

Haldimand County Lake Erie Hazard Mapping and Risk Assessment

Technical Report

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Haldimand County Lake Erie Hazard Mapping and Risk Assessment

Technical Report

Prepared for:



Grand River Conservation Authority Administration Centre 400 Clyde road Cambridge, ON N1R 5W6

On behalf of Haldimand County, Long Point Region Conservation Authority and Niagara Peninsula Conservation Authority



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1. Introduction

The Grand River Conservation Authority (GRCA), on behalf of Haldimand County and neighbouring Niagara Peninsula Conservation Authority (NPCA) and Long Point Region Conservation Authority (LPRCA) retained Baird & Associates with geotechnical sub-consultant Terraprobe Inc. to undertake the Haldimand County Lake Erie Hazard Mapping project. This report describes the technical studies undertaken to update the Lake Erie hazard mapping for Haldimand County.

Haldimand County has 87 km of Lake Erie shoreline, spanning parts of the jurisdictions of three Conservation Authorities (GRCA, LPRCA and NPCA) as shown in Figure 1.1. The lakeshore area is comprised predominantly of agricultural lands with strip residential developments bisected by the Lakeshore Road. There are designated tourist residential nodes that consist of a mix of seasonal and year-round developments. Some of these major nodes include Peacock Point, Featherstone Point, Hoover Point, Evans Point and Mohawk Point. There are also many seasonal trailer parks and campgrounds within the lakeshore area. In addition to these privately owned facilities, there are several Provincial Parks, Conservation Areas and other public facilities such as Port Maitland where the Grand River spills into Lake Erie. Dunnville is a town of 12,000 located on the Grand River about 7 km upstream from Lake Erie. Portions of Dunnville are at sufficiently low elevations where they are subject to lake related flood impacts in addition to riverine flooding. The Lake Erie flood hazard extends about 9 km upstream of the Dunnville Dam.

Previous shoreline hazard mapping for the County within LPRCA and GRCA jurisdictions was prepared in the late 1980s to early 1990s, while the mapping within the NPCA jurisdiction was updated in 2010. Since completion of some of this work, the provincial technical guidance has been updated (2001), and there have been legislative changes, including an updated Provincial Policy Statement (2014) under the Planning Act, and new regulations under the Conservation Authorities Act.

This report summarizes the technical analyses undertaken to update the Lake Erie shoreline flooding, erosion, and dynamic beach hazard mapping within Haldimand County. The mapping, provided under separate cover, supports land use planning and permitting decisions in at-risk communities such as Dunnville and Port Maitland and the numerous shoreline areas within the County. Updates to conservation authority shoreline management plans and Haldimand County official plan policies were outside the scope of the project.

The technical information for this project may also support flood and erosion-related response and mitigation planning. Updates to a risk assessment for shoreline flooding, including estimates of damage potential, are provided under separate cover.





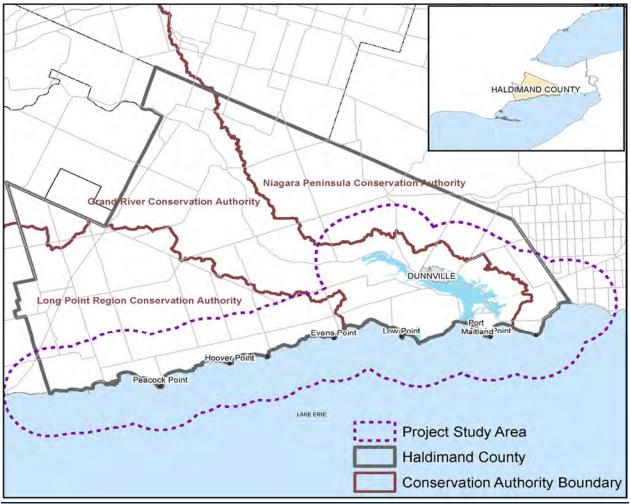


Figure 1.1: Map showing study area, Haldimand County, and Conservation Authority boundaries





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2. **Previous Technical Studies**

Key technical studies and data, relevant to the development of the Haldimand County Lake Erie hazard mapping are summarized in this section.

Policies for the Administration of Ontario Regulations 178/06, 150/06 and 2.1 155/06

Ontario Regulation 97/04 stipulates the criteria by which each Conservation Authority must establish its updated regulated area or 'Regulation Limit'. The Province of Ontario subsequently enacted the regulations listed in Table 2.1, requiring each Conservation Authority (CA) to regulate areas that are river or stream valleys, wetlands and other areas where development could interfere with the hydrologic function of a wetland, adjacent or close to the shoreline of Great Lakes-St. Lawrence System and inland lakes that may be affected by flooding, erosion or dynamic beach hazards. The Regulated Area represents the greatest extent of the combined hazards plus a prescribed allowance as set out in the Regulation.

Each CA has developed a policy for making decisions regarding the outcome of applications made under the Regulations, to ensure a consistent, timely and fair approach to the review of applications, staff recommendations and CA decisions, and to achieve efficient and effective use and allocation of available resources. The regulations and policies reviewed for this study are listed in Table 2.1.

Conservation Authority	Ontario Regulation	CA Policy
Long Point Region	178/06	Policies for the Administration of the Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation (received by Board of Directors Oct. 4, 2017)
Grand River	150/06	Policies for the Administration of the Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation (approved Oct. 23, 2015)
Niagara Peninsula	155/06	Policies for the Administration of the Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation (approved Sept. 19, 2018)

Table 2.1: Ontario regulations for the individual Conservation Authorities

2.2 **Shoreline Management Plans**

2.2.1 Grand River Conservation Authority (1994)

Shoreline Management Plan (Technical Components), Grand River Conservation Authority (Shoreplan Engineering Ltd., 1994) is the current shoreline management plan for the Grand River CA. It presents the methodologies used in 1994 to delineate the flood, erosion and dynamic beach hazards. This document predates the Technical Guide for the Great Lakes - St. Lawrence River System and Large Inland Lakes (MNR, 2001a), which provides technical direction on the methodologies to be used when delineating the natural hazard limits. The Average Annual Recession Rate (AARR) were based on limited data presented in

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the Great Lakes Shore Damage Survey Coastal Zone Atlas (MNR, EC, 1975). Since that time, additional data has become available and approaches to delineating the hazards have advanced.

2.2.2 Long Point Region Conservation Authority (1989)

Shoreline Management Plan. Long Point Region Conservation Authority (Philpott Associates, 1989) is the current shoreline management plan for the Long Point Region CA. It presents the methodologies used in 1989 to delineate the flood, erosion and dynamic beach hazards. This document predates MNR (2001a), which provides technical direction on the methodologies to be used when delineating the natural hazard limits. Philpott (1989) describes the flood hazard as the "100-year uprush limit"; the erosion hazard as 100 times the AARR plus a stable slope allowance; and the dynamic beach as the landward limit of the cohesionless beach deposit. Limited detail on mapping methodologies is provided. Since that time, additional data has become available and approaches to delineating the hazards have advanced.

2.2.3 Niagara Peninsula Conservation Authority (2010)

Lake Erie Shoreline Management Plan Update, Niagara Peninsula Conservation Authority (Shoreplan Engineering Limited, 2010) is the current shoreline management plan for Niagara Peninsula CA's Lake Erie shoreline. It presents the methodologies used to delineate the flood, erosion and dynamic beach hazards in 2010, and was an update to the Niagara Peninsula CA's previous Lake Erie shoreline management plan from 1992.

A review of Shoreplan (2010) indicates that the Average Annual Recession Rate (AARR) used to delineate the erosion hazard, was not updated for the 2010 mapping. Instead, AARR developed for the previous shoreline management plan based on the following data were used: the Coastal Zone Atlas (MNR and EC, 1975); the Great Lakes Erosion Monitoring Program (Boyd, 1981); and Erosion Monitoring Station profiles surveyed by NPCA between 1983 and 1990 to estimate the AARR. For some reaches, recession rates were based on limited data that did not meet the definition of an acceptable level of data as defined in MNR (2001a). A default stable slope allowance of 3 horizontal to 1 vertical (3H:1V) was used.

2.3 Haldimand County Official Plan

The Haldimand County Official Plan (2006) was approved by Haldimand County on June 26, 2006, and by the Ministry of Municipal Affairs and Housing in 2009. The document provides a 20-year strategic vision for managing growth and future land use decisions in the County. It also provides the link through which the Provincial Policy is implemented into the local context.

The Official Plan recognizes the natural hazards and identifies Haldimand County's commitment to the protection of life and property by respecting natural and man-made hazards. It states that development shall be directed away from Hazard Lands, while recognizing that there are certain areas of the County where extensive development has taken place within Hazard Lands. The hazard mapping that was updated during this project is referenced in the Official Plan.

2.4 Technical Direction

2.4.1 Technical Guide for Great Lakes - St. Lawrence River System

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In 2001, the Ministry of Natural Resources (now the Ontario Ministry of Natural Resources and Forestry (MNRF)) released the Technical Guide for the Great Lakes – St. Lawrence River System and Large Inland Lakes (MNR, 2001a). This guide provides the technical basis and procedures for establishing the hazard limits for flooding, erosion, and dynamic beaches in Ontario as well as options for addressing the hazards.

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2.4.2 **Understanding Natural Hazards**

The Ontario Ministry of Natural Resources (now the Ontario Ministry of Natural Resources and Forestry) also prepared Understanding Natural Hazards (MNR, 2001b) to assist the public and planning authorities with an explanation of the Natural Hazard Policies (3.1) of the Provincial Policy Statement of the Planning Act. This publication updates and replaces the older Natural Hazards Training Manual (from 1997). This document is also referenced when addressing natural hazard concerns.

2.4.3 **Great Lakes System Flood Levels and Water Related Hazards**

This document was developed by the Ontario Ministry of Natural Resources (1989) to assist Conservation Authorities in delineating shoreline hazard areas. It includes a combined probability analysis of Great Lakes water levels, considering monthly mean water levels and surge. Water levels are presented for the 100-year return period event, as well as other return periods. While this document is referenced in the Technical Guide (MNR, 2001a), for use in calculating hazard limits, it does not consider the 30 years of water level data collected since 1989. Section 6.1 provides an analysis of the most recent water level data.

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3. Data

3.1 Aerial Imagery

The 2015 Southwestern Ontario Orthophotography Project (SWOOP) acquired aerial imagery at 20 cm resolution through the Government of Ontario's Imagery Acquisition Strategy that provides Land Information Ontario (LIO) with a mandate to collect and refresh imagery for southern Ontario on a five-year cycle. Data was collected between 12 April and 23 May 2015. This dataset is consistent across the entire study area of Haldimand County. The imagery provides a visual reference for ground features such as the delineation of shore protection structures, indications of shoreline substrate, and was used as a base layer for the 1:2,000-scale mapping developed for this study.

3.2 Elevation

Two elevation datasets were used to develop the Hazard Mapping, 2017 Lake Erie Watershed LiDAR and 2015 SWOOP. These data sets provide elevation surfaces for calculations of flooding and erosion hazards, and they were used to extract profiles for the slope stability analysis. The data also provide contours as cartographic elements, that are included in the 1:2,000-scale series of maps.

The 2017 Lake Erie Watershed LiDAR data were collected as part of the Ontario Government's LiDAR Digital Terrain Model (2016-2018) LIO Dataset. The Airborne Topographic LiDAR (ATL) was acquired through a collaborative partnership between the Ministry of Natural Resources and Forestry (MNRF), the Ministry of Agriculture, Food and Rural Affairs (OMAFRA) and a private contractor. It was collected in March to May 2017 and October to December 2017. The LiDAR Digital Terrain Model (DTM) is a 50 cm resolution raster representing the bare-earth terrain derived from a classified LiDAR point cloud, which has been hydroflattened using water body breaklines. This dataset provides coverage of the Grand River and most of the Haldimand County Lake Erie shoreline, except for about 7.5 km of shoreline at the eastern limit.

The 2015 Southwestern Ontario Orthophotography Project (SWOOP) DSM and DTM are 2 metre raster elevation data products that were generated from a classified LAS (data format for storing airborne LiDAR data), acquired through the Government of Ontario's Imagery Acquisition Strategy that provides LIO with a mandate to collect and refresh imagery for southern Ontario on a five year cycle. Data was collected between 12 April and 23 May 2015. As part of this data collection a 2 metre DTM was generated. For this project, GRCA processed this DTM to create products in the new vertical datum of CGVD2013. GRCA converted the 2 m DTM to points and converted from CGVD28 to CGVD2013 using the Natural Resources Canada GPS-H desktop tool, then converted back to a raster with a 2 m cell size, then generated contours at a 1 m interval. This dataset does not have the same level of detail as the 2017 LiDAR but has sufficient detail to match the 1:2,000-scale mapping requirements of the project. This dataset was only used for the eastern end of Haldimand County, approximately 7.5 km of shoreline, where the 2017 LiDAR product does not provide coverage. Baird further processed this dataset by removing noise that occurred in Lake Erie.

3.3 Bathymetry

The Government of Canada Department of Fisheries and Oceans (DFO) bathymetry was collected by an airborne bathymetry sensor and was surveyed between 19 April and 19 June 2018. For this project, GRCA processed the original gridded point data, adjusting the vertical datum to CGVD2013 and generating gridded raster products at 5 m and 10 m resolutions. As a result of water clarity issues during the acquisition flights, this dataset has some gaps. In Figure 3.1, these gaps can be seen on the right side of the figure (areas without coloured data points). The gaps were filled with the Lake Erie 1 m depth contours, a dataset compiled by the

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US National Oceanographic and Atmospheric Administration (NOAA) National Geophysical Data Center Marine Geology and Geophysics Division (NGDC/MGG), the NOAA Great Lakes Environmental Research Laboratory (GLERL) and the Canadian Hydrographic Service (CHS). This product includes data from various data sets, collected over different years. The bathymetry is primarily used for calculating wave runup at select locations.

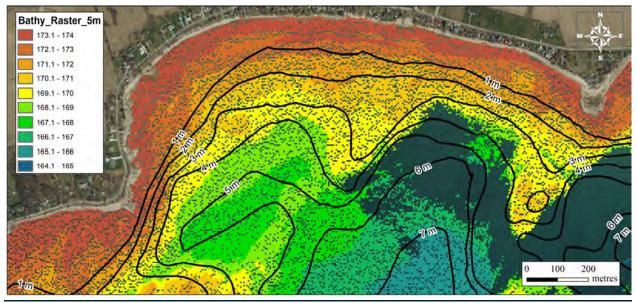


Figure 3.1: DFO aerial bathymetry data and NOAA contours

3.4 Water Levels

Lake Erie water levels were obtained from the Department of Fisheries and Oceans (DFO) Marine Environmental Data Service (MEDS). Permanent gauging stations are maintained at Port Dover (to the west) and Port Colborne (to the east) of Haldimand County. Approximately two months of measured water levels are available at Dunnville. A summary of the available hourly water level data is provided in Table 3.1.

Station Name	Station Number	Date Range of Hourly Data	Status
Port Colborne	12865	January 1,1962 to present	Permanent
Port Dover	12710	November 1, 1961 to present	Permanent
Dunnville	12805	July 4 to August 28, 1986	Temporary

It is noted that Port Colborne daily water level and annual peak instantaneous water level data extend back to 1911, however, the hourly dataset is only available from 1962.

3.5 Waves

Wave hindcast data were obtained from the US Army Corps of Engineers Wave Information Study (WIS). The wave hindcast consists of an hourly time series of modelled wave height, period, and direction at offshore locations where the waves are unaffected by the water depth. Approximately 20 output points are located

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offshore of the Haldimand County shoreline (see Figure 3.2). The hindcast extends from January 1, 1979 to December 31, 2014.

Figure 3.2: Wave hindcast output points from the US Army Corps of Engineers Wave Information Study

The offshore wave conditions were transformed to the Haldimand County nearshore region to assess wave uprush as discussed in Section 6.2.

3.6 Geotechnical

The geotechnical background data used for the slope stability analysis was reviewed by Terraprobe:

- Visual observations from site visits undertaken in August 2018 and April 2019
- Terraprobe reports from the areas Nanticoke, and Rainham. Burnaby and Wainfleet, Ontario
- Locally available geotechnical boreholes from the Ministry of Energy, Northern Development and Mines
- Locally available quaternary geology from the Ministry of Energy, Northern Development and Mines
- Locally available well records from the Government of Ontario
- LiDAR data of the shoreline described in Section 3.2

These data sets are discussed in further detail in Appendix A.



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4. Defining the Natural Hazards

4.1 Overview of Shoreline Hazards

The Provincial Policy Statement (PPS) provides policy direction on matters of provincial interest related to land use planning and development. Hazardous lands are defined in the PPS, (MMAH, 2014) as "property or lands that could be unsafe for development due to naturally occurring processes." Along shorelines of the Great Lakes – St. Lawrence River System, this means the land, including that covered by water between the international boundary where applicable, and the furthest landward extent of the flooding hazard, erosion hazard, or dynamic beach hazard limits.

The technical basis and methodologies for defining and applying the hazard limits for flooding, erosion, and dynamic beaches are provided by the Technical Guide for Flooding, Erosion and Dynamic Beaches, Great Lakes – St. Lawrence River System and Large Inland Lakes (MNR, 2001a). The basic procedures outlined in the Technical Guide (MNR, 2001a) with some modifications have been included in subsequent documents, such as Ontario Regulation 97/04 ("Generic Regulation") and Guidelines for Developing Schedules of Regulated Areas (Conservation Ontario, 2005). The methodologies outlined in MNR (2001a) have been used on this project.

It is important to note, as outlined in the Technical Guide (MNR, 2001a), that the regulated hazard limits are generally to be mapped based on the assumption of no shoreline protection works in place. The clearly stated intent is that the mapped flooding, erosion, and dynamic beach hazard limits are to represent the underlying ambient nature of the natural shoreline hazard and should not be modified by the presence of existing or proposed shoreline protection. The most landward limit of the Flooding, Erosion and Dynamic Beach hazards is utilized in determining the regulated area along the Haldimand County shoreline.

4.2 Flooding Hazard

The flooding hazard limit is defined as the 100-year flood level plus an allowance for wave uprush and other water-related hazards, as depicted graphically in Figure 4.1.

The 100-year flood level is the sum of the static water level plus storm surge with a combined 1% probability of being equalled or exceeded in a given year. This means that on average it has a one percent probability of occurring in any given year. The 100-year flood levels as defined by MNR (1989) and listed in Section 6.1 were used to map the flooding hazard for this project.

When shorelines are exposed to wave action, wave uprush and overtopping occur driving water above the 100-year water level. Other water-related hazards may include ship generated waves and ice. Site specific studies may be used to assess the allowance for wave uprush and water related hazards. The Technical Guide (MNR, 2001a) requires a flooding allowance of 15 m, measured horizontally from the location of the 100-year flood level, as shown in Figure 4.1, if a study using accepted engineering, and scientific principles is not undertaken. Wave uprush was calculated on a reach basis for this study, as presented in Section 6.2.





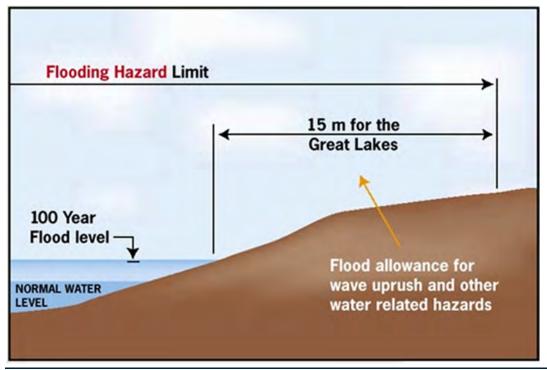


Figure 4.1: Flooding hazard limit for the Great Lakes (from MNR, 2001a)

4.3 Erosion Hazard

The erosion hazard limit is calculated as the sum of the stable slope allowance, plus the 100-year erosion allowance. Figure 4.2 shows the erosion hazard limit as defined in the Technical Guide (MNR, 2001a) and Understanding Natural Hazards (MNR, 2001b).

The approach used in Ontario Regulation 97/04 is similar, but the recession allowance is applied first and then the stable slope allowance is applied. The stable slope allowance was applied first for this study, because the stable slope line is used to identify lands and infrastructure in an imminent high risk zone.

The stable slope allowance is a horizontal allowance measured landward from the toe of the bluff or bank. It is dependent on soil characteristics and groundwater conditions. In the absence of a site-specific study, a stable slope allowance of three times the bluff height may be used. The bluff heights are calculated as the vertical change in elevation from the toe of bluff to the top of bluff. For this study, the stable slope allowance was determined on a reach basis, for representative profiles, and a geotechnical analysis of slope stability was undertaken as described in Section 6.4.

The erosion allowance is the distance the shoreline would erode in 100 years from present. It is calculated as 100 times the average annual recession rate (AARR) as shown in Figure 4.2. For this study, the AARR was calculated based on a comparison of historical aerial imagery where sufficient data existed (see Section 6.5). In the absence of a minimum 35 years of reliable data, a 30-metre erosion allowance is used (as shown in Figure 4.3). This is also applied in areas where the shoreline has been protected and an erosion allowance cannot be determined.

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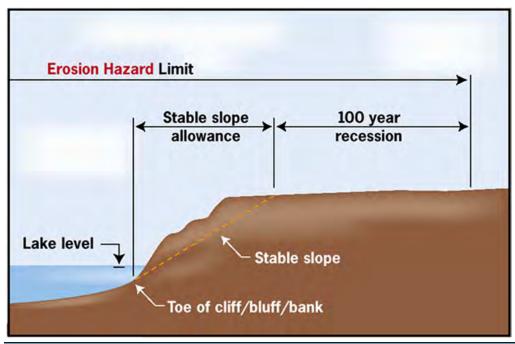


Figure 4.2: Erosion hazard limit defined with reliable recession data (from MNR, 2001a)

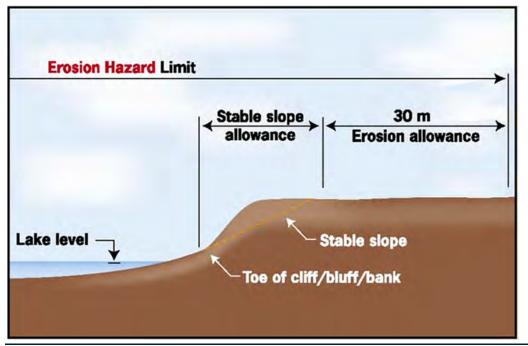


Figure 4.3: Erosion hazard limit defined where reliable recession data not available (from MNR, 2001a)





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4.4 **Dynamic Beach Hazard**

Assessment of the dynamic beach hazard involves the calculation of the cumulative impacts of the flooding hazard, an erosion allowance, and a dynamic beach allowance.

The dynamic beach hazard is only applied where: a beach or dune deposit exists landward of the water line; the beach or dune deposits overlying bedrock or cohesive material are equal to or greater than 0.3 m in thickness, 10 m in width, and 100 m in length along shoreline; and the fetch is more than 5 km (MNR, 2001a).

The dynamic beach hazard limit is defined as the landward limit of the flooding hazard (100-year flood level plus a flood allowance for wave uprush and other water related hazards), plus a 30 m dynamic beach allowance or a distance determined by an accepted coastal study (see Figure 4.4). If the dynamic beach is backed by an eroding bluff, the definition of the erosion hazard is applied to the bluff feature.

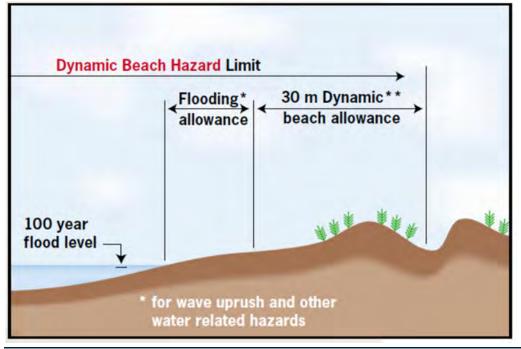


Figure 4.4: Dynamic beach hazard limit (from MNR, 2001a)



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Shoreline Reaches 5.

The shoreline was divided into reaches to support the mapping of the natural hazards (flood, erosion, and dynamic beach). Shoreline reaches are segments of shoreline having relatively uniform physical characteristics (MNR, 2001a). In establishing the reaches, the following factors were considered: shoreline type, controlling nearshore substrate, surficial nearshore substrate, and shoreline exposure and planform. Reaches defined by the Conservation Authority (CA) for previous mapping were used as a starting point and then refined. The reaches used for the mapping are shown in Figure 5.1 and Figure 5.2 and summarized in Table 5.1 including: the CA the reach is located in, reach number, general location, brief description of the shoreline, and approximate reach length. The hazard mapping, provided under separate cover, shows reach boundaries at higher resolution (1:2000).

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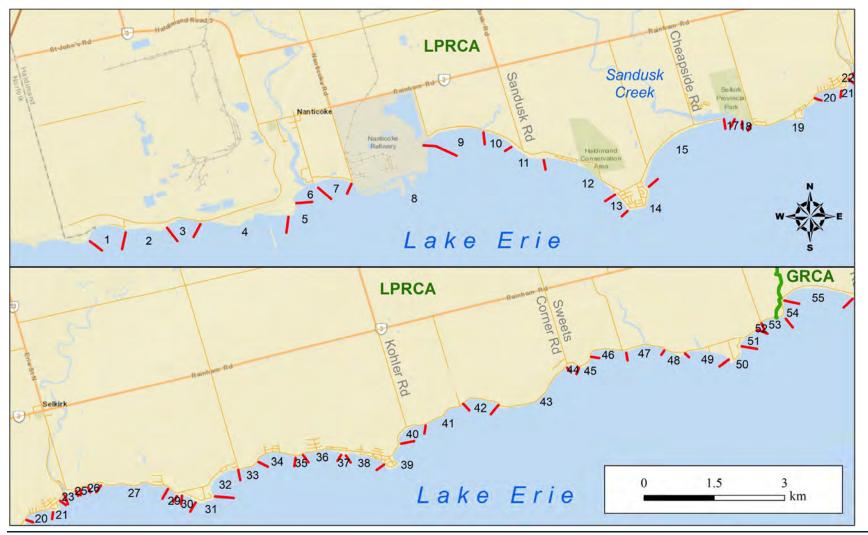


Figure 5.1: Reaches used for natural hazard delineation on Lake Erie, Haldimand County (west end)

Haldimand County Lake Erie Hazard Mapping and Risk Assessment Technical Report Baird.

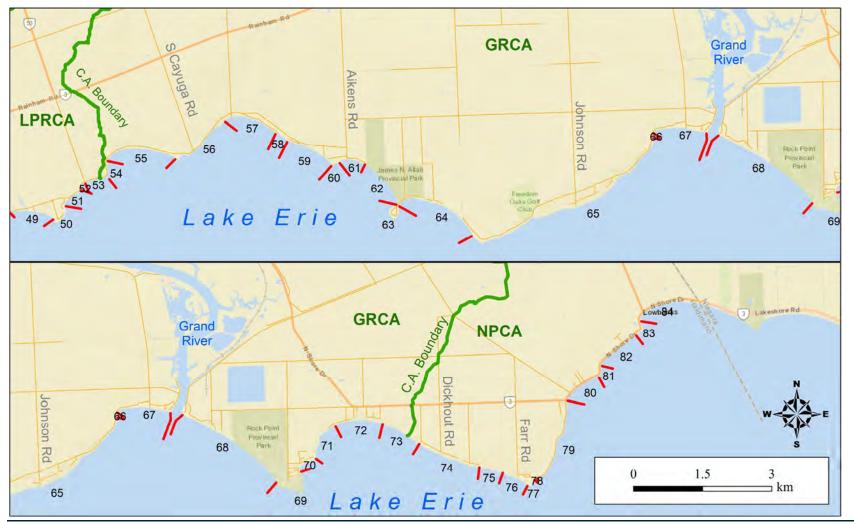


Figure 5.2: Reaches used for natural hazard delineation on Lake Erie, Haldimand County (east end)

Haldimand County Lake Erie Hazard Mapping and Risk Assessment Technical Report Baird.

CA	Reach #	Location	Description	Length (m)
L	1	County limit to 144 Old Lakeshore Rd.	Embayment	950
Р	2	Woodhouse CON 1 PT LOTS 22 TO 24	Low bank with sand/cobble deposit	870
R C	3	Woodhouse CON 1 PT LOTS 24 and Walpole CON 1 PT LOTS 1	Low bank embayment with sand/cobble deposit, partially protected with armourstone	750
A	4	1156 New Lakeshore Rd, Elmcrest Ln., 1 Riverside Dr., includes the US Steel Canada Nanticoke Works wharf consisting of causeway and pier to Part Lot 4	Low bank with sand/cobble deposit	2040
	5	1 Riverside Dr.	Rocky outcrop	450
	6	West of Nanticoke Creek	Embayment with sand/cobble deposit	530
	7	East of Nanticoke Creek, Hickory Beach Lane	Embayment with sand/cobble deposit	760
	8	Former Nanticoke Power Generating Station	Engineered fill and shoreline	3700
	9	East of former Nanticoke Power Generating Station to Hickory Creek	Embayment, remnant shoreline protection including armourstone and rock groynes, with sand/cobble deposit	1400
	10	Hickory Creek to 400 South Coast Dr.	Embayment with sand/cobble deposit	690
	11	402-488 South Coast Dr.	Sand/cobble deposit	800
	12	392 South Coast Dr. and West, Haldimand Cons. Area to 755 South Coast Dr.	Low bank with sand/cobble deposit	1760
	13	Peacock Point West shore	Fully protected shoreline	440
	14	Peacock Point	Rocky headland	910
	15	West of Sandusk Creek	Low bank with sand/cobble deposit	2370
	16	Selkirk Prov. Park	Sandy river mouth, cobble bar feature and small sand/cobble deposit	100
	17	Selkirk Prov. Park	Rocky	180
	18	Selkirk Prov. Park	Small sand/cobble deposit	240
	19	0-186 Blue Water Pkwy.	Rocky outcrop headland	1800
	20	195 Blue Water Pkwy. to 20 Summerhaven Cres.	Embayment, small sand/cobble deposit	640
	21	26-76 Summerhaven Cres.	Rocky headland	400
	22	West of Stoney Creek	Embayment, fill since 1973	150
	23	East of Stoney Creek, 6-15 Lakeshore Rd.	Rocky shoreline & nearshore	220
	24	25 Lakeshore Rd.	Sand/cobble deposit	110
	25	48-56 Lakeshore Rd.	Rocky headland	170
	26	65-98 Lakeshore Rd.	Sandy/cobble deposit	300
	27	104-299 Lakeshore Rd.	Rocky shoreline & nearshore	1500

Table 5.1: Reaches with location, description, and length

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| CA | Reach # | Location                                                | Description                                                  | Length (m) |
|----|---------|---------------------------------------------------------|--------------------------------------------------------------|------------|
|    | 28      | Rainham Conc. 1 Part Lot 4                              | Cobble shore, heavily protected                              | 250        |
|    | 29      | 358-370 Lakeshore Rd.                                   | Rocky outcrop headland                                       | 100        |
|    | 30      | Hoover Point west                                       | Rocky headland                                               | 340        |
|    | 31      | Hoover Point central                                    | Rocky headland                                               | 550        |
|    | 32      | East of Hoover Point, 76 Hoover Point Lane to 1         | Embayment, sand/cobble deposit                               | 940        |
|    |         | Anchor Lane, Hoover Cemetery                            |                                                              |            |
|    | 33      | 594-669 Lakeshore Rd.                                   | Rocky outcrop                                                | 570        |
|    | 34      | 699-789 Lakeshore Rd.                                   | Embayment, sand/cobble deposit                               | 880        |
|    | 35      | 791-811 Lakeshore Rd.                                   | Rocky outcrop                                                | 160        |
|    | 36      | 817-934 Lakeshore Rd.                                   | Embayment, sand/cobble deposit                               | 850        |
|    | 37      | 936-946 Lakeshore Rd.                                   | Rocky outcrop                                                | 120        |
|    | 38      | 948 Lakeshore to 6 Lake Rd.                             | Embayment (all protected), pockets of sand/cobble deposits   | 870        |
|    | 39      | Featherstone Point                                      | Rocky headland                                               | 1120       |
|    | 40      | 1126-1219 Lakeshore Rd.                                 | Embayment (all protected)                                    | 790        |
|    | 41      | 1238-1371 Lakeshore Rd.                                 | Rock shelf                                                   | 970        |
|    | 42      | 1373-1495 Lakeshore Rd.                                 | Embayment with creek outlet, pockets of sand/cobble deposits | 815        |
|    | 43      | 1497-1750 Lakeshore Rd.                                 | Rocky nearshore shelf                                        | 1950       |
|    | 44      | East of Sweets Corners Rd.                              | Embayment, sand/cobble deposit                               | 280        |
|    | 45      | 1806-1847 Lakeshore Rd.                                 | Rocky headland                                               | 450        |
|    | 46      | 1847 Lakeshore Rd. to Bookers Rd.                       | Embayment, sand/cobble deposit, with nearshore rock shelf    | 840        |
|    | 47      | Bookers Bay, Wardells Creek,<br>1982-2057 Lakeshore Rd. | Embayment, sand/cobble deposit                               | 850        |
|    | 48      | 2066-2079 Lakeshore Rd.                                 | Rocky headland, pocket sand/cobble deposit                   | 540        |
|    | 49      | 2086-2190 Lakeshore Rd.                                 | Embayment, sand/cobble deposit                               | 980        |
|    | 50      | Evans Point                                             | Rocky headland                                               | 660        |
|    | 51      | 15 Paradise Lane to 2301 Lakeshore Rd.                  | Rock shelf                                                   | 530        |
|    | 52      | Austins Trailer Park                                    | Rock shelf, small sand/cobble deposit                        | 200        |
| G  | 53      | LPRCA-GRCA boundary                                     | Rocky nearshore shelf, sand/cobble deposit                   | 510        |
| R  | 54      | 2455-2489 Lakeshore Rd.                                 | Rocky nearshore shelf                                        | 370        |
| С  | 55      | 2503-2742 Lakeshore Rd.                                 | Embayment, sand/cobble deposit                               | 1600       |
| А  | 56      | 2742-2894 Lakeshore Rd.                                 | Rocky headland nearshore shelf                               | 1560       |

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| CA     | Reach # | Location                                                                                                                                 | Description                                                                    | Length (m) |
|--------|---------|------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|------------|
|        | 57      | 2896 Lakeshore Rd. South Cayuga to 217<br>Lakeshore Rd. Dunnville,<br>Hald-Dunn Townline                                                 | Low bank with sand/cobble deposit                                              | 1200       |
|        | 58      | East end of Edgewater Place to 3100 Lakeshore Rd.<br>Former Lakeshore Rd lost                                                            | Low bank with sand/cobble deposit                                              | 310        |
|        | 59      | 3102 Lakeshore Rd. to 53 Horseshoe Bay Rd.                                                                                               | Low bank with sand/cobble deposit                                              | 1100       |
|        | 60      | Blott Point,<br>53-31 Horseshoe Bay Rd.                                                                                                  | Rocky headland with pocket sand/cobble deposit reshaping but not bluff eroding | 220        |
|        | 61      | 25 Horseshoe Bay Rd. to 50 Lakeview Line                                                                                                 | Embayment, sand/cobble deposit                                                 | 600        |
|        | 62      | James N. Allan Provincial Park                                                                                                           | Dynamic Beach (low plain, partial headland, sand and cobble)                   | 1160       |
|        | 63      | Low Point                                                                                                                                | Rocky headland                                                                 | 830        |
|        | 64      | Between Low and Grant Points, Paradise Lane,<br>Baygrove Line, 835-783 Sandy Bay Rd.                                                     | Dynamic Beach (low plain, partial headland, sand and cobble)                   | 1960       |
|        | 65      | Grant Point and East<br>771-445 Sandy Bay Rd., Dearden Lane,<br>Stonehaven Rd., Weatherburn Line, Greens Line,<br>297-135 Lighthouse Dr. | Rocky nearshore shelf                                                          | 4950       |
|        | 66      | 105-135 Lighthouse Dr.                                                                                                                   | Transition zone; lakefill                                                      | 120        |
|        | 67      | West of Grand River,<br>Port Maitland West Beach; Splatt Bay, 105-1<br>Lighthouse Dr., Dover St.                                         | Dynamic Beach (low plain, partial headland, sand and cobble)                   | 1190       |
|        | 68      | East of Grand River, Beckley Beach and Rock Point<br>Provincial Park                                                                     | Dynamic Beach (low plain, partial headland, sand and cobble)                   | 2550       |
|        | 69      | Rock Point                                                                                                                               | Rocky headland                                                                 | 1200       |
|        | 70      | Mohawk Bay West,<br>Rock Point B Line                                                                                                    | Embayment, sand/cobble deposit                                                 | 500        |
|        | 71      | Mohawk Bay West                                                                                                                          | Eroding bluff, sand/cobble deposit                                             | 930        |
| N<br>P | 72      | Mohawk Bay Central,<br>43-1 Gull Line, Warnick Rd., Lakeridge Blvd.                                                                      | Eroding bluff, sand/cobble deposit                                             | 1060       |
| C<br>A | 73      | Mohawk Bay Central,<br>1930-1958 North Shore Dr., 1980 Regional Rd 3 E.,<br>63 Pyle Rd.                                                  | Eroding high bluff                                                             | 920        |
|        | 74      | Mohawk Bay East; Villella-Derner-Erie Heights                                                                                            | Eroding bluff                                                                  | 1400       |
|        | 75      | Transition zone                                                                                                                          | Forested bluff                                                                 | 520        |

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СА	Reach #	Location	Description	Length (m)
	76	Mohawk Point West face	Rocky headland	600
	77	Mohawk Point East face	Rocky headland	250
	78	End of Mohawk Point Rd.	Pocket sand/cobble deposit	70
	79	Mohawk Point Rd.	Fill and armoured since 1955	1950
	80	2441-2543 North Shore Blvd.	Sand/cobble deposit	880
	81	2558-2587 North Shore Blvd.	Headland, fill since 1955	270
	82	2605-2718 North Shore Blvd.	Sand/cobble deposit, Fill since 1955	1000
	83	Lowbanks Cemetery East to 2758 North Shore Blvd.	Headland, fill since 1955, fully armoured shoreline; rocky	400
			nearshore substrate	
	84	2762 North Shore Blvd. to County Limit	Fully armoured shoreline, fill since 1955	1450

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## 6. Technical Analyses

### 6.1 100-Year Flood Level

Return period water levels for locations on the Great Lakes were developed by the Ontario Ministry of Natural Resources (MNR, 1989). The return period water level estimates in MNR (1989) were developed for static lake levels (i.e. monthly mean levels), storm surge, and all combinations of static lake levels and storm surge. The statistical analyses were conducted using the HYDSTAT software package developed by MNR (1982). The report defines the 100-year flood level, which is the still-water level (or peak instantaneous water level) having a 1% annual chance of being equalled or exceeded. The still-water level is equivalent to the hourly water level.

Unless otherwise noted, all water levels are reported in IGLD85. Datum conversions are listed in Table 6.1. The conversion from IGLD85 to CGVD2013 is based on the NRCan Benchmark Station Reports.

| Datum    | Port Dover<br>NRCAN Benchmark<br>MMDCCXXX | Port Colborne<br>NRCAN Benchmark<br>71U032 |  |  |
|----------|-------------------------------------------|--------------------------------------------|--|--|
| IGLD1955 | 175.627                                   | 175.731                                    |  |  |
| IGLD1985 | 175.797                                   | 175.921                                    |  |  |
| CGVD28   | 175.793                                   | 175.904                                    |  |  |
| CGVD2013 | 175.341                                   | 175.456                                    |  |  |

#### Table 6.1: Datum conversions for Port Dover and Port Colborne

#### 6.1.1 Static Water Levels

In MNR (1989), the historical monthly mean lake levels from 1900 to 1988 were adjusted to the constant set of conditions existing after about 1960 (regulation conditions, diversions, etc.) to form a consistent basis of comparison. The "Basis of Comparison" Lake Erie water levels are shown in Figure 6.1 with the measured water levels (1918-2018).

Considering that an additional 30 years of data has been measured since 1988, and recognizing the 1970s to 1990s were a period of higher water levels in the Great Lakes, Baird updated the static water level return periods for Port Dover and Port Colborne using only the measured data corresponding to the period of hourly water level measurements (1962-2018). This is a conservative approach (i.e. errs on the side of higher extreme lake levels). The data set includes 57 years of water level measurements under conditions (flow regulation, diversions, dredging, etc.) similar to the present.



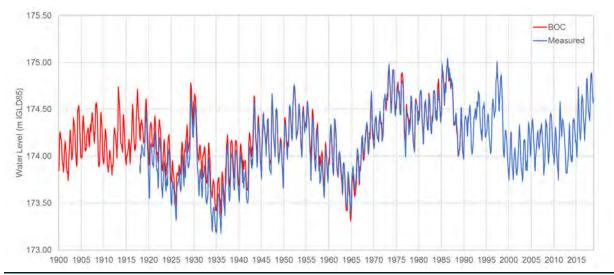


Figure 6.1: Lake Erie measured and "Basis of Comparison (BOC)" monthly water levels

#### 6.1.2 Surge Levels

Storm surge (or wind setup) was calculated in MNR (1989) by subtracting the mean monthly water level from the hourly water level measurements. A computer model was used to estimate storm surges for locations between gauge stations.

Baird updated the storm surge analysis using the 57 years of hourly water level data (1962-2018). In the analysis, static water levels were calculated using a Gaussian-weighted 30-day moving average filter to eliminate the stairstep effect between months. Surge was calculated by subtracting the hourly water level measurements from the "smoothed" static water level. Hourly water levels, calculated static levels, and calculated surges for Port Colborne are shown in Figure 6.2.

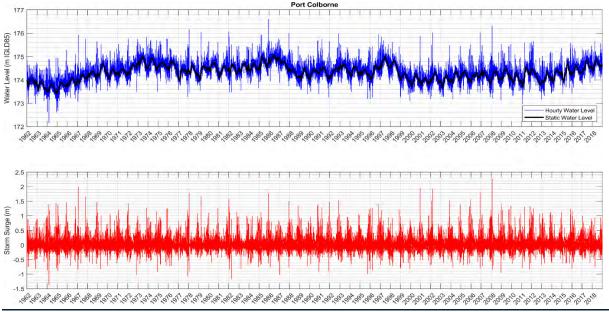


Figure 6.2: Hourly and static water level and calculated surge at Port Colborne 1962 to 2018

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A listing of the largest surge events at Port Colborne and Port Dover is provided in Table 6.2. The largest surge on record occurred on January 30, 2008.

|      | Port             | Colborne     |                           | Port Dover       |              |                           |  |
|------|------------------|--------------|---------------------------|------------------|--------------|---------------------------|--|
| Rank | Date             | Surge<br>(m) | Water level<br>(m IGLD85) | Date             | Surge<br>(m) | Water level<br>(m IGLD85) |  |
| 1    | 2008-01-30 07:00 | 2.27         | 176.31                    | 2008-01-30 08:00 | 1.63         | 175.63                    |  |
| 2    | 1967-02-16 06:00 | 1.99         | 175.93                    | 2006-12-01 19:00 | 1.50         | 175.69                    |  |
| 3    | 2000-12-12 06:00 | 1.94         | 175.87                    | 2002-03-10 00:00 | 1.44         | 175.50                    |  |
| 4    | 2002-03-10 00:00 | 1.92         | 176.02                    | 1967-02-16 07:00 | 1.31         | 175.24                    |  |
| 5    | 2006-12-01 18:00 | 1.80         | 176.03                    | 1967-10-27 20:00 | 1.31         | 175.37                    |  |

Table 6.2: Listing of the largest surge events at Port Colborne and Port Dover 1962 to 2018

#### 6.1.3 **Return Period Water Levels**

The HYDSTAT software package was used to estimate the return period static water levels, surge levels, and joint probability of static water levels and storm surge (still-water levels). The input data consisted of the annual maximum monthly water levels for 1962 to 2018 and the 57 largest surges over this period. The Log-Pearson Type 3 distribution, which was the best fitting distribution, was selected in the analyses.

The existing (MNR, 1989) and updated return period water levels for Port Colborne and Port Dover are summarized in Table 6.3 and Table 6.4, respectively. The updated 100-year still-water levels are within 1 cm of the levels in MNR (1989). Following review and discussion with the Project Team, it was decided that no update to the existing 100-year flood levels for Haldimand County's Lake Erie shoreline would be made. The 100-year Flood Level used in the Hazard Mapping is therefore as defined in MNR (1989).

| Cturchy         | Water      | Return Period Water Level (m and m IGLD85) |        |         |         |         |          |          |
|-----------------|------------|--------------------------------------------|--------|---------|---------|---------|----------|----------|
| Study           | Level      | 2 year                                     | 5 year | 10 year | 25 year | 50 year | 100 year | 200 year |
| MNR<br>(1989)   | Static     | 174.37                                     | 174.61 | 174.74  | 174.86  | 174.95  | 175.02   | 175.08   |
|                 | Surge      | 1.32                                       | 1.61   | 1.80    | 2.01    | 2.17    | 2.32     | 2.46     |
|                 | Stillwater | 175.70                                     | 176.07 | 176.28  | 176.51  | 176.66  | 176.80   | 176.93   |
| Baird<br>(2019) | Static     | 174.53                                     | 174.75 | 174.86  | 174.98  | 175.04  | 175.10   | 175.16   |
|                 | Surge      | 1.35                                       | 1.55   | 1.71    | 1.93    | 2.11    | 2.30     | 2.51     |
|                 | Stillwater | 175.91                                     | 176.22 | 176.39  | 176.57  | 176.69  | 176.80   | 176.90   |
| Difference      | Stillwater | 0.21                                       | 0.15   | 0.11    | 0.06    | 0.03    | 0.00     | -0.03    |

#### Table 6.3: Port Colborne return period water levels

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| Study           | Water      | Return Period Water Level (m and m IGLD85) |        |         |         |         |          |          |
|-----------------|------------|--------------------------------------------|--------|---------|---------|---------|----------|----------|
| Sludy           | Level      | 2 year                                     | 5 year | 10 year | 25 year | 50 year | 100 year | 200 year |
|                 | Static     | 174.35                                     | 174.59 | 174.72  | 174.84  | 174.93  | 175.00   | 175.06   |
| MNR<br>(1989)   | Surge      | 1.15                                       | 1.32   | 1.42    | 1.52    | 1.59    | 1.66     | 1.72     |
| (1505)          | Stillwater | 175.50                                     | 175.79 | 175.94  | 176.10  | 176.20  | 176.30   | 176.38   |
|                 | Static     | 174.53                                     | 174.75 | 174.86  | 174.98  | 175.04  | 175.10   | 175.16   |
| Baird<br>(2019) | Surge      | 1.01                                       | 1.17   | 1.28    | 1.43    | 1.55    | 1.68     | 1.81     |
| (2013)          | Stillwater | 175.55                                     | 175.82 | 175.96  | 176.11  | 176.21  | 176.29   | 176.37   |
| Difference      | Stillwater | 0.05                                       | 0.03   | 0.02    | 0.01    | 0.01    | -0.01    | -0.01    |

#### Table 6.4: Port Dover return period water levels

The 100-year flood levels for Port Colborne and Port Dover used to define the stillwater levels in the Haldimand County hazard mapping are summarized in Table 6.5. The 100-year flood levels were defined for each reach using a linear interpolation between the 100-year flood levels at Port Colborne and Port Dover adjusted to CGVD2013 datum. The values used in the mapping are discussed further in Section 7.1.

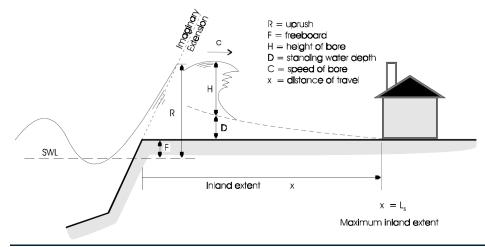
| Gauge Location | 100-year Flood Level<br>(m IGLD85) | 100-year Flood Level<br>(m CGVD2013) |  |  |
|----------------|------------------------------------|--------------------------------------|--|--|
| Port Colborne  | 176.80                             | 176.34                               |  |  |
| Port Dover     | 176.30                             | 175.84                               |  |  |

#### Table 6.5: 100-year flood levels at Port Colborne and Port Dover used for flood hazard mapping

#### 6.2 Wave Uprush

Wave uprush (runup), wave overtopping, and the inland extent of overtopping waves were calculated for each of the 84 shoreline reaches using a representative shoreline profile for each reach. The analysis used the 100-year flood level with the 20-year wave condition as per MNR (2001a). The definition sketch for wave uprush is shown in Figure 6.3. In this figure, "R" is the wave runup height for threshold extension of slope, "F" is the freeboard height; and "Ls" is the maximum distance that an overtopping wave is predicted to travel inland. The distance "Ls" is proportional to the excess runup (R minus F) and the wave period. The wave uprush allowance is equal to the horizontal extent of the wave runup on the slope measured from the 100-year flood level plus the distance "Ls".

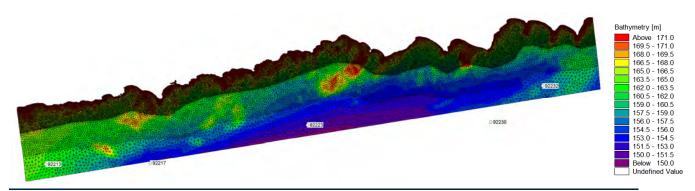






#### 6.2.1 Nearshore Wave Modelling

The two-dimensional spectral wave model MIKE21 SW was used to transform the offshore "deep water" wave conditions from the US Army Corps of Engineers (USACE) Wave Information Study (WIS) to the Haldimand County shoreline. The WIS hindcast consists of hourly wave data for 1979-2014. The nearshore wave model bathymetry was developed using a gridded bathymetric dataset of Lake Erie from NOAA and Canadian Hydrographic Service (CHS). The model domain extends approximately 10 km east and 5 km west of Haldimand County and the offshore boundary was selected to coincide with the WIS output points. The model mesh is composed of approximately 83,000 triangular elements which vary in size from 250 m at the offshore boundary to 50 m at the nearshore. The model mesh, bathymetry, and WIS output points are shown in Figure 6.4.



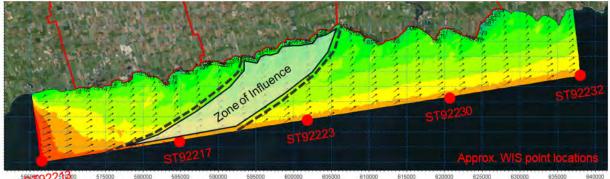


The nearshore wave model was run using spatially varying water levels corresponding to the 100-year flood levels at Port Colborne and Port Dover (interpolated over the model domain) and the 20-year offshore wave conditions at the WIS output points. The 20-year offshore wave heights varied between 3.4 m at the westernmost WIS point and 5.7 m at the easternmost WIS point. A series of model runs were carried out using the range of wave heights, periods, and directions that corresponded to the 20-year wave condition at the five WIS output points. Wind conditions were examined for the selected storm events, and a constant onshore wind of 22.5 m/s was applied in the model runs.

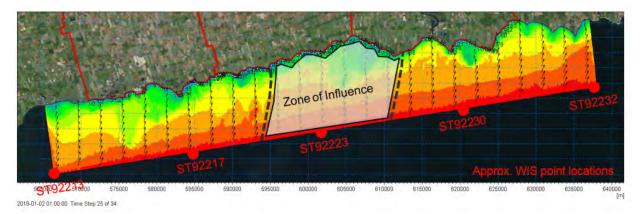
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An output point was defined at each of the 84 shoreline profiles (reaches), approximately 200 m from the shoreline. The wave direction vectors were examined for each of the model runs to determine the envelope of nearshore output points influenced by the particular model run (combination of wave height, period, and direction for a particular WIS output point). For example, Profiles 39-56 are influenced by the two WIS output points shown in Figure 6.5. The top panel shows the zone of influence based on a model run with Hm0=4.3 m; Tp=7 s; Dir =250 deg. The bottom panel shows the zone of influence based on a model run with Hm0=5.5 m; Tp=8.5 s; Dir =200 deg. The 20-year wave condition at each of the profile locations was selected as the maximum wave condition from the series of corresponding model runs.



5850700221000 575000 580000 585000 590000 590000 590000 595000 600000 805000 810000 615000 620000 625000 630000 630000 640000 [m] 2018-01-02 00 00 00 Time Step 24 of 34.





#### 6.2.2 Wave Uprush Analysis

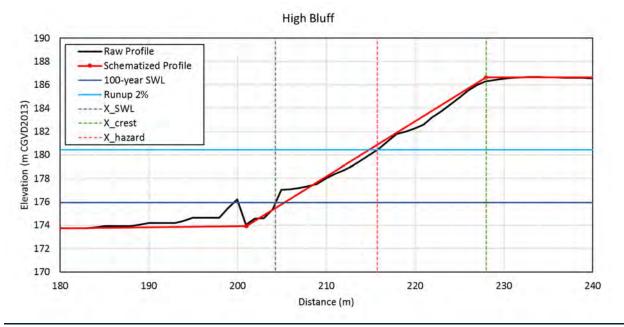
Wave uprush (runup) elevations and horizontal distances were calculated for each reach using a representative shoreline profile. The shoreline profiles were extracted from a high-resolution merged dataset (listed in order of priority for use in developing) of the 2017 SWOOP LiDAR, 2015 SWOOP LiDAR, 2018 DFO bathymetric LiDAR and the NOAA/CHS Lake Erie bathymetry. The profiles were schematized to define the nearshore lakebed slope, water depth at the toe of slope, lower slope, beach berm (if applicable), upper slope, and crest height. Wave runup elevations were calculated for each profile using the empirical equations in the EurOtop overtopping manual (Van der Meer et al., 2018) for the 100-year flood level, 20-year wave conditions (from the nearshore wave modelling), and schematized shoreline profile.

An example of the wave runup elevation and corresponding horizontal runup distance on a high bluff is shown in Figure 6.6. In this example, the wave runup is 4.5 m above the 100-year flood level, and the corresponding

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horizontal runup distance is 11 m. In this figure, the "spike" at x=200 m is an artifact of the merging of the different LiDAR datasets at the shoreline and, as such, the "spike" is ignored.



#### Figure 6.6: Example of wave uprush on a high bluff

An example of wave runup on a low bluff is shown in Figure 6.7. In this example, the wave runup is 4.6 m above the 100-year flood level, which exceeds the height of the bluff by 1.4 m.

When the wave runup exceeds the height of the bluff, the inland extent of the overtopping wave is then calculated according to the Cox-Machemehl equation (Eq. 1), as presented in MNR (2001a) and shown in Figure 6.3.

$$L_s = \frac{T \sqrt{g}}{5} (R - F)^{1/2}$$

where:

Ls = horizontal extent of wave uprush measured from the slope crest

T = wave period

g = acceleration due to gravity

R = wave runup

F = freeboard



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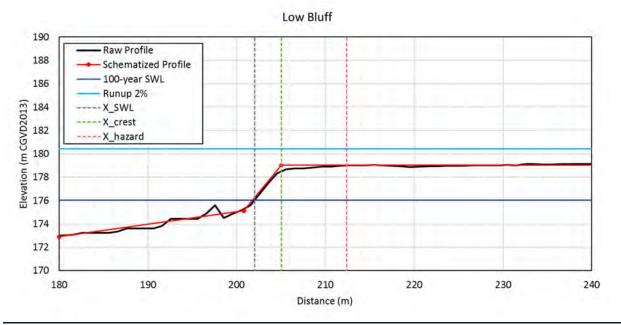


Figure 6.7: Example of wave uprush on a low bluff

In the example shown in Figure 6.7, the horizontal extent of wave uprush is 10 m (3 m horizontally on the slope and 7 m from the slope crest to the distance Ls).

#### 6.3 Ice Impacts

A risk assessment of ice ride-up/piling was conducted for the Haldimand County Lake Erie shoreline. This phenomenon is also sometimes called an ice shove, ice surge, or ice tsunami in newspapers and local media.

MNR (2001a) describes the process as being caused by onshore winds and waves. The wind and wave action help to break up the ice into smaller floes, providing the conditions needed for ice piling (MNR, 2001a). Onshore winds drive the ice floes into the shoreline, which then pile-up under their own momentum. Generally, ice piling does not cause serious damage to beaches, bulkheads, and riprap revetments (MNR, 2001a). However, shore perpendicular structures (e.g. groynes, dock walls, piers, etc.), buildings, and other infrastructure may be significantly damaged by ice piling. MNR (2001a) notes that local experience with the impacts of ice piling is the best guide to help define the extent of the ice hazard.

A photograph of the February 25, 2019 ice pile-up event at Fort Erie, Ontario (east of Haldimand County) is shown in Figure 6.8. No historical ice pile-up events of this magnitude were identified by the project team for Haldimand County.







Figure 6.8: Ice pile-up along Lake Erie shoreline in Fort Erie, Ontario during Feb 25, 2019 (Mazza, 2019)

This section of the report includes a review of historical ice pile-up events in Haldimand County, shoreline conditions vulnerable to ride-up/pile-up processes, and evaluation of the risk of ice pile-up for the 84 shoreline reaches in Haldimand County.

#### 6.3.1 Historical Ice Pile-up Events

A literature review was conducted to understand the historical risk of ice damage along the Haldimand County shoreline, and to obtain information or reports of past occurrences. From the literature review, and consultation with representatives of GRCA, NPCA, LPRCA and Haldimand County, it appears Haldimand County has historically had minimal impact due to ice pile-up. Ice piling is more common along the Niagara County shore of Lake Erie, where ice pile-up events have occurred in 2014, 2018, and 2019 (see Figure 6.9).





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Figure 6.9: January 31, 2008 ice pile-up event in Niagara County (from NPCA)

In addition to Fort Erie (located east of Haldimand County), Erieau and Wheatley (located west of Haldimand County) have also experienced significant ice piling in the past and are indicated as areas prone to ice piling in Figure 6.10 (from MNR, 2001a).





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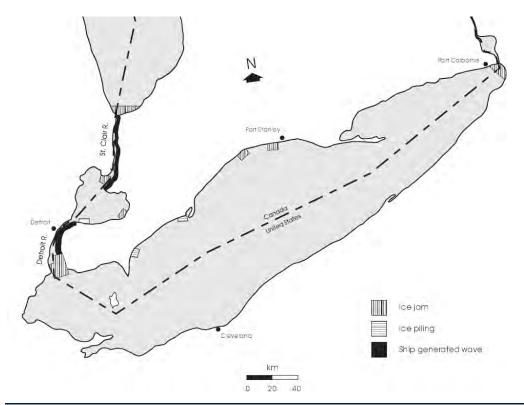


Figure 6.10: Ontario locations on Lake Erie vulnerable to ice piling (MNR, 2001a)

In Haldimand County, ice jams near the mouth of the Grand River are the primary ice and flooding concern. In January 2008, the combination of storm surge and wind, pushed a large amount of ice upstream into the Grand River, resulting in flooding near Dunnville. The Canadian Coast Guard often carries out ice breaking operations at the river mouth in the late winter to reduce the potential for upstream flooding (see Figure 6.11).



Figure 6.11: Canadian Coast Guard ice breaking operations in the Grand River, February 2009 (GRCA)

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In terms of less severe ice effects along the Haldimand County shoreline, anecdotal reports were obtained from the GRCA and various residents. From the information obtained, it is evident that ice spray can occur during winter months when the lake is not completely frozen, or ice has been broken up by wave action. This combined with winds, results in the spray of waves icing structures along the shoreline. Specifically, this was noted to have occurred in December 1985 and February 2019 but may occur more frequently.

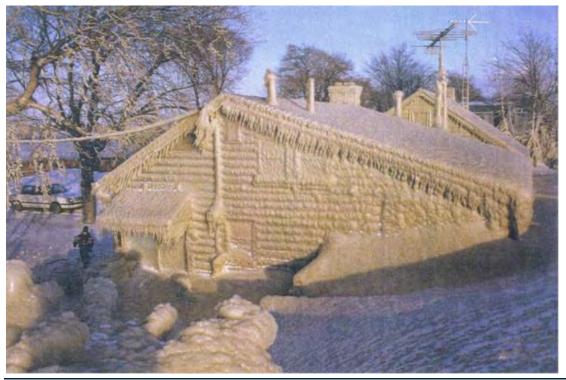


Figure 6.12: Example of Lake Erie ice spray on Erie Shore Drive (from LTVCA, date unknown)

## 6.3.2 Shoreline Conditions Vulnerable to Ice Ride-up/Pile-up

Ice ride-up tends to occur in places where the water is relatively deep, and the shore is relatively low and flat. Canadian experience on the Great Lakes and St. Lawrence River indicate that slopes of 2H:1V or steeper above the water line and about 4H:1V or flatter below the water line tend to limit ice pileup and damage (MacIntosh et al., 1995; Danys, 1979). The steeper slopes above the water line tend to contain the amount of ice ride-up/pile-up, and flatter slopes below the water line, or berms, will cause the ice to ground on the lakebed rather than pileup on the shoreline (MNR, 2001a).

## 6.3.3 Shoreline Risk Assessment

The risk of ice ride-up/pile-up was evaluated for the 84 shoreline reaches in Haldimand County based on the height of the shoreline bluff, shoreline orientation, above water slope, and below water slope. The open-water fetch distance for all reaches is sufficient for ice piling to occur.

The risk of ice ride-up/pile-up was estimated for each reach using the following criteria:

- 1. Freeboard Risk Factor:
  - 100% risk of ice ride-up when the bluff is at the same elevation as the 100-year flood level,
  - 0% risk of ice ride-up when the bluff is 3 m above the 100-year flood level.

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- 2. Azimuth Risk Factor:
  - 100% risk of ice ride-up when the wind is perpendicular to the shoreline and onshore,
  - 0% risk of ice ride-up when the wind is parallel to the shoreline or offshore.
- 3. Lower Slope Risk Factor:
  - 100% risk of ice ride-up when the below water slope is 2H:1V or steeper,
  - 0% risk of ice ride-up when the below water slope is 4H:1V or flatter.
- 4. Upper Slope Risk Factor:
  - 100% risk of ice ride-up when the above water slope is 4H:1V or flatter,
  - 0% risk of ice ride-up when the above water slope is 2H:1V or steeper.

The risk factors were assessed using the reach profiles developed for the wave uprush estimates. The 100year flood level was used for the freeboard risk factor estimates and is representative of a high-water condition that could occur during an ice pile-up event. Three metres was selected as a reasonable bluff height that would contain/limit the landward progression of an ice pile-up event (e.g. see Figure 6.8).

The azimuth (shoreline orientation) risk factor was calculated using the 40-year wind/wave hindcast for all wind occurrences over 10 m/s.

Based on information obtained from the literature review in relatively similar conditions to what is experienced along Haldimand County's shoreline (MacIntosh et al., 1995), both the lower and upper slopes of each reach profile were considered independently. For the lower slope, 2H:1V or steeper tends to promote the ice ride-up process, while slopes 4H:1V or milder will tend to promote grounding of the ice sheet and prevent ice ride-up. If the ice sheet is able to reach the upper slope, an upper slope of 2H:1V or steeper tends to prevent the ice from riding up the beach, while 4H:1V or milder will not. The slopes were considered with the associated bounds, and risk factors were calculated for each.

Given the limited information available on the quantification of different parameters and their influence on the overall ice ride-up process, minimum and maximum bounds were chosen for each parameter based on information obtained from the literature review, and a linear interpolation was done in between these bounds (see Figure 6.13).

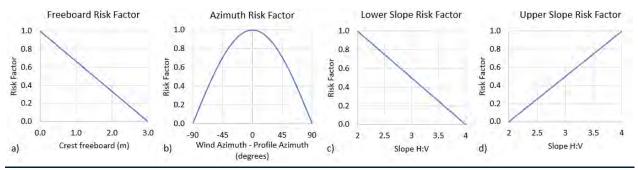


Figure 6.13: Functions used to estimate ice ride-up/pile-up risk factors

A combined Risk Factor (CRF) was calculated based on a weighted average using the equation below.

CRF = (Freeboard RF + Azimuth RF + 0.5\* Lower RF + 0.5\* Upper RF) / 3

Each reach was then classified as low, medium or high risk for ice ride-up/pile-up as follows: low (CRF<0.33); medium (0.33<CRF<0.66); or high (>0.66). Irrespective of the calculated CRF value, the combined risk of ice ride-up/pile-up was set to "low" for reaches when either of the following conditions were met:

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- Height of the shoreline bluff greater than 3 m above the 100-year flood level, or
- Above water slope 2H:1V or steeper and below water slope 4H:1V or flatter.

Table 6.6 summarizes the resulting classifications for each reach along the Haldimand County Shoreline.

| Risk of Ice Ride-up | Reaches                                                                                                                                                                   |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Low                 | 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 24, 26, 27, 28, 29, 30, 31, 35, 37, 46, 48, 55, 56, 57, 58, 59, 65, 66, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 82 |
| Medium              | 16, 17, 18, 19, 20, 21, 22, 23, 25, 32, 33, 34, 36, 38, 39, 40, 41, 42, 43, 44, 45, 47, 49, 50, 51, 52, 53, 54, 60, 61, 62, 63, 64, 67, 68, 80, 81, 83, 84                |
| High                | none                                                                                                                                                                      |

| Table | 6.6: | lce | risk | classification | by | reach |
|-------|------|-----|------|----------------|----|-------|
|-------|------|-----|------|----------------|----|-------|

#### 6.4 **Geotechnical Analysis of Stable Slope**

The Stable Slope Allowance used to determine the Erosion Hazard Limit (as defined in Section 4.3) is a horizontal allowance measured landward from the toe of the bluff, equivalent to three times the bluff height, or as determined through a study using accepted geotechnical principles (MNR, 2001a). For this project, a study was undertaken by Terraprobe Inc. to determine the stable slope allowance. The complete geotechnical report is provided in Appendix A, and the findings are summarized in this section.

The shoreline generally comprises sand beaches, visible limestone bedrock, or native slopes comprising glaciolacustrine silt and clay or glacial till. Stretches of shoreline are protected with armourstone, concrete retaining walls, steel sheet pile, and ad hoc protection.

The stable slope analysis was based on a review of publicly available subsurface information, existing Terraprobe reports for the area, and a detailed visual slope inspection. Cross-sections were developed from the 2017 LiDAR data at 52 representative locations in the reaches with a focus on the reaches where the Erosion Hazard governs (see Figure 6.14 and Figure 6.15). The subsurface conditions including general stratigraphy were assessed based on publicly available information, Terraprobe reports, and visual observations during the site visits. The water table was estimated from well records and site observations of seepage from the slope face.

An engineering analysis of slope stability was completed for each of the 52 locations. The analysis was conducted utilizing computer software (Slide 8.016, released July 23, 2018, developed by Rocscience Inc.) and several standard methods of limit equilibrium analysis (Bishop, Janbu, Morgenstern/Price, and Spencer). These methods of analysis allow the calculation of Factors of Safety for hypothetical or assumed slip surfaces through the slope. The analysis method is used to assess potential for movements of large masses of soil over a specific slip surface which can be curved or circular, or noncircular.

For a specific slip surface, the Factor of Safety is defined as the ratio of the available soil strength resisting movement, divided by the gravitational forces tending to cause movement. A Factor of Safety of 1.0 represents a "limiting equilibrium" condition where the slope is at a point of pending failure since the soil resistance is equal to forces tending to cause movement. It is usual to require a Factor of Safety greater than one (1) to ensure stability of the slope. The typical Factor of Safety used for engineering design of slopes for stability ranges from about 1.3 to 1.5 for developments situated close to the slope crest. For active land use, the MNR Policy Guidelines allow a minimum Factor of Safety of 1.4 to 1.5 for slope stability and a Factor of Safety of 1.5 was used for this study.

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The computed minimum Factors of Safety for the sections analyzed was as low as 1.0 and the minimum Factors of Safety obtained for existing conditions in 10 of 52 section locations are considered inadequate and unacceptable for long-term planning purposes.

The stable slope was determined for each section considering soil type and available data. The soil type of each section is composed of assumed earth fill, surficial sand, silt and clay, and/or glacial till. For the slopes with a composition of native silt and clay or glacial till, a number of representative trial stabilized slope profiles were analysed to obtain the required factor of safety. The stable slope inclinations for each of the reaches analyzed are listed in Table 6.7, along with the primary soil type. Where the slope is earth fill and/or surficial sand, a value of 3H:1V was used. Additional information on slope height, inclination and existing Factor of Safety (FS) are provided in Appendix A.

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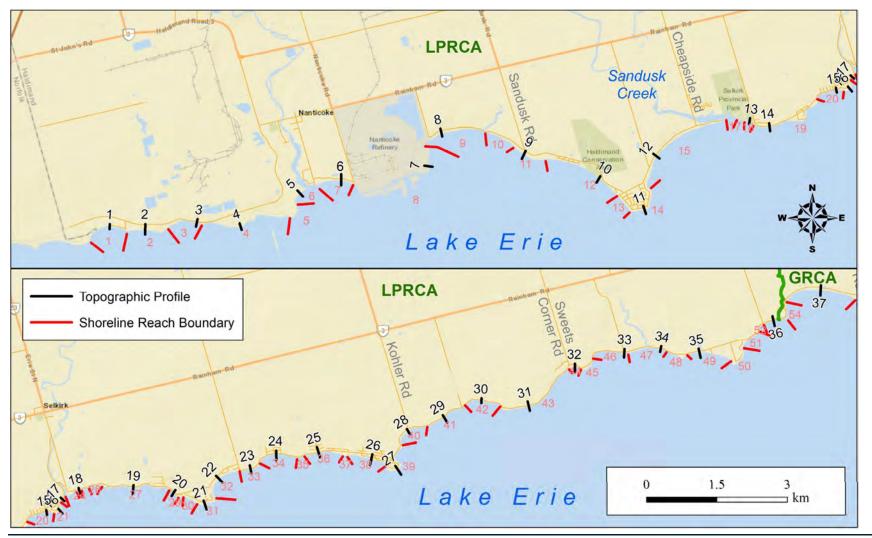


Figure 6.14: Map showing reaches and locations where a stable slope analysis was completed (west end of Haldimand County)

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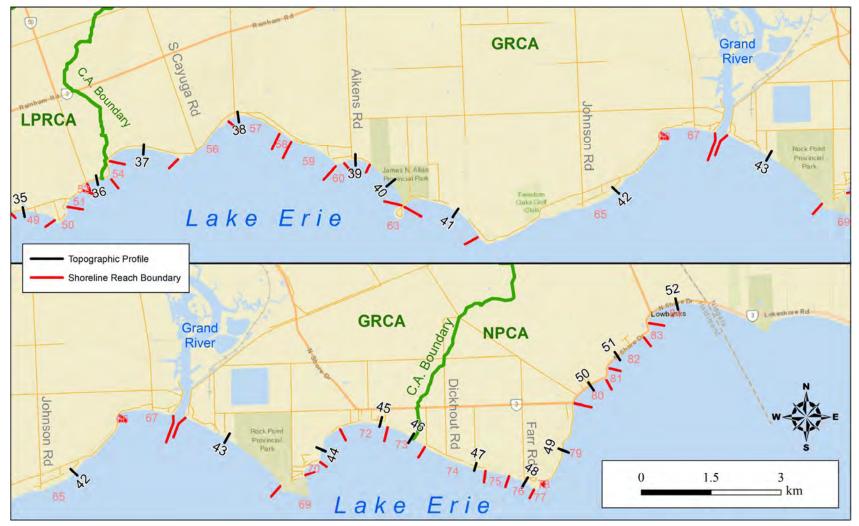


Figure 6.15: Map showing reaches and locations where a stable slope analysis was completed (east end of Haldimand County)

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| Reach | Section # | Primary Soil Type              | Stable Inclination |
|-------|-----------|--------------------------------|--------------------|
| 1     | 1         | glaciolacustrine silt and clay | 2.3H:1V            |
| 2     | 2         | glaciolacustrine silt and clay | 2.3H:1V            |
| 3     | 3         | glaciolacustrine silt and clay | 2.3H:1V            |
| 4     | 4         | glaciolacustrine silt and clay | 2.3H:1V            |
| 6     | 5         | glaciolacustrine silt and clay | 2.3H:1V            |
| 7     | 6         | glaciolacustrine silt and clay | 2.3H:1V            |
| 8     | 7         | earth fill                     | 3.0H:1V            |
| 9     | 8         | glaciolacustrine silt and clay | 2.3H:1V            |
| 11    | 9         | glaciolacustrine silt and clay | 2.3H:1V            |
| 12    | 10        | glaciolacustrine silt and clay | 2.3H:1V            |
| 14    | 11        | glaciolacustrine silt and clay | 2.3H:1V            |
| 15    | 12        | glaciolacustrine silt and clay | 2.3H:1V            |
| 18    | 13        | glaciolacustrine silt and clay | 2.3H:1V            |
| 19    | 14        | glaciolacustrine silt and clay | 2.3H:1V            |
| 20    | 15        | glaciolacustrine silt and clay | 2.3H:1V            |
| 21    | 16        | glaciolacustrine silt and clay | 2.3H:1V            |
| 22    | 17        | glaciolacustrine silt and clay | 2.3H:1V            |
| 24    | 18        | glaciolacustrine silt and clay | 2.3H:1V            |
|       | 10        | sand                           | 3.0H:1V            |
| 27    | 19        | glaciolacustrine silt and clay | 2.3H:1V            |
| 28    | 20        | glaciolacustrine silt and clay | 2.3H:1V            |
| 31    | 21        | glaciolacustrine silt and clay | 2.3H:1V            |
| 32    | 22        | glaciolacustrine silt and clay | 2.3H:1V            |
| 33    | 23        | glaciolacustrine silt and clay | 2.3H:1V            |
| 34    | 24        | glaciolacustrine silt and clay | 2.3H:1V            |
| 36    | 25        | glaciolacustrine silt and clay | 2.3H:1V            |
| 38    | 26        | glaciolacustrine silt and clay | 2.3H:1V            |
|       |           | sand                           | 3.0H:1V            |
| 39    | 27        | glaciolacustrine silt and clay | 2.3H:1V            |
| 40    | 28        | glaciolacustrine silt and clay | 2.3H:1V            |
| 41    | 29        | glaciolacustrine silt and clay | 2.3H:1V            |
| 42    | 30        | glaciolacustrine silt and clay | 2.3H:1V            |
| 43    | 31        | glaciolacustrine silt and clay | 2.3H:1V            |
| 44    | 32        | glaciolacustrine silt and clay | 2.3H:1V            |

#### Table 6.7: Stable slope inclinations for each of the cross sections based on the primary soil type

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| Reach | Section # | Primary Soil Type              | Stable Inclination |
|-------|-----------|--------------------------------|--------------------|
| 46    | 33        | glaciolacustrine silt and clay | 2.3H:1V            |
| 47    | 34        | glaciolacustrine silt and clay | 2.3H:1V            |
| 49    | 35        | sand                           | 3.0H:1V            |
| 53    | 36        | glaciolacustrine silt and clay | 2.3H:1V            |
| 55    | 37        | glaciolacustrine silt and clay | 2.3H:1V            |
| 57    | 38        | glacial till                   | 1.8H:1V            |
| 61    | 39        | glacial till                   | 1.8H:1V            |
| 62    | 40        | sand                           | 3.0H:1V            |
| 02    | 40        | glacial till                   | 1.8H:1V            |
| 64    | 41        | sand                           | 3.0H:1V            |
| 04    | 41        | glaciolacustrine silt and clay | 2.3H:1V            |
| CE.   | 65 42     | earth fill / unknown           | 3.0H:1V            |
| CO    | 42        | bedrock                        | 1.4H:1V            |
| 68    | 43        | sand                           | 3.0H:1V            |
| 00    | 43        | glaciolacustrine silt and clay | 2.3H:1V            |
| 71    | 44        | glacial till                   | 1.8H:1V            |
| 72    | 45        | glacial till                   | 1.8H:1V            |
| 73    | 46        | glacial till                   | 1.8H:1V            |
| 74    | 47        | glacial till                   | 1.8H:1V            |
| 76    | 48        | glacial till                   | 1.8H:1V            |
| 79    | 49        | sand                           | 3.0H:1V            |
| 19    | 49        | glacial till                   | 1.8H:1V            |
| 80    | 50        | sand                           | 3.0H:1V            |
| 82    | 51        | sand                           | 3.0H:1V            |
| 84    | 52        | sand                           | 3.0H:1V            |

#### 6.5 Average Annual Recession Rate (AARR)

The Average Annual Recession Rate (AARR) is used to delineate the Erosion Hazard, as defined in Section 4.3. The Technical Guide (MNR, 2001a) identifies the use of historic aerial photographs extending over long periods of time as a good indicator of future recession/erosion rates. Specifically, it is recommended that at least 35 years of sound recession information for the unprotected shoreline should exist to calculate an AARR.

The 2017 LiDAR data and the 2015 aerial imagery (described in Section 3.2) were used as a basis of comparison with historical imagery to estimate the AARR. The bank toe and crest lines were manually digitized in GIS, providing a good estimate of the existing bluff conditions upon which to estimate the future erosion setback. The elevation difference between the toe and crest was calculated at the representative profile in each reach to establish the bluff height.

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Historic aerial imagery for Haldimand County was obtained from sources including the National Air Photo Library, internal collections of the member Conservation Authorities, and various other government and university collections. These collections provided aerial photographs from dates including 1945, 1955, 1964, and 1973. When compared to the current 2015 aerial imagery, these aerial photos provide temporal change over periods ranging from 42 to 70 years.

The oldest historic aerial photographs would provide the longest temporal period to measure a more accurate long-term recession rate, but there are other factors to consider when selecting aerial photographs for shoreline change analysis including: photographic scale, lake water level, quality of the prints, time of year such that vegetation cover does not obscure ground features, type of photographic film (black and white, colour, near infrared), and other factors. Figure 6.16 is a map showing the selected historic aerial photographs reviewed for estimating the AARR. The oldest available photographs are from 1945 but were limited to the lands that became the Nanticoke Power Generation Station and the broader Lake Erie Industrial Park lands as far east as Peacock Point. The 1955 photographs were acquired in the summer months, so the tree canopy cover limited their use to the east end of the County where erosion was still observable on bluff faces. The 1964 photographs at the west end of the County. The 1973 photographs were acquired on May 19 and are infrared photographs providing a leaf-off view of the central shoreline where there is not a distinctive eroding high bluff.

For both the historic aerial photographs and the 2015/2017 dataset, a reference top of bank feature was digitized where the shoreline was unprotected and a change in top of bank location could be identified. The change in top of bank location was measured using a series of parallel transects at 10 metre spacing. Figure 6.17 is a map showing an example of these transects at unprotected shoreline stretches in Mohawk Bay. The transects used to estimate shoreline change are shown on the maps provided in Appendix B. The recession rate was determined based on the mean of the transect recessions in each reach plus one standard deviation (S.D.). The historic imagery date, temporal period of comparison, number of transects measured, average recession, standard deviation and AARR plus 1 S.D. are tabulated in Table 6.8, for the reaches where an AARR could be established. These values were used for mapping the Erosion Allowance as described in Section 7.1.2.





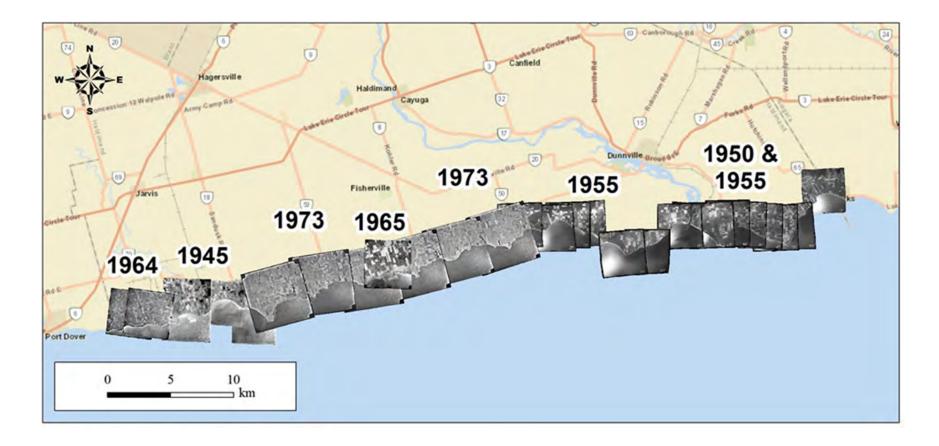


Figure 6.16: Map of selected historic aerial photographs used to estimate the AARR



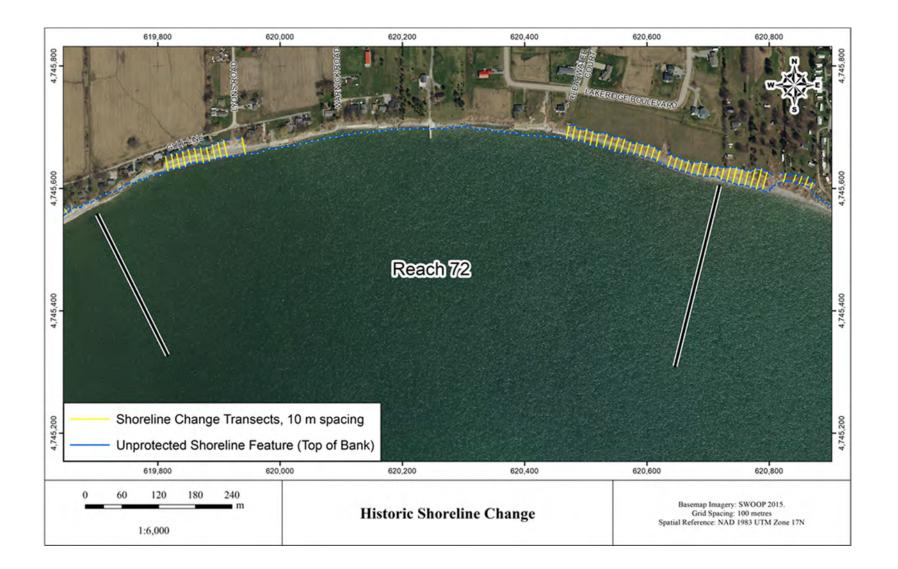


Figure 6.17: Example map of transects where change in top of bank location was measured at unprotected shoreline, to estimate the AARR

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| Reach | Historic<br>Year | Temporal<br>Period | Transect<br>Count | Average<br>Recession<br>(metres) | 1 S.D.<br>(metres) | Avgerage<br>+ 1 S.D.<br>(metres) | AARR + 1<br>S.D.<br>(metres/year) |
|-------|------------------|--------------------|-------------------|----------------------------------|--------------------|----------------------------------|-----------------------------------|
|       |                  |                    |                   |                                  |                    |                                  |                                   |
| 2     | 1964             | 51                 | 85                | 7.56                             | 5.11               | 12.67                            | 0.25                              |
| 6     | 1945             | 70                 | 35                | 17.32                            | 12.44              | 29.76                            | 0.43                              |
| 7     | 1945             | 70                 | 17                | 11.83                            | 4.14               | 15.96                            | 0.23                              |
| 9     | 1945             | 70                 | 55                | 4.28                             | 1.82               | 6.10                             | 0.09                              |
| 10    | 1945             | 70                 | 22                | 11.24                            | 3.91               | 15.14                            | 0.22                              |
| 11    | 1945             | 70                 | 22                | 4.33                             | 1.33               | 5.66                             | 0.08                              |
| 12    | 1945             | 70                 | 52                | 25.68                            | 5.19               | 30.87                            | 0.44                              |
| 15    | 1973             | 42                 | 32                | 17.35                            | 11.80              | 29.15                            | 0.69                              |
| 18    | 1973             | 42                 | 11                | 10.76                            | 1.18               | 11.94                            | 0.28                              |
| 32    | 1973             | 42                 | 18                | 7.21                             | 3.57               | 10.79                            | 0.26                              |
| 36    | 1973             | 42                 | 8                 | 2.37                             | 1.11               | 3.48                             | 0.08                              |
| 57    | 1955             | 60                 | 34                | 11.37                            | 1.21               | 12.59                            | 0.21                              |
| 58    | 1955             | 60                 | 8                 | 21.30                            | 1.87               | 23.17                            | 0.39                              |
| 59    | 1955             | 60                 | 20                | 15.74                            | 2.56               | 18.30                            | 0.30                              |
| 61    | 1955             | 60                 | 4                 | 18.92                            | 1.25               | 20.17                            | 0.34                              |
| 62    | 1955             | 60                 | 40                | 3.06                             | 1.80               | 4.85                             | 0.08                              |
| 64    | 1955             | 60                 | 32                | 19.40                            | 3.25               | 22.65                            | 0.38                              |
| 70    | 1955             | 60                 | 27                | 5.48                             | 2.81               | 8.28                             | 0.14                              |
| 71    | 1955             | 60                 | 72                | 14.96                            | 4.74               | 19.71                            | 0.33                              |
| 72    | 1955             | 60                 | 38                | 21.28                            | 2.92               | 24.21                            | 0.40                              |
| 73    | 1955             | 60                 | 71                | 24.14                            | 6.41               | 30.54                            | 0.51                              |
| 74    | 1955             | 60                 | 86                | 15.23                            | 5.44               | 20.66                            | 0.34                              |
| 75    | 1955             | 60                 | 14                | 10.85                            | 1.41               | 12.26                            | 0.20                              |

#### Table 6.8: Summary of calculated shoreline change and AARR for reaches where AARR was measured

#### 6.6 **Climate Change**

The Ontario Climate Consortium and Ontario Ministry of Natural Resources and Forestry published a climate change synthesis report for the Great Lakes basin in 2015 (McDermid et al., 2015). The report draws on over 70 scientific studies published since 2010 for the Great Lakes basin. The report outlines the anticipated climate change impacts, evidence, uncertainty, and agreement between studies in language that this accessible to the general public. Findings from the synthesis report will be referred to throughout this section as it reflects the current state of climate change science for the Great Lakes basin.

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## 6.6.1 Projected Climate Change Impacts

The impacts of climate change in the Great Lakes are uncertain and are likely to remain uncertain even as climate change science advances. The uncertainty is related to the complexity of the hydrological conditions in the Great Lakes basin including their long-term cyclic nature (precipitation, evapotranspiration, runoff, etc.), the difficulties in modelling the conditions, and predicting future green house gas levels which will depend on human actions and behaviours.

Future water levels will be most affected by changes in air temperature and precipitation. Over the past 60 years, average annual air temperatures have increased and are predicted to continue increasing. The increase in air temperature is expected to result in lower water levels due to increased evapotranspiration. The past 60 years have also been slightly wetter than the historical average and annual precipitation is predicted to increase over the next century. However, the increase in air temperature is predicted to be more significant than the increase in precipitation, resulting in overall drier conditions and lower lake levels (McDermid et al., 2015).

The natural variability in water supplies is likely more significant than the anticipated climate change impacts on water levels in the Great Lakes. Long-term (decadal) fluctuations in water supplies have been measured since 1860 and are believed to be driven by large-scale atmospheric and oceanic circulation patterns such as the Atlantic Multidecadal Oscillation (Hanrahan et al., 2014; Watras et al., 2014). These large-scale anomalies affect air temperature, moisture availability, and precipitation. The natural variation in monthly mean water levels is approximately 2 m for Lake Erie.

The terms, "confidence" and "uncertainty" are used extensively in climate change literature. In general, confidence relates to the amount, quality, and agreement of the evidence, and uncertainty relates to the magnitude of the unknowns. In McDermid et al. (2015) the various studies were reviewed by a cross-section of climate change researchers and information on each topic was evaluated and ranked as low, medium or high confidence based on the agreement among available studies; type, amount, and quality of the evidence; and limitations of the research.

Uncertainty in future projections is also related to the challenges of predicting future human behaviour related to future green house gas levels (scenario uncertainty), and model imperfection. Climate models use mathematical equations to represent complex processes between the atmosphere, earth surface, and human and natural systems. Model uncertainty is related to our understanding of those systems and the accuracy of the model results.

A summary of projected climate change impacts on factors affecting Lake Erie water levels are provided in Table 6.9. The various factors are discussed in detail in the following sections.

# Table 6.9: Projected impacts of climate change in the Great Lakes Basin (adapted from McDermid et al., 2015)

| Theme              | General Projections                                                                                                                                                                                | Trend    | Confidence                        |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------------------------------|
| Air<br>Temperature | <ul> <li>1.5 to 7 °C increase by the 2080s depending on climate scenario model used.</li> <li>Greater increases in the winter.</li> </ul>                                                          | Increase | High evidence<br>High agreement   |
| Precipitation      | <ul> <li>20% increase in annual precipitation across the Great<br/>Lakes Basin by 2080s under the highest emission<br/>scenario.</li> <li>Increases in rainfall, decreases in snowfall.</li> </ul> | Increase | High evidence<br>Medium agreement |

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| Theme                | General Projections                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Trend    | Confidence                          |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------------------------------|
|                      | <ul><li>Increased spring precipitation, decreased summer precipitation.</li><li>More frequent extreme rain events.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                              |          |                                     |
| Drought              | Increases in frequency and extent of drought.                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Increase | Low evidence<br>High agreement      |
| Wind                 | Increased wind gust events.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Increase | Low evidence<br>Low agreement       |
| Water<br>Temperature | <ul> <li>0.9 to 6.7 °C increase in surface water temperature by the 2080s.</li> <li>42-90 day increase in ice free season.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                     | Increase | High evidence<br>Low agreement      |
| Water<br>Levels      | <ul> <li>Water levels in the Great Lakes naturally fluctuate by up to 1.5m.</li> <li>Long-term water levels in the Great Lakes peaked in the 1980s and have been decreasing since.</li> <li>Projections of future lake water levels vary; however, they generally suggest fluctuations around lower mean water levels.</li> <li>Lower water levels are due to several factors including warmer air temperatures, increased evaporation and evapotranspiration, drought, and changes in precipitation patterns.</li> </ul> | Decrease | High evidence<br>Low agreement      |
| lce                  | <ul> <li>Projected decreases in ice cover duration, ice thickness, and ice extent.</li> <li>Increased mid-winter thaws, changing river ice dynamics.</li> </ul>                                                                                                                                                                                                                                                                                                                                                           | Decrease | Medium evidence<br>High agreement   |
| Flood                | Increases in flood severity and frequency.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Increase | Medium evidence<br>Medium agreement |

#### Air Temperature

There is high confidence that air temperatures in the Great Lakes basin have risen in the past 60 years and will continue to rise in the future. Average annual air temperatures have risen by up to 2°C and are predicted to continue to rise regardless of the emissions scenario (Lofgren et al., 2002; Hayhoe et al., 2010; McKenney et al., 2011). The largest temperature increases have occurred and are projected to occur in the winter and spring (McKenney et al. 2011), resulting in more winter rainfall (less snowfall), less ice cover (more evaporation), and also affecting the timing of the spring freshet. Higher air temperatures in the summer and fall are projected to result in increased evaporation and plant transpiration (collectively evapotranspiration).

#### Precipitation

There is medium to high confidence that the Great Lakes basin is in a period of slightly wetter weather. Future projections indicate that annual precipitation will increase by up to 20% across the Great Lakes basin (Lofgren et al., 2002; McKenney et al., 2011).

Rising air temperatures are expected to result in a higher percentage of precipitation falling as rain, and less as snow. Snowfall losses of up to 48% are projected for the Great Lakes basin by the end of the century (Notaro et al., 2014). The projected increase in winter rainfall and decline in snowpack is expected to affect the timing and magnitude of the spring freshet.

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Rainfall amounts are projected to increase in the spring and decline in the summer (Kling et al., 2003; Hayhoe et al., 2010). The resulting shifts in the timing of precipitation and snowmelt could present challenges for lake regulation, though this is less relevant for Lake Erie.

Heavy rainfalls are twice as frequent as a century ago and are projected to become more frequent in the future (Changnon and Kunkel, 2006; Kling et al., 2003). Heavy rainfalls are more of a concern for flood-prone urban and riverine areas.

#### Drought

There is moderate confidence that the Great Lakes basin has been and will become more vulnerable to drought (Bonsal et al., 2011). Air temperature and evapotranspiration are projected to increase in the summer while precipitation is predicted to decline.

#### Wind/Storminess

There is low confidence in projections of future wind speeds and wind patterns. It is believed that warmer air and water temperatures in the Great Lakes may increase atmospheric turbulence, resulting in higher wind speeds in the lower atmosphere (Austin and Colman, 2007; Desai et al., 2009; Huff et al., 2014). However, other studies such as Yao et al. (2012), project a decrease in wind speeds in the Great Lakes Basin by the year 2100. Cheng et al. (2012) projected that wind gusts will become at least 10% more frequent by the end of the century.

#### Water Temperature

There is moderate confidence that surface water temperatures in the Great Lakes basin have risen in the past century and will continue to rise in the future. The high evidence and low agreement for this topic indicates that there is considerable variability between studies. The increase in water temperature is projected to result in less ice cover (duration and extent), resulting in increased evaporation from the lake surface.

#### Water Levels

McDermid et al. (2015) reports moderate confidence that water levels in the Great Lakes peaked in the 1980s, declined, and will continue to decline in the future. This seems to ignore longer term variations in water levels prior to 1980, and water levels reached record highs on Lake Erie in 2019. Masking climate change impacts are the much larger natural (decadal) cycles of high and low water supplies.

Projections indicate that future mean water levels will be similar or slightly lower due to higher evapotranspiration rates, and changes in precipitation patterns (Mortsch et al., 2003; Hayhoe et al., 2010; Lofgren et al., 2002; McKenney et al., 2011; Angel and Kunkel, 2010; MacKay and Seglenieks, 2013). Some earlier studies, which predicted more severe water level declines, are believed to have overestimated evapotranspiration rates (Lofgren et al., 2011). Emerging research using an energy balance approach to evapotranspiration suggest that declines, and possibly increases, in water levels will be modest.

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There is moderate to high confidence that ice cover in the Great Lakes is decreasing and that mid-winter thaws are becoming more frequent. A decrease in the duration and extent of the ice cover will result in increased evaporation from the lake surface. The greatest evaporation losses on the Great Lakes occur in the fall and winter when cold, dry air blows over the warmer lakes (Mortsch et al., 2003). Mid-winter thaws may pose challenges for river ice management.

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The extent of ice cover on the Great Lakes decreased 71% between 1973 and 2010 (Wang et al., 2012) and the ice cover period decreased by 1 to 2 months over the past century (McDermid et al., 2015). Ice protects the shoreline and prevents erosion during winter storms. Therefore, a reduction in the ice-in period will render shorelines more susceptible to extreme storm events (Mortsch et al. 2003). Baird (2019) describes wave modeling undertaken on Lake Erie to examine the impact of future ice regimes on wave climatology. It was found that wave energy along the Chatham-Kent shoreline at the west end of Lake Erie would increase by 150% to 200% if lake ice disappears in the future.

#### Flood

There is medium confidence that summer floods will become more frequent and more severe and that spring floods will become less severe in the Great Lakes basin. Spring runoff is projected to decline due to the predicted decrease in snowfall (Notaro et al., 2014; Shaw and Riha, 2011). However, extreme rainfall events are projected to become more frequent in the future. These changes are likely to result in less frequent riverine flooding (smaller freshets), and more frequent urban (pluvial) flooding.

## 6.6.2 Summary

The latest climate change research related to precipitation, evaporation, snow and ice cover, and storminess in the Great Lakes basin was reviewed to assess potential future changes to static water levels, storm surge, waves and sediment processes in the study area.

Over the past 60 years, the Great Lakes basin has become warmer and has been slightly wetter (than the long-term average). Air temperature and precipitation are projected to increase in the future, with water levels in the Great Lakes remaining similar or slightly decreasing (McDermid et al., 2015). The uncertainty in water level projections is related to the relative roles of evapotranspiration and precipitation. It is likely that the impacts of climate change on static water levels will be less than the natural variability of Lake Erie.

Snowfall and ice cover in the Great Lakes-St. Lawrence River basin are projected to decrease resulting in an earlier and smaller spring freshet (Kling et al., 2003) and increased evaporation from the lake surface in the winter. In addition, predicted reduced ice cover will result in increased wave energy, which in turn would result in higher erosion rates and sediment transport rates. Increased exposure to surge could also be expected as a result on reduced ice cover.

Wind gusts, although expected to increase slightly over the next century, are anticipated to have a lesser impact on storm surge and waves.



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# 7. Mapping

# 7.1 Hazard Mapping

The 2015 SWOOP imagery was used to prepare the base maps for the hazard mapping. The flood, erosion and dynamic beach hazard limits were mapped as described below.

