

Keweenaw County Recession Rate Study 2017

Prepared by Kate Lederle, Specialist, High Risk Erosion Area Program
Great Lakes Shorelands Unit, Surface Water Assessment Section,
Water Resources Division, Michigan Department of Environmental Quality
Lansing, Michigan

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The shoreline of Keweenaw County was studied to update the recession rates previously determined in 1983. The State of Michigan is required to identify changes in the long-term rate of erosion occurring along the shoreline pursuant to R 281.22(22) of the Great Lakes Shorelands Administrative Rules, promulgated pursuant to Part 323, Shorelands Protection and Management, of the Natural Resources and Environmental Protection Act, 1994 PA 451 as amended. This study identifies shorelines where recession is occurring at an average annual rate of one foot or more per year based on a minimum period of 15 years, R 281.22(2).

Site Description

Keweenaw County is located in the western Upper Peninsula northwest of Marquette at the tip of the Keweenaw Peninsula in Lake Superior. The county has approximately 92 miles of Lake Superior shoreline amongst five townships: Allouez, Houghton, Eagle Harbor, Grant, and Sherman. The county is sparsely populated, with 2,156 people (2010 census). The shoreline structure varies and may be composed of bluffs of sandstone, exposed bedrock, cobble, and sand.

Methods

The study area was identified for the county. Included were all shorelines designated in 1983, areas identified as highly erodible by the United States Army Corps of Engineers (USACE) in 1971, and areas identified when viewing the 2012 USACE Oblique imagery and those areas identified by local government officials.

Imagery

The historic imagery used in the study was taken from the Department of Environmental Quality, Water Resources Division (DEQ-WRD) Aerial Imagery Archives. The available leaf-off imagery was reviewed and selected to represent the historic endpoint for the study. Efforts were made to ensure the study period was as long as possible to reflect water level fluctuations and storm events. Most of the historic aerial imagery used for the study was from April 1980 with a scale of 1:6000. The water level was 601.54 feet International Great Lakes Datum (IGLD) 1985. Historic imagery from May 1977 with a scale of 1:10,000 and water level of 601.28 feet IGLD 1985 were used in areas not covered by the 1980 imagery dataset, typically in Grant and Sherman Townships. Imagery was orthorectified to imagery collected in the spring of 2013 with a 1 foot resolution and available through the State of Michigan Department of Technology, Management, and Budget Center for Shared Solutions and a United States Geological Survey

National Elevation Dataset image with a 10 meter resolution was used to provide elevation information. The error due to orthorectification was approximately 0.6 feet plus or minus 0.3 feet.

The modern imagery was collected in May 2015 under contract with Applied Ecological Services, Brodhead, Wisconsin as part of a grant awarded to the Superior Watershed Partnership and Land Trust by the DEQ Office of Great Lakes. The imagery is housed on a DEQ-WRD external hard drive. The water level was 602.13 feet (IGLD 1985).

Erosion Hazard Line

The erosion hazard line (EHL) as defined in R 281.21 (1) (c) means the line along the shoreland that is the landward edge of the zone of active erosion or the line where the 604.4 feet, IGLD 1985, contour on Lake Superior meets the shoreland, whichever is furthest landward. The zone of active erosion means the area of the shoreland where the disturbance or loss of soil and substrate has occurred with sufficient frequency to cause unstable slopes or prevent vegetation of the area [R 281.21 (1) (r)]. The recession rate study compared the EHL on historic aerial photographs to the EHL on modern aerial photographs.

The historic EHL was determined by viewing the vegetation lines along the shoreline on the aerial photograph. The modern EHL was determined using the same method with the added information provided by low-level oblique aerial photographs, [2012 USACE Great Lakes Oblique Imagery](#), which shows detailed views of the shoreline from an offshore vantage point. An additional resource was the [Great Lakes Shoreline Geodatabase](#), which gives the approximate location of areas of various bluff heights among other attributes. Cross-referencing these resources with the modern imagery was helpful in determining the modern EHL. The shoreline was reviewed and the EHL was determined for all previously designated HREAs and areas of apparent erosion. The EHLs were hand-digitized.

Fieldwork

The location of the modern EHL was verified by gathering on-the-ground data using a sub meter Global Positioning System unit, Trimble Geo7x. All location data were differentially corrected. Data was gathered where there was public access such as at Seven Mile Point and W.C. Veale Park (2016) in Allouez Township and Great Sand Bay (2016) in Houghton Township. With landowner permission data was gathered along the shoreline of Great Sand Bay (2017) in Houghton.

All data were projected to Michigan Georef Meters North American Datum 83.

Hazard Area Identification

Transects were drawn perpendicular to the shoreline at 150 foot intervals and recession rates calculated along the transect lines. Digital Shoreline Analysis Software was used to determine recession rates. Similar rates were grouped into high risk erosion areas (Area). Average recession rates were calculated within each Area. Projected recession distances were determined for each Area (WRD-SWAS-028). Parcel boundaries and owner data was received from the Keweenaw County 911 Department. The current Area and parcel data were compared to the 1983 data to determine designation changes.

