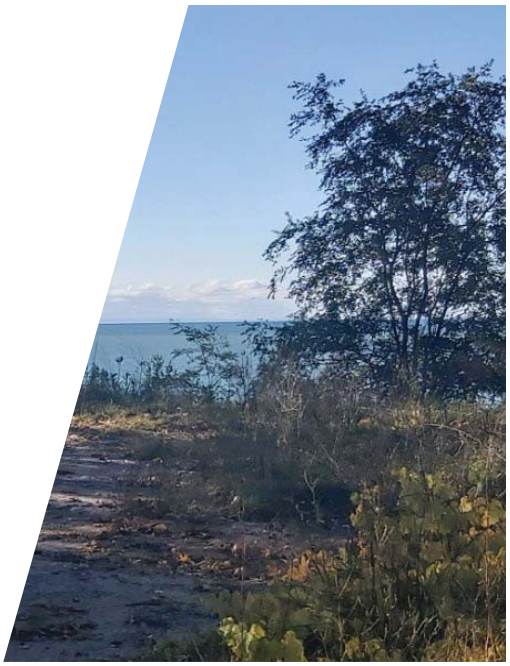
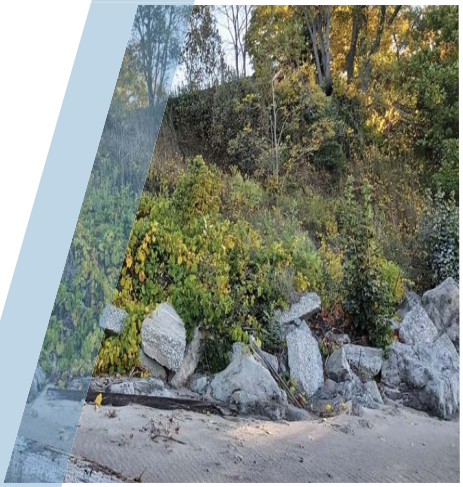


Coastal Study

2L49 Lakeshore Road
Wainfleet, Ontario

Rob McDowell
[redacted]



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1. Introduction

GHD was retained by Mr. Rob McDowell to complete a Coastal Study in support of a proposed single family residential development at 2L49 Lakeshore Road in Wainfleet, Ontario (hereinafter referred to as the site or subject property) on the shore of Lake Erie. GHD understands that it is the intention of the property owner to construct a building with full basement and sewage disposal system on the currently undeveloped property. This development was previously assessed by AMEC in 2010, and the now 10-year old documents have been reviewed by GHD to assess any required updating in order to align current regulations and guidelines. Based on the Record of Pre-Consultation document, it was concluded that the Slope Stability Assessment, including the Review of the 2010 Study, should be updated to include a Coastal Study, which would address the existing wave-based erosion and flood hazards, as well as list potential mitigation methods (if necessary). This Coastal Study addresses the required updates, coastal processes (from regional and local perspectives), natural hazard limits, and recommendations for mitigation methods and next steps in the development of the property.

2. Regional Perspective

The property is located within the eastern basin of Lake Erie, the shoreline of which is mostly dominated by limestone bedrock with only a thin overburden (Boyd, 1981). The orientation of the lake aligns with the predominant southwest wind direction, allowing long fetch distances to build up large waves which can erode the shore of the northeastern part of the lake. Due to the presence of bedrock, erosion is generally not as severe in the western basin. Boyd (1981) states that, during times of high water levels, one storm can cause nearly half the damage occurring typically in one year, and highlights the importance of awareness and planning for storm surge elevations.

Beach deposits, if present, can fluctuate within the headlands, but only a nominal amount of material is transported eastward (Reinders, 1988). Lake Erie's littoral drift is supply-limited (meaning there is more sediment transported by wave energy than sediment sources can supply). The large curved scallops between the headlands/spits allow for a discrete littoral sub-cell setup, with limited erosion of the sediment-providing bluffs, and rivers and streams, whose outlets can accumulate coarser sediments (Boyd, 1981).

