

CHAPTER 2 The Alternatives

INTRODUCTION

In general, the shoreline at Indiana Dunes National Lakeshore naturally functions as a dynamically stable environment. A dynamically stable shoreline is one that has experienced either minor or no positioning changes over a long period of time (i.e., 50 years or greater). Wave action maintains the beach profile by supplying and collecting sediment along the shoreline. Wind action and major storm events work in conjunction with lake processes to create the dune complex. As dunal succession is wind driven, the presence or absence of vegetation on the dune face can influence the speed at which the dunes move. Vegetation established on a dune reduces the amount of sediment blown away by wind action, thus slowing down the movement of the dune. With the introduction of urban development along the lakeshore came disruptions to the intricate coastal processes of Lake Michigan's southern shoreline. This *Shoreline Restoration and Management Plan / Draft Environmental Impact Statement (EIS)* addresses the restoration of certain natural processes within the context of a modified system. The proposed alternatives represent the range of possible actions the park is considering, consistent with NPS policy, Indiana Dunes National Lakeshore's purpose, and the interest of the public. The alternatives have been designed to be implemented at specific areas of the shoreline during approximately the next 20 years. Full implementation would require cooperation and coordination between local, state, and federal agencies. In addition, the plan anticipates that these alternative actions would be implemented in all reaches of the project area at the same time, rather than only in one reach at one time.

As discussed in detail below, alternative A is a continuation of current management practices and is included as the baseline for comparing the consequences of each alternative. Alternatives B through D represent variations of beach nourishment activities. Alternatives B-1 and B-5 include beach nourishment using

material trucked to the shoreline from an upland source in one- and five-year frequencies, respectively. Beach nourishment via dredged materials in one- and five-year frequencies is proposed under alternatives C-1 and C-5, respectively. Alternative D outlines nourishment activities achieved through a permanent bypass system. Finally, the use of a submerged cobble berm in conjunction with annual nourishment is discussed under alternative E.

It is important to include terrestrial management practices when discussing shoreline restoration alternatives, as terrestrial and aquatic habitats are directly affected by similar processes. For example, dune-stabilizing vegetation historically present along the beach has been trampled, thus disrupting the delicate balance of dune formation processes. As the park is a popular destination for millions of people, the impacts of human actions on the natural resources of the park are ever present. The purpose of terrestrial management actions in the park is resource protection. Actions that could introduce invasive species are constantly present as visitors arrive by foot, in vehicles, and by train, and bring pets and materials into the park, there is a risk of introducing nonnative invasive plant seeds. Habitat for endangered, threatened, and species of concern becomes more at risk as recreational uses of the park for activities such as hiking, cross-country skiing, snowshoeing, and horseback riding have extended farther into the fall and winter seasons.

PROJECT AREA DEFINITION

For the purpose of this plan / draft EIS, the shoreline has been divided into four reaches based on sediment accretion and erosion rates of the shoreline. The project area consists of reaches 1 through 4, numbered in an east-to-west direction. The shoreline within the park is not contiguous, but rather is interrupted by industrial and other properties. These reaches include industrial and navigational structures, as well as portions of the shoreline armored with revetment walls and other hardened structures. The alternatives developed for this plan were developed to benefit the entire shoreline as opposed to a single land owner. As depicted on Figure 2-1: Shoreline Reaches, the designated reaches encompass the following shoreline areas:

- reach 1, Crescent Dune to the east end of Lake Front Drive
- reach 2, east end of Lake Front Drive to Willow Lane
- reach 3, Willow Lane to Beach Lane
- reach 4, Beach Lane to the Gary-U.S. Steel East Breakwater

The direction of net transport of sediment moving along the park shoreline is from east-to-west. There are three primary man-made structures in and around the project area that constitute barriers to littoral drift and affect the park. These structures are federal and industrial harbors that impact the natural sediment transport by disrupting the natural sediment flow and generally result in accretion to the east (updrift) and erosion to the west (downdrift).

The three harbors adjacent to, and within, the project area are:

- to the east, the Michigan City Harbor (initial construction in 1834, harbor completed in the early 1900s)
- the Port of Indiana industrial complex (constructed in the late 1960s)

- to the west, the Gary-U.S. Steel Harbor (constructed in the early 1900s)

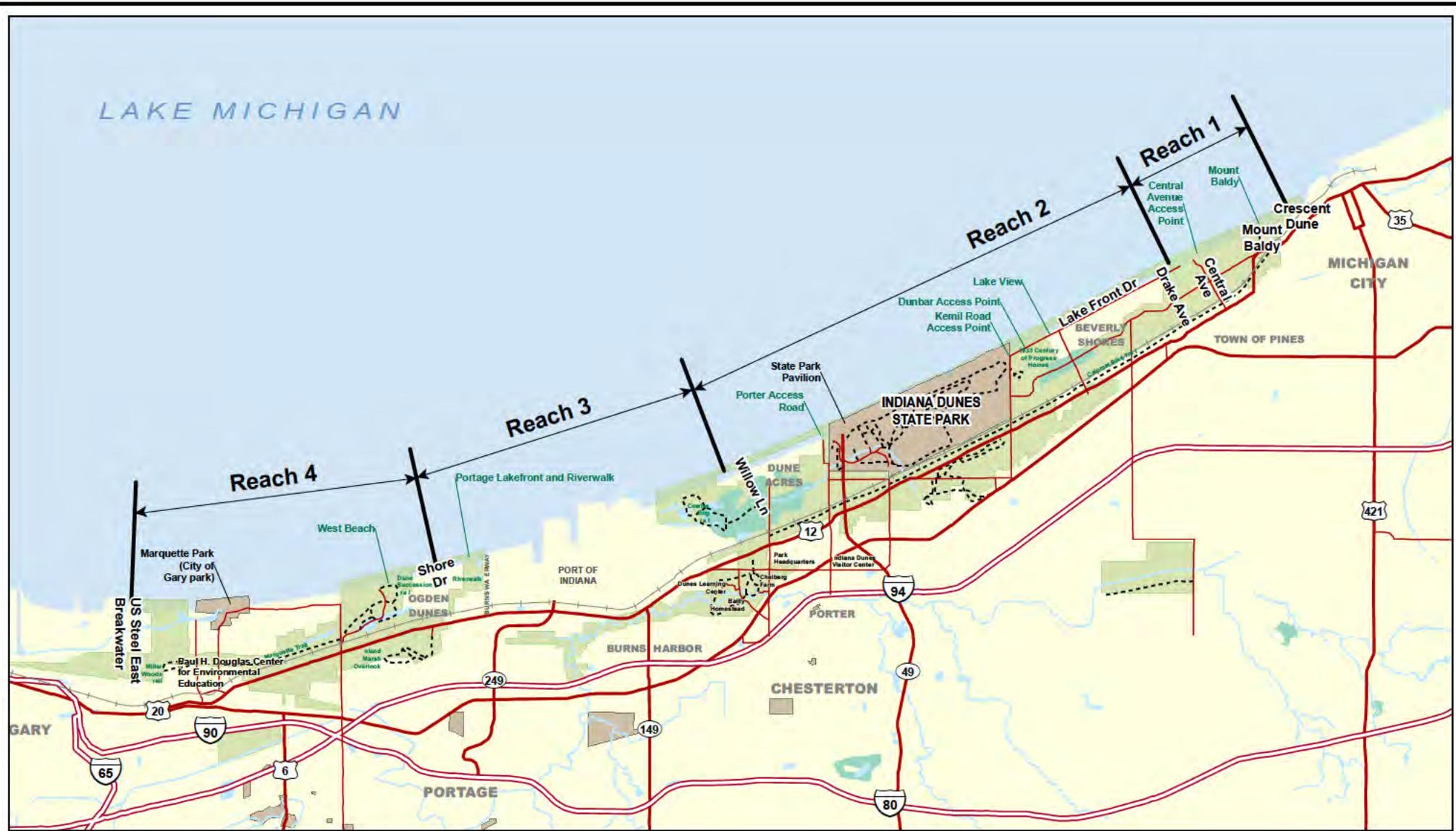
The preliminary analysis to estimate the total volume of sediment trapped by development was based on detailed aerial photographs from representative pre-harbor conditions to present. In addition, the analysis considered quantities dredged and the volume of sediment bypassing the shoreline because of the harbor structures to calculate (for reach 1) and estimate (for reach 3) sediment volume trapped. Based on preliminary calculations, the total quantities of accreted sediment (from pre-harbor conditions to present) on the east adjacent to the harbors are:

- Michigan City Harbor has approximately 28.2 million cubic meters (m^3) (36.8 million cubic yard [yds^3]) of accreted sediment. This quantity does not include the volume of sediment dredged in the navigation channel and artificially bypassed.
- Port of Indiana industrial complex has approximately 3.5 million m^3 (4.6 million yds^3) of accreted sediment. This quantity does not include sediment dredged and artificially bypassed, which totals 1.7 million m^3 (2.2 million yds^3).
- Gary-U.S. Steel has approximately 2.2 million m^3 (2.9 million yds^3) of accreted sediment. This quantity is based on the current shoreline orientation defined by the confined disposal facility constructed post-1950.

The restoration alternatives set forth are particularly relevant to reaches 1 and 3 along the park shoreline (see Figure 2-1: Shoreline Reaches). Reach 1, located at the easternmost end of the park shoreline, is an actively eroding area, particularly at the base of Mount Baldy. As the natural net sediment transport extends from east-to-west in the project area,

the Michigan City Harbor structure updrift of the project area interrupts the littoral drift, creating an accreting beach fillet on the east side of the harbor, and erosion within the area of Mount Baldy (which is downdrift). Reach 3 denotes the stretch of shoreline in the central portion of the project area and includes a shipping harbor (Port of Indiana industrial complex). Harbor structures associated with this property extend into Lake Michigan, creating a sediment accretion area to the east, and an erosion area at Portage Lakefront and Riverwalk. Each of these areas exhibit the

extreme effects of interruption to the littoral drift along the park shoreline; therefore, it is important to focus restoration efforts in these areas, provide beach nourishment material, and provide conditions for distribution of the nourishment material via natural lake processes to the extent possible. This plan assumes that these restoration efforts would be implemented in both reaches 1 and 3 at the same time in order to best mimic natural dynamics.



- Legend**
- Indiana Dunes National Lakeshore
 - State and Local Parkland

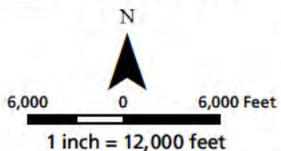


FIGURE 2-1
SHORELINE REACHES
 Indiana Dunes National Lakeshore
 Shoreline Restoration and Management
 Plan / Environmental Impact Statement
 National Park Service / U.S. Department of the Interior
 March 2012

ALTERNATIVES DEVELOPMENT PROCESS

TECHNICAL ANALYSIS

In September and October 2010 NPS park staff and consultant engineers and scientists observed and documented the existing shoreline conditions. Photographs and limited measurements were taken. In addition, a review of various reports and other documents, focused on local conditions of Lake Michigan's southern shoreline, was conducted to gather information on coastal processes, shoreline evolution, sediment sampling and analysis, dredging, and beach nourishment history. Additional information regarding this literature review is provided in Appendix C: Technical References.

The technical analyses completed for the project area are described below.

Shoreline Evolution

Analysis of the shoreline from 1951–1952 to 2010 was conducted to quantify long-term changes in shoreline position as depicted on Figure 2-2: Shoreline Comparison. The 1950 aerial year was chosen as representative of the pre-harbor conditions and represents the baseline shoreline “natural” conditions. This analysis considered the dredging and beach nourishment events in the project area that took place during this timeframe. The shoreline initially was divided into reaches based on areas of general accretion, erosion, and dynamically stable areas. The long-term highest erosion rates along the lakeshore were calculated at Mount Baldy (4.5 feet per year [ft./yr.]), and at Portage Lakefront and Riverwalk (2.7 ft./yr.). The highest accretion rates were identified at the Port of Indiana Industrial Complex East Fillet Beach (7.6 ft./yr.), and at the Gary-U.S. Steel Harbor East Fillet Beach (5.1 ft./yr.). These areas are depicted in Figure 2-3: Shoreline Erosion and Accretion Zones. Additional detailed information is provided in Appendix C: Technical References.

Water Level and Wave Climate

A probability analysis of recorded water levels and computer modeling of the Lake Michigan wave climate was conducted. This analysis provided conceptual designs for beach fill slope and extents, cobble sizes, and water depths for placement. The stability of both beach nourishment and submerged cobble berms would be directly affected over the plan's life by the water levels and storm events. The 100-year storm event was selected as the design condition for the shoreline improvements for a lake level of 584.7 feet (International Great Lakes Datum IGLD85). Wave height is controlled by water depth. Consequently, the 100-year storm event is directly related to extreme water levels. A maximum wave height of 10.7 feet at a reference 6-foot water depth contour at the base elevation, or low water datum, was calculated resulting in a total water depth of 13.2 feet. In other words, if a cobble berm retaining beach sediment is designed in a water depth of 6 feet of water the structure slope would be sized to withstand a 10.7-foot wave.

Longshore Sediment Transport

Waves breaking along the shoreline and the wave-induced currents generate movement of beach sediment known as longshore transport or littoral transport. The volume of sediment moved along the shoreline is referred to as littoral drift and is expressed in yds³ per year. Longshore sediment transport primarily consists of sediment movement suspended within the water column. Based on the variability of wind and wave directions sediment transport is often reported as a net volume indicating the sum of all transport to the east and west. Longshore transport can be interrupted by coastal structures extending into the lake which can block sediment transport.

A two-dimensional numerical model (COSMOS) was used to calculate sediment transport rates along the shoreline at selected intervals of 1.25 miles for current and historic pre-harbor conditions. The beach profiles extended out to a depth of approximately 15 meters (or approximately 49 feet) below chart datum (the lowest astronomically predictable tide level). It was determined that the net longshore sediment transport gradually decreases from New Buffalo (200,000 yds³ updrift of Michigan City) east to the Port of Indiana industrial complex. The longshore sediment transport rate is estimated at less than 30,000 yds³ per year near the Gary-U.S. Steel Harbor.

Sediment Budget at Mount Baldy

This analysis used the findings of a previous investigation performed for the Michigan City area (Baird 2004). A hydrodynamic and sediment transport analysis was completed to improve the understanding of the hydrodynamics at the Michigan City Harbor, patterns of sediment transport, bypassing rates around the harbor structures, and the role the Michigan City Harbor plays on the Mount Baldy sediment budget. A two-dimensional hydrodynamic and sediment transport model (HYDROSED) was applied to the analysis of the existing wave conditions, nearshore currents, and sediment transport rates at Michigan City. The model was then used to quantify the sedimentation and bypassing rates in the area. With the combined results of the COSMOS and HYDROSED modeling a sediment budget assessment was completed. The sediment budget accounts for all sediment sinks, sources, inputs, and outputs of sediment within a confined cell or boundary. This approach provides the framework to describe and understand long-term morphological changes, such as erosion and sedimentation rates. The annual long-term average trucked quantities of beach nourishment at Mount Baldy and quantities of Michigan City dredged and mechanically bypassed material were included in the sediment budget. It was

determined that the area around Mount Baldy has a calculated sediment budget deficit of 105,000 yds³ of sediment per year due to the sediment trapped at Michigan City.

Light Detection and Ranging (LIDAR)

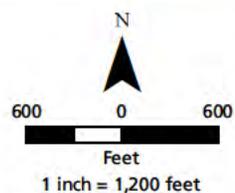
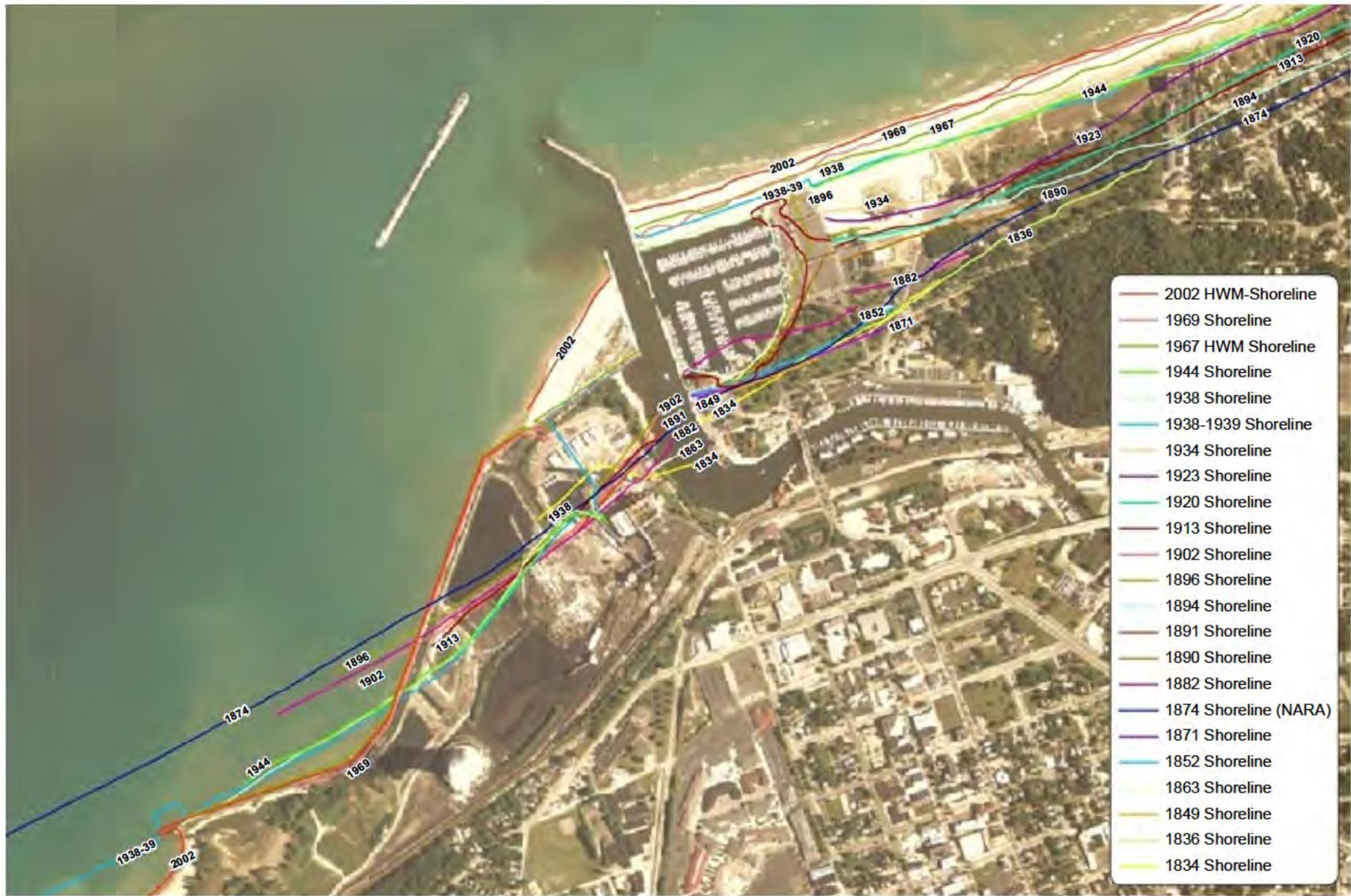
Based on the detailed LIDAR bathymetry (or underwater topography), an average nearshore slope was calculated between the 570 and 580 foot contours for the shoreline between Michigan City and the Port of Indiana industrial complex. Survey data and topographic information for reach 3 was not available, therefore a limited LIDAR data analysis was used to determine the feasibility of large-scale nourishment for reach 3.

