National Park Service
US Department of the Interior

Sleeping Bear Dunes National Lakeshore
Michigan

Sleeping Bear Dunes National Lakeshore

Improved Boat Access at the Manitou Islands

Environmental Assessment

April 2024

Back of Front Cover

EXECUTIVE SUMMARY

The National Park Service (NPS) at Sleeping Bear Dunes National Lakeshore (the park) has prepared an Environmental Assessment (EA) to evaluate the action alternative to continue providing safe and consistent boat access to unique visitor experiences at North and South Manitou Islands by developing sustainable and resilient solutions to longstanding access issues.

This EA analyzes the potential impacts these alternatives would have on the natural, historic, and human environment. This EA has been prepared in accordance with the National Environmental Policy Act of 1969 (NEPA), as amended (42 United States Code [USC] 4332[2] [C]); the implementing regulations of the Council on Environmental Quality (40 Code of Federal Regulations [CFR] 1500-1508); the Department of the Interior NEPA regulations (43 CFR Part 46); and NPS Director's Order #12: *Conservation Planning, Environmental Impact Analysis and Decision-Making* (NPS 2011) and the accompanying NEPA Handbook (NPS 2015).

Two alternatives for each island: the no-action alternative and the NPS action alternative (construction of a new dock and demolition of the existing dock). Under the no-action alternative, changes would be made to the docks on an as-needed basis and occasional dredging would be required to enable continued vessel access to the islands. Under the action alternative, new docks would be constructed in new locations on both of the Manitou Islands and the existing docks would be demolished. The alternatives are described in detail in chapter 2.

Note to Reviewers and Respondents:
This EA will be on formal public and agency review for 30 days from April 15, 2024, to May 15, 2024. If you wish to comment, please provide comments on the NPS Planning, Environment & Public Comment (PEPC) website at https://parkplanning.nps/gov/manitou-docks or by mailing to the name and address below. Mailed comments must be post marked by May 15, 2024. Before including your address, phone number, email address, or other personal identifying information in your comment, you should be aware that your entire comment, including your personal identifying information, may be made publicly available at any time. While you can ask us in your comment to withhold your personal identifying information from public review, we cannot guarantee that we will be able to do so.

Attn: Superintendent
RE: Improving Boat Access at the Manitou Islands
Sleeping Bear Dunes National Lakeshore
9922 Front Street
Empire, MI 49630

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1: PURPOSE AND NEED

1.1 INTRODUCTION

Sleeping Bear Dunes National Lakeshore (the park) was established by Congress in 1970 and comprises over 71,000 acres, including a 35-mile stretch of Lake Michigan's eastern shoreline and North and South Manitou Islands. The purpose of the park is to "preserve outstanding natural features, including forests, beaches, dune formations, wilderness character, and ancient glacial phenomena in their natural setting and protect them from developments and uses that would destroy the scenic beauty and natural character of the area, for the benefit, inspiration, education, recreation, and enjoyment of the public." (NPS 2016). Prior to its establishment as a national park, the area was settled or visited by American Indians, lumbermen, merchant sailors, and farmers, and has a long history of hunting, fishing, fur trading, timbering, and farming (NPS 2016).

The park's rich maritime history plays an important role in its significance, drawing over 1 million visits annually (NPS 2015). In order for visitors to access the Manitou Islands, they must take a passenger ferry or private boat from the mainland. In recent years, sand accumulation around the docks has affected visitor access, especially via the ferry service. At South Manitou Island, the park has extended the existing dock in an effort to provide access in deeper water but continued sand accumulation threatens to limit access. At North Manitou Island, sediment accumulation has resulted in a lack of functional access to the dock twice in the last three years and requires frequent, costly, and difficult dredging efforts. Shifting sands, part of a natural process known as littoral drift, have caused sand to accumulate around the existing docks, requiring regular dredging and improvements at the docks on both islands for continued access. High water levels in the lake and lack of ice cover in the last few years have worsened shoreline erosion and caused issues at the docks. The proposed project is needed to address these concerns. The purpose of this project is to provide safe and consistent boat access to the unique visitor experiences at North and South Manitou Islands by developing sustainable and resilient solutions to longstanding issues.

1.2 PROJECT AREA LOCATION AND DESCRIPTION

The park is situated in the northwestern portion of Michigan's Lower Peninsula and encompasses a total of 71,187 acres. The projects considered in this document are located on North and South Manitou Islands, which are located northwest of the park's mainland shoreline in Lake Michigan. North Manitou Island and South Manitou Island are approximately 12 and 16 miles west of Leland, MI, respectively. The concessioner ferry that most passengers use to access the Manitou Islands departs from the Leland Harbor. See figure 1 below for a map of the project vicinity.

The South Manitou Island project area is located along the natural harbor on the eastern side of the island. The project area encompasses the visitor services hub (which includes the visitor contact station, restrooms, and the historic South Manitou Life-Saving Station) where the existing dock is located and extends 1 mile north to Chicago Road where the new dock is proposed. The project area includes the old county roads connecting the two dock locations, and those areas proposed for new construction, access, and staging. The South Manitou Island project area is shown on figure 2.

The North Manitou Island project area is located on the eastern side of the island, anchored on the existing dock location. The project area generally comprises the existing dock; the area up to and including 400 feet north of the existing dock, where the proposed new dock would be constructed; and the area extending 3,600 feet south of the existing dock, along which sandy dredged material would be disposed. The boundaries of the North Manitou Island project area are shown on figure 3.

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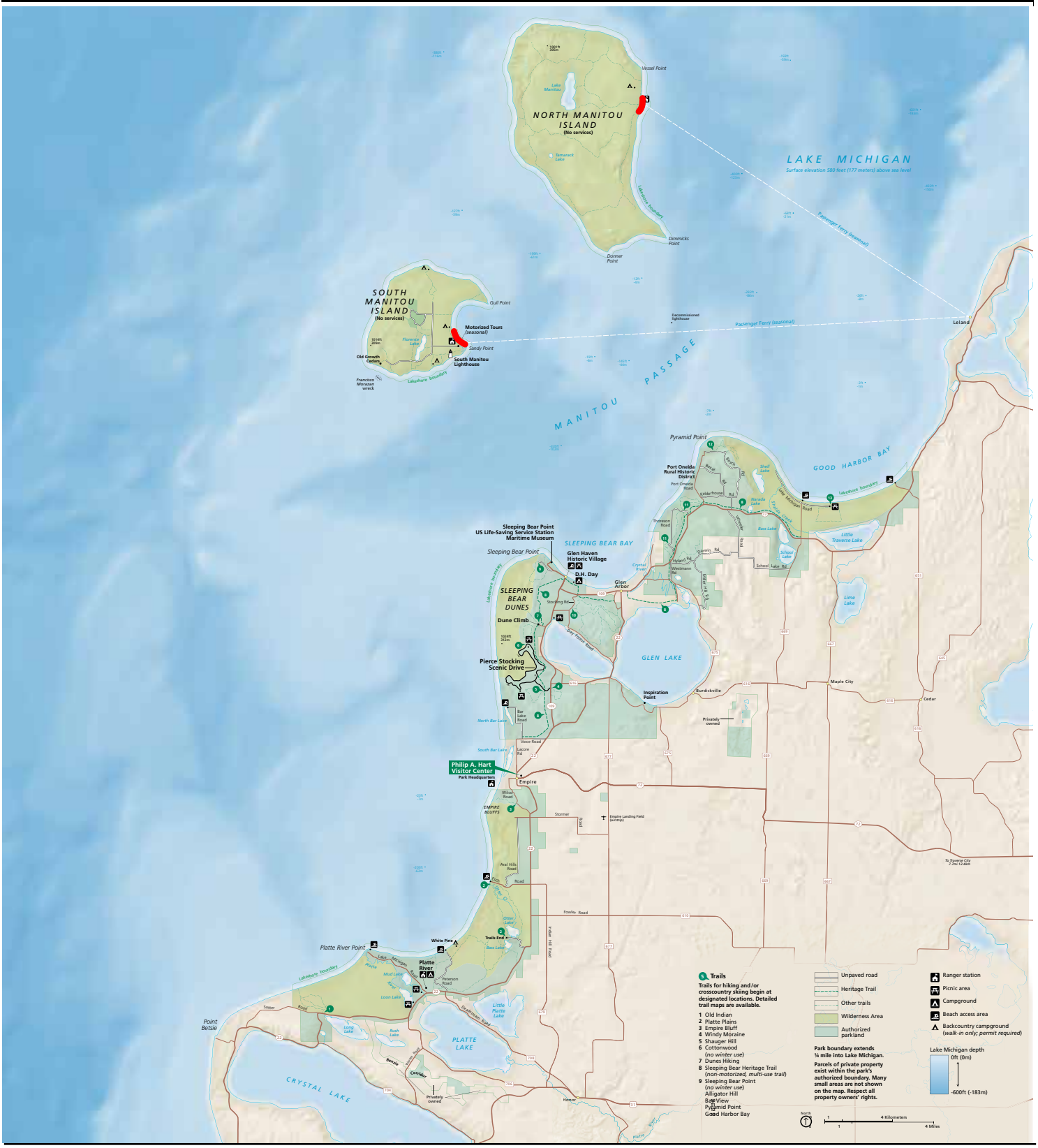

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Figure 1. Project Vicinity Map

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Project Area Boundary

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Figure 2: South Manitou Island Project Area

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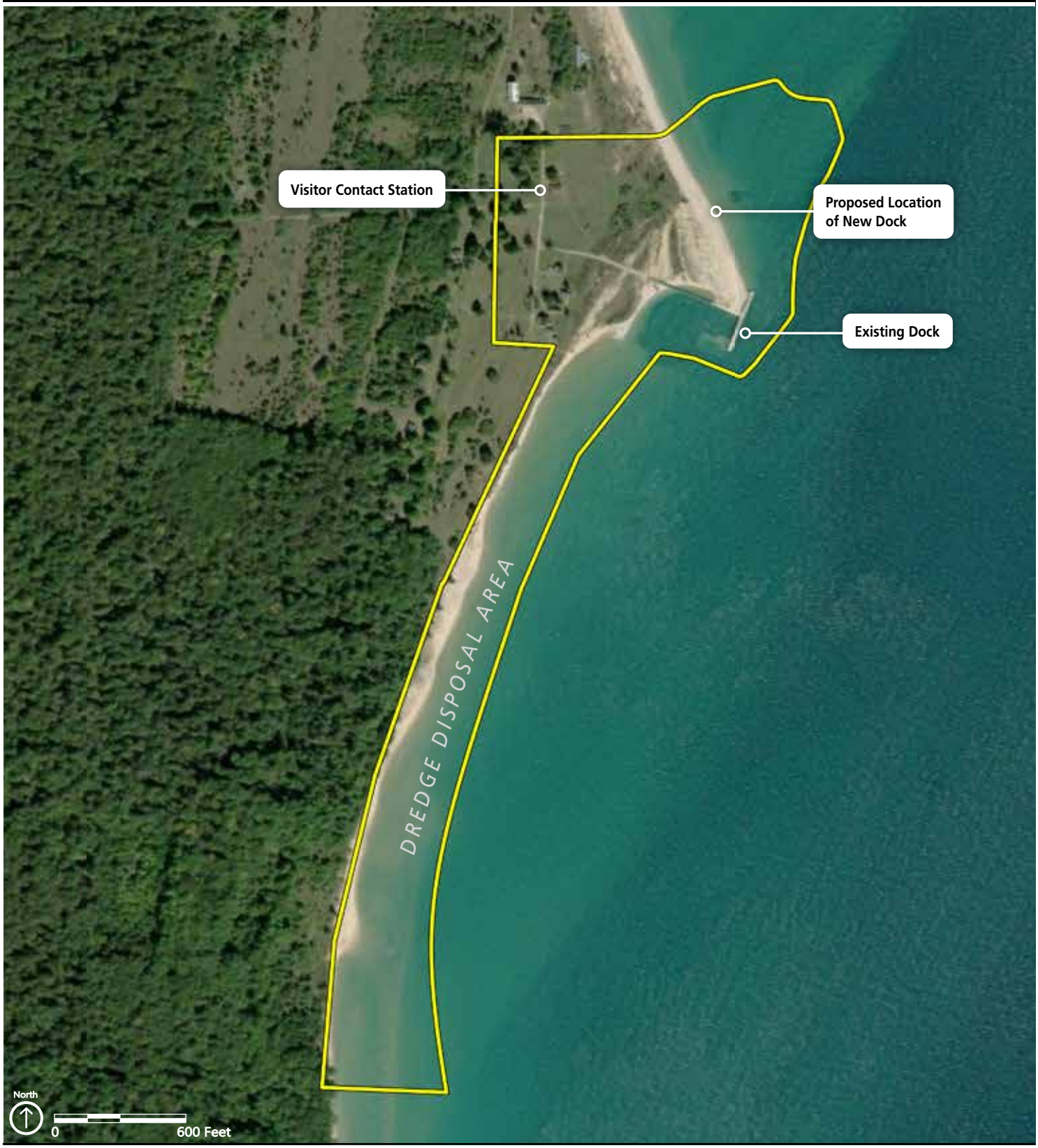

Project Area Boundary

Improved Boat Access at the Manitou Islands
Environmental Assessment

Figure 3. North Manitou Island Project Area

1.3 PURPOSE OF AND NEED FOR ACTION

The purpose of the action alternative is to provide safe and consistent boat access to the unique visitor experiences at North and South Manitou Islands by developing sustainable and resilient solutions to longstanding issues. The project is needed because shifting sands, part of a natural process known as littoral drift, have caused sand to accumulate around the existing docks, requiring regular dredging at North Manitou Island and extensive dock repairs and modifications at South Manitou Island in an effort to maintain access. High water levels in the lake and lack of frozen conditions in the last few years have allowed increasing volumes of sand to shift along the island shorelines (both eroding and accumulating, as dictated by local conditions). Both high water levels and sediment build-up have caused issues at the current dock locations.

1.4 ISSUES AND IMPACT TOPICS

During the planning process, the National Park Service (NPS) identified specific impact topics as critical to this project area. Impact topics are a means of organizing the discussion of issues and analysis of impacts. In the context of National Environmental Policy Act of 1969 (NEPA) reviews, issues can be problems, concerns, conflicts, obstacles, or benefits that would result if the action alternative or alternatives, including the no-action alternative, are implemented. During the scoping process, impact topics were either retained for further analysis or dismissed from further consideration. This section provides an overview of the impact topics that were retained for analysis. A topic was retained for analysis if it met one or more of the following conditions:

- the environmental impacts associated with the issue are central to the proposal or of critical importance;
- a detailed analysis of environmental impacts related to the issue is necessary to make a reasoned choice between alternatives;
- the environmental impacts associated with the issue are a big point of contention among the public or other agencies; or
- there are potentially significant impacts to resources associated with the issue.

The following five topics will be further analyzed in chapter 3, Affected Environment and Environmental Consequences, of this EA: visitor use, experience, and safety; wetlands and waters of the US; historic and cultural resources; vegetation; and special status species.

The following issues have been **dismissed from detailed analysis** because they are not central to the proposal or do not assist with making a reasoned choice between alternatives:

Socioeconomics and Environmental Justice

The action alternative would likely have an unmeasurable minor, beneficial impact on employment, occupations, income, or tax base at the park or surrounding area. Therefore, socioeconomics has been dismissed from further analysis.

The Department of the Interior requires its bureaus to specifically discuss and evaluate the impacts of their actions on minority and low-income populations and communities, as well as the equity of the distribution of the benefits and risk of the decision (NPS 2015). Environmental justice was considered but dismissed from further analysis for the following reasons:

- The park staff and planning team solicited public participation as part of the planning process and gave equal consideration to all input from persons regardless of age, race, income status, or other socioeconomic or demographic factors.
- Implementation of the action alternative would not result in any identifiable adverse human health effects. Therefore, there would be no direct or indirect adverse impacts on any minority or low-income population.
- The impacts associated with implementation of the action alternative would not disproportionately affect any minority or low-income population or community.
- Implementation of the action alternative would not result in any identified effects that would be specific to any minority or low-income community.

Soundscapes

Under the action alternative there would be no major change in the soundscape on North and South Manitou Islands. There would be an increase in noise emitted by machinery and construction activities that would end following the completion of the project. All best management practices would be followed to minimize and avoid effects on visitors and sensitive wildlife species. Long term, boats accessing the islands would use the new dock locations, which would be a spatial shift of approximately 1 mile on South Manitou Island and approximately 400 feet on North Manitou Island. The change in location would not noticeably change the potential to affect visitor experiences or sensitive species. For these reasons, this topic has been dismissed from further analysis.

Lightscapes

Under the action alternative there would be no major change in the lightscape (including night sky) of either North or South Manitou Islands. Under the action alternative there would be temporary impacts due to equipment and safety measures (for example, use of lights on anchored vessels). These impacts would be limited to what is required for safety during construction and would end once construction is completed (each dock is expected to be completed within one spring to fall season, excluding relevant wildlife closures, perhaps in the same year or perhaps in concurrent years). Due to the lack of noticeable permanent impacts associated with the action alternative expected on lightscapes on both islands, this topic has been dismissed from further analysis.

Wilderness

Most of North and South Manitou Islands are designated as wilderness areas. Per the minimum requirements analysis described in the Wilderness Act and subsequent NPS *Management Policies* (2006) and Director's Order 41 (described in NPS 2024a), the NPS applied this concept which "is a documented process used to determine if administrative actions, projects, or programs undertaken by the Service or its agents and affecting wilderness character, resources, or the visitor experience are necessary, and if so how to minimize impacts" (NPS 2006). This two-step process considers the necessity of the proposed management action and its impact to wilderness resources and character, as well as the techniques and types of equipment needed to ensure that impacts on wilderness resources and character are minimized (NPS 2006). The action alternative has been designed to avoid proposing any actions within wilderness areas by designing improvements within the county road right of ways excluded from wilderness on South Manitou Island and by designing improvements within the vicinity of the existing development at North Manitou Island. Although the project would avoid any direct, permanent impacts on wilderness character, construction activities may cause noise that slightly diminishes the opportunities for a natural and solitary experience for those within earshot of the improvements under construction. Following construction (which is expected to span one or two warm seasons), any changes to wilderness character would be limited to the sound of some additional vehicle use along Chicago Road, which would quickly dissipate through the forest. Additionally, the location of the proposed relocated South Manitou Dock may improve visitor access to the wilderness of that island. For these reasons, the topic has been dismissed from further analysis.

Floodplains

Due to the water-dependent nature of the proposed improvements, some of the associated development would take place within the floodplain. These structures would be designed to withstand flooding with minimal impediment to floodwaters. Due to the lack of noticeable impacts expected on floodplains with the action alternative, this topic has been dismissed from further analysis in this document. In compliance with Executive Order 11988: Floodplain Management, a Floodplains Statement of Findings is available in appendix A.

Wildlife (Non-Special Status Species)

Under the action alternative there would be no major change to the wildlife on North and South Manitou Islands. The action alternative would use heavy machinery, which may cause temporary daytime disturbance of wildlife using the project area. Some clearing of the forest (approximately 1.3 acres) and small, isolated wetland habitat (66 square feet or less than 0.002 acre) would be removed along Chicago Road to re-establish the road for regular use; however, this habitat removal represents a very small portion of habitat available on the island. Impacts on wetlands are addressed under the "Wetlands and Waters of the US" topic. Species of particular concern are addressed under the "Special Status Species" topic. Best management practices related to those special status species may also mitigate some impacts on other wildlife. For these reasons, this topic has been dismissed from further analysis. Further analysis of special status species can be found in chapter 3 of this document.

Non-Native/Noxious Species

While some non-native and invasive species may exist within the project area, this project would implement best management practices to avoid introducing or spreading non-native/noxious species, including forest pests. For example, there would be a risk of introducing and spreading oak wilt and hemlock woody adelgid from the mainland on construction vehicles under the action alternative. With mitigation, this risk would be greatly reduced. Mitigations for such impacts include best management practices to avoid and minimize the spread of invasive species and pests, such as ensuring that construction-related equipment arrives at the site free of mud or seed-bearing materials and certifying that all seeds are weed-free, inspecting equipment for debris prior to arrival to the islands, cutting oak trees outside of the active period for oak wilt, and having proper wound treatment measures in place for any affected trees. For these reasons, this topic has been dismissed from further analysis.

Indian Trust Resources

The Department of the Interior requires its bureaus to explicitly consider effects of its actions on Indian Trust resources in environmental documents (NPS 2015). The federal Indian Trust responsibility is a legally enforceable obligation on the part of the United States to protect tribal lands, assets, resources, and treaty rights, and it represents a duty to carry out the mandates of federal laws with respect to Native American tribes. The land comprising the park (including North and South Manitou Islands) was acquired by the US Government as part of the 1836 Treaty of Washington. Under this treaty, the US Government paid for nearly 14,000,000 acres of land, ceded by the Odawa and Ojibway nations of Native Americans (known collectively as the Anishinaabek) and guaranteed permanent reservation lands and perpetual access to natural resources, including hunting and fishing rights for the Anishinaabek. The terms of the treaty were subsequently altered by the US Government without the consent of the Anishinaabek, modifying their claim from permanent rights to only two years following signature of the treaty. The Anishinaabek successfully fought back against forcible removal from Northern Michigan and their claims were secured in the 1855 Treaty of Detroit (Mackinac Associates 2017). Implementation of this project would not affect these treaty rights including perpetual access to natural resources, along with hunting and fishing rights within Northern Michigan. Five tribes were consulted in preparation of this document and provided input that was considered by the planning team. Therefore, the impact topic of Indian Trust resources was considered but dismissed from further analysis.

CHAPTER 2: ALTERNATIVES

This chapter describes actions that would take place under each alternative. The Council on Environmental Quality (CEQ) regulations for implementation of the NEPA process call for the alternatives considered in a document to include a no-action alternative. The description and evaluation of this alternative provides a baseline to which action alternatives can be compared. This Environmental Assessment (EA) evaluates two alternatives: "Alternative A: No Action" and "Alternative B: Action Alternative – Construct New Docks (Preferred)." The elements of these alternatives are described in the following sections. Impacts associated with the alternatives are described in "Chapter 3: Affected Environment and Environmental Consequences."

2.1 ALTERNATIVE A: NO ACTION

South Manitou Island

Under the no-action alternative, maintenance of and dredging at the existing dock would be conducted on an as-needed basis, as funding allows. No new dock would be constructed. The wooden deck surface of the existing dock would continue to weather, with varying board elevations and visible cracking and residue buildup. As the dock ages, the need for repairs to keep the dock in safe working order would likely become more frequent. The configuration and location of the existing dock would likely continue to result in sediment buildup around the dock, creating shallow water conditions not suitable for vessel docking. To maintain access to the dock for boats, dredging would begin to be required every few years.

North Manitou Island

Under the no-action alternative, the NPS would continue to use the existing dock, and no new dock would be constructed. This dock is constructed of steel and concrete elements, which require minimal repairs; however, the sand in this area is building up in a way that then covers portions of the walkway completely, requiring sand removal to make it safe for park visitors and staff to walk along it. Under the no-action alternative, the need to remove sand from the walkway would likely become more frequent. The configuration and location of the existing dock would continue to require dredging on an annual or potentially more frequent basis to enable continued vessel access to the island and prevent overtopping the mooring locations along the dock. Frequent and extensive dredging at this area would be dependent upon the availability of funding for these costly operations.

2.2 ALTERNATIVE B: ACTION ALTERNATIVE – CONSTRUCT NEW DOCKS (PREFERRED)

The action alternative at both islands is construction of a new dock and demolition of the existing dock. Both docks have been designed with resiliency in mind. Precast concrete panels would be used for decking surfaces instead of wood. Steel piles were selected over wood piles to minimize the likelihood of damage due to wave action and to account for uplift forces from wave and ice action. Design also incorporates both 50-year storm wave heights and 100-year flood water level conditions (whereas design standards typically call for 20-year averages for both waves and flood height). Docks were designed to extend into deeper water to account for low-water conditions and variability in sediment transport, given the various predictions for how climate conditions may change in this area over the next 50 years.

In addition to the construction of new docks and demolition of existing docks and associated infrastructure, the action alternative also includes:

- Dredging (and dredge material disposal) for construction and/or for long-term operation; dredging assumptions for both sites as they affect impact analysis are discussed in the introduction to chapter 3.
- Removal of any existing infrastructure in the location of the proposed new docks (former dock piles)
- Construction of associated infrastructure (including how the new docks connect to the rest of the island and its existing circulation)
- Construction access and staging

All construction, demolition, access, and staging would take place outside of designated wilderness. On North Manitou Island, the construction access and staging areas would be located within the historic district boundaries of the North Manitou Island Association Farm Complex/Village District. These areas would be outside of but adjacent to the boundaries of the North Manitou Island Life-Saving Station and the Cottage Row Historic District. On South Manitou Island, the construction access and staging areas would be located within the historic district boundaries of the South Manitou Island Historic Agricultural District and the Life-Saving Station Historic District. All dredging activities would be subject to permitting with the US Army Corps of Engineers (USACE) and Michigan Department of Environment, Great Lakes, and Energy (EGLE), as described in chapter 5 of this document.

The island-specific proposals are described below.

South Manitou Island

Under the action alternative, the boat access to South Manitou Island would be improved through the construction of a new pile-supported dock and demolition of the existing dock. The new dock would be constructed where Chicago Road ends at the lake shore, which is approximately 1 mile north of the existing dock, in a location that provides access to deep water and relatively protected conditions from wind and wave action. This is the

location of a former dock, of which only a few pilings remain. Any in-water piles would be removed prior to construction of the new dock for safe navigation at the new dock, while a handful of remaining pilings would likely be retained in the onshore area. The dock would be approximately 325 feet long and 12 feet wide with an 86-foot-long horizontal T-section at the dock end furthest from the shoreline[1]. The new dock would be constructed of concrete decking supported by 12-inch diameter steel piles.

Due to the location of this dock in relatively deep water in an area with relatively neutral littoral drift, maintenance dredging is expected to be needed infrequently, if at all. At most approximately 20,000 cubic yards (CY) (in an area of approximately 18,000 square feet or 0.41 acres around the new dock) may be dredged once every 5-10 years to maintain operations at the dock. This dredged material would be disposed of offsite or repurposed where park facilities management has use for such materials.

Because of the distance of the new dock from the existing visitor services (such as restrooms and drinking water), the NPS would construct new visitor use and administrative facilities at the new dock location. These facilities would comprise an open-sided shade shelter, primitive toilets, a solar-powered water well, drinking fountains and bottle fillers, an information board, and an area for vehicles to turn around, as shown on figure 4. These items would be constructed approximately 100 feet from the new dock, screened from the lake by some existing trees. The shade shelter would be a post-style pavilion, approximately 40 feet by 60 feet with no side walls, with the roof sloped downward to the west. The shade shelter would be constructed with a timber frame and metal roof situated on a concrete slab. A small photovoltaic (PV) array would be situated on the solar-powered well pump house roof, which would be sufficiently sized to support the solar-powered well. This PV array would also support a visitor charging station. Four two-port vault toilets would also be included as part of dock-side development. Each toilet structure would be 8 feet by 12 feet. Two toilet structures would be installed to the northeast of the shade shelter and the other two to the northwest of the shelter. Two drinking fountains with bottle fillers would also be installed; one near each of the vault toilets. A 36-inch tri-side information board would also be positioned on the eastern side of the vehicle turn-around area. The solar-powered water well would include a small pump house for a fresh water well. The pump house for the well would be designed to minimize visual impact while providing adequate function and ease of maintenance. Ease of access would otherwise govern the location and configuration of the well house. The vehicle turn-around area would curve off of Chicago Road to form a semi-circle, just north of the proposed shade shelter and between the proposed vault toilet locations. The diameter of the turn-around area would be approximately 60 feet. All items would be constructed outside of the 100-year floodplain. It should be noted that the existing visitor facilities would continue to be maintained in their current conditions for both visitors and staff.

[1] Including the pilings, the maximum width would be 13 feet, 2 inches.

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Michigan

- Shelter
- Vault Toilet
- Information Board
- Well House
- Drinking Fountain

Improved Boat Access at the Manitou Islands
Environmental Assessment

Figure 4: New Dock and Dock-Side Improvements on South Manitou Island

The new dock would connect to the rest of the island primarily through existing roadways and trails. Chicago Road would be reestablished to a 12-foot width (paved with gravel or similar pervious surface that is locally sourced where possible in order to maintain compatibility with the historic landscape) with 4-foot shoulders on both sides cleared of woody vegetation, as shown on the example cross-section below (figure 5). During construction, an additional 4 feet beyond the shoulder would be subject to tree and shrub removal to facilitate construction access, resulting in an overall 28-foot-wide corridor subject to tree and shrub removal. The optimal height for tree clearing would be 15 feet, especially in the main road bed. This would improve the existing county road to allow vehicles to navigate the roads to transport equipment and people back and forth to the village and dock.

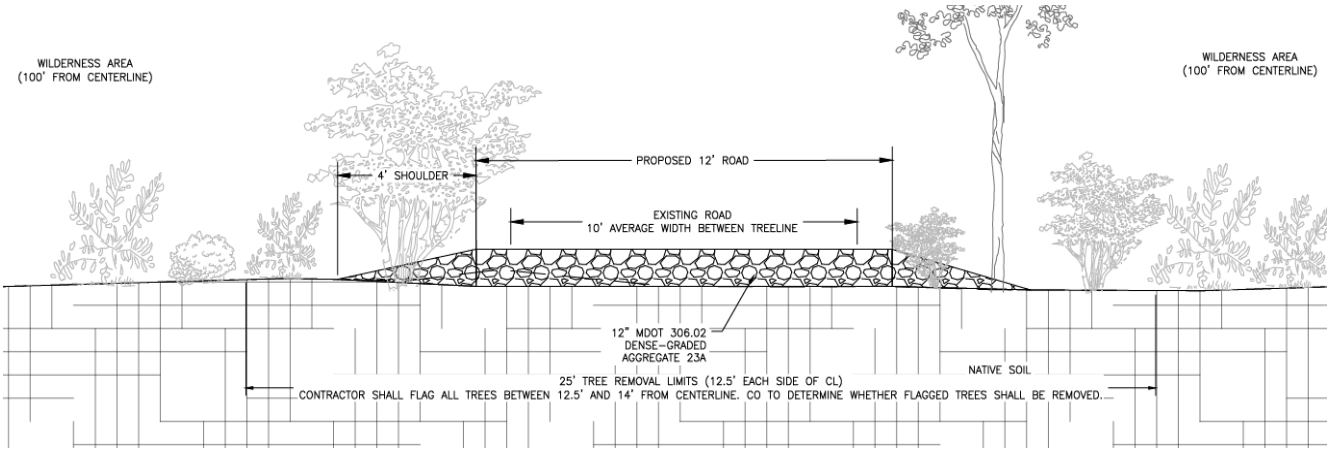

Figure 5. Example Cross-Section of Chicago Road Improvements

Construction of the dock, road, and new facilities would require access and staging areas. Some staging may take place on barges, and equipment and materials could be transported to staging areas on shore via landing craft or via the existing county roads (from the existing dock), as shown on figures 6 and 7. Limits of disturbance and access would be refined and delineated with park staff to avoid impacting select trees and other sensitive resources to the extent possible and to avoid wilderness areas.

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Michigan

Shelter
Vault Toilet
Information Board
Well House
Drinking Fountain

Improved Boat Access at the Manitou Islands
Environmental Assessment

Figure 6: New Dock and Dock-Side Improvements on South Manitou Island

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Michigan

Project Area Boundary
Staging Area
Construction Access

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Environmental Assessment

Figure 7. Construction Access and Staging on South Manitou Island

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Construction access for the dock-side facilities and improvements along Chicago Road would likely take place via the existing roads from the existing dock. As needed, the NPS may conduct some minor trimming of overhanging branches of some trees along the access route to allow for the passage of construction equipment. Because the park already transports some equipment back and forth in this area, minimal trimming would be expected. In addition to a staging area at the shoreline terminus of Chicago Road, three staging areas (see figure 7) would be established near the visitor services area to store equipment and materials during the construction process, as needed. Two would be located just south of the ranger station and visitor services area on the other side of Burdick Road; one of these would be in an open area surrounded by trees on all sides, south of where Burdick Road meets Grand Boulevard and the other would be near a large patch of worn grass where the path to the South Manitou Island Lighthouse meets Burdick Road. The third would be located near the existing NPS maintenance complex (where concessioner tractors used for village tours are stored), farther south of the visitor services area just off of Burdick Road. During construction of the new dock, the existing dock would remain in place and continue to be used for access to the island.

Once the new dock is available for use, the existing dock and supporting infrastructure would be demolished followed by restoration of the terrestrial areas. Demolition would likely include removal of decking and piles, to be disposed of offsite. The historic pilings on shore would remain in place as would the associated roadway for future use by the park's landing craft for park operations and maintenance.

North Manitou Island

Under the action alternative, the boat access to North Manitou Island would be improved through construction of a new flow-through, pile-supported dock at the former dock site location and demolition of the existing dock. The new dock location would be approximately 400 feet north of the existing dock, and the dock would take advantage of the natural angling of the beach in this area to provide opportunities to dock in a variety of ways on the structure, depending upon prevailing winds. The dock would be approximately 480 feet long and 12 feet wide with a T-section at the dock end furthest from the shoreline measuring 112.5 feet long[2]. The new dock would be concrete decking supported by steel pipe piles. In addition, the existing road trace between the visitor contact station and the former dock location would be reestablished to formalize connection of the new dock to the existing park facilities and trail system. The pathway would be 12 feet wide and approximately 500 feet long, paved with gravel or similar pervious surface that is locally sourced where possible in order to maintain compatibility with the historic landscape. It would also be designed for limited vehicle use by park staff and other permitted vehicles.

To prepare the location of the new dock for construction, the in-water pilings of the former dock would be removed, and approximately 10,000-20,000 CY of sand and cobble would be dredged. The dredge spoils would be disposed of along the shoreline, south

[2] Including the pilings, the maximum width would be 13 feet, 2 inches.

(downdrift) of the existing dock site, and may be repurposed where park facilities management has use for such materials or could be disposed of offsite. If required, the finer (sandy) materials may be separated from coarser materials (gravel and cobble) and each material handled appropriately, per permitting requirements.

While the site is being prepared for construction, a temporary dock (likely a barge approximately 100 feet long) may be attached to the existing dock via gangway to provide ongoing access for the ferry concessioner, park operations, and construction access. Some relatively small-scale dredging (less than what is needed for new construction or continued use of the existing dock) may take place for installation and operation of this temporary dock. Disposal of dredge material would take place as described above for dredging associated with construction of the new dock.

Once the new dock is ready for use, the existing dock and related infrastructure (access road and electrical service) would be demolished and associated terrestrial areas would be restored. To minimize the need for maintenance dredging in the future, the NPS would undertake some level of dredging/excavation[3] effort to remove the substantial amount of sediment and debris that has gathered around the existing dock. While initial efforts to re-establish the natural flow of sediment through this area may be limited to what is needed to demolish the existing dock, the park may eventually remove up to 60,000 CY of additional sand and cobble to remove the majority of the sediment that has been accumulating along the existing sheet pile dock. Dredged/excavated material would be disposed of as described above (disposed of along the downdrift shoreline, reused for park maintenance, or disposed of offsite). The quantity and frequency of maintenance dredging needed at the new dock would also depend on the extent of dredging undertaken during demolition of the existing dock and how natural processes affect sediment movement (littoral drift). Current estimates are that somewhere between 10,000 and 30,000 CY would be dredged approximately every five years.

The coverage of dredge spoil disposal associated with the construction of the new dock and the removal of the accumulated sediment around the existing dock would result in a maximum area of 1,240,000 square feet (approximately 28.5 acres). This area would stretch approximately 2,500 linear feet (approximately half a mile) along the shoreline south (downdrift) of the existing dock, as shown on figure 8. Disposal material would constitute primarily sand with cobble. Cobble may be disposed of offsite or may be disposed of along the shoreline, above ordinary high water but below the vegetation line. Placement of dredge spoil would avoid existing vegetation and would occur outside of historically significant viewsheds.

[3] Dredging is the term for removing underwater sediments, while excavation is the term used for removal of terrestrial sediments.

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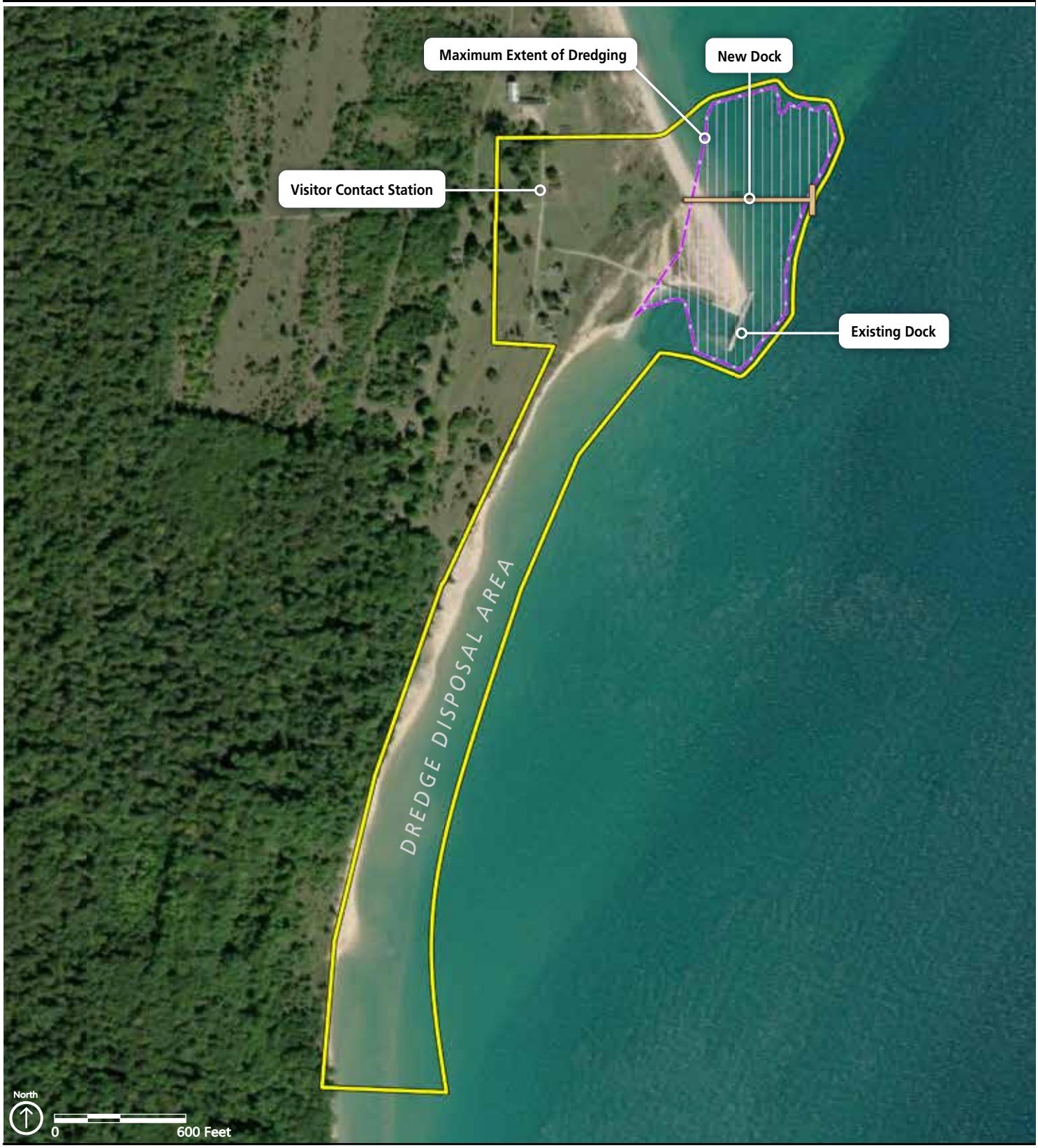


Project Area Boundary
Maximum Extent of Dredging

Improved Boat Access at the Manitou Islands
Environmental Assessment

Figure 8: New Dock Location and Potential Area of Dredge Disposal on North Manitou Island

Construction of the dock would likely take place using a barge for staging. As needed, equipment and materials could be transported to staging areas on shore via landing craft or via the existing roads (from the existing dock). Limits of disturbance and access would be delineated with park staff to avoid impacting sensitive resources to the extent possible and to stay outside of wilderness area. Two on-shore staging areas would be established slightly northwest of the existing dock, near the location of the proposed new dock and slightly inland from the shoreline. These staging areas would be on the north and south sides of the North Manitou Island Contact Station. These items are shown on figure 9. Revegetation/restoration of disturbed areas will be undertaken upon completion of project in accordance with pending Cultural Landscape Report (CLR) and Treatment Plans. See chapter 4 for mitigation measures.

National Park Service
US Department of the Interior

Sleeping Bear Dunes National Lakeshore
Michigan

Project Area Boundary
Proposed Walkway
Staging Area
Temporary Dock
Maximum Extent of Dreding

Improved Boat Access at the Manitou Islands
Environmental Assessment

Figure 9. New Dock, Dock-Side Improvements, and Construction Access and Staging on North Manitou Island

2.3 ALTERNATIVES CONSIDERED BUT DISMISSED

The action alternative as described above is the result of an iterative planning process where many other options for the design elements were considered. The action alternative moved ahead with elements that met the purpose of and needs for the project while providing context-sensitive placement and design. A couple distinct options considered but dismissed are described in detail below.

Extension of the Existing South Manitou Island Dock

The team considered extending both docks into deeper water to reduce the need for dredging. At South Manitou Island, such an extension has happened once already, but this area continues to be prone to sediment buildup due to its very gradual slope to deeper water at the edge of the island's natural harbor. The cost to extend and then maintain a much longer dock would be expected to be matched by only a modest reduction in dredging needs (compared to the little to no maintenance dredging expected at the Chicago Road location with a modest length of dock). Due to the lack of benefit associated with a relatively high cost alternative, this option was dismissed from further consideration.

Extending or Replacing the North Manitou Island Dock

At North Manitou Island, the existing dock includes a sheet-pile portion that prevents sediment from flowing under the dock, which has caused a substantial amount of sand to build up and create a new point at the existing dock. Without removing that sheet pile, sediment is likely to continue to build up at that point, eddying around to also block the downdrift side of the dock at a longer dock. Removal of the sheet pile (for replacement with flow-through pilings) would require extensive demolition, including removal of concrete decking and excavation/dredging of surrounding sediment. Similarly, replacing the dock in the same location, even with a flow-through structure, is expected to continue substantial sediment accretion and require frequent dredging. Due to the risk of requiring ongoing frequent dredging along with high costs and environmental effects associated with installation, this option was dismissed from further consideration.

Use of Jetties to Deflect Sediment Build-Up

The team considered options where stone jetties could be constructed to deflect sand away from the existing docks and also provide protection from some wave action (depending upon configuration). These designs caused substantial concern that jetties would likely be overtopped by sediment, would require costly maintenance, would require substantial up front investment, and would impose the greatest alteration of natural sediment flow along the shoreline. Additionally, these jetties would introduce non-historic structures into the cultural landscape and would detract from the historic viewshed. For these reasons, these options were dismissed from further consideration.

Old Railroad Location at South Manitou Island

The team considered a location at South Manitou Island between the existing dock and the Chicago Road terminus as another possible new dock location. While this dock would have been closer to the village at the life-saving station, it would have required substantial development along the sensitive back dune area to re-establish a roadway for vehicular access to that dock. In the water, the lake floor slopes down more quickly than at the existing dock but not as quickly as at the Chicago Road location, which means that this dock would need to be longer to reach the same depths as the Chicago Road location and provide the same reduction of dredging risks. For these reasons, this option was dismissed from further consideration.

CHAPTER 3: AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This chapter describes the current affected environmental conditions in and surrounding the project areas as they relate to each impact topic retained for analysis, as outlined in chapter 1. These conditions serve as a baseline for understanding and documenting the resources that could be impacted by implementing the project.

In accordance with CEQ regulations, the environmental consequences analysis includes the direct, indirect, and cumulative impacts (40 CFR 1502.16) of each alternative. The intensity of the impacts is assessed in the context of the park's purpose and significance and any resource-specific context that may be applicable (40 CFR 1508.27). The methods used to assess impacts vary depending on the resource considered, but generally are based on a review of pertinent literature and studies, information provided by on-site experts and other agencies, dialogue with tribal partners, professional judgment, and NPS staff knowledge and insight.

3.1 AFFECTED ENVIRONMENT

The affected environment describes existing conditions for those elements of the natural and cultural environment (including human health and safety and the visitor experience) which could be affected by the actions proposed in the alternatives. These descriptions serve as a baseline for understanding the resources that could be impacted by implementation of the action alternative.

3.2 IMPACTS

According to the 2022 CEQ revised regulations, "effects or impacts" are changes to the human environment that include reasonably foreseeable (1) direct effects, (2) indirect effects, and (3) cumulative effects [40 CFR §1508.1(g)].

Agencies consider the potentially affected environment and degree of effects to determine the significance of an action's impacts. The degree of effects is assessed in the context of the park's purpose and significance and any resource-specific context that may be applicable. When assessing the degree of effects, agencies consider:

- Both short (during construction and rehabilitation)- and long-term (post construction & rehabilitation) effects.
- Both beneficial and adverse effects.
- Effects on public health and safety.
- Effects that would violate Federal, State, Tribal, or local law protecting the environment. [40 CFR § 1501.3(b)]

None of the alternatives analyzed in this EA would violate any federal, state, tribal, or local laws that protect the environment.

Dredging Assumptions

For all dredging work described in this document, the planning team made certain assumptions as to how it would take place. These assumptions are based on the team's experience implementing similar projects in the Great Lakes region. For a year in which dredging is needed, dredging would begin as early as April, when the weather conditions on Lake Michigan allow access to the islands and conditions are favorable for conducting the work. Dredging operations would not take place during May 15 to July 15 to avoid spawning season for sensitive fish species. Dredging could then resume for the remainder of the season. Lake conditions typically preclude dredging operations by late October. If the need arose to conduct dredging during the fish spawning season, an exception to this permit condition would be requested.

Due to the mix of fine (sand) and coarse (cobble) sediments surrounding the existing docks, the method of dredging is likely to be mechanical (using heavy machinery to scoop the sediment), although hydraulic dredging (using pumps to pull up materials, best used with primarily fine sediments) could take place if the sediment to move is fine enough.

Cumulative Impacts Methodology

In accordance with the CEQ revised regulations, this EA also considers cumulative impacts, "which are effects on the environment that result from the incremental effects of the action when added to the effects of other past, present, and reasonably foreseeable actions regardless of what agency (federal or non-federal) or person undertakes such other actions" [§1508.1(g)(3)]. Cumulative impacts have been addressed in this EA by resource and are considered for each alternative.

Reasonably Foreseeable Planned Actions

Previous Dredging Efforts

In past years, the NPS has undertaken dredging efforts at North Manitou Island in order to maintain access to the dock due to sediment accumulation that has resulted from littoral drift. Most recently, sand deposits in winter of 2022 prevented access to the North Manitou Island dock, resulting in a dredging effort in the summer of 2023. Prior to this, numerous small-scale (annual activity) and large-scale (four- to five-year rotation) dredge efforts have taken place to maintain dock access and continued ferry service. Dredge quantities have varied with each effort, depending on the conditions over time, with dredged material typically placed in the nearshore area as beach nourishment. The most recent efforts were permitted in 2019 and were subject to an EA at that time.

Life-Saving Stations Cultural Landscape Report and Treatment Plans

In 2024, the NPS will begin development of a CLR and Treatment Plans for both life-saving stations on South Manitou and North Manitou Islands. CLRs are the primary guide for the treatment and use of historic landscapes. A CLR documents and evaluates the landscape characteristics, materials, and qualities that make a landscape eligible for the National Register. It analyzes the development and evolution of the landscape,

including modifications, materials, geographical context, and use in all periods. As defined by the NPS, the purpose of a landscape treatment plan is to set forth guidelines for preserving and enhancing historic landscape characteristics and features within the context of contemporary park uses (NPS 1998). Treatment describes the future appearance of the landscape at the planning level with preliminary design recommendations. It does not provide construction level details necessary for implementation, nor does it address routine maintenance.

Historic Structures Rehabilitation on the Manitou Islands

In 2024, the NPS will address deferred maintenance to external envelopes on multiple historic structures on the Manitou Islands. Structural repair and restoration are needed to improve building elements such as roof replacements (in kind), siding repairs (in kind), window and foundation issues, and exterior painting. At Trude Cottage, interior rehabilitation (repairing a door, removing and replacing the electrical system, and removing the sunken rear portion of the building and replacing it with a new addition) is needed to prepare the cottage for housing seasonal personnel and NPS park personnel. In other cases, the NPS will renew and upgrade administrative structures through the repair and replacement of obsolete exterior components, utilities, fixtures, foundations, and historic features at historic structures. Where needed, the project will also abate hazardous materials and carry out selective demolition (NPS 2023a).

Utilities Improvements on the Manitou Islands

In 2024, the NPS plans to upgrade the water distribution system on North Manitou Island. This project will include construction of a new 342-square foot pump house building at the existing pump house location, as well as two new wells west of the pump house to supplement the existing water lines. This location is the most convenient for the water loop system as it is central to provide more uniform flow in all directions. The construction process will be phased so that the existing system will remain in use during construction. Once the new building is constructed, the existing one will be demolished. As part of these improvements, the associated chlorination and pressure tank systems will also be upgraded to meet regulations. In addition, select utility systems on South Manitou Island will be rehabilitated and obsolete system replaced where needed (NPS 2023a).

Remediation of North Manitou Island Contaminated Site

In May 1989, a fuel oil spill occurred on North Manitou Island Historic Life Saving Complex. Today, there are nine existing groundwater monitoring wells in close proximity to the northern staging area. Data is collected from these monitoring wells on a bi-annual basis for EGLE. The NPS is working towards removal and disposal of all contaminated soil from this historic spill to obtain a "No Further Action" from EGLE during fiscal year 2025. Efforts to fund the removal of contaminated soil are underway and may take place concurrently with or shortly after the action alternative proposed in this EA.

Trends

Visitor Related Trends

In 2022, over 1.5 million people visited the park, with the heaviest visitation occurring in July and August. This number is a slight decrease from the highest visitation on record at the park of more than 1.7 million visitors in 2021 (NPS 2023b). Over the nearly 50 years since the park began performing visitor counts, visitation has fluctuated slightly year to year, but has consistently reached more than 1 million visitors annually since 1987 (NPS 2023b). Between 2017-2022, the average annual number of ferry passengers to South Manitou Island totaled 6,503 and passengers to North Manitou Island totaled 3,889[4] (NPS 2024b). Most visitors to South Manitou Island visit for the day, whereas visitors to North Manitou Island are primarily camping overnight. Permit camping at the Manitou Islands in 2022 included 8,003 visitors (NPS 2024b). The islands offer a wide array of activities, sites, and experiences, attracting a variety of visitors of all ages and abilities. Based on overall steady visitation at the park, the islands are likely to continue to see similar levels of visitation into the future.

Climate Related Trends

The Manitou Islands lie within Lake Michigan and are susceptible to increased extremes and variability from climate trends affecting the Great Lakes region. The Great Lakes are some of the fastest warming lakes in the world (O'Reilly et al. 2015). As a result, the lakes are at risk from seasonal shifts, as well as changes in ice cover, high summer temperatures, and oxygen levels (USGCRP 2023). Specifically, the area of Lake Michigan experiencing the fastest surface water temperature increases is the area directly surrounding the Manitou Islands (Mason et al. 2016). The annual average maximum ice cover for the Great Lakes was 47% for the 2000-2021 time period, an 11% decrease from the 1973-1999 average of 58% (NOAA 2022). Less ice cover can expose shorelines to winter storms and erosion. Future lake levels as a result of climate change are somewhat uncertain and still the subject of much research (NOAA 2022). For instance, Lake Michigan-Huron experienced lower lake levels in the first decade of the 21st century; since then, lake levels have risen rapidly since 2013, with the highest lake level since 1886 occurring in 2020 (NOAA 2022). Nevertheless, other research shows that there will be increased variability in yearly lake levels (Seglenieks & Temgoua 2022), that is, more extreme swings in lake levels, though the average water level on Lake Michigan will rise approximately 0.24 meters (AMI 2023a). Rising lake levels are projected to be a minor rise relative to the increase in interannual water level variation, which will increase from the current 1.2 meters of maximum variation to nearly 2.5 meters of maximum variation in lake levels.

Historically, water levels have, and will likely continue, to cycle between highs and lows approximately every 10-30 years. In addition, the frequency and intensity of extreme precipitation is projected to increase for Michigan, which could contribute to higher lake levels in the future (NOAA 2022). High lake levels can result "in the destruction of beaches,

[4] The years 2020 and 2023 were not included in this average because they were atypical years for park visitation due to cancellation of the ferry season in 2020 and inaccessibility at the North Manitou Island dock in 2023.

erosion of shorelines, and the flooding and destruction of near-shore structures" (NOAA 2022). The dock at South Manitou Island experienced such effects when it became inundated underwater during recent high-water levels. Combined, these factors will affect the water depth around the docks at the Manitou Islands, which determines the ferry's ability to run (along with weather conditions). Higher lake levels result in more shoreline erosion which occurs until the lake's new equilibrium is found. During periods of shoreline erosion, sediment is moved away from the immediate area and can actually aid in vessel access. However, specific areas of the shoreline can respond differently to higher lake levels and less ice cover, based on large- and small-scale dynamics within the immediate environs, as well as seasonal weather patterns. Low lake level periods can affect water quality and supply (NOAA 2022) and also present challenges for boats trying to dock, if channels are shallower. There are also projected increases in droughts, floods, and runoff events in the Great Lakes, which may increase erosion, harmful algal blooms, and the expansion of invasive species (USGCRP 2023). Notably, climate change has delayed the onset of cooler weather in the fall, resulting in shorter winter seasons for Lake Michigan (NOAA 2021). Increases in the lake's overall water temperature can substantially alter the process by which organisms make their own food sources, potentially disrupting much of the lake ecosystem (NOAA 2021).

3.3 VISITOR USE, EXPERIENCE, & SAFETY

Affected Environment

Most visitors traveling to the Manitou Islands arrive via passenger ferry boat from the Fishtown Dock in Leland, MI, just north of the park mainland. The ferry ride to either island is approximately 1.5 hours each way and is dependent on weather conditions in the area. The passenger ferry for South Manitou Island day trips and camping trips starts operating on Memorial Day weekend and operates daily beginning July 1 through Labor Day weekend. The ferry drops visitors off at 11:30 a.m. and picks up to return to Leland at 4:00 p.m. Following Labor Day, trips are available on select days of the week until the first weekend of October (Manitou Island Transit 2023). For North Manitou Island, ferry trips are available only for campers, during the same time of year with a more customized pick-up/drop-off schedule. The docks are also open to visitors with personal boats, including chartered vessels.

South Manitou Island

Visitors arrive at South Manitou Island via the existing dock located on the southeast side of the island, just south of a crescent bay which forms a natural harbor of the island. The majority of visitors to the island visit for the day, though the island also offers overnight camping at three campgrounds. Upon arrival, passengers disembark and walk down the dock towards the village and visitor services hub on the southeast side of the island, near Sandy Point.

The existing dock is constructed of wood deck boards, with board elevations varying higher or lower along the length of the dock, creating a safety risk for tripping due to the

uneven surface until maintenance staff are able to address the issue. The deck surface is starting to weather, with visible cracking and residue build-up along the surfaces.

The existing dock is located in an area that recent coastal analysis has estimated accumulates approximately 3–4 feet of sediment per year (AMI 2023a). In 2014, the NPS extended the dock in an effort to reach deeper water, but recurring sand accumulation threatens to limit access over time. When sediment accumulates to a point that prevents docking, ferry service to the island is halted, though visitors may still be able to access the island via private boat. This has not yet been a frequent issue at South Manitou Island, but informal estimates approximate that it could become an issue within 5 years, given current conditions.

In addition to sediment accumulation at the docks, storms (high waves) and very high or very low water levels can limit ferry access to the dock, resulting in canceled trips to the island. In the case of storm systems, cancellations may happen at the last-minute and may only last for one day or several days. In the case of spring 2020, high water levels caused the decking at South Manitou Island to become separated from the pilings, requiring extensive repair and contributing to the cancellation of the entire 2020 ferry season.

As visitors walk off the dock, they enter the life-saving station landscape, which includes the visitor contact station and restrooms. In this area, there are limited opportunities for visitors to sit and rest in the shade while waiting for the ferry. The lack of sheltered waiting areas results in visitors waiting for the ferry often having to stand out in the elements, with no cover from sun or inclement weather.

South of this area is the South Manitou Island Visitor Center, which was formerly a home before being turned into the island's general store in 1923 after the old dock closed, and which now provides interpretive exhibits such as photos and artifacts illustrating island life. The village also provides access to many of the island's trails. Trails vary from short walks to nearby sites such as the lighthouse (half-mile hike from the village) and village houses (less than 0.1 miles), to longer hikes that view the Shipwreck of the Morazan (approximately 2.5 miles from the existing dock) or hiking the beach all the way around the island (10 miles). The trail network on South Manitou Island is extensive and offers visitors a unique way to experience many of the island's features (see figure 10). Visitors can choose from venturing into the island's wilderness area on foot to enjoy primitive camping and opportunities for solitude, or they can choose to join one of the wagon tours that travel along the island's system of old roads. Due to the distance from the existing dock of some features of the island, many visitors use these wagon tours – operated by the ferry concessionaire - to make the most of their time on the island. When wind, waves, or sediment accumulation at the dock stops ferry service during portions of the season, wagon tours are also temporarily halted until ferry service resumes.

