Draft Conceptual Design Report

Twin Creeks Environmental Centre Landfill Optimization Project Environmental Assessment

Waste Management of Canada Corporation

Watford, Ontario

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Prepared by:

WSP Canada Inc.
55 King Street, Suite 700
St. Catharines, ON L2R 3H5

Acronyms, Units and Glossary

Acronyms

Acronym	Definition
EA	Environmental Assessment
ECA	Environmental Compliance Approval
EVGS	Early Vertical Gas System
FEM	Finite Element Model
GHG	Greenhouse Gas
IDF	Intensity-Duration-Frequency
LFG	Landfill Gas
MECP	Ministry of Environment, Conservation and Parks
OEAA	Ontario *Environmental Assessment Act*
PLCS	Primary Leachate Collection System
SRF	Strength Reduction Factor
TCEC	Twin Creeks Environmental Centre
ToR	Terms of Reference
WM	Waste Management of Canada Corporation

Units

Unit	Definition
cm/s	centimetres per second
ha	hectare
GPa	gigaPascal
km	kilometre
kN/m^3	kiloNewtons per cubic metre
kPa	kilopascal
MPa	megapascal
m	metre
m^2/s	square metres per second
m^3	cubic metres
Mm	millimetres
scfm	standard cubic feet per minute
T/m^3	tonnes per cubic metre

Glossary

Term	Definition
Approval	Permission granted by an authorized individual or organization for an undertaking to proceed. This may be in the form of program approval, certificate of approval or provisional certificate of approval.
Capacity (Disposal Volume)	The total volume of air space available for disposal of waste at a landfill site for a particular design (typically in m^3); includes both waste and daily cover materials, but excludes the final cover.
Circular Failure Surface	A hypothetical curved plane within a slope along which a potential soil failure might occur.
Composting	The controlled microbial decomposition of organic matter, such as food and yard wastes, in the presence of oxygen, into finished compost (humus), a soil-like material. Humus can be used in vegetable and flower gardens, hedges, etc.
Composting facility	A facility designed to compost organic matter either in the presence of oxygen (aerobic) or absence of oxygen (anaerobic).
Environment	As defined by the Ontario *Environmental Assessment Act*, environment means: • air, land or water; • plant and animal life, including human life; • the social, economic and cultural conditions that influence the life of humans or a community; • any building, structure, machine or other device or thing made by humans; • any solid, liquid, gas, odour, heat, sound, vibration or radiation resulting directly or indirectly from human activities; or • any part or combination of the foregoing and the interrelationships between any two or more of them (ecosystem approach).
Environmental Assessment (EA)	A systematic planning process that is conducted in accordance with applicable laws or regulations aimed at assessing the effects of a proposed undertaking on the environment.
Evaluation criteria	Evaluation criteria are considerations or factors taken into account in assessing the advantages and disadvantages of various alternatives being considered.
Greenhouse gas (GHG)	Any of the gases whose absorption of solar radiation is responsible for the greenhouse effect, including carbon dioxide, methane, ozone, and the fluorocarbons.
Indicators	Indicators are specific characteristics of the evaluation criteria that can be measured or determined in some way, as opposed to the actual criteria, which are fairly general.
Landfill gas (LFG)	The gases produced from the wastes disposed in a landfill; the main constituents are typically carbon dioxide and methane, with small amounts of other organic and odour-causing compounds.
Landfill site	An approved engineered site/facility used for the final disposal of waste. Landfills are waste disposal sites where waste is spread in layers, compacted to the smallest practical volume, and typically covered by soil.
Leachate	Liquid that drains from solid waste in a landfill and which contains dissolved, suspended and/or microbial contaminants from the breakdown of this waste.
Mitigation	Measures taken to reduce adverse impacts on the environment.
Proponent	A person who: • carries out or proposes to carry out an undertaking; or • is the owner or person having charge, management or control of an undertaking.
Receptor	The person, plant or wildlife species that may be affected due to exposure to a contaminant.

Glossary

Term	Definition
Terms of Reference (ToR)	A Terms of Reference is a document that sets out detailed requirements for the preparation of an Environmental Assessment.
Time of concentration	The time required for water falling on the most remote point of a drainage basin to reach the outlet where remoteness relates to time of travel rather than distance.
Undertaking	Is defined in the Ontario *Environmental Assessment Act* as follows: • An enterprise or activity or a proposal, plan or program in respect of an enterprise or activity by or on behalf of Her Majesty in right of Ontario, by a public body or public bodies or by a municipality or municipalities; • A major commercial or business enterprise or activity or a proposal, plan or program in respect of a major commercial or business enterprise or activity of a person or persons other than a person or persons referred to in clause (1) that is designated by the regulations; or • An enterprise or activity or a proposal, plan or program in respect of an enterprise or activity of a person or persons, other than a person or persons referred to in clause (a), if an agreement is entered into under section 3.0.1 in respect of the enterprise, activity, proposal, plan or program ("enterprise").
Waste	Refuse from places of human or animal habitation; unwanted materials left over from a manufacturing process.

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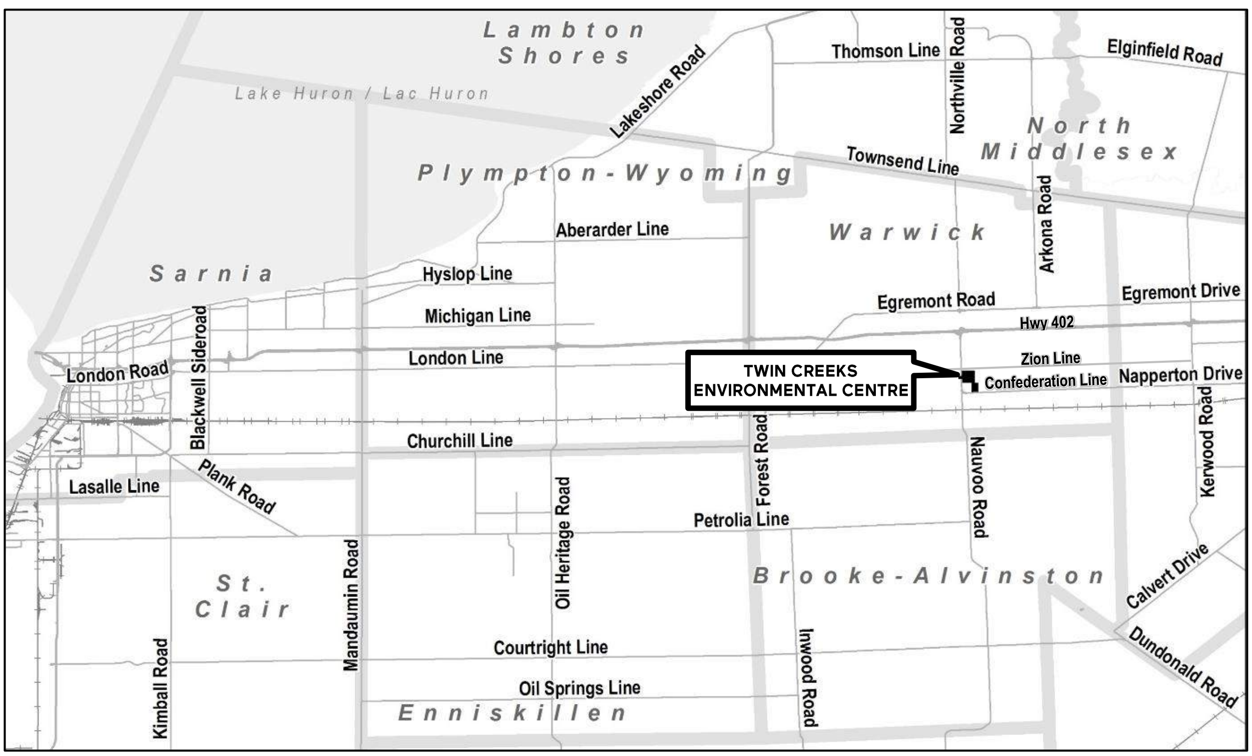
1 Introduction

1.1 Background

WM Canada (WM), the owner and operator of the Twin Creeks Environmental Centre (TCEC) in Watford, Ontario, has initiated the Environmental Assessment (EA) seeking approval to develop additional landfill disposal capacity as part of the optimization of the design and operation of the TCEC landfill. The proposed optimization would provide additional airspace of approximately 14 million cubic metres (m^3), which could extend the site life by approximately 12 years (from 2031 to 2043) and may be achieved through alternative landfill configurations or alternative methods within the existing 301 hectare (ha) TCEC site area. No changes are proposed to the size of the TCEC site area, approved service area, or annual fill rate.

The TCEC is located in the Township of Warwick near the Village of Watford, at the corner of Nauvoo Road and Zion Line, within the County of Lambton (**Figure 1-1**).

Figure 1-1. Location of the TCEC



The TCEC began operation as the Warwick Landfill in 1972. WM has owned and operated the TCEC since 1996. The landfill was approved under the Ontario *Environmental Assessment Act* (OEAA) for expansion in 2007 and has total airspace capacity of 26,508,000 m^3 over an area of 101.8 ha (referred to as the Closed Old Landfill and Expansion Landfill). The landfill provides safe and convenient disposal services for communities, businesses and industries serving the Province of Ontario. This landfill is approved to receive municipal, industrial, commercial, and institutional solid non-hazardous wastes, including non-hazardous contaminated soil. The TCEC is permitted to receive up to a maximum of 1.4 million tonnes per year of waste including contaminated soil for disposal at the site.

The landfill is engineered with environmental protection systems that meet or exceed regulatory requirements and is subject to highly regulated monitoring and reporting requirements. Systems include engineered liners and covers, leachate collection and management, landfill gas collection and control, and on-site leachate disposal through a phytoremediation system consisting of a 9.3 ha poplar system planted on the existing landfill cap in 2003. Surplus leachate is trucked off-site to approved wastewater treatment plants.

The Environmental Compliance Approval (ECA) A032203 for the TCEC allows the landfill to receive up to a maximum of 1.4 million tonnes per year of waste including contaminated soil for disposal at the site. The TCEC typically receives between 5,000 to 7,500 tonnes of residual waste, with an average of 200 waste hauling vehicles, per weekday. There are approximately 10 years of approved airspace capacity remaining at the Expansion Landfill (i.e., capacity will be reached in approximately 2031).

The layout of the TCEC is shown on **Figure 1-2**.

Figure 1-2. Layout of the TCEC

Source: HDR

The EA is being carried out in accordance with the requirements of the Ontario *Environmental Assessment Act* (OEAA) and Terms of Reference (ToR), which was approved by the Ministry of Environment, Conservation and Parks (MECP) on December 13, 2022.

'Alternative methods' of carrying out the undertaking are different ways of implementing the proposed project. As outlined in the approved ToR, the development of additional landfill capacity within the TCEC site area can be achieved through a vertical expansion of the currently approved Expansion Landfill footprint (75.4 ha within the 101.8 ha landfill area) or a horizontal expansion into other areas of the TCEC site. Based on a qualitative consideration of the potential vertical and horizontal expansion methods available within the site area, in addition to potentially locating waste in close proximity to the Village of Watford, horizontal alternative methods would result in significant additional costs and would not optimize the use of the available and constructed infrastructure at the site to the extent possible. Given the financial, technological, and community risks and concerns associated with the horizontal alternative methods, WM identified a preference for a vertical alternative method.

WM committed to undertaking a screening of vertical and horizontal alternative methods as part of the EA to confirm that a vertical alternative method would be preferred. The screening of alternative methods examined the development of approximately 14 million m^3 of landfill capacity within the 301 ha TCEC site area through a:

- vertical expansion within the currently-approved Expansion Landfill footprint (as per the EA submitted in 2005 and approved in 2007, and the 2017 Environmental Screening);
- horizontal expansion into other available areas of the TCEC site; or
- horizontal expansion over the closed Old Landfill to the east of the Expansion Landfill.

Representative concepts were developed for vertical and horizontal alternative methods within the defined development areas to accommodate the required landfill capacity. The representative concepts were intended to encompass several different landfill configurations that could occur within the defined development areas. These three representative alternative methods were evaluated and comparatively screened against each other using criteria consisting of:

- Environmental considerations;
- Cost and Constructability considerations;
- Technical considerations;
- Social and Cultural considerations; and
- Land Use considerations.

The results of the screening indicate that the representative vertical alternative method located within the expansion landfill footprint is preferred over the horizontal alternative methods for all criteria and considerations (HDR, 2024).

WM is proceeding with developing specific vertical alternative methods within the expansion landfill footprint area to achieve the additional landfill capacity. These vertical alternative methods will be assessed and comparatively evaluated in the EA in order to identify a preferred alternative.

1.2 Objectives

This Conceptual Design Report presents the conceptual design and operations details for three vertical alternative methods within the Expansion Landfill area, which are based on the preliminary alternative methods identified in the approved ToR. The ToR identified four preliminary vertical alternative methods; however, flexibility was included in the ToR to adjust the alternative methods to be considered in the EA.

The purpose of this report is to provide sufficient detail to enable each environmental discipline to assess the potential environmental effects of the alternative methods and to form the basis of their comparison. The outcome of the comparison will be the identification of a preferred alternative which will be compared against the ‘do nothing’ alternative. The ‘do nothing’ alternative is the Expansion Landfill as currently approved in the 2005 EA and 2017 Environmental Screening.

The aspects of the design and operations of the alternative methods included in this Conceptual Design Report are as follows:

- Landfill design and geometry (location, orientation, volume, key design features);
- Buffer zones around the waste footprint;
- Site development (phasing and schedule of landfill development and construction activities);
- Leachate generation, management, and treatment;
- Landfill gas generation, management, and treatment;
- Stormwater management;
- Ancillary facilities;
- Traffic management; and
- Landfill operations (operating hours, site equipment, waste placement, daily and intermediate cover, and nuisance controls).

The vertical expansion is intended to be carried out in accordance with O. Reg. 232/98 and the associated guidance document “Landfill Standards: A Guideline on the Regulatory and Approval Requirement for New or Expanding Landfilling Sites” (MOE, 2012).

A discussion is also provided on climate change considerations including the effects of climate change on the conceptual design (stormwater, operations, landfill gas, leachate) and the effects of the conceptual design on climate change (generation and emissions of landfill gas).

Upon selection of a preferred alternative method for the project, and completion of the EA, WM will proceed to develop the detailed design for the selected alternative method. It is understood that the concept presented in this report will be refined during detailed design.

2 Conceptual Design of Alternative Method 1

2.1 Overview

Alternative Method 1 includes the increase of final landfill side slopes from 4H:1V to 3H:1V between the original grade and elevation 320 masl (about 16 m in grade change), transitioning to a 20H:1V upper slope and peaking at elevation 324.5 masl (**Drawing 1.1**) over the Expansion Landfill. The proposed landfill expansion consists of five stages, as shown by the different colours for the contour lines as indicated in the legend of **Drawing 1.1**. The details of these stages are discussed in Section 2.4.1.

The Expansion Landfill is fully engineered and has an approved peak elevation of 280 masl. Alternative Method 1 will provide an additional 14.3 million m^3 of landfill capacity.

Considering the proposed final side slopes of 3H:1V are steeper than the current 4H:1V, as per O. Reg. 232/98, a geotechnical feasibility review was performed to confirm the slope stability and settlement. The geotechnical assessment showed that this alternative is acceptable with respect to the stability of the final slopes (3H:1V) and proposed peak profile height. The results of the geotechnical feasibility review for Alternative Method 1 are discussed in Section 2.2.

2.2 Landfill Design and Geometry

The geometry of Alternative Method 1 is shown in plan view in **Drawing 1.1.** Under the proposed vertical expansion, the existing approved waste disposal footprint area of the TCEC would not change, but rather, the maximum permitted height of waste would be increased by 44.5 m, from 280 masl (the current approved elevation for top of waste) to 324.5 masl, which is the maximum elevation of the top of the final cover for Alternative Method 1. The 3H:1V side slopes will start at the existing landfill toe slope continuing to elevation 320 masl, and then transition to a finished grade of 5% as indicated in **Drawing 1.2**. This will increase the current landfill capacity by approximately 14.3 million m^3.

To assess the stability of the final slopes and proposed peak profile height, a preliminary slope stability analysis was performed. The slope stability analysis involved: reviewing the design of Alternative Method 1; reviewing existing background information; and building a 2-Dimensional Finite Element Model (FEM) using Slide2 Modeler version 9.020 software and adopting the Bishop Simplified factor of safety method.

For the purposes of numerical modelling, the landfill design cross-sections were simplified into three primary layers (from top to bottom): Landfill Waste; Rannoch Till Subsoil; and Bedrock. Additionally, the following assumptions were made:

- Landfill base liners and drainage layers were ignored in the modelling analysis as these materials are thin compared to the overall profile, and their effect on the results are negligible.
- Groundwater levels at the site are close to the original ground surface (approx. 238 masl). Groundwater is captured by the primary drainage layer within the landfill area.
- No internal leachate mound is expected to develop. Leachate is captured and removed by the primary drainage layer.

A summary of selected engineering properties used in the FEM is provided in **Table 2-1**.

Table 2-1. Geotechnical Parameters

Material	Parameter	Typical Range[1]	Assigned Modelling Values
Landfill Waste (including daily cover material)	Unit Weight	12-15 kN/m^3	12 kN/m^3 (based on Alston, 2006)
	Effective Internal Friction Angle	30-35 degrees	30 degrees
	Apparent Effective Cohesion	0-10 kPa	0
	Material Type		Elastic, Drained
Rannoch Till Subsoil	Unit Weight	19-22 kN/m^3	20 kN/m^3
	Effective Internal Friction	30-35 degrees	32 degrees
	Apparent Effective Cohesion	0-25 kPa	10 kPa
	Deformation Modulus (M)	10-35 MPa	13 MPa
	Over-Consolidation Ratio	3 to 6	-
	Pre-Consolidation Pressure	300-450 kPa	-
	Material Type		Plastic, Drained
Bedrock	Unit Weight	20-27.5 kN/m^3	27 kN/m^3
	Deformation (Young's) Modulus	varies	20 GPa
	Poisson's Ratio	0.2 to 0.3	0.25
	Material Type		Elastic, Drained

Note 1: Typical Range based on available background data (Alston, 2006)

Based on the results of the model, the factor of safety of the circular failure surface for Alternative Method 1 is 1.76. Therefore, Alternative Method 1 meets the recommended minimum factor of safety of 1.3 for the side slopes.

The landfill base design is site-specific and comprises a double compacted clay liner with two (2) separate leachate drainage layers. Both primary and secondary drainage layers (leachate collection systems) have been designed to comply with O. Reg. 232/98. The landfill base was designed with a 0.5% minimum grade toward the leachate collectors, which are spaced such that the drainage path for leachate is no longer than 50 m for the primary collectors and 100 m for the secondary collectors.

Settlement was calculated at intervals along the base of the landfill for the approved landfill profile and Alternative Method 1 considering a unit weight of waste of 12 kN/m^3. Based on the results of the model, the overall slope in westerly direction (i.e., toward pumping station) will be maintained despite the slight changes in the approved landfill base grades due to long-term settlement under the heavier inferred waste loading. Additionally, base flattening on the west side will not exceed initial base conditions on the east side, which are considered minimum as defined by O. Reg. 232/98. Therefore, it is concluded that Alternative Method 1 will not have a significant effect on the functionality of the leachate collection system, and leachate will continue to drain toward the designated withdrawal points. The maximum calculated settlement at the landfill centre for Alternative Method 1 is 480 mm.

To determine if the existing primary leachate collection piping can withstand the loading associated with Alternative Method 1, the pipe specifications were reviewed and the deflection under the proposed design conditions was calculated.

The primary leachate collection piping is a 250 mm diameter high-density polyethylene (HDPE) Sclairpipe DR6, with perforations in accordance with Schedule 2, O. Reg. 232/98. Considering a unit weight of overlying material of 12 kN/m^3, the pipe deflection is around 5.75%.

The calculation requires supplier-recommended values for pipe deformation modulus and material strength reduction factors. The supplier has verified that the calculated deflection is acceptable relative to the maximum deflection criterion of 7.5%, as per CSA B182.11. In accordance with the Plastic Pipe Institute, a deflection limit of 7.5% provides at least a 3-to-1 safety factor against reverse curvature.

For the geonet performance, it is understood that Solmax Tendrain II HDPE Triplanar Geonet was used for the landfill secondary drainage layer. According to supplier documents, this geonet has a reported transmissivity of 3.5 x 10^{-3} m^2/s at normal load of 720 kPa and a hydraulic gradient of 0.1. Laboratory test reports for the supplied material are attached in **Appendix A**. At normal stress of 800 kPa and hydraulic gradient of 0.1, the 100-hr transmissivity was reported as 0.9 x 10^{-3} m^2/s. A transmissivity of 0.83 x 10^{-3} m^2/s was used in the design.

Geonet research (IntechOpen, 2019) indicates that triplanar geonet strains approach 30% at normal compressive loads up to 2 MPa. Based on a 0.1 hydraulic gradient, transmissivity of triplanar geonet reportedly decreases by up to 50% between normal loads of 800 and 1,500 kPa, which is the case for all proposed alternative methods.

The flow capacity (i.e., q = transmissivity x gradient) of the Solmax Tendrain geonet calculated under the 0.005 gradient for the original design is 4.2×10^{-6} m²/s (GENIVAR, 2009). Applying the 50% transmissivity reduction suggested above, the geonet flow capacity under the Alternative Method 1 expansion loading reduces to 2.1×10^{-6} m²/s, which is still higher than the flow capacity design requirement of 3.1×10^{-7} m²/s. Therefore, it is concluded that geonet secondary drainage capacity performance will meet the design requirements for Alternative Method 1.

In summary, it is concluded that Alternative Method 1 is acceptable with respect to:

- Post-settlement landfill base grades meeting O. Reg. 232/98 requirements and maintaining acceptable leachate collection in the primary drainage layer;
- Stability of the final slope (3H:1V maximum) and proposed peak profile height;
- Available collector pipe strength within the primary drainage layer; and
- Flow capacity of geonet within the secondary layer.

2.3 Buffer Zones

The TCEC is bounded to the north by Zion Line, to the east by the Twin Creeks Greenhouse and agricultural lands, to the south by lands owned by WM used for agricultural production and by Confederation Line, and to the west by Nauvoo Road (**Drawing 1.1**). The setbacks from the Expansion Landfill footprint to the property boundaries are 101 m to the north, about 206 to the east, 100 m to 256 m to the south, and 235 m to the west.

Since Alternative Method 1 would not change the existing approved landfill limit of waste, the existing property boundaries and buffer width will remain the same after the vertical expansion. Therefore, the buffer area for Alternative Method 1 will meet the requirements of Section 7 of O. Reg. 232/98.

2.4 Site Development

2.4.1 Phasing and Schedule of Site Development

The proposed landfill expansion consists of five (5) stages as shown in **Table 2-2** and **Drawing 1.2**. The areas and volumes of the stages shown in **Table 2-2** are approximate and will be confirmed through detailed design; however, the total landfill volume of Alternative Method 1 will remain at approximately 14.3 million m³.

Table 2-2. Alternative Method 1 Stage Areas and Volumes

Stage	Peak Elevation (masl)	Volume (M m^3)
Stage 1	287.4	3.5
Stage 2	287.4	3.5
Stage 3	305.2	2.6
Stage 4	305.2	2.1
Stage 5	324.5	2.6
TOTAL	-	**14.3**

The site development phases have taken into consideration to have adequate space to allow disposal and operational vehicles to operate in the same area. The phases are proposed to be developed from west to east, considering the removal of final/interim cover along the side slopes prior to waste placement (as explained in Section 2.4.2, below). The landfill gas collection system will be progressively expanded as waste is placed and cells reach final grades. Temporary separation berms between lateral phases will be implemented for surface water control and will be removed as the next phase becomes operational.

Considering the approved landfilling rate is 1.4 million tonnes per year, the additional airspace could extend the site life by approximately 12 years.

