

December 7, 2017

Consulting  
Engineers and  
Scientists

Mr. David Rowe, Esq.  
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202 E. State Street  
Traverse City, MI 49684  
via email: [DRowe@NMichlaw.com](mailto:DRowe@NMichlaw.com)

**RE: Comparative Slope Evaluation Report  
The 81 on East Bay Proposed Development  
Peninsula Township, Grand Traverse County, Michigan**

Dear Mr. Rowe:

Inland Seas Engineering/GEI Consultants of Michigan, P.C. (GEI) is pleased to present this evaluation report pursuant to our recent discussions. I have reviewed the Slope Stability Reconnaissance Report, dated October 26, 2016 and prepared by Otwell Mawby Geotechnical, P.C. (OMPC). The OMPC Reconnaissance Report (hereinafter; OMPC Report) documents the author's examination of the existing topography and alluvial geology at the property proposed for development, referred to as "The 81 on East Bay" (The 81). In addition to review of the OMPC Report, I have performed two (2) reconnaissance visits at The 81 property to examine the terrain and undeveloped conditions. From this review and reconnaissance, I find the OMPC Report adequately describes the existing topographic and glacial geologic conditions at The 81.

This letter presents a report of the topographic and glacial geologic conditions observed at The 81 and includes a review of public records available for the property and surrounding area pertinent to slope stability. This report expands upon the evaluation performed by OMPC and presents a fuller description of the conditions present at The 81, the surrounding area and region. Further, this report compares the development plans proposed for The 81 to existing residential development within Peninsula Township on similarly situated geographic and geologic terrain.

From this evaluation, it is concluded that the soil conditions at The 81 are suitable for excavation and site preparation grading operations, pursuant to the development plans included in the Special Use Permit (SUP) application. The SUP application describes a development that preserves the natural character of steep slopes, lake shore, hills and other natural assets. The preservation measures are depicted by the SUP application plans and comparable to other similar shoreline developments within the Township. In this comparative evaluation, development plans for The 81 not only mitigate the potential for erosion of steep slopes by increased development setbacks away from bluff crests and slope toes, but also reduce the soil loading acting at the crest of the slope as result of construction of the proposed residential structures. This is accomplished by reducing the elevation of the slope crest by several feet as part of the proposed site grading plan. This reduction