# 7.1.1 Flooding Hazard Mapping

The Flood Hazard Limit is the 100-year flood level plus an allowance for wave uprush as defined in MNR (2001a) and described in Section 4.2.

The 100-year flood level was established based on analyses described in Section 6.1. The 100-year flood levels were defined for each reach using a linear interpolation between the 100-year flood levels at Port Dover and Port Colborne adjusted to CGVD2013 datum. The flood levels were rounded to the nearest 0.1 m increment, with breaks occasionally adjusted to coincide with headland features. For example, the 100-year flood level transitions from 176.0 m to 176.1 m CGVD2013 at Hoover Point (Reaches 28/29) rather than at Reaches 34/35 (where the 100-year flood level transitions from 176.04 to 176.05 m). Shifting the 100-year flood level breaks to the headlands is supported by the understanding of the natural storm surge processes. The location of the 100-year flood level was mapped using the 2015 and 2017 elevation datasets, which are of sufficient scale and accuracy to locate the flood elevation.

The horizontal wave uprush allowance includes both the wave runup on the shoreline slope and the inland extent of overtopping waves. Wave uprush was established based on the analyses described in Section 6.2. The mapped wave uprush is based on the calculated horizontal extent of wave uprush measured from the 100-year flood level, except in cases where it was clear that wave uprush would not exceed the top of bluff elevation. In these cases, the wave uprush allowance was plotted at the calculated uprush elevation, on the bluff slope.

The average calculated horizontal wave uprush was 14.6 m for the 84 profiles, with a minimum value of 5 m and maximum value of 33 m. All values less than 15 m were mapped as 15 m due to possible variability in wave exposure, nearshore slope, water depth at the toe, and bluff height within a reach. Approximately 40% of the reaches have a wave uprush allowance greater than 15 m.

The 100-year flood level and allowance for wave uprush values used to map the Flooding Hazard are listed on a reach basis in Appendix C. While the vertical uprush elevation is listed in the table, this value should not be used to establish floodproofing elevations. Floodproofing is discussed further in Section 8.1 and in MNR (2001a, Appendix A7.1).

## 7.1.2 Erosion Hazard Mapping

The Erosion Hazard Limit is the stable slope allowance plus the erosion allowance as defined in MNR (2001a) and described in Section 4.3.

The stable slope allowance was defined on a reach basis, using a geotechnical study, as summarized in Section 6.4 and described in detail in Appendix A. For those reaches where a stable slope was not defined by a geotechnical study, a stable slope of 3H:1V was assumed, consistent with MNR (2001a). The stable slope allowance was calculated by multiplying the stable slope inclination by a representative bluff height within the reach. The stable slope allowance was measured inland from the delineated toe of bluff and mapped. Where the stable slope allowance plotted lakeward of the existing top of bluff, an adjustment was made, and the

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stable slope allowance was moved inland to the top of bluff. The stable slope allowance values used in the mapping are listed in Appendix C.

Where erosion could be measured using the historical shoreline comparison, the erosion allowance was calculated from the values presented in Section 6.5. The AARR + 1 S.D. was multiplied by 100, representing the 100-year planning horizon as specified in MNR (2001a). The erosion allowance was measured inshore from the stable slope allowance and mapped. Where erosion was not measured, due to the presence of shore protection along the reach or difficulty in delineating a bluff crest, an erosion allowance of 30 m was assumed, consistent with MNR (2001a). An erosion allowance of 40 m was applied at Reaches 78 and 79, located towards the east end of Haldimand County, because this value was reported in the Shoreline Management Plan update (Shoreplan, 2010), and there was no justification for reducing it to a less conservative value of 30 m.

There are a number of bedrock headlands along the Haldimand shoreline, where no measurable change in shoreline position was identified. At these locations, there is not a well defined top of bluff, however shoreline recession rates are low due to the geological characteristics. A 10 m erosion allowance was used at bedrock headlands. An abrupt change in recession rates can be expected where the shoreline changes from a bedrock headland to a cohesive bluff. An example of this occurs at Peacock Point; erosion rates increase east of Peacock Point. There are limited stretches of shoreline where erosion rates could be measured east of Peacock Point because the shoreline is largely protected. Shore protection is generally indicative of an eroding shoreline.

The erosion allowance was measured inland from the stable slope allowance and mapped. The erosion allowance values used in the mapping are listed in Appendix C.

At reach boundaries, the Erosion Hazard Limit changes from one reach to the next and no transition was applied. This may result in a discontinuity at reach boundaries.

## 7.1.3 Dynamic Beach Hazard Mapping

The Dynamic Beach Hazard Limit is the landward limit of the flooding hazard (100-year flood level plus a flood allowance for wave uprush and other water related hazards), plus a 30 m dynamic beach allowance or a distance determined by an accepted coastal study as defined in MNR (2001a) and described in Section 4.4.

The dynamic beach was mapped as described above.

#### 7.1.4 Establishing Hazard Limits Onsite

It is understood that the hazard limits will be measured onsite, in response to site specific development applications. While the mapping provides a visual representation of the hazard limits on a reach basis, a more accurate assessment should be determined onsite using information provided in this report. For example, a representative bluff height was used to establish the stable slope allowance within a given reach, however bluff height can vary to some degree along the reach and adjustments may be required. In addition, where shorelines are eroding, the hazard limit will need to be adjusted inland in response to erosion occurring after the date of the data used for mapping.

## 7.2 Flood Depth Mapping for Flood Preparedness

Mapping was developed to identify areas that would be rendered inaccessible to people and vehicles due to water depth and wave uprush conditions during the 100-year flood. Roads located within the Flooding Hazard (100-year flood level plus an allowance for wave uprush) were identified. Water depths on the roads were then mapped at 0.3 m intervals for the 100-year flood level. Roads located in the wave uprush zone are also

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indicated on the maps. Roads in the wave uprush zone will be exposed to moving water. Velocities within the wave uprush zone vary temporally and spatially and cannot be readily defined as is typically done for river flooding.

The mapping is presented in Appendix D. The mapping informs the National Disaster Mitigation Program, Risk Assessment Information Template (NDMP-RAIT) that was updated for this study and is provided under separate cover.

### 7.2.1 Vehicular Access/Egress

Ingress and egress from an area by the most "typical" automobiles will be halted by flood depths above 0.3 to 0.4 m (MNR, 2002). This is generally consistent with MNR (2001a), which references a depth limit of 0.3 - 0.5 m. This is the typical depth of key electrical components, which fail when submerged, preventing vehicle egress. A maximum flood velocity of 4.5 m/s would be permissible providing that flood depths are less than 0.3 m.

In Haldimand County, emergency responders make decisions about vehicle access on a case by case basis. In general, emergency vehicles will not access a road where flooding exceeds 0.3 m, the lines on the road are not visible, or the road is exposed to wave uprush.

#### 7.2.2 Pedestrian Access/Egress

MNR (2002) provides technical considerations for pedestrian access/egress during flooding. This document pertains to river and stream systems flooding but it is also relevant for Lake Erie flooding. Hazard to life is linked to the depth of the flood waters and the velocity of flow. A product of depth and velocity less than or equal to 0.4 m<sup>2</sup>/s defines a low risk hazard, providing that the depth does not exceed 0.8 m and velocity does not exceed 1.7 m/s (MNR, 2001a).

For stagnant backwater areas (i.e., zero flow velocity), depths in excess of about 1 m are sufficient to float young children, and depths above 1.4 m are sufficient to float teenage children and many adults. Even shallower depths can pose a risk. In shallow areas, velocities in excess of about 1.8 m/s pose a threat to the stability of many individuals (MNR, 2001a). In areas exposed to wave uprush, the combination of flood depth and velocities may be sufficient to pose danger to pedestrians. In areas subject to direct wave action, the maximum depth of flooding to define a low risk hazard is 0.25 m.



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# 8. Recommendations for Flooding and Erosion Prevention and Protection

This section provides general recommendations for flooding and erosion prevention and protection. Consultation with a coastal engineer is recommended as conditions will vary from reach to reach, and within a shoreline reach. The reader is referred to the Technical Guide for Great Lakes – St. Lawrence River System (MNR, 2001a) for further information. A permit from the Conservation Authority is required for any work undertaken within the Regulation Limit and other permits may also be required.

Shoreline management approaches can be classified as prevention or protection. Prevention is normally achieved through planning of land use and the regulation of development within the hazard limits. Prevention approaches are generally considered the most environmentally sound and cost-effective means of ensuring that buildings and structures are not susceptible to hazards. Protection approaches involve engineered methods for protecting development located within hazard susceptible shoreline areas. Where protection works are constructed, they are to be combined with an appropriate hazard allowance.

Prevention is generally considered to be the preferred approach. However, it is recognized that prevention is not always practicable, particularly for existing development. This section provides an overview of the floodproofing and protection works standards as they can be applied along the Lake Erie shoreline of Haldimand County.

# 8.1 Floodproofing Standard

Floodproofing is generally defined as a combination of structural changes and/or adjustments incorporated into the basic design and/or construction or alteration of individual buildings, structures or properties subject to flooding hazards so as to reduce the risk of flood damages, including wave uprush and other water related hazards. Floodproofing and flood protection works can only reduce the risk and/or lessen the damage to properties. No measure will prevent all damages due to flooding. Where it has been determined that development and site alteration could possibly be located within the less hazardous portion of the flooding hazard, the floodproofing standard should be applied. The minimum floodproofing standard is as follows: development and site alteration is to be protected from flooding, as a minimum, to an elevation equal to the sum of the 100-year static water level plus the 100-year surge plus a vertical flood allowance for wave uprush and other water related hazards. The 100-year static water level plus the 100-year surge is listed by reach in Appendix C. It is recommended that a minimum freeboard of 0.3 m be added to these elevations as a factor of safety to compensate for factors that may increase flood heights and uncertainties inherent in determining flood frequencies and flood elevations (ASCE/SEI, 2014). The vertical flood allowance for wave uprush varies with shoreline conditions and is determined on a site specific basis. Some example wave uprush values for selected shoreline conditions are listed in Appendix C. The flood proofing elevation should be determined by a Professional Engineer with experience in flood proofing.

Floodproofing measures that could be incorporated into the design of new buildings and retrofit of existing buildings is described in Part 7 of the Technical Guide (OMNR, 2001). Examples include elevating buildings on posts, piers, walls, pilings or engineered fill; elevating electrical equipment and utilities above the expected flood levels; using watertight closures for doors and windows; and using flood resistant materials. The guide describes "dry floodproofing" as measures that prevent the entry of floodwater into a building, and "wet floodproofing" as measures that minimize the impact of flooding. Dry floodproofing is usually accomplished by elevating the building above the floodproofing standard elevation, and is the most desirable measure for residential buildings. It may not be feasible or desirable to elevate certain non-residential buildings (e.g. garages, boathouses, sheds, warehouses, etc.) above the floodproofing standard elevation. Wet floodproofing

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measures such as the use of flood resistant building materials and elevating contents and utilities can lessen the impact of flooding and improve the clean up and recovery time for non-residential buildings.

Table 8.1 identifies the buildings that are most vulnerable to flooding from Lake Erie. The building location and other information can be obtained from the building inventory geodatabase using the unique Building ID (provided under separate cover in the RAIT deliverable). The minimum ground elevation along the perimeter of the building and the estimated first floor elevation is provided in the table. The first floor elevation is estimated to be 0.2 m above ground for commercial and institutional buildings, and 0.7 m above ground for residential buildings.

| Building<br>ID | Building Use | Reach     | Minimum Ground<br>Elevation<br>(m CGVD2013) | Estimated First Floor<br>Elevation<br>(m CGVD2013) |
|----------------|--------------|-----------|---------------------------------------------|----------------------------------------------------|
| 541            | residential  | 21        | 173.16                                      | 173.86                                             |
| 1116           | commercial   | 8         | 173.33                                      | 173.53                                             |
| 623            | commercial   | 8         | 173.50                                      | 173.70                                             |
| 1114           | commercial   | 8         | 173.51                                      | 173.71                                             |
| 2064           | commercial   | Dunnville | 173.73                                      | 173.93                                             |
| 517            | commercial   | 6         | 173.74                                      | 173.94                                             |
| 993            | residential  | 6         | 173.74                                      | 174.44                                             |
| 425            | residential  | Dunnville | 174.01                                      | 174.71                                             |
| 514            | residential  | 6         | 174.05                                      | 174.75                                             |
| 463            | commercial   | Dunnville | 174.07                                      | 174.27                                             |
| 496            | residential  | 16        | 174.29                                      | 174.99                                             |
| 498            | residential  | Dunnville | 174.32                                      | 175.02                                             |
| 453            | residential  | Dunnville | 174.33                                      | 175.03                                             |
| 499            | residential  | Dunnville | 174.35                                      | 175.05                                             |
| 973            | residential  | 39        | 174.35                                      | 175.05                                             |
| 1189           | residential  | 41        | 174.42                                      | 175.12                                             |
| 2598           | residential  | Dunnville | 174.45                                      | 175.15                                             |
| 525            | commercial   | 6         | 174.48                                      | 174.68                                             |
| 129            | residential  | 16        | 174.50                                      | 175.20                                             |
| 136            | residential  | 16        | 174.50                                      | 175.20                                             |
| 444            | residential  | Dunnville | 174.53                                      | 175.23                                             |
| 2503           | residential  | Dunnville | 174.57                                      | 175.27                                             |
| 422            | residential  | Dunnville | 174.58                                      | 175.28                                             |
| 1026           | residential  | Dunnville | 174.59                                      | 175.29                                             |
| 1039           | residential  | 42        | 174.59                                      | 175.29                                             |
| 1025           | residential  | Dunnville | 174.63                                      | 175.33                                             |
| 1283           | residential  | 64        | 174.63                                      | 175.33                                             |
| 429            | residential  | Dunnville | 174.65                                      | 175.35                                             |
| 519            | residential  | 6         | 174.67                                      | 175.37                                             |
| 2736           | residential  | Dunnville | 174.67                                      | 175.37                                             |
| 1281           | residential  | 64        | 174.69                                      | 175.39                                             |
| 1289           | residential  | 64        | 174.69                                      | 175.39                                             |
| 415            | residential  | Dunnville | 174.71                                      | 175.41                                             |
| 447            | residential  | Dunnville | 174.71                                      | 175.41                                             |

#### Table 8.1: List of buildings most vulnerable to flooding

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| Building<br>ID | Building Use | Reach     | Minimum Ground<br>Elevation<br>(m CGVD2013) | Estimated First Floor<br>Elevation<br>(m CGVD2013) |
|----------------|--------------|-----------|---------------------------------------------|----------------------------------------------------|
| 524            | commercial   | 6         | 174.72                                      | 174.92                                             |
| 1280           | residential  | 64        | 174.73                                      | 175.43                                             |
| 2499           | residential  | Dunnville | 174.73                                      | 175.43                                             |
| 984            | residential  | 57        | 174.73                                      | 175.43                                             |
| 2730           | residential  | Dunnville | 174.74                                      | 175.44                                             |
| 1198           | residential  | 42        | 174.76                                      | 175.46                                             |
| 991            | residential  | 30        | 174.76                                      | 175.46                                             |
| 2585           | residential  | Dunnville | 174.77                                      | 175.47                                             |
| 1500           | residential  | 64        | 174.79                                      | 175.49                                             |

## 8.2 Protection Works Standard

By definition (PPS, Section 6.0 Definitions), protection works standards "means the combination of nonstructural or structural works and allowances for slope stability and flooding/erosion to reduce the damages caused by flooding hazards, erosion hazards and other water-related hazards, and to allow access for their maintenance and repair" (PPS 2014). The Technical Guide (MNR 2001a), developed in support of the PPS, outlines specific guidelines for the protection works standard including protection works, the stable slope allowance and the erosion hazard allowance.

The three key elements of the protection works standard are described in the Technical Guide (MNR 2001a) as follows:

- Protection works should be of sound, durable construction and be designed by a qualified coastal engineer according to accepted practice;
- Protection works should be used in conjunction with appropriate stable slope and hazard allowances; and
- There must be access to the protection works for suitable equipment for future rehabilitation, replacement or repairs.

## 8.3 Shore Protection

This section describes some alternative shore protection measures that may be considered along the Haldimand County shoreline. Shore protection should be designed on a site specific basis by a coastal engineer. Permits are required for the construction of shore protection including an assessment to confirm there will be no negative impacts on adjacent properties.

#### 8.3.1 Armourstone Revetment

Armourstone revetments are sloped shore parallel structures with a protective layer of large "armour" stones that are built to prevent the direct attack of waves on the toe of a bluff (see Figure 8.1). These structures rely on the mass of the armour stones to withstand the forces of the waves. As waves impact the structure, energy is dissipated as the water moves over the rough, permeable sloped face of the structure, and through the voids between the armour stones. The land behind the structure is thus protected from the erosional stress that results from wave attack.

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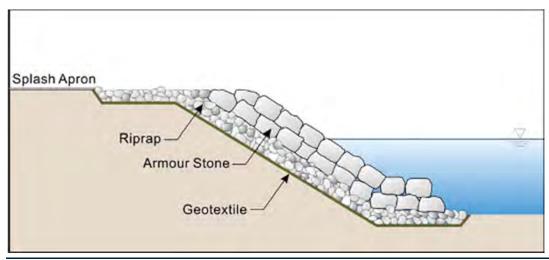


Figure 8.1: Schematic showing typical armourstone revetment section

Armour stone revetments have advantages over many other forms of shore protection, because they are flexible, can accommodate some settlement and do not generally fail catastrophically. The use of larger armour stones and/or a higher crest elevation will provide a stable structure which protects the backshore under more severe conditions. This type of structure can be designed to accommodate the ongoing erosion of the lakebed, thus providing long term protection to the backshore.

Revetments, like any other shore protection structure, have a number of disadvantages that make them inappropriate for some conditions. Revetments may severely limit access to the beach and water, and do not increase the amount of recreational space. Beach or water access must often be provided by staircases or ramps located intermittently along the shoreline. Access along the beach may also be obstructed. Another disadvantage of revetments is that the structure does not encourage beach development, and may in fact increase scour in front of the structure as a result of wave reflection at the structure. If the lakebed erodes, higher waves may be able to reach the structure, further eroding the bottom and possibly undermining the structure. Flanking can be an issue at the termination of the structure, particularly if the adjacent property is not protected and is eroding at a high rate.

Key design features for the armour stone revetment include: sound, good quality, durable armour stone with sufficient size to resist wave action and ice; sufficient crest elevation to protect against wave overtopping; riprap underlayer; and geotextile filter to prevent loss of backfill. The armour stone size is dependent on the wave height, the inclination of the revetment slope and placement (i.e., degree of "interlocking"). Typically, the individual armour stones in an armour stone have a mass of 3 to 5 tonnes for a single layer of armour; slightly smaller stones could be used with flatter slopes or double layers. A qualified coastal engineer should design the revetment. A double layer of armour provides more "reserve capacity" (i.e., damage to a double layer armour revetment is more progressive than damage to a single layer).

## 8.3.2 Seawalls

Seawalls are vertical, sloped, curved or stepped shore parallel walls that function in a very similar manner to a revetment (see Figure 8.2). They are typically made of steel sheet piles or concrete (pre-cast or cast-in-place) and are placed to protect the toe of a bluff from wave attack.

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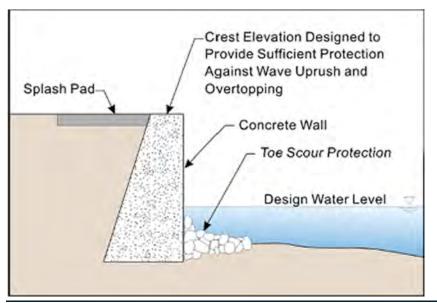


Figure 8.2: Schematic showing concrete seawall section

Some property owners consider seawalls to be more aesthetically pleasing than revetments for a number of reasons. Seawalls allow people to be closer to the water and/or beach than an armour stone revetment. It is also easier to incorporate stairs or ramps for access to the water. Seawalls also require less width than a revetment, possibly making construction feasible in some areas with a steep backshore where a sloped structure might require large amounts of earth moving.

However, seawalls are rigid structures and do not accommodate settlement. In addition, seawalls, due to their steep (often vertical), impermeable and generally smooth face, cause more wave reflection, resulting in increased scour and the risk of undermining at the toe of the structure. Because of this, seawalls may fail catastrophically if not designed correctly. Seawalls also require higher crest elevations than revetments to provide a similar level of protection against wave overtopping.

# 8.4 Critical Warning Levels

Being aware of risks is an important part of flood preparedness. Haldimand County and the Conservation Authorities provide information to the public, including critical warning levels for flooding. Communities along Lake Erie are susceptible to flooding due to storm surge, which can be exacerbated by high water levels. Water levels along the shoreline can change in a matter of hours and areas can become flooded. The situation can be further exacerbated by wave action. During flooding events, there is a heightened risk of shoreline flooding, beach submersion, crawl space and septic system inundation and wave-driven erosion along some reaches of Lake Erie.

The Conservation Authorities monitor water levels and flood warnings posted on the Ontario Ministry of Natural Resources and Forestry (OMNRF) Surface water Monitoring Centre's web site <a href="https://www.ontario.ca/law-and-safety/flood-forecasting-and-warning-program#section-3">https://www.ontario.ca/law-and-safety/flood-forecasting-and-warning-program#section-3</a>. Data published on this site is based on the Great Lakes Storm Surge Operational System (GLSSOS) developed for OMNRF. The system uses real time water level and meteorological data and the Danish Hydraulics Institute MIKE21 model to provide 48 hour forecasts with time series plots of water level, wave height, mean wave direction and peak wave period at selected locations on the Great Lakes. The locations nearest to Haldimand County are Port Colborne and Long Point.

LPRCA, GRCA and NPCA issue flood warnings based on the five stages shown in Figure 8.3. The figure also shows the probability of the water levels associated with the stages. Flood levels at the east end of the County

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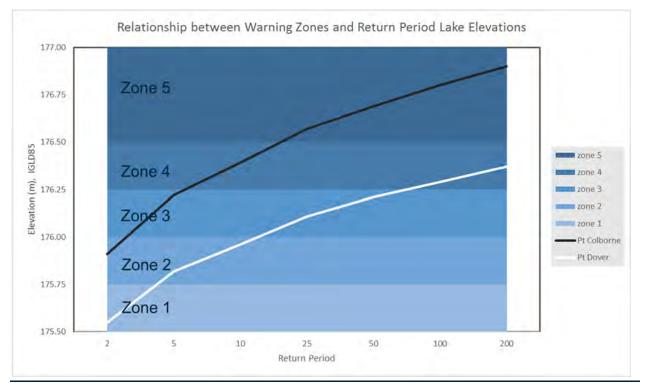


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are higher than at the west end of the County. For example, the 100-year return period flood level corresponds to a Stage 4 flood level at the west end of Haldimand County (Port Dover) and a Stage 5 flood level at the east end (Port Colborne).

A meeting was held with emergency responders from the County on January 21, 2020 to discuss issues related to emergency response and updates the National Disaster Mitigation Program Risk Assessment Information Template (NDMP RAIT) completed for this project. Based on that meeting, it is our recommendation that the current flood warning stages be maintained. The flood warnings are well understood by emergency responders and the correlation with probabilities of exceedance shown in Figure 8.3 provides additional context.

The CAs issue flood warning messages based on the data provided by the MNRF. Haldimand County issues flood messages on Twitter and Facebook. Emergency information is also broadcast on 92.9 the Grand FM, Haldimand County's official emergency information broadcast partner.





## 8.5 Emergency Access/Egress

The Technical Guide (MNR, 2001a) discusses access/egress with respect to development located within the flooding hazard and development that may be isolated from access/egress during flooding events. It is not desirable to have development isolated during the flood conditions because roads and escape routes are not passable. Flooding characteristics that must be considered when evaluating ingress/egress include:

- Depth of expected flooding and, in shoreline areas, height of wave crests.
- Velocity of flood waters and waves.
- Frequency of flooding, which is the amount of time between occurrences of damaging floods.
- Duration of flooding, which affects the length of time access/egress may be impacted.

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- Rate of rise, which indicates how rapidly water depth increases during flooding. This determines warning time before a flood, which will influence the need for access routes (ingress/egress) to be elevated above floodwaters.
- Ice and debris, which can block access/egress, and may damage roads and bridges. •

Mapping for flood preparedness is discussed in Section 7.2 and specific locations are identified, where access/egress may be disrupted during flooding events. Additional information on access/egress and emergency access planning is provided in the National Disaster Mitigation Plan, Risk Assessment Information Template (NDMP RAIT), prepared for Haldimand County for this project, and provided under separate cover. Mapping developed for the NDMP RAIT, showing flood depths during the 100-year return period event is provided in Appendix E for those reaches where roads and buildings are flooded. The mapping shows that 31 km of road is flooded during this event, including roads in the wave uprush zone. Table 8.2 identifies roads that are vulnerable to flooding from Lake Erie, the lowest elevation along the centreline of the road, and the corresponding Warning Zone used by the County and Conservation Authorities.

| Road Name                       | Reach     | Elevation<br>(m CGVD2013) | Elevation<br>(m IGLD1985) | Warning Zone |
|---------------------------------|-----------|---------------------------|---------------------------|--------------|
| East Lakeshore Road             | 22        | 174.1                     | 174.6                     | 0            |
| White Cap Lane                  | 48        | 174.5                     | 175.0                     | 0            |
| The Esplanade                   | 67        | 174.6                     | 175.0                     | 0            |
| Seagull Lane                    | 38        | 174.6                     | 175.1                     | 0            |
| Sandy Bay Road                  | 64        | 174.8                     | 175.2                     | 0            |
| Erie Street                     | 7         | 174.9                     | 175.4                     | 0            |
| Erie Avenue                     | 7         | 174.9                     | 175.4                     | 0            |
| Port Maitland Road              | 67        | 174.9                     | 175.4                     | 0            |
| Paradise Line                   | 64        | 174.9                     | 175.4                     | 0            |
| Myrnam Beach Road               | 64        | 174.9                     | 175.4                     | 0            |
| Feeder Canal Road               | 67        | 175.0                     | 175.4                     | 0            |
| Briar Line                      | 64        | 175.0                     | 175.5                     | 1            |
| Baygrove Line                   | 64        | 175.0                     | 175.5                     | 1            |
| Beckly Line                     | 67        | 175.0                     | 175.5                     | 1            |
| Lakeshore Road                  | 48        | 175.1                     | 175.6                     | 1            |
| Reicheld Road                   | 42        | 175.1                     | 175.6                     | 1            |
| Baygrove Line                   | 64        | 175.2                     | 175.7                     | 1            |
| Hydro Street                    | Dunnville | 175.2                     | 175.7                     | 1            |
| Lakeshore Road                  | 48        | 175.3                     | 175.7                     | 1            |
| Siddall Line                    | 67        | 175.3                     | 175.8                     | 2            |
| Central Lane                    | Dunnville | 175.3                     | 175.8                     | 2            |
| Blue Water Pkwy                 | 22        | 175.3                     | 175.8                     | 2            |
| Swallow Lane                    | 38        | 175.3                     | 175.8                     | 2            |
| Winger Bay Lane                 | 38        | 175.4                     | 175.8                     | 2            |
| Birch Lane                      | 38        | 175.4                     | 175.9                     | 2            |
| Lakeshore Road                  | 38        | 175.5                     | 175.9                     | 2            |
| Siddall Road                    | 67        | 175.5                     | 176.0                     | 3            |
| Heather Lane                    | 38        | 175.5                     | 176.0                     | 3            |
| Lakeshore Road (at Kohler Road) | 38        | 175.6                     | 176.0                     | 3            |

#### Table 8.2: List of roads most vulnerable to flooding

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| Road Name         | Reach     | Elevation<br>(m CGVD2013) | Elevation<br>(m IGLD1985) | Warning Zone |
|-------------------|-----------|---------------------------|---------------------------|--------------|
| Evan's Point Lane | 48        | 175.6                     | 176.0                     | 3            |
| Brant Street      | Dunnville | 175.6                     | 176.1                     | 3            |
| Brace Street      | Dunnville | 175.6                     | 176.1                     | 3            |
| Niagara Street    | Dunnville | 175.6                     | 176.1                     | 3            |
| Broad Street East | Dunnville | 175.7                     | 176.1                     | 3            |
| Lakeshore Road    | 42        | 175.7                     | 176.2                     | 3            |
| Haldimand Road 53 | 22        | 175.7                     | 176.2                     | 3            |
| Pike Lane         | 38        | 175.8                     | 176.2                     | 3            |
| Tamarac Street    | Dunnville | 175.8                     | 176.2                     | 3            |
| Front Street      | Dunnville | 175.8                     | 176.2                     | 3            |
| Dover Street      | 67        | 175.8                     | 176.3                     | 4            |
| Connor Bay Line   | 67        | 175.8                     | 176.3                     | 4            |
| Videoway Lane     | 38        | 175.8                     | 176.3                     | 4            |
| Queen Street      | Dunnville | 175.8                     | 176.3                     | 4            |
| Auld Lane         | 38        | 176.0                     | 176.4                     | 4            |
| Taylor Road       | Dunnville | 176.0                     | 176.5                     | 5            |

# 8.6 Protection of Municipal Infrastructure

When municipal structures are located within the hazard limits, a more detailed assessment of the risks may be warranted. A number of these structures, by their very nature are located within the hazard limits (e.g. water intake, bridges, drains, culverts, treatment and conveyance structures) and protection works are often required. Public parks are often located along the waterfront and some investment may be warranted to protect these public spaces, if the impacts can be mitigated.

Where municipal infrastructure is concerned, public safety, minimizing risks to life, property damage, adverse environmental impacts and social disruption are paramount. Ecological, geomorphological and socioeconomic elements must be considered. In addition, public access, recreation and aesthetics may be considerations.

There are areas where protection works may be inappropriate and unacceptable as they would not meet all of the requirements defined in the Technical Guide (MNR, 2001a). These areas may include, but are not limited to: locations where the active erosion of the site provides an essential sediment source for downdrift beaches; sites where the proposed protection works would result in unacceptable environmental impacts (i.e., adjacent wetland or fish habitat is significantly impacted); areas where the protection works create or aggravate hazards at updrift/downdrift properties (i.e., groynes trapping or deflecting alongshore sediment transport resulting in a significantly reduced quantity of sediment on beaches at adjacent properties thus increasing hazards).

Special consideration is required for roads located within the hazard limits. These roads may be used for access/egress and may become unusable during flooding events, or as a result of erosion. Examples in Haldimand County are discussed in Section 7.2. For roads at risk due to erosion, the recommendations for shore protection provided in Section 8.3 are applicable. As an alternative, it may be necessary to relocate roads.

For roads at risk due to flooding, mitigation measures include raising the road elevation, emergency access such as constructing temporary gravel roads and permanently relocating roads. As a planning tool, the County may wish to identify priority road segments where it may be possible to secure easements along the rear property lines for future road alignments.

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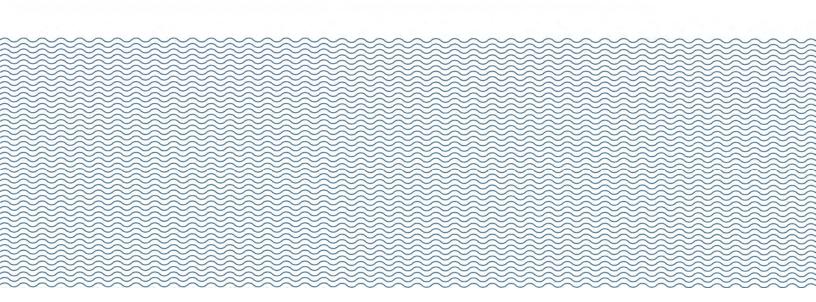
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# Appendix A

Terraprobe Slope Stability Analysis Report

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# **SLOPE STABILITY STUDY** LAKE ERIE NORTH SLOPE EAST OF LOWBANKS TO EAST OF PORT DOVER

**Prepared For:** W.F. Baird & Associates Coastal Engineers Ltd. 1267 Cornwall Road, Suite 100 Oakville, Ontario L6J 7T5

Attention: Fiona Duckett

> File No. 1-18-0402-01 Revision 1: October 15, 2019 © Terraprobe Inc.

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- Appendix E Slope Inspection Forms and MNR Slope Rating Charts
- Appendix F Slope Stability Analysis Explanation and Terminology
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# 1.0 THE PROJECT

Terraprobe was retained by W.F. Baird & Associates Coastal Engineers Ltd. to conduct a detailed slope stability and erosion risk assessment for the Lake Erie North Slope, which covers a total of 87 kms of the north shoreline of Lake Erie from east of Lowbanks to east of Port Dover. The subject slope along the shoreline is up to 21.5 m in height. The tableland is generally occupied by agricultural land, residential properties, conservation land, or municipal roadways. Lake Erie is present approximately at the toe of slope. A site location plan is provided as Figure 1.

This slope stability study and erosion risk assessment has been prepared for the purposes of establishing the Stable Slope Inclinations at a county scale. Site specific studies are recommended. The stable slope allowance is used for mapping the Erosion Hazard.

This report encompasses a review of publicly available subsurface information, existing Terraprobe reports in the area, and a detailed visual slope inspection to establish existing conditions. The scope of work also includes a detailed slope stability analysis. Based on these studies, this report provides geotechnical engineering recommendations pertaining to the site including the stable slope allowance for the slope along the north shoreline of Lake Erie.

# 2.0 SITE & PROJECT DESCRIPTION

The study area includes approximately 87 km of shoreline along Lake Erie's north shore, from east of Lowbanks to east of Port Dover. The tableland is generally flat, and is occupied by agricultural land, residential properties, conservation land, or municipal roadways. The shoreline generally comprises sand beaches, armourstone or concrete retaining walls, visible limestone bedrock, or native slopes comprising glaciolacustrine silt and clay or glacial till. The study area has been divided by Terraprobe into six areas (Area A to F). The areas are described in the table below.

| Area Label | Sections in Area | Limits - Towns                |
|------------|------------------|-------------------------------|
| А          | 1 to 7           | Crescent Bay to Nanticoke     |
| В          | 8 to 12          | Nanticoke to Peacock Point    |
| С          | 13 to 27         | Peacock Point to Featherstone |
| D          | 28 to 43         | Featherstone to Rock Point    |
| E          | 44 to 49         | Rock Point to Townline Road   |
| F          | 50 to 52         | Townline Road to Lowbanks     |

The stratigraphy and recommendations can be interpolated between sections by transitioning approximately halfway between adjacent sections.



At the west end of the study area (Area A and B, Crescent Bay to Peacock Point) the slope is up to 12.6 m in height with a composition of glaciolacustrine silt and clay. At the east end of the study area (Area E, Rock Point to Townline Road), there are glacial till bluffs up to 21.5 m in height. Relevant site features and photograph locations are provided in Appendix A.

Terraprobe was provided with cross sections created from LiDAR data of the entire study area in .xlsx format from Baird by email that included 0.50 m contours for Section 1 to 47 and 2.0 m contours for Section 48 to 52. The LiDAR data provided was used and relied on as factual in preparation of this report. The cross-section locations are shown on Appendix A and the detailed sections are provided in Appendix G.

Jory Hunter, EIT, of Terraprobe carried out a site and detailed slope inspection on August 10<sup>th</sup>, 2018. Jason Crowder, P.Eng., also inspected the slope in April 2019. The MNR Slope Stability Rating Chart was completed during the inspection (included in Appendix E). Area A and B (glaciolacustrine silt and clay slopes) obtained a value of 28, indicating a slight potential for instability. Area E (glacial till bluffs) obtained a value of 59, indicating a moderate potential for instability. Areas C, D, and F of the study area obtained a value of 26, indicating a slight potential for instability.

# 3.0 SUBSURFACE INFORMATION

# 3.1 Stratigraphy

Boreholes were not advanced as part of this scope of work. Terraprobe determined the subsurface conditions based on a review of publicly available subsurface information, existing Terraprobe reports in the area, and a detailed visual slope inspection. A flow chart depicting the steps to determining the soil type and subsequent analysis is included as Figure 2.

The Ministry of Northern Development and Mines (MNDM) has publicly available subsurface information including geotechnical boreholes (Appendix A), and quaternary geology (Figure 3) and surficial geology (Figure 4) of the study area. The government of Ontario has publicly available well records for wells drilled in the study area. The locations of the well records used for the study are included in Appendix A, and the well records are included in Appendix C. This information was used to determine the general stratigraphy encountered in the study area.

Terraprobe completed subsurface investigations in the study area, including the regions of Nanticoke (1974 and 2015), Rainham (2004), Burnaby (2016), and Wainfleet (2017), Ontario. The borehole logs are included in Appendix B.

Terraprobe relied on visual observation during the detailed visual slope inspection to confirm the subsurface conditions within the study area. Visual observations are included in Appendix A.



A summary of the stratigraphy at each of the cross sections can be seen in the table below.

| Area | Section<br># | Geotechnical<br>Borehole ID<br>from MNDM | Geotechnical<br>Borehole<br>Description<br>from MNDM | Quaternary<br>Geology from<br>MNDM | Surficial<br>Geology from<br>MNDM | Well<br>Record<br>ID | Well<br>Record<br>Soil<br>Description | Soil Type at<br>shoreline<br>through<br>visual<br>observation |
|------|--------------|------------------------------------------|------------------------------------------------------|------------------------------------|-----------------------------------|----------------------|---------------------------------------|---------------------------------------------------------------|
|      | 1            | n/a                                      | n/a                                                  | glaciolacustrine silt and clay     | glaciolacustrine silt and clay    | 7123004              | silty clay<br>over<br>limestone       | clayey silt                                                   |
|      | 2            | 700002                                   | clay, silt                                           | glaciolacustrine<br>silt and clay  | glaciolacustrine<br>silt and clay | 4401956              | clay over<br>rock                     | clayey silt                                                   |
|      | 3            | 700003                                   | clay, silt                                           | glaciolacustrine<br>silt and clay  | glaciolacustrine<br>silt and clay | 2600917              | clay over<br>rock                     | earth fill                                                    |
| A    | 4            | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay  | glaciolacustrine<br>silt and clay | 2600919              | clay over<br>rock                     | earth fill                                                    |
|      | 5            | 700004                                   | clay, silt,<br>pebbles                               | glaciolacustrine<br>silt and clay  | glaciolacustrine<br>silt and clay | 2600922              | clay over<br>rock                     | clayey silt                                                   |
|      | 6            | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay  | glaciolacustrine<br>silt and clay | 2600927              | clay over<br>rock                     | clayey silt                                                   |
|      | 7            | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay  | n/a                               | n/a                  | n/a                                   | earth fill                                                    |
|      | 8            | 700005                                   | clay, silt,<br>pebbles                               | glaciolacustrine<br>silt and clay  | glaciolacustrine<br>silt and clay | 2600928              | silty clay<br>over rock               | clayey silt                                                   |
|      | 9            | 700024                                   | clay, silt                                           | glaciolacustrine<br>silt and clay  | glaciolacustrine<br>silt and clay | 2602646              | clay over<br>rock                     | earth fill                                                    |
| В    | 10           | 700026                                   | clay, silt,<br>pebbles                               | glaciolacustrine<br>silt and clay  | glaciolacustrine<br>silt and clay | 2601326              | clay over<br>rock                     | clayey silt                                                   |
|      | 11           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay  | glaciolacustrine<br>silt and clay | 2600932              | clay over<br>rock                     | earth fill                                                    |
|      | 12           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay  | glaciolacustrine<br>silt and clay | n/a                  | n/a                                   | earth fill                                                    |
|      | 13           | n/a                                      | n/a                                                  | bedrock                            | glaciolacustrine<br>silt and clay | 2600939              | clay over<br>rock                     | sand                                                          |
|      | 14           | n/a                                      | n/a                                                  | bedrock                            | glaciolacustrine<br>silt and clay | n/a                  | n/a                                   | earth fill                                                    |
|      | 15           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay  | glaciolacustrine<br>silt and clay | 2600982              | clay over<br>rock                     | earth fill                                                    |
|      | 16           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay  | glaciolacustrine<br>silt and clay | 2601309              | brown clay<br>over rock               | earth fill                                                    |
|      | 17           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay  | bedrock                           | 2601001              | clay over<br>rock                     | earth fill                                                    |
|      | 18           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay  | glaciolacustrine<br>silt and clay | n/a                  | n/a                                   | earth fill                                                    |
| С    | 19           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay  | glaciolacustrine<br>silt and clay | 2600471              | red and grey clay                     | sand                                                          |
| U    | 20           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay  | glaciolacustrine<br>silt and clay | 2600474              | clay over<br>rock                     | earth fill                                                    |
|      | 21           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay  | glaciolacustrine<br>silt and clay | 2601283              | blue clay<br>over rock                | earth fill                                                    |
|      | 22           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay  | glaciolacustrine<br>silt and clay | n/a                  | n/a                                   | earth fill                                                    |
|      | 23           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay  | glaciolacustrine<br>silt and clay | 2601511              | clay over<br>rock                     | sand                                                          |
|      | 24           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay  | glaciolacustrine<br>silt and clay | 2601275              | clay over<br>rock                     | earth fill                                                    |
|      | 25           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay  | glaciolacustrine<br>silt and clay | 2601721              | clay over<br>rock                     | earth fill                                                    |
|      | 26           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay  | glaciolacustrine<br>silt and clay | 2600517              | clay over<br>rock                     | earth fill                                                    |



| Area | Section<br># | Geotechnical<br>Borehole ID<br>from MNDM | Geotechnical<br>Borehole<br>Description<br>from MNDM | Quaternary<br>Geology from<br>MNDM      | Surficial<br>Geology from<br>MNDM  | Well<br>Record<br>ID | Well<br>Record<br>Soil<br>Description | Soil Type at<br>shoreline<br>through<br>visual<br>observation |
|------|--------------|------------------------------------------|------------------------------------------------------|-----------------------------------------|------------------------------------|----------------------|---------------------------------------|---------------------------------------------------------------|
| С    | 27           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay       | eolian sand                        | 2600525              | clay over<br>rock                     | earth fill                                                    |
|      | 28           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay       | glaciolacustrine<br>silt and clay  | 2600534              | clay over<br>rock                     | earth fill                                                    |
|      | 29           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay       | glaciolacustrine<br>silt and clay  | 2600536              | clay over<br>rock                     | sand                                                          |
|      | 30           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay       | glaciolacustrine<br>silt and clay  | 2601421              | clay over<br>rock                     | sand                                                          |
|      | 31           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay       | glaciolacustrine<br>silt and clay  | 2600559              | clay over<br>rock                     | sand                                                          |
|      | 32           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay       | glaciolacustrine<br>silt and clay  | 2600566              | brown clay<br>over rock               | sand                                                          |
|      | 33           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay       | glaciolacustrine<br>silt and clay  | n/a                  | n/a                                   | sand                                                          |
|      | 34           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay       | glaciolacustrine<br>silt and clay  | 2600570              | clay over<br>rock                     | sand                                                          |
| D    | 35           | 856345                                   | clay, silt,<br>sand, very<br>stiff                   | glaciolacustrine silt and clay          | eolian sand                        | 2600574              | sand, clay<br>and gravel<br>over rock | earth fill                                                    |
| D    | 36           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay       | glaciolacustrine<br>silt and clay  | 2600579              | clay over<br>rock                     | sand                                                          |
|      | 37           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay       | glaciolacustrine<br>silt and clay  | 2600895              | clay over<br>rock                     | sand                                                          |
|      | 38           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay       | till                               | 2600884              | clay over<br>rock                     | sand                                                          |
|      | 39           | n/a                                      | n/a                                                  | halton till                             | till                               | 2600094              | brown and blue clay                   | earth fill                                                    |
|      | 40           | n/a                                      | n/a                                                  | halton till                             | glaciolacustrine<br>silt and clay  | n/a                  | n/a                                   | sand                                                          |
|      | 41           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay       | lacustrine sand                    | 2600101              | sand over<br>clay                     | sand                                                          |
|      | 42           | n/a                                      | n/a                                                  | halton till                             | till                               | 7144407              | clay over<br>rock                     | limestone<br>bedrock                                          |
|      | 43           | n/a                                      | n/a                                                  | fluvial deposits,<br>gravel and<br>sand | lacustrine sand                    | 2602506              | sand                                  | sand                                                          |
|      | 44           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay       | n/a                                | 2600833              | clay over<br>rock                     | glacial till                                                  |
|      | 45           | n/a                                      | n/a                                                  | glaciolacustrine silt and clay          | glaciolacustrine<br>sand (moraine) | 7049015              | clay and<br>boulders<br>over rock     | glacial till                                                  |
| E    | 46           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay       | glaciolacustrine<br>sand (moraine) | 2602105              | clay and sand                         | glacial till                                                  |
|      | 47           | 700802                                   | till, grey-<br>brown                                 | glaciolacustrine silt and clay          | till                               | 2601412              | clay and<br>gravel, over              | glacial till                                                  |
|      | 48           | 700804                                   | till, grey-<br>brown                                 | glaciolacustrine silt and clay          | till                               | 2601678              | clay with<br>stones over              | glacial till                                                  |
|      | 49           | 700805                                   | till, brown                                          | glaciolacustrine<br>silt and clay       | till                               | 2600840              | large gravel<br>over rock             | sand                                                          |
|      | 50           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay       | lacustrine sand                    | n/a                  | n/a                                   | sand                                                          |
| F    | 51           | 700801                                   | gravel, sand                                         | glaciolacustrine<br>silt and clay       | lacustrine sand                    | 7290178              | sand over<br>rock                     | sand                                                          |
|      | 52           | n/a                                      | n/a                                                  | glaciolacustrine<br>silt and clay       | lacustrine sand                    | 2600251              | sand                                  | sand                                                          |



A summary of the subsurface information provided in Terraprobe's reports in the surrounding area is included in the table below.

| Report                                                                                                                                                                                                                                                | Label                  | Soil Descriptions                                                                                                                                                                                                    |                                                                                                                                          |  |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|--|--|
| hopon                                                                                                                                                                                                                                                 | Lubor                  | Silty Clay                                                                                                                                                                                                           | Bedrock                                                                                                                                  |  |  |
| Publicly available borehole<br>information – no report attached                                                                                                                                                                                       | Nanticoke (1974)       | Silty Clay, hard, brown with grey mottling,<br>to very stiff, greyish brown, with faint<br>indication of thin stratifications<br>N = 19 to 39<br>(Elev. 190.3 to 181.3 m)                                            | Limestone, sound,<br>occasional cherty patches<br>Percent Core Recovery =<br>72% to 100%<br>RQD = 72% to 91%<br>(Elev. 181.3 to 175.5 m) |  |  |
| Publicly available borehole<br>information – no report attached                                                                                                                                                                                       | Nanticoke (2015)       | Silty Clay trace sand and gravel, stiff to<br>hard, brown with iron staining to grey, grey<br>fissures and occasional to numerous silt<br>lenses and shale fragments<br>N = 12 to 33<br>(Elev. 188.7 to 183.6 m)     | Inferred Bedrock<br>(Elev. 183.6 m)                                                                                                      |  |  |
| "Geotechnical Investigation,<br>Proposed Culvert Replacement",<br>Terraprobe, Project No. 7-04-0006-<br>6, dated March 7, 2004                                                                                                                        | Rainham (2004)         | Silty Clay trace sand and gravel, brown,<br>very stiff to hard, with silt seams and layers<br>N = 15 to 30<br>Elev. (97.2 to 95 ±m)                                                                                  | Inferred Bedrock                                                                                                                         |  |  |
| <ul> <li>"232 South Lakeshore Road, Port<br/>Dover, Ontario", Terraprobe,<br/>Project No. 1-18-0624, dated<br/>October 15, 2018</li> <li>Boreholes by Englobe, Project No.<br/>160-P-0016606-0-01-100-GE-R-<br/>0001-00, dated August 2018</li> </ul> | South Cayuga<br>(2018) | Silt some clay, trace to some sand, trace<br>gravel<br>brown, stiff to very stiff, moist<br>N = 10 to 23<br>(Elev. 188.8 to 185.0 m)<br>Silty Clay<br>grey, firm to stiff<br>N = 4 to 13<br>(Elev. 185.0 to 169.0 m) | Not observed in<br>borehole                                                                                                              |  |  |
| "Geotechnical Investigation, 11603<br>Lakeshore Road, Burnaby<br>Ontario", Terraprobe, Project No.<br>7-16-0133-01, dated February 20,<br>2018                                                                                                        | Burnaby (2016)         | Clayey Silt (Glacial Till), very stiff,<br>brownish black<br>N = 19<br>(Elev. 180.4 to 179.9 m)                                                                                                                      | Inferred Bedrock<br>(Elev. 179.9 m)                                                                                                      |  |  |
| "Preliminary Geotechnical<br>Investigation, 11705 Lakeshore<br>Road, Wainfleet Ontario",<br>Terraprobe, Project No. 7-16-0082-<br>01, dated April 19, 2017                                                                                            | Wainfleet (2017)       | Silty Clay, brown, very stiff to firm,<br>occasional seams and layers of silt<br>N = 8 to 21<br>Field Vane = 90 kPa<br>(Elev. 175.9 to 172.8 m)                                                                      | Inferred Bedrock<br>(Elev. 172.8 m)                                                                                                      |  |  |

## 3.2 Ground Water

Installing ground water monitoring wells was not part of the scope of work. Static water levels recorded on the well records are included in the table below. Due to the proximity of Lake Erie, the water table along the shoreline is hydraulically connected to the lake. The water table was estimated with this information and from observations of seepage at the slope face.

| Area | Section # | Well Record ID | Well Record Static Water Level (ft)<br>(depth below grade) | Well Record Static Water Level (m)<br>(depth below grade) |
|------|-----------|----------------|------------------------------------------------------------|-----------------------------------------------------------|
|      | 1         | 7123004        | n/a                                                        | n/a                                                       |
|      | 2         | 4401956        | 21                                                         | 6.4                                                       |
| А    | 3         | 2600917        | 25                                                         | 7.6                                                       |
|      | 4         | 2600919        | n/a                                                        | n/a                                                       |
|      | 5         | 2600922        | n/a                                                        | n/a                                                       |



| Area | Section # | Well Record ID | Well Record Static Water Level (ft)<br>(depth below grade) | Well Record Static Water Level (m)<br>(depth below grade) |
|------|-----------|----------------|------------------------------------------------------------|-----------------------------------------------------------|
| ^    |           |                | 25                                                         | 7.6                                                       |
| A    | 7         | n/a            | n/a                                                        | n/a                                                       |
|      | 8         | 2600928        | n/a                                                        | n/a                                                       |
|      | 9         | 2602646        | 23                                                         | 7.0                                                       |
| В    | 10        | 2601326        | 30                                                         | 9.1                                                       |
|      | 11        | 2600932        | 25                                                         | 7.6                                                       |
|      | 12        | n/a            | n/a                                                        | n/a                                                       |
|      | 13        | 2600939        | 12                                                         | 3.7                                                       |
|      | 14        | n/a            | n/a                                                        | n/a                                                       |
|      | 15        | 2600982        | 6                                                          | 1.8                                                       |
|      | 16        | 2601309        | 12                                                         | 3.7                                                       |
|      | 17        | 2601001        | 13                                                         | 4.0                                                       |
|      | 18        | n/a            | n/a                                                        | n/a                                                       |
|      | 19        | 2600471        | n/a                                                        | n/a                                                       |
| С    | 20        | 2600474        | 18                                                         | 5.5                                                       |
|      | 21        | 2601283        | 17                                                         | 5.2                                                       |
|      | 22        | n/a            | n/a                                                        | n/a                                                       |
|      | 23        | 2601511        | 17                                                         | 5.2                                                       |
|      | 24        | 2601275        | 13                                                         | 4.0                                                       |
|      | 25        | 2601721        | 10                                                         | 3.0                                                       |
|      | 26        | 2600517        | 8                                                          | 2.4                                                       |
|      | 27        | 2600525        | 12                                                         | 3.7                                                       |
|      | 28        | 2600534        | 41                                                         | 12.5                                                      |
|      | 29        | 2600536        | 14                                                         | 4.3                                                       |
|      | 30        | 2601421        | 8.5                                                        | 2.6                                                       |
|      | 31        | 2600559        | 6                                                          | 1.8                                                       |
|      | 32        | 2600566        | n/a                                                        | n/a                                                       |
|      | 33        | n/a            | n/a                                                        | n/a                                                       |
|      | 34        | 2600570        | 9                                                          | 2.7                                                       |
| D    | 35        | 2600574        | 14                                                         | 4.3                                                       |
|      | 36        | 2600579        | 10                                                         | 3.0                                                       |
|      | 37        | 2600895        | 25                                                         | 7.6                                                       |
|      | 38        | 2600884        | 18                                                         | 5.5                                                       |
|      | 39        | 2600094        | 15                                                         | 4.6                                                       |
|      | 40        | n/a            | n/a                                                        | n/a                                                       |
|      | 41        | 2600101        | 60                                                         | 18.3                                                      |

| Area | Section # | Well Record ID | Well Record Static Water Level (ft)<br>(depth below grade) | Well Record Static Water Level (m)<br>(depth below grade) |
|------|-----------|----------------|------------------------------------------------------------|-----------------------------------------------------------|
| D    | 42        | 7144407        | 18                                                         | 5.5                                                       |
|      | 43        | 2602506        | 17                                                         | 5.2                                                       |
|      | 44        | 2600833        | 26                                                         | 7.9                                                       |
|      | 45        | 7049015        | 40                                                         | 12.2                                                      |
| E    | 46        | 2602105        | n/a                                                        | n/a                                                       |
|      | 47        | 2601412        | 42                                                         | 12.8                                                      |
|      | 48        | 2601678        | 12                                                         | 3.7                                                       |
|      | 49        | 2600840        | 19                                                         | 5.8                                                       |
|      | 50        | n/a            | n/a                                                        | n/a                                                       |
| F    | 51        | 7290178        | 20                                                         | 6.1                                                       |
|      | 52        | 2600251        | 17                                                         | 5.2                                                       |

## 3.3 Visual Slope Inspections

A detailed visual slope inspection of the slope area from the crest to the toe was conducted by Jory Hunter of Terraprobe on August 10<sup>th</sup>, 2018. Jason Crowder of Terraprobe also inspected the slope in April 2019. General information pertaining to the existing slope features such as slope profile, slope drainage, water course features, vegetation cover, buildings in the vicinity of the slope, erosion features, and slope slide features were obtained during the inspection. A summary of the visual slope inspection is presented below. Photographs taken during the inspections are included as Appendix D. The locations of the features discussed below are shown on the Cross-sections, Photographs, and Site Features plan in Appendix A.

The study area includes approximately 87 km of shoreline running approximately west to east along Lake Erie's north shore, from east of Lowbanks to east of Port Dover. The tableland is generally flat, and is occupied by agricultural land, residential properties, conservation land, or municipal roadways. At the west end of the study area (Area A and B), there are native slopes up to 12.6 m in height with a composition of glaciolacustrine silt and clay. At the east end of the study area (Area E), there are glacial till bluffs up to 21.5 m in height. Otherwise, the shoreline generally comprises sand beaches, armourstone or concrete retaining walls, or visible limestone bedrock.

A large drainage pipe was observed in Area E at the end of Dickout Road, with the outlet at the toe of slope. Other drainage pipes were not observed, although there may be more drainage pipes over the slope in areas where there are dwellings in the tableland.

The tableland is generally vegetated with grass, shrubs, young to mature trees, or is occupied by agricultural land. At the west end of the study area (Areas A and B) the slope face is generally forested. The face of the glacial till bluffs (Area E) is bare. Majority of the shoreline (Areas C, D, and F), the slope



face is either vegetated with grass, shrubs, and young trees, or covered by armourstone walls, concrete walls, or an unvegetated sand veneer.

The glacial till bluffs at the east end of the study area (Area E) are near vertical to sub-vertical. There is talus accumulation at the toe of the slope. Ground water seepage was observed through the talus. There are staircases and informal walking paths down the glacial till bluffs to the sand and gravel beach below. Toe erosion protection was observed along the east end of the bluff formation, including concrete blocks and retaining walls. There are some dwellings in close proximity to the slope crest at Area E (from Pyle Road to Farr Road), where there was limited access to the slope. These dwellings are potentially within the erosion hazard, and therefore, a more detailed and site-specific analysis is recommended.

A summary of the visual observations across the study area is shown below.

| Area | Sections | General Slope<br>Height (±m) | General Slope<br>Inclination                       | Exposed Soil                                                                                                                                      | Features                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------|----------|------------------------------|----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A    | 1 to 7   | 3 to 13                      | steeper than<br>1.0H:1V to<br>3.0H:1V              | cohesionless <b>sand and</b><br><b>silt</b> overburden                                                                                            | <ul> <li>Agricultural land, dwellings, municipal roadways, and industrial facilities in the tableland</li> <li>Forested with shrubs and trees, landscaped with grass, or agricultural land</li> <li>At the toe, sand and gravel beaches, limestone shelf, or armourstone and concrete retaining walls (1-2 m height)</li> </ul>                                                                                                                                                                       |
| В    | 8 to 12  | 7 to 11                      | steeper than<br>1.0H:1V to<br>2.0H:1V              | cohesionless <b>sand and</b><br><b>silt</b> overlying <b>silt and</b><br><b>clay</b> , trace sand,<br>layered, grey, moist,<br>very stiff to hard | <ul> <li>Agricultural land, dwellings, and municipal roadways in the tableland</li> <li>Forested with shrubs and trees, landscaped with grass, or agricultural land</li> <li>At the toe, sand and gravel beaches or armourstone and concrete retaining walls (1-2 m height)</li> <li>Section 8: 1 m toe erosion scarp and tension cracks in upper slope</li> </ul>                                                                                                                                    |
| С    | 13 to 27 | 2 to 6                       | steeper than<br>1.0H:1V to flatter<br>than 3.0H:1V | surficial <b>sand or earth</b><br>fill                                                                                                            | <ul> <li>Agricultural land, dwellings, and municipal roadways in the tableland</li> <li>Forested with shrubs and trees, landscaped with grass, or agricultural land</li> <li>At the toe, sand and gravel beaches, limestone shelf, or armourstone and concrete retaining walls (1-4 m height)</li> </ul>                                                                                                                                                                                              |
| D    | 28 to 43 | 1.5 to 8                     | steeper than<br>1.0H:1V to flatter<br>than 3.0H:1V | surficial <b>sand or earth</b><br>fill                                                                                                            | <ul> <li>Agricultural land, dwellings, and municipal roadways in the tableland</li> <li>Forested with shrubs and trees, landscaped with grass, or agricultural land</li> <li>At the toe, sand and gravel beaches, limestone shelf, or armourstone and concrete retaining walls (1-2 m height)</li> </ul>                                                                                                                                                                                              |
| E    | 44 to 49 | 8 to 22                      | steeper than<br>1.0H:1V to<br>2.5H:1V              | Silt, some sand, some<br>clay, trace gravel, trace<br>cobbles and boulders,<br>reddish brown, moist to<br>wet, compact/stiff<br>(Glacial Till)    | <ul> <li>Agricultural land, dwellings, and municipal roadways in the tableland</li> <li>Tableland forested with shrubs and trees, landscaped with grass, or agricultural land</li> <li>Slope face is bare and unvegetated</li> <li>At the toe, sand and gravel beaches or armourstone, concrete, and gabion retaining walls (1-7 m height)</li> <li>Active erosion at the toe of slope</li> <li>Drainage pipe observed, extended to the toe of slope</li> <li>Seepage through talus at toe</li> </ul> |



| Area | Sections | General Slope<br>Height (±m) | General Slope<br>Inclination       | Exposed Soil          | Features                                                                                                                                                                                                                                                                               |
|------|----------|------------------------------|------------------------------------|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| F    | 50 to 52 | 3 to 4                       | 2.0H:1V to flatter<br>than 3.0H:1V | surficial <b>sand</b> | <ul> <li>Agricultural land, dwellings, and municipal roadways in the tableland</li> <li>Forested with shrubs and trees, landscaped with grass, or agricultural land</li> <li>At the toe, sand and gravel beaches or armourstone and concrete retaining walls (1-2 m height)</li> </ul> |

# 4.0 SLOPE STABILITY ANALYSIS

# 4.1 Existing Conditions

A detailed engineering analysis of slope stability was carried out on the subject slope as shown in plan as Appendix A, and in profile in Appendix G. The analysis was completed using the LiDAR data provided by Baird. Terraprobe has assumed for the present purposes that this factual data represents the existing slope conditions. A flow chart depicting the steps to the analysis is included as Figure 2.

The analysis was conducted utilizing computer software (Slide 8.016, released July 23, 2018, developed by Rocscience Inc.) and several standard methods of limit equilibrium analysis (Bishop, Janbu, Morgenstern/Price, and Spencer). These methods of analysis allow the calculation of Factors of Safety for hypothetical or assumed slip surfaces through the slope. The analysis method is used to assess potential for movements of large masses of soil over a specific slip surface which can be curved or circular, or noncircular. The analysis involves dividing the sliding mass into many thin slices and calculating the forces on each slice. The normal and shear forces acting on the sides and base of each slice are calculated. It is an iterative process that converges on a solution. An example analysis is provided as Appendix F, which shows the critical slip surface, the slices, and the inter-slice forces, as well as pertinent aspects of the slope stability output.

For a specific slip surface, the Factor of Safety is defined as the ratio of the available soil strength resisting movement, divided by the gravitational forces tending to cause movement. The Factor of Safety of 1.0 represents a "limiting equilibrium" condition where the slope is at a point of pending failure since the soil resistance is equal to forces tending to cause movement. It is usual to require a Factor of Safety greater than one (1) to ensure stability of the slope. The typical Factor of Safety used for engineering design of slopes for stability ranges from about 1.3 to 1.5 for developments situated close to the slope crest. The most common design guidelines are based on a 1.5 minimum Factor of Safety.

Each analysis was carried out by preparing a model of the slope geometry and subsurface conditions, and analyzing numerous different slip surfaces through the slope in search of the minimum or critical Factor of Safety for specific conditions. The pertinent data obtained from topographic plan, slope profiles, slope mapping, and the borehole information, were input for the slope stability analysis. Many calculations



were carried out to examine the Factor of Safety for varying depths of potential slip surfaces. Circular and non-circular surfaces were both analyzed and circular surfaces were found to govern.

The average soil properties utilized for the soil strata in the slope stability analysis were assessed from information secured from the boreholes, publicly available information, and visual inspection. The average soil properties are based on effective stress analysis for long-term slope stability, and are summarized in the table below. These soil properties are considered conservative; the soils on site are actually stronger. Short-term effects such as negative pore water pressures within unsaturated soils can increase the stability of a slope, and have been conservatively omitted. The presence of limestone at the shoreline has been conservatively omitted (except at Section 42).

| Material                       | Unit Weight (kN/m <sup>3</sup> ) | Cohesion (kPa) | Internal Friction Angle (deg.) |
|--------------------------------|----------------------------------|----------------|--------------------------------|
| Earth Fill                     | 19                               | 0              | 28                             |
| Glaciolacustrine Silt and Clay | 21                               | 6              | 30                             |
| Sand                           | 20                               | 0              | 30                             |
| Glacial Till                   | 20                               | 2              | 36                             |
| Limestone Bedrock              | 22                               | impenetrable   | impenetrable                   |

The Lake Erie water level was Elev. 173.2 m CGVD2013 on the date the LiDAR was collected in 2017.

The results of the slope stability analysis of the existing conditions are provided in Appendix G, and are summarized in the table below.

| Sector | Section # | Height from section (m) | Existing Inclination<br>from section | Existing FS | Critical (circular) Slip Surface<br>Description |
|--------|-----------|-------------------------|--------------------------------------|-------------|-------------------------------------------------|
|        | 1         | 12.6                    | 1.6 to 2.4H:1V                       | 1.6         | Surfaces pass through the lower slope profile   |
|        | 2         | 9.0                     | 1.9H:1V                              | 1.6         | Surfaces pass through the lower slope profile   |
|        | 3         | 8.1                     | 0.5 to 2.9H:1V                       | 1.3         | Surfaces pass through the lower slope profile   |
| А      | 4         | 5.7                     | 1.1H:1V                              | 1.5         | Surfaces pass through the<br>mid-slope profile  |
|        | 5         | 2.8                     | 2.0H:1V                              | 2.6         | Surfaces pass through the<br>mid-slope profile  |
|        | 6         | 6.7                     | 3.6H:1V                              | 2.1         | Surfaces pass through the lower slope profile   |
|        | 7         | 8.0                     | 3.0H:1V                              | 1.5         | Surfaces pass through the lower slope profile   |
| В      | 8         | 10.3                    | 0.6H:1V                              | 1.0         | Surfaces pass through the lower slope profile   |
| В      | 9         | 10.7                    | 1.5H:1V                              | 1.5         | Surfaces pass through the lower slope profile   |



| Sector | Section # | Height from section (m) | Existing Inclination from section | Existing FS | Critical (circular) Slip Surface<br>Description |
|--------|-----------|-------------------------|-----------------------------------|-------------|-------------------------------------------------|
|        | 10        | 7.7                     | 2.0H:1V                           | 1.5         | Surfaces pass through the lower slope profile   |
| В      | 11        | 8.0                     | 1.3H:1V                           | 1.5         | Surfaces pass through the lower slope profile   |
|        | 12        | 7.5                     | 1.9H:1V                           | 2.0         | Surfaces pass through the lower slope profile   |
|        | 13        | 2.3                     | 0.9H:1V                           | 1.8         | Surfaces pass through the<br>mid-slope profile  |
|        | 14        | 5.1                     | 0.8H:1V                           | 1.3         | Surfaces pass through the lower slope profile   |
|        | 15        | 3.7                     | 0.9H:1V                           | 2.2         | Surfaces pass through the lower slope profile   |
|        | 16        | 3.7                     | 1.1H:1V                           | 2.4         | Surfaces pass through the lower slope profile   |
|        | 17        | 2.8                     | 1.0H:1V                           | <1.0        | Surfaces pass through the lower slope profile   |
|        | 18        | 5.6                     | 1.5H:1V                           | 1.7         | Surfaces pass through the lower slope profile   |
|        | 19        | 2.4                     | 1.3H:1V                           | 2.1         | Surfaces pass through the<br>mid-slope profile  |
| С      | 20        | 5.9                     | 1.7H:1V                           | 1.8         | Surfaces pass through the lower slope profile   |
|        | 21        | 4.0                     | 1.5H:1V                           | 2.2         | Surfaces pass through the lower slope profile   |
|        | 22        | 3.2                     | 1.5H:1V                           | 3.0         | Surfaces pass through the lower slope profile   |
|        | 23        | 2.1                     | 1.5H:1V                           | 2.1         | Surfaces pass through the lower slope profile   |
|        | 24        | 3.1                     | 3.7H:1V                           | 2.7         | Surfaces pass through the lower slope profile   |
|        | 25        | 3.8                     | 2.7H:1V                           | 3.0         | Surfaces pass through the lower slope profile   |
|        | 26        | 2.6                     | 0.5H:1V                           | <1.0        | Surfaces pass through the lower slope profile   |
|        | 27        | 3.4                     | 1.0H:1V                           | 1.9         | Surfaces pass through the lower slope profile   |
|        | 28        | 2.6                     | 1.6H:1V                           | 1.9         | Surfaces pass through the lower slope profile   |
|        | 29        | 1.8                     | 0.8H:1V                           | 2.7         | Surfaces pass through the lower slope profile   |
|        | 30        | 3.6                     | 1.2H:1V                           | 2.2         | Surfaces pass through the<br>mid-slope profile  |
|        | 31        | 4.8                     | 2.2H:1V                           | 2.4         | Surfaces pass through the lower slope profile   |
| D      | 32        | 2.7                     | 1.2H:1V                           | 3.0         | Surfaces pass through the<br>mid-slope profile  |
| U      | 33        | 2.0                     | 1.0H:1V                           | 2.3         | Surfaces pass through the lower slope profile   |
|        | 34        | 2.6                     | 1.5H:1V                           | 2.4         | Surfaces pass through the lower slope profile   |
|        | 35        | 4.0                     | 1.7H:1V                           | 1.4         | Surfaces pass through the lower slope profile   |
|        | 36        | 2.6                     | 1.6H:1V                           | 2.2         | Surfaces pass through the lower slope profile   |
|        | 37        | 2.2                     | 0.8H:1V                           | 1.8         | Surfaces pass through the lower slope profile   |

| Sector | Section # | Height from section (m) | Existing Inclination<br>from section | Existing FS   | Critical (circular) Slip Surface<br>Description |
|--------|-----------|-------------------------|--------------------------------------|---------------|-------------------------------------------------|
|        | 38        | 7.1                     | 3.7H:1V                              | 1.2           | Surfaces pass through the<br>mid-slope profile  |
|        | 39        | 4.1                     | 1.6H:1V                              | 1.8           | Surfaces pass through the lower slope profile   |
| D      | 40        | 3.4                     | 4.4H:1V                              | 3.7           | Surfaces pass through the mid-<br>slope profile |
|        | 41        | 4.0                     | 4.4H:1V                              | 3.2           | Surfaces pass through the lower slope profile   |
|        | 42        | 7.5                     | 2.8H:1V                              | impenetrable* | n/a*                                            |
|        | 43        | 1.6                     | 1.1H:1V                              | 1.9           | Surfaces pass through the lower slope profile   |
|        | 44        | 8.2                     | 1.3H:1V                              | 1.5           | Surfaces pass through the lower slope profile   |
|        | 45        | 10.2                    | 0.5H:1V                              | <1.0          | Surfaces pass through the lower slope profile   |
| E      | 46        | 21.5                    | 0.3H:1V to 1.2H:1V                   | 1.1           | Surfaces pass through the lower slope profile   |
|        | 47        | 9.4                     | 1.5H:1V                              | 1.4           | Surfaces pass through the lower slope profile   |
|        | 48        | 8.8                     | 2.3H:1V                              | 2.0           | Surfaces pass through the lower slope profile   |
|        | 49        | 11.0                    | 2.4H:1V                              | 1.6           | Surfaces pass through the lower slope profile   |
|        | 50        | 3.0                     | 10H:1V to 4.3H:1V                    | 2.6           | Surfaces pass through the lower slope profile   |
| F      | 51        | 3.7                     | 2.3H:1V                              | 1.6           | Surfaces pass through the lower slope profile   |
|        | 52        | 3.8                     | 3.4H:1V                              | 2.9           | Surfaces pass through the lower slope profile   |

\*stratigraphy at this section is primarily bedrock, which is modelled as an infinite strength/impenetrable material.

Circular surfaces were found to govern for the existing conditions, with critical slip surfaces generally passing through the lower slope profile. The results indicate that the majority of the site (42 out of 52 sections) have adequate factors of safety of 1.5 or higher. Ten of the cross sections have factors of safety less than 1.5.

At Sections 3, 14, 17, 26, and 38 the slope appears to be oversteepened. Armourstone or concrete retaining walls were observed at the face of the slope. The slope at these sections is unstable to moderately stable with critical factors of safety of less than 1.0 to 1.3.

At Section 35, the critical factor of safety is 1.4, indicating the slope at this section is moderately stable.

At the west end of the study area (Section 8), the slope is unstable with a critical factor of safety of 1.0. There is active toe erosion that is undermining the toe of slope. Tension cracks were observed in the upper slope face. The slope is therefore considered unstable at this section.

At the east end of the study area (Sections 45 to 47), the slope is unstable to moderately stable with critical factors of safety of less than 1.0 to 1.4. There is active to eerosion which has caused glacial till



bluffs to become oversteepened. Talus accumulation was observed at the toe of slope. The slope is progressively self-stabilizing by eroding back (i.e. crest migration) to a more stable inclination. Future toe erosion and crest migration is anticipated.

# 4.2 Stable Inclination Setback

For active land use, the MNR Policy Guidelines allow a minimum Factor of Safety of 1.3 to 1.5 for slope stability, as follows.

| TYPE | LAND-USES                                                                                                                                                                                                                                      | DESIGN MINIMUM FACTOR<br>OF SAFETY |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|
| А    | PASSIVE: no buildings near slope; farm field, bush, forest, timberland, woods, wasteland, badlands, tundra                                                                                                                                     | 1.1                                |
| В    | LIGHT: no habitable structures near slope; recreational parks, golf courses, buried small utilities, tile beds, barns, garages, swimming pools, sheds, satellite dishes, dog houses                                                            | 1.20 to 1.30                       |
| С    | ACTIVE: habitable or occupied structures near slopes; residential, commercial, and industrial buildings, retaining walls, storage/warehousing of non-hazardous substances                                                                      | 1.30 to 1.50                       |
| D    | INFRASTRUCTURE and PUBLIC USE: public use structures and buildings (i.e. hospitals, schools, stadiums), cemeteries, bridges, high voltage power transmission lines, towers, storage/warehousing of hazardous materials, waste management areas | 1.40 to 1.50                       |

Based on the MNR policy guidelines, the LTSSC analysis was conducted using a Factor of Safety of 1.5 ("LTSSC<sub>1.5</sub>", for habitable or occupied structures near slopes). The computed minimum factors of safety is as low as less than 1.0, with critical (circular) slip surfaces generally passing through the lower slope profile. Therefore, the minimum factors of safety obtained under existing conditions in 10 of the 52 section locations are considered inadequate and unacceptable for long-term planning purposes. An additional setback from the existing top of slope will be required to achieve a long-term stable inclination.

#### 4.2.1 Stable Slope Inclination

The stable slope analysis was determined following the flow chart included as Figure 2, which depicts the steps to the analysis. Based on the soil type of the subject section (as described in Section 3.0 and shown in Appendix G), the subject slope is either composed of assumed earth fill, surficial sand, silt and clay and/or glacial till. Due to the variability or the earth fill and surficial sand, the Grand River Conservation Authority (GRCA), Long Point Region Conservation Authority (LPRCA), and Niagara Peninsula Conservation Authority (NPCA) guidelines were followed to determine the stable slope inclination for these soil types. For the slopes with a composition of native silt and clay or glacial till, a number of representative trial stabilized slope profiles were analysed to obtain the required factor of safety.



Terraprobe referred to the following documents for the policies in the study area:

- Grand River Conservation Authority, "Policies for the Administration of the Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation, Ontario Regulation 150/06", dated October 23, 2015.
- Long Point Region Conservation Authority, "Policies for the Administration of the Development, Interference with Wetlands, and Alterations to Shorelines and Watercourses Regulation, Ontario Regulation 178/06", dated October 4, 2017.
- Niagara Peninsula Conservation Authority, "NPCA Policy Document: Policies for the Administration of Ontario Regulation 155/06 and The Planning Act", dated September 2018.

The GRCA indicates that the stable slope angle is determined from a geotechnical study or engineering assessment. The LPRCA indicates that the stable slope inclination should be taken as 3.0H:1V unless a site-specific geotechnical investigation determines a different value. Due to the variable nature of earth fill and surficial sand across the study area, stable slope inclination of 3.0H:1V should apply to these soil types where encountered. The NPCA indicates that the stable slope allowance along the Great Lakes shoreline is 3:1 (horizontal to vertical) in the absence of a site specific geotechnical study.

For the slopes comprising the native glaciolacustrine silt and clay or glacial till, a number of representative trial stabilized slope profiles were analyzed to obtain a minimum factor of safety for global stability of 1.5 (shown in Appendix H) for normal ground water conditions and temporary and infrequent high water table conditions.

| Soil Type                      | Stable Slope Inclinations for:<br>Normal Ground Water Table (FS = 1.5)<br>Temporary and Infrequent High Ground Water Table (FS = 1.3) |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| Earth Fill                     | 3.0H:1V <sup>1</sup>                                                                                                                  |
| Sand                           | 3.0H:1V <sup>1</sup>                                                                                                                  |
| Glaciolacustrine Silt and Clay | 2.3H:1V <sup>2</sup>                                                                                                                  |
| Glacial Till                   | 1.8H:1V <sup>2</sup>                                                                                                                  |
| Bedrock                        | 1.4H:1V <sup>3</sup>                                                                                                                  |

The stable slope inclinations are shown in profile in Appendix H, and summarized in the table below.

1. Based on GRCA, LRPCA, and NPCA guidelines.

2. Based on Terraprobe analysis.

3. Based on other conservation guidelines in Ontario.

In addition to a stable slope inclination setback, an erosion allowance (to be provided by Baird) should be applied to determine the long-term stable slope crest position.



The following table provides the stable slope inclinations for each of the cross sections based on the primary soil type.

| Section # | Primary Soil Type              | Stable Inclination |
|-----------|--------------------------------|--------------------|
| 1         | glaciolacustrine silt and clay | 2.3H:1V            |
| 2         | glaciolacustrine silt and clay | 2.3H:1V            |
| 3         | glaciolacustrine silt and clay | 2.3H:1V            |
| 4         | glaciolacustrine silt and clay | 2.3H:1V            |
| 5         | glaciolacustrine silt and clay | 2.3H:1V            |
| 6         | glaciolacustrine silt and clay | 2.3H:1V            |
| 7         | earth fill                     | 3.0H:1V            |
| 8         | glaciolacustrine silt and clay | 2.3H:1V            |
| 9         | glaciolacustrine silt and clay | 2.3H:1V            |
| 10        | glaciolacustrine silt and clay | 2.3H:1V            |
| 11        | glaciolacustrine silt and clay | 2.3H:1V            |
| 12        | glaciolacustrine silt and clay | 2.3H:1V            |
| 13        | glaciolacustrine silt and clay | 2.3H:1V            |
| 14        | glaciolacustrine silt and clay | 2.3H:1V            |
| 15        | glaciolacustrine silt and clay | 2.3H:1V            |
| 16        | glaciolacustrine silt and clay | 2.3H:1V            |
| 17        | glaciolacustrine silt and clay | 2.3H:1V            |
| 18        | glaciolacustrine silt and clay | 2.3H:1V            |
| 19        | sand                           | 3.0H:1V            |
| 19        | glaciolacustrine silt and clay | 2.3H:1V            |
| 20        | glaciolacustrine silt and clay | 2.3H:1V            |
| 21        | glaciolacustrine silt and clay | 2.3H:1V            |
| 22        | glaciolacustrine silt and clay | 2.3H:1V            |
| 23        | glaciolacustrine silt and clay | 2.3H:1V            |
| 24        | glaciolacustrine silt and clay | 2.3H:1V            |
| 25        | glaciolacustrine silt and clay | 2.3H:1V            |
| 26        | glaciolacustrine silt and clay | 2.3H:1V            |
| 27        | sand                           | 3.0H:1V            |
| 21        | glaciolacustrine silt and clay | 2.3H:1V            |
| 28        | glaciolacustrine silt and clay | 2.3H:1V            |
| 29        | glaciolacustrine silt and clay | 2.3H:1V            |
| 30        | glaciolacustrine silt and clay | 2.3H:1V            |
| 31        | glaciolacustrine silt and clay | 2.3H:1V            |

| Section # | Primary Soil Type              | Stable Inclination |
|-----------|--------------------------------|--------------------|
| 32        | glaciolacustrine silt and clay | 2.3H:1V            |
| 33        | glaciolacustrine silt and clay | 2.3H:1V            |
| 34        | glaciolacustrine silt and clay | 2.3H:1V            |
| 35        | sand                           | 3.0H:1V            |
| 36        | glaciolacustrine silt and clay | 2.3H:1V            |
| 37        | glaciolacustrine silt and clay | 2.3H:1V            |
| 38        | glaciolacustrine silt and clay | 2.3H:1V            |
| 39        | glaciolacustrine silt and clay | 2.3H:1V            |
| 10        | sand                           | 3.0H:1V            |
| 40        | glaciolacustrine silt and clay | 2.3H:1V            |
|           | sand                           | 3.0H:1V            |
| 41        | glaciolacustrine silt and clay | 2.3H:1V            |
| 40        | earth fill / unknown           | 3.0H:1V            |
| 42        | bedrock                        | 1.4H:1V            |
| 10        | sand                           | 3.0H:1V            |
| 43        | glaciolacustrine silt and clay | 2.3H:1V            |
| 44        | glacial till                   | 1.8H:1V            |
| 45        | glacial till                   | 1.8H:1V            |
| 46        | glacial till                   | 1.8H:1V            |
| 47        | glacial till                   | 1.8H:1V            |
| 48        | glacial till                   | 1.8H:1V            |
| 10        | sand                           | 3.0H:1V            |
| 49        | glacial till                   | 1.8H:1V            |
| 50        | sand                           | 3.0H:1V            |
| 51        | sand                           | 3.0H:1V            |
| 52        | sand                           | 3.0H:1V            |

# 5.0 SUMMARY AND CLOSURE

This report encompasses slope stability and erosion risk assessment for the purpose of establishing the Stable Slope Inclinations at a county scale. Site specific studies are recommended. The stable slope allowance is used for mapping the Erosion Hazard.

The study area is along the Lake Erie North Slope, from east of Lowbanks to east of Port Dover. The subject slope along the shoreline is up to 21.5 m in height. The tableland is generally occupied by agricultural land, residential properties, conservation land, or municipal roadways. Lake Erie is present



approximately at the toe of slope. The scope of work includes a detailed visual slope inspection to review the existing slope conditions and a detailed slope stability analysis.

Based on the detailed slope stability analysis, the existing slope generally has a minimum Factor of Safety of greater than 1.5. In some areas, the minimum Factor of Safety of the slope is less than 1.5, and is not considered stable for long-term planning purposes. Minimum Factors of Safety of 1.5 for normal ground water and temporary elevated ground water conditions are achieved with a stable slope inclination of 3.0H:1V in the earth fill and sand, 2.3H:1V in the glaciolacustrine silt and clay, and 1.8H:1V in the glacial till. To determine the Long Term Stable Slope Crest, an erosion allowance must be applied. MNR guidelines require that developments, dwellings, buildings, or other structures have an additional setback for planning purposes.

There are some dwellings in close proximity to the slope crest at Area E (from Pyle Road to Farr Road), where there was limited access to the slope. These dwellings are potentially within the erosion hazard, and therefore, a more detailed and site-specific analysis is recommended.

In general, any site development and construction activities should be conducted in a manner which does not result in surface erosion of the slope. In particular, site grading and drainage should be designed to prevent direct concentrated or channelized surface runoff from flowing directly over the slope. Water drainage from down-spouts, sumps, road drainage, and the like should not be permitted to flow over the slope.

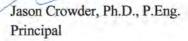
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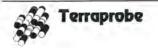
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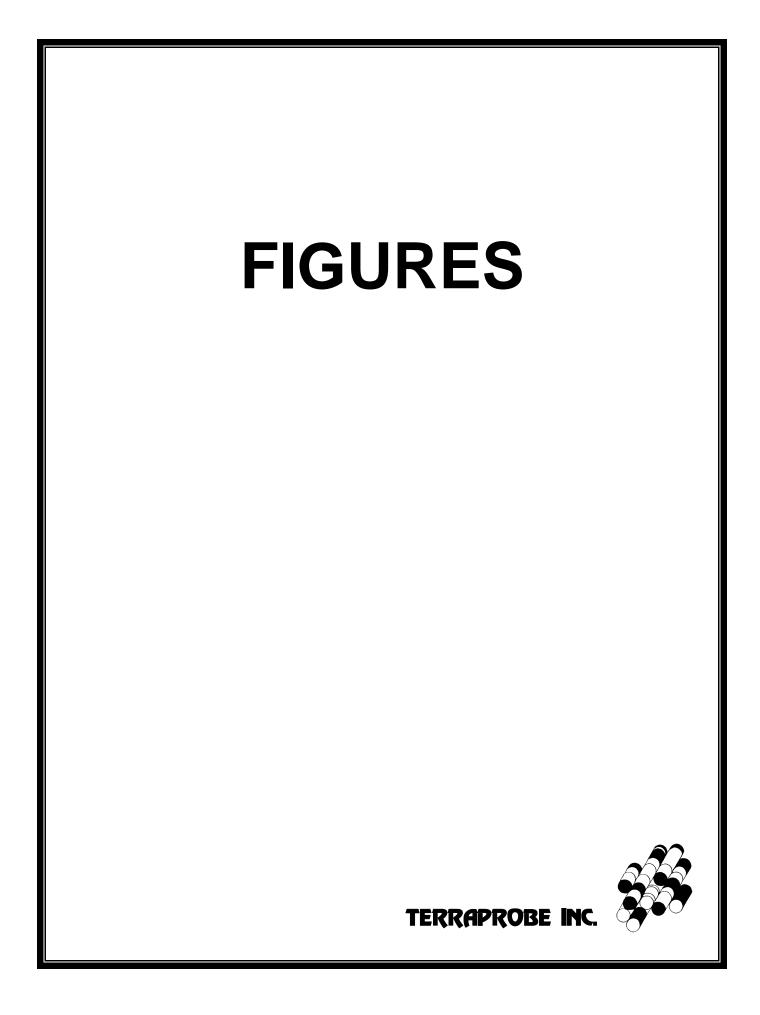
Jory Hunter, B.Sc.(Eng.), E.I.T. Geotechnical Engineering Division



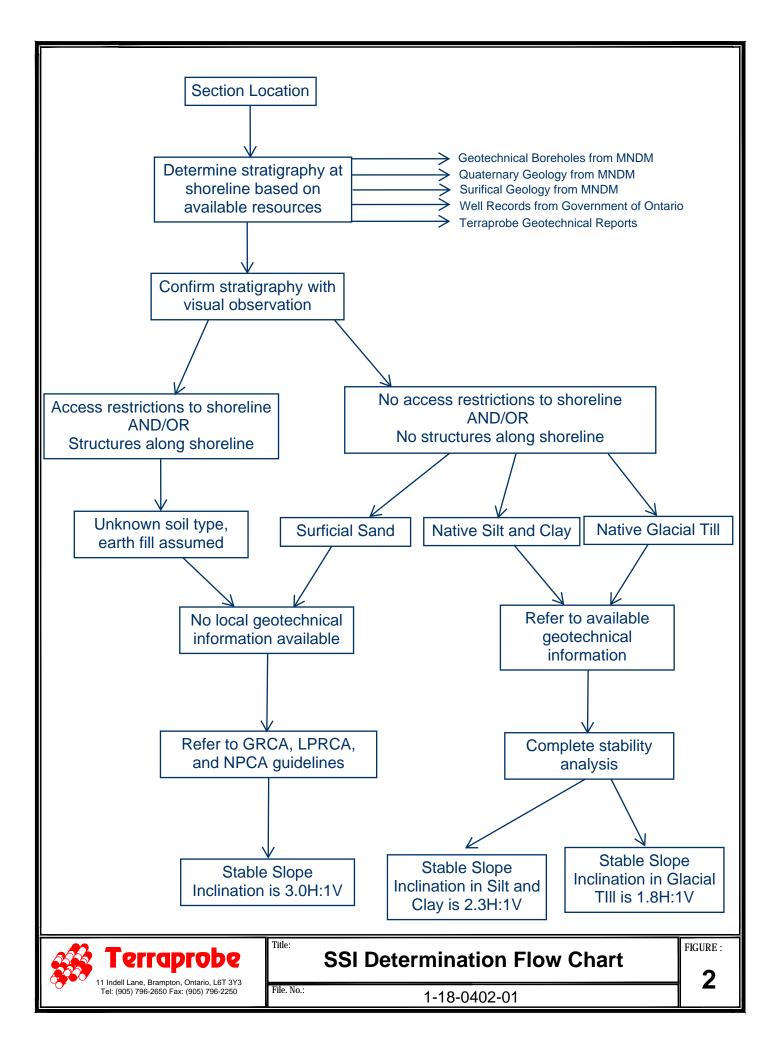


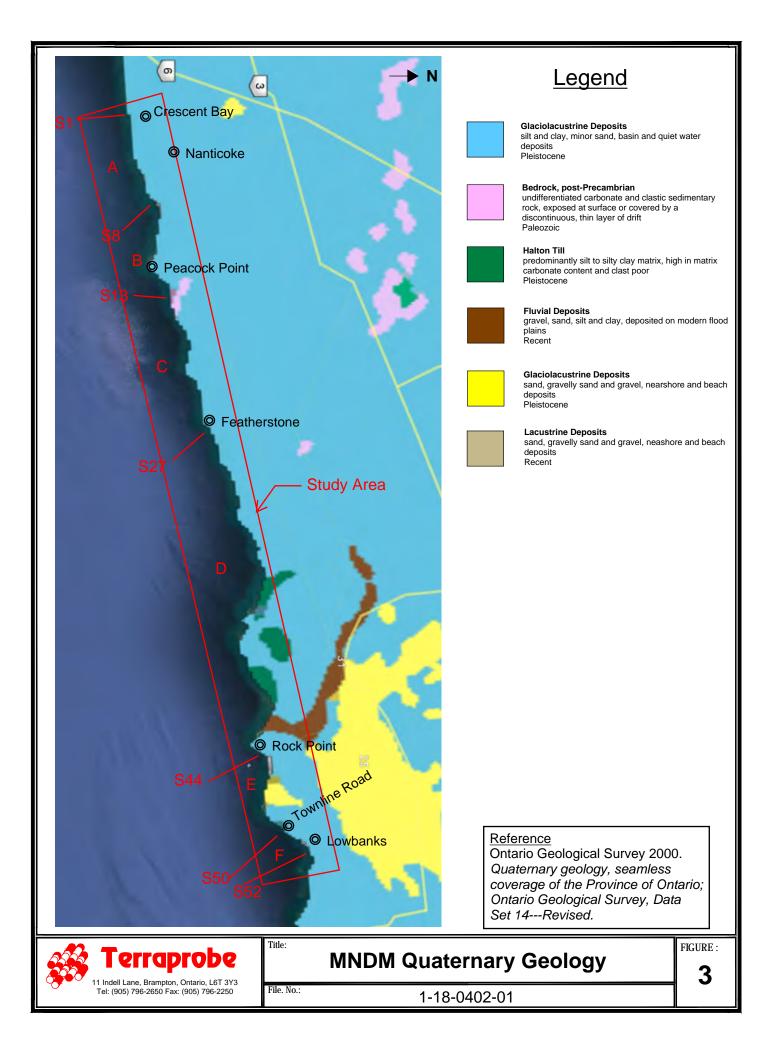


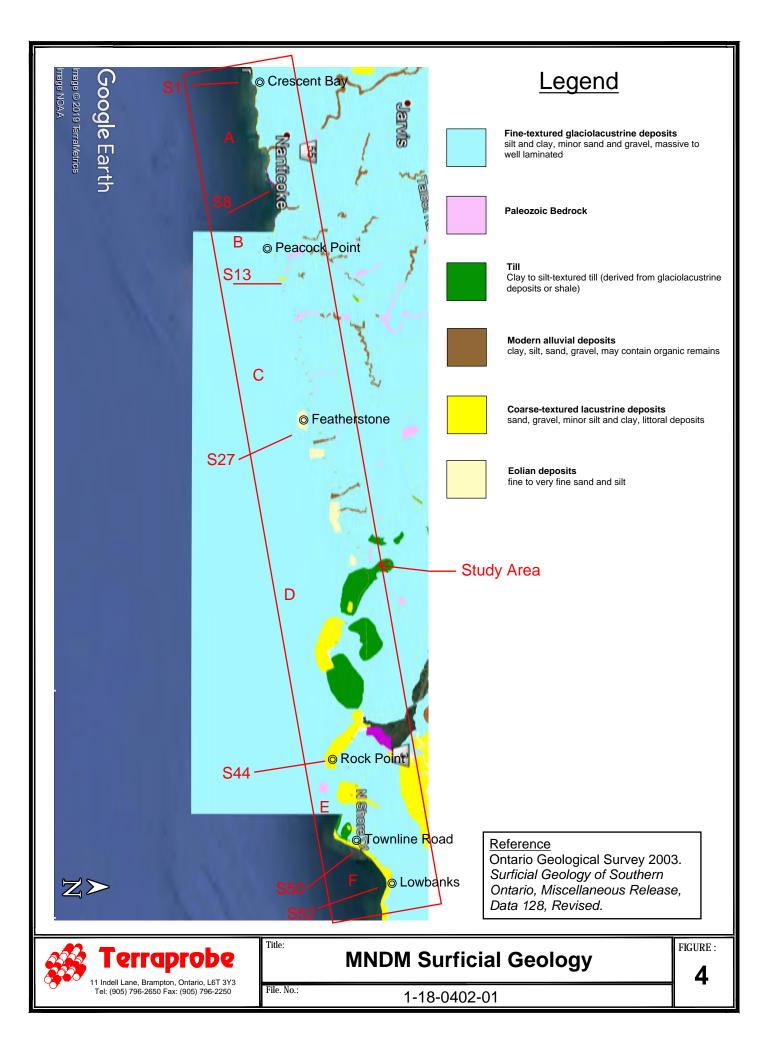
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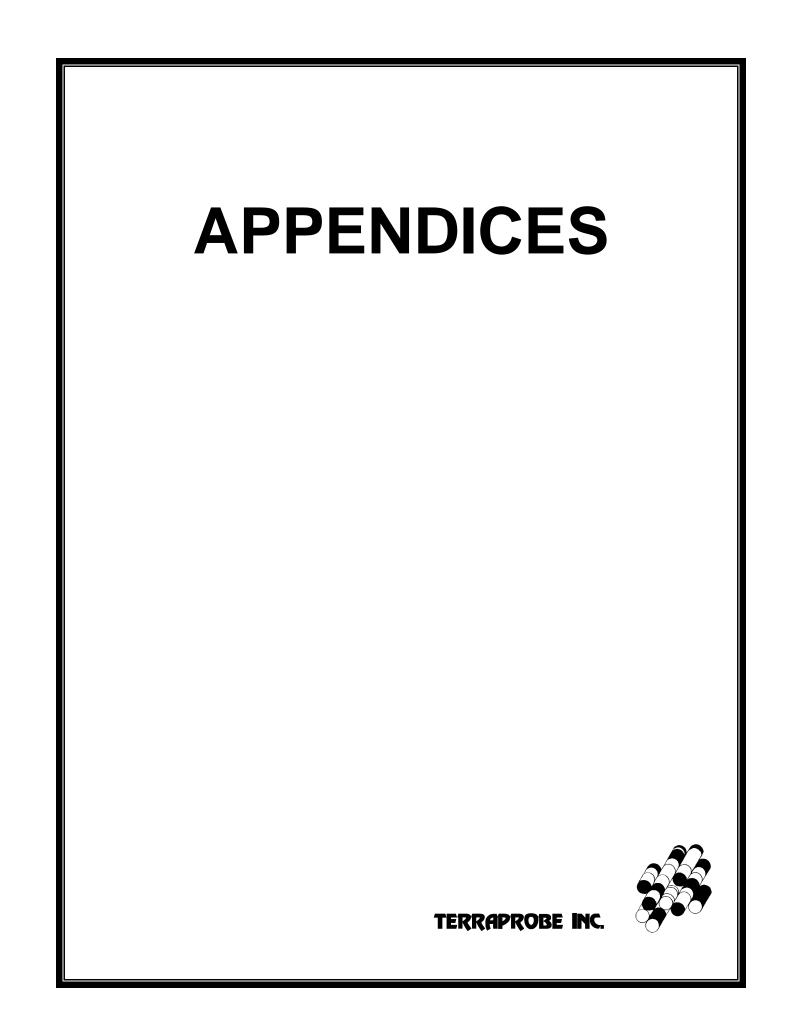


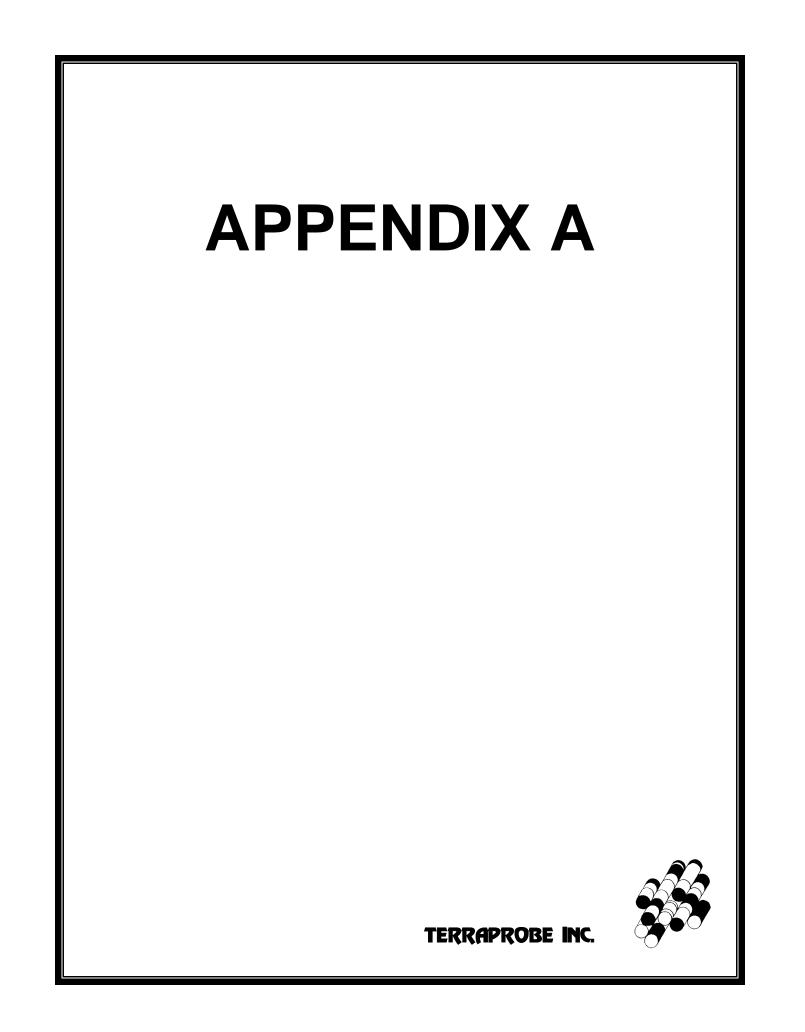












# Legend

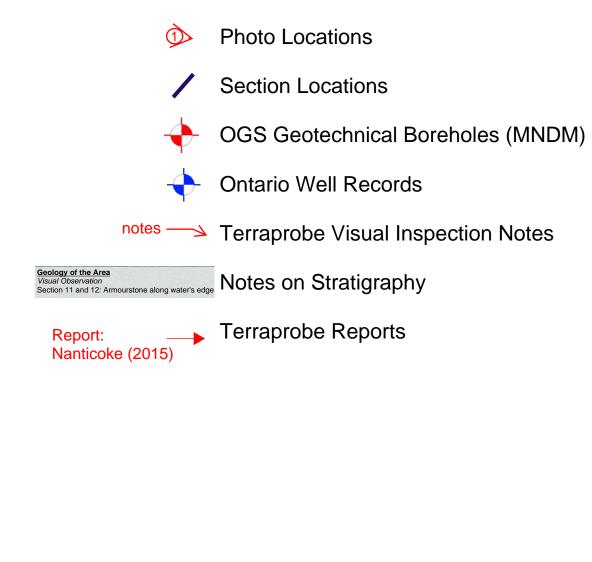




FIGURE :

Slop

Limestone bedrock, pebble beach to sand

up to 1.3H:1V.