Within these hazard areas, placement of new construction requires a permit and must meet setback distances based on projected recession distances when combined with the type of construction and other site specific conditions. The projected recession distance is the calculated rate of recession for the area over a 30-year [for readily moveable structures, as defined in R 281.21 (1) (k)] or 60-year [for permanent structures, as defined in R 281.21 (1) (i)] period as determined by R 281.22 (2). The required setback distance is based on this rate but may be greater in areas of bluffs over 25 feet in height.

Affected parcels were classified under one of the following three categories:

New: These parcels were not designated during the previous study as being in an area of high risk erosion; however, the current study found the long-term rate of recession has increased to, or is above, the one-foot-per-year threshold required for HREA designation. The properties are designated and subject to the regulations and permit requirements under Part 323 and the promulgated rules for high risk erosion areas.

Lower or decreasing: These are parcels where the average rate of recession was documented to be greater than one foot per year during the previous study and are currently designated as being in an HREA. The current study documented a decrease in the long-term recession rate, but the erosion rate is still at or above one foot per year resulting in a decrease in the projected recession distances.

Dedesignation: These are parcels where the average rate of recession was documented to be one foot per year or greater during the previous study; however, the current study found the long-term rate of recession has fallen below the one-foot-per-year threshold required for HREA designation. The HREA designation is therefore removed, also eliminating the permit requirements under Part 323.

Public Notification

Letters explaining the proposed changes and information regarding the opportunities for input were sent to property owners, local officials and legislators on July 13, 2017. A webinar explaining the study and proposed changes was recorded on August 1, 2017; two people attended the Webinar. A meeting with local officials including township supervisors, county equalization staff, building code and zoning officials, sanitarians, and other affected local governmental agencies was held the afternoon of August 9, 2017, in the Courtroom at the County Courthouse, 5095 4th Street, in Eagle River; three local officials attended. A public meeting was held at the same location the evening of August 9, 2017; twelve members of the public attended. One landowner requested a site visit to their property to determine the current location of the erosion hazard line on their property.

Results

There are approximately 92 miles of Lake Superior shoreline in Keweenaw County. During the current study 25 percent (23 miles) of the shoreline was identified as needing study because it was either previously designated or showed signs of erosion. Of the shoreline studied 2.6 percent (0.6 miles) was determined to be in an area of high risk for erosion. Of the currently identified areas of high risk erosion 81 percent (0.49 miles) will be designated for the first time. In 1983, approximately four miles of Keweenaw County shoreline was designated as being at

high risk for erosion. Of the originally designated shoreline 3 percent (0.11 miles) remain designated. Nearly four miles of shoreline will be dedesignated. Descriptive statistics for the county and municipalities are provided in Appendix 1. Final maps dated September 14, 2017, are provided in Appendix 2. The local zoning ordinance requires structures be located 75 feet landward of the ordinary high water mark of Lake Superior (*personal communication*, Ann Gasperich, Keweenaw County Zoning Administrator).

The study will affect a total of 113 parcels. Six parcels will be newly designated in the county. Five parcels will have lower projected recession distances. A total of 102 parcels will be dedesignated and will no longer require new structures, or their additions, to be set back a specific distance from the erosion hazard line per Part 323.

Historic water levels were obtained from the USACE (2015). The mean long term water level for Lake Superior from 1918 to 2015 was 601.71 feet IGLD 1985. All rates are average monthly rates.

Allouez Township

The available historic imagery was dated April 1980 and the water level was 601.54 feet IGLD 1985. The modern imagery was dated May 2015 and the water level was 602.13 feet IGLD 1985 when acquired. The study period spanned 35 years.

The existing Areas off Cedar Bay Road were receding at rates of 1.4 and 1.8 feet per year in 1983. The study indicated the shoreline is receding at a rate of less than 1 foot per year.

The existing Area south of Hill Creek was receding at a rate of 1.6 feet per year in 1983. The study indicated the shoreline is receding at a rate of less than 1 foot per year.

The existing Areas east of Five Mile Point were receding at rates of 1.2 and 1.5 feet per year in 1983. The current study determined the area is no longer eroding at this rate and shoreline change is less than an annual average of 1 foot per year.

Houghton Township

The available historic imagery was dated April 1980 and the water level was 601.54 feet IGLD 1985. The modern imagery was dated May 2015 and the water level was 602.13 feet IGLD 1985 when acquired. The study period spanned 35 years.

The existing Area designated in 1983 in Great Sand Bay had a calculated average annual recession rate of 1.7 feet per year. Approximately 250 feet of shoreline within this area have a current recession rate of 1.2 feet per year. Recession in the rest of this area was measured to be less than an average annual rate of 1 foot per year.

Property owners, Mr. and Mrs. Bosanko, requested an individual review of their shoreline on Great Sand Bay. On-site location data of the erosion hazard line was collected on August 9, 2017. Visual observation noted a definitive erosion line at the edge of vegetation. The comparison of the collected data with the historic EHL supports the designation.

Eagle Harbor Township

The available historic imagery was dated April 1980 and the water level was 601.54 feet IGLD 1985. The modern imagery was dated May 2015 and the water level was 602.13 feet IGLD 1985 when acquired. The study period spanned 35 years.

The existing Area south of Cat Harbor was receding at a rate of 1.2 feet per year in 1983 and is now receding at a rate of less than 1 foot per year.

