Water and Waste
Eaux et déchets

SCHEDULE F - Completion Report

GMF number	GMF 16862
Name of lead applicant (municipality or other partner)	City of Winnipeg
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Date of the report	February 12, 2021

City of Winnipeg Landfill Gas to Energy Beneficial Use Feasibility Study

1. Introduction

The City of Winnipeg awarded a contract to Tetra Tech Inc. in March 2020 to investigate the beneficial use of Brady Road Resource Management Facility (BRRMF) landfill gas (LFG) to alternative energy. The Study assesses the relative feasibility of four beneficial use options for the conversion of LFG captured at BRRMF into a marketable energy source. A Project Team was assembled, which included representatives from Winnipeg's Solid Waste Services Division and Tetra Tech.

Irvin Slike, Project Coordinator for Solid Waste Services Division served as the contract administrator, and Richard Bolton (MNRM), Environmental Planner coordinated funding application to the Federation of Canadian Municipalities. Geoff Reimer, Solid Waste Services' Superintendent of Operations and Becky Raddatz (RPP), Environmental Planner served on the City's project team and assisted with document review and internal communications. This included preparation of administrative reports to Council and briefings to Senior Management within the Water and Waste Department.

For this project, Tetra Tech Inc. assembled a team of leading industry experts from across North America, including solid waste specialists and design professionals who have undertaken similar projects in Canada and the United States. This included Project Manager, Michel Levebvre (M.Sc., P.Eng.), who has undertaken four similar LFG Utilization Studies and Feasibility Studies in the past five years in western Canada and is currently assisting with the development of two Renewable Natural Gas (RGN) facilities in British Columbia. Lauren Quan (P.Eng.), Lead for Manitoba Solid Waste in Management, coordinated the work within the Tetra Tech project team, and technical support was provided by senior advisors Mike Michels (P.E.) and Peter Klassen (MBA, P.Eng.).

The result of this work is the final feasibility study report, which provides recommendations and next steps for the City of Winnipeg to develop a LFG to alternative energy project at the BRRMF.

2. The Feasibility Study

Since the BRRMF landfill gas (LGF) capture system was first commissioned in 2013, Winnipeg has been actively investigating options of utilizing the LFG in a more beneficial manner than the present gas flaring. Previous efforts in this regard include:

- Landfill Gas Beneficial Use Project Feasibility Study, SCS Energy (May 2013)
- Conversion of LFG to Combined Heat & Power, Manitoba Hydro (January 2015)
- University of Manitoba, Winnipeg MB Renewable Energy Sources from Brady Road Landfill, Manitoba Hydro (January 2015)
- Review of Landfill Gas to Energy Pre-Feasibility Studies, SCS Engineers (October 2015)
- Brady Generator Interconnection Study, Manitoba Hydro (July 2019)

These various reports assessed the potential to use LFG for combined electricity and heat generation at the BRRMF, supplying gas to the University of Manitoba (UofM), capturing waste heat from the existing flare system, processing LFG to RNG, and processing LFG to compressed natural gas (CNG).

Subsequent to these previous reports being published, several provincial, national, and federal priorities have influenced energy markets affecting financial feasibility for potential beneficial use options. It was determined that an analysis of current available LFG to energy development options was required to properly inform potential future project development.

In March of 2020, the City awarded a contract for a Landfill Gas Beneficial Use Feasibility Study to Tetra Tech Inc. to investigate the beneficial use of BRRMF LFG to alternative energy (LFG Feasibility Study).

The LFG Feasibility Study builds on previously undertaken analysis of this resource, and assesses the relative feasibility of four beneficial use options for the conversion of LFG captured at BRRMF into a marketable energy source. Each of the four scenarios underwent a cost benefit analysis which included:

- Application and assessment of a consistent list of criteria including:
    - Modeling of the current and future landfill gas production at BRRMF
    - Financial analysis and modeling including estimates of revenue generating potential capital costs, and operating costs associated with each option over a 20-year period
- Cost benefit analysis of the various externalities and non-financial factors influencing the feasibility of each scenario included but was not limited to:
    - Market strength and market access
    - Maturity of technology including to the degree which the technology has been implemented and the presence of the technology in North America
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- Environmental and social considerations including greenhouse gas (GHG) offsets, public consultation requirements, risks, and environmental and social benefit
- Legal and contractual considerations
- Regulatory requirements including rights-of-way, permitting, environmental approvals

This study was largely a "desktop" exercise; therefore, it was determined that no public consultations were required. Regular engagement with key stakeholders occurred throughout the study via interviews and email correspondence. Broader public consultation through the Office of Public Engagement would likely occur in the future if City Council decides to develop one of the feasible options for LFG to energy conversion.

3. Feasibility Study Findings and Recommendations

This project has the potential to contribute greatly to the economic sustainability of Winnipeg's solid waste utility, while also supporting the City's GHG targets outlined in the Winnipeg Climate Action Plan and the Comprehensive Integrated Waste Management Strategy. As such, it was necessary that this project considered environmental, social and economic factors. Some of the benefits of a successful LFG to energy project that were identified include:

Offsetting the cost of constructing, expanding, and operating the LFG collection system.

- LFG beneficial use has the potential to generate revenue. The City's 2016 Business Case for LFG Beneficial Use identified that the revenue from using LFG could offset costs for collection which is required under the BRRMF's Environmental Act License.

Reducing GHG emissions by generating renewable energy.

