Volume II

Appendix J

Technical and Operational Considerations Report
Technical and Operational Considerations
Environmental Assessment to Expand the Biggars Lane Landfill

County of Brant
26 Park Avenue
Burford, ON N0E 1A0

R.J. Burnside & Associates Limited
17345 Leslie Street, Suite 200
Newmarket ON L3Y 0A4 CANADA

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Technical and Operational Considerations
October, 2018

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R.J. Burnside & Associates Limited

Report Prepared By:

Kent Hunter, P.Eng.
Senior Project Engineer
KH:cv

Report Reviewed By:

James R Hollingsworth, P.Eng.
Technical Lead, Solid Waste
JH:cv
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1.0 Introduction

The County of Brant (County) is in the process of undertaking an Environmental Assessment (EA) to obtain additional landfill capacity for the County at the Biggars Lane Landfill. The EA process has been divided into three separate phases. Phase 1 involved the preparation of the Terms of Reference (TOR), which was completed by Stantec Consulting Ltd. in March 2014 and was approved by the Minister of the Environment and Climate Change (MOECC) on May 15, 2016. Phase 2 involved the identification of four alternative methods for that could achieve the necessary landfill capacity for the period from 2020 to 2050 and work plans to assess each of the alternatives. Phase 2 was completed by Golder Associates and is documented in their Report on Phase 2 Activities (May 2016, revised October 2016) herein referred to as the Phase 2 Report. R.J. Burnside & Associates Limited (Burnside) was retained to implement Phase 3 of the EA process on behalf of the County, which consisted of completion of the EA process and obtaining EA Act approval for the landfill expansion.

This Report assesses the four landfill expansion alternatives with respect to Technical and Operational Considerations.

1.1 Site Description

The landfill site is located at 128 Biggars Lane in the County of Brant, east of Mount Pleasant as shown on Figure 1. The site currently comprises a 20.4 ha fill area within the 91.18 ha site (property). The site operates under the Ministry of the Environment and Climate Change (MOECC)’s Amended Environmental Compliance Approval (ECA) Number A100301.

The surrounding land uses are as follows:

- North: Agricultural lands. The agricultural lands are bounded to the north by Burtch Road (County Road 26; a 2-lane “Rural Collector” road).
- South: Hagan Road (a 2-lane “Rural Local” road), Fescue’s Edge Golf Club and woodlots.
- East: Agricultural lands. The agricultural lands are bounded to the east by Cockshutt Road (County Road 4; a 2-lane “Rural Arterial” road).
- West: Agricultural lands and Biggars Lane (a 2-lane “Rural Local” road).

1.2 Study Area

In accordance with the approved TOR, there are three generic study areas that have been established for the purposes of the EA: the Regional, Local and Site Study Areas. These three study areas are shown on Figure 1. The Regional Study Area, highlighted in yellow, encompasses the entire County of Brant. The Local Study Area, highlighted in green, extends approximately 500 m in all directions beyond the landfill site property. The Site Study Area, indicated by the red boundary, comprises the 91.18 ha landfill site property.
Figure 2 shows the existing facility and property boundary within which the future expansion is to be accommodated.

The County proposes to expand the existing landfill to meet their solid waste disposal needs until the year 2050. The total amount of waste to be generated over this 30-year period is 1.13 million cubic metres (Mm³) (estimated in Stantec 2014).

### 1.3 Expansion Alternatives

Four expansion alternatives were developed in the Phase 2 Report to provide the 1.13 Mm³ of airspace. As can be seen in Table 1-1, there are two basic options for the design approach (natural attenuation and leachate collection) and two basic options for the expansion location (west of the existing landfill, or west and east of the existing landfill), providing a total of four basic alternatives. Other metrics, such as overall footprint size, are a function of accommodating the 1.13 Mm³ of airspace necessary to expand the site.

#### Table 1-1: Summary of Landfill Expansion Alternative Characteristics

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Figure Number</th>
<th>Design Approach</th>
<th>Expansion location(s)</th>
<th>Distance to property boundary (m)</th>
<th>Footprint area (ha)</th>
<th>Maximum height above ground (m) with cover</th>
<th>Estimated excavated soil surplus (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Figure 3</td>
<td>Natural Attenuation</td>
<td>West</td>
<td>North-50 South-280 East-100 West-100</td>
<td>15.1</td>
<td>12 - 13</td>
<td>92,000</td>
</tr>
<tr>
<td>2</td>
<td>Figure 4</td>
<td>Leachate Collection</td>
<td>West</td>
<td>North-100 South-230 East-100 West-100</td>
<td>14.3</td>
<td>14 - 15</td>
<td>66,000</td>
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<td>3</td>
<td>Figure 5</td>
<td>Natural Attenuation</td>
<td>West and East</td>
<td>North-50 South-280 East-100 West-250</td>
<td>15.6</td>
<td>12 - 13</td>
<td>41,000</td>
</tr>
<tr>
<td>4</td>
<td>Figure 6</td>
<td>Leachate Collection</td>
<td>West and East</td>
<td>North-50 South-280 East-100 West-N/A</td>
<td>19.9</td>
<td>8 - 9</td>
<td>78,000</td>
</tr>
</tbody>
</table>

It should be noted that the numbers in the above table (e.g., surplus excavated soil), are from the Phase 2 Report and have not been updated based on the recent hydrogeological assessment or other studies underway by Burnside. Furthermore, it is likely that there will be some optimization in footprint and layout (e.g., to reduce berm size or avoid topographical...
constraints). In order to limit the potential effects if the factors change, each preference is discussed in the overall context of whether it seems reasonable or not, given the site alternatives.
2.0 Overall Methodology

The EA is being carried out in 10 steps, as follows:

- **Step 1:** Describe the service area waste disposal needs for the minimum planning period ending in 2050.
- **Step 2:** Develop criteria to be used in the evaluation of the alternative methods.
- **Step 3:** Develop design concepts for alternative methods for expanding the existing Biggars Lane Landfill site.
- **Step 4:** Carry out the studies required to address the evaluation criteria.
- **Step 5:** Describe the environment(s) potentially affected by the proposed undertaking.
- **Step 6:** Using the evaluation criteria identified in Step 2, carry out an evaluation of the alternative methods for the proposed undertaking and identify the effects to the environment.
- **Step 7:** Identify the preferred alternative method of landfill expansion; if the overall preferred alternative method of landfill expansion involves a base liner and leachate collection system (i.e., Alternatives 2 or 4), then carry out a comparative evaluation of alternatives leachate management and treatment options using the methodology and criteria provided Attachment C 10 (of the Phase 2 work plan).
- **Step 8:** Identify measures that may be necessary to prevent, change or mitigate possible environment effects of the preferred alternative method.
- **Step 9:** Prepare a description of the environmental advantages and disadvantages of the preferred alternative method based on net effects that will result following mitigation. The assessment of net effects include, effects associated with the construction, operations and any closure/post closure periods of the preferred alternative method.
- **Step 10:** Prepare monitoring and contingency plans to monitor for environmental effects.

This Technical and Operational Report follows Steps 4 through 9 as they pertain to the technical issues at the site.

A work plan for the Technical and Operations Consideration Report was developed in the Phase 2 Report which recommended assessing the alternatives with respect to the following four criteria:

- **Landfill Gas:** Which alternative expansion design is preferred with regard to landfill gas subsurface migration potential?
- **Vectors and Vermin:** Which alternative expansion design is preferred with regard to potential to attract vectors and vermin?
- **Geotechnical:** Which alternative expansion design is preferred from a geotechnical perspective?
• **Operational Infrastructure:** Which alternative expansion design is preferred regarding the requirement for operational infrastructure?

It should be noted that the work plan was not reviewed by regulators, stakeholders or the public. It was also prepared before the Phase 3 EA evaluations began. As a result, Burnside feels that it is reasonable to optimize the assessment criteria. Using the work plan in the Phase 2 Report, and our own experience and understanding of the site and process, plus the MOECC recent mandate to encourage applicants to consider Climate Change the criteria to assess the Technical and Operational Considerations are summarized in Table 2-1.

**Table 2-1: Technical and Operational Assessment Criteria**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Rationale</th>
<th>Indicators</th>
<th>Data Source</th>
</tr>
</thead>
</table>
| Landfill gas subsurface migration potential | The landfill expansion will produce landfill gas which is a fire, explosion and asphyxiation hazard. | Quality and quantity of gas for each alternative  
Likelihood for impacts to off-site receptors  
Likelihood of impacts to on-site structuresᵃ) | Landfill Gas Emission Modeling (LandGEM) software (v3.02)  
(Appendix A)  
Data from gas probes on-site  
Site geology  
Property map |
| Vectors and vermin | The landfill expansion could attract vectors and vermin which are a nuisance and can spread disease. | Predicted potential for attraction of vectors and vermin | Input from biologists  
Terrestrial survey of the site |
| Geotechnical | Failure of the site (slopes, settlement) can result in impacts and accidents. | Likelihood for slope failure  
Likelihood for differential settlement | Hydrogeological and Geotechnical investigation data (further discussed in Appendix B)  
Regulatory requirements |
The landfill expansion may require establishment of additional infrastructure, such as leachate management and/or landfill gas collection.

Complexity
Operational Flexibility
Ability to integrate with existing equipment\(^{(b,c)}\)


A preliminary conceptual design of the site, considering needs for roads, s/water controls, leachate and LFG systems, developed by Burnside as part of the assessment.

Certain approach may result in increased effects to climate change.

Emission of Green House Gas
Susceptibility to flooding, erosion or extreme weather events

Landfill Gas Emission Modeling (LandGEM) software (v3.02) (Appendix A).

a) Limiting greenhouse gas is not included as a standalone indicator, because it is included under the Atmospheric Assessment.

b) The need for additional infrastructure was not included as a standalone indicator, because it is included under the Economic Assessment.

c) The generation of leachate is not included as a standalone indicator because it is included under the Hydrogeological Assessment.

The effects assessment has been completed by evaluating each criterion based on the indicators noted in Table 2-1 and applying the following ranking to each alternative for each respective indicator. For each criterion, the alternative that receives the most favourable ranking is selected as the preferred. Section 4 provides an overall discussion of the preferred alternative from a technical and operational standpoint. The ranking to each alternative for each respective criterial is as follows:

- **Major Advantage**: • Best / Lowest Impact
- **Advantage**: ○ Good
- **Neutral**: ● Average
- **Disadvantage**: ◉ Poor
- **Major Disadvantage**: ○ Worst / Largest Impact
3.0 Effects Assessment and Results

3.1 Landfill Gas Assessment

3.1.1 Potential Effects

Landfill gas (LFG) is a natural by-product of the decomposition of organic material in landfills. LFG is composed of roughly 50 percent methane (the primary component of natural gas) and 50 percent carbon dioxide (CO₂) with a small amount of non-methane organic compounds. Methane is a potent greenhouse gas 25 times more effective than CO₂ at trapping heat in the atmosphere over a 100-year period¹. Methane is also extremely explosive. Within the subsurface, methane can build up pressure or even migrate under natural soil pressure gradients from a waste site into an enclosed structure, such as a building or sewer, where a spark could trigger an explosion or fire.

3.1.2 Effects Assessment

Landfill Gas Generation On-site (Quality and Quantity)

Appendix A contains LandGEM modeling of the landfill gas quantity and quality for all alternatives. As the input parameters consist of factors common to all alternatives (e.g., quantity of waste, waste composition) and do not include factors which differ from alternative to alternative (e.g., area and waste depth), there is no difference in the quantity or quality of landfill gas that will be generated from the site under the various alternatives. The largest quantity of landfill gas being emitted is 14 m³/min which will be generated around 2051. As all alternatives are generating the same quantity of landfill gas, all alternative are equally ranked with respect to this indicator.

- Alternative 1: Average – 🟢
- Alternative 2: Average – 🟢
- Alternative 3: Average – 🟢
- Alternative 4: Average – 🟢

Off-site Impacts (at property line) – Part 1: Distance to property line

The hydrogeological conditions across the entire property is consistent (refer to the Hydrogeological Assessment Report) and there are no factors which would make one alternative preferred from a Hydrogeological perspective with respect to gas migration. Furthermore, the monitoring of the existing landfill gas probes indicates that gas levels are generally non-detectable.