Grant Township

Historic imagery from 1977 and 1980 was used to study the Lake Superior shoreline of Grant Township. The historic imagery was dated May 1977, water level of 601.28 feet IGLD 1985. The historic imagery was dated April 1980 and the water level was 601.54 feet IGLD 1985. The modern imagery was dated May 2015, water level was 602.13 feet IGLD 1985 when acquired. The study period spanned a minimum of 35 years.

A new Area was noted in Keystone Bay, eroding at a rate of 1.1 feet per year. The 30-year projected recession distance is 50 feet, the 60-year projected recession distance is 80 feet.

The existing Area designated in Betsy Bay in 1983 had a calculated average annual recession rate of 1.2 feet per year and is now receding at a rate of less than 1 foot per year.

Sherman Township

The available historic imagery was dated May 1977 and the water level was 601.28 feet IGLD 1985. The modern imagery was dated May 2015 and the water level was 602.13 feet IGLD 1985 when acquired. The study period spanned 38 years.

No areas of erosion equal to or exceeding the regulatory annual average rate of 1 foot were noted in 1983. The area was studied in 2017 in response to local taxpayer concerns. During the study period the area was receding at a rate of less than an average of 1 foot per year.

All imagery and data are located in Lansing Michigan with the staff of the Great Lakes Shorelands Unit and Geographic Information System staff of the Wetlands, Lakes, and Streams Unit, Surface Water Assessment Section, Water Resources Division, Department of Environmental Quality.

Summary

The recession rate study meets the technical requirements of Subrule 2 (2). The high risk erosion area designations have changed on 113 parcels. With the higher water levels of Lake Superior the wave action will continue to erode the shoreline. Short term periods of significant erosion can be masked by the long-term average erosion rate. Because there is still a risk to structures from erosion, the property owner should be cautioned to locate new structures and additions set back from the bluff. When determining where to locate new projects they may want to consider using the previous study's projected recession distances as noted on the dedesignation letter. The 30-year projected recession distance applies to a readily moveable structure is a house of less than 3,500 square feet built on a basement or crawlspace. The 60-year projected recession distance applies to a non-readily moveable structure is a larger

house or a septic system. All structures should be built according to local building code and zoning ordinances.

References

United States Army Corps of Engineers. 2015. Coordinated Monthly Mean Lakewide Average Water Levels, 1918-2015. www.lre.usace.army.mil/Missions/Great-Lakes-Information/Great-Lakes-Water-Levels.

United States Census Bureau. 2010. <https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml>

WRD-SWAS-028. 2016. Department of Environmental Quality Water Resources Division Surface Water Assessment Section Policy and Procedure Part 323 – Determining Recession Rates of Great Lakes Shorelines.

Appendix 1. Keweenaw County descriptive statistics (all mileage is approximate).

Table 1. County-wide.

Year of Designation	1983	2017
Miles of shoreline in County = 92		
Miles of shoreline studied	unknown	23
Miles of shoreline designated	4	0.6
Miles of shoreline newly designated	4	0.5
Miles of shoreline that will remain designated	NA	0.1
Miles of shoreline with designation removed	NA	3.9
# of HREAs*	11	2
# of parcels designated	104	11
# of parcels newly designated	104	6
# of parcels remain designated	NA	5
# of parcels with designation removed	NA	102
Highest rate of recession (ft/yr) and PRDs** (ft)	1.7; 65/115	1.2; 50/85
Lowest rate of recession (ft/yr) and PRDs (ft)	1.2; 35/70	1.1; 50/80

The difference between the number of parcels designated in 1983 and the number of parcels with the designation removed in 2017 is attributed to parcel boundary changes made since 1983.

*HREA is High Risk Erosion Area per Part 323 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.

**PRD is the Projected Recession Distance (feet) at 30 years and 60 years respectively as referred to in Great Lakes Shorelands Rule 281.22.

Table 2a. Allouez Township descriptive statistics (all mileage is approximate).

Year of Designation	1983	2017
Miles of shoreline in Township = 14.5		
Miles of shoreline studied	unknown	5.5
Historic photo year	1954 and 1938	1980
Modern photo year	1980	2015
Number of years between historic and modern imagery	26 and 42	35
Miles of shoreline designated	1.3	0
Miles of shoreline newly designated	1.3	0
Miles of shoreline that will remain designated	NA	0
Miles of shoreline with designation removed	NA	1.3
# of HREAs*	5	0
# of parcels designated	45	0
# of parcels newly designated	45	0
# of parcels remain designated	NA	0
# of parcels with designation removed	NA	41
Highest rate of recession (ft/yr) and PRDs (ft)	1.7; 65/115	NA
Lowest rate of recession (ft/yr) and PRDs** (ft)	1.2; 35/70	NA

Table 2b. Allouez Township average annual recession rates and projected recession distances.

Study Site Name	1983 Rate (ft/yr)	1983 30yrPRD (ft)	1983 60yrPRD (ft)	2017 Rate (ft/yr)	2017 30yrPRD (ft)	2017 60yrPRD (ft)	2017 HREA	2017 Update Code
Five Mile Point	1.5	45	90	<1	NA	NA	NA	Dedesignated
Five Mile Point 2	1.2	35	70	<1	NA	NA	NA	Dedesignated
Hill Creek	1.6	60	110	<1	NA	NA	NA	Dedesignated
Cedar Bay	1.7	65	115	<1	NA	NA	NA	Dedesignated
Cedar Bay 2	1.4	40	85	<1	NA	NA	NA	Dedesignated

*HREA is High Risk Erosion Area per Part 323 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.