FORMULATION OF THE ALTERNATIVES

The alternatives, developed as a result of the technical analysis, focus on what restoration metrics or desired conditions should be achieved. Alternatives for managing Indiana Dunes National Lakeshore were developed by identifying different ways to address the planning issues identified in the “Purpose and Need for Action” chapter in context with the park’s purpose and significance. In developing this range of alternatives the National Park Service carefully considered the park’s purpose and significance while adhering to the park’s enabling legislation.

NEEDED FUTURE STUDIES AND PLANS

Once this plan is completed, many of the nourishment activities proposed under the alternatives could be implemented without further compliance or study. Other more detailed studies and plans would be needed before some specific actions could be implemented, including design specifications. These additional plans and studies would include an in-depth analysis of potential impacts, such as the impacts of the submerged



Airphoto: 2003 (summer)
 Spatial Reference UTM zone 16

FIGURE 2-2
SHORELINE COMPARISON
 Indiana Dunes National Lakeshore
 Shoreline Restoration and Management
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 March 2012

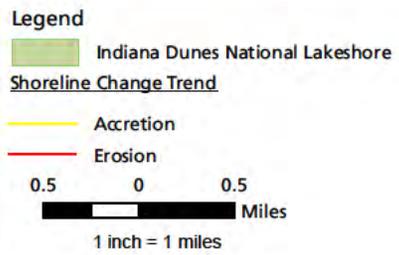
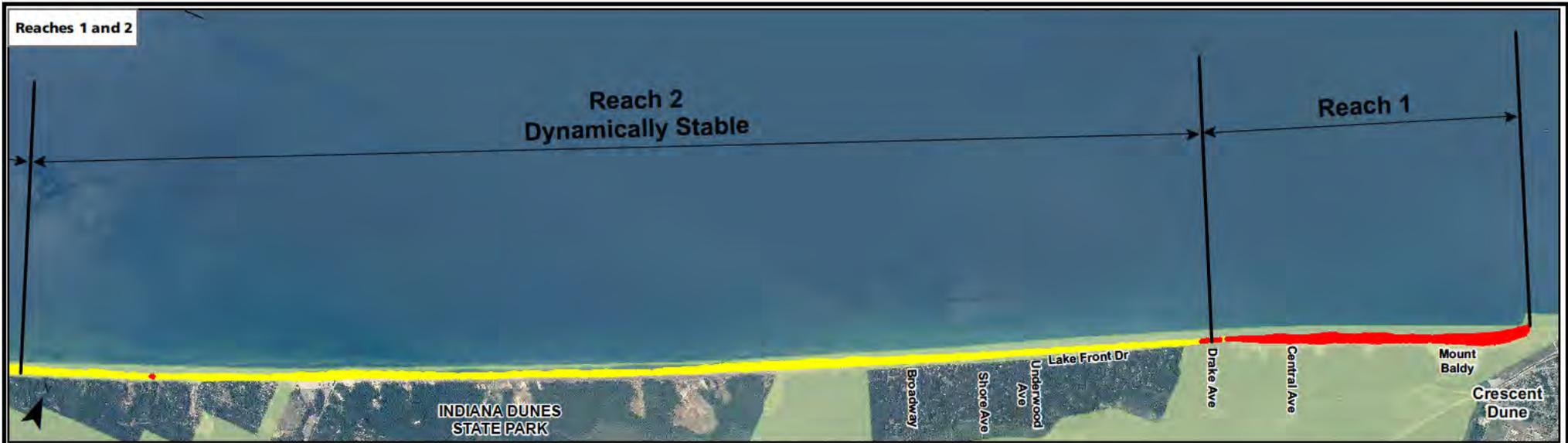


FIGURE 2-3
SHORELINE EROSION AND ACCRETION ZONES
 Indiana Dunes National Lakeshore
 Shoreline Restoration and Management
 Plan / Environmental Impact Statement
 National Park Service / U.S. Department of the Interior
 March 2012

cobble berm proposed under alternative E for reach 1. Additional environmental compliance (National Environmental Policy Act of 1969, as amended [NEPA], National Historic Preservation Act, as amended [NHPA], and other relevant laws and policies) and public involvement would also be conducted, as required.

CHOOSING BY ADVANTAGE PROCESS

Selection of the NPS preferred alternative involved evaluating the alternatives using an objective analysis process called Choosing by Advantages. This process included a three-day workshop in which 17 participants including a representative from the Chicago District U.S. Army Corps of Engineers (COE), consultant engineers and scientists, and NPS park staff representing a variety of divisions within the National Park Service, worked together to identify the preferred alternative. Through this process the planning team identified and compared the relative advantages of each alternative according to a set of factors. These factors were selected based on the key differences or decision points for each alternative in relation to fulfilling the purpose of the plan, while addressing the planning issues identified in the “Purpose and Need for Action” chapter. These factors included the following:

- factor 1 – addresses attributes of beach nourishment
- factor 2 – provides for protection of eroding areas
- factor 3 – provides for promoting foredune development
- factor 4 – provides habitat opportunities for desired native species
- factor 5 – discourages establishment of nonnative/invasive species
- factor 6 – maintains and enhances the shoreline’s recreation beach
- factor 7 – provides for restoration of the shoreline to a condition that mimics natural conditions

In addition to the factors identified above the planning team identified the following assumptions regarding the alternatives evaluated:

- the nourishment material would meet NPS requirements to the extent possible
- work would be scheduled to minimize impacts on visitors and park resources
- the proposed plan would be the beginning of a longer term process to return Indiana Dunes National Lakeshore to its natural condition as described in the “Proposed Plan for Implementation” section
- appropriate safety measures for the beach nourishment activities and work site(s) would be articulated in required permits

Decisions made during the Choosing by Advantages process were based on the importance of advantages between the alternatives. This involved identifying the attributes or characteristics of each alternative relative to the factors described above, determining the advantages for each alternative for each factor, and then assessing the importance of each advantage. The relationship between the advantages and costs of each alternative were also considered. This information was used to identify the alternative that provides the National Park Service and the public the greatest advantage for the most reasonable cost.

The results of the Choosing by Advantages process identified alternatives that provide the best combination of strategies to protect the park’s unique resources and visitor experience while improving the park’s operational sustainability within each reach. These alternatives also offer advantages to the neighboring communities. Overall, the preferred alternatives provide the National Park Service with the greatest overall benefits for each identified factor at the most reasonable cost.

SELECTION OF ALTERNATIVES FOR IMPLEMENTATION

Nourishment is the single-most important feature of this plan to restore a more natural sediment transport regime. The planning team considered that the two most likely sources for sediment that would reasonably be available for nourishment activities were upland sources and dredged sources. In terms of the action alternatives needed to address the deficit of sediment in the sediment transport regime, the sediments used for nourishment of the shoreline are required to match the conditions of the existing beach. These alternatives describe ideal conditions where the correct mix of sediment can be found from a single source to match existing beach conditions. In reality, there would be a need to mix sediment sources to achieve the correct sediment composition. This means that, should it become necessary to mix nourishment sources (upland and dredged) to meet the desired beach conditions, the National Park Service would do so without further analysis.

In identifying the preferred alternative for reaches 1 and 2, the one-year nourishment regime along with the submerged cobble berm was identified as providing the greatest advantage during alternative development because the berm would act both as a temporary buffer and as a means of replacing a missing component of the nearshore habitat in reach 1. The annual nourishment component of that alternative addressed the need to restore the transport of sediment. The remaining action alternatives analyzed within this draft EIS, each providing nourishment, were determined to perform equally in terms of providing value to the restoration process. Therefore, should it become necessary to implement the preferred alternative without the submerged cobble berm (due to the availability of funding, or should engineering the structure show that it would not work as anticipated), the National Park Service would implement the annual nourishment first, or

select one of the other nourishment strategies described in the alternatives.

In selecting the preferred alternative for reaches 3 and 4, the five-year nourishment regime provided the greatest advantage during alternative development because the five-year nourishment addressed the need to restore the transport of sediment and was the most cost efficient. The remaining action alternatives analyzed within the draft EIS provided similar advantages during alternative development with the exception of cost. Costs would initially be greater under the five-year alternative but would ultimately be lower over the life of the alternative. Therefore, should it become necessary to implement the alternate one-year action alternative (if further design analysis is required for the five-year alternative, or due to the availability of funding), the National Park Service would nourish on an annual basis either in place of, or pending the implementation of the five-year plan once design analysis and/or funding becomes available.

RESTORATION METRICS AND DESIRED CONDITIONS

The alternatives were designed to accomplish a balancing of sediment movement along the shoreline and the following:

- protect eroding areas of the shoreline
- provide habitat opportunities
- allow for natural processes to continue
- restore the shoreline in a cost-effective manner

To determine if the goals of the plan have been achieved, the NPS identified desired conditions. The desired conditions articulate the ideal conditions the National Park Service is striving to attain. Table 2-1: Desired Conditions, presents the restoration desired condition by resource for this plan.

TABLE 2-1: DESIRED CONDITIONS

Resource	Desired Conditions
Sediment Transport Process	Sediment supply would be increased to a quantity that would fulfill the calculated/estimated sediment budget deficit. This process would be implemented in a manner that mimics natural processes to the greatest extent possible. Sediment transport is important for the sustainability of the shoreline, foredunes and dunes. The long-term erosion of the shoreline's current profile would be prevented.
Dune Formation	Sediment supply would be sufficient for foredune creation along the Indiana Dunes National Lakeshore. The additional sediment placed on the beach would allow wind action to deposit material on the beach, creating foredunes.
Aquatic Fauna	The National Park Service <i>Management Policies 2006</i> requires that the natural resources within the park be managed to a high degree of ecological integrity. Actions taken to improve sediment transport along the shoreline would encourage desired native species to establish in the nearshore environment in healthy populations. An increase in the nonnative species populations relative to current assemblages would result in the need for corrective actions to be taken.
Terrestrial Habitat	A biologically diverse terrestrial vegetation community is a natural resource of vital importance to Indiana Dunes National Lakeshore. Several sensitive habitats within the project area include rare plant varieties. Native species would establish in communities, and would be enjoyed by the public without being disturbed or damaged such as by trampling. An increase in the nonnative species populations relative to current quantities would result in the need for corrective actions to be taken.
Threatened and Endangered Species and Species of Concern	Indiana Dunes National Lakeshore is home to several threatened and endangered species and species of concern. It is the policy of the National Park Service to protect threatened and endangered species and species of concern, to reduce the risk of injury or harm to habitats colonized by these species, and to provide suitable habitat and refugia. There would be a continued presence and establishment of threatened and endangered species and species of concern within the park. By reclaiming and providing habitat, the existence of special status species within the park would be enhanced.
Wetlands and Pannes	The wetlands and pannes in the park are rare habitats characterized by a high floristic quality that would be maintained and protected. Continued inventory of wetlands and pannes within the project area would allow park managers to determine to what extent these habitats are being protected. Threats to wetlands and pannes would be identified and effectively managed to encourage the establishment of native species.
Soundscape	Natural soundscapes would be preserved and noise of the surrounding urban development would be minimized to the extent practicable. Many areas along the shoreline of Indiana Dunes National Lakeshore provide an opportunity to experience the park with less prevalent industrial and vehicular sounds. Management measures would be implemented to ensure that the desired soundscape is maintained to the greatest extent possible.

Resource	Desired Conditions
Visitor Experience	<p>Visitors could experience park opportunities consistent with the purpose and significance of Indiana Dunes National Lakeshore. Visitor experience would include the education that provides for optimal visitor enjoyment while protecting the natural resources of the park. Visitors would actively contribute to the betterment of shoreline health through appropriate use and behavior. The public would be educated in the reasons for use management to encourage stewardship. The visual quality of the natural viewshed and landscapes would provide park visitors with an immediate and lasting experience that conveys the character of Indiana Dunes National Lakeshore. Key vistas would be identified and preserved.</p>

APPROACHES TO ADAPTIVE MANAGEMENT

Adaptive management is a decision process that promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. It involves monitoring practices to determine if they are meeting the set objectives, and facilitating changes to the management practices, if needed, to ensure the objectives are met. Adaptive management is based on the premise that managed ecosystems are complex and unpredictable, and therefore cannot be effectively managed within a rigid management context.

The process of adaptive management is vital for the success of this plan. Each of the alternatives for the shoreline and beach complex and the proposed actions for the foredune and dune complex employ an adaptive management element involving monitoring and evaluation. This means that although each alternative includes estimates as to the effectiveness of the restoration actions ultimately some of those actions could be modified over time as knowledge is gained through implementation. For example, the proposed beach nourishment program would be evaluated to determine its effectiveness over the course of the plan's life. Monitoring of the shoreline profile and nearshore habitats would be conducted to ensure that park resources were not negatively impacted by the implementation of an alternative.

MITIGATION MEASURES COMMON TO ALL ACTION ALTERNATIVES

National Park Service staff routinely evaluate and implement mitigation measures when conditions occur that would adversely affect the sustainability of NPS resources. Mitigation measures are the practicable and appropriate approaches that would be used under the action alternatives to avoid and/or minimize harm to park natural and cultural resources and visitor experience.

Within the context of this plan the mitigation measures described below would be used to avoid or minimize potential impacts from the implementation of the action alternatives. These measures would be applied to all of the action alternatives. Additional mitigation would be identified as part of implementation planning and for individual projects to further minimize impacts to park resources.

- During implementation of this plan NPS natural resource staff would identify areas to be avoided.
- Fencing or other means would be used to protect sensitive resources adjacent to nourishment activity areas.
- Nourishment activities would be monitored by resource specialists, as needed.
- Construction materials would be kept in work areas, especially if the work takes place near water bodies.
- Best management practices would be employed to reduce the introduction of invasive species during construction work and other soil-disturbing activities.
- Food-related items or rubbish brought into the park would be removed.

MINED NOURISHMENT MATERIAL

Nourishment material used during the implementation of the proposed restoration alternatives would be similar to the existing beach material to mimic natural processes. Selection and assessment of mine site material would be conducted prior to placement of the material. Mine site material would be similar in grain size distribution to the native beach material. The chemistry of sediment at the mine site would closely match that of the natural beach sediment and would be low in pollutants, silts, and clays.

NATURAL RESOURCES

General

Indiana Dunes National Lakeshore's resources, including air, water, soils, vegetation, and wildlife, would be inventoried and monitored as appropriate to provide information needed to avoid or minimize impacts of future work in the park.

Air Quality

- Measures to manage dust during beach nourishment would be implemented and would include the following: stabilize soils with water, minimize vegetation clearing, revegetate with native species, cover haul trucks, and employ speed limits on unpaved roads.
- Equipment and vehicle emissions would be minimized by limiting idling times (by either shutting equipment off when not in use or restricting the time of idling), maintaining equipment in proper working condition according to manufacturer's specifications, using the proper size of equipment for the work being performed, and training equipment operators in proper use of equipment.
- The use of equipment with new technologies (e.g., repowered engines, electric drive trains) and use of alternative fuels for generators (e.g.,

propane or solar) would be encouraged.

Soundscapes

- Sound abatement measures would be implemented. These measures could include the following: a schedule to minimize impacts in sound-sensitive areas, use of the best available sound management techniques wherever feasible, use of hydraulically or electrically powered impact tools when practicable, and placement of stationary sound sources as far from sensitive use areas as possible.
- Facilities would be located and designed to minimize objectionable noise.
- The idling of motors (e.g., power tools, equipment, vehicles, etc.) would be minimized.

Soils

The following discussion of soils does not mean the same as nourishment sediment.

- Soil erosion would be minimized by limiting the time that soil is left exposed and by applying other erosion management measures, such as erosion matting, silt fencing, and sedimentation basins in work areas. These measures would reduce erosion, surface scouring, and discharge to water bodies.
- Between nourishment activities filter fabric, temporary vegetative cover, and/or other means would be used as necessary to ensure stabilization of disturbed soils.
- Disturbed areas would be monitored for invasive and nonnative plants.
- After work is completed construction areas would be revegetated with native plants in a timely period.

