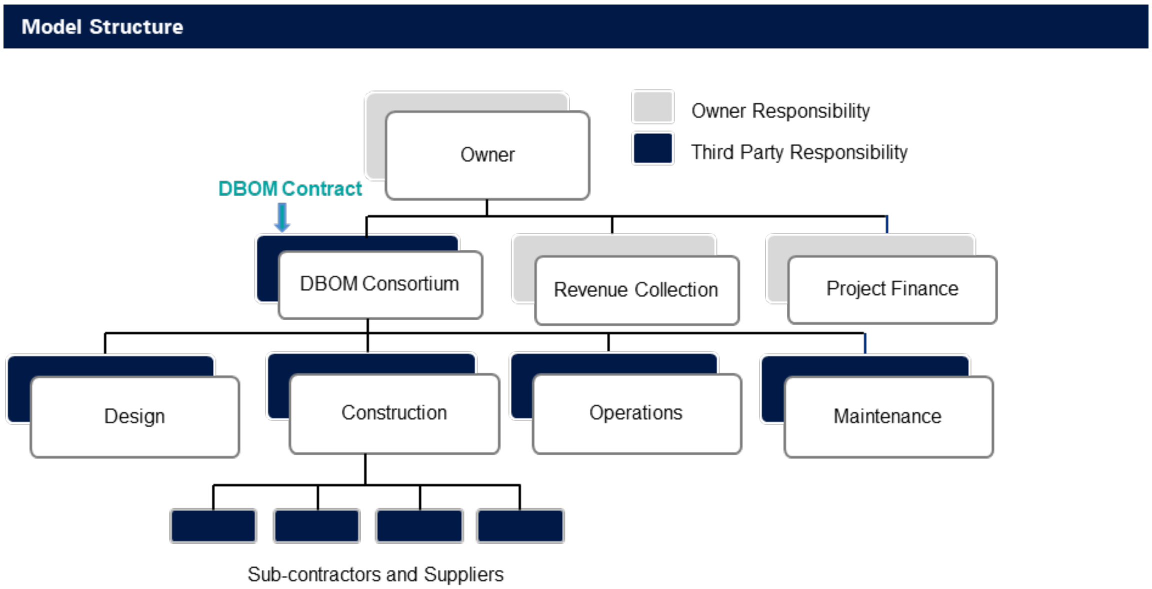
In the DB/EPC model, there is a single entity responsible for integrated design and construction which reduces contract management requirements and interface risk. This delivery model transfers design and construction risk from owner to the DB contractor. The public sector owner retains responsibility for the financing and long-term project O&M and major maintenance after the project has been constructed.

Similar to the DBB model, a DB/EPC approach that does not include a long-term operating component for the private partner can be challenging to implement due to the City being required to operate a specialized technology that it does not have prior experience delivering.

5.1.2 Design-Build-Operate-Maintain (DBOM)

An illustration of the DBOM procurement model is shown in Figure 3 below.

Figure 3: DBOM Procurement Model.



DBOM is a delivery model in which the design, build, operations, and maintenance of a project are procured together and contracted through a single contract. This model transfers more risk to the private sector by having the private sector design and build the project with the concept in mind that the private sector will have to operate and maintain the project as well. DBOM closely aligns with the DB model, with the key distinction being that operations and maintenance are handled by the private sector as well. In this specific DBOM model, the private sector typically covers ongoing maintenance costs, while the owner is responsible for end-of-life equipment upgrades.

Table 13: Benefits and Limitations for the DBOM Model

Benefits	Limitations
• **Operational Responsibility:** Assets with unique operational needs benefit from private operators, leveraging specialized expertise and incentives for efficient operations • **Cost and Schedule Certainty:** More certainty on whole of life cost due to fixed price elements for design and construction and O&M • **Enhanced Constructability:** Enhanced constructability of design plans compared to DBB due to integration of contractor • **Accelerated Delivery Schedule:** Can accelerate project delivery schedule compared to DBB	• **Risk Premium:** It can be reasonably expected that O&M providers will include a cost premium to account for various operational risks transferred to the service provider. • **Loss of Direct Control**: Owner loses direct control over asset operations; however would want to build in appropriate monitoring and oversight provisions into the contract • **Inflexibility:** Long-term contracts limit flexibility in responding to changing needs during the contract term (or will be costly if changes are made)

Benefits	Limitations
• **Reduced Risk:** Reduced design and construction risk for the Owner compared to DBB • **Increased Innovation:** Additional innovation is promoted during the construction and design process with the integration of the O&M provider • **Performance Guarantees:** Owner can define performance standards that must be achieved during the O&M period and tie payment incentives to achieving those standards.	• **Dependence on Partner**: Need to ensure the Owner has a reputable partner for the O&M period as the O&M provider will be key to achieving desired project outcomes

Applicability of DBOM Model

From an ownership perspective, DBOM is particularly suitable for projects such as WTE or MWP facilities, where the contractor assumes responsibility for the facility's operations under a long-term lease agreement (typically 20-30 years) with the public entity. Assets with specialized operational or maintenance requirements, such as MWP and WTE, can benefit from this model due to the specialized know how that a private partner can bring and the incentive structure built into the agreement can help to drive efficient delivery of the performance requirements.

Key risks for this model include procurement, performance, and marketing. It was emphasized that performance risk should be fully borne by the developer, while other risks, such as inflation or operational challenges, can be negotiated between the owner and the contractor. When a developer assumes greater risk, it is often reflected in the contracted price, with additional premiums if those risks materialize.

Both WTE and MWP projects face significant marketing challenges, particularly in securing buyers for the energy or recyclable materials extracted from waste. One participant, representing an owner, noted that DBOM is often their preferred model, as it allows for efficient risk transfer to the private sector, while the owner retains oversight.

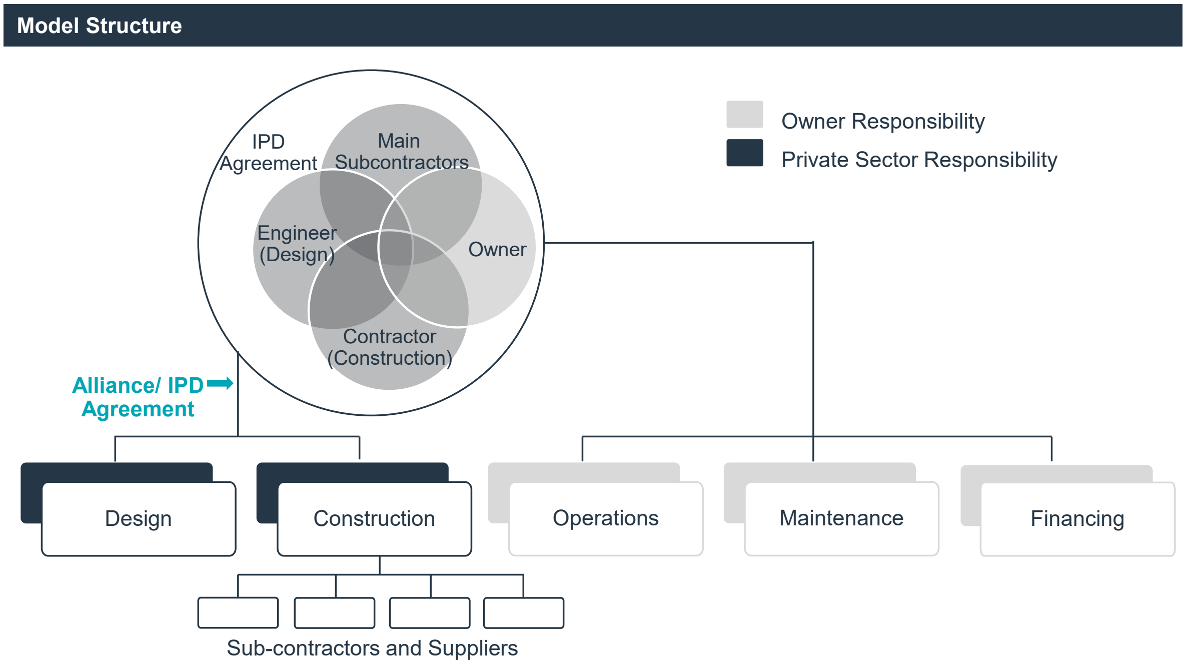
Another participant (an owner) explained that they typically engage in DBOM delivery models for these types of facilities due to the financing advantages. This participant mentioned that the municipalities often have access to lower interest rates than the private sector, and by leveraging municipal financing, can help to reduce the overall cost of the project when compared to models where the private sector raises the financing.

Through the market sounding exercise, owners expressed a preference for either DBOM or EPC (with an O&M agreement) models for future facilities, with long-term operating contracts typically spanning 15 to 20 years. However, one operator raised concerns, suggesting that companies with the necessary expertise and experience may be reluctant to engage in these projects if the delivery model is a fixed-price DBOM.

5.1.3 Integrated Project Delivery (IPD)

An illustration of the IPD procurement model is shown in Figure 4 below:

Figure 4: IPD Procurement Model.



The IPD contract is formed by the Owner, designer, construction contractor, suppliers and potentially stakeholders (e.g., local organization, community stakeholder, funding organization, etc.) to plan, design, construct and commission a capital project. Under this strategy, all parties share the responsibility for all aspects of the project, including design, construction, construction management, and risk management. Compensation under an IPD model is directly tied to cost, schedule and profitability milestones of the overall project.

Compensation under an IPD contract is open-book among participants. These provisions ensure that the costs which are reimbursed to the IPD members under the remuneration framework have been actually and reasonably incurred. Each member could grant the Owner, and other public sector bodies full access and audit rights to any information, analysis and methodology related to the documentation prepared for the project.

Compensation is directly tied to cost, schedule and profitability milestones of the overall project, and is typically comprised of three components:

- Reimbursement to cover costs and agreed upon profit;
- Incentives for achieving or bettering agreed project cost targets; and
- Rewards for accomplishing set project goals.

In addition to the aforementioned contractual and compensation characteristics, another key component to the IPD model is the establishment of the project target cost. Once the IPD team is established, the team endeavours to develop a target cost for the project. Once developed, the target cost is used as a benchmark with which to compare actual costs, profits, and losses. Any savings or additional costs in excess of the target cost are split amongst the IPD team members through gain-share / pain-share provisions.