**PRD is the Projected Recession Distance (feet) at 30 years and 60 years respectively as referred to in Great Lakes Shorelands Rule 281.22.

Table 3a. Houghton Township descriptive statistics (all mileage is approximate).

Year of Designation	1983	2017
Miles of shoreline in Township = 3.3		
Miles of shoreline studied	unknown	2.5
Historic photo year	1954	1980
Modern photo year	1980	2015
Number of years between historic and modern imagery	26	35
Miles of shoreline designated	1.8	0.1
Miles of shoreline newly designated	1.8	0
Miles of shoreline that will remain designated	NA	0.1
Miles of shoreline with designation removed	NA	1.7
# of HREAs*	1	1
# of parcels designated	58	5
# of parcels newly designated	58	0
# of parcels remain designated	NA	5
# of parcels with designation removed	NA	52
Highest rate of recession (ft/yr) and PRDs** (ft)	1.7; 65/115	1.2; 50/85
Lowest rate of recession (ft/yr) and PRDs (ft)	NA	NA

Table 3b. Houghton Township average annual recession rates and projected recession distances.

Study Site Name	1983 Rate (ft/yr)	1983 30yrPRD (ft)	1983 60yrPRD (ft)	2017 Rate (ft/yr)	2017 30yrPRD (ft)	2017 60yrPRD (ft)	2017 HREA	2017 Update Code
Great Sand Bay	1.7	65	115	1.2	50	85	A1	Lower
Great Sand Bay	1.7	65	115	<1	NA	NA	NA	Dedesignated

*HREA is High Risk Erosion Area per Part 323 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.

**PRD is the Projected Recession Distance (feet) at 30 years and 60 years respectively as referred to in Great Lakes Shorelands Rule 281.22.

Table 4a. Eagle Harbor Township descriptive statistics (all mileage is approximate).

Year of Designation	1983	2017
Miles of shoreline in Township = 16.5		
Miles of shoreline studied	2	1.8
Historic photo year	1938	1980
Modern photo year	1980	2015
Number of years between historic and modern imagery	42	35
Miles of shoreline designated	0.7	0
Miles of shoreline newly designated	0.7	0
Miles of shoreline that will remain designated	NA	0
Miles of shoreline with designation removed	NA	0
# of HREAs*	1	0
# of parcels designated	8	0
# of parcels newly designated	8	0
# of parcels remain designated	NA	0
# of parcels with designation removed	NA	8
Highest rate of recession (ft/yr) and PRDs** (ft)	1.2; 35/70	NA
Lowest rate of recession (ft/yr) and PRDs (ft)	NA	NA

Table 4b. Eagle Harbor Township average annual recession rates and projected recession distances

Study Site Name	1983 Rate (ft/yr)	1983 30yrPRD (ft)	1983 60yrPRD (ft)	2017 Rate (ft/yr)	2017 30yrPRD (ft)	2017 60yrPRD (ft)	2017 HREA	2017 Update Code
South of Cat Harbor	1.2	35	70	<1	NA	NA	NA	Dedesignated

*HREA is High Risk Erosion Area per Part 323 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.

**PRD is the Projected Recession Distance (feet) at 30 years and 60 years respectively as referred to in Great Lakes Shorelands Rule 281.22.

Table 5a. Grant Township descriptive statistics (all mileage is approximate).

Year of Designation	1983	2017
Miles of shoreline in Township = 38		
Miles of shoreline studied	unknown	10.8
Historic photo year	1954	1977 and 1980
Modern photo year	1980	2015
Number of years between historic and modern imagery	26	38 and 35
Miles of shoreline designated	0.2	0.5
Miles of shoreline newly designated	0.2	0.5
Miles of shoreline that will remain designated	NA	0
Miles of shoreline with designation removed	NA	1
# of HREAs*	1	1
# of parcels designated	1	6
# of parcels newly designated	1	6
# of parcels remain designated	NA	0
# of parcels with designation removed	NA	1
Highest rate of recession (ft/yr) and PRDs** (ft)	1.2; 35/70	1.1; 50/80
Lowest rate of recession (ft/yr) and PRDs (ft)	NA	NA

Table 5b. Grant Township average annual recession rates and projected recession distances.

Study Site Name	1983 Rate (ft/yr)	1983 30yrPRD (ft)	1983 60yrPRD (ft)	2017 Rate (ft/yr)	2017 30yrPRD (ft)	2017 60yrPRD (ft)	2017 HREA	2017 Update Code
Aster Shipwreck Park	NA	NA	NA	<1	NA	NA	NA	NA
Keystone Bay	NA	NA	NA	1.1	50	80	A1	New
North of Lac LaBelle	NA	NA	NA	<1	NA	NA	NA	NA
Oliver Bay (picnic table)	NA	NA	NA	<1	NA	NA	NA	NA
Betsy Bay	1.2	35	70	<1	NA	NA	NA	Dedesignated

*HREA is High Risk Erosion Area per Part 323 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.