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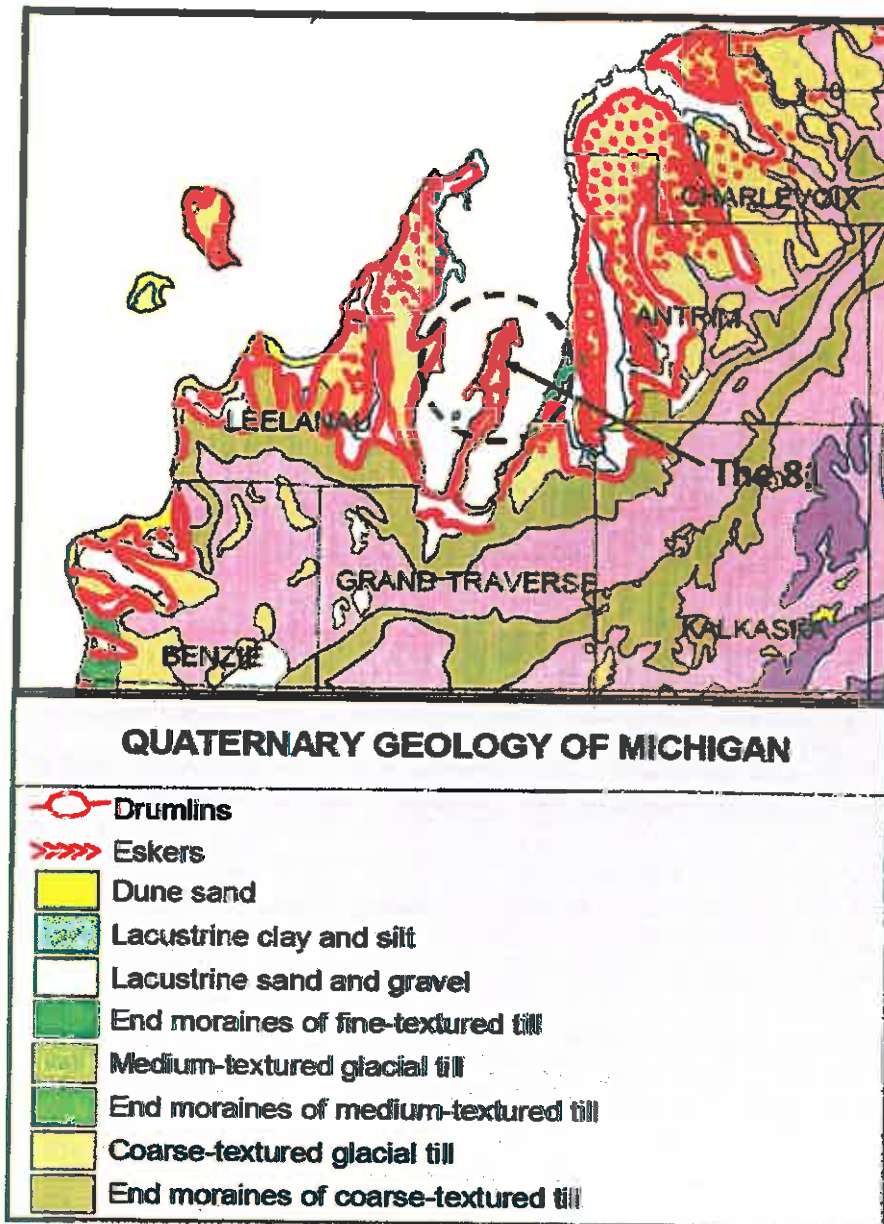
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in loading at the top of the slope decreased the driving forces that along with resting forces and soil shear strength govern slope stability.

**Regional Glacial Geologic Background**

As indicated in the OMPC Report, the glacial geologic setting at The 81 is characterized by the Map of Quaternary Geology of Southern Michigan. A portion of this map is excerpted below. The excerpt depicts the location of The 81 within the encircled area of Peninsula Township and displays the mapped glacial alluvium textures and deposition environment along with landforms. The excerpt shows that this area of Peninsula Township is just a portion of a broad region where recent glacial action imparted similar geologic conditions.

**EXCERPT FROM 1982 QUATERNARY GEOLOGY OF MICHIGAN MAP**



The excerpt shows the presence of glacial lake terraces/shorelines (see bold red lines) throughout the perimeter of Old Mission Peninsula and the presence of a few drumlin glacial landforms (red dots on map) which are common to the surface of the regional, coarse textured till deposits.

The "coarse textured till" description for the glacially deposited alluvium is a classification for the sediments typical in this mapped region. The dominant particle sizes present are larger in nominal diameter than clay or silt. The "till" term refers to the means by which the alluvium is generated and deposited. Till deposits are created through the movement of glaciers over land and the alluvium is deposited some distance from the ice flow, whether the ice is advancing or retreating over the earth. In the case of the till deposits present at The 81, throughout Peninsula township and the region mapped above, the glacial ice traversed over and resided above the alluvium for some significant period of time. The weight of the ice compressed and consolidated the till, compacting the alluvium into a very dense state.

The consolidation of the alluvium under thousands of feet of glacial ice caused the alluvium to gain substantial shear strength. The consolidation of this alluvium is evident in the steep slopes present in many areas of Peninsula Township, including the area about The 81. The steep nature of the slopes observed and documented in the OMPC Report are the landforms that arise millennia after glacier retreat and after the erosive forces of nature have sculpted the consolidated sediments.