Members of the IPD team are selected based on their ability to deliver the outcomes required to achieve the desired project outcomes, rather than through a competitive bid process (involving detailed designs and financial offers).

The characteristics of an IPD model and the issues associated with it depend upon the unique characteristics of the project. Table 14 includes a summary of the benefits and limitations of the IPD model.

Table 14: Benefits and Limitations for the IPD model.

Benefits	Limitations
• **Project Outcomes Focus:** Focuses on project outcomes and open communication • **Performance Enhancement:** Participants are encouraged to take calculated and agreed risks and opportunities to pursue cost savings and enhance project performance, without fear of legal liability if they fail • **Greater Visibility of Project Requirements:** Earlier involvement of all parties at preliminary design may provide greater visibility into project requirements compared to other models • **Flexibility:** There is flexibility to adapt to scope changes, risks and opportunities as they arise during delivery of the project • **Risk Allocation:** The project's risks can be better managed through a collaborative effort, where each party's knowledge, skills and resources are shared • **Higher Degree of Risk Sharing:** Higher degree of risk sharing compared to DBB and DB - may be desirable when risks are difficult to quantify, as they allow the Owner to incentivize the primary parties to manage risks without incurring a significant risk premium • **Greater Collaboration:** Integrated governance structure aims to reduce threat of disputes compared to traditional adversarial contracting approaches • **Enhanced Constructability:** Increased constructability of the design as communication between designers, constructors, and the client is instantaneous	• **Behaviour Dependency:** Project success is directly dependent on the behavior of individuals within the team • **Cost and Schedule Risk:** Cost and schedule risks are shared under IPD contracts which exposes the Owner to 'uncapped risk' • **'Soft' Target Cost:** An approach to the selection of IPD members, which does not evaluate price elements combined with any imbalance between the commercial capabilities of the non-owner participants ("NOPs") and the Owner, may result in a 'soft' Terms of Conditions ("TOC") which inflates the Owner's cost of delivering the project • **Significant Time Commitment:** Requires commitment and collaboration from all parties, including significant time commitment from the Owner • **Less Price Competition:** Projects are not competitively bid. Market participants may be hesitant to enter a risk-sharing arrangement before cost of project is defined • **Greater Upfront Time and Resources:** Can be very time consuming for parties to agree the final IPD/Alliance contract, particularly for asset owners not used to delivering major projects • **Lacks a Holistic Lifecycle Approach:** Requires the Owner to consider optimization of long-term quality / performance in developing the specifications due to the retention of O&M responsibilities by the Owner • **Low Market Experience:** Less project experience and lessons learned to draw from

Benefits	Limitations
• **Greater Integration of Resources:** Can be beneficial for projects that are significant in size and complexity – integrated approach enables pooling of resources and expertise and ensures no duplication of resources between parties	• **Low Owner Experience:** Successful implementation of IPD requires specific capabilities and governance structures. Due to owner inexperience, resources and effort will be required to develop necessary expertise.

Applicability of IPD Model

In addition to the benefits outlined above, market sounding participants suggested that an IPD model could be a strong option for delivering a MWP or WTE facility. The key advantage of the IPD model is its flexibility during the project definition and design development phase. By enabling teams to collaborate during the scope development and open-book costing phase, the City can adjust the project scope as necessary, adding or removing elements as the project evolves.

The open-book costing method ensures that these changes are made transparently, maximizing value throughout the process. As a result, the IPD model is commonly used for complex, multi-phase projects, as it allows for adaptability when project needs shift. Furthermore, the integration of teams within the IPD framework facilitates effective coordination on active sites, helping to manage shutdowns, control access, and work closely with operators to reduce disruption.

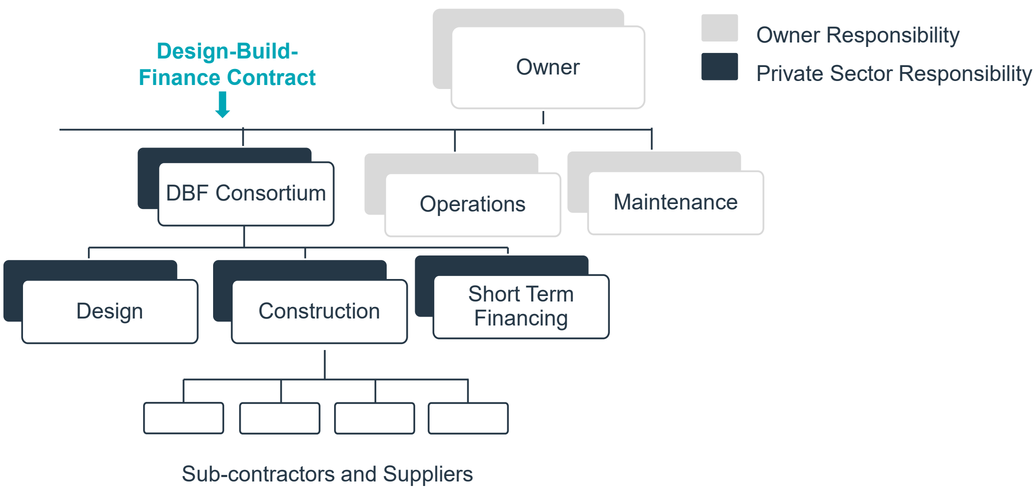
While an IPD model offers benefits, its success hinges on specialized skills, expertise, and governance structures. As the City has no prior IPD experience, implementing this model will require significant upskilling of resources to develop necessary capabilities, while also requiring the establishment of robust decision-making processes and potentially leveraging external advisors, to overcome the City's current gaps in skills and capacity.

5.1.4 Design-Build-Finance (DBF);

An illustration of the DBF procurement model is shown in Figure 5 below:

Figure 5: DBF Procurement Model.

Model Structure



Similar to a DB model, a DBF approach awards the design and construction under a single contract. Consortiums, joint ventures or subcontract agreements may be established between two or more companies to pool the resources and expertise necessary to deliver a DBF project.

The DBF consortium (Project Co) must obtain short-term construction financing from third-party lenders or use its own equity resources. Although gearing (debt to equity ratios) for DBF transactions have varied over-time, the current ratios range from 85:15 to 90:10 with some occasional outliers. A lump-sum payment at substantial completion is intended to pay off design and construction costs, and construction financing costs incurred by the DBF consortium. The DBF consortium will be motivated to complete the project on time as the Owner will withhold all or a significant proportion of payment until project completion. Any incremental interest costs and financial penalties associated with schedule delays will be borne by the DBF consortium.

This payment mechanism provides a more liquid form of security for the Owner since the contractor is not paid (assuming no progress payments during the construction period) until it demonstrates compliance with the technical specifications. The responsibility for operations, maintenance, and any expansions after project delivery are retained by the project Owner under the DBF arrangement.

The characteristics of a DBF model and the issues associated with it depend upon the unique characteristics of the project. Table 15 includes a summary of the benefits and limitations of the DBF model.

Table 15: Benefits and Limitations for the DBF model.

Benefits	Limitations
• **Greater Efficiencies and Cost Savings Potential:** Integration of design and construction creates efficiencies and cost savings • **Enhanced Constructability:** Enhanced constructability of design plans • Accelerated Project Delivery Schedule: Can accelerate project delivery schedule • **Greater Risk Transfer:** Reduced design and construction risk for the Owner. Financial risks borne by Project Co (construction period only) • **Greater Cost and Schedule Certainty:** Greater cost and schedule certainty - no payment to Project Co until substantial completion is achieved (assumes no progress payments) • **Performance Quality:** Substantial completion payment is performance based – partner must construct the project in compliance with specifications	• **Lacks a Holistic Lifecycle Approach:** Requires the Owner to consider optimization of long-term quality / performance in developing the specifications due to the retention of O&M responsibilities by the Owner • **No Performance Guarantee:** Other than typical warranty provisions within the contract, there are no performance guarantees provided, with the owner responsible for asset performance and quality. • **Less Opportunity for Innovation:** Less opportunity for private sector innovation, particularly for WTE of MWP facilities where sophisticated technologies are being deployed • **Higher Borrowing Cost:** Higher cost of private sector borrowing compared to public sector borrowing

Applicability of DBF Model

Similar to the DBB model, the DBF model is not considered suitable for the WTE or MWP facility, as market participants have also indicated limited interest in this approach. For this type of project, the use of the DBF model is likely to present the following challenges:

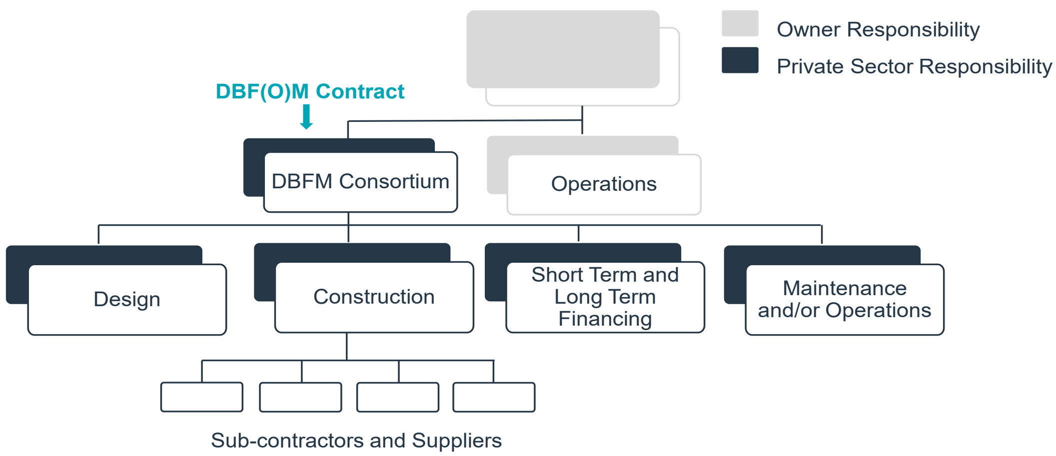
- The opportunity for the private sector to innovate is limited compared to other delivery models including DBFM, DBFOM and concession models. This can result in preventing the development of a WTE and MWP facility that the City envisions.
- Lack of operations element limits the benefit to the City of incurring private sector financing costs.

5.1.5 Design-Build-Finance-Maintain (DBFM);

An illustration of the DBFM procurement model is shown in Figure 6 below:

Figure 6: DBFM Procurement Model.