1

1

houses on slopes, 1.5H:1V to 2H:1V

Google Earth Page | 1 <u>Geology of the Area</u> Ontario Geological Survey "Glaciolacustrine silt and clay, minor sand"

*Terraprobe Reports (Naticoke)* "Silty clay overburden, fissured, thin stratifications, Avg N=24, brownish grey, Bedrock Elev. 180.6 to 181.4 m, water table at Elev. 187.4 m." (1974)

7123004

"Silty clay, brown to grey, silt seams, Avg N=19, Bedrock Elev. 183.6 m." (2015)

Visual Observation Section 1 and 2: Silty clay, so sand, brown, moist, very stiff, thin stratifications, silt seams

## Legend

New-Lake Shore Rd-

1 Photo Locations

Section Locations

- OGS Geotechnical Boreholes (MNDM)

Ontario Well Records

2

N

1000 ft

Legend

# Armourstones at waters edge

#### Creek

#### Borehole ID 700003

New Pake Shore Rd

#### Borehole ID 700002

Completion Year : 1975 Elevation (DEM) : 180.6 m Total Depth : 3 m Static Water Level : m

Borehole Log (metres) 0 ~ 3 m clay, silt

Google Earth Page | 2 Completion Year : 1975 Elevation (DEM) : 176.1 m Total Depth : 4.7 m Static Water Level : m

Borehole Log (metres) 0 ~ 2.1 m clay, silt 2.1 ~ 4.5 m clay, silt 4.5 ~ 4.7 m unknown

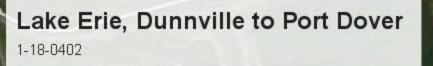
#### <u>Geology of the Area</u> Visual Observation Section 3: Armourstone along water's edge

### 1000 ft

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3

2



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Google Earth Page | 3 Jeake

1000 ft

A N

New-Laker Shore

Geology of the Area Ontario Geological Survey "Glaciolacustrine silt and clay, minor sand"

5

26(

*Terraprobe Reports (Naticoke)* "Silty clay overburden, fissured, thin stratifications, Avg N=24, brownish grey, Bedrock Elev. 180.6 to 181.4 m, water table at Elev. 187.4 m." (1974)

"Silty clay, brown to grey, silt seams, Avg N=19, Bedrock Elev. 183.6 m." (2015)

Visual Observation Section 5: Silty clay, so sand, brown, moist, very stiff, thin stratifications, silt seams

#### Borehole ID 700004

Legend

Completion Year : 1975 Elevation (DEM) : 179.4 m Total Depth : 4.9 m Static Water Level : m

Borehole Log (metres) 0 ~ 2.1 m clay, silt, pebbles 2.1 ~ 4.5 m clay, silt, pebbles 4.5 ~ 4.9 m unknown

Google Earth © 2018 Google Page | 4

TA INTO

N

Legend

A N

1000 ft

Hickory Beach

inclination flatter than — 3.0H:1V

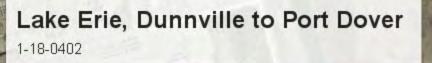
Google Earth Page | 5 <u>Geology of the Area</u> Ontario Geological Survey "Glaciolacustrine silt and clay, minor sand"

*Terraprobe Reports (Naticoke)* "Silty clay overburden, fissured, thin stratifications, Avg N=24, brownish grey, Bedrock Elev. 180.6 to 181.4 m, water table at Elev. 187.4 m." (1974)

Report:

Nanticoke (1974)

"Silty clay, brown to grey, silt seams, Avg N=19, Bedrock Elev. 183.6 m." (2015)



Report: Nanticoke (2015) 7

Google Earth

Here a

Geology of the Area Visual Observation Section 7: Earth fill embankment

1000 ft

Ñ

tension cracks tension crac

8

l a

armourstone

Legend

#### H:1V to 2H:1V, 1 m scarp at toe

#### Borehole ID 700005

Completion Year : 1975 Elevation (DEM) : 178.6 m Total Depth : 8.8 m Static Water Level : m

Borehole Log (metres) 0 ~ 3 m unknown 3 ~ 6.1 m clay, silt, pebbles 6.1 ~ 7.6 m clay, silt, stones 7.6 ~ 8.8 m till

Google Earth 8 2018 Google Page | 7



<u>Geology of the Area</u> Ontario Geological Survey "Glaciolacustrine silt and clay, minor sand"

*Terraprobe Reports (Naticoke)* "Silty clay overburden, fissured, thin stratifications, Avg N=24, brownish grey, Bedrock Elev. 180.6 to 181.4 m, water table at Elev. 187.4 m." (1974)

"Silty clay, brown to grey, silt seams, Avg N=19, Bedrock Elev. 183.6 m." (2015)

Visual Observation Section 8: Clayey silt, trace sand, grey, moist, trace rootlets, very stiff, thin stratifications

1000 ft

N

S-Coast-Dr

residential, no access, < 5 m height, some houses have erosion control at

Google Earth © 2018 Google Page | 8 Legend

SanduskeRd

N

9

## esidential, no access armourstone wall at shoreline

Google Earth Page | 9

## Borehole ID 700024

ПП

Completion Year : 1975 Elevation (DEM) : 178.2 m Total Depth : 9 m Static Water Level : m

Borehole Log (metres) 0 ~ 7.6 m clay, silt 7.6 ~ 8.2 m till 8.2 ~ 9 m limestone, chert

Geology of the Area Visual Observation Section 9: Armourstone along water's edge Legend

A N

1000 ft

Coast-D

eview

<u>Geology of the Area</u> Ontario Geological Survey "Glaciolacustrine silt and clay, minor sand"

#### Terraprobe Reports (Naticoke)

"Silty clay overburden, fissured, thin stratifications, Avg N=24, brownish grey, Bedrock Elev. 180.6 to 181.4 m, water table at Elev. 187.4 m." (1974)

"Silty clay, brown to grey, silt seams, Avg N=19, Bedrock Elev. 183.6 m." (2015)

## Borehole ID 700026

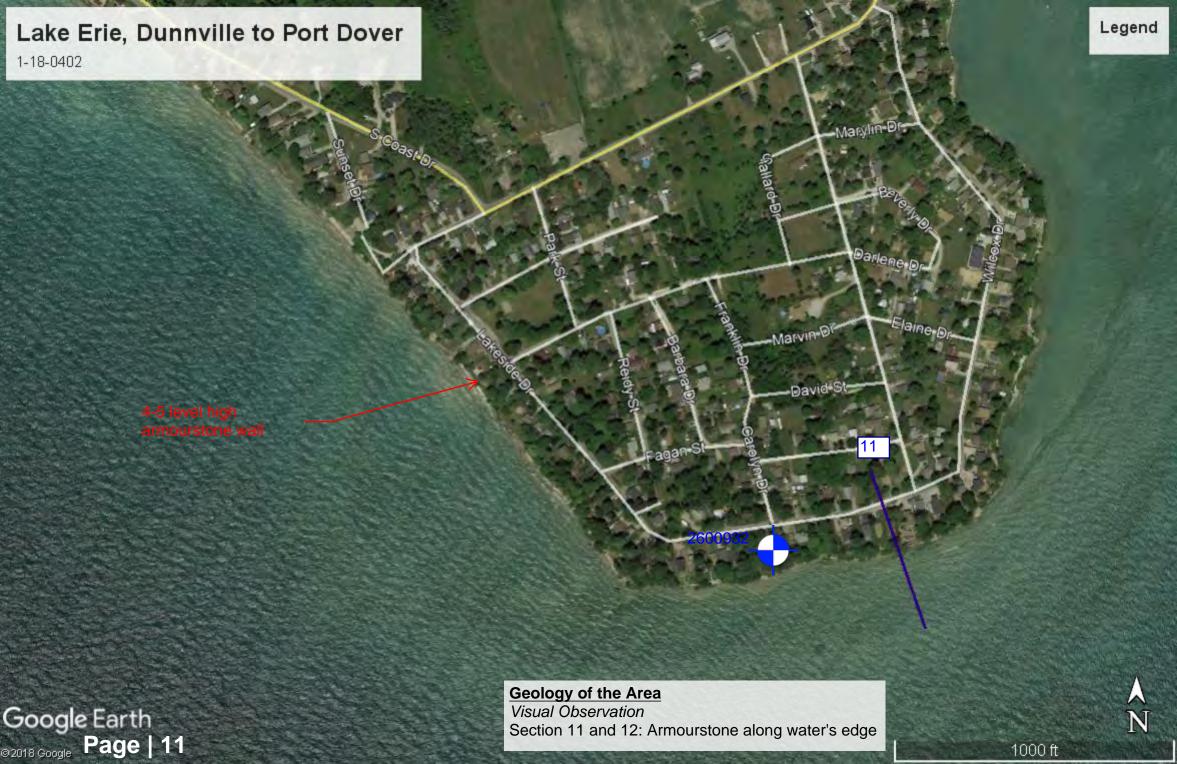
Legend

Completion Year : 1975 Elevation (DEM) : 177 m Total Depth : 8.8 m Static Water Level : m

Borehole Log (metres) 0 ~ 6.1 m clay, silt 6.1 ~ 8.2 m clay, pebbles 8.2 ~ 8.8 m unknown

1000 ft

Google Earth Page | 10





esidential, no access

Google Earth Page | 13 ∧ N

#### **Geology of the Area**

#### Legend

Ontario Geological Survey "Bedrock, post-Precambrian, undifferentiated carbonate and clastic sedimentary rock, exposed at surface or covered by discontinuous, thin layer of drift"

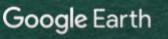
#### Visual Observation

14

Blue-Water Pkwy

Section 13: sand and gravel beach at water's edge Section 14: Armourstone along water's edge

13



© 2018 Google

N

Beach-L

armourstone / rip rap

1000 ft

15

Legend

A N

- armourstone/rip rap

Geology of the Area Ontario Geological Survey "Glaciolacustrine silt and clay, minor sand"

*Visual Observation* Section 15-18: Armourstone along water's edge

Google Earth

© 2018 Google

17

16

Summernanen

<u>Geology of the Area</u> Visual Observation Section 15-18: Armourstone along water's edge

(7)

Legend

A

N

1000 ft

Google Earth Page | 14

15



20

Legend

akeshore-Rd

21

1000

Google Earth <sup>© 2018 Google</sup> Page | 16

Geology of the Area Visual Observation Section 20-22: Armourstone along water's edge

Google Earth Page | 17 Geology of the Area Ontario Geological Survey

23

"Glaciolacustrine silt and clay, minor sand"

*Terraprobe Reports (Rainham)* "Silty clay, trace sand and gravel, brown, Avg N=21, Bedrock at 5 m depth." (2004) Legend

N

1000 ft

*Visual Observation* Section 23: silty clay, so sand, brown, moist Section 24: Armourstone along water's edge

Lakeshore Rd

Google Earth Page | 18 Legend

Geology of the Area

Upper Lake E

Grea

akeview

Ontario Geological Survey "Glaciolacustrine silt and clay, minor sand"

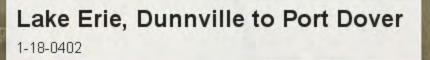
*Terraprobe Reports (Rainham)* "Silty clay, trace sand and gravel, brown, Avg N=21, Bedrock at 5 m depth." (2004)

*Visual Observation* Section 25 to 28: Armourstone along water's edge

1000 ft

N

Villoway-Lr



Lakeshore Rd-

Google Earth Page | 19 allow L

A

N

1000 ft

20000

<u>Geology of the Area</u> Ontario Geological Survey "Glaciolacustrine silt and clay, minor sand"

*Terraprobe Reports (Rainham)* "Silty clay, trace sand and gravel, brown, Avg N=21, Bedrock at 5 m depth." (2004)

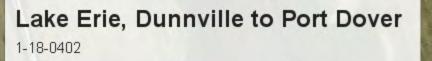
26

Winger-Bay-Ln

Visual Observation Section 25 to 28: Armourstone along water's edge



1000 ft



30 akeshore Rd

slope <5 m in height

<u>Geology of the Area</u> Ontario Geological Survey "Glaciolacustrine silt and clay, minor sand"

*Visual Observation* Section 29 to 34: Sand beach along water's edge

Google Earth © 2015 Google Page | 21

1000 ft

A N

Google Earth Page | 22

©2018 Google

31

Legend

Geology of the Area Ontario Geological Survey "Glaciolacustrine silt and clay, minor sand"

Visual Observation Section 29 to 34: Sand beach along water's edge

1000 ft

A N

32

A

N

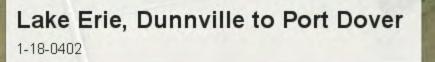
1000 ft

# \_ sandy beach, <5 m in

— limestone

Google Earth Page | 23 <u>Geology of the Area</u> Ontario Geological Survey "Glaciolacustrine silt and clay, minor sand"

*Visual Observation* Section 29 to 34: Sand beach along water's edge



Kers R

33

A N

1000 ft

<u>Geology of the Area</u> Ontario Geological Survey "Glaciolacustrine silt and clay, minor sand"

Visual Observation Section 29 to 34: Sand beach along water's edge



akeshore

Google Earth Page | 25 A N

1000 ft

## sandy beach over visible limestone

#### Borehole ID 856345

Completion Year : 1970 Elevation (DEM) : 174.1 m Total Depth : 5.9 m Static Water Level : 0.9 m

Borehole Log (metres) 0 ~ 0.3 m topsoil 0.3 ~ 4.9 m clay, silt, silt, fine sand, brown, very stiff 4.9 ~ 5.9 m till, silt, sand, gravel, brown, dense

35

<u>Geology of the Area</u> Ontario Geological Survey "Glaciolacustrine silt and clay, minor sand"

Visual Observation Section 35: Armourstone along water's edge

sandy beach over
visible limestone

Google Earth Page | 26

residential properties with armourstone/concrete walls at sho

Google Earth © 2018 Google Page | 27

36

shore

#### visible limestone

<u>Geology of the Area</u> Ontario Geological Survey "Glaciolacustrine silt and clay, minor sand"

*Visual Observation* Section 36: Sand beach along water's edge N

1000 ft

Lakeshore Rd-

A N

1000 ft

<u>Geology of the Area</u> Ontario Geological Survey "Glaciolacustrine silt and clay, minor sand"

*Visual Observation* Section 37: Armourstone along water's edge

Google Earth <sup>© 2018 Google</sup> Page | 28

Cayuga





Google Earth Page | 30 ŝ

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38

∧ N

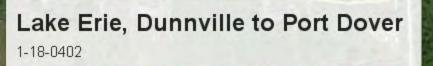
1000 ft

#### Geology of the Area Ontario Geological Survey "Glaciolacustrine silt and clay, minor sand"

New-bakeshore-Rd-Edgewater-Ph

Visual Observation Section 38: Sand beach along water's edge





N

1000 ft

### private properties, <5 m high slope

39

visible limestone

Google Earth © 2018 Google Page | 32

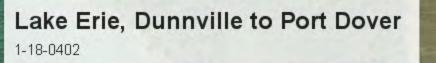
1 Star

Geology of the Area

-Horseshoe-Bay-Rd-

*Ontario Geological Survey* "Halton Till, predominantly silt to silty clay"

Visual Observation Section 39: Armourstone along water's edge



Google Earth © 2018 Google Page | 33 N

1000 ft

### Geology of the Area Ontario Geological Survey "Halton Till, predominantly silt to silty clay"

40

77

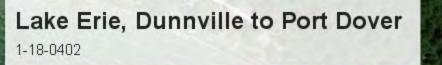
, flatter than

Visual Observation Section 40: Sand beach along water's edge

adisei

Legend

Google Earth © 2018 Google Page | 34



Google Earth Page | 35

000

<u>Geology of the Area</u> Ontario Geological Survey "Glaciolacustrine silt and clay, minor sand"

41

Marshall-Ro

Visual Observation Section 41: Sand beach along water's edge

<5 m in height, flatter than 3H:1V Legend

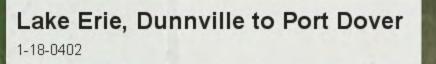
∧ N

1000 ft

Sandy-Bay-Re

visible limestone

Google Earth Page | 36



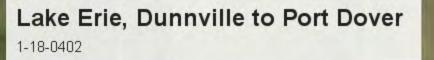
dv-Bay

Dearden Ln

Stonehaven

private property, no access





-eighthouse-Ol

Google Earth © 2018 Google Page | 38 42

A

N

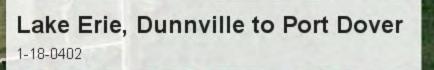
1000 ft

Geology of the Area Ontario Geological Survey "Halton Till, predominantly silt to silty clay"

Visual Observations Section 42: Sand beach along water's edge



Google Earth <sup>© 2018 Google</sup> Page | 39



Dover-St-

Legend

Sand beaches, < 5m n height, flatter than 3H:1V

Google Earth Page | 40

1000 ft

sand beach, <5 m height

Google Earth © 2018 Google Page | 41 Visual Observation Section 43: Sand beach along water's edge

"Fluvial Deposits, gravel, sand, silt and clay, deposited on modern flood plains"

<u>Geology of the Area</u> Ontario Geological Survey Legend

1000 ft

....

Burtom-E

N



sandy dunes, up to 7 m high and 2H:1V

visible limestone shelf

Google Earth © 2018 Google Page | 43 mage © 2019 TerraMetrics

Burtomer

∧ N

Legend

private farm field, no – access, slope ~10 m high and near vertice

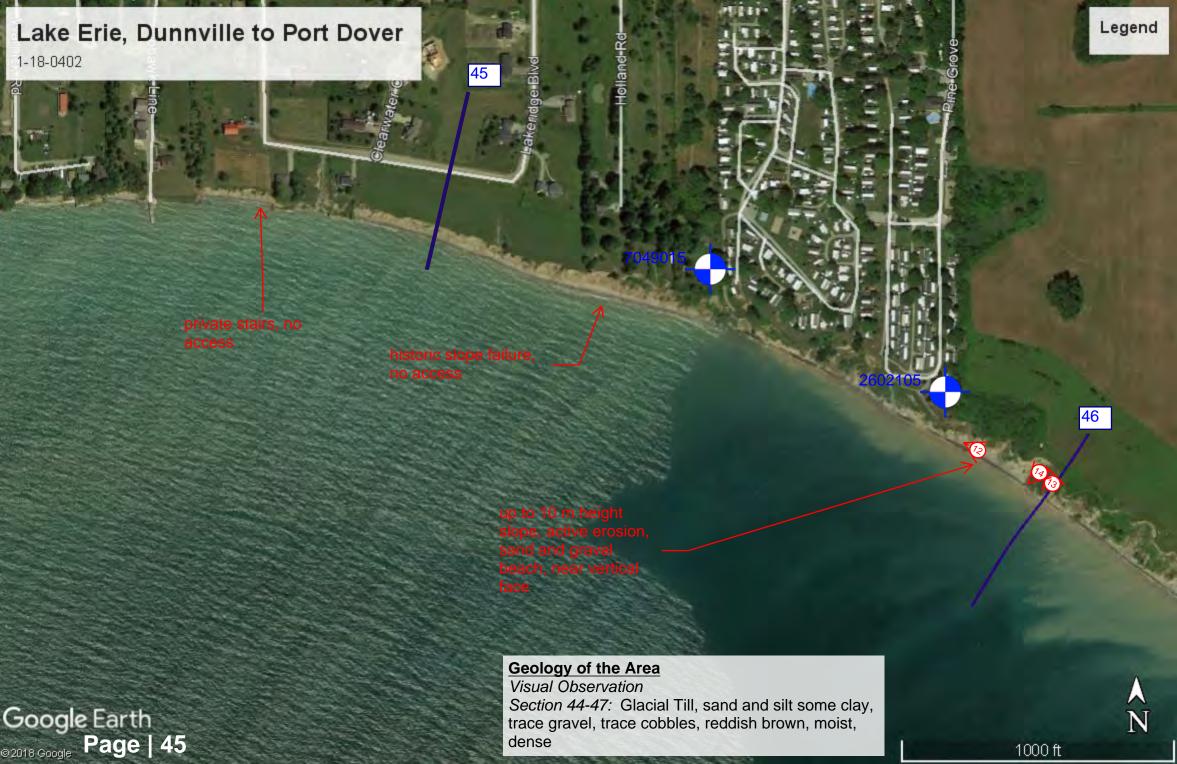
Google Earth Page | 44

44

<u>Geology of the Area</u> Visual Observation Section 44-47: Glacial Till, sand and silt some clay, trace gravel, trace cobbles, reddish brown, moist, dense

∧ N

1000 ft



armourstone wal along shoreline

>10 m high slope, construction of gabion stone walls ~6-7 m high

#### Geology of the Area

Visual Observation Section 44-47: Glacial Till, sand and silt some clay, trace gravel, trace cobbles, reddish brown, moist, dense

#### Borehole ID 700802

Completion Year : 1981 Elevation (DEM) : 175.5 m Total Depth : 8.2 m Static Water Level : m

Borehole Log (metres) 0 ~ 8.2 m till, grey-brown 0 ~ 8.2 m till, grey-brown

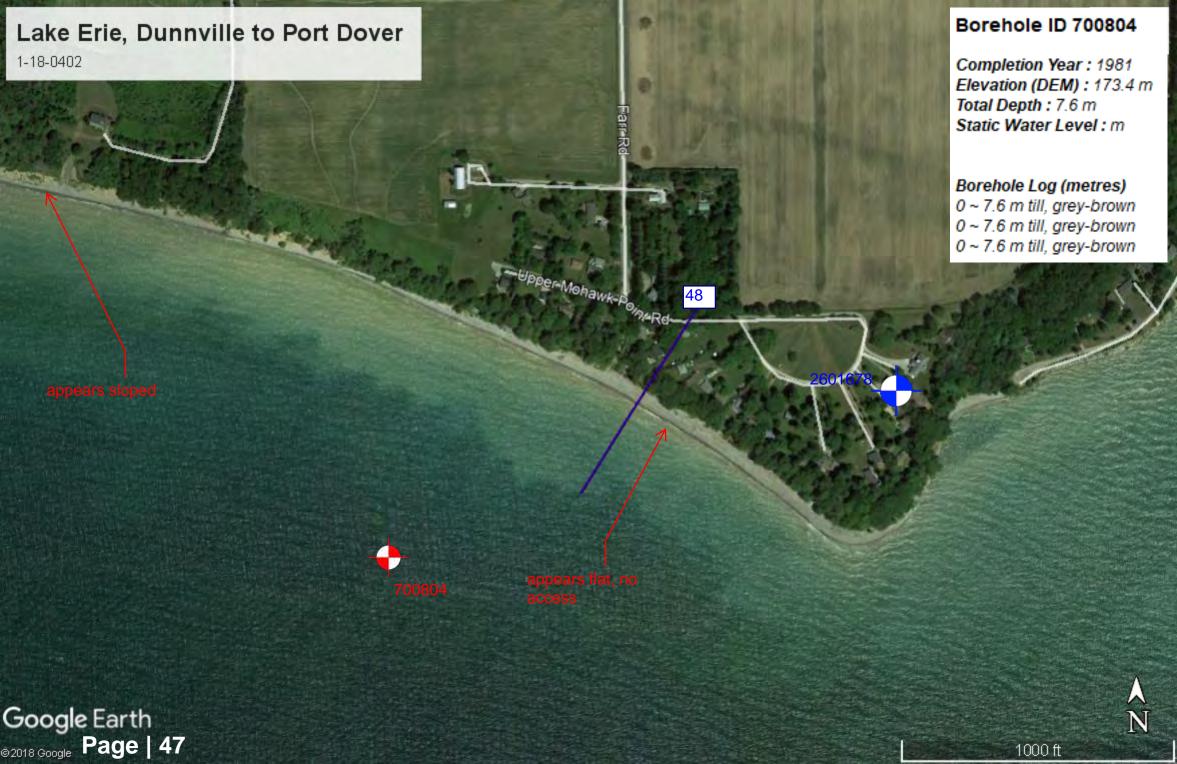
> A N

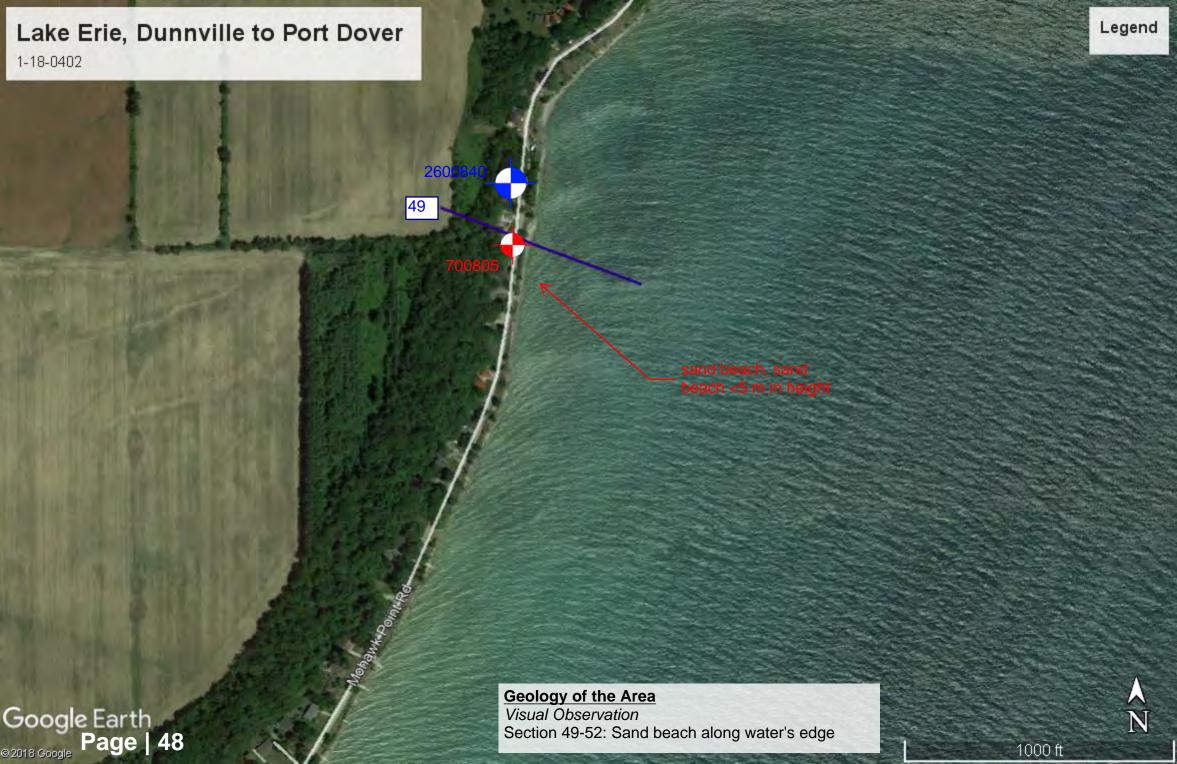


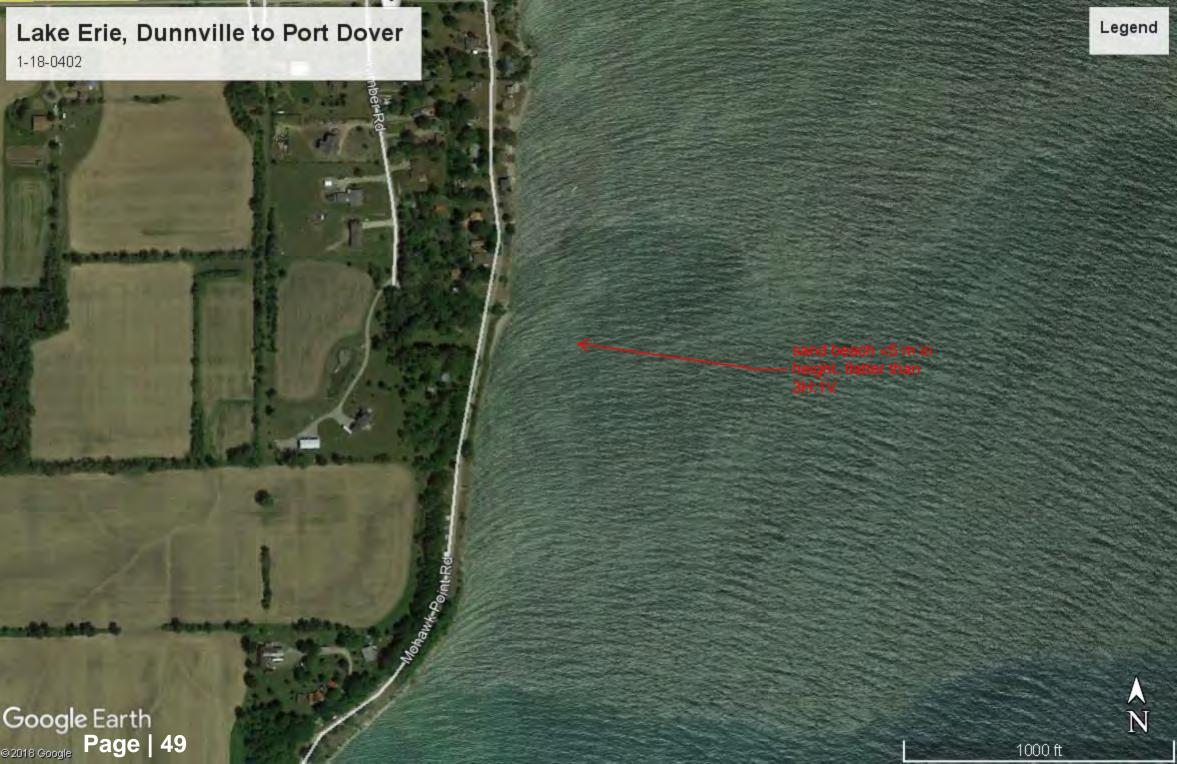
Heights-Liv

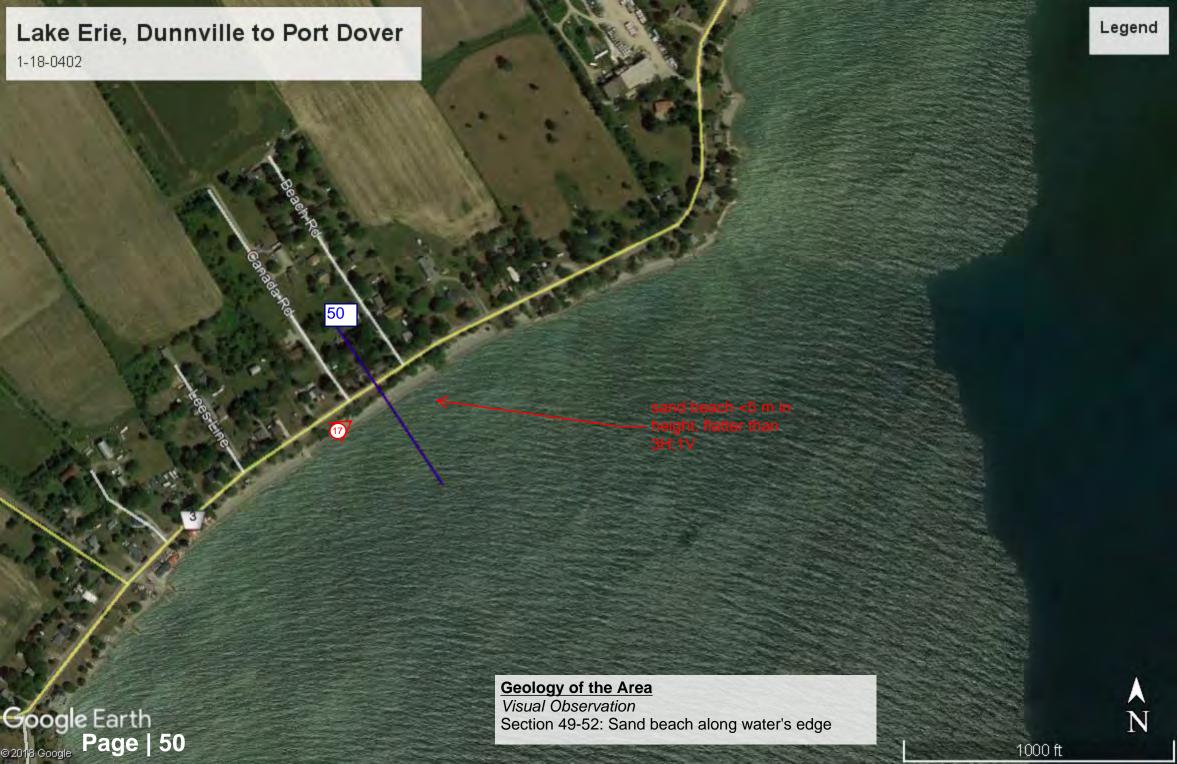
1000 ft

### Google Earth © 2018 Google Page | 46









Lake Erie, Dunnville to Port Dover 1-18-0402

51

#### Borehole ID 700801

Completion Year : 1981 Elevation (DEM) : 172.6 m Total Depth : 1.5 m Static Water Level : m

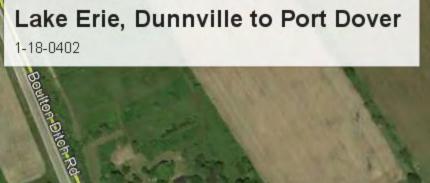
Borehole Log (metres) 0 ~ 1.5 m gravel, sand

Google Earth Page | 51 <u>Geology of the Area</u> Visual Observation Section 49-52: Sand beach along water's edge

1000 ft

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N





Report: Burnaby (2016) Legend

5

65

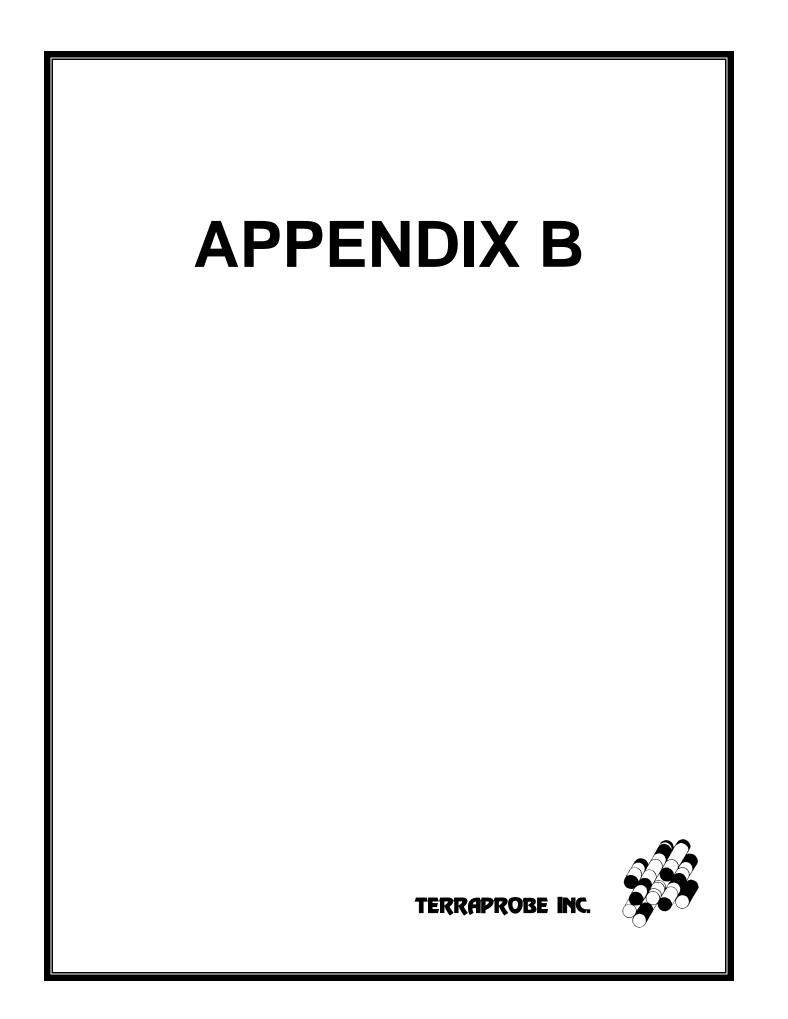
Google Earth Page | 52 beaches, <5 m height, flatter han 3H:1V

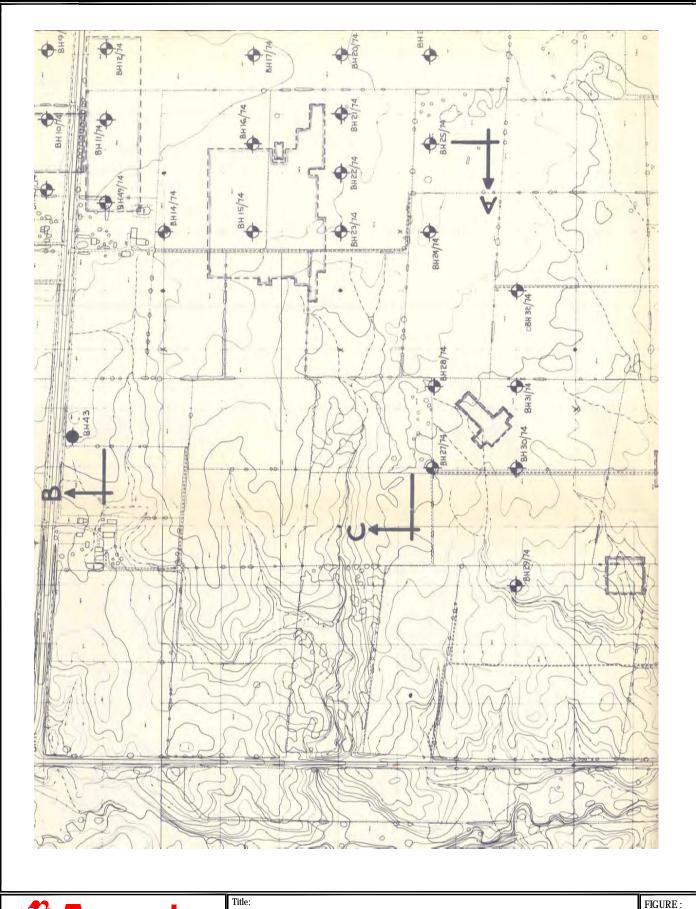
> Geology of the Area Visual Observation Section 49-52: Sand beach along water's edge

52

1000 ft

∧ N



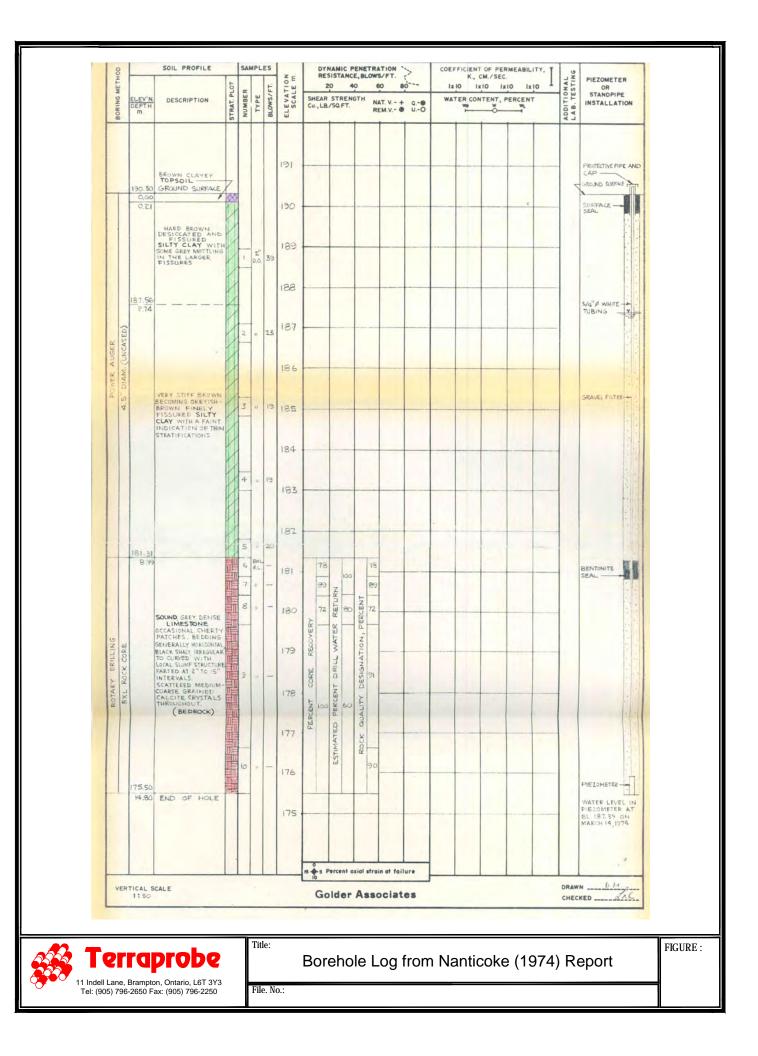


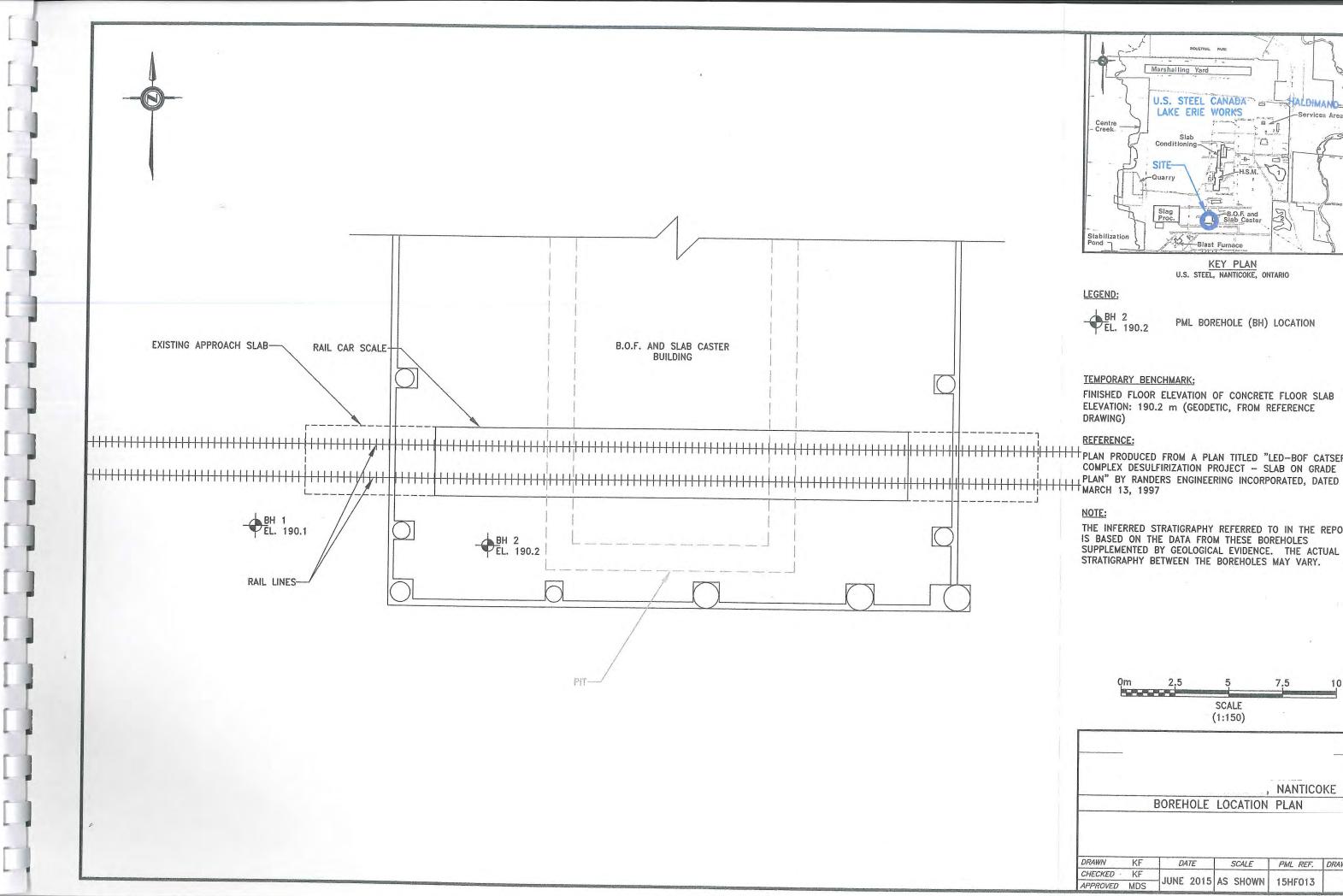
obe 211ap – 11 Indell Lane, Brampton, Ontario, L6T 3Y3 Tel: (905) 796-2650 Fax: (905) 796-2250

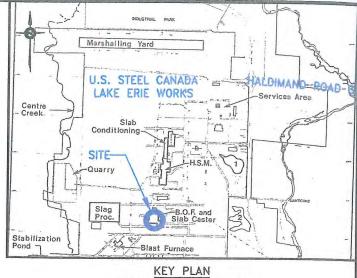
File. No.:

Borehole Location Plan from Nanticoke (1974) Report

FIGURE :







U.S. STEEL, NANTICOKE, ONTARIO

LEGEND:

BH 2 EL. 190.2

PML BOREHOLE (BH) LOCATION

**TEMPORARY BENCHMARK:** 

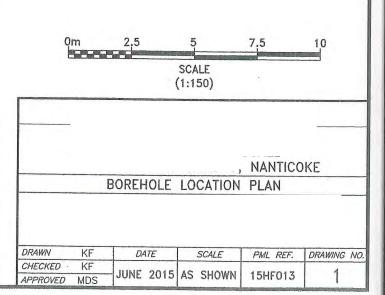
FINISHED FLOOR ELEVATION OF CONCRETE FLOOR SLAB ELEVATION: 190.2 m (GEODETIC, FROM REFERENCE DRAWING)

**REFERENCE:** 

HILLING A PLAN TITLED "LED-BOF CATSER COMPLEX DESULFIRIZATION PROJECT - SLAB ON GRADE

NOTE:

THE INFERRED STRATIGRAPHY REFERRED TO IN THE REPORT IS BASED ON THE DATA FROM THESE BOREHOLES SUPPLEMENTED BY GEOLOGICAL EVIDENCE. THE ACTUAL STRATIGRAPHY BETWEEN THE BOREHOLES MAY VARY.



|               | ING METHOD Continuous Flight Solid Str<br>SOIL PROFILE                                                                                  | 1          |           | SAM  | PLES       | SCALE      | SHE/ | AR STR                  |      | H (kPa<br>RVANE | )<br>O Qu | PLASTIC     | NATUR        | AL | LIQUID    | ţ                      | GROUND WATER                                                                                        |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------|------------|-----------|------|------------|------------|------|-------------------------|------|-----------------|-----------|-------------|--------------|----|-----------|------------------------|-----------------------------------------------------------------------------------------------------|
| DEPTH<br>ELEV | DESCRIPTION                                                                                                                             | STRAT PLOT | NUMBER    | TYPE | "N" VALUES | EVATION SC | AFU  | 50 1                    | 00 1 | 50 2            | 200       | LIMIT<br>Wp | CONTE        | NT |           | UNIT WEIGHT            | OBSERVATIONS<br>AND REMARKS                                                                         |
| (meters)      | SURFACE ELEVATION 190.1                                                                                                                 | STR        | N         | 6    | z          | ELEV       |      | MIC COL<br>DARD P<br>20 |      |                 | EST e     | WAT 10      | ER CON<br>20 |    | (%)<br>40 | S<br>kN/m <sup>3</sup> | GRAIN SIZE<br>DISTRIBUTION (S<br>GR SA SI CL                                                        |
| -189.9<br>0.7 | FILL: Dense, grey crushed limestone<br>gravel, some sand, damp<br>Dense, grey crushed slag and limestone                                | ×          | 1A<br>1B* | 55   | 39         | 19         |      |                         |      |                 |           | 0           |              |    |           |                        |                                                                                                     |
| 189,2         | isand and gravel mixed fill, damp<br>Dense, grey crushed limestone granular<br>base, moist; with filter cloth at tip                    |            | 2A<br>2B  | SS   | 39         | 18         | _    | 1                       |      | -               |           | 0           | -            |    |           |                        |                                                                                                     |
| 1.4<br>188.7  | Dense, grey crushed limestone granular<br>subbase, wet<br>CLAY: Very stilf, brown silty clay, trace<br>sand and gravel, DTPL: with Iron |            | 3*        | SS   | 20         |            |      | Y                       |      |                 |           |             | 0            |    |           |                        |                                                                                                     |
|               | staining, grey fissures and occasional silt<br>lenses and shale fragments                                                               | 1.         | 4         | SS   | 18         | 186        |      |                         |      |                 |           |             |              | 0  |           |                        |                                                                                                     |
| 187,2         | becoming stiff, WTPL                                                                                                                    |            | 5         | SS   | 13         | 187        | -    |                         | *    |                 |           |             | -            | 0  | -         |                        |                                                                                                     |
| 3.7<br>186.4  | becoming grey                                                                                                                           | 2          | 6         | SS   | 12         | 180        |      |                         |      |                 |           | Ц.          |              |    |           |                        |                                                                                                     |
| 4.4           | becoming very stiff                                                                                                                     |            | 7         | SS   | 18         | -          |      |                         |      |                 |           |             |              | 0  |           |                        |                                                                                                     |
| 5.2<br>184.9  | becoming hard, brown; with numerous silt<br>seams                                                                                       | 0          | 8         | SS   | 33         | 185        |      | $\sum$                  |      |                 | -         |             | -            |    |           |                        |                                                                                                     |
| 184.2         | becoming grey, with occasional limestone<br>fragments                                                                                   | 1 10       | 9         | SS   | 57/200mm   | 184        |      |                         | -    | /               | 1         |             | 0            |    |           | à                      |                                                                                                     |
|               | BOREHOLE TERMINATED AT 6.5 m<br>UPON PRACTICAL REFUSAL TO<br>AUGER ON PROBABLE BEDROCK                                                  |            |           |      |            |            |      |                         |      |                 |           |             |              |    |           |                        | Upon completion of augering<br>no free water, no cave<br>* Sample submitted for<br>chemical testing |

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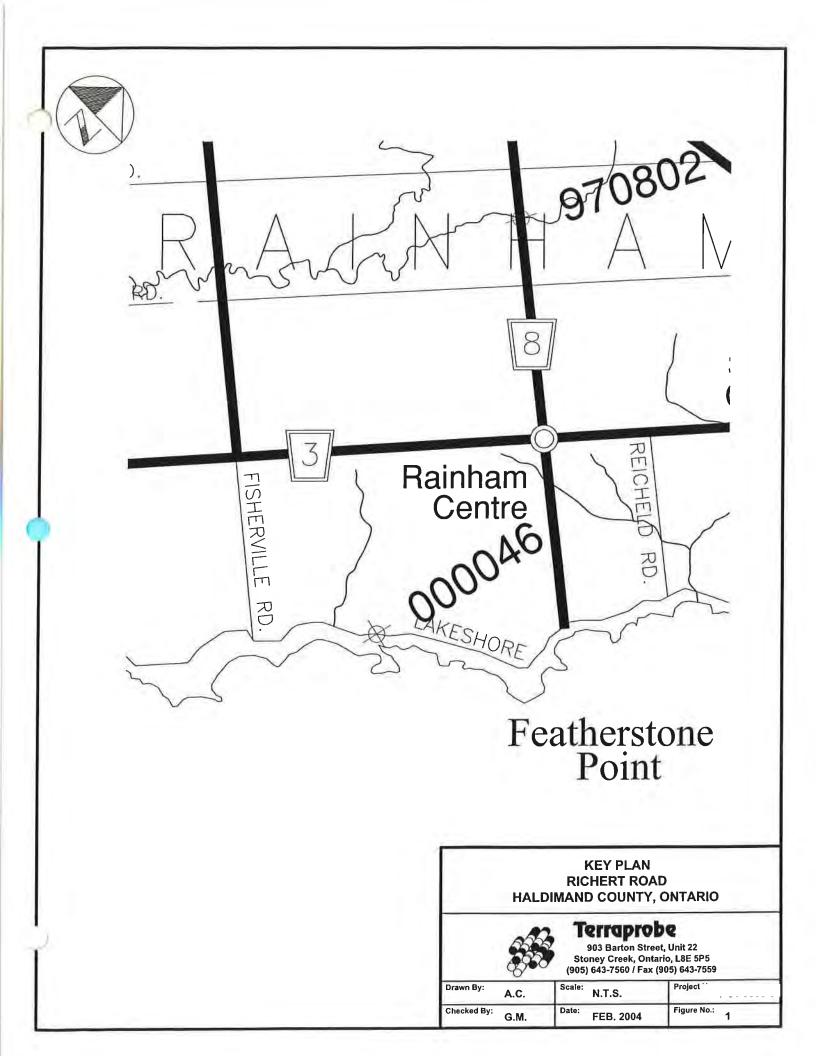
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1

#### LOG OF BOREHOLE NO. 2 17T 0573914E 4739332N 1 of 1 Nanticoke, ON BORING DATE June 2, 2015 BORING METHOD Continuous Flight Solid Stem Augers SHEAR STRENGTH (KPa) +FIELD VANE ATORVANE O QU PLASTIC MOISTURE CONTENT SOIL PROFILE SAMPLES ELEVATION SCALE LIQUID WEIGHT GROUND WATER STRAT PLOT OBSERVATIONS VALUES DEPTH ELEV NUMBER TYPE 50 100 150 200 W<sub>o</sub> w WL. DESCRIPTION AND REMARKS UNIT V (meters) DYNAMIC CONE PENETRATION STANDARD PENETRATION TEST WATER CONTENT (%) GRAIN SIZE DISTRIBUTION (%) GR SA SI CL z 20 40 60 10 20 30 SURFACE ELEVATION 190.2 CONCRETE: 100 mm concrete slab 40 80 dN/m 0.0 190.1 X 190 FILL: Dense to compact, grey crushed slag fill, damp 1\* SS 46 0 1.0 2 SS 20 ó 189 1.4 CLAY: Very stiff, brown silty clay, trace sand and gravel, DTPL: with occasional shale fragments, silt seams and iron 3\* SS 22 0 2.0 staining 188 4 SS 23 o 3.0-5 SS 24 187 186.5 becoming grey, WTPL 4.0 6 SS 15 186 185.8 becoming stiff, with some sand 7 SS 12 0 5,0 185.0 180 with numerous grey silt seams 8 SS 15 ۸ 0 6.0 18 9 SS 26 èA. 6,6 183,6 BOREHOLE TERMINATED AT 6.6 m Upon completion of augering, UPON PRACTICAL REFUSAL TO AUGER ON PROBABLE BEDROCK no free water, no cave 7.0 \* Sample submitted for chemical testing 8.0 9,0 10.0 11.0-12,0 13.0 14,0 15.0 NOTES PML - BH LOG GEO/ENV WITH MWS 15HF013 BH LOGS 2015-06-08.GPJ ON\_MOT.GDT 6/25/2015 9:39:34 AM





# LOG OF BOREHOLE 1

BORING DATE: February 10, 2004

**ELEVATION DATUM: Local** 

LOCATION: Lakeshore Road - Haldimand County

SAMPLER HAMMER, 63.5kg; DROP, 760mm

| 6                 | l u                      | SOIL PROFILE                                                    |             |                       | SA | AMPL | .ES       | PENETRATION<br>RESISTANCE PLOT                   |      |   |                    |                                                        |
|-------------------|--------------------------|-----------------------------------------------------------------|-------------|-----------------------|----|------|-----------|--------------------------------------------------|------|---|--------------------|--------------------------------------------------------|
| BORING METHOD     | DEPTH SCALE<br>IN METRES | DESCRIPTION                                                     | STRATA PLOT | ELEV.<br>DEPTH<br>(m) |    | ТҮРЕ | "N" VALUE | 20 40 60 80<br>SHEAR STRENGTH kPa<br>20 40 60 80 | w.p. | ( | CONTENT<br>%)<br>5 | INSTALLATION<br>INFORMATION                            |
| 1                 | 0 -                      | GROUND SURFACE                                                  |             | 100.08                |    | -    |           |                                                  |      |   |                    |                                                        |
|                   |                          | GRANULAR BASE/SUBBASE                                           |             | 99.53<br>0.55         | 1  | AS   |           |                                                  | 0    |   |                    |                                                        |
|                   | 1 -                      |                                                                 |             |                       | 2  | SS   | 13        |                                                  |      |   | 0                  |                                                        |
|                   | 2 —                      | Soft to stiff, black to dark grey,<br>SILTY CLAY (ORGANIC)      |             |                       | 3  | SS   | 3         |                                                  |      |   | c                  | 0.57%                                                  |
|                   |                          |                                                                 |             |                       | 4  | SS   | 4         |                                                  |      |   | 4                  | 2                                                      |
|                   | 3                        |                                                                 |             | 96.88<br>3.20         | 5  | SS   | 18        |                                                  |      |   | 0                  |                                                        |
| MOUNT             | 4                        | Very stiff, brown;<br>SILTY CLAY,<br>with silt seams and layers |             | -                     | 6  | SS   | 27        |                                                  |      | 0 |                    |                                                        |
| CME 75 TRUCKMOUNT | 5                        |                                                                 |             | 94.85                 | 7  | ss   | 20        |                                                  |      | 0 |                    | Feb 10/04                                              |
| CME               | 6                        | END OF BOREHOLE (Auger Refusal<br>Probably Bedrock)             | 1244        | 5.23                  |    |      |           |                                                  |      |   |                    |                                                        |
|                   | 8                        |                                                                 |             |                       |    |      |           |                                                  |      |   |                    | NOTES:<br>Water level in open<br>borehole at elevation |
|                   | 9                        |                                                                 |             |                       |    |      |           |                                                  |      |   |                    | 95.36m after drilling.                                 |



A. CUMMINGS

7-04-0006-6-1.DWC





BORING DATE: February 10, 2004

**ELEVATION DATUM: Local** 

LOCATION: Lakeshore Road - Haldimand County

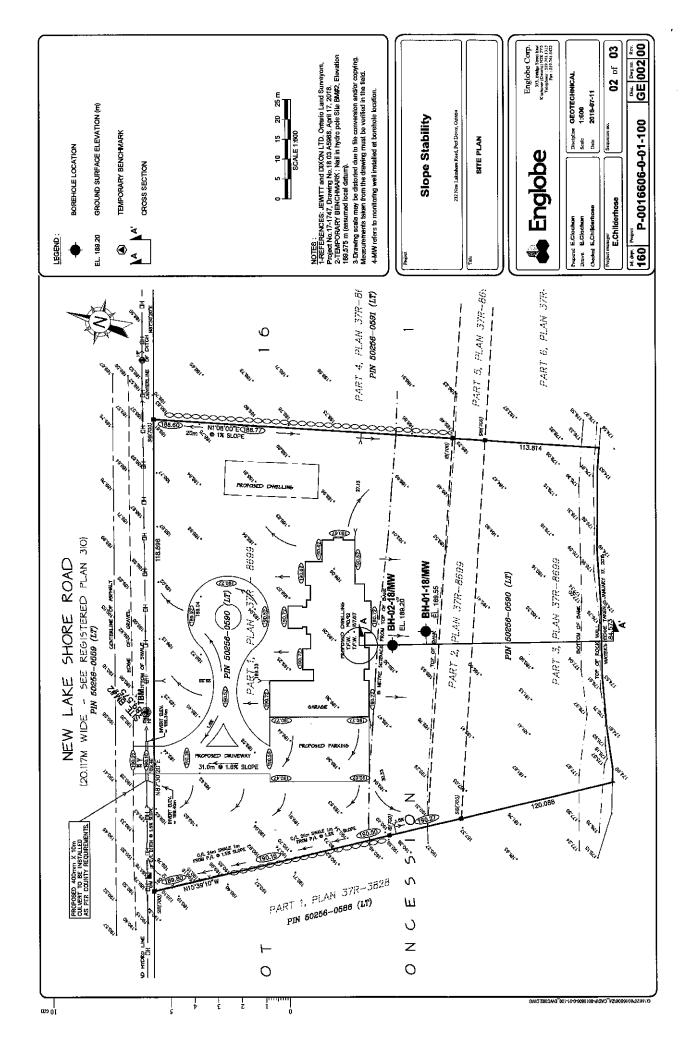
SAMPLER HAMMER, 63.5kg; DROP, 760mm

| [e                | 1                        | SOIL PROFILE                                                       |             |                       | SA     | MPL  | ES        | PENETRATION<br>RESISTANCE PLOT                   |                 |   |                                                                        |
|-------------------|--------------------------|--------------------------------------------------------------------|-------------|-----------------------|--------|------|-----------|--------------------------------------------------|-----------------|---|------------------------------------------------------------------------|
| BORING METHOD     | DEPTH SCALE<br>IN METRES | DESCRIPTION                                                        | STRATA PLOT | ELEV.<br>DEPTH<br>(m) | NUMBER | TYPE | "N" VALUE | 20 40 60 80<br>SHEAR STRENGTH kPa<br>20 40 60 80 | WATER CC<br>(%) |   | INSTALLATION<br>INFORMATION                                            |
|                   | 0 -                      | GROUND SURFACE<br>25mm Asphalt                                     | KXX)        | 100.00                |        |      |           |                                                  |                 |   | COLD PATCH                                                             |
|                   |                          | (FILL)<br>GRANULAR BASE/SUBBASE                                    |             | 99.50                 | 1      | AS   | 7         |                                                  | 0               |   | HOLE PLUG                                                              |
|                   | 1                        | (FILL)<br>Compact, black;<br>SILTY TOPSOIL                         |             | 0.50                  | 2      | SS   | 10        |                                                  |                 | 0 |                                                                        |
|                   | and the second           | Firm, grey and black;<br>SILTY CLAY (Organic)                      |             | 98.60<br>1.40         | 3      | SS   | 8         |                                                  |                 | 0 | 942.6%                                                                 |
|                   | 2                        |                                                                    |             | 97.60<br>240          | 4      | SS   | 15        |                                                  | 0               |   | CUTTINGS                                                               |
|                   | 3                        |                                                                    |             |                       |        |      |           |                                                  |                 |   |                                                                        |
|                   |                          | Very stiff to hard, brown;<br>SILTY CLAY,<br>trace sand and gravel |             |                       | 5      | SS   | 30        |                                                  | 0               |   | SCREEN                                                                 |
| MOUNT             | 4                        |                                                                    |             | ł                     | 6      | SS   | 21        |                                                  | o               |   | SLOTTED PIPE                                                           |
| CME 75 TRUCKMOUNT | 5                        |                                                                    |             | 94.97                 | 7      | ss   | 19        |                                                  | 0               |   |                                                                        |
| CME 7             |                          | END OF BOREHOLE (Auger Refusal<br>Probably Bedrock)                |             | 5.03                  |        |      |           |                                                  |                 |   |                                                                        |
|                   | 6                        |                                                                    |             |                       |        |      |           |                                                  |                 |   |                                                                        |
|                   | 7                        |                                                                    |             |                       |        |      |           |                                                  |                 |   |                                                                        |
|                   | 8                        |                                                                    |             |                       |        |      |           |                                                  |                 |   |                                                                        |
|                   | 9 -                      |                                                                    |             |                       |        |      |           |                                                  |                 |   | NOTES:<br>Borehole dry upon<br>completion of drilling.<br>SHEET 1 OF 1 |



A. CUMMINGS

7-04-0006-6-2.DWC





Ground Elevation: 189.55 m

#### **Borehole Number:**

BH-01-18

P-0016606-0-01-100

2018-07-06

D.Souter

**Drill Method:** 

Job N°:

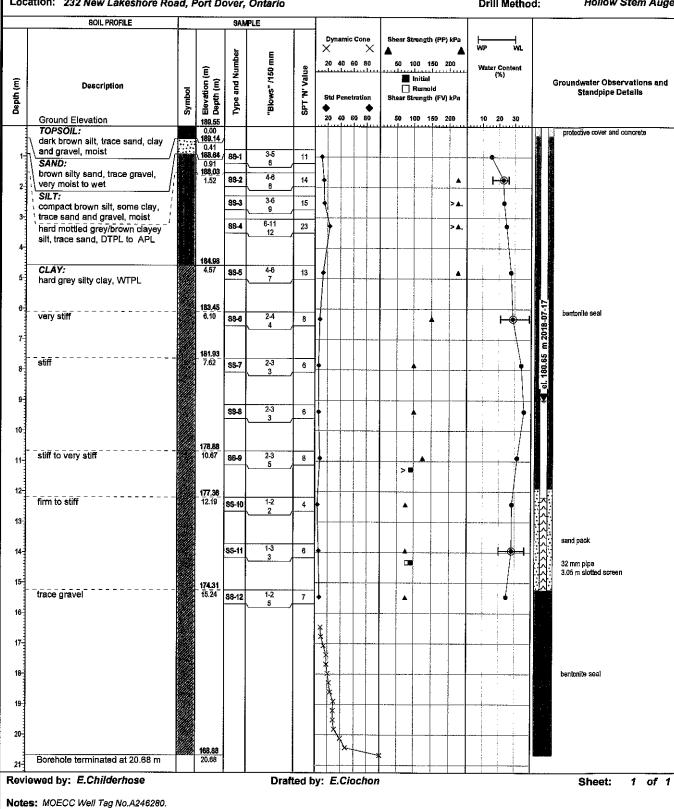
Drill Date:

Field Tech:

Hollow Stem Auger

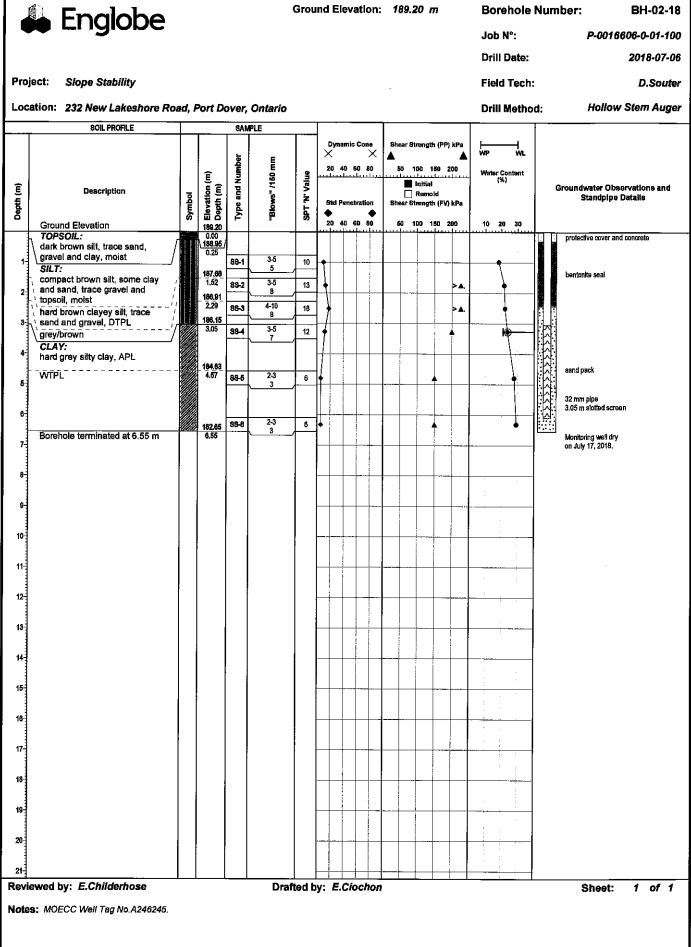
Project: Slope Stability

#### Location: 232 New Lakeshore Road, Port Dover, Ontario



Printed : 2018-08-02 08 h ZNStyte\_LVM\_OntarioLog Borehole\_Log\_LVM\_Ontario.sty -

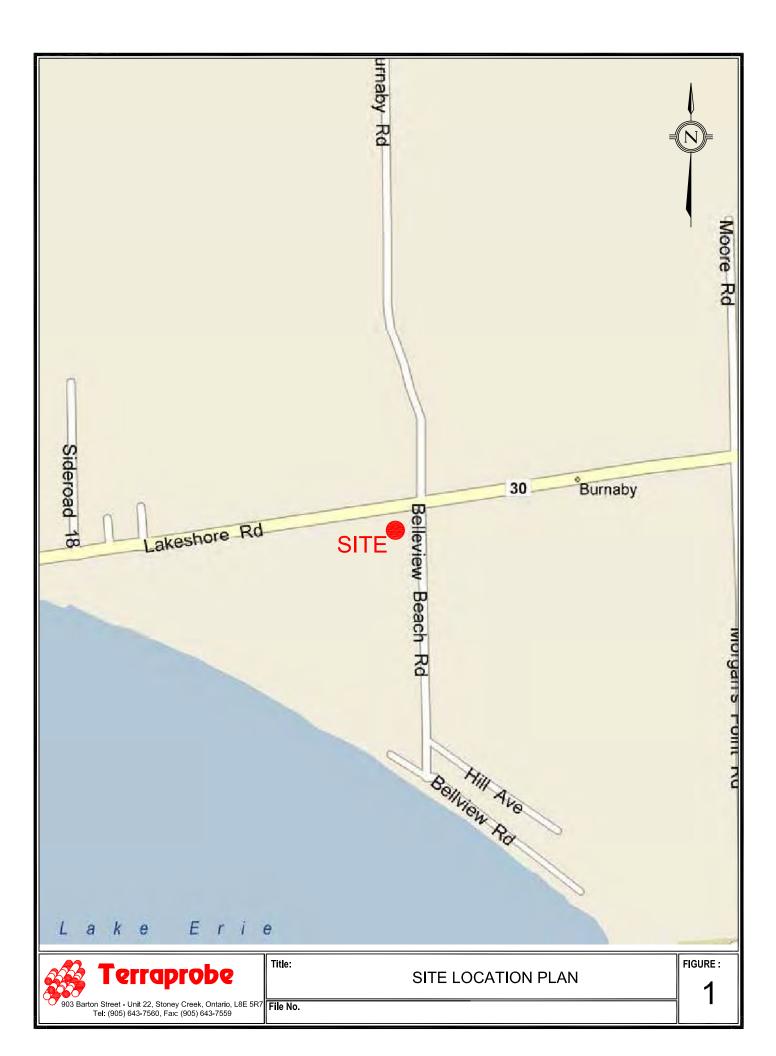
Vertical Scale = 1 : 120,0



Z:\Style\_LVM\_Ontario\Log\_Borehole\_Log\_LVM\_Ontario.sty - Printed : 2018-08-02 10 h

Vertical Scale = 1 : 120.0

EQ-09-Ge-72 R.1 18.02.201





## LOG OF BOREHOLE 1

Originated by : AF

#### Date started : October 2, 2016

Sheet No. : 1 of 1

Location : Burnaby , Ontario

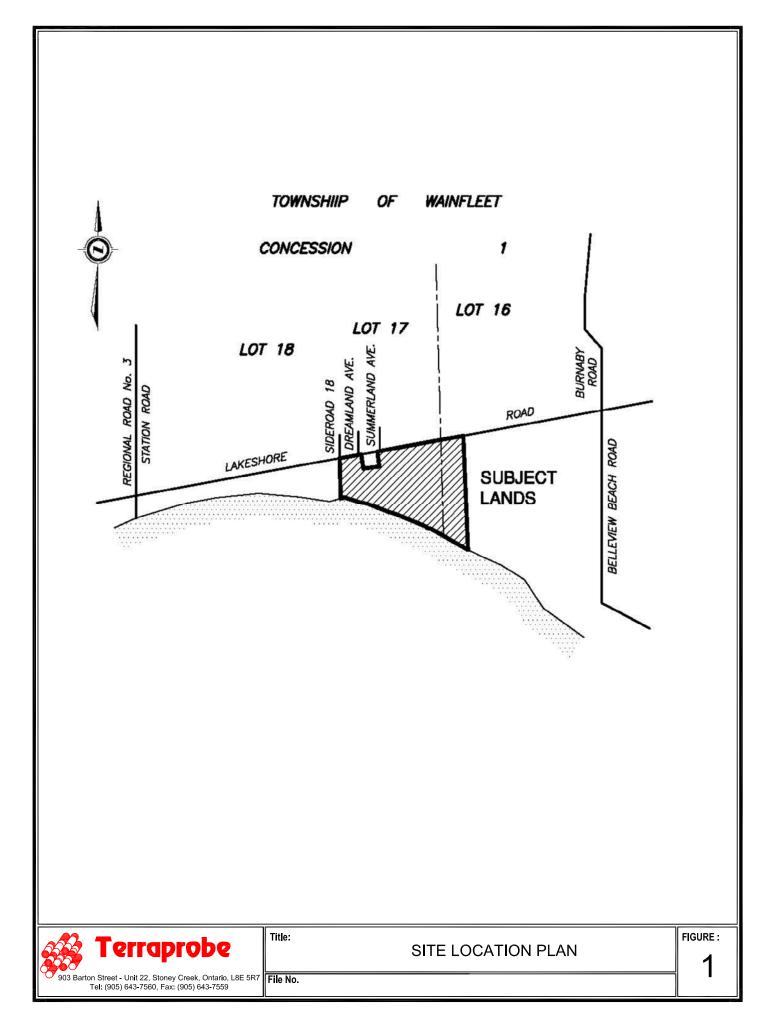
Compiled by : GM Checked by : GM

| Posit          | ion                         | : E: 634287, N: 4747565 (UTM 17T)                                    |                |        |      | Elevati      | on Datu            | m : Geode                      | tic (NA                       | D83)             |                                           |                  |             |                    |        |                             |                      |                                                                                     |
|----------------|-----------------------------|----------------------------------------------------------------------|----------------|--------|------|--------------|--------------------|--------------------------------|-------------------------------|------------------|-------------------------------------------|------------------|-------------|--------------------|--------|-----------------------------|----------------------|-------------------------------------------------------------------------------------|
| Rig t          | ype                         | : CME 55, track-mounted                                              |                |        |      | Drilling     | Method             | : Solid s                      | tem au                        | gers             |                                           |                  |             |                    |        |                             |                      |                                                                                     |
| (E)            |                             | SOIL PROFILE                                                         |                |        | SAMP | LES          | ale                | Penetration T<br>(Blows / 0.3m | est Valu                      | es               |                                           | M                | nisture     | / Plast            | ticity | Φ                           | t                    | Lab Data                                                                            |
| Depth Scale (n | <u>Elev</u><br>Depth<br>(m) | Description                                                          | Graphic Log    | Number | Type | PT 'N' Value | levation Sc<br>(m) | X Dynamic 0                    | cone<br>20<br>iear Stre<br>ed | ngth (kP<br>+ Fi | 4 <u>0</u><br>Pa)<br>ield Vane<br>ab Vane | Plastic<br>Limit | o N<br>Wate | atural<br>r Conten | Liquid | Headspac<br>Vapour<br>(ppm) | Instrumen<br>Details | Balling<br>and<br>Comments<br>GRAIN SIZE<br>GRAIN SIZE<br>DISTRIBUTION (%)<br>(MIT) |
| -0             | 180.7                       | GROUND SURFACE                                                       | 0              |        |      | SP           | ш                  | 40                             | 80 1                          | 20 1             | 60                                        | 1                | 0           | 20                 | 30     |                             |                      | GR SA SI CL                                                                         |
|                | <u>180.4</u><br>0.3         | 300mm TOPSOIL CLAYEY SILT, very stiff, brownish black (GLACIAL TILL) | 1/ 1/<br>1/ 1/ | 1      | SS   | 19           | -                  |                                |                               |                  |                                           |                  |             | 0                  |        |                             |                      |                                                                                     |
|                | 179.9<br>0.8                |                                                                      |                |        |      |              | 180 -              |                                |                               |                  |                                           |                  |             |                    |        | -                           |                      |                                                                                     |

END OF BOREHOLE

Auger refusal on inferred bedrock

Borehole was dry and open upon completion of drilling.





### LOG OF BOREHOLE 3

Originated by : KB

Compiled by : KB

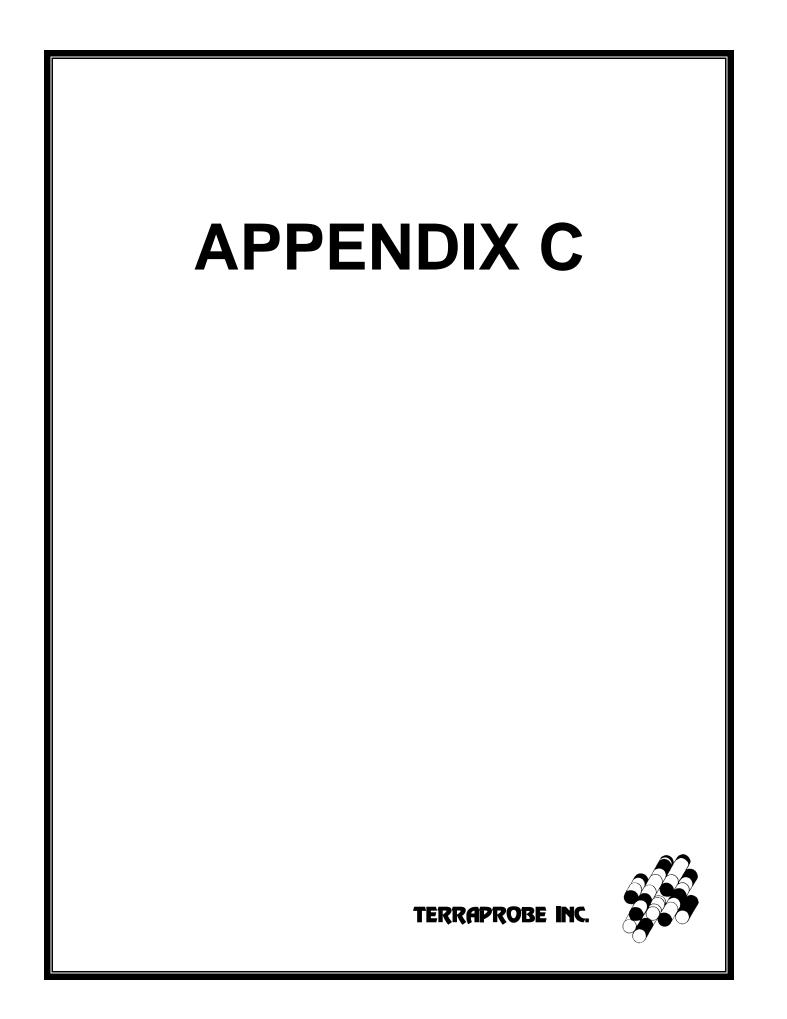
Checked by : GM

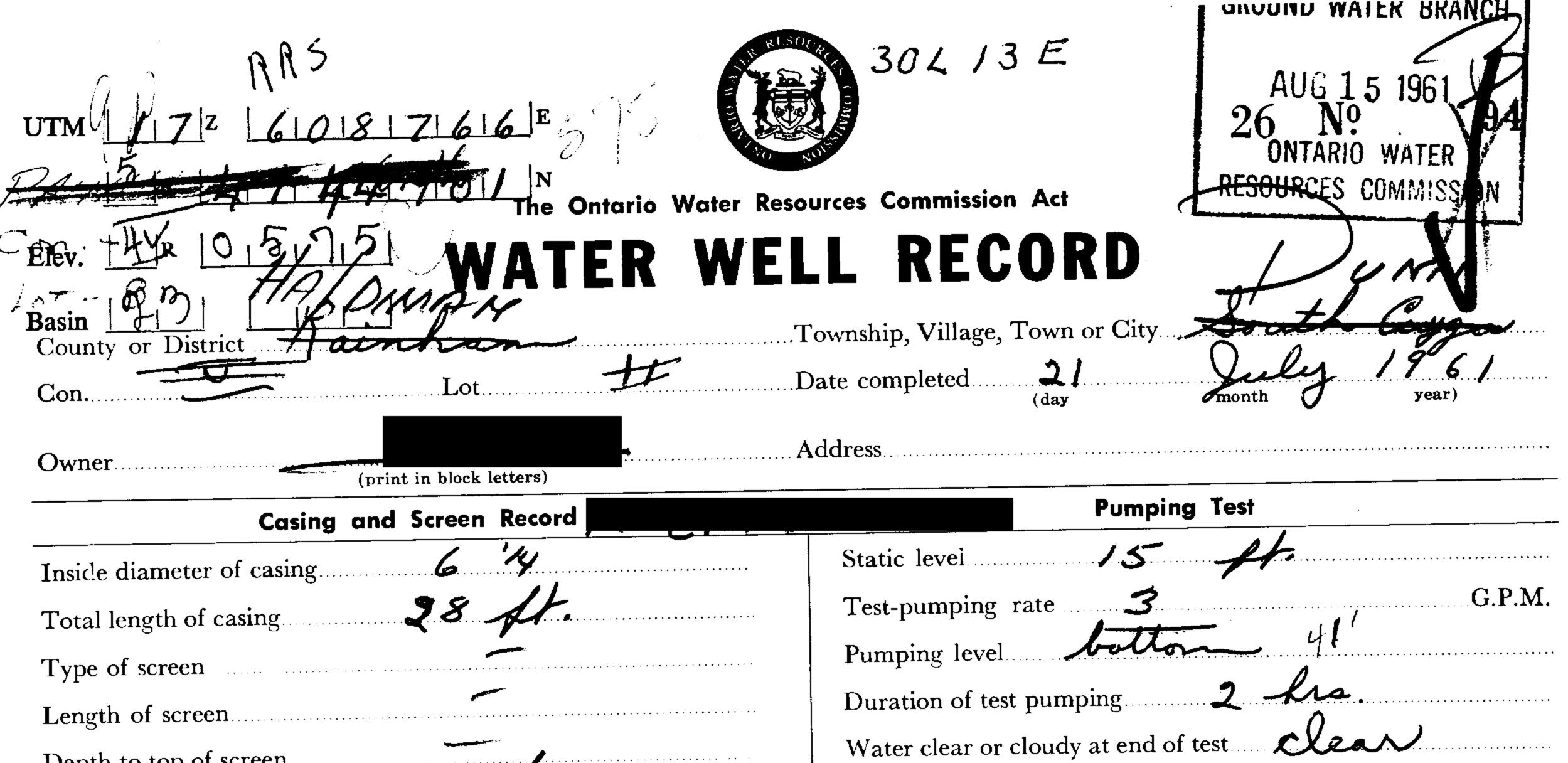
#### Date started : March 13, 2017

| Sheet No. | :1 of 1 |
|-----------|---------|
|-----------|---------|

Location : Wainfleet, Ontario

| SOIL PROFILE         SAMPLES         and or set                                                                                                                                                                                                                                                                                                             |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 176.6     200mm     TOPSOIL       0.2     SILTY CLAY, trace topsoil, trace<br>rootlets, firm, brown     1     SS     4       175.9                                                                                                                                                                                                                                                              |
| 0.2       SILTY CLAY, trace topsoil, trace rootets, firm, brown       1       SS       4         175.9       2       SS       17         0.9       SILTY CLAY, occasional seams and layers of silt, very stiff, brown       2       SS       17         3       SS       21       176       0         173.8       4       5       19       174         173.8       5       17       174       0 |
| 173.3       SILTY CLAY, occasional seams and layers of silt, very stiff, brown       2       SS       17         3       SS       21       175       0         4       SS       19       174       0         173.8       30       SILTY CLAY, firm, brown       174       0                                                                                                                     |
| 173.8<br>3.0 SILTY CLAY, firm, brown                                                                                                                                                                                                                                                                                                                                                            |
|                                                                                                                                                                                                                                                                                                                                                                                                 |
| FV 173- +                                                                                                                                                                                                                                                                                                                                                                                       |
| END OF BOREHOLE<br>Auger refusal on inferred bedrock<br>Borehole was dry and open upon<br>completion of drilling.                                                                                                                                                                                                                                                                               |





| Depth to top of screen $6/4$<br>Diameter of finished hole                                                       | r                                       |                      |           | 2<br>feet below                               | G.P.M.<br>w ground surface                  |
|-----------------------------------------------------------------------------------------------------------------|-----------------------------------------|----------------------|-----------|-----------------------------------------------|---------------------------------------------|
| Well Log                                                                                                        |                                         |                      |           | Water                                         | Record                                      |
| Overburden and Bedrock Record                                                                                   |                                         | rom<br>f <b>t.</b>   | To<br>ft. | Depth(s) at<br>which water(s)<br>found        | Kind of water<br>(fresh, salty,<br>sulphur) |
| - brown clar                                                                                                    |                                         | 0                    | 2         | 38                                            | fresh                                       |
| blue clay                                                                                                       |                                         | 2                    | 27        |                                               |                                             |
| - flint sock                                                                                                    | ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~ |                      |           |                                               |                                             |
|                                                                                                                 |                                         |                      |           |                                               |                                             |
|                                                                                                                 |                                         |                      |           |                                               |                                             |
|                                                                                                                 |                                         |                      |           |                                               |                                             |
|                                                                                                                 |                                         |                      |           |                                               | 1 y                                         |
| For what purpose(s) is the water to be used?<br>Cottage<br>Is well on upland, in valley, or on hillside? upland | In<br>re                                | n diagram<br>bad and |           | of Well<br>distances of we<br>dicate north by | errow.                                      |
| Is well on upland, in valley, or on hillside? upland.                                                           |                                         |                      |           | TH :                                          | $\ $                                        |

Drilling or Boring Firm Address 16 11.713. I TIV. Licence Number 3/8 ٩ Name of Driller or Borer Fund Chie Address 175 alderce & ave. Hamilto Date () (Signature of Licensed Drilling or Boring Contractor) LAPRIOMS 2EACH Form 7 15M Sets 60-5930 OWRC COPY W. Carl

| 27                                                                                                                                                                                                                                                                                              | 12 13 E                                       |                                           | Ň                                       |                                        | 1                                      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|-------------------------------------------|-----------------------------------------|----------------------------------------|----------------------------------------|
| UTM $\frac{1}{1}$ , $\frac{7}{2}$ $\frac{6}{1}$ , $\frac{10}{8}$ , $\frac{3}{6}$<br>$\frac{9}{R}$ $\frac{4}{7}$ , $\frac{36}{8}$ , $\frac{8}{6}$ , $\frac{8}{6}$<br>Elev. $\frac{9}{R}$ $\frac{05}{7}$ , $\frac{7}{5}$ , $\frac{57}{7}$<br>Basin $\frac{23}{2}$ $\frac{1}{1}$ The Department of | ONTARIO<br>Well Drillers A<br>Mines, Province | AUG<br>GEOLOG<br>DEPARTM<br>ce of Ontario | _                                       | 6 Nº                                   | 101                                    |
| Water V                                                                                                                                                                                                                                                                                         |                                               |                                           |                                         |                                        |                                        |
| Date Completed                                                                                                                                                                                                                                                                                  | `own o                                        | or City)                                  | <del>cing</del> . flu<br>192            | • • • • • • • • • • • • • •            | · · · · · · · · · · · · · · · · · · ·  |
| Pipe and Casing Record                                                                                                                                                                                                                                                                          |                                               |                                           | mping Test                              |                                        |                                        |
| Casing diameter(s)                                                                                                                                                                                                                                                                              | Pumping leve<br>Pumping rate<br>Duration of t | est.                                      | down<br>y<br>hinutes<br>bowls to ground |                                        |                                        |
|                                                                                                                                                                                                                                                                                                 |                                               |                                           | Death(a)                                | Kind of                                | No. of Feet                            |
| Kind (fresh or mineral)                                                                                                                                                                                                                                                                         | ••••••••••••••••••••••••••••••••••••••        | · · · · · · · · · · · · · · · · · · ·     | Depth(s)<br>to Water<br>Horizon(s)      | Water<br>Mulhfy                        | Water Rises                            |
| How far is well from possible source of contamination?<br>What is the source of contamination?<br>Enclose a copy of any mineral analysis that has been n<br>Well Log                                                                                                                            |                                               | •••••                                     |                                         | ation of Well                          |                                        |
| Overburden and Bedrock Record                                                                                                                                                                                                                                                                   | From                                          | To<br>Tft.                                |                                         |                                        | more of                                |
| Sand                                                                                                                                                                                                                                                                                            | 0 ft.                                         | 33A                                       | -                                       | elow show distand and lot lin          | e In-                                  |
| flint                                                                                                                                                                                                                                                                                           | 33                                            |                                           | dicate north                            | by arrow.<br>13<br>14<br>200 p<br>line | ft north<br>ahe bank<br>r East of weet |
|                                                                                                                                                                                                                                                                                                 |                                               |                                           | 1                                       |                                        |                                        |
|                                                                                                                                                                                                                                                                                                 |                                               |                                           | Lake                                    | <b>/</b>                               |                                        |
|                                                                                                                                                                                                                                                                                                 |                                               |                                           |                                         |                                        | -                                      |
| Situation: Is well on upland, in valley, or on hillside<br>Drilling Firm, feundation<br>Address                                                                                                                                                                                                 | l                                             | Address.                                  | grant                                   | 4<br>t o S<br>Cauge                    | UU                                     |
| FORM 5                                                                                                                                                                                                                                                                                          |                                               | -7                                        | Signature                               | of License                             |                                        |

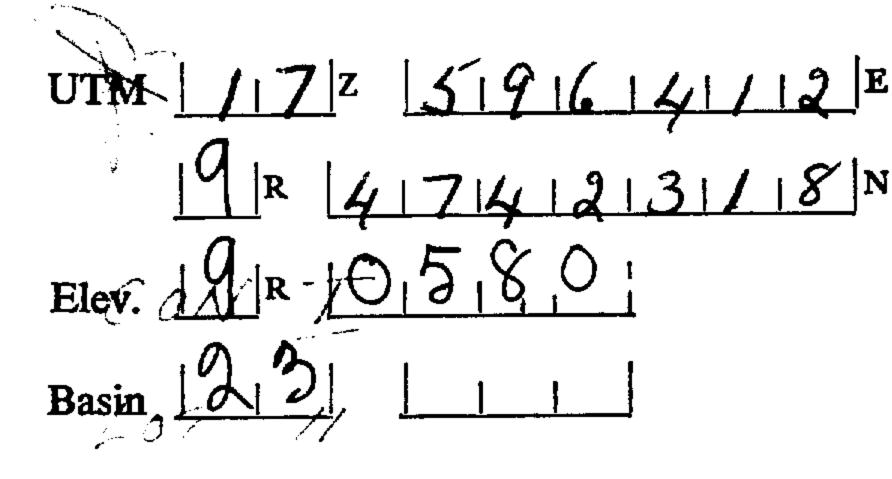
301 14 W ЪP. GROUND WATER BENNICH UTM 1172 6274111 E 2511 15 R 14 1714 1810.171 **5** 1962 *NA*L Elev. 12 R. Ontario Water Resources Commission Act, 1957 ONTARIO WATER Basin 12141 DESOURCES COMMISSION T RECOR WELL WATER Township, Village, Town or City. nou County or District Hold 61 vear **Pumping Test** Casing and Screen Record Inside diameter of casing 5 m Test-pumping rate / 6 G.P.M. Total length of casing 170 Pumping level 25 Type of screen Duration of test pumping 2 1 Lans Length of screen Water clear or cloudy at end of test. Chan Depth to top of screen Diameter of finished hole 5 ú Water Record Well Log Depth(s) at which water(s) Kind of water (fresh, salty, sulphur) No. of feet From ft. To water rises Overburden and Bedrock Record found 40 clor 0 15 170 50 40 55 50 Wate 100 5 160 100 168 60 170 168 Water Location of Well For what purpose(s) is the water to be used? In diagrant below show distances of well from Jomesti ot line. Indicate north by arrow. road and Is well on upland, in valley, or on hillside?..... 13 yela Jow Leve Bo Drilling Firm Address . CTYRD Licence Number Name of Driller ke a Ind R. R. Address .... 0m Date Dec. 6/ (Signature of Licensed Drilling Contractor)

| and a second | 1                                                                                                               |                                            | • •                                     |                            |
|----------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|--------------------------------------------|-----------------------------------------|----------------------------|
|                                                                                                                | 8 301 13W                                                                                                       |                                            |                                         |                            |
| UTM $\frac{17}{5890019}$                                                                                       |                                                                                                                 |                                            | 26 Nº                                   | 471                        |
| 19/1× 9/41714111718 N                                                                                          | The second se |                                            | _0                                      |                            |
| Elev. $ \mathcal{O} _{\mathbb{R}}  \mathcal{O} _{\mathcal{F}}  \mathcal{O} _{\mathcal{F}}$                     | (Star)                                                                                                          |                                            | ١.                                      |                            |
|                                                                                                                | ONTARIO                                                                                                         |                                            |                                         | /                          |
| $\frac{\text{Basin}[2,2]}{\text{Def}}$                                                                         | Well Drillers Act                                                                                               |                                            | V                                       | /                          |
| Department of                                                                                                  | Mines, Province of O                                                                                            | ntario                                     | Λ                                       |                            |
| v                                                                                                              |                                                                                                                 |                                            |                                         |                            |
| , Water                                                                                                        | Well Rec                                                                                                        | ord                                        |                                         |                            |
|                                                                                                                | ú                                                                                                               | на.<br>2 <b>е</b> р                        | <b>o</b> /                              | 10.01                      |
|                                                                                                                |                                                                                                                 | on. /Lot                                   | Pt. Lot                                 | est narg                   |
|                                                                                                                | KAN KIND.                                                                                                       | Acre                                       | es. <i>3.0</i>                          | • • • • • • • • •          |
| Date Completed                                                                                                 | ell (not including pump)                                                                                        | •••••••                                    | •••••••••••••                           | ••••                       |
| Pipe and Casing Record                                                                                         |                                                                                                                 | Pumping Test                               |                                         |                            |
| Casing diameter(s) Co./14                                                                                      | . Date                                                                                                          | · · · · · · · · · · · · · · · · · · ·      |                                         |                            |
| Length(s) of casing(s) $1.7$ $1.7$                                                                             |                                                                                                                 |                                            |                                         |                            |
| Length of screen                                                                                               |                                                                                                                 |                                            |                                         |                            |
| Type of screen                                                                                                 | Pumping Rate                                                                                                    |                                            |                                         | •••••                      |
| Type of pump                                                                                                   | . Drawdown                                                                                                      | $\mathcal{O}_{\mathcal{A}}$                | 11                                      | • • • • • • • • •          |
| Capacity of pump                                                                                               | 1                                                                                                               | ed well A.Q. 7                             | · · · · · · · · · · · · · · · · · · ·   | • • • • • • • •            |
| Depth of pump setting                                                                                          | . Is well a gravel-wall ty                                                                                      | /pe?                                       | •••••••••••                             | •••••                      |
|                                                                                                                | Water Record                                                                                                    |                                            |                                         |                            |
| <u>p</u> :                                                                                                     |                                                                                                                 |                                            |                                         | 1                          |
| Kind (fresh or mineral)                                                                                        | •••••••••••••••••••••••••••••••••••••••                                                                         | ···· Depth(s)<br>to<br>Water Horizon(s)    | Kind of<br>Water                        | No. of Feet<br>Water Rises |
| Quality (hard, soft, contains iron, sulphur etc.)                                                              |                                                                                                                 | 5 * * ·                                    |                                         | -                          |
| Appearance (clear, cloudy, coloured)                                                                           | · · · · · · · · · · · · · · · · · · ·                                                                           | 64 11 1.1.                                 | fruch                                   | 3417.                      |
| For what purpose(s) is the water to be used?                                                                   |                                                                                                                 | · · · · · · · · · · · · · · · · · · ·      | l                                       |                            |
|                                                                                                                |                                                                                                                 |                                            |                                         |                            |
| How far is well from possible source of contamination                                                          | ?                                                                                                               | · · · ]                                    |                                         |                            |
| What is source of contamination?                                                                               |                                                                                                                 |                                            |                                         |                            |
| Enclose a copy of any mineral analysis that has been                                                           | made of water                                                                                                   |                                            |                                         |                            |
| Well Log                                                                                                       | · · ·                                                                                                           |                                            | - · · · · · · · · · · · · · · · · · · · |                            |
| Drift and Bedrock Record                                                                                       | From To                                                                                                         |                                            | tion of Well                            |                            |
| Sub soil                                                                                                       | 0 ft                                                                                                            | In diagram belo<br>from road and <b>lo</b> |                                         | nces of well               |
| sed clay                                                                                                       | 3 12                                                                                                            | : · · · · · · · · · · · · · · · · · · ·    | 4                                       |                            |
| ally calait                                                                                                    | 1.2 1.4                                                                                                         |                                            | -2012                                   |                            |
| (-tiret ()                                                                                                     | 19 50                                                                                                           |                                            |                                         |                            |
|                                                                                                                |                                                                                                                 |                                            | 12 1                                    |                            |
|                                                                                                                |                                                                                                                 | Que honde                                  | All and                                 |                            |
|                                                                                                                |                                                                                                                 | Kallin Marine                              |                                         |                            |
|                                                                                                                |                                                                                                                 |                                            | 1 2 3                                   | 4                          |
|                                                                                                                |                                                                                                                 |                                            |                                         |                            |
|                                                                                                                | · · · · · · · · · · · · · · · · · · ·                                                                           |                                            |                                         |                            |
|                                                                                                                |                                                                                                                 |                                            | 104                                     |                            |
|                                                                                                                |                                                                                                                 |                                            | L' L                                    |                            |
|                                                                                                                |                                                                                                                 | •.                                         |                                         |                            |
|                                                                                                                |                                                                                                                 | 1                                          | Thenki                                  | ten                        |
| Situation: Is well on upland, in valley, or on hillsid                                                         | e? /                                                                                                            | mileret of                                 | trister a                               |                            |
| Drilling Firm                                                                                                  | <pre></pre>                                                                                                     | · · · · · · · · · · · · · · · · · · ·      | to 2 X 7 JAP de Cullin V                | • • • • • • • • •          |
| Address                                                                                                        |                                                                                                                 |                                            | • • • • • • • • • • • • • •             | · · · · · · · · · · ·      |
| Recorded by                                                                                                    |                                                                                                                 |                                            |                                         |                            |
| Date                                                                                                           |                                                                                                                 |                                            | ••••                                    | •••••                      |
|                                                                                                                |                                                                                                                 |                                            | CSS                                     | 5.58                       |

30113W 26 Nº UTM Ontario Water Resources Commission Act RECORD Elev Basin ......Township, Village, Town or City. County or District **7** (day Date completed ess RRH1 Ø **Pumping Test** Casing and Screen Record 18 Inside diameter of casing 614 Static level ... G.P.M. Test-pumping rate . 9 Pumping level pumps drug Type of screen Duration of test pumping. Length of screen clear Water clear or cloudy at end of test ..... Depth to top of screen ..... G.P.M. 6/4 Recommended pumping rate Diameter of finished hole feet below ground surface 29 with pump setting of Water Record Well Log Kind of water (fresh, salty, sulphur) Depth(s) at From ft. То which water(s) Overburden and Bedrock Record ft. found 0 15 15 3 n Location of Well For what purper (s) is the water to be used? In diagram below show distances of well from Summer cottage road and lot line. Indicate north by arrow. Is well on upland, in valley, or on hillside? Upland IAK Drilling or Boring Firm Address. Licence Number 2 438 Name of Driller or Borer CON 00 , del ぃく (X.O. # Address . une Date Licensed Drilling or Boring Contractor) Form 7 15M-60-4138 OWRC COPY

WAM

30L 13W

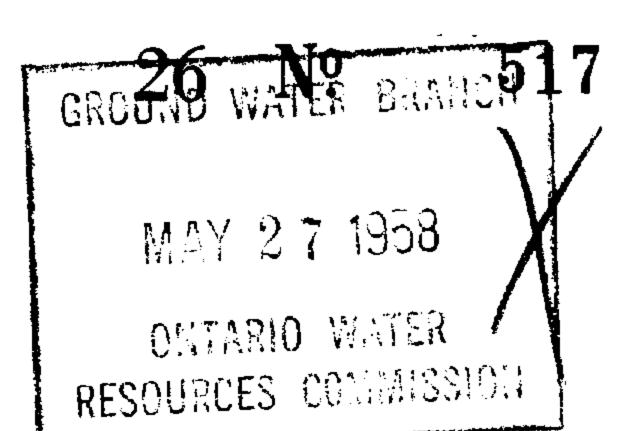




ONTARIO

The Water-well Drillers Act, 1954

**Department of Mines** 



# Water-Well Record

Pipe and Casing Record

**Pumping Test** 

| Casing diameter(s) | Static level |
|--------------------|--------------|
| Length(s)          |              |
| Type of screen     |              |
| Length of screen   |              |
|                    |              |

Well Log

Water Record

| Overburden and Bedrock Record | From<br>ft.<br>Ø | To<br>ft.<br>16 | Depth(s)<br>at which<br>water(s)<br>found<br>24 | No. of feet<br>water rises | Kind of water<br>(fresh, salty,<br>or sulphur)<br>SULPHUR |
|-------------------------------|------------------|-----------------|-------------------------------------------------|----------------------------|-----------------------------------------------------------|
| A DOCKI                       | 16               | 24              |                                                 |                            |                                                           |
|                               |                  |                 |                                                 |                            |                                                           |
|                               |                  |                 |                                                 |                            |                                                           |
|                               |                  |                 |                                                 |                            |                                                           |

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|  |  |                                       |
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|  |  |                                       |
|  |  |                                       |
|  |  |                                       |

For what purpose(s) is the water to be used? COTTAGE Is water clear or cloudy? Substitution of the state o

# Location of Well

In diagram below show distances of well from road and lot line. Indicate north by arrow.