Reinders (1988) identified the area of the subject property to be within Lake Erie's littoral cell E-11, which reaches from west of Port Ryerse to the Niagara River. Cell E-11 consists of a low glacial plain shoreline with outcropping of bedrock, creating many small headlands with some beaches on their western sides), such as found at the subject property. The net littoral drift is identified by Reinders (1988) to be eastward, with the volume of 25,000 m^3/yr. The same report notes that nearshore sediments as being glacial deposits and bedrock. Sand bodies are limited to being 10-30 cm thick (Reinders, 1988, p.76), and tend to be limited in extent. Within the cell E-11, bluff erosion and stream discharges are not considered to be a major contributor to littoral drift because of the resistant bedrock nature found along the majority of the shoreline (Reinders, 1988, p. 76).

3. Local Perspective

The property shows a wide beach (25 m - 30 m from the water line (on the day of the topographic survey) to the toe of the bluff), which is flanked by a steep, vegetated, sandy slope of approximately 10 m height. This height is then maintained over approximately 30 m before sloping back down gradually towards the northern end of the property. Such backshore dunes (also called bluffs) are typical of this area, as the wind is able to transport sand landward over the wide beach, forming said backshore dune from locally available coarse material (Boyd, 1981). According to Boyd (1981), the shoreline reach at the subject property is designated the title of a Group Two Profile, indicating wide beaches with steep inland sand profiles (dunes), which coincides with the observations made during the site inspection in September 2020 by GHD. Boyd (1981) further states that the beach zone in the Group Two Profiles, is wide and stable, providing sufficient protection of the backshore dunes from wave-based erosion. Group Two Profiles tend to experience annual changes in the beach profile, but not in the overall net volume of material comprising the beach zone. Rather than causing erosion, storm waves have been noted to carry sand landward during lake setup conditions (Boyd, 1975). Further insight to erosion is provided in Section 4 *Limits of Natural Hazards*.

The subject property, as shown in Figure 1, is considered to be partially located within the Regulated Shoreline Extent area, as defined based on the Great Lakes Shoreline Flood and Erosion Mapping database of the shoreline hazard line features, publicly provided on the NPCA Watershed Explorer. The subject property owner is aware of permitting requirements, should they wish to develop their land within the Regulated Shoreline Extent.

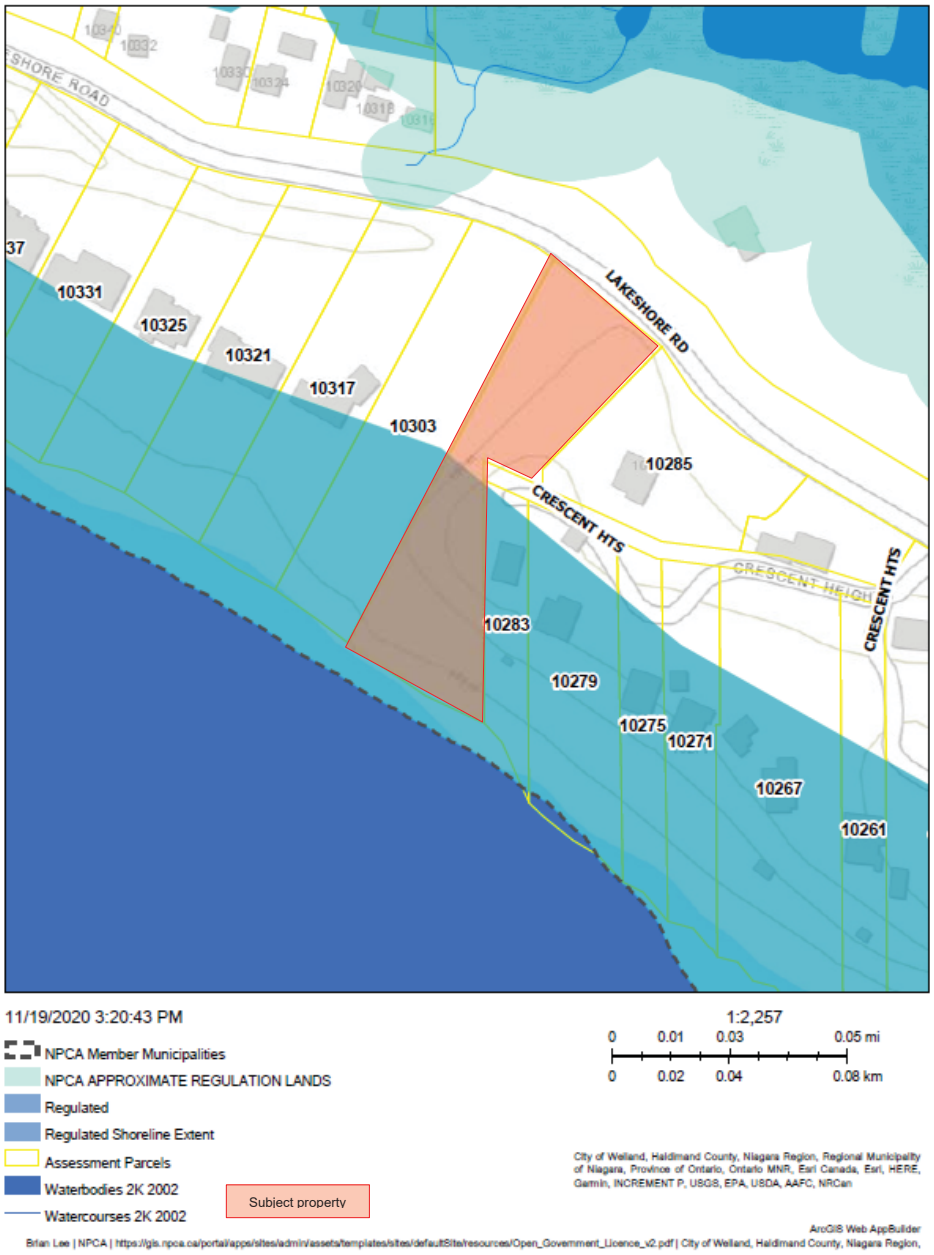
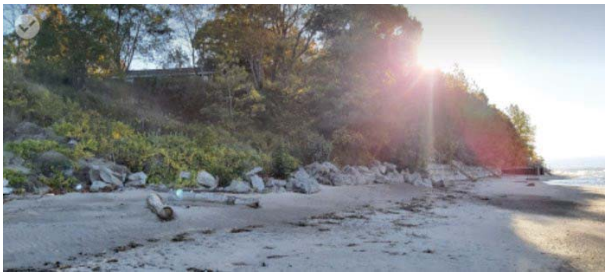