- To minimize soil erosion on new trails best management practices for trail work would be used. Examples of best management practices include installing water bars, checking dams and retaining walls, contouring lands to avoid erosion, and minimizing soil disturbance.

Water Resources (including Wetlands)

- To prevent water pollution during construction, equipment would be regularly inspected for leaks of petroleum and other chemicals. The use of heavy equipment in waterways would be minimized.
- Best management practices, such as the use of silt fences, would be followed to ensure that work-related effects are minimal and to prevent long-term impacts on water quality, wetlands, and aquatic species.
- Caution would be exercised to protect water resources from activities that have the potential to cause damage, such as construction, including erosion and siltation. Measures would be taken to keep unintended discharges from escaping work areas, especially near water bodies.
- Stormwater management measures would be implemented to reduce non-point source pollution discharge from parking lots and other impervious surfaces. Such actions would include oil/sediment separators, street sweeping, infiltration beds, use of permeable surfaces, and vegetated or natural filters to trap or filter stormwater runoff.
- Activities involving dredging or the placement of fill material below the ordinary high water line of Lake Michigan would comply with requirements of sections 401 and 404 of the Clean Water Act and with other applicable state permit programs (e.g., Great Lakes Submerged Lands Act). Impacts from potential fill or dredge

activities would be assessed further, and specific mitigation measures would be identified as part of final design.

following completion of work. Follow-up treatments would include mechanical, biological, chemical, and/or additional revegetation treatments.

Terrestrial Vegetation

- Revegetation plans would be prepared for disturbed areas and would specify such features as seed/plant source, seed/plant mixes, soil preparation, fertilizers, and mulching. To maintain genetic integrity, whenever possible, native plants that grow in the project area or region would be used in restoration efforts. Monitoring would occur to ensure that revegetation was successful, plantings were maintained, and unsuccessful plant materials were replaced.

Nonnative and Invasive Vegetation

- Special attention would be devoted to preventing the spread of nonnative and invasive weeds and other nonnative plants. Standard measures would include the following: ensure equipment arrives on-site free of mud or seed-bearing material; certify seeds and straw material as weed free; identify areas of nonnative and invasive weeds before work is performed; treat nonnative and invasive weeds or nonnative and invasives weed topsoil before work is performed (e.g., topsoil segregation, storage, herbicide treatment); and revegetate with appropriate native species.
- Equipment would be pressure-washed to ensure that it was clean and weed free before entering the park.
- Vehicle parking would be limited to road shoulders, parking areas, and previously disturbed areas.
- Monitoring and follow-up treatment of nonnative vegetation in revegetated areas would occur for several years

Wildlife

- Techniques would be employed to reduce impacts on wildlife from beach nourishment activities, such as scheduling, biological monitoring, erosion and sediment management, the use of fencing or other means to protect sensitive resources adjacent to work areas, the removal of food-related items and rubbish brought into the park, topsoil salvage, and revegetation. These actions would include specific work monitoring by resource specialists, as well as treatment and reporting procedures.
- Measures would be taken to reduce the potential for wildlife to access human food.
- Visitor impacts on wildlife would be addressed through visitor education programs, restrictions on visitor activities, and park ranger patrols.

Threatened and Endangered Species and Species of Concern

Mitigation actions would occur during normal park operations as well as before, during, and after nourishment activities to minimize immediate and long-term impacts on rare, threatened, and endangered species. These actions would vary by project and the area of the park affected, and additional mitigation would be added as appropriate depending on the specific action and location. Many of the measures listed above for vegetation and wildlife would also benefit rare, threatened, and endangered species by helping to preserve habitat. Mitigation actions specific to rare, threatened, and endangered species would include the following:

- Surveys would be conducted for rare, threatened, and endangered species as warranted.
- Critical habitat features would be protected and preserved whenever possible.
- Work would be conducted outside critical periods (such as nesting) for the specific species when possible. Work in areas in or near suitable threatened and endangered bird habitat would occur as late as possible in the fall/winter.
- Facilities / actions would be located and designed to avoid adverse effects on rare, threatened, and endangered species. If avoidance is impractical actions would be taken to minimize and compensate for adverse effects on rare, threatened, and endangered species as appropriate and in consultation with the appropriate resource agencies. Work would be conducted outside critical periods for the specific species.
- Restoration and/or monitoring plans would be developed and implemented as warranted. These plans would include approaches for implementation, performance standards, monitoring criteria, and adaptive management techniques.
- Measures to reduce adverse effects of nonnative plants and wildlife on rare, threatened, and endangered species would be implemented.
- Management practices to protect piping plover (*Charadrius melodus*) nesting areas would continue to be implemented, such as closing and fencing off beach areas from visitor use, monitoring the nesting areas throughout the breeding season, and minimizing trash along the beach that attracts piping plover predators. The National Park Service would continue to work cooperatively with the U.S. Fish and Wildlife Service (FWS) and other agency partners to identify and implement appropriate mitigation measures to protect piping plover

nesting areas and critical habitat within the park.

CULTURAL RESOURCES

All projects with the potential to affect cultural resources would be carried out in compliance with Section 106 of the NHPA, as amended, to ensure that the effects would be adequately addressed. Reasonable measures would be taken to avoid, minimize, or mitigate adverse effects in consultation with the Indiana State Historic Preservation Officer (SHPO), Tribal Historic Preservation Officers, and, as necessary, the Advisory Council on Historic Preservation, and other interested parties. In addition to adhering to the legal and policy requirements for cultural resource protection and preservation the National Park Service would also undertake the measures listed below to further protect the park's resources.

- Areas selected for construction and beach nourishment activities would be surveyed to ensure that cultural resources (i.e., archeological sites, historic structures, and cultural landscapes) in the area of affect are identified and protected by avoidance or, if necessary, mitigation measures.
- If, during beach nourishment activities, previously undiscovered archeological resources were uncovered work in the immediate vicinity of the discovery would be halted immediately until the resources were identified and documented, and an appropriate mitigation strategy was developed in consultation with the Indiana State Historic Preservation Office and, if necessary, associated American Indian tribes.
- Cultural landscapes would be protected, and alterations and changes affecting cultural landscapes would follow the Secretary of the Interior's *Standards for the Treatment of Historic Properties, with Guidelines for the Treatment of Cultural Landscapes*.

Actions being considered would incorporate compatible design guidelines to retain essential historic character and to mitigate potential adverse effects.

VISITOR EXPERIENCE

Measures to reduce adverse effects of beach nourishment activities on visitor safety and experience would be implemented, including project scheduling and the use of best management practices. Directional signs to orient visitors and education programs to promote understanding among visitors would continue.

Scenic Resources

Where appropriate, fencing would be used to route people away from sensitive natural and cultural resources while still permitting access to important viewpoints to the extent practicable.

HAZARDOUS MATERIALS

- Indiana Dunes National Lakeshore's spill prevention and pollution control program for hazardous materials would be followed and updated on a regular basis. Standard measures of this program include: hazardous materials storage and handling procedures; spill containment, cleanup, and reporting procedures; and limitation of refueling and other hazardous activities to upland/nonsensitive sites.
- Contract personnel would be directed to immediately stop work should suspected hazardous materials or wastes be encountered. National Park Service personnel would be notified, and appropriate remediation would be accomplished prior to resuming work.
- If appropriate, absorbent booms and other spill containment equipment and materials would be made available on-site during beach nourishment activities.

SHORELINE AND BEACH COMPLEX, REACHES 1 AND 2

The Indiana Dunes National Lakeshore shoreline within reach 1 is experiencing a high rate of erosion. The sandy substrate at the base of Mount Baldy has eroded away, exposing a clay layer that is now being undercut. The shoreline within reach 2 is considered dynamically stable, which means it is neither eroding or accumulating sediment. This stretch of shoreline contains sensitive aquatic and terrestrial habitats and is frequented by threatened and endangered species and species of concern. The natural processes of Lake Michigan have sustained the areas within reach 2, therefore it is assumed that no direct sediment nourishment would be conducted in reach 2. The actions taken under the alternatives for reach 1 would also impact the shoreline in reach 2 (and a portion of reach 3), providing additional sediment as the nourishment material would travel downdrift via wave action.

Proposed management actions related to terrestrial management would be conducted in conjunction with the shoreline and beach complex alternatives presented for reach 1.

ALTERNATIVE A: NO-ACTION

Under the no-action alternative the National Park Service would continue current management practices and for the foreseeable future, there would be no new actions taken to restore the park shoreline. Alternative A establishes a baseline for evaluating changes and impacts under the other action alternatives.

Since 1974 the COE has conducted beach nourishment within reach 1 on an intermittent basis. Nourishment was made available through specific funding obtained from Congress and given to the COE to implement, but there was no program funding for routine nourishment along the shoreline. Between 1974 and 2008 approximately 1 million yds³ of

sediment, an annual average of approximately 31,500 yds³, has been placed along the shoreline at Crescent Dune. The sediment placed has been mined from a permitted upland borrow site and transported to the lakeshore by truck. An access road has been constructed at the eastern end of Indiana Dunes National Lakeshore to facilitate placement of the upland material. There is no known designated funding source for additional nourishment activities, but the no-action alternative assumes some sort of intermittent nourishment over the next several years at about the same rate as in previous years.

The sediment chosen for the COE nourishment program was selected to increase retention time, but was not compatible with native materials, and was not of sufficient quantity to offset the continuing erosion in reach 1. Under the no-action alternative an estimated average quantity of 31,500 yds³ of sediment is placed in reach 1 annually. This quantity of sediment represents a fraction of the calculated 105,000 yds³ of sediment budget deficit as a result of sediment trapped updrift of the Michigan City Harbor. Over the course of the 20-year timeframe of this plan actions associated with the no-action alternative would allow for placement of approximately 630,000 yds³ of material from upland sources. The estimated calculated sediment budget deficit for the same timeframe is approximately 2.1 million yds³.

Despite nourishment efforts erosion would continue along the easternmost end of the park shoreline under the no-action alternative as the quantity of material currently being placed is insufficient relative to the calculated sediment budget. Figure 2-4: Alternatives for Shoreline and Beach Complex, Reaches 1 and 2, depicts the no-action alternative. The cost of the current nourishment activities under alternative A is estimated to be approximately

\$9.5 million over the 20-year lifetime of this plan.

ALTERNATIVE B-1: BEACH NOURISHMENT VIA UPLAND SOURCES, ANNUAL FREQUENCY

Under alternative B-1, there would be an increase in the annual quantity of sediment placed at Crescent Dune to account for the calculated sediment budget deficit. A total of 136,500 yds³ of nourishment material would be mined and placed on the beach each year from a permitted upland source. This quantity is the calculated sediment budget deficit estimated for reach 1. The material would be transported to Indiana Dunes National Lakeshore via truck, using the existing access road on the eastern end of the park, and would be dispersed along the shoreline with heavy equipment. With the exception of the quantity of sediment placed, activities would be conducted in a manner similar to the current beach nourishment program conducted by the COE. The placement of the sediment on the beach in reach 1 would take approximately four months to complete every year. The placement of the nourishment material would be conducted during a time of year deemed appropriate to minimize impacts on both natural resources and visitors of the park. Figure 2-4: Alternatives for Shoreline and Beach Complex, Reaches 1 and 2, depicts alternative B-1.

The implementation of the actions associated with alternative B-1 would maintain the current shoreline profile as the calculated sediment budget deficit would be fulfilled. Additional sediment placed on the beach would result in an initial increase in beach width at the base of Mount Baldy. The 136,500 yds³ of sediment would be sufficient to prevent additional erosion of the current shoreline for one year, as natural wave action and storm events would continue to erode the sediment after placement. The shorelines downdrift of Mount Baldy would receive an infusion of sediment following the material placement at Crescent Dune, thus affecting

not only reach 1, but reach 2 and a portion of reach 3 as well.

The sediment used for beach nourishment would be compatible with native site sediment, meaning similar in terms of color, shape, size, mineralogy, compaction, organic content, and texture. Any beach nourishment material would be free of harmful chemical contaminants, trash, debris, and large pieces of organic material. The total estimated cost of implementing alternative B-1 would be approximately \$43.8 million over the 20-year lifetime of this plan.

ALTERNATIVE B-5: BEACH NOURISHMENT VIA UPLAND SOURCES, FIVE-YEAR FREQUENCY

Under alternative B-5, the amount of sediment material deposited in reach 1 would fulfill the calculated sediment budget deficit. Rather than conducting annual nourishment activities as proposed under alternative B-1, the actions associated with alternative B-5 would place a total of 682,500 yds³ of sediment in reach 1 every five years. As under alternative B-1, the nourishment material would be mined from a permitted upland source, transported to the park via truck, and dispersed along the shoreline with heavy equipment. With the exception of the quantity of sediment placed, activities would be conducted in a manner similar to the current beach nourishment program conducted by the COE. The placement of sediment on the beach in reach 1 would take approximately 18 months to complete every five years. Due to the sediment volume and duration of the placement activities, mitigation measures, which would include restricting access to the beach for approximately 18 months every five years, would be required to protect natural resources and to maintain the safety of park visitors and employees.

As is the case under alternative B-1, the implementation of the actions associated with alternative B-5 would maintain the current shoreline profile as the calculated sediment

budget deficit would be fulfilled. Additional sediment placed on the beach would result in an initial increase in beach width at the base of Mount Baldy. The 682,500 yds³ of sediment would be sufficient to prevent additional erosion of the current shoreline for up to five years, as natural wave action and storm events would continue to erode the sediment after placement. The shorelines downdrift of Mount Baldy subsequently would also receive an infusion of sediment following the material placement at Crescent Dune, thus affecting not only reach 1, but reach 2 and a portion of reach 3, as well.

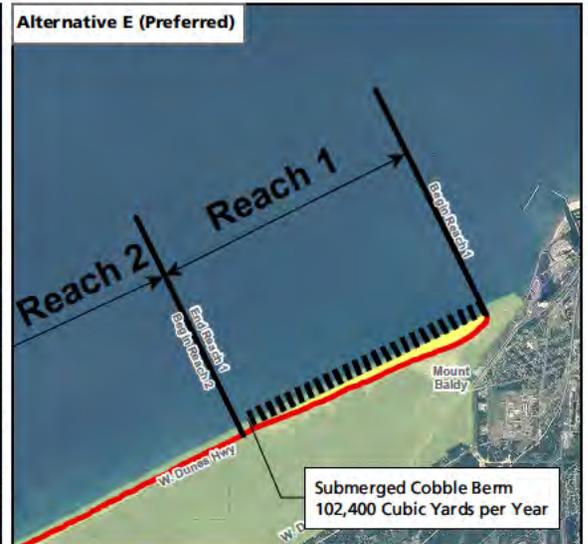
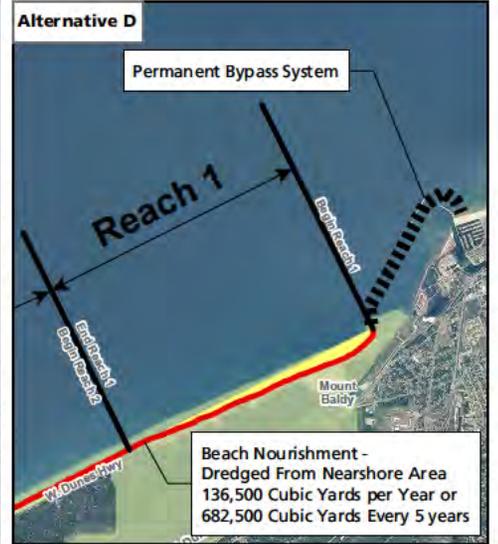
The sediment used for beach nourishment would be compatible with native site sediment, meaning similar in terms of color, shape, size, mineralogy, compaction, organic content, and texture. Any beach nourishment material should be free of harmful chemical contaminants, trash, debris, or large pieces of organic material. The total estimated cost of implementing alternative B-5 would be approximately \$35.5 million over the 20-year lifetime of this plan.

ALTERNATIVE C-1: BEACH NOURISHMENT VIA DREDGED SOURCES, ANNUAL FREQUENCY

Under alternative C-1, the amount of sediment material deposited in reach 1 would fulfill the calculated sediment budget deficit. Sediment would be dredged from an updrift location, such as the nearshore area east of the Michigan City Harbor (Baird 2004). Criteria used to determine the potential location would include minimizing impacts to the recreation beach in Michigan City. The specific location of the dredging source would be determined during the permitting process, based on consultation with local stakeholders and engineering constraints. A total of 136,500 yds³ of sediment would be placed annually on the beach in reach 1 to account for the calculated sediment budget deficit. The placement of sediment on the beach in reach 1 would take approximately two months to complete every year.

As previously mentioned in the discussion of alternative B-1, the implementation of alternative C-1 would maintain the current shoreline profile as the calculated sediment budget deficit would be fulfilled. Additional sediment placed on the beach would result in an initial increase in beach width at the placement area. The 136,500 yds³ of sediment would be sufficient to prevent additional erosion of the current shoreline for up to one year on average, as natural wave action and storm events would continue to erode the sediment after placement. The shorelines downdrift of Mount Baldy subsequently would receive an infusion of sediment following the material placement at Crescent Dune, thus affecting not only reach 1, but reach 2 and a portion of reach 3, as well. Figure 2-4: Alternatives for Shoreline and Beach Complex, Reaches 1 and 2, depicts alternative C-1.

Sediment compatibility between the proposed borrow material and the native beach were assessed by comparing grain size distribution curves. A potential location within the lakeshore where beach nourishment is proposed is east, updrift, of the Michigan City Harbor structure, and the native site (i.e., the site that would provide sediment similar in terms of color, shape, size, mineralogy, compaction, organic content, and texture to the existing beach sediment) for proposed nourishment is located to the west, downdrift, of the Michigan City Harbor approximately 1.5 miles at Mount Baldy. Sediment samples used to characterize both borrow and nourishment locations were collected from the beach/shoreline area at or immediately adjacent to each location and are representative of that material (NPS 2011b). The sediment located in the borrow site for reach 1 was similar in color to the material at the native site, and no substantial levels of contaminants were present in the borrow materials (Simon and Morris 2011).