The character of the natural environment throughout the area and region is manifested through the land forms and geography of the area. The SUP application for The 81 demonstrates how the proposed development will preserve that character by locating development and construction away from the slopes and bluffs, enhancing the endurance of the landscape. This preservation effort is well demonstrated by considering existing developments within Peninsula Township that have been completed on similar slopes and glacial landforms.

### **Comparative Developments on Steep Slopes**

Figure 1 (attached) was created from an aerial photograph that includes a portion of Peninsula Township. The photo has been annotated to show the approximate boundaries of mapped glacial alluvium textures presented from the map excerpt above. Also depicted are the approximate limits of the historic lake terrace landforms encompassing the perimeter of Old Mission Peninsula. Figure 1 shows the locations of two (2) existing development areas relative to the location of The 81 landforms. Comparative Site 1 is the residential development existing at the terminus of Smokey Ridge Road, just north of The 81. Comparative Site 2 is the residential development north and northwest of Bluff Road just east of Center Road.

Figure 2 depicts through various assembled graphic representations the existing topography and landforms present at The 81 and the proposed development on those landforms. Three (3) profile views are projected on the plan view of the development (A-A' through C-C') and the profiles of the topography, current and proposed, are also displayed. Figure 2 includes the proposed setback of development away from the bluff crest and slope face. It also shows, generally, how the bluff crest elevation will be lowered in some portions through site preparation grading. Removal of the mass of this glacial alluvium away from the slope lowers the gravitational forces (driving forces) acting on the slope.

Removing home site development from the bluff crest and slope toe further enhance slope stability and preserve the natural character of the landforms present. These setbacks reduce soil loading

from proposed structures, better control storm water runoff and reduce soil erosion at the slope crest and enhance slope stability by minimizing potentially destabilizing elements from the most sensitive portion of the landscape.

Figures 3 and 4 use the same graphic techniques to display the existing and comparative developments present on the same landform type as is present at The 81. Comparative Site 1 is differentiated from the proposed development at The 81 by recognizing the development at Site 1 is actually on the slope of the bluff, not set back from it and the total height of the slope is greater than The 81.. Thus, within approximately one mile of The 81, the same landform and alluvium is capable of supporting residential development on the slope face.

The Bluff Road developments (Comparative Site 2) also exist on slope faces and bluff crests as demonstrated in Figure 4. This contrasts significantly from The 81 proposed development site in that there are no setbacks from the bluff crest and the elevation and slope angle are greater than at The 81. Again, this provides evidence that soils of similar geologic origin, composition and strength properties are capable of safely supporting developments along the steep slopes adjacent to Lake Michigan. No significant erosion or slope instability is evident upon inspection of the Bluff Road developed slopes, even though they are steeper and have been disturbed to a greater degree than the development of The 81 considers.

### **Conclusions**

As the result of past glacial activity and consolidation of alluvial deposits the soils in the Peninsula Township are relatively more resistant to erosion and slope instability than less consolidated glacial alluvium and soil conditions in other areas of the Lake Michigan shoreline.

Unlike Comparable Sites 1 and 2, where the potentially destabilizing effects of soil disturbance, development loads and storm water runoff are amplified by development on slope faces, bluff crests and slope toes, development plans for The 81 remove the disturbance and development away from these critical, natural areas.

Locating development away from steep slopes is coupled in the development plan that includes only selective tree trimming/thinning. Plans to modify view sheds for individual development sites by selective harvesting of wood stand will minimize disturbance of slope soils. Selective thinning of the canopy will also promote increased sunlight penetration to the soil on slopes, promoting growth of forest floor species currently limited by shade. Remaining stumps and root systems after selective tree harvesting will give rise to shoot and new growth and associated development of new root systems. Root growth increase will promote soil retention and mitigate erosion on slope faces.