Figure 1 Regulated Shoreline Extent as per the NPCA Watershed Explorer

Section of beach, full toe of dune, and section of vegetated dune on subject property (red line)

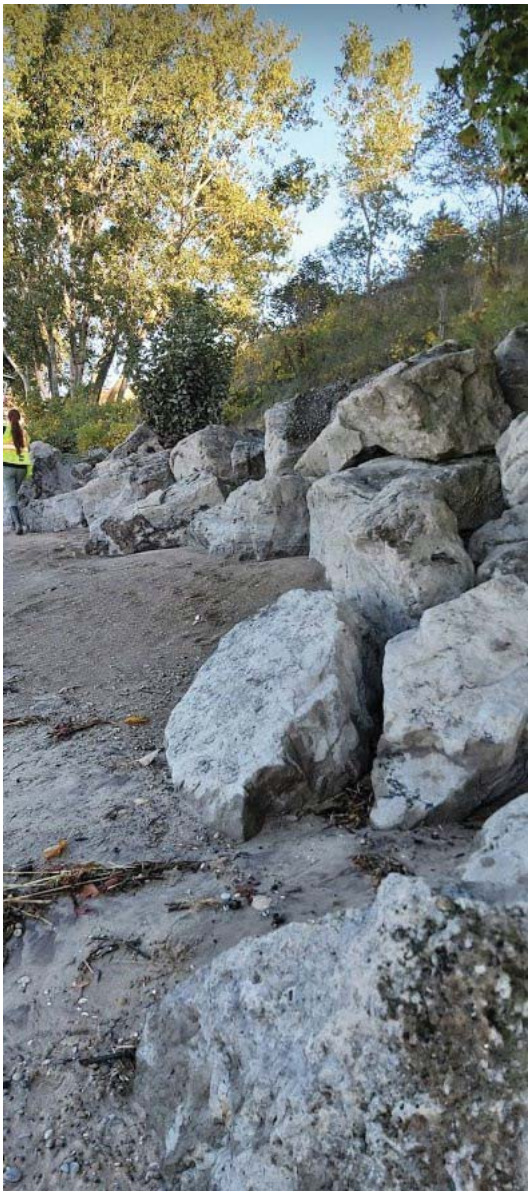
25 m -30 m wide beach on subject property, facing west