Licence Number.....

Ne 0.65 mile -1 I certify that the foregoing statements of fact are true. Date MAY 26 Reven Signature of Licensee 1

Form 5

CSS.S8

()AM

|                                                             |               | 302 131         | W                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                            | 27                                          |  |  |  |  |
|-------------------------------------------------------------|---------------|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|---------------------------------------------|--|--|--|--|
| UTM $ / 7 ^{z}  5 9 6 9 3 / ^{E}$                           |               |                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 26                         | Nº 525                                      |  |  |  |  |
| 5 R 4171412161015 N                                         |               |                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | GROUND WAT                 |                                             |  |  |  |  |
| 5+ + 5751                                                   |               | STUE            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                            |                                             |  |  |  |  |
| Elév. 47 R U 3   3                                          | io Water Reso | urces Commis    | usion Act, 1957                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | JAN 1                      | , 16                                        |  |  |  |  |
| Basing 7 1 A                                                |               |                 | TOODT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | ONTACIO                    | MATES ANNI SION                             |  |  |  |  |
| WATI                                                        | ER WI         | ELL K           | ECORI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | RECOURCES                  | COMMISSION                                  |  |  |  |  |
| County or District faldinian                                | d             | Township, V     | /illage, Town or                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | City Cotal                 | ale RAMAR                                   |  |  |  |  |
| County of District                                          | 1 ~           | te comp         | 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | may                        | 1959                                        |  |  |  |  |
|                                                             |               | est of<br>tress | Je at ber                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | month/                     | year)<br>Decent                             |  |  |  |  |
|                                                             | ik .          | ik hala Erre    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                            |                                             |  |  |  |  |
| Casing and Screen Record                                    | l             |                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | ping Test                  |                                             |  |  |  |  |
| Inside diameter of casing                                   |               | Static level    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                            |                                             |  |  |  |  |
| Total length of casing /6                                   |               | Test-pum        | Test-pumping rate                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                            |                                             |  |  |  |  |
| Type of screen                                              | •••••         | . Pumping       | Pumping level $\frac{2}{Duration of test pumping}$ $\frac{12}{May 2}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                            |                                             |  |  |  |  |
| Length of screen                                            |               | Duration        | of test pumping                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                            | KAL LAN                                     |  |  |  |  |
| Depth to top of screen                                      |               |                 | ear or cloudy at e                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | end of test                | G.P.M.                                      |  |  |  |  |
| Diameter of finished hole                                   |               | with            | ended pumping                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | f $\frac{12}{2}$           |                                             |  |  |  |  |
|                                                             | <u></u>       | with            | with pumping level of                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                            |                                             |  |  |  |  |
| Wel! Log                                                    |               | 1               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | ter Record                 |                                             |  |  |  |  |
| a to the state of Passad                                    | From<br>ft.   | To<br>ft.       | Depth(s)<br>at which<br>water(s)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | No. of feet<br>water rises | Kind of water<br>(fresh, salty,<br>sulphur) |  |  |  |  |
| Overburden and Bedrock Record                               |               |                 | found                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                            | Suprati                                     |  |  |  |  |
|                                                             | 6             | 15              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | -                          |                                             |  |  |  |  |
|                                                             |               |                 | 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                            | friet                                       |  |  |  |  |
| flint lirek.                                                | 5             |                 | <u> </u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 70                         | Tush                                        |  |  |  |  |
|                                                             |               |                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                            | -                                           |  |  |  |  |
|                                                             |               |                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                            |                                             |  |  |  |  |
|                                                             |               | ·               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                            |                                             |  |  |  |  |
|                                                             |               |                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | -                          |                                             |  |  |  |  |
|                                                             |               |                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | -                          |                                             |  |  |  |  |
|                                                             |               |                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                            |                                             |  |  |  |  |
|                                                             |               |                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                            |                                             |  |  |  |  |
| For what purpose(s) is the water to be used                 | 15            |                 | Loca                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | tion of Well               | ap                                          |  |  |  |  |
| For what purpose(s) is the which to be about the domination | 2<br>2        | I               | n diagram below                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | show distances             | of well from                                |  |  |  |  |
| ·····                                                       |               |                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | e. Indicate nort           | n by arrow.                                 |  |  |  |  |
| Is well on upland, in valley, or on hillside                | 4             |                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Lot                        | T 13                                        |  |  |  |  |
| Dilling Firm Sidaey H.M.                                    | i'v uitt      |                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 12                         |                                             |  |  |  |  |
| Drilling Firm                                               |               |                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                            |                                             |  |  |  |  |
| Address R.R.                                                | $\mathcal{O}$ | The the         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                            |                                             |  |  |  |  |
| muhille                                                     | $C_{j}$       | f.  .   ~ ~     | ** 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 500 +                      |                                             |  |  |  |  |
| Licence Number 35                                           |               | F /             | 150                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                            |                                             |  |  |  |  |
| Name of Driller Sidney W. merult                            |               |                 | 1×1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                            |                                             |  |  |  |  |
| Address RRI Stricthville                                    |               |                 | T / Lak                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | le Eri                     |                                             |  |  |  |  |
| Date $Cf = 2/59$ .                                          |               |                 | $\int \mathcal{O}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                            |                                             |  |  |  |  |
| holney merelt                                               |               |                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                            |                                             |  |  |  |  |
| (Signature of Licensed Drilling Contrac                     | 2107)         | 2               | and the second sec |                            |                                             |  |  |  |  |
|                                                             |               |                 | f c                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                            |                                             |  |  |  |  |
| Form 5<br>15M-58-4149                                       |               | 1               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                            | CSS.S8                                      |  |  |  |  |

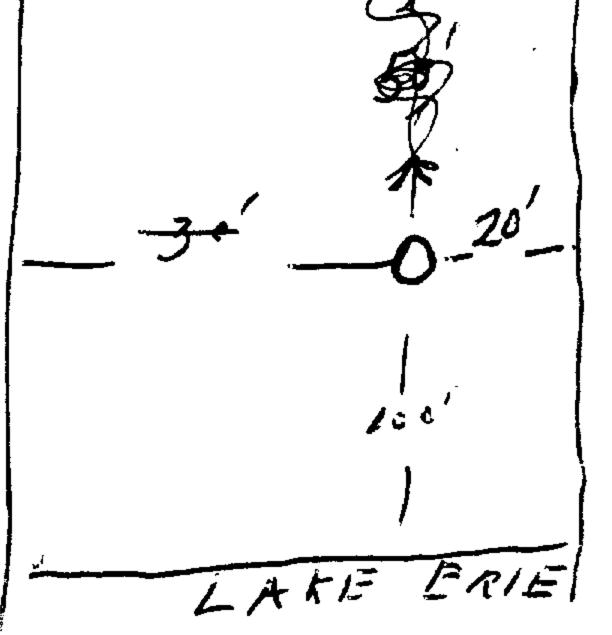
301 13W  $\hat{r}$  $\frac{|q|_{R}}{|4|7|4|3|3|7|5}$ Nº 534 26GROUND WATER BRANC'L ONTARIC Elev, 9 19 0580. JAN 1 3 1958 The Water-well Drillers Act, 1954 Basin + 23 **ONTARIO WATER Department** of Mines **RESOURCES COMMISSION** Water-Well Record ip, Village, Town or City. Lainham 7 foldement Village, Town or City)..... ddress Saruh Date completed ...... (month) (year) (day) **Pumping Test** Pipe and Casing Record 64 Static level ..... Casing diameter(s) ..... Length(s) 10 - 8perh Pumping level ...... Type of screen ..... Length of screen ..... Water Record Well Log Depth(s) Kind of water at which water (s) No. of feet From То (fresh, salty, Overburden and Bedrock Record water rises or sulphur) ft. ft. found 0 ٥ '5 10 For what purpose(s) is the water to be used? Location of Well Cottoge In diagram below show distances of well from Is water clear or cloudy?...... road and lot line. Indicate north by arrow. Is well on upland, in valley, or on hillside?..... effand Drilling firm pener Address & Achemalle Ø on Name of Driller Address F Shemille \_\_\_\_ ..... Licence Number 12/0 I certify that the foregoing statements of fact are true. Date,

30113W 010 E UTM ROUNS WA Ontario Water Resources Commission Act 1 0 1962 RECOR Elev. AIO WATER JT A SIGM Township, Village, Town or City Basin County Date completed. ss 90 Hirton **Pumping Test** Casing and Screen Record Static level Inside diameter of casing 6 **O** G.P.M. Test-pumping rate Total length of casing 10 Pumping level 201 Type of screen Duration of test pumping 20 mins Length of screen. Water clear or cloudy at end of test Depth to top of screen. G.P.M. Recommended pumping rate Diameter of finished hole 6 20 feet below ground surface with pump setting of Water Record Well Log Kind of water Depth(s) at To ft. From (fresh, salty, which water(s) found Overburden and Bedrock Record ft. sulphur 10 0 <u>e</u>l ふる 10 Location of Well For what purpose(s) is the water to be used? In diagram below show distances of well from ~ Jum mak road and lot line. Indicate north by arrow. Is well on upland, in valley, or on hillside? Drilling or Boring Address Licence Number 4 Name of Driller or Boren Address Date 0 (Signature of Licensed Drilling or Boring Contractor) ERIE. Form 7 10M-62-1152 CSS.S8 OWRC COPY

301 /3W MTM 1/17 2 51916191313 € WATER RESOURCES N0 Division 2671317 Nontario Water Resources Commission Act 1222 (13/R 14 1965 Eler 1 1 R 105 REC RIO WATER COM leman Township, Village, Town or City Lot Date completed Con. ss 837 ENVICE millon) **Casing and Screen Record Pumping Test** Inside diameter of casing 614 Ź. Static level ..... t 6 mehes Total length of casing.... 2 Test-pumping rate Welly 230 Pumping level every hour. Duration of test pumping 2 hts. Type of screen Length of screen Water clear or cloudy at end of test \_\_\_\_\_ Clean Depth to top of screen..... Diameter of finished hole ¥2, Recommended pumping rate .....G.P.M. 30 with pump setting of..... feet below ground surface Well Log Water Record Depth(s) at Kind of water From То Overburden and Bedrock Record (fresh, salty, which water(s) ft. ft. found sulphur) 9 ay & stone 0 2 38 3 For what purpose(s) is the water to be used? Location of Well Summer Cottade In diagram below show distances of well from S Is well on upland, in valley, or on hillside? ON lakeshore road and lot line. Indicate north by arrow. Drilling or Boring Firm Inen Selkik Address BRUND Tau ASELSKIS FARM. Licence Number 15 -96 ONCESSION Name of Driller or Borer. Address Date of Licensed Drilling or Boring Contractor) LAKE ERIE Form 7 15M-60-4138 CSS 88 OWRC COPY

| UTM $17z 51961599 E$                                                                            |                                           | 302 131                                                               |                                       | 26 N                                                                                                             | 566                        |  |  |
|-------------------------------------------------------------------------------------------------|-------------------------------------------|-----------------------------------------------------------------------|---------------------------------------|------------------------------------------------------------------------------------------------------------------|----------------------------|--|--|
| LE LE ALCIDIN                                                                                   | to NULT                                   | _                                                                     |                                       |                                                                                                                  |                            |  |  |
| The Ontario Water                                                                               |                                           | Commission A                                                          |                                       |                                                                                                                  |                            |  |  |
| Elev. $5 \times 051$ WATER W                                                                    | ELL                                       | RECU                                                                  | KD                                    | 2 ;                                                                                                              |                            |  |  |
| Basin 23 HALDIMAND                                                                              | Townsh                                    | ip, Village, Tow                                                      | n or City                             | KAIN H                                                                                                           | AM.                        |  |  |
| Con. Instruct Lot. 19                                                                           |                                           | mpleted 2                                                             | . 0                                   | month                                                                                                            | 1963<br>year)              |  |  |
|                                                                                                 | Address                                   | SELI                                                                  | FIRK                                  | RR /                                                                                                             |                            |  |  |
| (print in block letters)                                                                        | HA                                        | MILTON-                                                               | 130                                   | MC ANU                                                                                                           | LTY BLUE                   |  |  |
| Casing and Screen Record                                                                        |                                           |                                                                       | Pumping                               |                                                                                                                  |                            |  |  |
| Inside diameter of casing 5                                                                     |                                           |                                                                       |                                       |                                                                                                                  |                            |  |  |
| Total length of casing                                                                          | Test-pumping rate                         |                                                                       |                                       |                                                                                                                  |                            |  |  |
| Type of screen                                                                                  | Pumping level<br>Duration of test pumping |                                                                       |                                       |                                                                                                                  |                            |  |  |
| Length of screen                                                                                |                                           |                                                                       |                                       | and the second |                            |  |  |
| Depth to top of screen $5''$<br>Diameter of finished hole $5''$                                 |                                           | Water clear or cloudy at end of test.<br>Recommended pumping rate 100 |                                       |                                                                                                                  |                            |  |  |
| Diameter of finished hole 5                                                                     | Re                                        | commended put<br>th pump setting                                      | $\frac{1}{2} \frac{7}{7} \frac{7}{7}$ | feet belo                                                                                                        | w ground surface           |  |  |
|                                                                                                 | wl                                        | th pump setting                                                       |                                       |                                                                                                                  | Record                     |  |  |
| Well Log                                                                                        |                                           |                                                                       | <br>TL                                | Depth(s) at                                                                                                      | Kind of water              |  |  |
| Overburden and Bedrock Record                                                                   |                                           | From<br>ft.                                                           | To<br>ft.                             | which water(s)<br>found                                                                                          | (fresh, salty,<br>sulphur) |  |  |
| Anerbuden Brown Clay                                                                            |                                           | 0                                                                     | 10                                    | 0.71                                                                                                             | - tota                     |  |  |
| Flint Rock                                                                                      |                                           | 10'                                                                   | 26'                                   | 2.2                                                                                                              | Lugan                      |  |  |
|                                                                                                 |                                           |                                                                       | -                                     |                                                                                                                  |                            |  |  |
|                                                                                                 |                                           | -                                                                     |                                       |                                                                                                                  | •                          |  |  |
|                                                                                                 | GNU                                       |                                                                       | CETS 0                                |                                                                                                                  |                            |  |  |
|                                                                                                 |                                           | h SW                                                                  | Cr Coll.                              |                                                                                                                  |                            |  |  |
|                                                                                                 | CON.T                                     | 107 60                                                                | T                                     |                                                                                                                  |                            |  |  |
|                                                                                                 |                                           | 14 1                                                                  | 1<br>Location                         | of Well                                                                                                          |                            |  |  |
| For what purpose(s) is the water to be used?                                                    |                                           | In Hagram                                                             | n below show                          | v distances of we                                                                                                | ll from                    |  |  |
| Household                                                                                       |                                           | road and                                                              | lot line. In                          | dicate north by                                                                                                  | arrow.                     |  |  |
| Is well on upland, in valley, or on hillside? Upland<br>Drilling or Boring Firm UA. Denhis & In |                                           |                                                                       | LAKE Rd.                              |                                                                                                                  |                            |  |  |
| Drilling or Boring Firm                                                                         |                                           | K                                                                     | 80-                                   | 7                                                                                                                | 1                          |  |  |
|                                                                                                 |                                           |                                                                       |                                       | $\wedge$ $ $                                                                                                     | Ĭ                          |  |  |

Address RR-6 Watapur Licence Number 1938 Name of Driller or Borer Robert Genna Address RR-5 Walifu Address 19 Date Mon 30/65 Date Dit Humme Dut Humme Dwilling or Boring (Signature of Licensed Drilling or Boring Contractor) Form 7 15M-60-4138 OWRC COPY



CSS.58

| UFM $  /  7 ^{z}$ $ 6   6   3   5   7 ^{E}$<br>$ 9 ^{R}$ $ 4   7   4   4   8   4 ^{N}$<br>Elev. $ 9 ^{R}$ $ 0   5   5   0 $<br>Basin $ 2 ^{3}$ $ - - - - - - - - - - - - - - - - - - -$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Vell                     | JAN<br>GEOLOG<br>DEPARTN<br>ce of Ontario<br>Reco<br>age, Town or<br>or City)<br>Sauch Z<br>ng pump) | rd<br>Thy. P.a.              |                          | 570         |  |  |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|------------------------------------------------------------------------------------------------------|------------------------------|--------------------------|-------------|--|--|--|
| Pipe and Casing Record                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 1                        |                                                                                                      | mpi <b>ng Tes</b> t          |                          |             |  |  |  |
| Casing diameter (s)       3-5/8       Date.         Length (s) of casing (s)       1.8'       Static level.       9'         Type of screen.       Pumping level.       Bailus Less       Pumping rate.         Length of screen.       Pumping rate.       7.6.       Duration of test.         Distance from top of screen to ground level.       Duration of test.       Duration of test.         Is well a gravel-wall type?       Distance from cylinder or bowls to ground level.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                          |                                                                                                      |                              |                          |             |  |  |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Water Record             | ·····                                                                                                |                              |                          | No. of Feet |  |  |  |
| Kind (fresh or mineral)       Quality (hard, soft, contains iron, sulphur, etc.)         Quality (hard, soft, contains iron, sulphur, etc.)       Appearance (clear, cloudy, coloured)         For what purpose(s) is the water to be used?       How far is well from possible source of contamination?         What is the source of contamination?       Enclose a copy of any mineral analysis that has been mineraly analysis that has been mineral analysis that has been mineraly an | Hari<br>Elear<br>Fiarm - |                                                                                                      |                              | Kind of<br>Water         | Water Rises |  |  |  |
| Well Log                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                          |                                                                                                      |                              | cation of Well           |             |  |  |  |
| Overburden and Bedrock Record                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | From<br>0 ft.<br>28      |                                                                                                      | well from a<br>dicate nort   | 300<br>V<br>*4 200<br>EU | ne. In-     |  |  |  |
| Situation: Is well on upland, in valley, or on hillside<br>Drilling Firm. Jone Gromen Jan<br>Address. A. A. H. 2. Sectrank. A<br>Name of Driller Rageh & A Lake or<br>Date. Jan. 2. 5. J.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | ·····                    |                                                                                                      | RB2<br>umber.H.3<br>3 lake D |                          |             |  |  |  |

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**GROUND WATER BRANCH** 301 13 W 26-5 Nº 6101/11912E UTM | / 17 |z 01012 N ntario Water Resources Commission Act **ONTARIO WATER** RESOURCES COMMISSION RECORD Elev. Basin Township, <del>Village,</del> County or JugDate completed SSRR41 Inei Pumping Test Casing and Screen Record 14 Inside diameter of casing 614 Static level .... Total length of casing 23 ft Sinches G.P.M. Test-pumping rate 28-Pumping level Type of screen 30 mins Duration of test pumping Length of screen Water clear or cloudy at end of test ..... Depth to top of screen G.P.M. Recommended pumping rate Diameter of finished hole 6/4 28 feet below ground surface with pump setting of. Water Record Well Log Kind of water Depth(s) at (fresh, salty, sulphur) From ft. To which water(s) Overburden and Bedrock Record ft. found 0 20 ଶ 2 20 Ates 2 30 2 Location of Well For what purpose(s) is the water to be used? In diagram below ow distances of well from Summer cott road and lot line. Indicate north de Э Is well on upland, in valley, or on hillside? XJWEE Drilling or Boring Firm 6au ROSE Address Licence Number... ARDEL CREE Name of Driller or Borer ->15'2 Address ( Date. h k LAKE ERIE (Signature of Licensed Drilling or Boring Contractor) Form 7 10M-62-1152 CSS.S8 OWRC COPY

301 13E 10 UTM 1/17 2 610 2 71/13 E Elev.  $|\mathbf{q}|_{R} = 0.580$ OCT - 9 1953 **GEOLOGICAL BRANCH DEPARTMENT** of MINES The Well Drillers Act Basin 12 Department of Mines, Province of Ontario Well Record Water Mainham al elle Village, Town or wn or City) Date Completed... (year) (month) Pumping Test Pipe and Casing Record 1.0. . Date .... Casing diameter(s)..... Static level .... Length(s) of casing(s).... Pumping level . . . . . . Type of screen..... Duration of test...... Distance from top of screen to ground level..... Distance from cylinder or bowls to ground level.... 3.0.7 Is well a gravel-wall type?..... Water Record No. of Feet Water Rises Kind of Depth(s) to Water Horizon(s) Kind (fresh or mineral).... sullhur Quality (hard, soft, contains iron, sulphur, etc.).... Appearance (clear, cloudy, coloured)....... loudy For what purpose(s) is the water to be used?..... How far is well from possible source of contamination? Those What is the source of contamination? Enclose a copy of any mineral analysis that has been made of water. Well Log Location of Well То From Overburden and Bedrock Record In diagram below show distances of //...ft. 0 ft. well from road and lot line. In-304 Π dicate north by arro Br-drawn on back uplano Situation: Is well on upland, in valley, or on hillside?... Drilling Firm. ughell Address Name of Drills Licence,Numbe Date... A ignature of FORM 5 CSS.\$8

301 13E L.P. **GROUND WATER BRANCH** 61/19151019 E UTM NOV 21 Ontario Water Resources Commission Act **ONTARIO WATER** DESOURCES COMMISSION Elev. WF RECOR Basin dimand .Township, Village, Town or City County or 8 19 176 Date completed Lot Con Hamilt ddress..... **Pumping Test Casing and Screen Record** 2617-0 Static level Inside diameter of casing G.P.M Test-pumping rate Total length of casing 26-Pumping level Type of screen 2 his Duration of test pumping.... Length of screen Water clear or cloudy at end of test .... Depth to top of screen 52 Recommended pumping rate G.P.M. Diameter of finished hole with pump setting of 30feet below ground surface Water Record Well Log Depth(s) at which water(s) found Kind of water To ft. From (fresh, salty, sulphur) Overburden and Bedrock Record ft. 10 0 Location of Well For what purpose(s) is the water to be used? In diagram below show distances of well from rouse road, and lot line. Indicate north by arrow. Is well on upland, in valley, or on hillside? Upland Drilling or Boring Firm Kaughell Bros Address Hunwills RR H Licence Number rushell. Name of Driller or Borer. le (1 Address Date.. ure of Licensed Drilling opporing Contractor) Form 7 15M Sets 60-5930 fake Shore CSS. S8 OWRC COPY

301 13E L.P. **GROUND WATER BRANCH** 61/19151019 E UTM NOV 21 Ontario Water Resources Commission Act **ONTARIO WATER** DESOURCES COMMISSION Elev. WF RECOR Basin dimand .Township, Village, Town or City County or 8 19 176 Date completed Lot Con Hamilt ddress..... **Pumping Test Casing and Screen Record** 2617-0 Static level Inside diameter of casing G.P.M Test-pumping rate Total length of casing 26-Pumping level Type of screen 2 his Duration of test pumping.... Length of screen Water clear or cloudy at end of test .... Depth to top of screen 52 Recommended pumping rate G.P.M. Diameter of finished hole with pump setting of 30feet below ground surface Water Record Well Log Depth(s) at which water(s) found Kind of water To ft. From (fresh, salty, sulphur) Overburden and Bedrock Record ft. 10 0 Location of Well For what purpose(s) is the water to be used? In diagram below show distances of well from rouse road, and lot line. Indicate north by arrow. Is well on upland, in valley, or on hillside? Upland Drilling or Boring Firm Kaughell Bros Address Hunwills RR H Licence Number rushell. Name of Driller or Borer. le (1 Address Date.. ure of Licensed Drilling opporing Contractor) Form 7 15M Sets 60-5930 fake Shore CSS. S8 OWRC COPY

301 14 W GROUND WATER BRANCH 840 JTM 117 2 61214 141616 E 19 R 4171414191719 N JUN 3 0 1959 Elev. Q R 0575 Ontario Water Resources Commission Act, 1957 ONTARIO WATER RESOURCES COMMISSION Basin 2 WELL RECORD WATER 1.7 Haldimand Township, Village, Town or City Shubroo County or District.... e completed 10 Iress ..... **Pumping Test** Casing and Screen Record 19 down Inside diameter of casing 64 Static level G.P.M. Total length of casing 10 ft Test-pumping rate..... Pumping level Type of screen Duration of test pumping..... Length of screen Water clear or cloudy at end of test bloud Depth to top of screen..... Recommended pumping rate 30 **G**.P.M. Diameter of finished hole..... with pumping level of 21. -----Water Record Well Log Kind of water (fresh, salty, sulphur) Depth(s) at which water(s) No. of feet From ft. To ft. water rises Overburden and Bedrock Record found D <u>6/4</u> Ď 902 C Location of Well For what purpose(s) is the water to be used? In diagram below show distances of well from Cottage road and lot line. Indicate north by arrow. Is well on upland, in valley, or on hillside? Mylan Drilling Firm Caughell Bros. Address Hunmillo RB Licence Number..... 4 ront aughel Name of Drille ville BB4 un Address Date ughell ed prilling Contractor) CSS.S8

302 13E UTA 117 2 610 51716 884 9 1R 41714151918 SEP - 8 1954 **GEOLOGICAL BRANCH** Elev. |9 |R |05751 59 ONTARIO DEPARTMENT of MINES Basin 23 The Well Drillers Act Department of Mines, Province of Ontario Water Well Record Con VII 1.t 13 Haldimande tin, Village, Town or City & frathe Cayings wn or City) Cost of Well (excluding pump)..... Date Completed. (year) (month) (day) Pipe and Casing Record **Pumping Test** Casing diameter (s) ...... 5. 5.8 20 Date.... Static level. Type of screen..... Pumping level . . .< es in 3 gallon minu Pumping rate. Length of screen..... Distance from top of screen to ground leyel..... Duration of test.. Is well a gravel-wall type?..... Water Record Kind (fresh or mineral) ... , Munual Depth(s) to Water Horizon(s) No. of Feet Water Rises Kind of Water hard - sul Quality (hard, soft, contains iron, sulphur, etc.), Appearance (clear, cloudy, coloured).... 3 la sulphus For what purpose(s) is the water to be used?.... . . . . . . . . . . . . . . . . . . . How far is well from possible source of contamination?..... What is the source of contamination?..... Enclose a copy of any mineral analysis that has been made of water..... Well Log Location of Well Overburglen\_and Bedrock Record From То 9.9.ft. 0 ft. 10 Kal In diagram below show distances of well from road and lot line. In-38 lint 29 dicate north by arrow. Jours land fot do not 9 from Kon 7. 150 Pake Pric up. Situation: Is well on upland, in valley, or on hillsiden Drilling Firm. le ajughell //5 lok fekinnille Address..... hartle alla M Address. Name of Driller Date..... icence Number Land Signature of Licensee FORM 5

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|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|-------------------------|-----------------------------------------|----------------------------|---------------------------------|
| UTM 117 2 61013151616 E                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                          |                         | ç                                       | 26 Nº .                    | 895                             |
| 9 R 1/171/151/71/16 N                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                          |                         | -                                       | 20 M.                      |                                 |
| $\frac{1}{2} \frac{1}{2} \frac{1}$ | ONTARIO                                  |                         | DE                                      | CEIVE                      |                                 |
| The W                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Vell Drillers                            | Act                     | 1                                       |                            |                                 |
| Basin Department of I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                          |                         | anta i                                  | 27 2 4 1958                | . 1                             |
| Ca - VII                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                          |                         | GEOL                                    | ogical days<br>RTHIIT of E | Sal /                           |
| Water V                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                          | Kec                     | ord                                     |                            |                                 |
| hor Haldimand                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Terrebio Vil                             | lage, Town              | or City of ou                           | thela                      | yuga.                           |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                          | or City)                |                                         |                            |                                 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | باسوة                                    | Y. A                    | atherin                                 | un                         |                                 |
| Date Completed                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | t Well (exclud:                          | ing pump).              | • • • • • • • • • • • • • • • • • • • • | • • • • • • • • • • • •    | • • • • • • • • • •             |
| Pipe and Casing Record                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | · · · · · ·                              | ]                       | Pumping Test                            |                            | <u></u>                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Dete                                     | 1/                      | the aug                                 | - 25                       |                                 |
| Casing diameter(s)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Date<br>Static level.                    | 0+ 0 L                  | Kon tor                                 | $\sim$                     |                                 |
| Type of screen                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Pumping lev                              | - /                     | ft from                                 | ton                        |                                 |
| Length of screen                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Pumping rat                              |                         |                                         | is hr                      | ,<br>                           |
| Distance from top of screen to ground level.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Duration of                              |                         |                                         |                            | -13                             |
| Is well a gravel-wall type?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Distance from                            | n cylinder o            | or bowls to ground                      | level                      | ····                            |
| W                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | ater Record                              |                         |                                         |                            |                                 |
| Kind (fresh or mineral)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | ····                                     |                         | . Depth(s)<br>to Water                  | Kind of<br>Water           | No. of Feet<br>Water Rises      |
| Quality (hard, soft, contains iron, sulphur, etc.)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Iph s                                    |                         | Horizon(s)                              | water                      | Water Mises                     |
| Appearance (clear, cloudy, coloured)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | aug -                                    |                         | · 45.P                                  | Sulphin                    | 3714                            |
| For what purpose(s) is the water to be used? $f(t)$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | a sa | !                       | ·                                       |                            |                                 |
| How far is well from possible source of contamination?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | • • • • • • • • • • • • • • •            |                         | · ·                                     | ,                          |                                 |
| What is the source of contamination?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                          |                         |                                         |                            |                                 |
| Enclose a copy of any mineral analysis that has been ma                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | de of water                              | • • • • • • • • • • • • | ••                                      |                            |                                 |
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| Kind (fresh or mineral)Quality (hard, soft, contains iron, sulphur, etc.)<br>Appearance (clear, cloudy, coloured)<br>For what purpose(s) is the water to be used?<br>How far is well front possible source of contamination<br>What is the source of contamination?<br>Enclose a copy of any mineral analysis that has been | ndf fur<br>maria                                                                                      | · · · · · · · · · · · · · · · · · · · | •                     | Water                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                       |
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| <u></u>                                                                                                                                                                                                                                                                                                                     |                                                                                                       | J. ft.<br>30<br>62                    | well from dicate nort | below show dis<br>road and lot li<br>h by arrow.<br>how are<br>how | ne.                   |
| Situation: Is well on upland, in valley, or on hillsid<br>Drilling Firm.<br>Address.<br>Name of Driller:<br>Date                                                                                                                                                                                                            | 24 - T                                                                                                |                                       | Number.               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | •••••                 |

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| Casing diameter(s)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <ul> <li>Developed C</li> <li>Duration of</li> <li>Pumping Ra</li> <li>Drawdown .</li> <li>Static level of</li> </ul> | Capacity .<br>Test<br>te<br>of complet | ted well <i>I. S</i>                | · · · · · · · · · · · · · · · · · · · | ······                                |
| Depth of pump setting                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                       |                                        |                                     |                                       |                                       |
| W                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | ater Record                                                                                                           |                                        |                                     | ······                                |                                       |
| Kind (fresh or mineral)<br>Quality (hard, soft, contains iron, sulphur etc.)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | esk<br>Lard                                                                                                           | · · · · · · · · · · · ·                | Depth(s)<br>to<br>Water Horizon(s)  | Kind of<br>Water                      | No. of Feet<br>Water Rises            |
| How far is well from possible source of contamination?<br>What is source of contamination?<br>Enclose a copy of any mineral analysis that has been r                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | · · · · · · · · · · · · · · · · · · ·                                                                                 | · · · · · · · · · · · · · · · · · · ·  | · · · · ·                           |                                       |                                       |
| Well Log<br>Drift and Bedrock Record                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | From                                                                                                                  | To                                     | Loc                                 | ation of Well                         | l                                     |
| Sub soile<br>Clouy<br>flinkt                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 0 ft.<br>3<br>32.                                                                                                     |                                        | In diagram belo<br>from road and lo |                                       | nces of well                          |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                       |                                        |                                     | Bench                                 | an avad                               |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                       |                                        |                                     |                                       |                                       |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | ······                                                                                                                |                                        |                                     | x                                     |                                       |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | · · · · · · · · · · · · · · · · · · ·                                                                                 | -                                      | Laber Erie                          |                                       |                                       |
| Situation: Is well on upland, in valley, or on hillsid<br>Drilling Firm Address Address Address Address Dece 30/49                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                       |                                        |                                     | <u></u>                               | · · · · · · · · · · · · · · · · · · · |
| Date                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                       | Licenc                                 | ε inuilider Γ.                      |                                       | SS.58                                 |

|                                                                                                                                                                                                                                                                                                                                            | -                                     | 124                                                                      | 0_10                 |                                                        | (J.           | K.                                    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|--------------------------------------------------------------------------|----------------------|--------------------------------------------------------|---------------|---------------------------------------|
| $TM   \underline{/7}^{Z}   \underline{577584}  \underline{/F}^{E}$ $ \underline{Q} _{R}   \underline{\mathscr{A}}  \underline{75828} \underline{288}^{N}$ Hev. $ \underline{Q} _{R}   \underline{O}  \underline{Q}  \underline{O}  \underline{O} $ Hasin $ \underline{23}  \underline{218}   \underline{218} \underline{818}^{N}$ Departme |                                       | ONTARIO<br>ell Drillers A<br>fines, Provin                               |                      | RECEIN<br>JAN 12 19<br>GEOLOGICAL B<br>IntBERARTMENT O | E)<br>RANCH   | 922                                   |
| Wate                                                                                                                                                                                                                                                                                                                                       | er V                                  | Vell                                                                     | Red                  | cord                                                   | 3             |                                       |
|                                                                                                                                                                                                                                                                                                                                            | USE OF WEI                            | ort                                                                      | Do                   | Con. 1 Lot                                             | es            |                                       |
| Pipe and Casing Record                                                                                                                                                                                                                                                                                                                     |                                       |                                                                          |                      | Pumping Test                                           |               |                                       |
| Casing diameter(s) 6. //4<br>Length(s) of casing(s)                                                                                                                                                                                                                                                                                        | · · · · · · · · · · · · · · · · · · · | Developed C<br>Duration of<br>Pumping Ra<br>Drawdown .<br>Static level o | Capacity<br>Test<br> | eted well 9. 4. fr.                                    | ÷.            | · · · · · · · · · · · · · · · · · · · |
|                                                                                                                                                                                                                                                                                                                                            | W:                                    | ater Record                                                              | <u>.</u>             | valner y                                               |               |                                       |
| Kind (fresh or mineral)                                                                                                                                                                                                                                                                                                                    | m                                     | inera                                                                    | <b>?</b>             | Depth(s)<br>to<br>Water Horizon(s)                     |               | No. of Feet<br>Water Rises            |
| How far is well from possible source of contar<br>What is source of contamination?<br>Enclose a copy of any mineral analysis that h                                                                                                                                                                                                        |                                       |                                                                          |                      | •••••                                                  | 1             |                                       |
| Drift and Bedrock Record                                                                                                                                                                                                                                                                                                                   | <u></u>                               | From                                                                     | To                   | Loc                                                    | ation of Well | l                                     |
| Clay surface.                                                                                                                                                                                                                                                                                                                              |                                       | O ft.                                                                    | .48.ft.              | In diagram bel<br>fro <b>m</b> road and l              |               | nces of well                          |
| flint.                                                                                                                                                                                                                                                                                                                                     |                                       | 48                                                                       | 56                   | Ţ                                                      | V :           | jeo                                   |
|                                                                                                                                                                                                                                                                                                                                            |                                       |                                                                          | -                    | Dain                                                   | harre part    | ad                                    |
|                                                                                                                                                                                                                                                                                                                                            |                                       |                                                                          |                      |                                                        |               |                                       |
|                                                                                                                                                                                                                                                                                                                                            |                                       |                                                                          |                      | ،000 لم<br>لا                                          | 0 B           |                                       |
|                                                                                                                                                                                                                                                                                                                                            |                                       |                                                                          | -                    | Fate                                                   |               | aie                                   |
| Situation: Is wellon upland, in valley, or of<br>Drilling Firm. Address                                                                                                                                                                                                                                                                    |                                       |                                                                          | Addre                | ess Jamie<br>ce Number 4                               | <u>7</u> .    | <u>CS\$.\$8</u>                       |

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| UTM 12 577676 E<br>Cob R 4738676 Contario Water Resources<br>Eller. 15 16 10575 WATER WEL                                                                                                                                                                                                                                      | L REC                           | APR<br>Act ONTAI                | WATER BRANNER<br>26 Nº<br>1 4<br>1 4<br>1 0<br>1 0<br>1 4<br>1 0<br>1 0<br>1 0<br>1 0<br>1 0<br>1 0<br>1 0<br>1 0 | 921                                         |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|
| Basin 20 Haldimand                                                                                                                                                                                                                                                                                                             | ownship, Village, I             | Fown or City                    | Walpola to                                                                                                                                                                                                                                                                                | mship                                       |
| Con 1 Lot 6                                                                                                                                                                                                                                                                                                                    |                                 |                                 | month                                                                                                                                                                                                                                                                                     | year)                                       |
|                                                                                                                                                                                                                                                                                                                                | tress 57 But                    | rris St. H                      | amilton Ont.                                                                                                                                                                                                                                                                              | <b>X</b>                                    |
| Casing and Screen Record                                                                                                                                                                                                                                                                                                       |                                 | Pumpin                          | g Test                                                                                                                                                                                                                                                                                    |                                             |
| Inside diameter of casing $6\frac{1}{4}$ in.                                                                                                                                                                                                                                                                                   | Static level                    | 25ft.                           |                                                                                                                                                                                                                                                                                           |                                             |
| Total length of casing                                                                                                                                                                                                                                                                                                         | Test-pumping r                  | ate 15-2                        | 20                                                                                                                                                                                                                                                                                        | G.P.M.                                      |
| Type of screen                                                                                                                                                                                                                                                                                                                 | Pumping level                   | 05.04                           | •                                                                                                                                                                                                                                                                                         |                                             |
| Length of screen                                                                                                                                                                                                                                                                                                               | Duration of test                | pumping                         | l <sup>1</sup> / <sub>2</sub> hr.                                                                                                                                                                                                                                                         |                                             |
| Depth to top of screen                                                                                                                                                                                                                                                                                                         | Water clear or c                | loudy at end of                 | test cloudy                                                                                                                                                                                                                                                                               | 7                                           |
| Diameter of finished hole 64 in.                                                                                                                                                                                                                                                                                               | Recommended                     | pumping rate                    | 10-15                                                                                                                                                                                                                                                                                     | G.P.M.                                      |
|                                                                                                                                                                                                                                                                                                                                | with pump setti                 | ng of 30                        | ) feet belo                                                                                                                                                                                                                                                                               | w ground surface                            |
| Well Log                                                                                                                                                                                                                                                                                                                       |                                 |                                 | Water                                                                                                                                                                                                                                                                                     | Record                                      |
| Overburden and Bedrock Record                                                                                                                                                                                                                                                                                                  | From<br>ft.                     | To<br>ft.                       | Depth(s) at<br>which water(s)<br>found                                                                                                                                                                                                                                                    | Kind of water<br>(fresh, salty,<br>sulphur) |
| clay                                                                                                                                                                                                                                                                                                                           | 0                               | 31                              | 69                                                                                                                                                                                                                                                                                        |                                             |
| flint                                                                                                                                                                                                                                                                                                                          | 31                              | 70                              | 07                                                                                                                                                                                                                                                                                        | sulphur                                     |
| For what purpose(s) is the water to be used?<br>summer cottage<br>Is well on upland, in valley, or on hillside? upland<br>Drilling or Boring Firm Ray W.Swayze                                                                                                                                                                 | road and                        | am below show<br>d lot line. In | of Well<br>distances of we<br>dicate north by                                                                                                                                                                                                                                             | ll from<br>arrow.                           |
| Address       R.R.5       Simcoe         Address       1266         Licence Number       1266         Name of Driller or Borer       Ray Swayze         Address       R.R.5         Simcoe       Mar.11/64         Date       Mar.11/64         May       Swayze         (Signature of Licensed Drilling or Boring Contractor) | PLAN 1807<br>LOT 307<br>PTOFBLO | Z<br>ck A                       | 1200 74                                                                                                                                                                                                                                                                                   | CSS.58                                      |
| Form 7 10M-62-1152                                                                                                                                                                                                                                                                                                             | 3 L                             | AKE                             | ER                                                                                                                                                                                                                                                                                        | I E                                         |

| Basin 27 1 WATE                                                                        | ER WI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | ELL F                                 | ission Act, 1957<br>RECORI                 | RECTURDED                                                           |                                             |
|----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|--------------------------------------------|---------------------------------------------------------------------|---------------------------------------------|
| County or District Haldimon                                                            | d<br>9                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Township,<br>Date com                 | Village, Town or<br>pleted $\frac{20}{20}$ | City NANTI                                                          | <u>/960</u><br>year)                        |
|                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                       |                                            |                                                                     |                                             |
| Casing and Screen Record                                                               | and the second se |                                       | Pun                                        | nping Test                                                          |                                             |
| Inside diameter of casing                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Static ler                            |                                            |                                                                     |                                             |
| Total length of casing 27                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                       |                                            |                                                                     |                                             |
| Type of screen                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                       |                                            | ç                                                                   |                                             |
| Length of screen.                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                       |                                            | end of test                                                         |                                             |
| Diameter of finished hole.                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Recomm                                | nended pumping                             | rate                                                                | G.P.M.                                      |
|                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | with                                  | pumping level o                            | f                                                                   |                                             |
| Well Log                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                       | Wa                                         | iter Record                                                         |                                             |
| Overburden and Bedrock Record                                                          | From<br>ft.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | To<br>ft.                             | Depth(s)<br>at which<br>water(s)<br>found  | No. of feet<br>water rises                                          | Kind of water<br>(fresh, salty,<br>sulphur) |
| And Clay and and                                                                       | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 27                                    | $ \in  $                                   |                                                                     |                                             |
| July shale                                                                             | 27                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 190                                   | - Ry                                       | HOLE                                                                |                                             |
| /                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                       | -                                          |                                                                     |                                             |
|                                                                                        | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | _                                     |                                            |                                                                     | -                                           |
|                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                       |                                            |                                                                     |                                             |
| ·                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                       |                                            | _                                                                   |                                             |
|                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                       |                                            |                                                                     |                                             |
|                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                       | -                                          |                                                                     |                                             |
| ·                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                       | -                                          |                                                                     |                                             |
|                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                       |                                            |                                                                     |                                             |
| For what purpose(s) is the water to be used<br>Jean Jean Jean Jean Jean Jean Jean Jean | ?<br>1102<br>J<br>J<br>60.<br>G Maul                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | × × × × × × × × × × × × × × × × × × × | In/diagram below                           | Ation of Well<br>v show distances<br>e. Indicate nort<br>3 HIGH IVA |                                             |

| UTM $ P ^{R}  z   z   z   z   z   z   z   z   z   z$                                                          | The Wate<br>Dej                             | partment of                | GROUND WATER B<br>JUL 2 0 19<br>ONTARIO WAT<br>Mine<br>Resources comm<br>Mine | 26 1<br>58<br>TER          | Nº 932                                         |
|---------------------------------------------------------------------------------------------------------------|---------------------------------------------|----------------------------|-------------------------------------------------------------------------------|----------------------------|------------------------------------------------|
| County or Territorial District<br>Date completed                                                              | Haldiman                                    |                            | p, Village, Town or City<br>Village, Town or City<br>dress                    | ture of                    | Salpole.                                       |
| Pipe and Casing<br>Casing diameter(s)                                                                         | 4                                           | P<br>P                     | tatic level                                                                   | <u>G. P. H.</u><br><u></u> | <u>lace</u>                                    |
| Well Log<br>Overburden and Bedrock Record                                                                     | From<br>ft.                                 | To<br>ft.                  | Depth(s)<br>at which<br>water(s)<br>found                                     | No. of feet<br>water rises | Kind of water<br>(fresh, salty,<br>or sulphur) |
| Redish Clay<br>flint                                                                                          | 0<br>47'                                    | <u>47</u> '<br><u>60</u> ' | 60                                                                            | 351                        | Sulfhur                                        |
| For what purpose (s) is the water<br><u>Duck lice</u> <u>drum sung</u> <u>The</u><br>Is water clear or cloudy | alei<br>leas                                |                            | In diagram below s<br>road and lot line.                                      | Indicate north             |                                                |
| Is well on upland, in valley, or on<br>Drilling firm                                                          | Sleward<br>Nova<br>foregoing<br>t are true. | <br>                       |                                                                               | e well is you              | Jun lake E                                     |
| 0                                                                                                             |                                             |                            | Jake E                                                                        | Tric                       |                                                |

RECEIVED 30/1361 UTM  $\left| / \gamma \right|^{\mathbb{Z}} \left| \mathcal{S} \right| \mathcal{S} \left| \mathcal{S} \right| \mathcal{S} \left| \mathcal{S} \right|^{\mathbb{E}}$ Nº. 26939  $| \bigcirc | \mathbb{R} | 4 | \gamma | 3 | 9 | 8 | 6 | 4 | \mathbb{N}$ GEULUCIUM CHARGH Elev. 9 R 015115 DEPARTMENT OF MINES Basin 23 The Well Drillers Act Department of Mines, Province of Ontario Con Í Well Water Record lot 20 Village, Town or City..... 21.00. K. RR.I Date Completed . . . 5.5. Cost of Well (excluding pump)..... (month) Pipe and Casing Record **Pumping Test** Casing diameter (s) ..... Date..... Pumping level..... Type of screen. 2 m Length of screen.... Distance from top of screen to ground level. Duration of test... Is well a gravel-wall type?. ... Distance from cylinder or bowls to ground level..... Water Record Kind (fresh or mineral) .... SM. Marta Depth(s) to Water Horizon(s) Kind of Water No. of Feet Water Rises non Quality (hard, soft, contains iron, sulphur, etc.).... Appearance (clear, cloudy, coloured)..... mineral 141 For what purpose(s) is the water to be used?..... este 26 How far is well from possible source of contamination What is the source of contamination?.... Enclose a copy of any mineral analysis that has been made of water..... Well Log Location of Well Overburden and Bedrock Record From То 0 ft. ....ft. In diagram below show/distances of well from road and lot line. In-Ð 11 dicate north by arrow. 29 // deroad " Situation: Is well on upland, in valley, or on hillside? ennis forde Drilling Firm. J..... Address ... AL ......Address Name of Driller .....Licence Number. Date .... Alla. Signature of Licens FORM 5 602 92

|                                                  |                      |                 |            |                                       |                                       | dam                             |
|--------------------------------------------------|----------------------|-----------------|------------|---------------------------------------|---------------------------------------|---------------------------------|
| 17-150755                                        | 7.31                 | <b>3</b>        | a 🏂        |                                       |                                       |                                 |
| UTM $\frac{1}{1/2}$ $\frac{2}{2}$ $\frac{3}{12}$ |                      |                 |            |                                       | GROUGD WAR                            | <u>10 982</u>                   |
| $ 9 _{R}$ $ 4 7 4 0 5 $                          | 30 L 13U             |                 | Y)         |                                       | DIGOSTO MAL                           | LA DIGALO I                     |
| Elev. 9 R 0575                                   | 3000                 | ONT             | ARIO       |                                       | May 27                                | 1953                            |
| COM                                              | The Water            | -well D         | rillers    | Act, 1954                             | ONTARIO                               | X                               |
| Basin $[\sigma]$ $[]$                            | Dep                  | artment         | of N       | lines                                 | RESPERCES C                           |                                 |
|                                                  | Mator                | <b></b>         | 11         | Record                                | <b>k</b>                              |                                 |
|                                                  | w diei-              | AA G            | ┇┻╻┻       | vecor                                 | <b>.</b>                              |                                 |
|                                                  | 1/. //               |                 | in         | Village, Town or C                    | lity Va                               | orle                            |
|                                                  |                      |                 | 1 V        | village, Town or Ci                   | tv)                                   |                                 |
|                                                  |                      |                 |            | iress ALDER                           |                                       |                                 |
| -                                                |                      | <u>]958</u>     |            |                                       |                                       |                                 |
| (day)                                            | (month)              | (year)          |            |                                       | ·····                                 |                                 |
| Pipe and Casin                                   | g Record             |                 |            |                                       | Pumping Test                          |                                 |
| Casing diameter (s)                              |                      |                 | <i>a</i> , | tic level                             | 6'                                    |                                 |
| Length(s)                                        |                      |                 | Sta<br>Dur | nping rate                            | G. P. M.                              | ••••••                          |
| Type of screen                                   |                      |                 | Pur        | nping rate                            | 20'                                   | •••••••••                       |
| Length of screen                                 |                      |                 |            | ration of test                        | hr.                                   |                                 |
|                                                  |                      |                 | 24         |                                       |                                       |                                 |
| Well Log                                         | ,                    |                 |            |                                       | Water Record                          |                                 |
|                                                  | •                    |                 |            |                                       | ·······                               |                                 |
| Overburden and Bedrock Record                    | From                 | То              |            | Depth(s)<br>at which                  | No. of feet                           | Kind of water<br>(fresh, salty, |
|                                                  | ft.                  | ft.             |            | water (s)<br>found                    | water rises                           | or sulphur)                     |
| CLAY                                             |                      | <u> 8</u><br>26 |            | 26                                    | 20                                    | SULPHUR                         |
| <u>lockl-</u>                                    | 18                   | 26              |            |                                       |                                       | -                               |
|                                                  |                      |                 |            |                                       | · · · · · · · · · · · · · · · · · · · |                                 |
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|                                                  |                      |                 |            |                                       |                                       |                                 |
| Ear what number (a) is the mater                 | . 4.0 h.o            |                 |            |                                       |                                       | WAM                             |
| For what purpose(s) is the water<br>COTACE       |                      |                 |            |                                       | ation of Well                         |                                 |
| Is water clear or cloudy?                        |                      | 1               |            | In diagram below                      |                                       |                                 |
| Is well on upland, in valley, or or              |                      |                 |            | road and lot line.                    | N,                                    | by arrow.                       |
| UPLAND<br>Drilling firm HOKARD                   |                      |                 |            | LoT.                                  | 23 LOT 24                             |                                 |
| Drilling firm HOHARD                             | CROSS                |                 |            | L°                                    | F C                                   |                                 |
| Address Rycklan's C                              | O <i>RNERS</i>       |                 |            |                                       |                                       |                                 |
|                                                  | 00.00                |                 |            |                                       |                                       |                                 |
| Name of Driller ARTHUR                           | CHOSS                |                 |            |                                       |                                       |                                 |
| Address Ry CK In Mis                             | OISNERS              |                 |            |                                       |                                       |                                 |
| Tianna Numbar                                    | ••••••               |                 |            | 30                                    | · ~                                   |                                 |
| Licence Number<br>I certify that the             |                      |                 |            | 1 50                                  |                                       |                                 |
| statements of fact                               |                      |                 |            | 4.                                    | -<br>-<br>-                           |                                 |
|                                                  | 1 -                  |                 |            | /                                     | N.                                    |                                 |
| Date MAY 26                                      | and 6-00             | <b>a</b>        |            | Lake                                  |                                       |                                 |
| / 8                                              | ignature of Licensee |                 |            | £                                     | 1.1.1                                 |                                 |

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| $\frac{ 9 _{R}}{ 9 _{R}} \frac{ 5 _{R}}{ 17 _{1}} \frac{ 5 _{R}}{ 0 _{R}} \frac{ 7 _{1}}{ 17 _{1}} \frac{ 6 _{R}}{ 15 _{1}}$ Elev. $\frac{ 9 _{R}}{ 9 _{R}} \frac{ 0 _{5}}{ 15 _{1}} \frac{ 1 _{1}}{ 15 _{1}}$ Basin $\frac{ 3 _{3}}{ 10 _{1}} \frac{ 1 _{1}}{ 10 _{1}}$ $\frac{ 10 _{1}}{ 10 _{1}} \frac{ 1 _{1}}{ 10 _{1}}$ County or Territorial District2 | The Wa<br>I<br><b>Nater</b>                        | ontar<br>ter-well Dri<br>Department | llers Act, 1954<br>of Mines               | • /                                                              |                                                |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|-------------------------------------|-------------------------------------------|------------------------------------------------------------------|------------------------------------------------|
|                                                                                                                                                                                                                                                                                                                                                               |                                                    |                                     | n Village, Town or C<br>Address           | ity)<br>will out                                                 |                                                |
| (day)                                                                                                                                                                                                                                                                                                                                                         | (month)                                            | (year)                              |                                           |                                                                  |                                                |
| Pipe and Casin                                                                                                                                                                                                                                                                                                                                                | g Record                                           |                                     |                                           | Pumping Test                                                     |                                                |
| Casing diameter (s)                                                                                                                                                                                                                                                                                                                                           |                                                    |                                     | Static level                              | 2.0. gals pr.                                                    | minute                                         |
| Well Log                                                                                                                                                                                                                                                                                                                                                      | :                                                  |                                     |                                           | Water Record                                                     |                                                |
| Overburden and Bedrock Record                                                                                                                                                                                                                                                                                                                                 | From<br>ft.                                        | To<br>ft.                           | Depth(s)<br>at which<br>water(s)<br>found | No. of feet<br>water rises                                       | Kind of water<br>(fresh, salty,<br>or sulphur) |
| Clay<br>Flint                                                                                                                                                                                                                                                                                                                                                 | U                                                  | 10                                  |                                           |                                                                  |                                                |
|                                                                                                                                                                                                                                                                                                                                                               |                                                    |                                     |                                           |                                                                  |                                                |
| For what purpose(s) is the water<br>Is water clear or cloudy?                                                                                                                                                                                                                                                                                                 | ttagi<br>"kan                                      |                                     | In diagram below                          | ocation of Well<br>v show distances of<br>e. Indicate north<br>N |                                                |
| Drilling firmR. Cry<br>AddressR.<br>Name of Driller                                                                                                                                                                                                                                                                                                           | <i>L. K. S.</i><br>R. S.<br>foregoing<br>are true. |                                     | LAKE                                      | ERIE                                                             | 5ET<br>190077)                                 |

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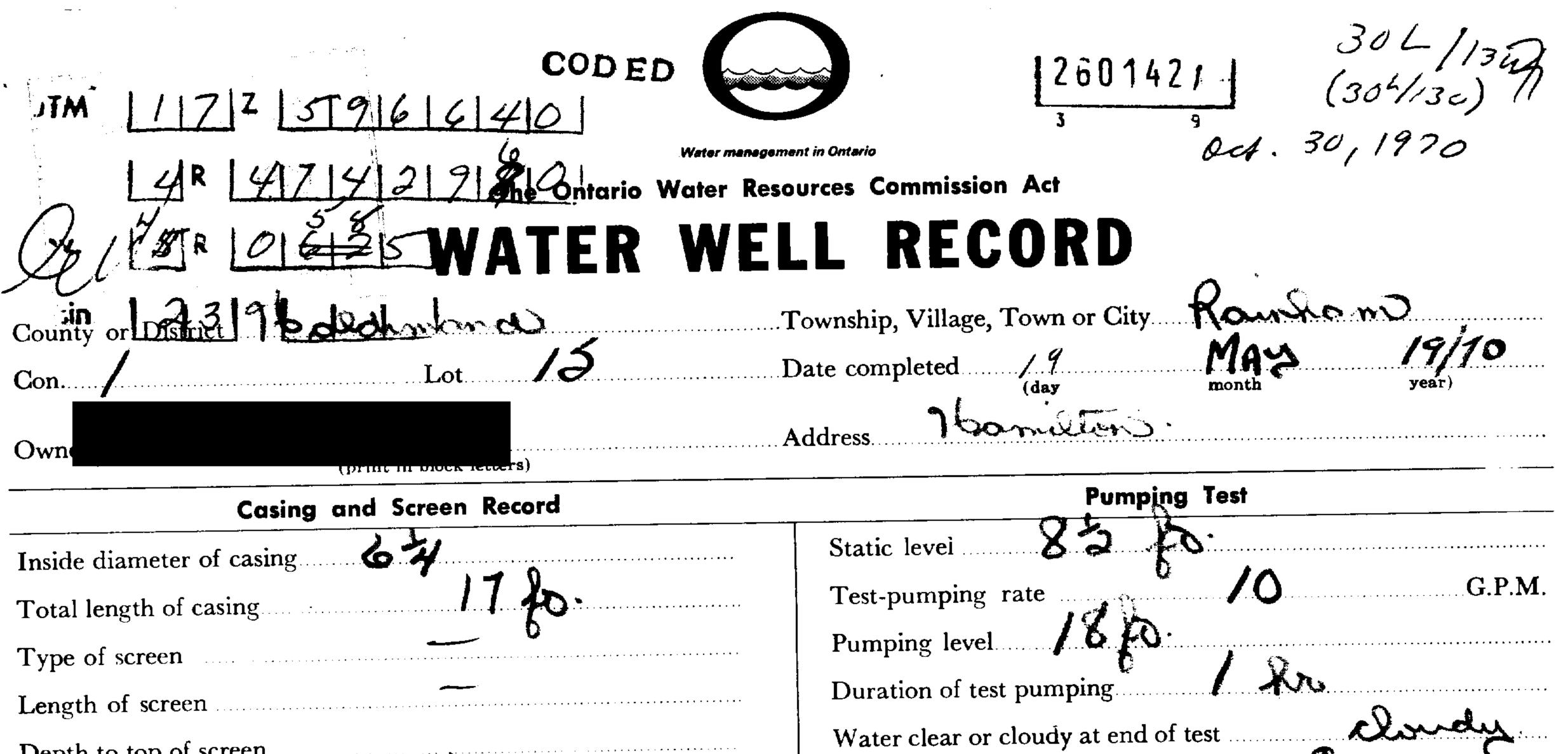
| 14/1 117 51912 2810<br>14/1 14/18/70                                                                                                            | Con I<br>Lat 8<br>CODED<br>Ontario Water Resour |                | Act                                                 | WATER<br>DEC                                         | SION OF<br>RESOURCES<br>16 1968             |
|-------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|----------------|-----------------------------------------------------|------------------------------------------------------|---------------------------------------------|
| in 231 HALDIMAND WAT<br>HALDIMAND WAT<br>County or District                                                                                     | TER WEL                                         |                | ORD                                                 | RESOURCES                                            | COMMISSION<br>68<br>year)                   |
| Casing and Screen Reco                                                                                                                          | ord                                             |                | Pumping                                             | Test                                                 |                                             |
| Inside diameter of casing12'Total length of casing12'Type of screen12'Length of screenNILDepth to top of screenNILDiameter of finished hole6''% |                                                 | Static level   | ate<br>pumping<br>loudy at end of<br>pumping rate   | 2 Ha<br>test ~ ~1                                    | G.P.M.                                      |
| Well Log                                                                                                                                        |                                                 |                |                                                     | Wate                                                 | r Record                                    |
| Overburden and Bedrock                                                                                                                          | Record                                          | From<br>ft.    | To<br>ft.                                           | Depth(s) at<br>which water(s)<br>found               | Kind of water<br>(fresh, salty,<br>sulphur) |
|                                                                                                                                                 | CLAY                                            | 0              |                                                     |                                                      |                                             |
|                                                                                                                                                 | FLINT                                           |                | 28/2                                                | 27                                                   | <del>27</del><br>FRESH                      |
| For what purpose(s) is the water to be used?<br>Is well on upland, in valley, or on hillside?<br>Drilling or Boring Firm<br>ELGIN MITC          | AOUSE<br>LEVEL                                  | In diagroad an | Location<br>am below show<br>d lot line. Inc<br>L A | of Well<br>distances of w<br>dicate north by<br>EIRE | arrow.                                      |
| Address<br>Licence Number<br>Name of Driller or Borer<br>Address<br>Date<br>Date<br>Signature of Licensed Drilling or Bo                        | ,<br>M,<br>ill                                  | FA.            | 4<br>- 7 HIT<br>                                    | - Anno - O                                           | - val                                       |
| (Signature of Licensed Drilling of BC<br>Form 7 15M-60-4138                                                                                     |                                                 | V-             |                                                     | 2-1°7css                                             |                                             |

304/13/4 (30+/13d 2601283 24019 ODED Ontario Water Resources Commission RECORD Township, Village, Town or City KAINH H HALD County or District .Date completed. Lot ress. **Pumping Test** Casing and Screen Record Static level Inside diameter of casing.... G.P.M. Test-pumping rate Total length of casing う Pumping level Type of screen ..... Kls Duration of test pumping Length of screen dear Water clear or cloudy at end of test..... 6" Depth to top of screen..... G.P.M. Recommended pumping rate.... Diameter of finished hole with pump setting of 3.2 feet below ground surface Water Record Well Log Kind of water Depth(s) at То (fresh, salty, sulphur) From which water(s) found Overburden and Bedrock Record ft. ft. 2 0 Sor FLINT For what purpose(s) is the water to be used? Hous EHOLD Location of Well In diagram below show distances of well from road and lot line. Indicate north by arrow. Is well on upland, in valley, or on hillside?..... itnon Drilling or Boring Firm EORD shore Address Licence Number 2813 SANIE Name of Driller or Borer..... Lota **Address** Lot 5 -0 Date gnature of Licensed Drilling or Boring Contractor) Form 7 5M 60-20912 HOOVER Lake ERIE OWRC COPY C55.58

UTM 1725876810E 304/134 74050 2601309-Elev. 91VISINE The Ontario Water Resources Commission Act JG 1 9 1968 Basin RECO RΠ HALDIMAND Township, Village, Town or City UAL PolE County or District 24 Date completed (day Lot... Çon..... 1671 Kin Casing and Screen Record **Pumping Test** 1 12 Inside diameter of casing..... Static level ..... .....G.P.M. Test-pumping rate Total length of casing. Pumping level Type of screen Duration of test pumping 2 HRS Length of screen Water clear or cloudy at end of test CLEAR Depth to top of screen 11 Recommended pumping rate Z- G.PM. Diameter of finished hole with pump setting of  $\mathbf{Z}$   $\mathbf{U}$  feet below ground surface Water Record Well Log Kind of water Depth(s) at To ft. From Overburden and Bedrock Record which water(s) (fresh, salty, ft. found sulphur) BROWN 2 H Location of Well For what purpose(s) is the water to be used?... In diagram below show distances of well from めつり ..... road and lot line. Indicate north by atrow. Is well on upland, in valley, or on hillside? Drilling or Boring Firm X3 BEI MIDLA SURVI RAZ- BRAM Address.... Licence Number.... SAME Name of Driller or Borer RAINA **Address** Lotzy of ilmi Date ... LOT nature of Licensed Drilling or Boring Contractor) Form 7 5M 60-20912 ERI OWRC COPY CC 58 Lakr Sc. J.B.

40I/16 J.B. 177M 2601326 (40 I/16a) 3902 2 - 1960 The Ontario Water Resources Commission Act WE R RECORD ''n ....Township, Village, Town or City. County or District Con.... Lot ss 47 Casing and Screen Record **Pumping Test** Inside diameter of casing... lo Static level 30 Total length of casing 54Test-pumping rate ... **Z**\_ G.P.M. Type of screen Pumping level... Duration of test pumping 2 Length of screen Depth to top of screen..... Water clear or cloudy at end of test C Diameter of finished hole 4 Recommended pumping rate 2 G.P.M. with pump setting of 40feet below ground surface Well Log Water Record Depth(s) at which water(s) found Kind of water From To ft. Overburden and Bedrock Record (fresh, salty, sulphur) ft. 18 0 63 19 56 56 3 ेर For what purpose(s) is the water to be used? Location of Well In diagram below show distances of well from road and lot line. Indicate north by arrow. Is well on upland, in valley, or on hillside? Drilling or Boring Firm. as pelou Lot 14 Address Lot-15 Confe<sup>c</sup> よ Licence Number. Name of Driller or Borer 175 Address Date\_ (Signature of Licensed Drilling or Boring Contractor Form 7 15M-60-4138 CSS.58 OWRC COPY

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     | ATERIAL AND                                                                                                                    | LING (<br>TYPE (<br>LE                     |                                                                               |
| 25-<br>30-<br>71 PUMPING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               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                            | Inches           10-111         2           2         3           0         4           17-18         1           2         0           3         0           4         0           17-18         1           2         0           3         0           4         2           24-25         1           3         0           4         4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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2           PUMP         2           ATIC         WATER L           VEL         PUMP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     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<sup>34</sup><br>4 MINERAL<br>10 PUMPING PATE<br>LER<br>LEVEL <sup>25</sup> WATEF<br>NG                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  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| TEEL 12<br>ALVANIZED<br>CONCRETE<br>DEEN HOLE<br>STEEL 19<br>GALVANIZED<br>CONCRETE<br>DEEN HOLE<br>STEEL 26<br>GALVANIZED<br>CONCRETE<br>OPEN HOLE<br>DURATION OF PUN<br>15-16<br>HOUR<br>20<br>20<br>15-16<br>HOUR<br>20<br>20<br>15-16<br>HOUR<br>15-16<br>HOUR                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     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<sup>34</sup><br>60<br>4 MINERAL<br>10 PUMPING BATE<br>LER<br>10 PUMPING BATE<br>LER<br>15 MINUTES<br>15 MINUTES<br>22-24<br>15 MINUTES<br>24-26<br>25-26<br>15 MINUTES<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>24-26<br>25-26<br>24-26<br>24-26<br>24-26<br>25-26<br>24-26<br>24-26<br>25-26<br>24-26<br>24-26<br>25-26<br>24-26<br>25-26<br>24-26<br>25-26<br>24-26<br>25-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26<br>26-26 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    30         MINUTES           29-31         30           ET         FEET                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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C           / 89         C           / 80         C           / 80         C           MPING         MINS.           20MPING         MINUTES           34         50 MINUTES           34         50 MINUTES           34         50 MINUTES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             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                              | GING<br>FEET M/<br>14-17<br>22-25<br>30-33 80<br>TION C<br>W DISTANCES<br>IRTH BY ARRO                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        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       TEST METHOD       PUMP         20       BAII         ATIC       WATER D         YPUMP       PUMPI         19-21       PUMPI         NG,       FEEL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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19<br/>GALVANIZED<br/>CONCRETE<br/>OPEN HOLE<br/>STEEL 26<br/>GALVANIZED<br/>CONCRETE<br/>OPEN HOLE<br/>DURATION OF PUN<br/>15-16<br/>HOUR<br/>15-16<br/>HOUR<br/>15-16<br/>CONCRETE<br/>OPEN HOLE<br/>15-16<br/>HOUR<br/>15-16<br/>CONCRETE<br/>OPEN HOLE<br/>15-16<br/>CONCRETE<br/>OPEN HOLE<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>15-16<br/>CONCRETE<br/>00<br/>1</td> <td>INCHES         FH           / 88         C           / 88         C           / 87         C           / 88         C           / 90         C</td> <td>2 00<br/>5 7<br/>1</td> <td>27-30<br/>IN DIAGRA<br/>LOT LINE.</td> <td>PLUG<br/>PTH SET AT -<br/>ROM<br/>10-13<br/>18-21<br/>26-29<br/>LOCA</td> <td>GING<br/>FEET M/<br/>14-17<br/>22-25<br/>30-33 80<br/>TION C<br/>W DISTANCES<br/>IRTH BY ARRO</td> <td>DF WE</td> <td>LING I<br/>TYPE (E<br/>LE<br/>LL</td> <td>RECOR<br/>CEMENT GROU<br/>AD PACKER, ET</td> | INCHES           10-11         1           2         2           3         2           0         4           17-18         1           2         2           3         2           4         2           24-25         1           2         2           3         3           4         3           4         3           6         3           6         3           7         1           11-14         0000           6         2           30         MINUTES           29-31         30           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                                                                                | INCHES         FH           / 88         C           / 88         C           / 87         C           / 88         C           / 90         C                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         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| 25-<br>30-<br>71 PUMPING<br>1 -<br>57,<br>1 -<br>57,<br>2 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| 1       FRESH         2       SALTY         23       1         23       1         23       1         24       1         25       SALTY         26       1         27       1         28       1         29       SALTY         33       1         20       SALTY         333       1         20       SALTY         7       FEST METHOD         PUMP       2         ATIC       WATER D         VEL       PUMPI         19-21       PUMPI         NG, FEE       CS         NG, FEE       ENDED PUMP TYPE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               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          3         0           11-14         0           0         0           3         0           10         0           10         0           10         0           10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | TEEL 12<br>CALVANIZED<br>CONCRETE<br>OPEN HOLE<br>STEEL 19<br>GALVANIZED<br>CONCRETE<br>OPEN HOLE<br>STEEL 26<br>GALVANIZED<br>CONCRETE<br>OPEN HOLE<br>DURATION OF PUN<br>15-16<br>A5 MINUTES<br>2 FEI<br>WATER AT END C<br>COLEAR<br>RECOMMENDED<br>PUMPING C                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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| 25-<br>30-<br>71 PUMPING<br>1 -<br>57,<br>1 -<br>57,<br>2 -<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>57,<br>2<br>-<br>5<br>-<br>5,<br>2<br>-<br>5,<br>2<br>-<br>5,<br>2<br>-<br>5,<br>2<br>-<br>5,<br>2<br>-<br>5,<br>2<br>-<br>5,<br>2<br>-<br>5,<br>-<br>5, | 1       FRESH         2       SALTY         23       1         1       FRESH         2       SALTY         28       1         1       FRESH         2       SALTY         33       1         1       FRESH         2       SALTY         33       1         TEST METHOD       PUMP         PUMP       PMATIC         VEL       PUMPT         19-21       FEEL         NG, FEEL       FEEL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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        | TEEL 12<br>ALVANIZED<br>CONCRETE<br>DEEN HOLE<br>STEEL 19<br>GALVANIZED<br>CONCRETE<br>DEEN HOLE<br>STEEL 26<br>GALVANIZED<br>CONCRETE<br>OPEN HOLE<br>DURATION OF PUN<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-1 | INCHES         FH           / 878         C           / 878         C           / 878         C           / 978         C                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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                                                                                           | PLUG<br>PTH SET AT -<br>ROM<br>10-13<br>18-21<br>26-29<br>LOCA<br>M BELOW SHO<br>INDICATE NO                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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                                                                                                                      | LING (<br>TYPE (<br>LE<br>LL<br>ROM ROAD A | RECOR<br>CEMENT GROU<br>AD PACKER, ET                                         |
| 25-<br>30-<br>71 PUMPING<br>1 -<br>ST.<br>ST.<br>ST.<br>ST.<br>ST.<br>ST.<br>ST.<br>ST.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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110       FRESH         110       WATER L         PUMP       PARD         ATIC       WATER L         PUMP       PUMPI         19-21       PUMPI         PEE       FEE         SHALLOW       PUMPI         PUMP       PUMPI         PUMP       PUMPI         SHALLOW       PUMPI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          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  SULPHUR         4       MINERAL         3       SULPHUR         4       MINERAL         10       PUMPING         10       PUMPING         22-24       15         56       15         76       26-1         77       15         78       26-1         79       96-41         70       PUMP INTAKE         6PM.       RECOMMENDEE         PUMP       SETTING         79       SETTING         70       SETTING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 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 4           2C         CLOUDY           46-49         GPM           FFICIENT SUPPLY         SUPPLY</td> <td>2 00<br/>5 77<br/>7</td> <td>27-30<br/>IN DIAGRA<br/>LOT LINE.</td> <td>PLUG<br/>PTH SET AT -<br/>ROM<br/>10-13<br/>18-21<br/>26-29<br/>LOCA<br/>M BELOW SHO<br/>INDICATE NO</td> <td>GING<br/>FEET<br/>TO<br/>14-17<br/>22-25<br/>30-33<br/>B0<br/>TION C<br/>W DISTANCES<br/>W DISTANCES<br/>RTH BY ARRO</td> <td>OF WELL F</td> <td>LING I</td> <td>RECOR<br/>CEMENT GROU<br/>AD PACKER, ET</td>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         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        | INCHES         FH           188         C           188         C           MPING         C           6:30         17-18           15:30         MINS.           2UMPING         BECOVERY           34         60 MINUTES           35-37         FET           FT EFST         4           2C         CLOUDY           46-49         GPM           FFICIENT SUPPLY         SUPPLY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             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| 25-<br>30-<br>71 PUMPING<br>1 -<br>ST.<br>ST.<br>ST.<br>ST.<br>ST.<br>ST.<br>ST.<br>ST.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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       7       TEST METHOD         PUMP       2         8       FEET         90       90         19-21       90         9       FEET         NG, FEE       SHALLOW         900       3         900       3         91       31                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           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SULPHUR         4       MINERAL         3       SULPHUR         4       MINERAL         10       PUMPING         22-24       15         15       WATEF         22-24       15         15       WATEF         23-31       PUMP INTAKE         GPM.       RECOMMENDER         PUMP       SETTING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   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                                                                                                                                                                                                                                                                                                                                                                                                                            | TEEL 12<br>ALVANIZED<br>CONCRETE<br>DEEN HOLE<br>STEEL 19<br>GALVANIZED<br>CONCRETE<br>DEEN HOLE<br>STEEL 26<br>GALVANIZED<br>CONCRETE<br>OPEN HOLE<br>DURATION OF PUN<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-16<br>HOUR<br>15-1 | INCHES         FH           188         C           188         C           MPING         C           6:30         17-18           15:30         MINS.           2UMPING         BECOVERY           34         60 MINUTES           35-37         FET           FT EFST         4           2C         CLOUDY           46-49         GPM           FFICIENT SUPPLY         SUPPLY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 2 00<br>5 77<br>7                | 27-30<br>IN DIAGRA<br>LOT LINE.                                                                                                | PLUG<br>PTH SET AT -<br>ROM<br>10-13<br>18-21<br>26-29<br>LOCA<br>M BELOW SHO<br>INDICATE NO                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | GING<br>FEET<br>14-17<br>22-25<br>30-33 BD<br>TION C<br>WW DISTANCES<br>RTH BY ARRO<br>C<br>C<br>C<br>C<br>C<br>C<br>C<br>C<br>C<br>C<br>C<br>C<br>C                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      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| 25-<br>30-<br>71 PUMPING<br>1 -<br>51 -<br>51 -<br>50-53<br>50-53<br>50-53<br>51 -<br>51 -<br>51 -<br>51 -<br>51 -<br>51 -<br>51 -<br>51 -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             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  SALTY         7       FEET METHOD         PUMP       2         8       FEEL         9       FEEL         9       FEEL         9       9         9       9         9       19-21         9       7         9       7         9       7         9       7         9       7         9       7         9       7         9       7         9       7         9       7         9       7         9       7         9       7 <td>4 MINERAL<br/>3 SULPHUR 19<br/>4 MINERAL<br/>3 SULPHUR 24<br/>4 MINERAL<br/>3 SULPHUR 24<br/>4 MINERAL<br/>3 SULPHUR 24<br/>4 MINERAL<br/>3 SULPHUR 34 80<br/>4 MINERAL<br/>3 SULPHUR 34 80<br/>4 MINERAL<br/>10 PUMPING PATE<br/>EVEL 25 WATEF<br/>NG<br/>22-24 IS MINUTES<br/>22-24 IS MINUTES<br/>22-24 IS MINUTES<br/>FEET OF SUPPLY<br/>COBERNATION WE<br/>, TEST HOLE</td> <td>INCHES           10-11         10-11           2         2           3         2           4         2           2         2           3         2           2         2           3         2           2         2           3         2           2         2           3         2           2         2           3         2           2         2           3         2           4         2           2         3           4         2           3         3           4         2           3         3           4         2           3         3           4         2           3         3           4         2           3         3           4         2           3         3           4         2           3         3           4         3           5         3           4         3     <td>TEEL 12<br/>ALVANIZED<br/>CONCRETE<br/>DPEN HOLE<br/>STEEL 19<br/>GALVANIZED<br/>CONCRETE<br/>DEN HOLE<br/>STEEL 26<br/>GALVANIZED<br/>CONCRETE<br/>OPEN HOLE<br/>DURATION OF PUN<br/>15-16<br/>HOUR<br/>2 FF<br/>45 MINUTES<br/>32-<br/>FEI<br/>WATER AT END C<br/>CLEAR<br/>RECOMMENDED<br/>PUMPING<br/>RATE<br/>DURATION OF, INSUF<br/>NDONED, INSUF<br/>NDONED, INSUF<br/>NDONED, POOR<br/>FINISHED<br/>RCIAL<br/>PAL</td><td>INCHES         FH           188         C           188         C           MPING         C           6:30         17-18           15:30         MINS.           2UMPING         BECOVERY           34         60 MINUTES           35-37         FET           FT EFST         4           2C         CLOUDY           46-49         GPM           FFICIENT SUPPLY         SUPPLY</td><td>2 00<br/>5 77<br/>7</td><td>27-30<br/>IN DIAGRA<br/>LOT LINE.</td><td>PLUG<br/>PTH SET AT -<br/>ROM<br/>10-13<br/>18-21<br/>26-29<br/>LOCA<br/>M BELOW SHO<br/>INDICATE NO</td><td>GING<br/>FEET<br/>TO<br/>14-17<br/>22-25<br/>30-33<br/>B0<br/>TION C<br/>W DISTANCES<br/>W DISTANCES<br/>RTH BY ARRO</td><td>DF WELL F<br/>OF WELL F<br/>W.<br/>5T LOT<br/>3 14<br/>150</td><td>LING I</td><td>RECOR<br/>CEMENT GROU<br/>AD PACKER, ET</td></td> | 4 MINERAL<br>3 SULPHUR 19<br>4 MINERAL<br>3 SULPHUR 24<br>4 MINERAL<br>3 SULPHUR 24<br>4 MINERAL<br>3 SULPHUR 24<br>4 MINERAL<br>3 SULPHUR 34 80<br>4 MINERAL<br>3 SULPHUR 34 80<br>4 MINERAL<br>10 PUMPING PATE<br>EVEL 25 WATEF<br>NG<br>22-24 IS MINUTES<br>22-24 IS MINUTES<br>22-24 IS MINUTES<br>FEET OF SUPPLY<br>COBERNATION WE<br>, TEST HOLE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | INCHES           10-11         10-11           2         2           3         2           4         2           2         2           3         2           2         2           3         2           2         2           3         2           2         2           3         2           2         2           3         2           2         2           3         2           4         2           2         3           4         2           3         3           4         2           3         3           4         2           3         3           4         2           3         3           4         2           3         3           4         2           3         3           4         2           3         3           4         3           5         3           4         3 <td>TEEL 12<br/>ALVANIZED<br/>CONCRETE<br/>DPEN HOLE<br/>STEEL 19<br/>GALVANIZED<br/>CONCRETE<br/>DEN HOLE<br/>STEEL 26<br/>GALVANIZED<br/>CONCRETE<br/>OPEN HOLE<br/>DURATION OF PUN<br/>15-16<br/>HOUR<br/>2 FF<br/>45 MINUTES<br/>32-<br/>FEI<br/>WATER AT END C<br/>CLEAR<br/>RECOMMENDED<br/>PUMPING<br/>RATE<br/>DURATION OF, INSUF<br/>NDONED, INSUF<br/>NDONED, INSUF<br/>NDONED, POOR<br/>FINISHED<br/>RCIAL<br/>PAL</td> <td>INCHES         FH           188         C           188         C           MPING         C           6:30         17-18           15:30         MINS.           2UMPING         BECOVERY           34         60 MINUTES           35-37         FET           FT EFST         4           2C         CLOUDY           46-49         GPM           FFICIENT SUPPLY         SUPPLY</td> <td>2 00<br/>5 77<br/>7</td> <td>27-30<br/>IN DIAGRA<br/>LOT LINE.</td> <td>PLUG<br/>PTH SET AT -<br/>ROM<br/>10-13<br/>18-21<br/>26-29<br/>LOCA<br/>M BELOW SHO<br/>INDICATE NO</td> <td>GING<br/>FEET<br/>TO<br/>14-17<br/>22-25<br/>30-33<br/>B0<br/>TION C<br/>W DISTANCES<br/>W DISTANCES<br/>RTH BY ARRO</td> <td>DF WELL F<br/>OF WELL F<br/>W.<br/>5T LOT<br/>3 14<br/>150</td> <td>LING I</td> <td>RECOR<br/>CEMENT GROU<br/>AD PACKER, ET</td>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | TEEL 12<br>ALVANIZED<br>CONCRETE<br>DPEN HOLE<br>STEEL 19<br>GALVANIZED<br>CONCRETE<br>DEN HOLE<br>STEEL 26<br>GALVANIZED<br>CONCRETE<br>OPEN HOLE<br>DURATION OF PUN<br>15-16<br>HOUR<br>2 FF<br>45 MINUTES<br>32-<br>FEI<br>WATER AT END C<br>CLEAR<br>RECOMMENDED<br>PUMPING<br>RATE<br>DURATION OF, INSUF<br>NDONED, INSUF<br>NDONED, INSUF<br>NDONED, POOR<br>FINISHED<br>RCIAL<br>PAL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         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                                                | 2 00<br>5 77<br>7                | 27-30<br>IN DIAGRA<br>LOT LINE.                                                                                                | PLUG<br>PTH SET AT -<br>ROM<br>10-13<br>18-21<br>26-29<br>LOCA<br>M BELOW SHO<br>INDICATE NO                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       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                                                                                                              | DF WELL F<br>OF WELL F<br>W.<br>5T LOT<br>3 14<br>150                                                                          | LING I                                     | RECOR<br>CEMENT GROU<br>AD PACKER, ET                                         |
| 25-<br>30-<br>71 PUMPING<br>ST/<br>GIVE RAT<br>GIVE RAT<br>ST/<br>OF<br>ST/<br>OF                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      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19-21         Refet         ENDED         PUMP         PUMP         Sector         NG,         FEE         Shallow         OOO         3         YEL         ATER         3         YEL         4         ATER         3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 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MINUTES<br>25 MINUTES<br>26 MINUTES<br>26 MINUTES<br>26 MINUTES<br>27 MINUTES<br>26 MINUTES<br>27 MINUTES<br>27 MINUTES<br>26 MINUTES<br>27 MINUTES<br>27 MINUTES<br>26 MINUTES<br>27 MINUTES<br>27 MINUTES<br>27 MINUTES<br>28 MINUTES<br>28 MINUTES<br>29 MINUTES<br>29 MINUTES<br>20 MINUTES<br>20 MINUTES<br>20 MINUTES<br>20 MINUTES<br>20 MINUTES<br>26 MINUTES<br>27 MINUTES<br>2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | INCHES           10-11         1           2         2           3         0           17-18         1           2         0           3         0           24-25         1           2         0           24-25         1           2         0           24-25         1           2         0           3         0           4         0           24-25         1           2         0           3         0           4         0           2         0           3         0           4         0           2         0           3         0           4         0           5         0           5         0           5         0           6         MUNICITY           5         0           5         0           6         MUNICITY           5         0           6         MUNICITY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 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26<br>GALVANIZED<br>CONCRETE<br>OPEN HOLE<br>DURATION OF PUN<br>15-16<br>AS MINUTES<br>32-<br>FEI<br>WATER AT END C<br>COLEAR<br>RECOMMENDED<br>PUMPING<br>RATE<br>COMMENDED, POOR<br>FINISHED<br>RCIAL<br>PAL<br>SUPPLY<br>G OR AIR CONT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | INCHES PH<br>INCHES PH                                                                                                                                                                                                                       | 2 00<br>5 77<br>7                | 27-30<br>IN DIAGRA<br>LOT LINE.                                                                                                | PLUG<br>PTH SET AT -<br>ROM<br>10-13<br>18-21<br>26-29<br>LOCA<br>M BELOW SHO<br>INDICATE NO                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | GING<br>FEET<br>10<br>14-17<br>22-25<br>30-33 BD<br>TION C<br>WW DISTANCES<br>RTH BY RRO<br>WW DISTANCES<br>RTH BY RRO<br>ACC<br>1<br>BCD                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      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      | LING I                                     | RECOR<br>CEMENT GROU<br>AD PACKER, ET                                         |
| 25-<br>30-<br>71 PUMPING<br>ST/<br>GIVE RAT<br>GIVE RAT<br>ST/<br>OF<br>ST/<br>OF                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      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WATER L         PUMP       PUMP         19-21       WATER L         NG       FEEL         ENDED PUMP TYPE         SHALLOW       2         NG       3         ATER       3         JSE       4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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GPM.<br>FEET 0 GET<br>6 GPM.<br>FEET 0 GET<br>15 MINUTES<br>15 MINUTES<br>15 MINUTES<br>15 MINUTES<br>15 MINUTES<br>15 MINUTES<br>15 MINUTES<br>16 GPM.<br>15 MINUTES<br>15 MINUTES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | INCHES         10-11       1         2       2         3       2         2       2         3       2         2       2         3       2         2       2         3       2         2       2         3       2         2       2         3       2         2       2         3       2         2       2         3       2         2       2         3       2         2       2         3       2         2       2         3       2         2       2         3       3         4       2         2       2         3       3         4       2         2       3         3       3         4       2         3       3         4       3         2       2         3       3         4       3         1                                                                                                                                                                                                                                                                                                                 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                                                                              | GING<br>FEET<br>14-17<br>22-25<br>30-33 BO<br>TION C<br>W DISTANCES<br>RTH BY ARRO<br>ACC<br>I<br>BOU<br>ACC<br>I<br>BOU                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 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| 25-<br>30-<br>71<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             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SALTY         19-21       WATER L         PUMP       PUMP         19-21       SALTY         PUMP       PUMPINP         PUMP       SALTY         SALTY       SALTY         PUMP       SALTY         PUMP       SALTY         PUMP       SALTY         PUMP       SALTY         PUMP       SALTY         SALTY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             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| INCHES PH<br>INCHES PH                                                                                                                                                                                                                       | 2 00<br>5 77<br>7                | 27-30<br>IN DIAGRA<br>LOT LINE.                                                                                                | PLUG<br>PTH SET AT -<br>ROM<br>10-13<br>18-21<br>26-29<br>LOCA<br>M BELOW SHO<br>INDICATE NO                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        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| 25-<br>30-<br>71<br>1<br>1<br>57,<br>1<br>57,<br>1<br>57,<br>1<br>57,<br>2<br>2<br>2<br>3<br>2<br>3<br>3<br>2<br>3<br>3<br>3<br>3<br>3<br>3<br>3<br>3<br>3<br>3<br>3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   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 SALTY         733       1       FRESH         2       SALTY         74       2         75       7         74       2         74       2         75       3         74       3         75       3         74       3         75       3         74       3         75       3         75       3         74       3         75       3         74       3         75       3         74       3         75       3         75<                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           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WATEF<br>15 MINERAL<br>10 PUMPING BATE<br>EVEL 25 WATEF<br>10 PUMPING BATE<br>EVEL 25 WATEF<br>10 PUMPING BATE<br>EVEL 25 WATEF<br>10 PUMPING BATE<br>EVEL 25 WATEF<br>10 PUMPING BATE<br>10 PUMPING BATE<br>EVEL 25 WATEF<br>10 PUMPING BATE<br>10 PUMPING BATE<br>EVEL 25 WATEF<br>10 PUMPING BATE<br>10 PUMPING BATE<br>EVEL 25 WATEF<br>10 PUMPING BATE<br>EVEL 25 WATEF<br>EVEL 25 WATE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             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26<br>GALVANIZED<br>CONCRETE 026<br>DURATION OF PUN<br>15-16<br>HOUR<br>2 FF<br>45 MINUTES<br>32-<br>FEI<br>WATER AT END C<br>CLEAR<br>RECOMMENDED<br>PUMPING<br>RATE 000<br>CLEAR<br>RECOMMENDED<br>PUMPING<br>RATE 000<br>CLEAR<br>RECOMMENDED<br>PUMPING<br>RATE 000<br>CLEAR<br>RECOMMENDED<br>PUMPING<br>RATE 000<br>CLEAR<br>RECOMMENDED<br>PUMPING<br>RATE 000<br>CLEAR<br>RECOMMENDED<br>PUMPING<br>RATE 000<br>CLEAR<br>RECOMMENDED<br>POR<br>NDONED, INSUF<br>NDONED, POOR<br>FINISHED<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMENDED<br>POR<br>CLEAR<br>RECOMMEND<br>POR<br>CLEAR<br>RECOMMEND<br>POR<br>CLEAR<br>RECOMMEND<br>POR<br>CLEAR<br>RECOMMEND<br>POR<br>CLEAR<br>RECOMMEND<br>POR<br>CLEAR<br>RECOMMEND<br>POR<br>CLEAR<br>RECOMMEND<br>POR<br>CLEAR<br>RECOMMEND<br>POR<br>CLEAR<br>RECOMMEND<br>POR<br>CLEAR<br>RECOMMEND<br>POR<br>CLEAR<br>RECOMMEND<br>POR<br>CLEAR<br>RECOMMEND<br>POR<br>CLEAR<br>RECOMMEND<br>POR<br>CLEAR<br>RECOMMEND<br>POR<br>CLEAR<br>RECOMMEND<br>POR<br>CLEAR<br>RECOMMEND<br>POR<br>CLEAR<br>RECOMMEND<br>RECOMMEND<br>POR<br>CLEAR<br>RECOMMEND<br>POR<br>CLEAR<br>RECOMMEND<br>POR<br>POR<br>POR<br>POR<br>POR<br>POR<br>POR<br>POR                                                                                                                                                                                                                                                                          | INCHES PH<br>INCHES PH                                                                                                                                                                                                                       |                                  | 27-30<br>IN DIAGRA<br>LOT LINE.                                                                                                | PLUG<br>PTH SET AT -<br>ROM<br>10-13<br>18-21<br>26-29<br>LOCA<br>M BELOW SHO<br>INDICATE NO<br>NEN<br>M BELOW SHO<br>INDICATE NO<br>INDICATE NO | GING<br>FEET<br>10<br>14-17<br>22-25<br>30-33 BD<br>TION C<br>WW DISTANCES<br>RTH BY ARRO<br>WW DISTANCES<br>RTH BY 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| DF WELL F<br>OF WELL F<br>W.<br>3 14<br>150<br>5 0,4<br>14                                                                     | LING I<br>D TYPE LE                        | RECOR<br>CEMENT GROU<br>AD PACKER, ET<br>ND                                   |
| 25-<br>30-<br>71 PUMPING<br>1 -<br>57.<br>57.<br>57.<br>57.<br>57.<br>50-53<br>FII<br>STA<br>OF<br>WA<br>C                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             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2         ATIC       WATER L         PUMP       2         NG,       2         RE       3         NAL       2         NAL       2         VEL       3         NAL       2         VEL       3         ATER       3         JSE       4         OF       3         LLING       4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           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<sup>25</sup><br>MATER SUPPLY<br>0 OBSERVATION WE<br>FEET HOLE<br>FOMÉSTIC<br>STOCK<br>1 IRIGATION<br>1 IRIGATION<br>1 INIGATION<br>1 INIGATI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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    3         2       4         2       3         2       4         2       3         2       4         2       3         2       4         2       3         2       4         3       4         3       3         4       3         2       3         3       3         4       3         2       3         3       3         4       3         3       3         4       3         11       11         4       3         11       11         11       11         11       11         1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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000<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMEND<br>RECOMMENDE<br>RECOMMENDE<br>RECOMMENDE<br>RECOMMENDE<br>RECOMMENDE<br>RECOMMENDE<br>RECOMMENDE<br>RECOM                                                                                                                                                                                                                       | INCHES PH                            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ARRO<br>AU<br>RTO<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>FEET<br>AU<br>AU<br>AU<br>AU<br>AU<br>AU<br>AU<br>AU<br>AU<br>AU 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| 25-<br>30-<br>21 PUMPING<br>ST/<br>ST/<br>ST/<br>OF<br>ST/<br>OF<br>ADDRI<br>20-<br>20-<br>20-<br>20-<br>20-<br>20-<br>20-<br>20-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      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NOT<br>11<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>13<br>14<br>12<br>12<br>13<br>14<br>19<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>10<br>10<br>10<br>10<br>10<br>10<br>10<br>10<br>10 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C<br/>BO<br/>ACC<br/>I<br/>BO<br/>C<br/>C<br/>C<br/>C<br/>C<br/>C<br/>C<br/>C<br/>C<br/>C<br/>C<br/>C<br/>C</td> <td>DF WELL F<br/>OF WELL F<br/>OF WELL F<br/>3 14<br/>150<br/>4<br/>50<br/>4<br/>50<br/>4<br/>50<br/>4<br/>50<br/>4<br/>50<br/>4<br/>50<br/>4<br/>5</td> <td>LING I<br/>D TYPE LE</td> <td>RECOR<br/>CEMENT GROU<br/>AD PACKER, ET<br/>ND<br/>ND<br/>Sanko<br/>Jok<br/>E<br/>Jok</td>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  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  S5-56         1       2         ATER       3         JSE       4         STOS       3         OF WELL CHITRAC       3         OF DRILLER       8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       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                                                                                                                                                                                                                                                                         | TEEL 12<br>ALVANIZED<br>CONCRETE<br>DEEN HOLE<br>STEEL 19<br>GALVANIZED<br>CONCRETE<br>DEEN HOLE<br>STEEL 26<br>GALVANIZED<br>CONCRETE<br>OPEN HOLE<br>DURATION OF PUN<br>15-16<br>HOUR<br>2 FE<br>45 MINUTES<br>32-<br>FEI<br>WATER AT END C<br>LEAR<br>RECOMMENDED<br>PUMPIN<br>RATE 000<br>STEEL<br>9 NOT<br>6 BORING<br>7 DIAMOND<br>8 JETTING<br>9 NOT<br>11<br>12<br>12<br>12<br>12<br>12<br>12<br>12<br>13<br>14<br>12<br>12<br>13<br>14<br>19<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>15-16<br>10<br>10<br>10<br>10<br>10<br>10<br>10<br>10<br>10<br>10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | INCHES         FN           / 88         C           / 89         C           / 88         C           / 80         17-18           6         30           34         57-37           51         7           51         60           60         MINUTES           34         57-37           57         7           57         7           57         7           57         7           57         7           57         7           57         7           57         7           57         7           57         7           57         7           60         7           60         7                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                  | IN DIAGRA<br>LOT LINE.<br>LOT LINE.<br>LOT LINE.<br>LOT LINE.<br>LOT LINE.<br>LOT LINE.<br>LOT LINE.<br>LOT LINE.<br>LOT LINE. | PLUG<br>PTH SET AT -<br>ROM<br>10-13<br>18-21<br>26-29<br>LOCA<br>M BELOW SHC<br>INDICATE NO<br>SA<br>SB CONTRAC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | GING<br>FEET<br>TO<br>TA-17<br>22-25<br>30-33 BO<br>TION C<br>TION C<br>BO<br>ACC<br>I<br>BO<br>C<br>C<br>C<br>C<br>C<br>C<br>C<br>C<br>C<br>C<br>C<br>C<br>C                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   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  | RECOR<br>CEMENT GROU<br>AD PACKER, ET<br>ND                                   |



| Depth to top of screen 64<br>Diameter of finished hole                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                 |          | umping rate                  | S                                      | G.P.M.                                      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------|------------------------------|----------------------------------------|---------------------------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | with pump       | p settin | g of                         |                                        | w ground surface<br>Record                  |
| Well Log<br>Overburden and Bedrock Record                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | From<br>ft.     |          | To<br>ft.                    | Depth(s) at<br>which water(s)<br>found | Kind of water<br>(fresh, salty,<br>sulphur) |
| Clay                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 0               |          | 15                           |                                        |                                             |
| Siline                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | /:              | <b>`</b> | 22                           |                                        |                                             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                 |          |                              | 19-20                                  | Mittley                                     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                 |          |                              |                                        | Support                                     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                 |          | Location                     | of Well                                |                                             |
| For what purpose(s) is the water to be used?<br>The set of the set o | In<br>In<br>roa | id and   | m below show<br>lot line. In | v distances of we<br>dicate north by   | ll from<br>arrow.<br>수                      |