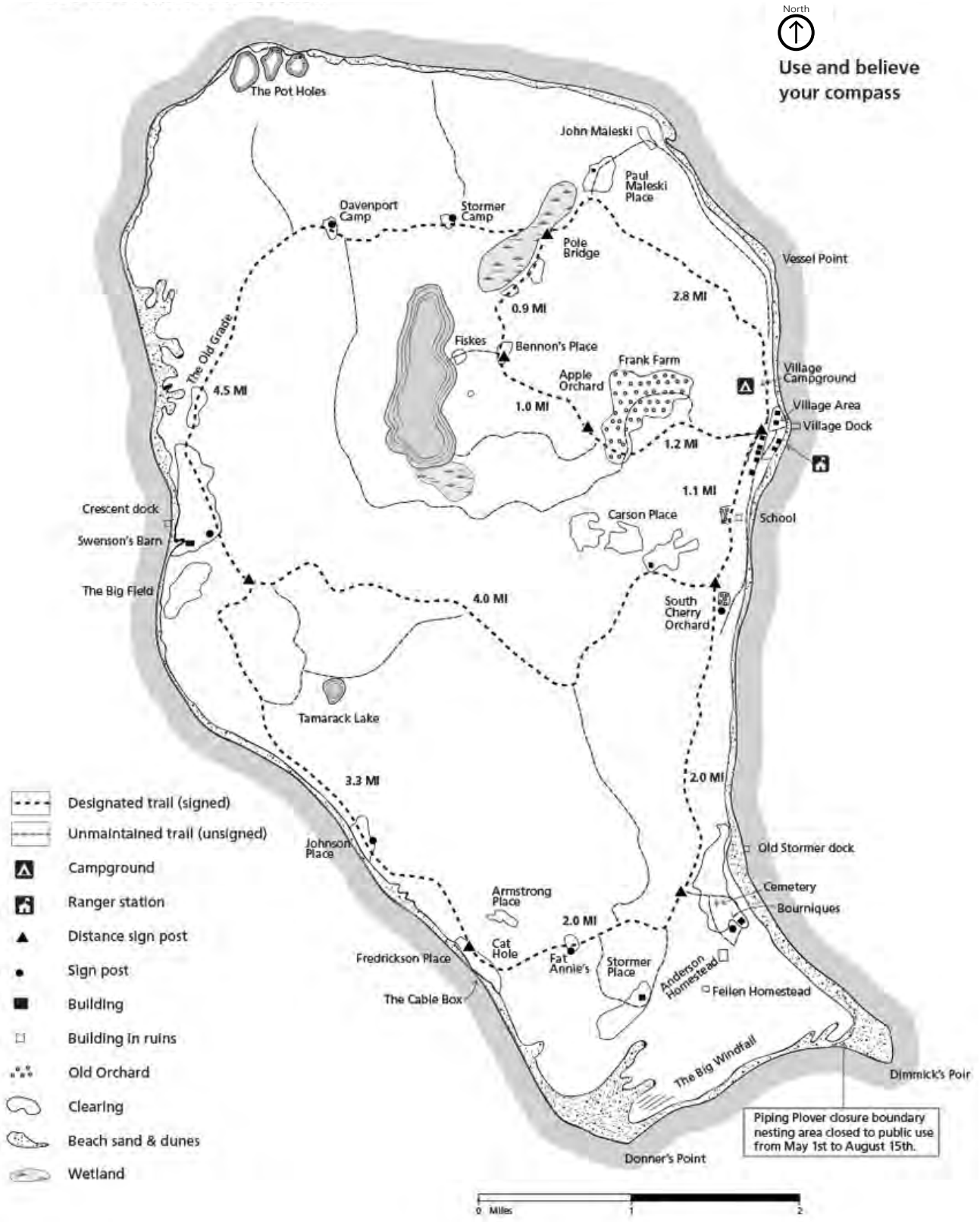


Figure 10. North Manitou Island Visitor Access Features

In addition to hiking and wagon tours, visitors also have the opportunity for camping (including the nearby Bay Campground, just north of the existing dock) and visiting the island museum.

South Manitou Island Dock
(Source: NPS)

Approximately 1 mile north of the existing dock is the location of an old dock, near where Chicago Road comes out to the beach. The pilings of the historical dock can still be seen near the shore, and the remnants of the old grocery store dating back to 1847, as well as graves of some former residents, can also be found here. No wagon tours currently serve this area, but some visitors walk to this area either along Chicago Road or along trails that follow the shoreline from the Bay Campground. There are no facilities at this location currently other than a small wayfinding sign.

North Manitou Island

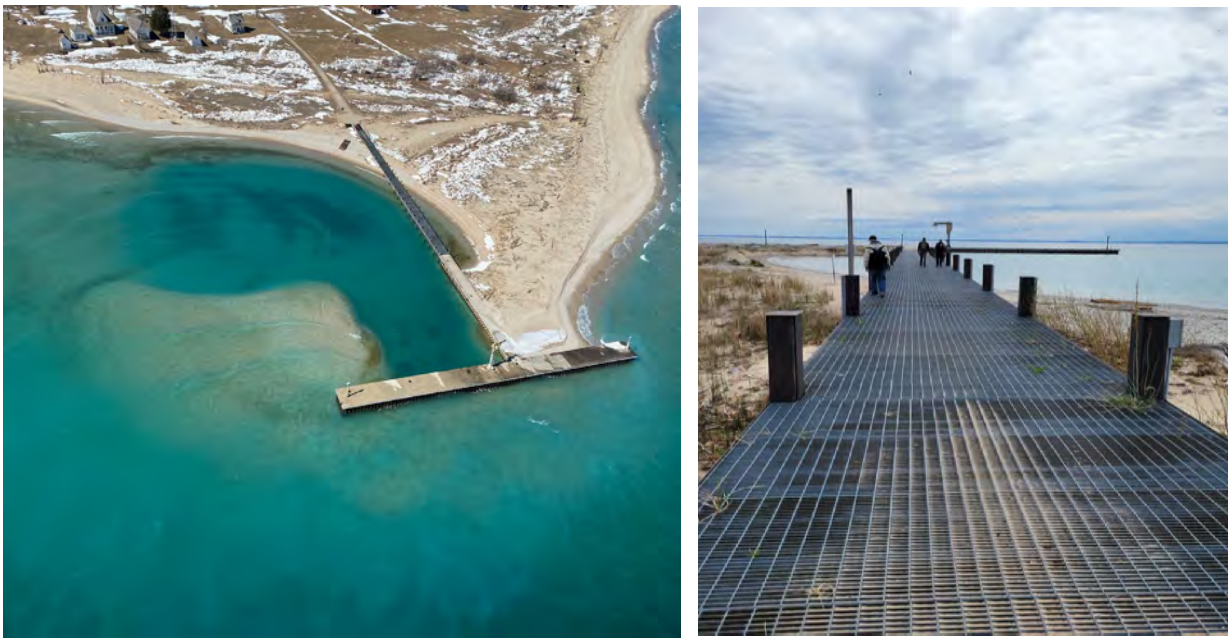
Visitors to North Manitou Island are primarily campers (the ferry currently provides one daily trip to this island). These visitors arrive at North Manitou Island via the existing T-shaped dock located on the eastern side of the island.

Similar to the description for South Manitou Island, the ability of the ferry to bring visitors to the island is dependent on weather (waves) and the ability to use the docks, as influenced by depth of water at the dock. The existing dock is located in an area that recent coastal analysis has estimated accumulates approximately 4 feet of sediment per year (AMI 2023a). When sediment accumulates to a point that prevents docking, ferry service to the island is halted, though visitors may still be able to access the island via private boat. Overall, sediment accumulation has resulted in a lack of functional access to the dock twice in the last three years. In the case of spring 2020, sediment accumulation at North Manitou Island was too great to allow safe access to the dock. The NPS had an agreement with the USACE to conduct dredging early in the season; however, the

USACE encountered issues that prevented completion of the dredging, contributing to the cancellation of the entire 2020 ferry season.

As passengers disembark the ferry, they walk down the dock which transitions from a concrete surface to a metal grate. The existing dock extends approximately 460 feet before meeting land and transitioning into a dirt path that leads to the village. At times, sediment accumulation can rise through/blow over the metal grate portion, causing sand to build up and cover this part of the dock walkway. This may result in unsafe conditions for some visitors due to the lack of traction until park maintenance staff are able to clear the sand.

As visitors disembark and approach the island, one of their first views is of the village, which comprises the U.S. Life-Saving Service Complex. To the north of the life-saving station is the visitor contact center and a primitive toilet facility (four two-port vault toilets). Behind this complex is Cottage Row which is a series of cottages built between 1893 and 1924 on a bluff overlooking the life-saving station (NPS 2022). Visitors can tour Cottage Row and view the cottage exteriors to learn more about the early inhabitants of the island and their way of life. In addition to touring the village, visitors to the island also camp, hike on dunes, beaches, and trails across the island, explore inland lakes, and view unique plants and animals (NPS 2023c). To the north of the existing dock are other historic buildings, such as the Shingle Mill, as well as the Village Campground (see figure 11). The majority of campers head away from the village to backcountry camp in the wilderness area; dispersed camping is also allowed on North Manitou Island.



(L) Aerial view of the dock at North Manitou Island in March 2023. (R) Sediment accumulation beneath the North Manitou Island dock in May 2022.
(Left Photo Source: US Coast Guard; Right Photo Source: VHB)

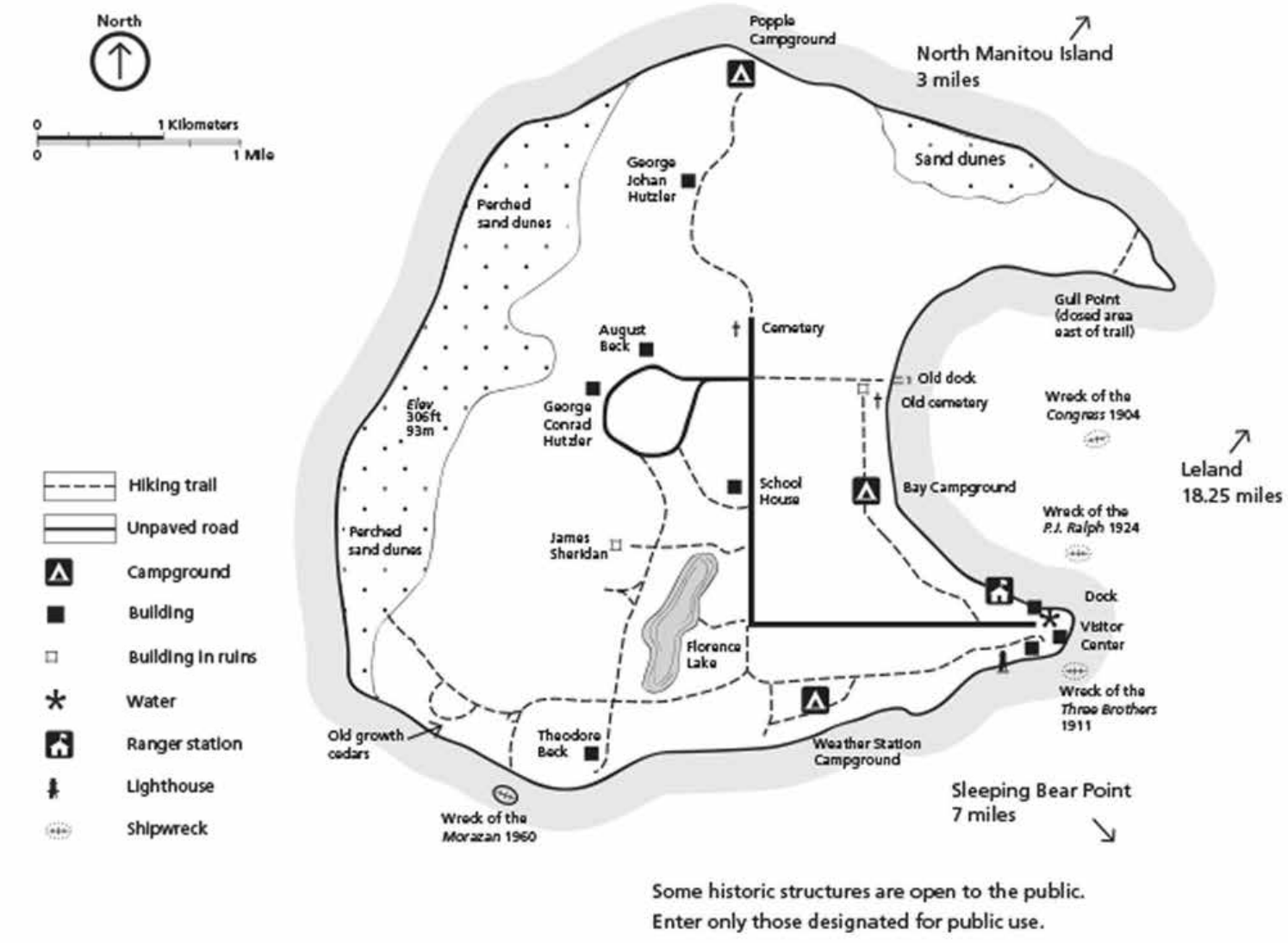


Figure 11. South Manitou Island Visitor Access Features

Environmental Consequences

Alternative A: No Action

South Manitou Island

Under the no-action alternative there would be no change from the current conditions outlined in the Affected Environment section above. The existing dock would remain in place and repairs would be made on an as-needed basis, resulting in continued long-term and intermittent adverse impacts to visitor use, experience, and safety. While waiting for the ferry to make the return trip to Leland, MI, some visitors may continue to experience a lack of shelter and seating while waiting in the elements, while other visitors wait at the contact station, which has limited space. Near the existing dock, visitors would have access to restroom facilities which offer two stalls for males and two stalls for females as well as drinking fountains and bottle fillers.

Sediment would continue to build up around the dock, requiring dredging every few years in order to maintain dock access for boats. Once accumulation reached a certain point, the ferry would no longer be able to dock and service would be suspended until the area could be dredged, preventing visitors from accessing the island via the ferry (private boats would likely still be able to access the island as drafts for these boats are typically shallower than for the ferry). In these situations, the wagon tours would also be temporarily closed as they are operated by the ferry concessionaire. As a result, visitors' plans to tour the islands would be disrupted, and visitors would miss the opportunity to fully experience the island's unique environment and history. Weathering of the dock surface would continue to degrade the decking over time and deck boards would remain uneven, posing a potential safety risk for some visitors as they travel down the dock. The ruins from the former dock would not be removed and would continue to serve as an attraction for visitors to experience. Visitors' use and experience of other features on the island would remain the same under the no-action alternative.

North Manitou Island

Under the no-action alternative there would be no change from the current conditions outlined in the Affected Environment section above. Visitors to North Manitou Island would continue to utilize the existing dock, which would continue to experience long-term and intermittent impacts to visitor use, experience, and safety. As sediment continues to accumulate around the dock, dredging would be required annually, if not more frequently, which would limit the times that the dock would be open for ferry service. To ensure regular dredging operations, the NPS would need to acquire substantial funding for this maintenance effort and undertake extensive coordination and consultation efforts. Ferry service would be halted once sediment reached a level that prevented boat docking. These occasional closures would impact visitor use and experience by making access to North Manitou Island inconsistent, which could disrupt visitors' travel plans or make it challenging for them to plan their trip (similar to South Manitou Island, private boats would likely still be able to access the island as drafts for these boats are typically shallower than for the ferry). Closures would also prevent visitors from fully experiencing the island's attractions, recreational offerings, and solitude opportunities. In addition, as

sediment accumulated in the dock area, it would build up beneath the grated portion of the dock, protruding above the grates, causing safety concerns and potentially limiting accessibility for some visitors. When the ferry is operating under normal conditions, visitors' use and experience of other features on the island would remain the same under the no-action alternative.

Alternative B: Action Alternative – Construct New Docks (Preferred)

South Manitou Island

Under the action alternative, there would be a long-term beneficial impact on the visitor use, experience, and safety once construction is complete. However, there would be some short-term negative impacts during construction of the new dock and associated improvements.

During construction of the new dock, visitors would continue to arrive at the existing dock until the new dock was completed. Visitors' views as they approach the island would be altered by construction equipment and a staging barge near Chicago Road, which would take away from the scenic viewshed. Some visitor access would be limited once on the island, most notably where staging equipment would be placed at the eastern terminus of Chicago Road and in areas where roadwork would take place to widen and improve Chicago Road (see figure 7). Restricted access in this area would prevent visitors from visiting sites such as the former general store and graveyard, which may diminish their experience of the island's history. In addition, on-shore staging areas located behind the visitor services hub would be visible to visitors, particularly the staging area located between the dock and the lighthouse. This would temporarily detract from visitors' experience of the historic setting but would be removed once construction was complete and no longer infringe on views. During construction, there would also be noticeable adverse noise impacts. However, these impacts would be temporary and only last the duration of construction, which would extend one or two warm seasons, from April to November.

Some former dock piles would be removed to aid safe navigation at the new dock, though a handful would remain in the nearshore area to educate visitors about the history of the previous dock. Although this would slightly alter the visitor experience of this site, visitors would still be able to view the remaining piles to contribute to their understanding of the island's history.

Once the new dock and associated improvements were constructed and open for use, the existing dock would be demolished and associated terrestrial areas would be restored. The condition of the dock decking would be new and the surface would be level, improving safety and ease of access for visitors as they walk or ride down the dock. Ferry access to the island would be improved due to the lower likelihood and frequency of sediment accumulation as well as less frequent dredging, all of which would allow for more reliable trip schedules, thus having a long-term beneficial impact to visitor use, experience, and safety. Some dredging may still be required at the new dock; however, due to the new location and design, dredging frequency should be reduced. In addition,

the proposed new dock at Chicago Road would improve visitor connectivity to the rest of the island through its more centralized location and by connecting through existing roadways and trails. This new dock location is also closer to attractions such as Popple Campground at the northern point of the island and the Farm Loop, which is a popular tour for many visitors. Though further from the life-saving station, visitor center, and lighthouse complex than the existing dock (which is within a half-mile of these features), visitors would still be able to access the southern portion of the island via an approximate 1-mile hike or by a revised wagon system for transporting visitors to and from the village. The increased distance from the dock to this visitor services hub may raise safety risks for some visitors due to greater chances for threats such as increased exposure, unstable footing/trip hazards, or more exertion while hiking, resulting in a long-term adverse impact to visitor use, experience, and safety.

Under the action alternative, visitor comfort at the new dock would be maintained and improved through the installation of new visitor amenities. New vault toilets near the dock area would maintain convenient restroom access for visitors arriving or departing on the ferry. The increase in number of restrooms (eight total stalls available) would reduce the need to wait during peak visitation. Drinking fountains and water bottle fillers would also enhance visitor comfort, providing an opportunity for hydration before and after touring the island. A new shade shelter with a charging station would improve visitor safety and convenience by providing an area to sit and rest, protected from the sun and any inclement weather, as well as an opportunity to recharge electronics. A new conveniently located information board would help orient visitors to the island as they arrive, provide wayfinding, and inform them of different opportunities on the island.

North Manitou Island

Under the action alternative, there would be a beneficial, long-term impact to visitor use, experience, and safety overall due to the new dock location and removal of the existing dock. Construction of the new dock in the new location in conjunction with removal of the existing dock would result in reduced sediment accumulation and consequently, less interruptions to visitor access due to ferry operations being unable to run.

During construction of the new dock, visitors may experience a modified way of accessing the island, potentially disembarking on a temporary dock extension, likely a barge attached to the existing dock via a gangway. Visitors' views as they approach the island would be altered by the presence of construction equipment and the temporary barge, which would detract from the scenic viewshed. Views would also be altered due to the removal of the former dock piles from the new location that could interfere with navigation or sediment transport. There would also be noticeable adverse noise impacts from ongoing construction activities. However, these impacts would be temporary and only last the duration of construction, which would be one or two seasons from April to November. In addition, on-shore staging areas located on the north and south sides of the visitor contact station would be visible to visitors (see figure 9), but this would only temporarily detract from visitors' experience of the historic setting and would be removed and restored once construction was complete, no longer infringing on views.

Once constructed, the new dock would improve visitor access and connectivity on the island due to the proposed new walkway extending from the dock to the visitor contact station. Formalizing this connection would create a more direct route from the dock to the visitor contact station and other village attractions as well as enable visitors of different abilities to travel from the ferry to island attractions more easily and safely. Safer access would also be improved through the design of the new dock, which would prevent sand from protruding over portions of the dock surface, thereby creating an even, sturdy surface for visitors of all abilities. Removal of the current dock and related infrastructure, along with restoration of terrestrial areas, would also improve visitor experience by restoring the historic setting and accuracy of appearance through removal of a contemporary structure. The primary improvement to visitor experience would be more reliable access to the island due to lower likelihood and frequency of sediment accumulation, which would allow more consistent ferry operations. Otherwise, during and after construction, island attractions and facilities would remain the same for visitor use, experience, and safety, maintaining a consistent feel for continued exploration and experiences on the island.

Cumulative Impacts

South Manitou Island

Impacts from some past, present, and reasonably foreseeable actions would result in a long-term beneficial impact to visitor use, experience, and safety. The rehabilitation of historic structures would help preserve and retain the existing character and integrity of sites, allowing visitors to experience them closer in appearance to their historic setting, enabling them to learn more during their visit. Utility improvements would result in a short-term adverse impact due to potential intrusion on the landscape where rehabilitation or replacement would take place. Previous dredging efforts and a dock extension have enabled continued access to the island for the past two decades which has provided visitors with a consistent and reliable approach for experiencing South Manitou Island's unique history and recreational opportunities. The reasonably foreseeable CLR and treatment plan for the South Manitou Island Life-Saving Station will set forth guidelines for preserving and enhancing the historic landscape features of the island within the context of contemporary park uses. This document will establish additional protections for the historic landscapes, sites, and features which are a draw for many visitors that come to the park.

Impacts from anticipated climate trends could result in various long-term adverse and beneficial impacts to visitor use, experience, and safety on South Manitou Island. Generally, it is projected that lake water levels will vary, resulting in cycles of high and low levels. This would produce a range of impacts to visitor use, experience, and safety. As increasing water temperatures, more extreme precipitation, and less ice cover are likely, higher lake levels may occur. As water depth around the dock affects the ferry's ability to run, there may be more uncertainty for visitors trying to access the island. High lake levels can also create safety concerns and inconvenience for offloading passengers onto the dock if the water level elevates the ferry high enough to create a far step down onto the dock. At South Manitou Island, high lake levels inundated the dock underwatering 2020, causing

the NPS to raise the dock by approximately 1 foot. Alternatively, higher lake levels, along with less ice cover, may also increase shoreline erosion until a new lake equilibrium is found which can move sediment from the immediate area and sometimes aid in vessel access, potentially benefiting visitors traveling to the island. It is also possible that the dock vicinity could remain a deposition area for shoreline erosion occurring updrift, which would impede vessel access. As noted above, more extreme swings in lake levels may occur. When lake levels are lower, it may be difficult for the ferry to dock which could affect its ability to run. Similar to the challenges anticipated with high lake levels, this could create uncertainty for visitors trying to access the island.

Impacts from the no-action alternative would contribute a long-term adverse increment to the cumulative impact by continuing to provide limited dock-side visitor amenities. It would also result in potentially inconsistent ferry service and disrupted visitor plans if the dock is inaccessible due to continued sediment accumulation at the current location. Combined with the beneficial impacts of previous dredging efforts and the planned CLR and treatment plans, and the long-term adverse impact from climate related trends, the overall cumulative impact on visitor use, experience, and safety under the no-action alternative would be long-term and adverse.

Impacts from the action alternative would contribute a beneficial increment overall to the cumulative impact through the addition of dock-side improvements to improve visitor comfort and safety, as well as construction of a new dock in a location that would require less dredging overall, which would improve reliability for visitors' trips. Although there would be short-term and intermittent adverse impacts from construction activities, these would be brief in duration (one season from approximately April to November) compared to the long-term benefits anticipated from the proposed improvements. Although climate related trends could introduce a long-term adverse or beneficial increment depending on the variability of high and low lake levels, the proposed location of the new dock is less vulnerable to lake level rise due to beach dunes in the area and because it is in a littoral cell (which contains a complete cycle of sedimentation). This location also has lower rates of sediment accumulation and is a more stable part of the shoreline than the existing dock. The new dock provides access to deeper water so that the area would not be as susceptible to sediment piling up and inhibiting vessel access. Combined with the beneficial impacts of previous dredging efforts and the planned CLR and treatment plans, the overall cumulative impact on visitor use, experience, and safety under the action alternative would be long-term and beneficial.

North Manitou Island

Impacts from some past, present, and reasonably foreseeable actions would result in an overall long-term beneficial impact to visitor use, experience, and safety on North Manitou Island. The rehabilitation of historic structures would help preserve and retain the existing character and integrity of sites, allowing visitors to experience them closer in appearance to their historic setting, enabling them to learn more during their visit. Utility improvements would result in a short-term adverse impact due to potential intrusion on the landscape where the new pump house would be constructed. In the short term, construction vehicles and activities may detract from the visitor experience, causing noises

and sights in the viewshed that are not part of the historic landscape. Soil remediation efforts may contribute to the construction traffic. However, these would be temporary and cease following construction of the new pump house and demolition of the existing one and completion of soil remediation efforts. Once construction is complete, the new pump house may be an intrusion on the landscape as a new structure but would be designed to be sympathetic with other structures in the vicinity to maintain the integrity of the cultural landscape so that visitors could continue to appreciate the historic setting. Also, the CLR and treatment plan for the North Manitou Island Life-Saving Station will set forth guidelines for preserving and enhancing the historic landscapes, sites, and features of the island, which are a draw for many visitors that come to the park. Previous dredging efforts have contributed a long-term beneficial impact, enabling continued access to the island for the past two decades which has allowed visitors to continue experiencing the island's unique history and recreational opportunities.

Impacts from anticipated climate trends could result in various long-term adverse and beneficial impacts to visitor use, experience, and safety on North Manitou Island. Generally, it is projected that lake water levels will vary, resulting in more extreme swings and cycles of high and low levels. This would produce a range of impacts to visitor use, experience, and safety. As increasing water temperatures, more extreme precipitation, and less ice cover are likely, higher lake levels may occur. Higher lake levels could affect the ferry's ability to run, as it is dependent on water depth at the dock, which could in turn adversely impact the visitor experience by creating more uncertainty for visitors trying to access the island. High lake levels can also create safety concerns and inconvenience for offloading passengers onto the dock if the water level elevates the ferry high enough to create a far step down onto the dock. Alternatively, higher lake levels and less ice cover may also increase shoreline erosion until a new lake equilibrium is found, which can move sediment from the immediate area and sometimes aid in vessel access, potentially benefiting visitors traveling to the island. As previously noted, more extreme swings in lake levels may occur. When lake levels are lower, it may be difficult for the ferry to dock which could affect its ability to run. Similar to the challenges anticipated with high lake levels, this could create uncertainty for visitors trying to access the island.

Impacts from the no-action alternative would add a long-term adverse increment to cumulative impacts by resulting in sediment accumulation around the dock, preventing visitor access via ferry service and disrupting visitors' trips. Sediment accumulation would also make conditions on the existing dock unsafe if sand continued to build up beneath the grates and limited visitor accessibility. Combined with the overall beneficial impact of past, present, and reasonably foreseeable actions and trends, the overall cumulative impact on visitor use, experience, and safety under the no-action alternative would be long-term and adverse.

Impacts from the action alternative would contribute a long-term, beneficial increment to the cumulative impact due to the new dock location and design (which would not obstruct sediment flow as the existing one does) and removal of the existing dock, which would enable more reliable access to the island and improve connectivity to island attractions. Although there would be short-term and intermittent adverse impacts from

construction activities, these would be brief in duration (one or two seasons from approximately April to November) compared to the long-term benefits anticipated from the proposed improvements. Climate related trends would introduce a long-term adverse or beneficial increment depending on the variability of high and low lake levels. However, the proposed new dock location and design would result in a lower likelihood and frequency of sediment accumulation overall. Combined with the beneficial impacts of previous dredging efforts and the planned CLR and treatment plans, the overall long-term cumulative impact on visitor use, experience, and safety under the action alternative would be beneficial.

3.4 WETLANDS AND WATERS OF THE US

Affected Environment

Coastal Environment

Based on a recent coastal analysis, the South Manitou Island shoreline near the existing dock has accreted (extended lakeward through sediment deposition) approximately 190 feet from 1935 to present. An analysis of sediment transport patterns for both South Manitou Island dock locations (existing and proposed) was conducted and found that accumulated sediment around Sandy Point (southwest of the existing dock) and the existing dock at South Manitou Island are being transported northerly. The proposed dock location for South Manitou Island had an accretion rate of 0.5 feet/year, as compared to the 2 feet/year calculated at a location closer to the existing dock (AMI 2023a). The accretion rates at the existing dock are estimated to be 3–4 feet/year.

At North Manitou Island, the shoreline near the existing dock location has accreted approximately 475 feet from 1953 to present. Sediments along the shoreline in the vicinity of the dock at North Manitou Island are transported in a southerly direction at a rate of approximately 21,000 CY/year, net littoral drift. Current accretion rates at the proposed dock location at North Manitou Island were estimated at approximately 5 feet/year, slightly more than the 4 feet/year calculated at the existing dock location (AMI 2023a). This is likely due to sediment accumulating on the updrift side of the existing dock's sheet pile structure.

The accretion of sandy materials on both islands has hindered navigational depths and use of the existing docks. Due to accumulating sand material around the South Manitou Island dock, a 100-foot extension was added to the original 200-foot dock in 2014 in order to reach deeper water, but this area is prone to continued accretion. In contrast to the natural accretion at the South Manitou Dock, which has an open design to allow sediment flow, the closed sheet pile structure at North Manitou Island dock has substantially altered sediment flow in this area, causing extensive accretion. This is evident in a timeline of satellite imagery assembled in figure 12, which shows how sediment has historically accumulated at the dock between dredging efforts.

Figure 12. Satellite imagery at the North Manitou Island dock (AMI 2023a). Large-scale dredging efforts were undertaken in in 2006 and 2012.

To counter this accretion and allow ongoing use of the sheltered portion of the North Manitou Island dock, the area around the North Manitou Island dock has been subject to dredging between 1998 to 2023 in an effort to maintain operational access to the dock. A 5-year permit was issued in 2019 allowing for the removal of 70,000 CY of sediment over a 5-year period, averaging 14,000 CY/year.

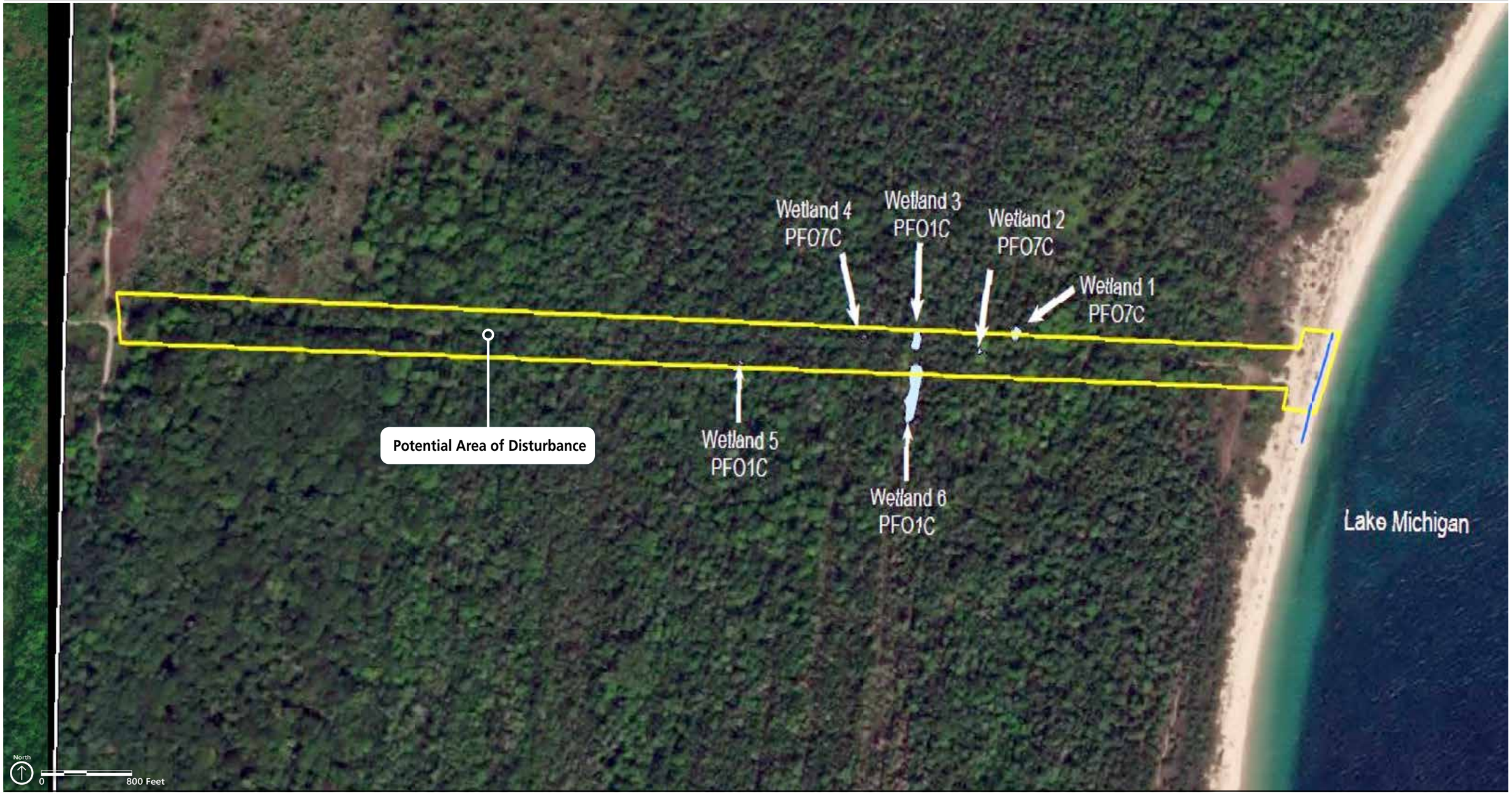
Wetlands

Jurisdictional wetlands and waters of the United States (waters of the US) were identified at both South Manitou Island and North Manitou Island. Onsite wetland delineations were conducted in 2023, with multiple patches of Palustrine Forested (PFO) wetlands (total of 0.16 acres) located along Chicago Road at South Manitou Island. No Palustrine Forested wetlands were identified within the North Manitou Island project area. However, lacustrine wetlands, both littoral and limnetic, are found within the project limits at South Manitou Island and North Manitou Island. Lacustrine Littoral Unconsolidated Bottom (L2UB) wetlands extend from the Ordinary High-Water Mark (OHWM) (as determined by ERDC/CRREL Report #TR-22-26 [USACE 2022]) of elevation 584.0 feet (datum IGLD) to a water depth of 8.2 feet or an elevation of 575.8 feet. Elevations below 575.8 feet, or deeper than 8.2 feet, are defined as Lacustrine Limnetic Unconsolidated Bottom (L1UB), as long as they lack underwater vegetation. No underwater vegetation was identified at either project site.

South Manitou Island

The project area at South Manitou Island includes approximately 1 mile of shoreline at the existing dock location. The OHWM is defined by the 584.0-foot contour. At the location of the new dock, an approximate 150-foot wide band of L2UB habitat extends from OHWM down to elevation 575.8 feet, running parallel to shore along the project area. The L1UB habitat lies lakeward of the L2UB habitat and extends beyond the limits of the proposed dock. At the existing dock, the L2UB habitat is slightly broader at approximately 200 feet wide and encompasses the existing dock. The deeper limnetic zone begins near the outer extent of the existing dock and extends lakeward. A wide range of sediment gradations characterize both habitats and can be described as having shingle and cobble-sized stones that are intermixed with sands.

Wetlands identified along the Chicago Road, as shown in figure 13, included Palustrine Forested Evergreen wetlands (PFO7C) and Palustrine Forested Broad-Leaved Deciduous wetlands (PFO1C). The evergreen wetlands (0.03 acres) were dominated by evergreen vegetation, such as cedars that are over 20 feet in height. The broad-leaved deciduous wetlands (0.13 acres) were dominated by deciduous vegetation, such as maples that are over 20 feet in height. These small wetland pockets were identified approximately 1,000 feet (0.2 miles) inland of the shoreline.



Improved Boat Access at the Manitou Islands
Environmental Assessment

Figure 13. Construction Access and Staging on South Manitou Island

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North Manitou Island
The project area at North Manitou Island includes approximately a quarter mile of shoreline at the existing dock location and approximately half a mile of shoreline where dredged material is proposed to be deposited. At the location of the existing dock, the L2UB and L1UB habitats are irregular due to substantial accretion patterns of sand and ongoing dredging that has altered the depths around the facility. However, the L2UB and L1UB habitats along the dredge disposal area located to the south of the existing dock are more uniform in width. Similar to South Manitou Island, a wide range of sediment gradations characterize both habitats and can be described as having shingle and cobble-sized stones that are intermixed with sands.

The 2023 coastal analysis reported a net southerly littoral drift at the project location with accretion rates estimated at approximately 5 feet/year, slightly more than the 4 feet/year calculated at the existing dock location. The NPS has been actively dredging the existing dock area approximately every five years since 2001, and the analysis indicated that approximately 21,000 CY of sediment is deposited within the dock area annually.

There were no Palustrine wetlands found within the areas of potential disturbance on North Manitou Island.

Environmental Consequences

Alternative A: No Action

South Manitou Island
Under the no-action alternative, the existing dock would remain in place and shoreline accretion rates of approximately 3-4 feet/year would result in continued shoaling around the dock. Costly dredging around the docks would be necessary on a long-term, regular basis to maintain navigability and access to the island. Dredging operations and placement of dredged material cause an increase in fine particles suspended in the water column, otherwise known as turbidity. These suspended particles settle out quickly following cessation of sediment disturbing activities.

There would be more frequent impacts to the lacustrine habitats during the dredging and also the placement of dredged material along the shoreline, although this would be considered temporary since these habitats would recover fairly quickly from the disturbance. In summary, there would be repeated short-term, adverse impacts on water quality in the vicinity of the existing South Manitou Island dock associated with dredging under the no-action alternative.

The existing wetland habitats along Chicago Road would continue to exist and their functions and values would remain the same.

North Manitou Island
Under the no-action alternative, the existing dock would remain in place, continuing to interrupt longshore sediment transport patterns and resulting in a build-up of sand

at an estimated rate of 5 feet/year. This build-up would continue to require an increased frequency and quantity of dredging to maintain navigability/vessel access to the dock. Increased dredging frequency (anticipated to be needed annually or more frequently, assuming funding is acquired) would cause more frequent episodes of increased turbidity. However, due to the coarse-grained nature of the dredged sediments, turbidity increases would occur close to the dredging operations and settle out almost immediately. Impacts to the lacustrine habitats during the dredging and disposal would continue, although they would be considered temporary since these habitats would recover fairly quickly from the disturbance. The duration of dredge-related shoreline change depends on how quickly the deposited sand is redistributed via natural processes such as littoral drift and wave action during storms. In summary, there would be frequent (annual or more frequent) short-term, adverse impacts on water quality associated with dredging of the existing North Manitou Island dock under the no-action alternative.

Alternative B: Action Alternative – Construct New Docks (Preferred)

NPS Director's Order 77-1 establishes NPS policies, requirements, and standards for implementing Executive Order 11990: "Protection of Wetlands." This project was reviewed with the NPS Water Resources Division, and the elements of the action alternative were determined to be excepted from needing compensation and a separate Statement of Findings beyond the analysis in this EA.

South Manitou Island

The proposed activity at South Manitou Island includes the removal of the current dock, with the goal of allowing natural littoral drift patterns to the area to continue. Dock removal would restore 2,604 square feet of L2UB and 46 square feet of L2UB habitat from errant pile removal. As the flow-through design of the existing dock contributes very little if at all to sediment accumulation in that area, removal is unlikely to noticeably affect sediment flow in that area or elsewhere on the island. The action alternative includes construction of a new 325-foot long by 12-foot-wide dock at the historical location near Chicago Road, having direct (installation of new piles) and indirect (shading) impacts on 1,910 square feet of L2UB and 3,238 square feet of L1UB habitat. Installation would disturb the lake bottom where new piles are driven, causing a temporary increase in turbidity. Sediment would be expected to settle back out quickly following installation of each pile. The new dock constructed at the terminus of Chicago Road would be installed at a location where the shallows are known to experience very little sand accumulation and the dock would reach into deeper water, thus reducing the frequency of dredging required to maintain navigability. Natural littoral drift patterns would be largely unaffected by the new dock due to the open-pile, elevated design allowing for water and sediment to move unimpeded. This location is also a more stable coastal shoreline position where the net sediment transport is approaching equilibrium and accretion rates are estimated at 0.5 feet/year. At the existing dock location, accretion rates are estimated to be 3–4 feet/year.

Approximately 20,000 CY of maintenance dredging every 5-10 years is anticipated at the proposed new dock location, if any is needed at all. Maintenance dredging would disturb up to 18,000 square feet of L1UB habitat, but this is expected to be an infrequent, localized disturbance to the bottom with suspended sediment settling out relatively quickly. The dredged materials would either be repurposed by the park onsite (in an upland location) or disposed of offsite. Overall, installation of the new dock and demolition of the existing dock would cause short-term adverse impacts on lacustrine habitats in the form of temporary increases in turbidity.

Road improvements would occur along Chicago Road to improve and widen the route to allow NPS and concessioner vehicles to access the new dock. The location of the road would be unchanged, but Chicago Road would be widened to 12 feet with 4-foot tapered shoulders, requiring fill of 66 square feet (0.002 acres) of PFO wetlands causing long-term adverse impact to this wetland.

North Manitou Island

The action alternative at North Manitou Island includes the removal of the current closed sheet pile dock, with the goal of restoring natural littoral drift patterns to the area. Removal is likely to noticeably affect sediment flow in this area as the design of the current dock captures sediment resulting in decreased sediment downdrift. Dock removal would restore 2,568 square feet of L2UB and 187 square feet of L2UB habitat from removal of errant piles. In addition, 7,590 square feet of L1UB habitat would be restored by removal of the dock. The action alternative includes construction of a new 480-foot long by 12-foot wide dock at the location approximately 400 feet to the north of a previous dock. The new dock footprint would impact approximately 4,664 square feet of L2UB and 2,779 square feet of L1UB habitat. Installation would disturb the lake bottom where new piles are driven, causing a temporary increase in turbidity. Sediment would be expected to settle back out quickly following installation of each pile. Natural littoral drift patterns would be largely unaffected by the new dock due to the open-pile, elevated design allowing for water and sediment to move unimpeded. In addition, the new dock would extend into deeper water. Together, these would reduce the frequency of dredging required to maintain navigability.

Construction at the new dock location would require one-time dredging of 10,000 to 20,000 CY of material and placing this sediment along the downdrift shoreline to the south. It should be noted that this material has likely accumulated in this area due to the altered sediment flows caused by the existing sheet pile dock. Dredged material may also be potentially repurposed by the park or disposed of offsite. Impacts are expected to be temporary as suspended sediments would settle out quickly and bottom conditions would quickly recover to pre-existing conditions. In addition, some small-scale dredging may be needed estimated to be 800 to 1,000 CY for a temporary dock (likely a barge) attached to the existing dock to provide ongoing access during construction. This dredged material would be disposed of as described above for the construction access at the new dock. All actions would result in some temporary, localized increases in turbidity.

The existing dock would be demolished (and temporary dock removed) following construction of the new dock. The NPS would conduct some level of sediment excavation and dredging associated with the existing dock demolition. Initial sediment removal may be modest (approximately 8,000 CY), with the hope that the natural north to south littoral drift would naturally redistribute the remaining sediment buildup around the existing dock. If the sediment buildup in that area persists to the point that it may negatively impact access to the new dock, the NPS may conduct additional excavation and dredging to remove the remaining materials that have built up around the existing dock structure. At most, the NPS would excavate or dredge approximately 60,000 CY of sediment that would be placed along the downdrift shoreline to the south, impacting 1,003,907 square feet (approximately 23 acres) of L2UB and 234,790 square feet (5.4 acres) of L1UB habitats. Similarly, the maximum extent of dredging would temporarily disrupt an estimated 311,757 square feet of L2UB habitat and 213,799 square feet of L1UB habitat. Although these impacts may be recurring during the phases of construction and during maintenance dredging in the future, these would be short-term, adverse impacts associated with changes in bathymetry and increased turbidity. There would also be a long-term benefit from removal of both the structure and artificial build-up of sediment to restore the north-to-south littoral flow of sediment.

This beneficial reuse of sandy dredged material would widen and increase the elevation of the existing shoreface, thereby increasing the shoreline's resiliency and ability to absorb storm waves and protect the adjacent, higher habitats. This broadened beach and associated protection would be temporary due to the dynamic nature of the shoreline, with constant interaction between the water and sediments. The duration of dredge-related shoreline change depends on how quickly the deposited sand is redistributed via natural processes such as littoral drift and wave action during storms.

The quantity and frequency of maintenance dredging needed at the new dock would also depend on the extent of dredging undertaken during demolition of the existing dock and how natural processes affect littoral drift. Estimates are that somewhere between 10,000 and 30,000 CY would be dredged approximately every five years (compared to dredging being needed annually under the no-action alternative). Dredged material would be disposed of along the southern shoreline, as described for the other dredged material placement actions. Temporary impacts to L2UB and L1UB (quantified above) would occur from this placement action but recovery of those habitats would be relatively quick.

Cumulative Impacts

South Manitou Island

Past, present, and reasonably foreseeable actions and trends would continue to affect wetlands and waters of the US on South Manitou Island. The extension of the existing dock to deeper water caused minor temporary adverse impacts to water quality at the time of dredging activities, due to the turbidity generated. On the shoreline, this past action had a beneficial impact due to accretion in the disposal area, which helped reduce erosion in the project area. Impacts from climate related trends would result in an

adverse impact to wetlands and waters of the US on South Manitou Island. Wetlands adjacent to Chicago Road where widening is proposed could be affected with warmer temperatures from climate change increasing evaporation rates and thereby affecting localized hydrology. As ice cover decreases and extreme precipitation and water temperatures increase, the shoreline may experience greater variability in lake levels and subsequently more erosion until a new lake equilibrium is found. Winter storms associated with a changing climate may further erode the shoreline over time.

Impacts from the no-action alternative would contribute an overall adverse increment to the cumulative impact due to shoreline accretion rates increasing and resulting in continued shoaling around the existing dock. To maintain access, frequent dredging would be required, impacting lacustrine wetland habitats and water quality. Climate related trends could continue to exacerbate shoreline erosion as a result of higher lake levels, though generally, it is projected that lake water levels will vary, resulting in cycles of high and low levels. Average lake levels will likely rise, though it will be a minor rise relative to the increase in interannual water level variation, which will increase from the current 1.2 meters of maximum variation to nearly 2.5 meters of maximum variation in lake levels. These more dramatic swings in lake levels may cause additional shoreline erosion north (updrift) of the dock, freeing up sediments that may accumulate at the dock.

Combined with the adverse impacts of past, present, and reasonably foreseeable actions and trends, the overall cumulative impact on wetlands and waters of the US under no-action alternative would be adverse.

Impacts from the action alternative would contribute an overall beneficial increment to the cumulative impact due to the new dock location. Some lacustrine habitat would be restored by removal of the existing dock, and relocating the new dock to an area where the rate of sediment accumulation is lower which would reduce the frequency of dredging and disturbance to waters of the US (e.g., turbidity). With the proposed open-pile, flow-through design of the new dock, natural littoral drift patterns would be mostly unaffected. A minor adverse impact would occur under the action alternative from the widening of Chicago Road into PFO wetlands (66 square feet or 0.002 acres); however, this action is considered maintenance activities for the road with such a minor amount of impact (0.1 acres or less) that the NPS would not consider replacement mitigation as a required action. Although climate related trends would continue to threaten the shoreline, the overall beneficial impact of previous dredging efforts combined with the action alternative would result in a beneficial cumulative impact under the action alternative.

North Manitou Island

Past, present, and reasonably foreseeable actions and trends would continue to affect wetlands and waters of the US on North Manitou Island. Although previous dredging efforts caused temporary adverse impacts to water quality (e.g., turbidity) at the time of dredging activity, these efforts have helped maintain the shoreline over time. Impacts from climate related trends, however, would result in an adverse impact to wetlands and waters of the US. As ice cover decreases and water temperatures and extreme precipitation increase, the shoreline near the dock may experience more erosion due to

higher lake levels and winter storms associated with a changing climate may further erode the shoreline over time. Any rise will likely be minor relative to the increase in interannual water level variation, which will increase from the current 1.2 meters of maximum variation to nearly 2.5 meters of maximum variation in lake levels. These more dramatic swings in lake levels may cause shoreline erosion to cause sediments to the accumulate at the dock.

Impacts from the no-action alternative would contribute an overall adverse increment to the cumulative impact due to retaining the existing dock in its current location. This would continue to interrupt longshore sediment transport patterns and result in continued sediment accumulation and erosion, and thus a need for frequent dredging. Frequent dredging would cause continued impacts to lacustrine wetland habitat. Combined with the beneficial impact of previous dredging efforts but the adverse impact of climate related trends, the overall cumulative impact under the no-action alternative would be adverse.

Impacts from the action alternative would contribute an overall beneficial increment to the cumulative impact due to the restoration of natural littoral drift patterns near the dock, which could potentially reduce the need for dredging over time. Although there would be adverse impacts to some wetland habitat under the action alternative due to dock removal and construction, the impacts from construction and demolition would be small in size relative to the entire wetland area. Also, impacts to wetland habitat from the placement of dredge material would be temporary since these habitats would recover relatively quickly. Combined with the beneficial impact of previous dredging efforts and the adverse impact from climate related trends, the overall cumulative impact under the action alternative would be beneficial.

3.5 HISTORIC AND CULTURAL RESOURCES

Affected Environment

South Manitou Island

Historic and cultural resources within the South Manitou Island project area include the South Manitou Island Lighthouse and Life-Saving Station Historic District and the South Manitou Island Historic Agricultural District (Burton's Harbor).

An underwater archeological survey was conducted for submerged portions of the project area at South Manitou Island in October 2022 and a follow up survey was completed in May 2023. The survey identified components of dock piles associated with the former dock location as well as remains of a sunken barge. The Michigan State Maritime Archeologist concurred that the unconnected remains of the former dock are not eligible for listing in the National Register in an email dated November 2, 2023. The historic sunken barge is well outside of the project area (in the vicinity of an alternate site considered but dismissed from further analysis). No other archeological resources were identified within the project area.

South Manitou Island Lighthouse Complex and Life-Saving Station Historic District
The South Manitou Island Lighthouse Complex and Life-Saving Station Historic District (the life-saving station) is located on the southeast end of the island, approximately 300 yards southwest of the present NPS ranger station and visitor center along the shoreline of Lake Michigan. The life-saving station historic district includes the only extant lighthouse in the park and is a significant reminder of a utilitarian yet very important profession which no longer exists in the United States. It is a testament to the historical role of the lighthouse keeper and a distinct way of life.

South Manitou Island became a popular refueling stop for steamboats in the 1830s due to its natural bay that could accommodate large vessels and dense hardwood forests. When the federal government recognized the importance of South Manitou Island's sheltered bay, a lighthouse and fog signal building were constructed on the island in 1839. In 1858, a new structure to hold the station's fog bell was constructed and the lighthouse was replaced. Additional improvements include the addition of a brick light tower in 1872, and a steam fog system that was added in 1875. After over a century of service, the US. Coast Guard closed the station in 1958 when new technology made the South Manitou Lighthouse obsolete (York 1983).

The life-saving station historic district was listed in the National Register in 1983 for its contributions to maritime navigation on Lake Michigan. The period of significance begins in 1858 when the original lighthouse was replaced and ends in 1958 when the station was closed. Features of the life-saving station historic district today consist of walkways, a boardwalk, views and viewsheds, many small-scale features, as well as structures including the lighthouse, light keeper's dwelling, and passageway (York 1983 and Quinn Evans 1999).

South Manitou Island Historic Agricultural District
The South Manitou Island Historic Agricultural District (the agricultural district) was evaluated as eligible for the National Register of Historic Places in a landscape study published by the NPS in 1996. The agricultural district is eligible for listing in the National Register for its association with the transformation of rural agriculture in America from general farming to scientific agriculture spanning a period from 1838 to 1940. In addition to the farm sites, other historic landscape components add to a cohesive setting, representing the period of significance in the overall district. These resources include a former dock site, the original island village at "Burton's Harbor" at the foot of Chicago Road, and the site of a railroad dock on the shoreline between Burton's Harbor and the life-saving station (Wheeler, Alanen, and Tishler 1996).

The former dock site at Burton's Harbor is a contributing resource because it was the center of trade for the island. Early settlers arrived and created the first village in its vicinity. Lumber and other agricultural products were sold at the dock, and it became the heart of island commerce, communication, and transportation with the rest of the world. The railroad dock is a contributing resource because it represents the island's historic transportation system. The roads, footpaths, and railroad tracks enabled farmers and

loggers to transport their goods to the dock and allowing access to trade with the steamer captains arriving at the island. Areas of significance for the proposed agricultural district are agriculture; exploration and settlement; and science (Williams, Alanen, and Tishler 1996).

North Manitou Island

Historic and cultural resources within the project area on North Manitou Island include the North Manitou Island Life-Saving Station, Cottage Row Historic District, and the Manitou Island Association/Village District (including extant dock pilings at a former dock site).

North Manitou Island Life-Saving Station

The North Manitou Island Life-Saving Station is situated on approximately 3 acres of land on the northeast side of North Manitou Island and was created to aid vessels traversing the Manitou Passage. The life-saving station was created in 1877 by the US Life-Saving Service, which was established in 1871. The life-saving station is listed in the National Register for its contributions to maritime history and transportation on the Great Lakes. The life-saving station is also listed as an excellent example of typical lifesaving stations constructed by the US Life-Saving Service at that time (Herd and Mann 2004; NPS 2010).

On August 6, 1998, the North Manitou Island Life-Saving Station was designated a National Historic Landmark for its multiplicity and diverse impacts on the island. During the life-saving station's tenure, its crew members and families not only performed their maritime duties but were also the local fire crew, assisted in first aid and law enforcement, helped to create a communications link to areas outside of the island, and created a small agricultural market with the locals. The North Manitou Island Life-Saving Station period of significance begins in 1854 with the construction of the Volunteer Life-Saving Station and continues until 1932 when the final crew occupied the station (Herd and Mann 2004; NPS 2010).

A cultural landscape associated with the life-saving station was documented in a Cultural Landscape Inventory, revised in 2016 (Herd and Mann 2004; NPS 2010). Multiple buildings and features are within the life-saving station complex and cultural landscape including the Hans Halseth House and Shed, the Volunteer Rescue Station, the storm tower and flag locker, the US Lifeboat Station, the capstan, the US Life-Saving Service Dwelling, the Crew Ready Room, the Generator Building, a flammable materials storage unit, a root cellar, the sea wall, the lookout tower abutments, sidewalks, a fire pump well, and the Lombardy poplars.

Cottage Row Historic District

The Cottage Row Historic District is located on the northeast shore of North Manitou Island along the crest of the beach ridge that overlooks the North Manitou Island Life-Saving Station and the Lake Michigan shoreline. It was a summer resort community first platted into ten lots in 1894 by W.O. Greene. Connecting each individually owned

cottage was a boardwalk, and the community was supported by a communal dining facility at the north end of the subdivision. Additionally, each subdivided lot also included one tenth ownership of the Cottage Row Park, located between the Cottage Row and the Lake Michigan shoreline to the southeast. Prior to the development of the Cottage Row subdivision, the area was cleared for agricultural purposes and contained orchards, farms, and the U.S. Life-Saving Station. The period of significance for the historic district begins in 1894 when the first cottage was constructed and the subdivision platted, and it ends in 1950 with the death of the island's largest property owner and controlling member of the Manitou Island Association, William Angell. Included within the historic district are cottages, outbuildings, small-scale features, constructed water features, and ornamental vegetation (NPS 2012).

The historic district also has associated cultural landscape, as documented in the 2012 Cultural Landscape Inventory for the site, which was updated in 2018. The approximately 11.37-acre cultural landscape contains a linear arrangement of structures that includes the Katie Shepard Hotel, the Rhoades Treehouse, the Trude Cottage, the Foote Cottage, the Riggs Cottage, the Blossom Cottage, along with contributing outbuildings and other landscape features. A road that ran along the rear of the lot lines (and is now a foot trail) creates the southwestern boundary line (NPS 2012).

In 1994, the Cottage Row historic district was determined eligible for listing in the National Register by the Michigan State Historic Preservation Officer (SHPO) for its association with the use of the island for recreation, its ties to Great Lakes maritime commerce, and its importance as an example of a turn-of-the-century Great Lakes summer resort community. Cottage Row is also eligible for its vernacular architecture constructed of unique materials (from the dismantled Manufacturer's Building at the 1893 World's Columbian Exposition) as well as its Mississippi Delta influence of the dogtrot style rarely seen in the Upper Midwest (NPS 2012).

Manitou Island Association Farm Complex/Village District

The Manitou Island Association Farm Complex/Village District (the MIA farm complex) consists of a landscape and building cluster located to the north of the North Manitou Island Life-Saving Station and to the east of Cottage Row Historic District. The MIA farm complex includes the site of a former dock built by logger, Nicholas Pickard in the 1840s to support his logging business on the island, just north of the existing NPS dock. It also includes a cluster of buildings constructed by the Manitou Island Association, an organization of businessmen formed in the 1920s that gradually took possession of much of North Manitou Island to operate it as a private retreat and game preserve. The MIA farm complex was the center of logging and agriculture on the island and was the largest employer on the island after the life-saving station. The MIA farm complex also includes a stone office, barn, sawmill, gas station, and water storage building, all constructed in the 1920s. An equipment shed was rebuilt by the NPS in 1996 for use as a maintenance and storage facility (MacDonald and Alanen 2000).

Associated with the MIA farm complex are in-water pilings that were part of a former dock site that was used to support the logging and agriculture industries on the island.

These dock pilings are listed as a contributing archeological site to the MIA farm complex. An underwater archeological survey conducted in October 2022 with follow-up survey in May 2023 identified the location of many of these former dock pilings.

In 2000, the MIA farm complex was evaluated as eligible for listing in the National Register at the local level for its association with the Manitou Island Association economic activities on the island. It represents the influence the Manitou Island Association had on the history and landscape of the island through its three most important activities: lumbering, recreation, and commercial fruit production. The MIA farm complex has a period of significance of 1927-1950 (MacDonald and Alanen 2000).

Archeological Resources
The above-mentioned underwater archeological survey conducted in 2022 and 2023 recorded no submerged resources aside from the pilings of the former dock discussed with the MIA farm complex description above. There is potential for unrecorded archeological resources in the vicinity of the new dock location on land and in the vicinity of the existing road and electrical lines that would be removed. No terrestrial archeological studies of these areas have been performed recently; therefore, additional terrestrial archeological surveys in support of the undertaking will be completed. Due to weather and travel conditions to North Manitou Island, archeological surveys of these areas will commence in spring 2024.

Environmental Consequences

Alternative A: No Action

South Manitou Island
Under the no-action alternative, there would be no changes to cultural landscapes and historic structures within the vicinity of the project area on South Manitou Island, and they would remain eligible for or listed in the National Register. There would be no impacts on historic and cultural resources under this alternative.

North Manitou Island
Under the no-action alternative, there would be no changes to cultural landscapes and historic structures within the vicinity of the project area on North Manitou Island, and they would remain eligible for or listed in the National Register. There would be no impacts on historic and cultural resources under this alternative.