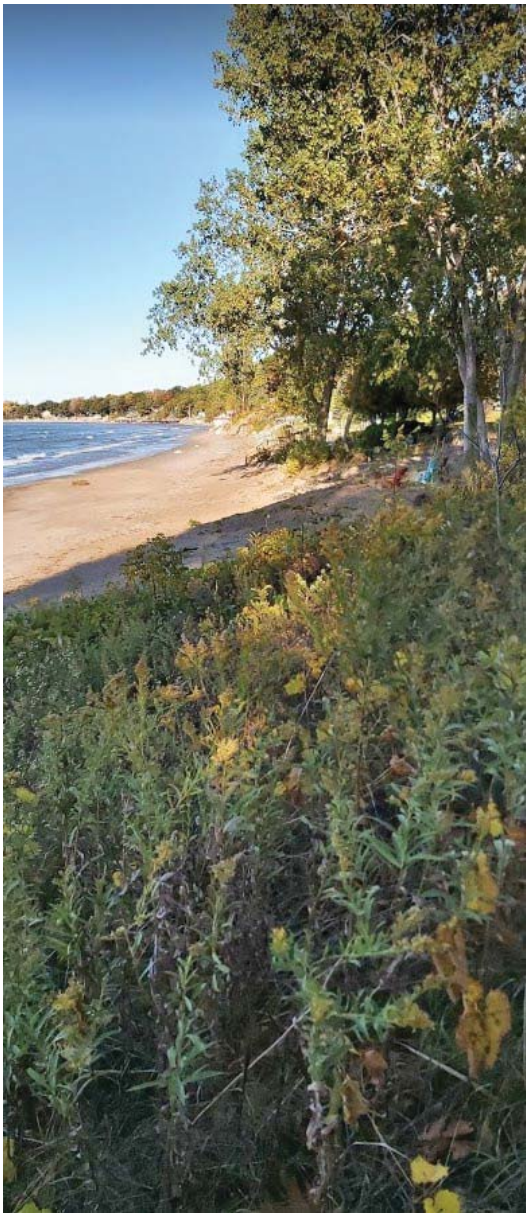
25 m -30 m wide beach and toe of dune on subject property, facing east

Toe of western side of dune

Toe of eastern side of dune



Toe of dune showing large armourstone, facing west



Heavily vegetated dune, facing west

View from the top of the dune. Overlooking heavy vegetation leading down to the wide beach.

4. Limits of Natural Hazards

The subject property is within the area regulated by the NPCA as the Great Lakes Shoreline component under the Generic Regulation of the Conservation Authorities Act known as Ontario Regulation 97/04. Publicly available data depict the extents of the shoreline regulated area as determined by extending from the currently mapped shoreline (2002) inland to the greatest of either the shoreline erosion (100 year erosion rate, dynamic beach), or shoreline flood (100-year flood level, wave uprush) hazards.