Model Structure



The DBFM model involves the private sector consortium ("Project Co") accepting responsibility for the design, construction, financing, regular maintenance and rehabilitation of the asset over the contract term to meet pre-defined performance specifications. The typical contract term for the maintenance work is around 20 to 30 years and the public sector retains ownership of the assets.

The financing component of the DBFM model includes both short-term and long-term financing. Long-term financing is needed since Project Co would not be fully paid for construction work following substantial completion, instead would be paid in instalments over the length of the maintenance term. These payments are subject to deductions if Project Co fails to meet contractual performance obligations. The payments over the maintenance term include:

- A fixed capital repayment component to repay Project Co's long-term debt and equity investors for their financing of the construction; and
- A maintenance payment to compensate Project Co for its ongoing maintenance work and major capital rehabilitation (supplemented by an operations payment to compensate Project Co for its day-to-day operations in the case of the DBFOM model).

At the end of the contract term, Project Co transfers control of the assets back to the government under agreed-upon terms and conditions, known as hand-back conditions. The hand-back conditions explicitly outline the expected condition in which the assets must be returned to the public sector and stipulate life-expectancy beyond the contract term.

This model is suited for projects where maintenance operations have the potential to be transferred to the private sector, whereas operations is retained by the public sector. Table 16 includes a summary of the benefits and limitations of the DBFM model.

Table 16: Benefits and Limitations for the DBFM model.

Benefits	Limitations
• **Greater Efficiencies and Cost Savings Potential:** Integration of design and construction creates efficiencies and cost savings • **Enhanced Constructability:** Enhanced constructability of design plans • **Accelerated Delivery Schedule:** Can accelerate project delivery schedule • **Significant Risk Transfer:** Significant risk transfer to Project Co over the life of the agreement. Reduced design and construction risk for the Owner. Financial risks borne by Project Co • **Greater Cost and Schedule Certainty:** Greater cost and schedule certainty - no payment to Project Co until substantial completion is achieved (assumes no progress payments) • **Greater Innovation Potential:** Greater potential for design and construction efficiencies and innovation than models that do not involve a long-term element • **Performance Quality:** Substantial completion payment is performance based – partner must construct the project in compliance with specifications • **Adopts a Holistic Lifecycle Approach:** Long terms maintenance costs set up front and funding plan put in place. Greater consideration for long-term quality and lifecycle costs • **Provides Performance Guarantee:** Performance-based service payments encourages higher operational efficiency and maintenance standards	• **Higher Borrowing Costs:** Higher cost of private sector borrowing compared to public sector borrowing • **Less Control:** Less direct control for owner as performance specifications are developed upfront during the procurement phase • **Greater Upfront Time and Resources:** Increased due diligence, planning and transaction costs leads to longer planning and procurement period • **Higher Maintenance Costs:** Long term maintenance costs are potentially higher due to risk premiums being added to the costs for fixed price contracts compared to more flexible O&M pricing • **Challenging for WTE / MWP Facilities:** The lack of transfer of operations can create challenges for a facility like a WTE or MWP as the maintenance and rehabilitation is closely linked to the operations of the facility (difficult to provide a fixed 'maintenance' cost when Project Co is not operating the facility)

Applicability of DBFM Model

The DBFM model is not considered suitable for the WTE or MWP facility, as market participants have highlighted limited interest in this approach given the challenges noted above regarding the mismatch between the operations of the facility and the requirement to provide fixed pricing for the long-term maintenance and rehabilitation of the facility.

5.1.6 Design-Build-Finance-Operate-Maintain (DBFOM);

The DBFOM model builds on the DBFM model as, in addition to Project Co accepting responsibility for the design, construction, financing, regular maintenance and rehabilitation of the asset over the contract term, it also involves Project Co taking responsibility for operations under the same contract. This model is suited for projects where both the maintenance and operations have the potential to be transferred to the private sector.

Table 17 includes a summary of the benefits and limitations of the DBFOM model.

Table 17: Benefits and Limitations for the DBFOM model.

Benefits	Limitations
• **Greater Efficiencies and Cost Savings Potential:** Integration of design and construction creates efficiencies and cost savings. Greater potential for design and construction efficiencies and innovation than models that do not involve a long-term element • **Enhanced Constructability:** Enhanced constructability of design plans • **Accelerated Delivery Schedule:** Can accelerate project delivery schedule • **Significant Risk Transfer:** Significant risk transfer to Project Co over the life of the agreement. Reduced design and construction risk for the Owner • **Greater Cost and Schedule Certainty:** Greater cost and schedule certainty - no payment to Project Co until substantial completion is achieved (assumes no progress payments) • **Performance Quality:** Substantial completion payment is performance based – partner must construct the project in compliance with specifications • **Performance Guarantee**: Lender discipline to ensure performance is met throughout the agreement and at handback. Performance-based service payments encourages higher maintenance quality. • **Encourages a Holistic Lifecycle Approach:** Optimizes long-term quality/performance and lifecycle costs (trade-offs between upfront costs, lifecycle costs and operating performance). Long term maintenance costs set up front and funding plan put in place	• **Higher Borrowing Costs:** Higher cost of private sector borrowing compared to public sector borrowing • **Less Control:** Less direct control for owner as performance specifications are developed upfront during the procurement phase • **Greater Upfront Time and Resources:** Increased due diligence, planning and transaction costs leading to a longer planning and procurement period • **Higher Maintenance Costs:** Long term maintenance costs are potentially higher than if a flexible approach was taken • **Less Flexibility:** Potentially less flexibility during operating period

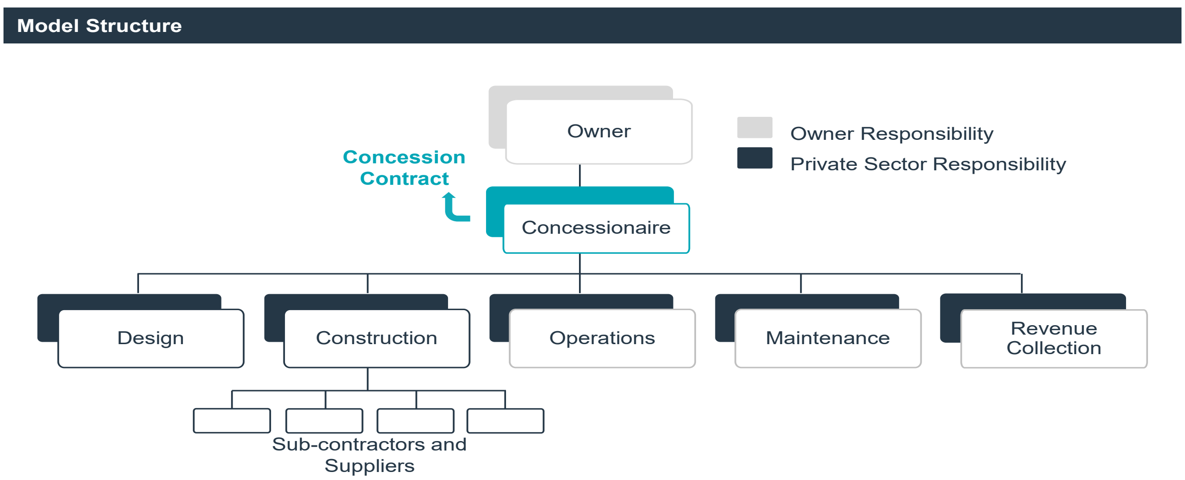
Applicability of DBFOM Model

- During the market sounding exercise, a participant indicated a willingness to consider various delivery models but expressed preference for the DBFOM model due to the higher degree of control it offers. However, the viability of DBFOM would depend on the private sector's appetite for assuming the majority, if not all, of the project risks.
- The other consideration under this model is the City’s ability to make monthly service payments to Project Co. As this is not a full concession model where significant revenue risks are transferred to Project Co, the City would be required to make monthly payments to cover the private sectors financing costs along with operations and maintenance costs.

5.1.7 Concession Model

An illustration of the Concession procurement model is shown in Figure 7 below:

Figure 7: Concession Procurement Model.



The concession model involves the private partner designing, building and financing an asset, providing regular maintenance and rehabilitation services, and operating, managing and investing in the business of the asset, under a long-term agreement. This model involves revenue risk transfer to the private sector since the private partner is compensated by revenue from user charges which in turn is used to finance its investment in the asset. The role of the public authority is primarily focused on regulatory compliance, monitoring, and customer protection through enforcing government regulations and the project agreement, as well as through policy decisions. This can include providing some level of guarantee or backstop on the revenue risk exposure of the concessionaire. For example, under a concession model for a WTE or MWP facility the public sector owner may guarantee a minimum tonnage to be directed to the facility through a supply agreement.

One form of a concession model discussed multiple times during the market sounding exercise was the Build-Operate-Transfer (BOT) model. Concessions involve the private partner providing a service directly to the public and taking end user risk (e.g., demand and revenue risk). While the public sector may guarantee some level of payment as mentioned above, the private partner invests in the asset and receives the majority of its revenue from user charges to cover its investment plus profit. As a result of this arrangement, the private partner has a direct relationship with the public. The attractiveness of concession models for the private sector depends on the extent of positive cash flows that can be generated by the private partner (e.g., tipping fees or other user charges) or through a combination of project revenue and government subsidies.

Unlike in traditional DBB procurements, the procuring authority typically does not create a detailed design. It leaves greater flexibility to the would-be concessionaires to develop their own designs, consistent with the public sector's objectives, in hopes of coming up with the most competitive approach to solving the problem.

Under this model, the public sector allocates significant risks related to the cost and performance of construction, lifecycle, maintenance and operations to the private sector. Capital costs are financed by the private sector and so lender discipline ensures performance is met throughout the agreement and at handback. By accepting these revenues, the private sector also accepts the risk of revenue uncertainty. This results in greater cost and budget certainty, higher maintenance standards, and encourages private sector innovation.

While ownership of the asset may be transferred to the private sector, this is not a defining characteristic of concessions as ownership can also be retained by the government authority. Under certain concession models, the asset reverts back to the authority at the end of the concession period. The term of a concession is for a period long enough to allow the private sector to recover its investments plus anticipated profit.

Table 18 includes a summary of the benefits and limitations of the concession model.

Table 18: Benefits and Limitations for the Concession Model.