¹ Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report (2012)
² Pie charges are used as a graphical representation of the ranking, to make overall assessment at the end of this stage of the Environmental Assessment easier to visualise.
Table 1-1 includes the offset to the property line for the various alternatives. Having a larger distance to the boundary is considered advantageous under this criterion because there is more buffer in which the gas can naturally dissipate. Alternative 2 has the greatest distances to the property line and is therefore preferred. The closest distances to the property line for the alternatives are summarized below:

- Alternative 1: 50 m to the north (Average – ⭐⭐
- Alternative 2: 100 m north and east (Good – ⭐⭐⭐
- Alternative 3: 50 m to the north and east (Average – ⭐⭐
- Alternative 4: 50 m to the north and east (Average – ⭐⭐

It should be noted that even the shortest offset (50 m) is considered acceptable from a design perspective, due to the shallow depth of the waste.

Off-site Impacts (at property line) – Part 2: Liner

Also of note, Alternatives 2 and 4 include landfill liners, which will act as a barrier for landfill gas migration. Options which include a liner are preferred under this indicator in that they also limit the potential for landfill gas migration. The alternatives can be summarized as follows:

- Alternative 1: No liner (Poor – ⭐)
- Alternative 2: Liner (Good – ⭐⭐⭐
- Alternative 3: No liner (Poor – ⭐)
- Alternative 4: Liner (Good – ⭐⭐⭐

On-site impacts (need for landfill gas monitors)

There are several buildings on-site which may become areas where landfill gas could accumulate. With respect to the alternatives, we note the following:

- Alternative 1: Main site infrastructure approximately 150 m south of proposed west footprint;
- Alternative 2: Main site infrastructure approximately 150 m south of proposed west footprint;
- Alternative 3: Existing barn located approximately 50 m to the west of the west footprint (note: this barn is removed under Alternative 1 and 2; the barn is in poor shape and could be removed under any Alternative if required), Main site infrastructure approximately 150 m south of proposed west footprint;
- Alternative 4: Existing barn located approximately 50 m to the west of the west footprint, Main site infrastructure approximately 150 m south of proposed west footprint.

Within this indicator, we have assigned the following rankings:

- Alternative 1: barn not present (Good – ⭐⭐⭐
- Alternative 2: barn not present (Good – ⭐⭐⭐
• Alternative 3: barn present but easy to mitigate (Average – ⚫)
• Alternative 4: barn present but easy to mitigate (Average – ⚫)

### 3.1.3 Mitigation

Mitigation measures associated with landfill gas are as follows:

- The Biggars Lane landfill will be required to install a landfill gas management system as it exceeds 1.5 Mm³ of waste due to the existing capacity and proposed expansion. This gas collection system will reduce the impacts associated with landfill gas.
- Inspection of the cover will be ongoing during the operation and post closure period to look for cracks or fissures in the cover or areas of stressed vegetation which may mean that the gas is breaking out.
- The existing barn may need a methane gas detector if it is to remain in place;
- Additional gas probes will be installed at the property boundaries for each alternative and will be monitored on a regular basis.

### 3.1.4 Net Effects

Landfill gas from the site can be managed for all alternatives. There are no Net Effects.

### 3.1.5 Summary

The following is a summary of the landfill gas criteria:

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Quality and Quantity</th>
<th>Off-site Impacts</th>
<th>On-site Impacts</th>
<th>Overall</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Distance</td>
<td>Liner</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Average</td>
<td>Average</td>
<td>Poor</td>
<td>Good</td>
</tr>
<tr>
<td>2</td>
<td>Average</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>3</td>
<td>Average</td>
<td>Average</td>
<td>Poor</td>
<td>Average</td>
</tr>
<tr>
<td>4</td>
<td>Average</td>
<td>Average</td>
<td>Good</td>
<td>Average</td>
</tr>
</tbody>
</table>

⚪️ ⚫ Best / Lowest Impact
⚫  Good
⚋ Average
⚠ Poor
⚪️ Worst/Largest Impact

As a whole, this assessment seems reasonable. With respect to landfill gas concerns all Alternatives are fairly close. Alternative 2 is marginally preferred because of the liner, distance to the property line, and lack of barn which could require landfill gas monitors or mitigation if it remains.
3.2 Vector and Vermin

3.2.1 Potential Effects

A *vector* is an organism, such as a mosquito or tick, which carries disease-causing micro-organisms from one host to another. Ticks are vectors for Lyme Disease, Rocky Mountain Spotted Fever, and Powassan Virus, among other diseases. In Ontario, mosquitos are predominantly known as vectors for West Nile Virus and Eastern Equine Encephalitis. *Vermin* are various small animals or insects, such as rats, gulls or cockroaches. These animals may nest in or feed upon waste, spreading litter, destroy fencing and environmental control features, and can also spread disease. In extreme cases, they can interact with people of the environment in a negative or injurious way (biting, scratching).

3.2.2 Effect Assessment

Though vectors and vermin can often be found in close association with humans, the surrounding natural landscape can influence the abundance of these organisms in a given area. The open upland fields and forests offer no indication that they would be exceptional in terms of habitat for vermin or vectors; however, a sizeable proportion of the adjacent lands are agricultural. Agricultural lands can attract vermin such as mice and rats, as well as larger mammals such as raccoons and deer. These organisms can carry and transmit disease but are also influential in spreading ticks.

There are several lowland areas around the project areas as well. Inundated ditches with poor drainage and stormwater can increase populations of mosquitos. Mosquito populations are typically kept in check by aerial insectivores such as swallows, swifts, and bats. The removal of natural forest habitat such as the deciduous and mixed woodlots that frame the eastern and southern portions of the landfill could contribute to a reduction in these insectivorous species, which could exacerbate the presence of mosquitos in the area.

Therefore, given that the expansions to the east may involve more removal of deciduous forests, it has been concluded that Alternatives 3 and 4 ranked Poor whereas Alternatives 1 and 2 ranked Average.

3.2.3 Mitigation

Regular cover placement is expected to minimize the site population of vectors and vermin. Cover placement will also help to limit the site’s attraction to larger animals such as skunks and raccoons.

If large animals become problematic at the site, it may be necessary to enlist the assistance of wildlife control officers from the Ministry of Natural Resources and Forests or the Conservation Authority. In any event, site staff should not attempt to interfere with these large and potentially dangerous animals. If large animals have uncovered wastes, the site staff should re-cover these wastes with cover material when it is safe to do so.
Control of vectors and vermin may require the use of a professional pest control service to spray, poison or trap.

If deciduous trees are removed, efforts should be made to increase natural bird nesting areas in the vicinity of the site.

3.2.4 Net Effects

Even with best management practices in place, there will still be some vectors and vermin. Best management practices can be used to minimize the impacts, but complete removal is not possible.

3.2.5 Summary

The vector and vermin criteria are summarised as follows:

<table>
<thead>
<tr>
<th>Table 3-2: Alternative Ranking With Respect to Vector and Vermin Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall</strong></td>
</tr>
<tr>
<td>Alternative 1</td>
</tr>
<tr>
<td>Alternative 2</td>
</tr>
<tr>
<td>Alternative 3</td>
</tr>
<tr>
<td>Alternative 4</td>
</tr>
</tbody>
</table>

As a whole this assessment seems reasonable. The expansions to the east may involve more removal of deciduous forests, resulting in the potential for more mosquitos and ticks.

3.3 Geotechnical

An overview of the Geotechnical Assessment is included as Appendix B.

3.3.1 Potential Effects

Geotechnical issues identified involve slope stability and settlement.

Alternatives that incorporate steep slopes or high mounds are less preferred to alternatives that do not within this criterion, because of the slope stability issues involved.

Settlement is a concern, because differential settling may lead to cracking of surface soils which could produce landfill gas or leachate, or failure of landfill gas or leachate piping. Soils which are inherently unstable, such as loose sands or peat layers are more likely to fail or settle as opposed to firm and dense soils. Alternatives which can avoid these conditions are preferred.
3.3.2 Effects Assessment

Slope Stability

General conceptual designs developed to date do not extend below grade to any significant level. Sideslopes are basically maintained at 3:1 or less\(^3\), which is generally considered stable. Climate change effects on slope stability may cause issues for steeper slopes (see also the discussion in Section 3.5).

As currently designed, all options include high berms (over 6 m high) to accommodate the waste. However, it seems reasonable that alternatives involving a larger footprint (such as those which consider expanding to both the east and west of the existing landfill) would have a significantly lower berm requirement and final landfill height. It is assumed that some adjustments of the design could reduce berm height and overall height within Alternatives 3 and 4 (which have a larger footprint), and therefore these have been given a better ranking under this indicator.

- Alternative 1: Poor – ☒
- Alternative 2: Poor – ☒
- Alternative 3: Average – ☑
- Alternative 4: Average – ☑

Settlement

There is no difference noted between the alternatives with respect to settlement. The soil is basically fairly homogeneous across the site. The waste footprints are expected to be built in firm, stable soils. There are no known areas of peat or sand layers that would result in settlement. The existing topsoil layer will be removed during development of the waste footprint and site roads, eliminating that potential settlement concern.

- Alternative 1: Average – ☑
- Alternative 2: Average – ☑
- Alternative 3: Average – ☑
- Alternative 4: Average – ☑

3.3.3 Mitigation

Minor adjustments to the site footprints may be desirable at the detailed design stage to minimise the waste height. It is reasonable to assume that the footprints would be optimised to limit berm height.

\(^3\) Slope ratios are expressed as horizontal (run) distance to vertical (rise) distance. Larger ratios have a lower slope. For example, 3:1 has a slope of 33\% or an angle of 18.4 degrees while 4:1 is 25\% or 14\°.
3.3.4 Net Effects

Effects from this option can be mitigated. Although not currently anticipated, geotechnical assessment prior to construction of the berms may be required.

3.3.5 Summary

Within the Geotechnical criteria, we note the following:

| Table 3-3: Alternative Ranking With Respect to Geotechnical Criteria |
|---|---|---|---|---|
| Alternative | Slope Stability | Settlement | Overall |
| 1 | Poor | Average | Poor |
| 2 | Poor | Average | Poor |
| 3 | Average | Average | Average |
| 4 | Average | Average | Average |

- ● Best/Lowest Impact
- ○ Good
- ◱ Average
- ○ Poor
- ○ Worst/Largest Impact

As a whole this assessment seems reasonable. Alternatives which can have a larger footprint, such as 3 and 4 can have lower berms and lower sideslopes. Therefore, Alternative 3 and 4 are preferred from a Geotechnical perspective.

3.4 Infrastructure and Operational Requirements

3.4.1 Potential Effects

Landfill operation is one of the most critical elements in mitigating the potential for impact to the environment. Although there are no potential effects associated with infrastructure and operations per se, a site which is more difficult to operate, or which uses high maintenance technology may be more likely to undergo equipment break down or have operators develop poor habits. Many impacts are associated with poor operational procedures, confusing operational requirements or poor design.

As previously mentioned, it is recognised that with additional infrastructure there is additional costs. The cost evaluation of the operational infrastructure is considered in the Economic Evaluation Report and is not included in this report.

3.4.2 Effects Assessment

Complexity

LFG Controls
O.Reg. 232/98 requires a landfill gas collection and destruction system (LFG controls) be installed when a new or expanded landfill site is larger than 1.5 Mm³. Once expanded using any of the Alternatives, the Biggars Lane Landfill will have a total capacity of 1.86 Mm³. As a result, it will require LFG controls.

The existing waste footprint has no LFG controls. Although it is assumed that LFG controls for this area are not being added, it would represent an increased complexity over existing conditions and would add to the complexity for LFG control of the expansion Alternative. However, this increased complexity would be equally applicable to any of the expansion Alternatives. As a result, LFG controls for the existing waste footprint are not considered from a system complexity standpoint.

Burnside has determined the preferred option for LFG collection as discussed in Appendix E. We considered the specific needs of the Biggars Lane Landfill under each Alternative Method of expansion. Specifically:

• A target LFG collection efficiency of 70% over the expansion’s operating and post-closure life is reasonable for the Site, regardless of the expansion configuration selected;
• To achieve the 70% average collection efficiency, LFG collection should begin in Year 11 of site operation or sooner. This allows final closure cover to be in place (or under construction) for part of the expansion, ensuring reasonable LFG collection efficiency;
• An active vertical extraction well system is best suited to all four of the Alternative Methods. Vertical collection allows an area of the expansion to have closure cover in place before installing the collection system, which in turn helps with system efficiency; and
• Monitoring of the installed LFG collection system will be required to ensure it is achieving the targeted efficiency. With a vertical extraction system there is an opportunity to install additional wells (collection points) should they be needed.