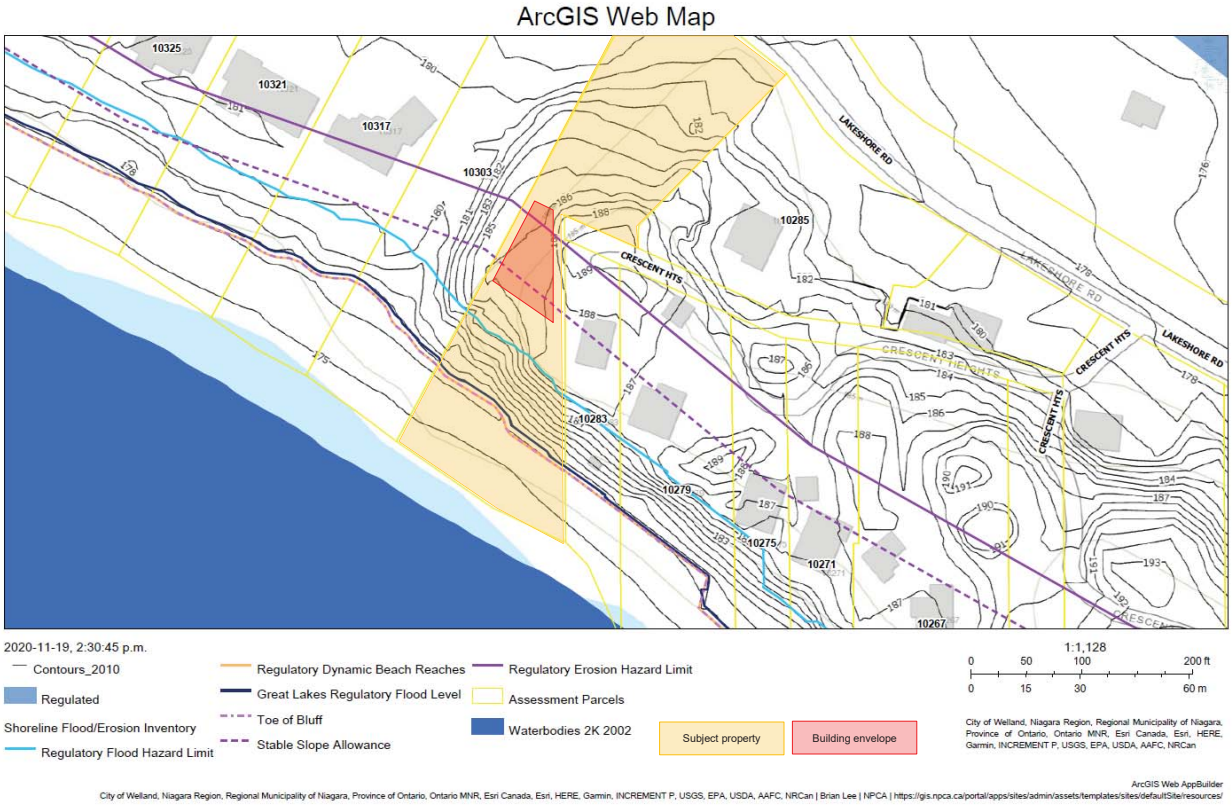


Figure 2 NPCA Watershed Explorer Search Results for Subject Property with Approximate Proposed Building Envelope

Based on the presence of the high (10 m) and steep (1.4:1 to 2:1 (H:V)) slope located inland of the beach, approximately 25 m from the water level (as observed and documented in September 2020), the subject property was found to be more vulnerable to erosion than to flooding hazards. Waves were not calculated to be able to overtop the steep slope (EurO Top PC-Overtopping, calculated November 2020 based on recorded topography, available bathymetry, and maximum water levels). This concurs with the NPCA Watershed Explorer data, as shown in Figure 2 above. As per Figure 2, the Regulatory Flood Hazard Limit and the Regulatory Erosion Hazard Limit are both 15 m inland from the Great Lakes Regulatory Flood and Erosion Levels respectively. At the subject property the Regulatory Flood Hazard Limit coincides approximately with the crest of the bluff, whereas the Regulatory Erosion Hazard Limit reaches 15 m to 20 m past the crest of the bluff. Therefore the Regulatory Erosion Hazard at this site prevails.

The slope, shape, and amount of vegetation covering a coastal bluff and the adjacent shoreline are directly related to the susceptibility of the bluff face to ongoing erosion. More heavily vegetated bluffs are less likely to be eroding than non-vegetated bluffs. Based on the observed vegetation (September 2020), and historical aerial photographs, it has been determined that the vegetation on the subject property is well established and provides some protection against wind-driven sand erosion.

Based on historical photographs and site observations, it appears that the Regulatory Erosion Hazard Limit is overly conservative for the subject property. This is supported by regional information indicating that bluff erosion is not considered to be a major contributor to littoral drift and local

information indicating that the site profile has a wide and stable beach zone which provides sufficient protection of backshore dunes from wave-based erosion, along with the confirmed presence of well-established vegetative cover on the bluffs. As such, a site-specific erosion allowance hazard has been created using the established stable top of slope (Geotechnical Slope Stability Review (GHD, 2020)) together with site-specific 100-year erosion rates. This approach and the establishment of the site-specific erosion rates follow the guidelines provided in the NPCA Policy Document (dated September 2018).