Benefits	Limitations
• **Adopts a Holistic Lifecycle Approach:** Strong incentives to minimize the full life-cycle costs of the project • **Guaranteed Maintenance:** Guaranteed maintenance for the entire term of the agreement • **Significant Risk Transfer:** Private sector bears a significant share of the risks • **Greater Opportunity for Innovation:** Potential for efficiency gains in all phases of project development and implementation	• **Higher Complexity:** Highly complex to implement and administer due to lack of flexibility under the project terms • **Greater Upfront Time and Resources:** Negotiation between parties and finally making a project deal may require extended duration • **On-going Oversight:** May require close regulatory oversight • **Risk to End Users:** End-users could have to pay high fees if the public sector does not have regulatory control and the contract risk allocation is sub-optimal

Applicability of Concession Model: BOT

A market sounding participant, specifically an operator from the private sector, demonstrated extensive expertise in the financing, design, and development of WTE and MWP facilities as a large number of their operations are BOTs. For greenfield projects, the operator primarily utilizes BOT models, where they oversee the design, build, financing, operation, and eventual transfer of the facility. These contracts typically span a 25-year term. However, in other jurisdictions and waste processing projects, the operator has also employed traditional DBFOM models. That said, both the BOT and DBFOM delivery models appear to be viable options for this project.

5.2 Summary of Market Sounding Insights

While the delivery model descriptions above contained some of the direct market sounding feedback received through our recent market sounding exercise, the main feedback and insights can be summarized into four key themes:

Private Sector Engagement and Interest: Strong level of private sector interest in participating in a WTE and MWP project, with emphasis on the conditions under which companies are willing to engage, especially in relation to risk-sharing and project control.

Procurement Models and Funding Structures: Messaging focuses on identifying the procurement models deemed most viable for the City, with consideration of those that align closely with the City's strategic objectives and operational needs. Additionally, understanding the current landscape of partnerships between municipalities and the private sector for WTE and MWP facilities.

Market Expertise and Operational Considerations: Strong depth of expertise available in delivering these projects across all market sounding participants, informed by past experiences and lessons learned.

Risk Management and Project Viability: Broad-based messaging across key risks and factors affecting the project's success were identified, offering a detailed perspective on the challenges the City may face, as well as the potential impacts on private sector participation and overall project feasibility.

The subsections below elaborate further on the themes highlighted above by discussing the information captured during the market sounding interviews.

5.2.1 Private Sector Engagement and Interest

Private sector market participants demonstrated strong interest in participating in a WTE and MWP project in Ontario. Specifically, they would engage in this procurement as investors, developers, and operators. However, one participant raised concerns about the province's lack of carbon capture infrastructure, which has influenced their interest. While this is seen as a potential advantage for projects like WTE or MWP that could incorporate carbon capture technology, the primary challenge lies in finding viable commercial uses for captured carbon. Another participant, while not currently using carbon capture, expressed an interest in exploring its applications and opportunities in WTE projects.

A majority of participants emphasized that, for projects of this nature, they prefer delivery models where they take on the design, build, operations, and maintenance phases. Typically, these models involve handing the facility back to the City after an extended concession period, usually between 20 to 25 years.

Regarding key considerations for engagement, participants consistently highlighted the critical role of revenue-sharing agreements in aligning the interests of municipalities and private operators. One participant noted that municipalities are often required to support the plant from a revenue standpoint, particularly in instances where the plant underperforms. In return, participants generally offer revenue-sharing models once the facility is operating efficiently. A preference of having revenue structure that incorporates long-term contracted revenues under an availability payment model, subject to performance deductions was highlighted by a participant (i.e., DBFOM). Protection mechanisms around key business plan risks, in particular volume and price volatility related to feedstock inputs and value outputs are encouraged to be provided by the City to the extent they are looking to incorporate revenue risk in the model.

In terms of risk management, participants typically engage in shared contracts with municipalities, distributing risk and reward. Examples of such contracts include revenue sharing, cost sharing, and waste-sharing agreements. Participants highlighted that bonus structures are critical in incentivizing all parties to operate facilities at high levels of efficiency. Additionally, successful P3s, particularly in sustainability and waste projects, require careful risk allocation. One participant emphasized that certain key risks including political, regulatory, environmental, and social should be retained or mitigated by the public sector.

From an operational perspective, a participant highlighted several factors influencing project success, including feedstock volumes, policy changes (such as the acceptance of commercial non-hazardous materials from MRFs), environmental permits, energy pricing, and sale of recyclable materials pricing. As these projects increase in size and complexity, the need for specialized equipment, digital systems, automation, and process optimization becomes essential to ensuring smooth and productive operations.

5.2.2 Procurement Models and Funding Structures

From a private sector perspective, market participants exhibited a strong preference for specific procurement models including, DBFOM, IPD and concession arrangements. Regarding DBFOM, a participant emphasized that its exclusivity in providing complete control is a critical aspect.

For the IPD model, the collaborative “one team” approach was highlighted as a major factor contributing to its success. This model fosters team flexibility, facilitating smoother operations within complex project environments by integrating teams early to manage potential shutdowns, minimize disruption, and streamline access. Meanwhile, concession models were often framed within BOT structures, typically spanning contract terms of up to 25 years.

From a financing standpoint, various models were discussed, including private financing and non-recourse structures. Notably, a participant anticipates that the most effective financing route would be the establishment of a Special Purpose Vehicle (SPV), which would secure non-recourse financing (aligned with DBFM or DBFOM models). Potential funding sources include long-term equity and long-term debt, the latter structured to mitigate refinancing risks. Additionally, short-term financing may be considered to cover milestone payments during construction phases.

It is important to note the critical role of governmental support, as the provincial government recently designated waste management as essential infrastructure. This designation significantly enhances the likelihood of successful funding outcomes. Private sector participants have indicated strong interest in specific programs such as CGF, the FCM Green Fund, and IESO. Furthermore, the development of WTE and MWP facilities is anticipated to attract interest from the CIB. The CIB’s ability to provide favorable financing terms, while managing project-related risks, is expected to positively impact the success of these projects.

From a public sector perspective, participants highlighted a preference for a DBOM model in which the WTE and MWP facilities are typically constructed on municipally-owned land. The facilities are then leased to a contractor under a 20-30 year agreement, which covers operations, maintenance, risk transfer, incentives, and performance benchmarks. Under this approach, it was noted that it may be beneficial to allow the City to leverage its public sector borrowing rate to reduce overall project financing costs rather than paying a premium on private financing. However, several participants mentioned that the choice of financing model whether municipality-led or private-led depends heavily on the specific business case, with both approaches offering distinct advantages and challenges.

- Municipality-led financing: Offers greater financing capacity and the ability to leverage public sector status to secure more favourable financing rates.
- Private-led financing: More agile, with the ability to adapt quickly to market conditions and take advantage of favorable pricing structures through refinancing.

Specific to the City of Ottawa, one participant emphasized that the City can play a key role in financing and funding the project by:

- Involving construction period payments (either milestone or progress-based) to reduce the need for long-term private financing;
- Securing PPAs that can be used to offset project costs; and/or
- Providing availability payments during the O&M phase to cover operating costs and repay private capital or allow the SPV to optimize project economics by purchasing feedstock and selling outputs.

5.2.3 Market Expertise and Operational Considerations

The majority of participants expressed a preference for WTE technology over MWP. However, one participant emphasized that for effective waste management, no single technology should be implemented in isolation. Instead, WTE and MWP need to work in combination. The selection of the appropriate technology must be based on a thorough understanding of the incoming feedstock, which is crucial for determining the output. Furthermore, collaboration and communication between the public and private sectors are vital to ensuring successful outcomes. From the private sector's perspective, long-term waste supply or feedstock guarantees from public authorities are essential to ensuring project bankability.

It was noted that municipalities must conduct extensive due diligence to ensure they select a reliable partner with a proven track record. Community education and outreach are equally important in managing public expectations and concerns. In some cases, waste management projects can become entangled in legal disputes, as illustrated by one participant currently involved in litigation with a vendor it terminated. Waste management decisions are often influenced by political factors, underscoring the need for increased education on the true costs and benefits of these technologies for communities.

Accurate population forecasting is critical when designing waste management facilities. The facility's capacity should align with anticipated population growth to avoid over- or under-sizing. Moreover, understanding the real diversion rates and the cost per tonne of waste diversion is paramount, this key metric should guide decision-making. It is also crucial to keep the operator accountable to the contract and their performance. Operators should not be allowed to price inflated costs into the contract. Instead, municipalities should fully leverage all potential revenue streams during negotiations.

There is limited appetite among private companies with relevant expertise for projects that are delivered through fixed-price DBOM contracts. This is linked to a preference for more flexible contract pricing when private financing is not involved. Over the past few years, municipalities and funding organizations have shifted their focus to emphasize several key factors in project delivery, including:

- **Company Experience**: Emphasis on existing and past operations, operational duration, company size, and management expertise.
- **Financial Strength**: The company's ability to secure investment and successfully execute the project.
- **Project Team**: A detailed assessment of the executive team's relevant experience and qualifications, as well as key partners with executed contracts.
- **Project Financials**: Evaluation of a discounted cash flow model, key economic assumptions, and expected economic performance.
- **Project Readiness**: Ensuring critical milestones are met, with confirmed site access, secured financing, and signed offtake agreements.

5.2.4 Risk Management and Project Viability

Participants noted that shared contracts between municipalities and private partners are an effective way to distribute both risk and reward. These arrangements often include revenue sharing, cost sharing, and energy or waste sharing, allowing for a balanced allocation of risks across all parties involved.

Several participants highlighted that long-term risks, such as changes in waste characterization, should be managed by the City. For example, changes in the composition of waste can affect the operational costs of facilities, particularly when unexpected maintenance arises. Legislative changes, participants emphasized, are best managed by municipalities, as private companies have limited influence over such issues.

In discussing the critical risks related to project viability, participants noted that securing a reliable waste supply is essential for the success of both WTE and MWP projects. The incoming waste feedstock is vital for determining overall project performance and profitability. Should the public sector be unable to supply sufficient waste, private sources must be considered to maintain operational continuity. In the case of Ottawa, it was noted that the relatively low population levels in the surrounding area could make it more challenging to source additional waste streams when compared to other urban centres in the province. Another participant highlighted that contingency plans should be in place to handle poor-quality waste, as it can significantly affect the facility's output and financial returns. Securing long-term waste supply guarantees or minimum revenue guarantees is crucial to ensuring private sector participation and project bankability.