Alternative B: Action Alternative – Construct New Docks (Preferred)

South Manitou Island
South Manitou Island Lighthouse and Life-Saving Station Historic District
Under the action alternative, the new dock and associated structures may be visible from higher points within the life-saving station such as from the top of the lighthouse. However, the action alternative would reintroduce a dock in a historic location, and therefore somewhat restore the historic view. The proposed structures including the shade shelter and pit toilets would introduce modern structures within the historic

viewshed; however, these structures would be sufficiently far away and partially screened by some existing trees to minimize alteration of the important viewshed of Lake Michigan from the life-saving station. No character-defining features of the life-saving station would be altered, and it would remain listed in the National Register; therefore, the action alternative would not result in any adverse impacts on the life-saving station.

South Manitou Island Historic Agricultural District
The action alternative would reintroduce a feature missing from the historic landscape of the South Manitou Island Agricultural District. Construction of the new dock at the end of Chicago Road would reintroduce a dock in the historic location, which would restore some of the historic appearance and circulation patterns of the agricultural district. Though the dock may have a different appearance and be constructed of different materials than the former dock, it would be designed to be complementary to the natural environment.

The proposed structures including the shade shelter, pit toilets, well house, and pump house would introduce contemporary structures within the agricultural district, and somewhat detract from the historic appearance and feeling within the vicinity of the dock. Additionally, construction of the 60-foot diameter vehicle turnaround would alter the appearance and feeling of the dock location and would introduce contemporary circulation patterns on the historic landscape. The impact of these new structures would be minimized by partially screening them from view by existing vegetation and using timber frame construction that would be complementary with the natural, wooded setting.

Reestablishing Chicago Road into a 20-foot-wide road corridor would alter the design and feeling of the agricultural district within the area of the corridor. The proposed road would be much wider than the historic road, and the clearing of vegetation along the corridor would alter the feeling from a rural, country road into one of a slightly more developed area. The impacts would be minimized through the use of gravel or other pervious surface and the use of the existing road alignment. The proposed road would continue to have a rural character, and it would be somewhat screened from view from the agricultural district through the remaining vegetation. The footpath from south of Chicago Road to the Bay Campground and Grand Boulevard would likely see an increase in foot traffic due to the dock relocation; however, this path and Grand Boulevard were historically and are currently used for circulation. Therefore, an increase in foot traffic would not result in an adverse impact. Impacts related to potential archeological resources within the vicinity of the road are discussed under the "Archeological Resources" heading below.

During construction, there would be visual and noise impacts on the historic setting of the agricultural district. The construction barge, equipment, and staging areas would be visible from within the district, and the noise generated from the construction activities would be noticeable. However, these impacts would be temporary and only

last the duration of construction, which would be one season from about April to November, or during possible maintenance dredging as needed.

Overall, the action alternative would result in some alteration to the setting, appearance, and feeling of the agricultural district. However, these alterations would generally be confined to the shoreline in the vicinity of the proposed dock. Vegetation screening and design of the proposed new structures would limit the visibility of the contemporary additions from within the core of the agricultural district, and the changes would be relatively small when compared to the overall agricultural district, which would remain mostly unchanged. There would be no changes to any character-defining features in a manner that would diminish the agricultural district's overall historic integrity, and it would remain eligible for listing in the National Register.

Archeological Resources
The action alternative would not result in any impact on the submerged barge due to distance from the resource. Additional terrestrial archeological survey would be required in the location of the proposed structures in the vicinity of the dock and along the existing road prior to any ground-disturbing activities are undertaken. Disturbance of any eligible archeological deposits identified during these future surveys would be avoided to the extent practicable during project implementation. An archeological monitor may be required to mitigate any potential impacts to archeological resources during construction. Because the remains of the former dock pilings are not considered to be eligible for listing in the National Register, their removal would not constitute an impact on historic and cultural resources.

North Manitou Island
North Manitou Island Life-Saving Station
The action alternative would reintroduce a dock within the viewshed of the North Manitou Island Life-Saving Station, which has been a feature missing from the historic viewshed. Though the dock may have a different appearance and be constructed of different materials than the former dock, it would be designed to be complementary to the natural environment and would not detract from the cultural landscape or viewshed of the life-saving station.

Disposal of dredge material along the shoreline south of the existing dock site may alter the appearance of the shoreline in the immediate vicinity; however, the natural littoral drift processes of the lake would eventually carry some of the material into the lake and the shoreline would naturally restore itself.

During construction, there would be visual and noise impacts on the historic setting of the life-saving station. The construction barge, equipment, and staging areas would be visible from within the district, and the noise generated from the construction activities would be noticeable. However, these impacts would be temporary and only last the duration of construction, which would be one season from about April to November.

Overall, the action alternative would result in some alteration to the appearance of the life-saving station. However, these alterations would generally be confined to the shoreline in the vicinity of the proposed dock. There would be no changes to any character-defining features in a manner that would diminish the life-saving station's overall historic integrity, and it would remain listed in the National Register.

Cottage Row Historic District
The action alternative would reintroduce a dock within the viewshed of the Cottage Row Historic District, which has been a feature missing from the historic viewshed. The impacts would be similar to those described for the life-saving station above. The impacts related to disposal of dredge material and construction activities would be the same as described for the life-saving station above.

Overall, the action alternative would alter the existing viewshed of the historic district, but it would reintroduce a missing feature, which would be consistent with the historic views of the shoreline from Cottage Row. There would be no changes to any character-defining features in a manner that would diminish the historic district's overall historic integrity, and it would remain eligible for listing in the National Register.

Manitou Island Association Farm Complex/Village District
The action alternative would reintroduce a dock in a historic location, which would restore some of the historic appearance of the MIA Farm Complex, particularly for areas closest to the former dock location. The impacts would be similar to those described for the life-saving station above and would also restore a part of the historic circulation patterns of the MIA Farm Complex. The impacts related to disposal of dredge material and construction activities would be the same as described for the life-saving station above.

Removal of the in-water pilings associated with the MIA Farm Complex former dock site would result in the loss of archeological features that contribute to the historic significance of the MIA Farm Complex. Measures to mitigate this loss may include documentation of the submerged pilings via photogrammetry and documentation of the remaining on-shore elements via probing, metal detecting, and shovel testing. All mitigation measures would be subject to discussion with the SHPO through the consultation process under Section 106 of the National Historic Preservation Act (NHPA).

Overall, the action alternative would result in some alteration to the appearance of the MIA Farm Complex and some loss of archeological features. However, the action alternative would also reintroduce a feature missing from the historic landscape and would generally be confined to the shoreline in the vicinity of the proposed dock. There would be no changes to any character-defining features in a manner that would diminish the farm complex's overall historic integrity, and it would remain eligible for listing in the National Register.

Archeological Resources
Removal of the in-water pilings would result in the loss of archeological resources associated with the MIA Farm Complex as described above. Additional archeological

survey would be required in the location of the proposed structures in the vicinity of the dock and along the existing road and underground electrical lines prior to any ground-disturbing activities are undertaken. Disturbance of any eligible archeological deposits identified during these future surveys would be avoided to the extent practicable during project implementation. An archeological monitor may be required to mitigate any potential impacts to archeological resources during construction.

Cumulative Impacts

South Manitou Island

Impacts from past, present, and reasonably foreseeable actions would result in beneficial and adverse impacts on historic and cultural resources. The reasonably foreseeable CLR and treatment plan for the South Manitou Island Life-Saving Station will set forth guidelines for preserving and enhancing the historic landscape features of the island within the context of contemporary park uses. This document will establish additional protections for the historic landscapes, sites, and features which will ensure the historic integrity of the landscape is retained through any future changes or development within the cultural landscape. The proposed rehabilitation of historic structures will help preserve and retain the existing character and integrity of sites, and ensure their long-term stability through improvements to the roof, siding, and foundations. The proposed utilities improvements will result in an adverse impact due to potential intrusion on the landscape where rehabilitation or replacement will take place. However, this intrusion on the landscape will be minimized through the design and materials used for the improvements, which would be sympathetic to the surrounding landscape. Impacts from anticipated climate trends would result in an adverse impact to historic and cultural resources on South Manitou Island. As increasing water temperatures, droughts, floods, and less ice cover are likely, physical changes to the cultural landscape and appearance of the historic districts are likely to occur. In the event of droughts, floods, and runoff events, for example, vegetation important to the cultural landscapes may no longer thrive on the island and coverage of invasive species may expand. More dramatic swings in lake levels, less ice cover, and higher average lake levels may result in erosion of the shoreline, which may not only alter the appearance and setting of historic and cultural resources but may put historic structures near the shoreline at risk of damage due to wave action.

Because there would be no impacts on historic and cultural resources as a result of the no-action alternative, the no-action alternative would not contribute to the cumulative impact on historic and cultural resources.

Impacts from the action alternative would contribute a slight beneficial increment to the overall cumulative impact through the reintroduction of a dock in the historic location where one had been missing from the landscape; the addition of contemporary structures within the setting and landscape of the historic life-saving station and the agricultural district would somewhat offset that benefit, but the adverse increment would be minimized due to vegetation screening. The CLR and treatment plan for the historic life-saving station would ensure additional changes to the setting and cultural landscape would not diminish the historic integrity in a manner that would make it no longer eligible for

listing in the National Register. Although climate related trends would introduce an adverse increment, the proposed location of the new dock provides access to deeper water so that the area would not be as noticeably affected by erosion as the existing dock location. Combined with the beneficial impacts of the planned CLR and treatment plans, the overall cumulative impact on historic and cultural resources under the action alternative would be beneficial.

North Manitou Island

Impacts from past, present, and reasonably foreseeable actions would result in beneficial and adverse impacts on historic and cultural resources. The reasonably foreseeable CLR and treatment plan for the North Manitou Island Life-Saving Station will set forth guidelines for preserving and enhancing the historic landscape features of the island within the context of contemporary park uses. This document will establish additional protections for the historic landscapes, sites, and features which will ensure the historic integrity of the landscape is retained through any future changes or development within the cultural landscape. The proposed project to rehabilitate historic structures including the Trude Cottage will ensure the structures retain their historic integrity and to ensure their long-term stability through improvements to the roof, siding, and foundations. The foreseeable utilities improvements would introduce a contemporary building in the form of a new pump house within the cultural landscape and setting of historic and cultural resources, particularly Cottage Row. The potential intrusion on the landscape would be minimized through the reuse of the pump house's existing location, as well as the design and materials. Impacts from anticipated climate trends would result in an adverse impact to historic and cultural resources on North Manitou Island. As increasing water temperatures, droughts, floods, and less ice cover are likely, physical changes to the cultural landscape and appearance of the historic districts are likely to occur. In the event of droughts, floods, and runoff events, for example, vegetation important to the cultural landscapes may no longer thrive on the island and coverage of invasive species may expand. More dramatic swings in lake levels, less ice cover, and higher average lake levels may result in erosion of the shoreline, which may not only alter the appearance and setting of historic and cultural resources but may put historic structures near the shoreline at risk of damage due to wave action.

Because there would be no impacts on historic and cultural resources as a result of the no-action alternative, the no-action alternative would not contribute to the cumulative impact on historic and cultural resources.

Impacts from the action alternative would contribute a slight adverse increment to the cumulative impact through the removal of the former dock pilings; however, this would be somewhat offset by the reintroduction of a dock in the historic location where one had been missing from the landscape. The CLR and treatment plan for the historic life-saving station and the rehabilitation of historic structures would add to that beneficial impact. The utilities improvements would somewhat offset the beneficial impact, but the alteration to the landscape would be minimized through design and placement of the pump house. Climate related trends would introduce an adverse increment by inducing higher lake levels and increased erosion along the shoreline, but with the proposed new dock location, there

would be lower likelihood and frequency of sediment accumulation overall. Combined with the impacts of the planned CLR and treatment plans, the overall cumulative impact on historic and cultural resources under the action alternative would be beneficial.

3.6 VEGETATION

Affected Environment

South Manitou Island

The project area on South Manitou Island includes the existing dock (and environs), approximately a mile of shoreline leading to the north, and the old roads that provide an inland connection between the existing dock and the proposed dock location at the shoreline terminus of Chicago Road. The dune vegetation on South Manitou Island is similar to the Great Lakes Juniper Dune Shrubland type (NPS 2011), where dune grasses and shrubs provide stabilization for wind-blown sand. Near the shoreline, vegetation on dunes becomes sparse from exposure to wind-blown sand, dry conditions, and reduced organic material to provide nutrients (Kost et al. 2007). Dune vegetation surveys conducted on South Manitou Island found American beachgrass (*Ammophila breviligulata*), wormwood (*Artemisia campestris*), field sagewort (*Artemisia campestris*), prairie sandreed (*Calamovilfa longifolia*), Pitcher's thistle (*Cirsium pitcheri*), little bluestem (*Schizachyrium scoparium*), reedgrass (*Calamagrostis stricta ssp. inexpansa*), smooth sawgrass (*Cladium mariscoides*), Kalm's St. Johnswort (*Hypericum kalmianum*). Impacts to federally protected species, including Pitcher's thistle, is covered in the "Special Status Species" section of this EA.

South Manitou Island's forests within the project area along the roads leading to the dock locations are predominantly made up of a patchwork of vegetative communities classified as pine barrens, northern hardwood-hemlock-white pine forests, small patches of jack pine-black spruce forests, eastern ruderal shrubland and grassland, beach-maple northern hardwood forest, and hardwood & conifer ruderal forest (NPS 2011). Common species include northern white cedar (*Thuja occidentalis*), jack pine (*Pinus banksiana)*, red maple (*Acer rubrum*), juniper (*Juniperus communis*), and eastern cottonwood (*Populus deltoides*). The coastal vegetation assemblages through the project area beyond the sand and cobble beach are vulnerable and imperiled juniper dune shrubland, beachgrass and pine barrens.

North Manitou Island

The project area on North Manitou Island is focused along the shoreline, including the existing dock location, the proposed new dock location, and approximately one-half mile of shoreline south of the existing dock. The project area extends inland slightly to incorporate areas for the improved connection between the new dock and the visitor contact station and for transportation and staging of construction materials. The vegetation community types within this project area are primarily developed vegetation, sand barrens, and ruderal shrubland and grassland (NPS 2011). The developed areas are

mowed grassland with some birch trees (*Betula* spp.) and sand cherry (*Prunus pumila*) dotting the landscape transitioning to dunes along the shoreline. Immediately inland of the current dock is an area of sand cherry shrubland that is imperiled under the global conservation status. The dunes are classified as the Great Lakes beachgrass vegetation type with plant assemblages common of the dune shoreline as described for South Manitou Island above.

Other vegetation found on North Manitou Island includes bluejoint (*Calamagrostis canadensis*), northern bugleweed (*Lycopus uniflorus*), the non-native reed canarygrass (*Phalaris arundinacea*), and woolgrass (*Scirpus cyperinus*). Further along the shoreline inland of the beach habitat are forest assemblages made up of white pine-red pine-jack pine-oak forest along with northern hardwood-hemlock-white pine forests.

Environmental Consequences

Alternative A: No Action

South Manitou Island
Under the no-action alternative, vegetation would generally continue to grow and proliferate as is. Trees along Chicago Road would continue to be subject to routine maintenance (trimming) resulting in short-term, temporary impacts. The NPS may resume dredging as it previously had around the existing dock for continued access, as needed, disposing of materials along the unvegetated portion of shoreline south of the existing dock, which may indirectly affect dune species by providing a wider beach until the sandy materials are washed away. The time it takes for the beach to return to its pre-nourished state would depend on the volume of sand deposited and environmental conditions following deposition.

North Manitou Island
Under the no-action alternative, vegetation would generally continue to grow and proliferate as is, affected by ongoing routine maintenance (mowing) within the project area. The NPS would continue to dredge around the existing dock for continued access, disposing of materials along the unvegetated portion of shoreline south of the existing dock, which may indirectly affect dune species by providing a wider beach until the sandy materials are washed away. The time it takes for the beach to return to its pre-nourished state would depend on the volume of sand deposited and environmental conditions following deposition.

Alternative B: Action Alternative – Construct New Docks (Preferred)

South Manitou Island
Under the action alternative, the primary impact on vegetation at South Manitou Island would be removal of some existing woody vegetation along Chicago Road resulting in long-term adverse impacts. Some additional vegetation, primarily herbaceous species, along the shoreline and at the transition between the shoreline and forest would be disturbed or removed as a result of the proposed improvements. Placement of dredge spoil from any future maintenance dredging would avoid existing

vegetation if placed along the shoreline. The time it takes the beach to return to its pre-nourished state would depend on the volume of sand deposited and environmental conditions following deposition.

Impacts to the vegetation at the dock-side development would be long-term, adverse, and minimal. Construction of the shade shelter, primitive toilets, solar powered water well and information board would require approximately 5,500 square footage of grassy/shrub vegetation removal resulting in long-term, adverse, minimal impacts to vegetation. These improvements have been located in such a way as to minimize if not completely avoid the need to remove any trees. The installation of the dock and associated improvements in this area would result in a localized increase foot traffic, contributing indirectly to some long-term trampling of vegetation in this area, an adverse effect.

Burdick and Ohio Roads would be used for equipment passage necessary for construction. These roads would experience minor trimming of overhanging branches. Chicago Road, however, would be widened to have a 12-foot road surface with 4-foot road shoulders (20-foot total width). This widening would require removal of roadside vegetation that has grown in over the years and continued maintenance through periodic mowing and trimming. Tree and shrub removal and trimming is expected 4 feet beyond the toe of the proposed road shoulders in order to provide sufficient space for the contractor to grade the road surface and shoulders. Large trees generally 12 inches in diameter or larger outside of the road shoulder footprint would be tagged for protection and would not be removed. This cleared area beyond the toe of the road shoulder would be allowed to revegetate naturally resulting in short-term adverse impacts. Loss of trees within the 20-foot-wide road improvement footprint would be long-term and adverse. The initial road widening would require approximately 135,000 square feet (3.1 acres) of clearing along the entire length of the 1.6-mile-long road based on 8-foot widths on each side. Permanent tree removal due to the road shoulders would amount to approximately 1.5 acres. Trees would be either cut to length or chipped for hauling offsite. While a portion of this road is through moderately open scrub vegetation, including juniper, beach grass, and sand cherry, more than half the road travels through northern hardwood and conifer forest types and would require removal of trees of various size classes. Approximately 550 acres of this forest type would remain generally intact and protected as wilderness area across the island.

Mitigation measures would be in place to reduce or avoid adverse impacts on vegetation. These measures would include designating limits of disturbance for contractors on design plans; requiring contractor fencing in all work areas to keep disturbances in an NPS-defined minimal impact area; establishing corridors for construction vehicle movement, staging of construction materials and equipment in minimal impact areas; and limiting construction access.

North Manitou Island

Under the action alternative, there would be very little impact to vegetation at North Manitou Island. Re-establishment of the road trace for a new walkway would require the replacement of approximately 6,000 square feet of mowed field with gravel pavement. The

proposed road trace would follow historic road patterns, reducing vegetation disturbances from creating new walkways.

Some additional vegetation along the shoreline and at the transition between the shoreline and forest may be disturbed or removed as a result of the proposed improvements resulting in minimal adverse impacts. Once the new dock is installed and the old dock is removed, the gravel trail leading to the existing dock and the electrical lines providing service to the existing dock would be removed. The gravel material from the current dock access route would be re-purposed for the proposed road trace. Following the construction of the new dock and road trace, the footprint of the existing dock and connecting road would be restored with native vegetation. The adverse effects of adding the gravel road to the mowed field would be generally offset by the restoration of the current access road.

Placement of dredge spoil from construction and any future maintenance dredging would avoid existing vegetation. The time it takes the beach to return to its pre-nourished state would depend on the volume of sand deposited and environmental conditions following deposition.

Mitigation measures would be in place to reduce or avoid adverse impacts on vegetation. These measures would include designating limits of disturbance for contractors, fencing in all work areas to keep disturbances in an NPS-defined minimal impact area, establishing corridors for construction vehicle movement, staging of construction materials and equipment in minimal impact areas, and limiting construction access.

Cumulative Impacts

South Manitou Island

Impacts from some past, present, and reasonably foreseeable actions would result in adverse impacts to vegetation. Climate related trends have and would continue to result in summer droughts, floods, runoff events, extreme swings in lake water levels, and shoreline erosion, all of which have the potential to diminish the habitat quality and quantity for vegetation in the project area.

The no-action alternative would not result in any impacts on vegetation; therefore, it would not contribute to the cumulative impact on vegetation.

Impacts from the action alternative would contribute a very small adverse increment to the cumulative impact due to removal of vegetation along Chicago Road and for construction of the visitor facilities at the end of Chicago Road. These impacts would build upon the climate related trends that may also affect vegetation within the project area. Combined with the adverse impacts of climate related trends and previous dredging efforts, the overall cumulative impact on vegetation under the action alternative would be adverse.

North Manitou Island

Impacts from some past, present, and reasonably foreseeable actions would result in adverse impacts to vegetation. Previous dredging has contributed to the impact of vegetation along the beach at the existing dock, while climate related trends have and would continue to result in summer droughts, floods, runoff events, extreme swings in lake water levels, and shoreline erosion, all of which have the potential to diminish the habitat quality and quantity for vegetation in the project area.

The no-action alternative would not result in any impacts on vegetation; therefore, it would not contribute to the cumulative impact on vegetation.

Impacts from the action alternative would contribute a very small adverse increment to the cumulative impact due to replacement of mowed field with gravel pavement, albeit generally offset by also contributing a small beneficial increment from restoration to natural conditions of the current dock access and electrical service. These impacts would build upon the climate related trends that may also affect vegetation within the project area. Combined with the adverse impacts of climate related trends, the overall cumulative impact on vegetation under the action alternative would be adverse.

3.7 SPECIAL STATUS SPECIES

Affected Environment

As noted under the "Vegetation" topic above, the communities present within the South Manitou Island project area include northern hardwood and conifer forests as well as dune shrubland. The communities present within the North Manitou Island project area include mostly open beach, dune habitat, and mown fields with scattered trees.

The Michigan Natural Features Inventory lists 58 special status species (rare, threatened, endangered, and candidate species) as potential inhabitants of Leelanau County. Species that have not been documented on North and South Manitou Islands were dismissed from further analysis. Those species known to be potential inhabitants of North and South Manitou Islands include 15 avian species, 4 mammals, 2 insect species, 2 fish species, and 13 plant species. Of these 36 species, 26 species were retained for further analysis due to the presence of suitable habitat types and/or known populations within (or near) the project area. The remaining 10 species were dismissed from further analysis due to the absence of habitat within the project areas. All species retained for analysis are listed in table 1 below. Those species dismissed are itemized in appendix B.

TABLE 1. FEDERAL AND STATE SPECIAL STATUS SPECIES

Species	Federal Status	State Status	Summary of Preferred Habitat Characteristics
Birds			
Piping Plover (*Charadrius melodus*)	E	SE	Sandy coastal areas near ephemeral pools and foraging habitat with abundant invertebrates
Rufa Red Knot (*Calidris canufus rufa*)	T		Coastal areas with exposed sediments for foraging; sandy shoals and sandbars particularly near inlets
Common Loon (*Gavia immer*)		ST	Freshwater lakes with remote grassy areas for nesting during summer months; range increases to rivers and streams in winter months
Bald Eagle (*Haliaeetus leucocephalus*)	Bald and Golden Eagle Protection Act		Preferred nesting areas are near shores utilizing large canopy trees; foraging areas are rivers, lakes, and estuaries where fish is the primary source of food
Black Billed Cuckoo (*Coccyzus erythropthalmus*)	US Fish and Wildlife Service (USFWS) Bird of Conservation Concern		Hardwood forests and shrubby habitats are preferred nesting areas
Canada Warbler (*Cardellina canadensis*)	USFWS Bird of Conservation Concern		Forest understory thickets of mature, moist hardwoods
Common Term (*Sterna hirundo*)	USFWS Bird of Conservation Concern	ST	Migratory breeding species using sandy areas along lakes, bays, and beaches for nesting; utilizes shallow waters for hunting fish
Eastern Whip Poor Will (*Antrostromus vociferus*)	USFWS Bird of Conservation Concern	ST	Deciduous or mixed forests with leafy ground cover where eggs are laid
Lesser Yellowlegs (*Tringa flavipes*)	USFWS Bird of Conservation Concern		Wading bird that utilizes marshes, mudflats, and shorelines
Pectoral Sandpiper *(Calidris melanotos)*	USFWS Bird of Conservation Concern		Migratory shorebird that nests in the tundra of North America; feeding areas during migration include muddy wetlands to forage for insects and other invertebrates
Ruddy Turnstone (*Arenaria interpres*)	USFWS Bird of Conservation Concern		Migratory species that breeds further north in tundra habitat; migratory foraging areas include beaches, rock jetties, and rocky shores
Wood Thrush (*Hyloocichla mustelina*)	USFWS Bird of Conservation Concern		Mature deciduous or mixed forests with relatively open understories
Plants			
Pitcher's thistle (*Cirsium pitcher*)	T	ST	Open sand dunes and low beach ridges along the Great Lakes
Broomrape (*Orobanche fasciculata)*		ST	Drier areas of foothills, rocky ridges, prairies, inland sands; in sandy soil; and as parasites on a variety of plants

Species	Federal Status	State Status	Summary of Preferred Habitat Characteristics
Prairie moonwort (*Botrychium campestre*)		ST	Dry prairies and sand dunes, especially perched dunes along northern Lake Michigan; also found in roadside habitats and old fields
Calypso orchid (*Calypso bulbosa*)		ST	Moist coniferous forests with cool soils; in Michigan, found in spruce-balsam-cedar swamps and cedar-fir thickets, often on calcareous substrates near shorelines
Dwarf Lake Iris (*Iris lacustris*)	T	ST	Openings of coastal cedar-fir forests and dune edges in thin hydric soils
Mammals			
Indiana Bat (*Myotis sodalist*)	E	SE	Winter hibernation in underground caves and mines with low temperatures around freezing; summer roosting sites
Northern Long-eared Bat (*Myotis septentrionalis*)	E	ST	Winter hibernation in caves and mines with constant temperatures, high humidity, and no air currents; in summer, roost underneath bark, in cavities or crevices of both live and dead trees
Tricolored Bat (*Perimyotis subflavus*)	PE	ST	Summer and fall roost sites in ling and dead leaf clusters or hardwood trees; in winter, hibernation in caves and mines with constant temperatures, high humidity, and no air currents
Little Brown Bat (*Myotis lucifugus*)		ST	Winter hibernation in caves, rock fissures, or abandoned mines with constant temperatures around 40 degrees Fahrenheit and high humidity; in active seasons, roosts in buildings (under roofs/eaves) and in hollow trees or wood piles
Insects			
Lake Huron Locust (*Trimerotropis huroniana*)		ST	Long stretches of sand dunes along the shores of Lakes Michigan, Huron, and Superior
Monarch Butterfly (*Danaus plexippus*)	C		Fields/meadows with flowering plants as a source of nectar; lay eggs on milkweed plants
Fish			
Lake Herring (*Coregonus artedi*)		ST	Deep inland lakes and the Great Lakes at depths ranging from 18 to 53 meters; also found in shallower depths (9-12 meters) when spawning over rocky substrates, and may spawn in shallow water (less than 20 feet deep)
Lake Sturgeon (*Acipenser fulvenscens*)		ST	Large rivers and shallow areas of large lakes; spawning can occur in gravel bottom streams or rocky, wave-swept lake shore and islands

E= Endangered, T=Threatened, PE= Proposed Endangered, ST=State Threatened, SE=State Endangered, C=Candidate for Listing, SC=State Species of Concern
Source: MNFI 2023a-f, USFWS 2023a-i

Animals

Piping plover (*Charadrius melodus*) is a small, federally endangered shorebird that can be found along coastal beaches throughout the United States with three distinct populations; in the Great Plains, along the Atlantic coastline and one in the Great Lakes. These three populations winter along the Gulf Coast and southern Atlantic Coast of the

United States and spend summer and breeding months in those three locations. There is a designated Critical Habitat for piping plovers along the southern shore of North Manitou Island that is outside of the project area; there is no Critical Habitat designated on South Manitou Island. Piping plovers have nested in the North Manitou Island project area annually starting in 2017 through 2023. None have nested within the South Manitou Island project area since 2018. Sleeping Bear Dunes National Lakeshore has an active monitoring and protection program on both North and South Manitou Islands that protect active nest sites from predation as well as from impacts caused by human interaction. These monitoring efforts and habitat protections contribute to critical restoration for the species on Lake Michigan and the Great Lakes region (USFWS 2023c).

Red knot (*Calidris canutus rufa*) is a medium robin-sized shorebird known for its brick red breeding plumage. These birds weigh 4-7 ounces and migrate long distances from South America to the arctic with migratory stops along the Atlantic coastline and Great Lakes. Red knots are molluscivores feeding on freshwater mussels and occasionally marine worms or other invertebrates (USFWS 2023g). Birds have been observed along the beaches of North and South Manitou Islands during their migration route.

The pectoral sandpiper (*Calidris melanotos*) is a medium size shorebird that is easily recognizable due to distinct brown stippling on the breast that abruptly transitions to a white belly (Cornell Lab of Ornithology 2024). These birds migrate far distances between South and North America for overwintering and breeding. The preferred nesting areas are grassy hummocks in wetlands of the tundra in North America after snowmelt. Birds forage in muddy areas for insects and other invertebrates. When the population was much higher a century ago, pectoral sandpipers were heavily hunted resulting in a sharp decline in numbers. Today, the reason for the population decline is not fully understood, although loss of wetland habitats is likely a contributing factor. Pectoral sandpipers do not nest at Sleeping Bear Dunes National Lakeshore. However, adult birds have been observed at North Manitou Island as a stopping point while passing through during migration.

The bald eagle (*Haliaeetus leucocephalus*) prefers large-canopy evergreen trees for building nests near open water habitats. NPS staff have observed eagles foraging along the shorelines of South and North Manitou Islands, but no nest sites have been documented in the project areas.

The common tern (*Sterna hirundo*), lesser yellowlegs (*Tringa flavipes*), and ruddy turnstone (*Arenaria interpres*) are migratory shorebirds that may seasonally utilize the shoreline of Lake Michigan to feed on mollusks, insects, and fish in shallow waters, beaches, and rocky shores as they pass through on their migration routes. Lesser yellowlegs and ruddy turnstone are both commonly observed on the islands during the migration season, but common terns are rarely seen. None of these species are known to nest on the islands.

The black billed cuckoo (*Coccyzus erythropthalmus*), eastern whip-poor-will (*Antrostromus vociferus*), Canada warbler (*Cardellina canadensis*), and wood thrush

(*Hyloocichla mustelina*) are migratory birds that use deciduous and mixed northern forests as breeding areas throughout central/eastern Canada and northern US. Sources of food include flying insects, moths, caterpillars, and larvae. The project area includes forested areas along Ohio Road, Burdick Road, and Chicago Road at South Manitou Island that would be considered habitat for these species.

The common loon (*Gavia immer*) is a large, migratory waterbird with black and white patterning and long black beak that can be found in northern freshwater lakes. Nesting occurs between May and July in marshy/boggy shorelines on nests built from grasses. There is no nesting habitat within the project areas. In the winter months common loons migrate to large rivers, lakes, and coastal ocean waters. Human interference provides the greatest threats to the common loon from habitat loss, harassment, and ingestion of lead fishing lures. Threats to nesting and reproductive success include egg predation and rapid changes in water levels (MNFI 2023e). Loons are often observed foraging near the island shorelines on small fish and invertebrates.

The Indiana Bat (*Myotis sodalist*) is a small brown migratory bat that feeds on insects. This federally endangered species can typically be found hibernating in caves and mines during winter months (August through spring of the following year). Females will form colonies in the spring and summer months, roosting in the bark of living or dead trees. Decline has been due to habitat loss due to human disturbances and population loss from white-nose syndrome (USFWS 2023d) The project area includes forested areas along Ohio Road, Burdick Road, and Chicago Road at South Manitou Island that would be considered habitat for this species.

The northern long-eared bat (*Myotis septentrionalis)* is a federally endangered bat species that can grow up to 4 inches long, has brown fur, and has distinctly long ears. During winter months the northern long-eared bat can be found hibernating in mines and caves, typically in between cracks and crevices. During the summer months, northern long-eared bats roost in crevices or bark of live trees or snags. Like most bat species, these crepuscular species forage on insects in forested areas. Habitat losses due to development and construction throughout their range in addition to threats from white nose syndrome have led to their listing (USFWS 2023e). The project area includes forested areas along Ohio Road, Burdick Road, and Chicago Road at South Manitou Island that would be considered habitat for this species.

The little brown bat (*Myotis lucifugus*) is a small, long-lived bat species that can be found throughout the US. The little brown bat can be found roosting in forests and manmade structures during the summer months and in mines and caves during winter hibernation. Like other bat species the little brown bat forages for flying insects throughout their range. Threats to the little brown bat include white-nose syndrome and mortality due to large scale wind turbines (MNFI 2023f). The project area includes forested areas along Ohio Road, Burdick Road, and Chicago Road at South Manitou Island that would be considered habitat for this species.

The tricolored bat (*Perimyotis subflavus*) is the smallest of the bat species potentially found within the project area. This proposed endangered species can be found in several habitats including grasslands, woodlands and both urban and suburban areas. This species will roost and hibernate in barns and other outbuildings. Tricolored bats have high site fidelity for winter hibernaculum and will return to a single site for many years (USFWS 2023f). The tricolored bat has been significantly impacted by white nose syndrome, particularly in winter colonies. The project area includes forested areas along Ohio Road, Burdick Road, and Chicago Road at South Manitou Island that would be considered habitat for this species.

Lake herring (*Coregonus artedi*) is a salmonid species characterized by its elongate body and rotund cross section with its 38-64 gill rakes being identifying features of lake herring in Lake Michigan. Lake herring use deep waters outside of spawning, when fish prefer shallower waters with rocky substrate. Exotic fish species are threats to lake herring in addition to eutrophication (USFWS 2023h).

Lake sturgeon (*Acipenser fulvescens)* is a large benthic freshwater fish species characterized by their size, elongate shape and bony scutes. Lake sturgeons can be found in unvegetated deep pools in Lake Michigan. Spawning habitat occurs in the rocky lakeshores and island areas when rivers and streams are unavailable. Human pressures of fishing and habitat loss have contributed as threats to the species (USFWS 2023i).

The Lake Huron locust (*Trimerotropis huroniana*) is a state threatened grasshopper identified by a black back and white wings with a prominent black band. The species occupies long sections of high-quality dunes along Lakes Michigan, Huron, and Superior where they feed on a variety of native dune plants such as beach grass, dune grass, wormwood, and Pitcher's thistle. Actions impacting the species include loss of dune vegetation from disturbances, coastal developments, and disturbed habitats dominated by weedy species. The dune habitat available for the species is present within the project areas along the shoreline.

The monarch butterfly (*Danaus plexippus*) is a federal candidate species for listed protection under the Endangered Species Act (16 USC 1531 et seq.). The species has a wingspan approximately 3–4 inches with wings recognized by the bright orange with bands of black and white spots along the outer border. These butterflies are native to South and North America. During the spring and summer months in North America, butterflies feed on nectar and lay eggs specifically on milkweed plants. In fall, reproduction is paused as butterflies begin their migration to Mexico. Habitat for the species within the project areas include vegetated dunes and meadows where nectar producing plants are present.

Plants

Pitcher's thistle or sand dune thistle *(Cirsium pitcher)* is a federally threatened perennial species native to the western Great Lakes region that can be found on early successional coastal sand dunes and beaches absent of vegetative competition. Smaller than other

thistle species, Pitcher's thistle grows up to 3 or 4 feet tall and flowers from June through September (USFWS 2023b). Threats to the plant include shoreline erosion from high lake levels, shoreline developments, human trampling and offroad RV use along beaches, and shoreline stabilization projects. Pitcher's thistle can be found throughout the upper shoreline and dunes of both islands. There are several documented clusters near both current dock locations. During a special species survey of both islands during September 2023 a total of 296 Pitcher's thistle plants were found (AMI 2023b). On North Manitou Island, 170 Pitcher's thistles were observed, and 126 were observed on the South Manitou Island project area. Pitcher's thistle was found in multiple life stages. All Pitcher's thistle recorded in the survey were found along the shoreline in unconsolidated sand away from wave action.

Broomrape (*Orobanche fasciculata)* is a small flowering plant that grows in dunes along the Great Lake's shorelines. Broomrape is parasitic on roots of wormwood, draining the nutrients from the plant it parasitizes. Broomrape relies heavily on the dynamic and fluctuating habitat of sand dunes, and threats to dune habitat impacts broomrapes survival and proliferation (MNFI 2023a). Broomrape has been historically observed near Chicago Road at South Manitou Island.

Pumpelly's bromegrass (*Bromus pumpellianus*) is a medium perennial grass found on sandy lakeshores and in dune habitats. Bromegrass matures in late summer. This bromegrass species has been known to withstand disturbances due to human recreational uses. Lakeside development has reduced this species' habitat outside of rural undeveloped areas (MNFI 2023b).

Calypso orchid (*Calypso bulbosa)* or fairy-slipper is a small perennial orchid that grows among conifer forests. The orchid blooms at the end of May through June and has singular pink/purple blooms. Calypso orchids grow in shady, mature stands of cedar/fir forests with moist soils. The forest overstory plays a critical role in the maintenance of the species (MNFI 2023c). Threats to the species include removal of forest canopy, deer browsing, and alterations to hydrology from land uses (Schmidt 2003). This plant has historically been observed near the end of Chicago Road at South Manitou Island.

Prairie moonwort (*Botrychium camprestre)* is a very small fern species that can be found growing along lakeshore dunes. Other habitats include abandoned orchards and other open disturbed grassy areas. Like many other dune species, prairie moonwort requires the dynamic nature of dune processes of sand movement and waterline fluctuation for survival and proliferation (MNFI 2023d). Threats to the species include disturbances to lake dune habitats caused by erosion, shoreline stabilization projects, and developments.

The dwarf lake iris (*Iris lacustris*) has a specialized habitat found in the norther portion of Michigan within cedar-spruce-fir forests and limestone pavement/grasslands along back dune/forest transitions near lakeshores. It is a small plant with leaves 15 centimeters tall. Once established, the plant can develop clusters from rhizomes. Habitat for the species was noted along the back dunes of South Manitou Island at the end of Chicago

Road and within cedar-spruce-fir wetlands along Chicago Road. No plants were observed occupying these areas, and the species is not known to occur on either island.

Environmental Consequences

Alternative A: No Action

South Manitou Island
Under the no-action alternative, the existing dock would remain in use, with continued maintenance and potential dredging taking place, as needed. The use of heavy equipment required for dredging and disposal could disturb species using the aquatic environment or the shoreline. For example, piping plovers, red knots and other shorebird species may use the shoreline for foraging or nesting. Placement of dredge spoil along the shoreline may temporarily result in a broader beach that may alter the existing particle sizes of that area and could bury benthic invertebrate prey species. Any broadened shoreline may be suitable habitat for species such as Pitcher's thistle, Pumpelly's bromegrass, and prairie moonwort, which favor dynamic dune habitat.

The level of change at the shoreline would depend upon the quantity of dredging needed and the frequency needed to maintain access to the existing dock. The duration of dredge-related shoreline change depends on how quickly the deposited sand is redistributed via natural processes such as littoral drift and wave action during storms.

To minimize impacts on special status species, the NPS would continue to implement conservation measures to minimize these impacts to the extent possible. This includes the placement of dredged material being supervised by park staff from the Maintenance and/or Natural Resource Divisions to avoid placement on shoreline vegetation. Only water-based dredging from a boat or barge would be considered. Land-based activities would be limited to placement of dredged material; placing the temporary hose or pipeline to transport dredged material to the beach nourishment site; and possible shaping of the spoil piles by a small bulldozer or tractor. Ongoing operation of the existing dock would not be expected to noticeably affect habitat or behavior for other special status species.

North Manitou Island
Under the no-action alternative, the existing dock would remain in use, requiring frequent (annual, if not more often) dredging and disposal of sediment south of the dock. Natural littoral drift would continue to be disrupted by the continued presence of the existing dock and sheet pile wall, resulting in further accumulation of sand. As described above, the use of heavy equipment required for dredging and disposal could disturb animal species using the aquatic environment or the shoreline; therefore, the NPS would continue to implement conservation measures to minimize these impacts to the extent possible. This frequent dredge/disposal cycle needed at North Manitou Island may nourish the shoreline south of the dock faster than natural processes can redistribute the sand downdrift, creating a wider sandy beach in this area than would

naturally occur, which may be suitable habitat for species such as Pitcher's thistle, Pumpelly's bromegrass, and prairie moonwort, which favor dynamic dune habitat.

Alternative B: Action Alternative – Construct New Docks (Preferred)

South Manitou Island

Under the action alternative, impacts include tree clearing for the reestablishment of Chicago Road, tree trimming along Burdick and Ohio Roads, construction of visitor facilities, demolition of the old dock structures, and construction of the new dock.

Construction activities for the new dock would contribute temporary noise and vibrational disturbance within wildlife habitat potentially used by nesting and foraging shorebirds foraging eagles, and fish species. By using time of year (TOY) restrictions for shorebird species, bats, and flowering plants, impacts to nesting shorebirds and other species would be minimized during dock demolition and construction of the new dock. Mitigation efforts, such as roping off sensitive areas and protective caging of plover nests, would reduce impacts to piping plovers and red knots. While no piping plover nests are known to occur around either dock location, the park's monitoring program for plovers would continue during construction.

Construction activities would impact Pitcher's thistle plants known to occur along the beach area, as well as habitat for the Lake Huron locust and monarch butterfly. Impacts would be minimized by placing the temporary construction shoreline access point within a narrow corridor absent of plants, although some plants may be impacted within staging areas. Park staff would transplant individual Pitcher's thistle plants outside of the construction zone as part of mitigation measures (see chapter 4). The number of plants that may be impacted is undetermined due to various life cycle stages. Impacts to the calypso orchid and dwarf lake iris, are not expected at the grassy construction zones and staging areas, although impacts could occur to plants that may occur along the roads where woody stems alter habitat. Once construction is completed, all disturbed areas would be restored, and it is expected that Pitcher's thistle would re-populate the area.

Impacts along Chicago Road would include loss of tree habitat for bat species and rare special status species birds such as the Eastern whip-poor-will, black-billed cuckoo, Canada warbler, and wood thrush. Impacts would be long-term and adverse, but minimal when considering the expanse of available habitat on the island. Trees would be removed in the first year of construction prior to the bat roosting/pupping season that generally starts on May 15 when overnight temperatures reach 55 degrees as well as prior to songbird nesting. On-shore construction staging at the terminus of Chicago Road would be identified outside of the wilderness area and on a grassy area not particularly favorable to the Pitcher's thistle. If tree removal cannot be performed prior to May 15 along Chicago Road, surveys would be conducted to understand bat presence, habitat, and best management practices to avoid and mitigate active season impacts to any bat species. Minimal impacts to low, wet habitats potentially available for the dwarf lake iris, and calypso orchid would be impacted for the road improvements.

In the unlikely case that maintenance dredging is needed at the new South Manitou Island dock, dredge spoil would be repurposed on the island by park maintenance or would be disposed of offsite. The dredging itself would take into consideration nesting and fledging shorebirds and Pitcher's thistle locations. Impacts would be mitigated through TOY restrictions, fencing, and transplanting (mitigation measures outlined in chapter 4).

Mitigation measures during construction of the dock would be in place to reduce or avoid adverse impacts on special status plant species. These measures would include designating limits of disturbance for contractors, fencing in all work areas to keep disturbances in an NPS-defined minimal impact area, establishing corridors for construction vehicle movement, staging of construction materials and equipment in minimal impact areas, restoration of staging areas upon completion, and implementing best practices to minimize introduction and spread of invasive species. Where construction and dredging would impact special status plant species such as Pitcher's thistle, transplanting of individual plants to nearby area outside of the project area may occur, and where possible, construction access would be restricted from large areas of sensitive vegetation.

Overall, the action alternative would result in short-term, adverse impacts to special status species due to construction activities along the beach construction zone. Minimal long-term, adverse impacts would occur to special status birds due to tree removal along Chicago Road. Mitigation measures and avoidance efforts would significantly reduce any impacts to wildlife and vegetation species in the project area during the construction of the new dock to South Manitou Island. Following construction and any infrequent maintenance dredging, the impacts described above would resolve and no significant loss of habitat is expected.

North Manitou Island

Under the action alternative, the construction on North Manitou Island would be focused on the demolition of the old dock and construction of a new dock. To prepare the location of the new dock for construction, the former dock piles that would interfere with navigation or sediment transport would be removed, and approximately 10,000-20,000 CY of sediment would be dredged and disposed of along the shoreline, south of the existing dock site. During demolition and construction there would be temporary noise and vibrational impacts from the removal and installation of dock pilings that could impact special status fish species. The work, however, would be accomplished outside of the fish spawning season. Impacts are expected to be short-term, adverse, and minimal. Best management practices, TOY restrictions, and additional mitigation measures (outlined in chapter 4) would be implemented thereby minimizing or avoiding impacts to nesting shorebirds and other species.

There is an extensive monitoring and protection program for piping plovers and nesting areas. Program monitoring of plovers would be initiated prior to the start of construction of both docks with special attention to the project areas. Mitigation measures to minimize the possibility of piping plover nesting in the work areas include staff patrols, visual deterrents such as motion and reflective devices, and/or bird grid wire. If any nesting sites are discovered in close proximity of the construction zone, the nest area

would be fenced off, work would temporarily cease in the immediate area, and USFWS consultation would be re-initiated.

During a special status species survey during September 2023, 170 Pitcher's thistle plants were found on in the project area on North Manitou Island in multiple life stages from young growth with no flowers present to mature Pitcher's thistle that had flowered and died. All Pitcher's thistle recorded in the survey were found along the shoreline in unconsolidated sand away from wave action. Mitigation measures during construction of the dock would be in place to reduce or avoid adverse impacts on special status plant species such as Pitcher's thistle. These measures would include designating limits of disturbance for contractors, fencing in all work areas to keep disturbances in an NPS-defined minimal impact area, establishing and adjusting corridors for construction vehicle movement to avoid direct impacts as much as possible, staging of construction materials and equipment in minimal impact areas, restoration of staging areas upon completion, and implementing best practices to minimize introduction and spread of invasive species. Where construction and dredging would impact Pitcher's thistle, transplanting of individual plants to a more protected area may occur, and where possible, construction access would be restricted from large areas of sensitive vegetation. Once construction is completed, disturbed areas within habitats for the species would be regraded to match natural conditions.

The action alternative includes the removal of the existing dock which is expected to naturally release the accumulated sand deposits via littoral drift. Pitcher's thistle plants currently inhabit portions of the accumulated sand deposits. This natural movement of sand would decrease the size of the beach north of the existing dock to more natural conditions and therefore reduce the population of the plant at that portion of the project area. However, the littoral drift of sand south of the dock is expected to increase the width of the beach habitat to the south of the dock to more natural conditions, thereby increasing habitat opportunities for the plant to inhabit. If the park finds that the littoral drift is slow to occur and continues to inhibit operations of boat traffic, the park would instigate artificial movement of sand via dredging and/or excavating at the sandy point. This work is expected to cause long-term adverse impacts to Pitcher's thistle with the loss of habitat. However, the littoral drift would increase habitat opportunities and return natural disturbance dynamics upon which Pitcher's thistle depends that would result in long-term beneficial impacts to the species.

Overall, the action alternative would result in some alteration to habitat and vegetation. However, these alterations would generally be confined to the shoreline in the vicinity of the proposed dock. Mitigation and avoidance efforts would significantly reduce any impacts to special status wildlife and vegetation species in the project area during the construction of the new dock at North Manitou Island. Following construction, the impacts described above would resolve and no significant loss of habitat is expected.

Cumulative Impacts

South Manitou Island

Impacts from some past, present, and reasonably foreseeable actions would result in adverse impacts to special status species. Previous dredging efforts and extending the existing dock has contributed to short-term adverse impacts to the lacustrine habitat. Climate related trends have and would continue to result in droughts, floods, runoff events, extreme swings in lake water levels, and shoreline erosion, all of which have the potential to diminish the habitat quality and quantity for special status plant and animal species in the project area.

Impacts from potential dredging activities under the no-action alternative would contribute a small adverse increment to the cumulative impact due to the use of heavy equipment and placement of dredge spoil which would disturb species using the aquatic environment or the shoreline for foraging or nesting. These impacts, though temporary, would somewhat build upon the climate related trends that may also affect habitat for special status species in the project area. Combined with the adverse impacts of climate related trends, the overall cumulative impact on special status species under the action alternative would be adverse.

Impacts from the action alternative would contribute an adverse increment to the cumulative impact due to dredging and construction activities in the water and shoreline as well as removal of trees and shrub vegetation along Chicago Road. These actions have the potential to disturb special status species using these habitats, such as aquatic species and bat species, which would somewhat build upon the climate related trends that may also affect habitat within the project area. Combined with the adverse impacts of climate related trends, the overall cumulative impact on special status species under the action alternative would be adverse.

North Manitou Island

Impacts from some past, present, and reasonably foreseeable actions would result in adverse impacts to special status species. Previous dredging efforts have contributed to short-term adverse impacts to the lacustrine habitat. Climate related trends have and would continue to result in droughts, floods, runoff events, extreme swings in lake water levels, and shoreline erosion, all of which have the potential to diminish the habitat quality and quantity for special status plant and animal species in the project area.

Impacts from dredging activities under the no-action alternative would contribute a small adverse increment to the cumulative impact due to the use of heavy equipment and placement of dredge spoil which would disturb species using the aquatic environment or the shoreline for foraging or nesting. These impacts, though temporary, would somewhat build upon the climate related trends that may also affect habitat for special status species in the project area. Combined with the adverse impacts of climate related trends, the overall cumulative impact on special status species under the action alternative would be adverse.

Impacts from the action alternative would contribute a small adverse increment to the cumulative impact due to dredging and construction activities in the water and shoreline. These actions have the potential to disturb special status species using these habitats, such as aquatic species, which would somewhat build upon the climate related trends that may also affect habitat within the project area. The action alternative would also contribute a noticeable beneficial increment to the cumulative impact due to the restored natural littoral flow that is expected following the removal of the existing dock. Combined with the adverse impacts of climate related trends, the overall cumulative impact on special status species under the action alternative would be adverse.

CHAPTER 4: MITIGATION

The NPS places a strong emphasis on avoiding, minimizing, and mitigating potentially adverse impacts to affected resources, whether under the jurisdiction of the NPS or as a result of an NPS decision. To help ensure the protection of natural and cultural resources and the quality of the visitor experience, the NPS would implement the following mitigation measures. This will allow the NPS to meet conservation mandates as required by the Organic Act (16 USC 1 et seq.) and as further detailed in NPS *Management Policies 2006*, and the NHPA and the Endangered Species Act. The NPS would also implement an appropriate level of monitoring throughout the construction process to help ensure that protective measures are being properly implemented and are achieving their intended results. Mitigation measures of the action alternative are provided below.

4.1 GENERAL MITIGATION MEASURES

- Instruct construction employees on the sensitivity of the general environment. Corridors for construction vehicle movement would be established and defined on the ground. Staging of construction equipment would be restricted to the road corridor, parking lots, and other identified previously disturbed areas to avoid impacts on natural and cultural resources.
- The park may create opportunities to educate visitors about the former dock locations for the new docks and their respective roles at each island.
- Where feasible, construction mats would be utilized to protect soils from disturbance caused by construction machinery.
- All erosion control materials must be safe for use around wildlife (e.g., no plastic mesh will be used; will use loose weave, non-welded, movable jointed netting).
- Best management practices to avoid and minimize the spread of invasive species and forest pests, including but not limited to:
  - All construction-related equipment and supplies should arrive at the site free of mud or seed-bearing materials
  - Certify that all seeds, fill, and straw-based erosion control materials are weed-free
  - Equipment and weed-free documentation will be inspected prior to arrival to the islands
  - Avoid the active period for oak wilt when developing tree removal plan and include decontamination protocols should cutting of oaks be necessary during active period (i.e., hazard tree development).
- Wound treatment measures would be in place for trees.
- A restoration plan would be in place for restoration of trees, vegetation, and soils after construction activities are complete. All areas that are temporarily disturbed during construction (including staging areas) would be reseeded or planted with native grasses and other native species compatible with the park's cultural landscape.

- A communication plan between park staff and contractor staff would be developed to ensure contractor understands mitigation measures and how to notify park staff of any issues.
- Construction activities would occur during daylight hours only. No nighttime construction activities would be conducted.
- Wildlife and plant surveys would be conducted covering all construction and mobilization areas, travel corridors, and a 50-meter buffer to prevent unintended impacts outside construction areas. All wildlife and plant surveys would be conducted by a trained biologist familiar with the fauna and flora of the area and the habitats present within the project area. Upon the identification of at-risk wildlife or protected plants, a mitigation plan would be developed or followed if already established. Depending upon the species, mitigation may involve relocation/transplanting, establishment of a buffer around the individual or active nest, monitoring of inactive nests to confirm abandonment, or delay of project activities until the individual has vacated the area.

4.2 MEASURES FOR PROTECTION OF CULTURAL RESOURCES

- An archeological monitor would be on site during relevant ground disturbing activities to ensure no disturbance to archeological resources occurs from the action alternative.
- NHPA Section 106 procedures would be reinitiated if and when any unknown significant archeological resources are uncovered during ground-disturbing activities.
- If any previously unknown archeological resources are discovered, all work in the immediate vicinity of the discovery shall be halted until the resources are identified and documented and an appropriate mitigation strategy developed, if necessary, in accordance with pertinent laws and regulations, including the stipulations of the 2008 Programmatic Agreement Among the NPS (US Department of the Interior), the Advisory Council on Historic Preservation, and the National Conference of SHPOs.
- Prior to removal of the historic dock pilings at North Manitou Island, NPS would undertake efforts to document remaining components both underwater and on-shore.
    - NPS will conduct single-camera photogrammetric documentation of the submerged historic dock pilings on the east side of North Manitou Island.
    - NPS will also conduct probing of the underground historic pilings in the onshore areas. Depending on the results of the probing, an inventory of metal detecting within the area will be conducted to identify or confirm the locations of additional pilings. Limited shovel testing may be conducted to confirm the location of one or more pilings identified by probing and/or metal detecting.

- Restoration of terrestrial areas would take place in accordance with the pending CLRs and Treatment Plans for the life-saving stations, if available at the time of restoration.
- Gravel used for paving should be sourced locally if possible to maintain compatibility with the cultural landscape.

4.3 MEASURES FOR PROTECTION OF WILDLIFE

- Vents/utility openings on new structures and vault toilets will have wildlife exclusion installed to prevent bats and other wildlife from entering.
- Standard noise abatement measures would be implemented during construction. Standard noise abatement measures could include the following elements: a schedule that minimizes impacts on adjacent noise-sensitive uses, the use of the best available noise control techniques wherever feasible, the use of hydraulically or electrically powered impact tools when feasible, and location of temporary noise sources as far from sensitive uses as possible.

4.4 MEASURES FOR PROTECTION OF BATS AND BIRDS IN WOODY AREAS

- Prior to vegetation removal associated with Chicago Road, park staff will identify and mark trees of large diameter at breast height (DBH) or of other value to avoid on the periphery of road corridor.
- Removal of trees and other woody vegetation with DBH of 3" or greater will occur between October 1 and May 15 to avoid impacts to roosting bats and most nesting birds.
- If woody vegetation management is needed between May 16 and Sept 30, trees and other woody vegetation under 3" DBH may be cut at any time with no affect to bats. However, the contractor will coordinate with the NPS prior to removal of trees less than 3" DBH between during this time to survey for bird nests. For trees greater than 3" DBH, the contractor will coordinate with the Natural Resources Division manager regarding Endangered Species Act Section 7 Consultation and additional conservation mitigations. Emergence surveys for bats must be performed by an USFWS-approved surveyor; if bats are detected during surveys, cutting will be delayed (unless the tree presents a hazardous condition). All trees felled between May 16 and September 30 must be inspected for bats, signs of bats, or bird nests, and if found, impactful activities must stop and observations must be reported by close of business day.

4.5 MEASURES FOR THE PROTECTION OF PITCHER'S THISTLE

- All attempts will be made to stage construction materials in areas where absence of Pitcher's thistle has been confirmed.

- To prevent, to the extent possible, damage or destruction of Pitcher's thistle during construction, the following actions will be taken:
  - Prior to any construction operations, the perimeter of the project area will be delineated by park Maintenance and Natural Resource Divisions staff in coordination with the contractor. Decisions will then be made on appropriate construction access and any areas of the shore that should be excluded from the limits of construction, and these areas will also be flagged.
  - If individuals cannot be avoided, proactive transplanting (late summer/fall year prior to construction) may occur.
  - Transplanting would include a percentage of juveniles in the area to maximize success and protect the overall population based on US Geological Survey data and experience.
  - No transplanting of adults or seedlings to take place.
  - Individuals with roots that cannot be fully separated from the surrounding substrate (e.g., roots located beneath heavy rocks, tree roots, etc.) will not be transplanted.
  - Transplants would occur to areas just outside the impact zone. Biologists would note the presence of other individual plants in the receiving area to insure their protection.
  - The park will consider collecting seed from adult plants to distribute at restoration locations at end of project.
  - If additional individuals encountered in Year 1 or if work extends to Year 2, the following transplant options would be implemented during construction depending on when issues are identified and if specific plants cannot be avoided.
    1. April: Plants likely not leafed out, making location for transplanting very difficult. No transplanting to take place.
    2. May: Transplantation of juveniles possible, prior to bolting.
    3. June: Plants likely to have bolted. No transplanting of adults to take place; juveniles considered for transplanting.
    4. Fall: Juveniles considered for transplanting. Seeds from adults collected and dispersed.

4.6 MEASURES FOR PROTECTION OF PIPING PLOVERS AND OTHER SHOREBIRDS

- Grassy areas will be mowed to maintain unfavorable grassland bird nesting habitat during construction. If mowing is to occur between May 1 and July 15, a nesting bird survey would be conducted prior to initial mowing.
- Birds would be deterred from nesting in the work areas along the shorelines and in grassy fields during the construction period. Deterrent measures may include the use of loud noises, installation of wire cover, patrols by trained staff, and visual deterrents (reflective materials and motion).