Publicly available photographs of sufficient quality were obtained and reviewed by GHD for the years 1954, 2000, 2006, 2010, 2013, and 2018. Comparison of these photographs revealed that there is a maximum change in the dune vegetation line (toe of the dune) of 5.2 m inland between 1954 (red line) and 2000-2018 (orange, yellow, green, blue, purple lines), as shown on Figure 3.

The aerial photograph review also indicated no evidence of the rock revetment constructed at the toe of the dune until 2000. Further, there is no evidence of erosion of the dune between the years of 2000 and 2018.

The following was considered in developing a site-specific erosion rate:

- The largest change in the dune vegetation line of 5.2 m inland occurred between 1954 and 2000. This equates to an annual erosion rate of 0.11 m/year, which aligns with the results provided in Shoreplan's Lake Erie Shoreline Management Plan Update (2010).

- A 70-year design life is assumed for the existing rock revetment.

- With an assumed installation in 2000, as supported by the historical aerial photograph review, the revetment has 49 years remaining in its design life during which no erosion can be expected.

Note that the above listed assumptions were confirmed with the NPCA before being applied.

Based on the foregoing, there would be 5.61 m of erosion over the next 100 years assuming that the rock revetment is not reconstructed after 49 years and 0.11 m of erosion occurs in each of the remaining 51 years. As such, the site-specific erosion hazard limit should be considered at 5.61 m set back from the Stable Top of Slope (on the lake-facing slope only) as provided in the Geotechnical Slope Stability Review (GHD, 2020) and shown as the 100-Year Erosion Hazard Line on Figure 4.