Participants also stated that public perception and political factors are significant risks in waste management projects. Community education and outreach were identified as key components for gaining public support and managing expectations. Effective communication helps the public better understand the costs and benefits of implementing advanced waste management technologies. Additionally, participants noted that municipalities must manage risks associated with environmental permits, fluctuating energy prices, and markets for recyclable materials, as these directly impact financial viability and regulatory compliance.

In terms of performance risk, it was highlighted that developers should assume full responsibility for facility operations to ensure accountability and performance. Tying the developer's compensation to their performance helps mitigate operational risks for municipalities. However, participants noted that when developers take on greater risks, these are typically reflected in higher contract prices, including premiums if such risks materialize.

For WTE projects, a participant noted that securing buyers for the energy produced is critical for project success, just as finding buyers for recyclable materials is crucial for MWP facilities. Both energy and material sales play a significant role in the overall financial model of these projects. Revenue-sharing and energy-sharing models, often with an 80/20 split, are commonly used to align the interests of public and private entities, ensuring that both parties benefit from the project's success.

Finally, risk allocation must be carefully managed, with risks assigned to the parties best equipped to handle them. For example, risks related to building insurance, capital financing, and operational performance should be distributed based on expertise and control, ensuring that both public and private sector partners have clear roles in mitigating project risks.

6. Key Considerations

This section of the report outlines the key considerations the City must address in selecting an appropriate delivery and funding model for a WTE or MWP facility. As the initiative is in its early stages, this section identifies key decision points that should be explored further as part of the feasibility study developed for the project.

6.1 Recommended Approach

At this stage, it is premature to recommend a definitive funding and delivery model for the development of a WTE or MWP facility. The initiative is still in its early stages, and critical steps need to be taken before any decisions can be made by the City. It is expected that the technical memos being developed by HDR and KPMG will support the City in identifying key considerations that need to be addressed prior to staff taking a recommendation to City Council. This involves gathering the necessary qualitative (e.g., technological capabilities) and quantitative (e.g., cost estimates, financial structures) data required to support the decision-making process and presenting them in a coherent manner as part of the feasibility study for the project. Once some of these key criteria are determined, it may be beneficial for the City to re-engage with the market through a second market sounding exercise where it can communicate details of the project and obtain feedback on commercial structuring and risk allocation based on the preferred delivery and operating model.

From a funding perspective, the City's Long-Range Financial Plan (2025-2053) projects that the reserve fund will remain in a deficit position until 2034. This, coupled with the City's limitations on debt financing require a careful and measured approach when assessing the City's ability to pay for this project. This preparation ensures the City can approach the private sector with a robust offering that aligns with the City's financial position, while reducing the likelihood of unanticipated challenges hindering the City's ability to achieve its objectives for the project.

To that end, the following key considerations should guide the City's approach as it prepares a formal business case for the project:

1. **Collaborative Approach**: A collaborative process that integrates input from both public and private sectors can help to ensure that the selected model is mutually beneficial. This overarching principle should guide all engagements with the private sector, fostering transparency and building trust from the start.
2. **Funding and Financing**: The City must consider a variety of funding sources and financing structures, understanding that long-term financial commitments will need to align with the City's projected financial position and capacity. Exploring the applicable delivery models described in section 5.1 allow for risk sharing and increased flexibility in project funding.
3. **Risk Allocation**: Defining clear lines of responsibility for risk is critical. The City should seek to allocate risks to the parties best equipped to manage them. For instance, operational and maintenance risks could be transferred to the private sector, while long-term risks, such as regulatory changes or waste supply variability, may need to be shared or retained by the City. Effective risk allocation will be pivotal in ensuring the project's long-term viability.
4. **Project Readiness**: It is essential that the City presents a well-prepared proposal to the private sector. This includes not only financial and technical plans but also a clear vision of the project's long-term objectives, the City's role, and the potential benefits to private partners. Engaging internally to align these elements will ensure that the City is in a strong negotiating position.

In conclusion, before any firm recommendations on funding or delivery models can be made, the City must first establish a solid internal foundation and strategically assess these key considerations and their impact on the viability of the project. This focused approach will enable the City to make informed decisions, ensuring that both the City's financial and public interests are aligned and that the project is positioned for success.

Appendix A – Market Sounding Package

Purpose of Market Sounding

This market sounding is designed to evaluate the market's interest and capacity to implement MWP and WTE projects under various delivery models, such as:

- Design-Bid-Build (DBB),
- Design-Build (DB),
- Engineering, Procurement, and Construction (EPC),
- Design-Build-Operate (DBO),
- Design-Build-Finance (DBF), and
- Design-Build-Finance-Operate-Maintain (DBFOM).

Both MWP and WTE technologies have distinct advantages and disadvantages, but they are more expensive than traditional landfilling methods.

The City has engaged a consulting team, led by HDR and KPMG, to prepare the draft business case to assist in the City's decision-making process. This market sounding initiative is a crucial part of the business case and aims to:

- Gauge the level of private sector interest in delivering a WTE and MWP project for the City;
- Identify and discuss potential transaction structures and procurement models that can support the City in achieving its objectives;
- Gain a deeper understanding of the market's expertise and experience in delivering these types of projects and technologies;
- Identify key lessons learned from precedent projects and procurement processes;
- Identify key considerations from an owner's perspective relating to the procurement, construction, operations, financing and funding of these types of facilities; and,
- Identify key risks or considerations that could impact the City's ability to deliver the Project or the private sector's willingness to participate.

The findings from this market sounding will be used as inputs in the development of the business case and the triple bottom line analysis that will be undertaken.

Market Sounding Questions

Questions for Owners

Company Information and Experience

1) Can you describe your organization’s capacity and experience in designing, developing, financing, and operating WTE and/or MWP facilities?

2) Can you share specific examples of your experience with WTE and MWP technologies, highlighting:

   a) Project details (location, waste processing capacity, revenue generated, timeline)

   b) Technologies used

   c) Delivery models used (e.g., DBB, DB, EPC, DBO, DBF, DBFOM)

   d) Lessons learned and leading practices

3) What type of operating model(s) have been utilized by your organization for MWP or WTE facility(ies)? If privately operated, what is the role of your organization versus the private sector?

Project Scope and Delivery Models

1) How did you determine the most suitable delivery model for your MWP or WTE project?

2) Which delivery models do you consider most suitable for this type of project (e.g., DBB, DB, EPC, DBO, DBF, DBFOM)?

   a) Based on your experience, what lessons have you learned from previous projects that utilized similar delivery models?

   b) What are the advantages and disadvantages of different delivery models from your perspective?

3) Could you suggest any other delivery models that the City should consider for this project?

   a) What advantages does this model offer?

4) What are your views on the best division of responsibilities between the public sector and the private sector for delivering and operating a WTE or MWP project?

   a) Which responsibilities should be kept within the public sector, and which should be transferred to the private sector to ensure the best project outcomes?

   b) Based on your experience, do you think operations and/or maintenance should be transferred to the private sector for a WTE or MWP? Why or why not?

Financing and Funding

1) What role should the City and private sector play in financing and funding the project?

2) Are there any innovative financing or funding mechanisms (e.g., green bonds, impact investments, ratepayers, development charges, Canada Infrastructure Bank) that the City should consider for this project?

3) What are your perspectives on revenue-sharing arrangements for a MWP or WTE facility?

    a) What revenue-sharing models have you encountered in similar projects, and which do you believe would be most effective for this project?

    b) How would you propose structuring a revenue-sharing agreement to balance risk and reward between the public and private sectors?

    c) What type of revenue streams (e.g., tipping fees, energy sales, by-product sales) do you consider most suitable for sharing, and how should they be allocated?

Project Risks

1) In your opinion, what are the biggest challenges and risks you foresee in developing a MWP and/or WTE facility?

    a) Which risks are best managed by the private sector?

    b) Which risks are best managed by the public sector?

2) What are some other common pitfalls or challenges you've encountered on similar projects, and how were they addressed?

Concluding Questions

1) Is there any other feedback or information you believe would be valuable for the City of Ottawa to consider for the delivery and operations of a WTE or MWP project?

Questions for Private Sector

Company Information and Experience

1) Can you describe your organization's capacity and experience in designing, developing, financing, and operating WTE and/or MWP facilities?

2) Can you share specific examples of your experience with WTE and MWP technologies, highlighting:

    a) Project details (location, waste processing capacity, revenue generated, timeline)

    b) Technologies used

    c) Delivery models used (e.g., DBB, DB, EPC, DBO, DBF, DBFOM)

    d) Lessons learned and leading practices

Interest and Capacity

1) What would be your level of interest in participating in a MWP or WTE facility project with the City of Ottawa?

    a) What role would you be looking to perform for the project – i.e., design, construction, operations, maintenance and/or financing?

    b) What are the key factors that would influence your decision to participate in such a project?

Delivery Models

1) Which delivery models do you consider most suitable for this type of project (e.g., DBB, DB, EPC, DBO, DBF, DBFOM)?

2) Could you suggest any other delivery models that the City could consider for this project?

    a) What advantages does this model offer?

    b) Have you observed the successful execution of a WTE or MWP project utilizing this model?

3) How do you envision the division of responsibilities between the public and private sectors for a WTE or MWP project?

    a) Which responsibilities should be retained by the owner, and which should be transferred to the private sector to ensure the best project outcomes?

    b) Based on your experience, do you think operations and/or maintenance should be transferred to the private sector for a WTE or MWP? Why or why not?

Financing and Funding

1) What experience do you have with the financing of MWP or WTE projects?

2) What financing models would be most attractive or feasible for a project of this scale and type?
3) What role should the City play in financing and funding the project?
4) Are there any innovative financing or funding mechanisms (e.g., green bonds, impact investments, ratepayers, development charges, Canada Infrastructure Bank) that the City should consider for this project?
5) What are your perspectives on revenue-sharing arrangements for a MWP or WTE facility?

   a) What revenue-sharing models have you encountered in similar projects, and which do you believe would be most effective for this project?

   b) How would you propose structuring a revenue-sharing agreement to balance risk and reward between the public and private sectors?

   c) What type of revenue streams (e.g., tipping fees, energy sales, by-product sales) do you consider most suitable for sharing, and how should they be allocated?