Based on the estimated volumes provided for each phase in

Table 2-2, Stage 1 and Stage 2 can provide a site life of about 3 years while the site life of the other stages will range between 1.5 to 2.5 years.

2.4.2 Construction Activities

The Expansion Landfill area has been already prepared for landfilling and currently is active. Some areas have interim/final cover that will require the removal of soil cover prior to waste placement. This operation procedure will take place as the staging progresses. The current maximum fill rate of 1.4 million tonnes per year will apply to the proposed expansion.

Transfer trailers with walking floors will discharge their contents at the rear of the truck. Piston-driven pusher types will push out their loads. Similarly, packer trucks will be discharged by the ram push. Roll-off trucks will raise the hydraulic hoist to discharge the load. There may even be a few smaller trucks that will be unloaded manually, although most vehicles are anticipated to have hydraulic cylinders to lift and unload the truck box.

The waste, once tipped from the trucks, will be pushed over the active cell in a uniform layer by the compactors. Waste placement will continue to be in daily lifts of 2.5 to 3 m thickness. The compactors will compact the waste by making three to four passes on each loose lift.

Waste haul vehicles (packer trucks, roll-off trucks, trailers, etc.) will travel to the working face via gravel access roads. These gravel access roads will be constructed prior to the active cells becoming operational.

In addition to waste placement, the landfill gas collection system expansion will be constructed as part of the landfill development sequence.

Daily/interim cover will continue to be placed as part of the landfill operations as per current landfill operations. The final cover will be placed on the side slopes of the phases that are no longer operational as an erosion control measure and to minimize the potential for leachate seeps.

2.5 Leachate Management

2.5.1 Leachate Generation

Alternative Method 1 will not change the current expected infiltration rate, instead, it will increase the rate of run-off due to higher side slopes. Consequently, the leachate collection system will not require changes as a result of Alternative Method 1. Details of the leachate generation assessment are provided below.

A leachate generation assessment was previously completed by Henderson Paddon & Associates Limited in 2008 for the Expansion Landfill, as summarized in Section 6.1.1 (page 6-1) of the 2008 Design and Operations (D&O) Report. A Hydrologic Evaluation of Landfill Performance (HELP) model (version 3.07) was also developed as part of the previous studies.

For the proposed landfill optimization, the previous HELP model was used as a basis of current study with some modifications. For calculating leachate generation, infiltration rates of 450 mm/year, 150 mm/year, and 100 mm/year were adopted for active areas, areas of interim cover, and areas of final cap, respectively. These are the same infiltration rates that were contemplated in the previous studies.

Additionally, the current HELP model considers:

- the landfill final cap (i.e., model layer 2) was simulated as a ‘barrier layer’ type, to allow use of the HELP model default clay material type (hydraulic conductivity k = 1.2×10^{-6} centimetres per second (cm/s));
- the default hydraulic conductivity of 1×10^{-3} cm/s was simulated for the three waste layers;
- simulation of the geotextile separators was included;
- the “drainage” options for the primary drainage layer and secondary drainage layer were activated;
- a hydraulic conductivity of 5×10^{-8} cm/s was used to simulate the primary liner;
- evaporative zone depth of 15 cm was simulated; and

- two models were developed to simulate both the top of waste mound and sideslopes. For Alternative Method 1, the average waste thicknesses for each model were adjusted to 96 m for the top of the waste mound and 53 m for the sideslopes.

The existing design profile is currently split with 67% on top of the mound and 33% sideslopes, while Alternative Method 1 inverts these proportions. Higher slope grades generally result in increased runoff and lower infiltration; as such, Alternative Method 1 could conceptually be expected to generate less leachate than the existing design.

Two HELP models were created to assess infiltration for Alternative Method 1: one to simulate infiltration at the top of waste mound and another to simulate infiltration on the sideslopes. The predicted infiltration in both cases is around 96 mm/year. An average annual infiltration rate of about 96 mm/year is also predicted for both the top of waste mound and sideslopes for the existing design. Thus, the results suggest that leachate generation at the Expansion Landfill is insensitive to either the slope of the final cap or the total waste thickness. This means that Alternative Method 1 will not change the expected infiltration rate used in the predicted leachate generation rates for the Expansion Landfill as outlined in Table 6.1 of the 2008 D&O Report.

The maximum leachate generation for Alternative Method 1 is predicted to peak at 120,500 m^3 per year (330 m^3 per day) in Year 3 after completion of Stage 1 (approximately 2036). Leachate generation will then decrease to approximately 106,700 m^3 per year (292 m^3 per day) following placement of the final cover in Year 12 (estimated to be in 2045). **Appendix B** provides the modelling results. An additional 25,550 m^3 of leachate annually (70 m^3 per day) is estimated to be generated from the closed Old Landfill.

Based on the above, maximum leachate generation is estimated at 400 m^3 per day (330 m^3 + 70 m^3) from both Alternative Method 1 (including the Expansion Landfill) and the closed Old Landfill, which is expected to occur in Year 3 (approximately 2036).

WM developed a leachate management framework and supporting documents in 2017 which identified that the HELP model produced overly conservative estimates of leachate generation at TCEC. In addition, since the Expansion Landfill footprint began operating in late 2009, WM has implemented a range of design and operational practices to minimize leachate generation. The March 2023 Leachate Management Plan reported that the volume of leachate extracted from the Expansion Landfill remained consistent for the past four years, at approximately 41,000 to 44,000 m^3 per year. Based on the annual leachate extraction volumes to the end of 2022, it is evident that the leachate generation estimates from the HELP model are overestimated. In addition, WM plans to continue to reduce the volume of leachate stored within the closed Old Landfill over several years. Initially, WM is targeting a reduction of 5,000 m^3 per year in the total volume stored.

Leachate generation volumes increased in 2023 to approximately 70,400 m^3. This is approximately 60% of the predicted peak generation of 120,500 m^3/year for Alternative Method 1. The Expansion Landfill continued to develop including construction of a new stage increasing the amount of open area and reopening previously covered areas for filling, resulting in increased leachate generation. The annual leachate volume is anticipated to continue to fluctuate as landfilling areas are opened and closed each year.

Based on the information presented, future generation of leachate should be anticipated to be at annual volumes between the HELP predictions and current levels.

2.5.2 Leachate Treatment

The current approach to managing leachate generated at the TCEC includes phytoremediation of a portion of the leachate volume generated through irrigation of the on-site Poplar System. The Poplar System is anticipated to manage approximately 15,000 m^3 of leachate per year. The balance of the leachate generated is removed from the site and sent to an off-site wastewater treatment plant for disposal.

The automated leachate pumping stations allow the leachate to be pumped to the equalization tank (capacity of 2,300 m^3) or to the Poplar System irrigation tanks. The irrigation liquid is applied to the Poplar System from May to mid-October and the remaining leachate is hauled for off-site treatment and disposal. The Poplar System refers to the poplar trees planted on the final cover of the closed Old Landfill. A new equalization tank with the same capacity as the existing tank will be implemented by 2025. This additional storage capacity will provide a contingency in case the existing tank needs to be maintained or repaired.

The 2005 EA for the Expansion Landfill identified the preferred alternative for leachate treatment as full on-site treatment with no liquid effluent discharge to surface water. Subsequently, a leachate treatment facility was designed and permitted with a rated capacity to treat 146,000 m^3/year (400 m^3/day).

When considering the leachate generation estimates being identified through the HELP model compared to actual leachate generation observed at the Expansion Landfill, the leachate treatment facility design is significantly oversized and, as a result, would not operate as intended. The leachate treatment facility has not yet been constructed and would require redesign and permitting prior to construction.

The proposed approach for leachate management and disposal for Alternative Method 1 is consistent with the current approach and includes a combination of the following:

- Phytoremediation of a portion of the leachate volume generated through irrigation of the on-site poplar system (up to approximately 15,000 m^3/year).
- Trucking of leachate to an off-site wastewater treatment plant (up to 8 trucks per day).
- Confirm the rated capacity required for the leachate treatment facility to reflect actual leachate generation being observed, update the rated capacity, and design for, and construct, a leachate treatment facility prior to landfill closure.

2.6 Landfill Gas Management

2.6.1 Landfill Gas Generation

Landfill gas (LFG) is produced as a by-product of the biological decomposition of organic matter within the waste and typically increasing throughout the operational period of the landfill development and peaking upon site closure.

The LFG production rate slowly declines over the years after the landfill is closed, until the waste has finished decomposing. Many factors affect LFG generation rates including, but not limited to, the waste moisture content, water movement (infiltration), temperature, pH, waste composition, waste age, and nutrient availability.

The generated LFG production was estimated by using the USEPA LANDGEM model, which is a recognized method by the MECP. The model considers a Methane Generation Capacity (Lo) of 108 m^3 per metric ton of waste and Reaction Constant (k) of 0.045 per year, which are representative of municipal waste.

For the Degradable Organic Carbon (DOC) content and the Reaction Constant, the default values as suggested by Environment and Climate Change Canada (ECCC) for Ontario are used (Canada National Inventory Report 1990-2018, published in 2020). Lo values are calculated based on a methane concentration in pure LFG of 60% and a DOCf (Fraction of degradable organic carbon which decomposes) of 50% (default value of ECCC).

The produced LFG estimated for the Old Landfill and Expansion Landfill with Alternative Method 1 (**Table 2-3**), estimates that the landfill will produce a peak amount of LFG of approximately 20,203 m^3/hr in 2043, of which 18,169 m^3/hr are estimated to be collected (**Figure 2-1**). Collection efficiency for the Old Landfill is assumed to be 67% as this gives the best fit with real operational data. For the Expansion Landfill and vertical expansion, the collection efficiency of 75% is assumed for areas with waste and LFG collection systems in place but without final cover. The collection efficiency is increased to 90% for areas with a final cover and an LFG collection system.

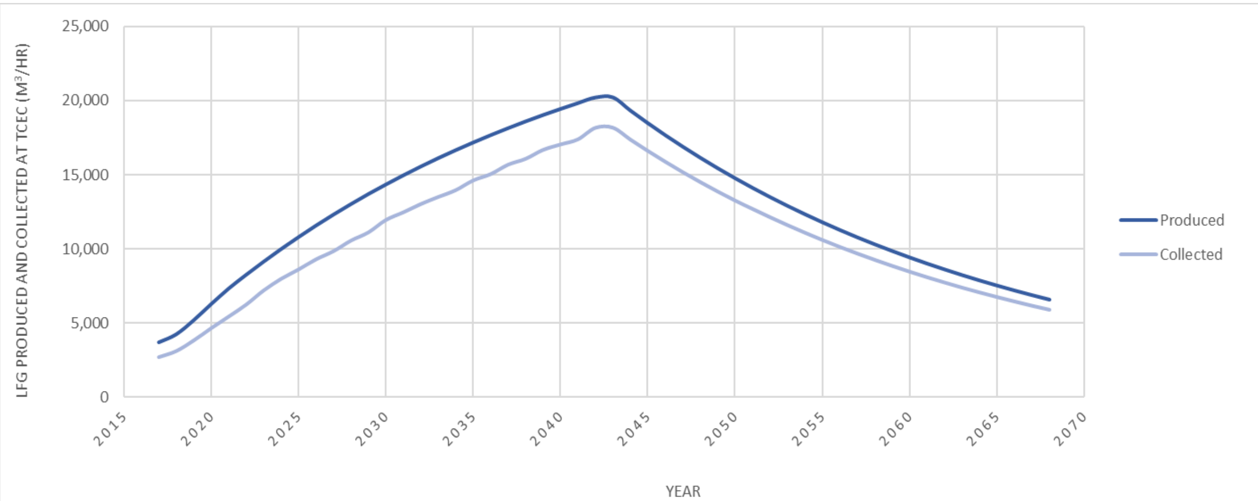
Table 2-3. LFG Produced and Collected Rates Alternative Method 1, 2 and 3

Year	LFG Produced at Old Landfill (m^3/hr)	LFG Produced at Expanding Landfill (m^3/hr)	Total LFG Produced at TCEC with Vertical Expansion (m^3/hr)	Total LFG Collected at TCEC with Vertical Expansion (m^3/hr)
2017	585	2,757	3,680	2,716
2018	559	3,259	4,224	3,126
2019	534	4,122	5,180	3,844
2020	510	5,105	6,271	4,665
2021	487	6,044	7,315	5,450
2022	465	6,882	8,244	6,252
2023	444	7,682	9,133	7,205
2024	424	8,447	9,982	7,988

Year	LFG Produced at Old Landfill (m^3/hr)	LFG Produced at Expanding Landfill (m^3/hr)	Total LFG Produced at TCEC with Vertical Expansion (m^3/hr)	Total LFG Collected at TCEC with Vertical Expansion (m^3/hr)
2025	405	9,179	10,793	8,621
2026	387	9,878	11,569	9,302
2027	370	10,547	12,311	9,850
2028	353	11,186	13,020	10,564
2029	337	11,797	13,699	11,119
2030	322	12,381	14,347	11,951
2031	308	12,939	14,967	12,472
2032	294	13,473	15,559	13,027
2033	281	13,984	16,125	13,505
2034	268	14,472	16,667	13,962
2035	256	14,938	17,185	14,618
2036	245	15,384	17,679	15,043
2037	234	15,810	18,153	15,680
2038	223	16,218	18,605	16,074
2039	213	16,607	19,037	16,675
2040	204	16,980	19,451	17,040
2041	195	17,336	19,846	17,389
2042	186	17,676	20,224	18,161
2043	178	17,690	20,231	18,169
2044	170	16,911	19,341	17,370
2045	162	16,167	18,489	16,605
2046	155	15,456	17,676	15,874
2047	148	14,776	16,898	15,176
2048	141	14,125	16,154	14,508
2049	135	13,504	15,443	13,870
2050	129	12,910	14,764	13,259
2051	123	12,342	14,114	12,697
2052	118	11,799	13,493	12,138
2053	112	11,279	12,899	11,604
2054	107	10,783	12,331	11,093
2055	103	10,309	11,789	10,605
2056	98	9,855	11,270	10,138
2057	94	9,421	10,774	9,692
2058	89	9,007	10,300	9,265
2059	85	8,610	9,846	8,858
2060	82	8,232	9,413	8,468

Year	LFG Produced at Old Landfill (m³/hr)	LFG Produced at Expanding Landfill (m³/hr)	Total LFG Produced at TCEC with Vertical Expansion (m³/hr)	Total LFG Collected at TCEC with Vertical Expansion (m³/hr)
2061	78	7,869	8,999	8,095
2062	74	7,523	8,603	7,739
2063	71	7,192	8,224	7,398
2064	68	6,876	7,862	7,073
2065	65	6,573	7,516	6,762
2066	62	6,284	7,185	6,464
2067	59	6,007	6,869	6,180

Figure 2-1. Landfill Gas Produced and Collected Curves for Alternative Method 1, 2 and 3



2.6.2 Landfill Gas Collection and Treatment

LFG is currently collected from the closed Old Landfill and the Expansion Landfill. The LFG collection system includes conventional vertical wells within the closed Old Landfill footprint and mostly Early Vertical Gas System (EVGS) wells within the Expansion Landfill. The Expansion Landfill also draws gas from the Primary Leachate Collection System (PLCS). All wells are connected to a network of laterals and sub-headers directing flow to the LFG Facility through a 900 mm diameter header pipe, which is sufficient to handle the generated LFG after vertical expansion. LFG is discharged to the on-site blower building and to fully enclosed flares.

The EVGS wells are extended upward as landfill operations progress and cells are filled. The LFG collection system is extended sequentially following horizontal and vertical growth of the Expansion Landfill. At approximately 15-metre intervals, additional gas subheaders and laterals are installed within the landfill. Condensate drains by gravity into several drain traps equipped with compressed air powered pumps which transfer liquid by forcemain for disposal into the PLCS. Vertical wells are extended as the waste placement progresses to minimize odours and reduce the amount of LFG escaping.

The expanded LFG collection system will be similar to the existing design and will comprise vertical wells, LFG subheaders, and LFG laterals that are connected to the main 900 mm header pipe located along the perimeter of the landfill.

The LFG collection system has a collection efficiency of approximately 75% for areas without final cover based on operational data and can be increased to 90% for areas with final clay cover. It is anticipated that this level of collection efficiency will continue to be achieved for Alternative Method 1. At peak LFG generation, approximately 18,169 m^3/hour (**Table 2-3**) of landfill gas will be collected and require treatment.

The landfill has four approved LFG flares. Flares 1 to 4 provide a combined capacity of approximately 25,847 m^3/hr or 15,213 scfm. The new Renewable Natural Gas (RNG) Facility, which is currently being constructed at the TCEC, has the capacity to process up to 13,592 m^3/hr or 8,000 scfm of LFG on a dry basis and transform it into RNG, reducing greenhouse emissions over the operating life of the site and during post-closure years. Additionally, Flares 5 and 6 are being constructed as part of the RNG Facility and will provide a capacity of 10,188 m^3/hr or 5,996 scfm.

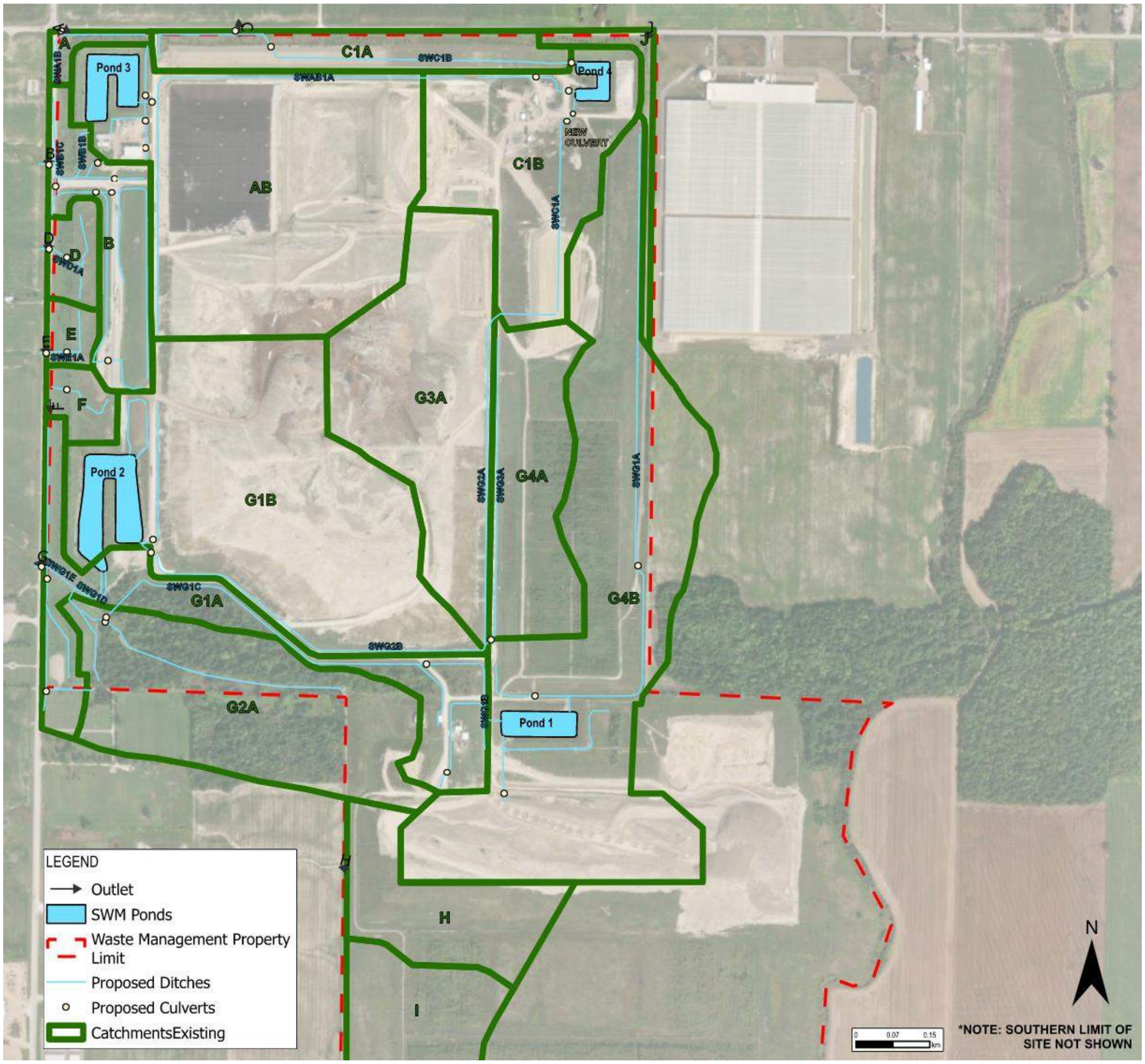
In total, the TCEC has an approved combined treatment/flare operational capacity of 49,627 m^3/hr or 29,209 scfm (considering the four flares, the RNG facility capacity and two flares), which provides an excess capacity of approximately 63% more than the estimated peak volume of LFG being generated at the site.

2.7 Stormwater Management

2.7.1 Existing System

Stormwater is currently managed on site through swales and detention ponds. Swales direct runoff to the ponds and outlets, providing infiltration along the way. Four stormwater management ponds that are situated at the corners of the Expansion Landfill footprint collect runoff from the surface of the landfill and release flows through culvert outlets. In this manner, they maintain peak site runoff at pre-development levels. There are ten stormwater outlets from the site, labelled A-J, four of which receive water from the detention ponds. **Figure 2-2** shows the layout of the existing stormwater management system, including the locations of the ponds, swales, and outlets. Details on these aspects of the stormwater management system is available in the Surface Water Quantity Existing Conditions Report.

Figure 2-2. Existing Stormwater Management



2.7.1.1 Analysis of System Capacity

An analysis of the existing stormwater management system was conducted for the Surface Water Quantity Existing Conditions Report. It was found that, so long as regular maintenance removes excess sediment buildup, there is sufficient capacity in the four detention ponds to hold a 3-hour 1:100-year storm. This was verified by modeling the stormwater management ponds within a hydrological software (Visual OTTHYMO Model Version 6.2).

Additionally, water quality treatment for runoff from the site will also be provided by the stormwater management ponds with a 75% TSS removal rate. Further, a 4-hour, 25-mm storm event was modelled within Visual OTTHYMO to confirm that the ponds have the capacity to store/treat the runoff volume generated from the landfill site.

Swales are designed for a 25-year return period; the swales were also found to have sufficient capacity under existing conditions.