- By April 15, visual deterrents would be deployed for plovers and other species to minimize impacts from nesting through time of activities on both islands. Visual deterrent to remain until contractor demobilizes for season.
- On North Manitou Island, additional deterrents – including wire cover and patrols - would be implemented during the primary nesting season while project activities are ongoing between May 15 and July 15. If no project activities are planned in an area for that timeframe, additional deterrents will not be employed in that area.
- At North Manitou Island, a grid wire system or similar product/design for wire cover would be installed over the majority of the sandy areas adjacent to and the existing and proposed docks, but particularly across the northern one-third of the sandy spit considered the best habitat and where nesting plover have utilized in past years. Installation must be complete by May 15 and maintained through July 30.
- At North Manitou Island, trained NPS staff would begin patrol on April 15 to prevent other shorebirds from nesting such as killdeer and spotted sandpipers. Patrols would continue through the piping plover nesting season to deter plovers from nesting. Daytime patrols would occur 3 times each day from sunset to sunrise, 7 days a week. The patrol area at North Manitou Island is to extend 250 meters north of the new dock and 250 meters south of the existing dock to include access routes as well as wire covered and open areas. Patrols may decrease on June 15 to one per day and end on July 15 or once nearby nest fledglings leave the nest.
- Patrols by trained staff will not purposefully flush any red knots.
- If piping plovers nest in the project area during construction despite deterrents, the contractor and park would employ a communications plan and establish an onsite plover monitor. Exclosures would be installed, and beach closures would be established to prevent disturbance of nesting activities. Work would be halted if it is determined the nest site is close enough to be affected by construction activities, and consultation with USFWS would be re-initiated.

CHAPTER 5: CONSULTATION AND COORDINATION

NPS Director's Order #12: *Conservation Planning, Environmental Impact Analysis, and Decision-making* requires "diligent" efforts to involve the interested and affected public in the NEPA process. This process helps to achieve the following: determine the important issues and eliminate those that are not; allocate assignments among the interdisciplinary team members and/or other participating agencies; identify related projects and associated documents; identify other permits, surveys, consultations, etc. required by other agencies; and create a schedule that allows adequate time to prepare and distribute the environmental document for public review and comment before a final decision is made. This chapter documents the agencies and Tribes consulted during the NEPA process and summarizes the public review process for this EA.

5.1 INTERNAL SCOPING

Internal scoping was conducted over the span of many virtual meetings with some combination of NPS staff from the park, the Denver Service Center, the Midwest Regional Office, and the consultant team. Meeting topics included purpose and need for the action alternative and culminated in the preparation of the Environmental Screening Form (which identified the issues and resource topics that should be addressed in the EA) and resource topics that could be dismissed from detailed analysis in October 2023. The existing conditions at the islands were also discussed. The team determined that it was appropriate to focus the environmental analysis on the no-action alternative and the preferred alternative, including previous planning iterations as considered but dismissed from further analysis. After determination of the preferred alternative, potential mitigation measures and management actions were discussed.

5.2 FEDERAL AGENCIES

US Fish and Wildlife Service

The Endangered Species Act of 1973 (16 USC 153 et seq.), as amended, in Section 7 directs all federal agencies to work to conserve endangered and threatened species and ensure the actions they take do not jeopardize the existence of any listed species. Because listed species may occur within the vicinity of the project area, the NPS is required to comply with the provisions of Section 7.

The NPS has prepared a biological assessment to analyze the potential for impacts on multiple plant and animal species (no designated critical habitat is present within the project area). The NPS will complete consultation under Section 7 prior to signing a decision document for the selected action. The NPS will reinitiate consultation if the project area changes or if federally listed species are encountered.

US Army Corps of Engineers

The NPS is also coordinating with the USACE to acquire applicable permits for in-water work.

5.3 TRIBAL PARTNERS

The following tribes were notified of the project:

- The Bay Mills Indian Community
- The Grand Traverse Band of Ottawa and Chippewa Indians
- The Little River Band of Ottawa Indians
- The Little Traverse Bay Bands of Odawa Indians
- The Sault Ste Marie Tribe of Chippewa Indians

The Chippewa Ottawa Resource Authority provided a letter on behalf of the Bay Mills Indian Community, the Grand Traverse Band of Ottawa and Chippewa Indians, the Little River Band of Ottawa Indians, the Little Traverse Bay Bands of Odawa Indians, and the Sault Ste Marie Tribe of Chippewa Indians on August 8, 2023, providing input for consideration by the planning team.

5.4 STATE AGENCIES

State Historic Preservation Officer

As required by Section 106 of the NHPA, the park consulted with the Michigan SHPO to assess effect of the project on historic properties. The planning team also discussed the project with the state maritime archeologist at the Michigan Department of Natural Resources.

A separate assessment of effect under Section 106 was prepared concurrently with this EA and submitted to the SHPO on February 28, 2024. In this assessment of effect, the NPS determined that the federal undertaking would have the potential for an adverse effect on historic properties. The NPS will continue to coordinate with the SHPO, the state maritime archeologist, and any relevant consulting parties during the next step of the Section 106 compliance process for this project, which is expected to require development of a Memorandum of Agreement. Preliminary mitigation measures have been developed by the NPS and would be subject to agreement by relevant signatories. The Section 106 process for this project will be completed prior to the NPS signing a decision document.

Michigan Department of Environment, Great Lakes, and Energy

A Coastal Zone Management Act Federal Consistency Determination was completed and determined that the action alternative is consistent with the enforceable policies of Michigan's approved coastal management program. This consistency determination was submitted to EGLE for certification on March 15, 2024. Certification would be required prior to the NPS decision to move ahead with the selected alternative.

The project team has also initiated pre-application discussions with EGLE to understand relevant concerns as they will apply to permitting efforts associated with dredging. All dredging and in-water disposal of dredged materials is subject to permitting, as noted below.

5.5 LOCAL AGENCIES

Park staff would continue to coordinate with the Grand Traverse Road Commission on the proposal for Chicago Road as design of these improvements continue.

5.6 PUBLIC SCOPING

A civic engagement newsletter notifying interested parties of a public scoping comment period was distributed on July 13, 2023. The comment period was open for 30 days, through August 14, 2023. During this comment period, the NPS shared information about the purpose of and need for the project, the action alternative, and the project goals. The NPS requested public input on the rehabilitation design and project impacts that should be considered during the planning process. During the open comment period, five pieces of correspondence were received.

5.7 OTHER ENVIRONMENTAL AND REGULATORY REQUIREMENTS

Permitting would be required for the dock construction and dredging proposed in the action alternative. Applicable permits would include: Section 404 and 401 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. These permits are administered by the USACE and EGLE. The NPS would acquire relevant permits prior to initiation of these activities.

5.8 PUBLIC REVIEW

This EA will be on formal public and agency review for 30 days and has been distributed to a variety of interested individuals, agencies, and organizations. It also is available on the internet at https://parkplanning.nps.gov/slbe, and hard copies are available at the park headquarters at Sleeping Bear Dunes National Lakeshore, 9922 Front Street, Empire, MI.

CHAPTER 6: ACRONYMS AND ABBREVIATIONS

CEQ	Council on Environmental Quality
CLR	Cultural Landscape Report
CY	Cubic yards
DBH	Diameter at breast height
EA	Environmental Assessment
EGLE	Michigan Department of Environment, Great Lakes, and Energy
L1UB	Lacustrine Limnetic Unconsolidated Bottom wetlands
L2UB	Lacustrine Littoral Unconsolidated Bottom wetlands
MIA Farm Complex	Manitou Island Association Farm Complex
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NPS	National Park Service
OHWM	Ordinary High-Water Mark
PFO7C	Palustrine Forested Evergreen wetlands
PFO1C	Palustrine Forested Broad-Leaved Deciduous wetlands
SHPO	State Historic Preservation Officer
TOY	Time of year
USACE	US Army Corps of Engineers
USFWS	US Fish and Wildlife Service

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APPENDIX A: FLOODPLAINS STATEMENT OF FINDINGS

Sleeping Bear Dunes National Lakeshore Comprehensive Facility Rehabilitation on North and South Manitou Islands

Sleeping Bear Dunes Nation Lakeshore

Floodplain Statement of Findings
PMIS 318729

Recommended:

_____

Scott Tucker Superintendent, Sleeping Bear Dunes National Lake Shore Date

Certification of Technical Adequacy and Service-wide Consistency:

_____

Ed Harvey, Chief, Water Resources Division Date

Approved:

_____

Herbert Frost, Director, NPS Midwest Region (Regions 3, 4, and 5) Date

TABLE OF CONTENTS

SLEEPING BEAR DUNES NATIONAL LAKESHORE COMPREHENSIVE FACILITY REHABILITATION ON NORTH AND SOUTH MANITOU ISLANDS
SLEEPING BEAR DUNES NATIONAL LAKESHORE

FLOODPLAIN STATEMENT OF FINDINGS

INTRODUCTION

Executive Order (EO) 11988, "Floodplain Management," and EO 13690, "Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input," require the National Park Service (NPS) and other federal agencies to evaluate the likely impacts of actions in floodplains. The objective of EO 11988 is to avoid, to the extent possible, the long-term and short-term adverse impacts associated with occupancy, modification, or destruction of floodplains and to avoid indirect support of development and new construction in such areas wherever there is a practicable alternative. EO 13690 was issued to establish a Flood Risk Management Standard for federally funded projects to improve the nation's resilience to floods and to ensure new federal infrastructure will last as long as intended. The NPS administers floodplain policy through Director's Order 77-2: *Floodplain Management* (DO 77-2) and Procedural Manual 77-2 *Floodplain Management* (PM 77-2).

It is NPS policy to preserve floodplain functions and values and minimize potentially hazardous conditions associated with flooding, including threats to human health/life, risk to capital (NPS) investment, and impacts on natural and beneficial floodplain values. If a proposed action is found to be in an applicable regulatory floodplain with associated impacts and relocating the action to a non-floodplain site is considered not to be a practicable alternative, then a formal floodplain "Statement of Findings" must be prepared. The "Statement of Findings" must (a) quantify flood conditions and associated hazards as a basis for management decision-making, (b) describe the rationale for the selection of a floodplain site, (c) disclose the resources and amount of risk associated with the chosen site, and (d) explain flood mitigation plans. The "Statement of Findings" will be available for public review and comment through the National Environmental Policy Act Environmental Assessment.

This Floodplain Statement of Findings:

- Quantifies the flood hazard associated with the rehabilitation of visitor access to North and South Manitou Islands.
- Presents the rationale for the development of proposed facilities within the regulatory floodplain of North and South Manitou Islands.
- Documents the anticipated negative impacts of these improvements on human health/life, capital investment, and floodplain functions and values.
- Presents mitigations to these impacts.

LOCATION

There are three project locations associated with the Sleeping Bear Dunes National Lake Shore Comprehensive Facility Rehabilitation on North and South Manitou Islands. There are two project areas on South Manitou Island. One project is located at the South Manitou Village (45.011695°, -86.094646°) and the other is located near Chicago Road (45.025213°, -86.101349°). There is one project area on North Manitou Island located at the North Manitou Village (45.121748°, -85.974979°) as depicted in Figure 1.

Figure 1: North and South Manitou Island project areas.

PROPOSED ACTION

The National Park Service (NPS) proposes the construction of new docks, constructed at the locations of the historical docks (Appendix A), and the removal of the existing docks on the North and South Manitou Islands. The goal of moving the docks to the historical dock locations is to promote natural littoral drift patterns in the project areas and create safe and functional boat access to North and South Manitou Islands for visitors and NPS employees. Please refer to Appendix A for more

information on the project locations. The detailed proposed actions for North and South Manitou Islands project locations can be found below.

PURPOSE AND NEED

The docks located within the North and South Manitou Islands project areas are critical to the daily operations of the park such as search and rescue, visitor access, park facility maintenance, and other park management activities. Currently, the locations and designs of the docks interfere with the natural littoral drift patterns causing sediment to accumulate around the existing docks. Over the years, high-water levels and storm events have increased the accumulation of sediment around the docks, creating hazardous conditions for navigation and access to the North and South Manitou Islands. The existing dock at North Manitou Island consists of a pile/sheet pile-supported dock system with steel grate and concrete decking. The current sheet pile dock design prevents water and sediment from freely moving through portions of the dock, creating high levels of sediment accumulation, leading to frequent, costly, and difficult dredging efforts to maintain navigability at North Manitou Island dock. The existing dock at South Manitou Island consists of a pile-supported dock system with a weathering wooden deck which has been experiencing sedimentation and non-natural littoral drift conditions impacting the dock and shoreline. The sediment accumulation creates shallow water conditions resulting in a lack of safe and functional access to the dock. Due to accumulating sediment around the South Manitou Island dock, the NPS recently added a 100-foot extension to the original 200-foot dock to provide access to deeper water. However, recurring sand accumulation threatens to limit access over time.

The purpose of the project is to provide safe and functional dock structures for visitors and NPS employees to access the North and South Manitou Islands. The immediate need to replace the existing docks would reduce sediment accumulation and promote the natural littoral drift patterns impacted by the existing docks at their current locations by constructing pile-supported docks at the historical dock locations allowing for water and sediment to migrate through the dock area largely unobstructed. Moving the docks to their historical location along with the open pile design of the docks will reduce the frequency of maintenance dredging to maintain navigability at the dock locations. The construction of new docks, constructed at the location of the historical docks would provide safer and more enjoyable docks for visitors as well as NPS employees maintaining the islands.

PROPOSED ACTION FOR NORTH MANITOU ISLAND

The NPS is proposing the removal of the existing dock and the construction of a new dock at the historical dock location, located 400 linear feet to the north of the existing dock (Appendix A). The construction includes the construction of a pile-supported dock at the historical dock location (north of the current dock), demolition of the existing dock, removal of existing infrastructure, and select dredging of the project area.

An engineering assessment and analysis of the project site were conducted to determine the optimal location for the new dock construction. Please refer to Appendix D for the assessment and analysis for the project site.

The new dock construction is a 50-year design and would be approximately 490 feet long with the deck being 13 feet, 2 inches wide. A horizontal T-section would be located at the end of the dock furthest from the shoreline. The horizontal T-section would be approximately 86 feet long and 13 feet, 2 inches wide. The new dock would be supported by 14-inch diameter steel piles spaced 12 foot on center and would have steel angle-supported concrete decking. Please reference Appendix B for dock design figures. The new design and location of the proposed dock will provide safer and more functional boat access to North Manitou Island by allowing for water and sediment to pass under the dock largely unobstructed preventing the buildup of sediment at the new dock location.

Before the construction of the new dock at North Manitou Island, approximately 10,000-20,000 cubic yards of sediment would be removed from the historical dock location to prepare the location for construction. Select historic dock piles currently located at the historic dock location pose the risk of interfering with navigational safety and sediment transport once the new dock is constructed. Select piles will be removed from the project area to provide safe navigation around the new dock. Historic piles that do not pose a threat to the construction and/or operation of the new dock will remain to educate visitors about the history of the previous dock.

The existing dock will be demolished once the new dock is operational. The removal of the existing sheet pile dock would allow water to flow more naturally in the area, restoring the natural littoral drift process to the area, and resulting in a decrease in future dredging activities. Minimal dredging would occur in the area following the removal of the existing dock, increasing navigability in the project area and allowing the natural littoral drift processes to continue. The NPS will wait to see if the sediment mobilizes naturally from the restoration of the natural littoral processes and will determine any need for future dredging. Up to approximately 76,500-86,500 cubic yards of accumulated sediment would be removed from the existing dock area if the natural littoral drift process is not successful at removing built-up sediment in the project area. It should be stated that the amount of material to be removed from the project area is a conservative number and it is the hope that removal of the existing dock at North Manitou Island will allow for natural littoral drift processes to decrease the amount of built-up sediment in the project area, reducing the need for dredging.

PROPOSED ACTION FOR SOUTH MANITOU ISLAND

The NPS is proposing the removal of the existing dock and the construction of a new dock at the historical dock location near Chicago Road, approximately 1 mile north of the existing dock (Appendix A). The construction includes the construction of a modern dock at the historical dock location (near Chicago Road), the demolition of the existing dock, and the removal of existing infrastructure at the current dock location.

An engineering assessment and analysis of the project site was conducted to determine the optimal location for the new dock construction. Please refer to Appendix D for the assessment and analysis for the project site.

The new dock construction is a 50-year pile-supported design and would be approximately 325 feet long and 13 feet, 2 inches wide with a horizontal T-section at the end of the dock furthest from the shoreline. The horizontal T-section would be approximately 86 feet long and 13 feet, 2 inches wide. The new dock would be supported by 14-inch diameter steel piles spaced 12 foot on center and

would have steel angle-supported concrete decking. Please reference Appendix B for dock design figures. The new design and location of the proposed dock will provide safer and more functional boat access to South Manitou Island.

Some of the historic dock piles currently in the historic dock location, where the proposed new dock is to be located, pose the risk of interfering with navigational safety and sediment transport; these piles will be removed. Historic piles that do not pose a threat to the construction and/or operation of the new dock will remain to educate visitors about the history of the previous dock.

JUSTIFICATION FOR THE USE OF THE FLOODPLAIN

INVESTIGATION OF ALTERNATIVE SITES

An engineering assessment and analysis of the project sites were conducted in the fall of 2022, spring of 2023, and fall of 2023, which included topside and underwater inspection, topographic and bathymetric surveys, spectral wave analysis, and sediment transport modeling. A preferred alternative design was completed in February 2023. Alternative options were considered for the project but were dismissed due to the designs either not meeting the park's needs or not being cost-effective. The Coastal Analysis Report details the assessment and analysis of alternative sites, and can be found in Appendix D.

OPTIONS FOR REMOVING STRUCTURES FROM THE FLOODPLAIN

The alternative option to move the project areas to non-floodplain sites was not feasible due to the objective of the project to provide safe and functional boat access to the park. Boats and ferries must have access to the docks to maintain access to the park sites. The operation of the docks necessitates that they be located within the floodplain to be operational.

DIFFERENT LOCATIONS AND RATIONALE FOR DISMISSAL

The alternative to relocating the project areas to a different location would still require the project areas to be within the floodplain as the operation of a dock necessitates its location within the floodplain. The current and proposed dock locations support water-based park management activities for both North and South Manitou Islands.

ELEVATING STRUCTURES AND RATIONALE FOR DISMISSAL

The current dock structures remain structurally sound and elevating the docks does not represent an opportunity to reduce risk to the structures from severe storm events. The current design and location of the existing docks result in sediment accumulation by impeding natural littoral drift, elevating the docks does not reduce the issues experienced with sediment accumulation. This alternative is not practicable, because even elevated, the location of substantial structures within the floodplain remains necessary.

JUSTIFICATION FOR FLOODPLAIN LOCATION

The purpose of the proposed action is to provide safe and functional access for visitors and NPS employees and to restore the natural littoral drift patterns near the project areas. The proposed action for the construction of new docks, and the demolition of the existing docks on North and South Manitou Islands, requires the project areas to be located within the floodplain. Boats and ferries must have access to the docks to maintain access to the park sites. For the docks to be operational, the docks must be located within the floodplain.

FLOODPLAIN DESCRIPTION, STANDARDS, AND RISK

DETERMINATION OF ACTION CLASS AND REGULATORY FLOODPLAIN

Following PM 77-2, three action classes were considered when establishing the regulatory floodplain:

1. Class I Actions include location or construction of administrative, residential, warehouse, and maintenance buildings; non-excepted parking lots; or other man-made features which by their nature entice or require individuals to occupy the site, are prone to flood damage, or result in impacts to natural floodplain values.
2. Class II Actions include any activity for which even a slight chance of flooding is too great such as construction of schools, medical facilities, emergency services, hazardous material storage, and records/collections storage.
3. Class III Actions include any action that involves human occupation or substantial human exposure in high hazard areas such as drainages subject to flash flooding.

This project constitutes a Class I Action. The regulatory floodplain for Class I actions is the 1-percent annual exceedance probability flood, also referred to as the 100-year flood or the base flood (DO #77-2).

DETERMINATION OF FEDERAL FLOOD RISK MANAGEMENT STANDARD

Additionally, following EO 13690, any proposed action that involves federal capital investment must include a Federal Flood Risk Management Standard (FFRMS) for new construction, substantial improvement, or repairing substantial damage. Per the Federal Emergency Management Agency's implementing guidelines for EOs 11988 and 13690, agencies may select one of three approaches to implementing the flood resiliency:

1. Climate-Informed Science Approach (CISA) – the elevation and flood hazard area that result from using the best-available, actionable hydrologic and hydraulic data and methods that integrate current and future changes in flooding, including climate change and other physical processes (e.g. land-use change)
2. Freeboard Value Approach (FVA) – the elevation and flood hazard area that result from adding an additional 2 feet to the base flood elevation for non-Critical Actions and by adding an additional 3 feet to the base flood elevation for Critical Actions
3. 0.2-Percent Annual Chance Flood Approach (0.2PFA) – the area subject to flooding by the 0.2-percent annual chance flood

For the proposed project, a Freeboard Value Approach (FVA) establishing FFRMS flood elevations is employed. This method adds 2 feet to the base flood elevation (BFE). Therefore, the regulatory floodplain for the proposed action is the 100-year flood elevation plus 2 feet added to the BFE.

The existing floodplain in the project areas were mapped using FEMA Flood Maps (Appendix C). The three project areas are located within the 100-year floodplain and are classified as Special Flood Hazard Areas (SFHA), Zone AE with a Base Flood Elevation (BFE) of 586 feet. Using the FVA, the FFRMS elevation of 588 feet was established for the project areas.

DESCRIPTION OF SITE-SPECIFIC FLOOD RISK

As stated above the three project areas are located within the 100-year floodplain and are classified as Special Flood Hazard Areas (SFHA) according to the FEMA Flood Maps (Appendix C). The SFHA is defined as an area that will be inundated by a flood event having a 1-percent chance of being equaled or exceeded in any given year, commonly referred to as the based flood or 100-year flood event. Flooding at the project locations is generally caused by high water levels within Lake Michigan coupled with storm surges/seiche events. These storm events can occur any time of the year but are most frequent in October and November when water levels are highest and significant storm events are most common. These storms can occur multiple times a year, or not at all in other years. The three project areas where the work is to be completed consist of relatively flat topography with minimal vegetation along the shoreline transitioning into highly vegetated areas further ashore which makes the project areas more vulnerable to flooding.

Flooding can occur at the sites in concurrence with a storm event depending on the size and strength of the storm event. Flooding associated with these storm events can range in depth and velocity depending on the size and strength of the storm. It is estimated based on topographic maps of the area and pictures taken by NPS during flood events that flood depths range from 0’ to 2’. Depending on topography and proximity to the shoreline. The velocity of flood water is presumed to be negligible due to flood waters pooling in low-lying areas and not flowing back to Lake Michigan.

To determine water surface elevations, AMI performed a long-range statistical analysis of water surface elevations of Lake Michigan, dating back to 1918. The data as presented on Figure 2, provides the monthly average water surface elevation of Lake Michigan, all water data is provided in the 1985 International Great Lakes Datum (IGLD85). This data shows a minimum documented water elevation of 576.02 feet during January 2013, and a maximum documented water elevation of 582.3 feet during June 2020, resulting in a total of 6.33 ft of fluctuation in standing water surface elevation alone since 1918. The average water surface elevation for March 2024 was also recorded to have an elevation of 578.87 feet. Potential future water surface elevations were calculated and are projected to rise approximately 0.34 feet over the next 50 years. The top of the proposed dock elevation (583.75 feet IGLD85) was included in Figure 2 for a visual comparison of the fluctuating water surface elevations of Lake Michigan.

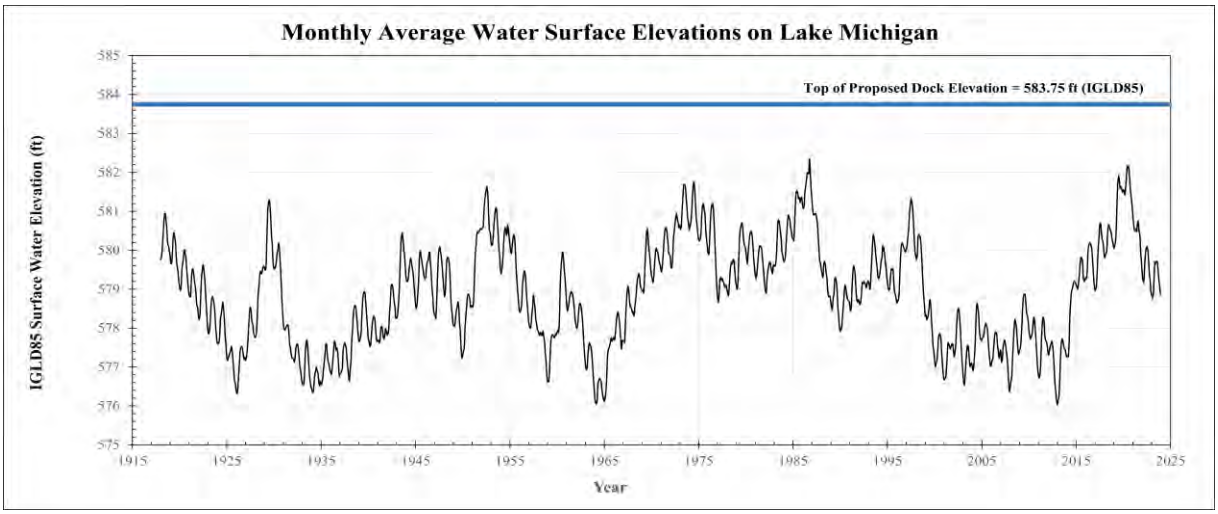


Figure 2. Monthly average water surface elevations on Lake Michigan and the elevation of the top of the proposed docks.

POTENTIAL RISK TO HUMAN HEALTH AND SAFETY

The risk to human health and safety is minimal due to the limited access to the islands during the time of the year with higher chances for flooding and during forecasted storm events and other conditions that could result in flooding or other risks. Currently, technology offers days-weeks of advanced warnings of potential flood events associated with major storm events (gales). As stated above, flooding at the project locations is generally caused by high water levels within Lake Michigan coupled with storm surges/seiche events. These storm events can occur any time of the year but are most frequent in October and November when water levels are highest and significant storm events are most common. The only way to access the islands is through private watercraft, NPS watercraft, or the privately owned ferry service. The ferry service's operational schedule runs from mid-May through the last weekend in September, avoiding the months for higher chances of flooding. In the event of inclement weather conditions that could result in flooding or other risks to human health and safety, the NPS and the ferry service will halt operations until conditions improve and are safe. The docks that are located within the floodplain area will not be in use during storm events, therefore, the potential risk to human health and safety is minimized.

POTENTIAL RISK TO PROPERTY

The only structures to be built within the floodplains are the docks. The top of the proposed docks will be at an elevation of 583.75 feet. With the FFRMS elevation of 588 feet, it is expected that the new docks will experience overtopping during a 100-year flood event. The docks have been engineered with properly sized steel supports and concrete decking to retain structural integrity during large storm and flood events. The original docks are located within the flood zone and have experienced minimal damage due to storm and flood events. Other properties such as watercraft should not be located within the floodplain at the time of flooding events due to storm events associated with flooding at the project sites causing Lake Michigan to be unnavigable.

POTENTIAL RISK TO FLOODPLAIN VALUES

Fish and Wildlife Habitat: The area of the project is a lake ecosystem providing habitat for aquatic species. However, the highly mobile sand substrate limits the opportunity for vegetation. Surveys by the park have identified Pitcher's Thistle within the project areas.

Natural Flood and Erosion Control: Being a lake ecosystem, the floodplains associated with this project do not provide natural flood or erosion control values. The floodplains in the project area consist of loose unconsolidated sands and a lack of vegetation leading them to be susceptible to erosion and not providing erosion control in the project area.

Surface Water Quality Maintenance: As part of Lake Michigan, the floodplains in this project area represent a substantial surface water body. Efforts around Lake Michigan are being conducted to improve the overall water quality. Proper Best Management Practices (BMPs) will be utilized during all in-water work to protect the water quality of Lake Michigan.

Groundwater Recharge: The substrate of Lake Michigan around North and South Manitou Islands are highly mobile sand sediments providing the opportunity to capture and retain water that supports groundwater recharge.

Biological Productivity: As part of the larger Lake Michigan, the floodplain provides substantial biological productivity. Within the project area, however, very little biological productivity is apparent. The exposed mobile sand substrate does not provide an opportunity for significant vegetation growth. However, surveys conducted at the islands have found the presence of Pitcher's Thistle in the project area. Pitcher's Thistle is classified by the U.S Fish and Wildlife Service (USFWS) as a threatened species.

Higher Quality Recreational Opportunities: The Manitou Island project areas are a significant recreational resource in these portions of the park.

FLOODPLAIN IMPACT MITIGATION MEASURES

ACTIONS TAKEN TO MINIMIZE IMPACT TO HUMAN LIFE AND PROPERTY IN FLOODPLAINS

NON-STRUCTURAL MITIGATION MEASURES

In the event of inclement weather conditions that could result in flooding or other risks to human life and property, the NPS and the ferry service will halt operations until conditions improve and are safe. Since the docks will not be in use during storm events, properties such as watercrafts should not be located within the floodplain at the time of flooding events, therefore minimizing the impacts on human life and property.

STRUCTURAL MITIGATION MEASURES

The only proposed structures to be built within the floodplains are the docks. The new docks have been engineered to retain structural integrity during large storm and flood events. Wave and ice impact forces have been thoroughly evaluated and applied to the design of the dock structure, its individual components, as well as its connections. Dynamic wave impact loads were applied in

addition to static loading due to the environment in which these docks will be exposed. The docks have been designed for resiliency to withstand the harsh conditions in which they are proposed. The new docks will be constructed with steel piles, beam-supported concrete decking, and at an elevation of 583.75 feet (IGLD85). It is important to note that IGLD85 is 0.25 feet lower than NAVD88 at the project locations. For example, IGLD elevation 583.75 feet => NAVD88 elevation 584.00 feet. The proposed dock elevation of 583.75 was designed to avoid the potential submersion based upon past, current, and potential future water surface elevation levels, with the expected temporary wave overtopping during wind-storm event.

Although the project site is within the floodplain, it is imperative to take low water surface elevations into account. Water surface elevations on Lake Michigan have dropped to 576.00 feet as recently as 2013. The purpose of the proposed action is to provide safe and functional access for visitors and NPS employees and to restore the natural littoral drift patterns near the project areas. For the docks to be safe and operational, the elevation of the top of the docks must consider the safety and overall usability of the docks during times of low water surface levels. Having the top of the proposed docks to be at the elevation of 583.75 feet ensures the docks will remain safe and functional during low water surface elevation levels, while still maintaining a safe elevation during times of higher water surface elevation levels. Figure 3 displays the ferry height at different elevations. Note this figure displays elevations in NAVD 88. To convert to IGLD 85, subtract 0.25 feet from the NAVD88 elevations shown.

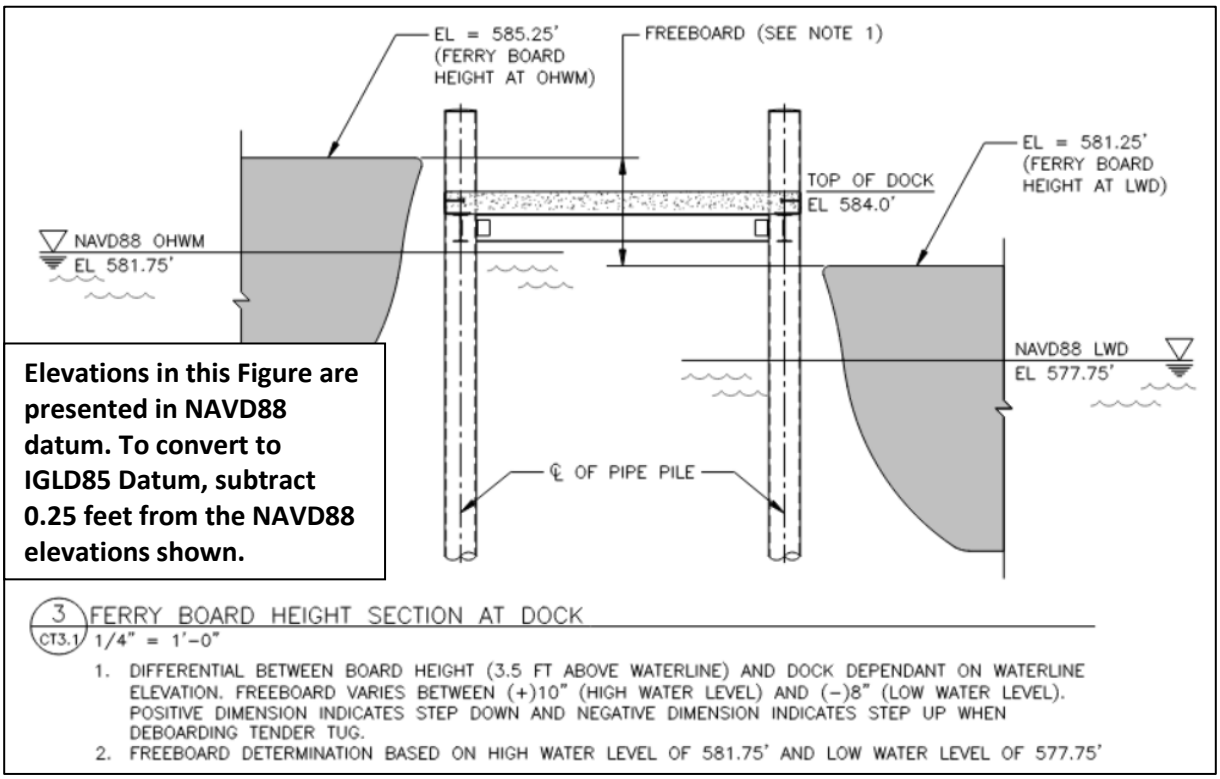


Figure 3: Ferry Board Height at Dock

ACTIONS TAKEN TO MINIMIZE IMPACTS TO NATURAL RESOURCES IN FLOODPLAINS

Modeling of different dock designs and locations was performed for both docks to evaluate the sediment transport around the docks (Appendix D). The new dock on North Manitou Island would take advantage of the natural angling of the beach in this area to provide opportunities to dock in a variety of ways on the structure, depending upon prevailing winds. The new dock on South Manitou Island will be in an area that provides access to deep water and relatively protected conditions from wind and wave action. The redesign and relocation of the docks have been designed to prevent the accumulation of sediment at the dock locations at the North and South Manitou Islands. This is an important factor in providing a safe, navigable area around the docks at both islands as well as minimizing the impact of the structures on sediment transport at the dock locations. Removing the existing dock on North Manitou Island will return the natural path of the littoral drift at the current dock location. Constructing pile-supported docks at the historical dock locations on the North and South Manitou Islands will maintain the natural littoral drift at the historic dock locations. The littoral drift analysis can be found in Appendix D.

SUMMARY

The NPS has determined that implementing the proposed actions detailed above to improve boat access to North and South Manitou Islands is the most viable option. Under the proposed actions, the boat access to North and South Manitou Islands would be improved through the construction of new docks at the historical dock locations, and the demolition of the existing docks on North and South Manitou Islands. The proposed actions will reduce sediment accumulation at the docks, increase dock usability, and promote the natural littoral drift patterns in the project areas. The protection of people and property, including natural resources, is of high priority to the NPS. The proposed projects would occur in areas that have been previously developed, and the NPS has concluded that no other alternative exists to meet their needs. It is believed that the design and placement of the docks in the flood zone will not adversely affect the floodplain and risk to life and property has been minimized.

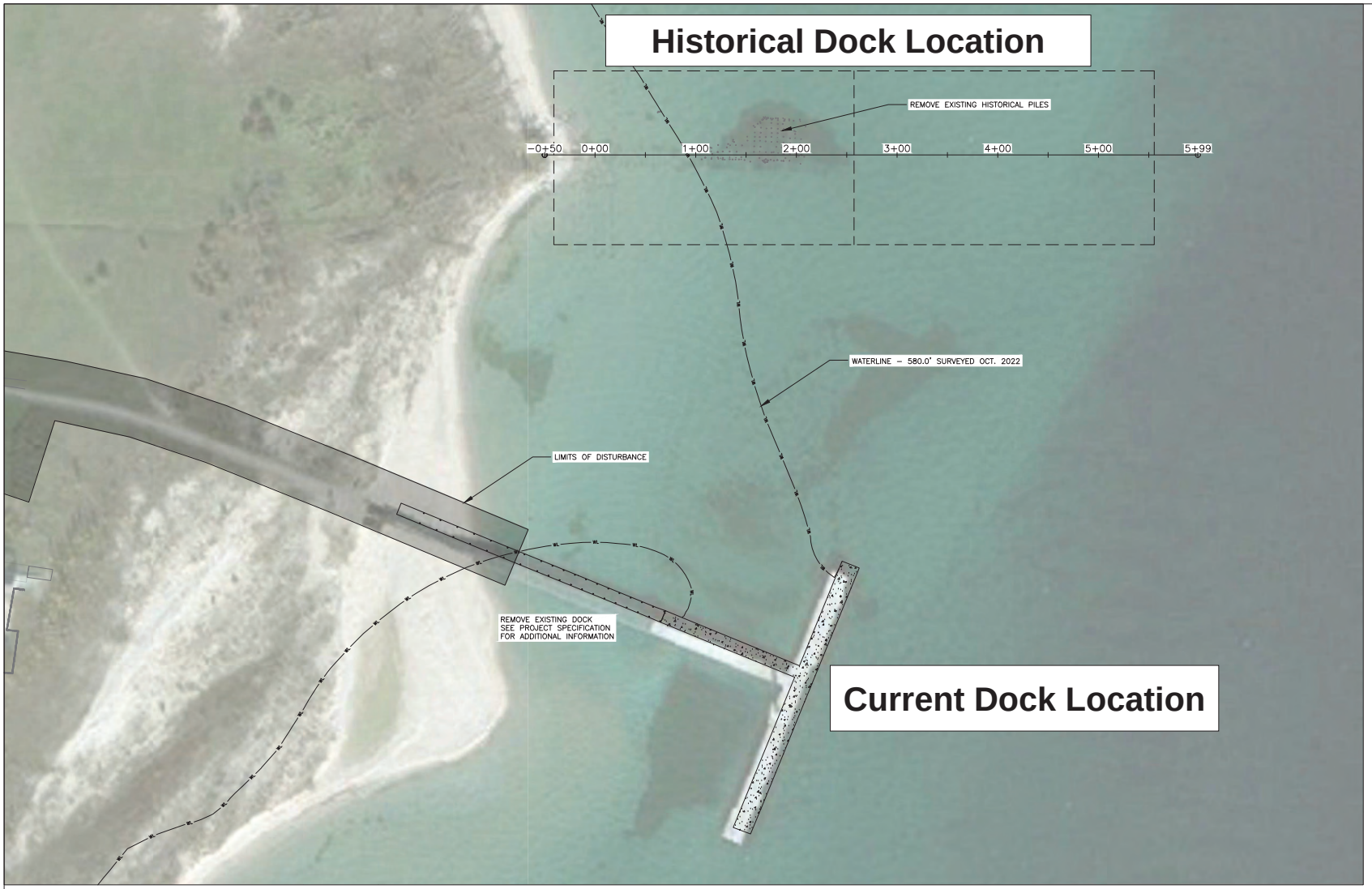
REFERENCES

Executive Order 11988, "Floodplain Management." 1980. Executive Order of the President of the United States. May 28.

Executive Order 13690, "Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input." 2015. Executive Order of the President of the United States. January 30.

National Park Service (NPS). 2003. Director's Order 77-2: *Floodplain Management*. Washington Office, Washington, D.C.

APPENDIX A
PROJECT LOCATION MAPS



N

0 60 120 Feet

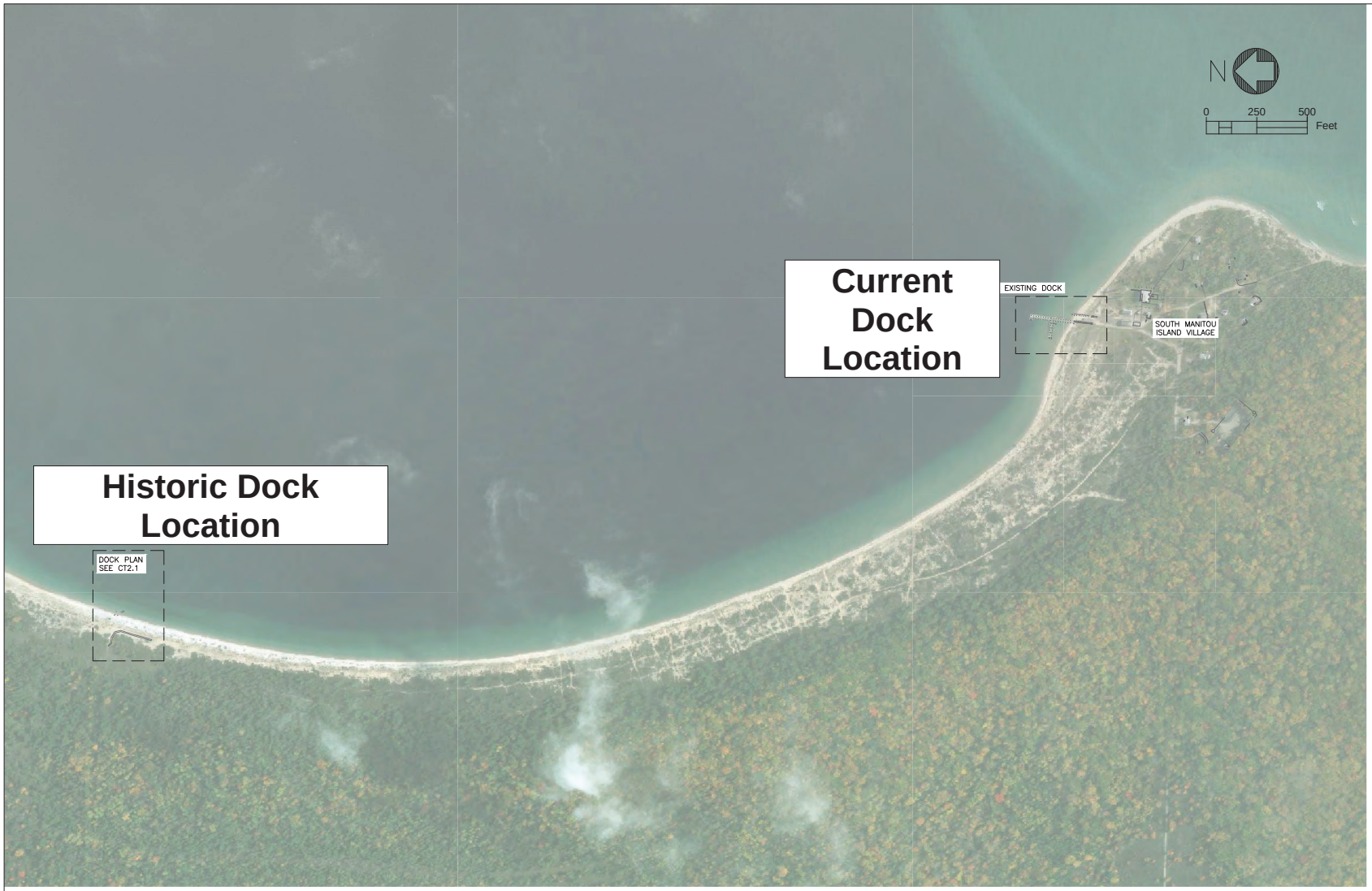
UNDERGROUND UTILITY LOCATIONS SHOWN ARE BASED UPON VARIOUS RECORD UTILITY MAPS IN CONJUNCTION WITH VISIBLE EVIDENCE GATHERED DURING THE TIME THE FIELD SURVEY WAS PERFORMED. THEREFORE, ALL UNDERGROUND UTILITY LOCATIONS SHOULD BE FIELD VERIFIED PRIOR TO CONSTRUCTION.

THIS DRAWING ONLY REFLECTS AND VERIFIES THE FIELD SURVEY DATA OF THOSE FEATURES AND CONDITIONS PRESENT AS OF MAY 7, 2023.

100% COMPLETE CONSTRUCTION DOCUMENTS

A/E FIRM PRIME: VHB WILLIAMSBURG, VA SUB: AMI SUPERIOR, WI	DESIGNED: MHO CHKD BRG TECH. REVIEW: DATE: 4/10/2024	SUB SHEET NO CT1.0	TITLE OF SHEET NMI DOCK DEMO PLAN FACILITY REHABILITATION ON MANITOU ISLANDS SLEEPING BEAR DUNES NATIONAL LAKESHORE	DRAWING NO. 634 177759 PMIS/PKG NO. SLBE-318729 SHEET 41 OF 191

8/11/2023 2:04 PM Z:\2021\212065 NPS VHB Facility Rehab on Manitou Islands SLBE\8_NPS PROJECT CAD HERE\SLBE\318729\CT - MARINE STRUCTURAL\CT1.0 NMI DOCK DEMO PLAN.dwg



UNDERGROUND UTILITY LOCATIONS SHOWN ARE BASED UPON VARIOUS RECORD UTILITY MAPS IN CONJUNCTION WITH VISIBLE EVIDENCE GATHERED DURING THE TIME THE FIELD SURVEY WAS PERFORMED. THEREFORE, ALL UNDERGROUND UTILITY LOCATIONS SHOULD BE FIELD VERIFIED PRIOR TO CONSTRUCTION.

THIS DRAWING ONLY REFLECTS AND VERIFIES THE FIELD SURVEY DATA OF THOSE FEATURES AND CONDITIONS PRESENT AS OF MAY 7, 2023.

SCHEMATIC DESIGN PREFERRED ALTERNATIVE

A/E FIRM	DESIGNED:	SUB SHEET NO	TITLE OF SHEET	DRAWING NO.
PRIME: VHB WILLIAMSBURG, VA	MHO	SMI	DOCK LOCATION OVERVIEW	XXX XXXXXX
SUB: AMI SUPERIOR, WI	CADD BRG	CT2.0	FACILITY REHABILITATION ON MANITOU ISLANDS	PMIS/PKG NO. SLBE-318729
	TECH. REVIEW:		SLEEPING BEAR DUNES NATIONAL LAKESHORE	SHEET 22 OF 24
	DATE: 7/26/2023			

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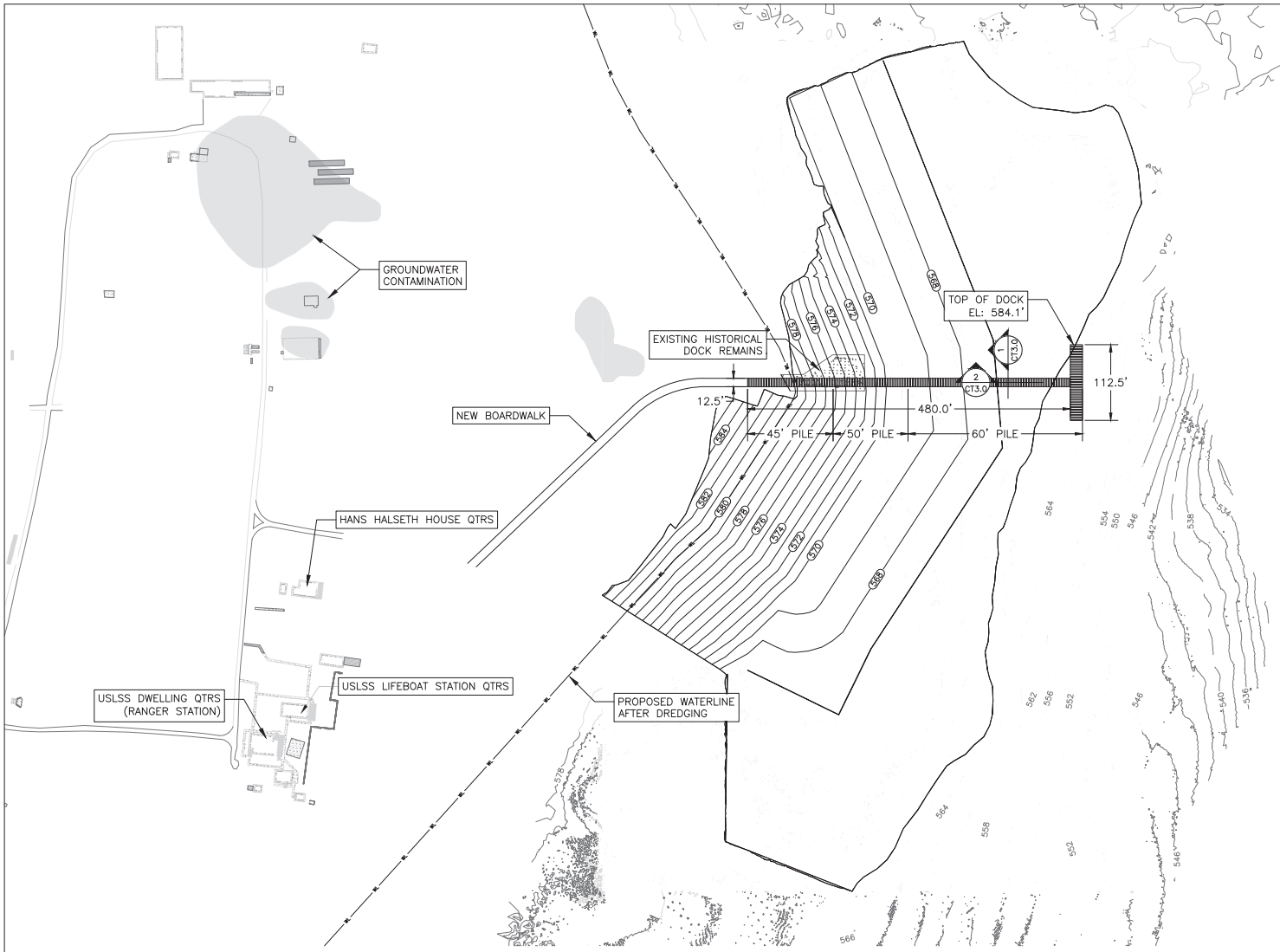
APPENDIX B
PREFERRED DESIGNS & PROJECT LOCATIONS



1) ALLOWS FOR NATURAL PROCESS FOR LITTORAL DRIFT.
2) LITTLE WAVE PROTECTION OFFERED.
3) FLOATING DOCK COULD BE INCORPORATED TO ADDRESS FLUCTUATING WATER LEVELS.
4) ADDITIONAL LAND DISTURBANCE FOR ROADWAY/PATH.

THIS DRAWING ONLY REFLECTS AND VERIFIES THE FIELD SURVEY DATA OF THOSE FEATURES AND CONDITIONS PRESENT AS OF MAY 7, 2023.

SCHEMATIC DESIGN

A/E FIRM	DESIGNED:	SUB SHEET NO	TITLE OF SHEET	DRAWING NO.
PRIME: VHB WILLIAMSBURG, VA	MHO	NMI	DOCK PLAN	634 177759
SUB: AMI SUPERIOR, WI	BRG	CT1.2	FACILITY REHABILITATION ON MANITOU ISLANDS	PMIS/PKG NO. SLBE-318729
	TECH. REVIEW:		SLEEPING BEAR DUNES NATIONAL LAKESHORE	SHEET 13 OF 35
	DATE: 8/15/2023			

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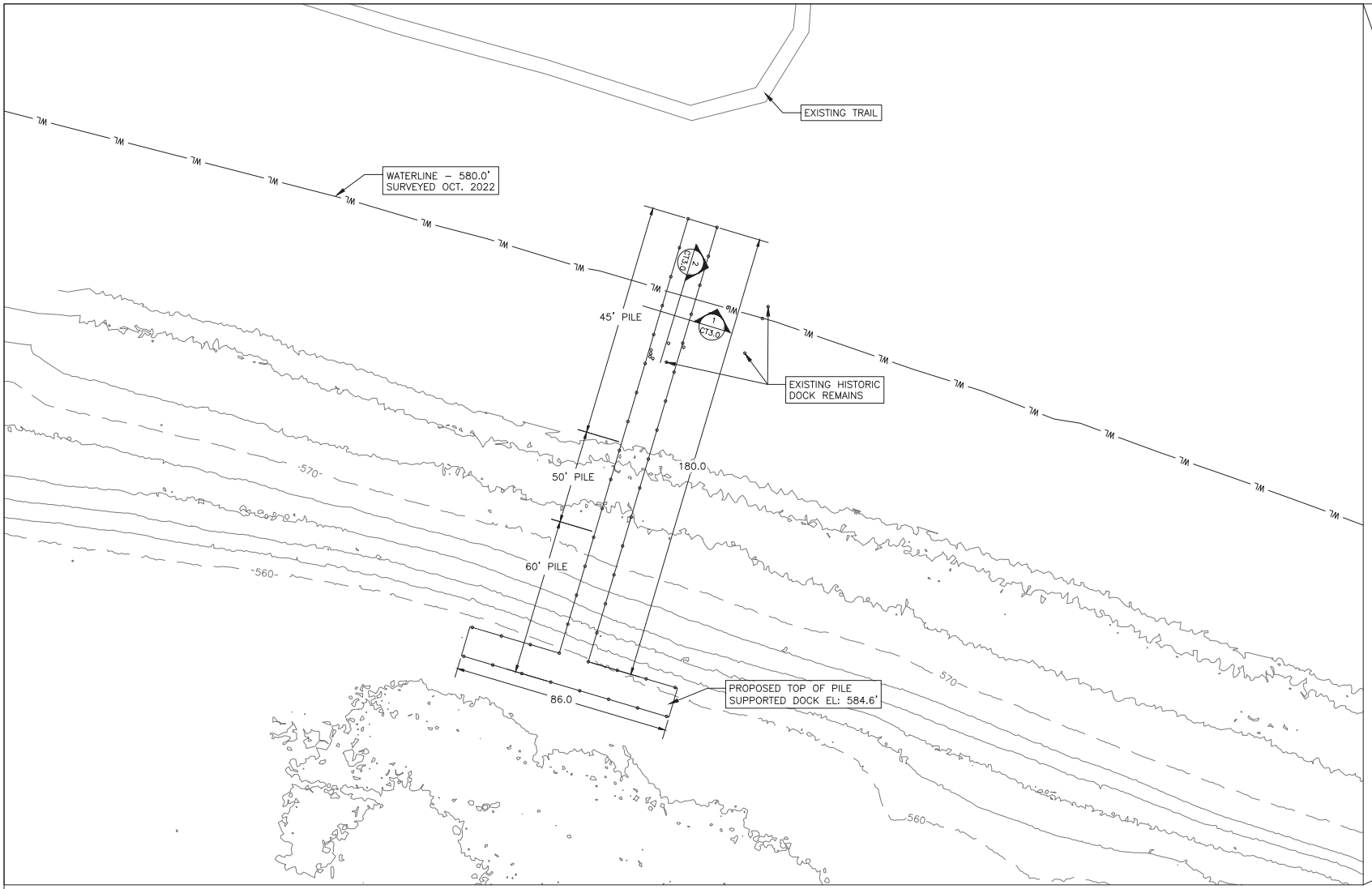
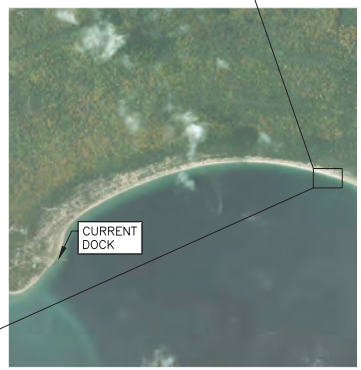


1) ALLOWS FOR NATURAL PROCESS FOR LITTORAL DRIFT.
2) LITTLE WAVE PROTECTION OFFERED.
3) FLOATING DOCK COULD BE INCORPORATED TO ADDRESS FLUCTUATING WATER LEVELS.
4) LAND IMPROVEMENTS/DISTURBANCE REQUIRED TO PROVIDE ACCESS TO EXISTING INFRASTRUCTURE.
5) END OF DOCK IS IN DEEPER WATER WHICH IS LESS SUSCEPTIBLE TO LITTORAL DRIFT WHICH REQUIRES DREDGING.



UNDERGROUND UTILITY LOCATIONS SHOWN ARE BASED UPON VARIOUS RECORD UTILITY MAPS IN CONJUNCTION WITH VISIBLE EVIDENCE GATHERED DURING THE TIME THE FIELD SURVEY WAS PERFORMED. THEREFORE, ALL UNDERGROUND UTILITY LOCATIONS SHOULD BE FIELD VERIFIED PRIOR TO CONSTRUCTION.

THIS DRAWING ONLY REFLECTS AND VERIFIES THE FIELD SURVEY DATA OF THOSE FEATURES AND CONDITIONS PRESENT AS OF MAY 7, 2023.