Assuming LFG controls are only required for the expansion footprints, Alternatives 1 and 2, with only a single footprint, is the least complex. The LFG control system would be comprised of a collection well network, collection piping, pumping system and flare. Alternatives 3 and 4 may also rely upon a single flare (though separate flares may be installed), but with two distinct waste footprints, and an overall larger footprint area, Alternatives 3 and 4 will require additional collection wells and piping. Alternatives 3 and 4 may also require a second pump and pump controls to accommodate the second (eastern) waste footprint.

This can be summarized as follows:

• Alternative 1: Good – ☑
• Alternative 2: Good – ☑
• Alternative 3: Average – ⬜
• Alternative 4: Average – ⬜

### Leachate Collection
The existing site currently manages leachate by natural attenuation, with no leachate collection system present. Alternatives 2 and 4 include engineered base containment that would require infrastructure to be built to handle the leachate being produced and collected.

Leachate quantities from for Alternatives 2 and 4 were estimated using the Hydrologic Evaluation of Landfill Performance (HELP) Model developed by the U.S. Environmental Protection Agency (Appendix C). The HELP model results show the maximum (peak) leachate collected by the collection system is approximately 683 m³ in one day, though the average is up to 87 m³ per day. For the purposes of this assessment, it has been assumed that the leachate would be trucked; there would be the need for three to nine trucks per day transporting leachate to the WPCP. It should be noted that the method to manage the leachate has not been determined yet, and it is possible that a forcemain or treatment system may be the preferred alternative. If an alternative other than trucking to managing leachate is selected, there would still be an increased complexity, so this assessment is still considered valid.

The leachate collection system means treating/transporting the leachate will need to be designed to be able to handle this upper limit of leachate that could be generated. Infrastructure requirements for Alternatives 1 and 2, with a single cell design, require a less intricate road and culvert system compared to the alternatives with a dual cell design (Alternatives 3 and 4). Alternative designs which include a leachate collection system will require piping, a pump house (or more than one), and treatment/storage infrastructure. Currently there is no leachate treatment/storage infrastructure onsite so with Alternatives 2 and 4, a system must be constructed. Volume of excavation of soils to facilitate each design must be considered with respect to cost of excavation of soils verses importing soils for operational cover usage.

Therefore, Alternatives 2 and 4 which involve leachate collection are more complex than Alternatives 1 and 3 which do not. Alternatives 1 and 2 which involve a single landfill location are generally simpler than Alternatives 3 and 4 which involve two locations.

This can be summarized as follows:

- Alternative 1: Good – (one cell and no leachate collection)
- Alternative 2: Poor – (one cell and leachate collection)
- Alternative 3: Average – (two cells but no leachate collection)
- Alternative 4: Worst – (two cells and no leachate collection)

**Final Cover**

Based on hydrogeological modeling (see Geologic and Hydrogeological Assessment report), Alternatives 1 and 3 require progressive final cover with very low permeability. At the conceptual design stage, the process necessary for achieving this is assumed to be as follows:

- Progressive final cover installed every 1.5 years;
- Final cover to comprise 40 mil LDPE (plastic) geomembrane, overlain by a drainage layer (geocomposite or sand) followed by general soil and topsoil;
- Undertaking a leak detection survey upon completion;
- Repairing any holes or damage detected during the leak detection survey.

It should be noted that during the detailed design, there may be other means of achieving the required permeability and perhaps this protocol would only be required at key areas of the site.

Therefore, Alternatives 1 and 3 which require this final cover are more complex than Alternatives 2 and 4 in which a standard cover, in accordance with O.Reg 232/98 s.29, is assumed to be sufficient. This can be summarized as follows:

- Alternative 1: Poor
- Alternative 2: Average
- Alternative 3: Poor
- Alternative 4: Average

**Operational Flexibility**

Landfills that operate by natural attenuation are generally more flexible than sites that operate with leachate management. If, for instance, the site wishes to stop operation for a period to implement new measures, leachate management systems must continue to operate.

However, the larger landfill footprint associated with Alternative 3 and 4 also allows for some operational flexibility, by adjusting the height or footprint as needed during design or even construction to accommodate (for example) irregularities in topography, visual issues (such as the height of a single cell design), poor soils (if observed during construction) and the ability to address currently unforeseen situations. This can be summarized as follows:

- Alternative 1: Average
- Alternative 2: Poor
- Alternative 3: Good
- Alternative 4: Average

**Integration with Existing Equipment**

The following equipment is present at the site:

- Caterpillar 826H landfill compactor
- Komatsu 65EX bulldozer
- JCB JS130 Excavator
- Freightliner FL80 Dual Axle Dump Truck

There is no need to change this equipment.

Currently, there is no leachate collection and management on the site. Therefore, alternatives which involve collection must incorporate new equipment. Furthermore, as discussed above, all
alternatives will involve LFG management. Therefore all alternatives will involve new equipment.

Within this indicator, Alternative 1 and 3, which do not involve leachate collection and management are preferred. This can be summarized as follows:

- Alternative 1: Good – ☀
- Alternative 2: Poor – ☾
- Alternative 3: Good – ☀
- Alternative 4: Poor – ☾

3.4.3 Mitigation

Most of the concerns with operational challenges can be addressed by developing good and thorough manuals and procedures and then providing proper training. The workers used by the County must be trained to fulfil their necessary roles at the site. This includes knowledge of the site approvals and relevant environmental legislation. If leachate treatment is part of the preferred Alternative (Alternatives 2 and 4), then efforts should be made to ensure that pumps and monitoring systems are compatible with systems already in place by the County for monitoring (sewage) pumping stations and related County facilities. Similarly for the LFG controls, being able to tie-in monitoring of the pump(s) and flare(s) will help to reduce training requirements and the complexity of the LFG control system.

3.4.4 Net Effects

Net effects from infrastructures effects can be managed for all alternatives. There are no Net Effects.

3.4.5 Summary

The Site Infrastructure criteria is summarised as follows:

Table 3-4: Alternative Ranking With Respect to Infrastructure Criteria

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Complexity LFG Controls</th>
<th>Leachate Collection</th>
<th>Final Cover</th>
<th>Operational Flexibility</th>
<th>Integration with Existing Equipment</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Good ☀</td>
<td>Good ☀</td>
<td>Poor ☾</td>
<td>Avg. ☾</td>
<td>Good ☀</td>
<td>Avg. ☀</td>
</tr>
<tr>
<td>2</td>
<td>Good ☀</td>
<td>Poor ☾</td>
<td>Avg. ☾</td>
<td>Poor ☾</td>
<td>Poor ☾</td>
<td>Poor ☾</td>
</tr>
<tr>
<td>4</td>
<td>Avg. ☽</td>
<td>Worst ☽</td>
<td>Avg. ☽</td>
<td>Avg. ☽</td>
<td>Poor ☾</td>
<td>Poor ☽</td>
</tr>
</tbody>
</table>
Generally, speaking, this appears to be influenced by the leachate collection system which adds complexity, and reduces operational flexibility, while making integration with the existing system more challenging.

3.5 Climate Change

3.5.1 Potential Effects

Landfill existence and operations, (which involve waste decomposition, equipment operation and haulage of waste and leachate) generate greenhouse gases including methane (CH₄), carbon dioxide (CO₂), nitrous oxide and certain halogenated carbon compounds. Greenhouse gases can exhibit heat-trapping properties in the earth’s atmosphere resulting in climate change. Some of the effects associated with climate change include changes in the frequency, intensity and duration of precipitation events, changes in soil moisture and permafrost, changes in sea levels and polar ice cover, shifts in plant growth and growing season, and in the geographic extent of species range, habitat and forest cover.

The MOECC⁴ indicates that during the Environmental Assessment proponents should consider the effects of climate change such that the selected alternative:

- Has taken into account alternative methods to reduce its greenhouse gas emissions and negative effects on carbon sinks; and
- Is more resilient to future changes in climate and helps maintain the ecological integrity of the local environment through an assessment of present and future environmental effects in the face of a changing climate.

3.5.2 Discussion

Project Effects on Climate Change

Carbon dioxide equivalent (CO₂e) is a measure used to compare the emissions from various greenhouse gases based upon their global warming potential. Appendix D contains estimates of the CO₂e of the various alternatives as shown on the table below:

---

⁴ Draft Guideline entitled Consideration of Climate Change in Environmental Assessment in Ontario (August 2016)
Table 3-5: Greenhouse Gas Emissions

<table>
<thead>
<tr>
<th></th>
<th>Alternatives 1 and 3 (No Leachate Haulage) CO₂-e Mg/y</th>
<th>Alternatives 2 and 4 (Includes Leachate Haulage)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO₂-e Mg/y % Increase</td>
<td>With 3 Trucks/day CO₂-e Mg/y % Increase</td>
<td>With 9 Trucks/day CO₂-e Mg/y % Increase</td>
<td></td>
</tr>
<tr>
<td>Expansion</td>
<td>2020</td>
<td>32,450</td>
<td>32,490</td>
<td>0.13%</td>
</tr>
<tr>
<td>Closure</td>
<td>2050</td>
<td>39,060</td>
<td>39,100</td>
<td>0.10%</td>
</tr>
<tr>
<td>Post-Closure</td>
<td>2080</td>
<td>9,190</td>
<td>9,230</td>
<td>0.44%</td>
</tr>
</tbody>
</table>

Percent increase is calculated from emission value before rounding.

It is noted that Alternative 2 and 4 generate slight more emissions. However, given the nature of the project, we do not consider this significant.

On this basis, the alternatives are ranked as follows:
- Alternative 1: Average – ○
- Alternative 2: Average – ○
- Alternative 3: Average – ○
- Alternative 4: Average – ○

It is worth noting that the management of landfill gases using a flare of other destruction methods reduces the greenhouse gas emissions by about 47% over the life of the expansion (operating and post-closure period – Refer to Appendix D). This is already reflected in Table 3-5.

**Climate Change Effects on Project**

The effects of climate change across all the alternatives are consistent and there are no factors which would make one alternative preferred with respect to the effects of climate change.

Climate change may increase risks for slope stability. Soils covering the waste may dry during periods without rain, reducing slope stability. Conversely, intense rains may cause landslides as the cover soils increase mass through infiltration. This risk is applicable to all alternatives and has been considered as part of the geotechnical criterion (see Section 3.3).

Overall for climate change effects on the project, the Alternatives are summarized as follows:
- Alternative 1: Average – ○
- Alternative 2: Average – ○
- Alternative 3: Average – ○
- Alternative 4: Average – ○

3.5.3 Mitigation

Mitigation measures associated with climate change are as follows:
• Installation of LFG controls as described above and in Appendix D. This is expected to reduce overall greenhouse gas emissions by about 47% compared to operating the expansion area without LFG controls.

• The Surface Water Management Report includes mitigation measure minimizing the impacts of erosion, and runoff through proper sizing of ditches and stormwater ponds.

• The Natural Heritage Report, which includes mitigation measures to reduce impacts through removal of trees and other forms of carbon sinks.

Net Effects
Due to the nature of waste management, there will be greenhouse gas generated. The net effects are as follows:

• Over the projected operating and post-closure care life of the expansion, the site is expected to generate a total of 3.3 Tg (3.3 million tonnes\(^5\)) CO\(_2\)-e. Of this, a total of 1.5 Tg (1.5 million tonnes) will be avoided by using LFG controls. LFG controls are equivalent to removing 3,600 passenger vehicles\(^6\) from the road.

• At the peak year of landfill gas generation, the LFG control system will eliminate 36,300 Mg (tonnes) of CO\(_2\)e.

3.5.4 Summary
The following is a summary of the climate change criteria:

Table 3-6: Alternative Ranking With Respect to Climate Change Criteria

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Project Effects on Climate Change</th>
<th>Climate Change Effects on Project</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Average</td>
<td>Average</td>
<td>Average</td>
</tr>
<tr>
<td>2</td>
<td>Average</td>
<td>Average</td>
<td>Average</td>
</tr>
<tr>
<td>3</td>
<td>Average</td>
<td>Average</td>
<td>Average</td>
</tr>
<tr>
<td>4</td>
<td>Average</td>
<td>Average</td>
<td>Average</td>
</tr>
</tbody>
</table>

\(\bullet\) Best / Lowest Impact
\(\bigcirc\) Good
\(\circ\) Average
\(\bigcirc\) Poor
\(\bigcirc\) Worst/Largest Impact

As a whole, this assessment seems reasonable. All Alternatives which involve trucking of leachate generate more greenhouse gas than alternatives without leachate trucking. However, given the nature of the project, we do not consider leachate trucking to be significant. As a result, all Alternatives are considered Average within this criterion.

---

\(^5\) A tonne, also called a metric tonne, is 1,000 kilograms or approximately 2,200 pounds.