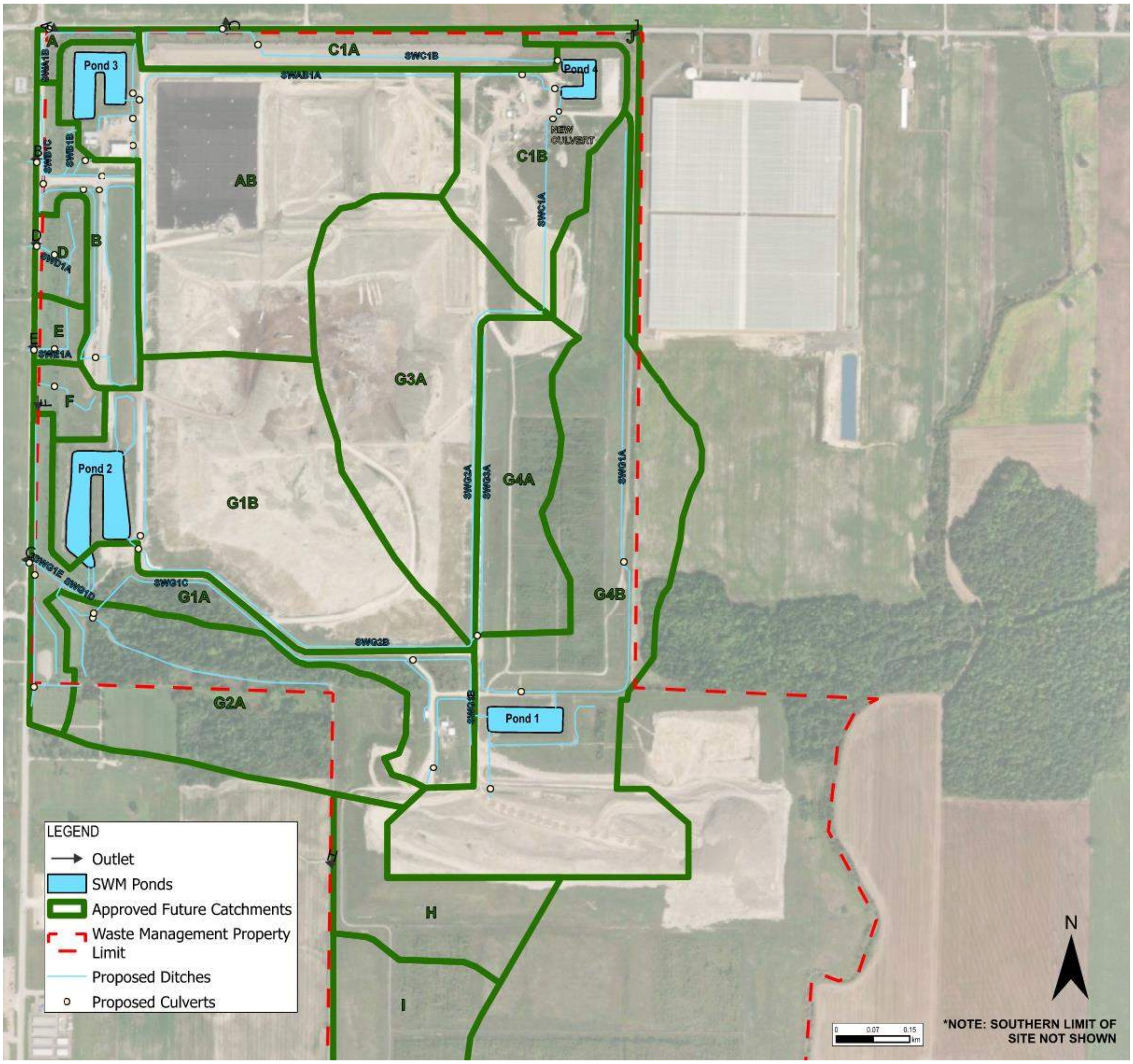
2.7.2 Baseline Future Scenario

Should the landfill optimization not proceed, the landfill development will continue until it has reached its full horizontal footprint and currently approved height of 280 masl. This will alter the outlets' catchment areas, land cover, and time of concentration, as well as the path of the swales in the northeast corner. This scenario is considered the future baseline and was modelled as part of the assessment of the proposed expansion as detailed below.

The full buildout of the landfill in the northeast corner will move the bordering swales to the east as shown in **Figure 2-3**.

The swale leading to Pond 4 will be slightly shorter (now 0.4 km in length), while the swale heading south towards Pond 2 will be longer (1.6 km total). A new culvert will be required under the servicing road. These new and realigned components of the stormwater system are not currently designed and as such were sized appropriately for the 25-year return period storm under Alternative Method 1 as described below.

Figure 2-3. Approved Stormwater Management



2.7.3 Impact of Alternative Method 1

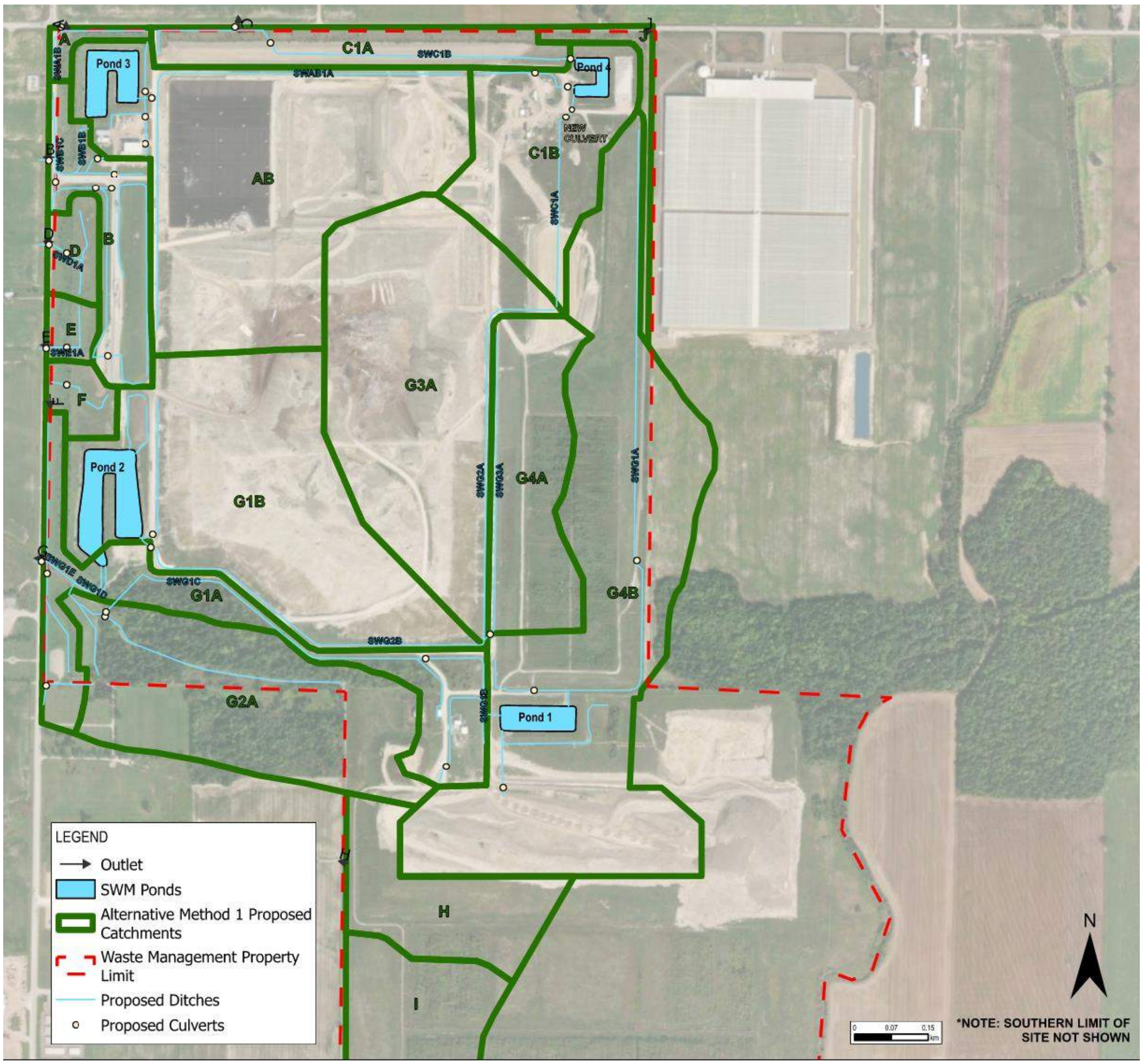
The proposed vertical landfill expansion will impact the stormwater management system in two ways:

1. Altering catchment areas within the landfill site; and
2. Decreasing time of concentration.

It is noteworthy that the landfill optimization will not change total runoff volume from the landfill site; however, the timing of peak flows and the redistribution of catchment areas is expected to increase or decrease some of the peak flows leaving through the outlets as shown in **Table 2-4**. For this reason, all catchments experiencing one or both of these above-noted changes under Alternative Method 1 were modelled under

Existing Conditions, and Baseline Future, and Future (Alternative Method 1) Scenarios to both compare changes to stormwater runoff and assess any capacity issues with the detention ponds and swales. This excluded Catchments D, E, F, H, I, and J, as they will not be physically altered in any way from their existing characteristics. The results of this analysis are presented in **Table 2-4 and Table 2-5**. Full results showing all return period storms are available in **Appendix C**. The locations of the named outlets, ponds, and swales are shown in **Appendix C**. The redistributed catchment areas for Alternative Method 1 are shown in **Figure 2-4**.

Figure 2-4. Stormwater Management for Alternative Method 1



The geometries of the realigned swales (SWC1A and SWG2A) and new culvert have been designed to blend with the grades of the existing surface and to mirror the cross-section and profile of the existing swales. Their required dimensions under the Future Alternative Method 1 + Climate Change conditions are presented in **Table 2-4** (please see Section 5.1.1 for a discussion of the climate change modelling procedure).

Table 2-4. Changes to Site Outlet peak flows during 100-year event

Outlets	Peak Runoff (cms / % increase from Existing Conditions)				
	Existing Conditions	Baseline Future		Future Alternative Method 1	
A	0.238	0.263	11%	0.263	11%
B	1.005	0.969	-4%	0.969	-4%
C	0.601	0.492	-18%	0.495	-18%
G	1.530	1.648	8%	1.634	7%

Table 2-5. SWM Pond function during 100-year event

Pond	Capacity (ha·m)	Peak Storage Used (ha·m)		
		Existing Conditions	Baseline Future	Future Alternative Method 1
1	2.773	0.896	0.896	0.896
2	5.271	1.491	1.704	1.690
3	2.857	0.709	0.731	0.731
4	1.099	0.335	0.277	0.274

The data presented in **Table 2-4** shows peak outflows from different outlets leaving the landfill site. The results for the Future Alternative Method 1 scenario closely mirror those of the Baseline Future scenario; in both, Outlets A and G experience an increase in peak flow compared to existing levels, while Outlets B and C demonstrate a decrease. It is noteworthy that Stormwater Management Pond 3 discharges flows to Outlets A and B and as seen from **Table 2-4,** Outlet A shows an increase in flows of approximately 11% and conversely Outlet B shows a decrease in flows of approximately 4% when compared to existing conditions. Outlet C shows a decrease in flows of approximately 18% when compared to existing conditions. Outlet G shows an approximate increase of 7% in flows when compared to existing conditions. However, it should be noted that the swales conveying the flows to Outlet G have sufficient capacity and are able to convey the flows downstream safely.

Further, the data presented in **Table 2-5** indicates that all four stormwater management ponds on the landfill site have enough capacity to store the 100-year flows across the Baseline Future and Future Alternative Method 1 scenarios. They do not require alteration or enlargement.

The existing swales around the landfill site currently are also able to safely convey the 25-year design storm (**Table 2-6**) without overtopping. Hence, a modification to the existing cross-section geometries of the swales is not warranted. The relocated swales (SWC1A) and SWG2A) and new culvert will also be able to convey these flows appropriately when constructed to the design requirements listed in **Table 2-7**.

Table 2-6. Swale function during 25-year event

Swale	Flow Capacity (L/s)	Peak Flow (L/s)	
		Baseline Future	Future Alternative Method 1
SWAB1A	9,384	1,458	1,513
SWA1B	6,256	179	181
SWB1B	23,461	204	204
SWB1C	120,733	772	772
SWC1A	3,699	547	540
SWC1B	191,849	457	148
SWD1A	28,626	221	221
SWE1A	100,850	202	202
SWG1A	3,981	1,053	1,053
SWG1B	17,669	392	392
SWG1C	11,847	726	726
SWG1D	6,229	325	321
SWG1E	10,909	1,157	1,152
Stream	18,095	1,157	1,152
SWG2A	1,592	637	659
SWG2B	12,631	2,677	2,590
SWG3A	1,246	283	283

Table 2-7. Design geometry of modified swales and new culvert

Name	Bottom Width / Diameter (m)	Depth (m)	Side Slope (x:1)	Slope
SWC1A	3	0.90	3:1	0.09%
SWG2A	1	0.54	3:1	0.64%
New Culvert (HDPE – 1 pipe)	1.2			0.44%

2.8 Ancillary Facilities

No additional ancillary facilities, beyond those already existing on the site, will be required for Alternative Method 1.

2.9 Site Traffic

There are no operational changes anticipated for the landfill optimization and the landfill will operate consistent with current conditions with the same annual tonnage limit. There is no proposed change to the effective catchment area for the facility, the origin-destination patterns of vehicles travelling to or from the TCEC, or the maximum daily trips generated. Accordingly, there should be little to no impact to the surrounding road network or along the haul routes within the greater context.

The landfill optimization is not expected to increase its average daily tonnage received. Therefore, traffic conditions are expected to remain the same as they are today. An existing traffic analysis (HDR, 2023) was prepared that reflected a peak operating day for the TCEC (the highest vehicular activity).

Weigh scale and turning movement count data was used to project traffic volumes for the TCEC under the following assumptions:

- A peak daily volume of 7,400 tonnes of total waste is received.
- Employee traffic volumes remain unchanged.
- The origins/destinations of site traffic do not change.
- Haul routes do not change.
- The hourly, daily, and seasonal patterns remain stable.
- The breakdown of vehicle types and average vehicle loads remain stable.

Turning movement counts (TMCs) were collected in November 2022 and validated with landfill weigh scale data. Site traffic was adjusted using the weigh scale information to adjust the site traffic so that it was representative of a peak day. There are typically 47 inbound and 77 outbound trips during the weekday AM peak hour, 44 inbound and 52 outbound trips during the midday peak hour, and 26 inbound trips and 30 outbound trips during the weekday PM peak hour.

No off-site road network improvements are required to accommodate the extension of the landfill's operating life to approximately 2043.

Traffic related to landfill construction is not anticipated (e.g., landfill cell preparation in advance of waste placement) as the landfill liner will be fully constructed prior to vertical expansion of the landfill. Current construction traffic and any materials used for landfill cover are captured in the weigh scale data provided for the traffic impact analysis and is therefore included in the projected vehicle trips.

2.10 Landfill Operations

2.10.1 Operating Hours

Waste is currently received at the site from 7:00 a.m. to 7:00 p.m. Monday to Saturday, excluding statutory holidays. On-site equipment used for daily operations can operate from 6:00 a.m. to 8:00 p.m. Monday to Saturday. No changes to the landfill operating hours are anticipated as a result of the landfill optimization.

2.10.2 Site Equipment

The list of normal site equipment will remain unchanged during the landfill optimization and will consist of the following:

- Working Face:
    - 2 CAT 836 Compactors
    - 2 CAT D8R Dozers
    - 1 CAT D6R Dozer
- Daily Cover and Capping:
    - 2 – Articulated CAT D400 Trucks
    - 1 – Excavator CAT 330L
- Road Maintenance
    - 1 – CAT 140H Grader
- Other Equipment:
    - 1 - Tracked Loader
    - 1 - Portable Air Compressor
    - 1 - Portable Pressure Washer
    - 1 - Utility Tractor with sweeper attachment, rear mounted scraper blade and bush hog-type mower
    - 1 - Portable Electric Generator and Lighting Plant;
    - 1 - Roll-off Truck, complete with roll-off bins
    - 1 - Pelican Road Sweepers with Water Flush System
    - 1 - Portable 100-mm Diesel Water Pump
    - 1 - 3/4 tonne 4 x 4 Pickup Truck, complete with hydraulic-operated
    - snow plough and diesel fuel tank and pump
    - 1 - Cat 950F Rubber-Tired Loader
    - Other auxiliary equipment, such as pickup trucks, maintenance equipment, steam jennies, welders, small tools, portable diesel generator for variable use and portable construction pumps, and power road sweeper attachment for farm tractor.
    - 1 - Portable Wood Crusher / Screener - periodic only

- 1 - Wood tub Grinder, 1 - Chipper - periodic only

2.10.3 Waste Placement

There are no operational changes anticipated to result from the landfill optimization and it will operate consistent with current conditions with the same 1.4 million tonnes annual capacity. Landfilling of waste will continue to occur in phases. Contaminated soil is anticipated to be disposed of in the active portions of the Expansion Landfill. Contaminated soil may also be disposed in the Existing Landfill, if a large enough demand for disposal of contaminated soil is required. Of note, contaminated soil must meet the 10% toxicity characteristic leachate procedure (TCLP) criteria for acceptable disposal at the TCEC.

Contaminated soil used for daily cover is only used where precipitation runoff would not be directed to a surface water drainage course (i.e., an inside sideslope).

The working face will be approximately 1,500 m², according to current site operations. This is a reasonable area for dozers to push the waste, to spread and level the waste from the tip face, and for the compactors to operate. An active face this wide could accommodate two (2) tippers, six (6) transfer trailers and four (4) packers unloading simultaneously. This width should be adequate for peak hour traffic during average day capacities. If additional capacity were required for peak days, the width or length of the working face would be increased accordingly.

2.10.4 Daily and Intermediate Cover

At the end of each working day, at least 75% of the working face will be covered with 0.15 m of soil cover or an approved alternative cover material.

Areas remaining inactive for six months or longer should be provided with 0.30 m intermediate cover of soil or an approved alternative cover material.

Cover materials that may be used as an alternative to soil include contaminated soil, automobile shredder residue, wood chips, or tarps.

2.10.5 Nuisance Controls

WM employs a variety of proactive measures to minimize nuisance effects related to odour, litter, dust, noise, and birds on the surrounding environment. These established measures, detailed below, are expected to continue at the TCEC until landfill closure.

2.10.5.1 Odour

Odour has been managing in the site in accordance with the Best Management Plan (Odour) prepared by RWDI listed as Item 84 in Schedule “A” of the ECA No. A032203. This plan will be applicable for any of the Alternative Methods.

The walkabout surveys are scheduled for completion in the spring and the early fall to identify unexplained odour events. The results of these walkabout surveys, the times they were completed, and any remedial actions will each be noted in the site odour log. Routine visual inspections of the landfill cap integrity will also occur on a monthly basis to identify possible problem areas. In addition, during the survey of site and during regular inspection periods, detectable odours from the site will be noted and recorded. At a minimum, the odour information will include a description of the odour, time of day (to correspond with wind conditions) and if possible, an indication of the main sources contributing to the odour.

The odour control measures relate largely to on-going monitoring and maintenance that has been identified in the Best Management Plan. However, there are a number of specific details including:

- Progressively expand and activate the landfill gas collection and flaring system (two installed and two flares proposed) to minimize the amount of odourous landfill gas that escapes through the mound. The systems should be constructed in a manner to ensure that a minimum of 70% collection efficiency is achieved on a regular basis.
- Regular repairs to the covered landfill areas (existing and future landfill areas) based on identifying any fissures, cracks or erosion of the soil cover that would allow for unmitigated landfill gas to escape directly to the atmosphere. These areas will be identified in the “walkabout” survey as described above. The areas requiring repair should be covered with clay, compacted, and then covered with topsoil.
- Routinely monitor the size of the active working face of the landfill. The size of the working face will be minimized, accounting for traffic at the working face.
- Regular inspection and monitoring of temperature and moisture of the compost windrows. If waste from the diversion area becomes unacceptable for composting or overly odourous, the material should be removed from this area and landfilled.
- Cap completed cells as quickly as possible with final cover to minimize odourous emissions.

2.10.5.2 Litter

Litter has been retrieved from the external access roads, on site, adjacent properties, and on more remote properties, if required. WM personnel (waste hauler drivers) are instructed to stop and retrieve any litter observed along the access route. On-site litter is controlled by the use of good operating practices such as prompt compaction of loose waste at the active face, daily cover application, interim cover (300 mm) of areas sitting dormant, final capping and vegetation of completed portions of the landfill, gull control, landfilling at a lower elevation during high wind events, high litter barrier fence on the downgradient side of high winds, moveable litter barriers near the active face that can be moved to the downwind side of the compaction and landfilling operation, prompt retrieval of blown litter both off and on site, and tree plantings on property lines to catch any loose litter before it reaches neighbouring properties.

A series of portable litter barriers will be used to shield the downwind side of the active face from escaping litter. These barriers will be skid-mounted and can be towed into place. Labourers will be engaged to pick litter regularly, both on and off WM property.

2.10.5.3 Dust

The TCEC has created a Best Management Practices Plan for dust that is implemented at the site and will be in effect after completion of Alternative Method 1. All TCEC employees are trained in the contents of the plan. Through the combined efforts of the mitigation measures and implementation of the Dust Management Plan, TCEC plans on limiting the number of total solid particles (TSP) exceedances during the periods of heavy construction and beyond.

Currently, particulate emission mitigation measures are in place at the TCEC and consist of watering on-site roadways and construction sites as well as a number of other practices as outlined in the Best Management Practices Plan for dust. The practices will not occur if precipitation events cause these activities to become redundant or if the ground is sufficiently wet from previous precipitation events.

As part of the dust control strategy, the shift supervisor will be responsible to see that a record of roadway sweeping and watering is maintained. The control measure will be initiated whenever a visible plume behind vehicles is longer than ¼ the length of the vehicle. These logs will be kept on-site for a period of not less than two (2) years and will be made available for inspection.

2.10.5.4 Noise

As outlined in Section 4.3.13 of the 2008 D&O Report, all landfill perimeter berms, road berms, and fills have been constructed to provide visual barriers, noise barriers, and dust barriers along the landfill and TCEC perimeter. The operational berms have significantly reduced noise from the operational face. Additionally, in accordance with the Noise Impact Assessment conducted in 2007, the operation of the dozer(s) for applying daily cover in the evening or removing it in the morning outside of daytime hours has been restricted (see Section 2.10.1).

The TCEC's obligations with respect to noise reporting are described in Amended Environment Compliance Approval Number A032203 (ECA) dated December 16, 2023. Monitoring of the facility noise levels are completed quarterly at four (4) monitoring sites around the perimeter of the TCEC. All measurements are conducted in compliance with requirements outlined in the Ministry Publication NPC-103 – Procedures (MOE 1978).

2.10.5.5 Birds

The following acoustic devices have been used to scare away gulls:

- Whistling and/or Pyrotechnic Pistol Cartridges;
- Shots fired from a starter pistol or other type of gun;

- Propane canons (“bird bangers”); and
- Electronic distress calls.

The above devices produce impulsive noise which is less than the MECP Landfill sound level limit of 70 dBAI, for all receptors, regardless of the position of firing within the TCEC.

In addition to using acoustic devices, trained birds of prey such as falcons, hawks, eagles or owls have been used in TCEC for bird control. The bird of prey is flown at intervals throughout the day, serving as a natural deterrent for seagull control.

3 Conceptual Design of Alternative Method 2

3.1 Overview

Alternative Method 2 includes the increase of final landfill side slopes from 4H:1V to 2.5H:1V between elevation 250 masl and elevation 310 masl, about 60 m in grade change, transitioning to a 20H:1V upper slope and peaking at elevation 319 masl (**Figure 3-1**) over the Expansion Landfill. The Expansion Landfill is fully engineered and has an approved peak elevation of 280 masl. Alternative Method 2 will provide an additional 14.3 million m^3 of landfill capacity.

Considering the proposed final side slopes of 2.5H:1V are steeper than the current 4H:1V as per O. Reg. 232/98, a geotechnical feasibility review was performed to confirm the slope stability and settlement. The geotechnical assessment showed that this alternative is acceptable with respect to the stability of the final slopes (2.5H:1V) and proposed peak profile height. The results of the geotechnical feasibility review for Alternative Method 2 are discussed in Section 3.2.

3.2 Landfill Design and Geometry

The geometry of Alternative Method 2 is shown in plan view in **Drawing 2.1**. Under the proposed vertical expansion, the existing approved waste disposal footprint area of the TCEC would not change, but rather, the maximum permitted height of waste would be increased by 39 m, from 280 masl (the current approved elevation for top of waste) to 319 masl, which is the maximum elevation of the top of the final cover for Alternative Method 2. The 2.5H:1V side slopes will start at elevation 250 masl (about 48 m in grade change) and continue to elevation 313 masl, and then transition to a grade of 5% and peaking at elevation 319 masl as indicated in **Drawing 2.1.** This will increase the current landfill capacity by approximately 14.3 million m^3.