FINAL SCHEMATIC DESIGN

A/E FIRM	DESIGNED:	SUB SHEET NO	TITLE OF SHEET	DRAWING NO.
PRIME: VHB WILLIAMSBURG, VA	MHO	SMI	DOCK PLAN	634 177759
SUB: AMI SUPERIOR, WI	BRG	CT2.1	FACILITY REHABILITATION ON MANITOU ISLANDS	PMIS/PKG NO. SLBE-318729
	TECH. REVIEW:		SLEEPING BEAR DUNES NATIONAL LAKESHORE	SHEET 30 OF 35
	DATE: 10/23/2023			

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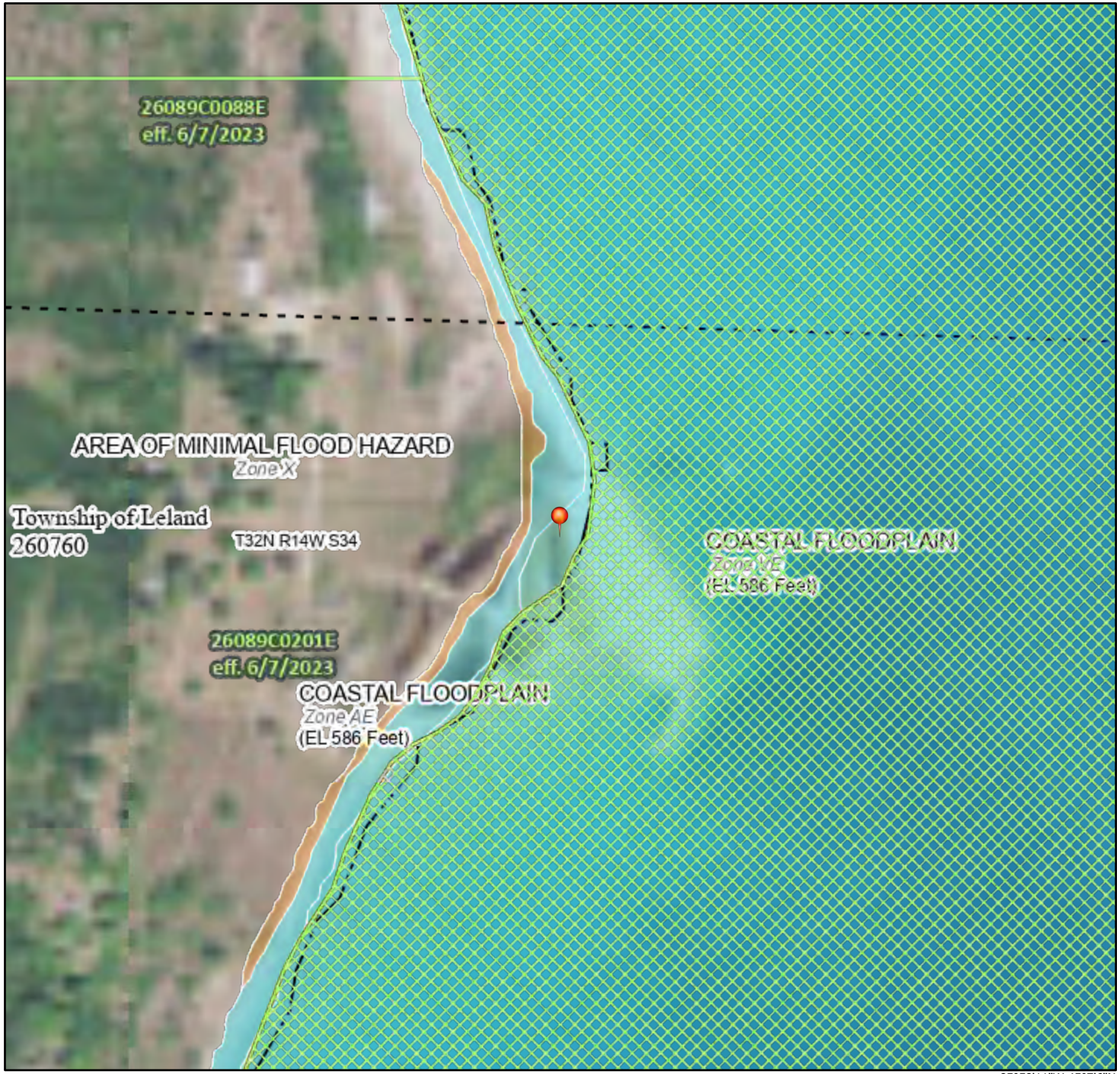
APPENDIX C
FLOOD PLAIN MAPS

National Flood Hazard Layer FIRMette

FEMA

85°58'49"W 45°7'32"N



85°58'11"W 45°7'6"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance / Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 10/23/2023 at 2:15 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

National Flood Hazard Layer FIRMette

FEMA

86°6'24"W 45°1'44"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

86°5'46"W 45°1'18"N

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 10/23/2023 at 2:11 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

National Flood Hazard Layer FIRMette

FEMA

86°6'W 45°0'56"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

86°5'23"W 45°0'30"N

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 10/23/2023 at 2:14 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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APPENDIX D
COASTAL ANALYSIS

SLEEPING BEAR DUNES NATIONAL LAKESHORE COASTAL ANALYSIS ON NORTH AND SOUTH MANITOU ISLANDS

Prepared for the National Park Service
Park: SLBE
PMIS: 318729

October 23rd, 2023

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SLEEPING BEAR DUNES NATIONAL LAKESHORE COASTAL ANALYSIS ON NORTH AND SOUTH MANITOU ISLANDS
AMI PROJECT NO. 212085
October 23rd, 2023

Table of Contents

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Executive Summary

This work provides a summary of the work conducted by AMI Consulting Engineers, P.A. (AMI) at North and South Manitou Islands, located within the Sleeping Bear Dunes National Lakeshore in Michigan. AMI's scope of work described in this report includes on-site topographic and bathymetric data collection, statistical analysis of meteorologic trends affecting the coastal climate at the islands, and numerical modelling to characterize the nearshore wave climates and coastal flooding susceptibility of the island villages.

AMI performed topographic and bathymetric surveys to assess the existing coastal conditions of the North Manitou Island (NMI) and the South Manitou Island (SMI). The field survey work was collected in the Fall of 2022 and was performed to the extent required for the desired coastal analysis. Supplementing this data with publicly available data, AMI created land surfaces that were integrated into a series of spectral wave models. Also integrated into the spectral wave models were wind forcing conditions and water levels determined to be suitable by AMI.

AMI's determination of a suitable design water level was performed by analysis of Lake Michigan water surface elevation data dating back to 1918. From this data, a peaks-over-threshold analysis was performed to plot a trendline of monthly average water surface elevations. These monthly average water surface elevations were further analyzed utilizing the Basis of Comparison, which corrects historic water levels to their predicted equivalent values under current water use and diversion regulatory systems in place on Lake Michigan. Further research was performed correlating long-term water surface elevations to relatively instantaneous storge surge effects. These correlations were utilized to determine water surface elevations for 50-year and 100-year return periods.

Wind forcing conditions applied to the model to meet that of a 50-year design storm were determined by AMI through a peaks-over-threshold analysis of significant wave heights (average highest one third of waves during a sampling period) at NOAA Station 45002, located approximately 20 miles west of the Manitou Islands. Through this approach, two storms occurring during the fall of 2022 were classified with a return period. Models were constructed to simulate and calibrate the modelling domain for these storms utilizing the NOAA 45002 station data as well as data collected from acoustic doppler current profilers placed at both North and South Manitou Island during the storms. The resulting wave heights of these storms were then scaled up to meet those of the determined 50-year storm, then wind forcing conditions were incrementally increased in the modelling domain to reach the desired wave height outputs. The wave models analyzed the wave conditions experienced at the dock locations at both islands from both northerly and southerly. The nearshore wave climate is essential to modeling sediment transport.

Based off of input from Vanasse Hangen Brustlin, Inc. (VHB), AMI, and the National Park Service (NPS), a total of four design alternatives were modeled (two at South Manitou Island and two at North Manitou Island). These design alternatives were modelled utilizing both northerly and southerly derived waves. Sediment transport modeling was completed to analyze sediment transport patterns and optimize the alternatives presented. Below is a summary of the wave and sediment transport analyses conducted for quick reference. Note that for structural design in coastal environments, significant wave heights (H_s) are typically converted to 10% design wave

heights (H_{10}) by the following formula: $H_{10} = H_s * 1.27$. This provides the required resiliency in structural design for dock applications.

Location - Alternate	Description	Significant wave height (ft) during 50 year storm		Sediment Accretion (ft/year)*	Additional Days per Year of Impact to Ferries**
		Southerly Wind	Northerly Wind		
SMI - Alt 1	Chicago Road	4.04	2.03	0.5	0
SMI - Alt 2	Grand Blvd	2.43	2.76	2	0
NMI - Alt 1	Existing Dock	5.41	5.09	4	10
NMI - Alt 2	Historical Dock	5.09	4.92	5	10

*Sediment accretion is based on seaward movement of design draft elevation of 567.5 ft

**At NMI, estimated between 6-14 additional days of impact to ferry services. See report for more detail

Section 1.0 – Introduction and Background Information

North and South Manitou Islands of Northern Lake Michigan are part of an island chain that extends from Glen Harbor, Michigan North to the Straights of Mackinaw (National Park Service, 2021). South Manitou Island is located approximately 16 miles from mainland and has an area of approximately 8 square miles, whereas North Manitou Island lies approximately 12 miles offshore and contains a land area of approximately 22 square miles. Figure 1 depicts the location of the two islands.

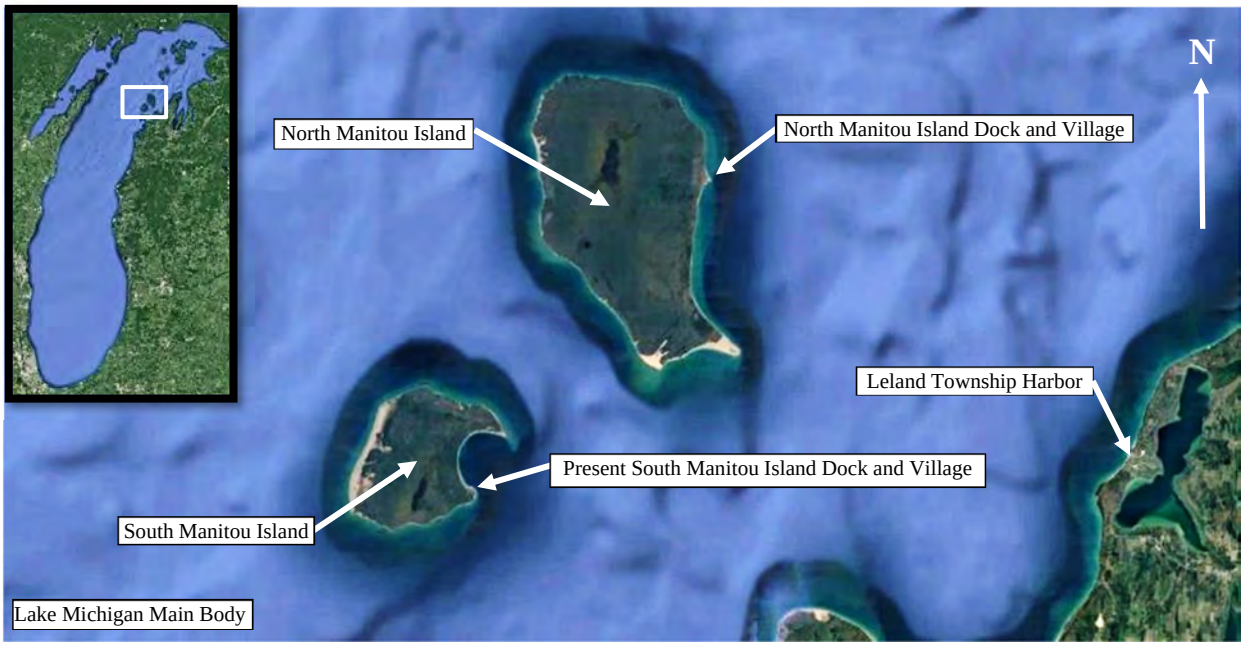


Figure 1: Site vicinity map.

The coastal environment of both North and South Manitou Islands are characterized by exposure to strong and frequent wind and wave patterns of Lake Michigan. Village and docking facilities are located on both islands and offer shelter from the most prominent wind directions, however,

the lakebed, shoreline, and islands themselves consist largely of sand with mixed gravel, cobbles, and boulders. Due to the combination of wind and wave environments, large quantities of shoreline materials have been mobilized and deposited into the areas surrounding the existing dock facilities. The material deposition has hindered navigational depth and overall use of the existing docks.

The scope of this study is to perform coastal modeling to assist in the preferred alternative for the proposed dock locations. The coastal modeling determines the nearshore wave environments, classify the coastal flood zones, and examines sediment transport characteristics with different dock locations/configurations. The coastal modeling required the following tasks be conducted for building models and validating results:

- Topographic and bathymetric survey at site locations.
- Acquisition and incorporation of nearshore bathymetric LiDAR data and global Lake Michigan bathymetric data.
- Sediment sampling to classify lakebed characteristics.
- Statistical analysis of historic Lake Michigan water levels.
- Statistical analysis of Lake Michigan wind characteristics and corresponding wave criteria.
- Review of climate change effects in correspondence with the National Park Service's Climate Change Response Program.
- Initial numerical modeling simulations and calibrations utilizing wind and wave data from buoys and land-based weather stations owned and operated by the National Oceanic and Atmospheric Administration (NOAA) as well as by two acoustic doppler current profilers (ADCPs) set nearshore at North and South Manitou Island.
- Spectral wave modelling to document both existing conditions and proposed conditions for design alternatives.
- Flood zone mapping based on a 1% annual occurrence (100-year) interval.
- Review of historic satellite imagery and observation of trends in shoreline morphology.
- Littoral drift modeling and quantification of sediment transport rates amidst existing conditions and considered design alternatives.

Section 2.0 – Existing Site Conditions

South Manitou Island

The island is characterized predominantly by beaches, sand dunes, or steep slopes. Images from a geologic report conducted in 1984 by McNamee, Porter & Seeley are provided in Figure 2. The images show that the eastern side of the island is entirely characterized by beach and shoreface sand, while the remaining shoreline of the islands contains a mix of outwash gravel and flat surfaces.

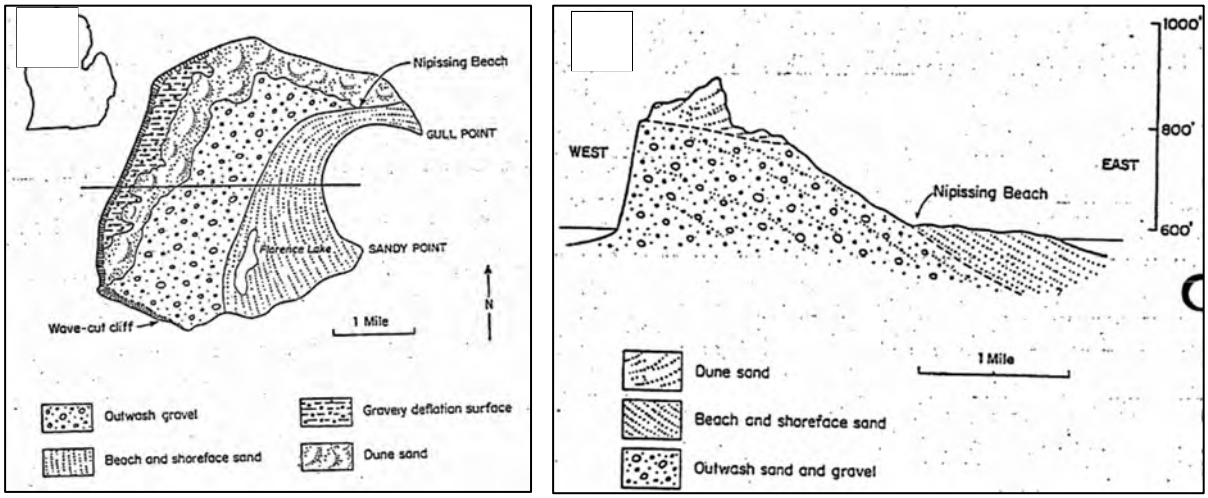


Figure 2: Geologic overview (A) and cross-section (B) of South Manitou Island.

At present, the Park Service maintains a number of historical structures while utilizing a pile-supported dock for transporting park staff as well as visitors to the island. This dock is placed parallel to a historic lifesaving station boat ramp at the southeastern tip of the island and extends outward into the lake. Prior to the lifesaving station, a historic dock existed at the end of Chicago Road. A dock structure is also believed to have been constructed between the Chicago Road Dock and the Existing Dock. Figure 3 shows the dock itself, whereas Figure 4 depicts the dock locations.

Figure 3: South Manitou Island dock.

Figure 4: Existing and historical dock locations at South Manitou Island.

Satellite imagery from 1993 indicates that the dock (at the time) extended approximately 200 ft out into the lake from the existing shoreline. Additional satellite imagery of the area containing lines traced over land/water interfaces, as shown in Figure 9 and Figure 10, provide an overview as to the extent of sand movement.

By 2012 a large portion of the docking area had become filled in with materials transported naturally down the shoreline and an extension was added onto the existing dock by 2015. The extension placed an additional 100 ft of dock structure out into the water. The most recent satellite image from 2022 indicates that sand continues to fill in around the docking area. Note that the satellite imagery alone does not account for changes in the location of the land/water interface due to water level fluctuations, nor do they account for changes in the shoreline due to dredging activities. These images are presented as a general overview only.

A historical photograph taken in 1935 shows the dock and the lifeboat launching house and ramp. While offering a glimpse into the past of South Manitou Island, this photo captured the apparent position of the shoreline and shoreface profile present at the site in 1935. Defining

features of this photo (buildings, ramp, water's edge, etc.) were able to be correlated into more recent satellite imagery of the site to graphically visualize and quantify the change in location of water's edge and accumulation of sediments since 1935. Figure 5 shows the 1935 photograph with water's edge and other recognizable features and Figure 6 presents the approximated extents of this image traced over satellite imagery obtained from 2022. Measurements of the approximated 1935 water's edge to the 2022 water's edge indicate approximately 190 ft of lakeward movement of the shoreface.

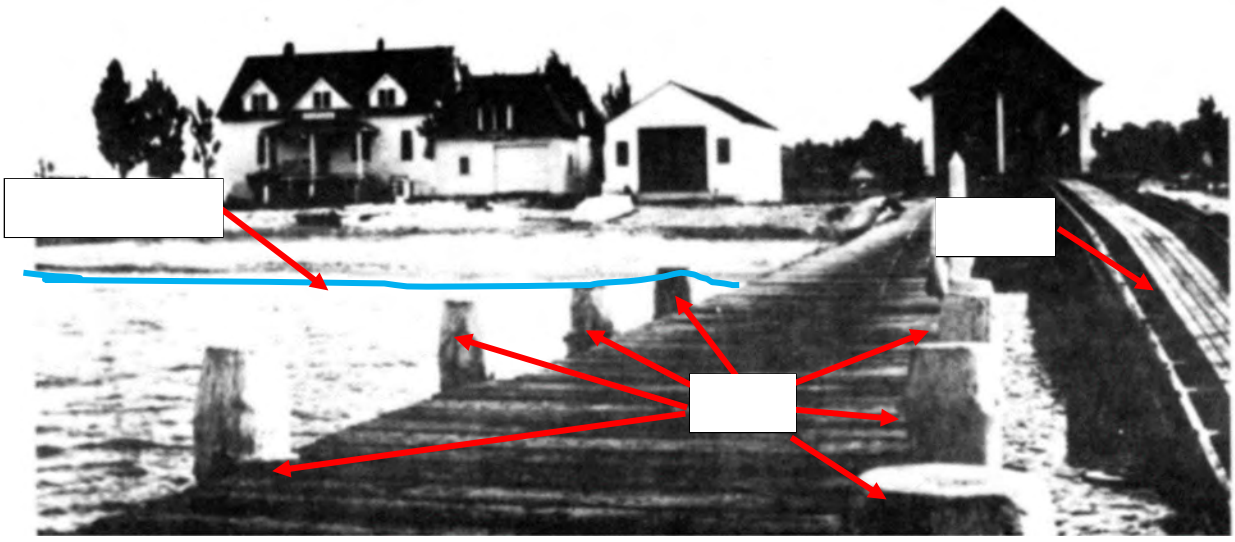


Figure 5: South Manitou Island lifesaving station photographed in 1935 (courtesy of Muhn 1984).

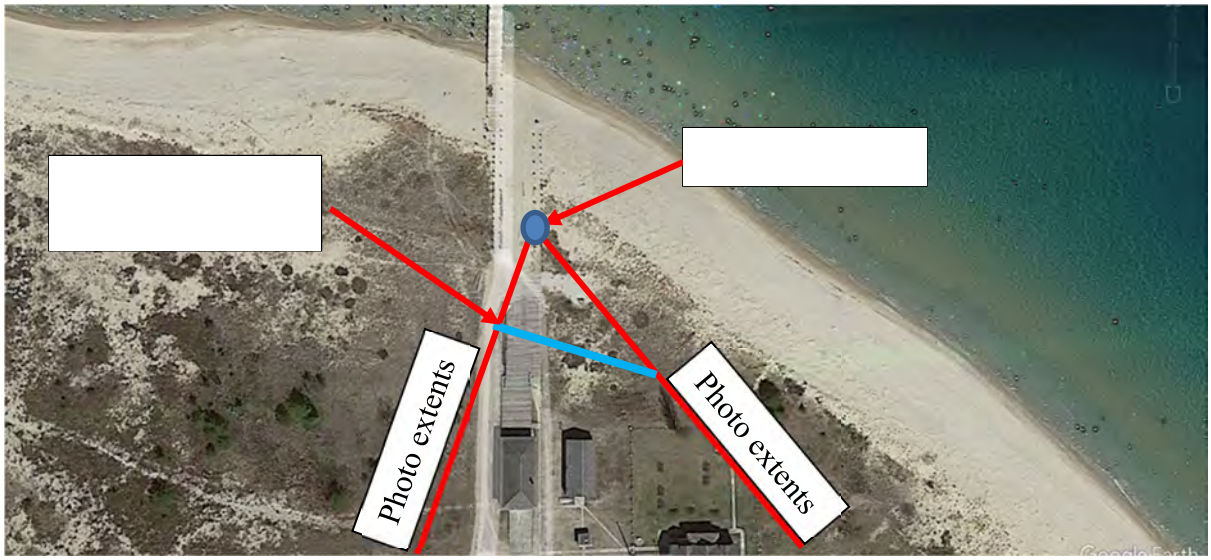


Figure 6: South Manitou Island lifesaving station 1935 photo extents superimposed over 2022 satellite imagery.

A photo of South Manitou Island offering sufficient detail for shoreline mapping was located for the year of 1954. The image, taken from a slightly oblique angle, is provided in Figure 7. Fixed locations such as building corners were used to scale and rotate the historic image onto current

satellite imagery. Figure 8 presents the traced locations of the shoreline at the time this image was taken as well as the small piece of shoreline approximated from the 1935 historic image.

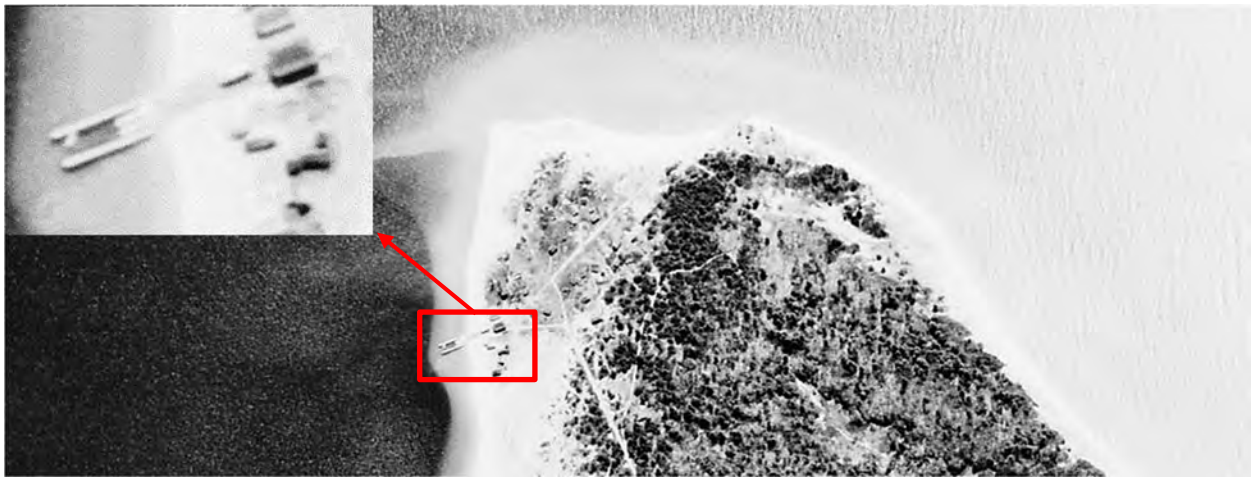


Figure 7: 1954 USGS aerial photo of South Manitou Island.

Figure 8: Shoreline Locations of South Manitou Island according to 1935 and 1954 imagery, traced over 2022 imagery.

A timeline of satellite imagery hosted by Google Earth from the years 1993 to 2022 is presented by Figure 9 and Figure 10. At the bottom of Figure 9 is an overview photo showing the total extents of shoreline movement between 1954 and 2022.

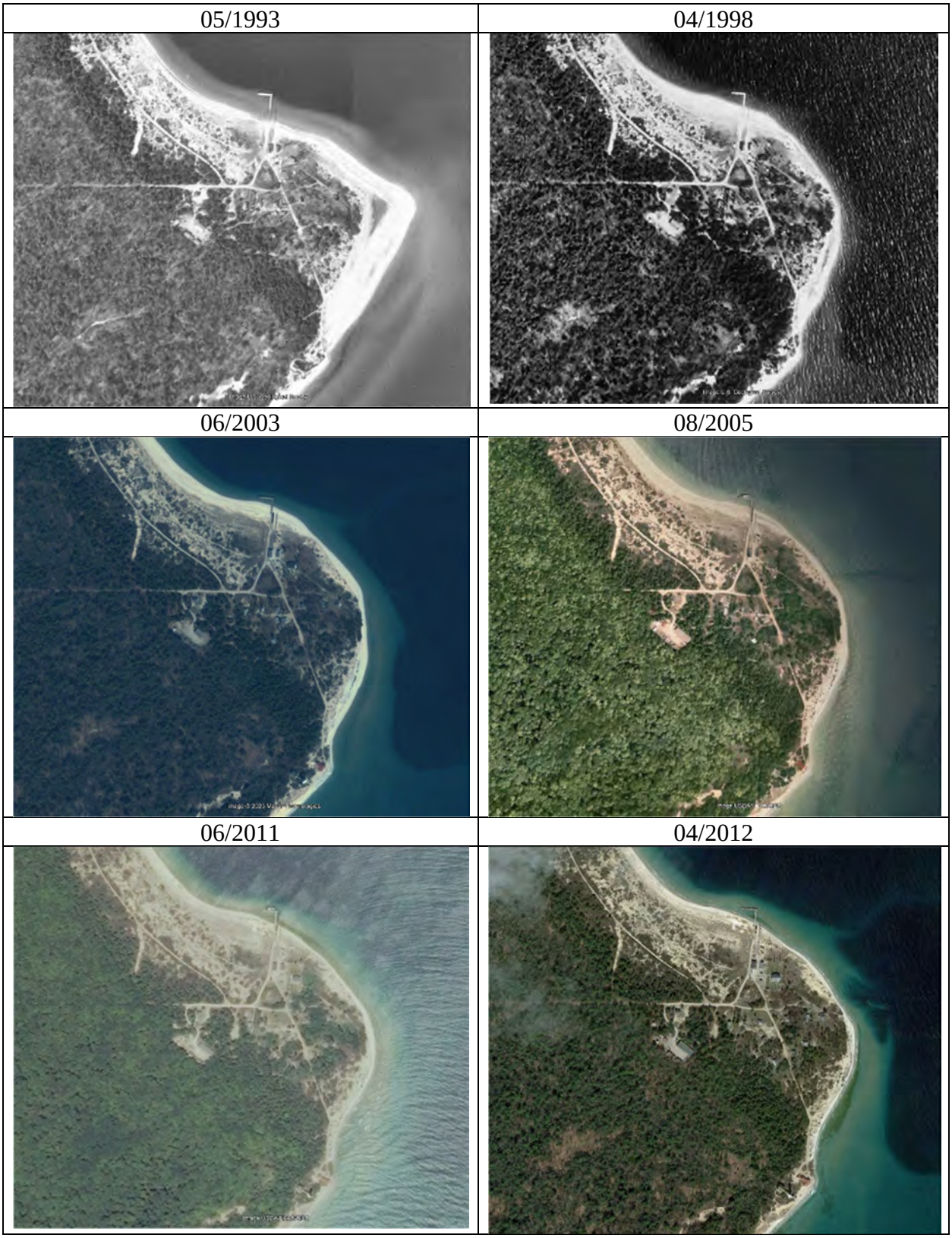


Figure 9: Satellite imagery at South Manitou Island.

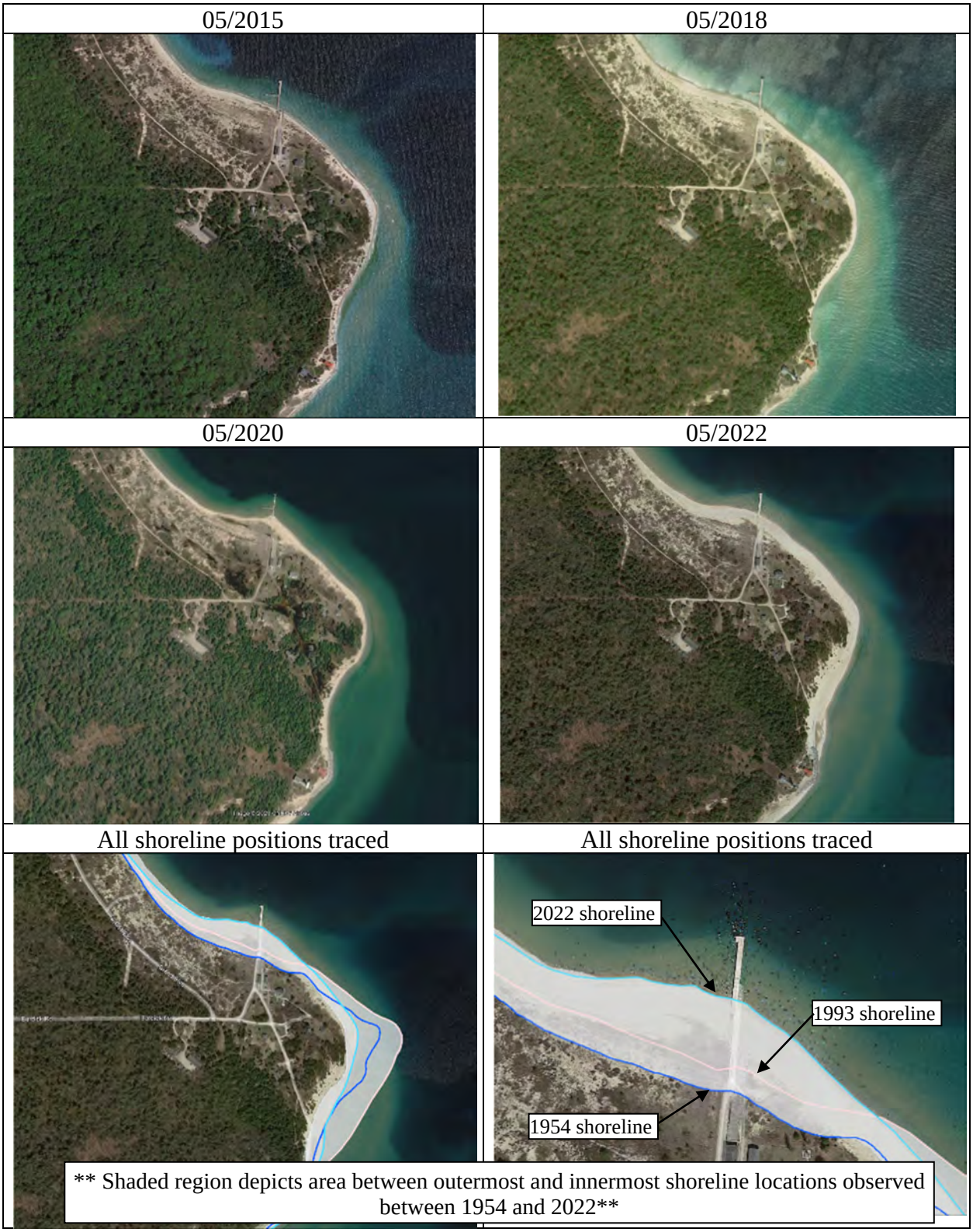


Figure 10: Satellite imagery and shoreline tracings at South Manitou Island.

Further assessment of the satellite imagery shows the Three Brothers Shipwreck with evident scouring and enhanced displacements of beach sand around its vicinity. This shipwreck, as stated by Michigan Preserves (2023) constitutes a 162-foot-long wooden steamer that was beached in September of 1911 and abandoned. Though quickly buried by shifting sands, the wreckage was revealed in 1996 as sand shifted. While the exact quantified effects of the wreckage on the littoral processes at this point of land are unknown, it can be visually observed that the natural process is being disrupted by the hard structure buried in the water.

Figure 11: Three Brothers Shipwreck and local sand displacement.

North Manitou Island

In the late 1980s, the National Park Service constructed an approximately 250 ft long pile-supported structure leading to a T-shaped closed-cell sheet pile dock approximately 160 ft long (perpendicular to shore) by 290 ft wide (parallel to shore). The placement of this dock is approximately 400 ft south of the remains of the historic pile-supported dock (reference Figure 12). The first observable satellite imagery of the new dock, taken during 1993, indicates that the outermost end of the dock was approximately 400 ft outward from the existing shoreline. Figure 13, taken on October 2nd of 2022 shows part of the dock as well as new gravelly land mass that has accumulated in front of it. Figure 16 and Figure 17 show a timeline of the shoreline morphology through satellite imagery. Note that the satellite imagery alone does not account for changes in the location of the land/water interface due to water level fluctuations, nor do they account for changes in the shoreline due to dredging activities. These images are presented as a general overview only.

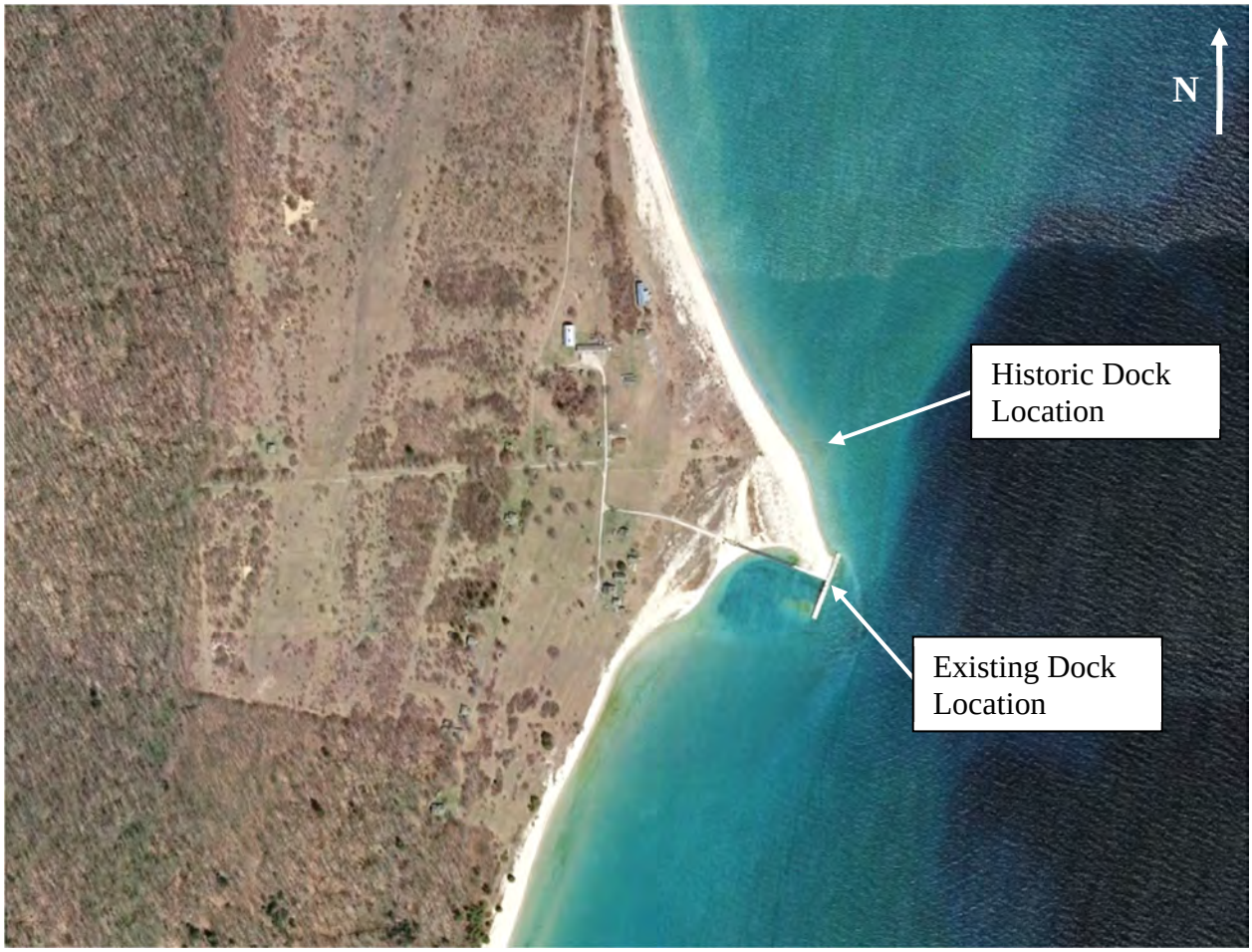


Figure 12: Existing and historical dock locations at North Manitou Island.

Figure 13: North Manitou Island dock.

Both flight-derived aerial imagery was obtained from the USGS as well as satellite imagery from

Google Earth. The USGS imagery, obtained in the years 1953, 1977, and 1983 as shown in Figure 14 (A), (B), and (C), show the island village complex. Each of these images were geolocated using distinguishable features such as building corners and roads in order to trace and track the movement of the shoreline with respect to time. These traced lines, as presented in Figure 15, show that through the 30 years that this data was examined, the shoreline appeared to have been on a continuous outward expansion both to the north and to the south of the previous dock location. In this photo, the lighter yellow line was taken in 1953, yellow/orange in 1977, and orange in 1983.

A timeline of satellite imagery obtained from Google Earth is presented in Figure 16 and Figure 17. These images of the island are presented beginning in the year 1993 and ending in 2022. The images show the new dock located approximately 400 ft to the south of the old dock. Through observation, there is an apparent accumulation of sediment immediately to the south following by erosion further south of the new dock. North of the dock depicts significant material accumulation by 2005. The dock area appears to have been cleared of sediments circa 2012, prior to completely filling in again by 2018. At the new dock itself, a total of approximately 475 ft of outward shoreline expansion has occurred since 1953 with 125 ft occurring between 1953 and 1983 and the remaining 350 ft since the-national park's acquisition in the island in 1984.

Figure 14: North Manitou Island village and dock location, taken in 1953.

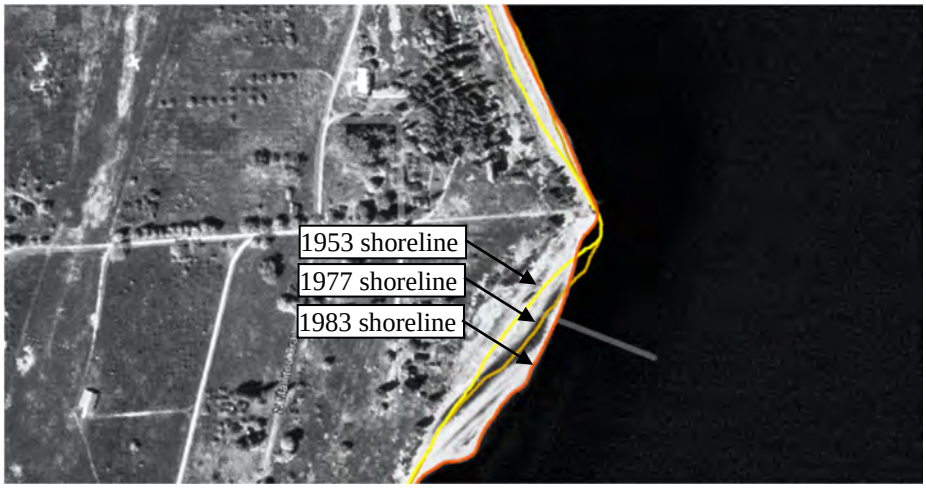


Figure 15: 1983 Imagery overlain by shoreline position tracing from 1953, 1977, and 1983.

Figure 16: Satellite imagery at the North Manitou Island dock.

Figure 17: Satellite imagery and traced shoreline positions at the North Manitou Island dock.

Section 3.0 – Model Preparation

In order to adequately determine the offshore wave climate and nearshore wave transformations contributing to coastal flooding and sediment transport, AMI performed detailed spectral wave modeling utilizing the MIKE Zero and MIKE21 SW modules by the Danish Hydraulic Institute (DHI). MIKE21 SW is a state-of-the spectral numerical modeling software that is well-suited for resolving the governing processes of wind-driven wave development and propagation and quantifying the corresponding physical coastal environment. The capabilities of this model are particularly well-suited for modelling globally across Lake Michigan as well as at a detailed scale at the North and South Manitou Island sites of interest. The outputs of this model are furthermore able to integrate seamlessly with sediment transport numerical modeling packages produced by DHI.

Specifically, the MIKE21 SW numerical model utilizes user-defined input conditions to calculate wind-driven wave development and propagation across open-water and diffraction around structures such as land masses and man-made structures. The model is able to recognize friction for a defined bottom and correlate that information to additional characteristics as waves move into and eventually break in shallow water. A list of user defined inputs into the modules includes but is not limited to bathymetry and topography, wind speed and direction, storm surge elevation, lakebed roughness, and two separate parameters utilized to calibrate wave energy dissipation due to wind-driven white capping. The model's resulting outputs include graphs, tables, and color-coded plots. An example of a model output from a previous study on South Manitou Island performed by AMI Consulting Engineers in 2017 is shown in Figure 18.

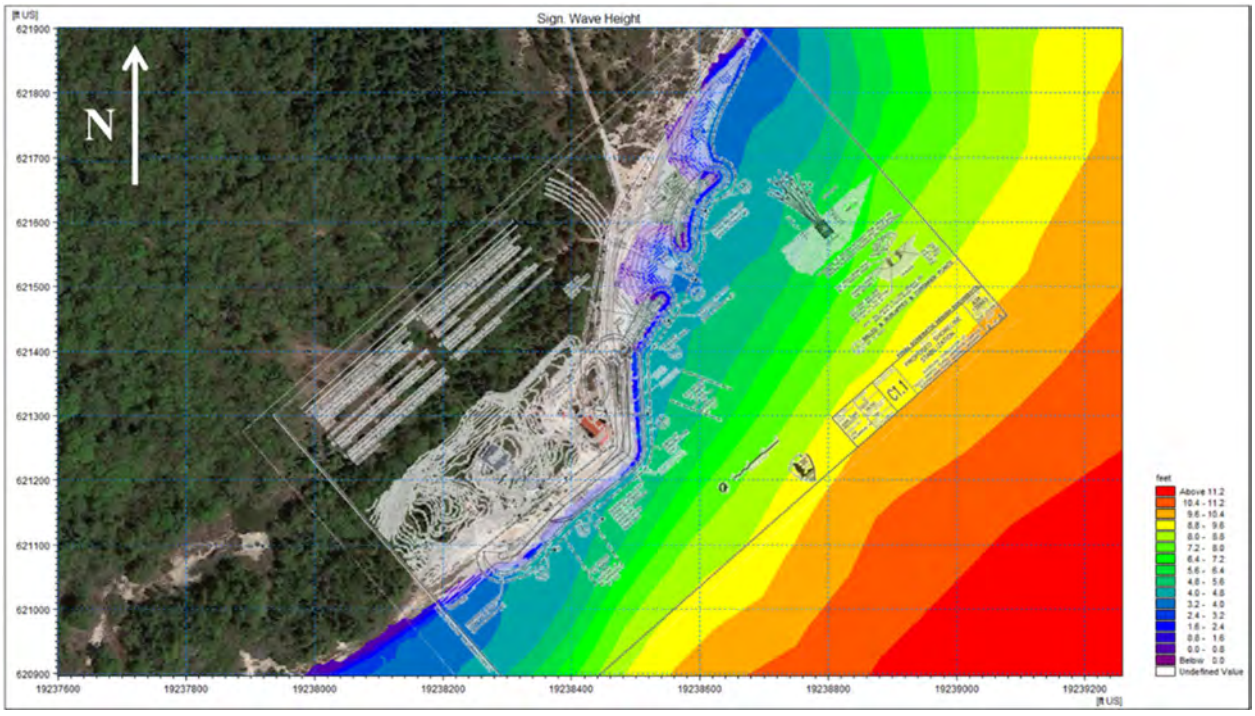


Figure 18: Example of spectral wave model outputs at the South Manitou Island lighthouse.

3.1 Topographic and Bathymetric Data

Bathymetric and topographic data was collected across all of Lake Michigan, North and South Manitou Islands, and at the locations of the docks. Data sources include an on-site survey as well as publicly available data hosted by the National Oceanic and Atmospheric Administration (NOAA).

Site Survey

A bathymetric and topographic survey was performed at both North and South Manitou Island. The surveys spanned the eastern length of both islands and were collected at an adequate resolution to classify both the beach profile as well as nearshore bathymetry for integration into numerical modeling software for nearshore wave transformation and sediment transport characteristics. The areas collected in the topographic and bathymetric surveys are indicated in Figure 19, where the green line indicates extents of the topographic survey. The bathymetric survey spanned the length of the same green line while extending up to a distance of up to 1300 feet offshore. Figure 20 shows a field survey crew on South Manitou Island as well as the hydrographic survey vessel in the Leland Harbor.

Figure 19: Site survey extents on North Manitou Island (A) and South manitou Island (B).

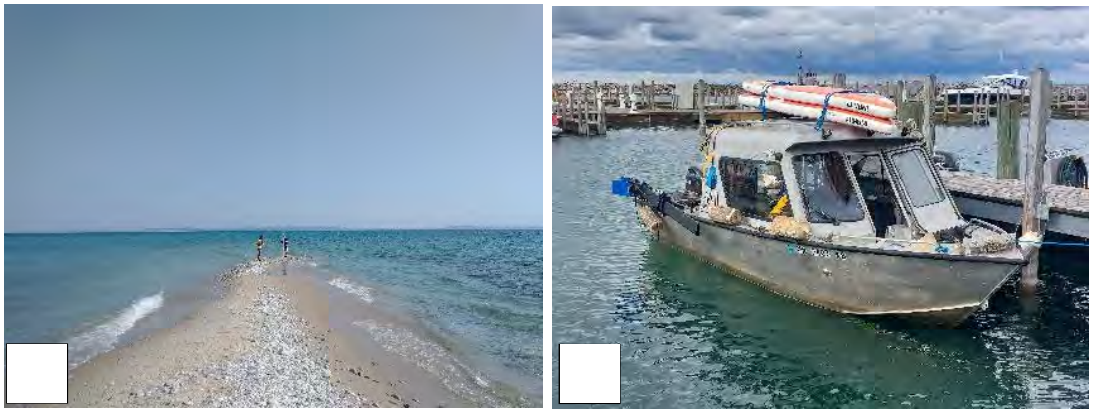


Figure 20: Site topographic survey (A) and bathymetric survey vessel utilized at site (B).

LiDAR and Additional Bathymetric Data

In order to fill out a model space for detailed modeling, additional bathymetric survey data was obtained across the entire body of Lake Michigan as well as specifically around both North and South Manitou Island in areas that were excluded from the on-site topographic and bathymetric surveys. The data obtained for this purpose across the body of Lake Michigan consisted of point data at a density of approximately 2000m grid spacing (NOAA, NCEI 2022). At North and South Manitou Islands themselves, high-resolution light detection and ranging (LiDAR) data was obtained from the NOAA Digital Coast Data Access Viewer. This data was sorted into as little as a 3-meter grid spacing and utilized to accurately define land/water boundaries, land elevations, and nearshore lakebed bathymetry around the islands in all areas excluded by bathymetric and topographic surveys as well as to extend the high-density data into deeper waters than the hydrographic survey encapsulated.

Some results of combining all site topographic and bathymetric data with the data obtained from NOAA are presented in Figure 21. In this figure, each dot represents one point of survey data. Increasingly tighter point densities cause individual points to become less and less distinguishable from their neighboring counterparts. These figures depict points densities becoming increasingly tighter at transitions from deep to intermediate, then intermediate to shallow water environments.

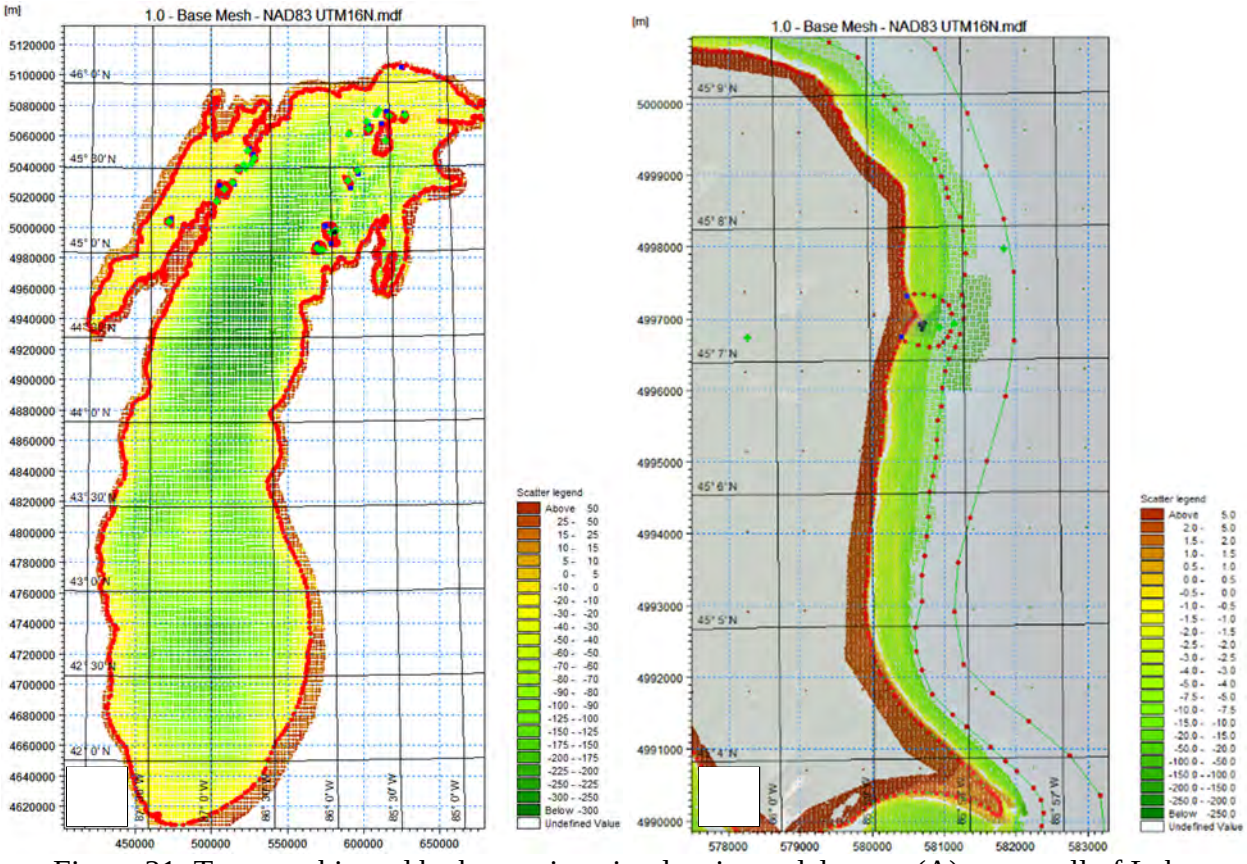


Figure 21: Topographic and bathymetric point data in model space (A) across all of Lake Michigan and (B) at the eastern side of North Manitou Island.

3.2 Mesh Creation

A 3-dimensional computational mesh that is representative of the lakebed and land surface is utilized in the models to generate realistic site conditions. In the numerical models, a tighter mesh (smaller triangular elements) enables the model to provide greater computational accuracy and resolution while causing a higher computational demand. In order to ensure efficiency in modeling, a loose mesh (large triangular elements) was defined across lake Michigan, with its element sizes becoming incrementally smaller with proximity to the project sites to provide a high-resolution mesh and model results without demanding excessive computing requirements. The mesh that was utilized for wave simulations of North and South Manitou Islands is shown in Figure 22 A, B, and C. In these images, the loose mesh defined globally across Lake Michigan is shown in the open-water areas surrounding the islands, with incrementally increasing mesh density with proximity to the island shorelines at the defined areas of study.

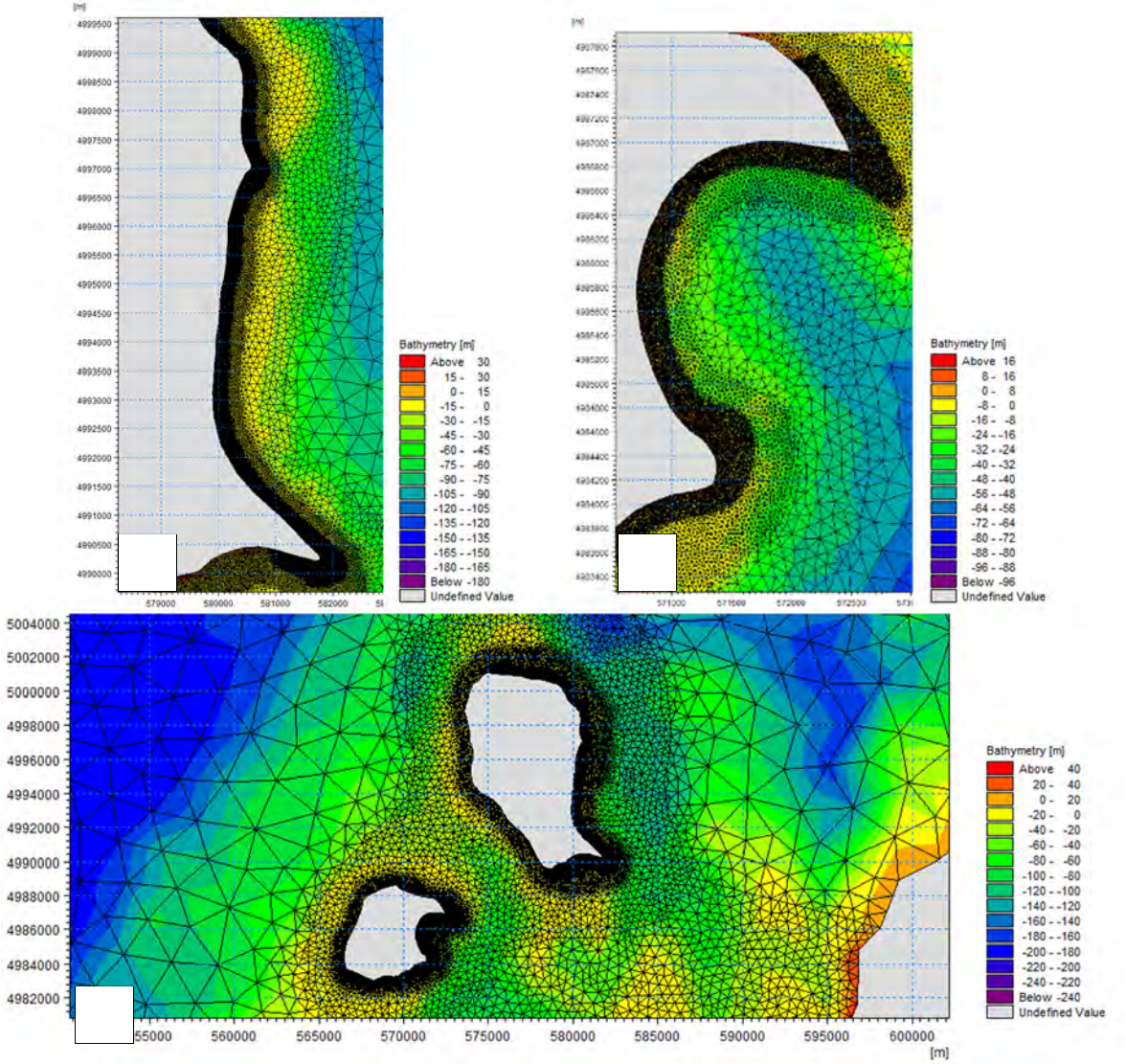


Figure 22: Computational mesh defined for (A) North Manitou Island, (B) South Manitou Island, and (C) globally across Lake Michigan.

3.3 Water Levels

The Mike 21 SW model allows users to define constant or varying water levels, as well as to perform parallel simulations to quantify the differences in model results amongst different water surface elevations. Differences in model outputs that may be situationally sensitive to water level fluctuations include nearshore wave heights, instances and occurrences of wave breaking and subsequent radiation stresses (which influence longshore currents in sediment transport modelling), and of course - coastal flooding and inundation. In order to determine water surface elevations to model, AMI performed a long-range statistical analysis of water surface elevations of Lake Michigan, dating back to 1918 utilizing gage data from NOAA Station 9087044 in Calumet Harbor, IL.

In addition to lake-wide water surface elevations, AMI investigated storm surges, which is additional water pooling across the lake which is driven by winds and barometric pressure variations. As defined by Keillor 1998, storm surges across Lake Michigan that are considered in a 1% design approach may reach up to 4.9 ft in Green Bay, whereas tides in the Great Lakes are generally less than five centimeters (National Ocean Service, NOAA, 2022). Due to the nature of these tides being masked by far greater fluctuations in water surface elevations produced by seasonal and yearly variations as well as storm surge, the Great Lakes are considered to be non-tidal. For the scope of this study, tides are excluded, and the focus of design water levels is centered on lake level fluctuations and the storm surge effect.

3.3.1 – Water Surface Elevations

Water surface elevation data dating back to 1918 from NOAA Station 9087044 in Calumet Harbor, IL was analyzed in order to determine water surface elevation for select return events. In order to neglect the effect of storm surge elevations in the statistical analysis. The investigation utilized monthly average water surface elevations at the site. The data as presented in Figure 23 shows a minimum documented value of 576.02 ft during January of 2013 and a maximum documented value of 582.35 ft during June of 2020, resulting in a total of 6.33 ft of fluctuation in standing water surface elevation alone since 1918.

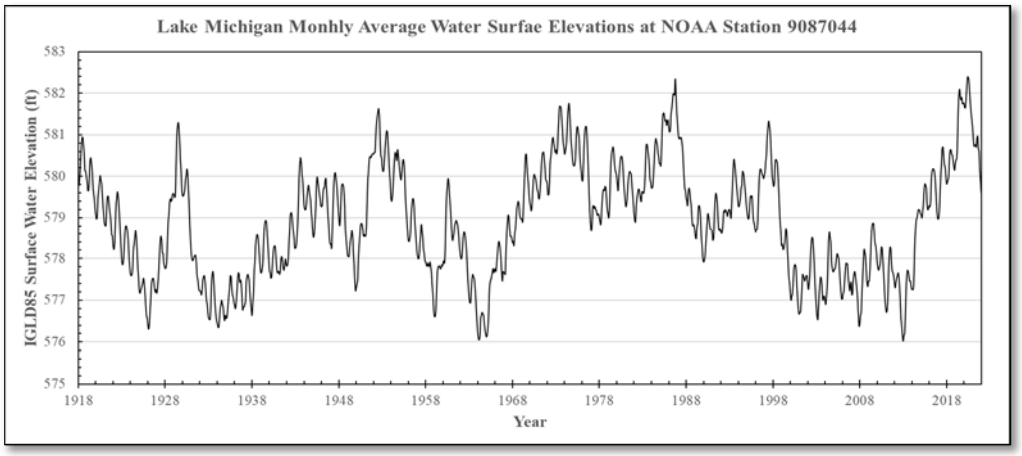


Figure 23: NOAA Station 9087044 monthly average water surface elevations.

In order to create a baseline determination of return period water levels, monthly average water surface elevation data was broken down into bins, where monthly average water surface elevation values between defined threshold values were quantified and tabulated. The results of this process are shown in a histogram presented in Figure 24, where the y-axis represents the number of occurrences, and the x-axis represents the defined bin values (minimum and maximum). A total of 26 bins were categorized - each with a range spanning across 0.25 ft of standing water surface elevation.