Legend

- Shoreline 2010
- Beach Nourishment Area
- Indiana Dunes National Lakeshore Park Boundary

Airphoto: Spring 2010 mosaic, USDA NAIP
Grid Spacing: 1000 meters
Spatial Reference UTM zone 16

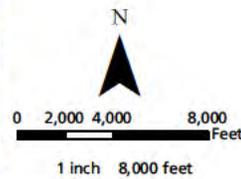


FIGURE 2-4
ALTERNATIVES FOR SHORELINE AND BEACH COMPLEX, REACHES 1 AND 2
Indiana Dunes National Lakeshore
Shoreline Restoration and Management
Plan / Environmental Impact Statement
National Park Service / U.S. Department of the Interior
March 2012

It is anticipated that the nourishment material would be placed by hydraulically pumping a sediment/water slurry onto the beach. Heavy equipment would then be used to distribute the sediment, creating the appropriate grade along the shoreline. Based on the short travel distance from Michigan City to the eastern end of reach 1, as well as the cost of removing and placing the sediment, it is estimated that alternative C-1 would be less expensive to implement and maintain than alternatives A, B-1, and B-5. The total estimated cost of implementing alternative C-1 would be approximately \$22.9 million over the 20-year lifetime of this plan.

ALTERNATIVE C-5: BEACH NOURISHMENT VIA DREDGED SOURCES, FIVE-YEAR FREQUENCY

The actions proposed under alternative C-5 include a beach nourishment program using sediment dredged from an updrift location, such as the nearshore area east of the Michigan City Harbor (Baird 2004). This area was proposed to minimize impacts on the recreation beach in Michigan City. The specific location of the dredging source would be determined during the permitting process, based on consultation with local stakeholders and engineering constraints. A total of 682,500 yds³ of sediment would be placed every five years on the beach in reach 1 under this alternative to account for the calculated sediment budget deficit. The placement of sediment on the beach in reach 1 would take approximately 10 months to complete every five years.

The implementation of alternative C-5 would maintain the current shoreline profile as the calculated sediment budget deficit would be fulfilled. Additional sediment placed on the beach would result in an initial increase in beach width at the placement area. The 682,500 yds³ of sediment would be sufficient to prevent additional erosion of the current shoreline for up to five years on average, as natural wave action and storm events would continue to erode the sediment after

placement. The shorelines downdrift of Mount Baldy subsequently would receive an infusion of sediment following the material placement at Crescent Dune, thus affecting not only reach 1, but reach 2 and a portion of reach 3, as well. Figure 2-4: Alternatives for Shoreline and Beach Complex, Reaches 1 and 2, depicts alternative C-5.

Sediment compatibility between the proposed borrow material and the native beach were assessed by comparing grain size distribution curves. A potential location within the lakeshore where beach nourishment is proposed is east, updrift, of the Michigan City Harbor structure, and the native site for proposed nourishment is located to the west, downdrift of the Michigan City Harbor approximately 1.5 miles at Mount Baldy. Sediment samples used to characterize both borrow and nourishment locations were collected from the beach/shoreline area at or immediately adjacent to each location and are representative of that material (NPS 2011b). The sediment located in the borrow site for reach 1 was similar in color to the material at the native site and no substantial levels of contaminants were present in the borrow materials (Simon and Morris 2011).

It is anticipated that the nourishment material would be placed by hydraulically pumping a sediment/water slurry onto the beach. Heavy equipment would then be used to distribute the sediment, creating the appropriate grade along the shoreline. Based on the short travel distance from Michigan City to the eastern end of reach 1, the cost of removing and placing the sediment, and the reduced frequency of nourishment as compared to alternative C-1, it is estimated that the actions associated with alternative C-5 would be less expensive to implement and maintain than the previously described alternatives. The total estimated cost of implementing alternative C-5 would be approximately \$18.6 million over the 20-year lifetime of this plan.

ALTERNATIVE D: BEACH NOURISHMENT VIA PERMANENT BYPASS SYSTEM

Under alternative D, the amount of sediment material deposited in reach 1 would fulfill the calculated sediment budget deficit. Under alternative D, a permanent bypass system would be constructed and operated to transport sediment from updrift of the Michigan City Harbor to reach 1. On average, a total of 136,500 yds³ of sediment would be bypassed annually to account for the calculated sediment budget deficit. A sediment trap would be created by initially dredging a quantity of sediment (to be determined) near the Michigan City Marina, at the end of the east jetty. An additional rubble-mound jetty modification would be required to develop an efficient sediment trap. This bypass system would be constructed along the lake bottom, around or under the existing harbor structures. Once the bypass system was constructed and operational, some annual maintenance would be required.

A system of pump and lift stations would hydraulically pump the 136,500 yds³ of sediment to the downdrift shoreline and place it on the beach at Crescent Dune. Heavy equipment would disperse the sediment along the shoreline to create the appropriate gradations. The hydraulically placed sediment would be sufficient to maintain the current shoreline profile as the calculated sediment budget deficit would be fulfilled. Additional sediment placed on the beach would result in an initial increase in beach width at the placement area. The 136,500 yds³ of sediment would be sufficient to prevent additional erosion of the current shoreline for up to one year on average, as natural wave action and storm events would continue to erode the sediment after placement. The shorelines downdrift of Mount Baldy subsequently would receive an infusion of sediment following the placement of nourishment material at Crescent Dune, thus affecting not only reach 1, but reach 2 and a portion of reach 3, as well.

As sediment is transported from the Michigan City Harbor vicinity to reach 1, the storage capacity of the east beach fillet would increase. Sedimentation in the federal navigation channel between the east pier of the Michigan City Harbor and the offshore breakwater would decrease slightly, resulting in a reduction in dredging requirements. The National Park Service would coordinate with stakeholders in order to implement this alternative. Additional analysis and compliance would be necessary prior to implementation of the actions associated with alternative D. The cost of implementing the actions associated with alternative D include the initial construction of the permanent bypass system, as well as maintenance and operation of the system over the 20-year lifetime of this plan. Implementing alternative D would cost approximately \$35.4 million. Figure 2-4: Alternatives for Shoreline and Beach Complex, Reaches 1 and 2, depicts alternative D.

ALTERNATIVE E: SUBMERGED COBBLE BERM AND BEACH NOURISHMENT, ANNUAL FREQUENCY (PREFERRED ALTERNATIVE)

Under alternative E, the amount of sediment material deposited in reach 1 would fulfill the calculated sediment budget deficit. Under this alternative, a submerged cobble berm would be constructed parallel to the shoreline in approximately 10 feet of water depth at low water datum, between the western terminus of the Northern Indiana Public Service Company (NIPSCO) seawall and the eastern terminus of reach 2. The submerged cobble berm would be used in conjunction with a beach nourishment program to restore reach 1 of Indiana Dunes National Lakeshore. The objectives of constructing the submerged cobble berm would be to stabilize the shoreline downdrift of the Michigan City Harbor by reducing the quantity of sediment needed for beach nourishment, to enhance aquatic habitat by diversifying the nearshore substrate, and to improve erosion protection during storm events.

A quantity of up to 102,400 yds³ of sediment obtained from a dredged source, located east, updrift of the Michigan City Harbor structure, would be hydraulically placed on the beach in reach 1 annually to provide nourishment and protection of the shoreline. The submerged cobble berm would be comprised of appropriate-sized aggregate material from local glacial deposits which would dissipate over time via natural coastal processes such as wave action and storm events. This dispersion process would take up to five years, after which the aggregate material would cover the clay lakebed, protecting it against further down-cutting. The length of time necessary for breakdown of the submerged cobble berm would depend largely on the final design, including the size of the aggregate material used, and also future lake processes (e.g., frequency and intensity of storm events). Until the aggregate material dissipates, the submerged cobble berm would temporarily present a safety concern to draft vessels traveling near the shoreline. Signs would be installed to warn the public of potential hazards. Over time, the submerged cobble berm would have a natural appearance and would not adversely alter the viewshed from elevated heights. Based on the offshore location, which would be along the existing 10-foot water depth contour, the submerged cobble berm would not present safety concerns for beach users.

The potential effectiveness of a submerged cobble berm has been analyzed in previous physical and numerical modeling studies (Baird 2000). Various dimensions and sizes of aggregate material were tested. Based on the results of the investigations, a 2- to 9-inch diameter aggregate submerged cobble berm placed at 10 feet below low water datum with a crest approximately 4 feet below low water datum was identified as a feasible conceptual design to be considered. Some cobbles would get pushed landward toward the beach; however, most of the berm material would remain offshore of the 5-foot to 6.5-foot contour from the beach, and the area from the shore to this contour would remain generally free of cobbles.

The submerged cobble berm proposed under alternative E, the NPS preferred alternative, would reduce shoreline erosion by breaking wave energy in the nearshore, thus allowing for greater sediment retention (Baird 2000). As previously described, the submerged cobble berm would break down over time and become part of the shoreline sediment mix. Over the lifetime of this plan, a reduced quantity of beach nourishment material would be required to fulfill the calculated sediment budget deficit. The specific reduced quantity of sediment needed in conjunction with the submerged cobble berm has not been calculated; however, the amount would be determined with additional analysis prior to implementation of the actions associated with alternative E.

Additional analysis would be required prior to implementation of the actions associated with alternative E, particularly in the design phase. Figure 2-5: Alternative E: Submerged Cobble Berm and Beach Nourishment, Annual Frequency (Preferred Alternative) for Reaches 1 and 2, depicts alternative E.

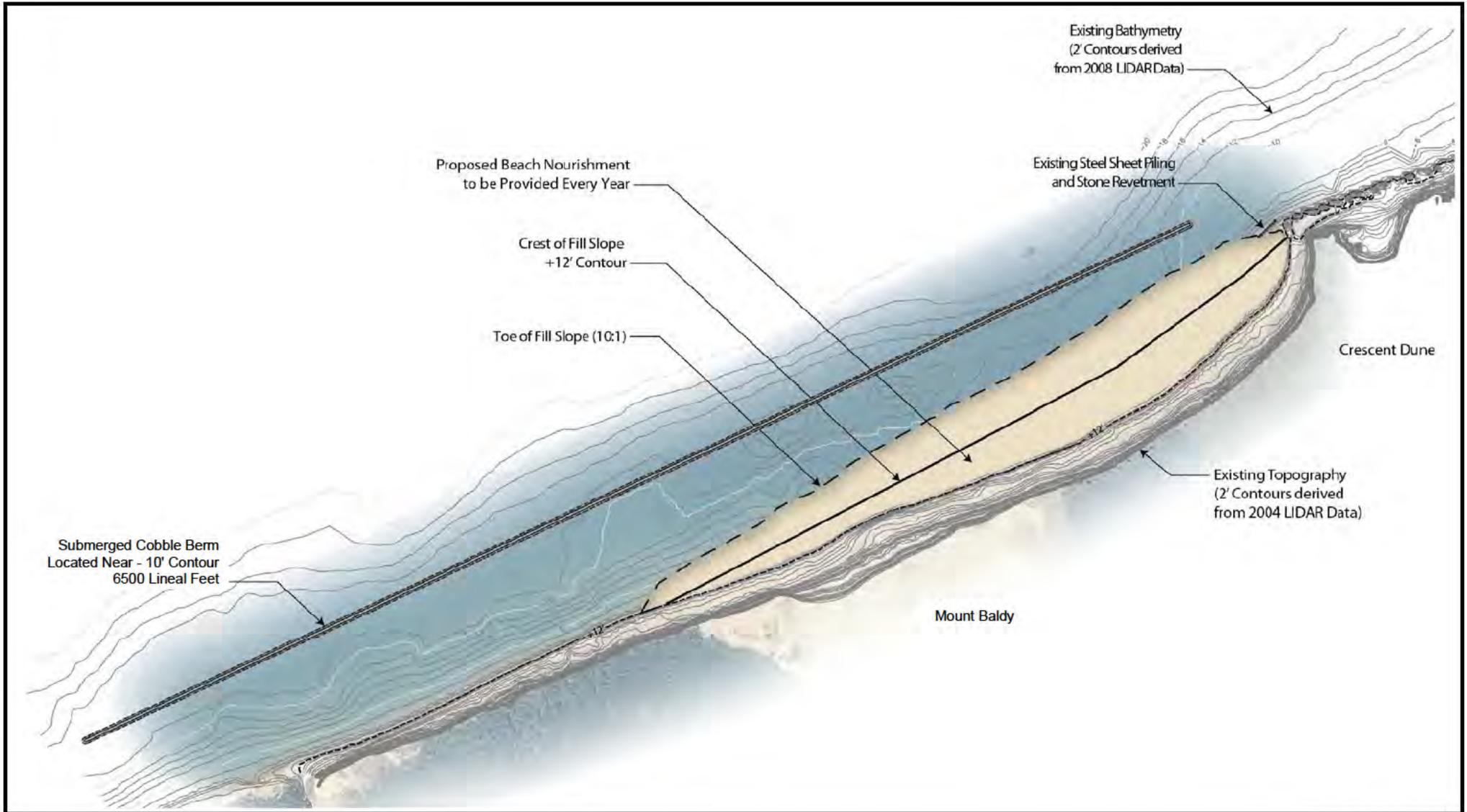
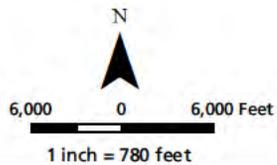


FIGURE 2-5
ALTERNATIVE E: SUBMERGED COBBLE BERM AND BEACH NOURISHMENT,
ANNUAL FREQUENCY (PREFERRED ALTERNATIVE) FOR REACHES 1 AND 2

Indiana Dunes National Lakeshore
 Shoreline Restoration and Management
 Plan / Environmental Impact Statement
 National Park Service / U.S. Department of the Interior



SHORELINE AND BEACH COMPLEX, REACHES 3 AND 4

Reach 3 of the park shoreline encompasses areas of both accretion and accelerated erosion. This disproportionate distribution of sediment is the result of interruptions to the littoral drift. In addition to the industrial and navigational harbors along Lake Michigan's southern shoreline, several sections of beach have been reinforced with hardened structures.

The park shoreline within reach 4 is considered dynamically stable. Therefore, it is assumed that no beach nourishment would be needed to allow natural lake processes to continue unassisted in that reach. The actions proposed under the action alternatives for reach 3 would impact the shoreline in reach 4, and provide additional sediment as the nourishment material would travel downdrift via natural lake processes.

ALTERNATIVE A: NO-ACTION

Under the no-action alternative, the National Park Service would continue current management practices. There would be no additional actions taken to restore the park shoreline.

The shoreline along the western portion of reach 3 is armored by approximately 2,100 linear feet of vertical steel sheet piling, an additional 1,500 linear feet of vertical steel sheet piling with toe stone, and 580 feet of stone revetment, which protects an industrial complex (see Figure 2-6: Alternatives for Shoreline and Beach Complex, Reaches 3 and 4). Approximately 120 linear feet of shoreline within this reach is unarmored and representative of the natural shoreline appearance.

Severe storm events, including those documented in 1998 and 2010, have resulted in substantial shoreline erosion and structural damages to the protection structures in front of the Town of Ogden Dunes. Even during

times of low lake levels, this portion of the shoreline is comprised of a very narrow beach. Severe erosion would be expected to continue in this area, ultimately affecting the dune habitat immediately south of the beach.

Due to a high rate of accretion on the updrift side of the Port of Indiana industrial complex (NIPSCO/Bailly intake area), maintenance dredging would maintain a target depth for normal dredging operations. The Burns Waterway Small Boat Harbor has been subject to maintenance dredging to maintain a safe navigation depth in the federal channels. A summary of the dredging performed in these three areas is presented below.

The area around the NIPSCO/Bailly intake has been dredged to a depth of 21 feet at low water datum by NIPSCO (1980 to 1999), and by the COE (2006 to 2009). Between 1999 and 2006, no dredging occurred around this intake. For several reasons, the maintenance program has been irregular, making planning predictions of future dredging a challenge. From 2006 through 2009, an average annual quantity of 118,000 yds³ was removed from the intake area and placed in the nearshore in front of Ogden Dunes.

The Burns Waterway Small Boat Harbor dredging records (1985, 2000, and 2009) indicate approximately 282,000 yds³ of dredged sediment was placed on the beach to the west of the harbor breakwater (1985, 2000) as well as in the nearshore area of Ogden Dunes (2009). Historic dredging records for the Burns Waterway Small Boat Harbor between 1986 and 2009 indicate that a total of 537,000 yds³ of sediment was dredged and disposed in open-water, offshore of the harbor.

On a long-term annual average basis between 1986 and 2009, approximately 74,000 yds³ were placed at Ogden Dunes in the nearshore area. It is assumed that this volume represents the baseline condition and future quantity to

be placed annually. The nearshore nourishment in front of Ogden Dunes began in 1986 and consisted of material placed approximately 1,500 feet offshore, and 1,500 feet west of the Burns Waterway Small Boat Harbor's inner breakwater. The sediment is currently permitted to be placed in 12 to 18 feet of water (at low water datum), a depth considered as safe draft for opening split-hull barges bottom hull, but yet shallow enough to prevent the placed sediment from migrating offshore (COE 2010).

The no-action alternative assumes the continuation of the maintenance dredging of 74,000 yds³ of sediment per year around the intake. The dredged material would be placed in the nearshore at Portage Lakefront and Riverwalk, while sediment from the Burns Waterway Small Boat Harbor would have an offshore, open-water placement.