To assess the stability of the final slopes and proposed peak profile height, a preliminary slope stability analysis was performed. The slope stability analysis involved: reviewing the design of Alternative Method 2; reviewing existing background information; and building a 2-Dimensional Finite Element Model (FEM) using Slide2

Modeler version 9.020 software and adopting the Bishop Simplified factor of safety method. For the assumptions used in the model and the summary of selected engineering properties used in the FEM, please refer to Section 2.2 and **Table 2-1**.

Based on the results of the model, the factor of safety of the circular failure surface for Alternative Method 2 is 1.50. Therefore, Alternative Method 2 meets the recommended minimum factor of safety of 1.3 for slopes.

Settlement was calculated at intervals along the base of the landfill for the approved landfill profile and Alternative Method 2 considering a unit weight of waste of 12 kN/m³. Based on the results of the model, the overall slope in westerly direction (i.e., toward pumping station) will be maintained despite the slight changes in the approved landfill base grades due to long-term settlement under the heavier inferred waste loading. Additionally, base flattening on the west side will not exceed initial base conditions on the east side, which are considered minimum as defined by O. Reg. 232/98. Therefore, it is concluded that Alternative Method 2 will not have a significant effect on the functionality of the leachate collection system, and leachate will continue to drain toward the designated withdrawal points. The maximum calculated settlement at the landfill centre for Alternative Method 2 is 590 mm.

For the details of the leachate collection piping, please refer to Section 2.2. Considering a unit weight of overlying material of 12 kN/m³, the pipe deflection under the loading associated with the Alternative Method 2 is around 6.8%, which is lower than the deflection limit of 7.5%, as described in Section 2.2.

For the geonet, based on what is mentioned in Section 2.2, it is concluded that geonet secondary drainage capacity performance will meet the design requirements for Alternative Method 2.

In summary, it is concluded that Alternative Method 2 is acceptable with respect to:

- Post-settlement Landfill base grades meeting O. Reg. 232/98 requirements and maintaining acceptable leachate collection in the primary drainage layer;
- Stability of the final slope (4H:1V maximum) and proposed peak profile height;
- Available collector pipe strength within the primary drainage layer; and
- Flow capacity of geonet within the secondary layer.

3.3 Buffer Zones

Since Alternative Method 2 would not change the existing approved landfill limit of waste, the existing property boundaries and buffer width, as mentioned in Section 2.3, will remain the same after the vertical expansion as indicated in **Drawing 2.1**. Therefore, the buffer area for Alternative Method 2 will meet the requirements of Section 7 of O. Reg. 232/98.

3.4 Site Development

3.4.1 Phasing and Schedule of Site Development

The proposed landfill expansion consists of four (4) stages as shown in **Table 3-1** and **Figure 3-2**. The areas and volumes of the stages shown in **Table 3-1** are approximate and will be confirmed through detailed design; however, the total landfill volume of Alternative Method 2 will remain at approximately 14.3 million m^3.

Table 3-1. Alternative Method 2 Stage Areas and Volumes

Stage	Peak Elevation (masl)	Volume (M m^3)
Stage 1	313	3.2
Stage 2	313	4.3
Stage 3	319	3.0
Stage 4	319	3.8
TOTAL	-	**14.3**

The site development phases have taken into consideration to have adequate space to allow disposal and operational vehicles to operate in the same area. The phases will be developed from west to east, considering the removal of final/interim cover along the side slopes prior to waste placement (as explained in Section 2.4.2).

Considering the approved landfilling rate is 1.4 million tonnes per year, the additional airspace could extend the site life by approximately 12 years.

Based on the estimated volumes provided for each phase in **Table 3-1**, Stage 2 can provide a site life of about 3.0 years while the other phases site life will range between 2.1 to 2.7 years.

3.4.2 Construction Activities

Please refer to Section 2.4.2.

3.5 Leachate Management

Similar to Alternative Method 1, Alternative Method 2 will not change the current expected infiltration rate, instead, it increases the rate of run-off due to the higher side slopes compared to the existing condition. Therefore, the leachate collection system will remain the same after vertical expansion. For more details, please refer to Section 2.5.

3.5.1 Leachate Generation

The maximum leachate generation for Alternative Method 2 is predicted to peak at 119,000 m^3 per year (326 m^3 per day) in Year 3 after completion of Stage 1 (approximately 2036). Leachate generation will then decrease to approximately 107,000 m^3 per year (293 m^3 per day) following placement of the final cover in Year 12 (estimated to be in 2045). **Appendix B** provides the modelling results. An additional 25,550 m^3 of leachate annually (70 m^3 per day) is estimated to be generated from the closed Old Landfill.

Based on the above, maximum leachate generation is estimated at 363 m^3 per day (293 m^3 + 70 m^3) from both Alternative Method 2 (including the Expansion Landfill) and the closed Old Landfill, which is expected to occur in Year 3 (approximately 2036).

Details regarding the HELP modelling are provided in Section 2.5.1. Based on the information presented, future generation of leachate should be anticipated to be at annual volumes between the HELP predictions and current levels.

3.5.2 Leachate Storage and Treatment

Please refer to Section 2.5.2.

3.6 Landfill Gas Management

3.6.1 Landfill Gas Generation

Please refer to Section 2.6.1.

3.6.2 Landfill Gas Collection and Treatment

Please refer to Section 2.6.2.

3.7 Stormwater Management

3.7.1 Existing System

Please refer to Section 2.7.1 for a discussion of the analysis of the existing system.

3.7.2 Baseline Future Scenario

Should the landfill optimization not proceed, the landfill development will continue until it has reached its full horizontal footprint and currently approved height of 280 masl. This will alter the outlets' catchment areas, land cover, and time of concentration, as well as the path of the swales in the northeast corner. This scenario is considered the future baseline and was modelled as part of the assessment of the proposed expansion as detailed below.

Please refer to Section 2.7.2 for a discussion on the analysis of the baseline future scenario.

3.7.3 Impact of Alternative Method 2

The impacts of Alternative Method 2 would be similar to that of Alternative Method 1 in several ways. The factors altering the magnitude and timing of the peak flows (although not the total runoff volume) are the same. The same scenarios were modelled: Existing; Baseline Future; and Future (Alternative Method 2). **Tables 3-2** to **3-4** highlight the differences in 100-year peak flows at the landfill outlets, SWM pond function under a 100-year design storm, and swale function under a 25-year design storm between the different scenarios. **Table 3-5** presents the geometric requirements of realigned swales SWC1A and SWG2A and the new culvert leading to Pond 4. Please refer to Section 2.7.3 for a more detailed description of the methodology used and **Appendix C** for the full results for storms of 2-year to 100-year return periods. The redistributed catchment areas for Alternative Method 2 are shown on **Figure 3-1**.

Table 3-2. Changes to Site Outlet peak flows during 100-year event

Catchment	Peak Runoff (cms / % increase from Existing Conditions)				
	Existing Conditions	Baseline Future		Future Alternative Method 2	
A	0.238	0.263	11%	0.267	12%
B	1.005	0.969	-4%	0.969	-4%
C	0.601	0.492	-18%	0.497	-17%
G	1.530	1.648	8%	1.621	6%

Table 3-3. SWM Pond function during 100-year event

Pond	Capacity (ha·m)	Peak Storage Used (ha·m)		
		Existing Conditions	Baseline Future	Future Alternative Method 2
1	2.773	0.896	0.896	0.896
2	5.271	1.491	1.704	1.616
3	2.857	0.709	0.731	0.771
4	1.099	0.335	0.277	0.275

Figure 3-1. Stormwater Management for Alternative Method 2

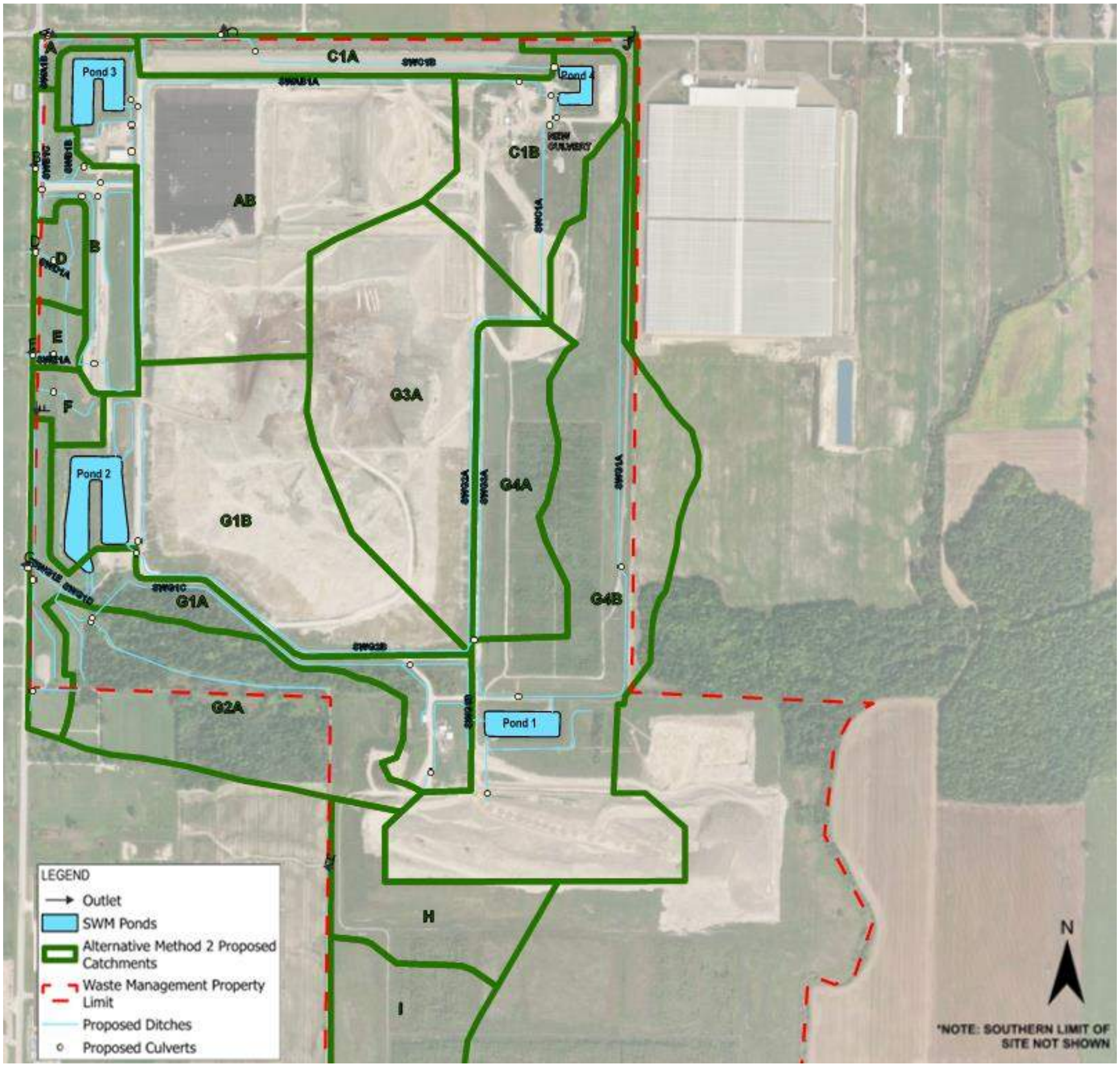


Table 3-4. Swale function during 25-year event

Swale	Flow Capacity (L/s)	Peak Flow (L/s)	
		Baseline Future	Future Alternative Method 2
SWAB1A	9,384	1458	1588
SWA1B	6,256	179	198
SWB1B	23,461	204	224
SWB1C	120,733	772	772
SWC1A	3,699	547	550
SWC1B	191,849	457	459

Swale	Flow Capacity (L/s)	Peak Flow (L/s)	
		Baseline Future	Future Alternative Method 2
SWD1A	28,626	221	221
SWE1A	100,850	202	202
SWG1A	3,981	1,053	1,053
SWG1B	17,669	392	392
SWG1C	11,847	726	334
SWG1D	6,229	325	303
SWG1E	10,909	1,157	1,143
Stream	18,095	1,157	1,143
SWG2A	1,592	637	630
SWG2B	12,631	2,677	2,423
SWG3A	1,246	283	283

Table 3-5. Design geometry of modified swales and new culvert

Name	Bottom Width / Diameter (m)	Depth (m)	Side Slope (x:1)	Slope
SWC1A	3	0.90	3:1	0.09%
SWG2A	1	0.54	3:1	0.64%
New Culvert (HDPE – 1 pipe)	1.2			0.44%

The data presented in the tables above mirror those of Section 2.7.3. Like Alternative Method 1, peak outflows from different outlets leaving the site under the Future Alternative Method 2 scenario are comparable to the Baseline Future scenario. It is noteworthy that Stormwater Management Pond 3 discharges flows to Outlets A and B and as seen from **Table 3-2**, Outlet A shows an increase in flows of approximately 12% and conversely Outlet B shows a decrease in flows of approximately 4% when compared to existing conditions. Outlet C shows a decrease in flows of approximately 17% when compared to existing conditions. Outlet G shows an approximate increase of 6% in flows when compared to existing conditions. However, it should be noted that the swales conveying the flows to Outlet G have sufficient capacity and are able to convey the flows downstream safely. These results are presented in greater detail in **Appendix C**.

Table 3-3 and **Table 3-4** demonstrate that the existing stormwater management ponds and swales will have enough capacity to process their respective design storms under Alternative Method 2. The relocated swales (SWC1A and SWG2A) and new culvert will also be able to convey these flows appropriately as long as they meet the design requirements listed in **Table 3-5**.

3.8 Ancillary Facilities

Please refer to Section 2.8.

3.9 Site Traffic

Please refer to Section 2.9.

3.10 Landfill Operations

3.10.1 Operating Hours

Please refer to Section 2.10.1.

3.10.2 Site Equipment

Please refer to Section 2.10.2.

3.10.3 Waste Placement

Please refer to Section 2.10.3.

3.10.4 Daily and Intermediate Cover

Please refer to Section 2.10.4.

3.10.5 Nuisance Controls

Please refer to Section 2.10.5.

3.10.5.1 Odour

Please refer to Section 2.10.5.1.

3.10.5.2 Litter

Please refer to Section 2.10.5.2.

3.10.5.3 Dust

Please refer to Section 2.10.5.3.

3.10.5.4 Noise

Please refer to Section 2.10.5.4.

3.10.5.5 Birds

Please refer to Section 2.10.5.5.

4 Conceptual Design of Alternative Method 3

4.1 Overview

Alternative Method 3 includes the increase of final landfill side slopes from 4H:1V to 2.5H:1V between elevation 260 masl and elevation 360 masl, about 100 m in grade change, peaking at elevation 360 masl (**Drawing 3.1**) over the Expansion Landfill. The Expansion Landfill is fully engineered and has an approved peak elevation of 280 masl. Alternative Method 3 will provide an additional 14.3 million m³ of landfill capacity.

Considering the proposed final side slopes of 2.5H:1V are steeper than the current 4H:1V, as per O. Reg. 232/98, a geotechnical feasibility review was performed to confirm the slope stability and settlement. The geotechnical assessment showed that this alternative is acceptable with respect to the stability of the final slopes (2.5H:1V) and proposed peak profile height. The results of the geotechnical feasibility review for Alternative Method 3 are discussed in Section 4.2.

4.2 Landfill Design and Geometry

The geometry of Alternative Method 3 is shown in plan view in **Drawing 3.1**. Under the proposed vertical expansion, the existing approved waste disposal footprint area of the TCEC would not change, but rather, the maximum permitted height of waste would be increased by 80 m, from 280 masl (the current approved elevation for top of waste) to 360 masl, which is the maximum elevation of the top of the final cover for Alternative Method 3. The 2.5H:1V side slopes will start at the existing landfill toe slope (about 21 m in grade change) continuing to elevation 360 masl, and then peaking at elevation 360 masl as indicated in **Drawing 3-2**. This will increase the current landfill capacity by approximately 14.3 million m³.

To assess the stability of the final slopes and proposed peak profile height, a preliminary slope stability analysis was performed. The slope stability analysis involved: reviewing the design of Alternative Method 3; reviewing existing background information; and building a 2-Dimensional Finite Element Model (FEM) using Slide2 Modeler version 9.020 software and adopting the Bishop Simplified factor of safety method. For the assumptions used in the model and the summary of selected engineering properties used in the FEM, please refer to Section 2.2 and **Table 2-1**.

Based on the results of the model, the factor of safety of the circular failure surface for Alternative Method 3 is 1.47. Therefore, Alternative Method 3 meets the recommended minimum factor of safety of 1.3 for slopes.

Settlement was calculated at intervals along the base of the landfill for the approved landfill profile and Alternative Method 3 considering a unit weight of waste of 12 kN/m³. Based on the results of the model, the overall slope in westerly direction (i.e., toward pumping station) will be maintained, despite the slight changes in the approved landfill base grades due to long-term settlement under the heavier inferred waste loading. Additionally, base flattening on the west side will not exceed initial base conditions on the east side which are considered minimum as defined by O. Reg. 232/98. Therefore, it is concluded that Alternative Method 3 will not have a significant effect on the functionality of the leachate collection system and leachate will continue to drain toward the designated withdrawal points. The maximum calculated settlement at the landfill centre for Alternative Method 3 is 545 mm.

For the details of the leachate collection piping, please refer to Section 2.2. Considering a unit weight of overlying material of 12 kN/m³, the pipe deflection under the loading associated with the Alternative Method 3 is around 7.9%, which is slightly than the deflection limit of 7.5%, as described in Section 2.2. Therefore, Alternative Method 3 provides lower than 3 to 1 safety factor against reserve curvature and might require a reinforcement of the leachate collection system (i.e., building a perimeter leachate collection system).

For the geonet, based on what is mentioned in Section 2.2, it is concluded that geonet secondary drainage capacity performance will meet the design requirements for Alternative Method 3.

In summary, it is concluded that Alternative Method 3 is acceptable with respect to:

- Post-settlement Landfill base grades meeting O. Reg. 232/98 requirements and maintaining acceptable leachate collection in the primary drainage layer;
- Stability of the final slope (2.5H:1V maximum) and proposed peak profile height;
- Flow capacity of geonet within the secondary layer.

4.3 Buffer Zones

Since Alternative Method 3 would not change the existing approved landfill limit of waste, the existing property boundaries and buffer width, as mentioned in Section 2.3, will remain the same after the vertical expansion, as indicated in **Drawing 3.1**. Therefore, the buffer area for Alternative Method 3 will meet the requirements of Section 7 of O. Reg. 232/98.

4.4 Site Development

4.4.1 Phasing and Schedule of Site Development

The proposed landfill expansion consists of five (5) stages as shown in **Table 4-1** and **Drawing 3.2**. The areas and volumes of the stages shown in **Table 4-1** are approximate and will be confirmed through detailed design; however, the total landfill volume of Alternative Method 3 will remain at approximately 14.3 million m³.

Table 4-1. Alternative Method 3 Stage Areas and Volumes

Stage	Peak Elevation (masl)	Volume (M m³)
Stage 1	290	3.2
Stage 2	290	3.8
Stage 3	325	2.7
Stage 4	325	2.3
Stage 5	360	2.3
TOTAL	-	**14.3**

The site development phases have taken into consideration to have adequate space to allow disposal and operational vehicles to operate in the same area. The phases will be developed from west to east, considering the removal of final/interim cover along the side slopes prior to waste placement (as explained in Section 2.4.2).

Considering the approved landfilling rate is 1.4 million tonnes per year, the additional airspace could extend the site life by approximately 12 years.

Based on the estimated volumes provided for each phase in **Table 4-1**, Stage 2 can provide a site life of about 2.7 years while the other phases site life will range between 1.6 to 2.3 years.

4.4.2 Construction Activities

Please refer to Section 2.4.2.

4.5 Leachate Management

Similar to Alternative Method 1, Alternative Method 3 will not change the current expected infiltration rate, instead, it increases the rate of run-off due to the higher side slopes compared to the existing condition. Therefore, the leachate collection system will remain the same after vertical expansion. For more details, please refer to Section 2.5.

4.5.1 Leachate Generation

The maximum leachate generation for Alternative Method 3 is predicted to peak at 118,500 m³ per year (325 m³ per day) in Year 3 after completion of Stage 1 (approximately 2036). Leachate generation will then decrease to approximately 101,700 m³ per year (279 m³ per day) following placement of the final cover in Year 12 (estimated to be in 2045). **Appendix B** provides the modelling results. An additional 25,550 m³ of leachate annually (70 m³ per day) is estimated to be generated from the closed Old Landfill.

Based on the above, maximum leachate generation is estimated at 395 m^3 per day (325 m^3 + 70 m^3) from both Alternative Method 3 (including the Expansion Landfill) and the closed Old Landfill, which is expected to occur in Year 3 (approximately 2036).

Details regarding the HELP modelling are provided in Section 2.5.1. Based on the information presented, future generation of leachate should be anticipated to be at annual volumes between the HELP predictions and current levels.

4.5.2 Leachate Storage and Treatment

Please refer to Section 2.5.2.

4.6 Landfill Gas Management

4.6.1 Landfill Gas Generation

Please refer to Section 2.6.1.

4.6.2 Landfill Gas Collection and Treatment

Please refer to Section 2.6.2.

4.7 Stormwater Management

4.7.1 Existing System

Please refer to Section 2.7.1 for a discussion on the analysis of the existing system

4.7.2 Baseline Future Scenario

Should the landfill expansion optimization not proceed, the landfill development will continue until it has reached footprint will reach its full horizontal footprint and currently approved height of 280 masl. This will alter the outlets' catchment areas, land cover, and times of concentration, as well as the path of the swales in the northeast corner. This scenario is considered the future baseline and was modelled as part of the assessment of the proposed expansion as detailed below.

Please refer to Section 2.7.2 for a discussion of the analysis of the baseline future scenario.

4.7.3 Impact of Alternative Method 3

The impacts of Alternative Method 3 would be similar to that of Alternative Methods 1 and 2 in several ways. The factors altering the magnitude and timing of the peak flows (although not, again, the total runoff volume) are the consistent. The same scenarios were modelled: Existing; Baseline Future; and Future (Alternative Method 3). **Tables 4-2** to **4-4** highlight the differences in 100-year peak flows at the landfill outlets, SWM pond function under a 100-year design storm, and swale function under a

25-year design storm between the different scenarios. **Table 4-5** presents the geometric requirements of realigned swales SWC1A and SWG2A and the new culvert leading to Pond 4. Please refer to Section 2.7.3 for a more detailed description of the methodology used and **Appendix C** for the full results for storms of 2-year to 100-year return periods. The redistributed catchment areas for Alternative Method 3 are shown in **Figure 4-1**.