The 81's planned setbacks from the slope crest and toe present a preferable alternative in terms of loading and erosion control. Intuitively, if large homes like those existing at the comparative developments can be built on the face of slopes steeper and higher than those present at The 81, then development of The 81 using 40-foot setbacks should provide comfort for the SUP application reviewers that the proposed development is preserving the natural character of steep slopes, lakeshore, hills and similar natural assets, consistent with the provisions of Peninsula Township Ordinances.

**Closing**

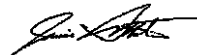
I look forward to reviewing this report with you early next week.

Respectfully submitted,

**INLAND SEAS ENGINEERING, INC.**  
a division of GEI Consultants of Michigan, PC



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Enclosures:

Figures 1 through 4

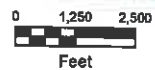
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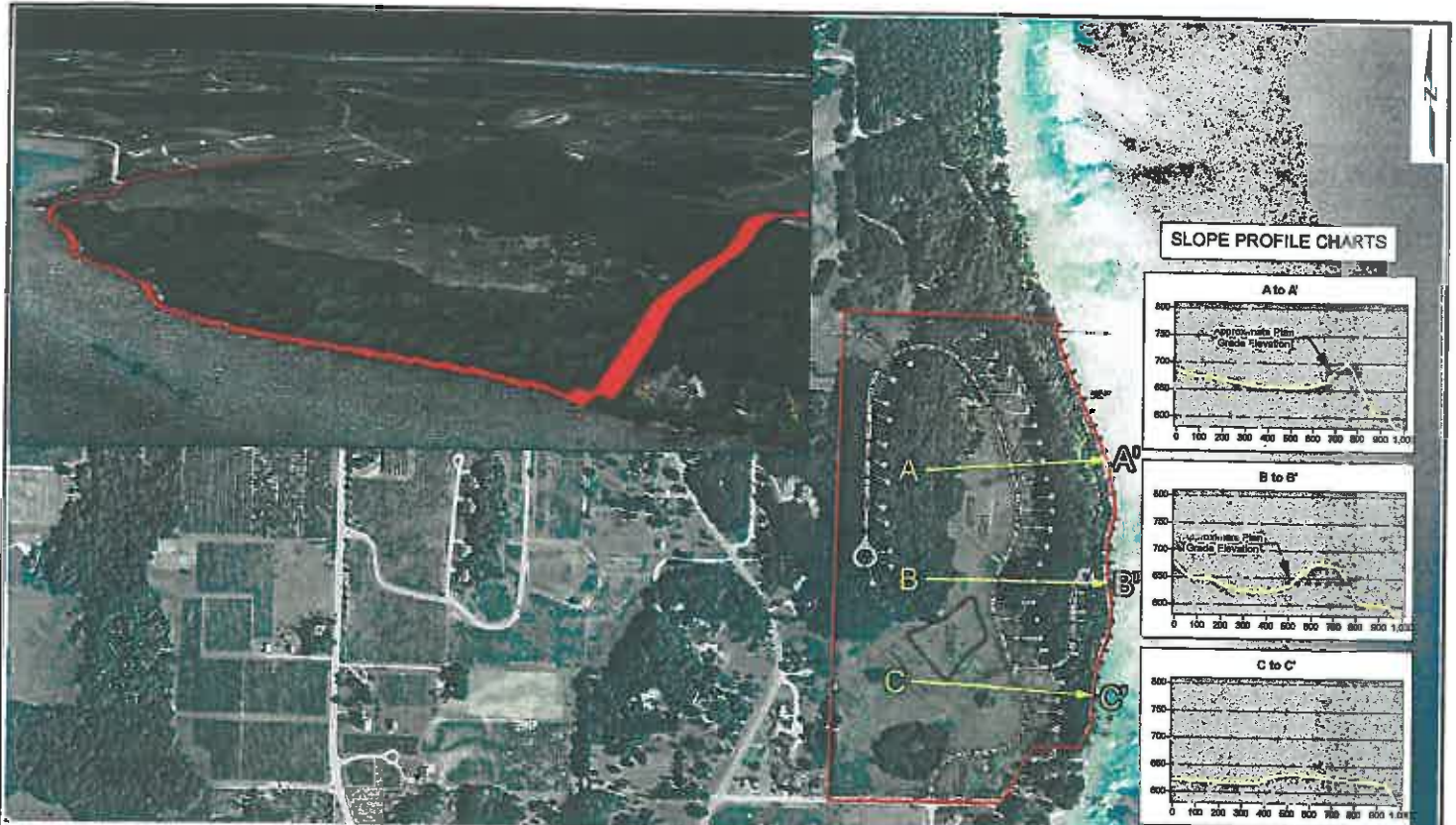
**Legend**