KOND KAZNHAM Drilling or Boring Firm GATES REICHELDS SIOEROND CREEN > MY73 Address. 1662 Licence Number... to dil Name of Driller or Borer. ERTE **Address** 19/70 Date..... nature of Licensed Drilling or Boring Contractor) Form 7 OWRC COPY CSS.S8

|                                                    | ۶۳                                                                                                |                                    | BACIBW                                                |
|----------------------------------------------------|---------------------------------------------------------------------------------------------------|------------------------------------|-------------------------------------------------------|
|                                                    | The Ontario Water Reso                                                                            |                                    | Bo C 13 W<br>(304/13d)                                |
| W.                                                 | AIEK WEL                                                                                          | L RECORD                           | CON                                                   |
| er management in Ontario 1. PRINT ONLY IN S        | PACES PROVIDED                                                                                    | 2601511. 36007                     | 15 22 23 24                                           |
| 2. CHECK X CORR                                    | TOWNSHIP, DORONOL, COTT, TOWN, MICH.                                                              | 3 9 CON., BLOCK, TRACT, OUTVET     | , ETC: LOT 25-27                                      |
| MAND                                               | RAIN HAM                                                                                          | <u> </u>                           | DATE COMPLETED 48-53                                  |
|                                                    | 69. U-P                                                                                           | PE SHERMAN AVE                     | DAY 0 MO 2 YR 4                                       |
|                                                    | 415 DO L                                                                                          | 6 5 75 5 23                        | 47                                                    |
|                                                    | OG OF OVERBURDEN AND BEDR                                                                         | OCK MATERIALS (SEE INSTRUCTIONS)   | 4                                                     |
| MOST                                               | OTHER MATERIALS                                                                                   | GENERAL DESCRIPTION                | DEPTH – FEET<br>FROM TO                               |
|                                                    |                                                                                                   |                                    | 0-11                                                  |
| REY CLAY<br>FLINT                                  |                                                                                                   |                                    | 11 23                                                 |
| <u> </u>                                           |                                                                                                   |                                    |                                                       |
|                                                    |                                                                                                   |                                    |                                                       |
| · · · ·                                            |                                                                                                   |                                    |                                                       |
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| Maria Car                                          |                                                                                                   |                                    |                                                       |
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| 2                                                  |                                                                                                   |                                    |                                                       |
| ) agnizast 1 lac                                   | 123 15 11 1111                                                                                    |                                    |                                                       |
|                                                    |                                                                                                   | 43<br>54<br>SIZE(S) OF OPENING     | 65 75<br>31-33 DIAMETER 34-38 LENGTH 39               |
| WATER RECORD                                       | 151 CASING & OPEN HO                                                                              |                                    | INCHES FI                                             |
| ATER FOUND<br>AT - FEET<br>10-13 1 FRESH 3 SULPHUR | DIAM MATERIAL THICKNESS                                                                           | FROM TO WATERIAL AND TYPE          | OF SCREEN                                             |
| 2 2 SALTY 4 I MINERAL                              |                                                                                                   |                                    | & SEALING RECORD                                      |
| 1 C FRESH 3 SULPHUR<br>2 SALTY 4 MINERAL           | 17-18 1 OPEN HOLE                                                                                 | 20-23 DEPTH SET AT - FEET          | ATERIAL AND TYPE (CEMENT GROUT,<br>LEAD PACKER, ETC.) |
| 20-23<br>1  FRESH 3 SULPHUR 2 SALTY 4 MINERAL      | 3 CONCRETE                                                                                        | 11-6 10-13 14-17                   |                                                       |
| 25-28 1                                            |                                                                                                   | 27-30 18-21 22-25                  |                                                       |
| 30-33 1 🗌 FRESH 3 🗋 SULPHUR                        | 2 	GALVANIZED<br>34 80<br>3 	CONCRETE<br>4 	OPEN HOLE                                             | 26-29 30-33 80                     |                                                       |
| 2 SALTY 4 MINERAL                                  |                                                                                                   | LOCATION                           | OF WELL                                               |
|                                                    | GPM                                                                                               | NS. IN DIAGRAM BELOW SHOW DISTANCE | S OF WELL FROM ROAD AND                               |
| LEVEL PUMPING                                      | ATER LEVELS DURING 2 2 1 DUMPING 2 2 1 DUMPING 2 1 OMINUTES 1 30 MINUTES 1 60 MINUTES 1 60 MINUTE | LOT LINE. INDICATE NORTH BY ARR    |                                                       |
| NIL NIL                                            | 26-28 29-31 32-34 35                                                                              | 5-37                               |                                                       |
| FEET 023 FEET                                      | TAKE SET AT WATER AT END OF TEST                                                                  |                                    |                                                       |
| GIVE RATE GPM.                                     |                                                                                                   | 5-49                               |                                                       |
| SHALLOW DEEP SETTING                               | PUMPING UUUUU                                                                                     |                                    |                                                       |
|                                                    | PECIFIC CAPACITY                                                                                  | - Lot.                             | 7                                                     |
| FINAL                                              | N WELL 6 🗌 ABANDONED, POOR QUALITY                                                                | T Lor. Lor                         | >                                                     |
| STATUS 3  TEST HOLE OF WELL 4  RECHARGE V          | 7 🗌 UNFINISHED                                                                                    | 4                                  | ic a s                                                |
| 55-56 1 DOMESTIC<br>2 D STOCK                      | 5 COMMERCIAL<br>6 MUNICIPAL                                                                       |                                    | 2                                                     |
|                                                    | 7 PUBLIC SUPPLY<br>8 COOLING OR AIR CONDITIONING                                                  |                                    | 0                                                     |
|                                                    | CAMMER COTTAGE NOT USED                                                                           | + HIC -> EAS                       | T 70 25                                               |
| METHOD 57 1 CABLE TOOL<br>2 ROTARY (CO             | NVENTIONAL) 7 🗌 DIAMOND                                                                           |                                    | .0                                                    |
|                                                    | VERSE) 8 🗆 JETTING<br>R) 9 🗍 DRIVING                                                              |                                    |                                                       |
|                                                    |                                                                                                   |                                    | -62 DATE RECEIVED 7 2. 63-6                           |
| J.R. NAUM                                          |                                                                                                   | AT SOURCE / 3801                   | 120112                                                |
| ADDRESS                                            |                                                                                                   | W 55-1.72                          | Php. 1                                                |
| A ISHER VIAL                                       | ONT                                                                                               |                                    |                                                       |
| J. R. NAUMA                                        | N 3801                                                                                            | 22 0                               | CSS.S8                                                |
| Signature of contractor                            |                                                                                                   | <u>72</u> 0                        |                                                       |
| OWRC COPY                                          | a                                                                                                 |                                    |                                                       |

|                                                                    | a or a she                                                                     |                                                                                                    | RY OF THE EN                                     | VIRONMENT<br>esources Act |                                           | 30-14                               | -0                  |
|--------------------------------------------------------------------|--------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|--------------------------------------------------|---------------------------|-------------------------------------------|-------------------------------------|---------------------|
|                                                                    |                                                                                |                                                                                                    |                                                  |                           | CORD                                      | 30+130                              |                     |
| Ontario                                                            |                                                                                | SPACES PROVIDED                                                                                    |                                                  | 126016                    |                                           | in the                              | 5<br>   0           |
| COUNTY OR DISTRICT                                                 |                                                                                | TOWNSHIP, BOROUGH. CITY,                                                                           | TOWN, VILLAGE                                    |                           | 10 10111<br>CON., BLOCK, TRACT, SURVEY, I |                                     | 22 23 24            |
| Hald                                                               | imand                                                                          | Sherb                                                                                              | rook                                             | Ċ                         | Conl                                      |                                     | 0                   |
|                                                                    |                                                                                | 2 E                                                                                                | 1se 5                                            |                           | St. Catherine                             | дау <u>21</u> но                    | 2 vR.74             |
|                                                                    | 10 12                                                                          | 7442                                                                                               | 2.80 4                                           | 0620                      |                                           |                                     | 47                  |
|                                                                    | L                                                                              | OG OF OVERBURDEN                                                                                   | AND BEDROC                                       | K MATERIALS (             | SEE INSTRUCTIONS)                         |                                     |                     |
| GENERAL COLOUR                                                     | NOST<br>COMMON MATERIAL                                                        | OTHER MATE                                                                                         | T                                                | G                         | ENERAL DESCRIPTION                        | FROM                                | то                  |
| brown                                                              | clay                                                                           | stone                                                                                              | .5                                               | pac                       | cKed                                      | 0                                   | 12.6                |
| grey                                                               | limestone                                                                      | Flint                                                                                              |                                                  | /@y                       | crea                                      | 12.6                                | 7-                  |
| · · · · · · · · · · · · · · · · · · ·                              |                                                                                |                                                                                                    | <b>,</b>                                         |                           |                                           |                                     |                     |
|                                                                    | -                                                                              |                                                                                                    |                                                  | -                         |                                           |                                     |                     |
|                                                                    |                                                                                |                                                                                                    |                                                  |                           |                                           |                                     | Å                   |
| ·····                                                              | -                                                                              |                                                                                                    | <b>~</b> 1                                       |                           | ,                                         |                                     |                     |
|                                                                    | 19:007                                                                         |                                                                                                    |                                                  |                           | • • • • • • • • • • • • • • • • • • •     |                                     |                     |
|                                                                    | 1.0/                                                                           |                                                                                                    |                                                  |                           |                                           |                                     | <u></u>             |
|                                                                    | - 7 /                                                                          |                                                                                                    |                                                  |                           |                                           |                                     |                     |
| ·                                                                  |                                                                                |                                                                                                    |                                                  |                           |                                           | <u>í</u>                            |                     |
| $\begin{array}{c} 31 \\ 32 \\ 32 \\ 32 \\ 32 \\ 32 \\ 32 \\ 32 \\$ | 360512 1004                                                                    | <u>527.5</u>                                                                                       |                                                  |                           |                                           |                                     |                     |
|                                                                    | TER RECORD                                                                     | 51 CASING & C                                                                                      |                                                  |                           | (SLOT NO.)                                | 65<br>-33 DIAMETER 34-38 LE         | 75 80<br>NGTH 39-40 |
| WATER FOUND<br>AT - FEET                                           | KIND OF WATER                                                                  | INSIDE<br>DIAM. MATERIAL<br>INCHES                                                                 |                                                  |                           | MATERIAL AND TYPE                         | INCHES<br>DEPTH TO TOP<br>OF SCREEN | FEET<br>41-44 80    |
|                                                                    | FRESH 3 SULPHUR <sup>14</sup><br>SALTY 4 MINERAL                               | 12 12 12 12 12 12 12 12 12 12 12 12 12 1                                                           | 188 0                                            | here -                    | · · · ·                                   |                                     | FEET                |
| 2                                                                  | _ FRESH <sup>3</sup> _ SULPHUR <sup>19</sup><br>_ SALTY <sup>4</sup> _ MINERAL | 06 <sup>3</sup> □ CONCRETE<br>4 □ OPEN HOLE<br><sup>17-18</sup> <sup>1</sup> □ STEEL <sup>19</sup> |                                                  |                           | FPTH SET AT - FEET                        |                                     | T GROUT.            |
| 2                                                                  | ] FRESH <sup>3</sup> ∏ SULPHUR <sup>24</sup><br>] SALTY <sup>4</sup> ∏ MINERAL | 06 <sup>2</sup> □ GALVANIZED<br><sup>3</sup> □ CONCRETE                                            | 12.                                              | 6 43                      | FROM TO 10-12 14-17                       | LEAD PAC                            | KER, ETC.)          |
| 2                                                                  | 29<br>FRESH 3 SULPHUR 29<br>SALTY 4 MINERAL                                    | 4 OPEN HOLE<br>24-25 1 □ STEEL 26<br>2 □ GALVANIZED                                                |                                                  | 27-30                     | 18-21 22-25                               |                                     |                     |
|                                                                    | ☐ FRESH 3 ☐ SULPHUR <sup>34</sup><br>☐ Salty 4 <mark>[ Mineral</mark>          | 3 CONCRETE<br>4 OPEN HOLE                                                                          |                                                  |                           | 26-29 30-33 80                            |                                     |                     |
|                                                                    | 2 BAILER DOC                                                                   | 0/ 15-1                                                                                            | INPING<br>6 00 17-18<br>RSNINS                   |                           | LOCATION OF                               | WELL 244                            | H                   |
| STATIC                                                             | WATER LEVEL 25                                                                 | · · · · · · · · · · · · · · · · · · ·                                                              | PUMPING<br>RECOVERY                              | LOT LINE.                 | BELOW SHOW DISTANCES                      |                                     | ID , .              |
|                                                                    | 045 030                                                                        | 21 015 31 012                                                                                      | <sup>60</sup> μίμυτες<br>34 0/2 <sup>35-37</sup> | IN .                      |                                           | ALM                                 | _                   |
| IF FLOWING.<br>GIVE RATE                                           | FEET FEET F                                                                    |                                                                                                    |                                                  | N N                       |                                           | over                                |                     |
| IF FLOWING.<br>GIVE RATE                                           | PUMP                                                                           |                                                                                                    | 46-49                                            |                           | A COX                                     | Í –                                 |                     |
| 50-53                                                              | W Q DEEP SETT : C                                                              | FEET RATE UU                                                                                       |                                                  | lot the                   |                                           |                                     | $\rightarrow$       |
| FINAL                                                              | 1 WATER SUPPLY<br>2 D OBSERVATION W                                            | 5 🗌 ABANDONED, INSUF<br>ELL 6 🗌 ABANDONED, POOR                                                    | FICIENT SUPPLY                                   | 1001 60                   | TXX                                       |                                     | Ś                   |
| STATUS<br>OF WELL                                                  | 3                                                                              | 7 UNFINISHED                                                                                       |                                                  | 8 18                      | 119                                       | <u> </u>                            |                     |
| WATER                                                              | 55-56 1 DOMESTIC<br>2 STOCK<br>3 IRRIGATION                                    | 5 COMMERCIAL<br>6 MUNICIPAL<br>7 PUBLIC SUPPLY                                                     | 1                                                | Mohaw K/                  | 4. [r.a.]                                 |                                     |                     |
| USE                                                                |                                                                                | B COOLING OR AIR CONDI<br>B D COOLING OR AIR CONDI                                                 |                                                  | N Jalmil                  | phant P+RO.                               |                                     |                     |
| METHOD                                                             | 57 1 CABLE TOOL                                                                | 6 🗌 BORING<br>NTONAL) 7 🗌 DIAMOND                                                                  |                                                  | last                      | haskptRd.<br>house                        |                                     |                     |
| OF                                                                 | 3 TH ROTARY (REVER                                                             | SE) B JETTING<br>9 DRIVING                                                                         |                                                  |                           | V W U V                                   |                                     |                     |
| NAME OF WEL                                                        |                                                                                |                                                                                                    | CENCE NUMBER                                     | DRILLERS REMARKS:         | S8 CONTRACTOR 59-62                       | ATE RECEIVED                        | 63-68 80            |
|                                                                    | A Me                                                                           | fritt 1                                                                                            | 3640                                             | SOURCE                    | 2010                                      | 4 09 74                             |                     |
| VA R                                                               | #15m.                                                                          | thville                                                                                            |                                                  |                           |                                           |                                     | <u> </u>            |
| IN Por                                                             | LER OR BORER                                                                   | erritt.                                                                                            | 3140                                             |                           |                                           | P                                   | KP                  |
|                                                                    | La Men                                                                         | SUBMISSION DATE                                                                                    | ang. v. 14                                       | OFF                       | CS                                        | 5.S8 V                              |                     |
| MINISTR                                                            | Y OF THE ENVI                                                                  | RONMENT COPY                                                                                       |                                                  |                           |                                           | FORM                                | 17 07-091           |

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Act                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                   | 10                                | .1                       |
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| Ontario                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 1. 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| 20-23 1 _ FRE<br>2 _ SAL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               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                                      | 17-18 1 ☐ STEEL<br>2 ☐ GALVANIZ<br>3 ☐ CONCRETI                                                                                                                                                                          |                                                                                |                | FROM                                | то                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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| 25-28 1 🗌 FRE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          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| FINAL<br>STATUS<br>OF WELL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             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                                      | ECIFIC CAPACITY<br>B C ABANDONED, 1<br>LL G ABANDONED, F<br>7 UNFINISHED                                                                                                                                                 |                                                                                |                | 15 00'                              | 1.45                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          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| FINAL<br>STATUS<br>OF WELL<br>58-55                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | GPM./PT, SPE<br>GPM./PT, SPE<br>WATER SUPPLY<br>COBSERVATION WEI<br>COBSERVATION WEI<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>COBSERVATION<br>CO | ECIFIC CAPACITY<br>S ABANDONED. 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I<br>7 UNFINISHED<br>S COMMERCIAL<br>6 MUNICIPAL                                                                                                                        |                                                                                |                | 15 00'                              | 1.45                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | niles<br>miles    |                                   |                          |
| FINAL<br>STATUS<br>OF WELL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             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F<br>7 UNFINISHED<br>S COMMERCIAL<br>6 MUNICIPAL<br>7 PUBLIC SUPPLY<br>8 COOLING OR AIR C                                                                               | POOR QUALITY                                                                   |                | 15 00'                              | 1.45                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | miles<br>miles    | $\rightarrow$                     |                          |
| FINAL<br>STATUS<br>OF WELL<br>WATEP<br>USE 0 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         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| FINAL<br>STATUS<br>OF WELL<br>WATEP<br>USE 0 1<br>METHOD 1<br>OF                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       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| FINAL<br>50-53<br>FINAL<br>STATUS<br>OF WELL<br>55-56<br>WATER<br>USE<br>WATER<br>USE<br>I<br>METHOD<br>SF<br>DRILLING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 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|                           | Ministry<br>of the<br>Environment                                                                   | ٦                                                             | WAT                    | The Ontar<br>ER M                    | io Water Reso<br>ELL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                       | CO                  | RC                                                |
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| COUNTY OR DIS             |                                                                                                     | TOWNSHIP, BOROUGH CITY                                        |                        | WBAN                                 | CON BLOCK TRACT S<br>ONE<br>KS<br>IC BASIN CODE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | DATE COMP                             | LETED               | LOT 23-27<br>P.T. 10<br>48-53<br>T_ YR <b>T.3</b> |
| 1 2                       | M 10 12                                                                                             | HING<br>17 18                                                 | 24 25                  |                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                       | <u>l</u>            |                                                   |
|                           | TSOM                                                                                                | G OF OVERBURDEN                                               |                        |                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                       | DEPTH               | I - FEET                                          |
| GENERAL COL               | COMMON MATERIAL                                                                                     | OTHER MAT                                                     | ERIALS                 | GE                                   | ENERAL DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | •                                     | FROM                | 35                                                |
| REDIS                     |                                                                                                     |                                                               |                        |                                      | · · ·                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                       | 25                  | 94                                                |
| GRE/<br>BROWN             |                                                                                                     |                                                               |                        |                                      | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                       | 94                  | 109                                               |
|                           |                                                                                                     |                                                               |                        |                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                       | 109                 | 101                                               |
| FLINT                     | DRY HOLE                                                                                            | (A MALALE                                                     | R WANTE                | DTAA                                 | UT DRIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 1017                                  | 101                 | +                                                 |
|                           | DRYHOLE                                                                                             |                                                               |                        |                                      | DCASI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                       | ·                   |                                                   |
|                           |                                                                                                     |                                                               | Ł                      |                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                       | • ··· · · · · · · · | · · · · · · · · · · · · · · · · · · ·             |
|                           |                                                                                                     |                                                               |                        |                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                       | :<br>*              |                                                   |
|                           | · ·                                                                                                 |                                                               |                        |                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                       | ļ                   |                                                   |
| 31                        |                                                                                                     |                                                               |                        |                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                       |                     |                                                   |
| 1 2 10                    | WATER RECORD                                                                                        | 51 CASING &                                                   | OPEN HOLE RE           |                                      | 54<br>SIZE (S) OF OPENING<br>(SLOT NO.)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 31-33 DIAME                           |                     | 25<br>LENGTH 39-4                                 |
| WATER FOUND<br>AT - FEET  | KIND OF WATER                                                                                       | INSIDE<br>DIAM MATERIAL                                       | WALL DEP               |                                      | MATERIAL AND TYPE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 6                                     | INCHES              | FE<br>41-44                                       |
| 10-13                     | 1 _ FRESH 3 [] SULPHUR<br>2 _ SALTY 4 _ MINERAL                                                     | 10-11 2 1 STEEL 12<br>2 1 GALVANIZED                          |                        | 13-16 ·07                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                       | OF SCREEN           | FEET                                              |
| 15.18                     | FRESH 3 [] SULPHUR<br>C SALTY 4 [] MINERAL                                                          | 4 3 CONCRETE                                                  | Ø                      | 109 61                               | I] PLUGO                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | ING & SEAL                            | ING REC             | ORD                                               |
| 20-23                     |                                                                                                     | 17-18 1 STEEL1<br>2 [] GALVANIJED                             |                        |                                      | ROM TO                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | MATERIAL ANI                          | LEAU P              | IENT GROUT<br>PACKER LTC 1                        |
| 25-28                     | 1 _ FRESH 3 _ SULPHUR 29                                                                            | 3 [] CONCRETE<br>4 [] OPEN HOLE<br>24-25 1 [] STEEL 26        | s                      | 27-30                                | 10-13 14-17<br>18-21 22-25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | FLUC                                  | (-EQ                |                                                   |
| 30-33                     | 2 _ SALTY 4 _ MINERAL<br>I _ FRESH 3 _ SULPHUR <sup>34</sup> <sup>40</sup><br>2 _ SALTY 4 _ MINERAL | 1 □ STEEL<br>2 □ GALVANIZED<br>3 □ CONCRETE<br>4 □ OPEN HOLE  |                        |                                      | 26-29 30-33                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 80                                    |                     |                                                   |
| 71                        | EST METHOD 10 PUMPING RATE                                                                          | 15-                                                           | 16 17-18               |                                      | LOCATION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | OF WEL                                | L                   |                                                   |
| STAT                      | IC WATER LEVEL 25                                                                                   | EVELS DURING                                                  | PUMPING<br>RECOVERY    | IN DIAGRAM<br>LOT LINE               | BELOW SHOW DIST                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                       | FROM ROAD           | AND                                               |
| TEST                      | 19-21 22-24 15 MINUTES<br>26-2                                                                      | 30 MINUTES 45 MINUTES                                         |                        |                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 47                                    |                     |                                                   |
|                           | FEET FEET FEE<br>IG 33-41 PUMP INTAKE                                                               |                                                               | EET FEET<br>OF TEST 42 |                                      | i<br>A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | t ·                                   |                     |                                                   |
| SI IF FLOWIN<br>GIVE RATE | GPM                                                                                                 | PEEI                                                          | 2 🗍 CLOUDY             |                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | lan M<br>1 ann                        | ang<br>Rajaria      |                                                   |
| S⊁                        | DED PUMP TYPE RECOMMENDED<br>PUMP<br>HALLOW DEEP SETTING                                            | A1-45 RECOMMENDED<br>PUMPING<br>FEET RATE                     | 46-49<br>GPM           | •<br>•                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                       | n der<br>A          |                                                   |
| 50-53                     |                                                                                                     |                                                               |                        |                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                       |                     | -                                                 |
| FINA<br>STAT<br>OF W      | US                                                                                                  | S C ABANDONED, INSU<br>L B C ABANDONED POOR<br>7 C UNFINISHED | 1 1                    | ÷,                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | · · · · · · · · · · · · · · · · · · · | 16 IN G             | ν, τ.<br>                                         |
| WAT                       | 55-56 I □ DOMESTIC<br>2 □ STOCK<br>ER 3 □ IRRIGATION                                                | 5 🗌 ÇOMMERCIAL<br>6 🗋 MUNICIPAL<br>7 🔲 PUBLIC SUPPLY          |                        | -                                    | ** <sub>11</sub>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                       | na a Canada<br>Na   |                                                   |
| USI                       |                                                                                                     | 8 COOLING OR AIR COND<br>9 Not                                |                        |                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                       | <b>•</b>            |                                                   |
| METH                      |                                                                                                     |                                                               |                        |                                      | an ka Carika                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                       |                     |                                                   |
| DRILL                     |                                                                                                     | 9 🗋 DRIVING                                                   |                        | DRILLERS REMARKS                     | en en en en en en                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1 i (                                 |                     |                                                   |
|                           | WELL CONTRACTOR                                                                                     |                                                               | CENCE NUMBER           | DATA<br>SOURCE<br>DATE OF INSPECTION | 58 CONTRACTOR 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 9-62 DATREZE                          | 01                  | 3 43-68                                           |
| ADDRESS                   | fances 7 W                                                                                          | A 1                                                           | AIKO                   | DATE OF INSPECTION                   | INSPECT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | OR :                                  |                     | ·                                                 |
| MANE OF                   | PR 2 Low                                                                                            | Th u                                                          | CENCE NUMBER           |                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                       |                     |                                                   |
|                           | Y. Convers (1) M/Da                                                                                 | AU A                                                          |                        |                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                       |                     |                                                   |
| SIGNATE                   | E OF CONTRACTOR                                                                                     | SUBMISSION DATE                                               | 5405                   | 04410                                | and the second sec | 'n                                    | CSS                 |                                                   |

|

| Ministry of<br>Environment<br>and Energy                            | 6                                                                                                                                                                                               |                                                                                      |                        |                          | The                  |                               | <i>Water R</i><br>R WEL                    |                      |                     |
|---------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|------------------------|--------------------------|----------------------|-------------------------------|--------------------------------------------|----------------------|---------------------|
| Print only in spaces prov<br>Mark correct box with a c<br>HALDIMAN  | checkmark, where app                                                                                                                                                                            | licable.                                                                             | 11                     | 2602                     | 506                  |                               | 09                                         | AND R                |                     |
| County or District                                                  |                                                                                                                                                                                                 | Township                                                                             | /Borough/City/1<br>DUれ | own/Village<br>ノN レノレヒモ  | £                    |                               | tract survey                               | y, etc. Loi          |                     |
|                                                                     |                                                                                                                                                                                                 | Address<br>39                                                                        |                        | ND RIVE                  |                      |                               | Date<br>completed                          | 9 1                  | 8 96                |
| 21                                                                  | · · · · ·                                                                                                                                                                                       |                                                                                      | Northing               |                          | Elevation RC         | Basin Code                    | ii                                         | day mi               | onth year           |
| <u> </u>                                                            | M 10                                                                                                                                                                                            | G OF OVERBURDE                                                                       |                        |                          | LS (see instruct     | ions)                         | · · · · · · · · · · · · · · · · · · ·      |                      | 4/                  |
| General colour N                                                    | lost common material                                                                                                                                                                            | O                                                                                    | ther materials         |                          | Genera               | I description                 |                                            | De<br>From           | pth – feet<br>To    |
| BROWN                                                               | TOP-SOIL                                                                                                                                                                                        | -                                                                                    |                        |                          |                      |                               |                                            | 0                    | 1                   |
| /                                                                   | SAND                                                                                                                                                                                            |                                                                                      |                        |                          |                      |                               |                                            | /                    | 17                  |
| BROWN                                                               | SAND                                                                                                                                                                                            | e GRAVE                                                                              |                        |                          | ARSE                 | <b>.</b>                      |                                            | 22                   | 28                  |
| BROWN                                                               | SAND                                                                                                                                                                                            | EGRAVE                                                                               | <u> </u>               |                          | AR JIS               |                               |                                            | da                   | 20                  |
|                                                                     |                                                                                                                                                                                                 |                                                                                      |                        |                          |                      |                               |                                            |                      |                     |
|                                                                     |                                                                                                                                                                                                 |                                                                                      |                        |                          |                      |                               |                                            |                      |                     |
|                                                                     | :<br>                                                                                                                                                                                           |                                                                                      |                        |                          |                      |                               |                                            |                      |                     |
| <u> </u>                                                            |                                                                                                                                                                                                 |                                                                                      |                        |                          |                      |                               |                                            |                      |                     |
|                                                                     |                                                                                                                                                                                                 |                                                                                      |                        |                          |                      |                               |                                            |                      |                     |
| 31                                                                  |                                                                                                                                                                                                 |                                                                                      |                        |                          |                      |                               |                                            |                      | <u> </u>            |
| 32                                                                  | المشافر ، أن الما المار الم<br>الما المارين الما الماري ال                                                                                                                                      |                                                                                      |                        |                          | - i - i - Lucaria    | inne i i e c<br>Alle la la la | لين من |                      |                     |
| 41 WATER RE                                                         | Insi                                                                                                                                                                                            | de                                                                                   | Vall                   | E RECORD<br>Depth - feet | Sizes of (Slot No.   |                               | 31 33 Diameter                             |                      |                     |
| at - feet Nind                                                      | of water diar                                                                                                                                                                                   |                                                                                      | thickness<br>inches    | From To                  |                      | and type                      |                                            | Depth at top         | of screen 30        |
| $ 172  \square calle $                                              | $\begin{array}{c c} \square & \text{Minerals} \\ \hline & \square & \text{Gas} \\ \hline \end{array} \\ \hline \end{array} \\ \begin{array}{c} 2 \\ 2 \\ 2 \\ 2 \\ 2 \\ 2 \\ 2 \\ 2 \\ 2 \\ 2 $ | 2 🖸 Galvanized                                                                       | 3                      | 0 27:                    | PER                  | 4 370                         | NE                                         |                      | feet                |
| 2 🗆 Salty                                                           | Gas                                                                                                                                                                                             | 5 Plastic                                                                            |                        | 20                       | 23 61                | PLUGGIN<br>Annular space      | IG & SEALIN                                | G RECOR              |                     |
| □ Salty                                                             | Gasi                                                                                                                                                                                            | 2 <b>⊡</b> Galvanized        3     □       4     □       0pen hole                   | 188                    | 16 28                    | Depth set at<br>From | - feet                        | erial and type (Ce                         | ement grout, b       | entonite, etc.)     |
| 25-28 1 Eresh<br>2 Salty                                            | Minerals                                                                                                                                                                                        | 5 Plastic<br>24.25 1 Steel 26<br>2 Galvanized                                        | 0                      | 51                       | -30 10 13            |                               | AKKI                                       |                      |                     |
| 30 <sup>-333</sup> 1 □ Fresh 3<br>2 □ Salty 5                       | 3      Sulphur 34 60     Minerals     Gas                                                                                                                                                       | <ul> <li>Gaivanized</li> <li>Concrete</li> <li>Open hole</li> <li>Plastic</li> </ul> |                        |                          | 26-29                | 30 33 80                      | NTINI                                      | TE                   | IOINT?              |
| Pumping test method                                                 | Pumping rate                                                                                                                                                                                    | 11-14 Duration of pump                                                               | bing                   |                          |                      |                               | - \                                        |                      |                     |
| 71 Pump 2 Bailer                                                    |                                                                                                                                                                                                 |                                                                                      | 2 🗆 Recovery           |                          | ram below show       |                               |                                            | ad and lot I         | ine.                |
| end of pull                                                         | 2-74 15 minutes 30 mini                                                                                                                                                                         | · - · •                                                                              | 60 minutes             |                          | e north by arrow     | •                             |                                            |                      |                     |
|                                                                     | feet feet                                                                                                                                                                                       | feet feet<br>Water at end of t                                                       | feet                   | A                        |                      | 4                             | 1                                          |                      |                     |
|                                                                     | Pump intake set at<br>FM<br>e Recommended                                                                                                                                                       | feet Clear                                                                           | Cloudy                 | K                        | [                    | <i>/U</i> -                   |                                            | >                    |                     |
| Recommended pump type                                               | pump setting                                                                                                                                                                                    | feet                                                                                 | GPM                    | E                        |                      |                               |                                            |                      |                     |
| 50-53                                                               | ELL 54                                                                                                                                                                                          |                                                                                      |                        | E                        | GLA                  | NO                            | RIVE                                       |                      |                     |
| 2 Observation well<br>3 Test hole                                   |                                                                                                                                                                                                 | icient supply 🤋 🔲 Unfini<br>quality no 🗌 Repla<br>)                                  | shed<br>cement well    | K                        |                      | •                             | KIVE                                       | R                    |                     |
| A 🖸 Recharge well                                                   | B Dewatering                                                                                                                                                                                    |                                                                                      |                        | E /                      | -                    |                               |                                            | _                    |                     |
| WATER USE                                                           | 55-56<br>5 🗌 Commercial<br>6 🔲 Municipal                                                                                                                                                        | ₃ 🗌 Notus                                                                            | sed                    |                          |                      | ٨                             | WELL                                       |                      | <b>_</b>            |
| 3   Irrigation<br>4   Industrial                                    | <ul> <li>Public supply</li> <li>Cooling &amp; air cond</li> </ul>                                                                                                                               |                                                                                      |                        |                          |                      | - TL                          | J NEU<br>COT                               | J<br>TAGE            | ų                   |
| METHOD OF CONSTR                                                    |                                                                                                                                                                                                 |                                                                                      |                        | T                        |                      | 120                           | × 60                                       | 20'                  | -38<br>-4           |
| t □ Cable tool     2 □ Rotary (conventiona     3 □ Rotary (reverse) | 7 🔲 Diamond                                                                                                                                                                                     | 9 🛛 Drivin<br>10 🗖 Diggir<br>11 🗖 Other                                              |                        | DEAD                     | GRI                  | AND                           | RIVER                                      | e del                | 7<br>6/59 4         |
| A D Rotary (air)                                                    |                                                                                                                                                                                                 |                                                                                      |                        | END                      |                      |                               |                                            | .009                 | <del>1 8 -</del> '3 |
| Name of Well Contractor                                             | 2 BAETZ                                                                                                                                                                                         | - Well Contrac                                                                       | tor's Licence No.      | Data<br>source           | 58 Contractor        | )30                           | 59-62 Date rec                             | eived<br>P19         | 1996                |
| Address R#                                                          | $\square$                                                                                                                                                                                       | ASANT                                                                                |                        | Uate of insper           | ction                | Inspector                     |                                            |                      | ·····               |
| Name of Well Technician                                             |                                                                                                                                                                                                 | Weli Technic                                                                         | ian's Licence No.      | Remarks                  |                      |                               |                                            |                      |                     |
| Signature of Techniplan/Contr                                       | actory                                                                                                                                                                                          | Submission of                                                                        | <u>338</u><br>date     | Remarks<br>NIN           |                      |                               |                                            | ~~~                  | ¥.                  |
| 4 Jai                                                               | 3                                                                                                                                                                                               | day mo                                                                               |                        |                          |                      |                               |                                            | CSS.<br>0506 (07/94) | Front Form 9        |
| 2 - MINISTRY                                                        | OF ENVIRONI                                                                                                                                                                                     | MENT & ENI                                                                           | ERGY CO                | YYU                      |                      |                               |                                            | 3                    |                     |

| ন্থি       | Mini<br>of th            |                                                                                                                         |                                                            | MA.                                  |               |               | Water Resource                          |                                                 | DRD                             |
|------------|--------------------------|-------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|--------------------------------------|---------------|---------------|-----------------------------------------|-------------------------------------------------|---------------------------------|
| Onta       |                          | ironment<br>1. print only in s                                                                                          | PACES PROVIDED                                             | 11                                   | 2602          | 2646          | <u>56010</u>                            |                                                 |                                 |
|            | Y OR DISTRICT            |                                                                                                                         | ECT BOX WHERE APPLICABLE                                   | TOWN. VILLAGI                        | E             | CON           | 10 14<br>BLOCK TRACT, SURVEY E          | 15                                              | 22 23 24<br>LOT 25-27           |
| 1          | HACO                     | MAND                                                                                                                    | MACPO<br>ADDRESS                                           |                                      |               |               |                                         | DATE COMPLETED                                  | 48-53                           |
|            |                          |                                                                                                                         |                                                            | NAN                                  | RC ELEVATION  |               | BASIN CODE                              | DAY MO<br>NN                                    | <u>7_v</u>                      |
|            | 1                        |                                                                                                                         | 17 18                                                      | 24                                   |               |               | 31                                      |                                                 |                                 |
|            |                          | LC<br>Most                                                                                                              | OG OF OVERBURDEN                                           |                                      | ROCK MATE     |               | RAL DESCRIPTION                         |                                                 | TH - FEET                       |
|            |                          | COMMON MATERIAL                                                                                                         |                                                            |                                      |               |               |                                         | FROM                                            | 1                               |
|            | 2EY_                     | CLAY                                                                                                                    |                                                            |                                      |               |               |                                         | ١                                               | 31                              |
|            | <u> ()</u>               | BROWNLIME                                                                                                               |                                                            |                                      |               |               |                                         | 31                                              | 70                              |
|            |                          |                                                                                                                         |                                                            |                                      |               |               |                                         |                                                 |                                 |
|            |                          |                                                                                                                         |                                                            |                                      |               |               |                                         |                                                 |                                 |
|            |                          |                                                                                                                         |                                                            |                                      |               |               |                                         |                                                 |                                 |
|            |                          | <u> </u>                                                                                                                |                                                            |                                      | •             |               |                                         |                                                 |                                 |
|            |                          |                                                                                                                         |                                                            |                                      |               |               |                                         |                                                 |                                 |
|            |                          |                                                                                                                         |                                                            |                                      |               |               |                                         |                                                 |                                 |
|            |                          |                                                                                                                         |                                                            | ##¥                                  |               |               |                                         |                                                 |                                 |
| 31         | <u> </u>                 | <u> </u>                                                                                                                | <u> </u>                                                   |                                      |               |               |                                         |                                                 | <b></b>                         |
| 32         | ] (<br>] (               |                                                                                                                         |                                                            |                                      |               |               |                                         |                                                 |                                 |
| 41         |                          | TER RECORD                                                                                                              |                                                            | <b>г</b>                             |               |               | E(S) OF OPENING 3                       | 1-33 DIAMETER 34-3                              |                                 |
| AT         | - FEET                   | KIND OF WATER                                                                                                           | INSIDE<br>DIAM MATERIAL<br>INCHES<br>10-11 1 STEEL         | WALL<br>THICKNESS<br>INCHES          | FROM TO       |               | TERIAL AND TYPE                         | DEPTH TO TO<br>OF SCREEN                        |                                 |
| 6          | , ð '                    | $\square SALTY \stackrel{4}{\square} MINERAL$ $\square FRESH \stackrel{3}{\square} SULPHUR \stackrel{19}{\blacksquare}$ | Concrete                                                   | . 188                                | 03            |               | PLUGGING                                | & SEALING RE                                    |                                 |
| <b>_</b>   | 1                        | $\square SALTY \stackrel{4}{\square} MINERAL$ $\square FRESH \stackrel{3}{\square} SULPHUR \stackrel{24}{\square}$      | 4 ] OPEN HOLE<br>17-18 1 ] STEEL<br>2 ] GALVAN'ZED         | 19                                   |               |               | H SET AT - FEET                         |                                                 | CEMENT GROUT<br>ID PACKER ETC ) |
|            | 2                        | □ SALTY 4 □ MINERAL<br>□ FRESH 3 □ SULPHUR 29                                                                           | CONCRETE                                                   |                                      |               | 0             | 10-13 14-17                             |                                                 |                                 |
|            | 2                        | □ SALTY 4 □ MINERAL<br>□ FRESH 3 □ SULPHUR 34 8                                                                         |                                                            | :6                                   |               | 27-30         | 18-21 22-25<br>26-29 30-33 80           |                                                 |                                 |
|            | 2                        | SALTY 4 MINERAL                                                                                                         | I OPEN HOLE                                                | PUMPING                              |               |               |                                         |                                                 |                                 |
| 71         | PUMPING TEST M           | 2 BAILER Z                                                                                                              | 5 GPMHC                                                    | -16 <u>O</u>                         | uns           |               | LOCATION O                              |                                                 | D AND                           |
| L.         | STATIC<br>LEVEL          | PUMPING                                                                                                                 | LEVELS DURING 2                                            | PUMPING<br>RECOVERY<br>S   60 MINUTI |               |               | NDICATE NORTH BY ARE                    |                                                 |                                 |
| 3 TEST     | 23.                      | ET 33 FEET 26"                                                                                                          | <sup>20</sup> 29 <sup>0-31</sup> 32 <sup>3</sup>           | <sup>2-34</sup> 33                   | 5-37<br>FEET. |               |                                         |                                                 |                                 |
| PUMPING    | IF FLOWING.<br>GIVE RATE | 38-41 PUMP INTAKI                                                                                                       |                                                            | D OF TEST<br>R 2 🗌 CLOU              | 42<br>0Y      |               |                                         |                                                 |                                 |
| PUN        |                          |                                                                                                                         | ED 43-45 RECOMMENDED PUMPING RATE                          | 15                                   | 6-43<br>GPM   |               | LAKES                                   | SHDE K                                          | 20.                             |
|            | 50-53                    |                                                                                                                         |                                                            |                                      |               |               | 1                                       | (                                               | 20.<br>ON, I                    |
|            | FINAL<br>STATUS          | <ul> <li>I Swater supply</li> <li>OBSERVATION WI</li> <li>I TEST HOLE</li> </ul>                                        | S ABANDONED, INS<br>ELL G ABANDONED POO<br>7 (] UNFINISHED |                                      | PLY           |               | 80                                      |                                                 |                                 |
|            | OF WELL                  |                                                                                                                         | —                                                          |                                      |               |               | <ul> <li>4.150<sup>-</sup>→O</li> </ul> | L                                               | OT 13                           |
|            | WATER                    | 2 🗌 STOCK<br>3 🔲 IRRIGATION                                                                                             | MUNICIPAL     PUBLIC SUPPLY                                |                                      |               |               |                                         |                                                 |                                 |
|            | USE                      | 4 🗋 INDUSTRIAL                                                                                                          | COOLING OR AIR CON     D N                                 |                                      |               |               | _                                       |                                                 |                                 |
|            | METHOD                   | 57 1 🗌 CABLE TOOL<br>2 🗌 ROTARY (CONVE                                                                                  | 6 🗍 BORING<br>NTIONAL) 7 🗍 DIAMON                          | D                                    |               |               |                                         | HOUSE                                           |                                 |
|            |                          | G S ROTARY (REVER:<br>C ROTARY (AIR)<br>S AIR PERCUSSION                                                                | 9 🗌 DRIVING                                                |                                      | DRILLERS      | DEMARKS       |                                         |                                                 |                                 |
|            | NAME OF WEI              |                                                                                                                         |                                                            | LICENCE NUMBER                       |               | 58            | CONTRACTOR 59-62                        | FEB 18                                          | 2002 *3.48 **                   |
| LOR<br>LOR | ELG<br>ADDRESS           | IN MITCH                                                                                                                | HELC & SUNS                                                | 3604                                 |               | OF INSPECTION | 3604                                    | FED TO                                          | 2002                            |
| NTRACTOR   | NAME OF DRI              | LLER OR BORER                                                                                                           |                                                            | LICENCE HUMBER                       |               | iks.          |                                         |                                                 |                                 |
| CONT       | TOGO<br>SIGNATURE        | ER MITCH                                                                                                                | SUBMISSION DATE                                            | T-046                                |               |               |                                         | CSS.I                                           | 200                             |
| Ľ          | 1 veres                  | a MAL.                                                                                                                  | ect DAY 31 M                                               | 5 <u>8</u> yr                        | 0/ 0          |               |                                         |                                                 | 0506-4-77 FORM 7                |
|            | MINIS                    | TRY OF THE ENVIR                                                                                                        | ONMENT COPY                                                |                                      |               |               | -                                       | ang a sa ang ang ang ang ang ang ang ang ang an |                                 |

| 401/16E                                                            |                                        |                             | <b>'.</b>                                  |                                             |
|--------------------------------------------------------------------|----------------------------------------|-----------------------------|--------------------------------------------|---------------------------------------------|
| UTR/172 572800 E                                                   |                                        | ·<br>·<br>·                 | 44 NS                                      | 1956                                        |
| $15^{R}$ $473750^{N}$ Ontario Water Reso                           | ources Commission A                    | ct                          |                                            |                                             |
|                                                                    |                                        |                             |                                            |                                             |
| Basin 23 - NORF-01/-                                               | L KEGU<br>Fownship, Village, Tow       |                             | NOOP                                       | HOUSE                                       |
| County or District $-\frac{100}{100}$ Lot $24$                     | Fownship, Village, Tow                 | n or City<br>2              |                                            | · · · · · · · · · · · · · · · · · · ·       |
|                                                                    | da                                     | с.                          | month                                      | year)                                       |
| Owner                                                              | Address PORT                           | D                           | OVER<br>R                                  | R # 3                                       |
| Casing and Screen Record                                           |                                        | Pumping                     | Test                                       |                                             |
| Inside diameter of casing 6/10                                     | Static level                           | 21                          | • • • • • • • • • • • • • • • • • • •      |                                             |
| Total length of casing $3$                                         | Test-pumping rate                      | - 4                         | •<br>• • · · · · · · · · · · · · · · · · · | G.P.M.                                      |
| Type of screen                                                     | Pumping level                          |                             |                                            |                                             |
| Length of screen                                                   | Duration of test pun                   | nping                       | 14                                         | Hours                                       |
| Depth to top of screen                                             | Water clear or cloud                   | ly at end of te             | st C                                       | SLEAR                                       |
| Diameter of finished hole                                          | Recommended pun                        | nping rate                  | 5                                          | G.P.M.                                      |
|                                                                    | with pump setting o                    | f                           | feet belo                                  | w ground surface                            |
| Well Log                                                           | ······································ |                             | Water                                      | Record                                      |
| Overburden and Bedrock Record                                      | From<br>ft.                            | To<br>ft.                   | Depth(s) at<br>which water(s)<br>found     | Kind of water<br>(fresh, salty,<br>sulphur) |
| CLAY                                                               |                                        | 3/                          | V                                          |                                             |
| BROWN LINE<br>FLINT                                                | 3/                                     | 35                          | 33%                                        | SLIGHT<br>Solphor                           |
|                                                                    |                                        |                             |                                            | 50.00                                       |
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| For what put pose(s) is the water to be used?                      |                                        |                             |                                            |                                             |
| For what purpose(s) is the water to be used?<br>GTTAGE $HOUSEHOLD$ | In diagram b                           | Location of<br>elow show di | stan 2 of such                             | from                                        |
| Is well on upland, in valley, or on hillside? $LEUEL$              | road and lot                           | line. Indica                | te north by                                | POR DO'S ET                                 |
| The set of upland, in valley, or on miniside: $-5000$              | LAK                                    | EEKIL                       |                                            | P P                                         |

Drilling or Boring Firm L L G IN A MITTE Address ELIZABETH 51 LAKE SHONEROOWSH Licence Number 2646 Name of Driller or Borer DON PATTEN NAR. 215 ٣Q  $\sqrt{N}$ Address JARUIS Date SUNF1367 Ellin 2015 (Signature of Licensed Drilling or Boring Contractor) Form 7 15M-60-4138 OWRC COPY CSS.S8 5.C.

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                             |                                     | A CONTRACT OF |                           |  |  |  |
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| Sontario Ministry of the Environme                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | ent Mell Tao Numb                                           | number belo                         |                                                                                                                 | Well Record               |  |  |  |
| Instructions for Completing Form                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | A044                                                        | 120                                 |                                                                                                                 | page of                   |  |  |  |
| <ul> <li>For use in the Province of Ontario on</li> <li>All Sections must be completed in full</li> <li>Questions regarding completing this ap</li> <li>All metre measurements shall be reported and the second statement in the second statement in the second statement in the second statement is shall be reported at the second statement in the second statement is shall be reported at the second statement in the second statement is shall be reported at the second statement in the second statement is shall be used at the second statement is shall be reported at the second statement in the second statement is shall be reported at the second statement in the second statement is shall be reported at the second statement in the second statement is shall be reported at the second statement in the second statement is shall be reported at the second statement in the second statement is shall be reported at the second statement in the second statement is shall be reported at the second statement in the second statement is shall be reported at the second statement in the second statement is shall be reported at the second statement in the second statement is shall be reported at the second statement in the second statement is shall be reported at the second statement in the second statement in the second statement in the second statement is shall be set at the second statement in the second statement is second statement.</li> </ul> | to avoid delays in processing polication can be directed to | g. Further instructions             | s and explanations are available                                                                                | on the back of this form. |  |  |  |
| <ul> <li>Please print clearly in blue or black ink</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                             |                                     | Ministry Use Only                                                                                               | /                         |  |  |  |
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| Address of Well Location (County/District/Municip                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | pality) Tow                                                 | vnship                              | Lot / O                                                                                                         | Concession                |  |  |  |
| RR#/Street Number WTM 47.45661 City/Town/Village Site/Compartment/Block/Tract etc.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                             |                                     |                                                                                                                 |                           |  |  |  |
| GPS Reading NAD Zone Easting                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | (2,569, 42,51                                               | Jnit Make/Model                     | Mode of Operation: Undifferenti                                                                                 |                           |  |  |  |
| Log of Overburden and Bedrock Mater                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | rials (see instructions)                                    | 0.800                               |                                                                                                                 |                           |  |  |  |
| General Colour Most common material                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Other Materials                                             | General Description Depth M<br>From |                                                                                                                 |                           |  |  |  |
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| DN. NAVICA alterrain@golden.nct<br>Bus.Telephone No. (inc. area code) Name of Well Technician Last Name, Firs |                                                       |                         | First Name)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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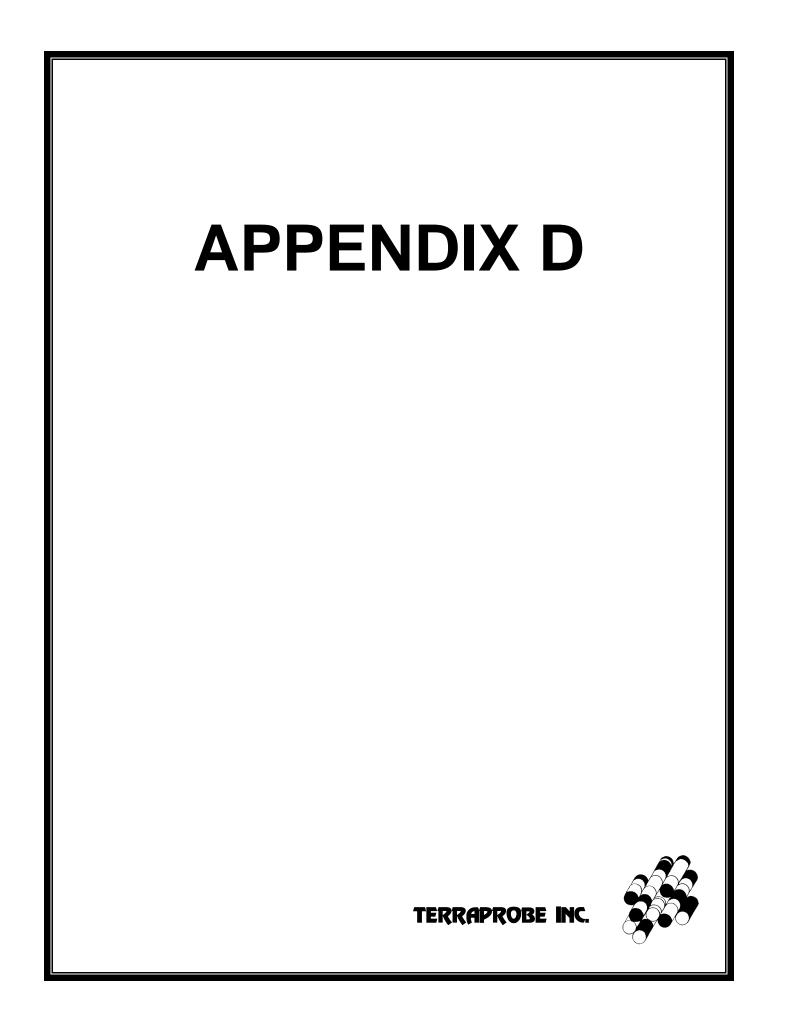
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all Location (Street, Number/Name) Pt- 19=20 LINE City/Town/Village Postal Code unty/District/Municipality Dunnui Le Municipal Plan and Sublot Number NIA2W2 Ontario Northing Other UTM Coordina s Zone Easting UTM 4744625 NAD 8 3 17 TO613897 42 50 743 Overburden and Bedrock Materials/Abandonment Sealing Record (see instructions on the back of this form) Depth (m/ft) General Description General Colour Most Common Material Other Materials From 4 0 CQV BROWN 4 boulder 3 16 Car CREV 4 RE lin Reporter **Results of Well Yield Testing** Annular Space After test of well yield, water was: Draw Down Recovery Type of Sealant Used (Material and Type) Depth Set at (m/ft) Volume Placed Time | Water Level (m3/ft3) Time Water Level Clear and sand free From To (min) (m/ft) Other, specify (min) (m/ft) 0 20 1 enseel Static 18 If pumping discontinued, give reason: Level 1 1 Pump intake set at (m/ft) 2 3 2 30<sup>1</sup> Pumping rate (Vmin / GPM) 3 3 Method of Construction Well Use 10 GPM 4 Not used 4 Public Commercial Cable Tool Diamond Duration of pumpi Dewatering Jetting Rotary (Conventional) Domestic Municipal 5 5 / hrs + 0 min Livestock Monitoring Driving Rotary (Reverse) Test Hole Final water level end of pumping (m/ft) Boring Digging Cooling & Air Conditioning 10 10 18 Air percussion Industrial Other, specify Other, specify 15 15 If flowing give rate (I/min / GPM) Status of Well **Construction Record - Casing** 20 20 Depth (m/ft) Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel) Wall Thickness (cm/in) Inside Water Supply Recommended pump depth (m/ft) Diamete (cm/in) Replacement Well 25 30 25 To From Test Hole Recommended pump rate (Vmin / GPM) 8" 30 30 Recharge Well OPEN 22 0 10 GPM Dewatering Well 40 40 Stee Observation and/or 188 6 2) Well production (Umin 0 Monitoring Hole 13GPM 50 50 Alteration Disinfected? (Construction) 60 Yes X No 60 Abandoned, Insufficient Supply Map of Well Location Please provide a map below following instructions on the back Construction Record - Screen Abandoned, Poor Outside Depth (m/ft) Water Quality Material Slot No Diameter (Plastic, Galvanized, Sta Abandoned, other, From To (cm/in) specify Lakeshore WERTHERDURN Other, specify 5 5 Water Details Hole Diameter Water found at Depth Kind of Water: Fresh Untested 30 (m/ft) Gas Other, specify Water found at Depth Kind of Water: Fresh Untested Depth (m/lt) Diameter W From To (cm/in) 6 " 42 0 (m/ft) Gas Other, specify DRIVE Water found at Depth Kind of Water: Fresh Untested (m/ft) Gas Other, specify well 380 -Well Contractor and Well Technician Information Business Name of Well Contractor Contractor's Licence No. FIELD WELL DRILLIN G Business Address (Street Number/Name) 4703 Spring Creek Province Postal Code Business E-mail Ad ONT, LO R 200 Bus Telephone No. (inc. area orde) Name of Well Technician 212 ERIE LAKE icipality Comments St. por ine and S Business E-mail Address Ministry Use Only Well owner's Date Package Delivered Audit No. 2 099760 Bus.Telephone No. (inc. area code) Name of Well Technician (Last Name, First Name), 9055637355 FIELD MARSHALL Well Technician's Licence No. Signature of Technician and/or Contractor Date Submitted information package delivered Y Y Y M M DIO Date Work Completed Yes MAY 1 3 2010 YYYMMD X NO TO365 2010 15 © Queen's Printer for Ontario, 2007 0506E (12/2007) Ministry's Copy





| Location:    | Toe of slope around Section 1                                                                                             |
|--------------|---------------------------------------------------------------------------------------------------------------------------|
| Viewing:     | East                                                                                                                      |
| Description: | The slope face is forested, the toe of slope is bare. Clayey silt soil is visible. There is a limestone shelf at the toe. |



### Photograph 2

| Location:    | Mid-slope around Section 3                                                                                                  |
|--------------|-----------------------------------------------------------------------------------------------------------------------------|
| Viewing:     | East                                                                                                                        |
| Description: | The slope is vegetated with<br>grass. There is an<br>armourstone wall at the toe of<br>slope. No bare soil was<br>observed. |



| Location:    | Toe of Section 8                                                                                                                           |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| Viewing:     | East                                                                                                                                       |
| Description: | There is an approximately 2 m<br>high erosion scarp at the toe.<br>The soil is clayey silt, trace<br>sand, grey and moist, and<br>layered. |





| Location:    | Top of slope around Section 8                                                           |
|--------------|-----------------------------------------------------------------------------------------|
| Viewing:     | East                                                                                    |
| Description: | There are tension cracks visible in the upper slope face of the slope around Section 8. |



#### Photograph 5

| Location:    | Toe of slope around Section 12                                                                                                          |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| Viewing:     | East                                                                                                                                    |
| Description: | The slope at this section is<br>vegetated with shrubs and<br>young trees. There is rip rap<br>along the toe of slope and slope<br>face. |



| Location:    | Toe of slope around Section 14                                                               |
|--------------|----------------------------------------------------------------------------------------------|
| Viewing:     | West                                                                                         |
| Description: | There is an armourstone wall<br>along the toe of slope. The<br>tableland is relatively flat. |





| Location:    | Toe of slope around Section 18                                                                                                           |
|--------------|------------------------------------------------------------------------------------------------------------------------------------------|
| Viewing:     | West                                                                                                                                     |
| Description: | There is rip rap along the toe of<br>slope. The tableland appears to<br>be relatively flat, and vegetated<br>with grass and young trees. |



#### Photograph 8

| Location:    | Slope around Section 23                                                              |
|--------------|--------------------------------------------------------------------------------------|
| Viewing:     | West                                                                                 |
| Description: | There is sand at the toe of slope. The shoreline is vegetated with glass and shrubs. |



| Location:    | Between Section 31 and 32                                                                                                           |
|--------------|-------------------------------------------------------------------------------------------------------------------------------------|
| Viewing:     | West                                                                                                                                |
| Description: | There is a sand and pebble<br>beach along the shoreline.<br>The tableland is vegetated<br>with grass, and mature to<br>young trees. |





| Location:    | Slope around Section 39                                                                                                     |
|--------------|-----------------------------------------------------------------------------------------------------------------------------|
| Viewing:     | East                                                                                                                        |
| Description: | There is an approximately a 5 m high slope at the shoreline with erosion protection. The tableland is vegetated with grass. |



#### Photograph 11

| Location:    | Slope around Section 40                  |
|--------------|------------------------------------------|
| Viewing:     | West                                     |
| Description: | There is a sand beach around Section 40. |



| Location:    | Slope around Section 45                                                                                                                                                                                                        |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Viewing:     | East                                                                                                                                                                                                                           |
| Description: | There are glacial till bluffs at the<br>shoreline. The bluffs at Section<br>45 are near vertical. The glacial<br>till is a reddish brown sand and<br>silt, with some clay, trace gravel<br>trace cobbles, moist, and<br>dense. |





| Location:    | Slope at Section 46                                                                                                                                                          |
|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Viewing:     | North                                                                                                                                                                        |
| Description: | There is a near vertical scarp in<br>the upper slope face, with talus<br>accumulation on the mid to<br>lower slope face. The talus is<br>vegetated with grass and<br>shrubs. |

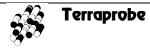


## Photograph 14

| Location:    | Slope at Section 46                                                             |
|--------------|---------------------------------------------------------------------------------|
| Viewing:     | Slope                                                                           |
| Description: | Talus accumulation at the toe of<br>slope along the shoreline at<br>Section 46. |



| Location:    | Slope at Dickout Road                                                                                                                                                                            |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Viewing:     | Gabion and Limestone retaining walls                                                                                                                                                             |
| Description: | At the end of Dickout Road<br>there is construction of retaining<br>walls at the toe of slope, with a<br>drainage pipe down the slope<br>face. The retaining walls are up<br>to 6-7 m in height. |





### Photograph 16

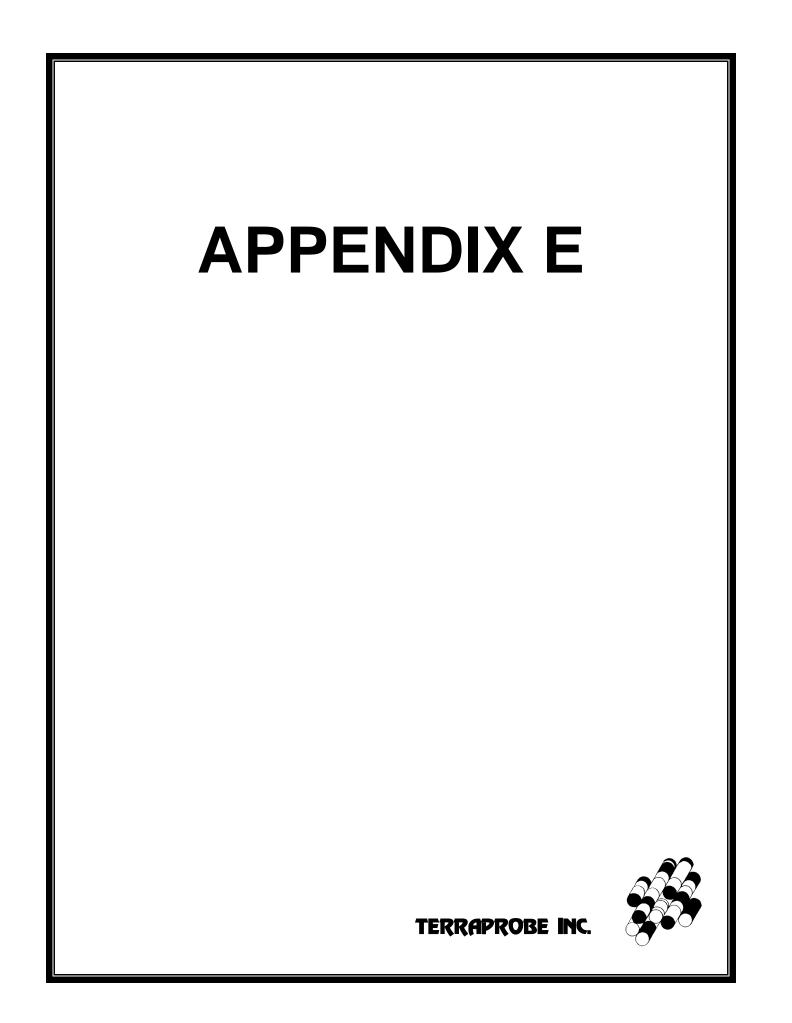
| Location:    | Slope at Dickout Road                                                                                                                                            |
|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Viewing:     | Retaining walls                                                                                                                                                  |
| Description: | There is a limestone toe wall<br>across from the gabion stone<br>wall up to approximately 5 m in<br>height. There is a gravel beach<br>in between the two walls. |



#### Photograph 17

| Location:    | Slope around Section 50                                             |
|--------------|---------------------------------------------------------------------|
| Viewing:     | West                                                                |
| Description: | Shoreline is composed of a sand and gravel beach with some rip rap. |





| -Zà | Terraprobe                                        |
|-----|---------------------------------------------------|
| 210 | Consulting Geotechnical & Environmental Engineers |
| -07 | Construction Materials Inspection & Testing       |

# **SLOPE INSPECTION FORM**

Page 1

| 1. INSPECTION DATE (DD-MM-YYYY): Augus                                                                                                                   | FILE NO. 1-18-0402.                                                                                                            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| WEATHER (circle): Xsunny opartly cloudy ocloudy<br>oclear of gorain osnow<br>INSPECTED BY (name): Jory HUNCA.<br>2. SITE LOCATION / DIRECTIONS (describe | <ul> <li>o calm Xbreeze o windy</li> <li>o cold o cool o warm o hot</li> <li>estimated air temperature:</li> <li>C.</li> </ul> |
| Lake Eric North Shoreline from<br>SKETCH                                                                                                                 | m Port Dover to Dunnville.                                                                                                     |
| 3. WATERSHED<br>Lake Erie<br>4. PROPERTY OWNERSHIP (name, address, ph                                                                                    | none):                                                                                                                         |
| LEGAL DESCRIPTION                                                                                                                                        |                                                                                                                                |
| Lot                                                                                                                                                      | Concession                                                                                                                     |
| Township                                                                                                                                                 | County                                                                                                                         |
|                                                                                                                                                          | -                                                                                                                              |
| CURRENT LAND USE (circle and describe)                                                                                                                   |                                                                                                                                |
| Xvacant - field, bush, woods, forest, wildernes                                                                                                          | s, tundra,                                                                                                                     |
| <ul> <li>passive - recreational parks, golf courses, nor</li> </ul>                                                                                      | n-habitable structures, buried utilities, swimming pools,                                                                      |
| Xactive - habitable structures, residential, cor                                                                                                         | nmercial, industrial, warehousing and storage,                                                                                 |
| ○ infra-structure or public use - stadiums, hospit                                                                                                       | als, schools, bridges, high voltage power lines, waste management sites,                                                       |

## Terraprobe Consulting Geotechnical & Environmental Engineers Page 2 Construction Materials Inspection & Testing 5. SLOPE DATA X3-6m 06-10m 010-15m X15-20m -> beaches # annourstone. + bluffs # slopes. INCLINATION AND SHAPE HEIGHT ∘ up to 2:1 50 % 26½° up to 3:1 4:1 or flatter 25 % 14° 33 % 18½° estimated height (m): up to 22m (Lidar) Xup to 1:1 steeper than ½:1 o up to 1/2:1 100 % 45° 200 % 631/2 > 631/2° some near verhcal 6. SLOPE DRAINAGE (describe) TOP where there are dwellings in the table land there may be drainage over the Slope FACE -> ground water scepage observed through the face of the bluffs at the easterd of the study area. BOTTOM None observed. 7. SLOPE SOIL STRATIGRAPHY (describe, positions, thicknesses, types) TOP Earth fill or sand. FACE Clayey sit or glacial till BOTTOM Inustone bedrock. 8. WATER COURSE FEATURES (circle and describe) SWALE, CHANNEL GULLY STREAM, CREEK, RIVER POND, BAY CAKE Lake Frie at the toe of slopes. SPRINGS MARSHY GROUND

SLOPE INSPECTION FORM

## **SLOPE INSPECTION FORM**

Page 3

9. VEGETATION COVER (grasses, weeds, shrubs, saplings, trees) TOP -> generally landscaped. ->grass, shrubs, some young to manure trees. - Some farmland in table land FACE »Where there are bluffs or scarps the slope face is generally bare ~ generally should or grass -> at west end of study area some forested parts of slope. BOTTOM -> bare, annourstone or beaches generally **10. STRUCTURES** (buildings, walls, fences, sewers, roads, stairs, decks, towers, ) TOP -> generally dwellings or roadways in the table land. FACE -> armourstone walls or concrete walls. No access to these areas. -> earth fill embankment at section 7. BOTTOM -> armourstone walls or concrete walls. No access to these areas. 11. EROSION FEATURES (scour, undercutting, bare areas, piping, rills, gully) TOP -none observat. FACE -none observal. BOTTOM -> erosion scarps at toe around Im in height

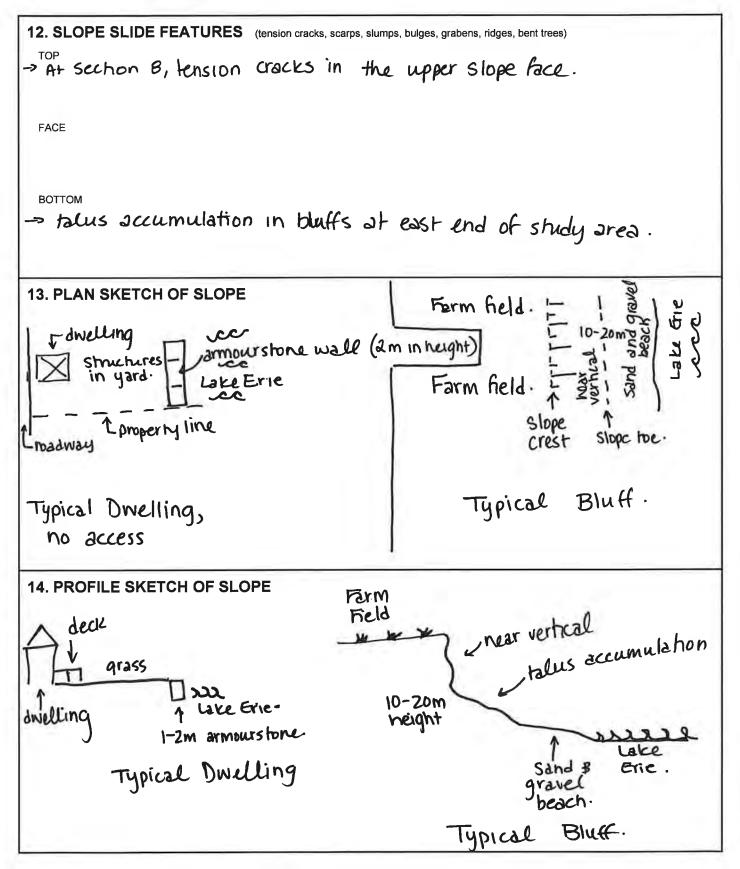
Terraprobe

Consulting Geotechnical & Environmental Engineers Construction Materials Inspection & Testing



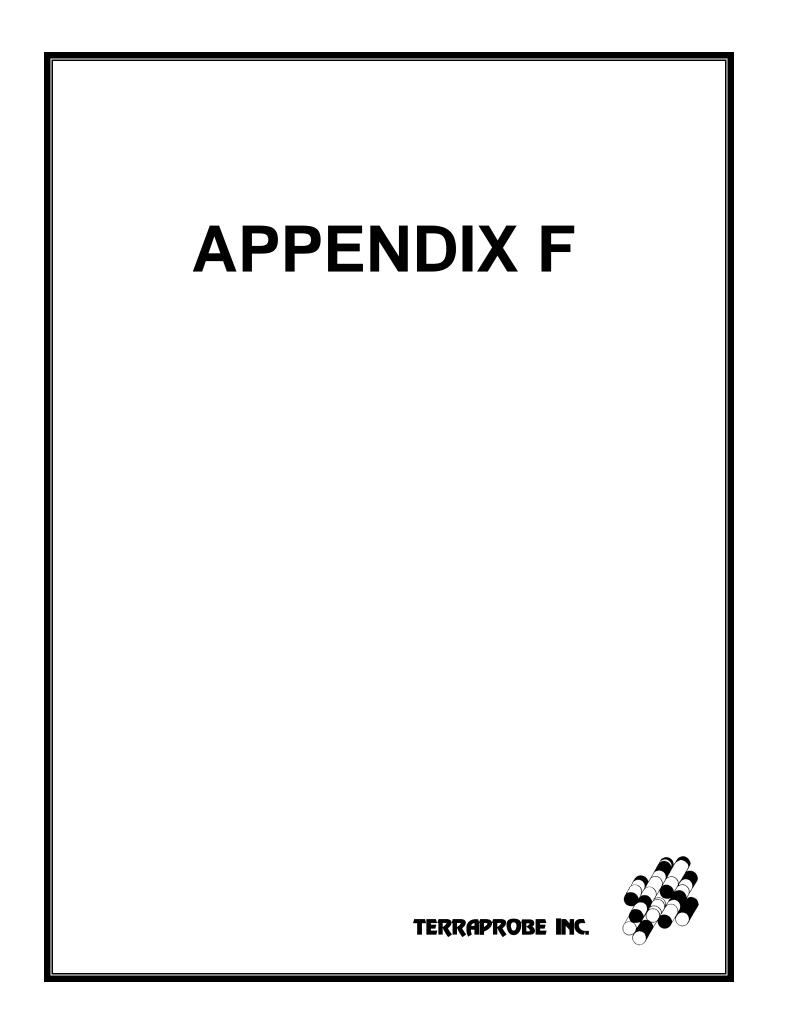
**SLOPE INSPECTION FORM** 

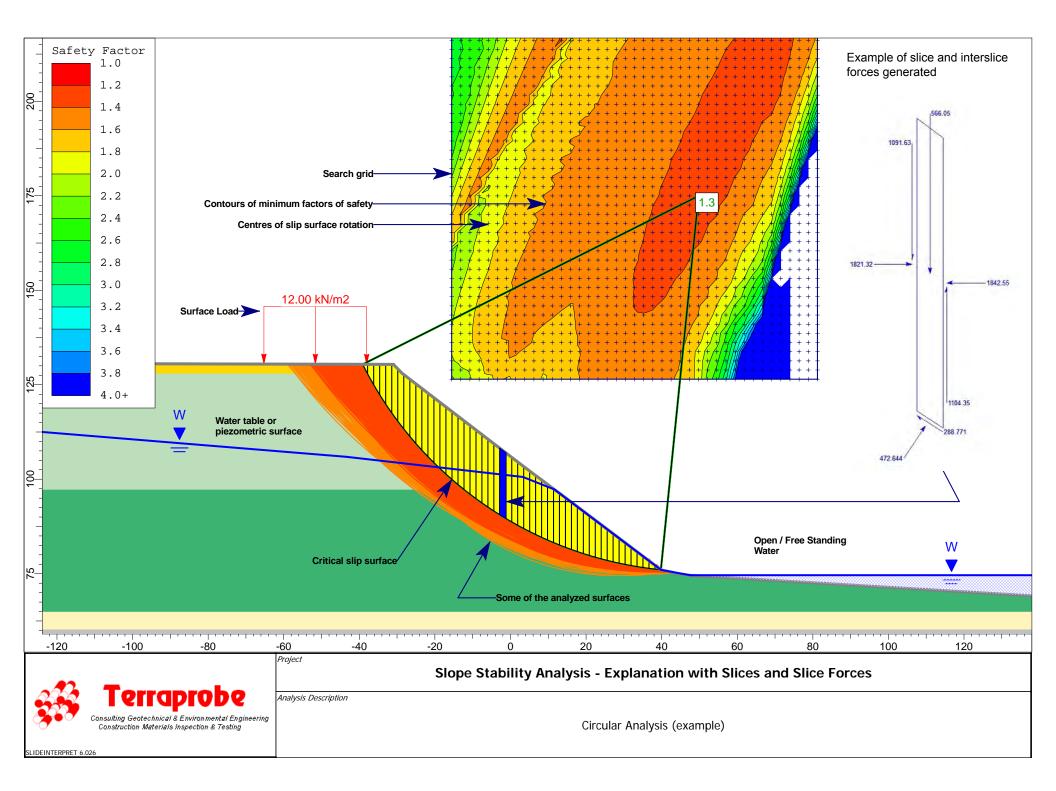
Page 4

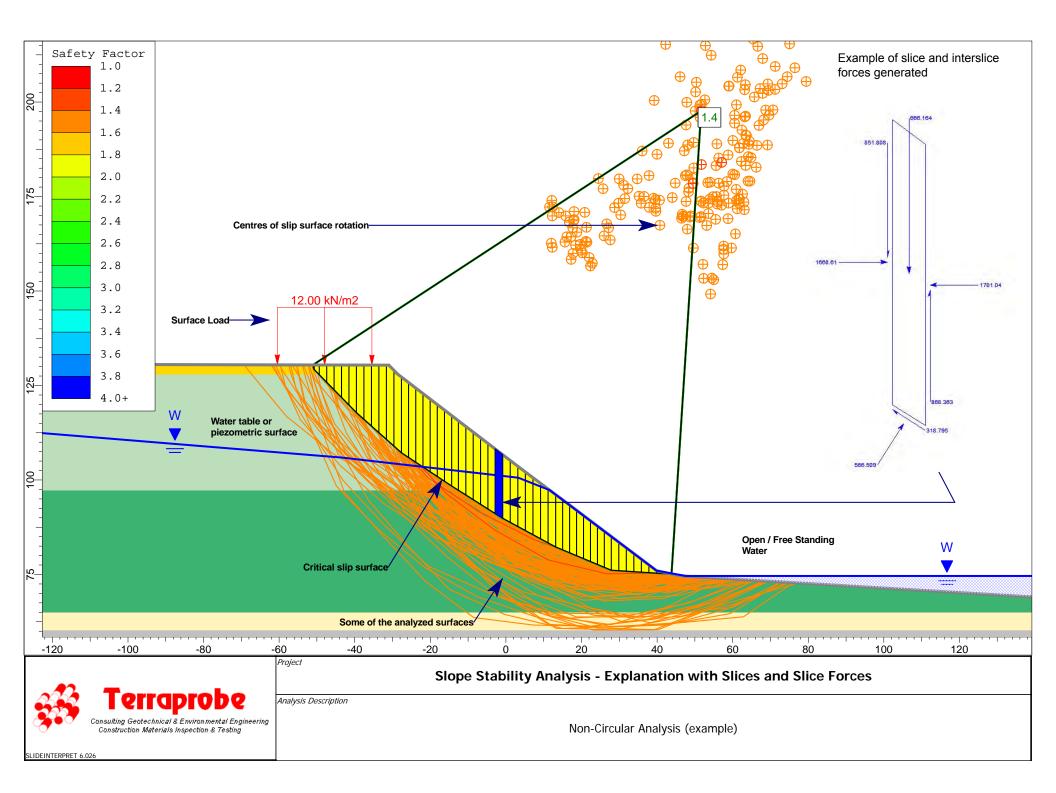


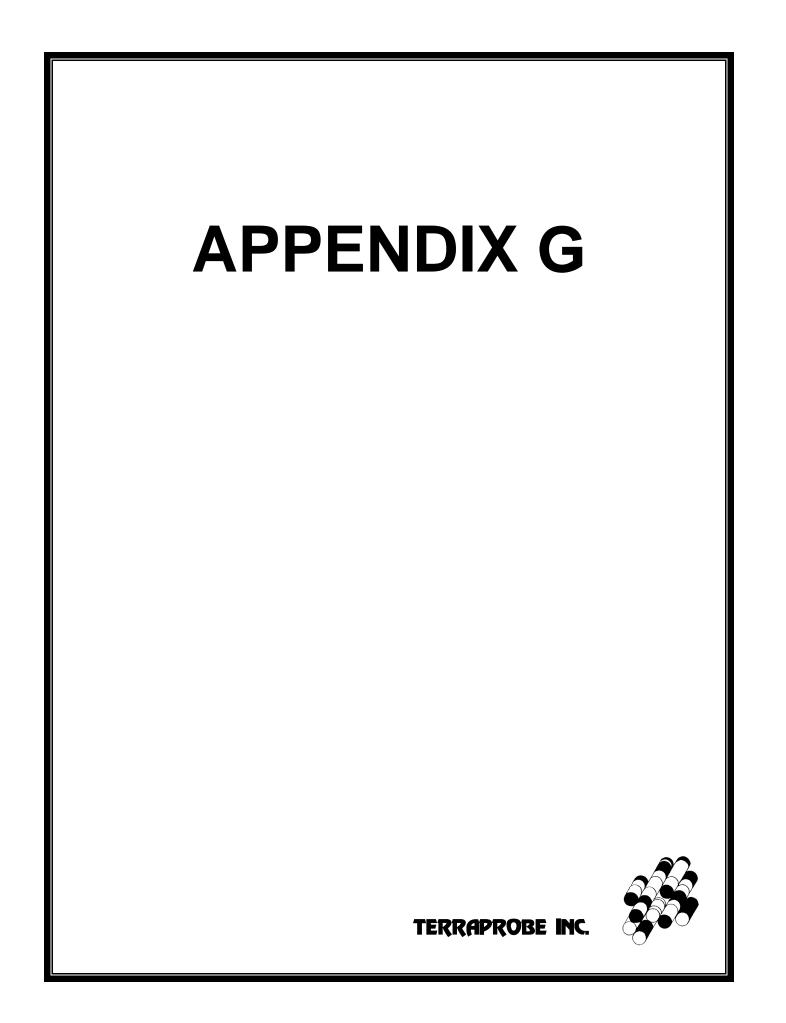
#### TABLE 8.1 - SLOPE STABILITY RATING CHART

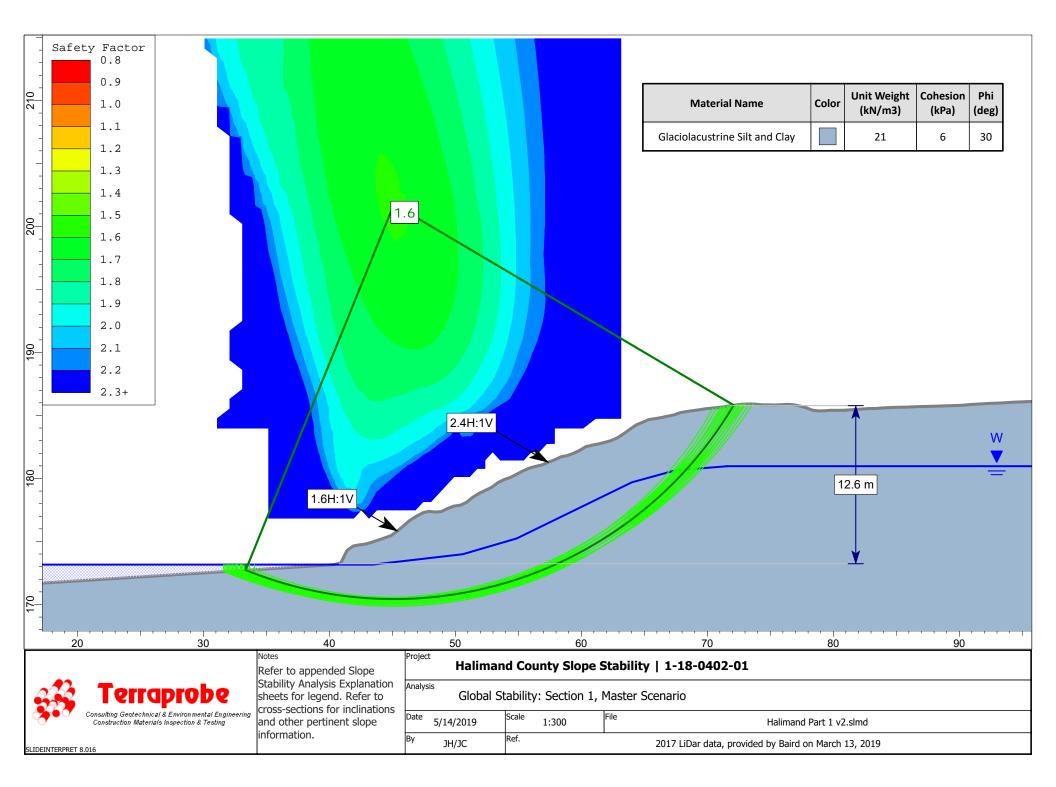
| Property | tion: <b>Brt Dover to Dan</b><br>Owner:<br>1 By: <b>Jon: Hunter</b> : |                                                                                                                                                                                                          | Inspection<br>Weather:                        | Date:                       |  |  |
|----------|-----------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|-----------------------------|--|--|
|          | ,                                                                     |                                                                                                                                                                                                          |                                               | <b>N</b> . <b>N</b> .       |  |  |
| 1.       | SLOPE INCLINATION                                                     |                                                                                                                                                                                                          |                                               | Rating Value<br>west mid ea |  |  |
|          | degrees                                                               | <b>horiz. : ve</b><br>3 : 1 or fla                                                                                                                                                                       |                                               | Q (0)                       |  |  |
|          | a) 18 or less<br>b) 18 - 26                                           |                                                                                                                                                                                                          | ore than 3 : 1                                | 6                           |  |  |
|          | b) 18 - 26<br>c) more than 26                                         | steeper tha                                                                                                                                                                                              |                                               | 16 16 (1                    |  |  |
|          |                                                                       |                                                                                                                                                                                                          |                                               |                             |  |  |
| 2.       | SOIL STRATIGRAPHY                                                     |                                                                                                                                                                                                          |                                               | 0 0 0                       |  |  |
|          | a) Shale, Limestone, Granite (Bedrock)                                |                                                                                                                                                                                                          |                                               | 6 6 9<br>12 12<br>16 16 16  |  |  |
|          | b) Sand, Gravel<br>c) Glacial Till                                    |                                                                                                                                                                                                          |                                               | 9 0 9                       |  |  |
|          | c) Glacial Till<br>d) Clay, Silt                                      |                                                                                                                                                                                                          |                                               | 12 12 12                    |  |  |
|          |                                                                       |                                                                                                                                                                                                          |                                               | 16 16 16                    |  |  |
|          | e) Fill<br>f) Leda Clay                                               |                                                                                                                                                                                                          |                                               | 24 24 24                    |  |  |
|          |                                                                       |                                                                                                                                                                                                          |                                               | E1 - E1                     |  |  |
| 3.       | SEEPAGE FROM SLOPE FACE                                               |                                                                                                                                                                                                          |                                               | 000                         |  |  |
|          | a) None or Near both                                                  | •                                                                                                                                                                                                        |                                               |                             |  |  |
|          | b) Near mid-slope of                                                  |                                                                                                                                                                                                          |                                               | 6 6 6<br>12 12 12           |  |  |
|          | c) Near crest only or                                                 | , From several levels                                                                                                                                                                                    |                                               | 16 12 16                    |  |  |
| 4.       | <b>SLOPE HEIGHT</b>                                                   |                                                                                                                                                                                                          |                                               | 0                           |  |  |
|          | a) 2 m or less                                                        |                                                                                                                                                                                                          |                                               | 0 2 0 2<br>4 4 4            |  |  |
|          | b) 2.1 to 5 m                                                         |                                                                                                                                                                                                          |                                               | 4 2 2                       |  |  |
|          | c) 5.1 to 10 m                                                        |                                                                                                                                                                                                          |                                               | 2 2 2<br>4 4 4<br>8 8 8     |  |  |
|          | d) more than 10 m                                                     |                                                                                                                                                                                                          |                                               | 0 8 0                       |  |  |
| 5.       | VEGETATION COVER ON SLOPE FACE                                        |                                                                                                                                                                                                          |                                               | 0.0                         |  |  |
|          | a) Well vegetated; heavy shrubs or forested with mature trees         |                                                                                                                                                                                                          |                                               | 0 0 0<br>4 4 4 4            |  |  |
|          | b) Light vegetation;                                                  | Mostly grass, weeds, occa                                                                                                                                                                                | sional trees, shrubs                          | 4 4 4                       |  |  |
| _        | c) No vegetation, ba                                                  | re                                                                                                                                                                                                       |                                               | 8 8 8                       |  |  |
| 6.       | TABLE LAND DRAINAGE                                                   |                                                                                                                                                                                                          |                                               | 000                         |  |  |
|          | a) Table land flat, no                                                | Q 0 Q                                                                                                                                                                                                    |                                               |                             |  |  |
|          | b) Minor drainage over slope, no active erosion                       |                                                                                                                                                                                                          |                                               | 2 2 Z                       |  |  |
|          | c) Drainage over slo                                                  | <u> </u>                                                                                                                                                                                                 |                                               |                             |  |  |
| 7.       | PROXIMITY OF WATERCOURSE TO SLOPE TOE                                 |                                                                                                                                                                                                          |                                               |                             |  |  |
|          | a) 15 metres or more from slope toe                                   |                                                                                                                                                                                                          |                                               | 0 0 0                       |  |  |
|          | b) Less than 15 metr                                                  | es from slope toe                                                                                                                                                                                        |                                               | 6666                        |  |  |
| 8.       | PREVIOUS LANDSLIDE ACTIVITY                                           |                                                                                                                                                                                                          |                                               | -                           |  |  |
| 0.       | a) No                                                                 |                                                                                                                                                                                                          |                                               | 000                         |  |  |
| _        | b) Yes                                                                |                                                                                                                                                                                                          |                                               | 666                         |  |  |
|          | SLOPE INSTABILITY RATING VALUES INVESTIGATION                         |                                                                                                                                                                                                          | TOTAL                                         |                             |  |  |
|          | RATING                                                                | TOTAL                                                                                                                                                                                                    | REQUIREMENTS                                  | 101112                      |  |  |
|          | NATING                                                                | TOTAL                                                                                                                                                                                                    |                                               | 28 26 5                     |  |  |
|          | T                                                                     | -04                                                                                                                                                                                                      |                                               |                             |  |  |
| 5        | Low potential < 24 Site inspection only, confirmation, report letter  |                                                                                                                                                                                                          |                                               |                             |  |  |
| 3        | Slight potential                                                      | 25-35                                                                                                                                                                                                    | Site inspection and surveying, preliminary s  |                             |  |  |
| 3.)      | Moderate potential                                                    | > 35                                                                                                                                                                                                     | Boreholes, piezometers, lab tests, surveying  | , detailed report.          |  |  |
| NOTES:   | a) Choose only one                                                    | from each category; comp                                                                                                                                                                                 | are total rating value with above requirement | s.                          |  |  |
|          |                                                                       | b) If there is a water body (stream, creek, river, pond, bay, lake) at the slope toe; the potential for toe erosion and undercutting should be evaluated in detail and, protection provided if required. |                                               |                             |  |  |