4.0 Summary

The alternatives are summarized in the following table:

**Table 4-1: Alternative Ranking With Respect to Technical and Operational Considerations**

<table>
<thead>
<tr>
<th></th>
<th>Alternative 1</th>
<th>Alternative 2</th>
<th>Alternative 3</th>
<th>Alternative 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas Generation</td>
<td>Average</td>
<td>〇</td>
<td>♦</td>
<td>♦</td>
</tr>
<tr>
<td>Vectors</td>
<td>Average</td>
<td>〇</td>
<td>♦</td>
<td>♦</td>
</tr>
<tr>
<td>Geotechnical</td>
<td>Poor</td>
<td>〇</td>
<td>♦</td>
<td>♦</td>
</tr>
<tr>
<td>Operational Infrastructure</td>
<td>Average</td>
<td>〇</td>
<td>♦</td>
<td>♦</td>
</tr>
<tr>
<td>Climate Change</td>
<td>Average</td>
<td>〇</td>
<td>♦</td>
<td>♦</td>
</tr>
<tr>
<td><strong>OVERALL RANK</strong></td>
<td>Average</td>
<td>〇</td>
<td>♦</td>
<td>♦</td>
</tr>
</tbody>
</table>

- 〇: Best / Lowest Impact
- ♦: Good
- 〇: Average
- 〇: Poor
- 〇: Worst/Largest Impact
5.0 Mitigation and Monitoring Program

The Biggars Lane landfill will be required by Environmental Protection Act Regulation 232/98 to install a landfill gas management system as it exceeds 1.5 Mm³ of waste due to the existing and proposed expansion volumes. This gas collection system will reduce the impacts associated with landfill gas.

Inspection of the cover will be ongoing during the operation and post closure period to look for cracks, fissures or distressed vegetation which may mean that the gas is breaking out.

The existing barn located in the western portion of the site may need a methane gas detector if it is to remain on-site.

Additional gas probes will be installed at the property boundaries for each alternative and will be monitored on a regular basis.

Regular cover placement is expected to minimize the site population of vectors and vermin. Cover placement will also help to limit the site’s attraction to larger animals.

If large animals become problematic at the site, it may be necessary to enlist the assistance of wildlife control officers from the MNRF or the Conservation Authority. In any event, site staff should not attempt to interfere with these large and potentially dangerous animals. If large animals have uncovered wastes, the site staff should re-cover these wastes with cover material when it is safe to do so.

Control of vectors and vermin may require the use of a professional pest control service to spray, poison or trap.

If deciduous trees are removed, efforts should be made to increase natural bird nesting areas in the vicinity of the site.

Adjusting the site footprints may be required at the detailed design stage to minimise the waste height. It is reasonable to assume that the footprints would be optimised to limit berm height and waste loading.

Most of the concerns with operational challenges can be addressed with proper training and establishment of good and thorough manuals and procedures. The workers used by the County must be trained such that they can perform any of the roles necessary at the site. This includes knowledge of the site approvals and relevant environmental legislation. If leachate treatment is part of the preferred Alternative (Alternatives 2 and 4), then efforts should be made to ensure that pumps and monitoring systems are compatible with systems already in place by the County.
Note: Regional Study Area encompasses the County of Brant but does not include the City of Brantford, Six Nations of the Grand River Territory or the Mississaugas of New Credit First Nation.
The attached Alternative Plans and Cross Sections were developed by Golder Associates and are described in their report entitled Golder Associates (May 2016), Report On Phase 2 Activities, Environmental Assessment To Expand The Biggars Lane Landfill County of Brant. These plans are being as the basis of evaluation for the Environmental Assessment as directed by the County of Brant, to assess potential environmental effects of alternatives and define mitigation requirements. It is reasonable to assume that overall configuration (footprint size, depth of excavation, height of fill and other general parameters) will be refined during the subsequent Design stages.

Satellite & Air Photo Source:
Satellite Imagery: 2013/2015, Ministry of Natural Resources, © Queen’s Printer for Ontario
The Attached Alternative Plans and Cross Sections were developed by Golder Associates and are described in their report entitled Golder Associates (May 2016), Report On Phase 2 Activities, Environmental Assessment To Expand The Biggars Lane Landfill, County of Brant. These plans are being used as the basis of evaluation for the Environmental Assessment as directed by the County of Brant, to assess potential environmental effects of alternatives and define mitigation requirements. It is reasonable to assume that overall configuration (footprint size, depth of excavation, height of fill and other general parameters) will be refined during the subsequent Design stages.

COUNTY OF BRANT

BIGGARS LANE LANDFILL

ALTERNATIVE 1 SECTION VIEW

Scale: 1:2,500

Date: SEPTEMBER 2017

Figure No.: 4
The attached Alternative Plans and Cross Sections were developed by Golder Associates and are described in their report entitled Golder Associates (May 2016), Report On Phase 2 Activities, Environmental Assessment To Expand The Biggars Lane Landfill. These plans are being used as the basis of evaluation for the Environmental Assessment as directed by the County of Brant, to assess potential environmental effects of alternatives and define mitigation requirements. It is reasonable to assume that overall configuration (footprint size, depth of excavation, height of fill and other general parameters) will be refined during the subsequent design stages.
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Satellite & Air Photo Source:
Satellite Imagery: 2013 WQDO, Ministry of Natural Resources, © Queen’s Printer for Ontario
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NOT FOR CONSTRUCTION

Scale Project No.

Date Plotted: September 18, 2017 - 9:16 AM

County

COUNTY OF BRANT

Not For Construction

Figure Title

BIGGARS LANE LANDFILL

ALTERNATIVE 3 WEST SECTION VIEW

REPRODUCTION OF GOLDER DRAWING

Date

SEPTEMBER 2017

Figure No.

8

Scale

1:2,500 m

Project No.

30003631.0000
The Attached Alternative Plans and Cross Sections were developed by Golder Associates and are described in their report entitled Golder Associates (May 2016), Report On Phase 2 Activities, Environmental Assessment To Expand The Biggars Lane Landfill, County of Brant. These plans are being used as the basis of evaluation for the Environmental Assessment as directed by the County of Brant, to assess potential environmental effects of alternatives and define mitigation requirements. It is reasonable to assume that overall configuration (footprint size, depth of excavation, height of fill and other general parameters) will be refined during the subsequent Design stages.
The Attached Alternative Plans and Cross Sections were developed by Golder Associates and are described in their report entitled "Golder Associates (May 2016), Report On Phase 2 Activities, Environmental Assessment To Expand The Biggars Lane Landfill County of Brant." These plans are being used as the basis for evaluation for the Environmental Assessment as directed by the County of Brant, to assess potential environmental effects of alternatives and define mitigation requirements. It is reasonable to assume that overall configuration (footprint size, depth of excavation, height of fill and other general parameters) will be refined during the subsequent Design stages.

Satellite & Air Photo Source:
Satellite Imagery: 2013 WGS84, Ministry of Natural Resources, © Queen’s Printer for Ontario
The Attached Alternative Plans and Cross Sections were developed by Golder Associates and are described in their report entitled Golder Associates (May 2016), Report On Phase 2 Activities, Environmental Assessment To Expand The Biggars Lane Landfill County of Brant. These plans are being assessed as the basis of evaluation for the Environmental Assessment as directed by the County of Brant, to assess potential environmental effects of alternatives and define mitigation requirements. It is reasonable to assume that overall configuration (footprint size, depth of excavation, height of fill and other general parameters) will be refined during the subsequent Design stages.
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COUNTY OF BRANT

BIGGARS LANE LANDFILL

ALTERNATIVE 4 EAST SECTION VIEW

Scale

1:2,500 m

Date

SEPTEMBER 2017

Figure No.

12

Project No.

30003631.0000

Scale

1:2,500 m
Appendix A

LandGem Modeling
1.0 Introduction

The Landfill Gas Emission Modeling (LandGEM) software (v3.02) was used to obtain data for Technical and Operational Considerations of the proposed Alternatives Methods of landfill expansion for the Biggars Lane Landfill. The LandGEM Model, developed by the United States Environmental Protection Agency (EPA), is a mathematical software tool which quantifies the emissions from the decomposition of landfilled waste in municipal solid waste landfills.

The Waste Free Ontario Act and the Province’s Strategy for a Waste-Free Ontario – Building the Circular Economy both indicate that organics diversion will be implemented as a requirement for waste management systems in the near future. Organics diversion (landfill avoidance) would dramatically alter landfill gas emissions, particularly the balance between methane (CH₄) and carbon dioxide (CO₂). Additionally, climate change is expected to influence the frequency, intensity and duration of precipitation events as well as increased average temperatures. These climate change effects may in turn change the rate of decomposition in landfills, affecting the ratio of methane to carbon dioxide and the overall annual rate of landfill gas generation. The effects of these potential changes are not considered by the LandGEM Model or this Memorandum.

2.0 LandGEM Inputs

2.1 Introduction

LandGEM uses waste acceptance rates along with waste design capacity (mass) or closure year to model emissions of landfill gas. As a result, the emission of gas will be consistent for Alternatives 1 to 4. For each Alternative the expansion volume and timing for receipt of waste is consistent. The Alternatives only vary by footprint area and height of fill.
The expansion of the Biggars Lane Landfill is for 1.13 million cubic metres (Mm$^3$). Including the existing waste footprint, the expanded site will have a total airspace volume of 1.86 Mm$^3$. An average waste density of 696 kg/m$^3$ is used for this modeling; provided in the project Terms of Reference document prepared by Stantec, 2014.

The pollutants selected for modeling are:
- Total Landfill Gas (TLG)
- Methane
- Carbon Dioxide
- Non-Methane Organic Compound (NMOC)

The existing landfill footprint is expected to close in 2020 with the expanded footprint (under any Alternative) opening in year 2021. The expanded footprint will have a 30-year life, closing at the end of 2050.

2.2 LandGEM Assumptions and Limitations

The major assumptions and limitations of the LandGEM software are:
- LandGEM is based on the gas generated from anaerobic decomposition of landfilled waste which has methane content between 40% and 60% (volume basis).
- Methane gas concentrations must be specified in the Model. We have selected the default model setting of 50% (volume basis).
- Default pollutant concentrations used by LandGEM have been corrected for air infiltration, as stated in AP-42.

3.0 Results

Existing conditions at the Biggars Lane Landfill site have been modeled to determine the Do Nothing\(^1\) emissions of landfill gas. The County has provided filling rates from 2006 through 2016. Landfilling rates previous to 2006 have been conservatively extrapolated while estimates for 2017 and beyond are based on the EA waste disposal estimates.

LandGEM estimates methane (CH$_4$) generation using the potential CH$_4$ generation capacity of the waste, the CH$_4$ generation constant, and the waste acceptance rates. Since CH$_4$ generation is proportional to waste added to the landfill footprint, the year that has the greatest CH$_4$ gas generation is year 2051; this can be seen in Figure 1.

\(^1\) “Do Nothing” represents no landfill expansion, with site closure (accepting no more waste) in 2020.
Beyond year 2051, emissions will steadily decline as waste is no longer being added to the landfill footprint. The landfill gas emissions for the entire site including the past, current, and future footprint are modeled to determine the total emissions of the site. Below is a summary of the emissions from the site in year 2051.

Table 3-1: Peak Landfill Gas Emissions (2051, existing and expansion footprints)

<table>
<thead>
<tr>
<th>Gas/Pollutant</th>
<th>Emissions (Mg/year)</th>
<th>Emissions (m³/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Landfill Gas</td>
<td>9,558</td>
<td>7,801,000</td>
</tr>
<tr>
<td>Methane</td>
<td>2,719</td>
<td>3,901,000</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>7,416</td>
<td>3,901,000</td>
</tr>
<tr>
<td>NMOC</td>
<td>112</td>
<td>31,200</td>
</tr>
</tbody>
</table>

Figure 1: Methane Emissions of Site Over Entire Lifespan
4.0 Conclusions

The total landfill gas emissions for the operating and post-closure lifespan of the expansion footprint are modeled to be 3,264,256 Mg from year 2020 to year 2111, resulting in an average emission of 35,871 Mg/year. The peak gaseous emissions are at year 2051, being 75,438 Mg. This is seen in Table 3-1 and Figure 1.