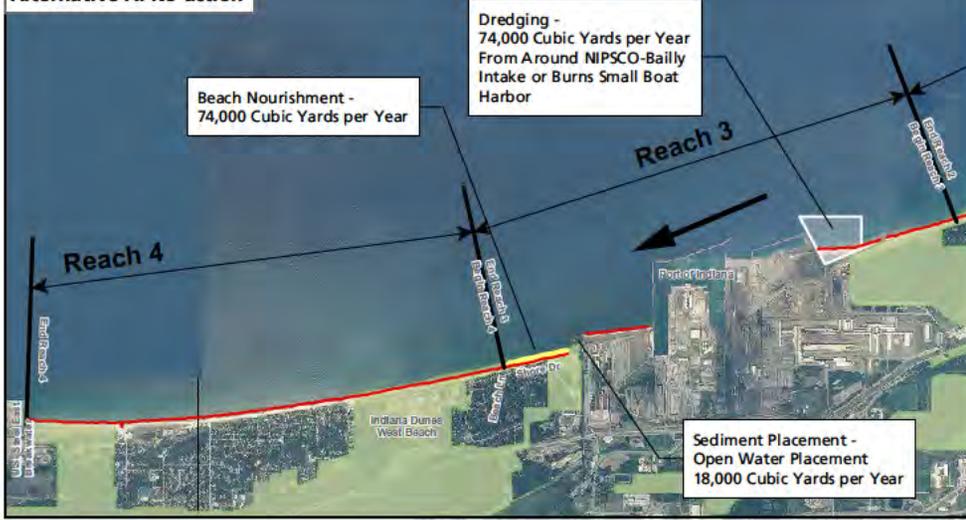
Based on the compiled historic dredging data and the shoreline evolution analysis, and despite the ongoing maintenance dredging operations, the NIPSCO/Bailly accretion area would continue to grow, and the shoreline at Portage Lakefront and Riverwalk would continue to erode under the no-action alternative. In the future, the NIPSCO/Bailly accretion area would achieve a stable profile, allowing sediment to bypass the Arcelor-Mittal breakwater. Sediment would be captured by the federal channel at the Burns Waterway Small Boat Harbor. The accreting sediment at the west end of the beach would affect the industrial warm-water discharge location, extending it to the east toward the park shoreline. As the area of sediment accretion grows, so too would the maintenance dredging requirements for the federal channel. Excessive sedimentation around the intake would inhibit the use of the cold-water intake structure, resulting in emergency plant shutdowns. Figure 2-6: Alternatives for Shoreline and Beach Complex, Reaches 3 and 4, depicts alternative A. The cost of continuing with the existing actions associated with alternative A would be approximately \$13.3 million over the 20-year lifetime of this plan.

ALTERNATIVE C-1: BEACH NOURISHMENT VIA DREDGED SOURCES, ANNUAL FREQUENCY

Under alternative C-1, the amount of sediment material deposited in reach 3 would fulfill the estimated sediment budget deficit. Under this alternative, sediment would be dredged from an updrift location in Lake Michigan. A total of 74,000 yds³ of sediment would be placed annually on the beach at Portage Lakefront and Riverwalk to account for the estimated sediment budget deficit. The placement of sediment on the beach in reach 3 would take approximately two months to complete every year. A potential sediment source of dredged material was identified as the area around the NIPSCO/Bailly intake. The specific location of the dredging source would be determined during the permitting process, based on consultation with local stakeholders and engineering constraints.

Despite ongoing maintenance dredging operations, the accreting beach updrift of the NIPSCO/Bailly complex would continue to grow under alternative C-1. The beach would potentially achieve a stable profile, allowing sediment to bypass the Arcelor-Mittal breakwater. Sediment would be captured by the federal channel at the Burns Waterway Small Boat Harbor. The accreting sediment at the west end of the beach would affect the industrial warm-water discharge location, extending it to the east toward the park shoreline. As the area of sediment accretion grows, so too would the need for maintenance dredging for the federal channel.

Alternative A: No-action



Alternatives C-1 and C-5 (Preferred)



Reaches 3 and 4



Alternative D



Legend

- Shoreline 2010
- Beach Nourishment Area
- Indiana Dunes National Lakeshore Park Boundary

Airphoto: Spring 2010 mosaic, USDA NAIP
 Grid Spacing: 1000 meters
 Spatial Reference UTM zone 16

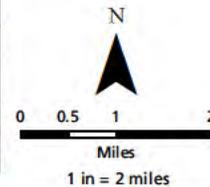


FIGURE 2-6
ALTERNATIVES FOR SHORELINE AND BEACH COMPLEX, REACHES 3 AND 4
 Indiana Dunes National Lakeshore
 Shoreline Restoration and Management Plan / Environmental Impact Statement
 National Park Service / U.S. Department of the Interior
 March 2012

The implementation of the actions associated with alternative C-1 would maintain the current shoreline profile as the estimated sediment budget deficit would be fulfilled. Additional sediment placed on the beach would result in an initial increase in beach width at the placement area. The 74,000 yds³ of sediment would be sufficient to prevent additional erosion of the current shoreline for up to one year on average, as natural wave action and storm events would continue to erode the sediment after placement. The shoreline downdrift of Portage Lakefront and Riverwalk subsequently would receive an infusion of sediment following the material placement, thus affecting not only reach 3, but reach 4, as well. Figure 2-6: Alternatives for Shoreline and Beach Complex, Reaches 3 and 4, depicts alternative C-1.

Sediment compatibility between the proposed borrow material and the native beach were assessed by comparing grain size distribution curves. A potential location within the lakeshore where beach nourishment is proposed is northeast of the Port of Indiana industrial complex and the native site for proposed nourishment is located to the west, downdrift, approximately 3.5 miles at Portage Lakefront and Riverwalk. Sediment samples used to characterize both borrow and nourishment locations were collected from the beach/shoreline area at or immediately adjacent to each location and are representative of that material (NPS 2011c). The sediment located in the borrow site for reach 3 was similar in color to the material at the native site and no substantial levels of contaminants were present in the borrow materials (Simon and Morris 2011).

Under alternative C-1, the dredged material would be placed directly on the beach, thereby increasing the sediment retention time at the placement location and the efficiency of shoreline protection. It is anticipated that the nourishment material would be placed by hydraulically pumping a sediment/water slurry onto the beach. Heavy equipment would then be used to distribute the sediment, creating the appropriate grade

along the shoreline. Within reach 3, it is estimated that the actions associated with alternative C-1 would be more expensive to implement and maintain than alternative A. The total estimated cost of implementing alternative C-1 would be approximately \$25.0 million over the 20-year lifetime of this plan.

ALTERNATIVE C-5: BEACH NOURISHMENT VIA DREDGED SOURCES, FIVE-YEAR FREQUENCY (PREFERRED ALTERNATIVE)

Under alternative C-5, the amount of sediment material deposited in reach 3 would fulfill the estimated sediment budget deficit. As with alternative C-1, sediment would be dredged from an updrift location in Lake Michigan, such as near the NIPSCO/Bailly intake. The specific location of the dredging source would be determined during the permitting process, based on consultation with local stakeholders and engineering constraints. A total of 370,000 yds³ of sediment would be placed every five years on the beach in reach 3 to account for the estimated sediment budget deficit. The placement of sediment on the beach in reach 3 would take approximately six months to complete every five years. The footprint of the placement area would be the entire length west of the Burns Waterway Small Boat Harbor, with an increase in beach elevation to approximately 12 feet above low water datum.

Despite ongoing maintenance dredging operations, the accreting beach updrift of the NIPSCO/Bailly complex would continue to grow under alternative C-5. The beach would potentially achieve a stable profile, allowing sediment to bypass the Arcelor-Mittal breakwater. Sediment could be captured by the federal channel at the Burns Waterway Small Boat Harbor, which could increase maintenance dredging costs. The accreting sediment at the west end of the beach would also affect the industrial warm-water discharge location, extending it to the east further toward the park shoreline. As the area

of sediment accretion grows, so too would the need for maintenance dredging for the federal channel. Implications for the long-term shoreline placement of dredged sediment on the beach are unknown; however, additional analysis would be conducted in a later phase of the planning process.

The implementation of the actions associated with alternative C-5, the preferred alternative for reaches 3 and 4, would maintain the current shoreline profile as the estimated sediment budget deficit would be fulfilled. Additional sediment placed on the beach would result in an initial increase in beach width at the placement area. The 370,000 yds³ of sediment would be sufficient to prevent additional erosion of the current shoreline for up to five years on average, as natural wave action and storm events would continue to erode the sediment after placement. The shoreline downdrift of Portage Lakefront and Riverwalk subsequently would receive an infusion of sediment following the material placement, thus affecting not only reach 3, but reach 4, as well. Figure 2-7: Alternative C-5 Beach Nourishment via Dredged Sources, Five-Year Frequency (Preferred Alternative) for Reaches 3 and 4, depicts alternative C-5.

Sediment compatibility between the proposed borrow material and the native beach were assessed by comparing grain size distribution curves. A potential location within the lakeshore where beach nourishment is proposed is northeast of the Port of Indiana industrial complex and the native site for proposed nourishment is located to the west, downdrift, approximately 3.5 miles at Portage Lakefront and Riverwalk. Sediment samples used to characterize both borrow and nourishment locations were collected from the beach/shoreline area at or immediately adjacent to each location and are representative of that material (NPS 2011c). The sediment located in the borrow site for reach 3 was similar in color to the material at the native site and no substantial levels of contaminants were present in the borrow materials (Simon and Morris 2011).

Under alternative C-5, the dredged material would be placed directly on the beach, thereby increasing the sediment retention time at the placement location and the efficiency of shoreline protection. The nourishment material would be placed by hydraulically pumping a sediment/water slurry onto the beach. Heavy equipment would then be used to distribute the sediment, creating the appropriate grade along the shoreline. Within reach 3, it is estimated that the actions associated with alternative C-5 would be less expensive to implement and maintain than alternative C-1. The total estimated cost of implementing alternative C-5 would be approximately \$20.3 million over the 20-year lifetime of this plan.

ALTERNATIVE D: BEACH NOURISHMENT VIA PERMANENT BYPASS SYSTEM

Under alternative D, the amount of sediment material deposited in reach 3 would fulfill the estimated sediment budget deficit. A permanent bypass system would be constructed and operated under this alternative to transport sediment from updrift of the NIPSCO/Bailly complex to Portage Lakefront and Riverwalk. A total of 74,000 yds³ of sediment would be bypassed annually to account for the estimated sediment budget deficit. A sediment trap would be created by initially dredging a quantity of sediment (to be determined) east of the intake. An additional rubble-mound jetty modification would be required to develop an efficient sediment trap. The permanent bypass system would be constructed along the lake bottom, around the existing harbor structures. After the permanent bypass system was constructed and operational, some annual maintenance would be required.

Under alternative D, a permanent bypass system of pump and lift stations would hydraulically pump the 74,000 yds³ of sediment to the downdrift shoreline and place it on the beach in the vicinity of Portage Lakefront and Riverwalk. Heavy equipment

would disperse the sediment along the shoreline to create the appropriate gradations. The hydraulically placed sediment would be sufficient to maintain the current shoreline profile as the estimated sediment budget deficit would be fulfilled. Additional sediment placed on the beach would result in an initial increase in beach width at the placement area. The 74,000 yds³ of sediment would be sufficient to prevent additional erosion of the current shoreline for up to one year on average, as natural wave action and storm events would continue to erode the sediment after placement. The shorelines downdrift of Portage Lakefront and Riverwalk subsequently would receive an infusion of sediment following the placement of nourishment material, thus affecting not only reach 3, but reach 4, as well.

As sediment was transported from the NIPSCO/Bailly complex to Portage Lakefront and Riverwalk via the permanent bypass

system, the storage capacity of the east beach fillet would increase. Under alternative D, there would be an increase in the beach nourishment material retention time. A target of 74,000 yds³ of material would be bypassed annually; however, the actual volume would fluctuate based on natural factors, such as sediment supply and the local wave climate. Additional analysis and compliance would be necessary prior to implementation of the actions associated with alternative D.

The costs of implementing the actions associated with alternative D would include the initial construction of the permanent bypass system as well as maintenance and operation of the system over the 20-year lifetime of this plan. Alternative D would cost approximately \$23.3 million to implement. Figure 2-6: Alternatives for Shoreline and Beach Complex, Reaches 3 and 4, depicts alternative D.

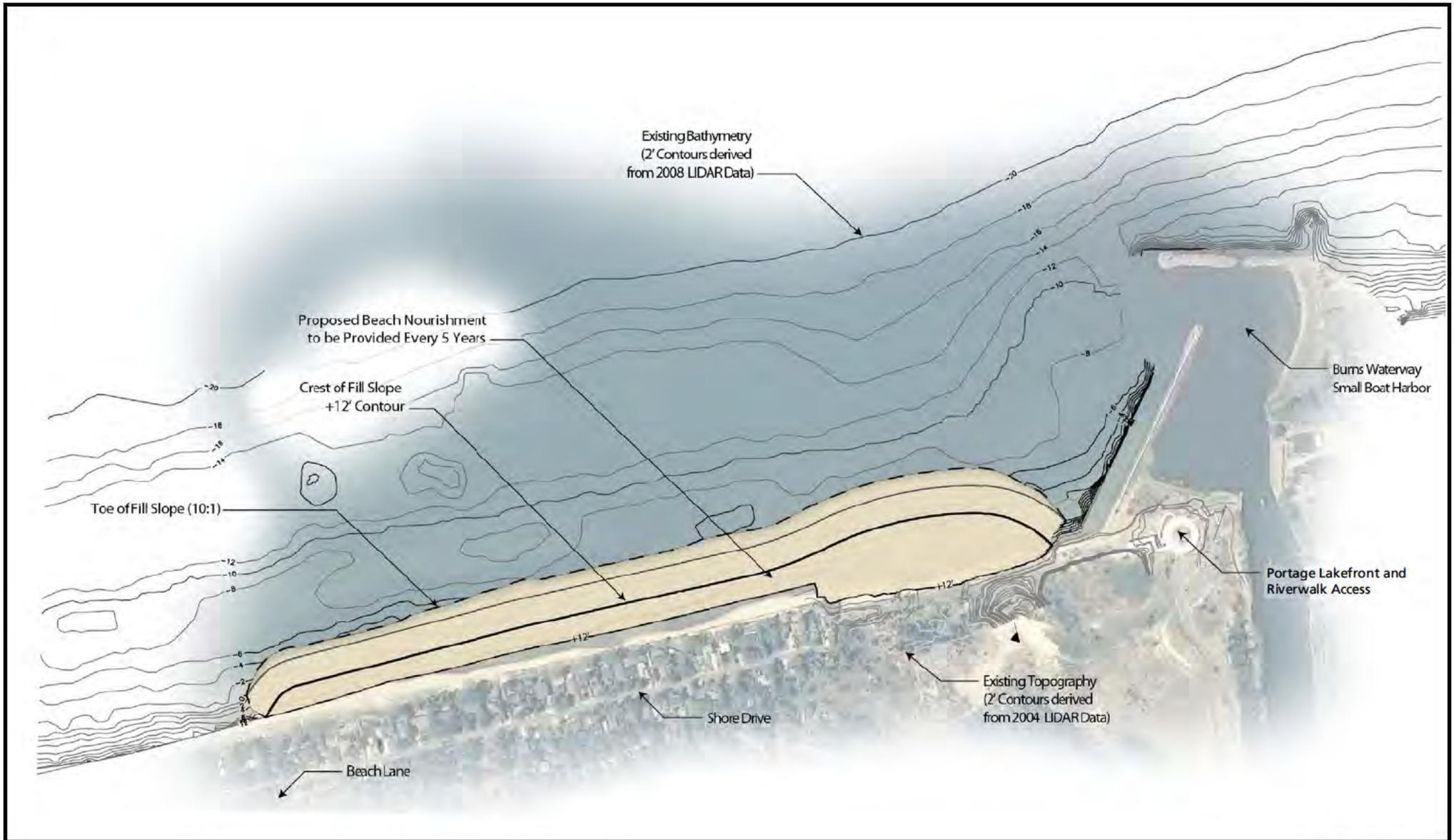
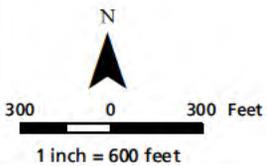


FIGURE 2-7
ALTERNATIVE C-5: BEACH NOURISHMENT VIA DREDGED SOURCES,
FIVE-YEAR FREQUENCY (PREFERRED ALTERNATIVE) FOR REACHES 3 AND 4

Indiana Dunes National Lakeshore
 Shoreline Restoration and Management
 Plan / Environmental Impact Statement
 National Park Service / U.S. Department of the Interior
 March 2012



FOREDUNE AND DUNE COMPLEX

In addition to the shoreline restoration alternatives, this plan includes natural resource management strategies for the protection and improvement of the park's terrestrial ecosystem within the project area. Plant communities and physiography are continually changing with the disturbance-prone habitats of the foredune complex. The foredune and dune complex encourages biological diversity unique to this region of the country. Migratory bird habitat, intradunal wetlands, and the various stages of dune succession are critical components of the park. The National Park Service is responsible for the protection of these sensitive habitats. Protection is currently accomplished with the following management strategies:

- preservation and restoration of sensitive habitats
- management of nonnative invasive plant species
- reduction of anthropogenic influences on native dune vegetation and critical habitat

The National Park Service is currently in the process of preparing an environmental assessment (EA) for a Great Lakes Invasive Plant Management Plan for parks located in the Great Lakes region. The National Park Service is proposing to use integrated pest management strategies to guide the development of the Great Lakes Invasive Plant Management Plan / EA. The National Park Service defines integrated pest management "as a decision-making process that coordinates knowledge of pest biology, the environment, and available technology to prevent unacceptable levels of pest damage, by cost-effective means, while posing the least possible risk to people and park resources" (NPS 2011c). Integrated pest management employs physical, chemical, mechanical, cultural, biological, and education methodologies to effectively manage and minimize the impacts of invasive plants. Once completed, the Great Lakes Invasive Plant

Management Plan would establish a long-term management strategy to mitigate the current and emerging ecological effects of invasive plants within the Great Lakes region.