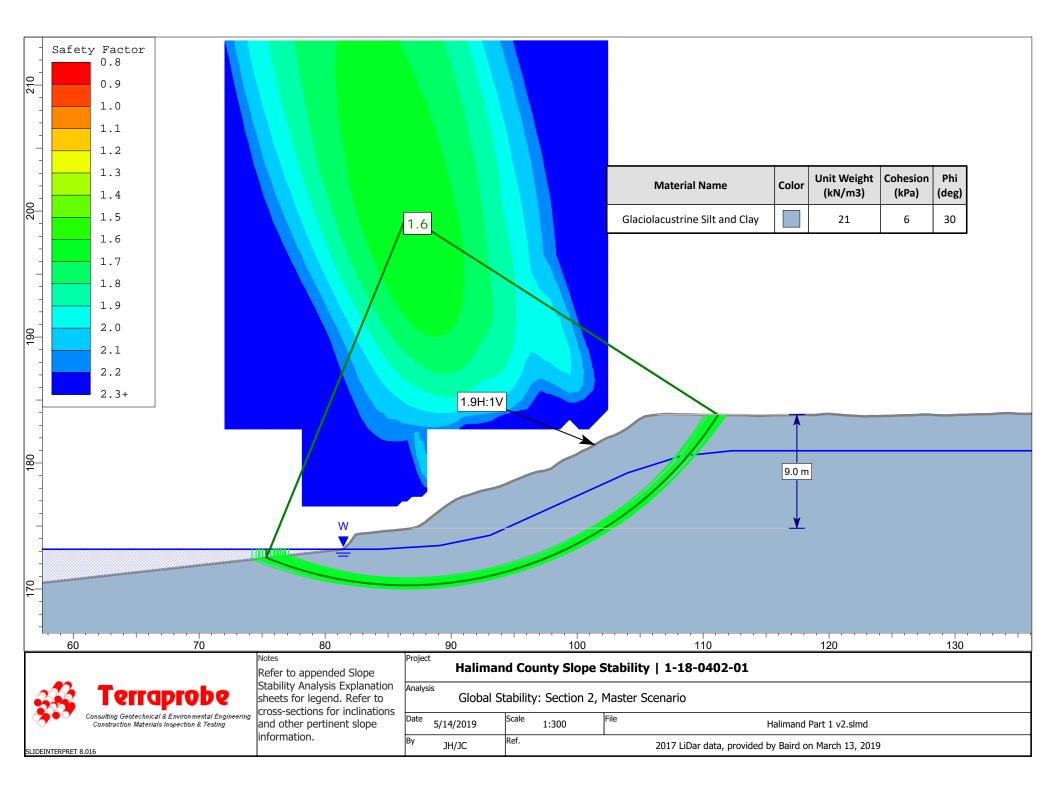


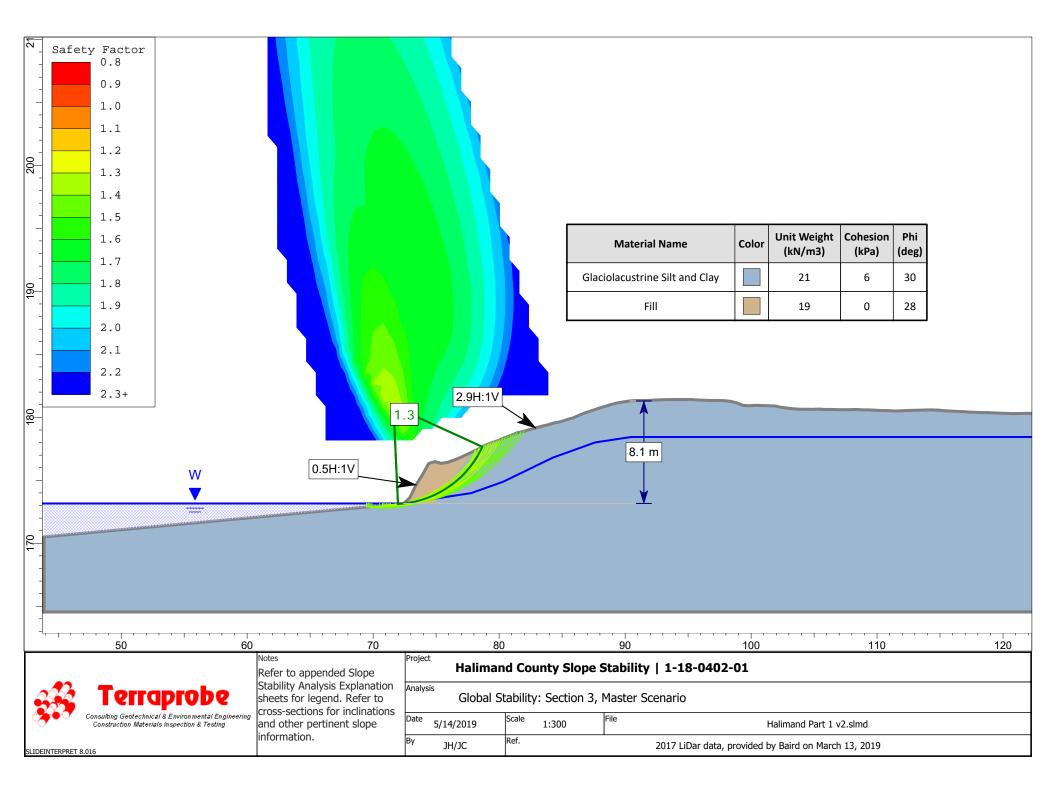


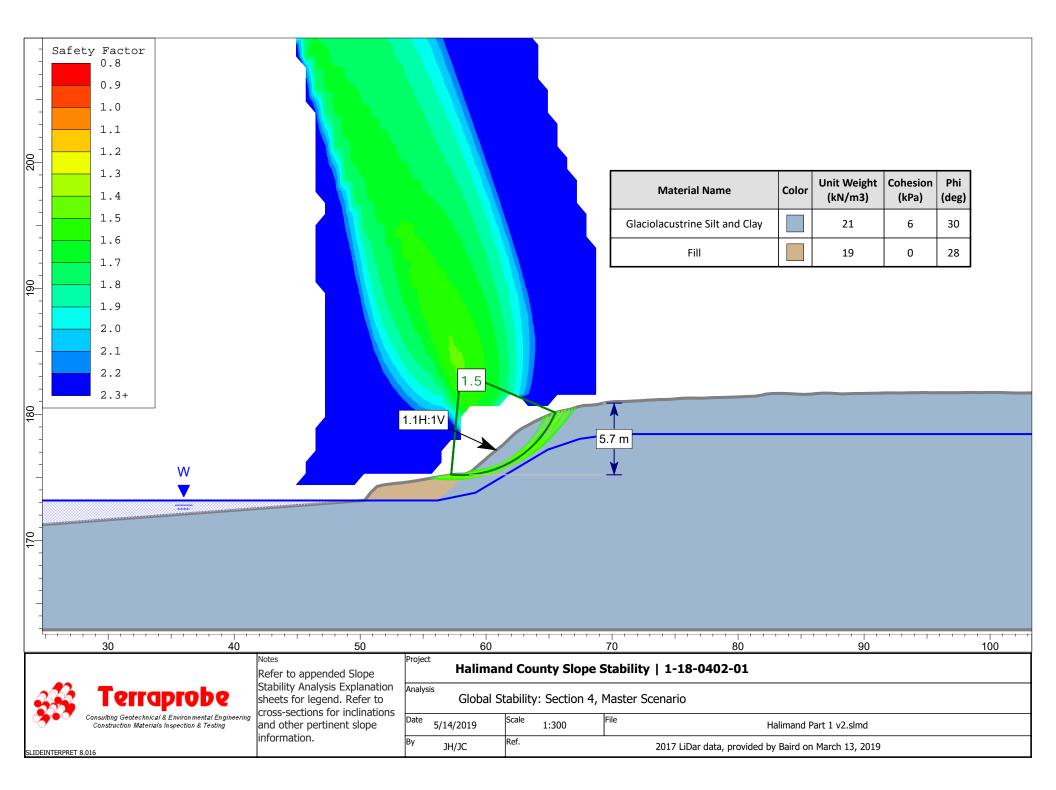


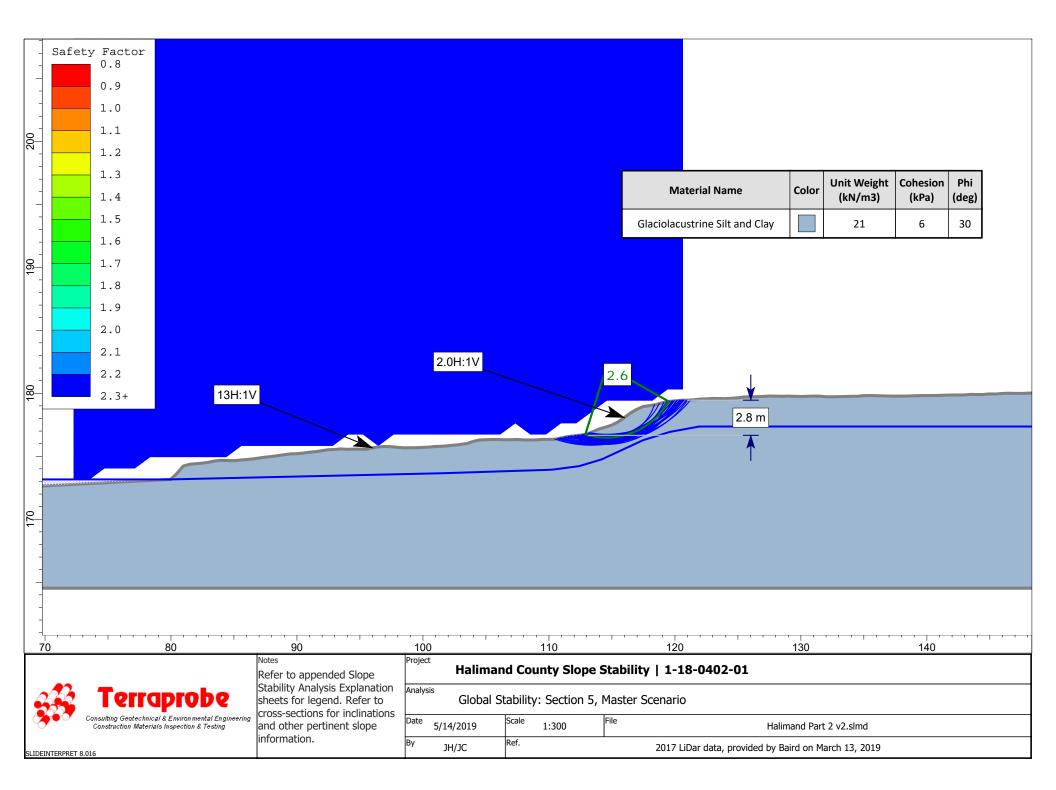


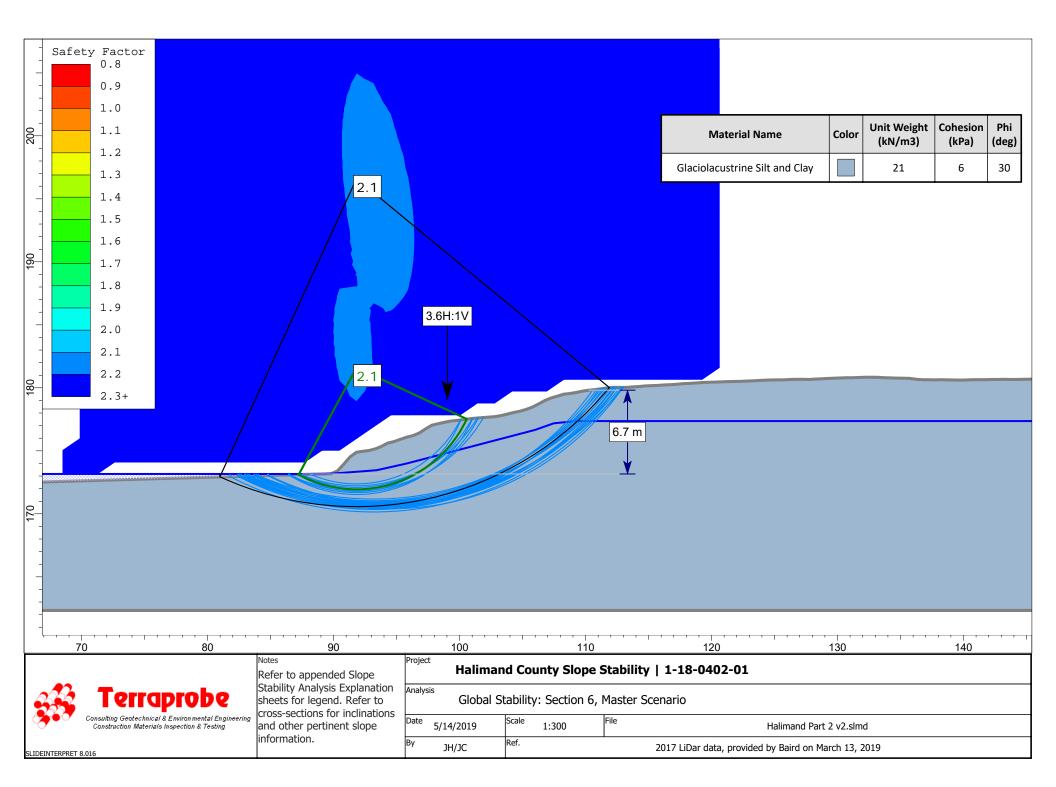


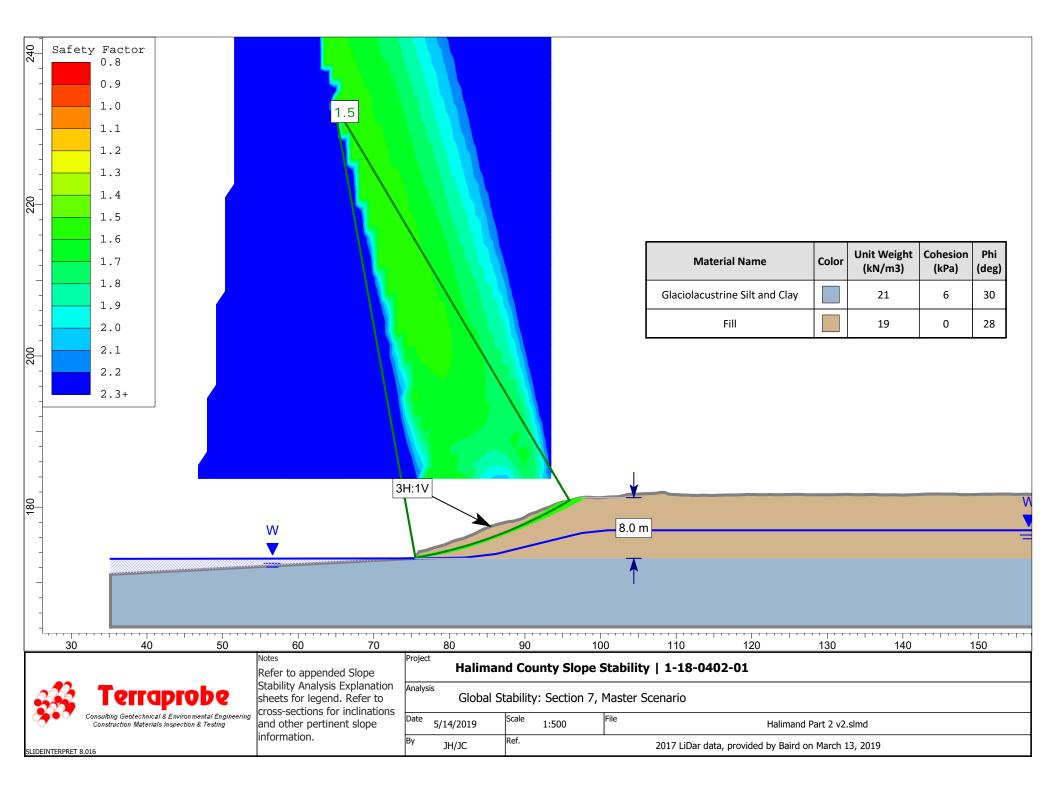


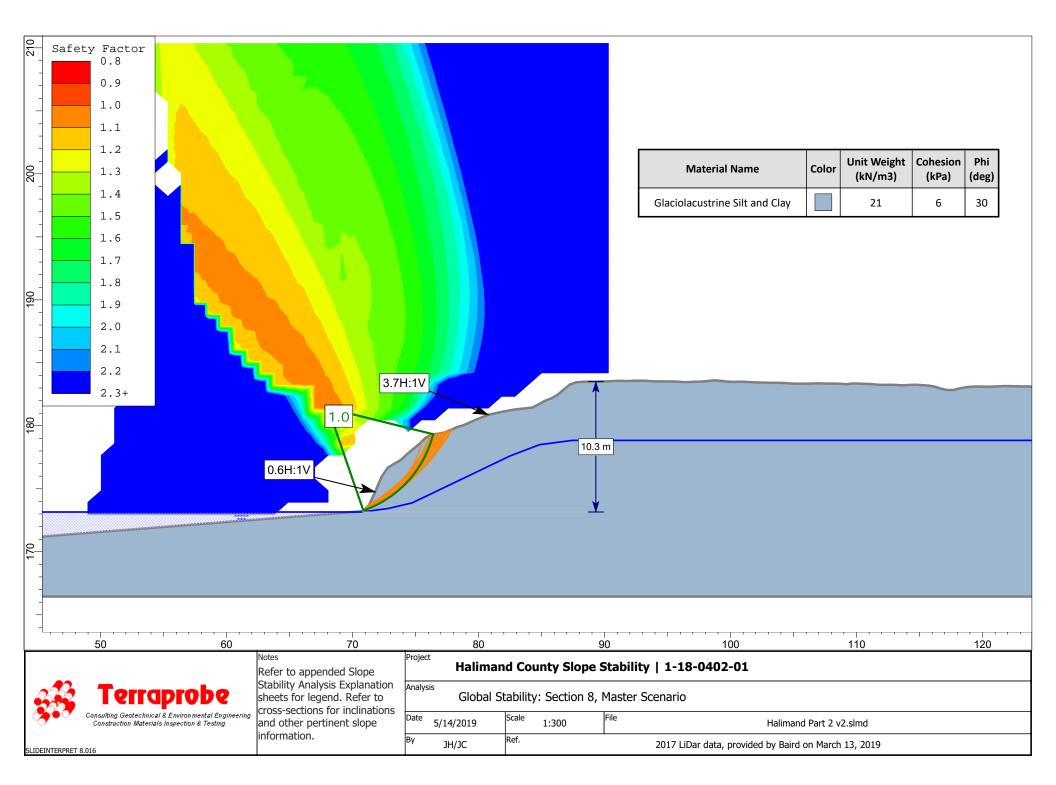


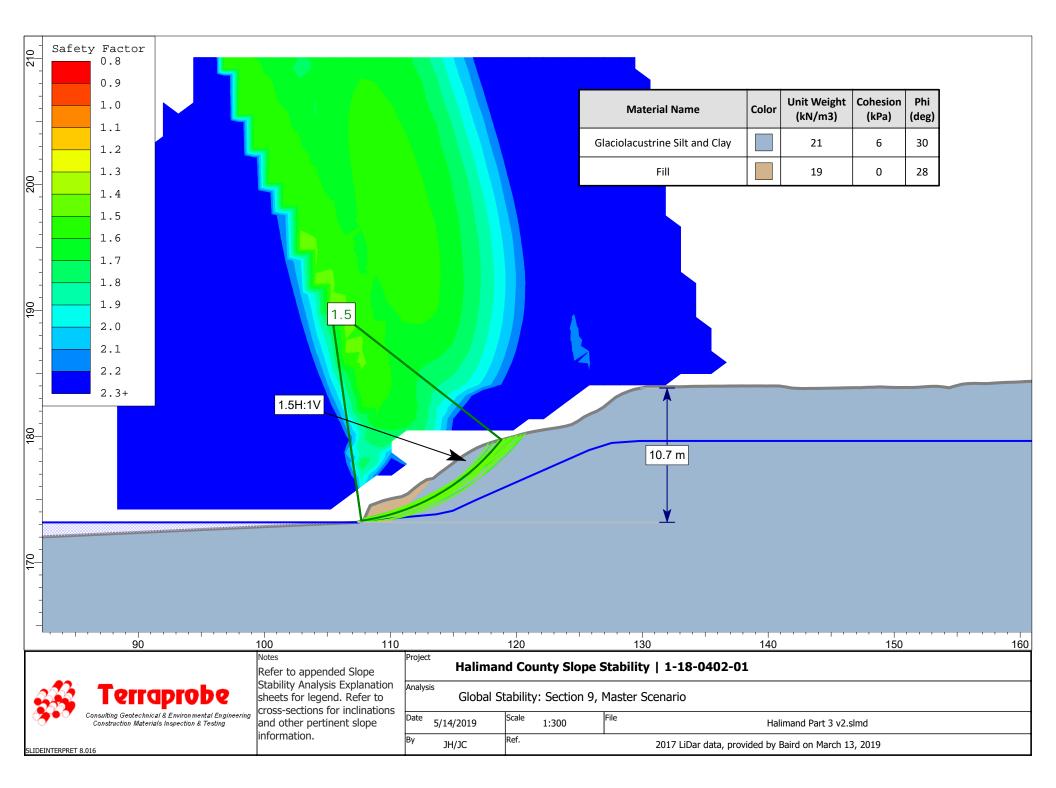


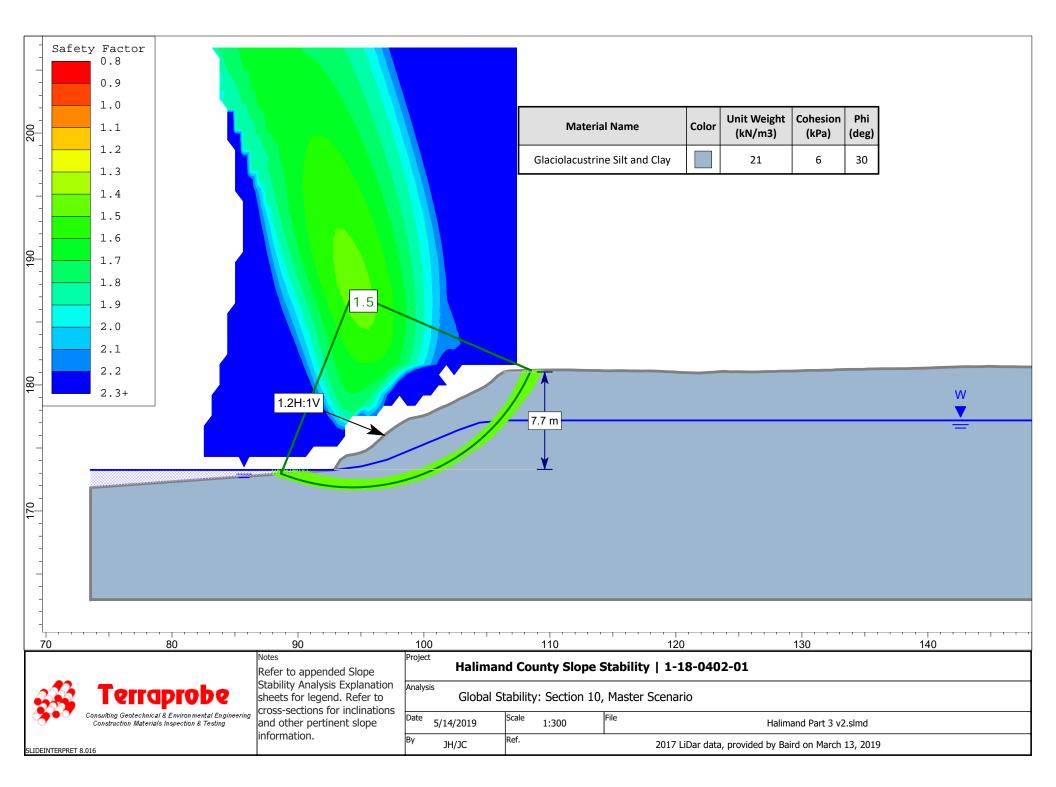


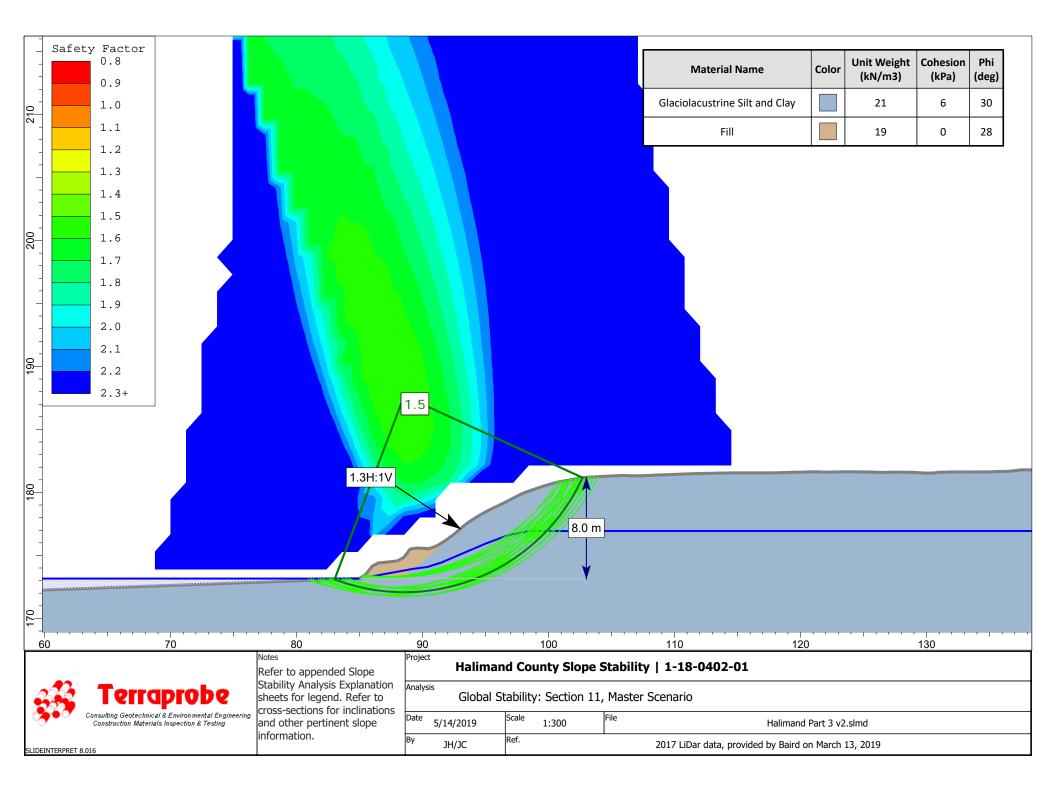


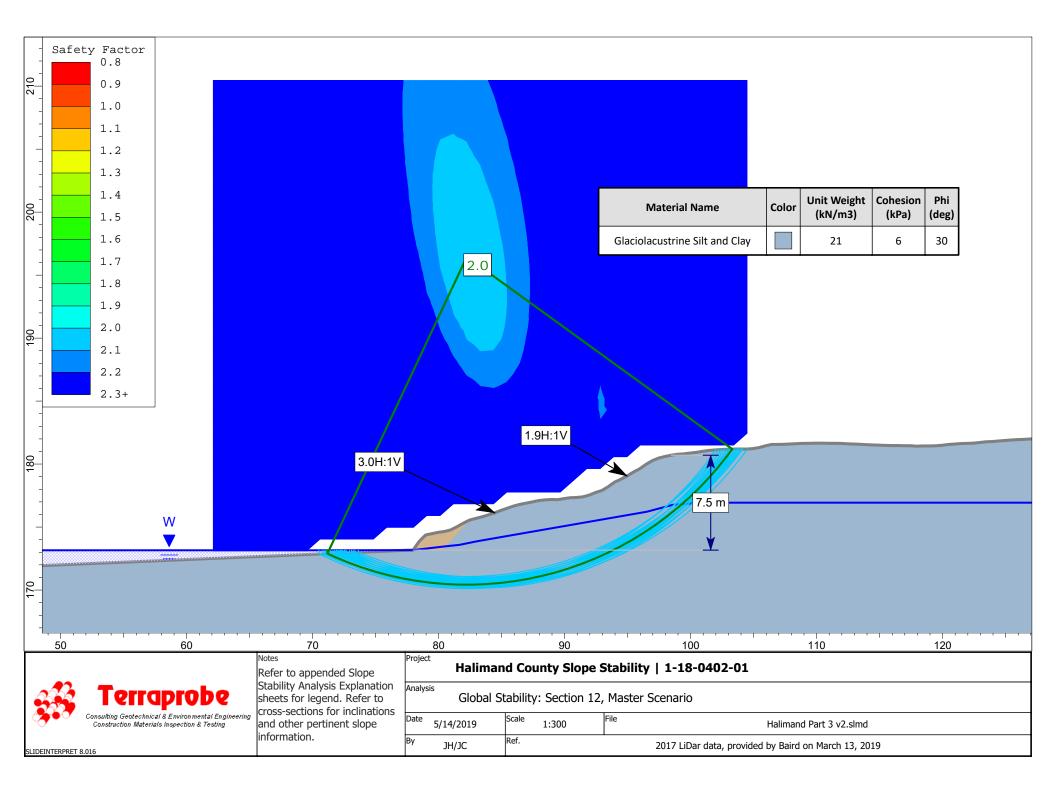


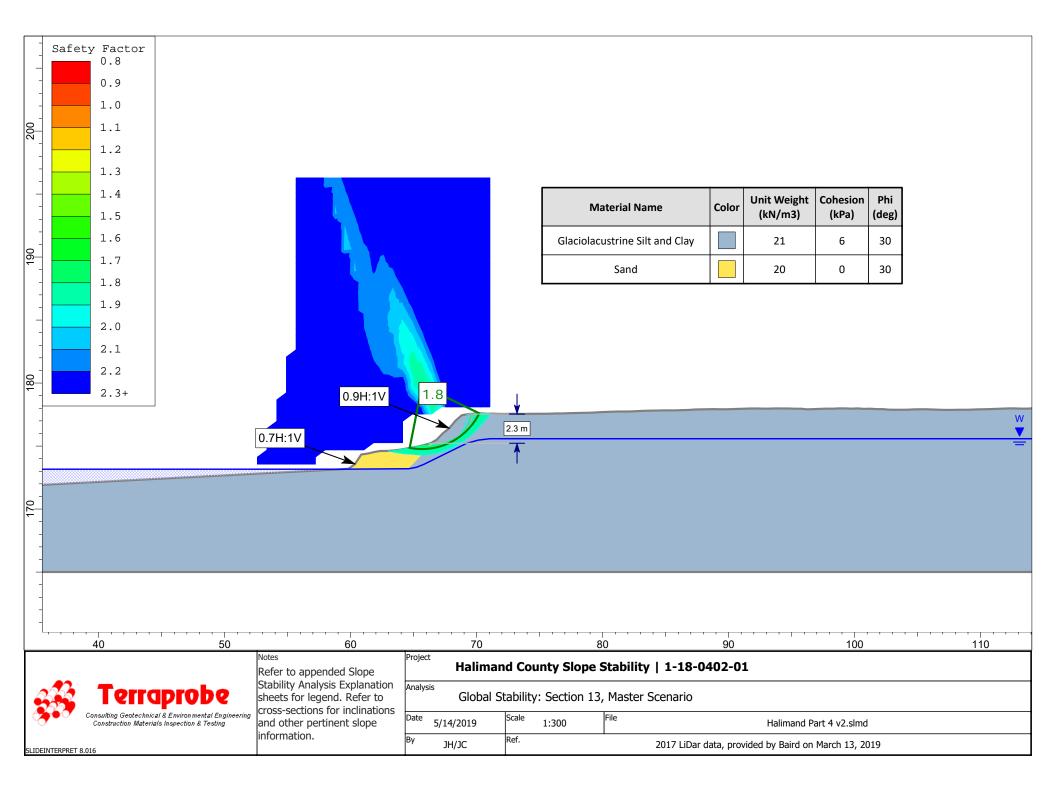


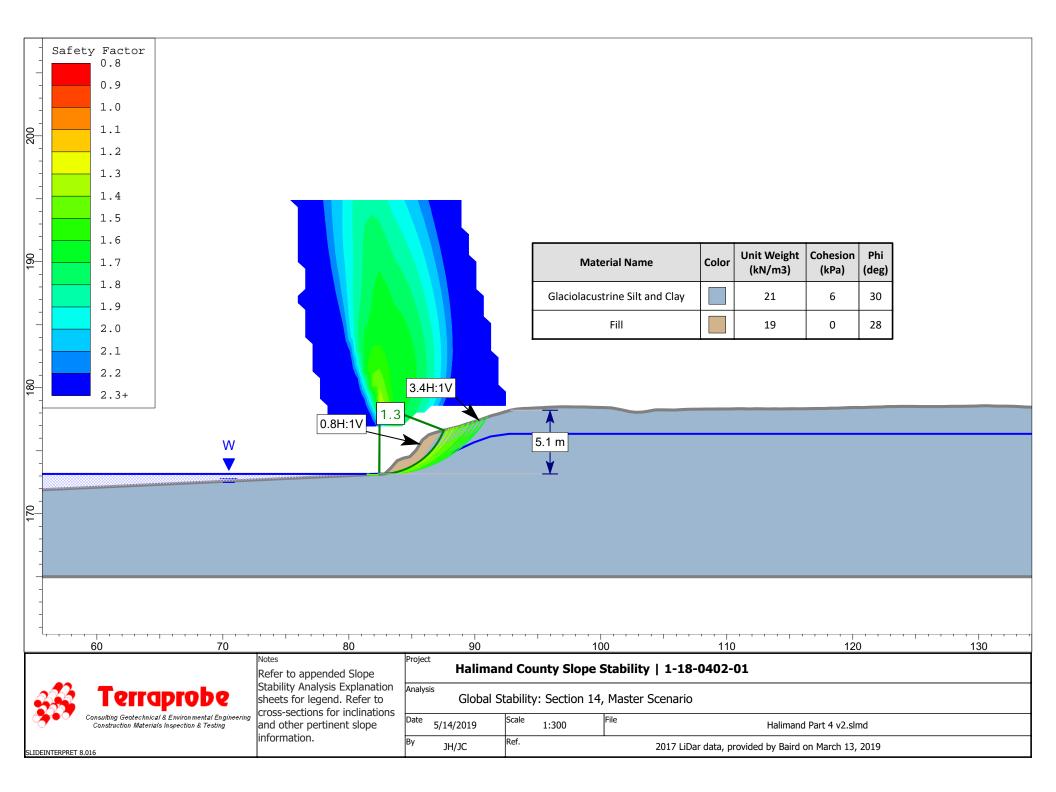


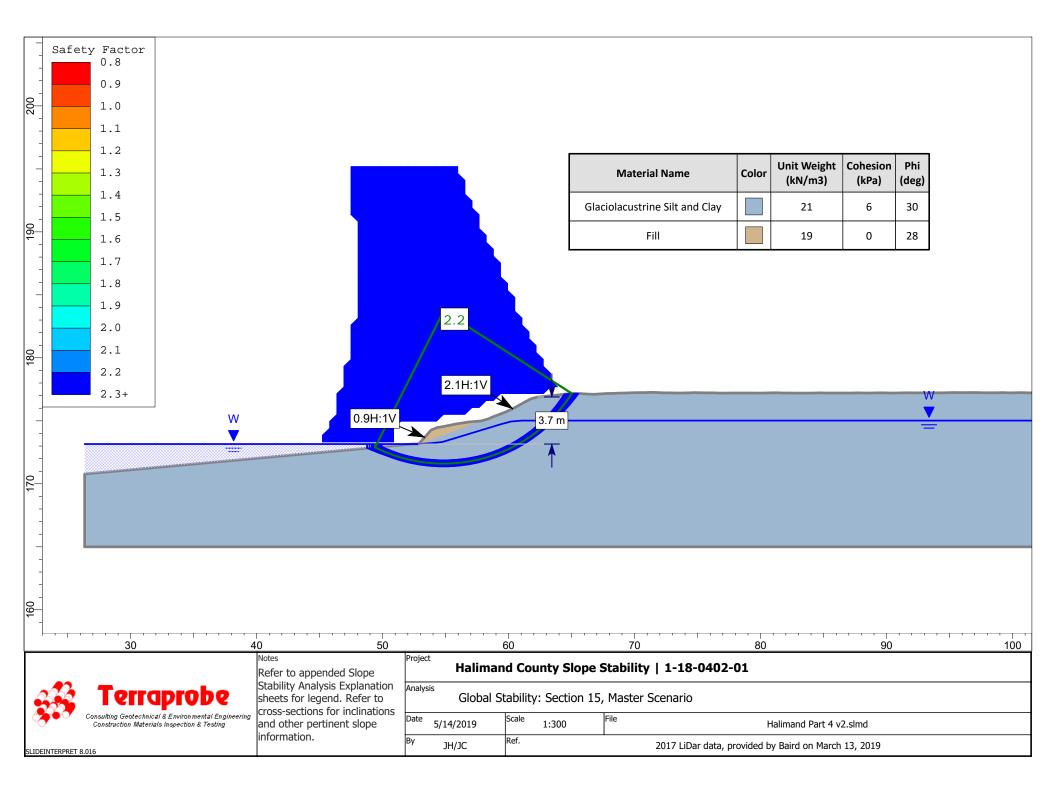


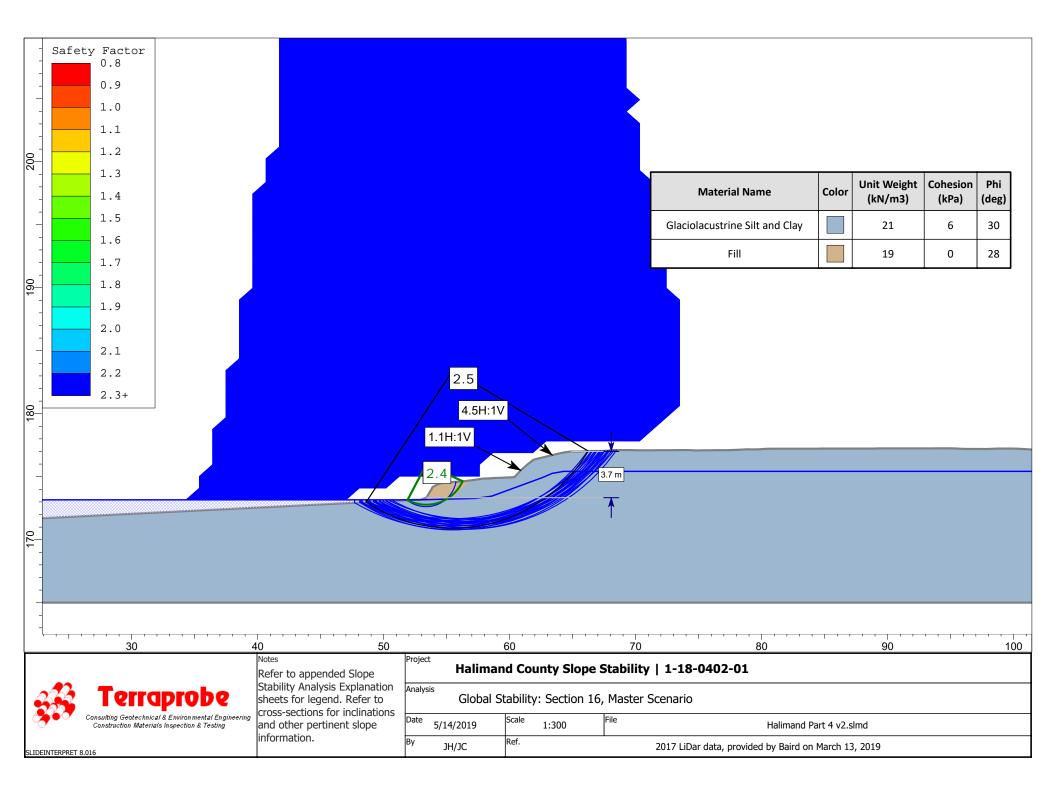


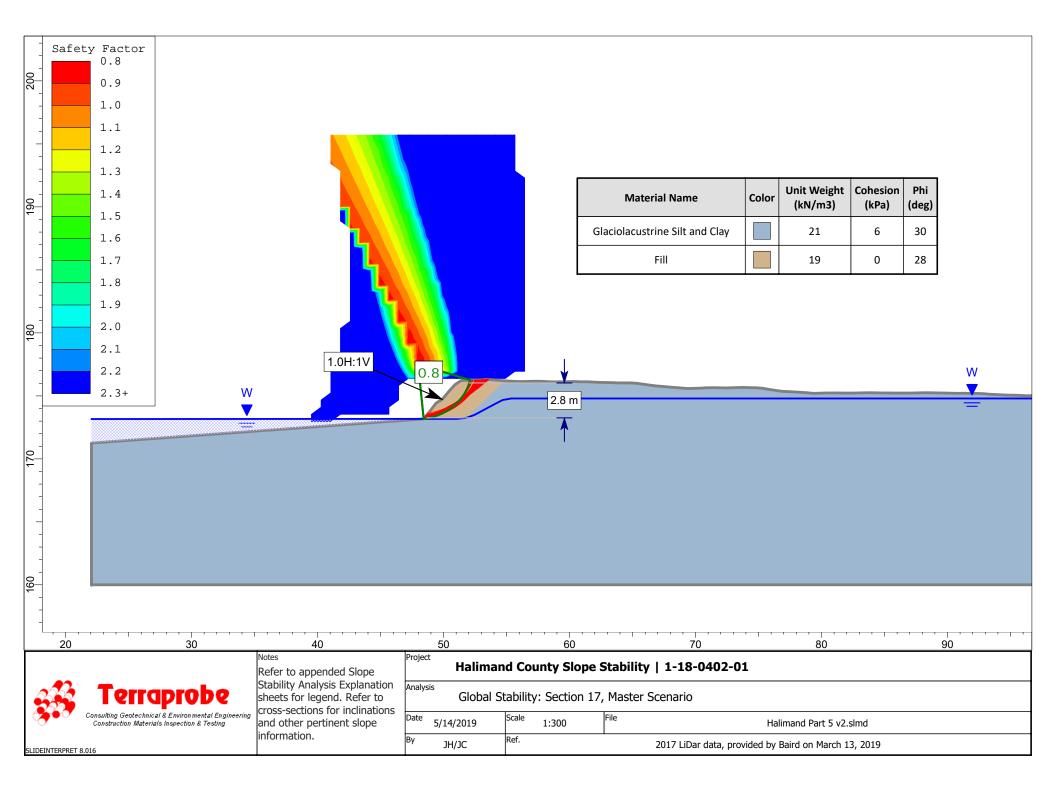


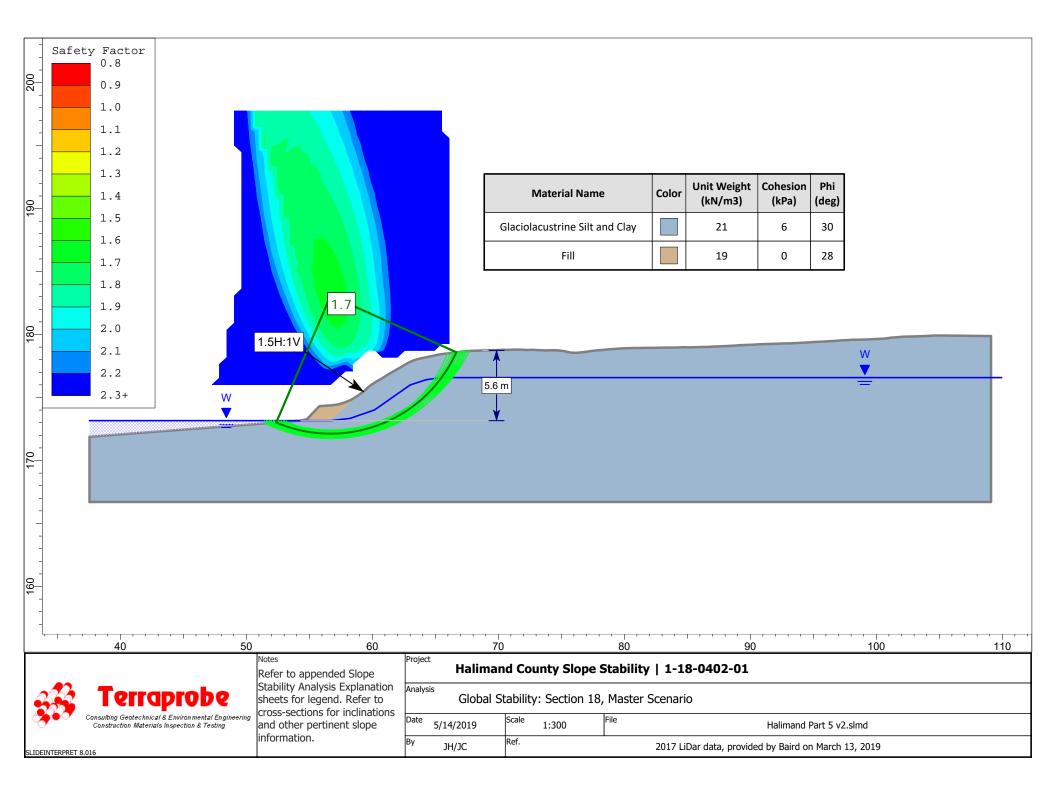


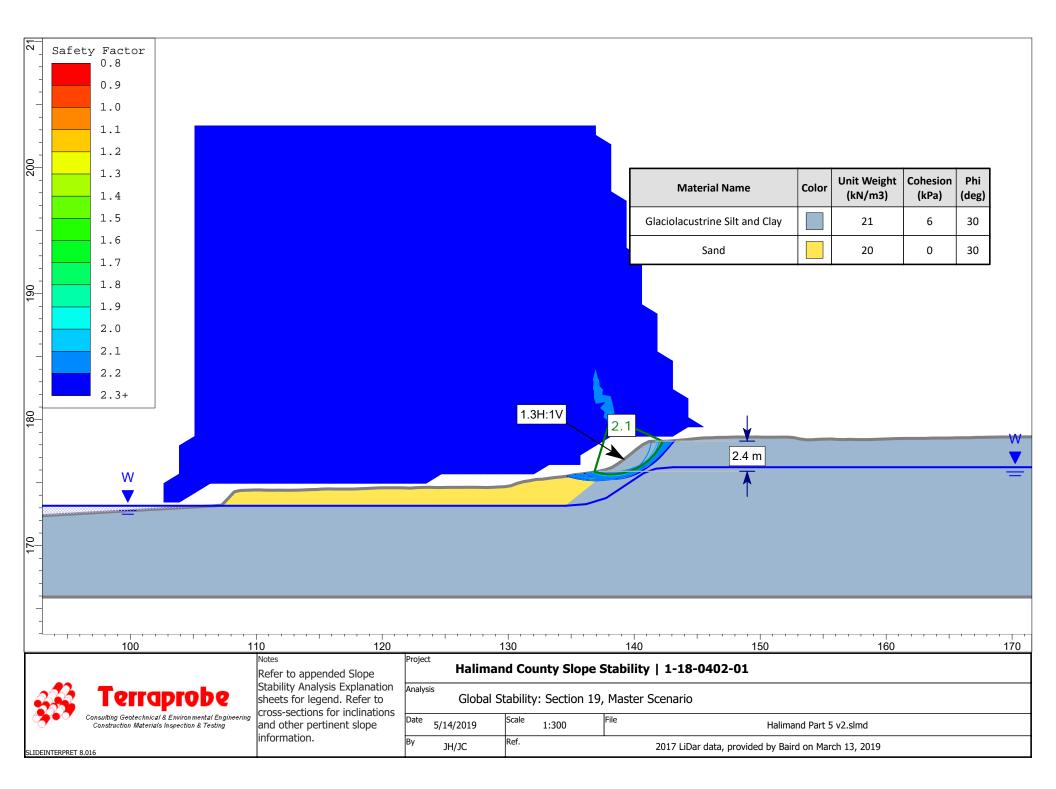


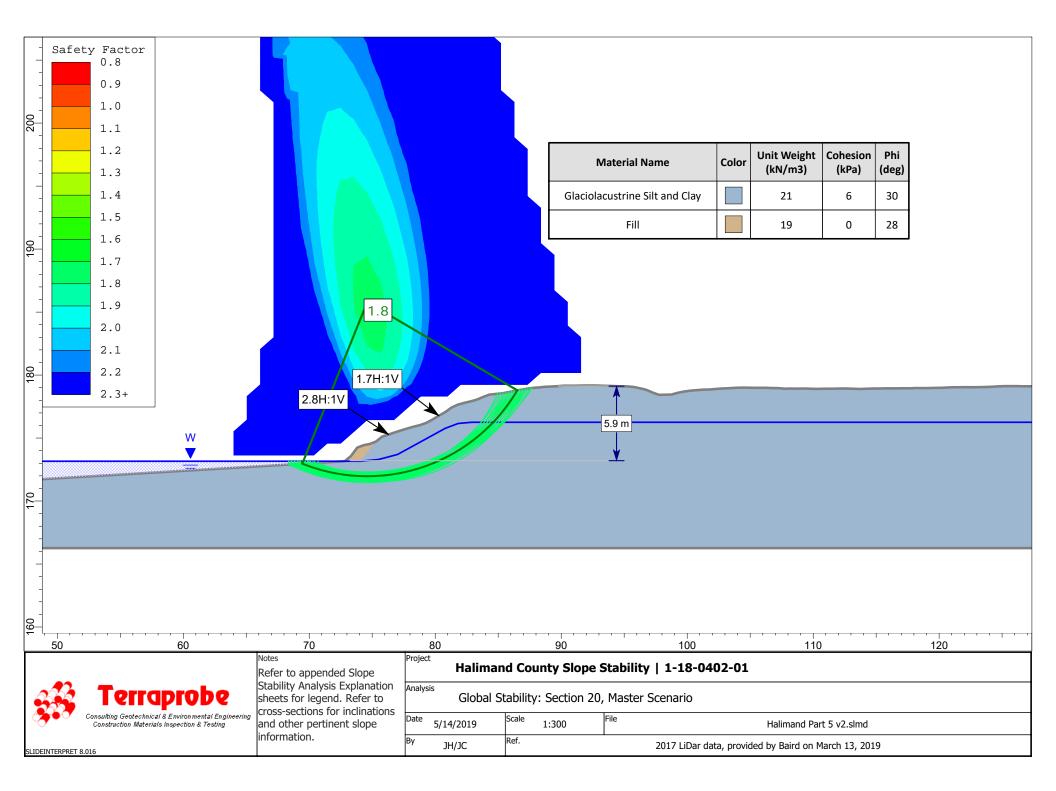


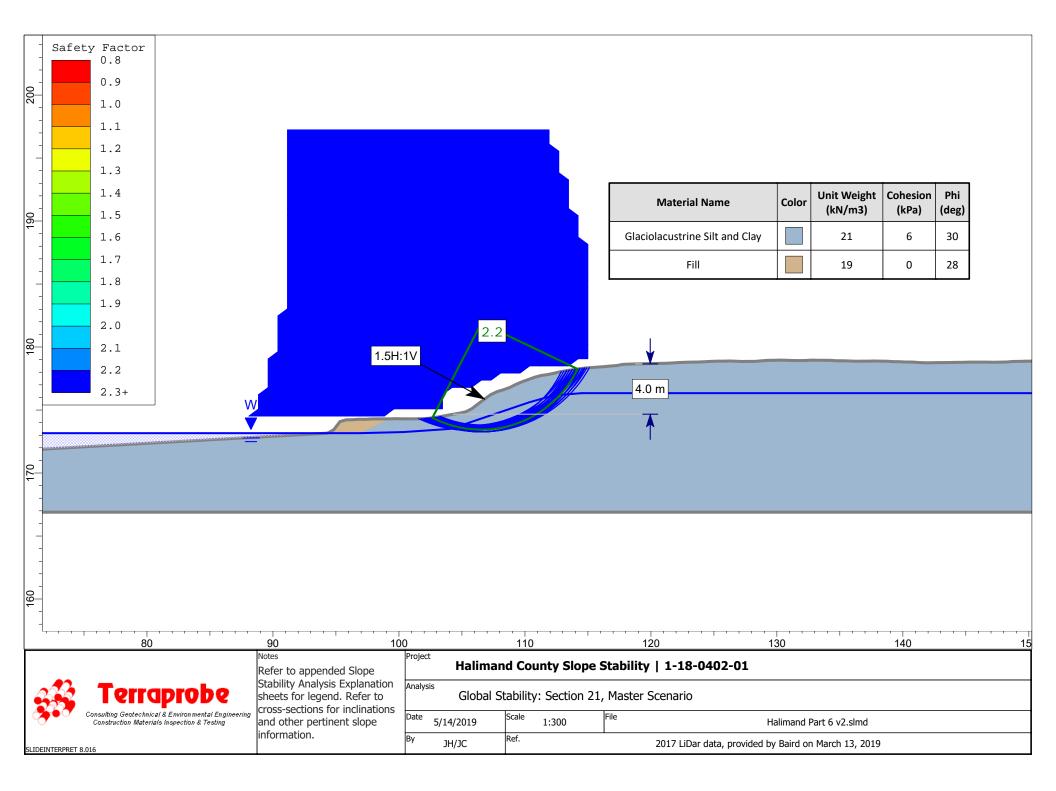


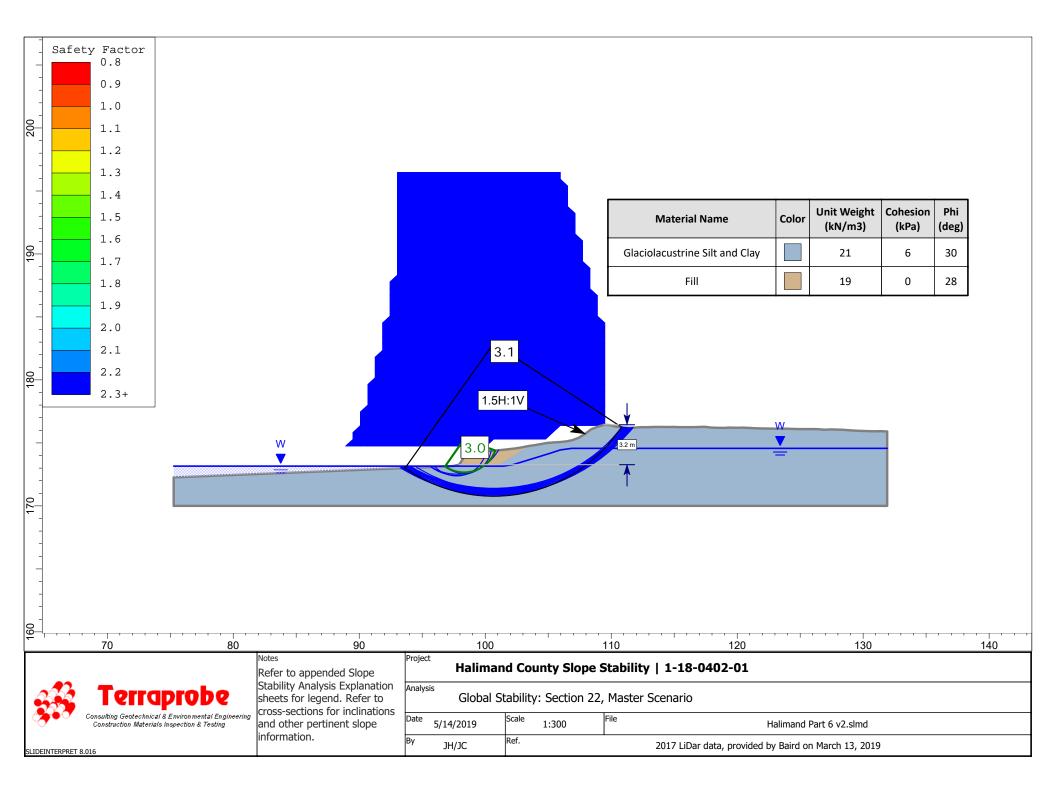


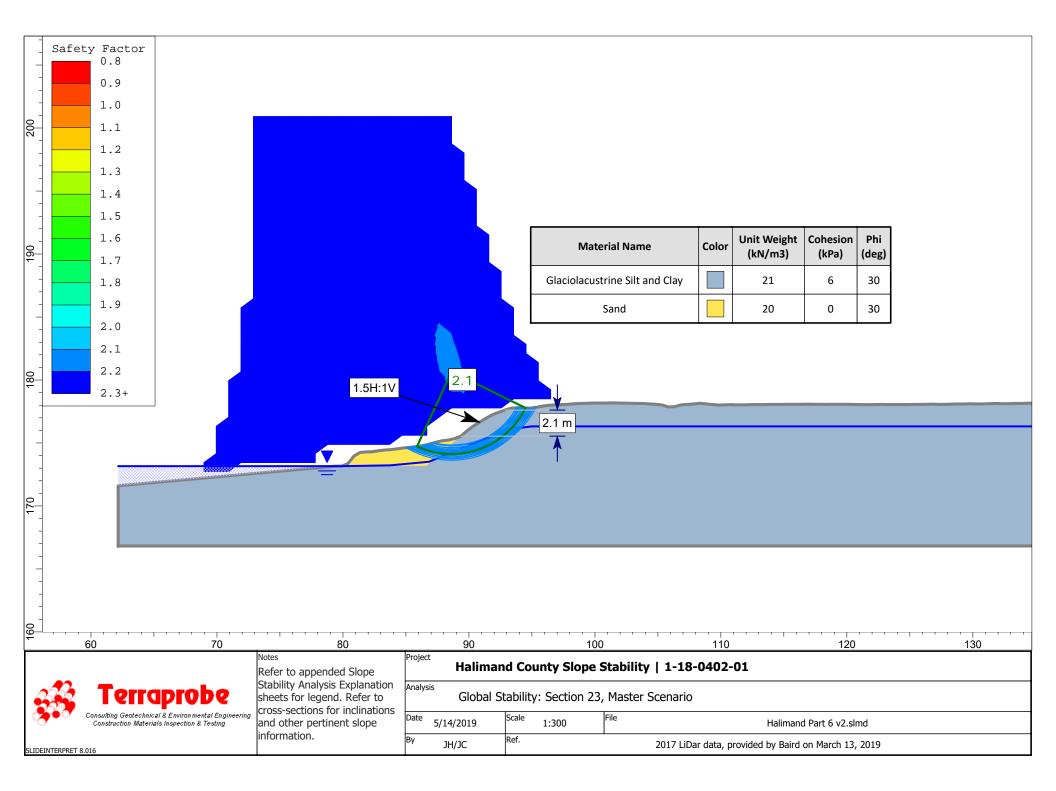


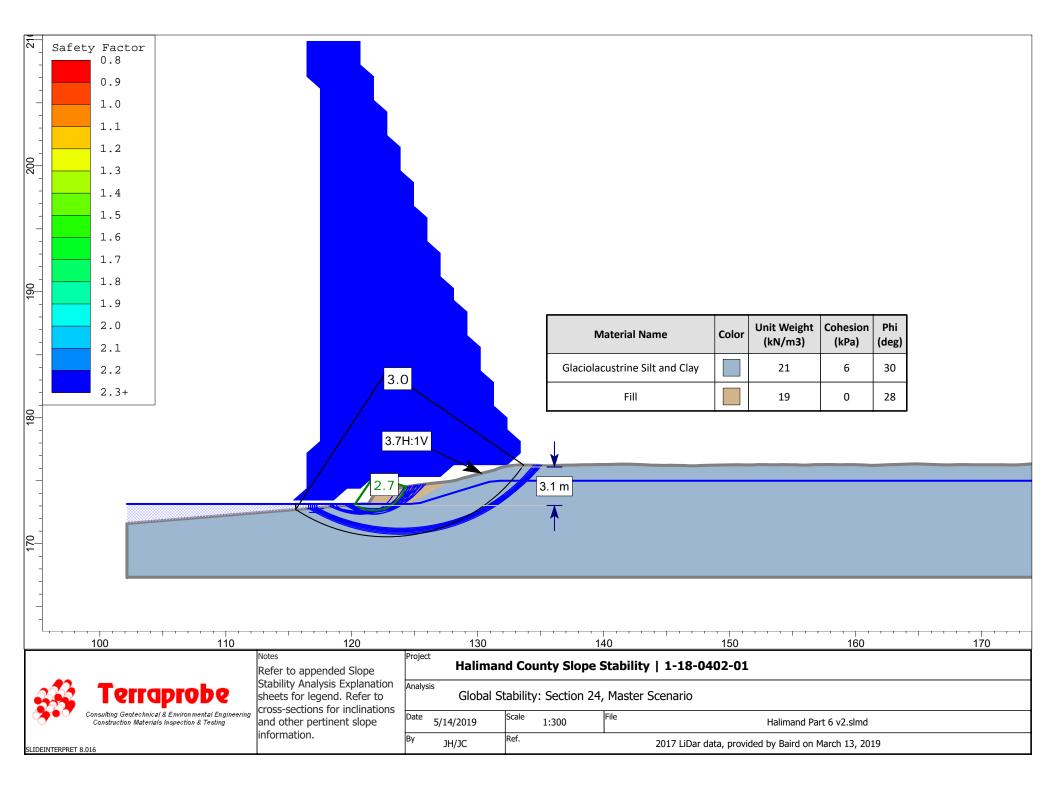


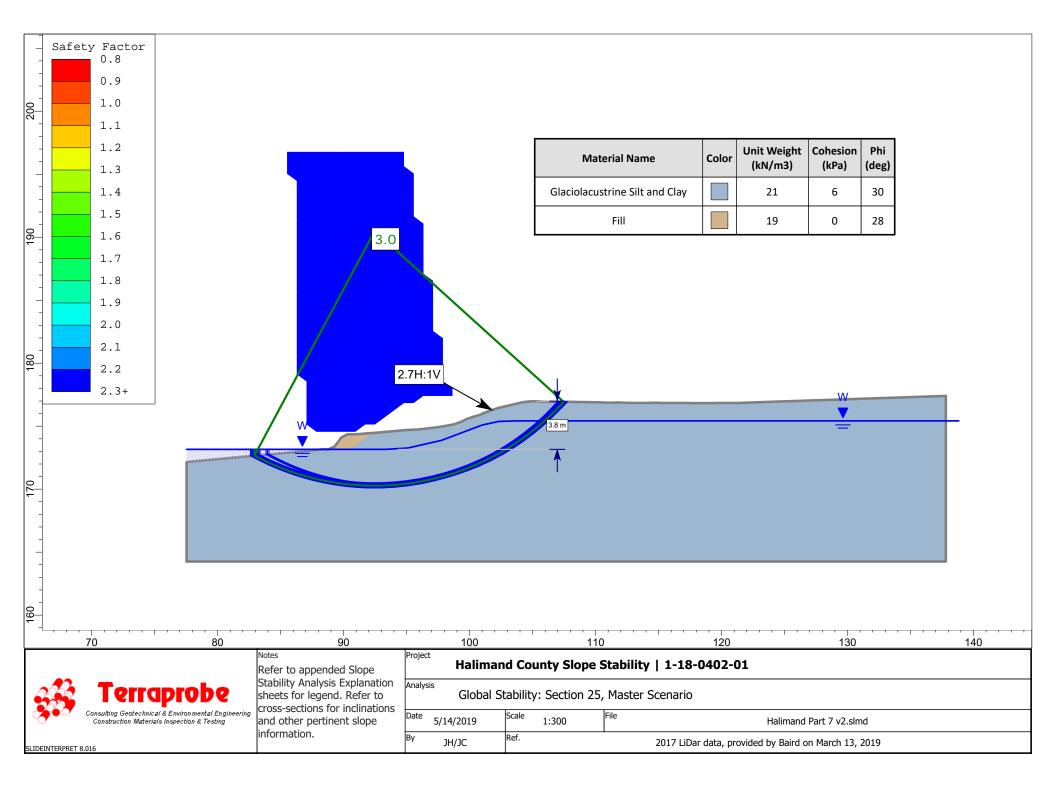


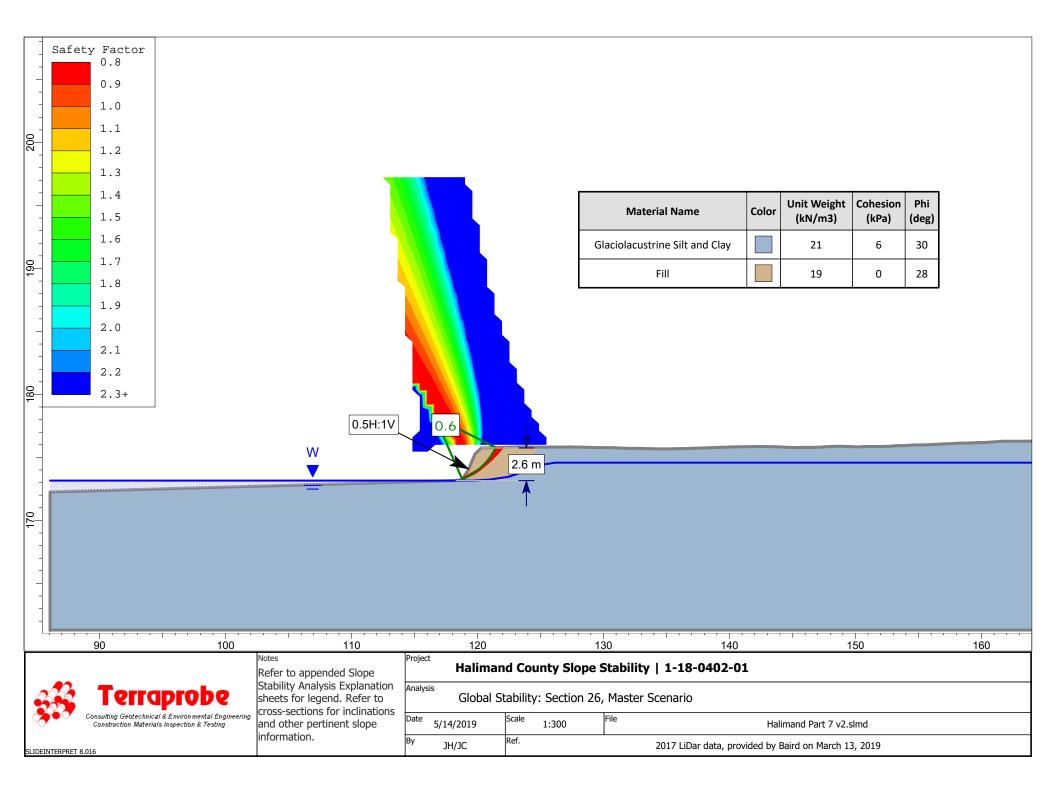


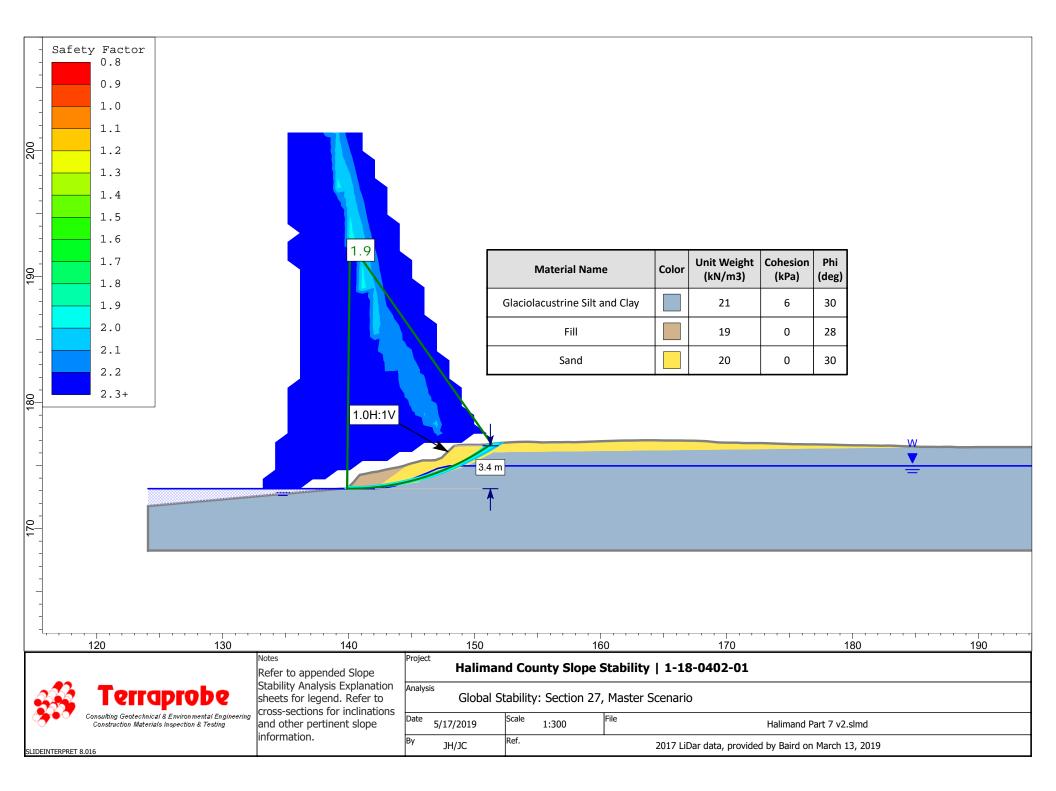


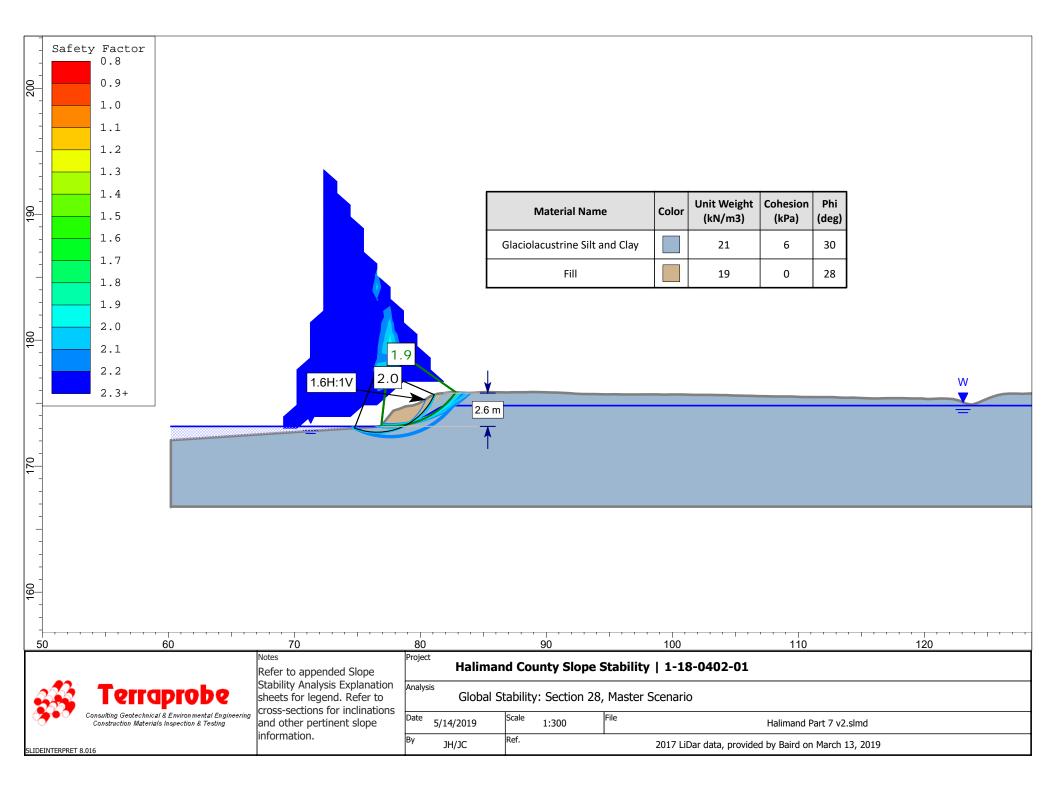


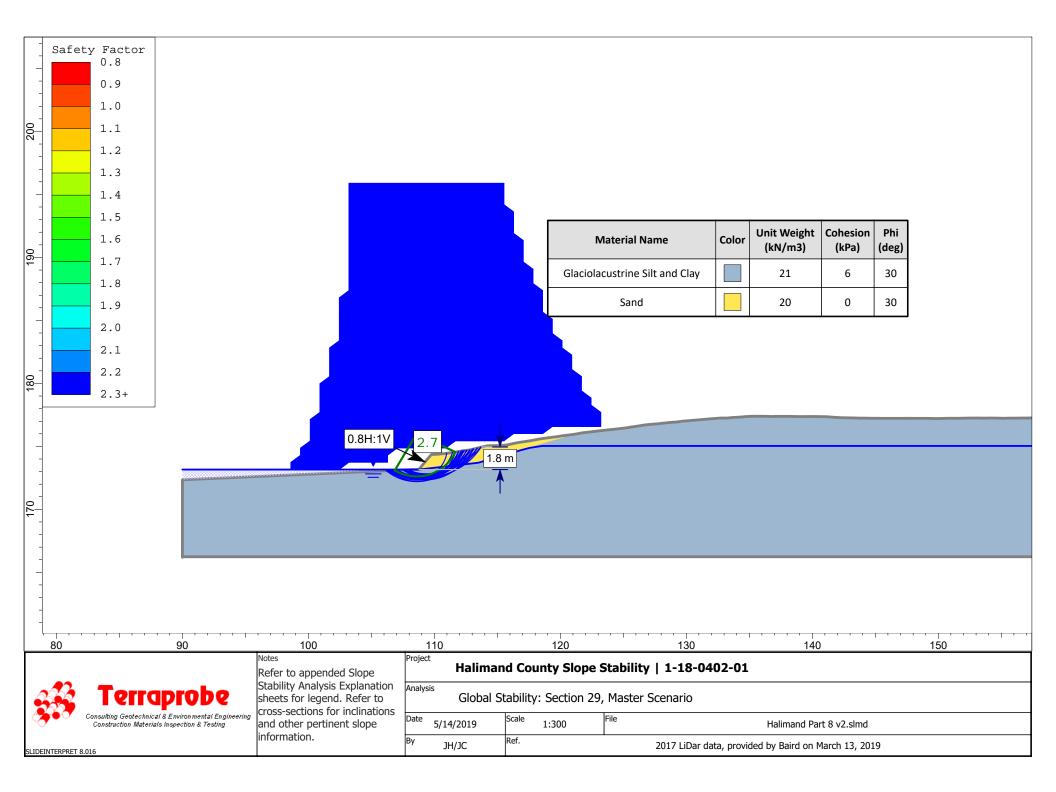


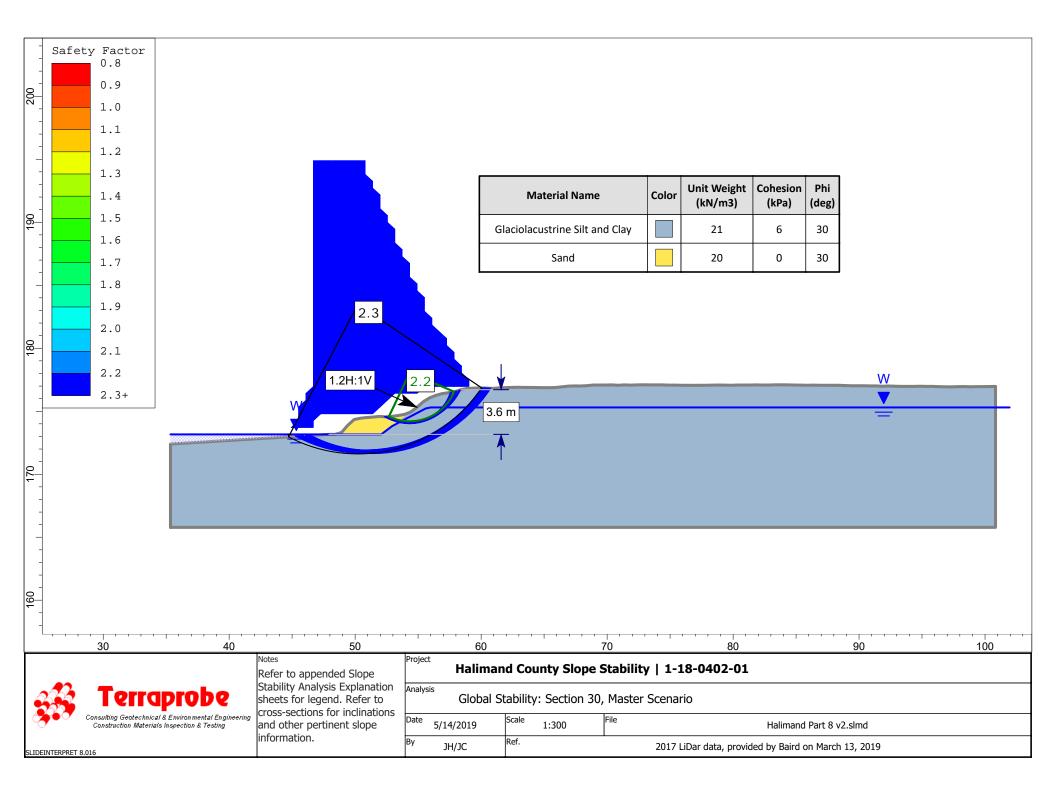


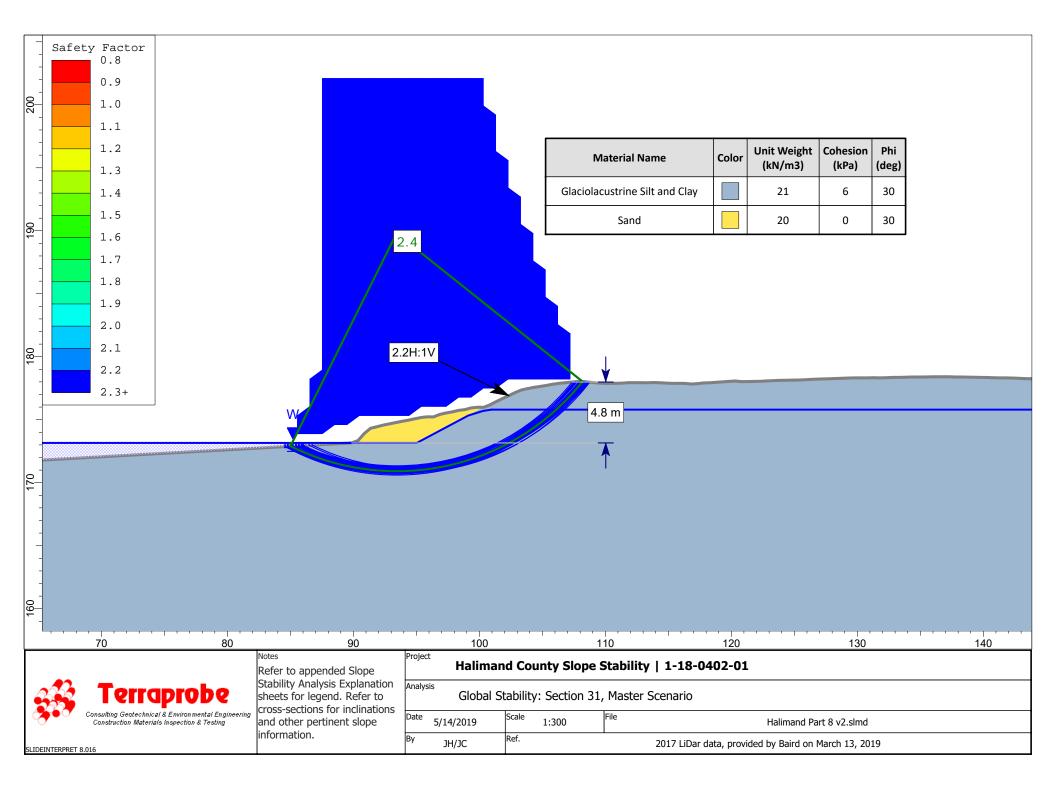


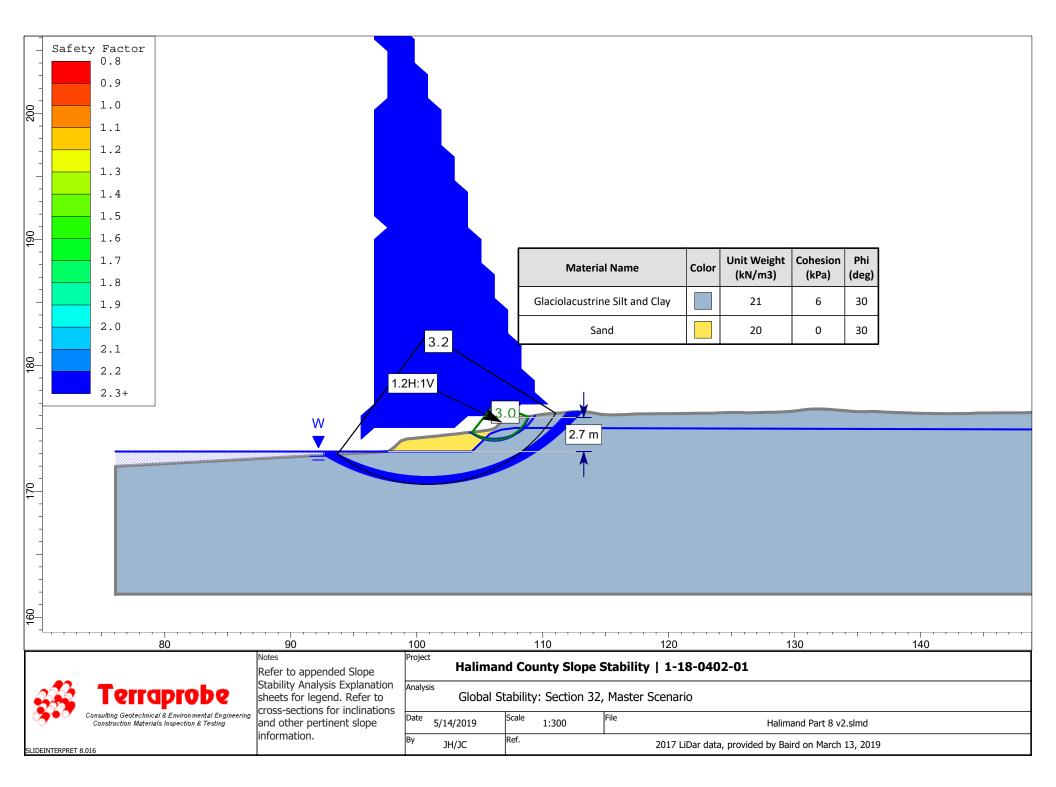


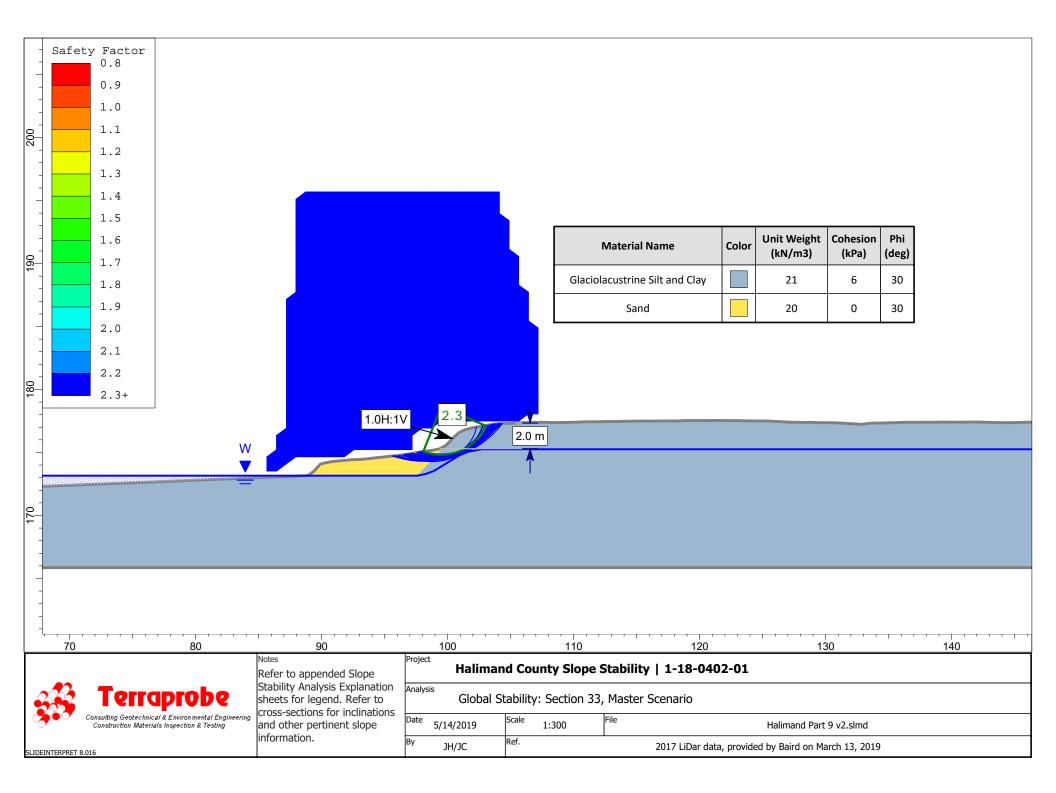


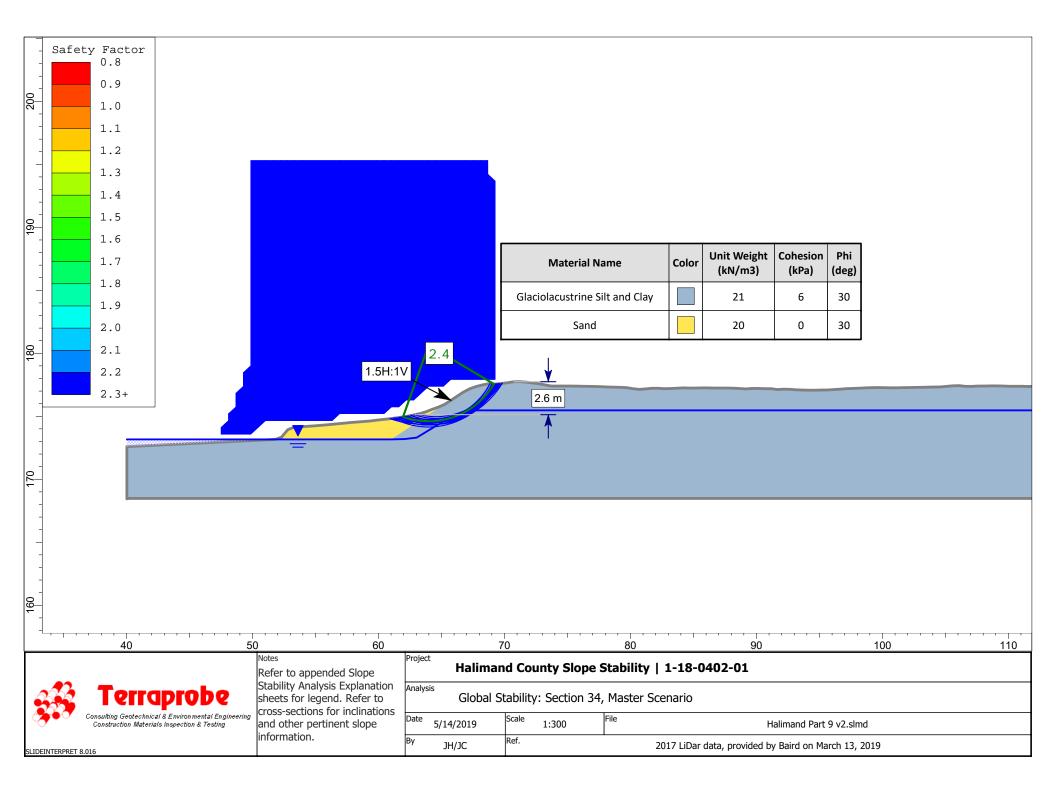


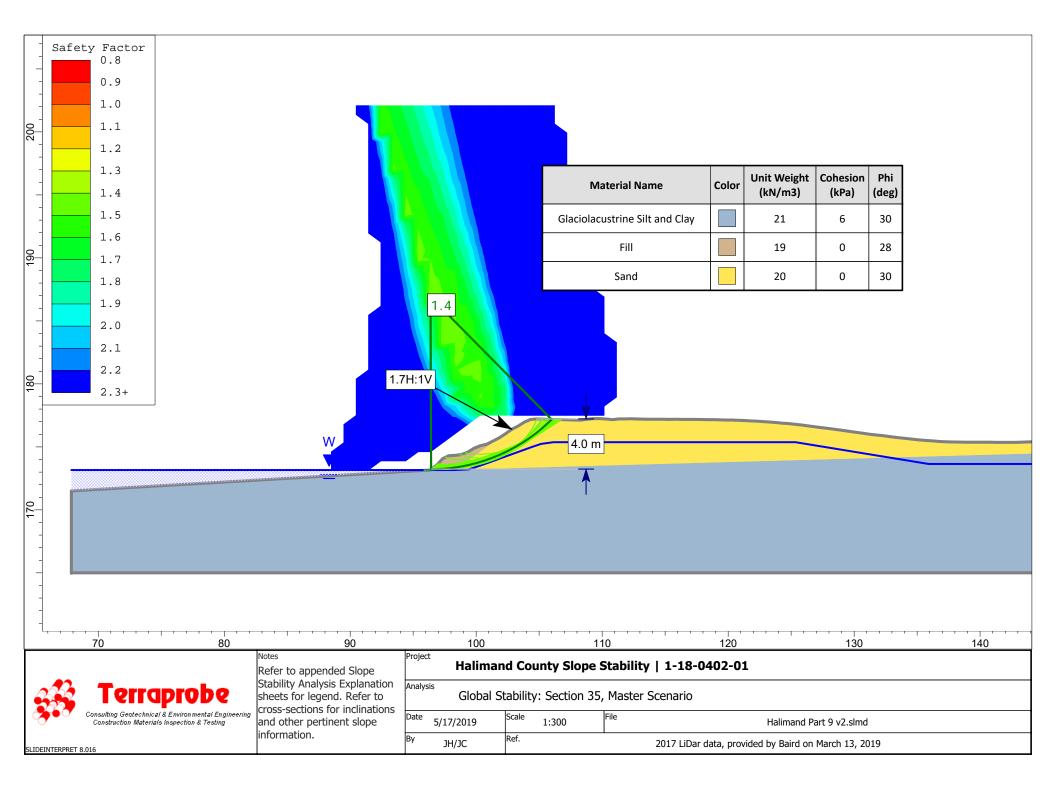


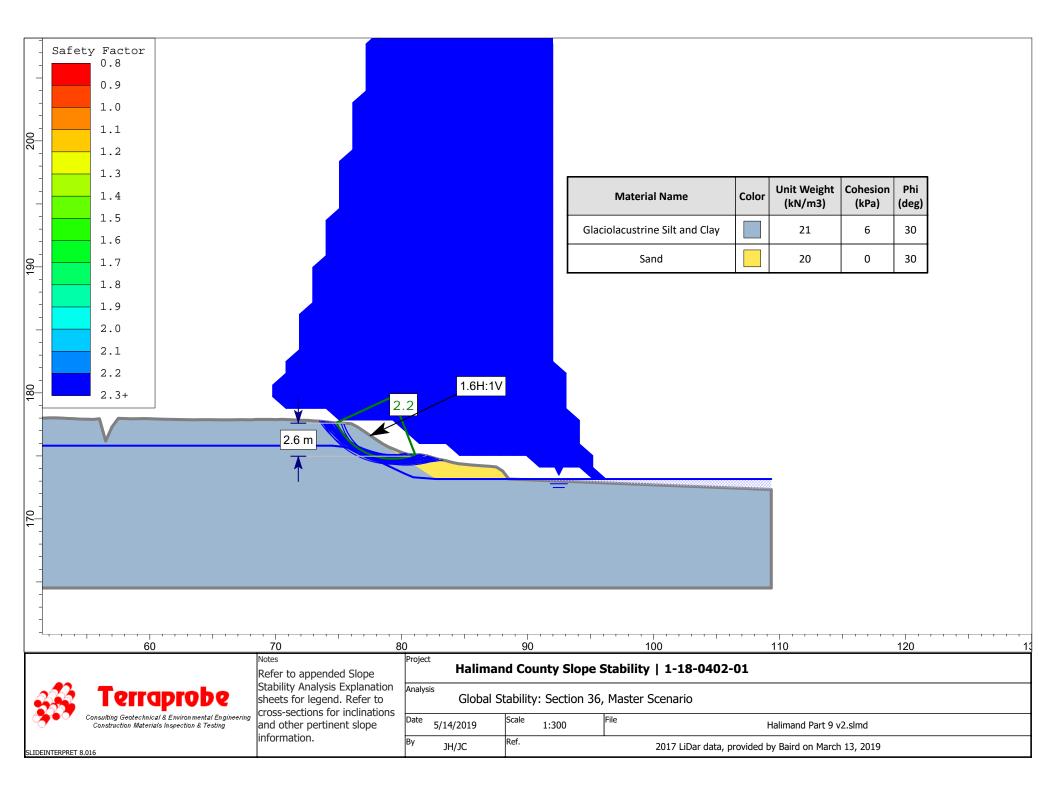


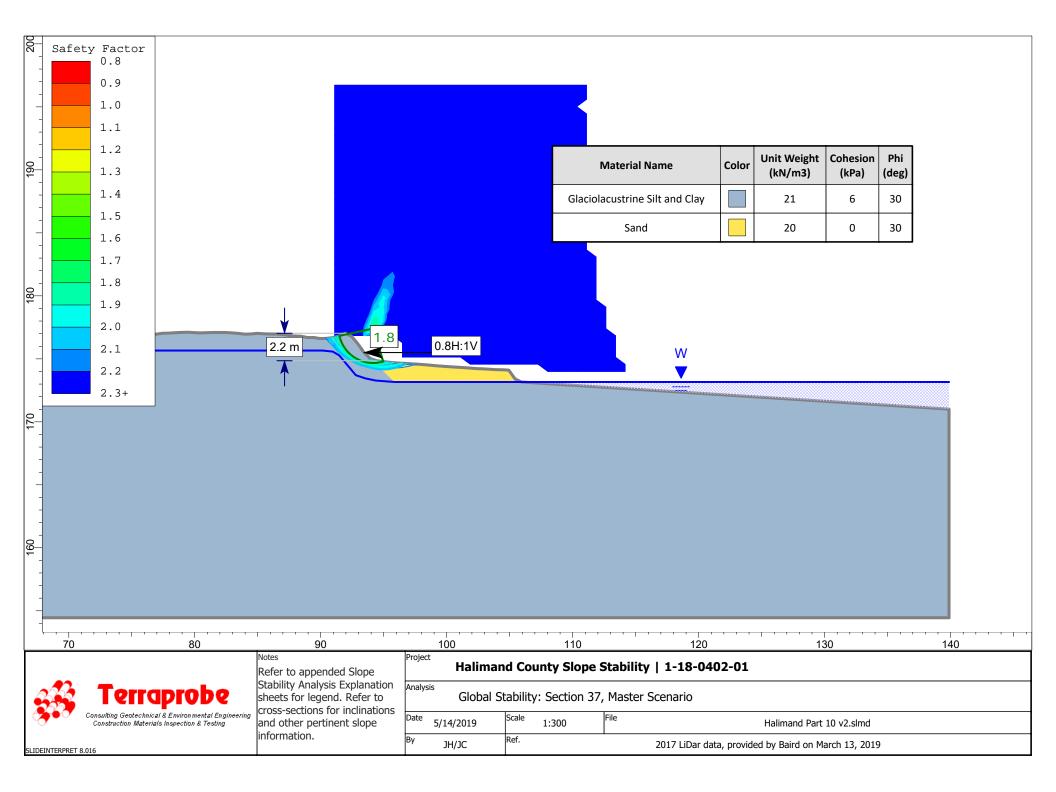


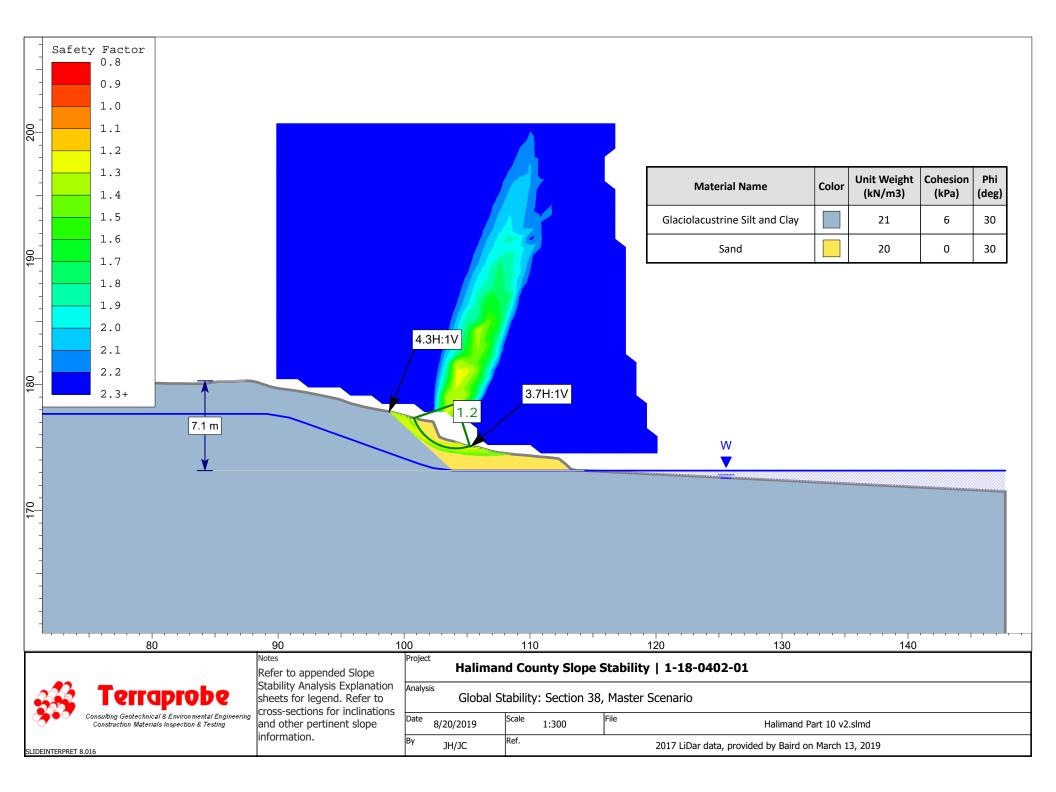