**PRD is the Projected Recession Distance (feet) at 30 years and 60 years respectively as referred to in Great Lakes Shorelands Rule 281.22.

Table 6a. Sherman Township descriptive (all mileage is approximate) statistics.

Year of Designation	1983	2017
Miles of shoreline in Township = 8		
Miles of shoreline studied	Hermit Bay	2.4
Historic photo year	1938	1977
Modern photo year	1977	2015
Number of years between historic and modern imagery	39	38
Miles of shoreline designated	0	0
Miles of shoreline newly designated	0	0
Miles of shoreline that will remain designated	NA	0
Miles of shoreline with designation removed	NA	0
# of HREAs*	NA	0
# of parcels designated	NA	0
# of parcels newly designated	NA	0
# of parcels remain designated	NA	0
# of parcels with designation removed	NA	0
Highest rate of recession (ft/yr) and PRDs** (ft)	NA	NA
Lowest rate of recession (ft/yr) and PRDs (ft)	NA	NA

Table 6b. Sherman Township average annual recession rates and projected recession distances.

Study Site Name	1983 Rate (ft/yr)	1983 30yrPRD (ft)	1983 60yrPRD (ft)	2017 Rate (ft/yr)	2017 30yrPRD (ft)	2017 60yrPRD (ft)	2017 HREA	2017 Update Code
North of Tobacco River	NA	NA	NA	<1	NA	NA	NA	NA
Gay	NA	NA	NA	<1	NA	NA	NA	NA

*HREA is High Risk Erosion Area per Part 323 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.

**PRD is the Projected Recession Distance (feet) at 30 years and 60 years respectively as referred to in Great Lakes Shorelands Rule 281.22.

Appendix 2. Maps.

Index of maps.

Map Name	Study Site Name	Municipality	Township Range Section
Cedar Bay Road	Cedar Bay, Cedar Bay 2	Allouez Township	T57N R33W Section 27
Hill Creek	Hill Creek	Allouez Township	T57N R33W Section 22, 23
Five Mile Point	Five Mile Point, Five Mile Point 2	Allouez Township	T58N R32W Section 26 T58N R32W Section 27, 28
Great Sand Bay	Great Sand Bay	Houghton Township	T58N R31W Section 18, 17, 16
South of Cat Harbor	South of Cat Harbor	Eagle Harbor Township	T58N R31W Section 10
Keystone Bay	Keystone Bay	Grant Township	T58N R27W Section 20
Betsy Bay	Betsy Bay	Grant Township	T58N R30W Section 36

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Lake Superior

SECTION 27
T57N R33W

SECTION 26
T57N R33W

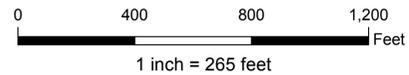
High-Risk Erosion Area Update - 2017

Allouez Township, Keweenaw County
T57N, R33W Section 27

Cedar Bay Road

High Risk Erosion Areas De-Designated Parcels

-  Roads
-  1983 HREAs (approximate)
-  Sections
-  Parcels
-  De-Designated Parcels



MAP INFORMATION:

This map identifies potential High-Risk Erosion Areas under Part 323, Shorelands Protection and Management, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. The shaded areas indicate recession of at least one foot per year.

Background imagery, as well as roads and survey data were provided by the State of Michigan, Center for Shared Solutions and Technology Partnerships.

Questions regarding this map should be directed to the Michigan Department of Environmental Quality at 517-284-5567.



Map Created by: Jeremy Jones
Environmental Quality Analyst
Water Resources Division
Michigan Department Of Environmental Quality
9/14/2017

Recession/Accretion values for each area were calculated using the Digital Shoreline Analysis System from the USGS (Thaler, E.R., Himmelstoss, E.A., Zichichi, J.L., and Ergul, Ayhan, 2009, Digital Shoreline Analysis System (DSAS) version 4.0 - An ArcGIS extension for calculating shoreline change: U.S. Geological Survey Open-File Report 2008-127).

Lake Superior

SECTION 22
T57N R33W

SECTION 14
T57N R33W

SECTION 23
T57N R33W

Allouez Twp

Allouez Twp

Hill Creek

Hill Creek

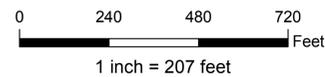
High-Risk Erosion Area Update - 2017

Allouez Township, Keweenaw County
T57N, R33W Section 22, 23

Hill Creek

High Risk Erosion Areas De-Designated Parcels

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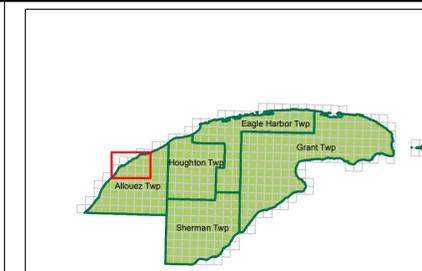


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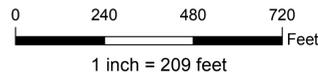
High-Risk Erosion Area Update - 2017