- Sites
- 1982 Quaternary Geology

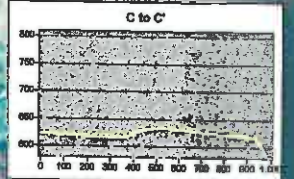
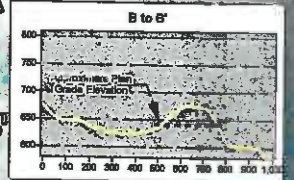
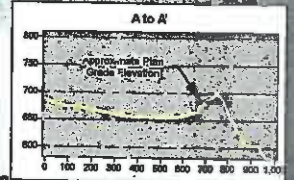


**SOURCE:**  
 Aerial Photo: USDA NAIP 2016  
 1982 Quaternary Geology: Michigan Natural Features Inventory and Michigan Department

Comparative Development Evaluation Report The 81 on East Bay Peninsula Township, Grand Traverse County, Michigan		<b>LOCATION MAP          SUBJECT AND          COMPARISON SITES</b>
The 81 Development Co., LLC Clarkston, Michigan	Project 1704495	December 2017



**SLOPE PROFILE CHARTS**



**SOURCE:**  
 Aerial Photo: USDA NIP 2016  
 Site Photo: Google Earth  
 Elevation: USGS NED Grand Traverse

**Legend**

- Existing Elevation Profile
- Site Boundary



Comparative Development Evaluation Report  
 The 81 on East Bay  
 Peninsula Township, Grand Traverse County, Michigan  
 The 81 Development Co., LLC  
 Clarkston, Michigan