Table 4-2. Changes to Site Outlet peak flows during 100-year event

Catchment	Peak Runoff (cms / % increase from Existing Conditions)				
	Existing Conditions	Baseline Future		Future Alternative Method 3	
A	0.238	0.263	11%	0.261	10%
B	1.005	0.969	-4%	0.969	-4%
C	0.601	0.492	-18%	0.494	-18%
G	1.530	1.648	8%	1.629	6%

Table 4-3. SWM Pond function during 100-year event

Pond	Capacity (ha·m)	Peak Storage Used (ha·m)		
		Existing Conditions	Baseline Future	Future Alternative Method 3
1	2.773	0.896	0.896	0.896
2	5.271	1.491	1.704	1.630
3	2.857	0.709	0.731	0.761
4	1.099	0.335	0.277	0.272

Figure 4-1. Stormwater Management for Alternative Method 3

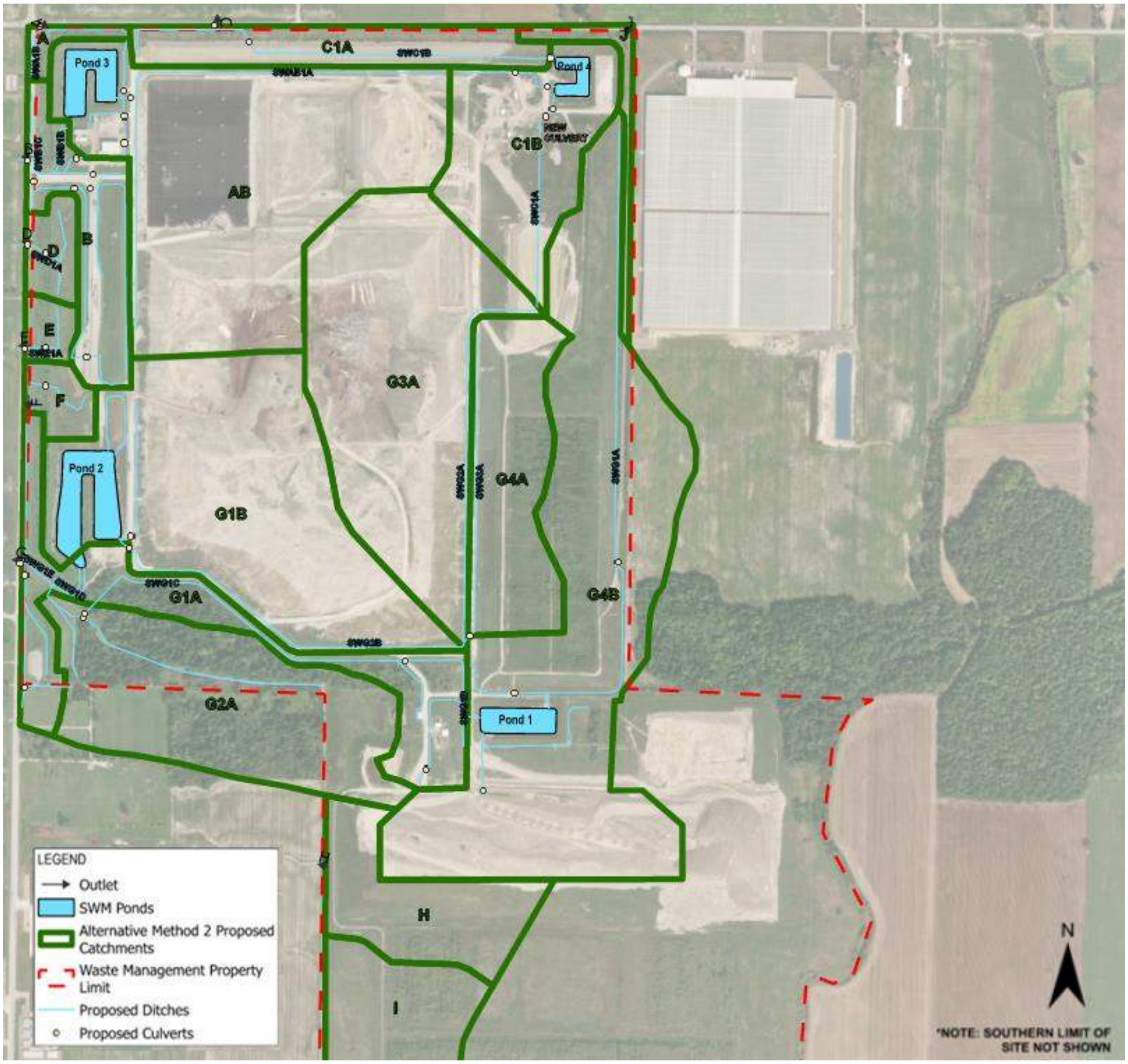


Table 4-4. Swale function during 25-year event

Swale	Flow Capacity (L/s)	Peak Flow (L/s)	
		Baseline Future	Future Alternative Method 3
SWAB1A	9,384	1,458	1,556
SWA1B	6,256	179	193
SWB1B	23,461	204	220
SWB1C	120,733	772	772
SWC1A	3,699	547	535
SWC1B	191,849	457	456
SWD1A	28,626	221	221

Swale	Flow Capacity (L/s)	Peak Flow (L/s)	
		Baseline Future	Future Alternative Method 3
SWE1A	100,850	202	202
SWG1A	3,981	1,053	1,053
SWG1B	17,669	392	392
SWG1C	11,847	726	726
SWG1D	6,229	325	306
SWG1E	10,909	1,157	1,145
Stream	18,095	1,157	1,145
SWG2A	1,592	637	627
SWG2B	12,631	2,677	2,476
SWG3A	1,246	283	283

Table 4-5. Design geometry of modified swales and new culvert

Name	Bottom Width / Diameter (m)	Depth (m)	Side Slope (x:1)	Slope
SWC1A	3	0.90	3:1	0.09%
SWG2A	1	0.54	3:1	0.64%
New Culvert (HDPE – 1 pipe)	1.2			0.44%

The data presented in the tables above mirror those of Section 2.7.3. Like Alternative Methods 1 and 2, peak outflows from different outlets leaving the site under the Future Alternative Method 3 scenario are comparable to the Baseline Future scenario. It is noteworthy that Stormwater Management Pond 3 discharges flows to Outlets A and B and as seen from **Table 4-2**, Outlet A shows an increase in flows of approximately 10% and conversely Outlet B shows a decrease in flows of approximately 4% when compared to existing conditions. Outlet C shows a decrease in flows of approximately 18% when compared to existing conditions. Outlet G shows an approximate increase of 6% in flows when compared to existing conditions. However, it should be noted that the swales conveying the flows to Outlet G have sufficient capacity and are able to convey the flows downstream safely. These results are presented in greater detail in **Appendix C**.

Tables 4-3 and 4-4 demonstrate that the existing stormwater management ponds and swales will have enough capacity to process their respective design storms under Alternative Method 3. The relocated swales (SWC1A) and SWG2A) and new culvert will also be able to convey these flows appropriately as long as they meet the design requirements listed in **Table 4-5**.

4.8 Ancillary Facilities

Please refer to Section 2.8.

4.9 Site Traffic

Please refer to Section 2.9.

4.10 Landfill Operations

4.10.1 Operating Hours

Please refer to Section 2.10.1.

4.10.2 Site Equipment

Please refer to Section 2.10.2.

4.10.3 Waste Placement

Please refer to Section 2.10.3.

4.10.4 Daily and Intermediate Cover

Please refer to Section 2.10.4.

4.10.5 Nuisance Controls

Please refer to Section 2.10.5.

4.10.5.1 Odour

Please refer to Section 2.10.5.1.

4.10.5.2 Litter

Please refer to Section 2.10.5.2.

4.10.5.3 Dust

Please refer to Section 2.10.5.3.

4.10.5.4 Noise

Please refer to Section 2.10.5.4.

4.10.5.5 Birds

Please refer to Section 2.10.5.5.

5 Climate Change Considerations

The document entitled "Considering Climate Change in the Environmental Assessment Process" (MOECC, 2017) was used as a guide for incorporating measures in the landfill expansion design that reduce both its impact on climate change (i.e., climate change mitigation) and the impact of climate change on the landfill (i.e., climate change adaptation). These measures are described in the following sections.

5.1 Effects of Climate Change on Landfill Design and Operations

Climate change has resulted in extreme weather events including increasingly severe rainfall and wind events, temperature extremes, and reduced snow cover. The potential impacts of these events are expected to influence mainly the design of the stormwater management system as well as routine site operations. These events are not expected to have a significant influence on the design of the LFG or leachate management systems, although they may influence the rate of generation of leachate and LFG.

5.1.1 Stormwater Management Design

Extreme weather events caused by climate change are relevant to the design of stormwater management systems in the diversion/control of runoff, as well as erosion and sedimentation control. Climate change will impact the stormwater management system by increasing the intensity and frequency of storms, which will cause larger peak flows, sometimes by a significant amount. It is for this reason that the future conditions were modelled for the currently approved landfill buildout and the three Alternative Methods using current and future climate change intensity-duration-frequency (IDF) curves. These curves were taken from the Sarnia weather station as reported/predicted by Environment and Climate Change Canada. The 2071-2100 SSP2-4.5 (moderate emissions scenario) was used, representing a 27-29% in peak intensity. The analysis demonstrated that despite the increase in peak flows climate change will cause, the existing ponds and swales have sufficient capacity to manage the runoff under the design storms.

5.1.2 Landfill Operations

Extreme rainfall and wind events can influence landfill operations although these influences can be mitigated by adapting operating practices. The landfill operations will adapt to climate change by implementing by considering:

- Installing higher or longer litter control fences designed to handle stronger winds.

- Maintaining the on-site perimeter ditches and culverts clear of sediment to promote positive drainage during high intensity precipitation events.
- During extreme heat and cold weather, staff working outdoors will be required to follow WM health and safety operational procedures. On-site vehicles and heavy equipment will be maintained to provide climate-controlled conditions for the operational staff.

5.1.3 Landfill Gas Management System Design

The rate of generation of methane (e.g., Methane Generation Rate, k) is highly dependent upon the moisture in the waste mass, and the overall methane generation capacity (e.g., Methane Generation Capacity, Lo) depends on the type and composition of waste in the landfill. Extreme weather events caused by climate change may influence the amount of moisture within the waste and therefore the rate at which methane is generated. If climate change results in a lowering of moisture content, the generation rate will be reduced; conversely if the moisture content increases the generation rate will be increased.

The proposed landfill design includes a low permeability soil final cover that will be constructed progressively as the site is developed, and as the final covered area increases, the effect of variations in rain events on moisture content of the waste will be diminished. WM will monitor the landfill gas generation rate throughout the life of the site and will ensure that adequate gas management capability (e.g., RNG facility and gas flaring) is maintained.

The gas treatment/flare system has sufficient operational capacity to manage up to 24,824 m^3/hr, which is greater than the estimated gas generation rate of 18,169 m^3/hour (**Table 2-3**), without considering the additional Flares 5 and 6 which will operate in the event the RNG facility is not operational.

5.1.4 Leachate Collection System Design

Extreme weather events resulting from climate change are not expected to have a significant long-term effect on precipitation infiltration and generation of leachate considering the site will be progressively capped with a low permeability final cover. Additional infiltration will increase the leachate generation rate within the active cells (without soil cover), but the effect will be reduced by moisture initially going into storage in the waste mass, as well as the progressive closure of the site. The current leachate collection system is capable of managing the additional leachate generation rates.

5.2 Effect of the Landfill on Climate Change

The greatest potential influence of the landfill on climate change relates to the generation and emission of LFG, which is comprised primarily of methane and carbon dioxide, both of which are greenhouse gases (GHGs). This effect is anticipated to be minimal given the following aspects of the landfill design:

- The landfill optimization will incorporate an active LFG collection system with an estimated efficiency of 90% in areas under final cover, limiting LFG emissions to the atmosphere.
- Collected LFG will be processed and converted to Renewable Natural Gas (RNG) or combusted by on-site flares.
- Progressively placement of interim and final cover will reduce LFG emissions.

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Ontario Ministry of the Environment

2012 Landfill Standards – A Guideline on the Regulatory and Approval Requirements for New or Expanding Landfill Sites.

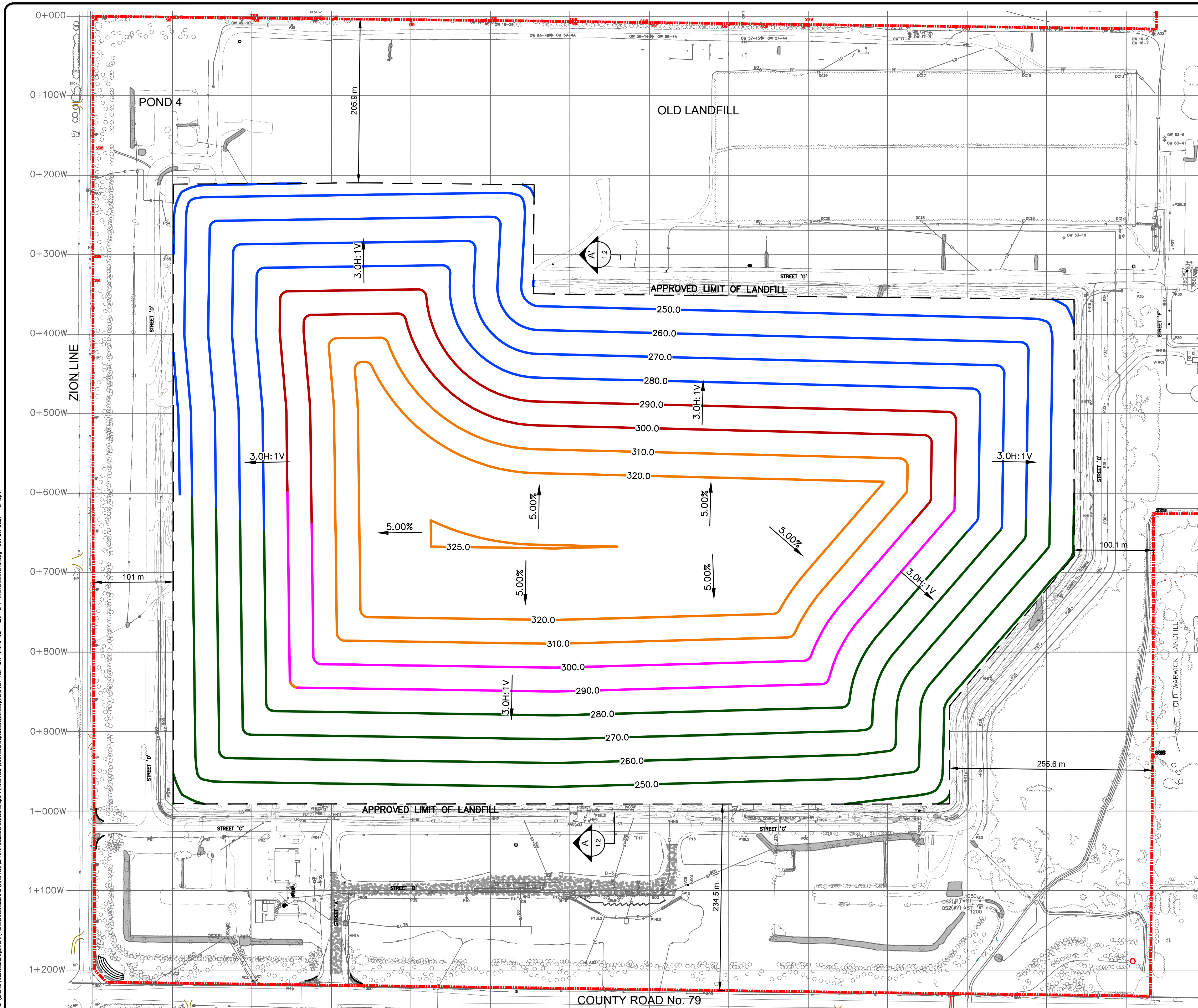
Ontario Ministry of the Environment, Conservation and Parks

2017 Considering climate change in the environmental assessment process https://www.ontario.ca/page/considering-climate-change-environmental-assessment-process

RWDI AIR Inc.

2023 Twin Creeks Environmental Centre: 2022 Fourth Quarter & Annual Monitoring Report.

Drawings



LEGEND

- WASTE MANAGEMENT OF CANADA CORPORATION PROPERTY LIMIT
- APPROVED LIMIT OF LANDFILL
- EXISTING RIP RAP
- EXISTING PAVED ROAD
- EXISTING GRAVEL ROAD/TRAIL
- EXISTING DITCH/SWALE
- EXISTING CULVERT - PIPE
- EXISTING CULVERT - CONCRETE BOX
- CT EXISTING COMMON TRENCH
- ST EXISTING STORM SEWER
- EXISTING TREE LINE
- EXISTING GROUND CONTOURS
- 280.0 PROPOSED TOP OF LANDFILL CONTOURS (STAGE 1)
- 280.0 PROPOSED TOP OF LANDFILL CONTOURS (STAGE 2)
- 300.0 PROPOSED TOP OF LANDFILL CONTOURS (STAGE 3)
- 300.0 PROPOSED TOP OF LANDFILL CONTOURS (STAGE 4)
- 325.0 PROPOSED TOP OF LANDFILL CONTOURS (STAGE 5)
- 3.0H:1V PROPOSED TOP OF LANDFILL SLOPE

DATE	DESCRIPTION
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CONCEPTUAL DESIGN REPORT
ALTERNATIVE METHOD 1
PROPOSED FINAL LANDFILL CONTOURS

TWIN CREEKS ENVIRONMENTAL CENTRE
WARWICK TOWNSHIP

DWN BY: W S DATE: JULY 3, 2024
CHK BY: C O R SCALE: SEE BAR SCALE

WASTE MANAGEMENT OF CANADA CORP.

DRAWING NO. CA-WSP-211-01678-02-1.1

DRAWING 1.1

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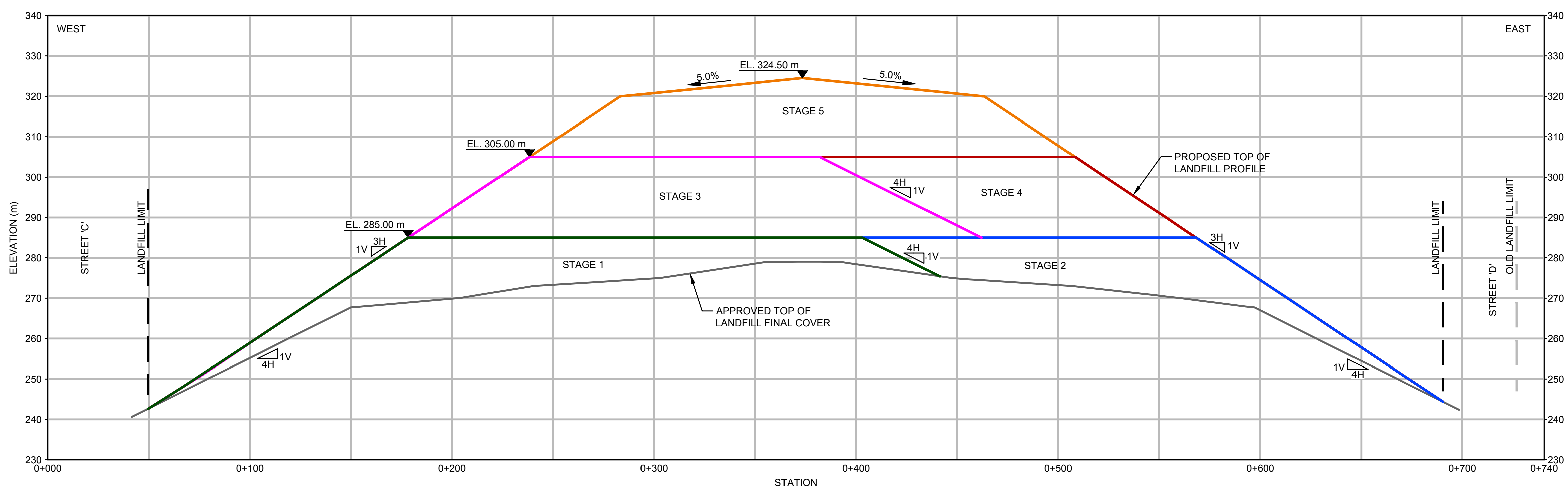

SCALE 1:2,500 m
VERT. SCALE 1:1,250 m
A
1.1
PROPOSED LANDFILL ALTERNATIVE METHOD 1 SECTION

VER. 0 50 100 1:1,250 METRES

HOR. 0 100 200 1:2,500 METRES

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CONCEPTUAL DESIGN REPORT
ALTERNATIVE METHOD 1
PROPOSED LANDFILL SECTION

TWIN CREEKS ENVIRONMENTAL CENTRE
WARWICK TOWNSHIP

DWN BY: W S DATE: JULY 3, 2024
CHK BY: C O R SCALE: SEE BAR SCALE

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DRAWING NO. CA-WSP-211-01678-02-1.2

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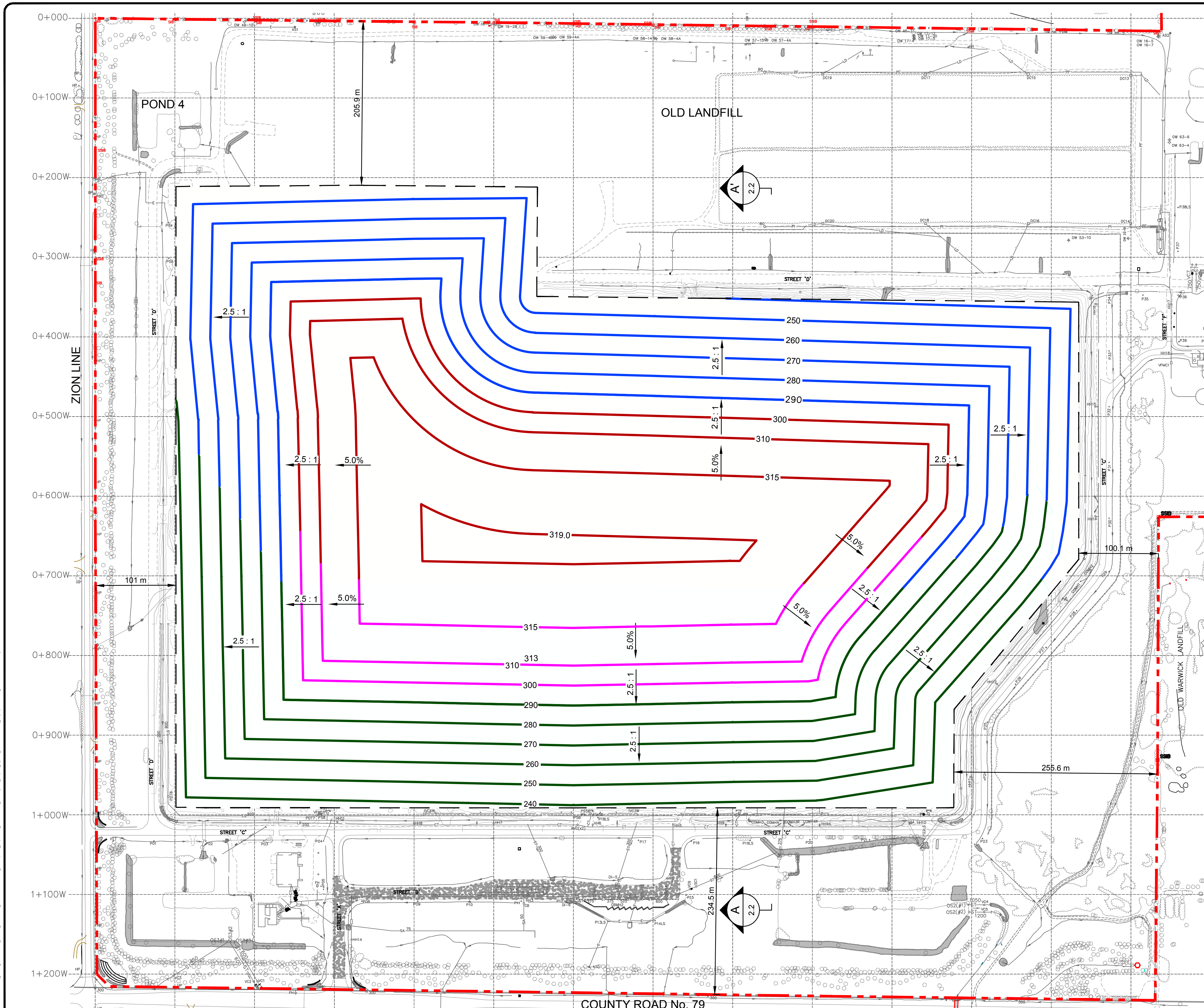

LEGEND

- WASTE MANAGEMENT OF CANADA CORPORATION PROPERTY LIMIT
- APPROVED LIMIT OF LANDFILL
- EXISTING RIP RAP
- EXISTING PAVED ROAD
- EXISTING GRAVEL ROAD/TRAIL
- EXISTING DITCH/SWALE
- EXISTING CULVERT - PIPE
- EXISTING CULVERT - CONCRETE BOX
- CT EXISTING COMMON TRENCH
- ST EXISTING STORM SEWER
- EXISTING TREE LINE
- EXISTING GROUND CONTOURS
- 290 PROPOSED TOP OF LANDFILL CONTOURS (STAGE 1)
- 290 PROPOSED TOP OF LANDFILL CONTOURS (STAGE 2)
- 315 PROPOSED TOP OF LANDFILL CONTOURS (STAGE 3)
- 319.0 PROPOSED TOP OF LANDFILL CONTOURS (STAGE 4)
- 2.5:1 PROPOSED TOP OF LANDFILL SLOPE

0 100 200
1:5,000 METRES

DATE	DESCRIPTION
	REVISION / ISSUE

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CONCEPTUAL DESIGN REPORT
ALTERNATIVE METHOD 2
PROPOSED STAGE 4 LANDFILL CONTOURS

TWIN CREEKS ENVIRONMENTAL CENTRE
WARWICK TOWNSHIP

DWN BY: KJK/WS DATE: JULY 3, 2024
CHK BY: COR SCALE: SEE BAR SCALE

WASTE MANAGEMENT OF CANADA CORP.