Project Risks

1) What are the key risks (e.g., construction, operational, financial, regulatory) associated with a MWP and WTE facility, and how would you propose to mitigate them?
   a) Which risks are best managed by the private sector?
   b) Which risks are best managed by the public sector?
2) How do you typically manage long-term risks such as changes in waste supply, energy prices, or regulatory requirements?
3) What would be your expectations regarding the City’s role in mitigating risks, such as providing waste supply guarantees or long-term off-take agreements for energy?
4) What are some other common pitfalls or challenges you've encountered on similar projects, and how were they addressed?
5) Concluding Questions
6) Is there any other feedback or information you believe would be valuable for the City of Ottawa to consider for the delivery and operations of a WTE or MWP project?

Appendix G

Technical Memorandum No. 4

City of Ottawa

Feasibility Study For Waste to Energy and Mixed Waste Processing

Technical Memorandum No. 4
Evaluation Criteria, Scoring Matrix and Weightings

June 2, 2025

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Acronyms

CRN	Canadian Registration Number
CWA	Clean Water Act
CEA	Comprehensive Environmental Assessment
ESA	Endangered Species Act
EFW	Energy from Waste
EA	Environmental Assessment
EAA	Environmental Assessment Act
EAPD	Environmental Assessment and Permissions Division
ECA	Environmental Compliance Approvals
EPA	Environmental Protection Act
ESP	Environmental Screening Process
IEA	Individual Environmental Assessment
IPZ	Intake Protection Zone
LRIA	Lakes and Rivers Improvement Act
LAHJ	Local Authority Having Jurisdiction
MMAH	Ministry of Municipal Affairs and Housing
MNR	Ministry of Natural Resources
MECP	Ministry of the Environment, Conservation and Parks
MWP	Mixed Waste Processing
OWRA	Ontario Water Resources Act
POR	Points of Reception
PM	Project Manager
REA	Renewable Energy Approvals
RU	Rural Countryside Zone
RH	Rural Heavy Industrial Zone
SWMP	Solid Waste Management Plan
TSSA	Technical Standards and Safety Authority
Trail	Trail Waste Facility
WTE	Waste-to-Energy
WHPA	Wellhead Protection Area

1 INTRODUCTION

The City of Ottawa, the Nation's capital and sixth largest city in Canada, is in the process of implementing a 30-year Solid Waste Master Plan (SWMP) with the aim of decreasing the amount of waste managed by the City, diverting as much waste as possible from landfill, and looking for opportunities to maximize recovery of resources and energy in an environmentally sustainable manner. Furthermore, the City's current primary disposal option, the Trail Waste Facility (Trail) is nearing capacity in the next 10 to 15 years and waste management options to potentially extend the life of the Trail need to be determined.

The City recognizes that there is no single solution to addressing future waste management challenges and has developed the SWMP to address these issues through a multi-pronged approach. The recommendations outlined in the SWMP span the collection and management of waste from curbside-residential and multi-residential homes, parks and other public spaces, City facilities and operations, and existing partner programs. The key factors that were considered in developing the recommendations in the SWMP were:

1. the role of all three levels of government in Canada (i.e., federal, provincial, and municipal);
2. the impacts of climate change;
3. leveraging innovation and technology alternatives to traditional methods of waste processing and disposal; and,
4. consideration of the waste management hierarchy with the aspirational goal of moving the City closer to its Zero Waste vision for the future.

Based on these considerations and key factors, the City identified 50 recommended SWMP Actions that are laid out by short-term (0-5 years), medium-term (5-10 years), and long-term (>10 years) time frames. Five objectives were developed to present and measure how the recommended SWMP Actions would directly impact achieving the City's Zero Waste vision. The five SWMP objectives are:

1. **Maximize the Reduction and Reuse of Waste.** Actions under this objective are prioritized to begin in the short-term time frame to immediately decrease the waste generated and minimize the amount of waste that needs to be managed at a disposal facility.
2. **Maximize the Recycling of Waste.** Actions under this objective will have the biggest impact on diversion from landfill and potential reduction of greenhouse gases (GHGs) and will be prioritized in the short-term time frame.
3. **Maximize the Recovery of Waste and Energy and the Optimal Management of Remaining Residuals.** Actions under this objective will be assessed in the short-term and if deemed feasible, implemented over the medium and long-term time frames to address the immediate and future need to extend available landfill capacity and to extract maximum resources and energy from the remaining residual waste stream.

4. **Maximize Operational Advancements.** Actions within this objective support operational advancements through innovation and new technology to make operations more efficient and to reduce impacts on the environment.

5. **Develop a Zero Waste Culture Across the City.** Actions under this objective will educate residents on how they can contribute to the City's goal of a Zero Waste future, and influence industry and the wider community to reduce, reuse, and divert waste.

The Waste Recovery and/or Treatment Facility Study Action Suite within the SWMP recommends the City advance a Feasibility Study and Business Case during the short-term to identify a technology(ies) that can reduce the amount of waste sent to landfill and potentially recover additional resources and energy. The City retained HDR Corporation (HDR) to conduct the Feasibility Study and draft Business Case to compare the Waste-to-Energy (WTE) and Mixed Waste Processing (MWP) options to landfilling. The Study and Business Case will provide recommendations that will be presented to City Council for the processing of the City's residential residual waste for the next 30 years and beyond. The two alternative technologies being considered as part of this action are WTE (specifically mass burn incineration with energy recovery) and MWP, or a combination of these two technologies. In addition to the WTE and MWP technology options, the Feasibility Study will consider existing and new landfill options for the future disposal of residual waste streams.

From the SWMP the City is committed to managing residents' residual waste over the next 30 years and a guiding principle from the SWMP is "k*eeping waste local by treating residential waste within the City's boundaries, wherever operationally and economically feasible".* These two points will be considered throughout the Study and Business Case.

The five scenarios being considered in this Study are defined as the following:

- **Option 1: Status Quo and Private Facilities.** Under this option, the City would continue to dispose of non-diverted waste for final disposal at Trail until it reaches capacity (estimated to be in 2035) and then negotiate waste supply agreements for disposal with one or several regional third-party waste management facilities.
- **Option 2: WTE Facility.** Under this option, the City would build a new WTE facility that can process all of their non-diverted waste with disposal of rejects and ash residue at a third-party waste management facility.
- **Option 3: MWP Facility.** Under this option, the City builds a MWP Facility that can process all of the City's non-diverted waste, recover additional recyclables and dispose of the remaining process residuals at a private third-party waste management facility.
- **Option 4. WTE and MWP Facilities.** Under this option, the City builds a MWP Facility to recover additional recyclables and builds a WTE facility to process and recover energy from the remaining residual waste. Reject and ash residue from WTE will be disposed of at a private third-party waste management facility.
- **Option 5. Construct a New Landfill.** Under this option, the City builds a new greenfield landfill within the region to take all non-recyclable residuals after Trail reaches capacity.

It is noted that the implementation of a new landfill was thoroughly assessed during the development of the SWMP. Although initially considered for deferral to future SWMP iterations, this option is being included for comparison purposes.

As a component of the Feasibility Study and the purpose of Technical Memorandum No. 4, HDR has developed a matrix which includes the evaluation criteria, scoring, and weighting system that the City can utilize to assess the five (5) scenarios outlined above.

2 UNDERSTANDING OF OBJECTIVES

2.1 Project Understanding

A critical aspect of the Feasibility Study is the development of an evaluation criteria, weighting, and scoring system that can be applied to the five (5) scenarios. To accomplish this task, HDR utilized our experience with similar studies, the information obtained during the development of Technical Memorandums 1, 2, and 3, and our collaboration with City staff with the initial development of this evaluation approach. This information and any concerns identified by the City during the preliminary consultation were incorporated into the development of the evaluation criteria and a scoring matrix to rank the five waste management scenarios being evaluated. The criteria considered the triple bottom line analysis to identify the potential environmental, social, and financial contributions or impacts of each option versus performing an assessment based on just a traditional technical or financial analysis.

The evaluation criteria and scoring matrix will be applied in the overall analysis being performed in the Feasibility Study to assist the City with identifying and ranking the preferred technology scenario/options.

2.2 Factor Consideration

HDR developed primary evaluation criterion that were divided into four primary factors that will be critical in the selection of the preferred long-term waste management scenario(s). The four primary factors were selected with consideration to the goals identified in the City's 30-year SWMP, as well as the objectives of this Feasibility Study. Each of the primary criterion was developed with consideration of specific subset factors that we believe will be valuable for the City's assessment of the five scenarios. These factors are summarized in **Table 2-1** and described in further detail in **Section 2.3**.

Long-term solid waste management projects can invoke strong opinions in favour of or against the proposed action and options being considered. Incorporating these factors into the evaluation criteria, scoring, and weighting provides valuable insight into the priorities identified by the City. This approach also draws on HDR's experience in addressing stakeholder and public concerns when determining the preferred option. The intent of the evaluation methodology is to support the City's final decision through the development of a transparent and more defensible process when all factors are considered.

Table 2-1: Evaluation Criteria Subsets

Environmental	Social	Financial	Technical
Energy Recovery Potential	Potential Visual Impacts	Capital Costs	Technical Complexity
Landfill Diversion Percentage	Other Nuisance Impacts	Operation and Maintenance Costs	Timing/Schedule Requirements
Opportunity to Recover Marketable Commodities	System Transportation Impacts	Revenue Generating Potential	Feedstock Flexibility
Emissions - Discharges to Air, Land, and Water	Potential for Property Value Impacts	Overall Financial Feasibility	Scalability
Potential for GHG Impacts	Opportunity for Community Support		Process Reliability (Risk Potential)
			Siting Requirements
			Approvals/Permitting /Regulatory Requirements for Implementation
			Number and Complexity of Required Contracts

2.3 Evaluation Criteria Definitions

The evaluation criteria subsets presented in Table 2-1 will be used to perform a detailed comparison of one scenario versus another and are divided into the following sub-criteria: Environmental; Social; Economic/Financial; and Technical.

2.3.1 Environmental Requirements

The intent of this component is to assess the nature of the potential impacts to the environment (e.g., air, water, land) that technology may pose. Protection of the environment and public health will be a key factor in evaluating whether the technology(ies) can be implemented in the City.

The environmental requirements criteria shall at a minimum address the following specific factors:

- **Energy Recovery Potential:** The amount of potential energy (in GWh) that can be harnessed from the scenario over the 30-year planning period, as well as the ability to generate different types of energy (e.g., district heating or RNG).