Landfill gas at the expansion of the Biggars Lane Landfill will be managed in accordance with O.Reg. 232/98. This means that a landfill gas collection and destruction system will need to be installed for the site. As a result, the actual landfill gas emissions from the site will be significantly reduced.
Appendix B

Overview of Geotechnical Assessment
The proposed geotechnical field program outlined in the work program included:

- **Standard Penetration Tests (SPT)** completed at 1.5 m intervals over the full depth of borehole to confirm compactness and obtain samples for classification and index testing. The boreholes were to include:
  - two boreholes augered through the overburden and cored into the upper bedrock to prove the presence of bedrock and determine the thickness of the overlying soil.
  - two boreholes augered through the overburden and terminated at auger refusal on the bedrock to determine the thickness of the soil.
  - six boreholes augered to the top of the clay deposit to assess the distribution and thickness of the surficial sand and silt units.

- **In-situ vane testing** within the clayey deposits (where the shear strength allowed) to investigate the shear strength profile of the full thickness of the deposit.

- **Undisturbed Shelby tube samples** from representative intervals within the clay deposits for laboratory consolidation and/or triaxial testing. Borehole locations MW45, MW52, and MW43 were listed in the work plan.

Laboratory testing was to be carried out on selected representative soil samples index/classification testing (e.g., grain size distribution, Atterberg limit/plasticity, and water), as well as testing relating to strength and compressibility focusing on the clay.

The following is a summary of the field testing completed.

**Standard Penetration Tests** – were completed in the deepest borehole at all drilling locations. There were 19 drilling locations. ‘N’ values are recorded on the borehole logs contained in the Geology and Hydrogeology Study Report. Representative soil samples were collected at each drilling location. The soil types were found to be relatively consistent across the site. Four representative samples were submitted to a laboratory for grain-size analysis.
In-Situ Vane Testing – All deep borehole locations were assessed for vane testing. No testing was done. The testing was to be carried out on the clay soil. The soils encountered on-site were primarily stratified sand and silt underlain by a glacial till (silt and clay containing gravel and cobbles). Clay was occasionally encountered between the sand/silt and the till; however, it would occur as a thin layer and sometime contained traces of gravel and cobbles that was not deemed suitable for correct testing, due to the presence of the coarser material. Typical depths for this clay layer were 21 m to 30 m. At those depths, the weight of the cable was too heavy to properly conduct the test.

Shelby Tubes – These are thin walled steel tubes used to collect undisturbed soil samples. Two Shelby tube samples were collected, one from MW45 (29 m) and one from MW43 (22 m). As with the in-situ vane testing, the tubes could not be used if there was gravel or cobbles present because of the thin-walled construction of the tubes. The two tubes collected were sent to a laboratory for grain-size. No other laboratory testing was done due to the depth of the samples.
Appendix C

Hydrogeological Evaluation of Landfill Performance Modeling
Technical Memorandum

Date: October 27, 2017  Project No.: 300036031.0000

Project Name: Hydrologic Evaluation of Landfill Performance (HELP) Model

Client Name: County of Brant

Submitted By: Zack Moshonas

Reviewed By: James Hollingsworth

1.0 Introduction

The Hydrologic Evaluation of Landfill Performance (HELP) model, Version 3.07, was used to obtain data for Technical and Operational Considerations of the proposed Alternatives for the Biggars Lane Landfill. Specifically, the modelling was used to assist Burnside in the following tasks:

- To evaluate the Alternatives for the proposed expansion at the Biggars Lane Landfill site.
- To estimate the amount of leachate generated by the Alternative and potentially collected depending on the Alternative selected.
- To estimate the total amount of leachate that may infiltrate through the sublayer of the landfill based on the Alternative selected.

This Technical Memorandum summarizes the findings of the HELP analysis.

2.0 HELP Model Inputs

The HELP model accepts meteorological, soil, and landfill configuration data and then applies a quasi-two-dimensional mathematical equation that accounts for surface storage, runoff, infiltration, percolation, evapotranspiration, soil moisture storage, and lateral drainage. The model simulates the effects of hydrological processes on the water balance for the landfill by performing daily sequential analysis using deterministic approaches. The HELP model assists designers in the estimation of runoff, drainage, and leachate production that may result after placement of the landfill final cover, as well as for the assumed conditions during operation of the site. The program also estimates the head of leachate on various layers within the landfill.
2.1HELP Model Assumptions and Limitations

The major assumptions and limitations of the HELP model are summarized below:

- Areas adjacent to the landfill do not drain into the landfill. It should be noted that the design includes exterior and interior ditches to control runoff.
- The flow through the soil and the solid waste layer generally follow Darcy’s law.
- The seepage velocity through each layer is equal to the hydraulic conductivity of the layer at field saturation.
- The physical characteristics of the landfill remain constant over the modeling period. The model does not account for the changes that occur as the landfill ages.
- Precipitation during the modeling period follows a similar pattern to the period of annual precipitation measurements for the reference location.
- The base time unit for the HELP model is one day. As such, the HELP model may overestimate evapotranspiration and underestimate surface run-off by calculating storms as 24-hour normalized events. In high-precipitation areas where large storm events commonly result in large surface flows, this effect becomes more noticeable.
- All infiltration through the waste becomes leachate.
- The moisture content of all soils and waste materials are at field capacity.
- No significant lateral or upward inflow of groundwater occurs.
- Surface runoff on cover material is clean and can be conveyed to appropriate drainage channels.

For a complete description of the HELP model and its limitations, the HELP model User's Guide and Engineering Documentation (Schroeder et al., 1994a; Schroeder et al., 1994b) should be consulted.

2.2Meteorological Data & Climate Change

For the precipitation, temperature, and solar radiation data, 100 years of synthetic data was generated based on HELP library data for Syracuse, New York\(^1\). Evapotranspiration data from Ottawa was used in the modeling\(^2\).

All indications are that climate change will result in a greater frequency of extreme weather events. Various prognoses indicate that the nature of these events will vary with geographic regions. The projections for Southern Ontario are that this region will generally become hotter, wetter and will experience more extreme events. This means that the Biggars Lane Landfill could see fewer rain events that drop only a few millimetres while larger, more intense events,

---

\(^1\) Syracuse was selected over closer US cities like Buffalo, Cleveland or Toledo because the Syracuse data provides higher (more conservative) precipitation rates.

\(^2\) Most Canadian data sets are incompatible with the HELP model. Ottawa is the closest available data.
like a current 10-year (plus) storm, may occur more frequently. Climate change effects are not
recognized in the HELP model data.

The HELP model assumes runoff occurs when the upper most layer of the landfill becomes
saturated. As a result, high intensity precipitation is more likely to become runoff than infiltrate
and become leachate. Similarly, higher temperatures associated with climate change
predictions are likely to lead to increased evaporation and evapotranspiration than is predicted
by the HELP model. This will also reduce the amount of infiltration that becomes leachate.
Overall, it is believed that the HELP model is likely to over predict leachate generation under
anticipated climate change conditions.

2.3 Site Design

The following are the Design Parameters used for the modeling:

- The typical landfill waste has been normally compacted. This is considered a reasonable
  assumption based on expected landfilling practices at the site.
- Local cover soil is general soils classified as silt and clay with minor sands.
- A geomembrane with good placement is modeled for Alternatives 2 and 4.

The designs of the possible landfill expansion alternatives are supplied in Appendix A of
Phase 2 of the Environmental Assessment to Expand the Biggars Lane Landfill (Golder
Associates).

2.4 Designs of Alternatives

Table 1: Proposed Landfill Expansion Alternatives

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Model Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>B-EXP-1</td>
<td>Landfill footprint area of 15.1 ha with a single cell design on the West side of the existing landfill. Final cover present in model. No leachate collection system.</td>
</tr>
<tr>
<td>2</td>
<td>B-EXP-2</td>
<td>Landfill footprint area of 14.3 ha with a single cell design on the West side of the existing landfill. Final cover present in model. Geomembrane leachate collection system present.</td>
</tr>
<tr>
<td>3</td>
<td>B-EXP-3W and B-EXP-3E</td>
<td>Landfill footprint area of 15.6 ha with a double cell design on the West and East side of the existing landfill. Final cover present in model. No leachate collection system.</td>
</tr>
<tr>
<td>4</td>
<td>B-EXP-4W and B-EXP-4E</td>
<td>Landfill footprint area of 19.9 ha with a double cell design on the West and East side of the existing landfill. Final cove present in model. Geomembrane leachate collection system present.</td>
</tr>
</tbody>
</table>

3.0 Results

Each Alternative scenario was modeled by using the HELP model outputs of the potential
Alternative design. The water balance of the precipitation, runoff, evaporation (including
evapotranspiration), collection, and infiltration are expressed volumetrically for each Alternative.
Table 2: HELP Model Annual Water Balance Results of Proposed Alternatives

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Precipitation (m³/y)³</th>
<th>Runoff (m³/y)</th>
<th>Evaporation (m³/y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>152,470.90</td>
<td>58,521.20</td>
<td>69,547.03</td>
</tr>
<tr>
<td>2</td>
<td>141,914.50</td>
<td>54,469.43</td>
<td>64,731.89</td>
</tr>
<tr>
<td>3</td>
<td>154,960.70</td>
<td>58,786.25</td>
<td>70,924.28</td>
</tr>
<tr>
<td>4</td>
<td>198,062.90</td>
<td>76,020.21</td>
<td>90,343.00</td>
</tr>
</tbody>
</table>

Table 3: HELP Model Leachate Generation Results of Proposed Alternatives

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Collection¹ (m³/y)</th>
<th>(%)</th>
<th>Infiltration² (m³/y)</th>
<th>(%)</th>
<th>Average Daily Leachate Generation (m³/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-</td>
<td>-</td>
<td>24,549.56</td>
<td>16.10</td>
<td>67.26</td>
</tr>
<tr>
<td>2</td>
<td>22,848.71</td>
<td>16.10</td>
<td>0.008</td>
<td>0.00</td>
<td>62.60</td>
</tr>
<tr>
<td>3</td>
<td>-</td>
<td>-</td>
<td>25,403.25</td>
<td>16.31</td>
<td>69.60</td>
</tr>
<tr>
<td>4</td>
<td>31,890.28</td>
<td>16.10</td>
<td>0.011</td>
<td>0.00-</td>
<td>87.37</td>
</tr>
</tbody>
</table>

¹The collection volume is the rainfall which has passed through the waste layers and is collected in the lateral drainage layer on the base of the expansion.
²Infiltration refers to the volume/percentage of rainwater which passes through the waste layers and infiltrates beyond the lateral drainage layer.

Table 4: HELP Model Peak Daily Results of Proposed Alternatives

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Peak Collection (m³/day)</th>
<th>Peak Infiltration (m³/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-</td>
<td>525.65</td>
</tr>
<tr>
<td>2</td>
<td>481.40</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>-</td>
<td>524.81</td>
</tr>
<tr>
<td>4</td>
<td>683.11</td>
<td>-</td>
</tr>
</tbody>
</table>

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036031 Technical Memorandum - HELP Model
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³An average of 995.89 mm of rain falls on the waste footprint per year. Precipitation volume (m³/y) is a product of the rainfall accumulated over the waste footprint area.
Technical Memorandum

Date: August 9, 2018  Project No.: 300036031.0000

Project Name: Considering Greenhouse Gas Impacts from the Biggars Lane Landfill Expansion

Submitted By: Zack Moshonas

Reviewed By: Kent Hunter, P.Eng.

1.0 Introduction

The purpose of this Technical Memorandum is to assess the Greenhouse Gas (GHG) emissions resulting from the landfill expansion project under the various alternatives. Data from emissions modeling will be used to make general comments on the effects of GHG on climate change.

1.1 Considering Emissions of Greenhouse Gas from Waste Footprint

Landfill gas, comprising mainly methane (CH₄) and carbon dioxide (CO₂) is a primary source of Greenhouse Gas emissions. The generation of landfill gas is discussed in the Technical Memorandum on Landfill Gas Modeling. As described there, the LandGEM¹ software predicts landfill gas emissions based on the volume and timing of waste placement. Since Alternatives 1 to 4 all provide the same total disposal capacity and the rate of fill (timing) will be identical for each Alternative, we have assumed here that the same landfill gas emissions will result regardless of the selected Alternative. Note that methane has a climate change impact which is 25 times greater than that of carbon dioxide (measured in CO₂-e units)². The software predicts peak methane and CO₂ emissions in year 2051 as shown on Table 1-1.