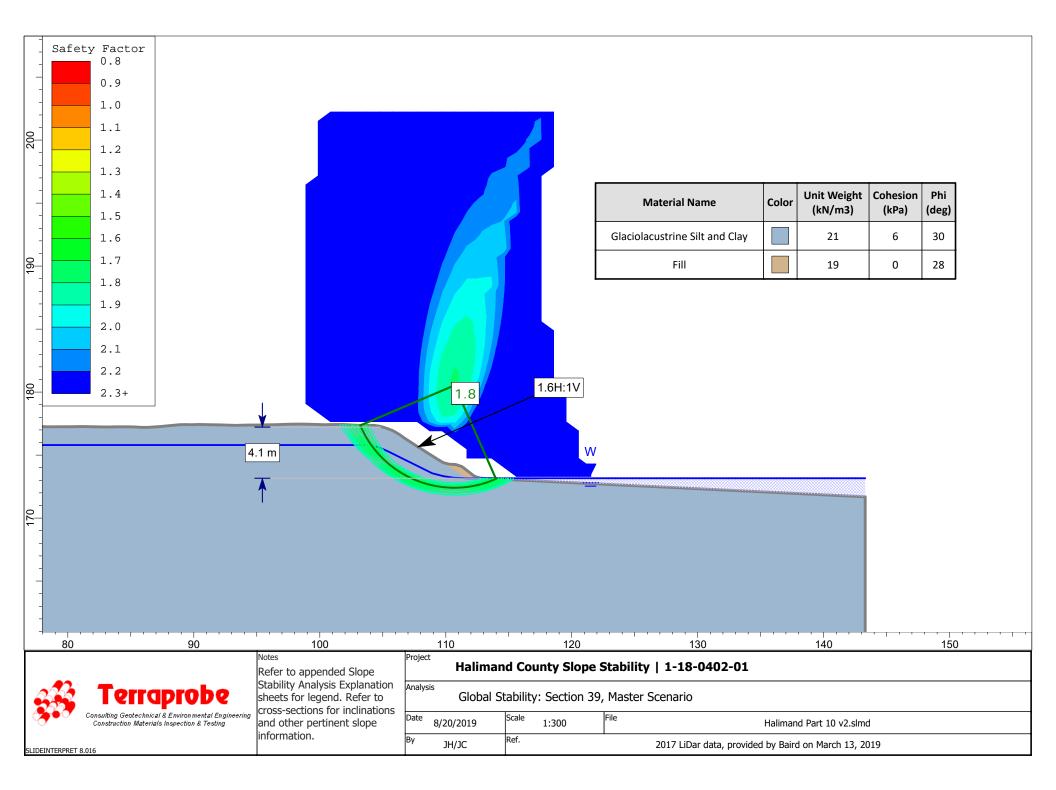


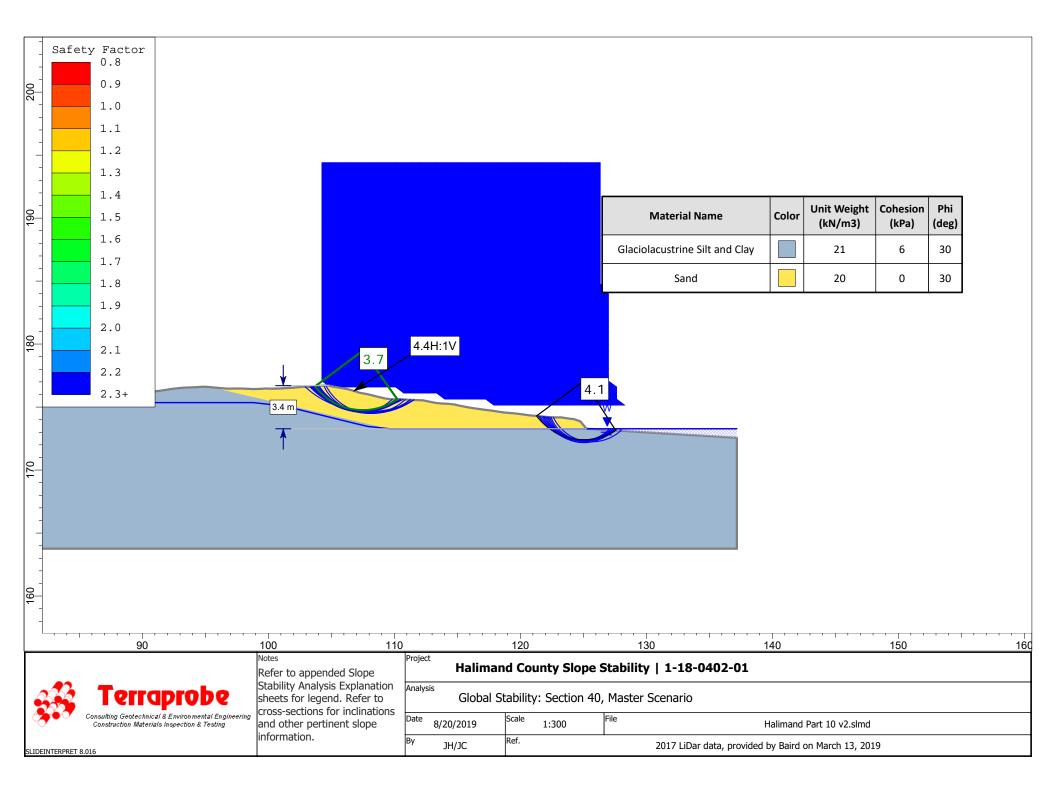


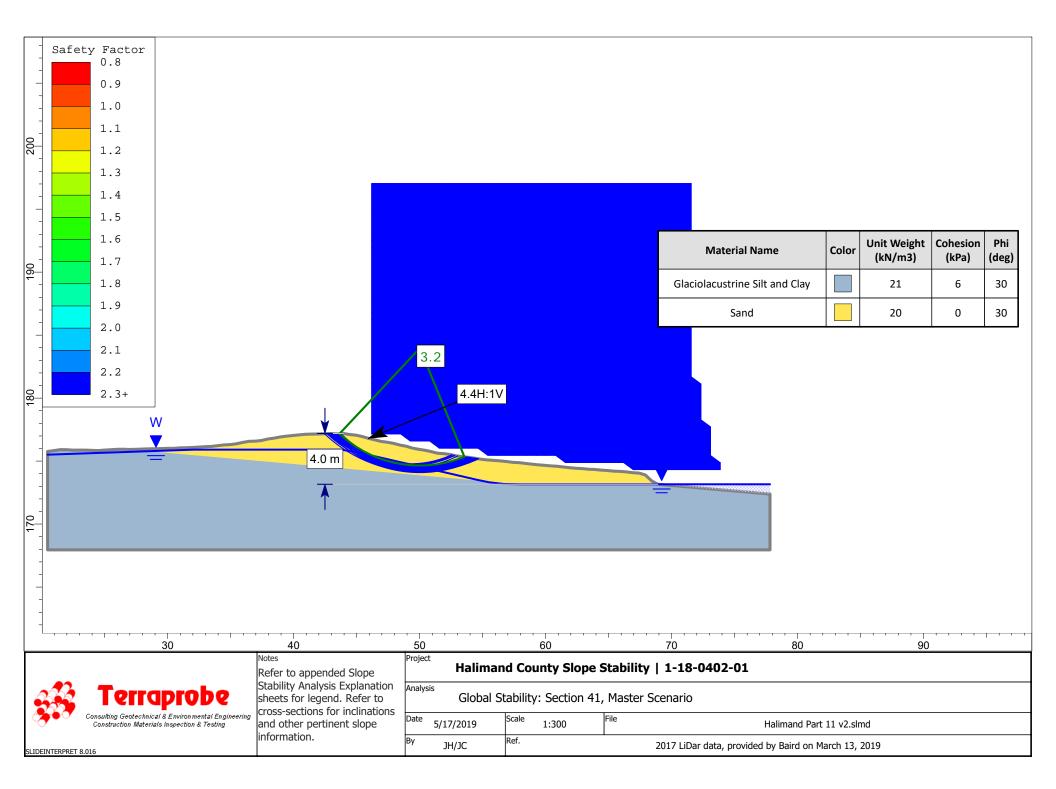


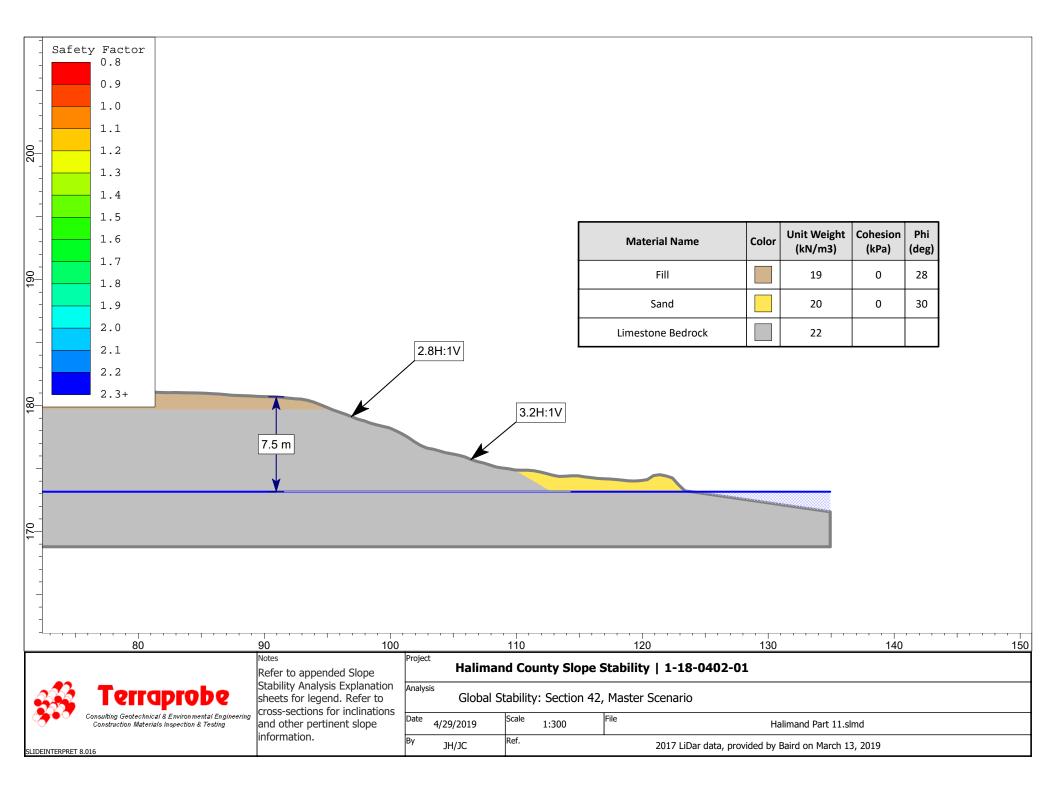


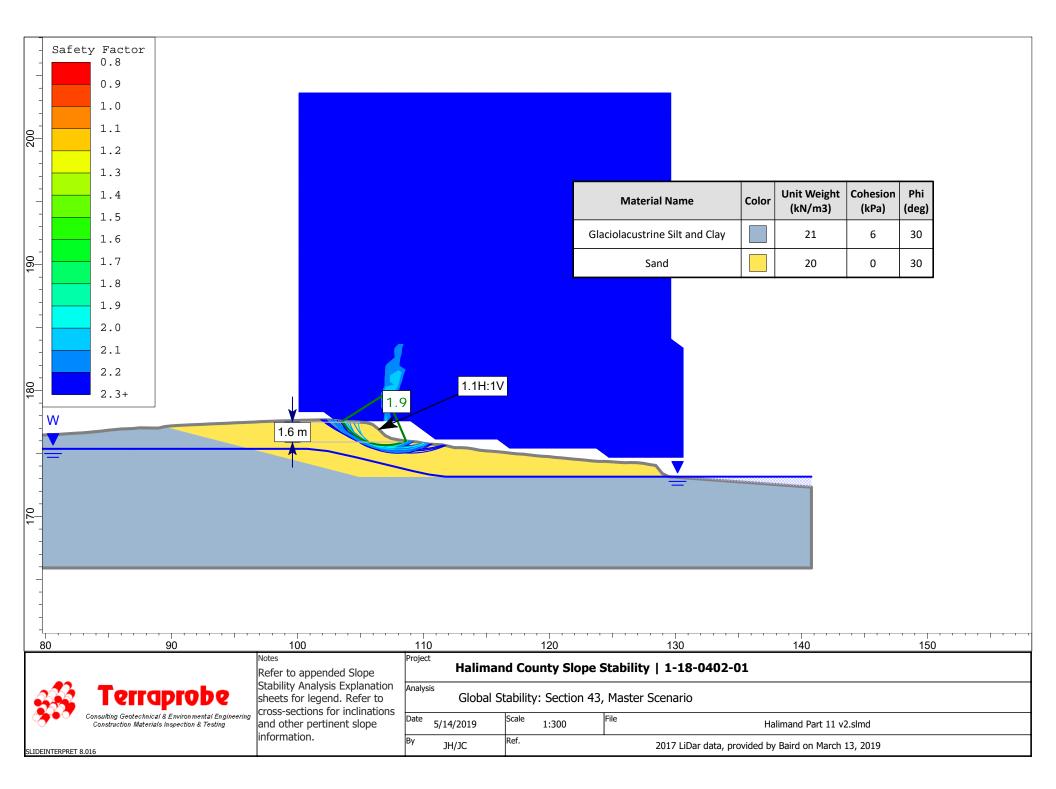


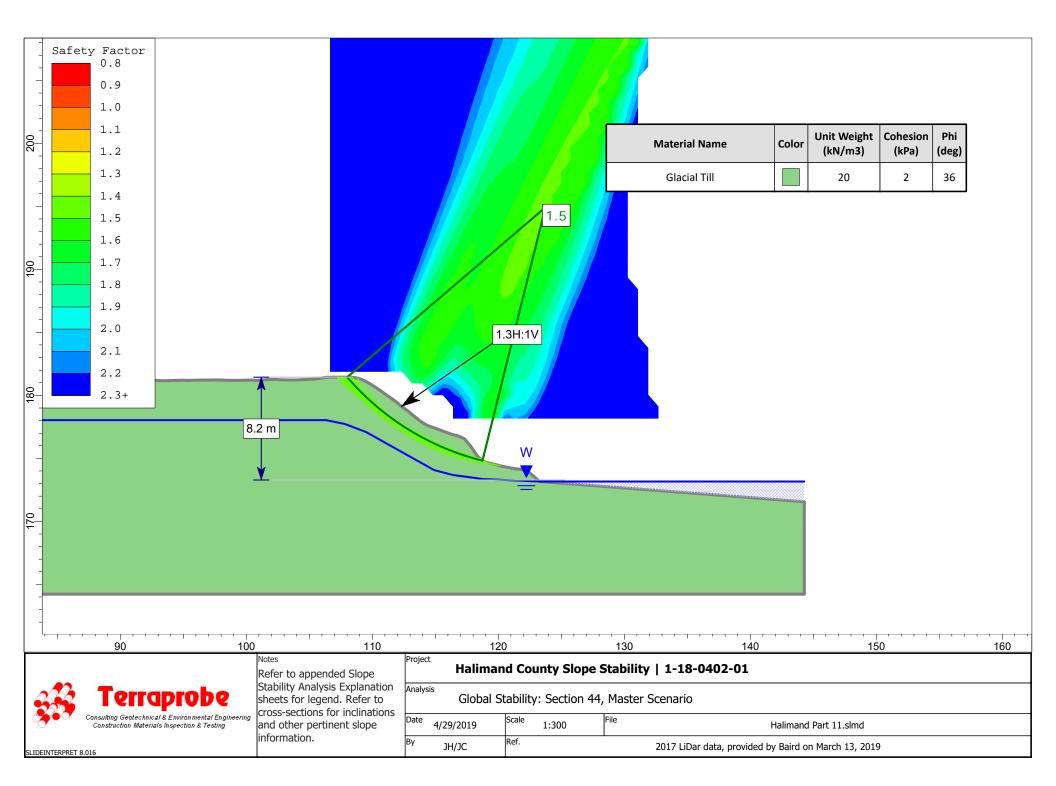


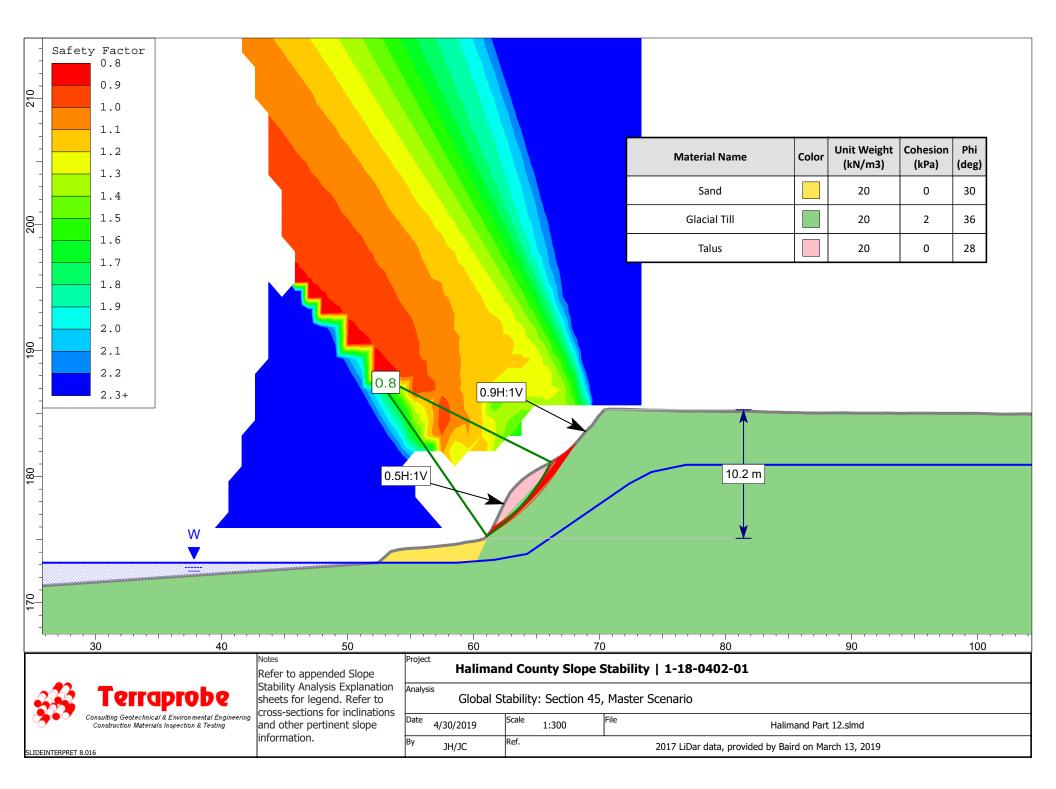


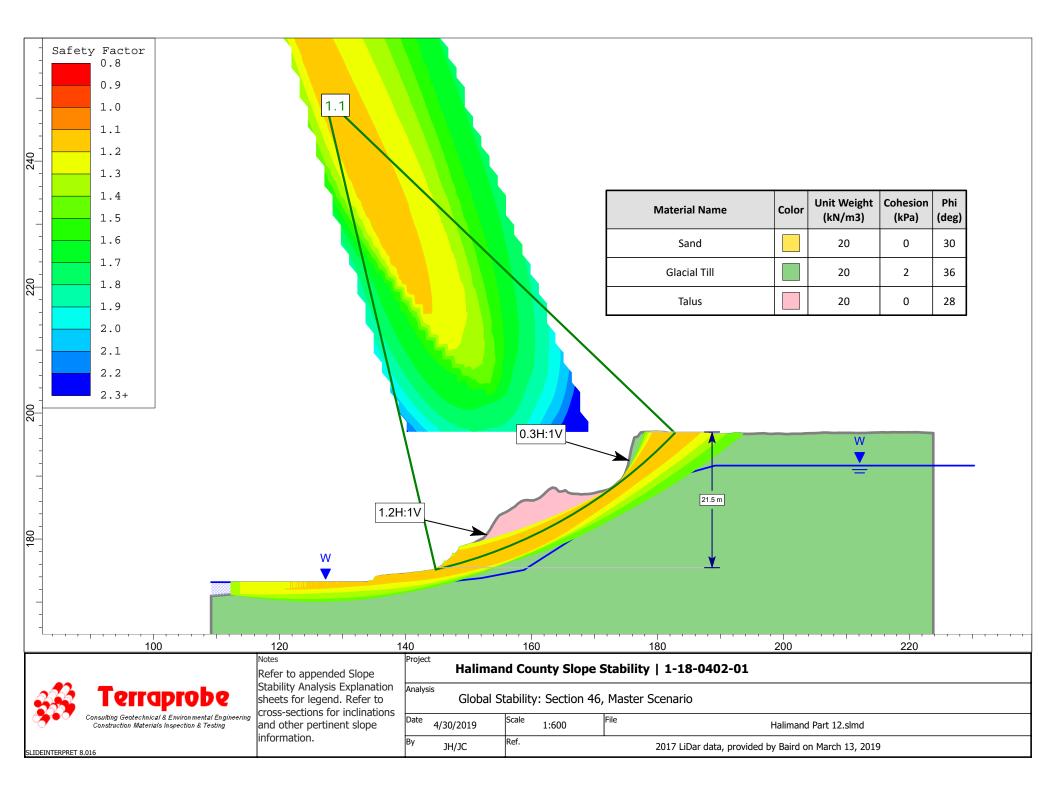


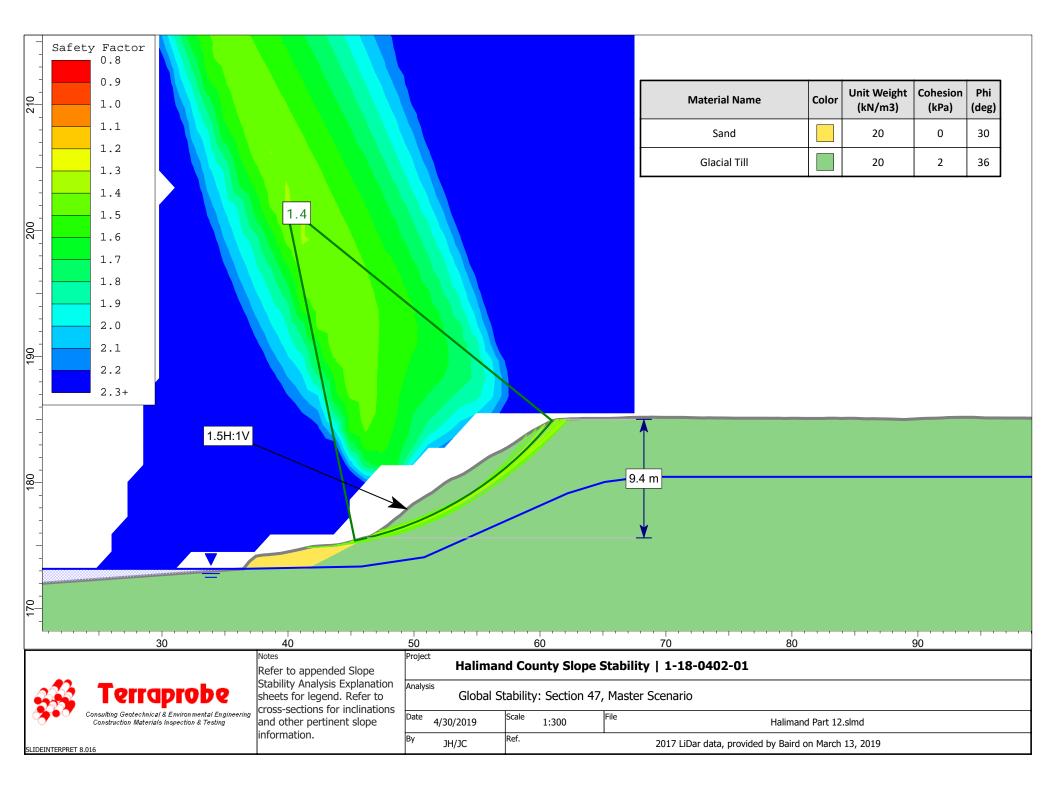


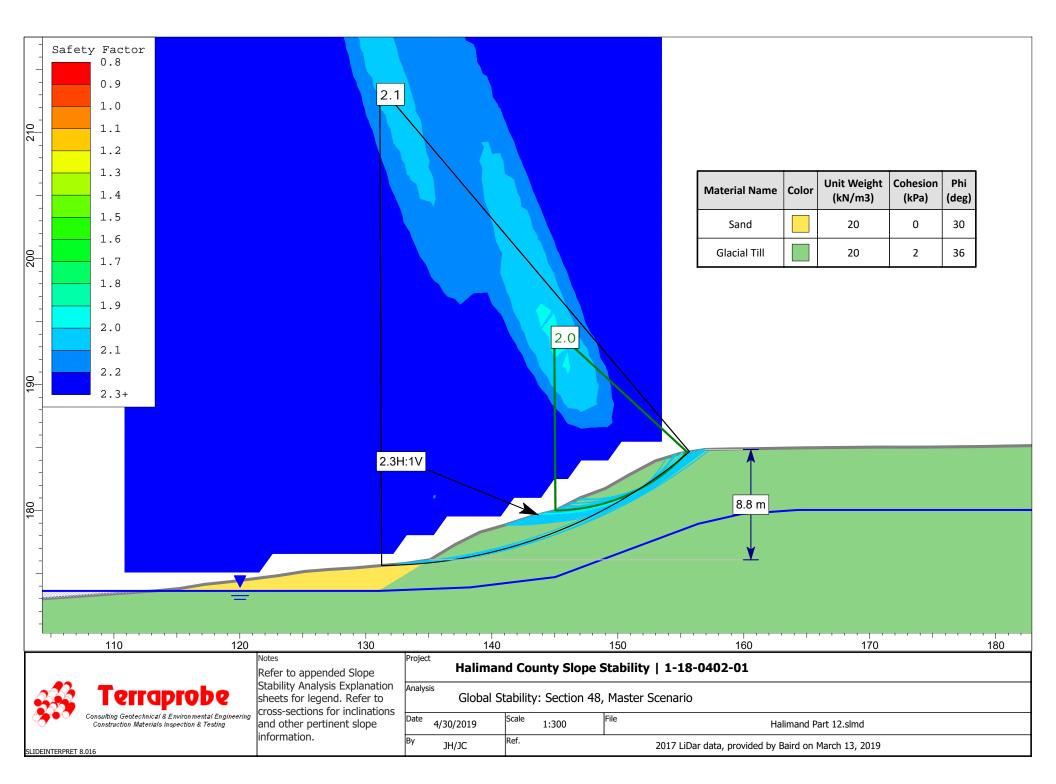


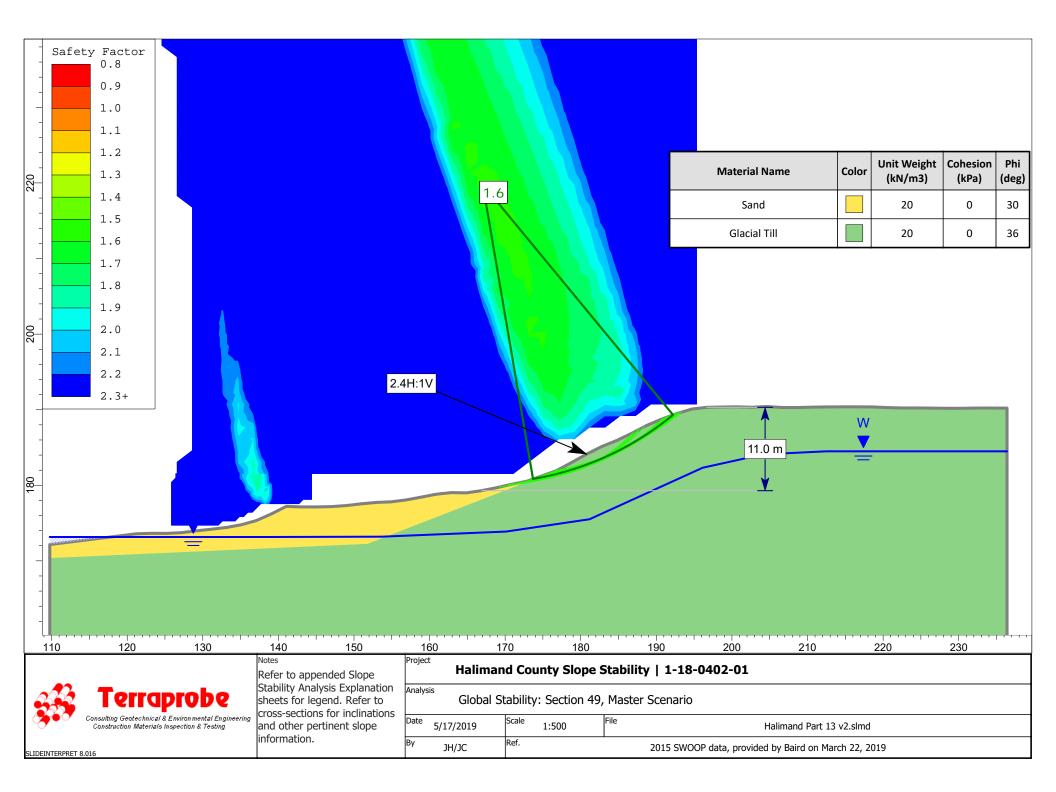


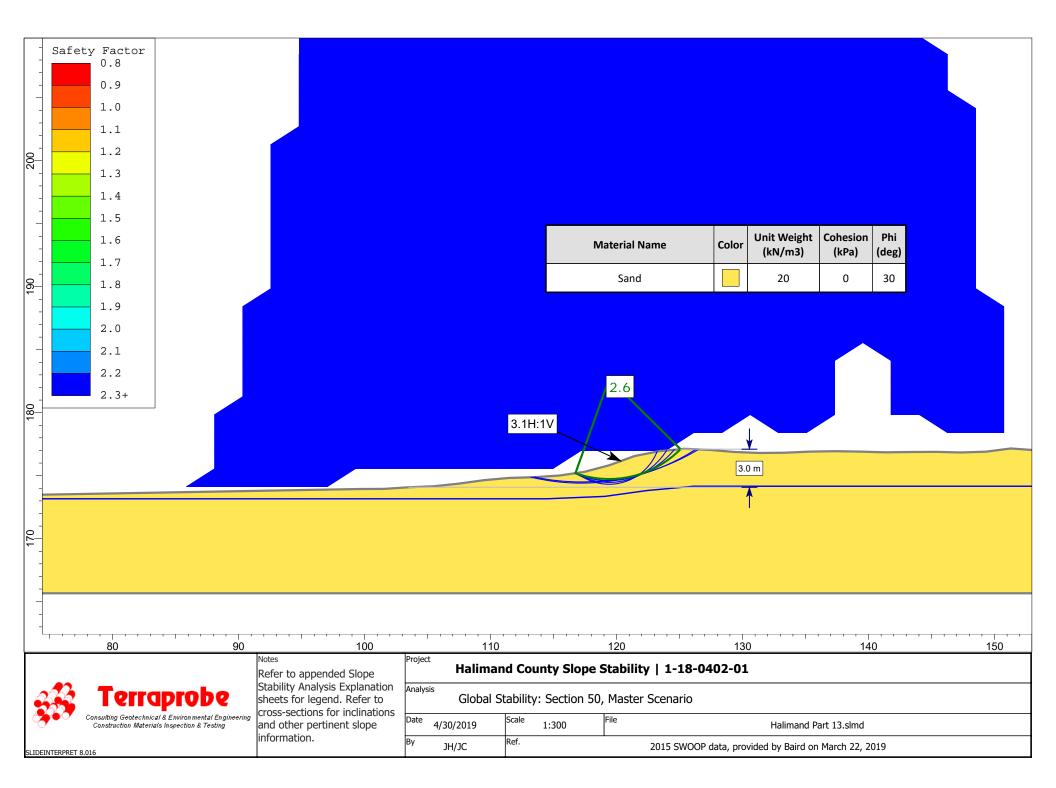


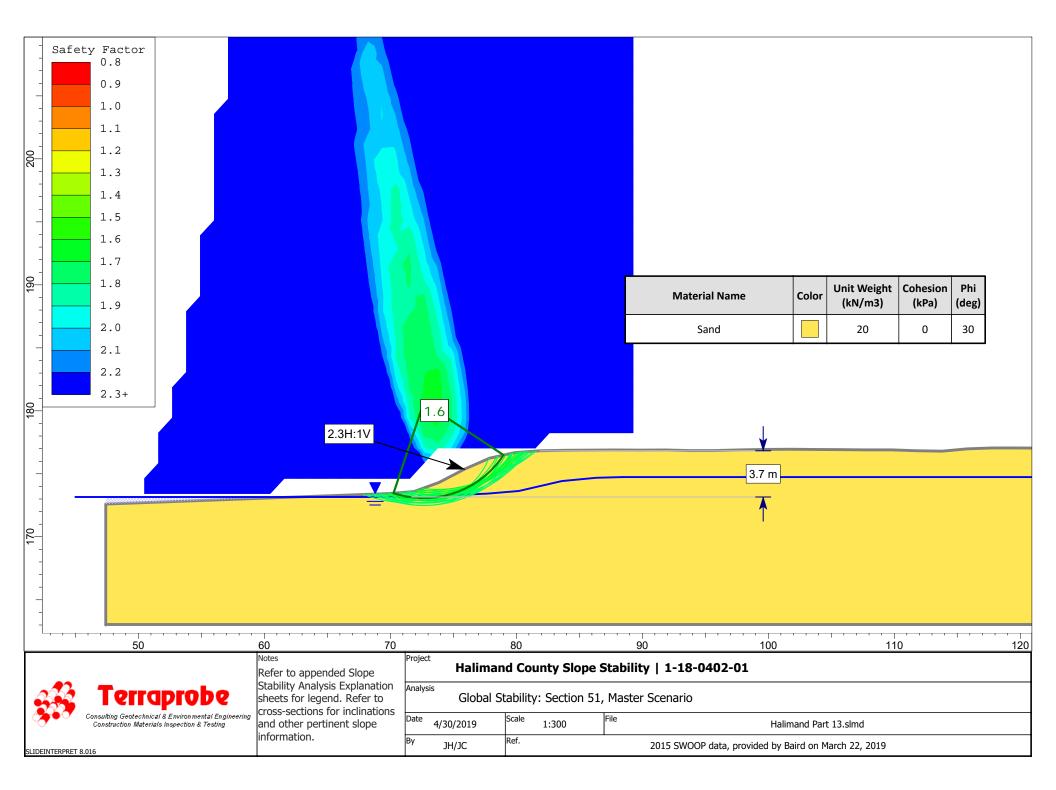


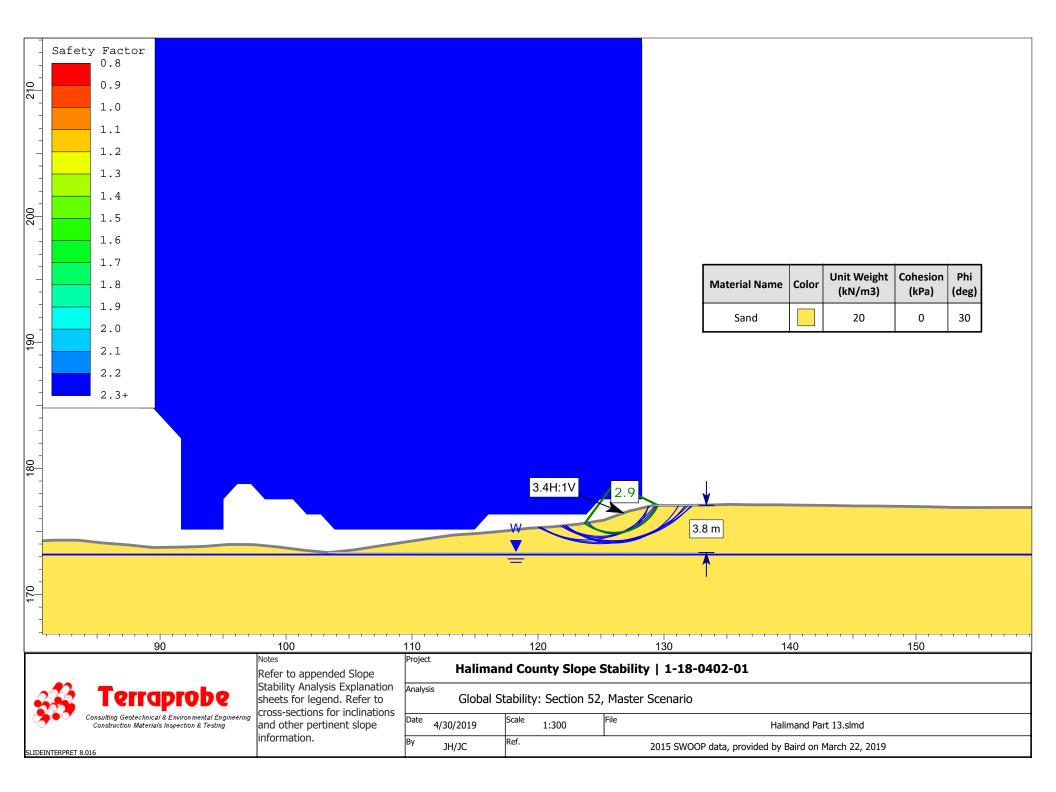


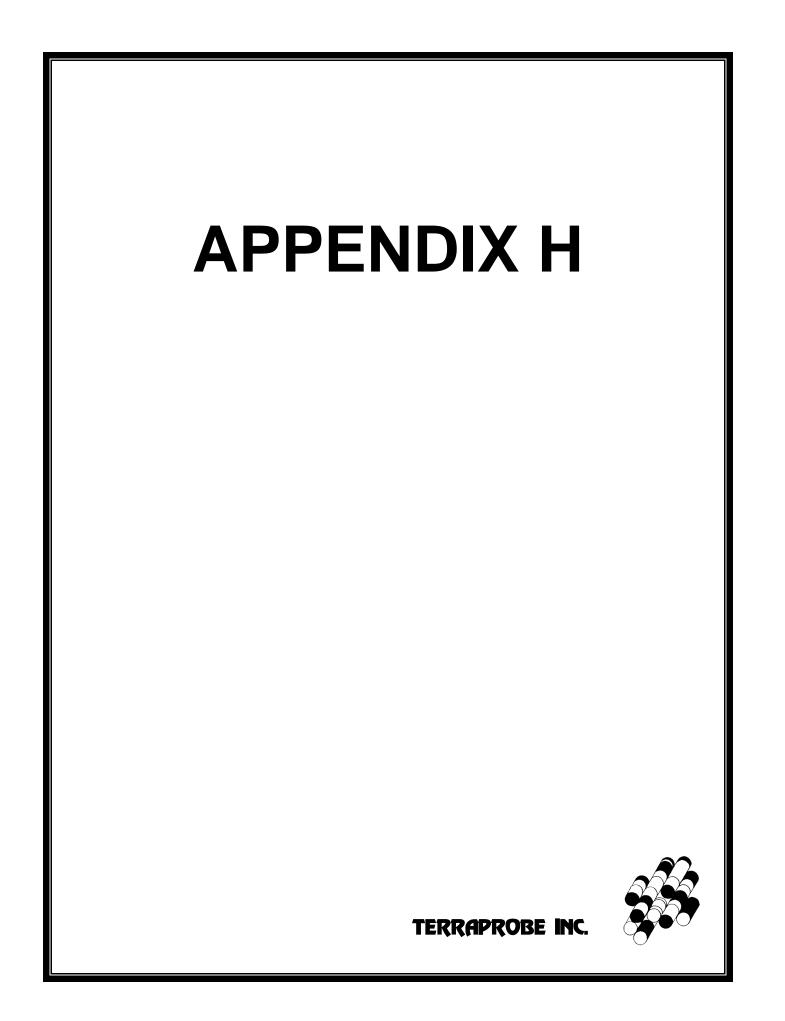


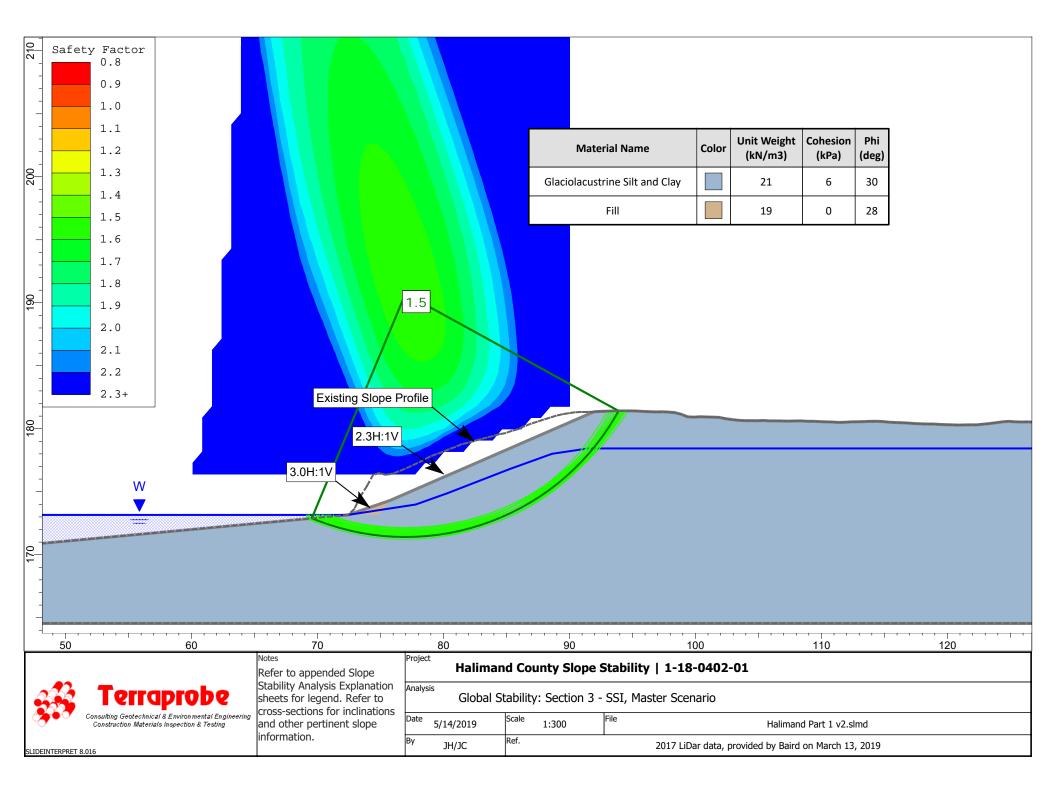


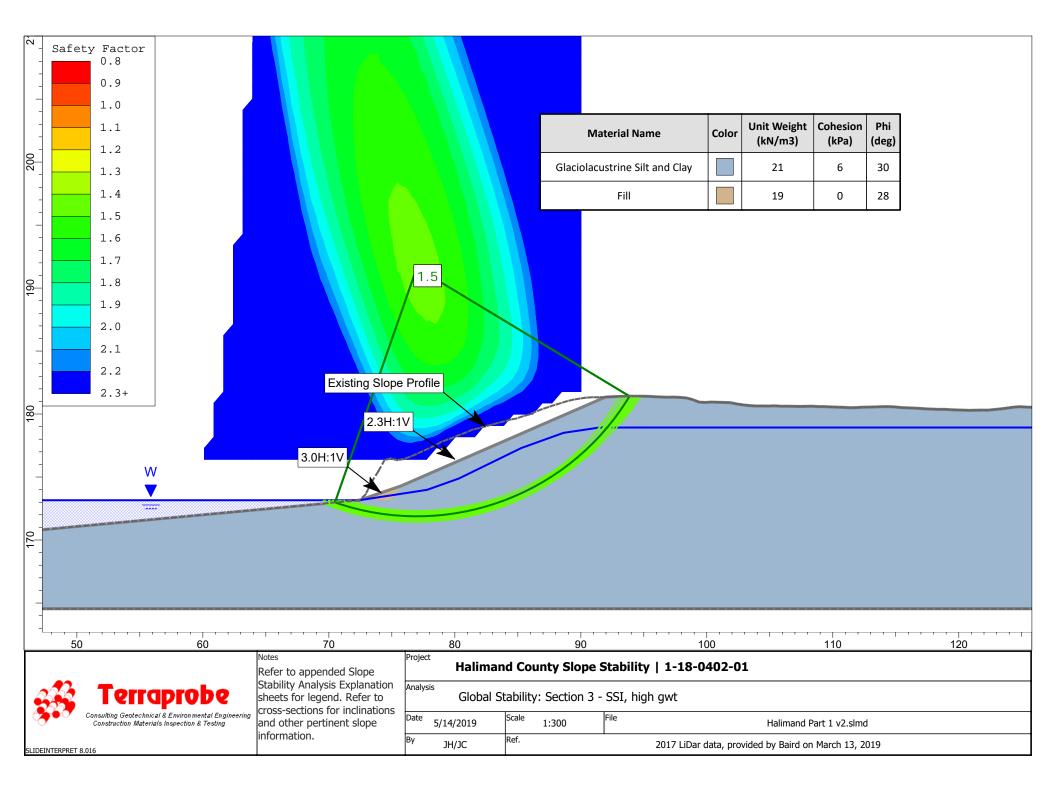


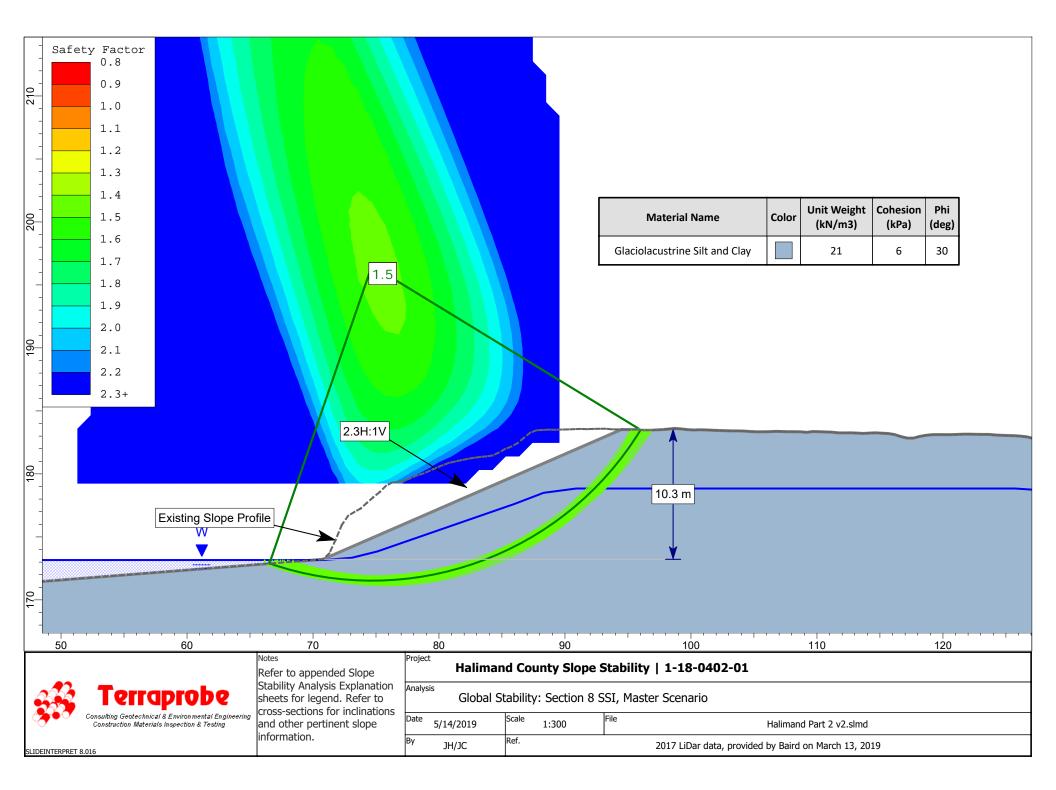


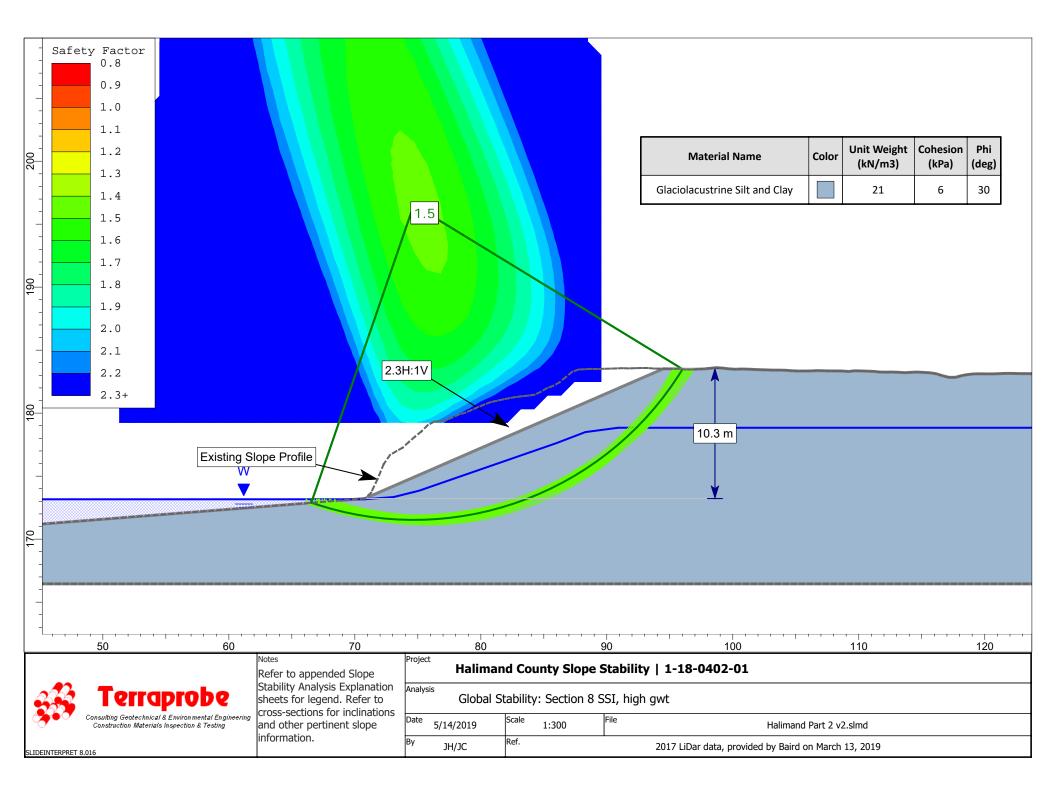


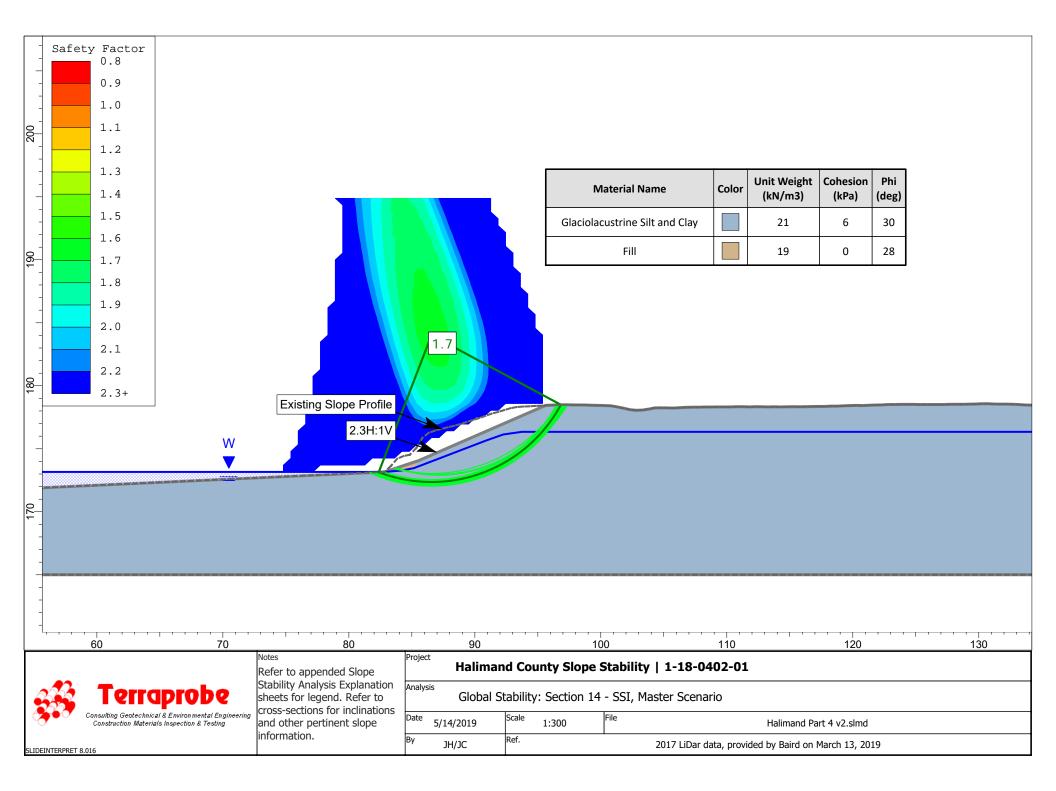


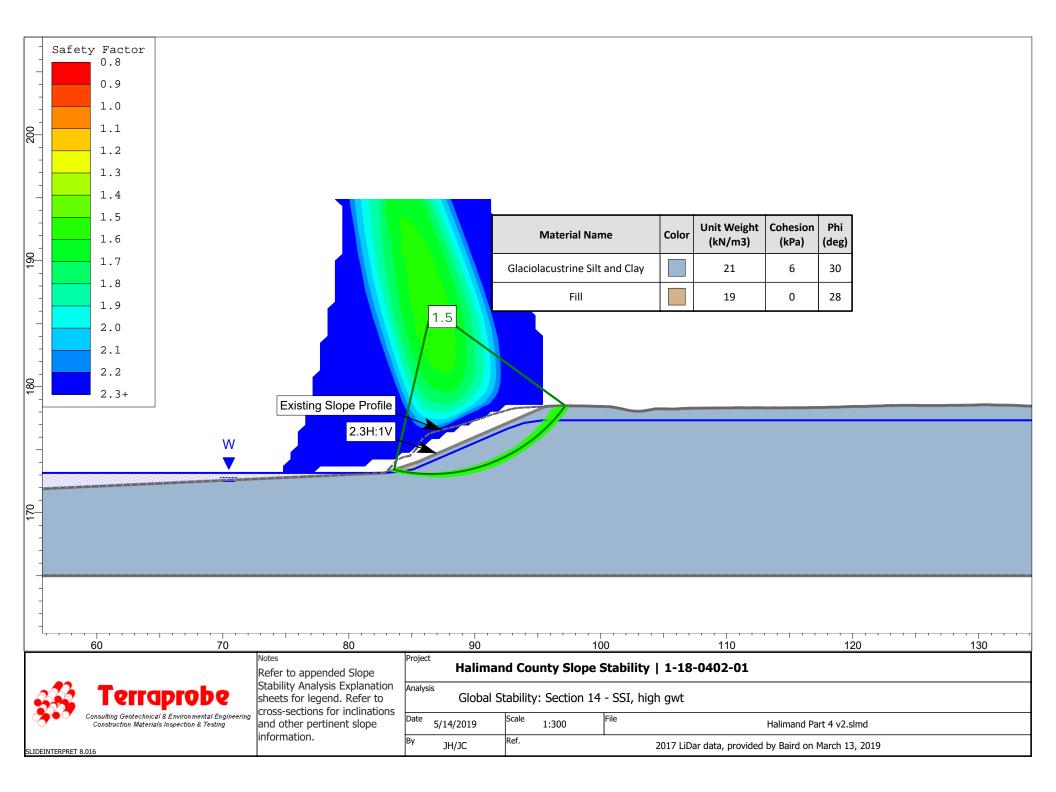


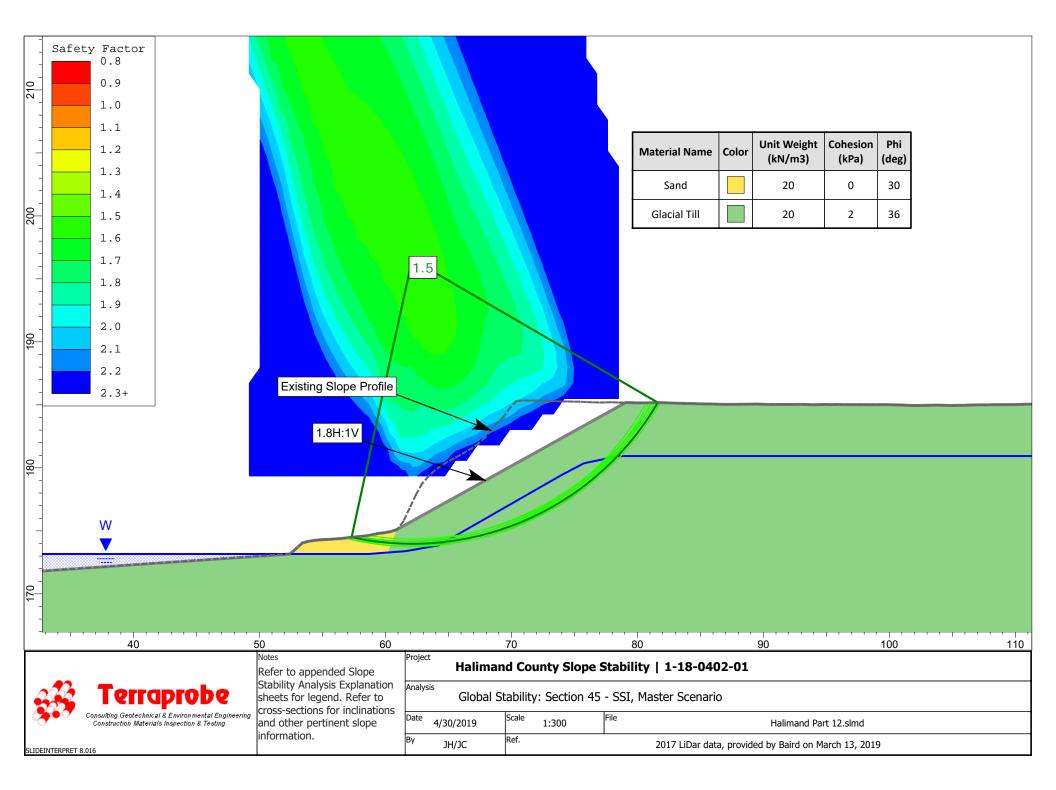


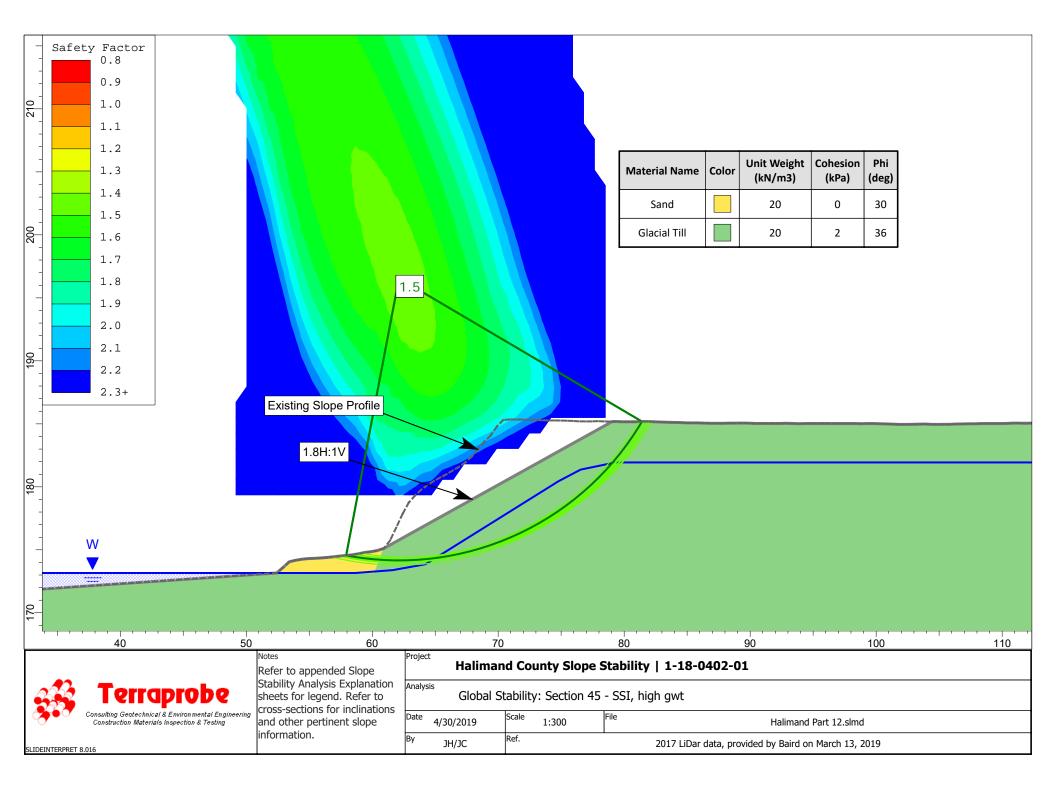


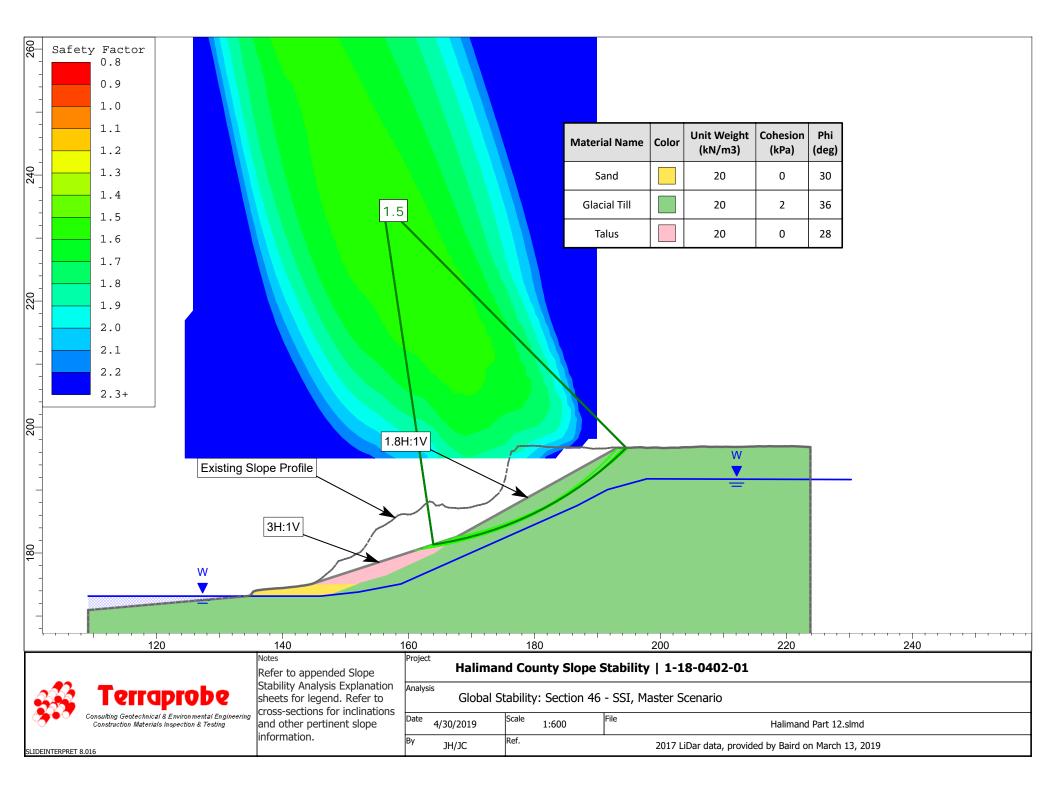


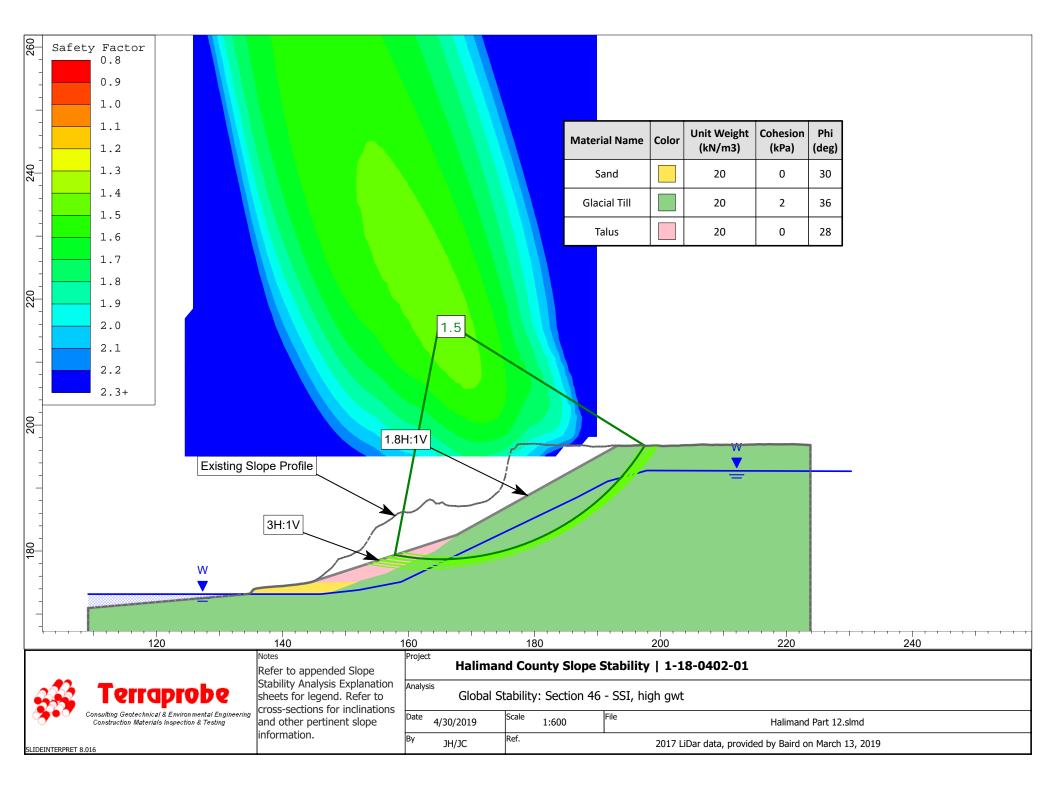


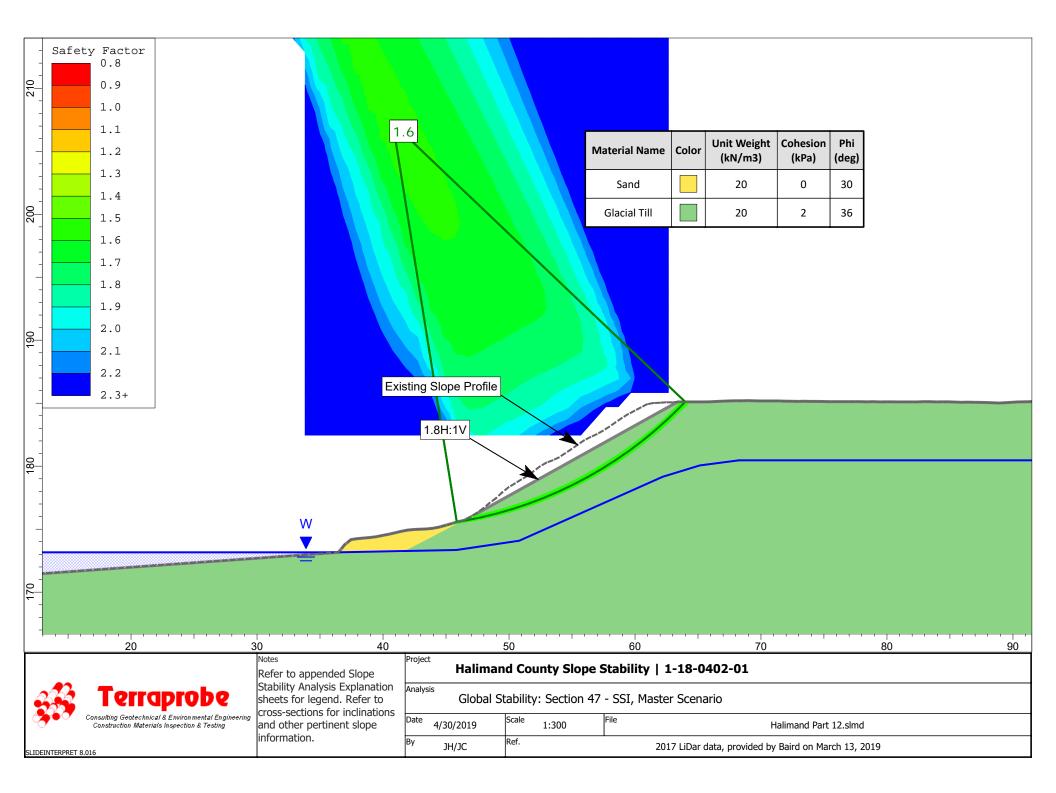


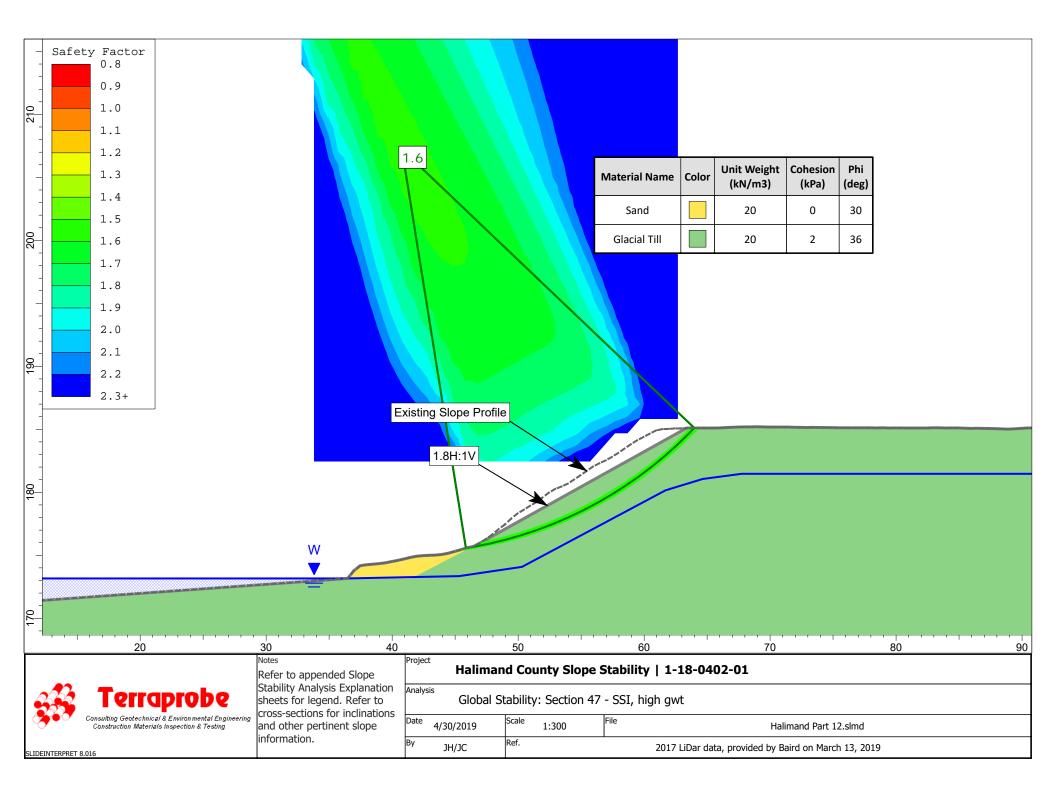


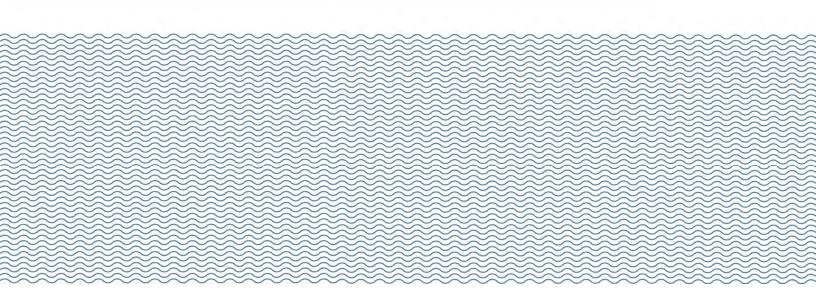












# Appendix B

Shoreline Change Maps

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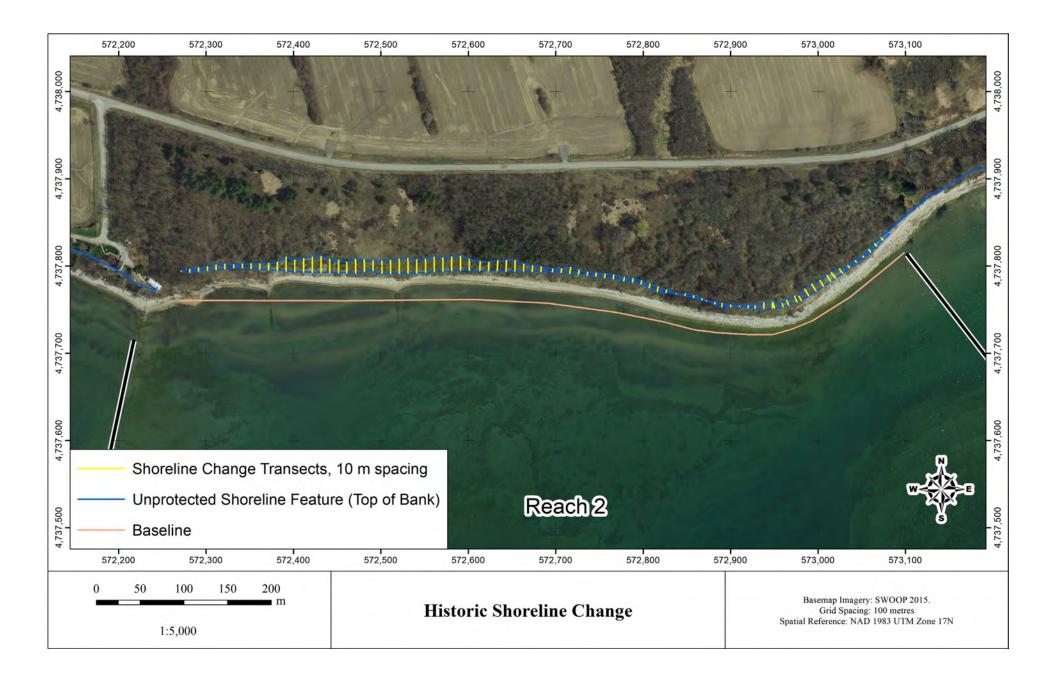


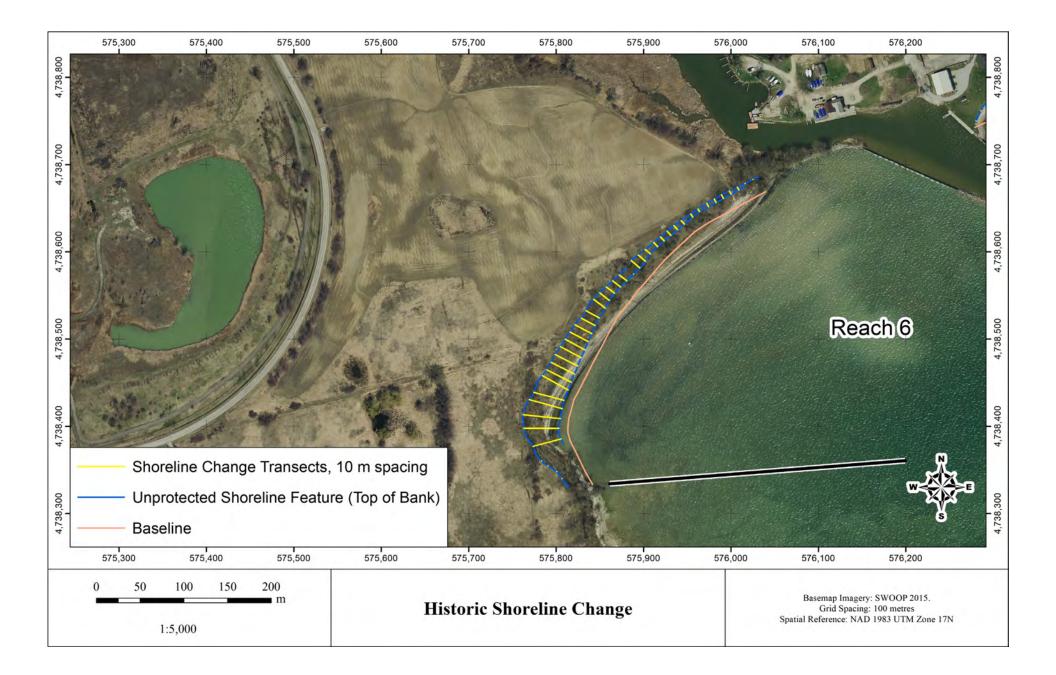
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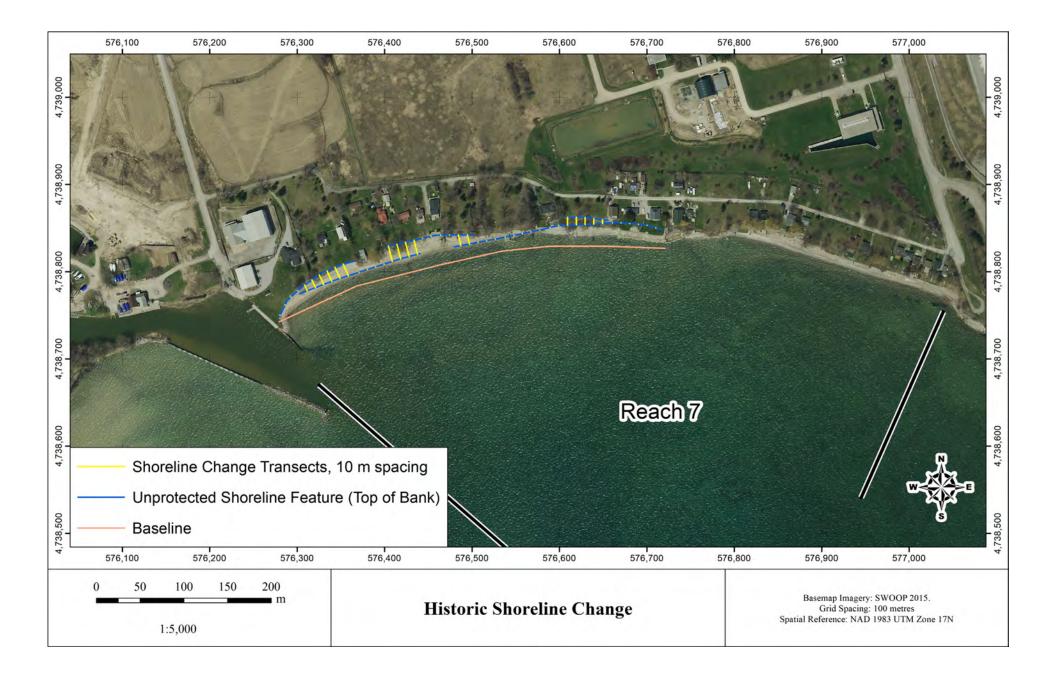
-

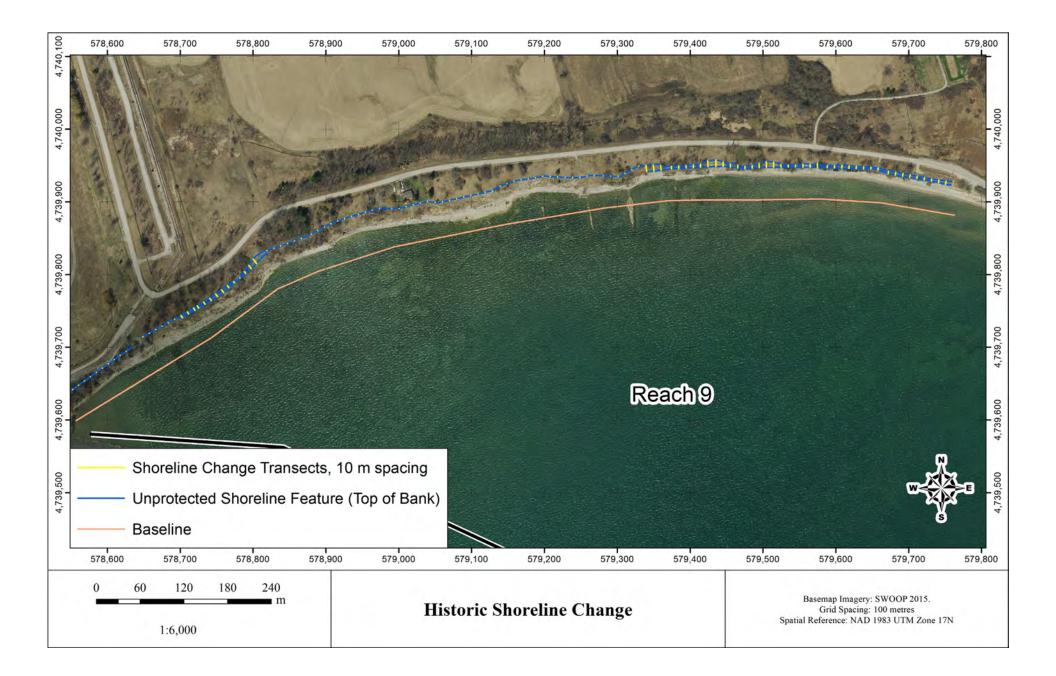
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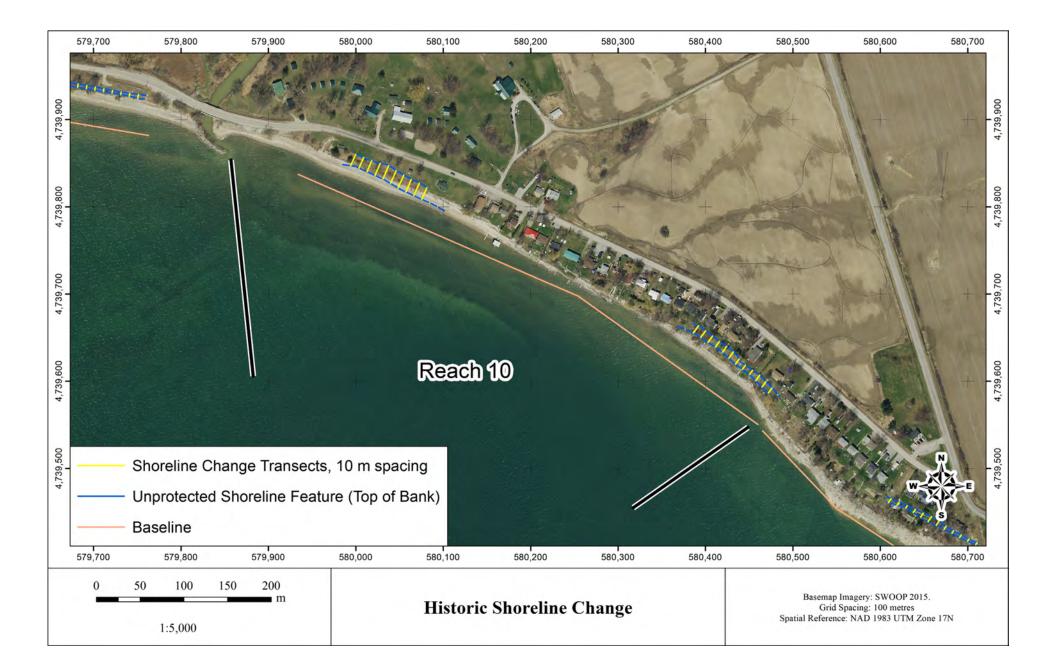
Appendix B