- **Landfill Diversion Percentage:** The percentage of the incoming waste stream that is diverted from landfill disposal by either recovery of marketable materials or through thermal conversion.
- **Opportunity to Recover Marketable Commodities:** The ability of a specific scenario to recover materials with a known/defined market, plus the type and quantity of those materials recovered over the 30-year life cycle**.**
- **Emissions – Discharges to Air, Land, and Water:** Potential to emit pollutant emissions/discharges to the air, land, or water, including those from odours.
- **Potential for GHG Impacts –** The type and quantity of greenhouse gas (GHG) emissions generated from the scenario over its life cycle.

2.3.2 Social Requirements

The intent of this component is to address potential impacts to the social environment, where the implementation of specific technology could impact the way people live and interact in the area around the facility.

The social requirements criteria shall at a minimum address the following specific factors:

- **Potential Visual Impacts:** Potential for scenario to create visual to neighbouring properties due to the size and associated equipment/operations of the scenario(s).
- **Other Nuisances:** Potential for scenario to create other nuisance impacts (e.g., noise, litter/debris, vectors) to neighbouring properties due to the size and associated equipment/operations of the scenario(s).
- **System Transportation Impacts:** Potential impacts to local traffic volumes along potential haul routes, including transportation impacts in areas near city owned facilities and third-party disposal facilities that may receive waste as a result of the scenario, if required.
- **Potential for Property Value Impacts:** Potential for scenario to negatively impact adjacent property values due to the activities associated with an active waste management site.
- **Opportunity for Community Support:** Potential for the local community to support the project, as well as for the scenario to provide additional educational and social benefits for the community.

2.3.3 Economic/Financial Requirements

The financial requirements will assess the capital and operating costs of the technology or waste processing system.

The financial requirements criteria shall at a minimum address the following specific factors:

- **Capital Costs:** Capital Costs, including debt servicing costs amortized over the life of the asset.

- **Operating and Maintenance Costs:** Operating costs, including but not limited to potential long-term major maintenance costs, (this will depend in part on the ownership structure) and tipping fees for waste going to landfills
- **Revenue Generation Potential:** The potential revenues generated by the scenario through existing markets for recovered materials and energy produced by the technology.
- **Overall Financial Feasibility:** The potential for the scenario to generate positive cashflow and meet the City's other long-term financial objectives.

2.3.4 Technical Requirements

The technical component of the evaluation criteria is meant to address the readiness of the technology. The operational history of all process steps, from waste receipt through energy conversion, to management and recovery of material streams and handling of residuals, will also be considered.

The technical requirements criteria shall at a minimum address the following specific factors:

- **Technical Complexity:** The number and type of complex systems that make up the technology, and the skillsets required to operate and maintain the technology efficiently and reliably.
- **Timing/Schedule Requirements:** The amount of time and effort to procure, site, permit, design, and construct a facility ready for operation.
- **Feedstock Flexibility:** The ability of a scenario to receive and efficiently process a variety of wastes of differing quantity, compositions, and quality (i.e., energy content) that may be found in the City's waste stream.
- **Scalability:** Ability of the scenario to adjust to increases in waste throughput and expanded should additional capacity be required.
- **Process Reliability (Risk Potential):** Risks associated with overall system reliability and resiliency, including the amount of time the scenario is available to accept and process waste versus downtime for scheduled and unscheduled maintenance.
- **Siting Requirements:** The overall area of the site required, plus the required infrastructure and utilities required, and proximity to major roads and highways required to accommodate the scenario.
- **Approvals/Permitting/Regulatory Requirements for Implementation:** The number and complexity of regulatory approvals and permits that will be required to implement the scenario, as well as operate the facility.
- **Number and Complexity of Required Contracts:** The amount of complex contractual arrangements required to implement and operate the scenario, including the timing of negotiations and administrative requirements.

3 COMPARATIVE EVALUATION METHODOLOGY AND CRITERIA

There are different methods (qualitative or quantitative or a combination of both) that can be used to evaluate the potential technologies and systems. In undertaking this type of evaluation, there is no requirement to apply any specific methodology. The proposed methodology and approach utilized in the following evaluation is commonly applied and is consistent with the more exhaustive and stringent systems analysis requirements undertaken to address the approval requirements of the Ontario Environmental Assessment Act (as provided in the Comprehensive Environmental Assessment process or the Environmental Screening Process (ESP)).

3.1 Comparative Evaluation Methodology

The proposed evaluation methodology includes a primarily qualitative approach, comparing each system based on its relative strengths and weaknesses. For each criterion (e.g., $/t, $MTCO_2e$, etc.) systems are graded to determine whether they are most preferred, preferred, neutral, less preferred or least preferred. Furthermore, each of the grades are weighted to calculate a score for each criterion to support the ranking of each of the five options being considered. For a neutral grade to be issued, there is no preference or dispreference considered for the option but the overall evaluation for the assessment is “equal” with respect to the criterion. Therefore, when “rolling up” the grades they are excluded from the overall evaluation scoring. There could be a scenario in this evaluation where a criteria subset for one or more options receives the same grade. In this scenario, the options would both receive the same grade and weighting for that subset of criteria.

Table 3-1 provides guidance on how particular grades and weightings will be assigned in the evaluation and what would constitute a preferred option or not.

Table 3-1: Comparative Evaluation Methodology Scoring/Weighting Guidance

Grade (Weighting)	Description	Example
Most Preferred (+2)	The Technology/System would have minimal impact based on the criteria/indicator being applied and could potentially result in a net benefit as a result of the facility's development.	A facility that could be developed and offer low-cost thermal energy (i.e., steam and/or hot water) that would attract new industry to the area would be considered most preferred over a system that does not provide the same economic benefit.
Preferred (+1)	Development of the Technology/ Scenario would have a manageable impact based on the criteria/ indicator being applied and, in some cases, a net benefit could potentially result from facility development.	In comparison to the above example, a Technology/Scenario that produces thermal energy, but in much smaller quantities, would still be considered preferred; however, when compared to another system with a greater thermal or electrical output to market, it would not be considered most preferred.

Grade (Weighting)	Description	Example
Neutral (0)	The Technology/System development would have no potential impacts (positive or negative) based on the criteria/indicator being applied.	A situation where all facilities would require obtaining the same permits and the same permitting risk would be considered neutral in that there is no substantial difference between any of the Technology/System options.
Less Preferred (-1)	Development of the Technology/System would have some negative impacts based on the criteria/indicator being applied and would likely require some mitigation measures to reduce the potential impact.	In comparison to the below example, a Technology/ System that produces a wastewater discharge, but in much smaller quantities, would still be considered less preferred (when compared to a zero wastewater discharge facility); however, when compared to another system with a relatively greater wastewater discharge, it would not be considered least preferred.
Least Preferred (-2)	Development of the Technology/System would have a significant negative impact based on the criteria/indicator being applied and would require extensive mitigation measures to reduce the potential impact.	A Technology/System with a relatively large wastewater discharge would be considered least preferred over a system with a minimal or no wastewater discharge.

Because the process of applying the evaluation criteria and identifying potential effects inherently incorporates 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 measures.

Ultimately, the preferred system is the one with the appropriate balance of strengths (preferences) and acceptable weaknesses (dispreferences) relative to the established criteria.

3.2 SROI Analysis

3.2.1 Overview

This section describes HDR's proprietary Sustainable Return on Investment (SROI) decision-making tool and how, utilizing the available data for each scenario compiled in Technical Memo No. 1, this tool will generate quantitative outputs to assist with the evaluation of certain criteria and selection of the preferred option(s). These quantitative results from the SROI model will be applied to the applicable criteria subsets identified in Table 2-1 to support the comparative evaluation.

The SROI analysis process generally follows the following steps:

- Identification of key impacts for assessment (e.g., benefits and costs);

- Stakeholder review of methodology and key assumptions;
- Quantification of select environmental, community, and economic impacts for each waste solution scenario; and,
- Production of detailed economic cost and benefit analysis results, including:
  - Economic (e.g., net costs of energy production and consumption).
  - Environmental (e.g., greenhouse gas emissions).
  - Social (e.g., transportation impacts).

For this assessment, it is anticipated that the baseline will be defined as the Status Quo and Private Facilities option where the City continues to dispose of non-diverted waste for final disposal at Trail until it reaches capacity, which is then followed by disposal at regional third-party facilities.

A more detailed explanation of the assumptions used to perform the analysis and the outputs generated by the model is provided in Appendix A. While the SROI can produce its own ranking of the alternatives from all quantifiable benefits and costs, the results from the SROI will only provide support for the qualitative scoring in the criteria evaluation for metrics that can be quantified in the SROI.

Table 3-2 provides a summary of the quantitative outputs from the SROI model that will be applied to some of the sub-criteria identified in Section 2 to support the grading and scoring for the Comparative Evaluation.

Table 3-2: SROI Analysis Outputs Used in the Evaluation

Criteria/Sub-Criteria	SROI Output
ENVIRONMENTAL REQUIREMENTS	
Energy Recovery Potential	GWh of Energy Produced – Annual GWh of Energy Produced – Lifecycle
Landfill Diversion Percentage	Tonnes of Material Avoided Being Landfilled - Annual Tonnes of Material Avoided Being Landfilled - Lifecycle (Millions)
Opportunity to Recover Marketable Commodities	Tonnes of Materials Recovered - Annual Tonnes of Materials Recovered - Lifecycle (Millions)
Potential for GHG Impacts	Tonnes of GHG Emitted – Annual Tonnes of GHG Emitted - Lifecycle (Millions) *Includes Corporate Anthropogenic Emissions, Community Anthropogenic Emissions, and Biogenic Emissions*
SOCIAL REQUIREMENTS	
System Transportation Impacts	Total Truck Kilometers Travelled - Annual Total Truck Kilometers Travelled - Lifecycle (Millions)
FINANCIAL REQUIREMENTS	
Capital Costs	Total Capital Costs - Lifecycle (Millions 2024$) *Presented as Real Values (Undiscounted 2024$)*
Operation and Maintenance Costs	Total Facility O&M Costs (2024$) - Annual Total Facility O&M Costs - Lifecycle (Millions 2024$) *Presented as Real Values (Undiscounted 2024$)*
Revenue Generation Potential	Total Revenues from Energy and Material Recovery (2024$) - Annual Total Revenues from Energy and Material Recovery - Lifecycle (Millions 2024$) *Presented as Real Values (Undiscounted 2024$)*
Overall Financial Feasibility	Total Cash Outflow (2024$) – Annual Total Cash Outflow - Lifecycle (Millions 2024$) *Presented as Present Values (Discounted), and as Real Values (Undiscounted 2024$)*

3.3 Evaluation Summary Table

Table 3-3 provides an example of how the evaluation criteria will be presented in the Feasibility Study and identifies what criteria will be graded using either quantitative or qualitative information, or a combination of the two.