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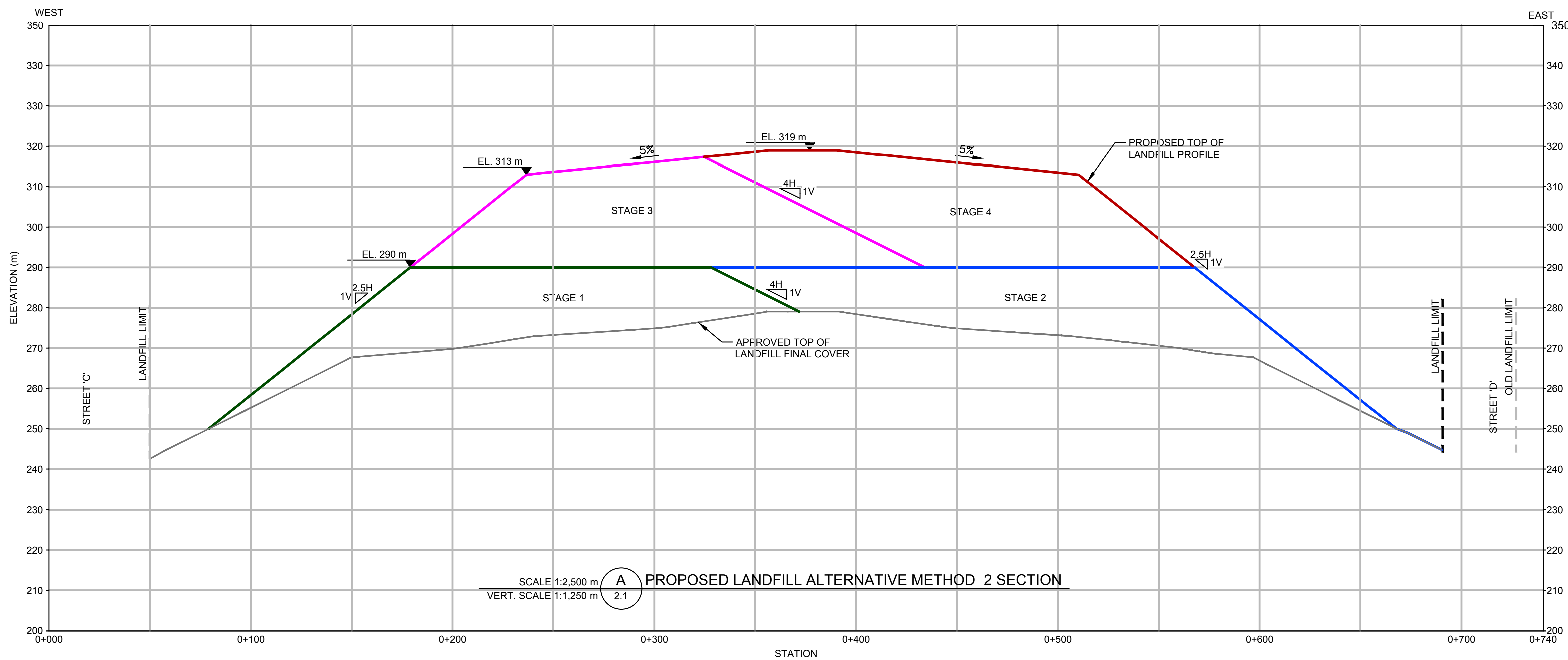

VER. 0 50 100
1:1,250 METRES

HOR. 0 100 200
1:2,500 METRES

DATE	DESCRIPTION

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CONCEPTUAL DESIGN REPORT
ALTERNATIVE METHOD 2
PROPOSED LANDFILL SECTION

TWIN CREEKS ENVIRONMENTAL CENTRE
WARWICK TOWNSHIP

DWN BY: KJK/WS DATE: JULY 3, 2024
CHK BY: COR SCALE: SEE BAR SCALE

WASTE MANAGEMENT OF CANADA CORP.

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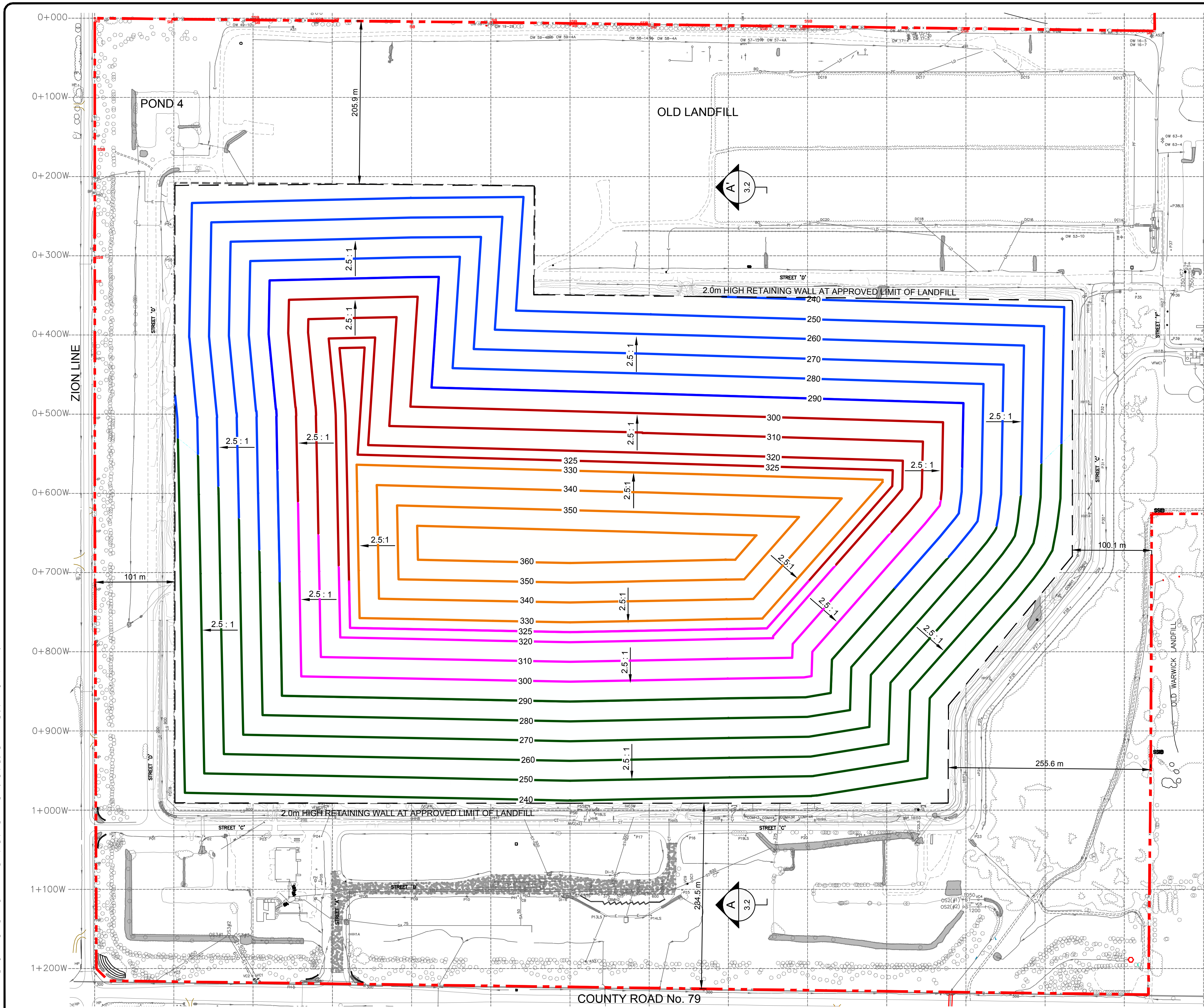

LEGEND

	WASTE MANAGEMENT OF CANADA CORPORATION PROPERTY LIMIT
	APPROVED LIMIT OF LANDFILL
	EXISTING RIP RAP
	EXISTING PAVED ROAD
	EXISTING GRAVEL ROAD/TRAIL
	EXISTING DITCH/SWALE
	EXISTING CULVERT - PIPE
	EXISTING CULVERT - CONCRETE BOX
CT	EXISTING COMMON TRENCH
ST	EXISTING STORM SEWER
	EXISTING TREE LINE
	EXISTING GROUND CONTOURS
290	PROPOSED TOP OF LANDFILL CONTOURS (STAGE 1)
290	PROPOSED TOP OF LANDFILL CONTOURS (STAGE 2)
325	PROPOSED TOP OF LANDFILL CONTOURS (STAGE 3)
325	PROPOSED TOP OF LANDFILL CONTOURS (STAGE 4)
360	PROPOSED TOP OF LANDFILL CONTOURS (STAGE 5)
2.5:1	PROPOSED TOP OF LANDFILL SLOPE

0 100 200
1:5,000 METRES

DATE	DESCRIPTION

REVISION / ISSUE

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CONCEPTUAL DESIGN REPORT
ALTERNATIVE METHOD 3
PROPOSED STAGE 5 LANDFILL CONTOURS

TWIN CREEKS ENVIRONMENTAL CENTRE
WARWICK TOWNSHIP

DWN BY: KJK/WS DATE: JULY 3, 2024
CHK BY: COR SCALE: SEE BAR SCALE

WASTE MANAGEMENT OF CANADA CORP.

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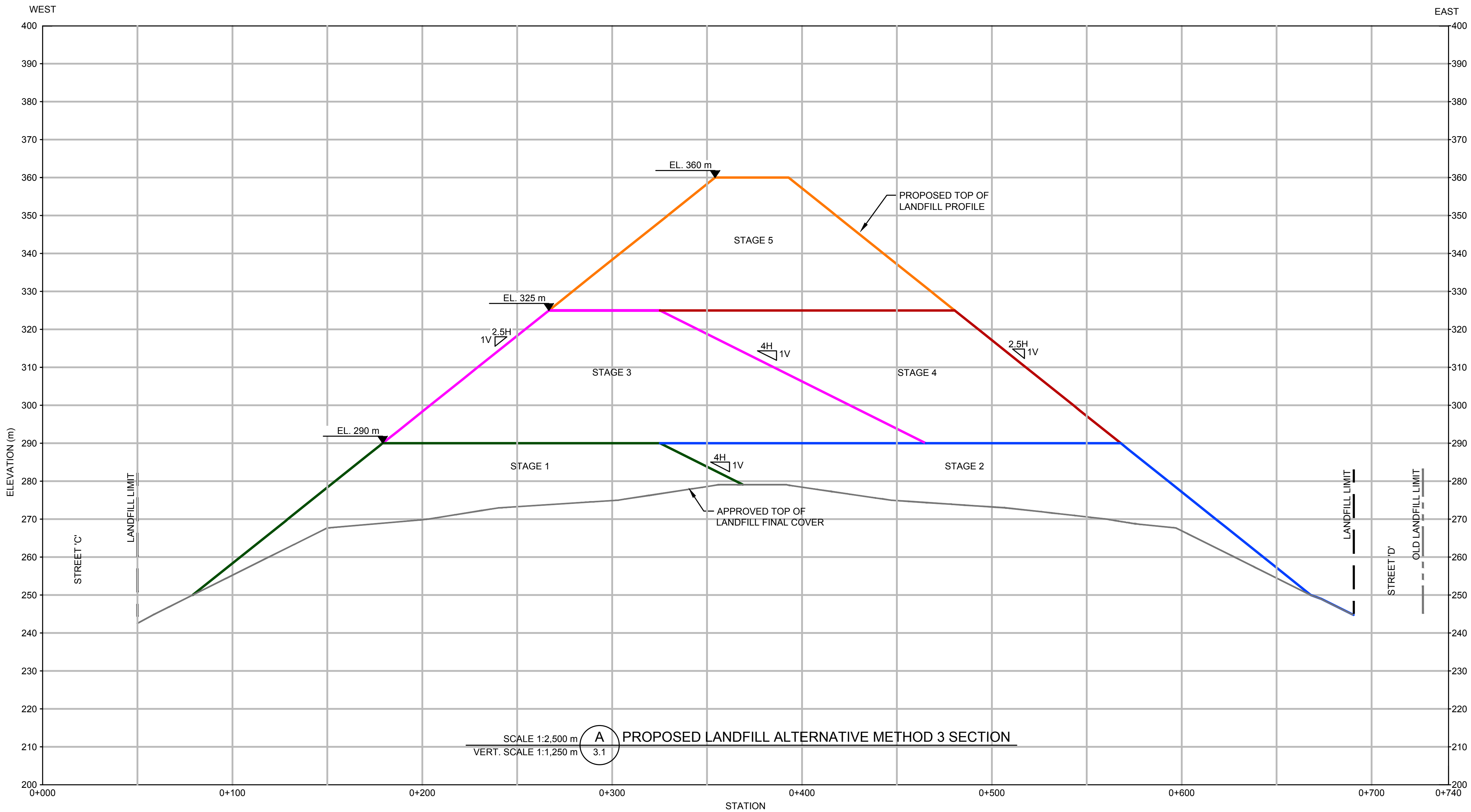

VER. 0 50 100 1:1,250 METRES

HOR. 0 100 200 1:2,500 METRES

DATE	DESCRIPTION

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CONCEPTUAL DESIGN REPORT
ALTERNATIVE METHOD 3
PROPOSED LANDFILL SECTION

TWIN CREEKS ENVIRONMENTAL CENTRE
WARWICK TOWNSHIP

DWN BY: KJK/WS DATE: JULY 3, 2024
CHK BY: COR SCALE: SEE BAR SCALE

WASTE MANAGEMENT OF CANADA CORP.

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A

Geonet Analysis Report

GroupeCTTGroup
Division SAGEOS
Geosynthetics Géosynthétiques

ANALYSIS REPORT
SCC Accreditation No.: 40‡

Mr Peter Brodzikowski
Genivar

Date: October 25, 2010
Report: S996-002-46085A

IDENTIFICATION: Installed structure (top to bottom): Clayey Silt / Drainage geocompositeTendrain II 91010-2 / Rannoch Till

Project: #105716
Received: October 4, 2010

STANDARD:

TEST: (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geos. Using a Constant Head ASTM D4716 - 08

TEST CONDITIONS: 2 test specimens in machine direction (MD);
Temperature of the water (°C): 22
The test specimens were taken at less than one third of the edge ;
Installation of the specimen: Clayey Silt / Drainage géocomposite / Rannoch Till
Width of the test specimen (mm): 300
Length of the test specimen (mm): 300
Calibration of the apparatus: April 15, 2010
The hydraulic losses of the equipment are in conformance with section 11.1.3 of the standard ;
Tested from October 21 to 25, 2010

RESULTS: Individual Data

Hydraulic Gradient:	0.02			
Normal Compressive Stress:	800 kPa			
Seating time:	15min	1h	24h	100h
Transmissivity (E-04 m²/s) :	19.2	19.0	19.4	17.5
Flow Rate (l/min) :	0.738	0.731	0.711	0.643
Flow Rate (gal/min) :	0.195	0.193	0.188	0.170

Hydraulic Gradient:	0.1			
Normal Compressive Stress:	800 kPa			
Seating time:	15min	1h	24h	100h
Transmissivity (E-04 m²/s) :	10.4	10.3	10.5	9.0
Flow Rate (l/min) :	2.00	1.97	1.93	1.65
Flow Rate (gal/min):	0.528	0.521	0.509	0.436

Prepared by:
Maxime Côté
Maxime Côté, Tech.
Technician

Approved by:
Eric Blond, Eng., M.Sc.A.
Vice-President
Date: October 25, 2010

For any information concerning this report, please contact Eric Blond

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GroupeCTTGroup
Division SAGEOS
Geosynthetics Géosynthétiques

ANALYSIS REPORT
SCC Accreditation No.: 40‡

Mr Peter Brodzikowski
Genivar

Date: October 25, 2010
Report: S996-002-46085A

IDENTIFICATION: Installed structure (top to bottom): Clayey Silt / Drainage geocompositeTendrain II 91010-2 / Rannoch Till

Project: #105716
Received: October 4, 2010

STANDARD:

TEST: (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geos. Using a Constant Head — ASTM D4716 - 08

RESULTS (CONT): Individual Data

Hydraulic Gradient:	1.0			
Normal Compressive Stress:	800 kPa			
Seating time:	15min	1h	24h	100h
Transmissivity (E-04 m^2/s) :	4.0	3.9	3.9	3.5
Flow Rate (l/min) :	7.62	7.56	7.10	6.35
Flow Rate (gal/min):	2.01	2.00	1.88	1.68

Prepared by:

Maxime Côté
Maxime Côté, Tech.
Technician

Approved by:

Eric Blond, Eng., M.Sc.A.
Vice-President

Date: October 25, 2010

*****For any information concerning this report, please contact Eric Blond*****

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ANALYSIS REPORT
SCC Accreditation No.: 40‡

Mr Peter Brodzikowski
Genivar

Date: December 23, 2010
Report: S996-002-46086B

IDENTIFICATION:	Interface: Rannoch Till soil / Geocomposite Tendrain II 91010-2 Project: #105716 Received: October 7, 2010
STANDARD:	
TEST:	Coefficient of Soil and Geosynthetic or Geosynt. and Geosynt. Friction by the Direct Shear Method — ASTM D5321-08
TEST CONDITIONS:	Shear surface 304 x 304 mm; Rate of horizontal displacement(mm/min); 0.05 (0.002 in/min) Tested in machine direction ; Submerged interface (24 hours under 10 kPa, than consolidated under the tested normal stress); Testing configuration - Upper box / Lower box: textured steel plate / Rannoch Till soil / Tendrain II 91010-2 geocomposite / textured steel plate; The test was subcontracted to another laboratory ; Tested from November 3 to December 3, 2010

RESULTS:	Individual Data		
Normal Compressive Pressure (kPa):	130.3	239.9	399.9
PROPERTIES OF THE SOIL	...		
Water content of compaction (%):	14.4	14.4	14.4
Dry unit weight after compaction (kg/m³):	1842	1842	1842
Duration of the consolidation (hours):	24	24	24
TEST RESULTS	...		
Maximum Shear Stress (kPa):	78.6	125.5	203.4
Residual Shear Stress (kPa):	67.6	95.8	203.4

REMARKS: Secant friction angles:
under 130 kPa : peak : 31°, residual: 27°
under 240 kPa : peak : 28°, residual: 22°
under 400 kPa : peak : 27°, residual: 27°
The geocomposite did not exhibit any evidence of delamination under any normal load

Prepared by: Jonathan Trudel
Jonathan Trudel, Tech.
Technician

Approved by:
Eric Blond, Eng., M.Sc.A.
Vice-President
Date: December 23, 2010

For any information concerning this report, please contact Eric Blond

The reports are identified by an alphanumeric code, the last character refers to the number of revision(s), this is emitted in ascending order. The samples in relation to this test are retained for a period of 30 days following the expedition day of the written report, unless other instructions are received. The fees for all services after the tests are 125.00 $ per hour and for appraisal in Court, 195.00$ per hour. The above reported results refer exclusively to the samples submitted for evaluation. This analysis report cannot be partly used or reproduced, unless in whole, without CTT Group prior written consent. ‡ CTT Group is accredited by the SCC for specific tests as listed on www.scc.ca. For customer's complete address, please refer to the front page.