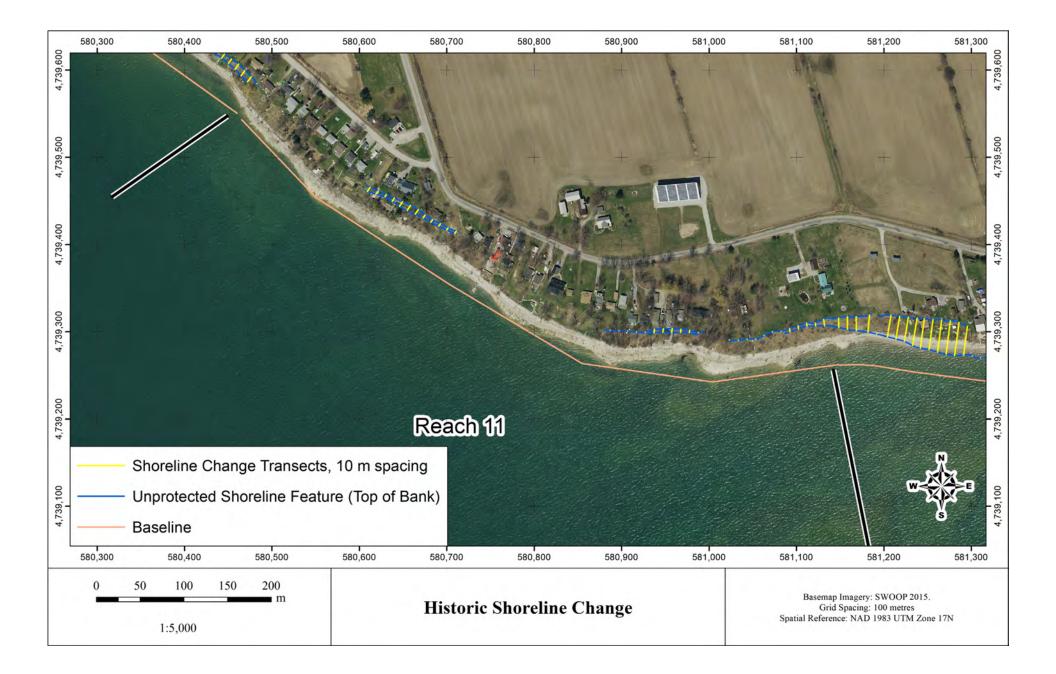


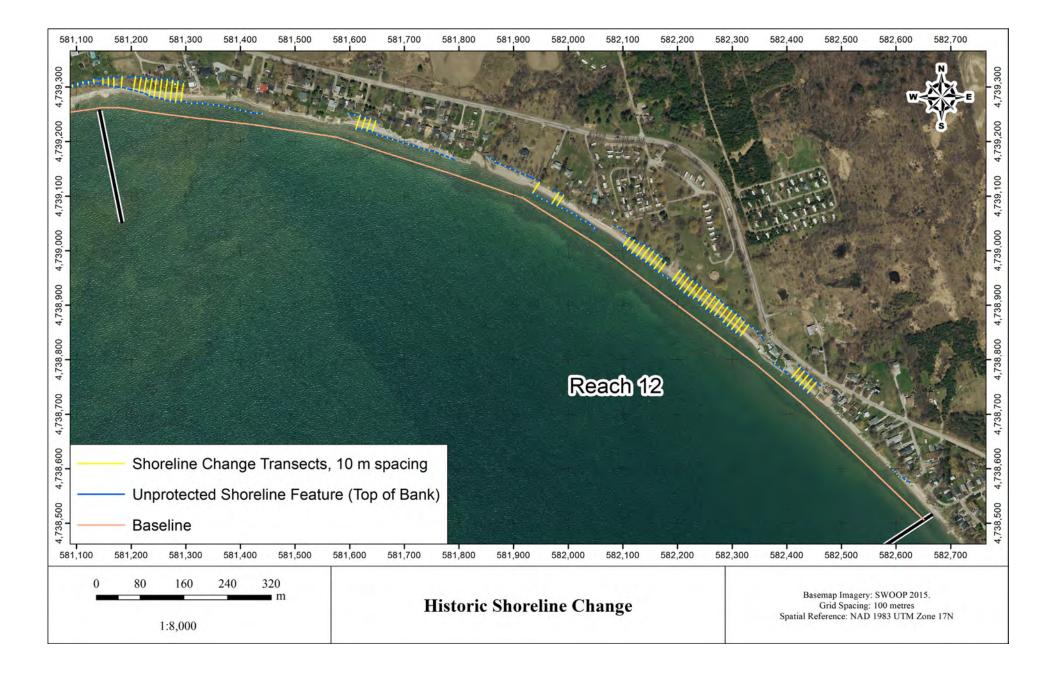


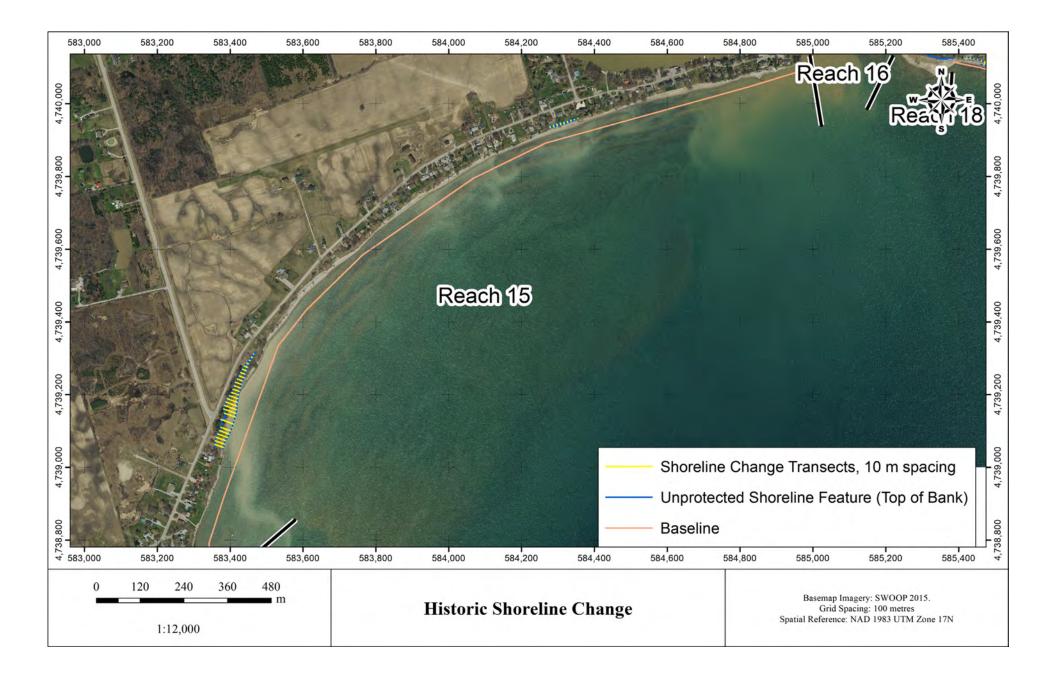


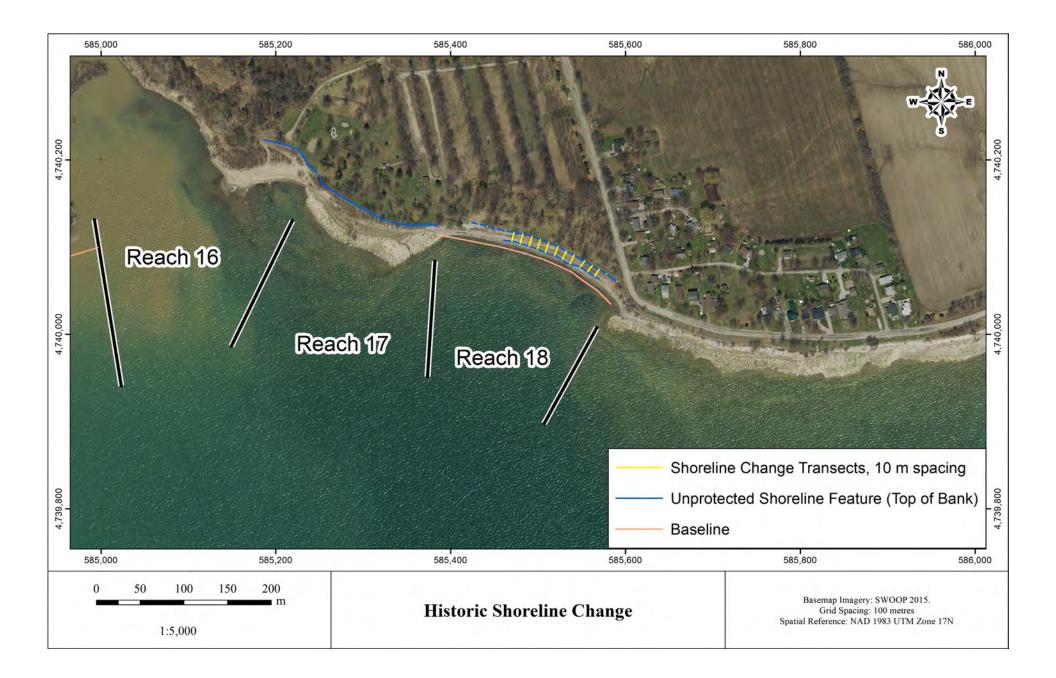


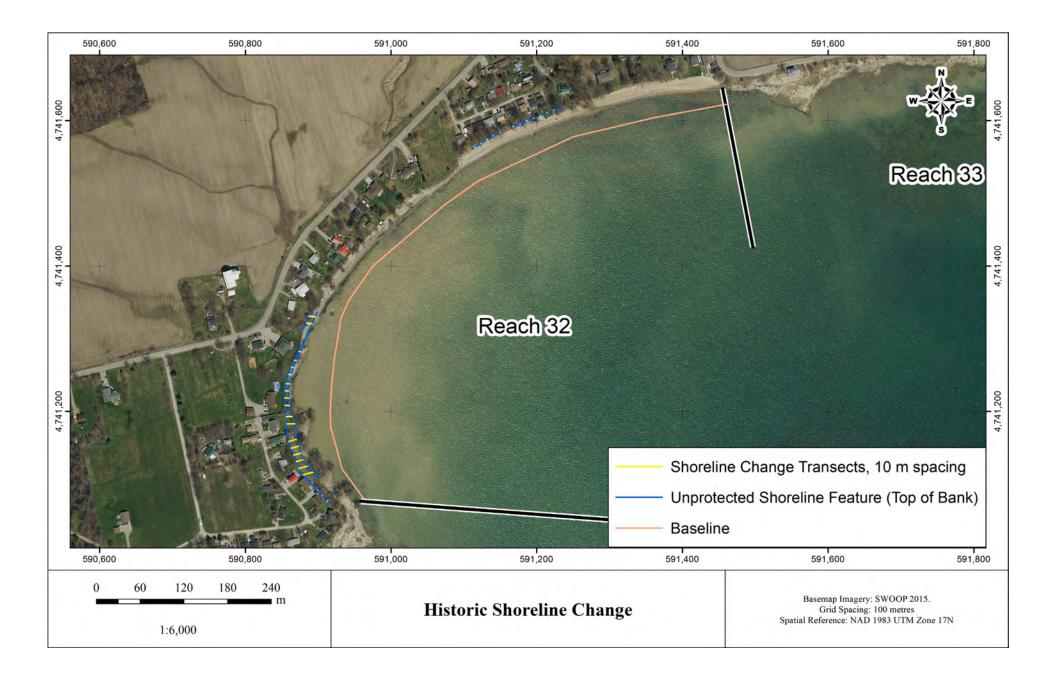


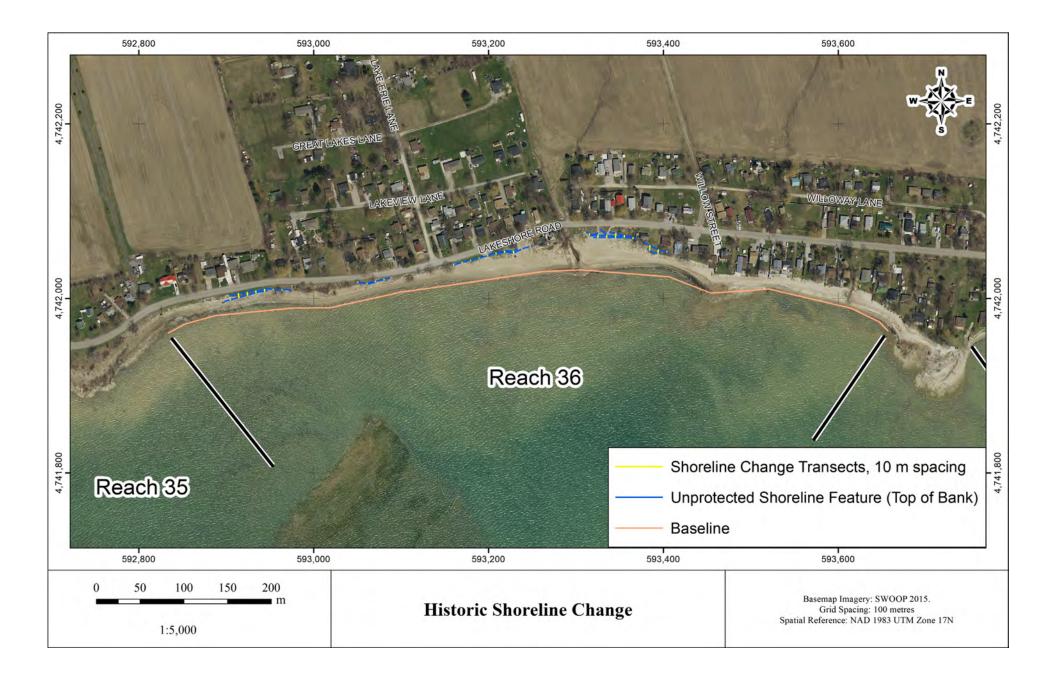


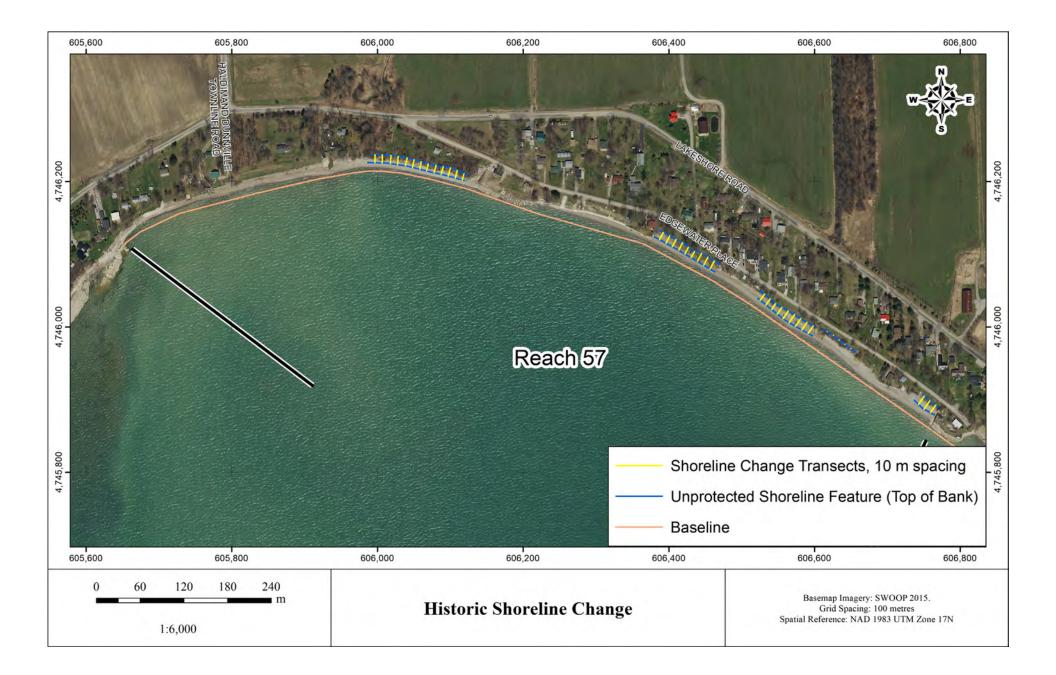


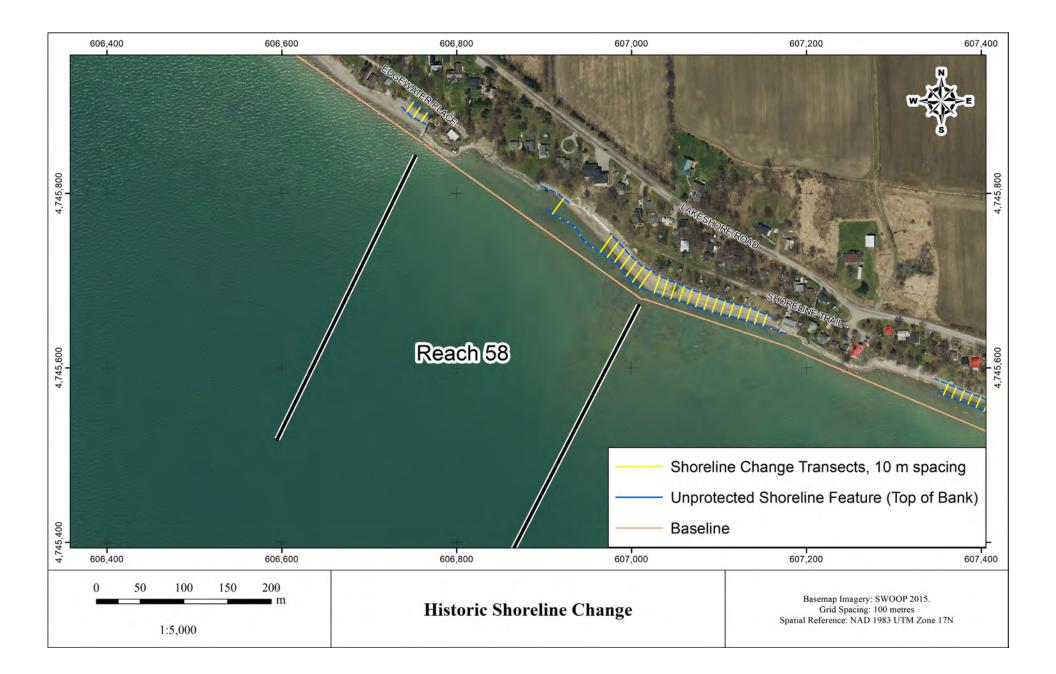


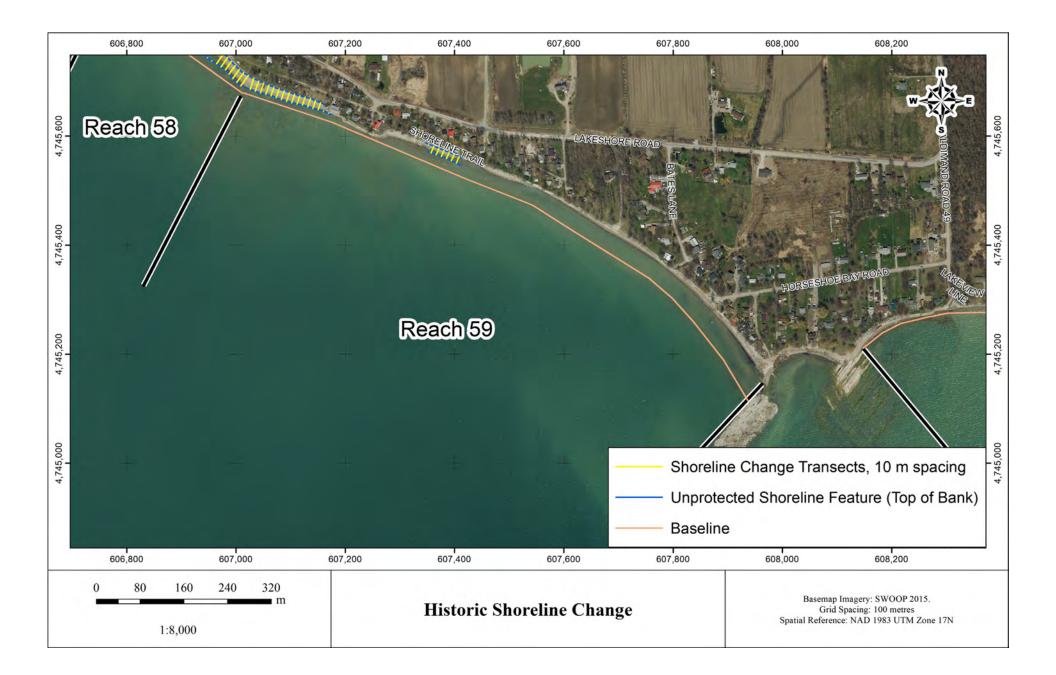


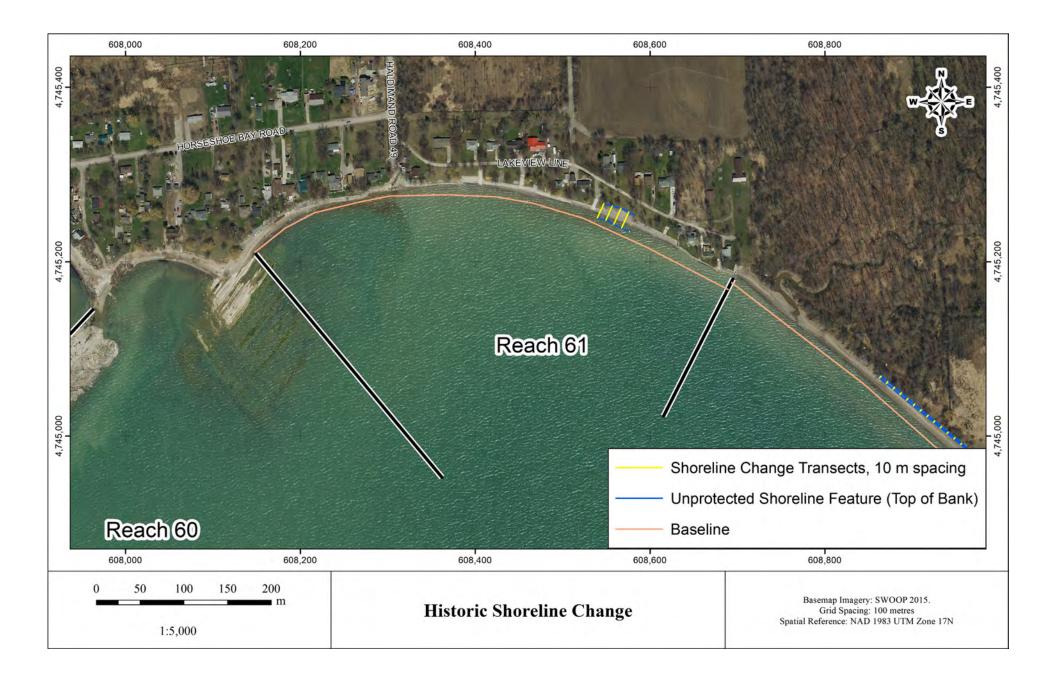


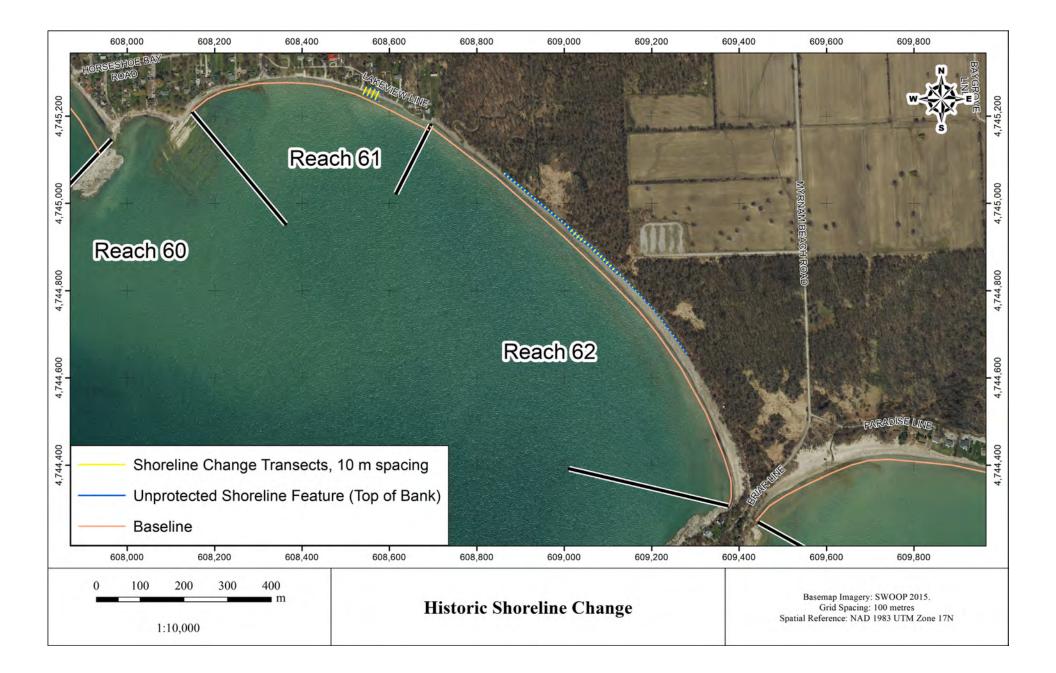




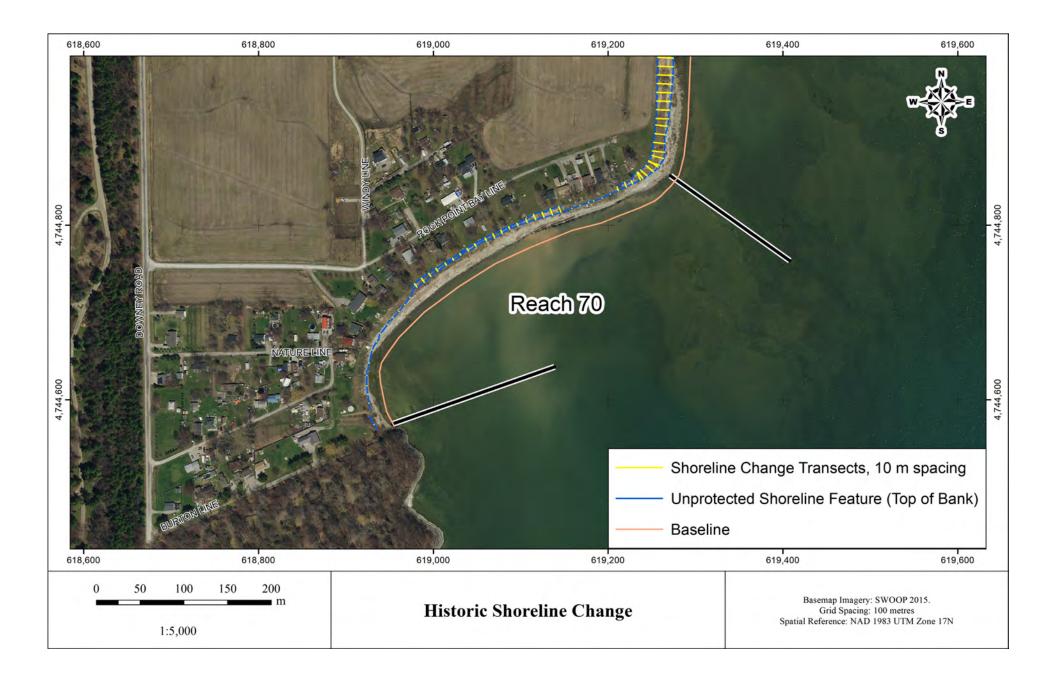


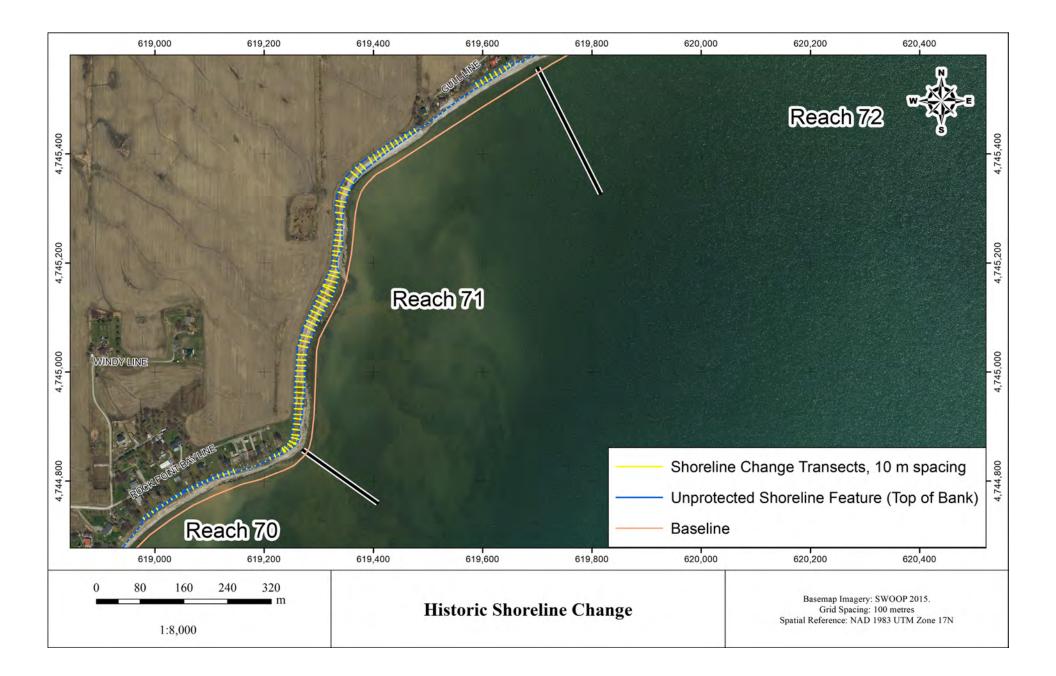


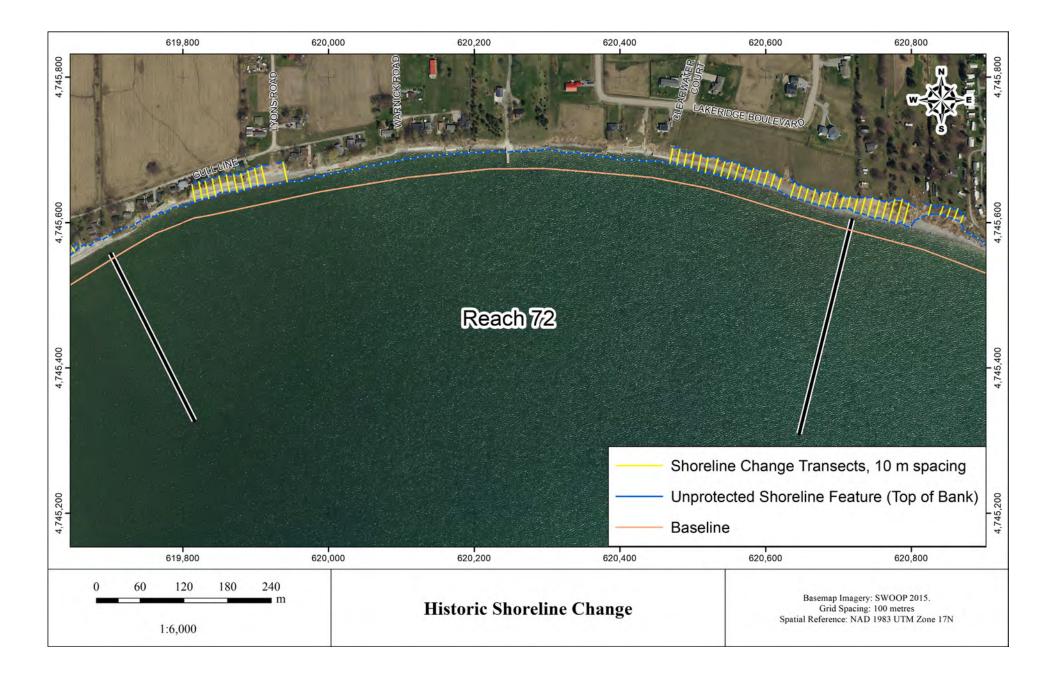


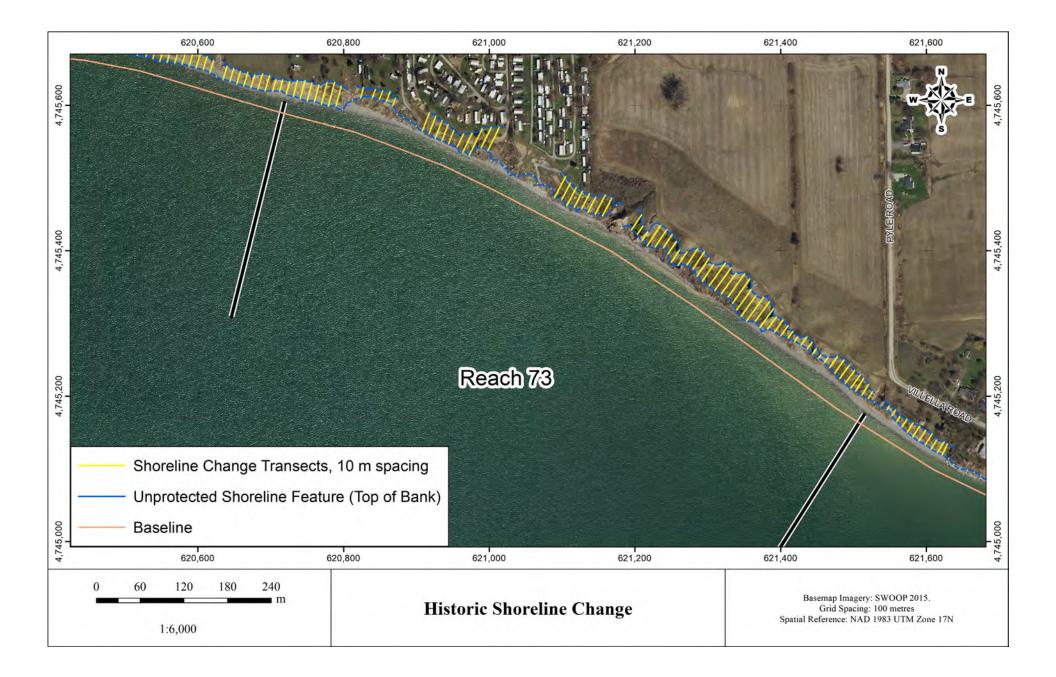


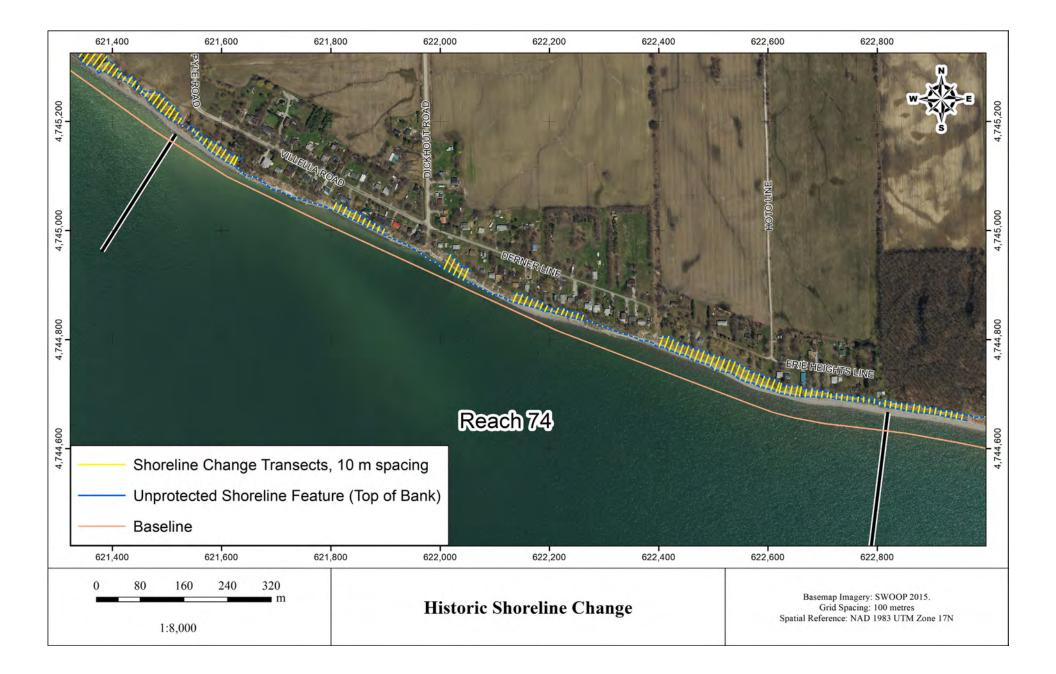


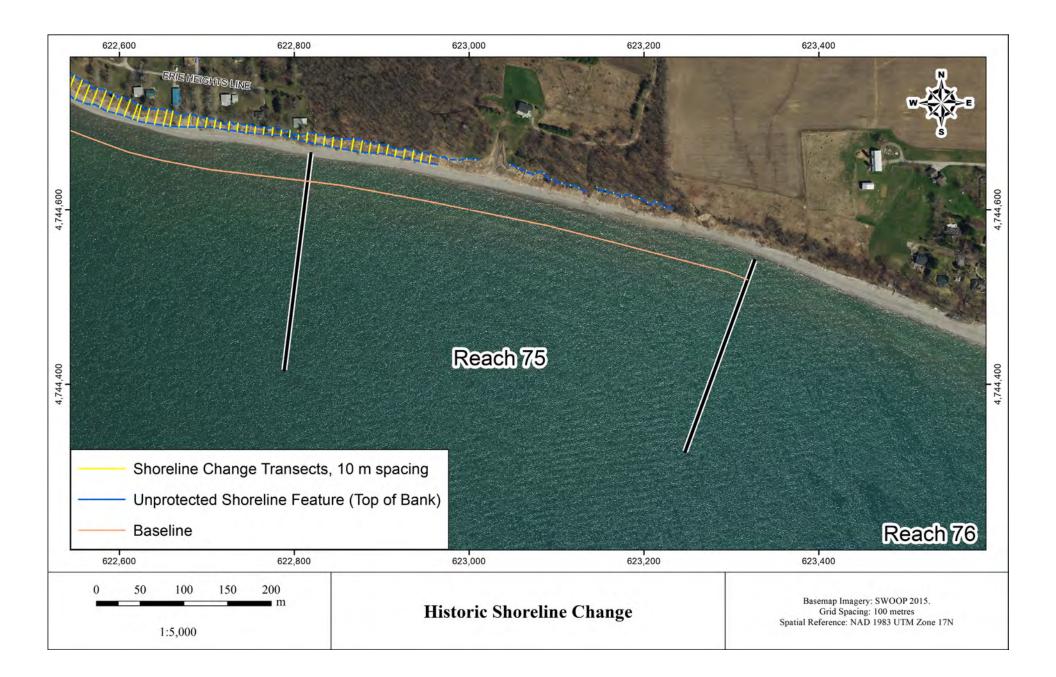


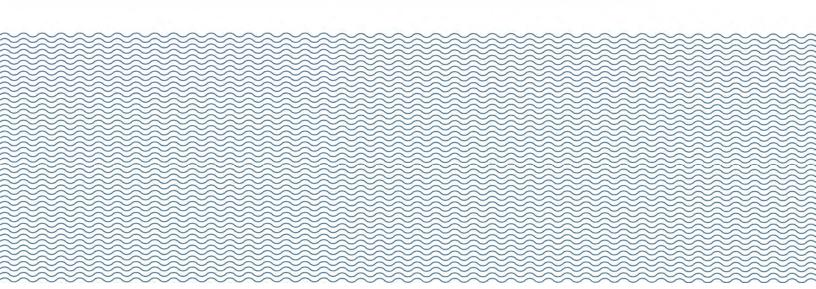












# Appendix C

Hazard Mapping Data

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| Reach | Stillwater Level (m) |                    | Horizontal                      | Uprush elevation (m) |                    |
|-------|----------------------|--------------------|---------------------------------|----------------------|--------------------|
|       | CGVD2013             | CGVD28 /<br>IGLD85 | Wave Uprush<br>(m) <sup>1</sup> | CGVD2013             | CGVD28 /<br>IGLD85 |
| 1     | 175.9                | 176.4              | 5 <sup>1</sup>                  | 179.7                | 180.2              |
| 2     | 175.9                | 176.4              | 11 <sup>1</sup>                 | 181.0                | 181.5              |
| 3     | 175.9                | 176.4              | 13 <sup>1</sup>                 | 180.4                | 180.9              |
| 4     | 175.9                | 176.4              | 5 <sup>1</sup>                  | 179.5                | 180.0              |
| 5     | 175.9                | 176.4              | 10 <sup>1</sup>                 | 180.2                | 180.7              |
| 6     | 175.9                | 176.4              | 20                              | 180.1                | 180.6              |
| 7     | 175.9                | 176.4              | 19                              | 181.1                | 181.6              |
| 8     | 176.0                | 176.5              | 17                              | 183.0                | 183.5              |
| 9     | 176.0                | 176.5              | 10 <sup>1</sup>                 | 180.6                | 181.1              |
| 10    | 176.0                | 176.5              | 19                              | 181.3                | 181.8              |
| 11    | 176.0                | 176.5              | 10 <sup>1</sup>                 | 180.6                | 181.1              |
| 12    | 176.0                | 176.5              | 14 <sup>1</sup>                 | 179.8                | 180.3              |
| 13    | 176.0                | 176.5              | 17                              | 181.4                | 181.9              |
| 14    | 176.0                | 176.5              | 11 <sup>1</sup>                 | 181.1                | 181.6              |
| 15    | 176.0                | 176.5              | 12 <sup>1</sup>                 | 181.2                | 181.7              |
| 16    | 176.0                | 176.5              | 11 <sup>1</sup>                 | 180.8                | 181.3              |
| 17    | 176.0                | 176.5              | 10 <sup>1</sup>                 | 180.2                | 180.7              |
| 18    | 176.0                | 176.5              | 17                              | 177.8                | 178.3              |
| 19    | 176.0                | 176.5              | 10 <sup>1</sup>                 | 180.9                | 181.4              |
| 20    | 176.0                | 176.5              | 10 <sup>1</sup>                 | 180.4                | 180.9              |
| 21    | 176.0                | 176.5              | 14 <sup>1</sup>                 | 182.0                | 182.5              |
| 22    | 176.0                | 176.5              | 10 <sup>1</sup>                 | 179.9                | 180.4              |
| 23    | 176.0                | 176.5              | 22                              | 178.0                | 178.5              |
| 24    | 176.0                | 176.5              | 15                              | 180.6                | 181.1              |
| 25    | 176.0                | 176.5              | 12 <sup>1</sup>                 | 178.3                | 178.8              |
| 26    | 176.0                | 176.5              | 14 <sup>1</sup>                 | 181.0                | 181.5              |
| 27    | 176.0                | 176.5              | 11 <sup>1</sup>                 | 179.8                | 180.3              |
| 28    | 176.0                | 176.5              | 14 <sup>1</sup>                 | 180.5                | 181.0              |
| 29    | 176.1                | 176.6              | 8 <sup>1</sup>                  | 178.7                | 179.2              |
| 30    | 176.1                | 176.6              | 15                              | 181.3                | 181.8              |
| 31    | 176.1                | 176.6              | 16                              | 181.2                | 181.7              |

Table C.1: 100-year flood level and wave uprush allowance by reach, used to map Flooding Hazard

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| Reach | Stillwater Level (m) |                    | Horizontal                      | Uprush elevation (m) |                    |
|-------|----------------------|--------------------|---------------------------------|----------------------|--------------------|
|       | CGVD2013             | CGVD28 /<br>IGLD85 | Wave Uprush<br>(m) <sup>1</sup> | CGVD2013             | CGVD28 /<br>IGLD85 |
| 32    | 176.1                | 176.6              | 22                              | 178.0                | 178.5              |
| 33    | 176.1                | 176.6              | 11 <sup>1</sup>                 | 180.7                | 181.2              |
| 34    | 176.1                | 176.6              | 10 <sup>1</sup>                 | 180.3                | 180.8              |
| 35    | 176.1                | 176.6              | 13 <sup>1</sup>                 | 179.9                | 180.4              |
| 36    | 176.1                | 176.6              | 13 <sup>1</sup>                 | 181.3                | 181.8              |
| 37    | 176.1                | 176.6              | 8 <sup>1</sup>                  | 179.4                | 179.9              |
| 38    | 176.1                | 176.6              | 21                              | 177.2                | 177.7              |
| 39    | 176.1                | 176.6              | 20                              | 177.4                | 177.9              |
| 40    | 176.1                | 176.6              | 11 <sup>1</sup>                 | 178.0                | 178.5              |
| 41    | 176.1                | 176.6              | 14 <sup>1</sup>                 | 178.1                | 178.6              |
| 42    | 176.1                | 176.6              | 18                              | 178.4                | 178.9              |
| 43    | 176.1                | 176.6              | 14 <sup>1</sup>                 | 180.4                | 180.9              |
| 44    | 176.1                | 176.6              | 10 <sup>1</sup>                 | 179.7                | 180.2              |
| 45    | 176.1                | 176.6              | 19                              | 178.1                | 178.6              |
| 46    | 176.1                | 176.6              | 10 <sup>1</sup>                 | 179.9                | 180.4              |
| 47    | 176.1                | 176.6              | 17                              | 178.1                | 178.6              |
| 48    | 176.1                | 176.6              | 18                              | 181.5                | 182.0              |
| 49    | 176.1                | 176.6              | 13 <sup>1</sup>                 | 181.7                | 182.2              |
| 50    | 176.1                | 176.6              | 14 <sup>1</sup>                 | 179.6                | 180.1              |
| 51    | 176.1                | 176.6              | 15                              | 182.7                | 183.2              |
| 52    | 176.1                | 176.6              | 12 <sup>1</sup>                 | 181.1                | 181.6              |
| 53    | 176.1                | 176.6              | 12 <sup>1</sup>                 | 181.3                | 181.8              |
| 54    | 176.1                | 176.6              | 12 <sup>1</sup>                 | 179.1                | 179.6              |
| 55    | 176.1                | 176.6              | 13 <sup>1</sup>                 | 180.8                | 181.3              |
| 56    | 176.1                | 176.6              | 14 <sup>1</sup>                 | 182.4                | 182.9              |
| 57    | 176.1                | 176.6              | 24                              | 183.4                | 183.9              |
| 58    | 176.1                | 176.6              | 14 <sup>1</sup>                 | 181.6                | 182.1              |
| 59    | 176.1                | 176.6              | 12 <sup>1</sup>                 | 182.3                | 182.8              |
| 60    | 176.1                | 176.6              | 13 <sup>1</sup>                 | 182.0                | 182.5              |
| 61    | 176.1                | 176.6              | 13 <sup>1</sup>                 | 181.4                | 181.9              |
| 62    | 176.1                | 176.6              | 14 <sup>1</sup>                 | 182.9                | 183.4              |
| 63    | 176.2                | 176.7              | 11 <sup>1</sup>                 | 180.7                | 181.2              |

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| Reach | Stillwater Level (m) |                    | Horizontal                      | Uprush elevation (m) |                    |
|-------|----------------------|--------------------|---------------------------------|----------------------|--------------------|
|       | CGVD2013             | CGVD28 /<br>IGLD85 | Wave Uprush<br>(m) <sup>1</sup> | CGVD2013             | CGVD28 /<br>IGLD85 |
| 64    | 176.2                | 176.7              | 14 <sup>1</sup>                 | 180.6                | 181.1              |
| 65    | 176.2                | 176.7              | 24                              | 184.1                | 184.6              |
| 66    | 176.2                | 176.7              | 16                              | 181.7                | 182.2              |
| 67    | 176.2                | 176.7              | 18                              | 178.7                | 179.2              |
| 68    | 176.2                | 176.7              | 18                              | 185.2                | 185.7              |
| 69    | 176.2                | 176.7              | 20                              | 180.3                | 180.8              |
| 70    | 176.2                | 176.7              | 10 <sup>1</sup>                 | 181.7                | 182.2              |
| 71    | 176.2                | 176.7              | 71                              | 180.7                | 181.2              |
| 72    | 176.2                | 176.7              | 71                              | 182.9                | 183.4              |
| 73    | 176.2                | 176.7              | 7 <sup>1</sup>                  | 181.1                | 181.6              |
| 74    | 176.2                | 176.7              | 11 <sup>1</sup>                 | 183.2                | 183.7              |
| 75    | 176.2                | 176.7              | 21                              | 182.0                | 182.5              |
| 76    | 176.2                | 176.7              | 19                              | 184.6                | 185.1              |
| 77    | 176.3                | 176.8              | 16                              | 181.7                | 182.2              |
| 78    | 176.3                | 176.8              | 24                              | 180.0                | 180.5              |
| 79    | 176.3                | 176.8              | 25                              | 179.2                | 179.7              |
| 80    | 176.3                | 176.8              | 17                              | 182.8                | 183.3              |
| 81    | 176.3                | 176.8              | 23                              | 178.3                | 178.8              |
| 82    | 176.3                | 176.8              | 33                              | 178.3                | 178.8              |
| 83    | 176.3                | 176.8              | 22                              | 178.0                | 178.5              |
| 84    | 176.3                | 176.8              | 17                              | 182.1                | 182.6              |

<sup>1</sup>Note that all values with horizontal wave uprush calculated as less than 15 m were mapped as 15 m due to possible variability in wave exposure, nearshore slope, water depth at the toe, and bluff height within a reach.



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|       | Staple Slop                      | e Allowance                             | Erosion Allowance |                          |  |
|-------|----------------------------------|-----------------------------------------|-------------------|--------------------------|--|
| Reach | Geotechnical<br>Analysis Section | Final Stable Slope<br>for Mapping (H:V) | AARR+1SD (m)      | Erosion Allowance<br>(m) |  |
| 1     | 1                                | 2.3:1                                   |                   | 30                       |  |
| 2     | 2                                | 2.3                                     | 0.25              | 25                       |  |
| 3     | 3                                | 2.3:1                                   |                   | 30                       |  |
| 4     | 4                                | 2.3:1                                   |                   | 30                       |  |
| 5     |                                  | 2.3:1                                   |                   | 10                       |  |
| 6     | 5                                | 2.3:1                                   | 0.43              | 43                       |  |
| 7     | 6                                | 2.3:1                                   | 0.23              | 23                       |  |
| 8     | 7                                | 3:1                                     |                   | 30                       |  |
| 9     | 8                                | 2.3:1                                   | 0.09              | 9                        |  |
| 10    |                                  | 2.3:1                                   | 0.22              | 22                       |  |
| 11    | 9                                | 2.3:1                                   | 0.08              | 8                        |  |
| 12    | 10                               | 2.3:1                                   | 0.44              | 44                       |  |
| 13    |                                  | 2.3:1                                   |                   | 30                       |  |
| 14    | 11                               | 2.3:1                                   |                   | 10                       |  |
| 15    | 12                               | 2.3:1                                   | 0.69              | 69                       |  |
| 16    |                                  | 3:1                                     |                   | 30                       |  |
| 17    |                                  | 3:1                                     |                   | 10                       |  |
| 18    | 13                               | 2.3:1                                   | 0.28              | 28                       |  |
| 19    | 14                               | 2.3:1                                   |                   | 30                       |  |
| 20    | 15                               | 2.3:1                                   |                   | 30                       |  |
| 21    | 16                               | 2.3:1                                   |                   | 30                       |  |
| 22    | 17                               | 2.3:1                                   |                   | 30                       |  |
| 23    |                                  | 2.3:1                                   |                   | 10                       |  |
| 24    | 18                               | 2.3:1                                   |                   | 30                       |  |
| 25    |                                  | 2.3:1                                   |                   | 30                       |  |
| 26    |                                  | 2.3:1                                   |                   | 30                       |  |
| 27    | 19                               | 3:1                                     |                   | 10                       |  |
| 28    | 20                               | 2.3:1                                   |                   | 30                       |  |
| 29    |                                  | 2.3:1                                   |                   | 10                       |  |
| 30    |                                  | 2.3:1                                   |                   | 30                       |  |
| 31    | 21                               | 2.3:1                                   |                   | 10                       |  |
| 32    | 22                               | 2.3:1                                   | 0.26              | 26                       |  |

# Table C.2: Stable slope allowance and erosion allowance used to map Erosion Hazard

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|       | Staple Slop                      | e Allowance                             | Erosion Allowance |                          |  |
|-------|----------------------------------|-----------------------------------------|-------------------|--------------------------|--|
| Reach | Geotechnical<br>Analysis Section | Final Stable Slope<br>for Mapping (H:V) | AARR+1SD (m)      | Erosion Allowance<br>(m) |  |
| 33    | 23                               | 2.3:1                                   |                   | 10                       |  |
| 34    | 24                               | 2.3:1                                   |                   | 30                       |  |
| 35    |                                  | 2.3:1                                   |                   | 10                       |  |
| 36    | 25                               | 2.3:1                                   | 0.08              | 8                        |  |
| 37    |                                  | 2.3:1                                   |                   | 10                       |  |
| 38    | 26                               | 2.3:1                                   |                   | 30                       |  |
| 39    | 27                               | 3:1                                     |                   | 10                       |  |
| 40    | 28                               | 2.3:1                                   |                   | 30                       |  |
| 41    | 29                               | 2.3:1                                   |                   | 10                       |  |
| 42    | 30                               | 2.3:1                                   |                   | 30                       |  |
| 43    | 31                               | 2.3:1                                   |                   | 30                       |  |
| 44    | 32                               | 2.3:1                                   |                   | 30                       |  |
| 45    |                                  | 2.3:1                                   |                   | 10                       |  |
| 46    | 33                               | 2.3:1                                   |                   | 30                       |  |
| 47    | 34                               | 2.3:1                                   |                   | 30                       |  |
| 48    |                                  | 3:1                                     |                   | 10                       |  |
| 49    | 35                               | 3:1                                     |                   | 30                       |  |
| 50    |                                  | 3:1                                     |                   | 10                       |  |
| 51    |                                  | 3:1                                     |                   | 10                       |  |
| 52    |                                  | 3:1                                     |                   | 30                       |  |
| 53    | 36                               | 2.3:1                                   |                   | 30                       |  |
| 54    |                                  | 2.3:1                                   |                   | 10                       |  |
| 55    | 37                               | 2.3:1                                   |                   | 30                       |  |
| 56    |                                  | 2.3:1                                   |                   | 10                       |  |
| 57    | 38                               | 2.3:1                                   | 0.21              | 21                       |  |
| 58    |                                  | 3:1                                     | 0.39              | 39                       |  |
| 59    |                                  | 3:1                                     | 0.30              | 30                       |  |
| 60    |                                  | 3:1                                     |                   | 30                       |  |
| 61    | 39                               | 2.3:1                                   | 0.34              | 34                       |  |
| 62    | 40                               | 3:1                                     | 0.08              | 8                        |  |
| 63    |                                  | 3:1                                     |                   | 10                       |  |
| 64    | 41                               | 3:1                                     | 0.38              | 38                       |  |
| 65    | 42                               | 1.4:1                                   |                   | 10                       |  |
| 66    |                                  | 3:1                                     |                   | 30                       |  |

# Haldimand County Lake Erie Hazard Mapping and Risk Assessment



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|       | Staple Slop                      | e Allowance                             | Erosion Allowance |                          |  |
|-------|----------------------------------|-----------------------------------------|-------------------|--------------------------|--|
| Reach | Geotechnical<br>Analysis Section | Final Stable Slope<br>for Mapping (H:V) | AARR+1SD (m)      | Erosion Allowance<br>(m) |  |
| 67    |                                  | 3:1                                     |                   | 30                       |  |
| 68    | 43                               | 3:1                                     |                   | 30                       |  |
| 69    |                                  | 3:1                                     |                   | 10                       |  |
| 70    |                                  | 3:1                                     | 0.14              | 14                       |  |
| 71    | 44                               | 1.8:1                                   | 0.33              | 33                       |  |
| 72    | 45                               | 1.8:1                                   | 0.40              | 40                       |  |
| 73    | 46                               | 1.8:1                                   | 0.51              | 51                       |  |
| 74    | 47                               | 1.8:1                                   | 0.34              | 34                       |  |
| 75    |                                  | 1.8:1                                   | 0.20              | 20                       |  |
| 76    | 48                               | 1.8:1                                   |                   | 30                       |  |
| 77    |                                  | 1.8:1                                   |                   | 10                       |  |
| 78    |                                  | 1.8:1                                   |                   | 40                       |  |
| 79    | 49                               | 3:1                                     |                   | 40                       |  |
| 80    | 50                               | 3:1                                     |                   | 30                       |  |
| 81    |                                  | 3:1                                     |                   | 30                       |  |
| 82    | 51                               | 3:1                                     |                   | 30                       |  |
| 83    |                                  | 3:1                                     |                   | 30                       |  |
| 84    | 52                               | 3:1                                     |                   | 30                       |  |

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# Table C.3: Examples of estimated flood proofing elevations by reach for selected shoreline treatments

### Notes:

- Lake Erie 100-year Static Lake Level (values from Baird analysis used, as they are more conservative): 175.16 m IGLD85 174.70 m CGVD2013
- 2. Depth limited breaking wave assumed; Tp=10s
- 3. Uprush on beach calculated using Stockdon et. Al. (2006)
- 4. All other uprush calculated using EurOTop (2018)
- 5. Tables provide examples only. Flood proofing elevation should be determined on a site specific basis by a Professional Engineer with experience in flood proofing.

| Reaches  |                                | Reach<br>number<br>from MNR<br>(1989) | 100-year<br>storm surge<br>(m) from<br>MNR (1989) | 100-year static lake<br>level plus 100-year<br>storm surge (m<br>CGVD2013) | 100-year<br>flood level<br>(m<br>CGVD2013) |
|----------|--------------------------------|---------------------------------------|---------------------------------------------------|----------------------------------------------------------------------------|--------------------------------------------|
| 1 to 7   | West County Limit to Nanticoke | E-18                                  | 1.77                                              | 176.41                                                                     | 175.9                                      |
| 8 to 28  | Nanticoke to Hoover Point      | E-18/E-19                             | 1.84                                              | 176.48                                                                     | 176.0                                      |
| 29 to 62 | Hoover Point to Low Point      | E-19                                  | 1.84                                              | 176.48                                                                     | 176.1                                      |
| 63 to 76 | Low Point to Mohawk Point      | E-20/E-21                             | 2.04                                              | 176.68                                                                     | 176.2                                      |
| 77 to 84 | Mohawk Point to Lowbanks       | E-22                                  | 2.32                                              | 176.96                                                                     | 176.3                                      |

### Lake Erie 100-year Storm Surge

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Lake Erie Minimum Floodproofing Standard Elevation (m)

| Reaches | 100-year static lake<br>level plus 100-year<br>storm surge (m<br>CGVD2013) | Structure            | Toe Elevation<br>(m CGVD2013) | Water depth<br>(m) | Wave<br>Height<br>(m) | Uprush<br>(m) | Uprush<br>Elevation<br>(m CGVD2013) | Uprush<br>Elevation<br>(m IGLD85) |
|---------|----------------------------------------------------------------------------|----------------------|-------------------------------|--------------------|-----------------------|---------------|-------------------------------------|-----------------------------------|
| 1 to 7  | 176.4                                                                      | 1:50 sloped beach    | 172.4                         | 4.0                | 3.1                   | 1.0           | 177.4                               | 177.9                             |
|         |                                                                            | 1:10 sloped dune     | 175.4                         | 1.0                | 0.8                   | 2.2           | 178.6                               | 179.1                             |
|         |                                                                            | 1:10 sloped dune     | 174.4                         | 2.0                | 1.6                   | 2.5           | 178.9                               | 179.4                             |
|         |                                                                            | 1:10 sloped dune     | 173.4                         | 3.0                | 2.3                   | 3.0           | 179.4                               | 179.9                             |
|         |                                                                            | 1:10 sloped dune     | 172.4                         | 4.0                | 3.1                   | 3.5           | 179.9                               | 180.4                             |
|         |                                                                            | 1:2 sloped revetment | 175.4                         | 1.0                | 0.8                   | 2.4           | 178.8                               | 179.3                             |
|         |                                                                            | 1:2 sloped revetment | 174.4                         | 2.0                | 1.6                   | 4.7           | 181.1                               | 181.6                             |
|         |                                                                            | 1:2 sloped revetment | 173.4                         | 3.0                | 2.3                   | 6.9           | 183.3                               | 183.8                             |
|         |                                                                            | 1:2 sloped revetment | 172.4                         | 4.0                | 3.1                   | 9.0           | 185.4                               | 185.9                             |
|         |                                                                            | vertical wall        | 175.4                         | 1.0                | 0.8                   | 3.3           | 179.7                               | 180.2                             |
|         |                                                                            | vertical wall        | 174.4                         | 2.0                | 1.6                   | 3.0           | 179.4                               | 179.9                             |
|         |                                                                            | vertical wall        | 173.4                         | 3.0                | 2.3                   | 4.5           | 180.9                               | 181.4                             |
|         |                                                                            | vertical wall        | 172.4                         | 4.0                | 3.1                   | 6.0           | 182.4                               | 182.9                             |
| 8 to 28 | 176.5                                                                      | 1:50 sloped beach    | 172.5                         | 4.0                | 3.1                   | 1.0           | 177.5                               | 177.9                             |
|         |                                                                            | 1:10 sloped dune     | 175.5                         | 1.0                | 0.8                   | 2.2           | 178.7                               | 179.1                             |
|         |                                                                            | 1:10 sloped dune     | 174.5                         | 2.0                | 1.6                   | 2.5           | 179.0                               | 179.4                             |

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| Reaches  | 100-year static lake<br>level plus 100-year<br>storm surge (m<br>CGVD2013) | Structure            | Toe Elevation<br>(m CGVD2013) | Water depth<br>(m) | Wave<br>Height<br>(m) | Uprush<br>(m) | Uprush<br>Elevation<br>(m CGVD2013) | Uprush<br>Elevation<br>(m IGLD85) |
|----------|----------------------------------------------------------------------------|----------------------|-------------------------------|--------------------|-----------------------|---------------|-------------------------------------|-----------------------------------|
|          |                                                                            | 1:10 sloped dune     | 173.5                         | 3.0                | 2.3                   | 3.0           | 179.5                               | 179.9                             |
|          |                                                                            | 1:10 sloped dune     | 172.5                         | 4.0                | 3.1                   | 3.5           | 180.0                               | 180.4                             |
|          |                                                                            | 1:2 sloped revetment | 175.5                         | 1.0                | 0.8                   | 2.4           | 178.9                               | 179.3                             |
|          |                                                                            | 1:2 sloped revetment | 174.5                         | 2.0                | 1.6                   | 4.7           | 181.2                               | 181.6                             |
|          |                                                                            | 1:2 sloped revetment | 173.5                         | 3.0                | 2.3                   | 6.9           | 183.4                               | 183.8                             |
|          |                                                                            | 1:2 sloped revetment | 172.5                         | 4.0                | 3.1                   | 9.0           | 185.5                               | 185.9                             |
|          |                                                                            | vertical wall        | 175.5                         | 1.0                | 0.8                   | 3.3           | 179.8                               | 180.2                             |
|          |                                                                            | vertical wall        | 174.5                         | 2.0                | 1.6                   | 3.0           | 179.5                               | 179.9                             |
|          |                                                                            | vertical wall        | 173.5                         | 3.0                | 2.3                   | 4.5           | 181.0                               | 181.4                             |
|          |                                                                            | vertical wall        | 172.5                         | 4.0                | 3.1                   | 6.0           | 182.5                               | 182.9                             |
| 29 to 62 | 176.5                                                                      | 1:50 sloped beach    | 172.5                         | 4.0                | 3.1                   | 1.0           | 177.5                               | 177.9                             |
|          |                                                                            | 1:10 sloped dune     | 175.5                         | 1.0                | 0.8                   | 2.2           | 178.7                               | 179.1                             |
|          |                                                                            | 1:10 sloped dune     | 174.5                         | 2.0                | 1.6                   | 2.5           | 179.0                               | 179.4                             |
|          |                                                                            | 1:10 sloped dune     | 173.5                         | 3.0                | 2.3                   | 3.0           | 179.5                               | 179.9                             |
|          |                                                                            | 1:10 sloped dune     | 172.5                         | 4.0                | 3.1                   | 3.5           | 180.0                               | 180.4                             |
|          |                                                                            | 1:2 sloped revetment | 175.5                         | 1.0                | 0.8                   | 2.4           | 178.9                               | 179.3                             |
|          |                                                                            | 1:2 sloped revetment | 174.5                         | 2.0                | 1.6                   | 4.7           | 181.2                               | 181.6                             |
|          |                                                                            | 1:2 sloped revetment | 173.5                         | 3.0                | 2.3                   | 6.9           | 183.4                               | 183.8                             |
|          |                                                                            | 1:2 sloped revetment | 172.5                         | 4.0                | 3.1                   | 9.0           | 185.5                               | 185.9                             |
|          |                                                                            | vertical wall        | 175.5                         | 1.0                | 0.8                   | 3.3           | 179.8                               | 180.2                             |
|          |                                                                            | vertical wall        | 174.5                         | 2.0                | 1.6                   | 3.0           | 179.5                               | 179.9                             |
|          |                                                                            | vertical wall        | 173.5                         | 3.0                | 2.3                   | 4.5           | 181.0                               | 181.4                             |
|          |                                                                            | vertical wall        | 172.5                         | 4.0                | 3.1                   | 6.0           | 182.5                               | 182.9                             |

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Appendix C

| Reaches  | 100-year static lake<br>level plus 100-year<br>storm surge (m<br>CGVD2013) | Structure            | Toe Elevation<br>(m CGVD2013) | Water depth<br>(m) | Wave<br>Height<br>(m) | Uprush<br>(m) | Uprush<br>Elevation<br>(m CGVD2013) | Uprush<br>Elevation<br>(m IGLD85) |
|----------|----------------------------------------------------------------------------|----------------------|-------------------------------|--------------------|-----------------------|---------------|-------------------------------------|-----------------------------------|
| 63 to 76 | 176.7                                                                      | 1:50 sloped beach    | 172.7                         | 4.0                | 3.1                   | 1.0           | 177.7                               | 178.1                             |
|          |                                                                            | 1:10 sloped dune     | 175.7                         | 1.0                | 0.8                   | 2.2           | 178.9                               | 179.3                             |
|          |                                                                            | 1:10 sloped dune     | 174.7                         | 2.0                | 1.6                   | 2.5           | 179.2                               | 179.6                             |
|          |                                                                            | 1:10 sloped dune     | 173.7                         | 3.0                | 2.3                   | 3.0           | 179.7                               | 180.1                             |
|          |                                                                            | 1:10 sloped dune     | 172.7                         | 4.0                | 3.1                   | 3.5           | 180.2                               | 180.6                             |
|          |                                                                            | 1:2 sloped revetment | 175.7                         | 1.0                | 0.8                   | 2.4           | 179.1                               | 179.5                             |
|          |                                                                            | 1:2 sloped revetment | 174.7                         | 2.0                | 1.6                   | 4.7           | 181.4                               | 181.8                             |
|          |                                                                            | 1:2 sloped revetment | 173.7                         | 3.0                | 2.3                   | 6.9           | 183.6                               | 184.0                             |
|          |                                                                            | 1:2 sloped revetment | 172.7                         | 4.0                | 3.1                   | 9.0           | 185.7                               | 186.1                             |
|          |                                                                            | vertical wall        | 175.7                         | 1.0                | 0.8                   | 3.3           | 180.0                               | 180.4                             |
|          |                                                                            | vertical wall        | 174.7                         | 2.0                | 1.6                   | 3.0           | 179.7                               | 180.1                             |
|          |                                                                            | vertical wall        | 173.7                         | 3.0                | 2.3                   | 4.5           | 181.2                               | 181.6                             |
|          |                                                                            | vertical wall        | 172.7                         | 4.0                | 3.1                   | 6.0           | 182.7                               | 183.1                             |
| 77 to 84 | 177.0                                                                      | 1:50 sloped beach    | 173.0                         | 4.0                | 3.1                   | 1.0           | 178.0                               | 178.4                             |
|          |                                                                            | 1:10 sloped dune     | 176.0                         | 1.0                | 0.8                   | 2.2           | 179.2                               | 179.6                             |
|          |                                                                            | 1:10 sloped dune     | 175.0                         | 2.0                | 1.6                   | 2.5           | 179.5                               | 179.9                             |
|          |                                                                            | 1:10 sloped dune     | 174.0                         | 3.0                | 2.3                   | 3.0           | 180.0                               | 180.4                             |
|          |                                                                            | 1:10 sloped dune     | 173.0                         | 4.0                | 3.1                   | 3.5           | 180.5                               | 180.9                             |
|          |                                                                            | 1:2 sloped revetment | 176.0                         | 1.0                | 0.8                   | 2.4           | 179.4                               | 179.8                             |
|          |                                                                            | 1:2 sloped revetment | 175.0                         | 2.0                | 1.6                   | 4.7           | 181.7                               | 182.1                             |
|          |                                                                            | 1:2 sloped revetment | 174.0                         | 3.0                | 2.3                   | 6.9           | 183.9                               | 184.3                             |
|          |                                                                            | 1:2 sloped revetment | 173.0                         | 4.0                | 3.1                   | 9.0           | 186.0                               | 186.4                             |
|          |                                                                            | vertical wall        | 176.0                         | 1.0                | 0.8                   | 3.3           | 180.3                               | 180.7                             |
|          |                                                                            | vertical wall        | 175.0                         | 2.0                | 1.6                   | 3.0           | 180.0                               | 180.4                             |

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Appendix C

| Reaches | 100-year static lake<br>level plus 100-year<br>storm surge (m<br>CGVD2013) | Structure     | Toe Elevation<br>(m CGVD2013) | Water depth<br>(m) | Wave<br>Height<br>(m) | Uprush<br>(m) | Uprush<br>Elevation<br>(m CGVD2013) | Uprush<br>Elevation<br>(m IGLD85) |
|---------|----------------------------------------------------------------------------|---------------|-------------------------------|--------------------|-----------------------|---------------|-------------------------------------|-----------------------------------|
|         |                                                                            | vertical wall | 174.0                         | 3.0                | 2.3                   | 4.5           | 181.5                               | 181.9                             |
|         |                                                                            | vertical wall | 173.0                         | 4.0                | 3.1                   | 6.0           | 183.0                               | 183.4                             |

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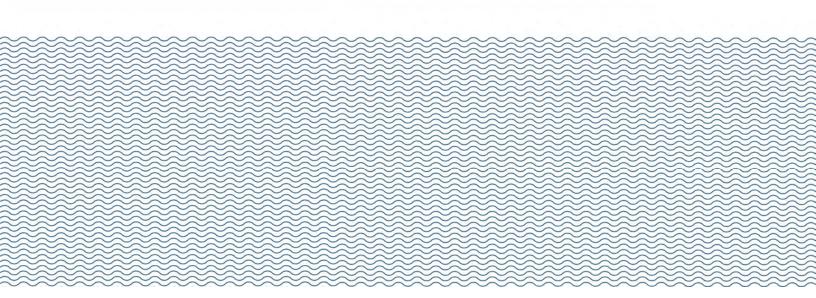
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Appendix C



#### Appendix D

Flood Depth Mapping for Flood Preparedness

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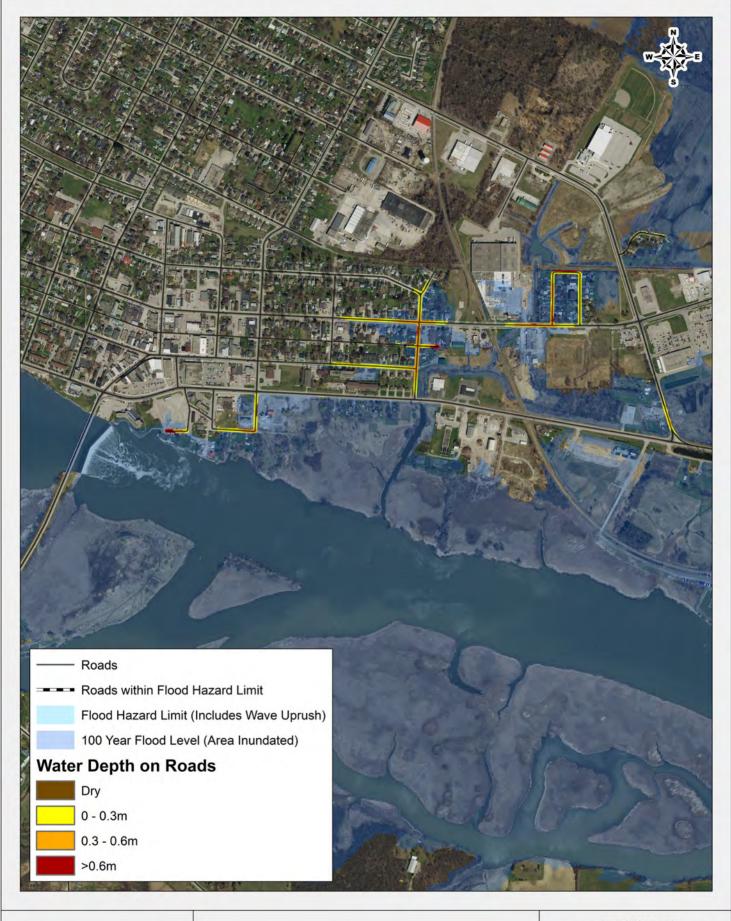
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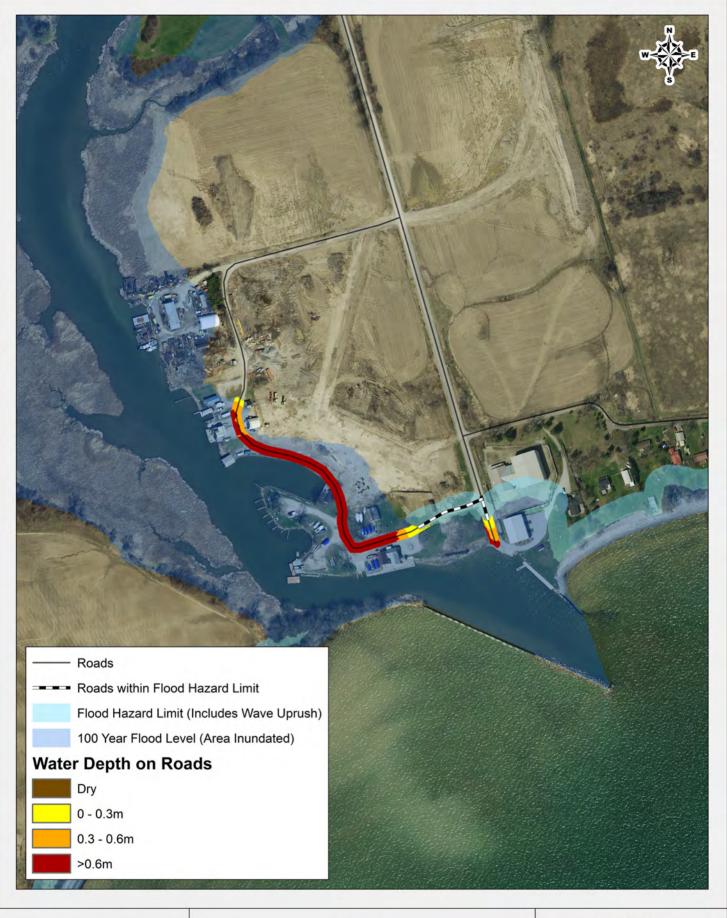
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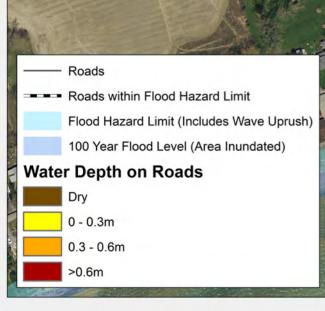
Dunnville

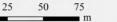




Reach 6

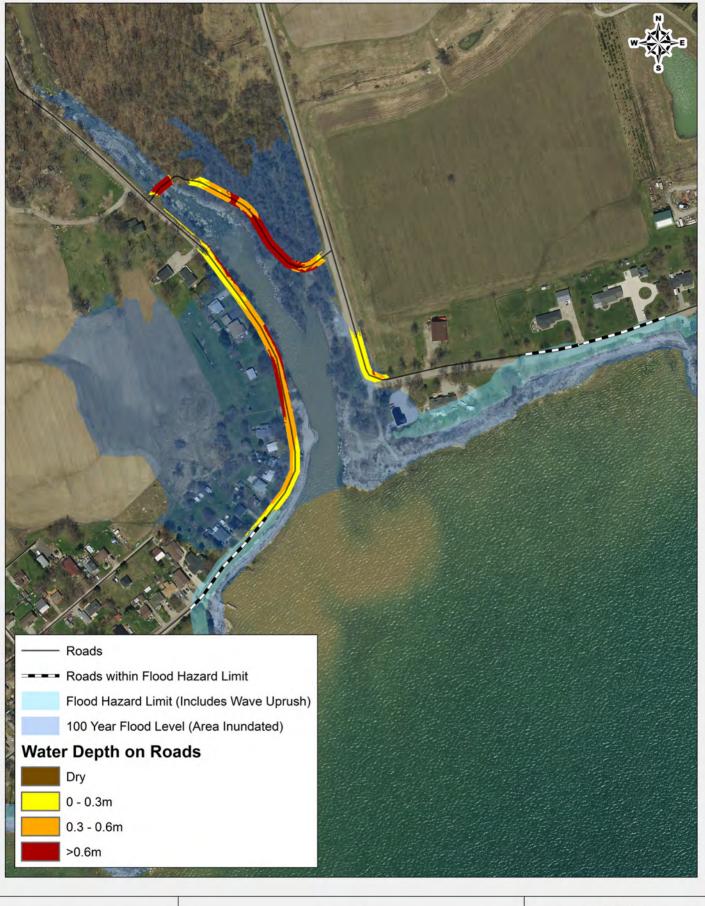




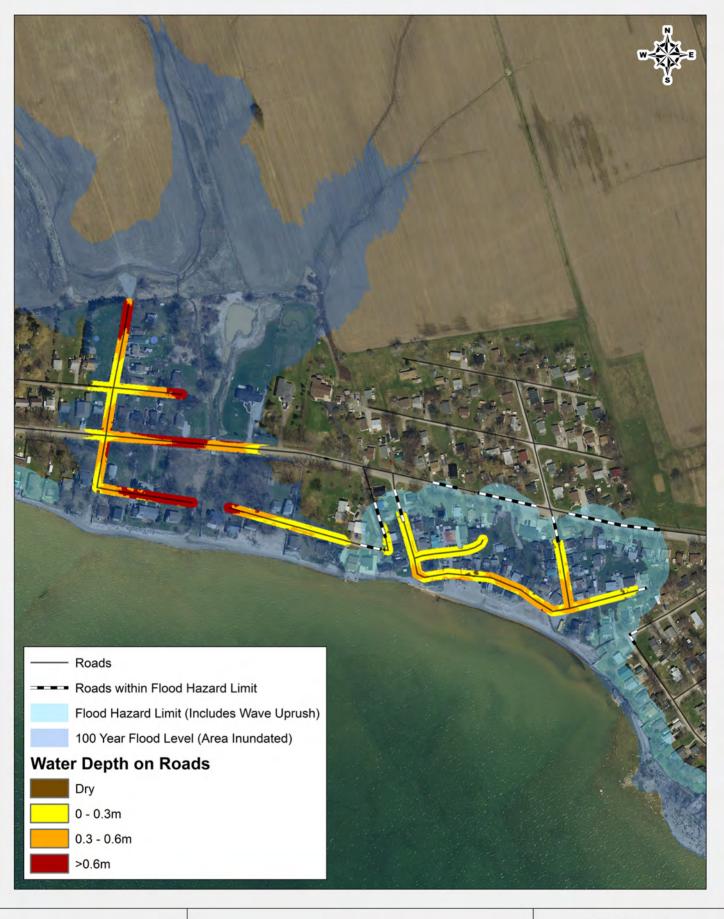


Reach 15

Baird.





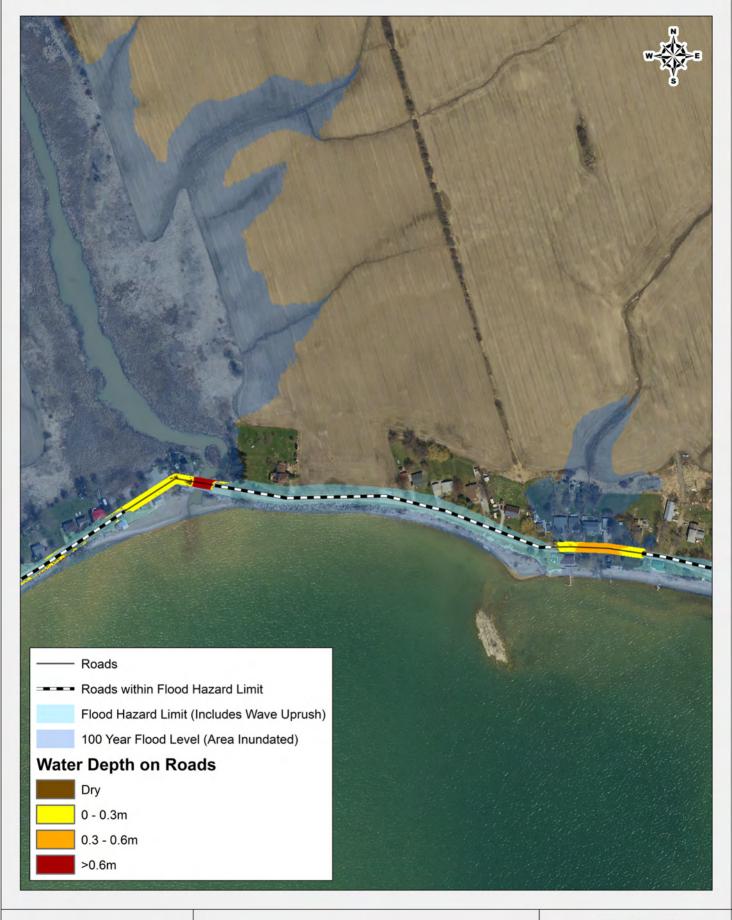




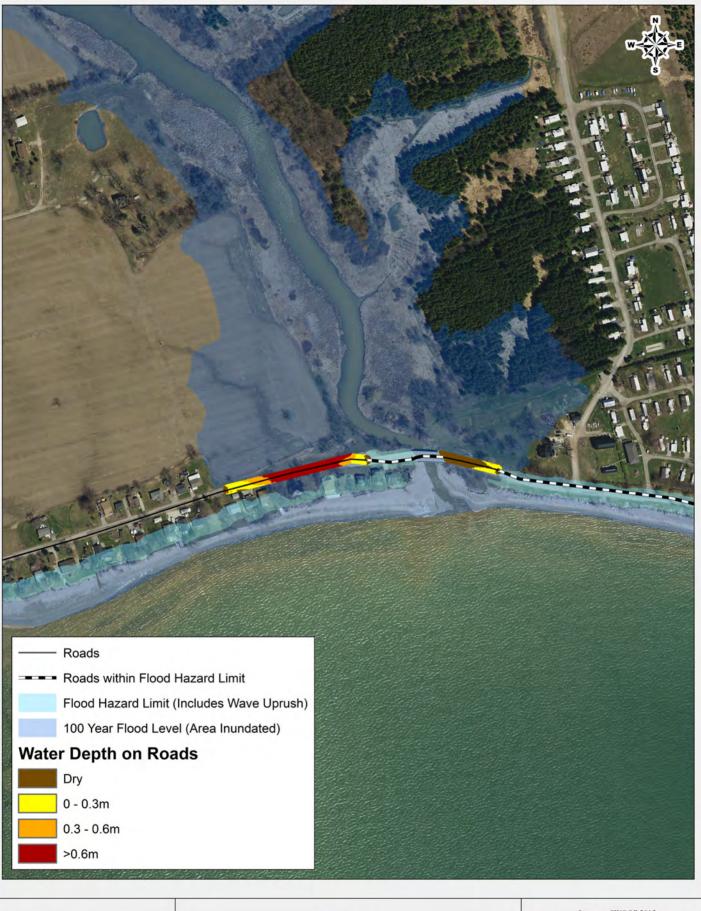


0 20 40 60 m

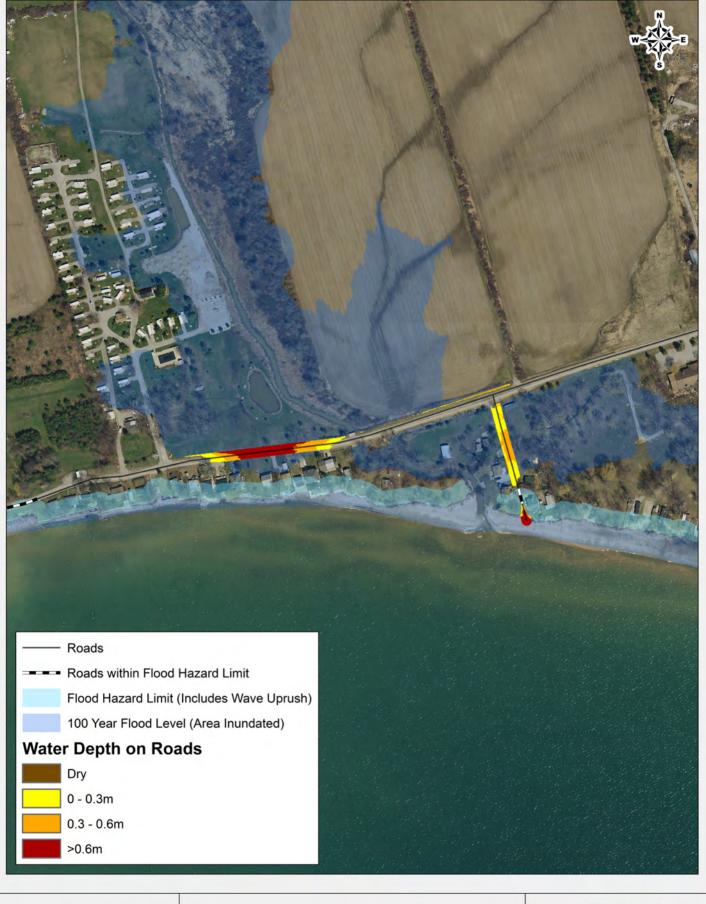












0 40 80 120 m

Reach 49





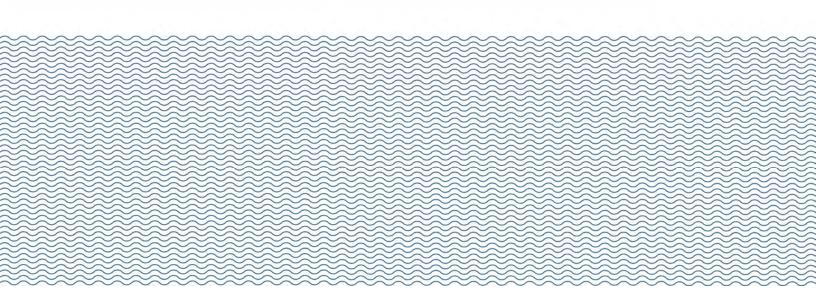




0 80 160 240 m

Reach 68





#### Appendix E

Road and Building Flood Depth Mapping

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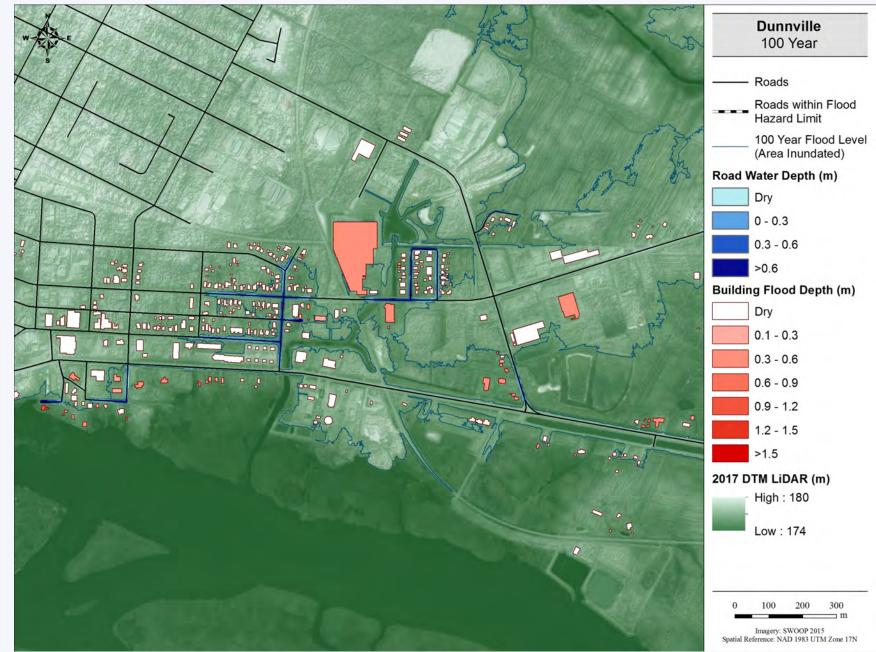
Appendix E

## Area #1 – Dunnville 100-year Flood Depths

100-yr flood level = 176.2m CGVD2013

| Street                           | Flood level when street becomes<br>impacted |        |  |  |
|----------------------------------|---------------------------------------------|--------|--|--|
|                                  | CGVD2013                                    | IGLD85 |  |  |
| HYDRO STREET                     | 175.2                                       | 175.7  |  |  |
| TAMARAC STREET &<br>FRONT STREET | 175.8                                       | 176.2  |  |  |
| BROAD STREET EAST                | 175.7                                       | 176.1  |  |  |
| NIAGARA STREET                   | 175.6                                       | 176.1  |  |  |
| CENTRAL LANE                     | 175.3                                       | 175.8  |  |  |
| QUEEN STREET                     | 175.8                                       | 176.3  |  |  |
| BRANT STREET &<br>BRACE STREET   | 175.6                                       | 176.1  |  |  |
| TAYLOR ROAD                      | 176.0                                       | 176.5  |  |  |

B.



### Area #2 – Nanticoke 100-year Flood Depths

| Street      | Flood level when street becomes<br>impacted |        |  |  |  |
|-------------|---------------------------------------------|--------|--|--|--|
|             | CGVD2013                                    | IGLD85 |  |  |  |
| ERIE AVENUE | 174.9                                       | 175.4  |  |  |  |
| ERIE STREET | 174.9                                       | 175.4  |  |  |  |

**100-yr flood level = 175.9m** 

**CGVD2013** 





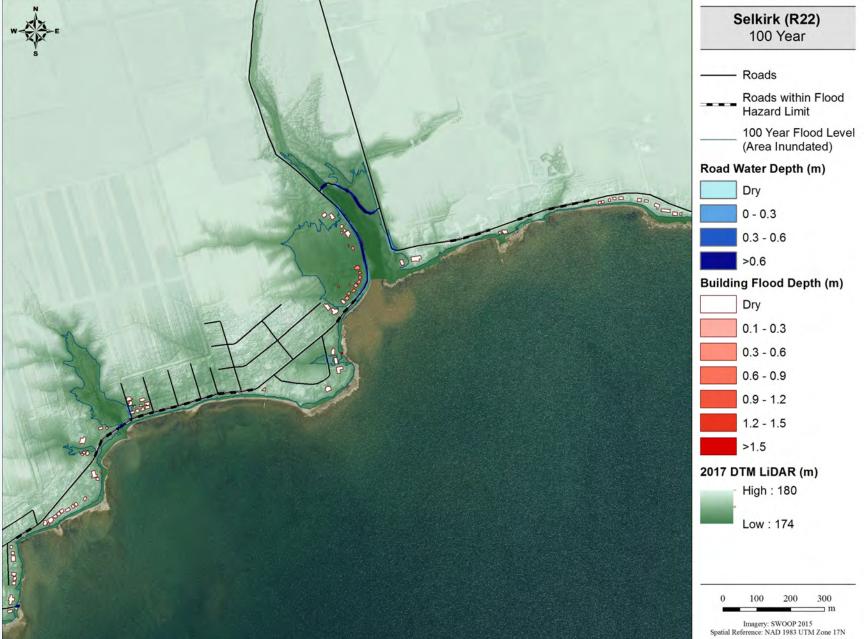
### Area #3 – Selkirk 100-year Flood Depths

|                   |          |                           | 1  |
|-------------------|----------|---------------------------|----|
| Street            |          | n street becomes<br>acted | 74 |
|                   | CGVD2013 | IGLD85                    |    |
| BLUE WATER PKWY   | 175.3    | 175.8                     | A  |
| EAST LAKESHORE RD | 174.1    | 174.6                     |    |
| HALDIMAND ROAD 53 | 175.7    | 176.2                     |    |

**100-yr flood level = 176.0m** 

**CGVD2013** 

B.

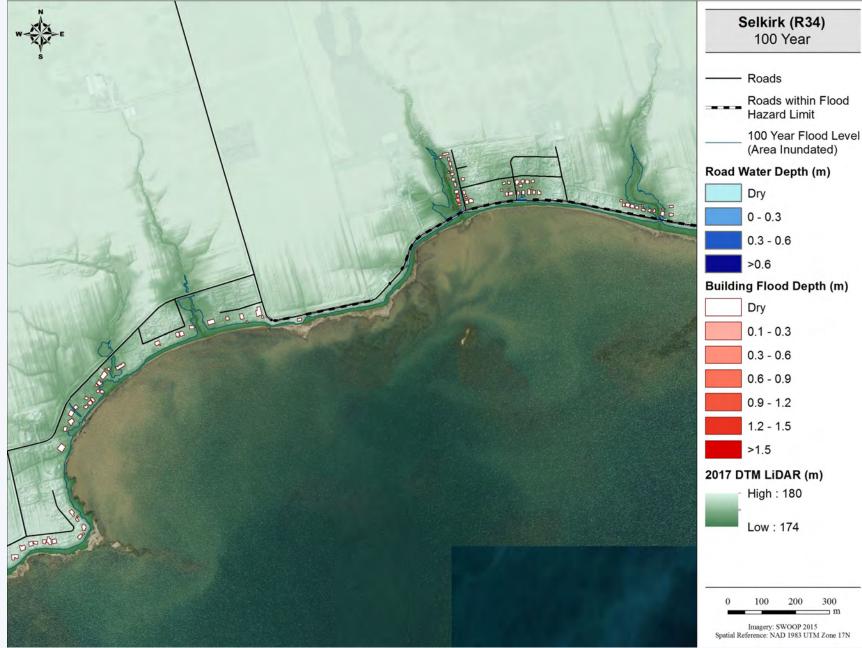


# Area #4 – Hoover Point 100-year Flood Depths

#### 100-yr flood level = 176.1m CGVD2013

| Street |          | Flood level when street becomes<br>impacted |  |  |  |  |
|--------|----------|---------------------------------------------|--|--|--|--|
|        | CGVD2013 | IGLD85                                      |  |  |  |  |
|        |          |                                             |  |  |  |  |

B.



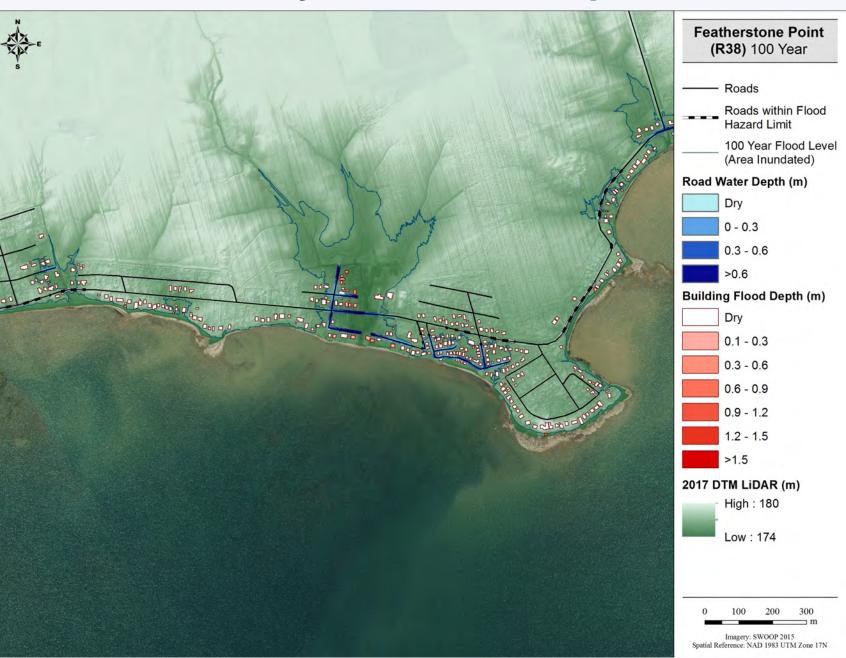
# Area #5 – Featherstone Point 100-year Flood Depths

| Street                          | Flood level when<br>impa |        |
|---------------------------------|--------------------------|--------|
|                                 | CGVD2013                 | IGLD85 |
| BIRCH LANE                      | 175.4                    | 175.9  |
| SWALLOW LANE                    | 175.3                    | 175.8  |
| LAKESHORE ROAD                  | 175.5                    | 175.9  |
| SEAGULL LANE                    | 174.6                    | 175.1  |
| WINGER BAY LANE                 | 175.4                    | 175.8  |
| AULD LANE                       | 176.0                    | 176.4  |
| VIDEOWAY LANE                   | 175.8                    | 176.3  |
| HEATHER LANE                    | 175.5                    | 176.0  |
| PIKE LANE<br>LAKESHORE ROAD (at | 175.8                    | 176.2  |
| KOHLER ROAD)                    | 175.6                    | 176.0  |

**100-yr flood level = 176.1m** 

**CGVD2013** 

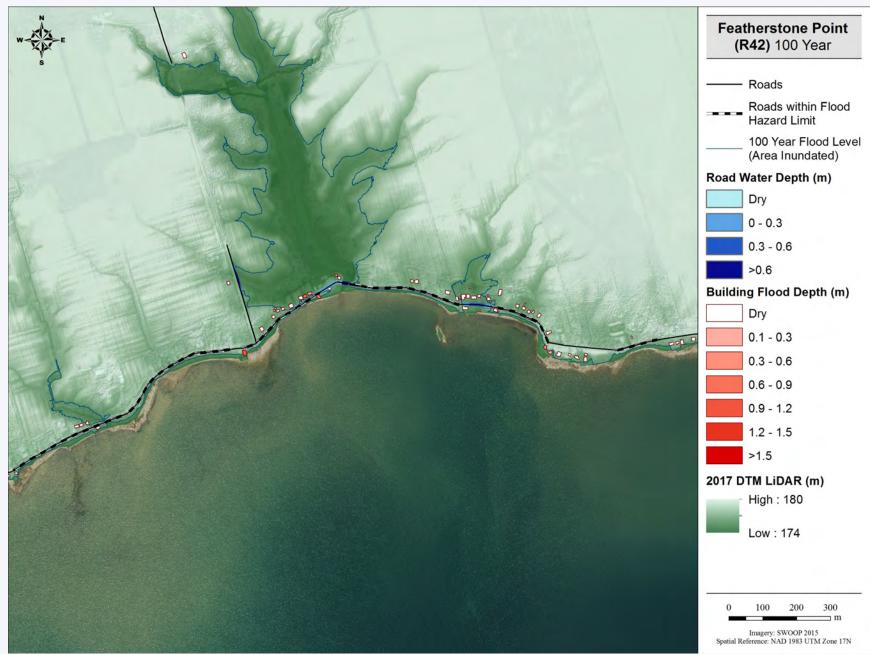
B.



# Area #6 – Featherstone Point 100-year Flood Depths

#### 100-yr flood level = 176.1m CGVD2013

| Street         | Flood level when street becomes<br>impacted |        |  |  |  |
|----------------|---------------------------------------------|--------|--|--|--|
|                | CGVD2013                                    | IGLD85 |  |  |  |
| REICHELD ROAD  | 175.1                                       | 175.6  |  |  |  |
| LAKESHORE ROAD | 175.7                                       | 176.2  |  |  |  |

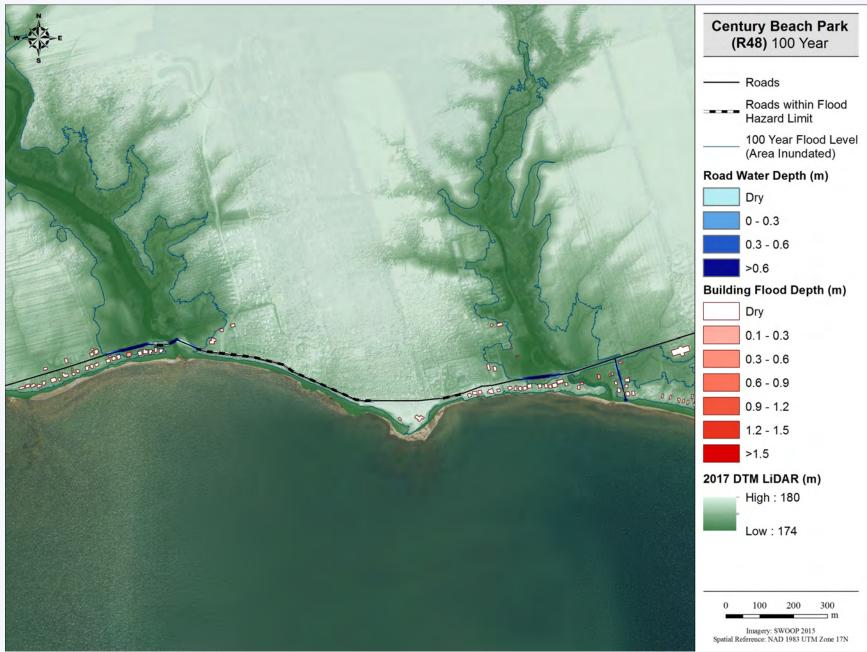




# Area #7 – Century Beach Park 100-year Flood Depths

100-yr flood level = 176.1m CGVD2013

| Street                     | Flood level when street becomes<br>impacted |        |  |  |
|----------------------------|---------------------------------------------|--------|--|--|
|                            | CGVD2013                                    | IGLD85 |  |  |
| LAKESHORE ROAD (at<br>R47) | 175.1                                       | 175.6  |  |  |
| LAKESHORE ROAD (at<br>R49) | 175.3                                       | 175.7  |  |  |
| WHITE CAP LANE             | 174.5                                       | 175.0  |  |  |
| EVAN'S POINT LANE          | 175.6                                       | 176.0  |  |  |



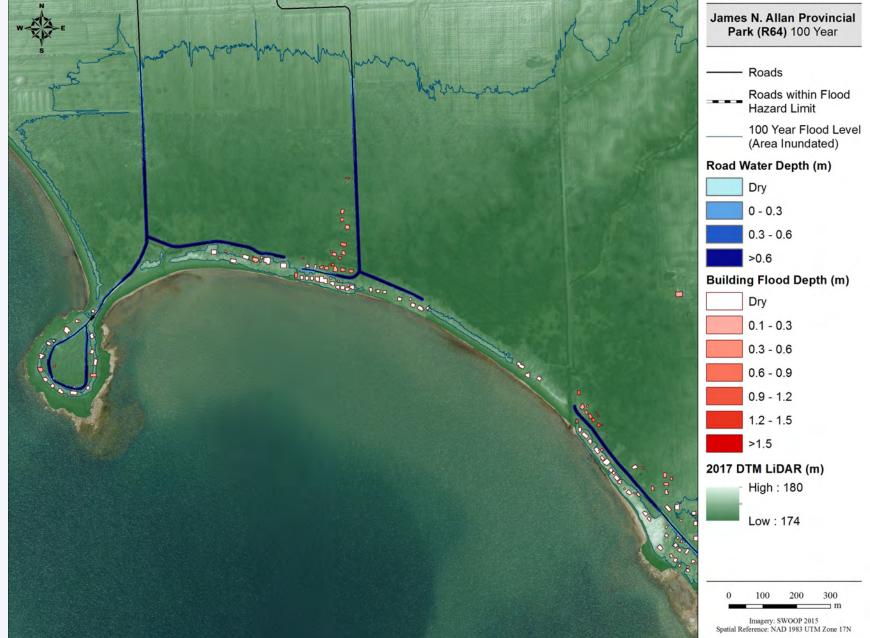


### Area #8 – James Allan Provincial Park 100-year Flood Depths

#### 100-yr flood level = 176.2m CGVD2013

| Street              | Flood level when street becomes<br>impacted |        |
|---------------------|---------------------------------------------|--------|
|                     | CGVD2013                                    | IGLD85 |
| MYRNAM BEACH        |                                             |        |
| ROAD                | 174.9                                       | 175.4  |
| BRIAR LINE          | 175.0                                       | 175.5  |
| PARADISE LINE       | 174.9                                       | 175.4  |
| BAYGROVE LINE       |                                             |        |
| (parallel to shore) | 175.2                                       | 175.7  |
| BAYGROVE LINE       | 175.0                                       | 175.5  |
| SANDY BAY ROAD      | 174.8                                       | 175.2  |

B.

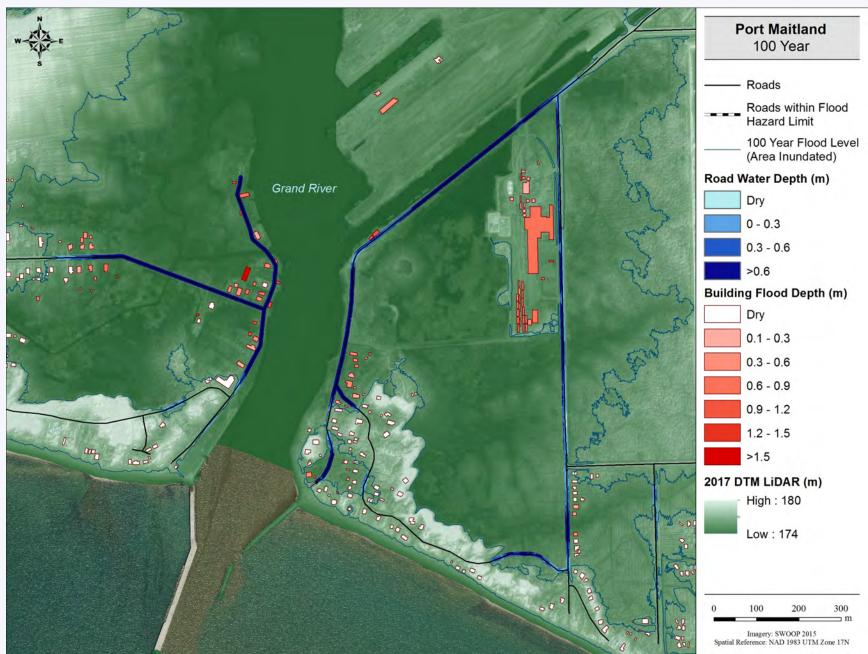


# Area #9 – Port Maitland 100-year Flood Depths

#### 100-yr flood level = 176.2m CGVD2013

| Street           | Flood level when street becomes<br>impacted |        |  |
|------------------|---------------------------------------------|--------|--|
|                  | CGVD2013                                    | IGLD85 |  |
| DOVER STREET     | 175.8                                       | 176.3  |  |
| PORT MAITLAND RD | 174.9                                       | 175.4  |  |
| THE ESPLANADE    | 174.6                                       | 175.0  |  |
| FEEDER CANAL RD  | 175.0                                       | 175.4  |  |
| SIDDALL ROAD     | 175.5                                       | 176.0  |  |
| BECKLY LINE      | 175.0                                       | 175.5  |  |
| SIDDALL LINE     | 175.3                                       | 175.8  |  |
| CONNOR BAY LINE  | 175.8                                       | 176.3  |  |

**B**.



# Area #10 – Lowbanks 100-year Flood Depths

100-yr flood level = 176.3m CGVD2013

| Street |          | Flood level when street becomes<br>impacted |  |
|--------|----------|---------------------------------------------|--|
|        | CGVD2013 | IGLD85                                      |  |
| _      |          |                                             |  |