Table 3-3: Evaluation Summary Table

Criteria	Type of Criteria	Status Quo and Private Facilities	WTE	MWP	MWP and WTE	New Landfill
ENVIRONMENTAL REQUIREMENTS						
Energy Recovery Potential *GWh of Energy Produced over Facility Lifecycle*	**QUANTITATIVE (SROI)**					
Landfill Diversion Percentage	**QUANTITATIVE (SROI)**					
Opportunity to Recover Marketable Commodities *Potential tonnes of Marketable Material Recovered over Lifecycle (Millions)*	**QUANTITATIVE (SROI)**					
Emission - Discharges to Air, Land and Water	**QUALITATIVE**					
Potential for GHG Impacts *Tonnes of GHG Emitted (Millions)*	**QUANTITATIVE (SROI)**					
SOCIAL REQUIREMENTS						
Potential Visual Impacts	**QUALITATIVE**					
Other Nuisance Impacts	**QUALITATIVE**					
System Transportation Impacts *Total Vehicle-Kilometres Travelled (Millions)*	**QUANTITATIVE (SROI)**					
Potential for Property Value Impacts	**QUALITATIVE**					
Opportunity for Community Support	**QUALITATIVE**					
FINANCIAL REQUIREMENTS						
Capital Costs *(Millions 2024)*	**QUANTITATIVE (SROI)**					
Operation and Maintenance Costs *(Millions 2024)*	**QUANTITATIVE (SROI)**					
Revenue Generation Potential *Total Revenue from Energy & Material Recovery (Millions 2024)*	**QUANTITATIVE (SROI)**					
Overall Financial Feasibility *Total Cash Outflow (Millions 2024)*	**QUANTITATIVE (SROI)**					
TECHNICAL REQUIREMENTS						
Technical Complexity	**QUALITATIVE**					
Timing/Schedule Requirements	**QUALITATIVE**					
Feedstock Flexibility	**QUALITATIVE**					

Criteria	Type of Criteria	Status Quo and Private Facilities	WTE	MWP	MWP and WTE	New Landfill
Scalability	**QUALITATIVE**					
Process Reliability (Risk Potential)	**QUALITATIVE**					
Siting Requirements	**QUALITATIVE**					
Approvals/Permitting/Regulatory Requirements for Implementation	**QUALITATIVE**					
Number and Complexity of Contracts	**QUALITATIVE**					

4 NEXT STEPS

The next steps in the Feasibility Study will be to summarize the information and data compiled during the preparation of Technical Memo No.1 – Technology and Background Summary, Technical Memo No. 2 – Siting and Approvals, Technical Memo No. 3 – Project Delivery Models and Funding Opportunities, and apply that information to the evaluation methodology developed in Technical Memo No. 4. The quantitative data (e.g., costs, GHG emissions, etc.) and the assumptions outlined in this technical memo will be input into the SROI analysis to support the grades and scoring assigned for each of the criteria. In addition to the output from the SROI analysis, some of grades and scoring for the criterion identified in Section 3 will be developed from data obtained by HDR for similar studies, as well as from our research and professional engineering judgement.

Once the results and information for each criterion are compiled for each of the five scenarios, grades will be assigned (e.g., Most Preferred, Preferred, Neutral, etc.) and entered in the Evaluation Table. The final step will be to “roll up” the grades and assign the weighting to those grades to formulate the rankings for the scenarios being considered in this Study.

Table 4-1 provides an example of how the final grading and scoring table would be presented in the Feasibility Study to determine the rankings for the five scenarios. The number of grades determined for the criteria subsets are totaled up for each scenario and the weighted points are calculated based on those grades. The final rank for each scenario is then determined by “rolling up” the weighted points total. In this example, there were 12 criteria subsets being evaluated. Alternative Option 1 in this case, received six (6) “Most Preferred” grades, which are worth two (2) points each for a total of 12 weighted points. Alternative Option 1 also received four (4) “Neutral” grades worth no points and two (2) “Less Preferred” grades, which subtracts two points from the total score (i.e., 2 “Less Preferred” grades times -1 points/each will equal -2 points total). The ranks given to each scenario in this example are determined by the final calculated “Weighted Point Total”.

Table 4-1: Example of Comparative Evaluation Summary and Scenario Ranking

RANKINGS (POINTS)	Status Quo and Private Facilities	Alternative Option 1	Alternative Option 2	Alternative Option 3	Alternative Option 4
Most Preferred (+2)	1	6	2	-	1
Preferred (+1)	2	-	3	3	2
Neutral (0)	6	4	5	6	6
Less Preferred (-1)	3	2	1	1	2
Least Preferred (-2)	-	-	1	2	1
Weighted Point Total	**1**	**10**	**4**	**-2**	**0**
Rank Order	**3**	**1**	**2**	**5**	**4**

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Appendix A

SROI Detailed Description

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SUSTAINABLE RETURN ON INVESTMENT DETAILED DESCRIPTION

A.1 Boundaries of Study

The SROI process will allow the City to have quantifiable impacts to justify scoring of specific criteria for the comparative evaluation framework. For the analysis, each scenario can be compared against the baseline scenario, which is represented as a business-as-usual or Status Quo and Private Facilities scenario. Final SROI values are presented as both total and annualized values, undiscounted (real) and discounted 2024 terms[1]. For discounted values presented in the Net Present Value (NPV), any costs or revenues incurred in the future are discounted to reflect the time value of money.

The SROI analysis assumes that the existing waste management operations will remain unchanged, and most waste materials will continue to be collected and transported to Trail. Therefore, the boundary of the study starts with the transfer of materials collected and delivered to the existing or alternative disposal facilities, which are assumed to be located within the City of Ottawa's boundaries.

The boundary of the study extends as far as to capture the impacts of shipping recovered materials within eastern Ontario. All residual materials that either cannot be converted to energy or shipped off-site as a commodity are assumed to be transported to an approved facility for final disposal.

A.2 Assumptions

HDR used the following assumptions in conjunction with developing the evaluation criteria to identify feasibility alternative processing options for the City's waste. A more comprehensive list of critical assumptions and source references for the SROI model will be developed as the analysis progresses and will be provided in the final Feasibility Study.

- For each option, HDR will evaluate the facilities being sized to receive 100% of the City's waste.
- The assumptions anticipate that the alternative options will be fully operational by 2035, and that the study period extends to capture 30 years of operations at the new facilities (i.e. 2035-2064). It is noted that the period outlined in the 30-year SWMP ends in 2053. However, for the purpose of the model and this Study, the typical minimum lifespan of the alternative options of 30-years is used and measured from the assumed operation start for these alternatives, which is 2035.
- Bulky scrap metal, blue box materials and organic waste will be collected and handled separately and is not included in the parameters of this study.
- Hazardous materials, such as asbestos, will be collected and handled separately.

[1] Discounted (present) value refers to the value of a cost/revenue stream that is weighted by a discount factor to account for the time value of money, which typically represent an opportunity cost. Undiscounted value refers to the total value of cost/revenue over time without factoring in the time value of money. Real value refers to the cost/revenue stream that are in constant terms, excluding the growth in prices from inflation.

- Waste volumes are expected to grow according to the waste projections provided to HDR at the project onset. As such, the alternative facilities will be sized for the ultimate capacity requirements, which are based on anticipated waste generation rates in 2053.
- The City's current waste composition is expected to remain consistent with the projections outlined in the City's Solid Waste Master Plan (SWMP).
- Excess energy generated can be sold back to the grid at the contracted rate of $0.13/kWh.
- Trucks transporting waste for the City are operating on diesel fuel.
- 2.0% annual inflation and 5.0% discount rate are used for the Net Present Value (NPV) calculations.
- The WTE options use the Durham York Energy Center's average emissions rate which includes the biogenic fraction.
- GHG emissions are presented and assessed solely based on their anthropogenic emissions, split between corporate (city-owned) and community (3rd party) emissions. Total biogenic emissions are presented but are not evaluated in the comparative evaluation.[2]
- The landfill gas collection system is assumed to capture up to 90% of landfill gas generated at Trail or 85% of landfill gas generated at other landfills and successfully destroy 99% of methane captured. Landfill emissions are only calculated through the end of the study period.

A.3 SROI Analysis

For each alternative, the diversion of waste is calculated based on the new infrastructure constructed, and the subsequent impacts are evaluated relative to the baseline. For example, constructing a MWP facility will result in some material being diverted for sale in secondary markets and being recycled. In doing so, the transportation impacts include the distances driven from the city centre to the MWP. From the MWP, material not diverted must be transported to a regional private waste facility, while material that is diverted is sent to secondary markets. The SROI calculates the number of truck trips required and the total distance travelled based on assumptions around truck capacity and transportation distances between origins and destinations.

Once the quantitative results have been estimated from the SROI, these can be mapped back to the criteria used in the comparative evaluation. For example, options where waste is hauled further may be more likely to have greater disbenefits to other local motorists, which could result in lower scoring for the System Transportation Impacts criteria. Similar exercises will be performed for other criteria that can be measured within the SROI. For criteria that cannot be measured by the SROI, we will rely on our experience and/or industry research to support the scores given.

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[2] Biogenic emissions include carbon dioxide released from disposed materials with organic carbon. An example of this occurs when organic material decays at a landfill and releases carbon dioxide as a component of landfill gas. Biogenic emissions are not evaluated as it is part of the carbon lifecycle and does not represent an increase in GHG emissions within the environment.

The outputs generated that align with the quantitative criterion are then applied to the comparative evaluation sub-criteria to determine the grade and associated weighting/score as defined in Section 3.1. The grades and scoring will then be “rolled up” in the Evaluation Table to develop final rankings for the five (5) scenarios being considered for this Feasibility Study.

PAC Test Report

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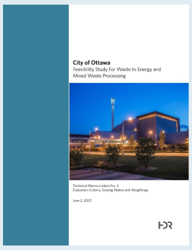

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