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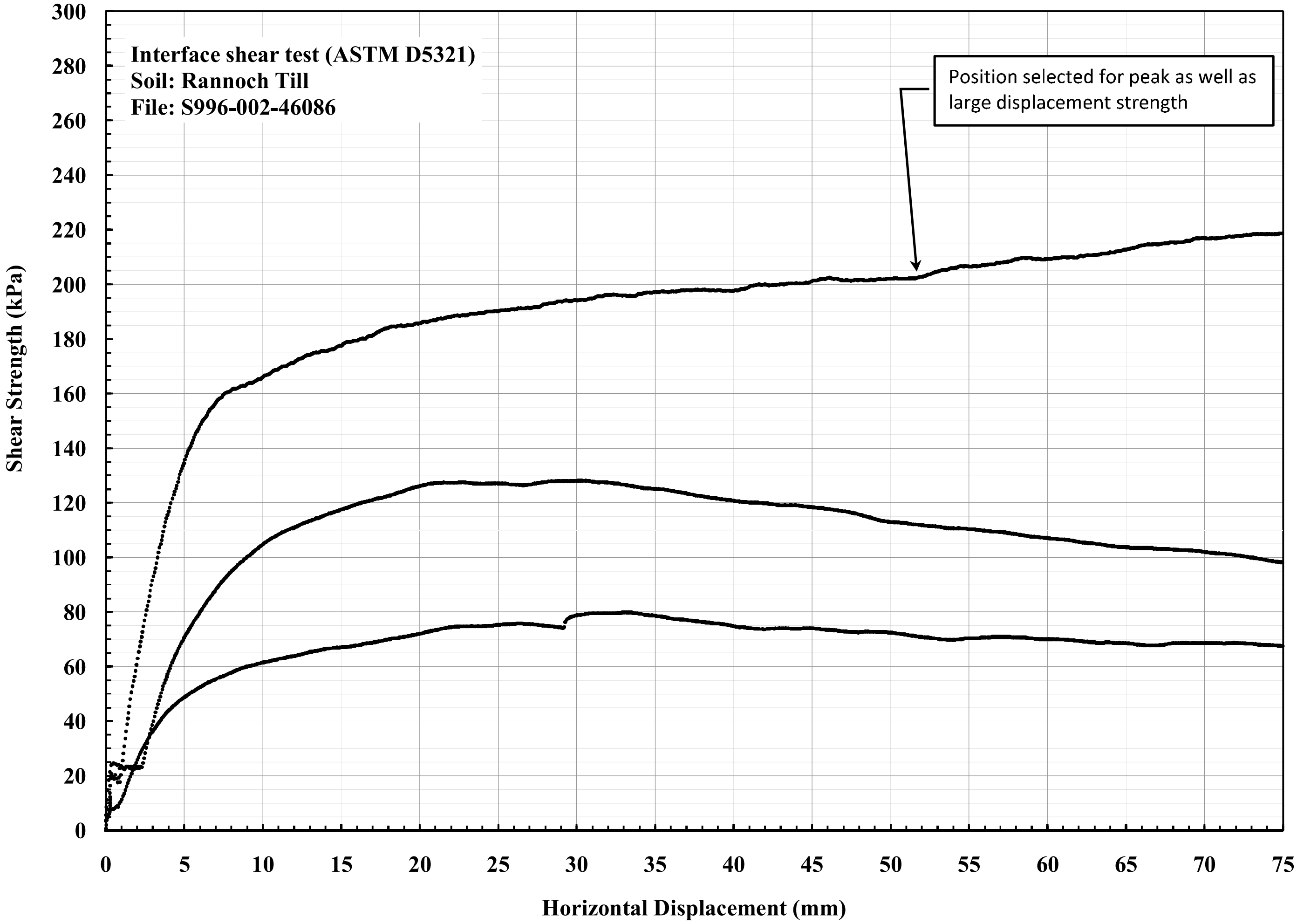
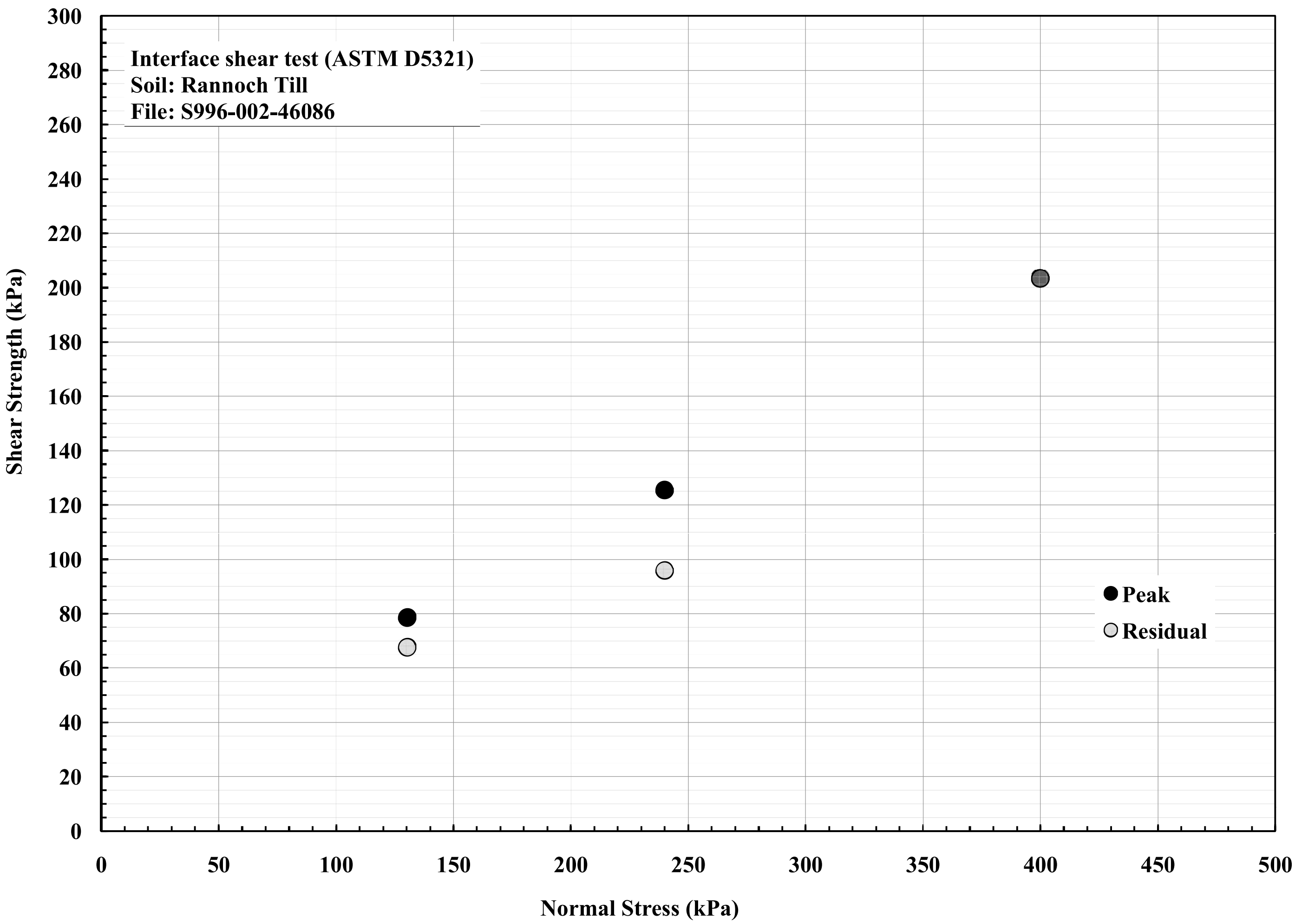


Interface shear test (ASTM D5321)
Soil: Rannoch Till
File: S996-002-46086
Position selected for peak as well as large displacement strength
Shear Strength (kPa)
Horizontal Displacement (mm)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75



Interface shear test (ASTM D5321)
Soil: Rannoch Till
File: S996-002-46086
Shear Strength (kPa)
Normal Stress (kPa)
Peak
Residual
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
0
50
100
150
200
250
300
350
400
450
500

GroupeCTTGroup
Division SAGEOS
Geosynthetics Géosynthétiques

ANALYSIS REPORT
SCC Accreditation No.: 40‡

Mr Peter Brodzikowski
Genivar

Date: December 23, 2010
Report: S996-002-46966B

IDENTIFICATION:	Interface: Clayey Silt soil / Geocomposite Tendrain II 91010-2 Project: #105716 Received: October 7, 2010
STANDARD:	
TEST:	Coefficient of Soil and Geosynthetic or Geosynt. and Geosynt. Friction by the Direct Shear Method — ASTM D5321-08
TEST CONDITIONS:	Shear surface 304 x 304 mm; Rate of horizontal displacement(mm/min); 0.05 (0.002 in/min); Tested in machine direction ; Submerged interface (24 hours under 10 kPa, than consolidated under the tested normal stress); Testing configuration - Upper box / Lower box: textured steel plate / Clayey Silt soil / Tendrain II 91010-2 geocomposite / textured steel plate; Tested from November 11 to 15, 2010

RESULTS:	Individual Data			**Avg.**	**S.D.**	**% CV**
Normal Compressive Pressure (kPa):	130.3	239.9	399.9			
PROPERTIES OF THE SOIL	…					
Water content of compaction (%):	19.0	19.0	19.0			
Dry unit weight after compaction (kg/m³):	1762	1762	1762			
Duration of the consolidation (hours):	24	24	24			
TEST RESULTS	…					
Maximum Shear Stress (kPa):	75.2	144.1	221.3			
Residual Shear Stress (kPa):	68.9	131.7	197.2			
Estimated maximum angle of friction (°):	28					
Estimated maximum adhesion (kPa):	8.3					
Estimated residual angle of friction (°):	25					
Estimated residual adhesion (kPa):	11.7					

REMARKS: Secant friction angles:
under 130 kPa : peak : 30°, residual: 28°
under 240 kPa : peak : 31°, residual: 29°
under 400 kPa : peak : 29°, residual: 26°
The geocomposite did not exhibit any evidence of delamination under any normal load

Prepared by: Jonathan Trudel
Jonathan Trudel, Tech.
Technician

Approved by:
Eric Blond, Eng., M.Sc.A.
Vice-President

Date: December 23, 2010

For any information concerning this report, please contact Eric Blond

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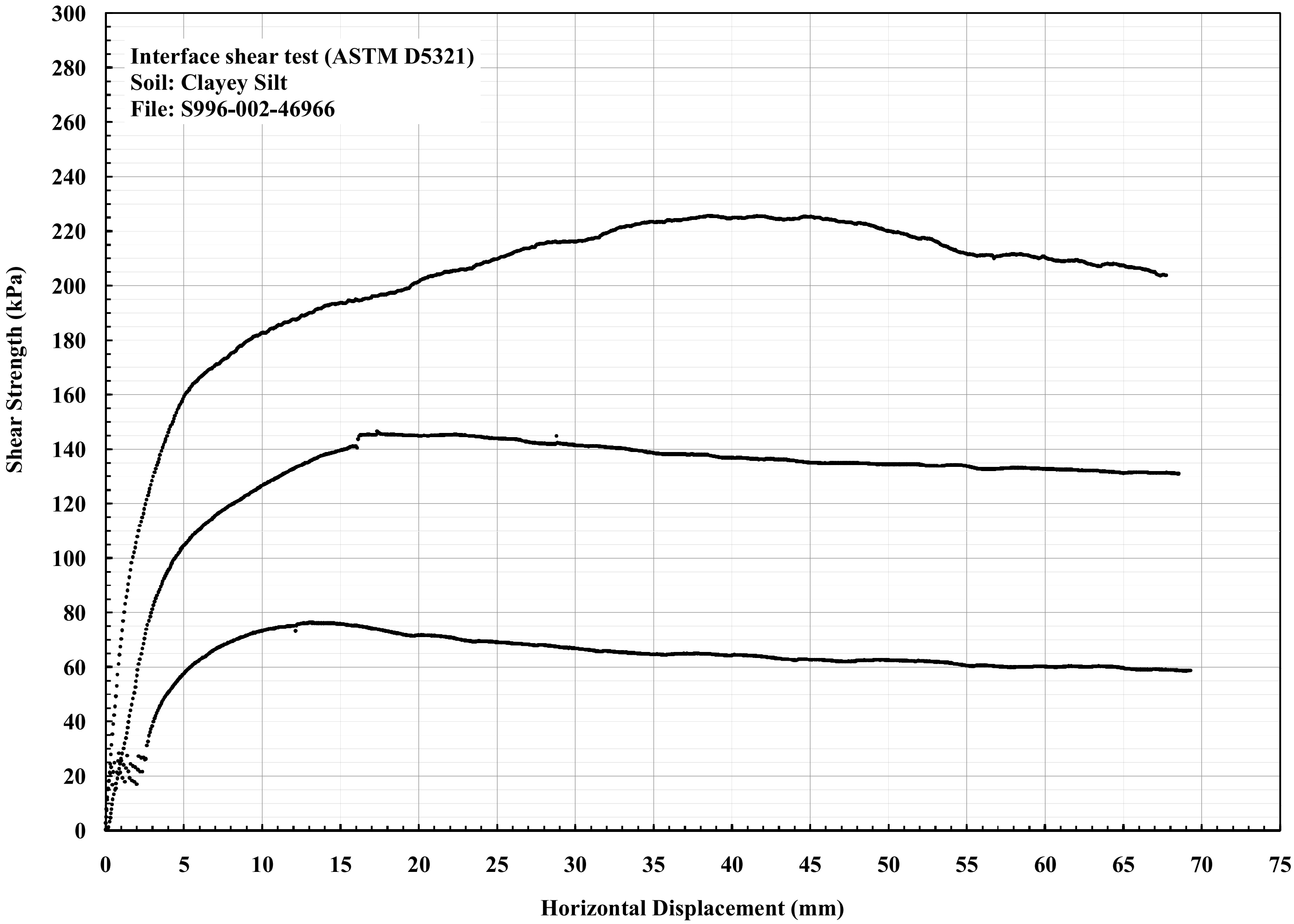
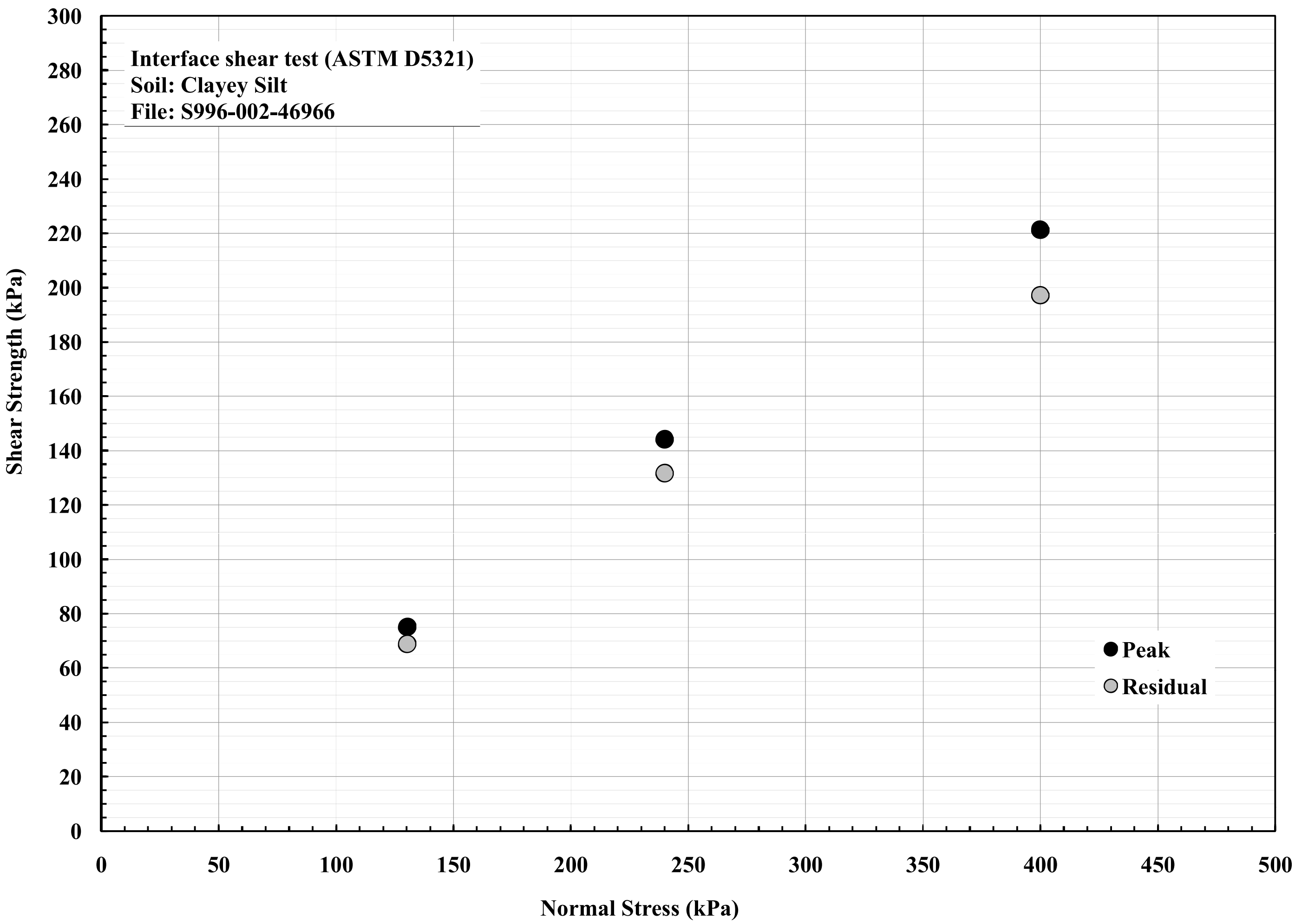


Interface shear test (ASTM D5321)
Soil: Clayey Silt
File: S996-002-46966
Shear Strength (kPa)
Horizontal Displacement (mm)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75


Interface shear test (ASTM D5321)
Soil: Clayey Silt
File: S996-002-46966
Shear Strength (kPa)
Normal Stress (kPa)
Peak
Residual
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
0
50
100
150
200
250
300
350
400
450
500

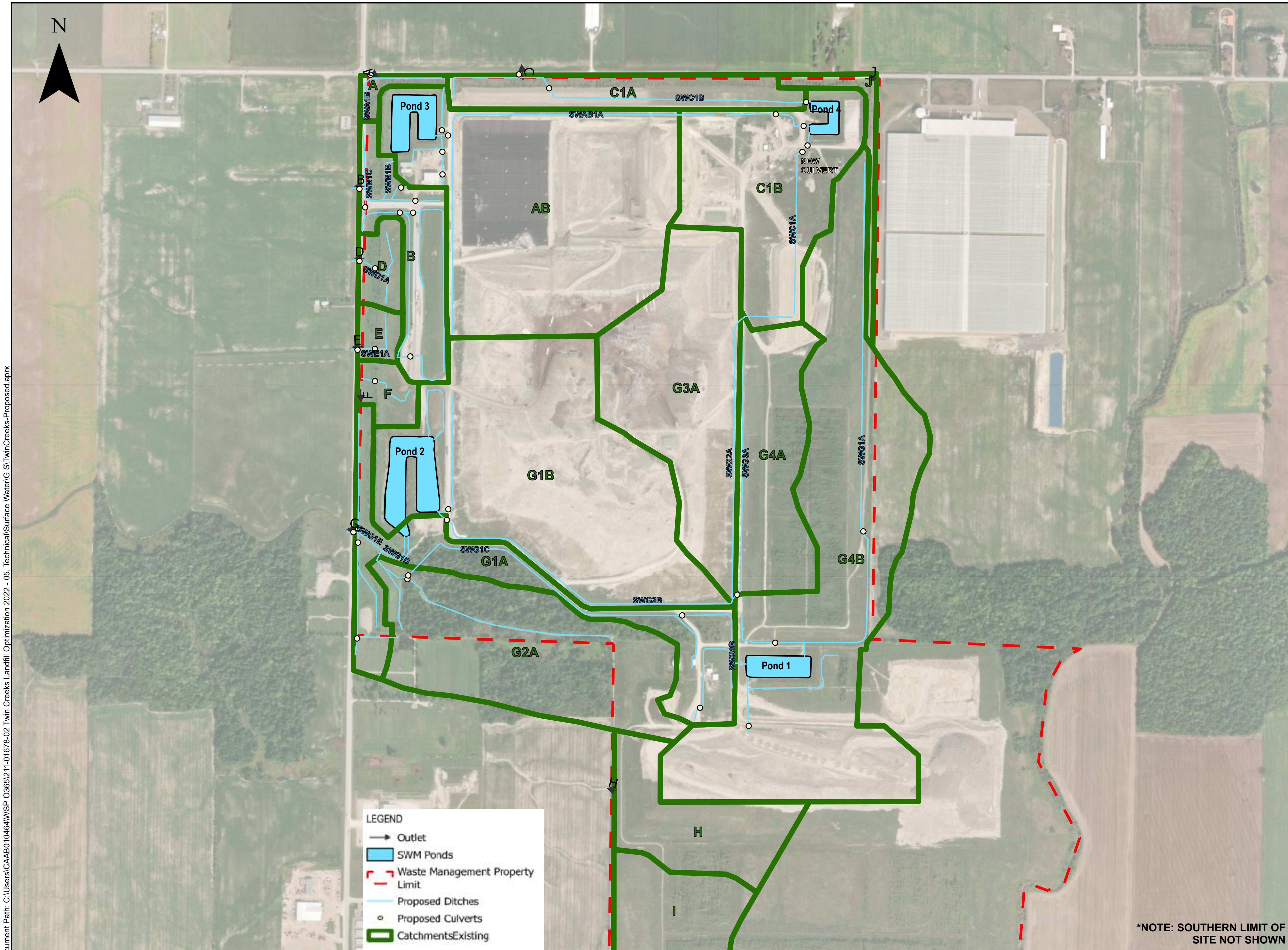
B

HELP Modelling

Details of HELP Modelling
available upon request.

C

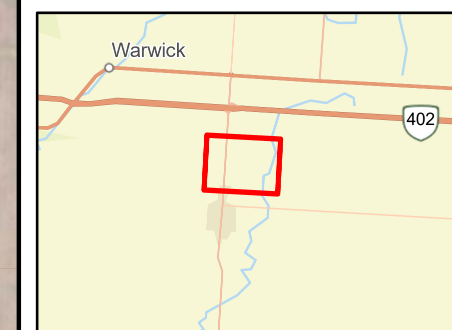
Hydrologic Modelling



CLIENT
WASTE MANAGEMENT OF CANADA CORP.

PROJECT
TWIN CREEKS LANDFILL OPTIMIZATION

TITLE
EXHIBIT 1
CATCHMENT AREAS
EXISTING CONDITIONS



LEGEND
Outlet
SWM Ponds
Waste Management Property Limit
Proposed Ditches
Proposed Culverts
CatchmentsExisting

0 0.07 0.15 km

DRAWN BY AB	CHECKED BY EK
April 2024	
NAD 1983 CSRS UTM Zone 17N	
1:9,000	

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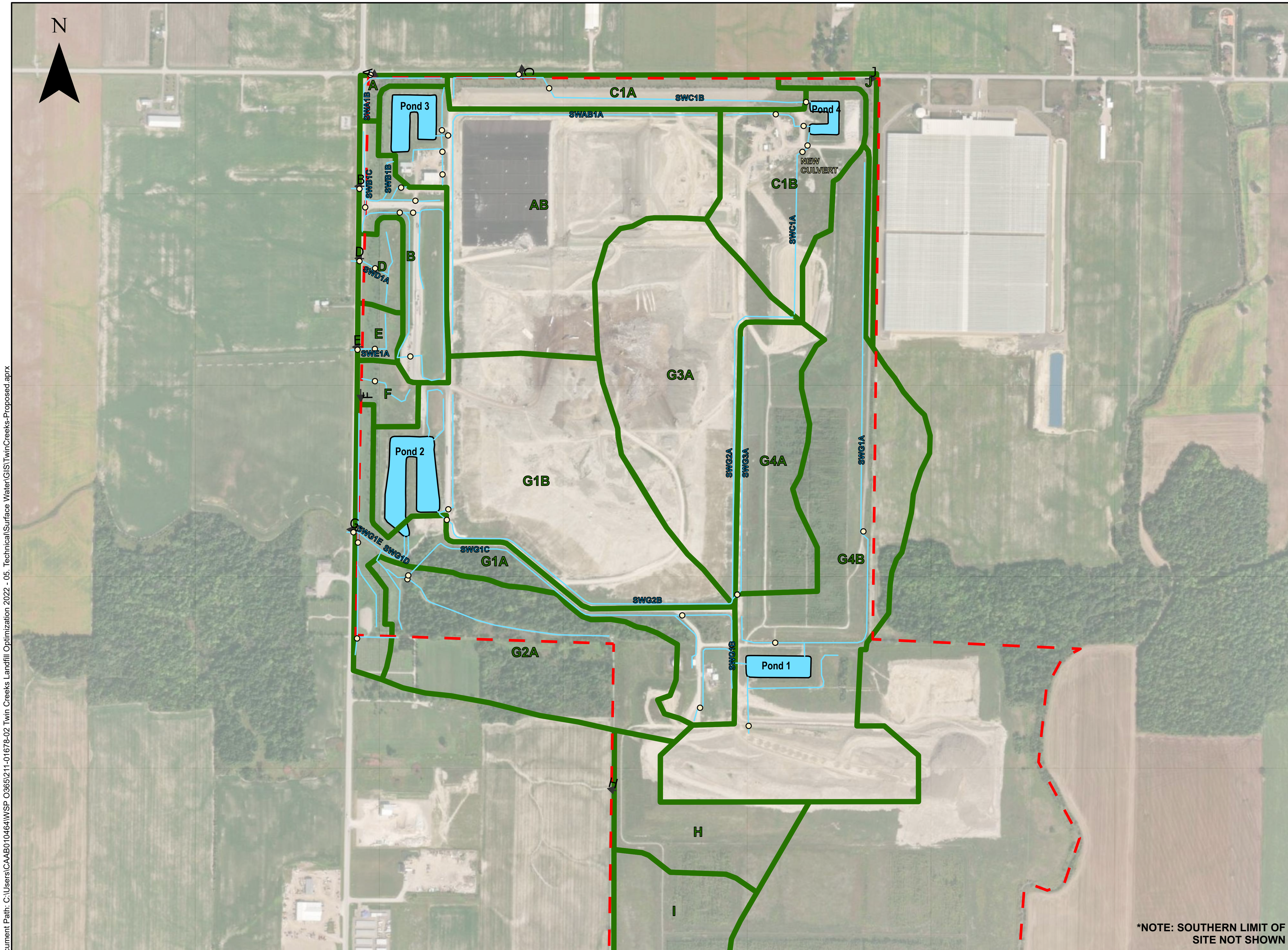

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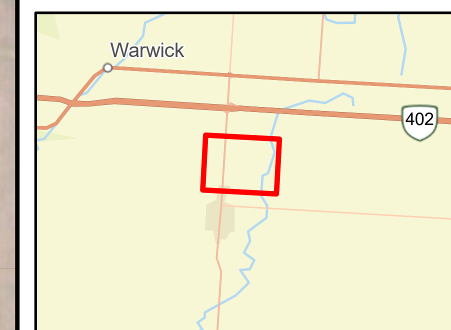
WASTE MANAGEMENT OF CANADA CORP.