The Waste Free Ontario Act and the Province’s Strategy for a Waste-Free Ontario – Building the Circular Economy both indicate that organics diversion will be implemented as a requirement for waste management systems in the near future. Organics diversion (landfill avoidance) would dramatically alter landfill gas emissions, particularly the balance between

¹ The LandGEM is a model produced and openly distributed by the United States Environmental Protection Agency.
² The Global Warming Potential for methane varies by source. We have chosen to use 25 times as it appears to be the most currently accepted value. See also: https://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=cad07259-1, accessed March 29, 2017.
methane (CH₄) and carbon dioxide (CO₂). Additionally, climate change is expected to influence the frequency, intensity, and duration of precipitation events as well as increased average temperatures. These climate change effects may in turn change the rate of decomposition in landfills, affecting the ratio of methane to carbon dioxide, and the overall annual rate of landfill gas generation. The effects of these potential changes are not considered by the LandGEM Model or this Memorandum.

Table 1-1: Predicted Landfill Gas Emissions (Peak Year, 2051)

<table>
<thead>
<tr>
<th>Source</th>
<th>Methane (Mg)</th>
<th>CO₂ (Mg)</th>
<th>CO₂·e (Mg)†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing Cell</td>
<td>345</td>
<td>945</td>
<td>9,558</td>
</tr>
<tr>
<td>Expansion Footprint (any Alternative)</td>
<td>2,375</td>
<td>6,515</td>
<td>65,879</td>
</tr>
<tr>
<td>Total</td>
<td>2,719</td>
<td>7,461</td>
<td>75,438</td>
</tr>
</tbody>
</table>

† CO₂·e = (25 × Methane) + CO₂

1.1.1 Landfill Gas Collection and Flaring System

O.Reg. 232/98 requires a landfill gas collection and destruction system (LFG controls) be installed when a new or expanded landfill site is larger than 1.5 Mm³. Once expanded using any of the Alternatives, the Biggars Lane Landfill will have a total capacity of 1.86 Mm³. As a result, it will require a LFG controls. To be conservative, Burnside assumes:

- The landfill gas collection system will only be installed for the expansion footprint. There will be no landfill gas collection for the existing cell.
- The landfill gas collection system will have a 70% collection efficiency. With a properly installed final cover system, the efficiency may be significantly higher³.
- The landfill gas destruction system will use a flare. Under ideal conditions the flare combusts the methane as \( \text{CH}_4 + 2\text{O}_2 \xrightarrow{\text{yield}} \text{CO}_2 + 2\text{H}_2\text{O} \) (+energy). To be conservative, it is assumed the flare combusts 98% of the methane.

Table 1-2 summarizes the Greenhouse Gas emissions from the site when using LFG controls. As can be seen on Figure 1, the collection and flaring of landfill gas will reduce Greenhouse Gas emissions for the entire site (CO₂·e) by 48% at the peak of landfill gas production. Although it varies because the existing waste footprint is not equipped with LFG controls, in general, the site’s total emissions are reduced by about 41% over the life of the expansion (operating and post-closure⁴). When considering just the expansion area, LFG controls will help avoid 55% of the greenhouse gasses that are created. This benefit is seen on Figure 1. Over the projected operating and post-closure care life of the expansion, a total of 1.3 Tg (million


⁴ Post-closure landfill gas generation modeled to year 2111.
tonnes\textsuperscript{5} of CO\textsubscript{2}-e will be avoided by using LFG controls. This is equivalent to 14,700 Mg (tonnes) of CO\textsubscript{2}-e annually or 3,140 passenger vehicles driven each year\textsuperscript{6}.

Table 1-2: Summary of Landfill Gas Emissions

<table>
<thead>
<tr>
<th>Landfill Gas (Year 2051)</th>
<th>Methane (Mg)</th>
<th>CO\textsubscript{2} (Mg)</th>
<th>CO\textsubscript{2}-e (Mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landfill gas collected (70% efficiency):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Existing Cell (see Table 1)</td>
<td>0</td>
<td>0</td>
<td>Sent to Flare</td>
</tr>
<tr>
<td>Expansion Footprint (see Table 1)</td>
<td>1,662</td>
<td>4,561</td>
<td></td>
</tr>
<tr>
<td>Landfill gas not captured by collection system:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Existing Cell (see Table 1)</td>
<td>345</td>
<td>945</td>
<td></td>
</tr>
<tr>
<td>Expansion Footprint (see Table 1)</td>
<td>712</td>
<td>1,955</td>
<td>29,322</td>
</tr>
<tr>
<td>Emissions from Flare (98% efficiency)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not combusted (2% methane, 100% CO\textsubscript{2})</td>
<td>33</td>
<td>4,561</td>
<td>5,392</td>
</tr>
<tr>
<td>Combusted</td>
<td>Converts to CO\textsubscript{2}</td>
<td>4,469</td>
<td>4,469</td>
</tr>
<tr>
<td>Total CO\textsubscript{2}-e</td>
<td>-</td>
<td>-</td>
<td>39,183</td>
</tr>
</tbody>
</table>

Figure 1: Comparison of Annual CO\textsubscript{2}-e Emissions During Site Life

\textsuperscript{†}Assumes 70\% of LFG collected from the expansion area (only), with 98\% of collected methane combusted.

\textsuperscript{5} A tonne, also called a metric tonne, is 1,000 kilograms or approximately 2,200 pounds.

From Figure 1, we can also see that adding a landfill gas collection system to the existing waste footprint (shown as “do nothing”) would not provide a significant benefit. The landfill gas generated by the existing cell has nearly reached its peak at the time the new waste footprint opens. LFG controls would likely not be constructed in time to capture this peak generation period.

1.2 Emissions of Leachate Collection and Haulage

The key points considered for climate change impacts of implementation of a leachate collection system are as follows:

- Construction vehicles and materials used for installing leachate collection/management system.
- Tanker trucks which will transport the collected leachate off-site for treatment.
- Additional energy use to operate collection system (pumps, monitoring systems).
- Distance to a facility to treat leachate.

Emissions from medium duty diesel vehicles are estimated using emission factors\(^7\) and average vehicle fuel consumption\(^8\) data. Combining these allows us to create a CO\(_2\)e value for interpretation of the effect of Leachate Collection on climate change.

Implementing a leachate collection system (proposed in Alternatives 2 and 4) will require additional infrastructure to operate. The emissions from vehicles and manufacturing components must also be taken into account for constructing the system itself. While the emissions of the production of materials and the construction of a leachate collection system are beyond the scope of this assessment, the operational emissions from transporting leachate for off-site treatment can be modeled as discussed below.

Table 1-3 outlines the CO\(_2\)e emissions from trucking leachate for off-site treatment to two pollution control plants in the County of Brant (the closest two plants were selected). The closest (and largest treatment capacity) plant is located at 120 Race Street (the Paris WWTP), and the second closest plant is located at 43 Victor Boulevard (the St. George WWTP). The plant at 120 Race Street was selected for emissions modeling as it has the largest capacity for treatment.

Emissions for operating the leachate collection system would originate from energy provided by the electrical grid. In the event of a power outage, diesel generators could be used to allow

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\(^8\) Natural Resources Canada: Canadian Vehicle Survey 2009 Summary Report.
continuous operation, though power disruptions of several hours may not require such supplemental electrical power.

1.2.1 Emissions of Trucking Leachate for Off-Site Treatment

Table 1-3 compares the emissions of trucking leachate for off-site treatment verses the emissions without trucking. These emissions are for the entire site, though they only apply to the expansion areas under Alternatives 2 or 4.

<table>
<thead>
<tr>
<th></th>
<th>Landfill Emissions (CO₂-e Mg/y)</th>
<th>With 3 Trucks/Day</th>
<th>With 9 Trucks/Day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(CO₂-e Mg/y) % Increase</td>
<td>(CO₂e Mg/y) % Increase</td>
<td></td>
</tr>
<tr>
<td>Expansion 2020</td>
<td>32,450</td>
<td>32,490 0.13%</td>
<td>32,570 0.38%</td>
</tr>
<tr>
<td>Closure 2050</td>
<td>39,060</td>
<td>39,100 0.10%</td>
<td>39,180 0.31%</td>
</tr>
<tr>
<td>Post Closure 2080</td>
<td>9,190</td>
<td>9,230 0.44%</td>
<td>9,310 1.32%</td>
</tr>
</tbody>
</table>

The emission estimates are based on current medium duty diesel vehicles. It is expected that trucking technology will change, and the resulting Greenhouse Gas emissions will fall in the future. Even without quantifying this likely change, we note that leachate trucking emissions are less than 2% of the landfill emissions at the assumed end of the site’s post-closure care period (2080), and less than 1% during the site’s (expanded) operating life. It is therefore reasonable to consider the effect of leachate trucking to be negligible from a Greenhouse Gas perspective.

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Appendix E

Landfill Gas Collection Options
Technical Memorandum

Date: July 24, 2018  Project No.: 300036031.0000

Project Name: Landfill Gas Collection Options

Client Name: County of Brant

Submitted By: James R. Hollingsworth, P.Eng.

Reviewed By: Kent Hunter, P.Eng.

1.0 Background

The May 15, 2014 Terms of Reference Notice of Approval included the following amendment to the Terms of Reference:

Under Section 6.3, the following text will be added:

- As per Ontario Regulation 232/98, proponents are required to collect and burn or use the landfill gas generated at the site during site operation and following site closure if the total waste disposal volume is being increased to more than 1.5 million m³. Therefore, in addition to assessing alternative expansions and footprints to accommodate the increase of landfill capacity, the County will also assess landfill gas collection options for each alternative method. This will ensure that potential natural environmental impacts as a result of landfill gas emissions are minimized and mitigated, and to ensure that considerations for climate change are adequately assessed.

The goal of O.Reg. 232/98, s. 15, and the reason for this assessment, is to minimize greenhouse gas production. Methane is a potent greenhouse gas 25 times more effective than CO₂ at trapping heat in the atmosphere over a 100-year period. This memo addresses the requirement to assess landfill gas (LFG) collection options for each of the four Alternative Methods.

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1 Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report (2012)
2.0 Design Parameters

In order to determine the preferred alternative, we must consider the following design parameters:

1. Target LFG Collection Efficiency

2. Implementation Schedule

2.1 Target LFG Collection Efficiency

Annual LFG collection efficiencies range from 50% to 95%, with an average annual efficiency of 75% [ref. 6a]. It is noted that:

- Collection efficiency is usually low during site operations.
  - The collection system must have sufficient waste depth to operate effectively (it must be deep or use less than optimum draw (suction) to avoid air capture); and
  - The collection system layout may be limited to prevent collision/damage from operating equipment.

- Once an area of the site reaches closure, efficiency can increase.
  - Final closure cover can act as a barrier, helping trap the LFG within the waste and improving collection efficiency; and
  - Disposal operations are no longer a concern, so the LFG system can add additional horizontal trenches or vertical wells to improve and maximize collection efficiency.

- A system’s overall LFG collection efficiency allows for down time to address maintenance and unanticipated repairs. A system repair that takes one week reduces the system’s potential efficiency by just less than 2% (1 week + 52 weeks). If a system hopes to maintain an annual efficiency of 70% and includes 1 week of down-time, the actual operating efficiency for the rest of the year needs to be 71.4%.

- LFG collection efficiency increases with the size of the landfill site. This EA is seeking to expand the Biggars Lane Landfill by 1.13 Mm³, giving it a total disposal capacity of approximately 1.86 Mm³. Even after the expansion the site will be among the smallest in Ontario with a LFG collection system.

Current industry practice is to assume a collection efficiency of 75% of the methane generated annually. This may be difficult for the Biggars Lane Landfill to achieve during initial, post expansion, site operations. The site’s fill rate, waste depth and area under final cover will be low initially. However, upon closure of fill areas, LFG collection efficiency is expected to improve. As an example, the 5.9 Mm³ Oxford County Waste Management Facility has targeted a 70% collection efficiency, yet after many years of operation it has only achieved a 20%

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2 Based on Ontario’s 2011 large landfill site list (https://www.ontario.ca/data/large-landfill-sites, accessed March 28, 2018), the Biggars Lane Landfill will rank 30th or lower after expansion.
efficiency [ref. 8]. It is expected that the Oxford site’s collection efficiency will increase over time, as final cover is applied to completed cells.

We recommend a target efficiency of 70% collection efficiency over the life of the expansion area. We assume the efficiency will be less than 70% during operations, that the site will achieve a higher capture rate (above 70%) as areas of the site close, and that the most efficient LFG collection will occur during the post-closure period.

2.2 Phasing/Timing of System Operation

The associated LFG capture guideline [ref. 2] says that “phasing/timing of system installation, start up and operation – particularly with respect to integration with overall landfill operation and maximizing landfill gas control” must be considered. Combusting LFG that has a low percentage of methane – the part that burns – is not practical for greenhouse gas destruction. Doing so would require another energy source such as propane or natural gas, resulting in additional greenhouse gases or emissions.