Allouez Township, Keweenaw County
T58N, R32W Section 28, 27, 26

Five Mile Point

High Risk Erosion Areas De-Designated Parcels

- Roads
- 1983 HREAs (approximate)
- Sections
- Parcels
- De-Designated Parcels



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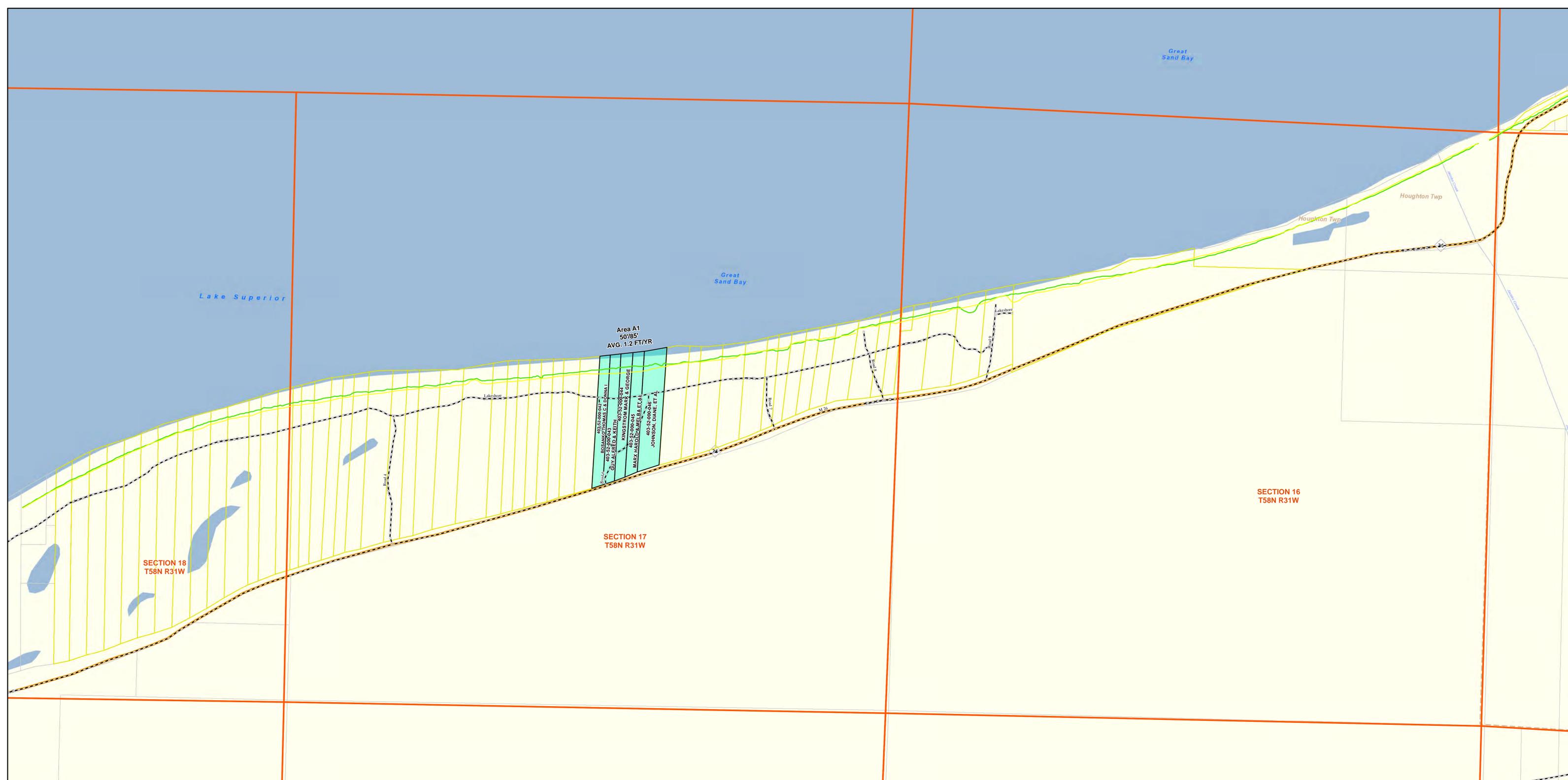
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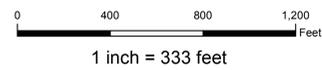
High-Risk Erosion Area Update - 2017

Houghton Township, Keweenaw County
T58N, R31W Section 17

Great Sand Bay

High Risk Erosion Areas 30 YR/60 YR Projected Recession Distance (Feet) Average Annual Rate of Recession (FT/YR)

AREA A1: 50'/85' (Avg. 1.2 FT/YR)



- Roads
- Sections
- HREA Parcels
- 1983 HREAs (approximate)
- Parcels
- De-Designated Parcels

MAP INFORMATION:

This map identifies potential High-Risk Erosion Areas under Part 323, Shorelands Protection and Management, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. The shaded areas indicate recession of at least one foot per year.

Background imagery, as well as roads and survey data were provided by the State of Michigan, Center for Shared Solutions and Technology Partnerships.

Questions regarding this map should be directed to the Michigan Department of Environmental Quality at 517-284-5567.



Map Created by: Jeremy Jones
Environmental Quality Analyst
Water Resources Division
Michigan Department Of Environmental Quality
9/14/2017

Recession/Accretion values for each area were calculated using the Digital Shoreline Analysis System from the USGS (Thaler, E.R., Himmelstoss, E.A., Zichichi, J.L., and Ergul, Ayhan, 2009, Digital Shoreline Analysis System (DSAS) version 4.0 - An ArcGIS extension for calculating shoreline change: U.S. Geological Survey Open-File Report 2008-127).