**SUBJECT SITE**  
 THE 81

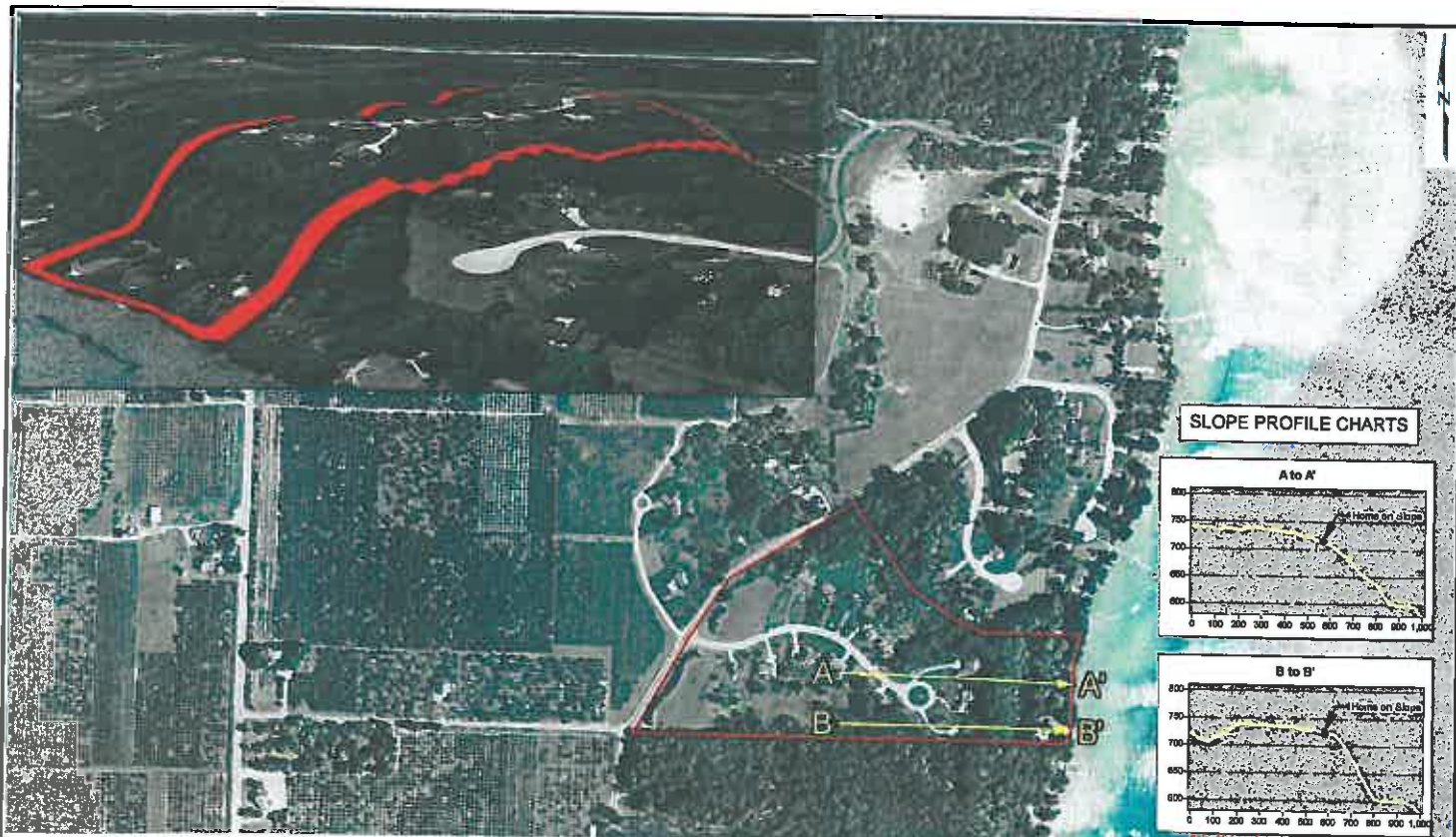
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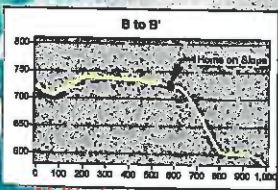
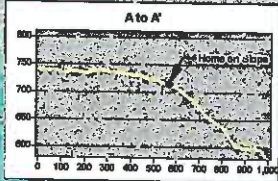
Fig. 2