Nonnative invasive plant species are currently affecting sensitive habitats and species of special concern. According to the park's Invasive Plant Management Strategy (NPS 2011d), more than 130 species of special concern have the potential to be affected by nonnative invasive plant species. Species of special concern, including threatened and endangered species, as well as critical habitat, would be monitored and protected under all alternatives of this plan.

An adaptive terrestrial management approach would account for future uncertainties and maximize the outcomes of resource management activities. The lakeshore area, including the foredune and dune complex, faces numerous issues related to invasive species and coastal processes. Park resource managers would have flexibility regarding management actions and strategies to produce desired conditions within the project area under this plan.

The park is an attractive destination for visitors and local residents. Mount Baldy (located in reach 1) is the only dune in the lakeshore where climbing is allowed on designated trails. Visitors hike the dune and from the top, on a clear day, can view Chicago's skyline and the southern Lake Michigan shoreline. However, numerous social trails have developed in non-designated areas on Mount Baldy and other areas of the park. West Beach (located in reach 4) is one of the most popular and highly visited entry points in the park. Numerous social trails extend from the parking lots to the beach. Portage Lakefront and Riverwalk (located in reach 3) has also become a popular destination for visitors and local residents, and social trails that cut across the dunes to access the beach have increased substantially.

As a result, ecologically sensitive areas, such as highly erodible dune slopes, have been affected. These social trails are accelerating erosion and habitat degradation while serving as pathways for nonnative invasive plant species. As visitor use increases, so does the trampling of native vegetation.

The park currently utilizes management tools such as closing trails, developing new trails, realigning trails, fencing, signs, ticketing/fining, and visitor education to manage anthropogenic influences.

FOREDUNE AND DUNE COMPLEX, REACH 1

Mount Baldy, located at the eastern terminus of reach 1, is one of the most popular and highly visited dunes in the park. It is best characterized by stabilized dune forests with a degraded and highly eroded foredune complex. The beach width is relatively narrow in this area compared to other reaches. Mount Baldy has gone through drastic changes recently. The dune is moving landward and burying leeward trees and herbaceous vegetation. The erosion is in large part caused by off-trail anthropogenic disturbances, loss of dune vegetation, and a sediment supply deficit (Dillon 2011). Over the last several years, park officials at Indiana Dunes National Lakeshore have noted that Mount Baldy has begun moving inland at an alarming pace. Left unchecked, the dune could start to cover over its own parking lot in as few as seven years. The reason for the increased movement seems to be a combination of too little dune grass on top of Mount Baldy and too many people climbing its southern slope. The lack of dune grass, also known as Marram grass, allows the wind to more easily move the sediment. In addition, every footstep up and down the dune helps push sediment down the steeper southern slope toward the parking lot while also killing off Marram grass attempting to take root.

Crescent Dune is located directly behind the revetment wall at the eastern terminus of

reach 1, and demonstrates moderate floristic quality compared to the other panes at the West Beach and Miller units. The National Park Service has documented numerous species of special concern at this panne, including five stated-listed plant species. See Appendix D: Species Lists, for additional information on these species.

The western terminus of reach 1, defined by East Lakefront Drive and the rock revetments, has been infested with nonnative trees such as Siberian elm (*Ulmus pumila*) and black locust (*Robinia pseudoacacia*). This stretch of beach/foredune demonstrates the lowest floristic quality and poorest characteristic plant assemblages for the foredune complex in the project area.

Current Management Actions

Sensitive Habitat Restoration. Sensitive habitat restoration includes: preserving the panne by maintaining natural processes and providing nonnative invasive species management; restoring the foredune and dune complex by stabilizing select areas of eroded dunes with native vegetation; and fencing off highly eroded and environmentally sensitive areas on Mount Baldy and revegetating with American beachgrass (*Ammophila breviligulata*).

Invasive Vegetation Management. Invasive vegetation management includes: managing sand ryegrass (*Leymus arenarius*) and spotted knapweed (*Centaurea maculosa*) in the foredune complex; managing purple loosestrife (*Lythrum salicaria*), common reed (*Phragmites australis*), and hybrid cattail (*Typha x glauca*) in the panne; and managing some woody invasive vegetation such as Siberian elm, black locust, and tree-of-heaven (*Ailanthus altissima*).

Anthropogenic Influence. Management of anthropogenic influences includes: protecting the leeward slope of Mount Baldy by installing fencing; maintaining an appropriate designated route to and from Mount Baldy

from the parking lot; reducing social trails; and providing education and outreach to visitors.

Proposed Management Actions

Sensitive Habitat Restoration. Proposed management of sensitive habitat restoration includes the continuation of current management actions by preserving the pannes and restoring the foredune and dune complex through native plant revegetation.

Invasive Vegetation Management. Proposed invasive vegetation management includes continued current management actions in addition to: implementation of an early detection and rapid response program and protocols; implementation of an invasive plant management plan; providing education and outreach about the impacts of nonnative invasive plant species to visitors; managing sand ryegrass and spotted knapweed in the foredune complex and outlying areas; and managing nonnative invasive plant species along East Lakefront Drive.

Anthropogenic Influence. Proposed management of anthropogenic influences includes continue current management actions by protecting the south slope from pedestrian use; designating appropriate routes to and from parking lots to popular visitor sites; reducing social trails; and providing education and outreach to visitors. In addition, proposed management actions include: consideration of the realignment of trails; development and implementation of a mitigation plan for new proposed access points or trails to Crescent Dune; and enforcement of pedestrian access routes.

FOREDUNE AND DUNE COMPLEX, REACH 2

Reach 2 supports a dynamically stable foredune complex. The majority of blowouts in the project area are located in this reach. The best example of a Pitcher's thistle

(*Cirsium pitcheri*) metapopulation is located in reach 2 of the project area. Many of the foredunes in reach 2 eventually intergrade into mature, stabilized dune forests. In addition, natural coastal processes, foredune development, and dune succession are readily observed in reach 2. Piping plovers often use shoreline habitat that is most influenced by natural processes, such as sediment deposition, natural rates of shoreline erosion, and scouring for maintenance (FWS 2003a). The U.S. Fish and Wildlife Service has determined that reach 2 is the only segment along the Indiana shoreline that currently has the physical conditions suitable for piping plover breeding activities.

The encroachment of nonnative species, particularly invasive plants, is a substantial problem that affects habitats within reach 2. A large population of Lombardy poplar (*Populus nigra*) and other invasive trees has invaded the Porter Beach unit and has the potential to invade the foredune and dune complex, including Keiser Blowout. Spotted knapweed, oriental bittersweet (*Celastrus orbiculatus*), cypress spurge (*Euphorbia cyparissias*), and garlic mustard (*Alliaria petiolata*) have also been documented in this reach.

Current Management Actions

Sensitive Habitat Restoration. Sensitive habitat restoration includes preserving the existing ecological conditions by sustaining natural coastal processes.

Invasive Vegetation Management. Invasive vegetation management includes managing existing nonnative invasive plant species. Targets include the following: sand ryegrass on the foredune; Lombardy poplar along the roads; and invasive shrubs and trees, such as autumn olive (*Elaeagnus umbellata*) and black locust, at parking lots. Current management also includes the mapping and monitoring of treated nonnative invasive plant species.

Anthropogenic Influence. Management of anthropogenic influences includes providing education and outreach to visitors.

Proposed Management Actions

Sensitive Habitat Restoration. Proposed management of sensitive habitat restoration includes continued current management actions in addition to preserving the foredune and dune complex (including blowouts), and restoring Pitcher's thistle habitat and piping plover habitat.

Invasive Vegetation Management. Proposed invasive vegetation management includes continued current management actions in addition to implementation of an early detection and rapid response program and protocols; and implementation of integrated pest management strategies.

Anthropogenic Influence. Proposed management of anthropogenic influences includes the continuation of current management actions in addition to designating an appropriate route to the beach from the Kemil Road parking lot, and reducing social trails on the foredune complex, including blowouts, at the Kemil Road access point.

FOREDUNE AND DUNE COMPLEX, REACH 3

A drastically altered shoreline, including artificial harbors, lakefill revetments, detached breakwaters, and a hardened shoreline, separates the NIPSCO/Bailly unit from Portage Lakefront and Riverwalk. Portage Lakefront and Riverwalk has an intact panne and foredune complex with degraded beach plant communities. Pitcher's thistle populations are located in respective blowout communities in this reach. The high accretion zone at the revetment at the NIPSCO/Bailly beach fillet allows for lakeward development of the foredunes.

The mouth of the Burns Waterway intake is located at Portage Lakefront and Riverwalk. The banks are extremely erodible, because it was constructed with steep slopes and sandy substrate. The erosion is jeopardizing species of special concern, including the state rare bearberry (*Arctostaphylos uva-ursi*). Portage Lakefront and Riverwalk has become a popular destination for visitors and local residents since its recent opening. As a result, visitor use and other anthropogenic influences have increased substantially in this reach. In addition, social trails that cut across the dunes to access the beach have increased substantially.

Invasive species are prevalent at Portage Lakefront and Riverwalk. Spotted knapweed, yellow sweet clover (*Melilotus officinalis*), and prairie sunflower (*Helianthus petiolaris*) have invaded roadside and trail edges through the unit. Purple loosestrife and common reed have also invaded the panne. Sand ryegrass has been observed throughout the foredune complex. In addition, oriental bittersweet and black locust trees are also encroaching upon areas within the dune complex in reach 3.

Current Management Actions

Sensitive Habitat Restoration. Sensitive habitat restoration includes preservation of the panne and the foredune complex by maintaining natural processes, and preservation of Pitcher's thistle populations at blowouts, including Portage Lakefront and Riverwalk.

Invasive Vegetation Management. Invasive vegetation management includes managing existing nonnative invasive plant species in the panne.

Anthropogenic Influence. Management of anthropogenic influences includes providing education and outreach to visitors.

Proposed Management Actions

Sensitive Habitat Restoration. Proposed management of sensitive habitat restoration includes continued current management actions in addition to restoring the foredune and dune complex by stabilizing select areas of eroded dunes with native vegetation, and preserving existing ecological conditions by sustaining natural coastal processes.

Invasive Vegetation Management. Proposed invasive vegetation management includes continued current management actions in addition to implementation of an early detection and rapid response program and protocols, and implementation of integrated pest management strategies.

Anthropogenic Influence. Proposed management of anthropogenic influences includes the continuation of current management actions in addition to reducing social trails and other anthropogenic influences on the foredune complex.

FOREDUNE AND DUNE COMPLEX, REACH 4

The foredune complex is generally more extensive in reach 4, compared to the stabilized, closed-canopy structure of the dune forests in reaches 1 and 2. Reach 4 subsequently supports a dynamically stable foredune complex. The foredune complex at the Miller unit is interrupted by leeward pannes and aquatic plant communities. The largest concentration of high quality pannes in the project area is located within West Beach. Beach pea restoration and reintroduction has also occurred in the foredune complex at the Miller unit.

West Beach is one of the most popular and highly visited entry points in the park. Numerous social trails extend from the parking lots to the beach. These trails traverse through sensitive habitat within the foredune complex.

Common reed, purple loosestrife, and white cattail (*Typha glauca*) are among the greatest concerns to the pannes in reach 4. The foredune complex is being invaded by sand ryegrass, spotted knapweed, and nonnative bush honeysuckle (*Lonicera* sp.). Yellow sweet clover and prairie sunflower nonnative invasive plant species are also invading the roadside and parking lot edges at West Beach.

Current Management Actions

Sensitive Habitat Restoration. Sensitive habitat restoration includes the preservation of the pannes at the West Beach and Miller units by managing nonnative invasive plant species, targeting purple loosestrife, common reed, and hybrid cattail.

Invasive Vegetation Management. Invasive vegetation management includes managing existing nonnative invasive plant species. Targets include: common reed, purple loosestrife, and white cattail in the pannes; sand ryegrass on the beach and foredunes; and yellow sweet clover and prairie sunflower. Current management also includes the mapping and monitoring of treated nonnative invasive plant species.

Anthropogenic Influence. Management of anthropogenic influences includes providing education and outreach to visitors.

Proposed Management Actions

Sensitive Habitat Restoration. Proposed management of sensitive habitat restoration includes continued current management actions in addition to restoring the foredune and dune complex by stabilizing select areas of eroded dunes with native vegetation, and fencing off highly eroded and environmental sensitive areas in the foredune complex to allow for ecological recovery of natural communities.

Invasive Vegetation Management.

Proposed invasive vegetation management includes continued current management actions in addition to implementation of an early detection and rapid response program and protocols, and implementation of integrated pest management strategies.

Anthropogenic Influence. Proposed management of anthropogenic influences

includes the continuation of current management actions in addition to designating and enforcing an appropriate route to and from the parking lots to the beach; reducing social trails; and fencing off highly eroded and environmental sensitive areas in the foredune complex, including the pannes, to reduce trampling of native vegetation.

ACTIONS AND ALTERNATIVES ELIMINATED FROM FURTHER CONSIDERATION

During the preparation of this plan, various approaches to restore Indiana Dunes National Lakeshore were discussed. Some actions and alternatives were proposed and eliminated from further consideration. The rationale for the dismissal of alternatives is provided below.

REACH 3, BEACH NOURISHMENT VIA UPLAND SOURCES

The planning team considered the possibility of conducting beach nourishment at Portage Lakefront and Riverwalk by trucking in material from an upland source. As is the case for reach 1, this alternative would have looked at conducting nourishment on an annual or frequency.

The proposed alternatives for conducting beach nourishment using an upland sediment source in reach 3 were dismissed because of the limited accessibility to the potential work area, lack of an appropriate haul road, and high costs associated with transporting materials over land. Maintenance dredging has occurred in the vicinity of the NIPSCO/Bailly intake since the 1980s. The COE intermittently operates a dredging program to manage sedimentation around the intake. If this program were interrupted, the sediment would continue to accrete in the area updrift of the industrial complex, pushing the adjacent warm-water discharge point farther east and north, potentially affecting the aquatic habitat along the shoreline. The sediment accumulation would result in operational concerns for NIPSCO as sediment enters its systems via the cold-water intake, and could cause emergency shutdowns and dredging activities. In the future, the NIPSCO/Bailly beach fillet may potentially achieve a stable profile, allowing natural sediment bypassing of the harbor structures. This could result in sediment accumulation in

the navigational channel, consequently increasing the federal maintenance dredging. Compared to other nourishment activities proposed for reach 3, relatively high costs would be expected under this alternative in association with nourishment from upland sources due to the required travel distance and the need to construct an access road with associated staging areas. Due to the expected impacts of interrupting the maintenance dredging activities at the NIPSCO/Bailly complex and the high costs, nourishment from upland sources was not considered for reach 3.

REACH 3, ENGINEERED STRUCTURES

Initially, the planning team considered the possibility of constructing permanent submerged engineered structures along the shoreline in front of Portage Lakefront and Riverwalk. These structures would be designed as permanent underwater berms constructed parallel to the shoreline. Unlike the submerged cobble berm proposed for reach 1, this alternative considered placing several segmented structures that would not break down or dissipate, but that would remain in place. These berms would facilitate a nourishment program by retaining sediment along the shoreline for longer periods of time.

This proposed alternative was dismissed from further consideration for several reasons. The beach along Portage Lakefront and Riverwalk would eventually expand, forming a scalloped shoreline profile. Such a beach appearance is an unnatural condition and therefore unsupported. Additionally, a scalloped beach profile would occur as sediment from the beach extended into the lake and connected to the segmented breakwaters. This new access to the breakwaters would pose a safety concern to visitors, potentially drawing inexperienced swimmers to waters deeper

than they would typically enter. The permanent submerged structures would also pose a safety concern to recreational boaters traveling near the shoreline. Despite the additional signs that would have been used to warn the public and boaters about the safety issue, as the crest of the structures would be approximately four feet from the water's surface, the potential for accidents would have persisted.

In addition to the concerns associated with the beach profile and safety, the permanent structures associated with this alternative would also impact the visitor's viewshed. While the berms would have been constructed beneath the water surface, they would have been seen from elevated heights. Due to the expected impacts of implementing the permanent structures, this alternative was dismissed from further consideration in reach 3.

NATIONAL PARK SERVICE PREFERRED ALTERNATIVES

During the Choosing by Advantages process (previously described under “Choosing by Advantage Process” section) attributes, or characteristics, of each alternative were used to identify the alternatives that provide the National Park Service and the public the greatest advantage for the most reasonable cost. These advantages were the largest determining considerations in identifying the agency’s preferred alternatives. Overall, the preferred alternatives provide the National Park Service with the greatest overall benefits at the most reasonable cost.

The National Park Service identified alternative E (Submerged Cobble Berm and Beach Nourishment, Annual Frequency) for reaches 1 and 2, and alternative C-5 (Beach

Nourishment via Dredged Sources, Five-Year Frequency) for reaches 3 and 4, as the agency’s preferred alternatives. These alternatives provide the best combination of strategies to protect the park’s unique resources and visitor experience, while improving the park’s operational sustainability within each reach. These alternatives also offer advantages to the neighboring communities. Actions under alternative E in reaches 1 and 2 provide for the greatest level of beach nourishment and habitat opportunities for desired native species. Actions under alternative C-5 in reaches 3 and 4 provide the best, and most cost-efficient method of foredune creation, and the greatest level of protection from major storm events.