Lake Superior

SECTION 10
T58N R31W

SECTION 11
T58N R31W

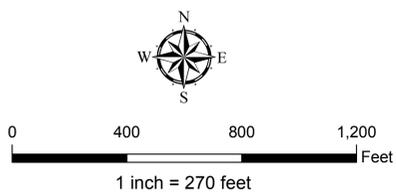
High-Risk Erosion Area Update - 2017

Eagle Harbor Township, Keweenaw County
T58N, R31W Section 10, 11

South of Cat Harbor

High Risk Erosion Areas De-Designated Parcels

-  Roads
-  1983 HREAs (approximate)
-  Sections
-  Parcels
-  De-Designated Parcels



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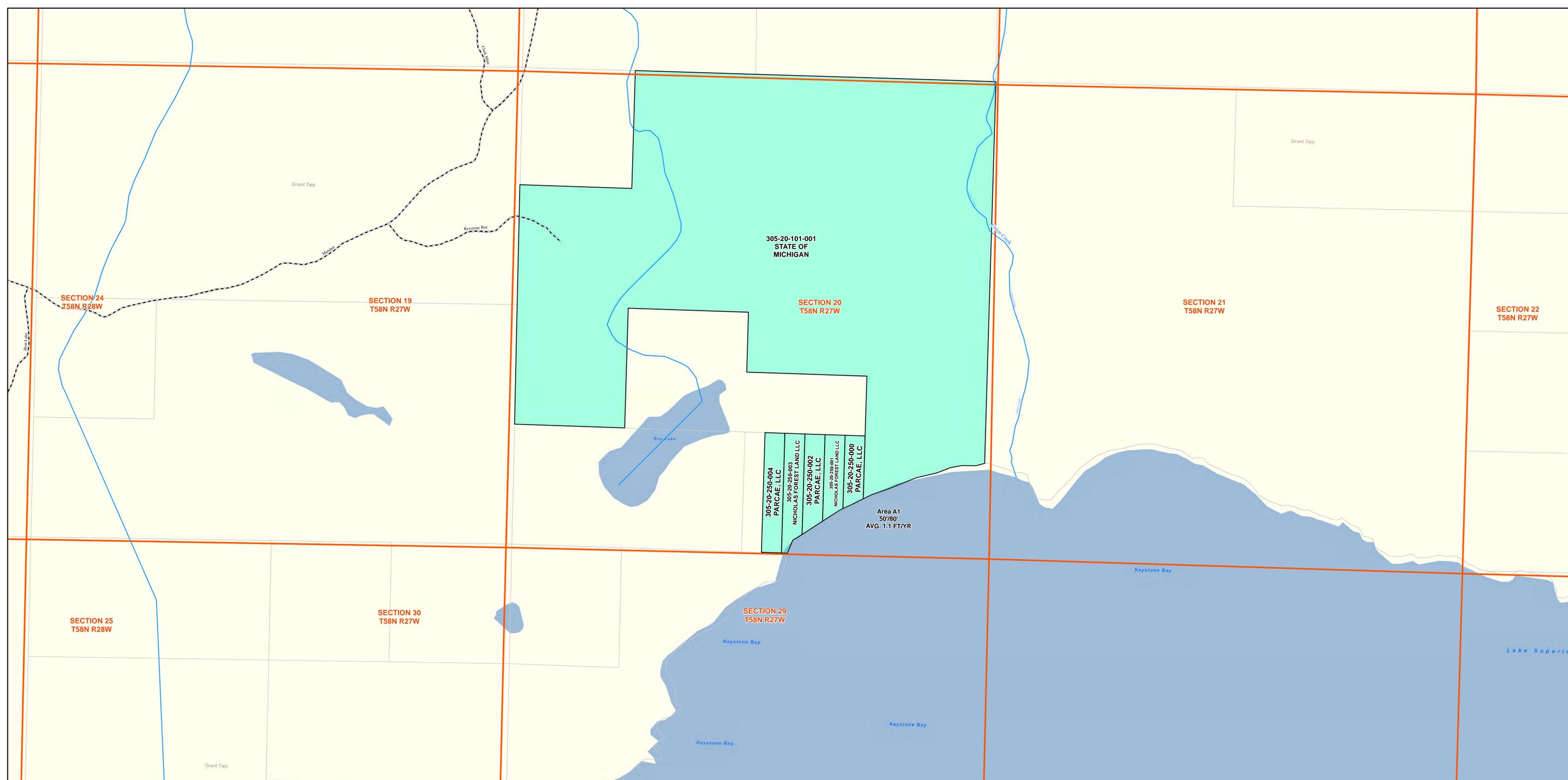
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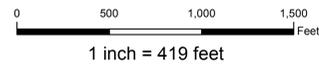
High-Risk Erosion Area Update - 2017

Grant Township, Keweenaw County
T58N, R27W Section 20

Keystone Bay

High Risk Erosion Areas 30 YR/60 YR Projected Recession Distance (Feet) Average Annual Rate of Recession (FT/YR)

AREA A1: 50/80' (Avg. 1.1 FT/YR)



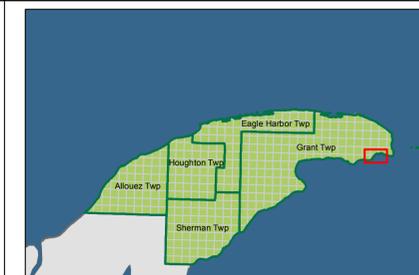
- Roads
- Sections
- Parcels
- HREA Parcels

MAP INFORMATION:

This map identifies potential High-Risk Erosion Areas under Part 323, Shorelands Protection and Management, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. The shaded areas indicate recession of at least one foot per year.