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**SLOPE PROFILE CHARTS**



**SOURCE:**  
 Aerial Photo: USDA NAD 2016  
 Site Photo: Google Earth  
 Elevation: USGS NED Grand Traverse

**Legend**

-  Existing Elevation Profile
-  Site Boundary

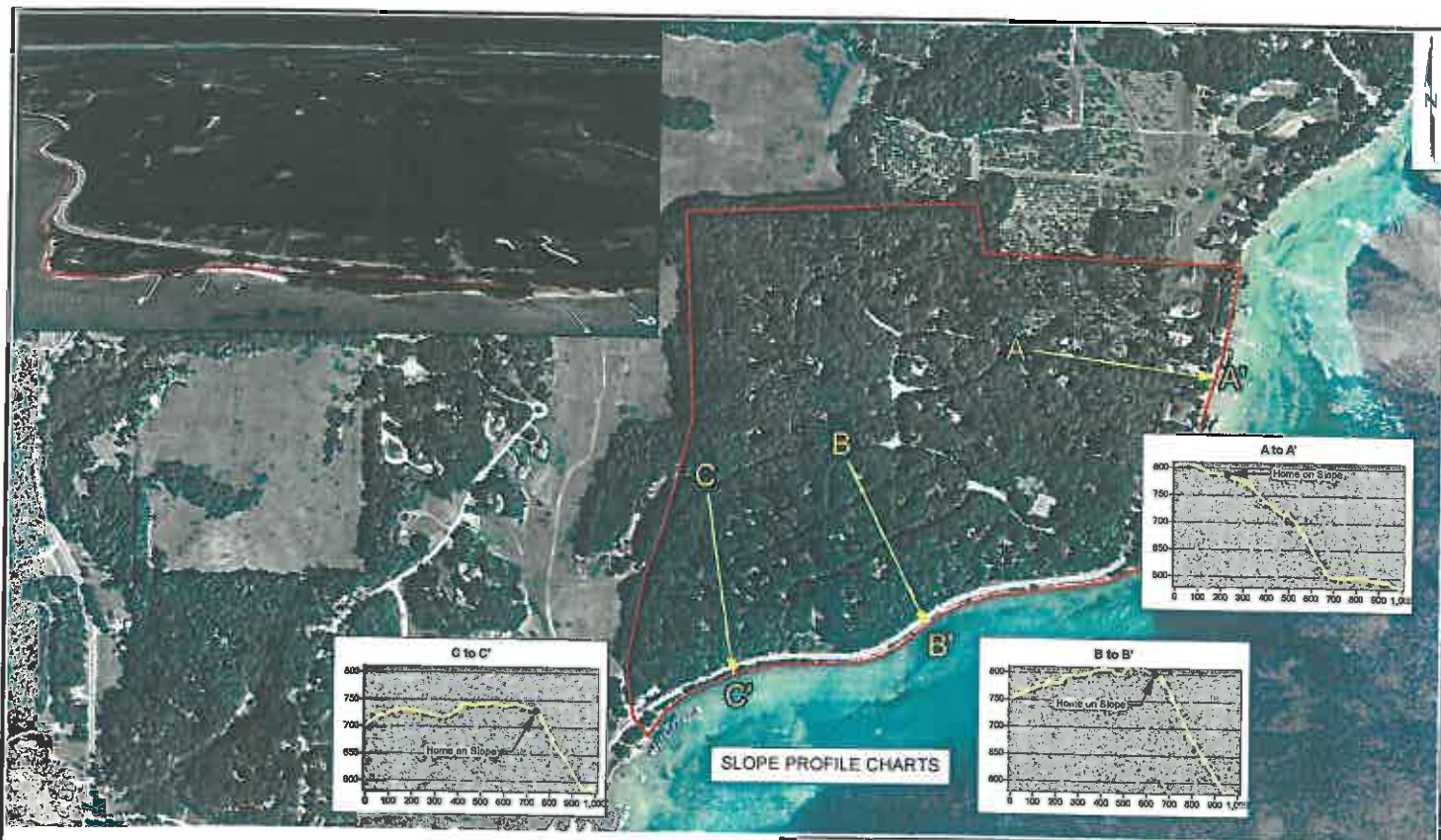


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 The 81 on East Bay  
 Peninsula Township, Grand Traverse County, Michigan  
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**COMPARABLE SITE 1**  
**SMOKEY RIDGE**  
 Project 1704495 December 2017





**SOURCE:**  
 Aerial Photo: USDA NAF 2016  
 Site Photo: Google Earth  
 Elevation: USGS MED Grand Traverse

**Legend**

- Existing Elevation Profile
- Site Boundary



Comparative Development Evaluation Report  
 The 81 on East Bay  
 Peninsula Township, Grand Traverse County, Michigan  
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**COMPARABLE SITE 2  
 THE BLUFF**

Project 1704495

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Fig. 4

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