ENVIRONMENTALLY PREFERABLE ALTERNATIVES

The National Park Service is required to identify the environmentally preferable alternative in its NEPA documents for public review and comment. Guidance from the Council on Environmental Quality (CEQ) “Forty Most Asked Questions,” (Q6a) defines the environmentally preferable alternative as “the alternative that causes the least damage to the biological and physical environment; it also means the alternative which best protects, preserves, and enhances historic, cultural, and natural resources” (46 *Federal Register* 18026, Q6a). It should be noted that there is no requirement that the environmentally preferable alternative and the NPS preferred alternative be the same. The National Park Service has identified alternative E (Submerged Cobble Berm and Beach Nourishment, Annual Frequency)) for reaches 1 and 2, and alternative C-5 (Beach Nourishment via Dredged Sources, Five-Year Frequency) for reaches 3 and 4, as the environmentally preferable alternatives.

In analyzing the impacts to natural resources, as summarized in tables 2-3 and 2-4, all action alternatives would benefit coastal processes. There would be adverse effects on aquatic fauna, terrestrial habitat, threatened and endangered species and species of concern, and the soundscape as a result of activities associated with the placement of nourishment material. The duration and intensity of these effects would vary depending on the source of the nourishment materials (i.e., upland or dredged) and the volume of nourishment material proposed under each alternative. Compared to the other alternatives, the NPS preferred alternatives would have similar adverse impacts on resources in the project area. Under alternative E in reaches 1 and 2, effects on all resources would be no greater than moderate adverse. Under alternative C-5 in reaches 3 and 4, effects would be no greater than short-term, moderate and adverse on all resources except aquatic fauna. There would be long-term, moderate to major, adverse impacts on aquatic fauna as fish would be

displaced during nourishment activities, and fish life cycles would be interrupted. In addition, the larger footprint of the placement area under alternative C-5 in reaches 3 and 4 (when compared to the other action alternatives) would result in burial of benthic communities along most of reach 3. However, under all the action alternatives, the impacted resources (e.g., coastal processes, aquatic fauna, terrestrial habitat, threatened and endangered species and species of concern, and soundscape) would benefit in the long-term from the reduction of severe shoreline and beach erosion and the creation of a more natural ecosystem of shoreline vegetation and foredune and dune complexes and processes.

Among all action alternatives considered, the NPS preferred alternatives offer a high level of protection of natural resources along the shoreline. As a result, implementation of the NPS preferred alternatives would better mimic natural shoreline processes, and better protect the beach, foredunes, and dunes from erosion, and would better support the development of foredunes and dunes than under the no-action alternatives. The implementation of alternative E for reaches 1 and 2 would also provide potential habitat opportunities for desired native aquatic and terrestrial species to a greater degree than the other alternatives. The implementation of alternative C-5 in reaches 3 and 4 would provide the greatest potential for foredune creation and the greatest protection from major storm events when compared to the other alternatives. In addition, under both of the NPS preferred alternatives, the National Park Service would integrate resource protection and education with an appropriate range of visitor uses. For these reasons, alternative E for reaches 1 and 2 and alternative C-5 for reaches 3 and 4 are the environmentally preferable alternatives. These alternatives best protect, preserve, and enhance natural resources and natural processes in the park.

CONSISTENCY OF THE ALTERNATIVES WITH THE NATIONAL ENVIRONMENTAL POLICY ACT OF 1969, AS AMENDED

The National Environmental Policy Act of 1969, as amended requires an analysis of how each alternative meets or achieves the purposes of the act, as stated in section 101(b). Each alternative analyzed in a NEPA document must be assessed as to how it meets the following purposes:

1. fulfill the responsibilities of each generation as trustee of the environment for succeeding generations
2. assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings
3. attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences
4. preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity, and variety of individual choices
5. achieve a balance between population and resource use, which would permit high standards of living and a wide sharing of life's amenities
6. enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources

The CEQ has promulgated regulations for federal agency implementation of NEPA (40 Code of Federal Regulations [CFR], parts 1500–1508). Section 1500.2 states that federal agencies shall, to the fullest extent possible, interpret and administer the policies, regulations, and public laws of the United States (U.S.) in accordance with the policies set forth in the act (sections 101(b) and 102(1)); therefore, other acts and NPS

Management Policies 2006 are referenced as applicable in the following discussion.

Criterion 1. Fulfill the Responsibilities of Each Generation as Trustee of the Environment for Succeeding Generations

All alternatives considered in this plan / draft EIS, including alternative A, must comply with law and NPS policy (e.g., the *Organic Act of 1916* and *NPS Management Policies 2006*) that require the agency to manage park units by such means and in such a manner “that will leave them unimpaired for the enjoyment of future generations.” Each alternative meets this criterion, although the “action alternatives” (alternatives B-1, B-5, C-1, C-5, D, and E in reaches 1 and 2; and alternatives C-1, C-5, and D in reaches 3 and 4) provide enhanced stewardship and trusteeship of the park’s resources in comparison to alternative A. The no-action alternatives in reaches 1 and 2 and reaches 3 and 4 do not provide comprehensive management direction for shoreline restoration efforts and also do not provide for adequate nourishment to offset the continuing erosion along the park’s shoreline.

Criterion 2. Assure for All Americans Safe, Healthful, Productive, and Aesthetically and Culturally Pleasing Surroundings

Under all alternatives, the National Park Service would strive to provide for safe, healthful, productive, and aesthetically and culturally pleasing surroundings. The ability of the park to achieve this purpose would be enhanced under all action alternatives when compared to alternative A for reaches 1 and 2 and alternative A reaches 3 and 4 by reducing shoreline erosion, creating conditions that more closely mimic natural coastal processes, and providing for enhanced development of foredune and dune complexes and processes.

Criterion 3. Attain the Widest Range of Beneficial Uses of the Environment Without Degradation, Risk of Health or Safety, or Other Undesirable and Unintended Consequences

All the action alternatives promote a wide range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences. The action alternatives would allow an appropriate range of beach and lakeshore experiences for park visitors while providing additional resource protection than under the no-action alternatives for reaches 1 and 2 and reaches 3 and 4. All action alternatives include proposals to reduce social trails and other anthropogenic influences in the park. Compared to the other alternatives, including the no-action alternatives, the preferred alternatives (alternative E in reaches 1 and 2 and alternative C-5 in reaches 3 and 4) would better provide for the enhancement of natural shoreline processes, better protect the foredunes, dunes, and shoreline from erosion, and better support the development of foredune and dune complexes and processes. Ample visitor use opportunities would be available under all alternatives, and activities that promote natural processes and minimize environmental impacts would continue.

Criterion 4. Preserve Important Historic, Cultural, and Natural Aspects of Our National Heritage and Maintain, Wherever Possible, An Environment that Supports Diversity and Variety of Individual Choice

The preservation of important historic, cultural, and natural aspects of our national heritage would be maintained under the implementation of all alternatives. As discussed in the “Impact Topics Dismissed from Further Consideration” section in the “Purpose and Need for Action” chapter, the implementation of this plan would not affect historic, submerged, or archeological resources. In addition, mitigation measures (as

described previously in “The Alternatives” chapter) would be implemented for the action alternatives to minimize unanticipated adverse effects to cultural resources. Under all of the action alternatives, there would be no appreciable impact on minorities or low-income populations or communities. This plan focuses on the shoreline as a whole. The alternatives were developed in consideration of the park’s neighboring communities and the effects on not only park property, but also on neighboring community properties.

Criterion 5. Achieve a Balance Between Population and Resource Use that will Permit High Standards of Living and a Wide Sharing of Life’s Amenities

All action alternatives would provide enhanced opportunities for visitors to access and experience the Indiana Dunes National Lakeshore’s unique and diverse landscape. The NPS preferred alternatives best achieve a balance between providing a high level of protection of natural resources while also providing a wide range of neutral and beneficial uses of the environment. Compared to the other alternatives, the preferred alternatives better provide for enhanced natural shoreline processes, protection of the foredunes and dunes, from erosion, and development of foredune and dune complexes and processes.

Criterion 6. Enhance the Quality of Renewable Resources and Approach the Maximum Attainable Recycling of Depletable Resources

In accordance with NPS *Management Policies 2006*, all the action alternatives incorporate measures to ensure that actions are conducted in an environmentally responsible and sustainable manner. The park staff would continue to demonstrate environmental leadership in implementing these shoreline restoration activities and execution of park operations would maximize the attainable recycling of depletable resources.

HOW ALTERNATIVES MEET OBJECTIVES

All action alternatives selected for analysis must meet all objectives to a large degree. The action alternatives must also address the stated purpose of taking action and resolve the need for action; therefore, the alternatives were individually assessed in light of how well they would meet the objectives of this plan / draft EIS, which are stated in the “Purpose and Need for Action” chapter. This process is the foundation for determining the NPS preferred alternative. Alternatives that did not meet the objectives were not analyzed further (see the “Actions and Alternatives Eliminated

from Further Consideration” section of “The Alternatives” chapter). Tables 2-2A and 2-2B: Comparison of Alternatives, compares how each of the alternatives described in “The Alternatives” chapter would meet the objectives of this plan. Table 2-3: Alternatives Impacts Table, Reaches 1 and 2, and Table 2-4: Alternatives Impacts Table, Reaches 3 and 4 summarizes the impacts under each alternative on each resource, as described in the “Environmental Consequences” chapter.

TABLE 2-2A: COMPARISON OF ALTERNATIVES, REACHES 1 AND 2

Alternative Element	Alternatives						
	Alternative A No-action	Alternative B-1 Beach Nourishment via Upland Sources, Annual Frequency	Alternative B-5 Beach Nourishment via Upland Sources, Five-Year Frequency	Alternative C-1 Beach Nourishment via Dredged Sources, Annual Frequency	Alternative C-5 Beach Nourishment via Dredged Sources, Five-Year Frequency	Alternative D Beach Nourishment via Permanent Bypass System	Alternative E Submerged Cobble Berm and Beach Nourishment, Annual Frequency (Preferred Alternative)
Shoreline and Beach Complex, Reaches 1 and 2							
Average Sediment Placed	31,500 yd ³ /annually	136,500 yd ³ /annually	682,500 yd ³ /every five years	136,500 yd ³ /annually	682,500 yd ³ /every five years	136,500 yd ³ /annually	102,400 yd ³ /annually
Where Sediment Obtained From	Mined from a permitted upland borrow site	Mined from a permitted upland borrow site	Similar to alternative B-1	Dredged from an updrift location, such as the nearshore area east of the Michigan City Harbor	Similar to alternative C-1	Bypassed from updrift of the Michigan City Harbor, such as near the Michigan City Marina, at the end of the east jetty	Submerged cobble berm would be constructed between the western terminus of the NIPSCO seawall and the eastern terminus of reach 2 and used in conjunction with beach nourishment activities similar to alternative C-1
Method of Placement	Sediment transported via truck along existing access road / heavy equipment would distribute sediment	Sediment transported via truck along existing access road / heavy equipment would distribute sediment and create appropriate gradations	Similar to alternative B-1	Sediment-water slurry hydraulically pumped on to beach / heavy equipment would distribute sediment and create appropriate gradations	Similar to alternative C-1	Sediment would be transported via a permanent bypass system / a sediment trap would be created by initially dredging a TBD quantity of sediment / pump and lift stations would hydraulically pump sediment on to beach / heavy equipment would distribute sediment and create appropriate gradations	The submerged cobble berm would be comprised of appropriate-sized aggregate material from local glacial deposits which would gradually dissipate and cover the lakebed
Sediment Placement	For onshore, placed along shoreline at Crescent Dune/or offshore, deposited nearshore off reach 1	Placed along shoreline of beach in reach 1	Similar to alternative B-1	Similar to alternative B-1	Similar to alternative B-1	Placed on the beach at Crescent Dune	Lakebed
NPV Over 20 Years	\$9.5 million	\$43.8 million	\$35.5 million	\$22.9 million	\$18.6 million	\$35.4 million	\$20.4 million
Foredune and Dune Complex, Reach 1							
Sensitive Habitat Restoration							
	Preserve pannes by maintaining natural processes and providing nonnative invasive species management.						
	Restore the foredune and dune complex by stabilizing select areas of eroded dunes with native plant vegetation. Fence-off highly eroded and environmental sensitive areas on Mount Baldy, and revegetate with American beach grass.						

Alternative Element	Alternatives						
	Alternative A No-action	Alternative B-1 Beach Nourishment via Upland Sources, Annual Frequency	Alternative B-5 Beach Nourishment via Upland Sources, Five-Year Frequency	Alternative C-1 Beach Nourishment via Dredged Sources, Annual Frequency	Alternative C-5 Beach Nourishment via Dredged Sources, Five-Year Frequency	Alternative D Beach Nourishment via Permanent Bypass System	Alternative E Submerged Cobble Berm and Beach Nourishment, Annual Frequency (Preferred Alternative)
Invasive Vegetation Management							
	Manage sand ryegrass and spotted knapweed in the foredune complex	Continue current management actions. Manage sand ryegrass and spotted knapweed in the foredune complex and outlying areas. In addition, implement an early detection and rapid response program and strategies; implement an Invasive Plant Management Plan; and provide education and outreach about the impacts of nonnative invasive plant species to visitors.					
	Manage purple loosestrife, common reed, and hybrid cattail in the panne						
	Manage some woody invasive vegetation, such as Siberian elm, black locust, and tree-of-heaven						
Anthropogenic Influences							
	Maintain an appropriate designated route to and from Mount Baldy from the parking lot	Continue current management actions by: Protecting the south slope of Mount Baldy from pedestrian use. Designating appropriate routes to and from parking lots to popular visitor sites. Reducing social trails. Providing education and outreach to visitors. Consider the realignment of trails; develop a mitigation plan for any new proposed access points or trails to Crescent Dune; and enforce pedestrian access routes.					
	Designate an appropriate route to and from Mount Baldy from the parking lot						
	Reduce social trails						
	Provide education and outreach						
Foredune and Dune Complex, Reach 2							
Sensitive Habitat Restoration							
	Preserve existing ecological conditions by sustaining natural coastal processes	Continue current management actions. In addition, preserve the foredune and dune complex, including blowouts; and restore Pitcher's thistle habitat and piping plover habitat.					
Invasive Vegetation Management							
	Manage existing nonnative invasive plant species. Targets include the following: sand ryegrass on foredunes; Lombardy poplar along the roads; and invasive shrubs and trees, such as autumn olive and black locust, at parking lots	Continue current management actions. In addition, implement an early detection and rapid response program and protocols, and implement integrated pest management strategies.					
	Map and monitor treated nonnative invasive plant species						

Alternative Element	Alternatives						
	Alternative A No-action	Alternative B-1 Beach Nourishment via Upland Sources, Annual Frequency	Alternative B-5 Beach Nourishment via Upland Sources, Five-Year Frequency	Alternative C-1 Beach Nourishment via Dredged Sources, Annual Frequency	Alternative C-5 Beach Nourishment via Dredged Sources, Five-Year Frequency	Alternative D Beach Nourishment via Permanent Bypass System	Alternative E Submerged Cobble Berm and Beach Nourishment, Annual Frequency (Preferred Alternative)
Anthropogenic Influences							
	Provide education and outreach to visitors	Continue current management actions. In addition, designate appropriate route to the beach from the Kemil Road parking lot; and reduce social trails on the foredune complex, including blowouts, at the Kemil Road access point; and provide education and outreach to visitors.					
How the Alternatives Meet the Objectives of the Plan							
Shoreline Restoration Does the alternative develop strategies that would support the reestablishment of more sustainable shoreline sediment movement and a more natural ecosystem of shoreline vegetation and foredune and dune complexes?							
	No - Under the no-action alternative the park would not develop strategies for sustainable shoreline sediment movement.	Yes - Under the proposed action alternatives, strategies for sustainable shoreline sediment movement and a more natural ecosystem of the shoreline would be developed.					
Exotic and Invasive Species Does the alternative develop new strategies to identify, manage, and remove aquatic and terrestrial exotic and invasive species; and develop strategies to support ongoing management efforts to remove aquatic and terrestrial exotic and invasive species, and to prevent conditions detrimental to those effects?							
	No - Under the no-action alternative, no new strategies would be developed.	Yes - Under the proposed action alternatives, new strategies to identify, manage, and remove aquatic and terrestrial exotic and invasive species, and new strategies to support ongoing management efforts to remove aquatic and terrestrial exotic and invasive species would be developed.					
Management Methodology Does the alternative determine shoreline desired conditions that would serve as thresholds for management actions within Indiana Dunes National Lakeshore, and develop and implement an adaptive management approach for maintaining a sustainable shoreline ecosystem within Indiana Dunes National Lakeshore?							
	No - Under the no-action alternative, there would be no adaptive management approach.	Yes - Under the proposed action alternatives, desired conditions would be developed and an adaptive management approach would be implemented.					