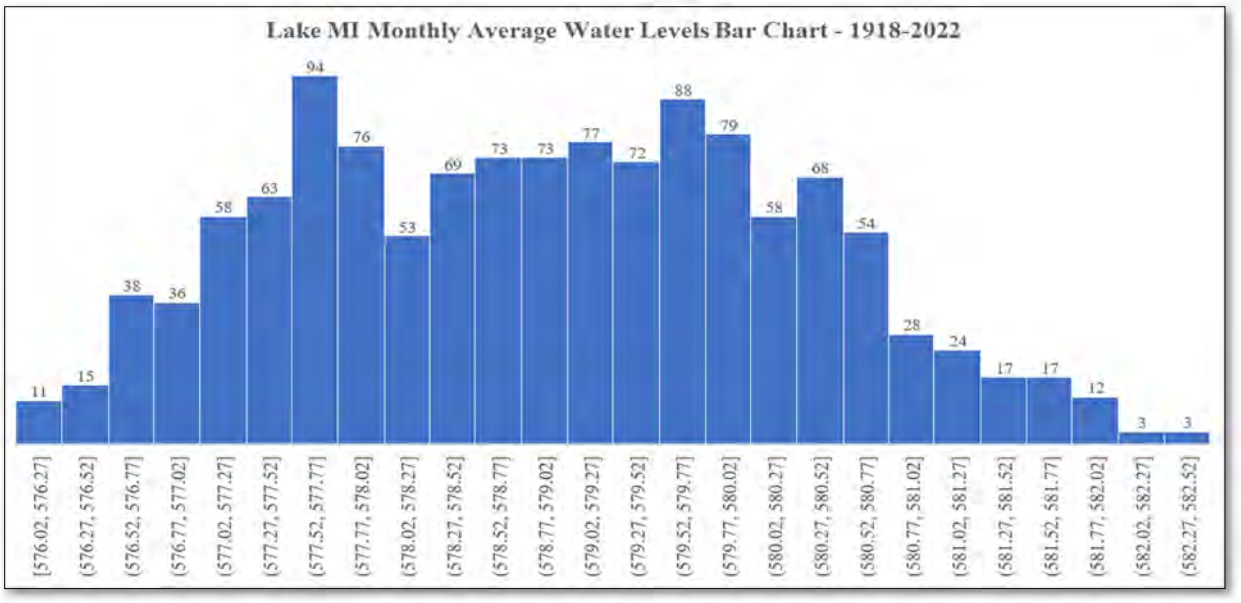


Figure 24: Histogram of NOAA Station 9087044 monthly average water surface elevations.

From the preceding plot, it is observable that there is an abundance of data between 577 and 578 ft and a lack of a peak in the data frequency at 579 ft. Due to the nature of this data not being in acceptable correlation to a normal distribution, a peaks-over-threshold analysis was performed and then fitted into a Weibull distribution. From the trendline obtained by fitting to a Weibull Distribution with a 580.25ft threshold, the following water surface elevations are extrapolated for return periods: 10-year = 581.66 ft, 25-year = 582.02 ft, 50-year = 582.29 ft, 100-year = 582.55 ft. Note that at the location of this gauge, IGLD height is approximately 0.3 ft lower than NAVD88 height.

3.3.2 – Storm Surge Effect

While the statistical analysis of monthly water elevations was able to characterize standing water surface elevations, it was not intended to account for design water surface elevations, which are a culmination of both standing water surface elevations and the effect of storm surges. Storm surges are classified by “mounds” of water moving across open water towards areas of lesser barometric pressure and pooling against land boundaries. While the exact science and determination of storm surges is complex and beyond the scope of this study, documentation by Keiler, 1998 exists to offer design engineers and planners guidance to selecting realistic storm surge elevations for various locations across the Great Lakes. Though a linear interpolation of a storm surge at the islands out in open water may not truly represent the actual quantified effect of a storm surge at the Manitou Islands, it is determined to be a conservative approach, as storm

surges are typically greater against large land barriers where water is forced to pool, rather than flow past.

3.3.3 – Resulting Design Water Levels

The combined effects of water levels coupled with storm surge occurrences utilizing the Basis of Comparison hindcasted lake level values were detailed Caraballo, 2012. In this study, hourly as well as 6-minute historic water surface elevation data was analyzed to capture not only the resting water surface elevations on Lake Michigan, but also the localized instantaneous increases and decreases in water surface elevation due to storm surges. Additionally, the storm surges themselves were isolated from the data sets and a POT analysis was performed to characterize storm surge return periods. At the Ludington gauging station, a 100-year storm surge amounts to approximately 1.5 ft. When combined with analysis of historic lake level conditions, it was determined that a 100-year water surface elevation at the Ludington gauge is equivalent to 583.2 ft and a 50-year water surface elevation meets 582.85ft.

3.4 Wind Speed and Direction

Being characterized by an approximately 300 mile long and 60-mile wind uninterrupted area of open water, Lake Michigan is known to be subject to high winds occurring on a regular basis. While most commonly blowing from southerly directions, strong northerly, easterly, and westerly winds are known to occur as well. In order to characterize the wind environment of Lake Michigan, AMI downloaded hourly data from NOAA Buoy Stations 45002 in Northern Lake Michigan and NOAA Station 45007 in Southern Lake Michigan.

NOAA 45002 – Northern Lake Michigan

Station 45002 was placed in 1979 and has been providing hourly wind data during its time of service. Due to ice movement across Lake Michigan during the winter months, the buoy is removed each season at the end of fall and placed back into the waters at the beginning of each spring. A wind rose of all data obtained by the station since its implementation is shown in Figure 25. This image is a composite of a total of 220,333 hourly wind values occurring primarily between the months of April and November from the years 1979 through 2022. The wind rose displays wind data plotted onto a directional compass, with bars of color-coded wind speed extending from the origin outward. The circular axis of the plot indicates frequency of occurrence that the wind blows at or below the defined speed and within the directional window indicated by the color bar. From the data, it is observable that the strongest and most frequent winds at Station 45002 come from the south southwestern direction.

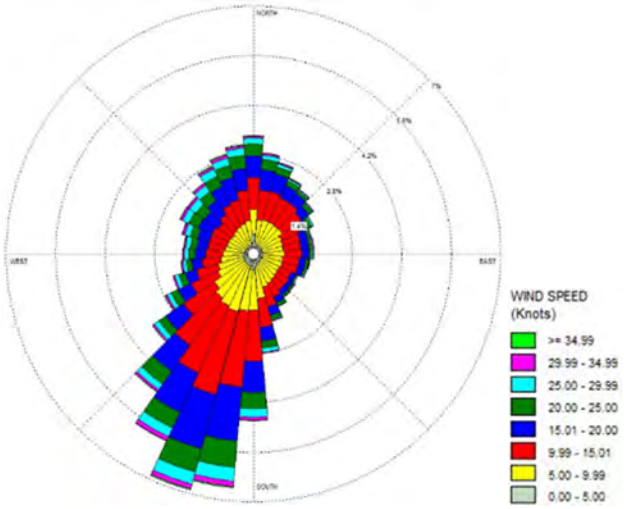


Figure 25: Wind Rose at NOAA Station 45002 of all data recorded since 1979.

45007 – Southern Lake Michigan

Station 45007 was placed in 1981 and has been providing hourly wind data during its time of service. Due to ice movement across Lake Michigan during the winter months, the buoy is removed each season at the end of fall and placed back into the waters at the beginning of each spring. A wind rose of all data obtained by the station since its implementation is shown in Figure 26. This image is a composite of a total of 223,862 hourly wind values occurring primarily between the months of April and November from the years 1981 through 2022. From the data, it is observable that the strongest and most frequent winds at Station 45007 come from both the southern and northern directions, with relatively infrequent winds from the east and west.

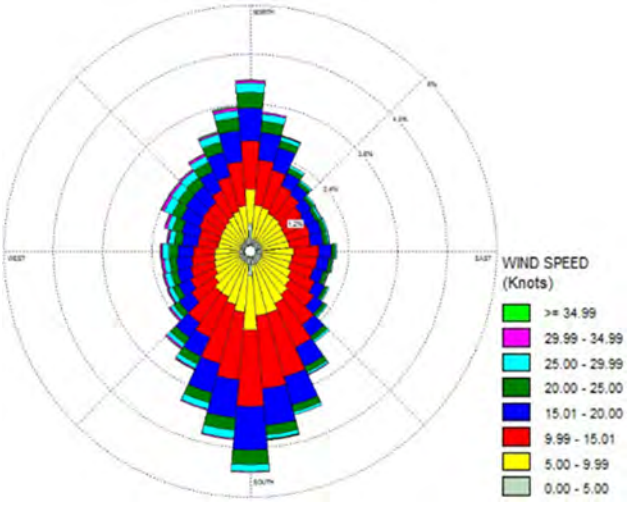


Figure 26: Wind Rose at NOAA Station 45007 of all data recorded since 1981.

A summation of the wind data suggests that the wind speeds and frequencies of occurrence in Southern Lake Michigan are nearly evenly distributed between northern and southern directions, with a noticeable increase in wind speeds and frequencies of occurrence from western directions

in comparison to winds from eastern directions. NOAA Station 45002 in North Lake Michigan follows a similar trend in terms of western and eastern winds with a defining difference in southern vs northern winds, where it is observed that the wind blows much more frequently from southern directions that from northern directions.

3.5 Waves

Because wind waves are a development of wind blowing over water, AMI performed a peaks-over-threshold (POT) analysis of wave heights at NOAA Buoy Stations 45002 and 45007 in order to identify notable storms that have occurred since the placement of the buoys in 1979 and 1981, respectively. An analysis was also performed to select a design year of wind and wave data for sediment transport analysis. The wind data from select storms meeting defined wave size criteria was then downloaded from several meteorological stations across Lake Michigan and implemented into the MIKE21 SW Model space.

Peaks-Over-Threshold Storm Data

As defined by the US Army Corps of Engineers (USACE) Wave Information Study (WIS), a "threshold" storm on Lake Michigan amounts to wave height recordings of two meters (6.56 ft) for a minimum duration of four consecutive hours. Storms meeting these criteria were identified from hourly data readings at NOAA 45002 and 45007 and utilized to create several extreme analysis plots for defined windows of wind direction. Figure 27 presents all of the significant wave height data recorded at NOAA Station 45002 from 1979 through the end of 2022 with a 6.56 ft threshold overlain on the data. Figure 28 presents the same data for NOAA Station 45007. The threshold means that when running statistics on wave heights for the determination of return periods, all wave height data below a value of 6.56 ft was excluded from the analysis as it is known to skew results for determination of return periods for larger storm events.

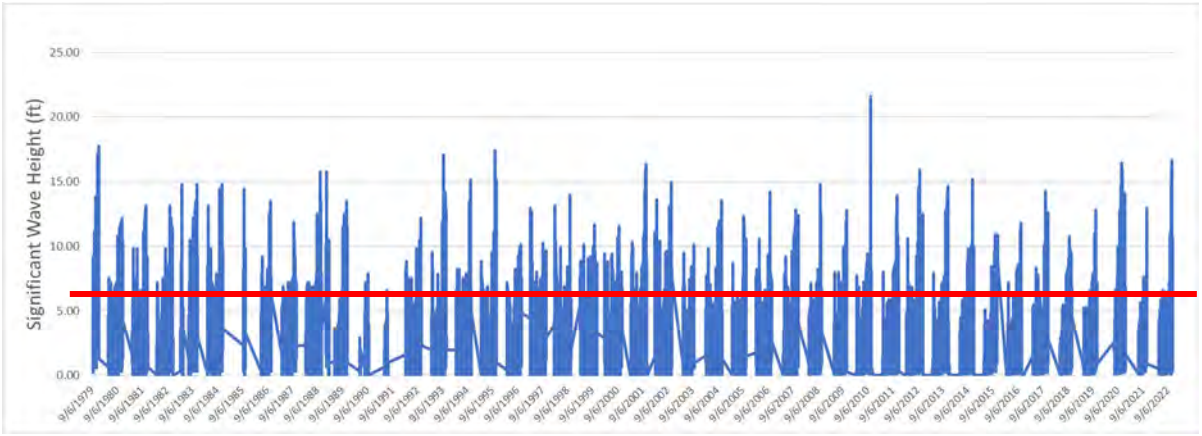


Figure 27: NOAA Station 45002 significant wave height data with 6.56ft threshold.

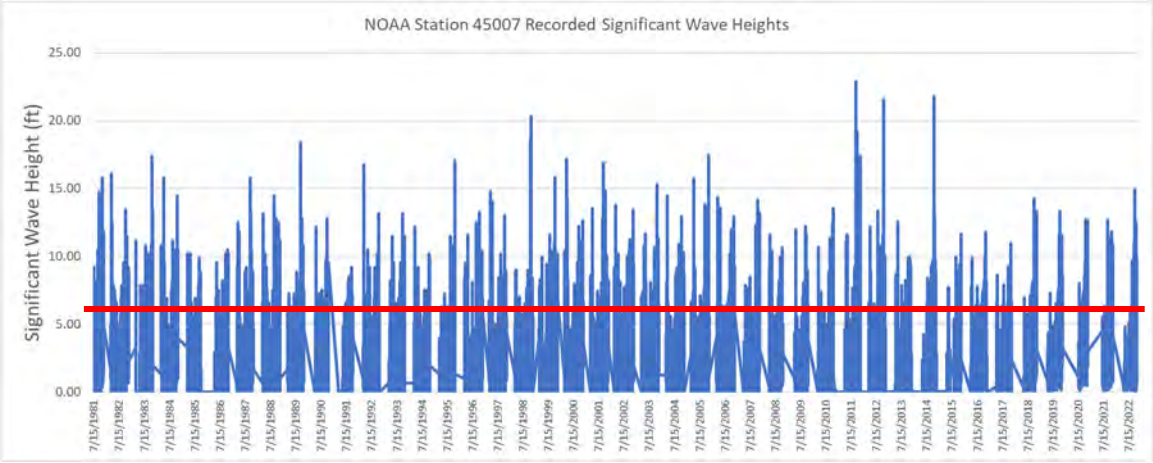


Figure 28: NOAA Station 45007 significant wave height data with a 6.56ft threshold.

The POT analysis of Buoys 45002 and 45007 performed by AMI was further refined by implementing boundary wind conditions into the data sorting process. Doing so allowed AMI to characterize not only return wave events at the given locations of Stations 45002 and 45007, but to determine return events for specified wind (and consequentially wave) directions. The resulting analysis of breaking wave events into windows of wind direction at the station locations allows the coastal environments at North and South Manitou islands to be further understood by knowing not only the frequency and sizing of different waves striking the shoreline, but the frequency at which select angles of incidence occur for any defined wave height above the threshold value of two meters.

At Station 45002 located 20 miles west of North Manitou Island, the two selected windows of wind direction for POT analysis of northern and southern winds included 315-60 degrees and 150-270 degrees. These windows were determined to be appropriate through inspection of storm data and an understanding of climatic trends in low pressure systems and resulting wind patterns. Figure 29 shows the two selected POT analysis to be implemented into the MIKE model space (outlined in red). Additionally presented are Figure 30 and Figure 31, which detail the POT analysis, present the linear best-fit trendline determined from the data, and present the calculated wave heights for return periods of 5, 10, 25, 43, 50, and 100-year storm events.

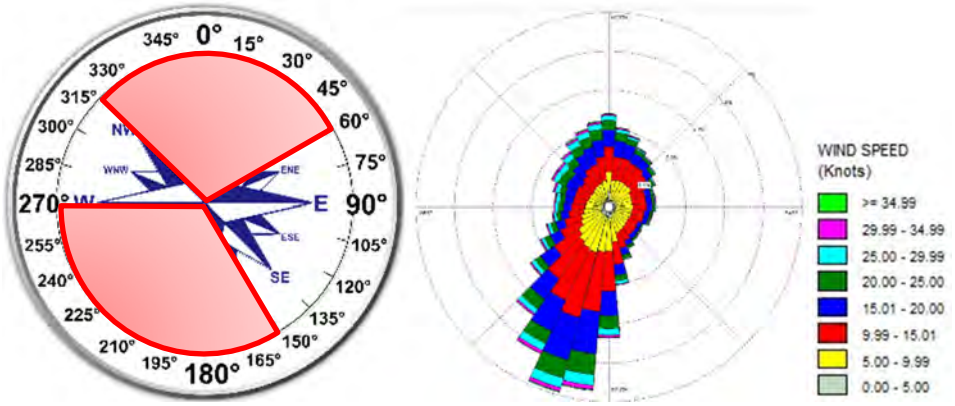
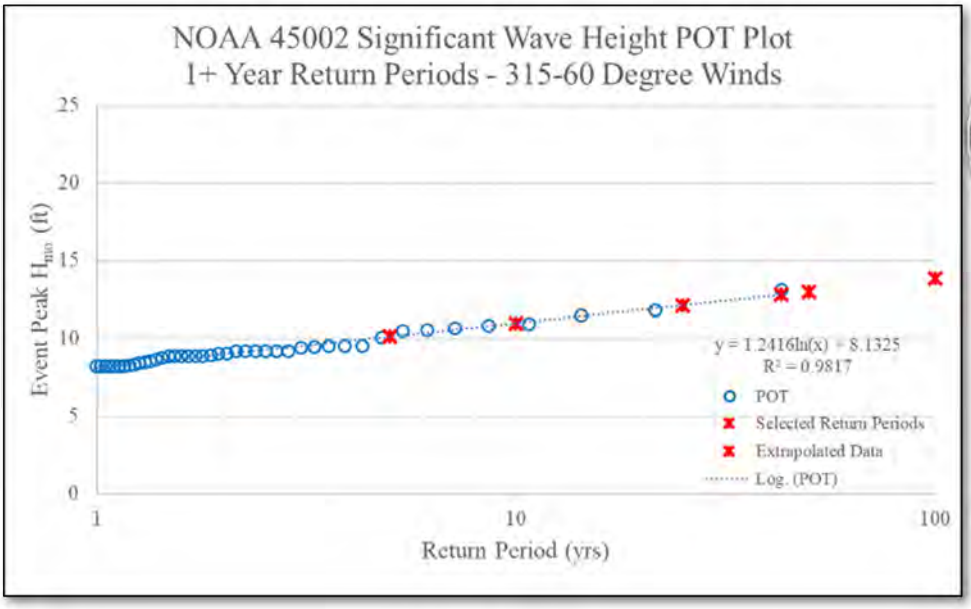
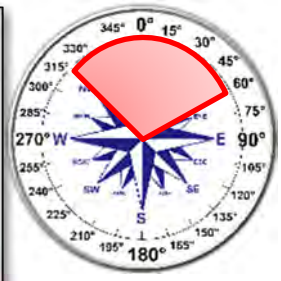


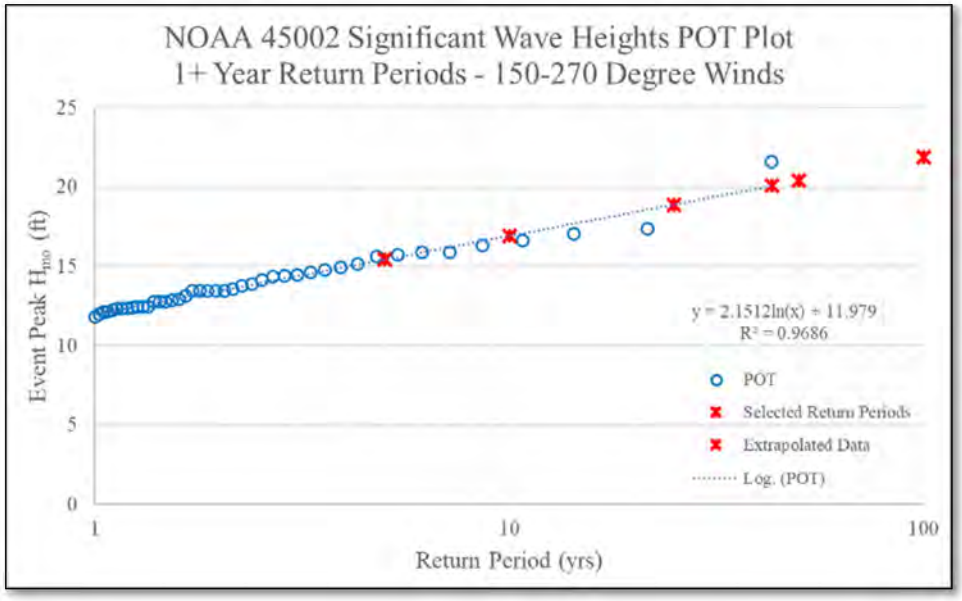
Figure 29: Wind criteria windows defined for POT analysis and wind rose for NOAA 45002.

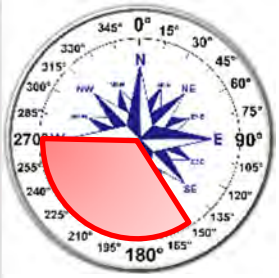




1+ year return periods	
Series "Selected RPs"	
Return Period	Hmo (ft)
5	10.13
10	10.99
25	12.13
43	12.80
50	12.99
100	13.85

Figure 30: POT Plot at NOAA 45002 for winds blowing between 315 and 60 degrees.





1+ Year Return Periods	
Series "Selected RPs"	
Return Period	Hmo (ft)
5	15.44
10	16.93
25	18.90
43	20.07
50	20.39
100	21.89

Figure 31: POT Plot at NOAA 45002 for wind blowing between 150 and 270 degrees.

Annual Wind-Wave Data

To select a representative year of data for analysis, AMI reviewed the completeness of the data set, storm events, water levels, and the time-period of the data available. The representative year of data was compared to other years of data and the year selected for analysis was 2022. 2022 was also selected as the ADCPs utilized to calibrate the wave model were deployed during a portion of the season which assisted in the validation of the data set.

A wave rose for NOAA Buoy 45002 is presented in Figure 32 for the complete data set available for the buoy (between 1979-2022). Figure 33 depicts the wave rose for the year 2022. Similar to

the wind roses presented earlier in this report, the wave roses show the depict that the prevailing wave directions at NOAA Station 45002 are from the South-Southwestern direction.

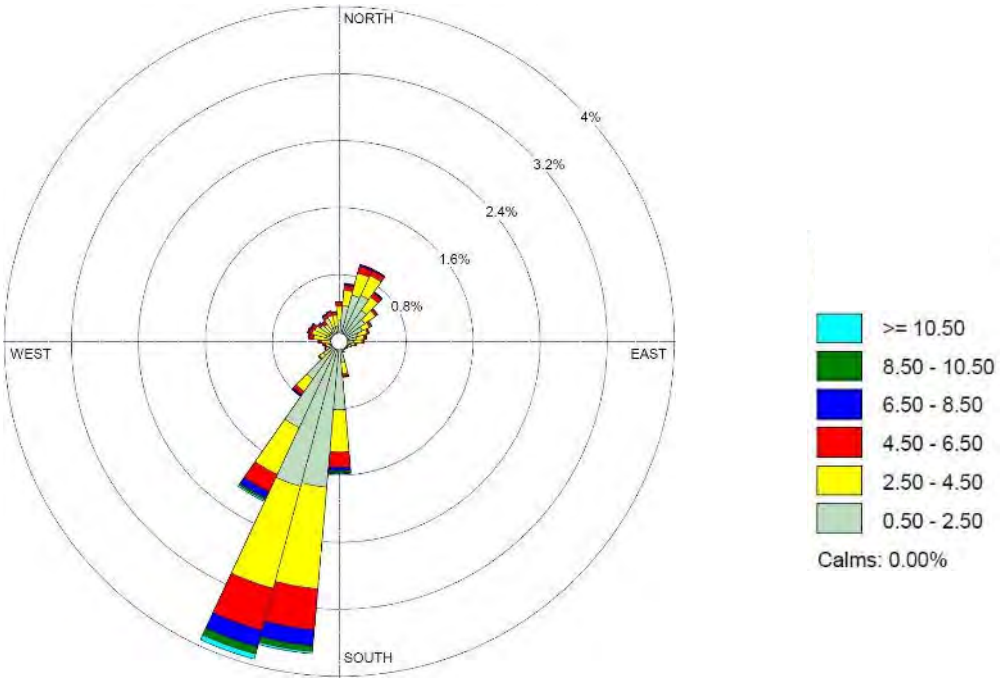


Figure 32: 1979-2022 Wave Rose for NOAA Buoy 45002.

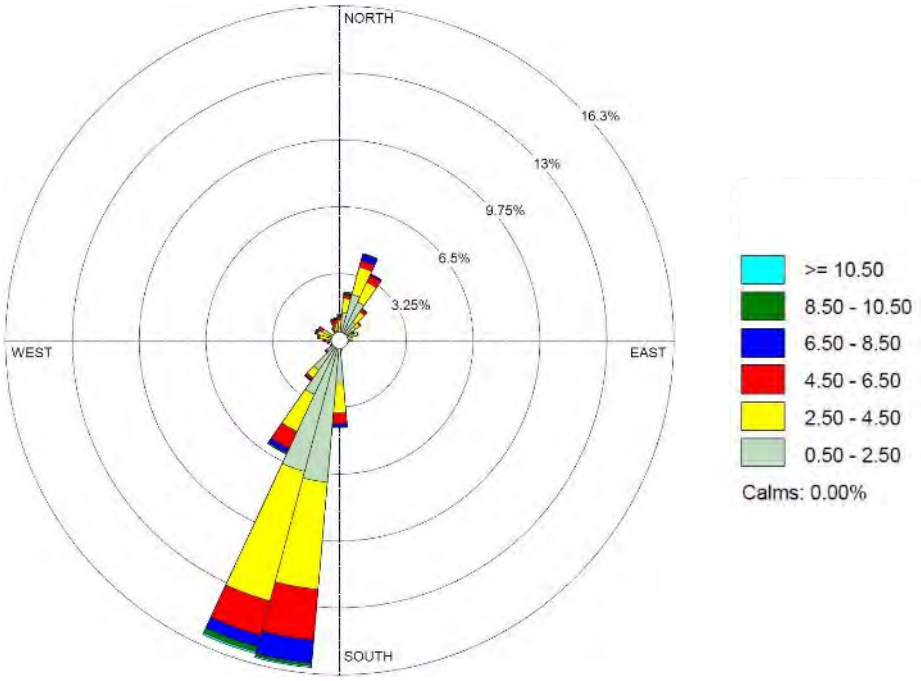


Figure 33: 2022 Wave Rose for NOAA Buoy 45002.

Figure 34Figure 36 and Figure 35 show wave roses for the two proposed dock locations for North Manitou Island. Waves primarily approach both proposed docks out of the North-East, but the largest waves approach the proposed docks from the East.

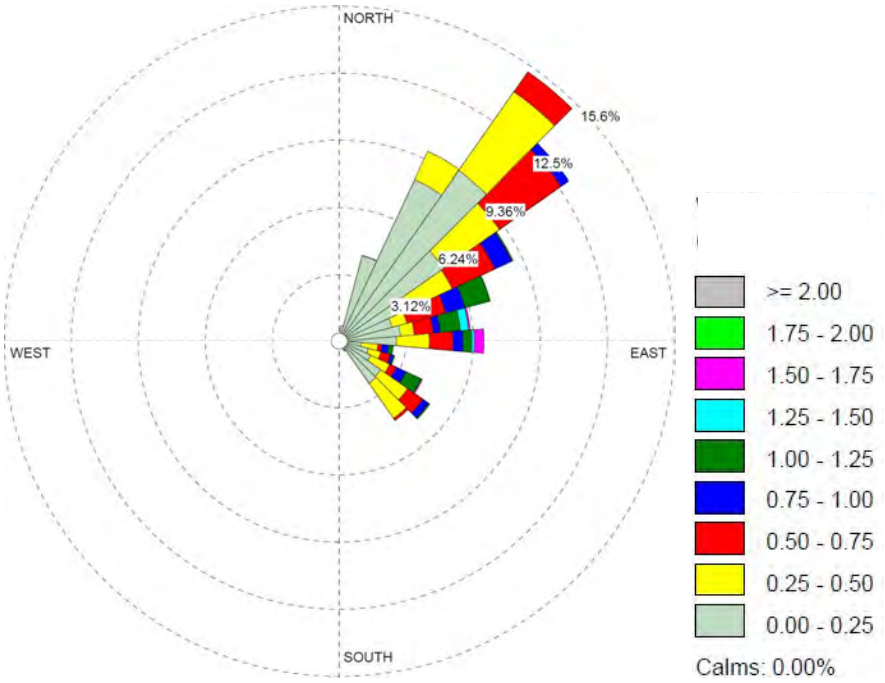


Figure 34: Wave Rose for the Old Dock Location

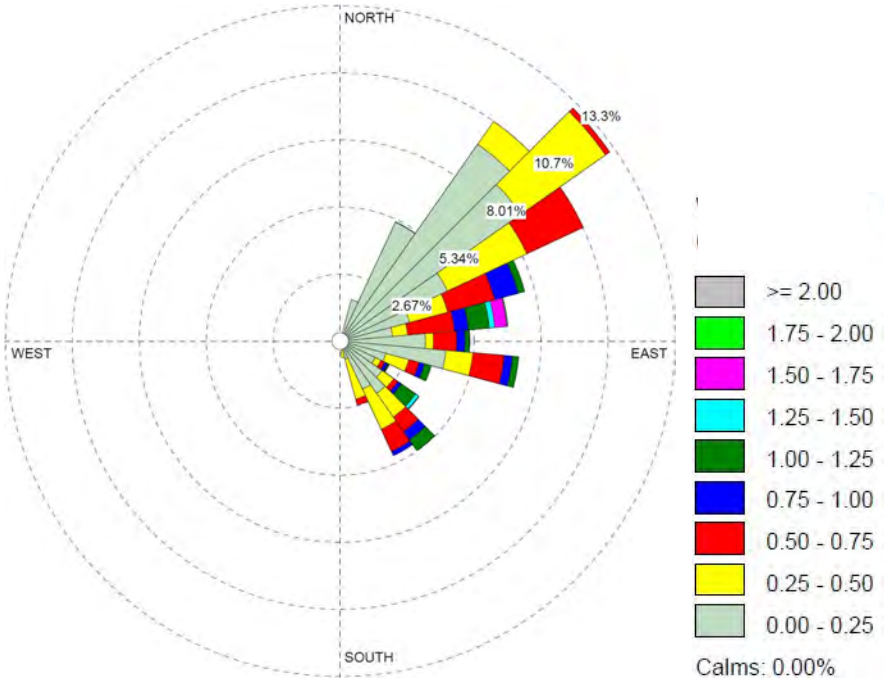


Figure 35: Wave Rose for the Current Dock Location

Figure 36 and Figure 37 show wave roses for the two proposed dock locations for South Manitou Island. For the Chicago Road location, it can be seen that the waves come primarily out of the South-East while at Grand Boulevard the waves come primarily out of the east.

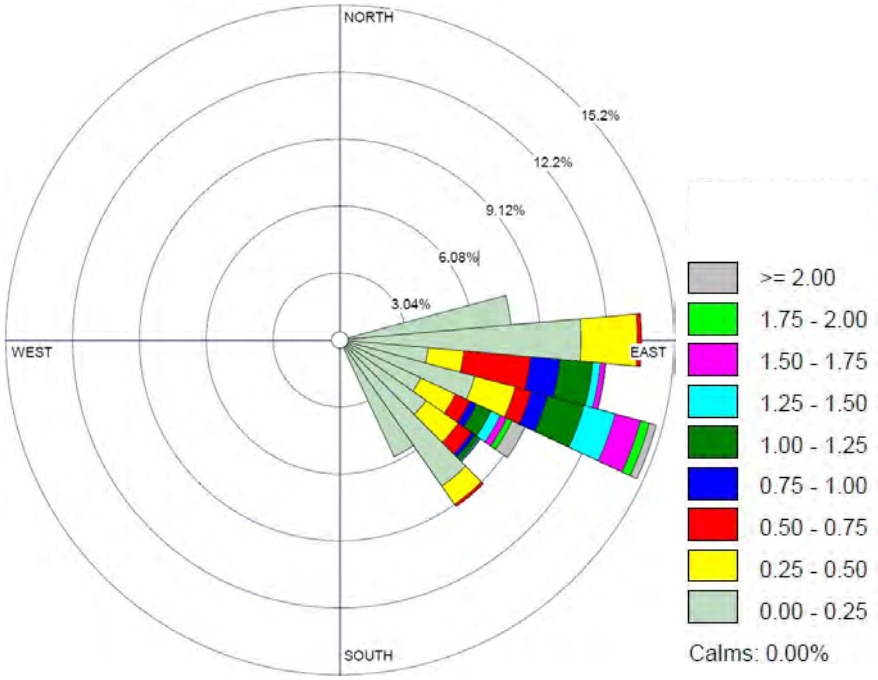


Figure 36: 2022 Wave Rose for the Chicago Road Proposed Dock

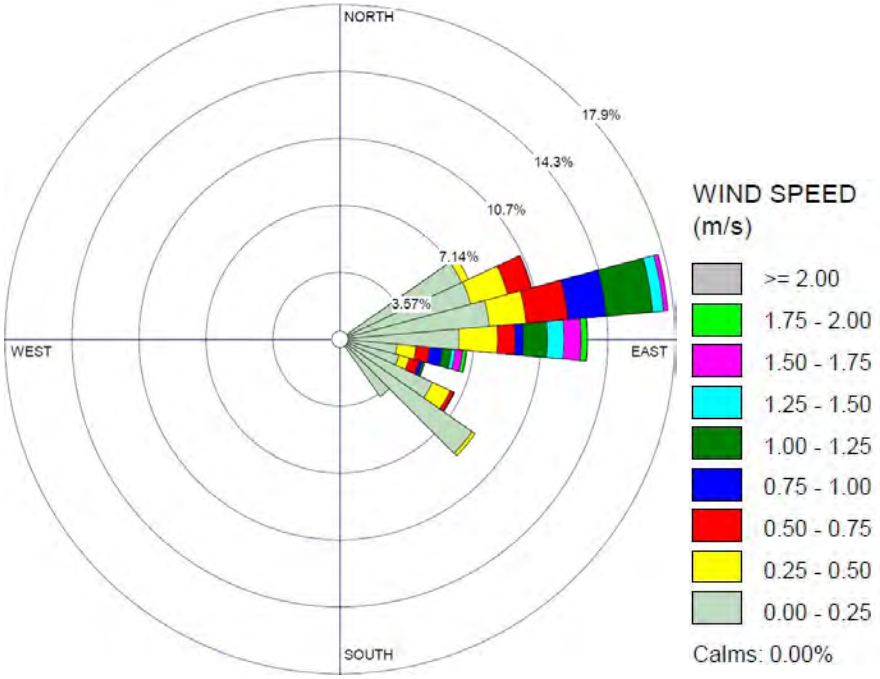


Figure 37: 2022 Wave Rose for the Grand Boulevard Proposed Dock

It is important to note that all of the wave roses utilize modeled data. This means that there is a possibility that the data varries slightly from what would be observed at a physical station in the same locations.

3.6 Model Calibration

In order to verify the accuracy of the spectral wave model and the resulting wave heights and periods, AMI performed a sensitivity analysis within the model while correlating results to real-world data recorded at various meteorological stations in Lake Michigan. Sites utilized for model calibration included NOAA Stations 45007, 45002, and 45183 as well as two acoustic doppler profile (ADCP) sensors placed at North and South Manitou Island. The NOAA buoys are equipped with accelerometers (NOAA NDBC, 2022) that feed data to a computer which interprets, amongst many other data criteria, significant wave heights as the average highest one third of waves during a sampling period. The locations of the NOAA buoys stations and ADCP devices utilized for model calibration are presented in Figure 38 (A) and (B). Figure 38 (C) shows AMI setting the ADCP device at South Manitou Island.

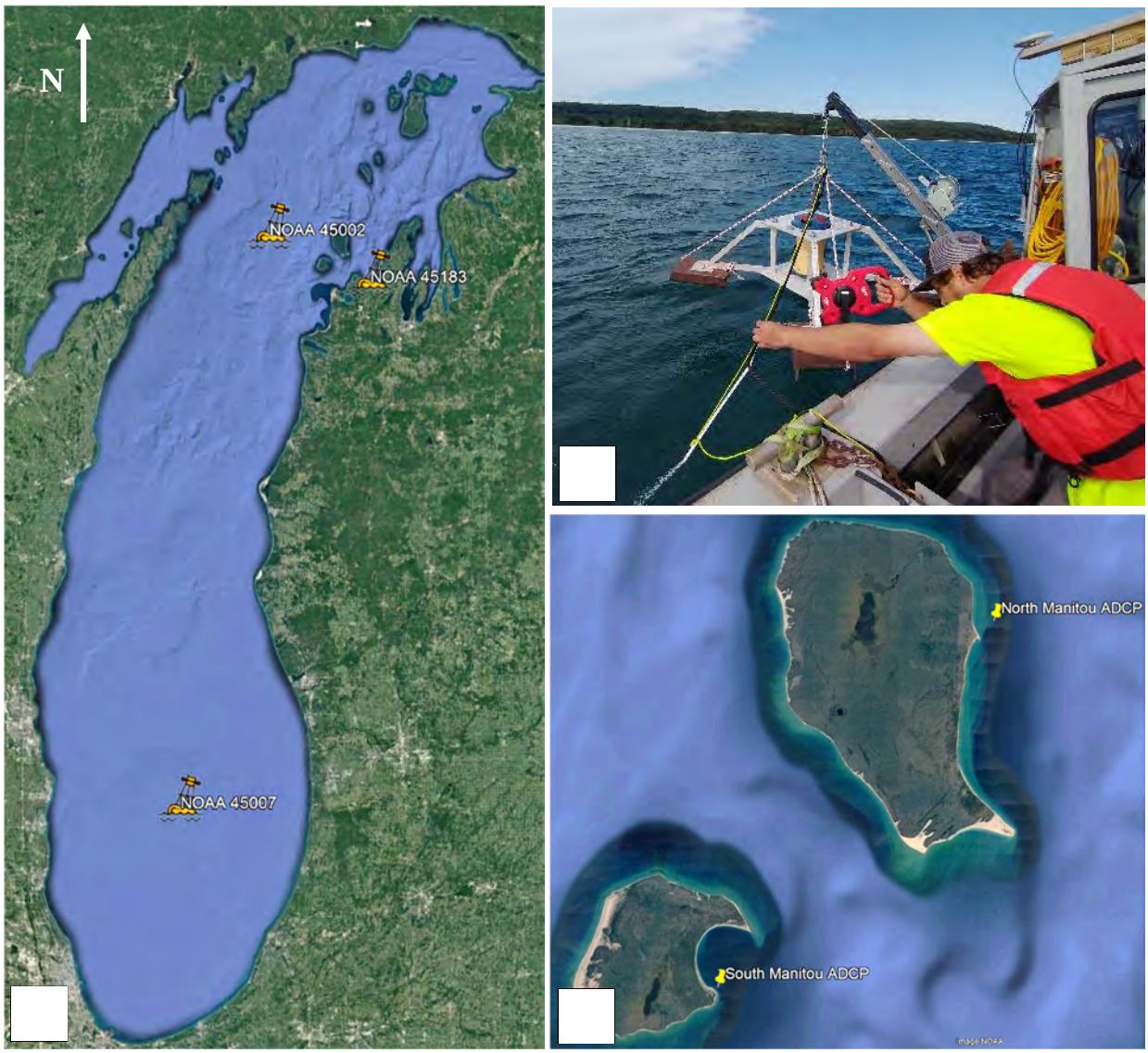


Figure 38: (A) Locations of NOAA Stations 45002 and 45007 as well as (B) locations of ADCP instruments and (C) placement of ADCP instruments.

Two storms were utilized for the model calibration, one storm from the south occurring on November 5th, 2022, and one coming from the north occurring on October 18, 2022. Through an iterative process the MIKE 21SW model was able to simulate outputs falling in-line with the recorded station data. Figure 39 and
Figure 40 present comparisons of the MIKE21 SW model significant wave height and wave period results with the data recorded by NOAA 45002 during the storm occurring on November 5th of 2022.
Figure 41 A and B present calibration result of significant wave heights at NOAA stations 45002 and 45183. Model calibrations were initially performed for significant wave heights and wave periods at Station 45002 and 45183, then further refined utilizing the ADCP significant wave height, period, and wave direction data.

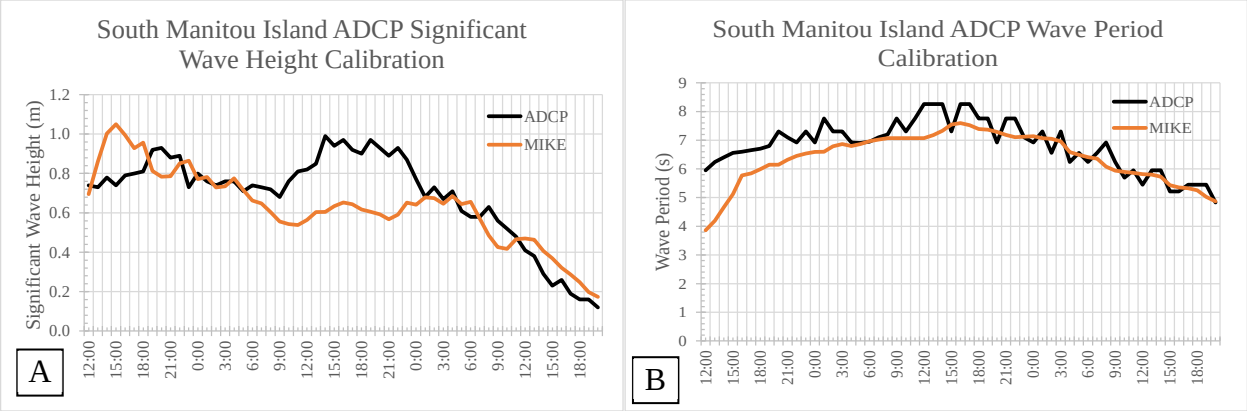


Figure 42 (A) and (B) present significant wave height and wave period data for the ADCP at South Manitou Island. Figure 43 (A) and (B) present significant wave height and wave direction of travel data for the ADCP at North Manitou Island.

Note that due to the limited amount of wind data available across all of Lake Michigan's open-water area, it is not possible to calibrate the model to account for any instances of higher localized wind or irregularly varying wind directions between the two known points. Due to this limitation, it is not practical to calibrate the model with the intent of fitting the lines to perfection. Rather, the MIKE model was simulated utilizing gridded wind speed and direction values that were interpolated across Lake Michigan based on the known values at Station 45002 and 45007.

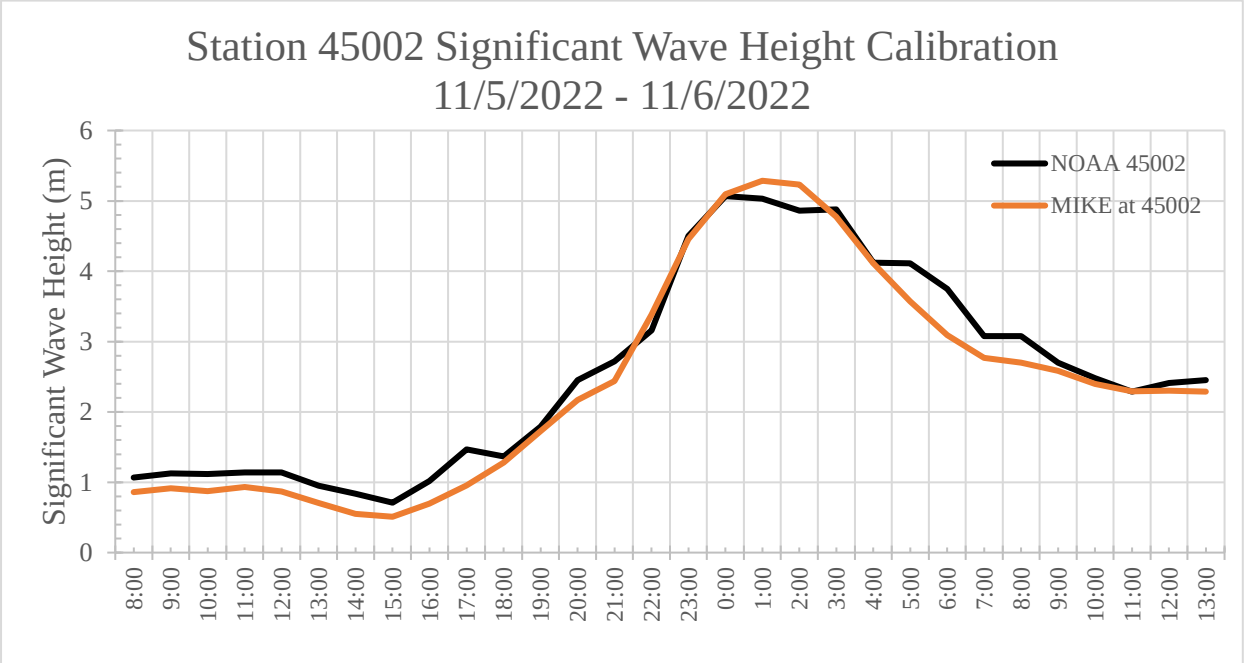


Figure 39: Significant wave height calibration at NOAA 45002 from November 5-6th, 2022.

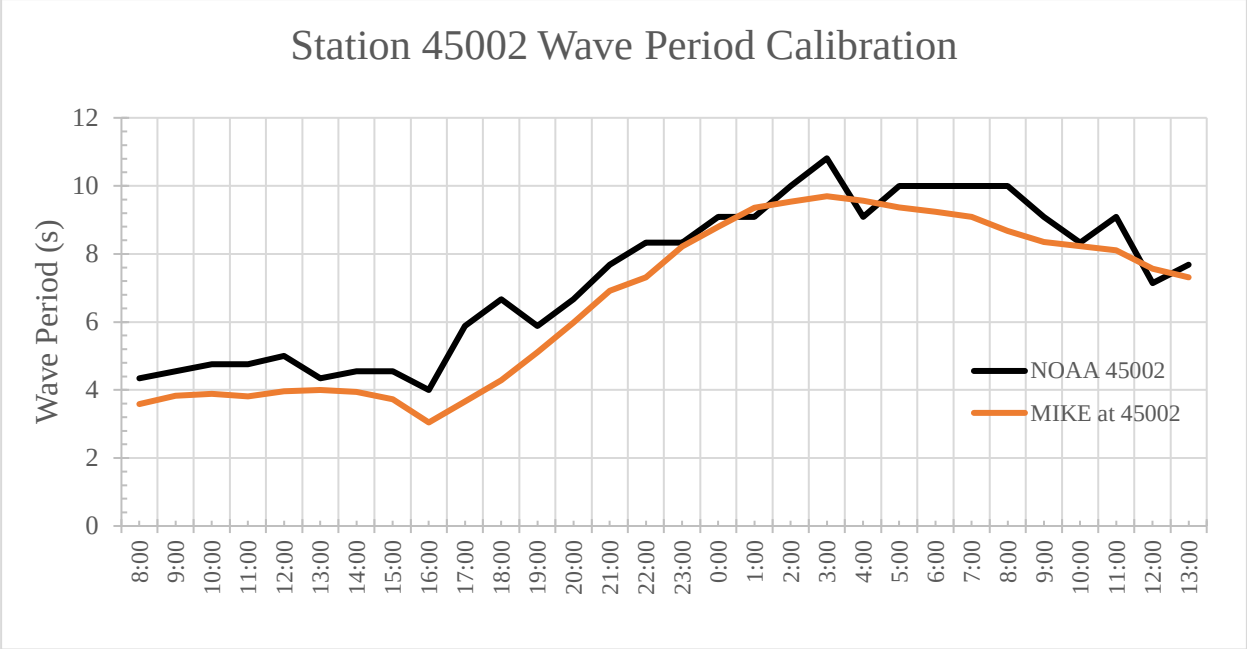


Figure 40: Significant wave height calibration at NOAA 45002 from November 5-6th, 2022.

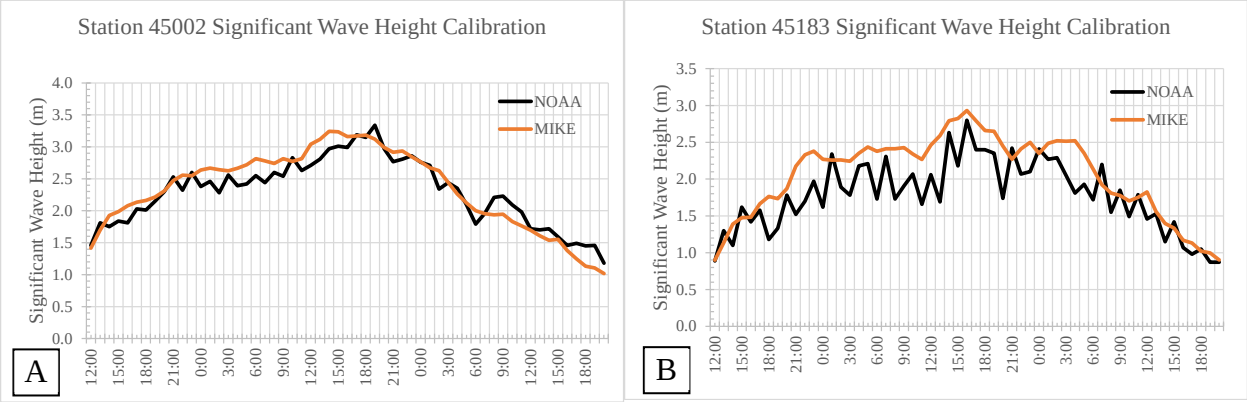


Figure 41: Significant wave height calibration at NOAA Stations (A) 45002 and (B) 45183.

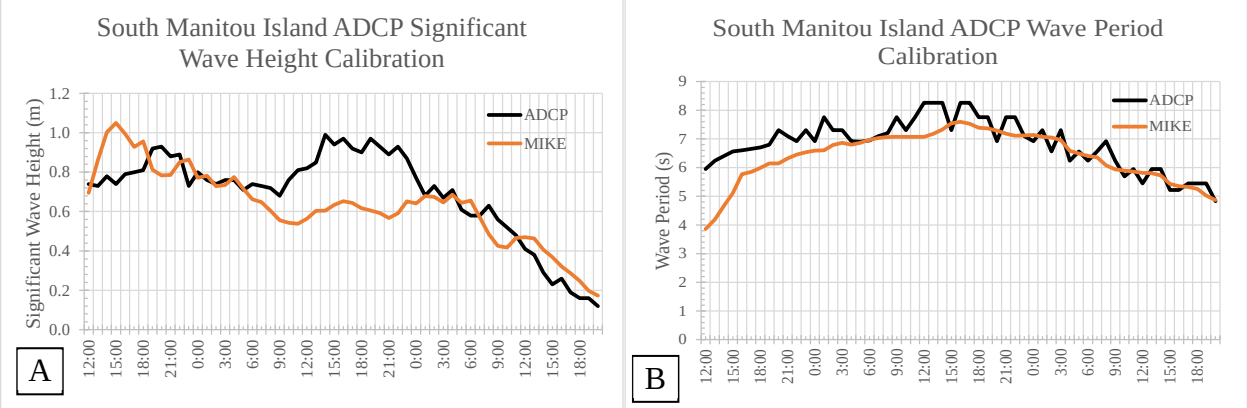


Figure 42: South Manitou Island ADCP calibrations for (A) significant wave height and (B) wave period.

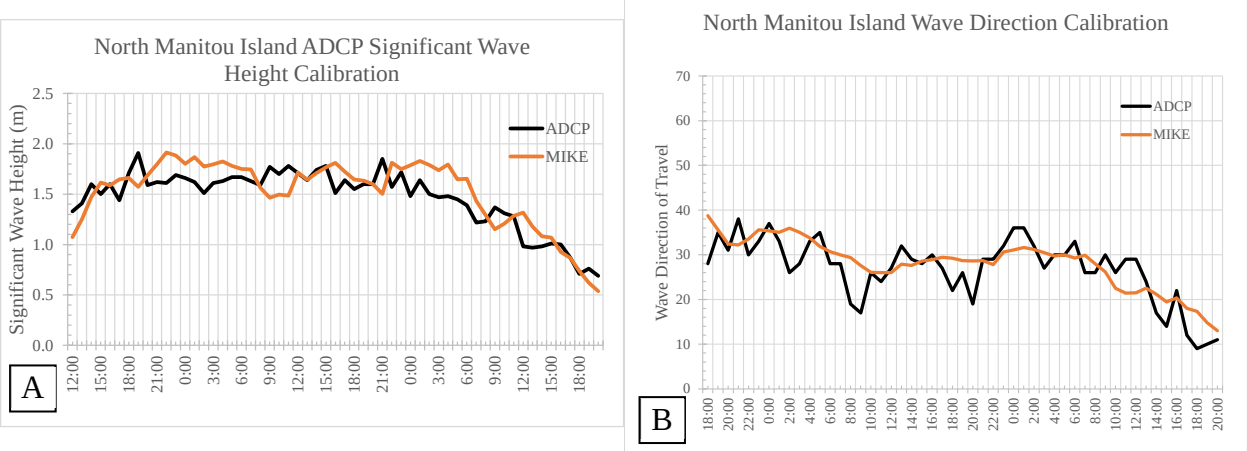


Figure 43: North Manitou Island ADCP data calibrations of (A) significant wave height and (B) wave direction.

3.7 Design Storm Calibrations

Once the model calibration parameters were defined from the iterative process, AMI scaled the resulting wave heights of the 10-year storms collected from both north and south winds to meet

that of a 50-year equivalent. While limited amounts of “scaling” were desired to provide data as close to “real-world data” as possible, there were no 50-year storms represented in the POT data sets. The storms recorded during Fall of 2022 from both northern and Southern direction were each approximately equivalent to that of a 10-year storm and each had complete wind and wave datasets from the NOAA monitoring stations with them. Several larger storms for both southern and northern wind directions were considered to be utilized for the purpose of “scaling” from, however, these storms were decided to not be utilized due to incomplete wind and wave datasets from desired NOAA monitoring stations.

Through the POT analyses conducted for the north & south winds, the conditions for a 50-year storm were determined. For the south wind, wave height data from the approximately 10-year storm occurring on 11/06/2022 was plotted and incrementally scaled by a factor of 112.5% to meet the 50-year maximum significant wave height of 20.4 ft. Figure 44 shows the recorded 10-year storm and the scaled 50-year storm. For the north wind, wave height data from the approximately 10-year storm occurring on 10/17/2022 was plotted and incrementally scaled to 107.5% to meet the 50-year maximum significant wave height of 12.99 ft.
Figure 45 shows the recorded 10-year storm and the scaled 50-year storm.

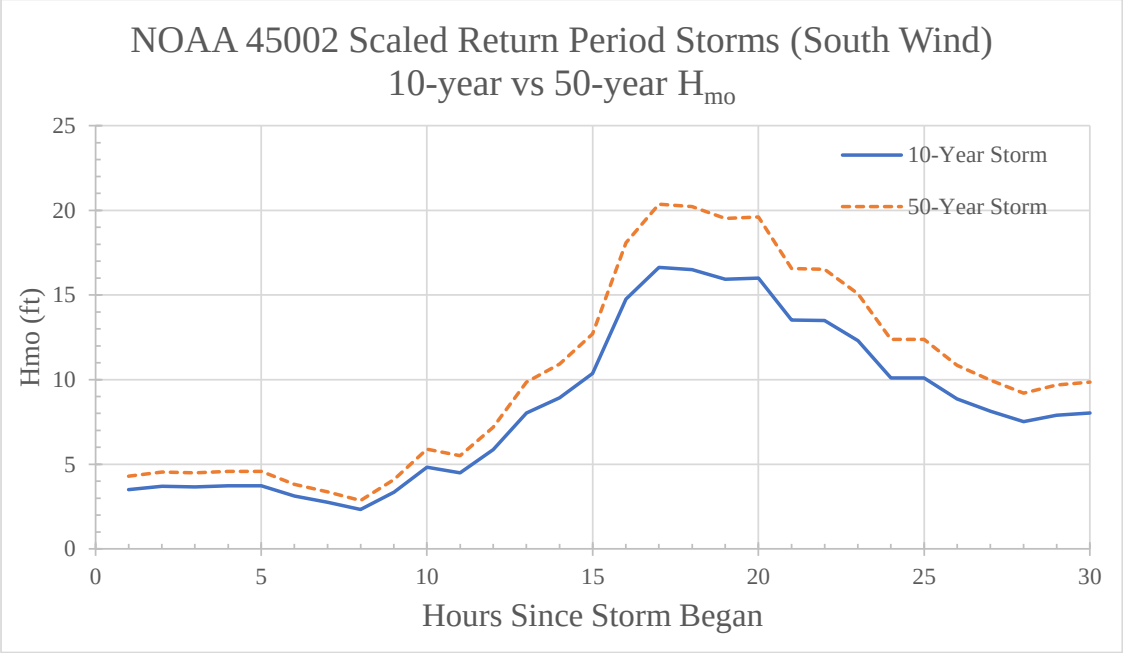


Figure 44: 10-year and scaled 50-year southerly derived storm at NOAA 45002.

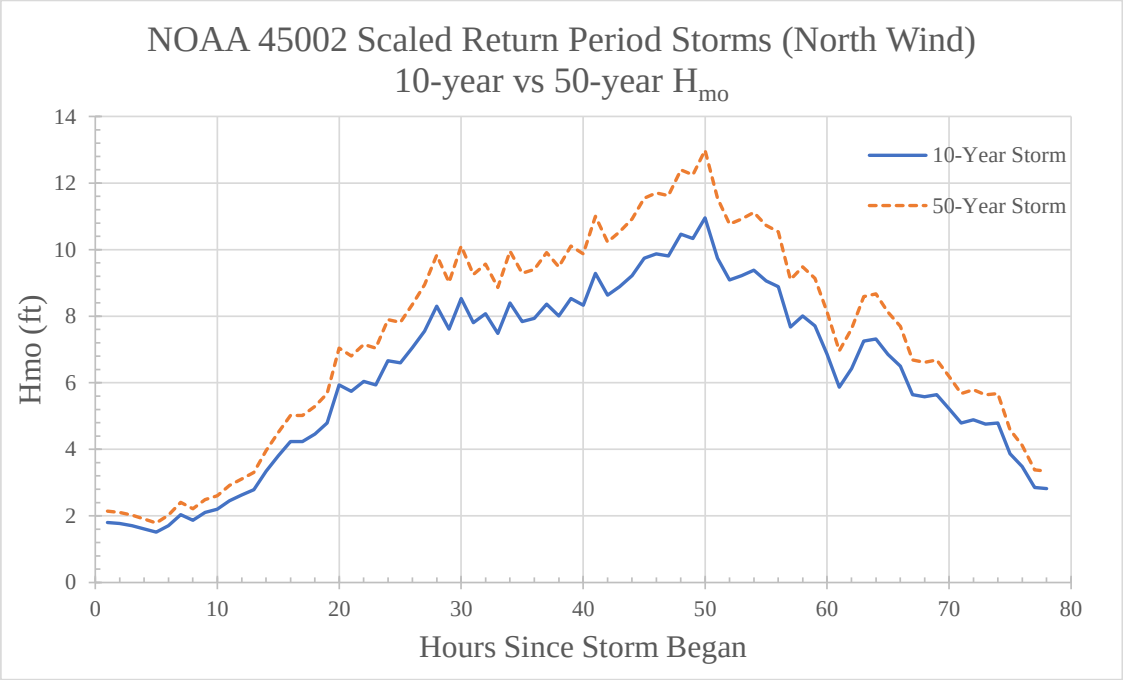


Figure 45: 10-year and scaled 50-year northerly derived storm at NOAA 45002.