PROJECT

TWIN CREEKS LANDFILL OPTIMIZATION

TITLE

EXHIBIT 1
CATCHMENT AREAS
APPROVED FUTURE



LEGEND

- Outlet
- SWM Ponds
- Approved Future Catchments
- Waste Management Property Limit
- Proposed Ditches
- Proposed Culverts

0 0.07 0.15 km

DRAWN BY	AB	CHECKED BY	EK
March 2024			
NAD 1983 CSRS UTM Zone 17N			
1:9,000			

wsp

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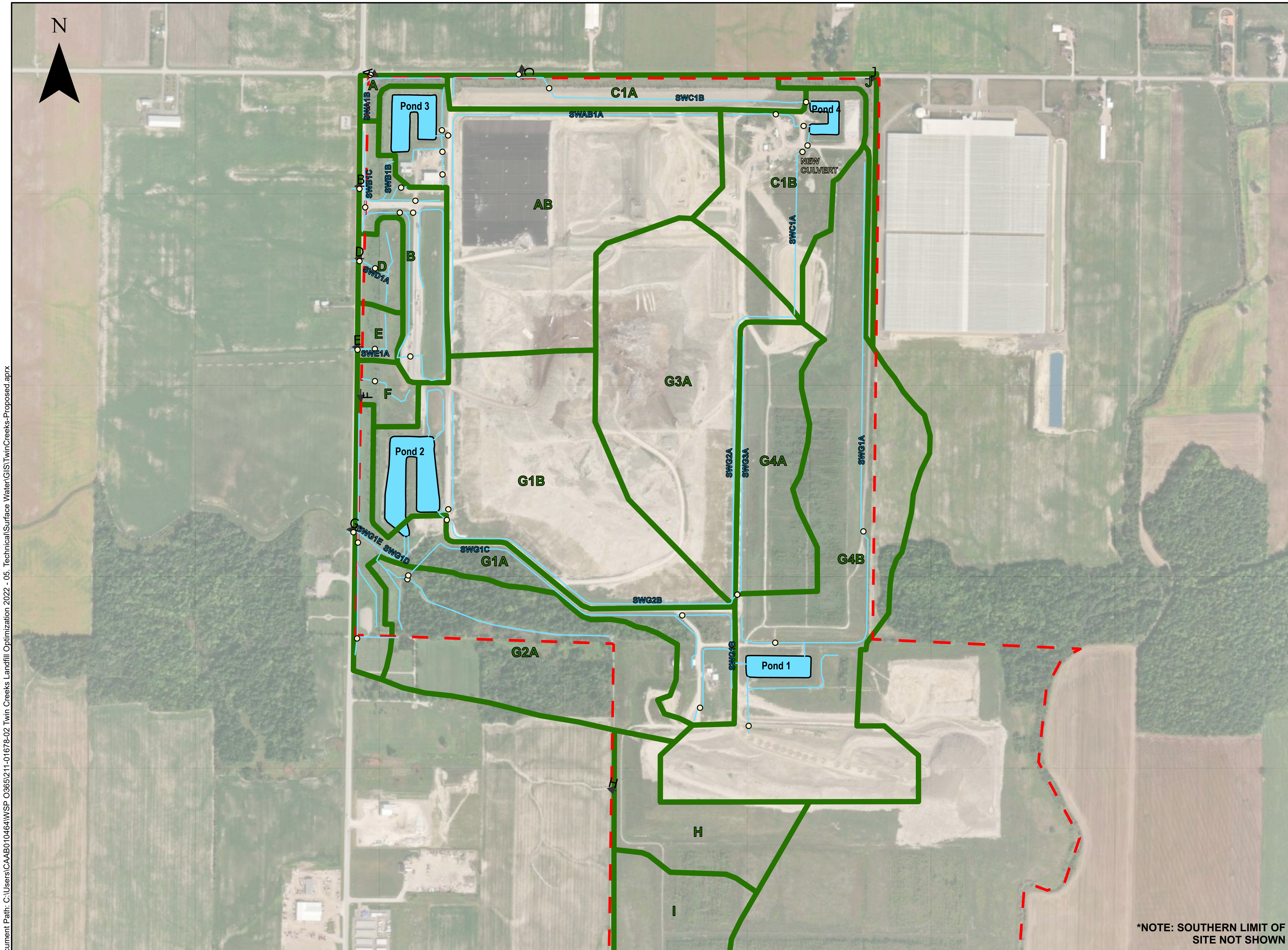

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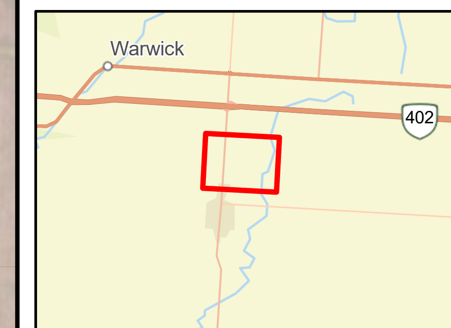
CLIENT
WASTE MANAGEMENT OF CANADA CORP.

PROJECT
TWIN CREEKS LANDFILL OPTIMIZATION

TITLE
EXHIBIT 1
CATCHMENT AREAS
ALTERNATIVE METHOD 1



LEGEND
- Outlet
- SWM Ponds
- Alternative Method 1 Proposed Catchments
- Waste Management Property Limit
- Proposed Ditches
- Proposed Culverts

0 0.07 0.15 km

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March 2024	
NAD 1983 CSRS UTM Zone 17N	
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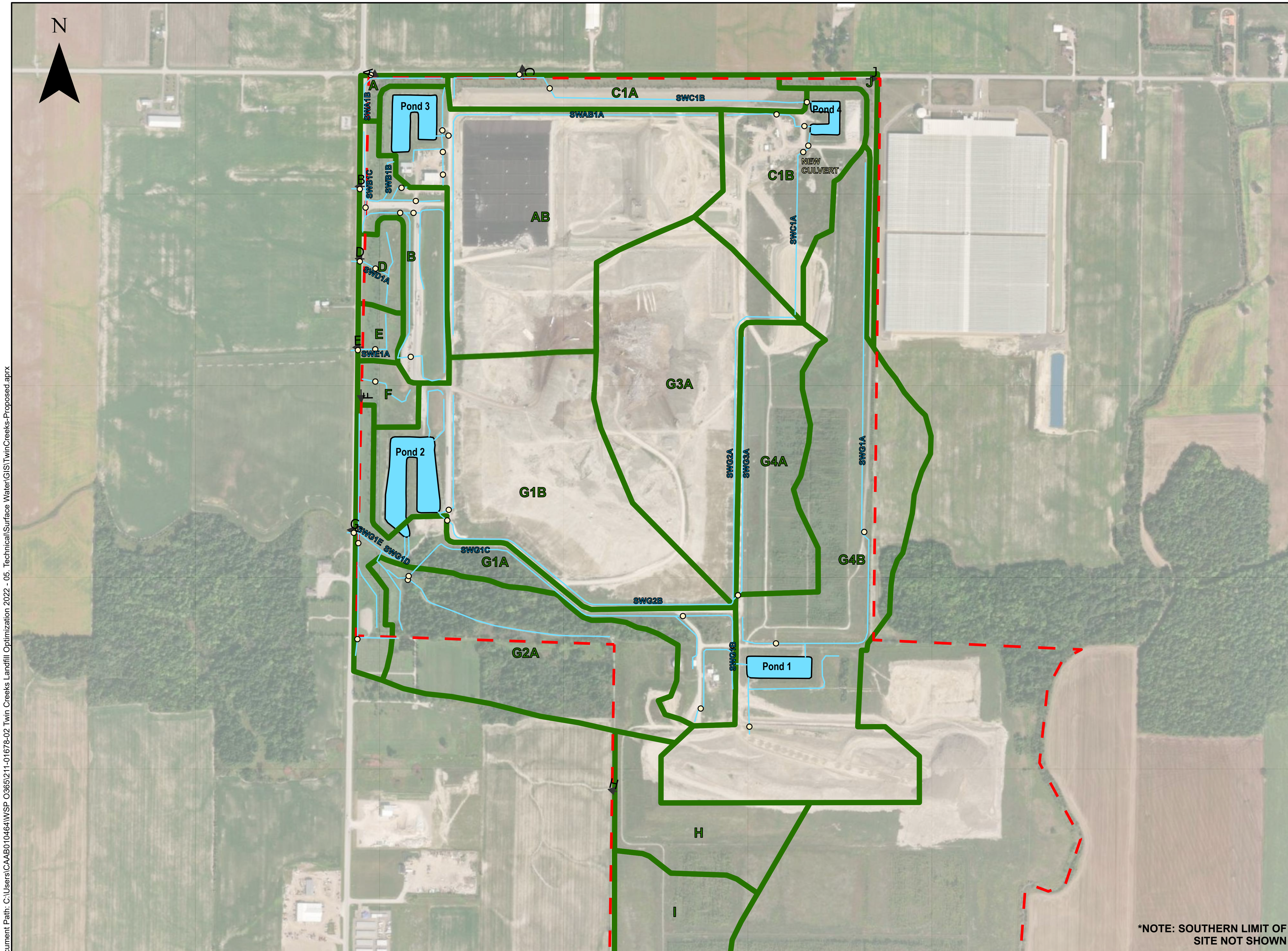
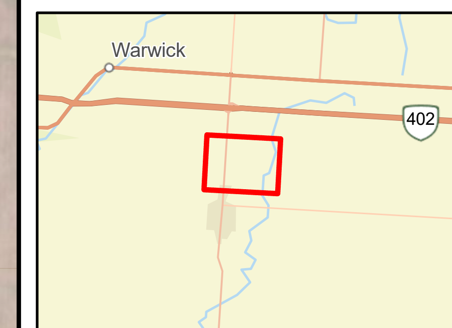


CLIENT
WASTE MANAGEMENT OF CANADA CORP.

PROJECT
TWIN CREEKS LANDFILL OPTIMIZATION

TITLE
EXHIBIT 1
CATCHMENT AREAS
ALTERNATIVE METHOD 2



LEGEND
- Outlet
- SWM Ponds
- Alternative Method 2 Proposed Catchments
- Waste Management Property Limit
- Proposed Ditches
- Proposed Culverts

0 0.07 0.15 km

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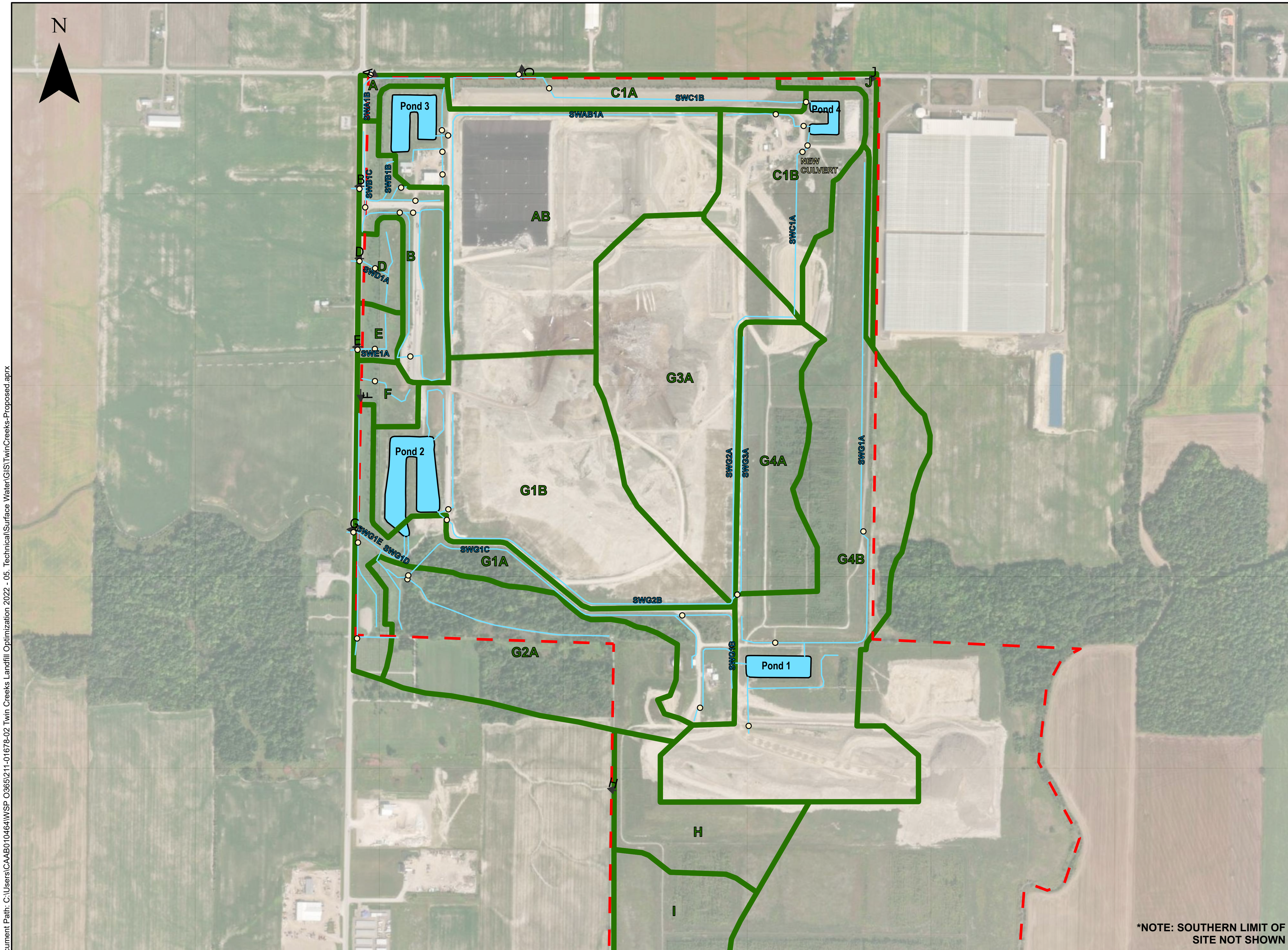


CLIENT

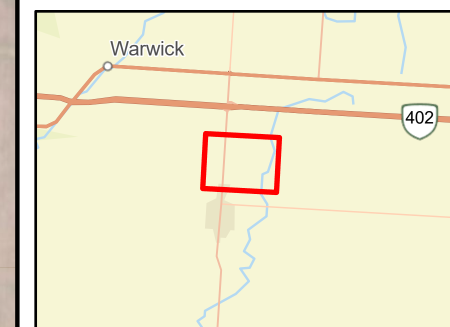
WASTE MANAGEMENT OF CANADA CORP.

PROJECT

TWIN CREEKS LANDFILL OPTIMIZATION

TITLE

EXHIBIT 1
CATCHMENT AREAS
ALTERNATIVE METHOD 3



LEGEND

- Outlet
- SWM Ponds
- Alternative Method 3 Proposed Catchments
- Waste Management Property Limit
- Proposed Ditches
- Proposed Culverts

0 0.07 0.15 km

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Comparison of Catchment Areas (ha)

Catchment	Existing	Do Nothing	Method 1	Method 2	Method 3
A	0.94	0.94	0.94	0.94	0.94
AB	31.84	32.61	32.52	33.05	32.33
B	6.99	6.99	6.99	6.99	6.99
C1A	6.77	6.77	6.82	6.82	6.82
C1B	15.77	12.32	12.17	12.23	12.06
G1A	12.45	12.45	12.45	12.45	12.45
G1B	32.91	30.09	28.68	28.74	29.27
G2A	19.40	19.40	19.40	19.40	19.40
G3A	18.71	24.10	25.70	25.07	25.41
G4A	10.64	10.73	10.73	10.73	10.73
G4B	40.21	40.21	40.21	40.21	40.21

Comparison of Catchment Time to Peak (hrs)

Catchment	Existing	Do Nothing	Method 1	Method 2	Method 3
A	0.12	0.12	0.12	0.12	0.12
AB	0.93	0.55	0.52	0.55	0.55
B	n/a	n/a	n/a	n/a	n/a
C1A	0.50	0.50	0.50	0.50	0.50
C1B	0.42	0.55	0.55	0.54	0.55
G1A	1.03	1.03	1.03	1.03	1.03
G1B	0.60	0.40	0.41	0.41	0.40
G2A	0.66	0.66	0.66	0.66	0.66
G3A	2.44	1.12	1.11	1.14	1.17
G4A	1.12	1.12	1.12	1.12	1.12
G4B	1.20	1.20	1.20	1.20	1.20

Existing

Outlet ID	2-year	5-year	10-year	25-year	50-year	100-year
A	0.061	0.093	0.121	0.167	0.201	0.238
B	0.417	0.573	0.676	0.807	0.906	1.005
C	0.134	0.231	0.299	0.404	0.494	0.601
D	0.068	0.123	0.164	0.221	0.266	0.313
E	0.062	0.112	0.150	0.202	0.245	0.288
F	0.049	0.088	0.116	0.155	0.187	0.219
G	0.385	0.656	0.855	1.120	1.324	1.530

Do Nothing

Outlet ID	2-year	5-year	10-year	25-year	50-year	100-year
A	0.062	0.095	0.128	0.179	0.220	0.263
B	0.388	0.540	0.642	0.772	0.870	0.969
C	0.114	0.202	0.267	0.355	0.423	0.492
D	0.068	0.123	0.164	0.221	0.266	0.313
E	0.062	0.112	0.150	0.202	0.245	0.288
F	0.049	0.088	0.116	0.155	0.187	0.219
G	0.408	0.695	0.892	1.157	1.369	1.648

Future Approved Difference from Existing

Outlet ID	2-year	5-year	10-year	25-year	50-year	100-year
A	2%	2%	6%	7%	9%	11%
B	-7%	-6%	-5%	-4%	-4%	-4%
C	-15%	-13%	-11%	-12%	-14%	-18%
D	0%	0%	0%	0%	0%	0%
E	0%	0%	0%	0%	0%	0%
F	0%	0%	0%	0%	0%	0%
G	6%	6%	4%	3%	3%	8%

Alternative Method 1

Outlet ID	2-year	5-year	10-year	25-year	50-year	100-year
A	0.062	0.096	0.129	0.181	0.222	0.263
B	0.388	0.540	0.642	0.772	0.870	0.969
C	0.115	0.202	0.268	0.356	0.425	0.495
D	0.068	0.123	0.164	0.221	0.266	0.313
E	0.062	0.112	0.150	0.202	0.245	0.288
F	0.049	0.088	0.116	0.155	0.187	0.219
G	0.405	0.692	0.888	1.152	1.363	1.634

Alternative Method 1 Difference from Existing

Outlet ID	2-year	5-year	10-year	25-year	50-year	100-year
A	2%	3%	7%	8%	10%	11%
B	-7%	-6%	-5%	-4%	-4%	-4%
C	-14%	-13%	-10%	-12%	-14%	-18%
D	0%	0%	0%	0%	0%	0%
E	0%	0%	0%	0%	0%	0%
F	0%	0%	0%	0%	0%	0%
G	5%	5%	4%	3%	3%	7%

Alternative Method 2

Outlet ID	2-year	5-year	10-year	25-year	50-year	100-year
A	0.062	0.097	0.130	0.182	0.224	0.267
B	0.388	0.540	0.642	0.772	0.870	0.969
C	0.115	0.204	0.270	0.358	0.427	0.497
D	0.068	0.123	0.164	0.221	0.266	0.313
E	0.062	0.112	0.150	0.202	0.245	0.288
F	0.049	0.088	0.116	0.155	0.187	0.219
G	0.403	0.690	0.887	1.151	1.361	1.621

Alternative Method 2 Difference from Existing

Outlet ID	2-year	5-year	10-year	25-year	50-year	100-year
A	2%	4%	7%	9%	11%	12%
B	-7%	-6%	-5%	-4%	-4%	-4%
C	-14%	-12%	-10%	-11%	-14%	-17%
D	0%	0%	0%	0%	0%	0%
E	0%	0%	0%	0%	0%	0%
F	0%	0%	0%	0%	0%	0%
G	5%	5%	4%	3%	3%	6%

Alternative Method 2 Difference from Do Nothing

Outlet ID	2-year	5-year	10-year	25-year	50-year	100-year
A	0%	2%	2%	2%	2%	2%
B	0%	0%	0%	0%	0%	0%
C	1%	1%	1%	1%	1%	1%
D	0%	0%	0%	0%	0%	0%
E	0%	0%	0%	0%	0%	0%
F	0%	0%	0%	0%	0%	0%
G	-1%	-1%	-1%	-1%	-1%	-2%

Alternative Method 3

Outlet ID	2-year	5-year	10-year	25-year	50-year	100-year
A	0.061	0.094	0.126	0.177	0.217	0.261
B	0.388	0.540	0.642	0.772	0.870	0.969
C	0.115	0.202	0.268	0.356	0.425	0.494
D	0.068	0.123	0.164	0.221	0.266	0.313
E	0.062	0.112	0.150	0.202	0.245	0.288
F	0.049	0.088	0.116	0.155	0.187	0.219
G	0.405	0.692	0.889	1.153	1.364	1.629

Alternative Method 3 Difference from Existing

Outlet ID	2-year	5-year	10-year	25-year	50-year	100-year
A	0%	1%	4%	6%	8%	10%
B	-7%	-6%	-5%	-4%	-4%	-4%
C	-14%	-13%	-10%	-12%	-14%	-18%
D	0%	0%	0%	0%	0%	0%
E	0%	0%	0%	0%	0%	0%
F	0%	0%	0%	0%	0%	0%
G	5%	5%	4%	3%	3%	6%

Peak Pond Storage in 100-year storm (ha·m)

Pond	Available	Existing	Do Nothing	AM 1	AM 2	AM 3
1	2.773	0.896	0.896	0.896	0.896	0.896
2	5.271	1.491	1.704	1.690	1.673	1.687
3	2.857	0.709	0.731	0.731	0.737	0.727
4	1.099	0.335	0.277	0.274	0.275	0.272

Peak Swale Conveyance during 25-year Storm

		Geometry					Peak Swale Conveyance (L/s)				
Name	Contributing Catchments	Length (m)	Representative Bottom Width (m)	Representative Depth (m)	Representative Side Slope (X:1)	Average Slope (%)	Available	Future Approved	AM 1	AM 2	AM 3
SWAB1A	AB	665	1.8	0.8	4.8	0.8%	9384	1458	1513	1478	1446
SWA1B	Outlet A	105.3	1	0.77	3.9	0.9%	6256	179	181	182	177
SWB1B	Culvert 3(#2) + 3(#3)	121	2	1.15	3.7	1.1%	23461	204	204	207	202
SWB1C	Outlet B	63.2	2.7	1.7	4.7	1.7%	120733	772	772	772	772
SWC1A	C1B	380	3	0.9	3.0	0.1%	3699	547	540	550	535
SWC1B	Pond 4 + C1A	612	4	2.9	2.9	0.5%	191849	457	148	459	456
SWD1A	Outlet D	87	2.5	1	5.3	1.5%	28626	221	221	221	221
SWE1A	Outlet E	141	1	1.7	6.4	0.8%	100850	202	202	202	202
SWG1A	G4B	1280	1.5	0.62	6.9	0.3%	3981	1053	1053	1053	1053
SWG1B	Pond 1	456	1	1.3	3.8	0.4%	17669	392	392	392	392
SWG1C	Pond 1 + G1A	631	1.5	1	3.8	0.7%	11847	726	726	726	726
SWG1D	Pond 2	116	1.5	0.87	5.2	0.2%	6229	325	321	317	321
SWG1E	Outlet G	71	3	0.9	3.6	0.6%	10909	1157	1152	1151	1153
Stream	Outlet G	38	4	1.4	1.2	0.5%	18095	1157	1152	1151	1153
SWG2A	G3A	799	1	0.54	3.0	0.6%	1592	637	659	630	627
SWG2B	G3A+G4A+G1B	751	0.75	0.92	5.6	0.7%	12631	2677	2590	2565	2619
SWG3A	G4A	606	1	0.44	4.5	0.5%	1246	283	283	283	283

Details of Hydrologic Modelling
available upon request.