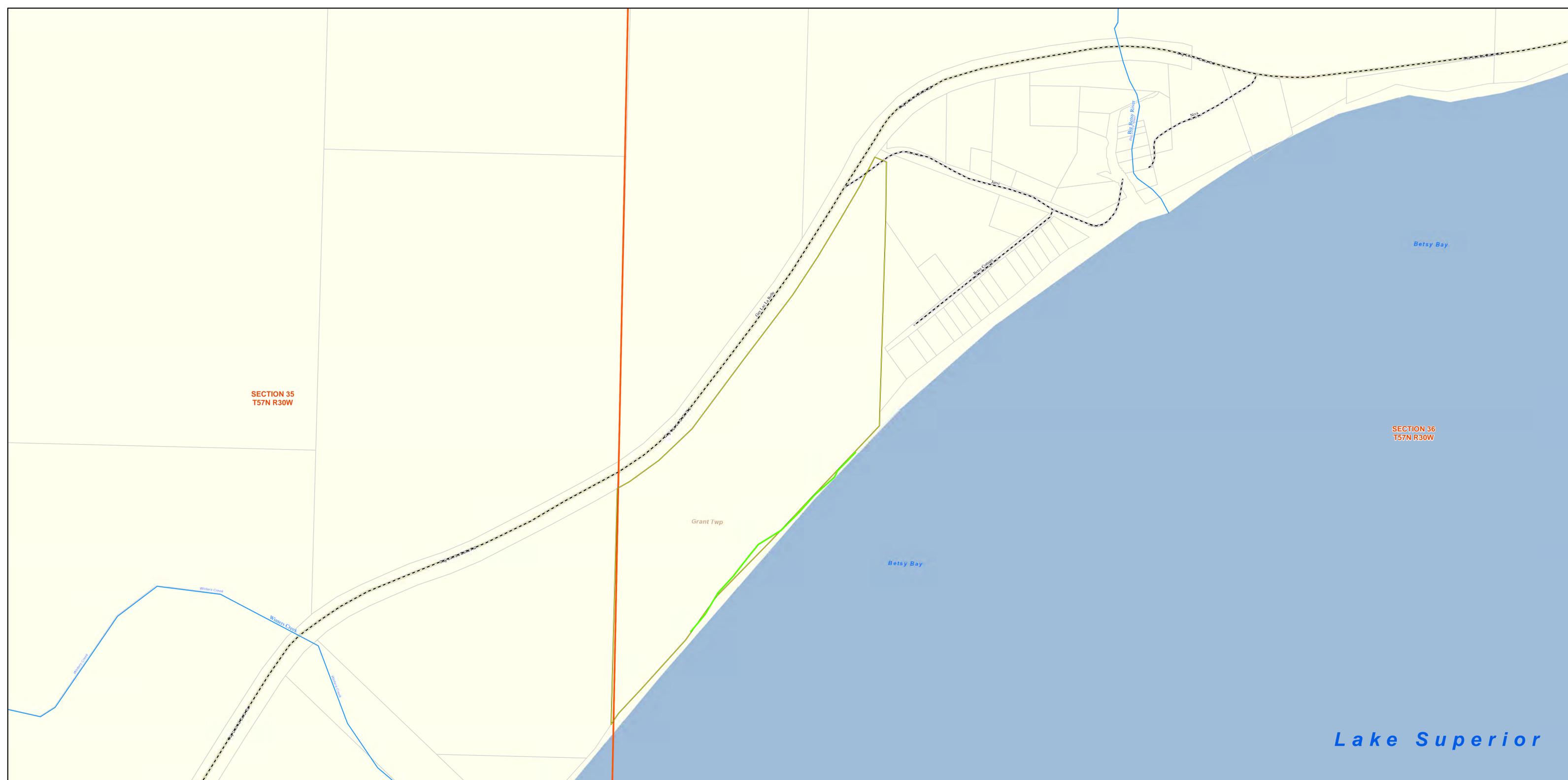
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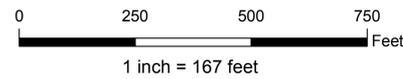
High-Risk Erosion Area Update - 2017

Grant Township, Keweenaw County
T57N, R30W Section 36

Betsy Bay

High Risk Erosion Areas De-Designated Parcels

- Roads
- 1983 HREAs (approximate)
- Parcels
- Sections
- De-Designated Parcels



MAP INFORMATION:

This map identifies potential High-Risk Erosion Areas under Part 323, Shorelands Protection and Management, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. The shaded areas indicate recession of at least one foot per year.

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