Section 4 – Spectral Wave Results (Existing Conditions)

Results obtained from spectral wave models of the existing site conditions at North and South Manitou Island utilizing a 50-year water surface elevation of 582.85 ft with 50-year significant wave heights from both southerly and northerly wind directions are presented in Figure 46 through Figure 49. In these figures, the significant wave height is presented in meters over a color-coded plot. Vectors indicating wave height and direction of travel are also displayed in the images. Additionally, a summary of the results from these models of existing conditions is presented in Table 1 for North Manitou Island and Table 2 for South Manitou Island. An overview of offshore wave conditions around the Manitou Islands influencing the modelled nearshore wave environments is provided in Appendix D.

4.1 South Manitou Island

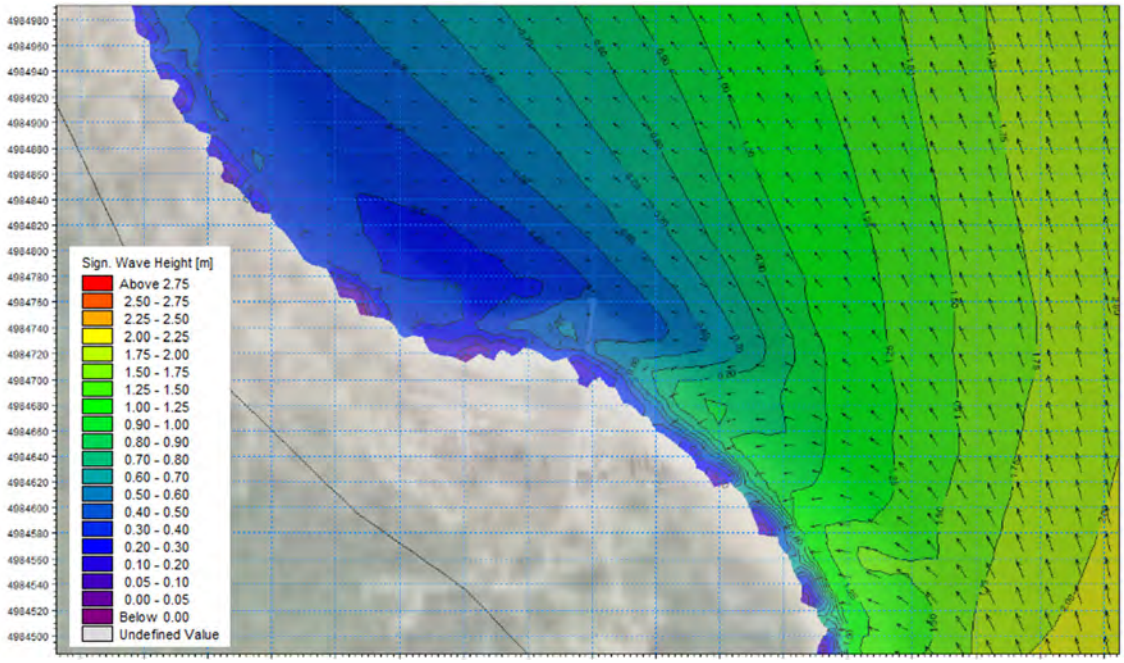


Figure 46: Spectral wave results at South Manitou Island during a 50-year southerly storm

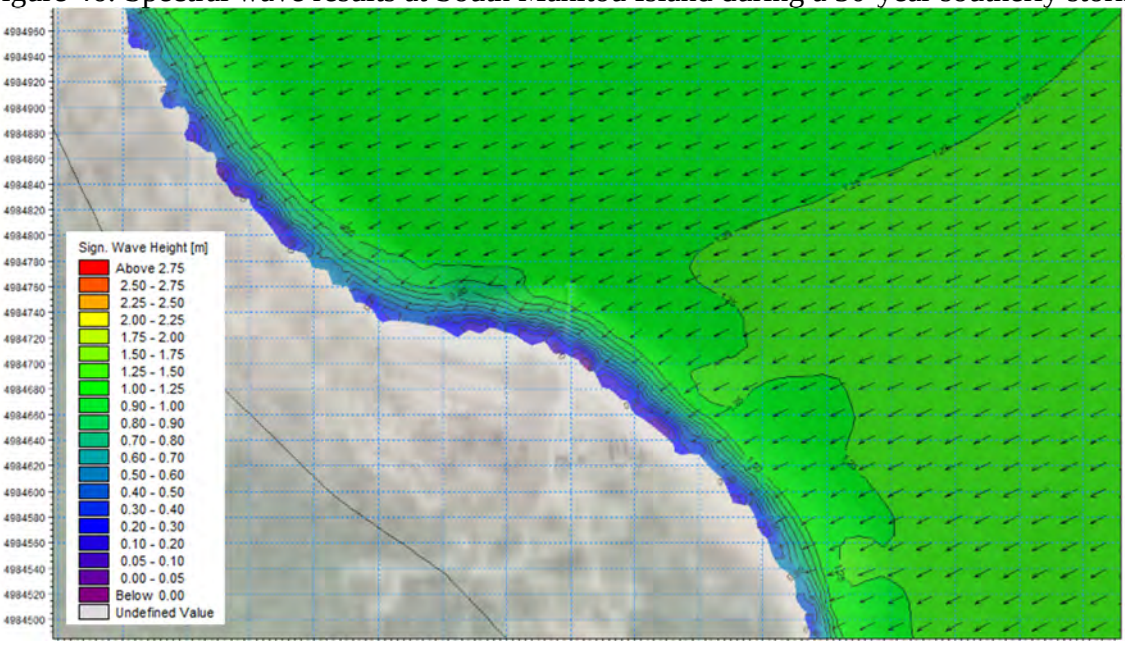


Figure 47: Spectral wave results at South Manitou Island during a 50-year northerly storm

Table 1: South Manitou Island spectral wave results

South Manitou Island			
Location	Wind Direction	Significant Wave Height (m)	Wave Period (s)
End of Existing Dock	Southerly	0.5	10.8
End of Existing Dock	Northerly	1.25	5.0

4.2 North Manitou Island

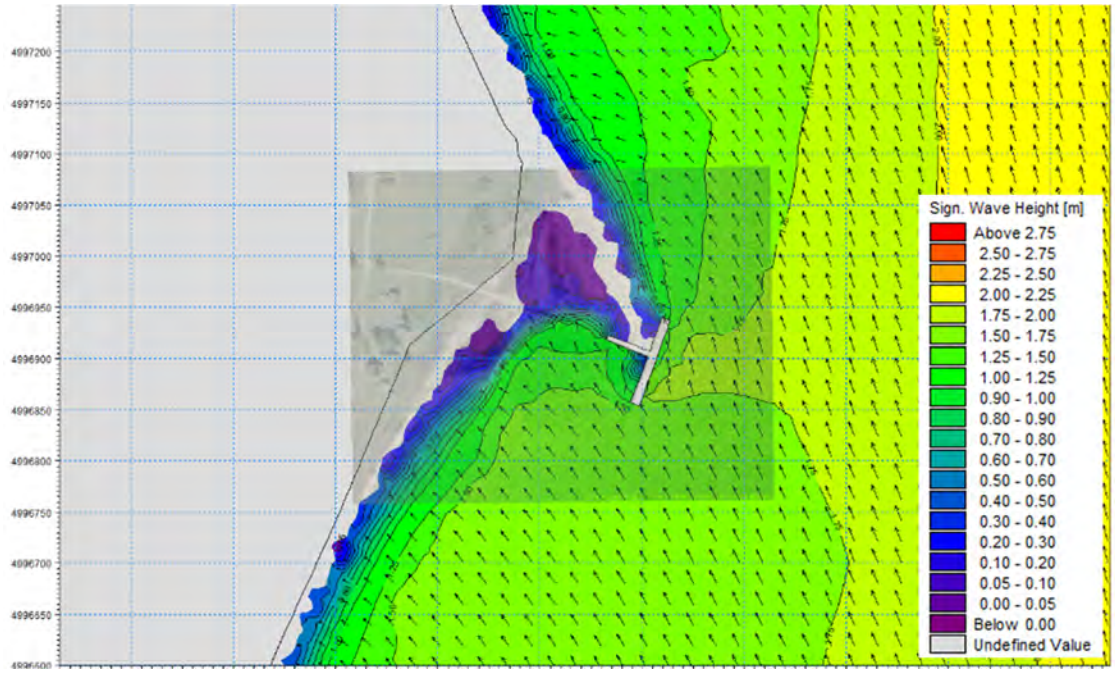


Figure 48: Spectral wave results at North Manitou Island during a 50-year southerly storm

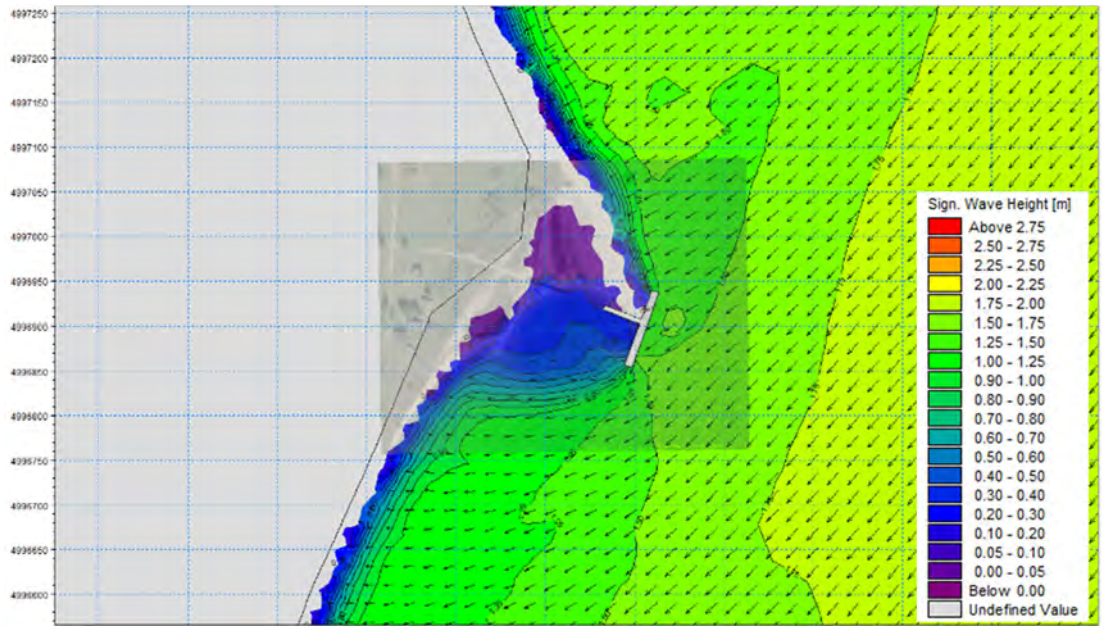


Figure 49: Spectral wave results at North manitou Island during a 50-year northerly storm

Table 2: North Manitou Island spectral wave results

North Manitou Island			
Location	Wind Direction	Significant Wave Height (m)	Wave Period (s)
End of Existing Dock	Southerly	1.75	5.0
End of Existing Dock	Northerly	1.5	4.7

Section 5 – Flood Zone Mapping

Flood zone mapping was performed at both South and North Manitou Island villages by integration of site-wide LiDAR data and spectral wave results into the Xbeach-G modelling software. Within the Xbeach-G model, a 583.2 ft water surface elevation representative of a 1% chance of exceedance in accordance with the 100-year return interval as used by the Federal Emergency Management Agency (FEMA) was established and utilized to simulate the extents of wave run up and overtopping along the beach faces of North and South Manitou Island. Models were simulated at this water level utilizing waves generated from both northerly and southerly directions. From analysis of model results and observations of site topography, the coastal flooding zones were characterized.

At South Manitou Island, the coastal flooding zones were characterized by beach face elevations reaching up to an elevation of 587.2ft as well as inland elevations located behind the beach face meeting elevations of 584.7 were defined as prone to coastal flooding. At North Manitou Island, the same beach face elevation of 587.2 ft was defined whereas a land elevation of up to 585.2 ft beyond the beach face were defined as prone to coastal flooding. The results of mapping out these defined areas are shown in Appendix C.

Section 6 – Sediment Transport Analysis

AMI performed sediment transport analysis for the existing and proposed dock structures and locations on the North and South Manitou Islands. This analysis was deemed necessary in order to determine how best to provide dock access to the islands without experiencing the issues that are plaguing the existing docks on the islands.

6.1 Overview

The Sediment transport analysis was conducted through MIKE by DHI's coupled sediment transport module. This allows for both waves and currents to be accounted for in the sediment transport process, providing a more detailed understanding of the local sediment transport. In order to save on run time when setting up the model, the model was simplified by utilizing a wave transmission boundary for each island. The conditions at this boundary were determined by running a model of all of Lake Michigan, allowing the majority of the Lake to be removed from subsequent models.

6.2 Lakebed and Sediment Characteristics

Sediment samples were collected at both islands during the 2022 site visit. All samples collected were geolocated in order to provide an insight into how the sediment gradations vary across each island. Samples were collected at each of the current and proposed dock locations, both onshore and offshore. A wide range in sediment gradations was found across both islands, showing shingle and cobble sized stones were intermixed with the sands of the islands. For North Manitou Island, the mean grain diameter was set to 0.30 millimeters with a grading coefficient of 1.32. For South Manitou Island, the mean grain diameter was set to 0.35 millimeters with a grading coefficient of 1.35. Figure 50 and Figure 51 show the variation in the sediments present at both islands.

Figure 50: North Manitou Sediment Samples

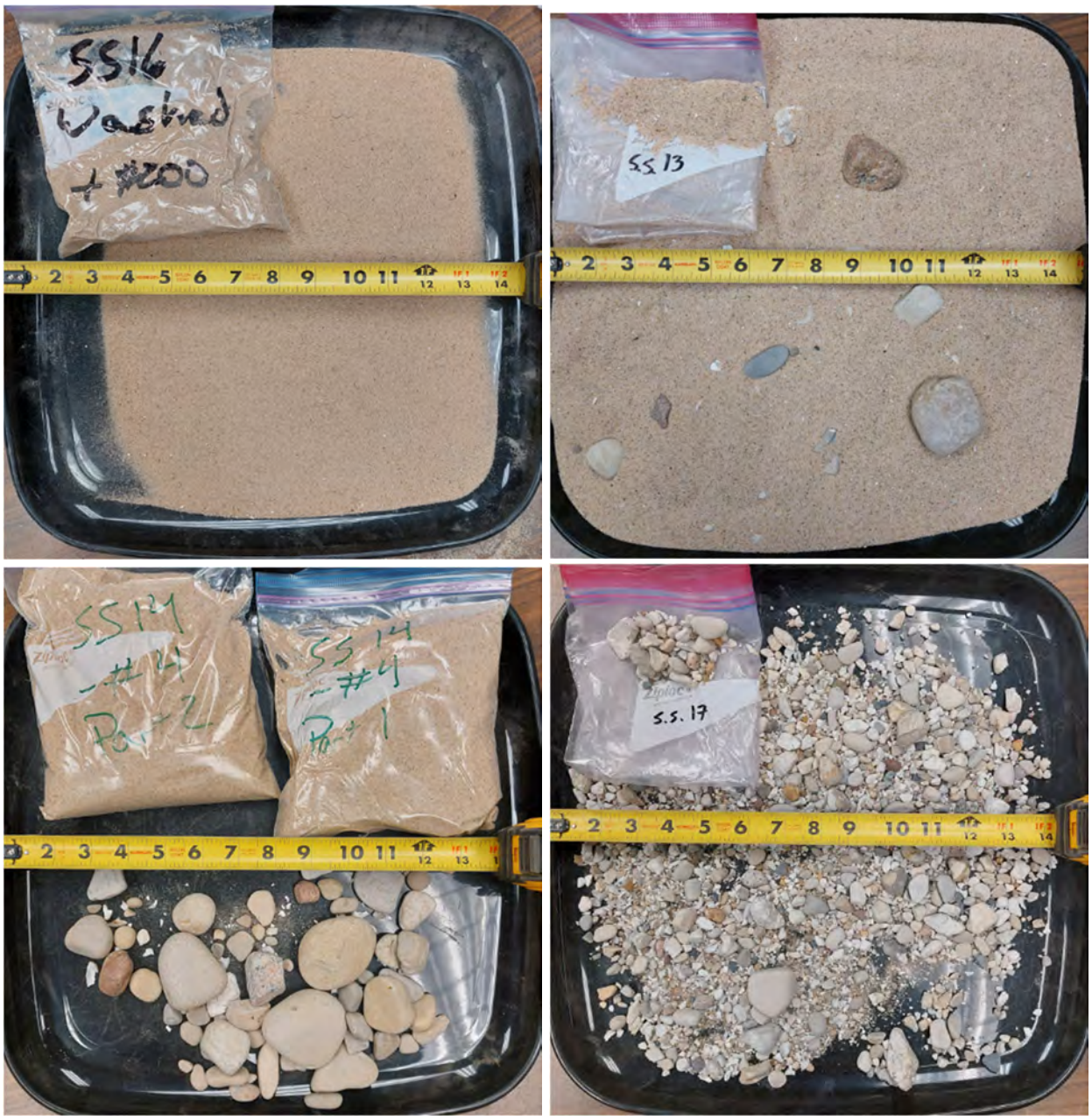


Figure 51: South Manitou Sediment Samples

6.3 Calibration

North Manitou Island is currently covered under a maintenance dredging permit that allows for 70,000 CY of sediment to be dredged from the island over five years. This number was used to inform our target transport near the North Manitou dock. Because there are no available records of dredging on South Manitou Island, the same parameters were utilized on the South Island as on the north.

It was determined through discussions with DHI that it would be best to run the model with an all-sand gradation rather than a combined sand and rock gradation. The model was then calibrated by adjusting the bed roughness to account for the lack of rock in the gradations. An

approximate net littoral drift to the south of 21,000 CY of sediment resulted.

Calibration was not available for South Manitou Island due to the limited survey data and historical dredging information provided. The same calibration parameters used for the North Manitou Island sediment transport modeling was utilized for the South Manitou Island sediment transport modeling.

Dredging History

Dredging documentation for North Manitou Island has been provided by the National Park Service covering the period of time from 1998 to 2023. Funding requests for dredging were made in 1998, 2003, 2004, 2005, 2006, 2012, & 2017. Not all of these requests were funded, and the resulting dredges occurred in 2001, 2006, 2011, & 2020. Notably, the 2003 funding request included funds to purchase equipment so that maintenance dredging could be conducted in-house rather than requesting expensive contract dredging periodically. This request was funded, and it appears that in-house dredging was conducted on a one-to-two-year basis between 2011 and 2017. It is assumed that in-house dredging was performed by the United States Army Corps of Engineers.

Dredge volumes were either not recorded or not provided for most of the historic dredging operations. However, it is known that the 5-year maintenance permit issued in 2019 allows for 70,000 CY of dredging over 5 years, averaging 14,000 CY a year. This matches the 2020 dredge total of 13,000 CY. From this, it can be inferred that the North Manitou dock struggles with a sediment deposition issue of no less than 14,000 CY annually.

6.4 Results

South Manitou Island

No dredging information has been provided by the National Park Service regarding the South Manitou Island Dock. From sediment transport modeling, the Chicago Road alternative 1 has a lower net littoral drift than the proposed Grand Blvd. dock alternative 2. The following figures depict the vertical elevation and shoreline changes obtained from the study, “Investigating Geomorphic Change Using a Structure from Motion Elevation Model Created from Historical Aerial Imagery: A Case Study in Northern Lake Michigan, USA” (DeWitt and Ashland, 2023).

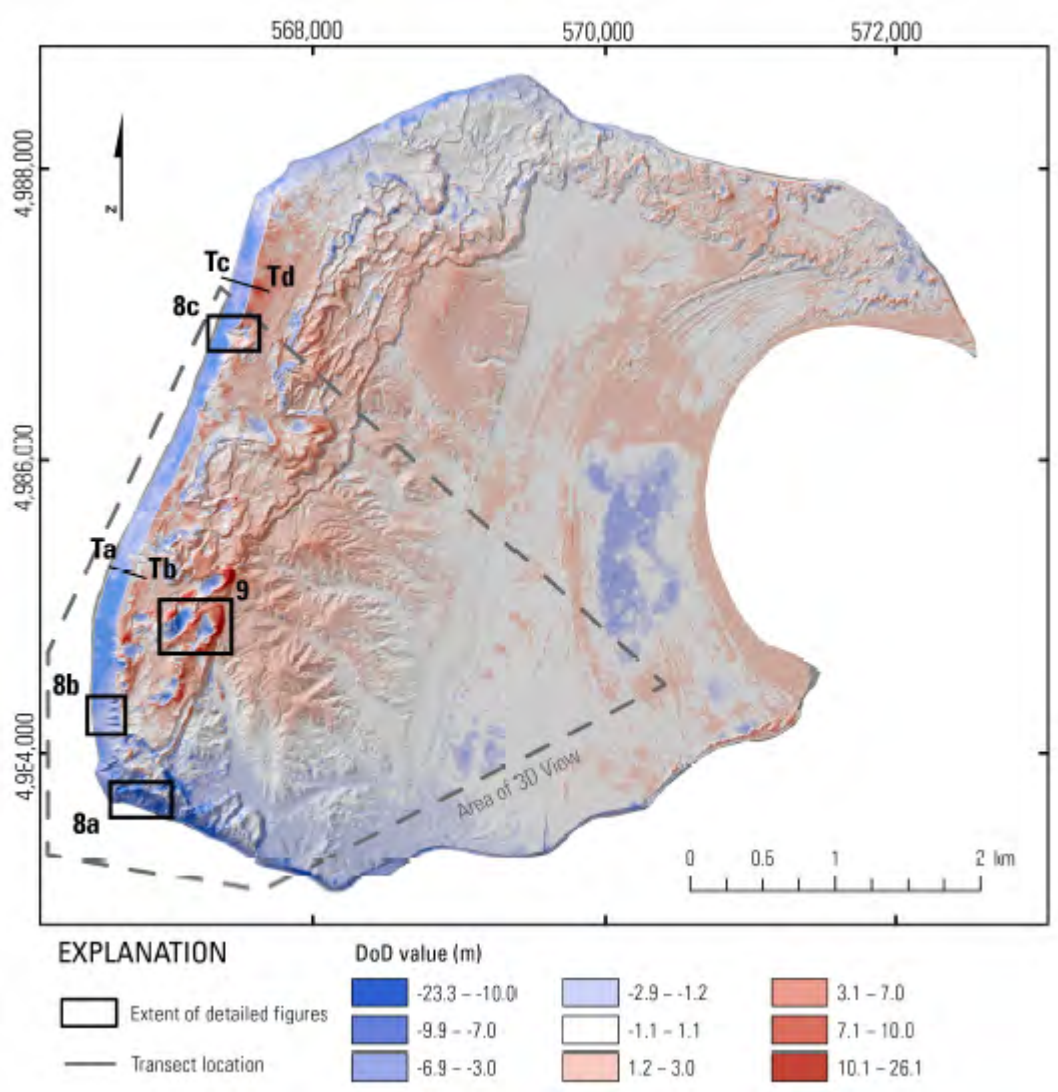


Figure 52: SMI – Net vertical terrain change between 1955 and 2016, (DeWitt and Ashland, 2023).

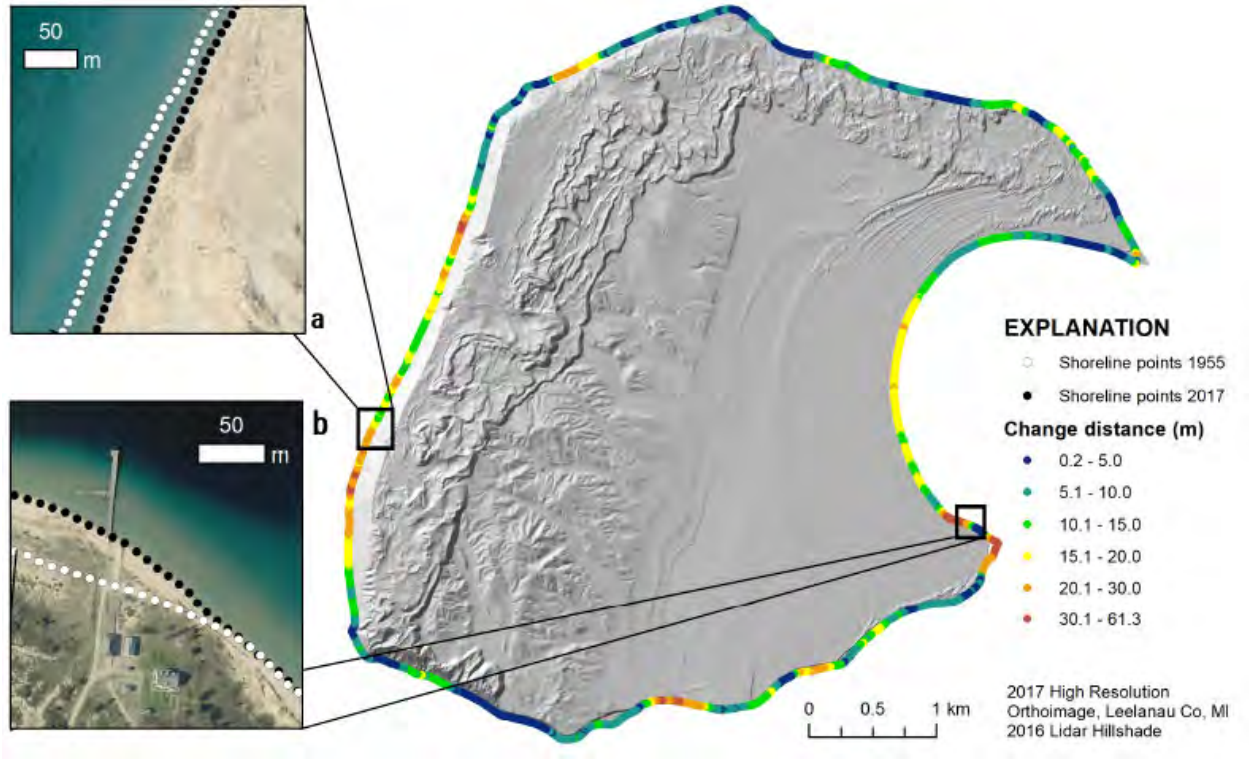


Figure 53: SMI – Shoreline change between 1955 and 2017,
(DeWitt and Ashland, 2023).

In general, AMI concurs with the findings of DeWitt and Ashland. From reviewing the imagery coupled with sediment transport modeling performed, it is anticipated that in the future, the accumulated sediment around sand point (reference Figure 53b) will continue to transport northward which will result in the shoreline extending further into the water. This is largely due to the prevailing winds coming from the South-Southwestern direction which will push the sandy material further into the bay. In particular, the Grand Blvd. location is anticipated to accumulate more sediment than the Chicago Road location due to this observation.

The future estimated design draft elevations for the Chicago Road Dock and the Grand Blvd Dock alternatives along with proposed dredging limits are presented in Section 9.0, Figure 58 and Figure 60, respectively. The design draft elevations were presented to inform the decision-making process with respect to vessel operations and dredging required.

North Manitou Island

Dredging contracts were provided by the NPS; however, no quantities were provided. Permitted dredging contract quantities of 14,000 CY/year were utilized as the minimum amount of sediment transport anticipated for calibration of model purposes. Through the calibration process, AMI estimated that 14,000 CY/year was insufficient and that the net littoral drift from the north is closer to 21,000 CY/year in a typical year. The following figures depict the shoreline positions which were developed using historical imagery from 1953 to 2022.

Figure 54: NMI – Existing Dock Alt. 1 – 1953, 1993, & 2022 shoreline positions.

Figure 55: NMI – Historical Dock Alt. 2 – 1953, 1993, & 2022 shoreline positions.

The future estimated design draft elevations for the Existing Dock and the Historical Dock alternatives along with proposed dredging limits are presented in Section 9.0, Figure 63 and Figure 66, respectively.

Section 7.0 – Climate Change Considerations

AMI has performed a review of the climatic trends on the Great Lakes and in particular on Lake Michigan. AMI's climatic review and climate change considerations can be found in Appendix B.

Section 8.0 – Impacts to the Accessibility of North Manitou Island

With the proposed removal of the sheet pile portions of the North Manitou Dock, there were concerns about the ability to land visitors at the dock on North Manitou Island. Because of these concerns, a peak over threshold analysis was done for buoy 45002. The location of buoy 45002 is shown in Figure 56. A 1-meter wave height was utilized as an assumed condition since the exact conditions that prohibit the ferry from landing visitors are unknown.

Figure 56: North Manitou Island Buoy Locations

The peak-over-threshold analysis looked for all instances of wave heights greater than 1 meter that come out of the north. We excluded southern storms because if a storm from the south is large enough to prevent the landing of visitors on the North Island, then the Manitou Island Ferry would be unable to cross the Manitou passage. Buoy station 45002 was utilized for the POT analysis. Below is a list of the assumptions and conclusions from the analysis:

- Analyzed 13 years of data (2010-2022)
- Between May 1 – Oct 1 (153 days) each year
- Assumed operating 6 days/week
- Assumed 1 meter wave height (Hs) as operating limits
- Only Northerly & Easterly conditions analyzed
- Assumed only storms over 4 hours in duration apply
- Anticipated maximum impact to Ferry Operations ~ 5%-10% (6-14 days)
- Limitation: does not differentiate time of 1m wave events
    - Implication – smaller impact to ferry operations

While multiday storms were accounted for, it is important to note that the time when the storm occurs is not accounted for in this analysis. This means that some of the 1-meter wave storms may be occurring overnight and not impacting the ferry service to the islands.

Section 9.0 – Proposed Design Alternatives

Based off of input from Vanasse Hangen Brustlin, Inc. (VHB), AMI, and the National Park Service (NPS), two design alternatives were modeled for each of the existing dock locations. The design alternatives were selected based on considerations which are outside the scope of this report. This report will address the wave conditions and sediment transport conditions for each design alternative to better inform the decision-making process.

9.1 South Manitou Island – Design Alternative 1

Design Alternative 1 consists of abandoning the existing dock location and installing a new pile supported dock at the old Chicago Road dock location. The proposed dock measures approximately 170 ft and extends approximately 140 ft into the lake from the waterline. This design alternative was incorporated into the MIKE modelling domain and computed utilizing 50-year water levels and 50-year wave events from both northerly and southerly winds. The results obtained from the southerly wind are presented in Figure 57.

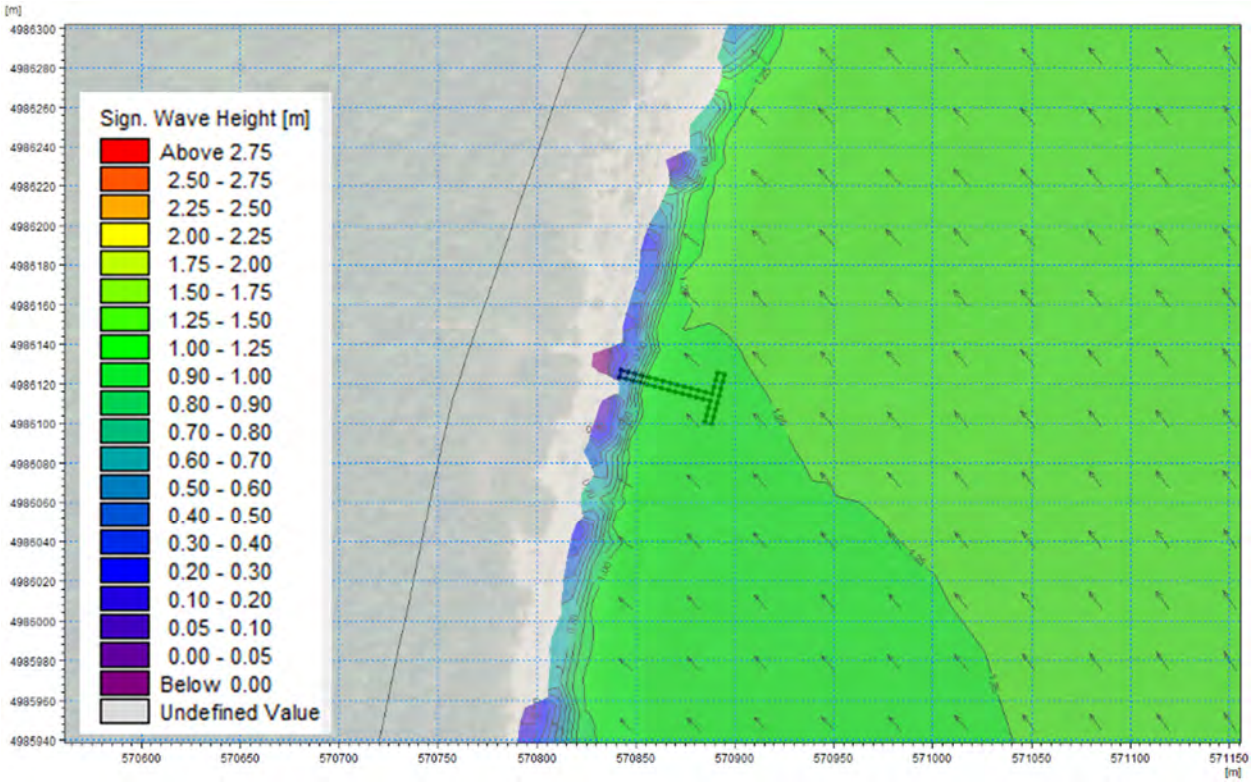


Figure 57: Spectral wave results at Design Alternative 1 of South Manitou Island

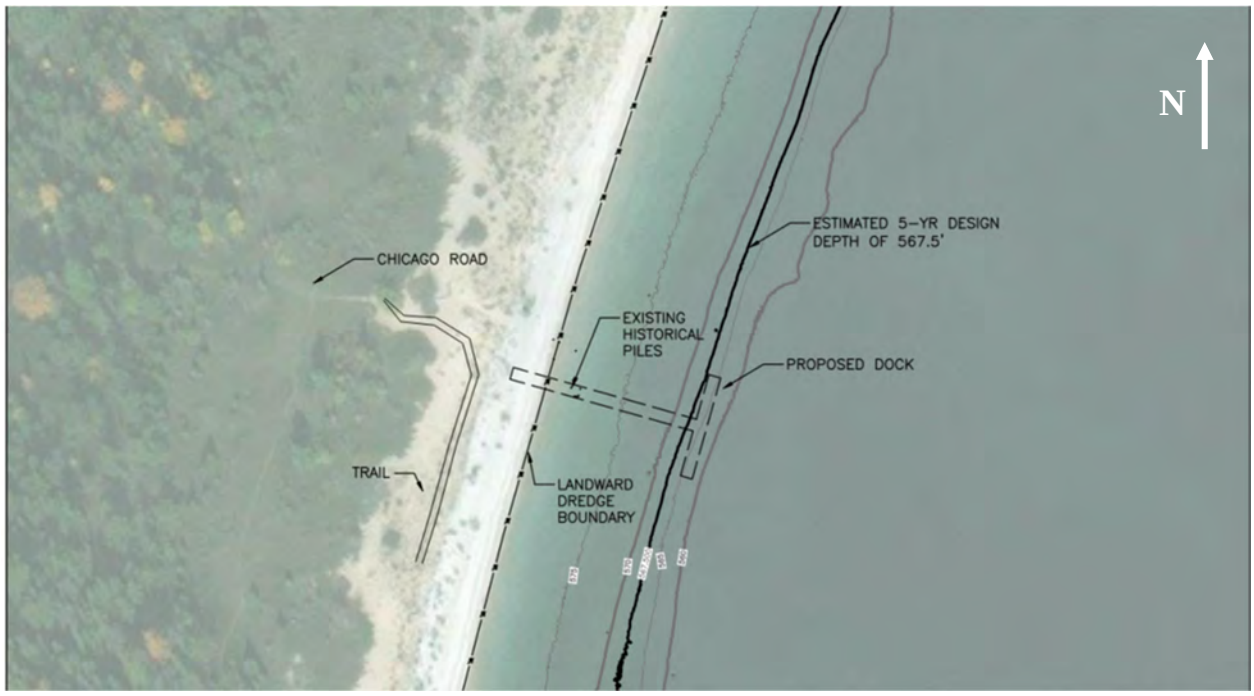


Figure 58: SMI – Chicago Road Alt. 1 estimated 5-year design depth line.

9.2 South Manitou Island – Design Alternative 2

Design Alternative 2 consists of abandoning the existing dock location and installing a new pile supported dock at the assumed Grand Blvd dock location. The proposed structure measures approximately 230 ft and extends approximately 200 ft into the lake from the waterline. This design alternative was incorporated into the MIKE modelling domain and computed utilizing 50-year water levels and 50-year wave events from both northerly and southerly winds. The results obtained from the southerly wind are presented in Figure 59.

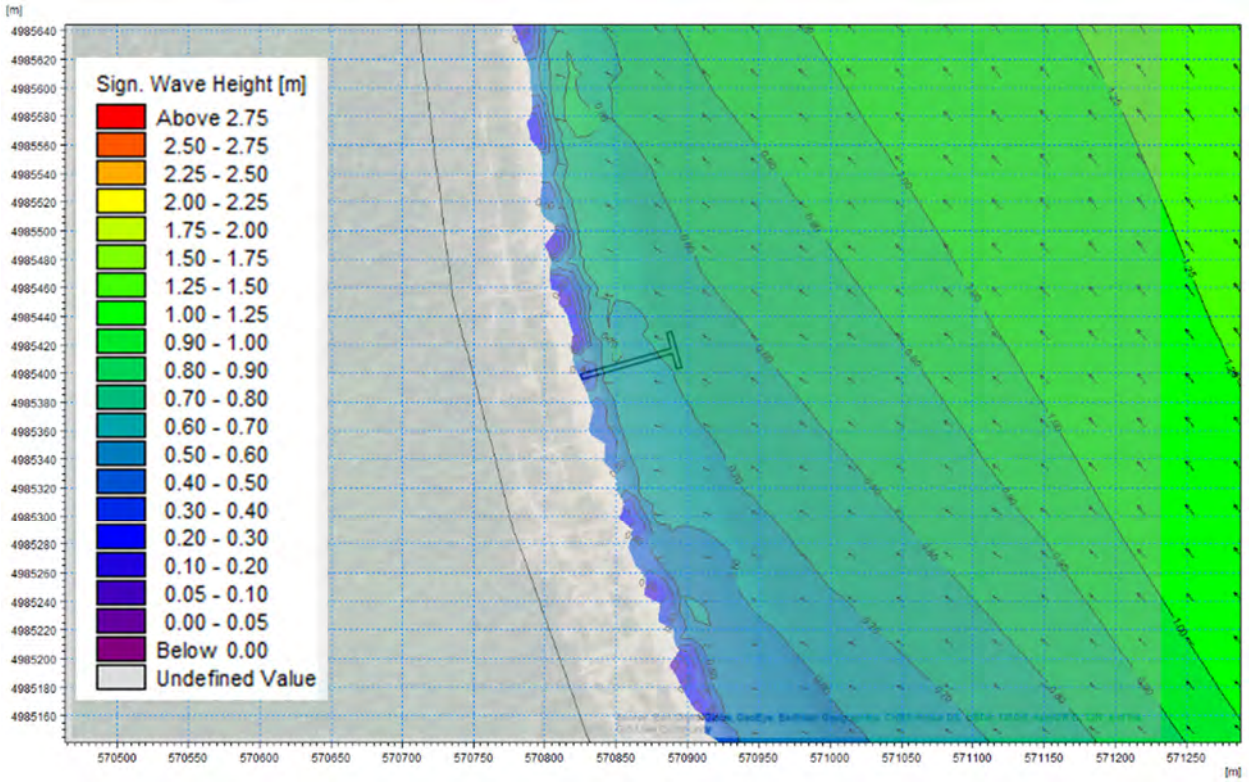


Figure 59: Spectral wave results at Design Alternative 2 of South Manitou Island

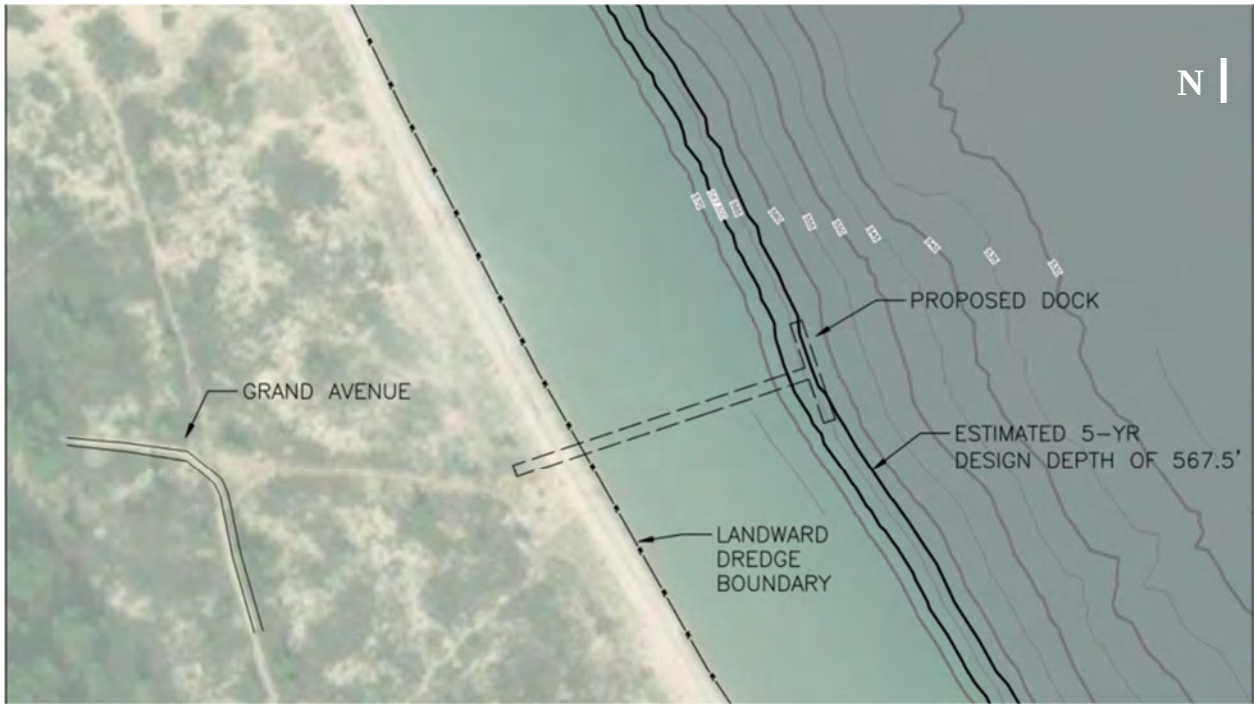


Figure 60: SMI – Grand Blvd. Alt. 2 estimated 5-year design depth line.

9.3 South Manitou Island – Design Alternative Summary

Results extracted at the lakeward-most end of both Design Alternative 1 and 2 of South Manitou

Island are presented in Table 3 below. The model results suggest that during the storm analyzed, wave conditions at the Grand Blvd. location are less than that of the Old Chicago Road location during a southerly storm, but more than the Chicago Road location during a northerly storm.

Table 3: Spectral Wave Modeling Summary for South Manitou Island Design Alternatives 1 & 2

Location	Wind Direction	Significant Wave Height (m)	Sediment Accretion (ft/year)*
Chicago Road	Southerly	1.23	0.5
Chicago Road	Northerly	0.62	
Grand Blvd	Southerly	0.74	2
Grand Blvd	Northerly	0.84	

*Sediment accretion is based on seaward movement of design draft elevation of 567.5 ft.

9.4 North Manitou Island – Design Alternative 1

Design Alternative 1 consists of removing the sheet pile portion of the existing dock. The end of the existing dock would then be added onto with a new pile supported dock. The proposed extension of the pile-supported dock extends approximately 275 ft beyond the end of the existing pile-supported dock section and places the end of the proposed structure approximately 110 ft beyond the end of the existing dock. This design alternative was incorporated into the MIKE modelling domain and computed utilizing 50-year water levels and 50-year wave events from both northerly and southerly winds. The results obtained from the southerly wind are presented in Figure 61. Note that in this image, the background image is presented for visual reference only, and that the estimated dredging extents were integrated into the MIKE modelling domain.

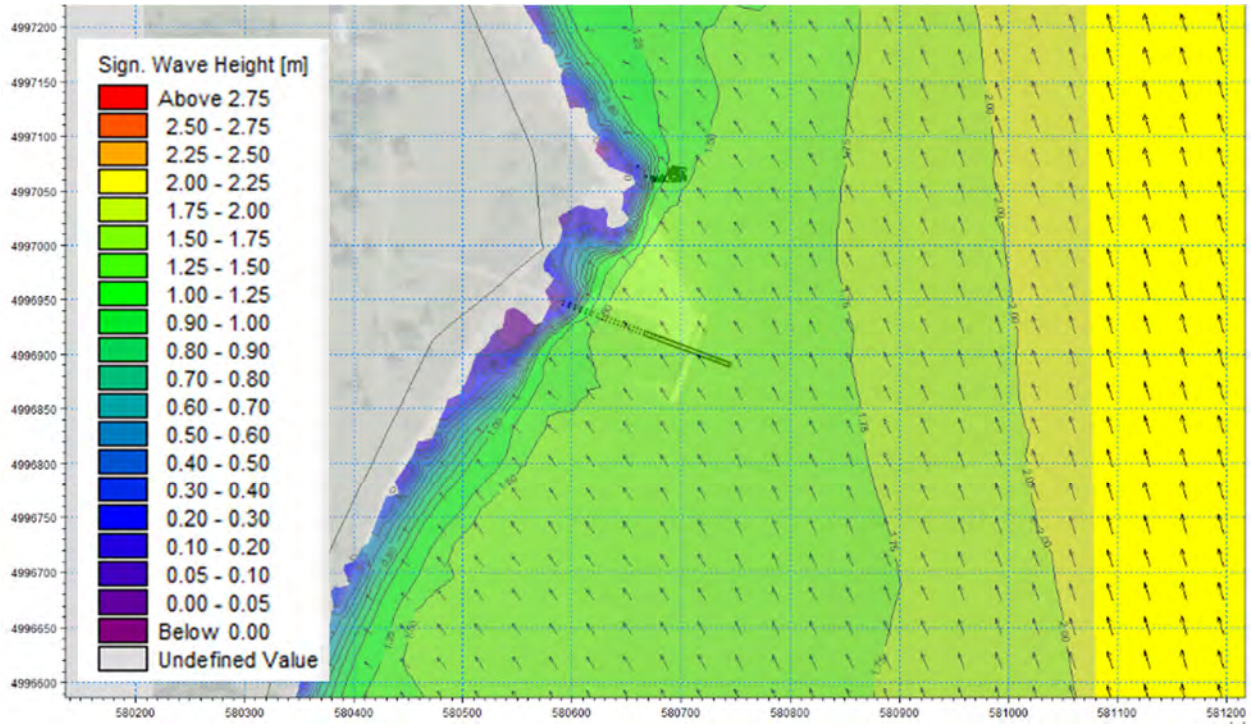


Figure 61: NMI Design Alternative 1 Southerly storm wave conditions.

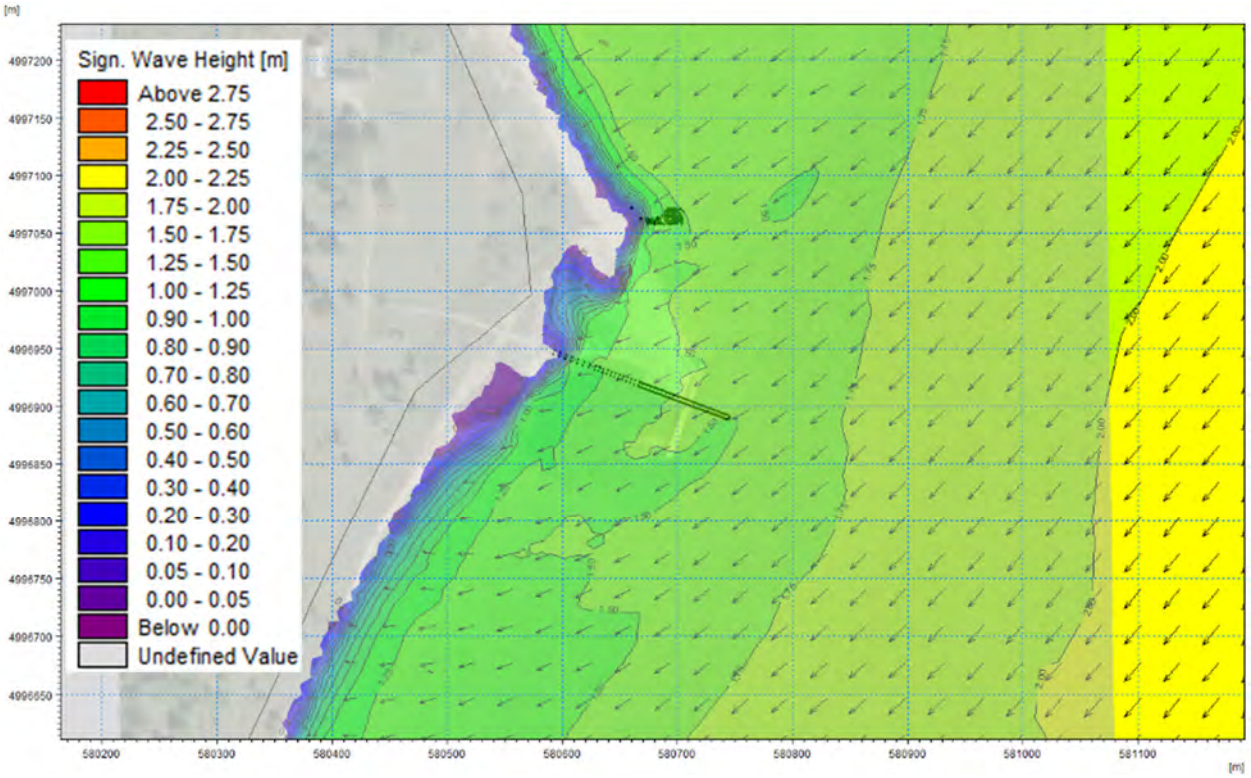


Figure 62: NMI Design Alternative 1 Northerly storm wave conditions.

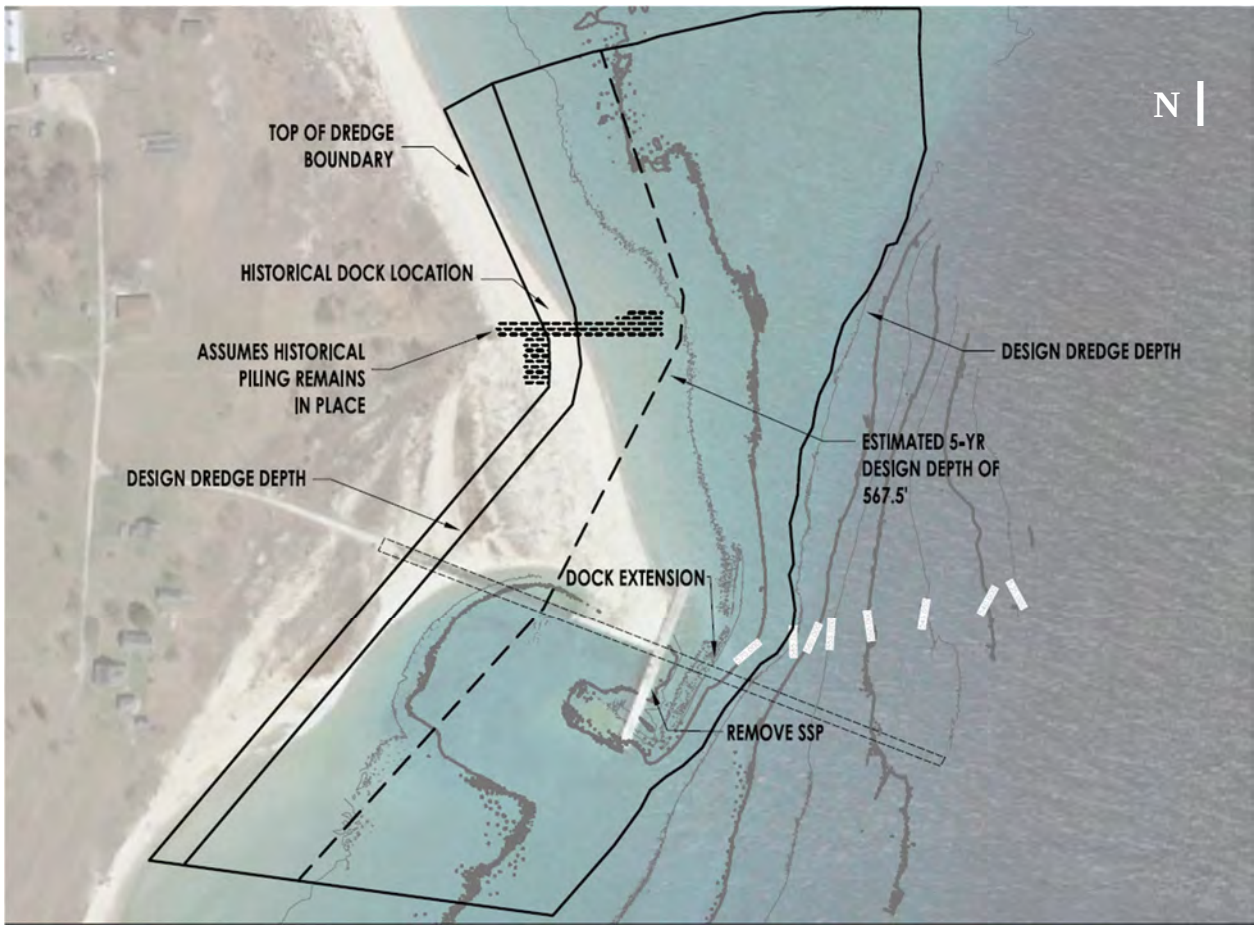


Figure 63: NMI – Existing Dock Alt. 1 estimated 5-year design depth line.

9.5 North Manitou Island – Design Alternative 2

Design Alternative 2 consists of removing the existing dock and installing a new pile supported dock near the historic dock location. This design alternative was incorporated into the MIKE modelling domain and computed utilizing 50-year water levels and 50-year wave events from both northerly and southerly winds. The results obtained from the southerly wind are presented in Figure 64. Note that in this image, the background image is presented for visual reference only. Some small amounts of dredging were integrated into the lakebed at the location of the proposed new dock, while the dredging extents of the proposed conditions for Design Alternative 1 were concurrently utilized under the assumption that the sand spit will be moved in time by littoral drift.

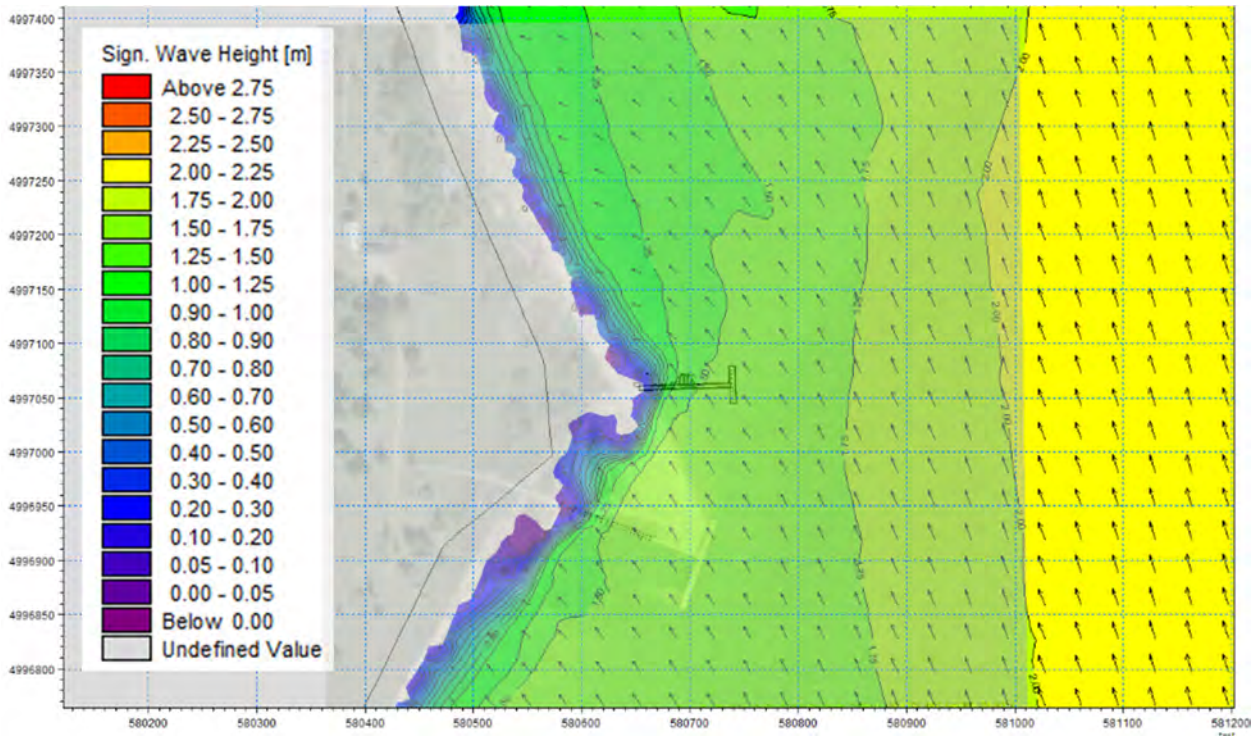


Figure 64: NMI Design Alternative 2 Southerly storm wave conditions.