2.2.1 Timing of LFG Generation

When waste is landfilled it undergoes aerobic (with oxygen) and then anoxic (depleted oxygen) decomposition stages where little methane is generated. Once the oxygen has been used up, anaerobic (without air) conditions result in methane generation. As waste depth increases it is more difficult for air (oxygen) to be replenished, leading to methane generation.

The generation of landfill gas is discussed in the Technical Memorandum on Landfill Gas Modeling (Appendix A of the Technical and Operational Considerations report). As described there, the LandGEM software predicts landfill gas emissions based on the volume and timing of waste placement. For the Biggars Lane Landfill expansion, LandGEM predicts the first five years of operation will represent less than 2% of the LFG generated (i.e., without collection and flaring) during its entire operating and post-closure life. Less than 7% will be generated in the first 10 years. Peak LFG generation will occur in the last year of waste disposal, year 2050.

2.2.2 Sequence of Landfill Development

The expansion footprint area(s) will be developed in a series of “cells”. Cell development sequences balance the capital cost of construction with environmental needs, rate-of-fill and operational considerations. Cells often provide five to seven years of disposal capacity before the next cell is required, though shorter and longer periods are also possible.

- For Alternative Methods 1 and 3, we are anticipating cell development every 1.5 years. Such a short period, while uncommon, has been selected due to leachate impact concerns (see Geology and Hydrogeology Considerations Report).

- For Alternative Methods 2 and 4, we are anticipating cell development approximately every 5 years. This is a more common cell development period for planning purposes.
A cell providing five years of capacity during the beginning of a landfill’s life will contain less volume than each subsequent cell. The last 5-year cell would typically be the largest. This is because a landfill’s rate-of-fill is closely associated with the population served. Excepting any change to disposal patterns, as the County of Brant grows so will its waste disposal needs. Determining the cell development and filling sequence is a detailed design effort that will be completed as part of the Environmental Protection Act approval process.

### 2.2.3 Anticipated LFG Collection Timing

Due to the site’s anticipated fill rate and resulting waste depth, methane generation is likely to begin slowly, after 4 to 7 years of waste have been landfilled. However, the LandGEM model assumes that the waste will begin generating LFG one year after waste placement. Using LandGEM, Burnside estimated the combination of when LFG collection begins and the required annual collection efficiency to achieve an overall 70% collection efficiency for the expanded site’s entire LFG generating lifespan. The results are provided in Table 2.1.

#### Table 2-1: Collection Efficiency Required to Achieve 70% Average (Site Life) Collection Efficiency

<table>
<thead>
<tr>
<th>Alternative Method</th>
<th>Efficiency Required if Collection Begins in…</th>
<th>Upon Closure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Year 6</td>
<td>Year 11</td>
</tr>
<tr>
<td>1</td>
<td>71%</td>
<td>75%</td>
</tr>
<tr>
<td>2</td>
<td>71%</td>
<td>75%</td>
</tr>
<tr>
<td>3</td>
<td>73%</td>
<td>80%</td>
</tr>
<tr>
<td>4</td>
<td>73%</td>
<td>79%</td>
</tr>
</tbody>
</table>

Note: Alternative Methods 3 and 4 have two waste footprints. In both cases, the west footprint is assumed to be the first area filled (beginning in 2020). LFG collection begins after the indicated number of years of operation in the footprint. For example, the first column (Year 6) means 6 years after the west footprint opens, several years for filling the west footprint, and then another 6 years after the east footprint opens. The same is true for the second column (Year 11), but it’s 11 years after each footprint opens.

‡ West footprint LFG collection starts in Year 16 (for all Alternative Methods), and east LFG collection starts 6 years after filling begins in the east cell (for Alternative Methods 3 and 4).

* For Alternative Methods 3 and 4, west footprint reaches closure and east footprint LFG collection starts 6 years after filling begins in the east cell.

§ Even if 100% of the LFG could be collected shortly after closure of the footprint, it would not be sufficient to achieve a 70% average collection efficiency over the site’s operating and post-closure LFG generating life.

Since average annual LFG collection efficiencies are typically 75% [ref. 6a], it is recommended that collection begin in Year 11 of site operation or sooner. For Alternative Methods 2 and 4, at least one and perhaps two cells will be completed by this time with closure cover partly in place; closure cover won’t be placed on surfaces that are to receive additional waste during
subsequent cell development. For Alternative Methods 1 and 3, several smaller cells will have been likewise completed with closure cover.

### 3.0 Methods of LFG Collection

There are several methods of LFG collection that can be applied at a landfill site. These methods include:

- Do Nothing;
- Passive Venting;
- Horizontal Collection Trench (Active);
- Vertical Extraction Wells (Active); and
- Combination of Horizontal and Vertical Collection.

Each of these methods were considered with regard to their possible application for the expansion of the Biggars Lane Landfill. The following sections provide a technical description of each method and a recommendation of whether the method is suited for application at the Biggars Lane Landfill. The application of the preferred method of LFG collection for each Alternative Method is further discussed in Section 4.0.

#### 3.1 Do Nothing

The actual mechanics of LFG movement are complex and can occur in many ways. However, in simple terms, waste decomposition creates LFG. As more LFG is created, pressure increases. Eventually the pressure pushes the LFG to areas with lower pressure, typically the atmosphere above the landfill. The “do nothing” method simply allows the natural process of LFG movement way from the waste mound.

The “do nothing” alternative does not meet the O.Reg. 232/98 requirement “for the collection, and for the burning or use, of landfill gas generated by the site during site operation and following site closure.” This is because the “do nothing” method does not collect the LFG and by extension, there is no means of directing the LFG to equipment for combustion or use.

The “do nothing” method is not recommended for any of the Biggars Lane Landfill Site alternative expansion methods. “Do nothing” has been included in this technical memorandum as it provides a benchmark for the evaluation of alternatives and must be considered to ensure a complete assessment in accordance with the *Code of Practice for Preparing and Reviewing Environmental Assessments in Ontario* [ref. 9].

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3 O. Reg. 232/98, s. 15 (1)
4 An enclosed and controlled flare is used for LFG combustion. Beneficial use equipment often includes a conditioning stage to remove moisture, grit and undesirable components from the LFG before it is used as a fuel for an engine or a boiler, or is injected into a natural gas pipeline.
3.2 Passive Venting

Passive venting is a means of controlling the movement of LFG. The same principles of LFG movement discussed in the “do nothing” method still apply. The difference is that instead of waiting for the LFG to make its way to the atmosphere, a passive venting system is installed to intercept the LFG before it reaches the atmosphere. Once intercepted, the passive venting system provides a preferential (easier) pathway for the LFG to escape the site. Passive venting is typically used to protect building foundations or otherwise prevent sub-surface migration of LFG beyond the location of the passive venting system.

A passive system can consist of:

- Barriers to minimize or prevent movement of LFG in certain directions. Barrier examples include landfill liners, interim and final closure cover, and purpose-built cut-off walls made of low permeability materials.

- Horizontal collection trenches placed to intercept LFG movement. These are often constructed with barriers on the far side of the collection feature; LFG moves from its source to a horizontal collection feature, with a barrier installed to prevent movement beyond the collection feature.

- Vertical collection wells are another way to provide a “path of least resistance” for the LFG to move from where it’s being generated to a lower pressure area (i.e., the atmosphere).

A passive venting system would, strictly speaking, collect LFG. To prevent significant LFG discharge to the atmosphere the collection system would require a very high density of collection pipes, wells and barrier systems to adequately capture the LFG. However, the collection would rely on the natural LFG movement processes, and mainly upon pressure differences between the LFG source and atmospheric pressure. In the case of high atmospheric pressure (weather events), the LFG could be pushed back into the landfill. This makes the collection amount highly variable over time.

While installing combustion or use equipment on a passive venting system may theoretically be accomplished, such as design is impractical if not impossible to implement for the Biggars Lane Landfill. With an uncontrolled quantity of LFG, the sizing of the equipment would be difficult to select. Further, operation of the equipment would be inconsistent without control of the LFG feed rate.

If it were possible to install a passive venting system, it could technically meet the requirements of O.Reg. 232/98. However, the cost of installing an adequate system to collect LFG before it is discharged to the atmosphere would be prohibitive. Further, a passive venting system is unlikely to receive Ministry of the Environment, Conservation and Parks approval for an expanded Biggars Lane Landfill.

A passive venting system is not recommended for any of the Alternative Methods of landfill expansion under consideration in this Environmental Assessment.
3.3 Horizontal Collection Trench (Active)

An active collection system uses extraction equipment to draw LFG through the pipe network placed over the LFG collection area. The extraction equipment is basically an industrial vacuum that lowers the pressure in the collection pipes below atmospheric pressure. The piping network endpoints can be either horizontal collection trenches (described here), vertical extraction wells (described in Section 3.4), or both (Section 3.5). Proper design of the extraction equipment, the collection network and spacing between trenches and/or wells ensures that the target efficiency is met. Once captured, the collection network directs the LFG to equipment for combustion or use, meeting the requirements of O.Reg. 232/98.

Horizontal collection trenches consist of perforated pipes surrounded by granular bedding. A typical schematic of this is shown on Figure 1. The extraction system lowers the pressure in the collection trench to draw LFG into the pipes. Horizontal collection trenches can collect LFG from areas below active landfill operations without exposing parts of the system to potential damage from the operating equipment. Horizontal collection trenches are normally installed within the waste as filling progresses.

Horizontal collection pipes are installed progressively as the landfill is developed. Some pipes may be unused for long periods of time, while waste filling operations cover them to a sufficient depth. Once operational, the LFG capture zone of the collection pipes depends on many factors. System design and construction, waste types, waste age, and cover materials (operational, interim and final) greatly influence the ultimate LFG recovery rate.

The main concerns for horizontal collection trenches are:

- **Balancing can be challenging:** Adequate collection of LFG from all parts of the system requires balancing system pressures (vacuum) to ensure LFG collection from the entire length of the trench, and from each separate branch of the system. However, as a buried system, there is less ability to balance the system during ongoing operation.

- **Differential settlement:** Waste decomposition and settlement may result in breaks in the horizontal collection trench. If this occurs the trench may no-longer collect LFG from the area beyond.

- **Leachate blockage:** If leachate is not drained from the horizontal line, either due to settlement or perched leachate conditions in the site, then the liquid will act as a barrier, preventing LFG collection from the area beyond the blockage.

- **Air intrusion:** Shallow waste and operational/interim cover over the horizontal collection trench could capture air from above.
  - Air would dilute the LFG, making it more difficult to combust or use;
  - Drawing air into the waste can disrupt the LFG generation processes; and
  - Air can also increase the risk of LFG explosion or landfill fires.
These main concerns can be addressed through proper design of the horizontal collection trench system.

A horizontal collection system would be difficult to build and operate for the Biggars Lane expansion alternatives. Horizontal systems are typically used where large operating areas remain open while LFG collection is a requirement. Given the sequence of landfill development anticipated for the alternatives (see Section 2.2.2), this is not a requirement. Further:

- Installation of a horizontal collection system would need to occur during the operation of each cell. Parallel construction activities and landfill operations would be inconvenient within the small footprint area of each cell.

- To allow operation without air infiltration, horizontal pipes need to be installed so they can operate independently for each cell as cover is applied. Pipes close to the next cell may need to be installed with valves or other controls to prevent air infiltration. Access to these valves may be difficult as filling progresses.

- If valves fail, excavation for repairs would be expensive, would release LFG (odours and GHG issues) and may retard future LFG production in the area due to oxygen exposure (stopping anaerobic LFG processes that generate methane).

Figure 1: Horizontal Collection Trench Cross-Sections (Typical)
Based on these reasons, an active horizontal collection trench system should not be considered for collecting LFG from an expanded Biggars Lane Landfill.

### 3.4 Vertical Extraction Wells (Active)

A vertical extraction well system uses the same extraction, piping and combustion or use equipment described in the first paragraph of Section 3.3. A typical vertical extraction well is shown on Figure 2. Although not shown on Figure 2, some designs include a lockable chamber, above or below final cover grade, to protect the part of the well above the landfill surface.

Vertical extraction wells are generally considered more efficient when used at sites like Biggars Lane Landfill where the footprint area is limited (Alternative Method 1 is 15.1 ha, and all other alternatives are smaller) and the waste depth is shallow (Alternative Method 2 has an average depth of 7.9 m, while all other footprints are less). A vertical extraction well is typically installed after waste filling has been completed for an area, often while final cover is being placed. They are installed using similar equipment to water wells. Vertical extraction wells can be extended if required due to continued filling in an area.