- The generation of renewable energy (typically either electricity or RNG). The generation and consumption of this renewable energy would assist Winnipeg in reducing its carbon footprint.

Providing economic opportunities to the surrounding facilities.

- LFG beneficial use may provide economic opportunities to the areas surrounding the landfill by providing economic opportunity to local industry associated with stable pricing on low-grade fuel feedstock.

The City identified three major scenarios for consideration as potential methods of LFG beneficial use. Financial analysis and modeling and cost:benefit analysis were completed for each of these scenarios as well as for an alternative role that the City could play in the beneficial use of LFG from the BRRMF. These scenarios are presented in Tables 1 and 2. Further details on each scenario are presented in Section 8 of the feasibility study's final report (page 24).

Cost:Benefit Analysis

A Cost:Benefit analysis was performed on each scenario for the following criteria:

- Economic Analysis including NPV, market strength, and market access;
- Maturity of Technology including the degree to which the technology has been implemented and presence of the technology in North America;
- Environmental and Social Considerations including GHG offsets, public consultation requirements, risks, and environmental and social benefit;
- Legal and Contractual Considerations including non-financial risk based on standard contract arrangements and flexibility for the City to negotiate favorable terms; and
- Regulatory Requirements including rights-of-way, permitting, environmental approvals, and required documentation.

Results are presented in Table 1 below. Further details on the financial and cost:benefit analyses are detailed in page 52 the final report.

Table 1. Cost:Benefit Analysis Results

Scenario	Acceptable Performance					
	Market	Financial Analysis	Maturity of Technology	Environmental and Social Considerations	Legal and Contractual Considerations	Regulatory Authorities and Requirements
Electricity Generation Sold to Manitoba Hydro	Yes	No	Yes	No	No	Yes
Pipeline Quality Gas Sold to the Open Market as RNG	Yes	Yes	Yes	Yes	Yes	Yes
Supply of gas to the UofM	No	No	Yes	Yes	Yes	Yes
Feedstock Supplier to Independent Power Producer	Yes	Yes	Yes	Yes	Yes	Yes

Financial Analysis

Based on the analysis of potential revenue and costs of construction and operation, the Study identified two options with a positive Net Present Value (NPV) worth further analysis (meaning the project has a positive return on investment) and identified two options with a negative NPV not worth pursuing further (meaning the projects have a negative return on investment) over the 20-year lifespan of the project. These are highlighted in Table 2 below.

Table 2. Financial Analysis Results

Option	O&M Cost	Gross Revenue	Net Revenue	Capital Cost	Net Present Value
Electricity Generation Sold to Manitoba Hydro	-$0.959M	$1.126M	$0.167M	-$10.903M	-$7.90M
Pipeline Quality Gas Sold to the Open Market as RNG	$-1.18M	$3.56M	$ 2.38M	- $19.311M	$21.36M
Supply of gas to the University of Manitoba	-$0.87M	$0.609M	$-0.261M	-$8.819M	-$12.50M
Feedstock Supplier to Independent Power Producer	$0.00M	$0.28M	$0.28M	-$0.50M	$4.26M

Based on these results, the study recommends Winnipeg complete a business case and class 3 estimate for the design, construction and development of a system that converts landfill gas to pipeline quality gas to be sold to the open market as Renewable Natural Gas.

The scope of the RFP will encompass an analysis of procurement and development/governance options for the construction and operation of a facility which would be most beneficial to the City - options which would include:

1) A city owned and operated facility (Option 1)
2) A Public Private partnership (Option 1 with alternative funding)
3) The City being a raw resource LFG supplier (Option 2)

4. Next Steps

The next steps for this project are to present the study's recommendations to Council. Following Winnipeg's standard decision-making process, this requires the recommendations to be passed by the Special Policy Committee, Executive Policy Committee, and Council. If Council ultimately decides to accept the recommendations of the report, Winnipeg's Solid Waste Services Division will develop a request for proposal (RFP) for a qualified consultant to complete a business case and class 3 estimate for the design, construction and development of a system that converts landfill gas to pipeline quality gas to

be sold to the open market as Renewable Natural Gas. This RFP will be posted on MERX and awarded to a qualified consulting firm, based on Winnipeg's standard procurement policies.

5. Lessons Learned

A major lesson learned during this study is to keep all stakeholders informed during every stage of the project. Even if public consultation is not included in the scope of the project or required by municipal, provincial or national regulations, regular communication with key stakeholders is an important strategy for avoiding any project delays after the study is completed.

The most significant barrier specific to the feasibility phase of this project was obtaining accurate revenue figures from all of the potential markets of renewable energy (eg. electricity, RNG). Stakeholders that represented different energy markets were in some cases not open to sharing specific numbers (rates, revenues, etc.) due to skepticisms of whether the project was valid, or would actually be carried out. In many ways, this is a common hurdle experienced during the feasibility stage of a project of this nature. We overcame this by using conservative estimates based on the numbers provided, adding continency where necessary, and comparing pricing with other existing projects of a similar nature.

6. Knowledge Sharing

The City of Winnipeg has a webpage which presents information on the BRRMF landfill gas collection system, which is located here: https://www.winnipeg.ca/waterandwaste/garbage/bradyMethane.stm. Future progress on LFG to energy may be added to this website.

This project was carried out with assistance from the Green Municipal Fund, a Fund financed by the Government of Canada and administered by the Federation of Canadian Municipalities. Notwithstanding this support, the views expressed are the personal views of the authors, and the Federation of Canadian Municipalities and the Government of Canada accept no responsibility for them.