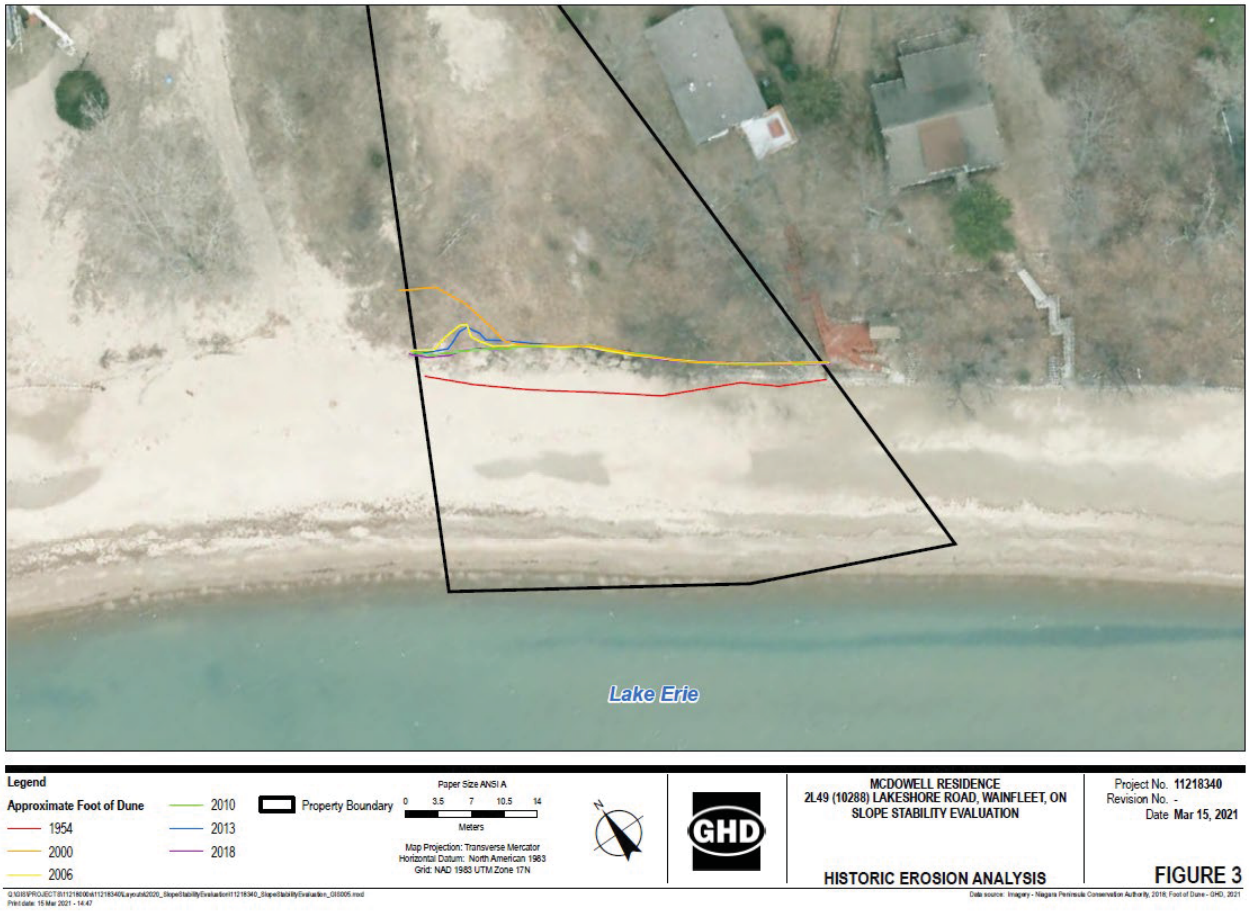


Figure 3 **Historical** Erosion Analysis

Figure 4 Long-Term Stable Top of Slope and 100-Year Erosion Hazard Line

Note that full drawings of Figures 3 and 4 are included in Appendix A.

5. Recommendations

Based on the Coastal Study, including review of historical information, a site inspection, review of NPCA regulatory requirements, and development of site-specific erosion rates, the current lake-facing slope could erode 5.6 m in the next 100 years. A newly constructed revetment would reduce this erosion to 3.3 m over the next 100 years. It is noted that the proposed building footprint would still be within the erosion hazard if a new revetment is installed. Annual visual assessments of the vegetation on the dune are recommended in order to determine whether the existing rock revetment is fulfilling its design purpose against significant erosion, as would be indicated by the progressive disappearance of vegetative cover on the dune.

Geotechnical expertise should be sought if construction of the proposed dwelling is considered within the proposed building envelope beyond the erosion hazard limit as well as the stable top of slope.

It is noted that the 2010 plan also proposed that the building envelope extend beyond the top of the stable slope which, at that time, would have also required geotechnical expertise if the proposed building footprint extended beyond the stable top of slope.

All of Which is Respectfully Submitted,

GHD

Jennifer Penton, Ph.D.
JP/MG/01

Max Osburn, P.Eng.