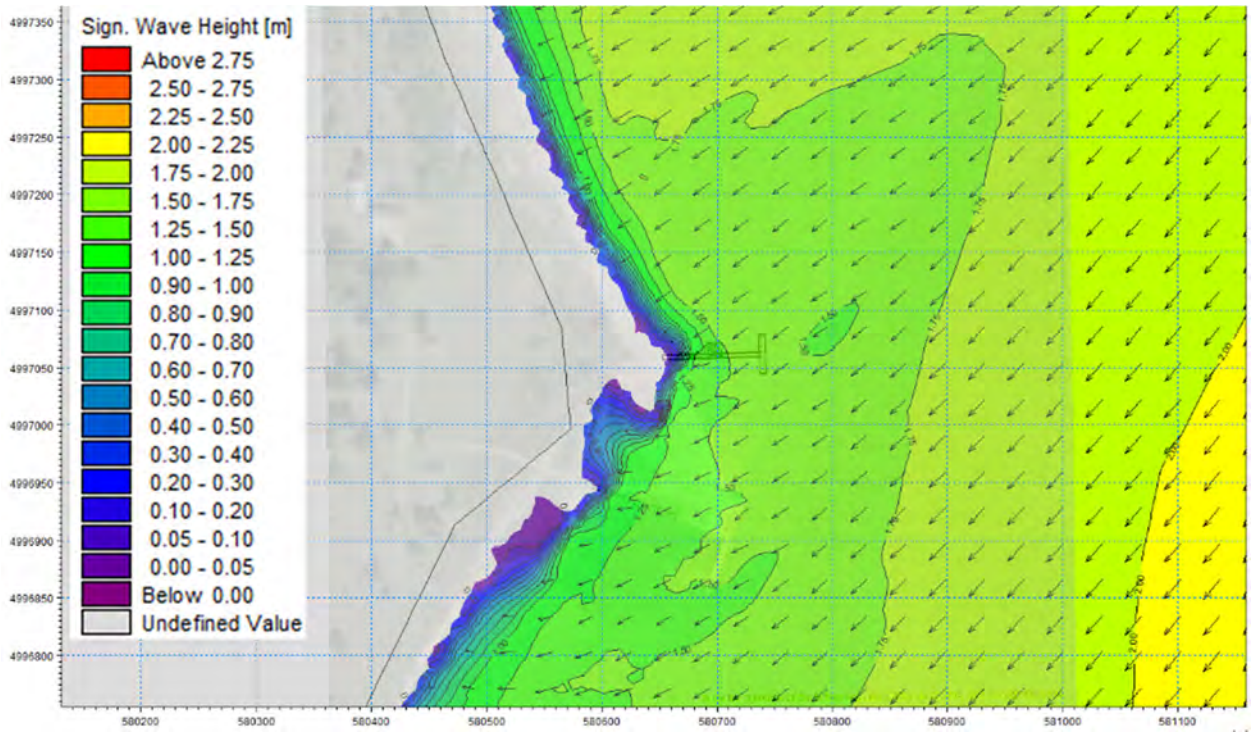


Figure 65: NMI Design Alternative 2 Northerly storm conditions.

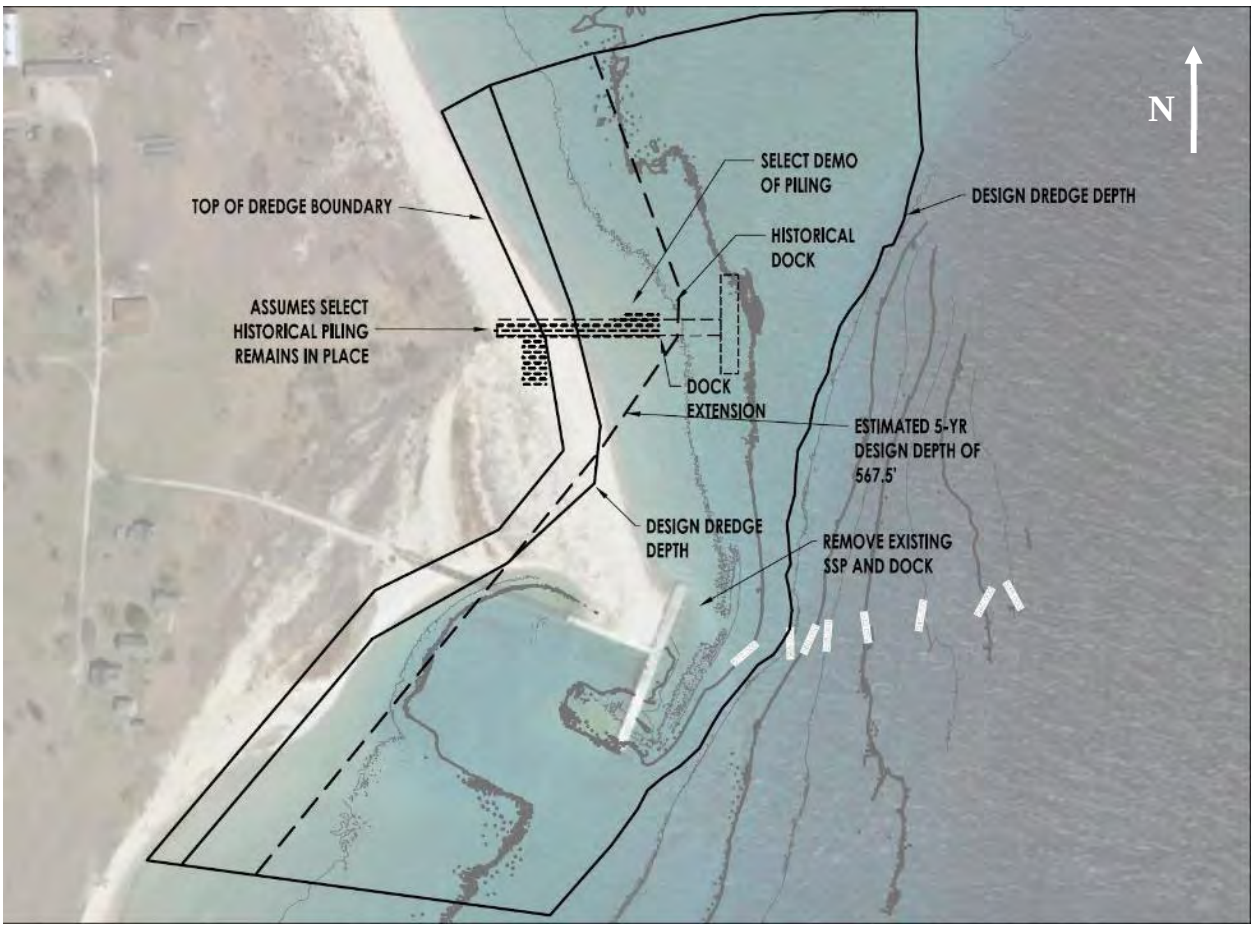


Figure 66: NMI – Historical Dock Alt. 2 estimated 5-year design depth line.

9.6 North Manitou Island – Design Alternative Summary

Results extracted at the lakeward-most end of both Design Alternatives 1 and 2 of South Manitou Island are presented in Table 3 below. The results suggest very little difference in the nearshore wave environment between the two locations.

Table 4: Spectral Wave Modeling Summary for North Manitou Island Design Alternatives 1 & 2

Location	Wind Direction	Significant Wave Height (m)	Sediment Accretion (ft/year)*
Existing Dock	Southerly	1.65	4
Existing Dock	Northerly	1.55	
Old Dock	Southerly	1.55	5
Old Dock	Northerly	1.5	

*Sediment accretion is based on seaward movement of design draft elevation of 567.5 ft.

Section 10.0 – Summary

AMI was tasked with on-site data collection, statistical analysis of meteorological conditions affecting the coastal environment of Lake Michigan, and detailed spectral wave modelling to characterize the nearshore wave climates of both North and South Manitou Island. Through on-

site data collection, AMI was able to obtain a lakebed and land surface profile that was integrated into previously existing datasets to accurately define the land surface surrounding the islands. AMI performed research and analysis of Lake Michigan water levels and storm surges to determine return periods for water levels at North and South Manitou Island. Through acquisition of buoy and ADCP data in Lake Michigan, AMI performed a peaks-over-threshold analysis to determine return periods for significant wave heights affecting the islands and also a representative annual data set for sediment transport modeling.

Each piece of the above-described information was utilized in the production of numerical models in the MIKE21 SW model to characterize the nearshore wave environments and sediment transport characteristics at the North and South Manitou Island docks for both existing conditions and proposed design alternatives. The simulated proposed design alternatives were selected with the intent of minimizing the need for ongoing maintenance dredging due to excessive amounts of littoral drift occurring at the existing dock locations and structure types. Additionally, the information and computed nearshore wave climates were utilized in the production of flood mapping at both the North and South Manitou Island villages.

A summary of the primary coastal results is summarized below. Note that for structural design in coastal environments, significant wave heights (H_s) are typically converted to 10% design wave heights (H_{10}) by the following formula: $H_{10} = H_s * 1.27$. This provides the required resiliency in structural design for dock applications.

Lastly, please note that the flood zone mapping analysis is provided in the Appendix.

Location - Alternate	Description	Significant wave height (ft) during 50 year storm		Sediment Accretion (ft/year)*	Additional Days per Year of Impact to Ferries**
		Southerly Wind	Northerly Wind		
SMI - Alt 1	Chicago Road	4.04	2.03	0.5	0
SMI - Alt 2	Grand Blvd	2.43	2.76	2	0
NMI - Alt 1	Existing Dock	5.41	5.09	4	10
NMI - Alt 2	Historical Dock	5.09	4.92	5	10

*Sediment accretion is based on seaward movement of design draft elevation of 567.5 ft

**At NMI, estimated between 6-14 additional days of impact to ferry services. See report for more detail

Respectfully Submitted,

Zac Morris, PE

Coastal Department Manager
AMI Consulting Engineers, P.A.

Attachments:

- Appendix A: References
- Appendix B: Climate Change Considerations
- Appendix C: Flood Mapping
- Appendix D: Spectral Wave Outputs

Appendix A: References

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9575113.659227459,5633561.85867406>

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Appendix B: Climate Change Considerations

Memorandum of Findings

Re: Evaluation of Predicted Climate Change Effects – Sleeping Bear Dunes National Lakeshore

Introduction

The NPS doesn't have a clear-cut process for addressing climate change in the Great Lakes region. However, after reviewing the *Coastal Adaptation Strategies Handbook 2016*, it was determined that four factors need to be considered when looking at climate change and its effects on strategic planning. Notably, the RAD (Resist-Accept-Direct) Framework, devised by the U.S. Department of the Interior, is for use in directing decision making regarding any plans on site, though this is likely only relevant to the park service employees.

Figure 67. Information on the implementation of the RAD framework
(Courtesy of USGS Resist-Accept-Direct Framework Webpage)

When reviewing materials about climate change, two emission scenarios are used for nearly every analysis: RCP 8.5 & RCP 4.5. The IPCC (International Panel on Climate Change) has developed RCP's (Representative Concentration Pathways) to standardize how researchers

analyze possible climate scenarios. RCP 8.5 was developed to show what would occur if CO2 emissions continued to climb through the 21st century. RCP 4.5 was developed as a moderate climate change scenario with emissions beginning to taper off around the 2040s. According to Hausfather and Peters, current climate change policies will keep the globe from the RCP 8.5 scenario, and likely below the RCP 6.0 scenario. Because of this, it is recommended that RCP 4.5 scenarios be given higher credence than RCP 8.5 scenarios when reviewing climate change predictions for the Great Lakes.

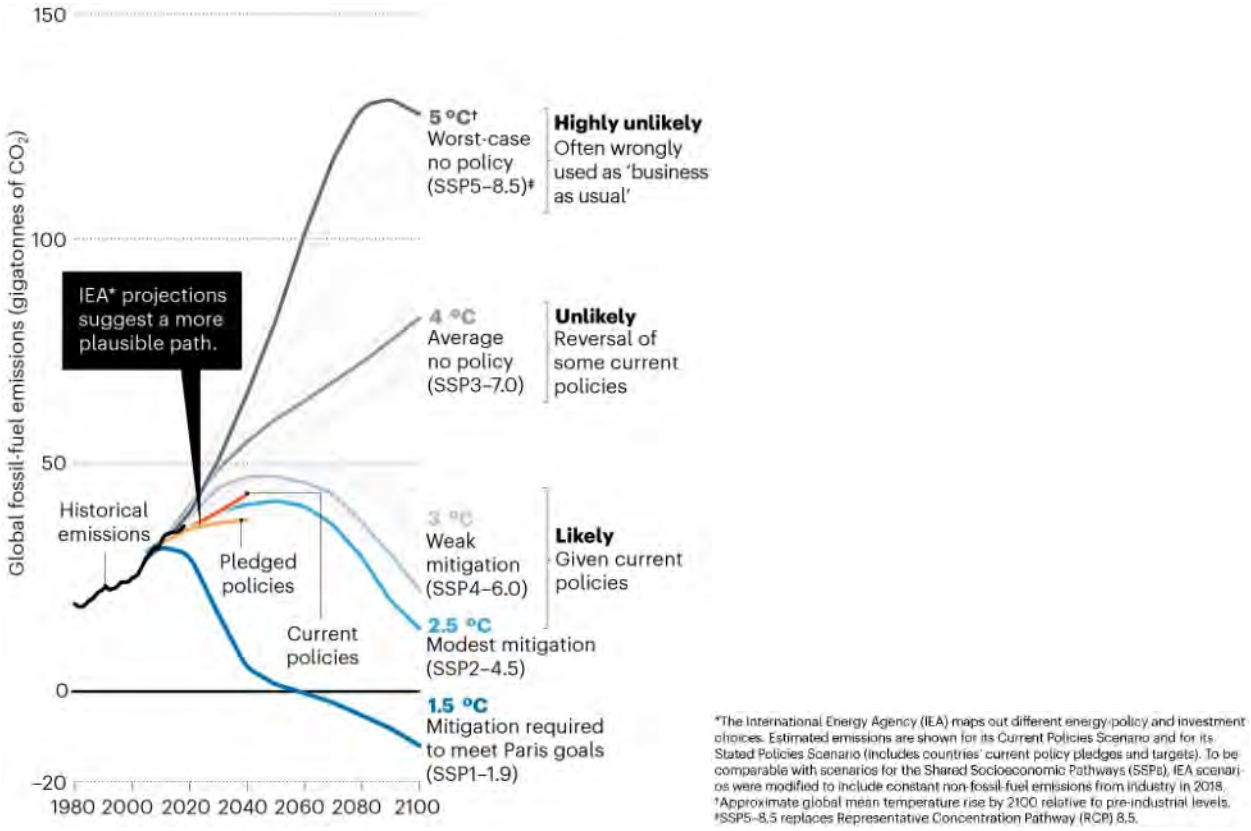

Figure 68. Graphical representation of each standard climate scenario and our likely futures (Courtesy of Hausfather & Peters, 2020)

In this review of climate change predictions for the Great Lakes, four climate change factors were identified as important to consider. First are lake levels, since these will have a direct impact on any development near the shoreline of the Great Lakes. Second is precipitation, which can affect coastal flooding and the net water supply in the Great Lakes basin. Third is the wind intensity and direction. During storm events, the wind causes a localized storm surge that can increase the reach of breaking waves in the shoreland. A change in direction can also cause a change in sediment transport and areas of concern because waves would approach from a different angle than in the past. Last is temperature, which has effects on water temperature and ice formation, which is important because it can allow for a larger window each year for large storm events since ice coverage typically limits wave formation and impact.

Lake Levels

The future of lake levels on the Great Lakes is fuzzy. Most predictions for lake levels follow the

"Off-Line" methods of Croley (1990). (*Gronewold et al., 2013*) However, concerns about Croley's methods have been raised, primarily by Lofgren et al. (2011), who noticed that the resulting surface energy budgets and the input surface energy budgets do not line up in the off-line model, which lead to an overestimate in drops in lake levels. (*Gronewold et al., 2013*) When looking at predictions, the methods of Croley (1990) result in a drop of approximately 0.75 meters by the late 21st century using an RCP 4.5 scenario, while the methods outlined by Lofgren & Rouhana finds that lake levels will drop approximately 0.2 meters by the late 21st century using an RCP 4.5 scenario. (*Lofgren & Rouhana, 2016*) A new study by Seglenieks & Temgoua (2022) found even more mild lake level changes for a range of temperature changes between 1.5 °C and 3 °C. These simulations are meant to show the result of a constants high temperature, and as a result were ran for a 30-year model time. Looking at the 3 °C prediction, the one we are currently most likely to hit, the average lake level on Lake Michigan will rise approximately 0.24 meters. It is important to note that the box and whisker plots below show that there will be increased variability in yearly lake levels, which Lofgren & Rouhana (2016) agrees on.

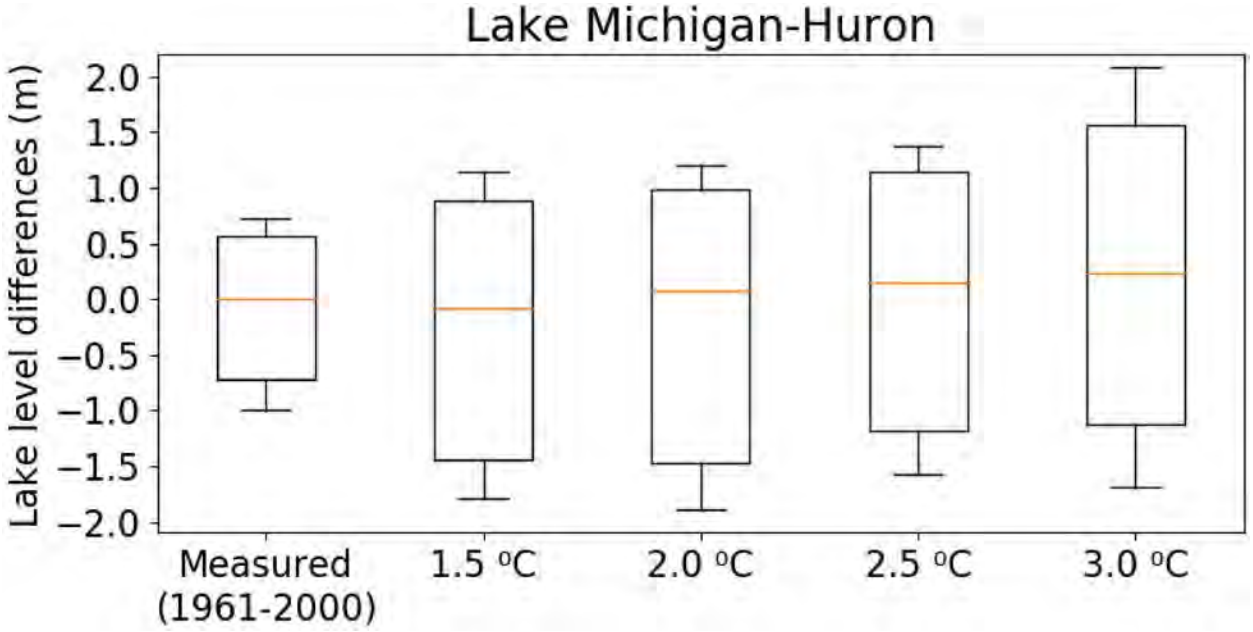

Figure 69. Predicted changes in average lake levels and interannual lake level variability (Courtesy of Seglenieks & Temgoua, 2022)

Precipitation

Predicted precipitation changes in the Great Lake region are far less contentious than lake level changes. Research shows that precipitation will increase overall in the reason, with Peltier et al. (2018) and Byun et al. (2019) agreeing on this. Since Peltier et al. (2018) utilizes RCP 8.5 in their analysis, the findings of Byun et al. (2019) will be used instead. Byun et al. (2019) found that, under RCP 4.5, precipitation will increase in total with seasonal increases between November and May, and a seasonal decrease from June to October. It was also found that peak total precipitation increase would happen around mid-century, with a divergence in seasonal intensity following, causing a lower total increase in rainfall by late-century. (*Peltier et al., 2018 and Byun et al., 2019*) The increase in rainfall through the century also correlates to a predicted

increase in streamflow runoff. (*Byun et al., 2019*) Notably, the USGS analyzed the period between 1960 and 2015 and found that, over the 55-year period, there was a statistically significant upwards trend in precipitation for the Lake Michigan Subbasin. (*Norton et al., 2019*)

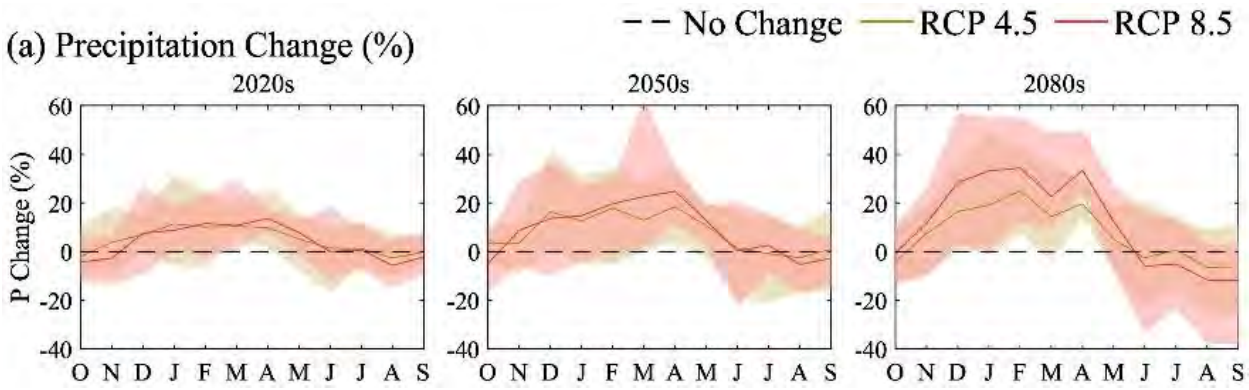

Figure 70. Predicted changes in precipitation over the next century for RCP 4.5 & 8.5 scenarios (Courtesy of Byun et al., 2019)

Temperature

Temperature rises are predicted due to climate change. Jabbari et al. (2021) found that there has been a measured change in air temperature of 0.4 degrees Celsius per decade. This has directly resulted in the loss of ice cover on all great lakes. (*Mason et al., 2016*) The effects of Great Lakes ice coverage loss are discussed further when looking at wind pattern changes. Notably, the area of Lake Michigan that is experiencing the fastest surface water temperature increases are directly surrounding the Manitou islands. (*Mason et al., 2016*)

Wind Intensity & Direction

Predicted changes in wind patterns are conflicting and contradictory. It does appear that some of these contradictions arise from different elevations for wind measurements. Notably, Li et al (2010) used wind data at 80 meters, Waples and Klump (2002) used lake level (buoy) data, and Jabbari et al. (2021) and Yurk & Hansen (2021) used wind data at 10 meters. Paired with this, it is unclear whether all of the articles included land-based weather data or if some used just buoy data.

When looking at historical data, it has been observed that wave power, and thus wind power, has increased over the period of 1980 – 2020, with an average observed increase in wind speed of 0.3 to 0.5 m/s per decade for winds out of the south and southwest. (*Jabbari et al., 2021*) However, contrary to this, Yurk & Hansen (2021) found a “progressive decrease in wind speeds” (Pg 1515) across the Lake Michigan region. My understanding is that this discrepancy is due to Jabbari et al. (2021) looking at over lake winds while Yurk & Hansen (2021) looks at over land and over lake winds. This makes a difference since decreasing ice coverage in the lakes is leading to a longer period of the year for wind to affect wave power. (*Mason et al., 2016*)

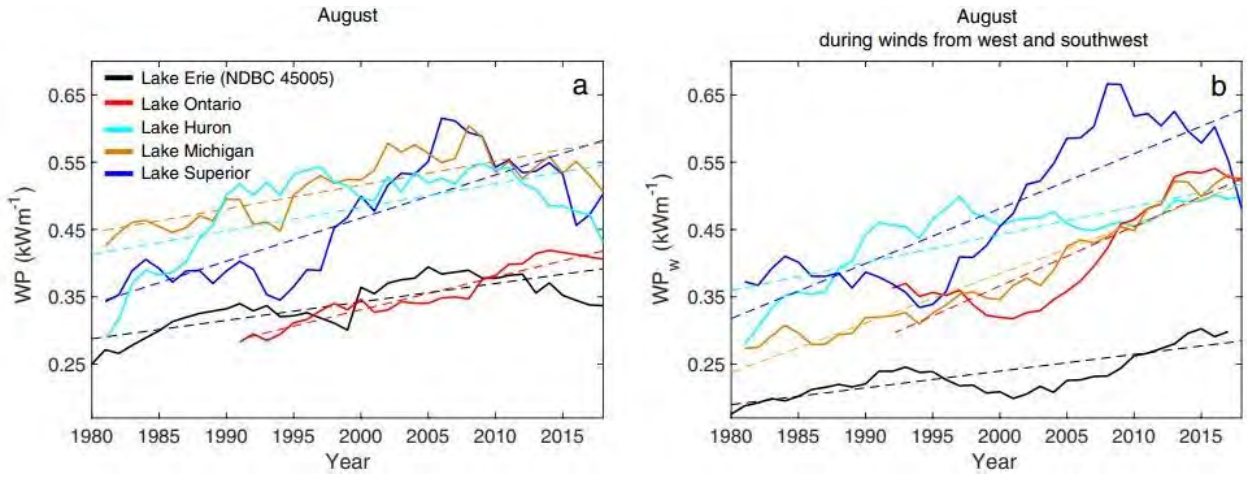

Figure 71. Measured wave power for each Great Lake and trendline of the measurements (Courtesy of Jabbari et al., 2021)

Regarding prevailing winds, Waples and Klump (2002) found that, over the period of record between 1981 and 1999, prevailing wind directions over the great lakes have shifted counterclockwise. However, when looking at significant winds, those that can cause sediment transport, over the period of 1948 to 2017, the winds appear to oscillate with longer term trends, remaining relatively consistent. (*Yurk & Hansen, 2021*)

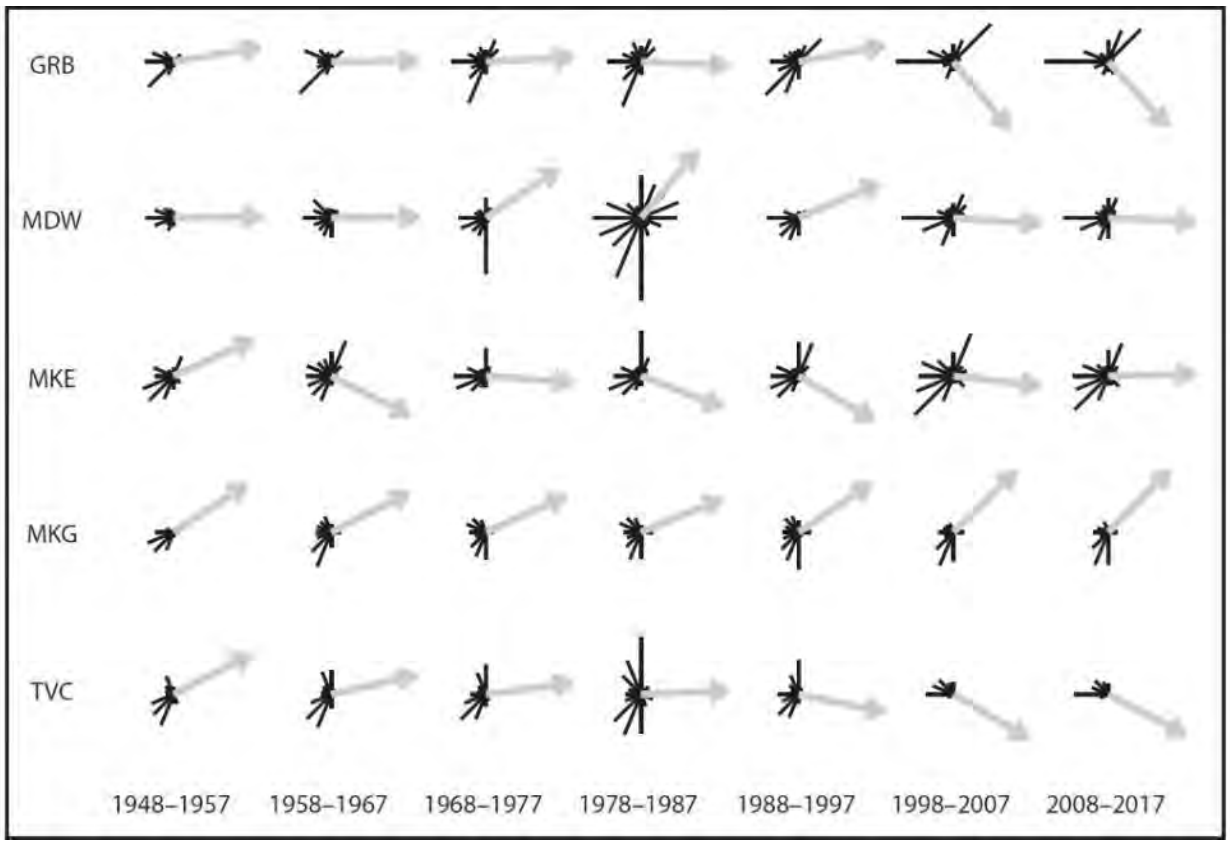

Figure 72. Decadal wind rose diagrams for various measurement sites around Lake Michigan (Courtesy of Yurk & Hansen, 2021)

Conclusion

Climate change will affect the Manitou Islands, and the Great Lake more broadly. Average lake levels will likely rise, though it will be a minor rise relative to the increase in interannual water level variation, which will increase from the current 1.2 meters of maximum variation to nearly 2.5 meters of maximum variation in lake levels. Precipitation will nominally increase, though this is due to a large increase in rain in the winter months and a mild drop in rain during the summer months, which will lead to an increased likelihood of summer droughts. Increasing temperatures, which will be ~3°C by the end of the century with current policies, will lead to warmer lakes, less ice, and a longer storm season each year. Wind patterns are likely to remain constant, oscillating on a multi-decadal cycle. However, wind power is likely to decrease over time, leading to less powerful average winds with more powerful storm winds.

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Appendix C: Flood Mapping

12/19/2018 11:37 -M Z:\2021\212085 NPS VHB Facility Rehab on Manitou Islands SLBE\Coastal\3_C-D\1 - Coastal Flood Mapping -nolysis\North_South Flood

Appendix D: Spectral Wave Outputs

Site Overview – Southerly Storm

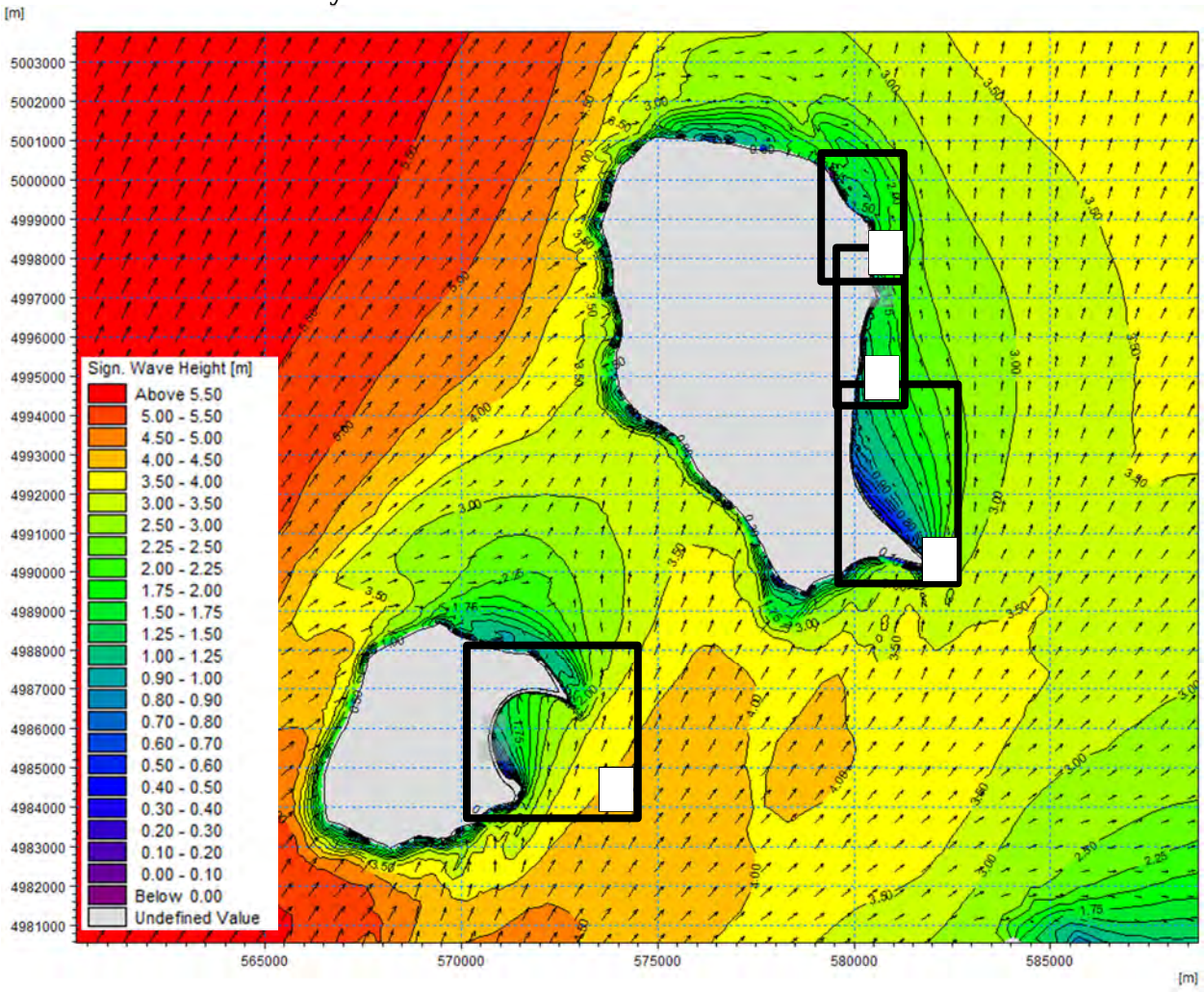

Figure 73: Offshore spectral wave results during a 50-year southerly storm

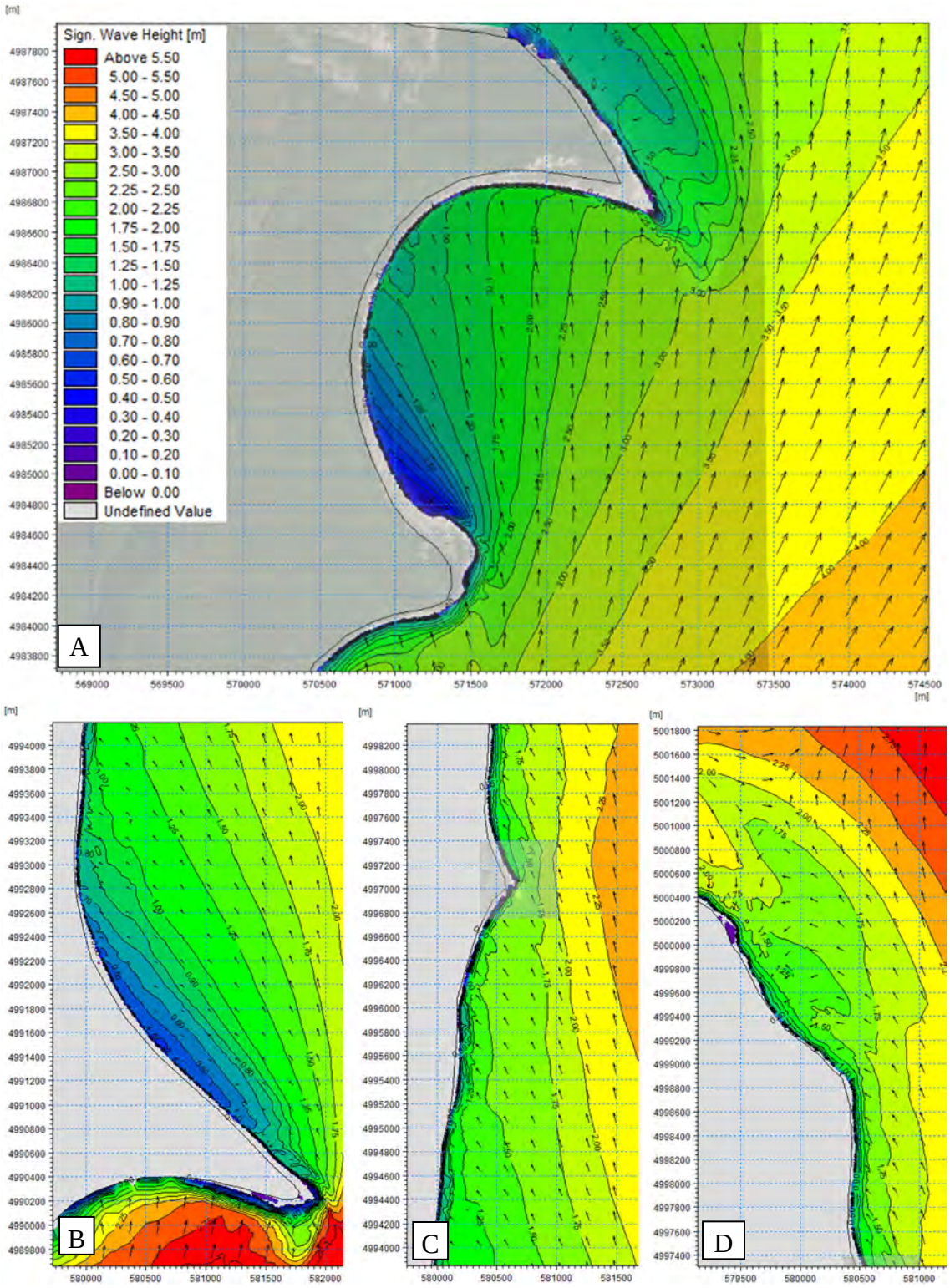

Figure 74: Nearshore significant wave heights at North and South Manitou Island during a 50-year southerly storm

Site Overview – Northly Storm

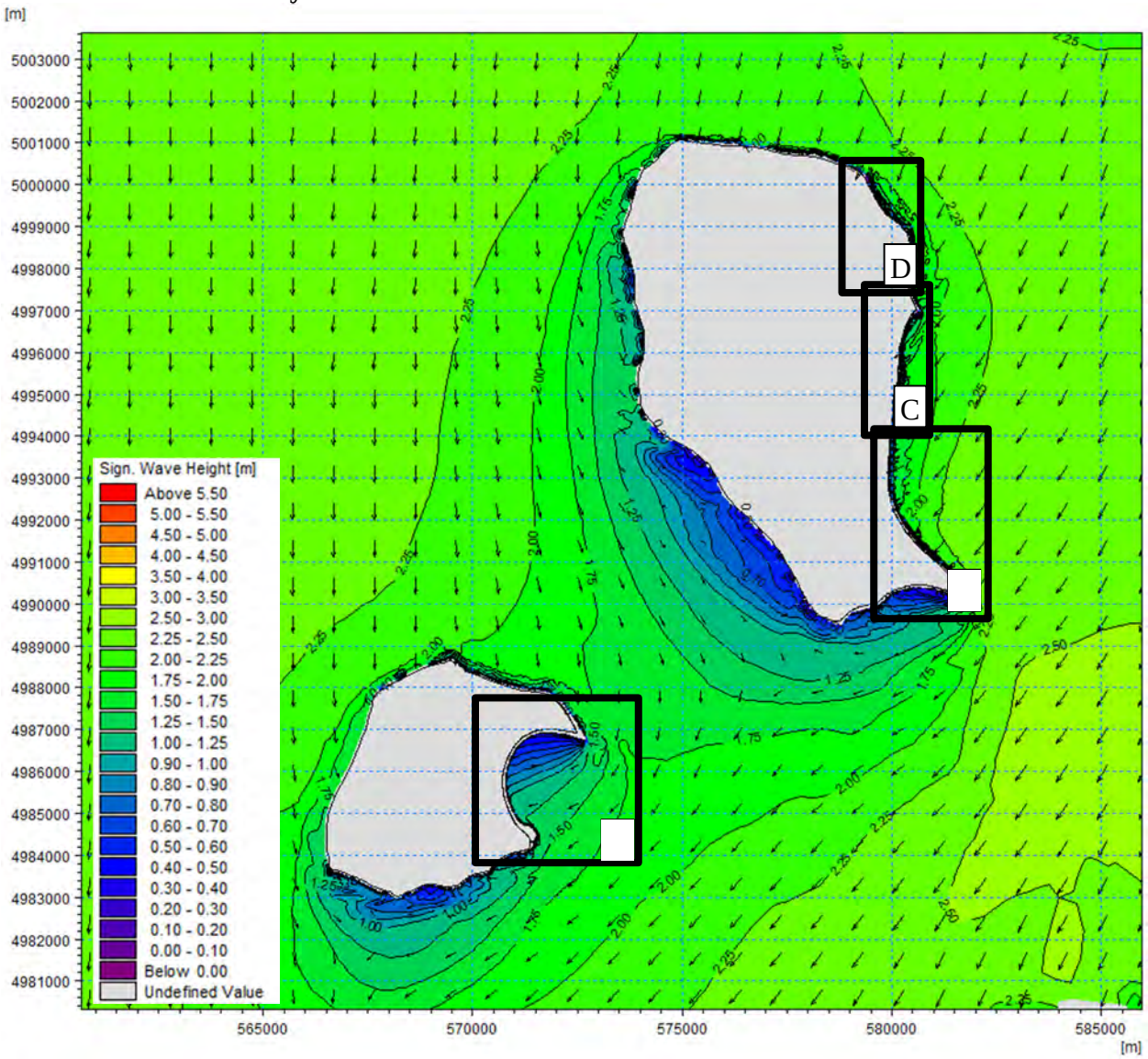

Figure 75: Offshore spectral wave results during a 50-year northerly storm

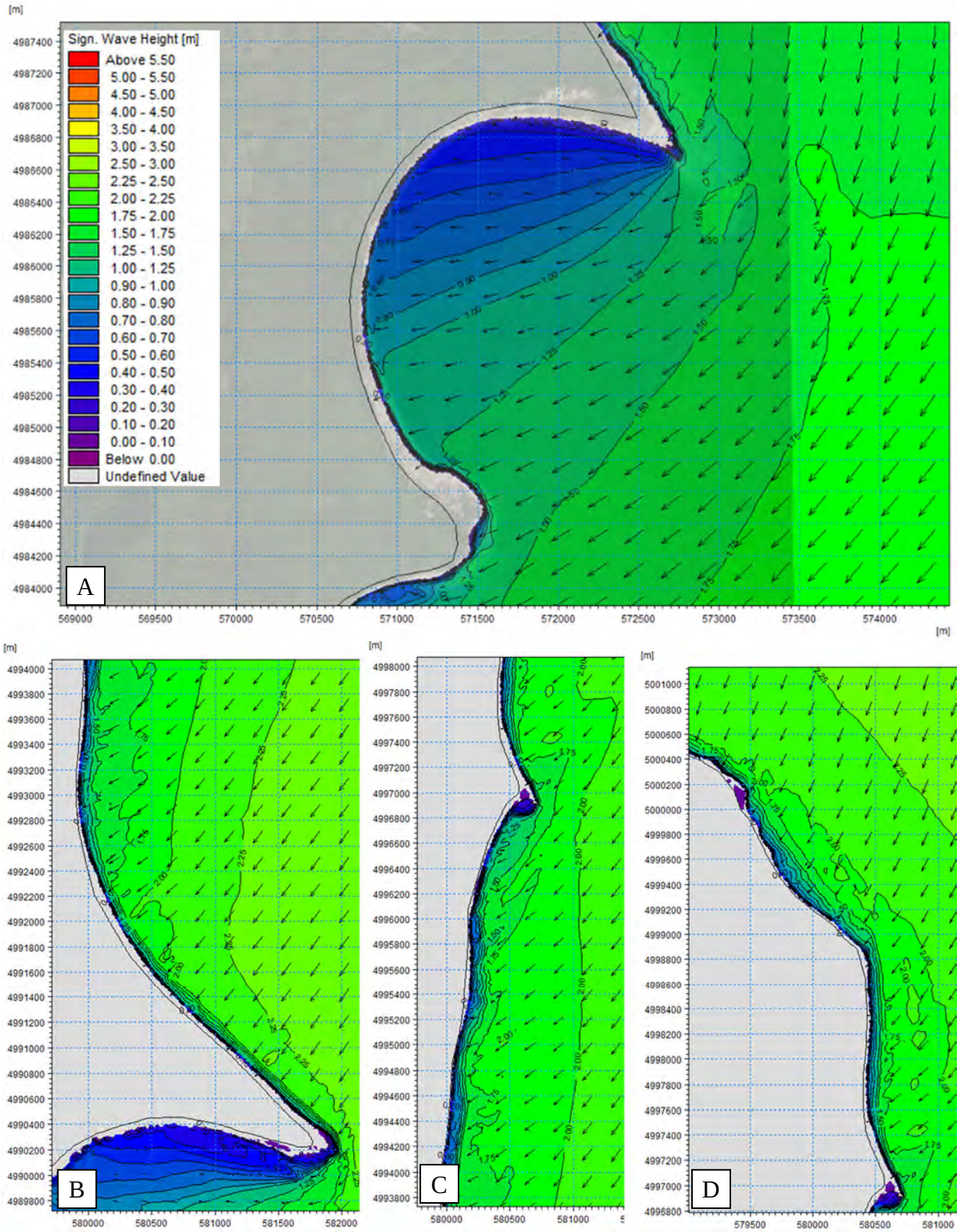

Figure 76: Nearshore Significant Wave Heights at North and South Manitou Island during a 50-year northerly storm

South Manitou (North Wind)
Design Alternative 1 – Chicago Road

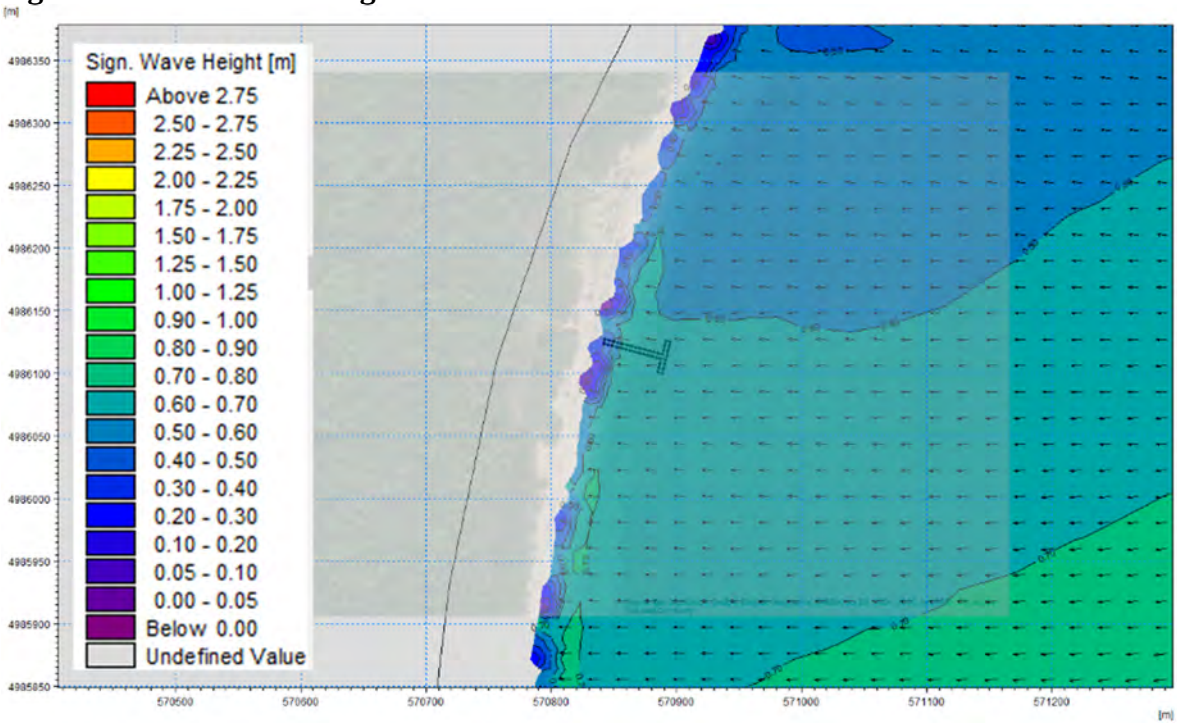

Figure 77: Design Alternative 1 at Chicago Road during a 50-year northerly storm.

Design Alternative 2 – Grand Blvd

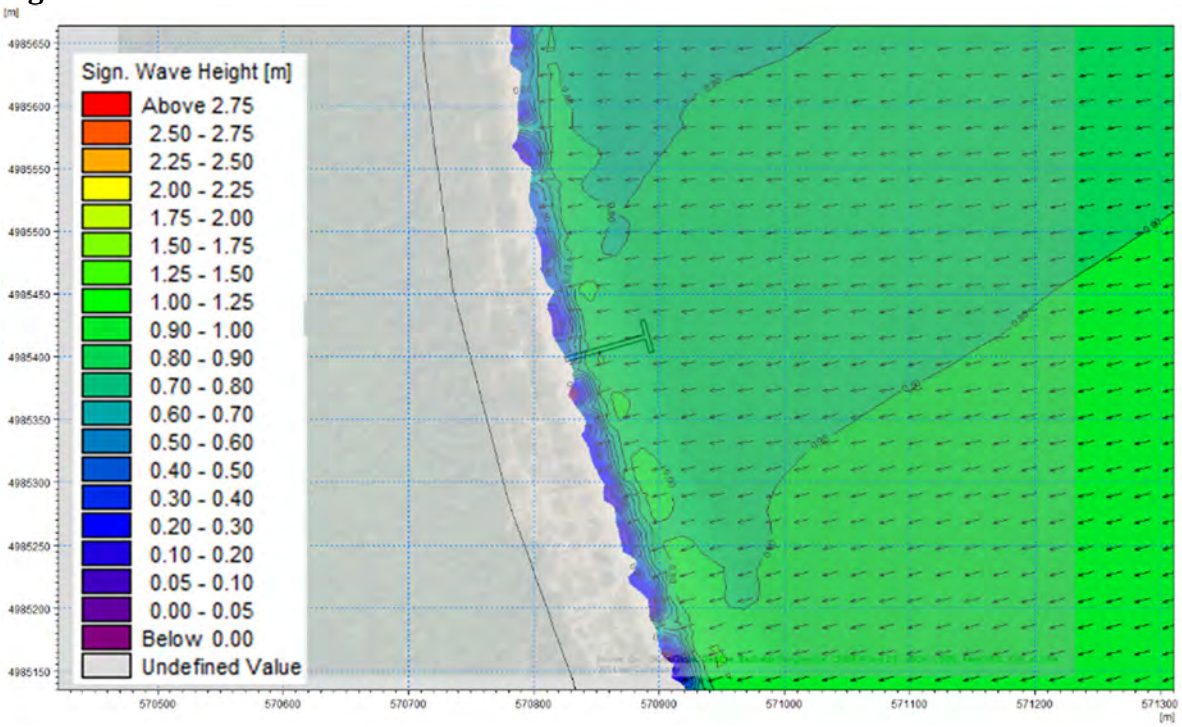

Figure 78: Design Alternative 2 at Grand Boulevard during a 50-year northerly storm.

North Manitou (North Wind)
Design Alternative 1 – Existing Dock Extension

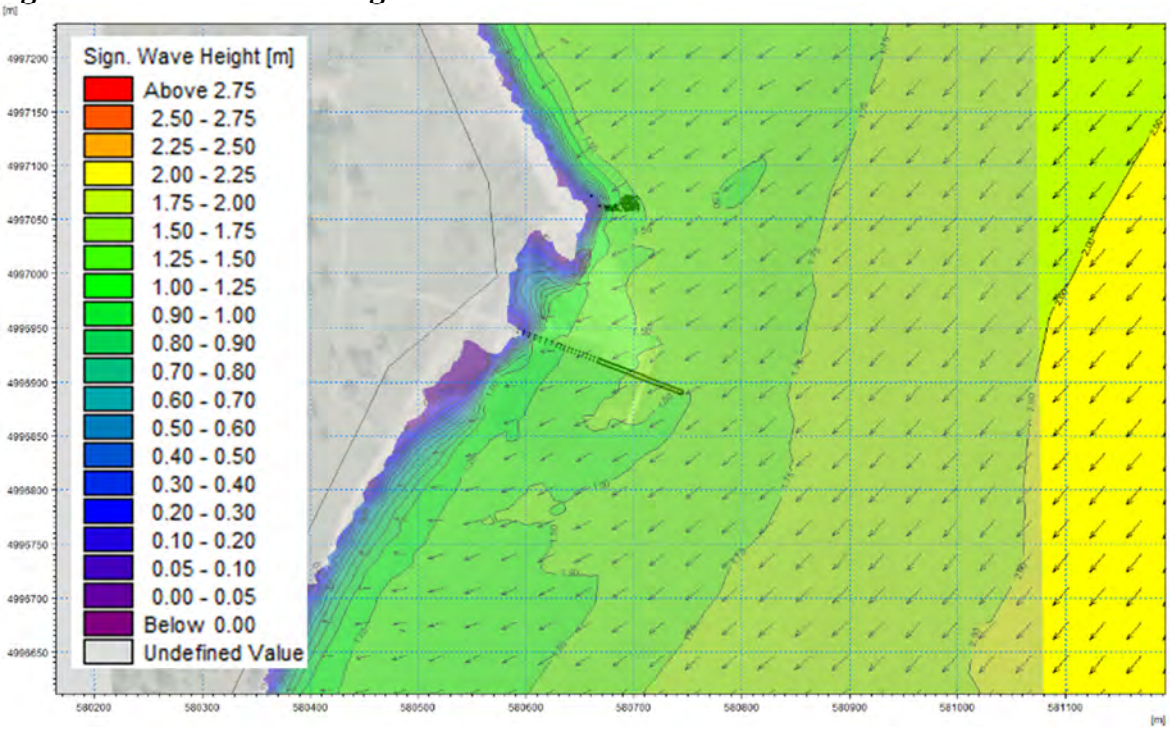

Figure 79: Design Alternative 1 at the existing dock during a 50-year northerly storm.

Design Alternative 2 – Historic Dock Location

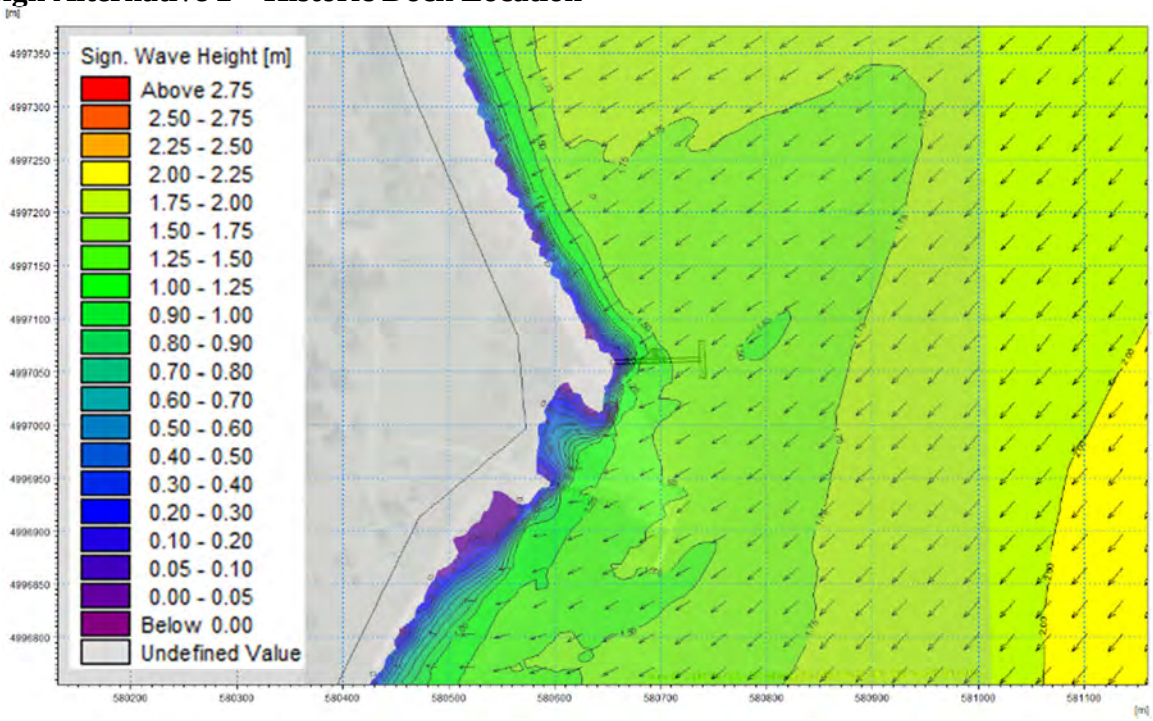

Figure 80: Design Alternative 2 at the historic dock location during a 50-year southerly storm.

APPENDIX B: SPECIES DISMISSED FROM FURTHER ANALYSIS

TABLE 1. FEDERAL AND STATE SPECIAL STATUS SPECIES DISMISSED FROM FURTHER ANALYSIS

Species Common Name	Scientific Name	Federal Status	State Status	Dismiss or Retain
Birds				
Black Tern	*Chlidonias niger*	USFWS Bird of Conservation Concern	Threatened	Dismissed due to lack of appropriate habitat in area of analysis.
Chimney Swift	*Chaetura pelagica*	USFWS Bird of Conservation Concern		Dismissed due to lack of appropriate habitat in area of analysis.
Olive-sided Flycatcher	*Contopus cooperi*	USFWS Bird of Conservation Concern		Dismissed due to lack of appropriate habitat in area of analysis.
Plants				
Spatulate moonwort	*Botrychium lunaria*		Extirpated	Dismissed due to lack of appropriate habitat in area of analysis.
Pumpelly's bromegrass	*Bromus pumpellianus*		Threatened	Dismissed due to lack of appropriate habitat in area of analysis
Pine drops	*Pterospora andromedea*		Threatened	Dismissed due to lack of appropriate habitat in area of analysis.
Walking fern	*Asplenium rhizophyllum*		Threatened	Dismissed due to lack of appropriate habitat in area of analysis.
Ginseng	*Panax ginseng*		Threatened	Dismissed due to lack of appropriate habitat in area of analysis.
Northern hollyfern	*Polystichum lonchitis*		SLBE Rare	Dismissed due to lack of appropriate habitat in area of analysis.
Michigan Monkey-Flower	*Mimulus michiganensis*	Endangered	Endangered	Dismissed due to lack of appropriate habitat in area of analysis.
Reptiles				
Eastern Massasauga	*Sistrurus catenatus*	Threatened	Threatened	Dismissed due to lack of appropriate habitat in area of analysis.

As the nation's principal conservation agency, the Department of the Interior has responsibilities for most of our nationally owned public lands and natural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historic places, and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people. The department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

April 2024