Common concerns for vertical extraction wells are:

- Extending wells as the vertical layers (lifts) of waste placement progress can be accomplished, though these extendable wells may not be as efficient for LFG collection.

- If installed within an active landfilling area, they may be damaged by landfill equipment or waste delivery vehicles.

- Depending on the location, well installation during final cover placement could mean that several years of operation have already occurred and the LFG generated during that (pre-installation) time has already escaped.

- Equipment used for well installation may have limited ability to work on the landfill’s slopes. Benching may be required, though that may have geotechnical slope stability implications.

- Pipe perforations (see Figure 2) too close to the landfill surface, or where the well’s capture zone intersects landfill side slope, can result in air capture.

- Care must be taken to ensure the extraction well installation does not pierce the landfill liner (if any) or create a preferential pathway for leachate into the groundwater.

- Wells are expected to fail over time, requiring replacement over the life and post-closure care period of the site. However, because wells are installed from the surface, it is much easier to repair or install wells than it is to repair horizontal collection trenches, which are buried.
With careful design, coordination of landfill operating/closure sequence, well construction and extraction system operation, the common concerns for vertical extraction well systems can be addressed. As such, an active vertical extraction well system can be considered for collecting LFG from an expanded Biggars Lane Landfill.

### 3.5 Combination of Horizontal and Vertical Collection

A combination of horizontal collection trenches and vertical extraction wells can also be used with an active LFG collection system. Typically, this combination system uses trenches to collect LFG while landfill operations are underway. This is particularly true of very large landfills (much larger than the Biggars site) where an area may be filled in many lifts (layers) before...
closure cover is applied. When final closure cover is ready to be installed for an area, extraction wells are added. This can improve the system’s overall efficiency. Depending on the design, extraction from the trenches may be discontinued as wells are installed in the same collection zone.

The same concerns of individual horizontal or vertical collection systems apply to such a combined system. However, the concerns for the horizontal system may be mitigated as that part is replaced later in the site’s life with vertical wells.

Overall, a combination system could be considered for collecting LFG from an expanded Biggars Lane Landfill. However, given the size (footprint) and average depth of the alternative expansion methods, there is little to be gained from an efficiency perspective while the additional capital cost would be significant. As a result, Burnside does not recommend a combined horizontal and vertical LFG collection system for the Biggars Lane Landfill.

4.0 Preferred LFG Collection Option

There are four alternative expansion methods proposed for the Biggars Lane Landfill. Although they are all intended to provide disposal capacity until 2050 (30 years and 1.13 Mm³ of disposal capacity), each alternative varies in its footprint, waste depth, liner and cover requirements. Details are provided in the following reports:

- Report on Phase 2 Activities,
- Geologic and Hydrogeological Assessment Report,
- Stormwater Management Assessment Technical Memo, and
- Technical and Operational Considerations Report.

While vertical extraction wells (active) are the preferred method of collection, the differences noted may affect the timing of well installations, the distance between wells, or other factors. The subsections below describe the currently preferred LFG collection options for each alternative.

Regardless of the preferred LFG collection system applied to an alternative expansion method, it is assumed that the detailed design for the preferred method will attempt to achieve the LFG collection requirements described in Section 2.0, namely an average collection efficiency of 70% when measured over the life of the expansion (including the site’s post-closure, LFG generating, period).

It is noted that Burnside is working from conceptual designs for each alternative and we have not prepared expansion or LFG collection system designs. Detailed design of the preferred alternative will follow completion of the EA process. We anticipate that the conceptual design advice provided here will be considered as part of the detailed design process. The designers are not constrained by the preferred LFG collection option described below though they are expected to achieve or exceed the 70% methane collection rate over the methane generating life of the expansion.
4.1 Alternative Method 1

This alternative involves a single waste footprint on native soils, with the landfill operating as a natural attenuation site. Some conceptual design parameters relevant to LFG generation are provided in Table 4.1.

Table 4-1: Alternative Method 1 Capacity Parameters

<table>
<thead>
<tr>
<th></th>
<th>Alternative Method 1</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Footprint Area</td>
<td>15.1</td>
<td>hectares (ha)</td>
</tr>
<tr>
<td>Waste Volume</td>
<td>1,130,000</td>
<td>cubic metres (m³)</td>
</tr>
<tr>
<td>Average Waste Depth</td>
<td>7.5</td>
<td>metres (m)</td>
</tr>
<tr>
<td>Peak Waste Depth</td>
<td>13.0</td>
<td>metres (m)</td>
</tr>
</tbody>
</table>

Based on hydrogeological modeling (see Geologic and Hydrogeological Assessment Report), Alternative Method 1 requires final cover with very low permeability\(^5\) installed progressively, about every 1.5 years. The low permeability cover may act as a barrier, enhancing LFG collection. To allow progressive installation of final cover, the area to be covered (the cell) must first be filled. This means that filling will be focussed on as small an area as practical so that the final waste elevation (thickness) can be reached quickly.

With small, 1.5-year cells, the distance to an uncovered above grade slope may be relatively short. Such uncovered slopes would allow air into the LFG collection system. To avoid this, Burnside is recommending that several cells be completed with final cover before installing (or operating) the LFG collection system. Based on modelling (see Table 2.1), it’s recommended that the LFG collection system begin operating in Year 11 or earlier. Earlier operation, perhaps after two or three (1.5-year) cells are closed, may also be practical and would be preferred.

An active vertical extraction well system is preferred for this alternative based on the rationale provided in Section 3.0. The vertical LFG collection system could be developed for the site in stages. During the first several years of operation (between five and ten years, per Table 2.1), no LFG collection efforts are required. Subsequently:

1. Approximately one year before LFG collection is to begin, the County would construct/install the extraction equipment, the first vertical collection well field (penetrating and repairing the closure cover as required), the first segment of the collection network piping and the combustion or use equipment.

2. Move landfilling operations to the next cell.

\(^5\) Low permeability refers to the ability of the cover to prevent infiltration of precipitation. The cover will also act as a barrier, limiting the capture of air by the LFG collection system.
3. As subsequent cells are filled (approximately every 1.5-years):
   
a) Construct additional vertical extraction well(s) and connect the well(s) to the collection network piping.

   b) Install the final closure cover on the cell.

4. Repeat steps 2 and 3 to the end of the site life.

4.2 Alternative Method 2

The second expansion alternative is a single waste footprint with a landfill liner and a leachate collection system. It uses a standard closure cover, per O.Reg. 232/98, rather than the very low permeability cover of Alternative Method 1. Other design parameters are provided in Table 4.2.

Table 4-2: Alternative Method 2 Capacity Parameters

<table>
<thead>
<tr>
<th></th>
<th>Alternative Method 2</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Footprint Area</td>
<td>14.3</td>
<td>hectares (ha)</td>
</tr>
<tr>
<td>Waste Volume</td>
<td>1,130,000</td>
<td>cubic metres (m³)</td>
</tr>
<tr>
<td>Average Waste Depth</td>
<td>7.9</td>
<td>metres (m)</td>
</tr>
<tr>
<td>Peak Waste Depth</td>
<td>15.0</td>
<td>metres (m)</td>
</tr>
</tbody>
</table>

As discussed in Section 2.2.2, cells will be constructed for staged development and operation of Alternative Method 2. Assuming an average cell life of five years, it is reasonable to assume one or two cells will be completed before LFG collection begins in Year 6 or 11 (see Section 2.2.3). A vertical well field could be developed just before this time in the cells that have closed or are approaching closure. Installation of the closure cover will act as a barrier to air infiltration, improving the collection efficiency. The sequence of LFG system development would be the same as Alternative Method 1, though the subsequent well installations would mirror the cell development frequency (5 years versus 1.5 years).

4.3 Alternative Method 3

Alternative Method 3 is similar to Alternative Method 1 but with two waste footprints instead of one. The two expansion areas are referred to as the “west” and “east” footprints. Filling would be completed in one footprint before moving to the second footprint. Like Alternative Method 1, each waste footprint will have a very low permeability final cover installed progressively every 1.5 years. The conceptual design parameters for Alternative Method 3 are provided in Table 4.3.
Table 4-3: Alternative Method 3 Capacity Parameters

<table>
<thead>
<tr>
<th>Alternative Method 3</th>
<th>West</th>
<th>East</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Footprint Area</td>
<td>10.9</td>
<td>4.7</td>
<td>hectares (ha)</td>
</tr>
<tr>
<td>Waste Volume</td>
<td>786,000</td>
<td>346,000</td>
<td>cubic metres (m³)</td>
</tr>
<tr>
<td>Average Waste Depth</td>
<td>7.2</td>
<td>7.4</td>
<td>metres (m)</td>
</tr>
<tr>
<td>Peak Waste Depth</td>
<td>13.0</td>
<td>9.0</td>
<td>metres (m)</td>
</tr>
</tbody>
</table>

As the larger footprint, it is expected that the west footprint will be developed first. LFG collection from this footprint should start in Year 11 or sooner (see Section 2.2.3). It is anticipated that an active vertical extraction well system will be constructed and expanded in the same way as described for Alternative Method 1 (Section 4.1). The last well field expansion for the west footprint will coincide with it's closure cover installation.

As the west footprint is nearing the end of it's operating life (last one or two years), the east footprint will be constructed. Operations will begin in the east footprint once the west footprint has been filled. LFG collection in the east footprint should start 11 years, or sooner, following the beginning of operations in the east footprint.

An active vertical extraction well system is preferred for the east footprint. The east footprint well field can be connected to the existing west footprint collection equipment, piping network and the combustion or use equipment. Alternately, dedicated collection equipment, piping network and combustion or use equipment can be installed for the eastern footprint. In this latter case, it may be beneficial to consider connecting the individual systems to allow components of either system, say the combustion equipment, to provide backup to the opposite system.

4.4 Alternative Method 4

Like Alternative Method 2, Alternative Method 4 makes use of a landfill liner and a leachate collection system. Alternative Method 4 and Alternative Method 3 are also similar in that they have “west” and “east” waste footprints. Table 4.4 provides some conceptual design details for Alternative Method 4.

Table 4-4: Alternative Method 4 Capacity Parameters

<table>
<thead>
<tr>
<th>Alternative Method 4</th>
<th>West</th>
<th>East</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Footprint Area</td>
<td>11.7</td>
<td>8.2</td>
<td>hectares (ha)</td>
</tr>
<tr>
<td>Waste Volume</td>
<td>660,000</td>
<td>476,000</td>
<td>cubic metres (m³)</td>
</tr>
</tbody>
</table>
As with Alternative Method 3, it is assumed that the west footprint will be developed first. Installation of a vertical well field should be scheduled to allow LFG collection and combustion or use in Year 11 or sooner. One or two cells of the west footprint are likely to be completed and covered by this time, which will help with the collection efficiencies. 11 years or sooner after the opening of the east footprint, the east (vertical) well field should begin operation. As with Alternative Method 3, a dedicated LFG collection and combustion or use system can be created for the east footprint, or the east well field can be fed into the west system.

### 5.0 LFG Collection Contingencies

For all alternative expansion methods, the LFG created by the site and the portion collected by the LFG collection system should be monitored. Monitoring should include testing for the presence of methane in leachate monitoring wells and/or gas probes. The presence of air (oxygen) in the collected LFG is also an important indicator. Efforts to rebalance the system to draw from specific parts of the site may be necessary to collect more methane from an area or to avoid air capture.

Ongoing monitoring will be required during landfill operation (filling) and after the site receives its last load of waste. LFG generation can continue for 40, 50 years or more after the last load of waste is received. Therefore, the LFG system operation will be required for this entire post-closure period. Monitoring of the LFG system and gas probes/leachate monitoring wells during the post-closure period will determine when the system can be decommissioned.

Should additional LFG collection be required, the system operator may decide to increase the vacuum on the existing vertical extraction wells. However, this may not be enough; additional vertical extraction wells may be required. These can be placed into areas where filling has been completed or areas that have not yet reached final contours. In the latter case, the well may need to be extended as filling continues.

### 6.0 References

The following information was reviewed and used in preparation of this technical memorandum:


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6 LFG monitoring will only work if the well screen extends above the leachate level within the well.

3. Report on Phase 2 Activities, Environmental Assessment to Expand the Biggars Lane Landfill, County of Brant, prepared by Golder Associates Ltd., May 2016.
   a. Appendix A: technical memorandum, Alternative Methods, Biggars Lane Landfill Expansion Environmental Assessment, County of Brant, Ontario, May 18, 2016.


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