Appendix A: Full drawings

Legend

Approximate Foot of Dune
- 1954
- 2000
- 2006
- 2010
- 2013
- 2018

Property Boundary

Paper Size ANSI A

0 3.5 7 10.5 14

Meters

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

MCDOWELL RESIDENCE
2L49 (10288) LAKESHORE ROAD, WAINFLEET, ON
SLOPE STABILITY EVALUATION

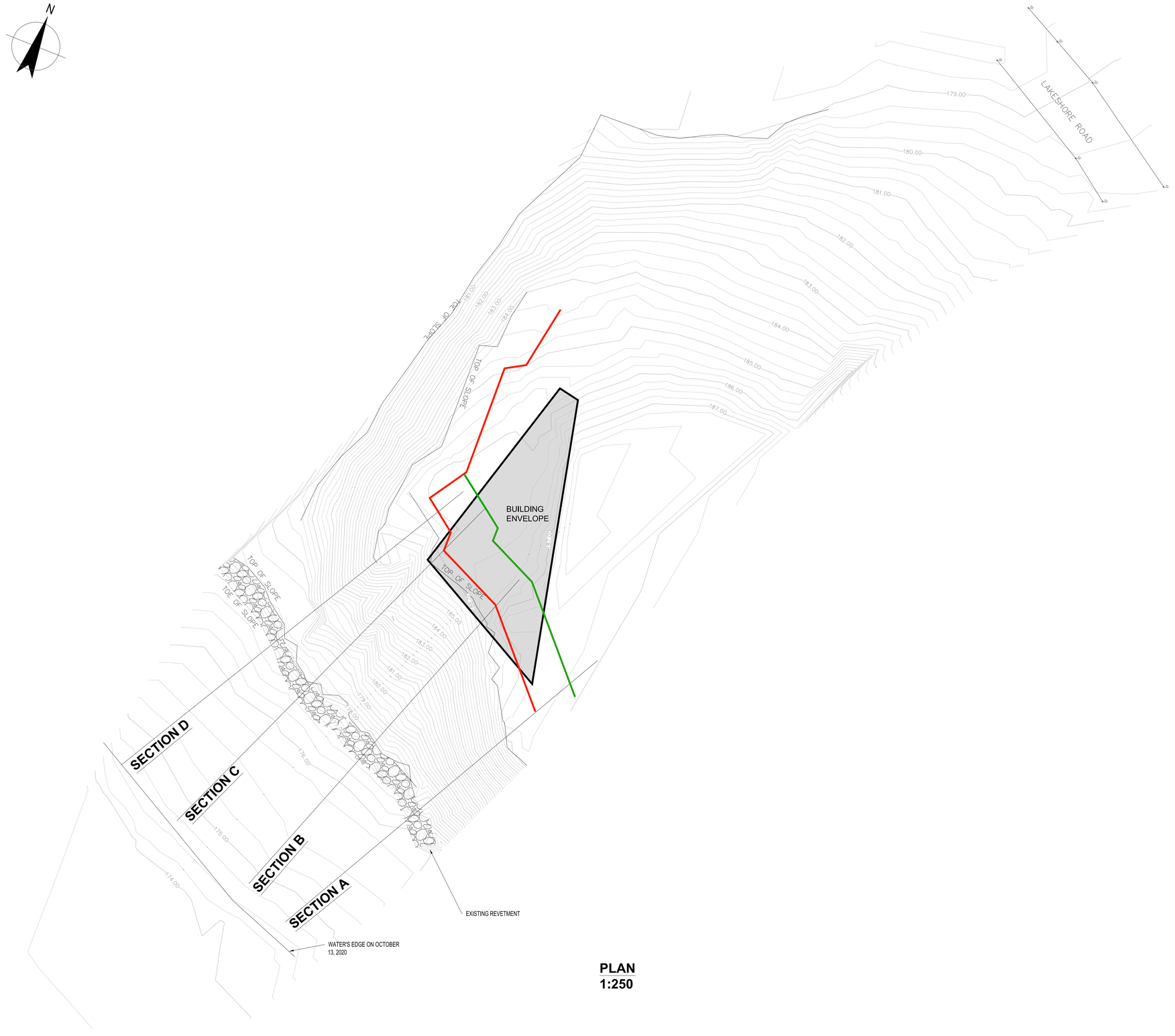
HISTORIC EROSION ANALYSIS

Project No. 11218340
Revision No. -
Date Mar 15, 2021

FIGURE 1

Q:\GIS\PROJECTS\11218000s\11218340\Layouts\2020_SlopeStabilityEvaluation\11218340_SlopeStabilityEvaluation_GIS005.mxd
Print date: 15 Mar 2021 - 14:47

Data source: Imagery - Niagara Peninsula Conservation Authority, 2018; Foot of Dune - GHD, 2021



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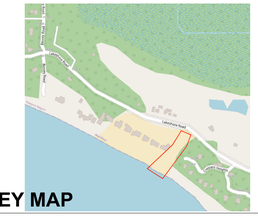

KEY MAP

LEGEND

LONG TERM STABLE TOP OF SLOPE

100 YEAR EROSION HAZARD LINE

No.	Revision	Drawn	Job Manager	Project Director	Date

Drawing Revisions

Note: * Indicates signatures on original issue of drawing or last revision of drawing

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Client **MR. ROB McDOWELL**

Project **10288 LAKESHORE ROAD W SHORELINE PROTECTION**

Title **EXISTING CONDITIONS**

Scale	AS NOTED	**DO NOT SCALE**
Drawn	J.C.	
Designer	--	
Drafting Check	J.P.	
Design Check	J.P.	
Approved (Project Director)	XXXXXXXXX	
Date	DECEMBER 2020	

This Drawing must not be used for Construction unless signed as Approved

Drawing No. **11218340-SP01**

Original Size **Arch D**

Rev. **001**

Plot Date: 19 May 2021 - 1:42 PM Plotted by: Jeremy Clark Cad File No: N:\CA\Mississauga\Projects\Legacy\Geomorphic\JC\11218340 Wainfleet Erosion Hazard update - Copy.dwg

about GHD

GHD is one of the world's leading professional services companies operating in the global markets of water, energy and resources, environment, property and buildings, and transportation. We provide engineering, environmental, and construction services to private and public sector clients.

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