Notes:

- NPV = net present value
- TBD = to be determined
- yd3 = cubic yards

TABLE 2-2B: COMPARISON OF ALTERNATIVES, REACHES 3 AND 4

Evaluation Criteria	Alternatives			
	Alternative A No-action	Alternative C-1 Beach Nourishment via Dredged Sources, Annual Frequency	Alternative C-5 (Preferred Alternative) Beach Nourishment via Dredged Sources, Five-Year Frequency	Alternative D Beach Nourishment via Permanent Bypass System
Shoreline and Beach Complex, Reaches 3 and 4				
Average Sediment Placed	74,000 yd ³ /annually	74,000 yd ³ /annually	370,000 yd ³ /every five years	74,000 yd ³ /annually
Where Sediment Obtained From	Dredged from around the NIPSCO/Bailly intake	Dredged from an updrift location in Lake Michigan, such as near the NIPSCO/Bailly intake	Similar to alternative C-1	Bypassed from updrift of the NIPSCO/Bailly complex to Portage Lakefront and Riverwalk
Method of Placement	Open water disposal between 12 and 18 feet of water depth at Low Water Datum	Sediment-water slurry would be hydraulically pumped on to beach / heavy equipment would distribute sediment and create appropriate gradations	Similar to alternative C-1	Sediment would be transported via a permanent bypass system / a sediment trap would be created by initially dredging a TBD quantity of sediment / pump and lift stations would hydraulically pump sediment on to beach / heavy equipment would distribute sediment and create appropriate gradations
Sediment Placement	Open water disposal between 12 and 18 feet of water depth at Low Water Datum using open split-hull barges	Placed on the beach at Portage Lakefront and Riverwalk	Similar to alternative C-1	Similar to alternative C-1
NPV Over 20 Years	\$13.3 million	\$25.0 million	\$20.3 million	\$23.3 million
Foredune and Dune Complex, Reach 3				
Sensitive Habitat Restoration				
	Preserve panne and foredune complex by maintaining natural processes	Continue current management actions. In addition, restore the foredune and dune complex by stabilizing select areas of eroded dunes with native vegetation, and preserve existing ecological conditions by sustaining natural coastal processes.		
	Preserve Pitcher's thistle populations at blowouts, including Portage Lakefront and Riverwalk			
Invasive Vegetation Management				
	Manage nonnative invasive plant species in the panne	Continue current management actions. In addition, implement an early detection and rapid response program and protocols, and implement integrated pest management strategies.		
Anthropogenic Influences				
	Provide education and outreach to visitors	Continue current management actions. In addition, reduce social trails and other anthropogenic influences on the foredune complex.		
Foredune and Dune Complex, Reach 4				
Sensitive Habitat Restoration				
	Preserve the pannes at the West Beach and Miller units by managing nonnative invasive plant species, targeting purple loosestrife, common reed, and hybrid cattail	Continue current management actions. In addition, restore the foredune and dune complex by stabilizing select areas of eroded dunes with native vegetation, and fence-off highly eroded and environmental sensitive areas on the foredunes to allow for ecological recovery of natural communities.		
Invasive Vegetation Management				
	Manage existing nonnative invasive plant species. Targets include the following: common reed, purple loosestrife, and white cattail in the pannes; sand ryegrass on the beach and foredunes; and yellow sweet clover and prairie sunflower.	Continue current management actions. In addition, implement an early detection and rapid response program and protocols, and implement integrated pest management strategies.		
	Map and monitor treated nonnative invasive plant species			
Anthropogenic Influences				
	Provide education and outreach to visitors	Continue current management actions. In addition, designate and enforce appropriate routes to and from parking lots; reduce social trails; and fence-off highly eroded and environmental sensitive areas in the foredune complex, including pannes, to reduce trampling of native vegetation.		

Evaluation Criteria	Alternatives			
	Alternative A No-action	Alternative C-1 Beach Nourishment via Dredged Sources, Annual Frequency	Alternative C-5 (Preferred Alternative) Beach Nourishment via Dredged Sources, Five-Year Frequency	Alternative D Beach Nourishment via Permanent Bypass System
How the Alternatives Meet the Objectives of the Plan				
Shoreline Restoration				
Does the alternative develop strategies that would support the reestablishment of more sustainable shoreline sediment movement and a more natural ecosystem of shoreline vegetation and foredune and dune complexes?				
	No - Under the no-action alternative, the park would not develop strategies for sustainable shoreline sediment movement.	Yes - Under the proposed action alternatives, strategies for sustainable shoreline sediment movement and a more natural ecosystem of the shoreline would be developed.		
Exotic and Invasive Species				
Does the alternative develop new strategies to identify, manage, and remove aquatic and terrestrial exotic and invasive species; and develop strategies to support ongoing management efforts to remove aquatic and terrestrial exotic and invasive species and to prevent conditions detrimental to those effects?				
	No - Under the no-action alternative, no new strategies would be developed.	Yes - Under the proposed action alternatives, new strategies to identify, manage, and remove aquatic and terrestrial exotic and invasive species, and new strategies to support ongoing management efforts to remove aquatic and terrestrial exotic and invasive species would be developed.		
Management Methodology				
Does the alternative determine shoreline desired conditions that would serve as thresholds for management actions within Indiana Dunes National Lakeshore; and develop and implement an adaptive management approach for maintaining a sustainable shoreline ecosystem within Indiana Dunes National Lakeshore?				
	No - Under the no-action alternative, there would be no adaptive management approach.	Yes - Under the proposed action alternatives, desired conditions would be developed and an adaptive management approach would be implemented.		

Notes:

NIPSCO = Northern Indiana Public Service Company

NPV = net present value

TBD = to be determined

yd³ = cubic yards

TABLE 2-3: ALTERNATIVES IMPACTS TABLE, REACHES 1 AND 2

Impact Topic	Alternative A (No-action Alternative)	Alternative B-1 (Beach Nourishment via Upland Sources, Annual Frequency)	Alternative B-5 (Beach Nourishment via Upland Sources, Five-Year Frequency)	Alternative C-1 (Beach Nourishment via Dredged Sources, Annual Frequency)	Alternative C-5 (Beach Nourishment via Dredged Sources, Five-Year Frequency)	Alternative D (Beach Nourishment via Permanent Bypass System)	Alternative E (Submerged Cobble Berm and Beach Nourishment, Annual Frequency) – Preferred Alternative
Coastal Processes							
Sediment Transport Process	<u>Moderate, long-term, adverse impacts</u> due to continued sediment budget deficit and shoreline erosion.	<u>Moderate, long-term, beneficial impacts</u> from balancing the sediment budget deficit and improved protection of the shoreline from erosion.	<u>Moderate, long-term, beneficial impacts</u> from balancing the sediment budget deficit and improved protection of the shoreline from erosion.	<u>Moderate to major, long-term, beneficial impacts</u> as the estimated sediment budget deficit would be provided from an updrift source, that would more closely mimic natural processes.	<u>Moderate to major, long-term, beneficial impacts</u> as the estimated sediment budget deficit would be provided from an updrift source, that would more closely mimic natural processes.	<u>Moderate to major, long-term, beneficial impacts</u> as the estimated sediment budget deficit would be provided from an updrift source, that would more closely mimic natural processes.	<u>Moderate, long-term, beneficial impacts</u> from a balanced sediment budget deficit, and additional protection of the shoreline and lake bottom from erosion.
Foredune and Dune Formation Process	<u>Moderate, long-term, adverse impacts</u> due to the continued sediment budget deficit that creates a deficit of material for dune formation.	<u>Moderate, long-term, beneficial impacts</u> as the sediment placed on the beach would allow for additional sediment supply to create foredunes.	<u>Moderate to major, long-term, beneficial impacts</u> as the additional quantity of material on the beach would foster foredune development.	<u>Moderate, long-term, beneficial impacts</u> as the sediment placed on the beach would allow for additional sediment supply to create foredunes.	<u>Moderate to major, long-term, beneficial impacts</u> as the additional quantity of material on the beach would foster foredune development.	<u>Moderate, long-term, beneficial impacts</u> as the sediment placed on the beach would allow for additional sediment supply to create foredunes.	<u>Moderate, long-term, beneficial impacts</u> as the sediment placed on the beach would allow for additional sediment supply to create foredunes.
Aquatic Fauna	<u>Minor, short-term, adverse impacts</u> as fish would be temporarily displaced due to turbidity, and the benthic communities would be smothered during placement of sediment. <u>Negligible, short-term, adverse impacts</u> as nourishment activities would result in a disrupted environment, which would allow for the introduction/establishment of invasive and nonnative species.	<u>Minor, short-term, adverse impacts</u> as fish would be temporarily displaced due to turbidity. The benthic communities would be temporarily smothered during placement of sediment. <u>Negligible, short-term, adverse impacts</u> as nourishment activities would result in a disrupted environment, which would allow for the introduction/establishment of invasive and nonnative species. <u>Minor, long-term, beneficial impacts</u> as there would be less environmental stress from erosion and no disturbance from dredging.	<u>Moderate, long-term, adverse impacts</u> due to the duration of placement activities. Fish would be displaced and fish life-cycles would be interrupted. The larger footprint of the placement area would result in smothering of benthic communities along the majority of reach 1. <u>Negligible, short-term, adverse impacts</u> as nourishment activities would result in a disrupted environment, which would allow for the introduction/establishment of invasive and nonnative species. <u>Minor, long-term, beneficial effects</u> from reducing erosion in the area and enhancing the fish and benthic habitat.	<u>Minor, short-term, adverse impacts</u> as fish would be temporarily displaced due to turbidity. The benthic communities would be temporarily smothered during placement of sediment. <u>Negligible, short-term, adverse impacts</u> as nourishment activities would result in a disrupted environment, which would allow for the introduction/establishment of invasive and nonnative species. <u>Minor, long-term, beneficial effects</u> from reducing erosion in the area and enhancing the fish and benthic habitat.	<u>Moderate to major, short- and long-term, adverse impacts</u> as fish would be displaced and fish life cycles would be interrupted. The larger footprint of the placement area would result in smothering of the benthic communities along the majority of reach 1. <u>Negligible, short-term, adverse impacts</u> as nourishment activities would result in a disrupted environment, which would allow for the introduction/establishment of invasive and nonnative species. <u>Minor, long-term, beneficial effects</u> from reducing erosion in the area and enhancing the benthic and fish habitat.	<u>Minor, short-term, adverse impacts</u> as fish would be temporarily displaced due to turbidity. The benthic communities would be temporarily smothered during the placement of sediment. <u>Negligible, short-term, adverse impacts</u> as nourishment activities would result in a disrupted environment, which would allow for the introduction/establishment of invasive and nonnative species. <u>Minor, long-term, beneficial effects</u> from reducing erosion in the area and enhancing the benthic and fish habitat.	<u>Minor, short-term, adverse impacts</u> as fish would be temporarily displaced during construction and nourishment activities. The benthic communities would be smothered during placement of the sediment. <u>Minor, long-term, adverse impacts</u> as the aggregate material – and associated interstitial spaces – in the submerged cobble berm would be an attractive habitat for invasive and nonnative species until the material had dissipated and was covered by sediment. <u>Moderate, long-term, beneficial impacts</u> as the aggregate material placed would create additional benthic and fish habitat and reduce the effects from erosion in the area.

Impact Topic	Alternative A (No-action Alternative)	Alternative B-1 (Beach Nourishment via Upland Sources, Annual Frequency)	Alternative B-5 (Beach Nourishment via Upland Sources, Five-Year Frequency)	Alternative C-1 (Beach Nourishment via Dredged Sources, Annual Frequency)	Alternative C-5 (Beach Nourishment via Dredged Sources, Five-Year Frequency)	Alternative D (Beach Nourishment via Permanent Bypass System)	Alternative E (Submerged Cobble Berm and Beach Nourishment, Annual Frequency) – Preferred Alternative
Terrestrial Habitat	<u>Minor, short- and long-term, adverse impacts</u> from the erosion and destabilization of habitat that would continue from taking no new actions in the park, including any actions to invite or deter invasive and nonnative plants. Taking no new actions in the park would not improve the ability of the beach to withstand storm events and preserve habitat.	<u>Minor, short-term, adverse impacts</u> from the introduction of invasive nonnative plant species into the park during sediment placement activities. <u>Minor, short-term, beneficial impacts</u> from nourishment of the park shoreline, particularly in areas of accelerated erosion. <u>Negligible to minor, short-term, beneficial effects</u> from the improved ability of the beach to withstand storm events and preserve terrestrial habitat for plants and animals.	<u>Minor, long-term, adverse impacts</u> from the introduction of invasive nonnative plant species into the park during sediment placement activities, and from the longer duration of nourishment activities and the larger footprint of sediment placed on the beach. <u>Minor, long-term, beneficial impacts</u> from nourishment of the park shoreline, particularly in areas of accelerated erosion, and from a reduction in the erosion and degradation of the foredune and colonization by invasive and nonnative plant species. <u>Negligible to minor, long-term, beneficial effects</u> from the improved ability of the beach to withstand storm events and preserve terrestrial habitat.	<u>Negligible to minor, short-term, adverse impacts</u> from re-vegetation efforts that would affect sensitive habitats. <u>Minor, short-term, beneficial impacts</u> from nourishment of the park shoreline, particularly in areas of accelerated erosion. <u>Negligible to minor, short-term, beneficial effects</u> from the improved ability of the beach to withstand storm events and preserve terrestrial habitat for plants, and since material dredged from the lake bottom would have no or limited viable nonnative invasive plant species seedbank.	<u>Negligible to minor, short-term, adverse impacts</u> from re-vegetation efforts that would affect sensitive habitats. <u>Moderate, short-term, beneficial impacts</u> from nourishment of the park shoreline. <u>Moderate, long-term, adverse impacts</u> from the longer duration of nourishment activities and the larger footprint of sediment placed on the beach. <u>Negligible to minor, long-term, beneficial effects</u> from the improved ability of the beach to withstand storm events and preserve terrestrial habitat for plants, and since material dredged from the lake bottom would have no or limited viable nonnative invasive plant species seedbank.	<u>Negligible to minor, short-term, adverse impacts</u> from re-vegetation efforts that would affect sensitive habitats. <u>Minor, short-term, beneficial impacts</u> from nourishment of the park shoreline, and from the decreased erosion and improved natural ecological setting for native plants and animals. <u>Minor, short-term, adverse impacts</u> as some beach vegetation would be smothered during placement activities. <u>Negligible to minor, short-term, beneficial effects</u> from the improved ability of the beach to withstand storm events and preserve terrestrial habitat.	<u>Minor, long-term, beneficial impacts</u> from dune stabilization and foredune development. <u>Minor, long-term, adverse effects</u> from interference with an already stable area in reach 2. <u>Minor to moderate, long-term, beneficial impacts</u> from restoration of the park shoreline, particularly in areas of accelerated erosion, and from the reduced consumption of material for nourishment activities. <u>Negligible to minor, short-term, beneficial effects</u> from the improved ability of the beach to withstand storm events and preserve terrestrial habitat for plants and animals.
Threatened and Endangered Species and Species of Concern	<u>Moderate, short-term, adverse impacts</u> from continued erosion, loss of habitat for piping plover and Pitcher's thistle, and continued sediment budget deficit. <u>May affect, and is likely to adversely affect</u> piping plover and Pitcher's thistle because development of future habitat is not addressed and substantial erosion would continue. <u>No effect</u> on the Karner blue butterfly, Indiana bat, and eastern massasauga rattlesnake as beach nourishment activities would not affect their habitat.	<u>Moderate to major, short-term, beneficial impacts</u> on Pitcher's thistle and piping plover (threatened and endangered species), from the habitat restoration that would result from the expanded beach nourishment activities. <u>Minor, short-term, adverse impacts</u> as placement of nourishment material from an upland source would temporarily disturb the ability of piping plover to nest and for Pitcher's thistle to establish. <u>May affect, but is not likely to adversely affect</u> piping plover and Pitcher's thistle as beach nourishment activities would result in habitat restoration. <u>No effect</u> on the Karner blue butterfly, Indiana bat, and eastern massasauga rattlesnake as beach nourishment activities would not affect their habitat.	<u>Moderate to major, long-term, beneficial impacts</u> on Pitcher's thistle and piping plover from the habitat restoration that would result from the expanded beach nourishment activities. <u>Moderate, long-term, adverse impacts</u> on these species as placement of nourishment material from an upland source would disturb the ability of piping plover to nest and for Pitcher's thistle to establish. <u>May affect, but is not likely to adversely affect</u> piping plover and Pitcher's thistle as beach nourishment activities would result in habitat restoration. <u>No effect</u> on the Karner blue butterfly, Indiana bat, and eastern massasauga rattlesnake as beach nourishment activities would not affect their habitat.	<u>Moderate to major, short-term, beneficial impacts</u> from the habitat restoration that would result from the expanded beach nourishment activities. <u>Minor, short-term, adverse impacts</u> as placement of nourishment material would temporarily disturb the ability of piping plover to nest and for Pitcher's thistle to establish. <u>May affect, but is not likely to adversely affect</u> piping plover and Pitcher's thistle as beach nourishment activities would result in habitat restoration. <u>No effect</u> on the Karner blue butterfly, Indiana bat, and eastern massasauga rattlesnake as beach nourishment activities would not affect their habitat.	<u>Moderate to major, long-term, beneficial impacts</u> on Pitcher's thistle and piping plover from the habitat restoration that would result from the expanded beach nourishment activities. <u>Minor to moderate, short-term, adverse impacts</u> on these species as placement of nourishment material would disturb the ability of piping plover to nest and for Pitcher's thistle to establish. <u>May affect, but is not likely to adversely affect</u> piping plover and Pitcher's thistle as beach nourishment activities would result in habitat restoration. <u>No effect</u> on the Karner blue butterfly, Indiana bat, and eastern massasauga rattlesnake as beach nourishment activities would not affect their habitat.	<u>Moderate to major, short-term, beneficial impacts</u> from the habitat restoration that would result from the expanded beach nourishment activities. <u>Minor, short-term, adverse impacts</u> as placement of nourishment material would temporarily disturb the ability of piping plover to nest and for Pitcher's thistle to establish, and from the temporary visual intrusions being introduced in to the park during construction of the permanent bypass system. <u>May affect, but is not likely to adversely affect</u> piping plover and Pitcher's thistle as beach nourishment activities would result in habitat restoration. <u>No effect</u> on the Karner blue butterfly, Indiana bat, and eastern massasauga rattlesnake as beach nourishment activities would not affect their habitat.	<u>Major, long-term, beneficial impacts</u> on Pitcher's thistle and piping plover from the habitat restoration that would result from the placement of the submerged cobble berm. <u>Minor, short-term, adverse impacts</u> as placement of nourishment material would temporarily disturb the ability of piping plover to nest and for Pitcher's thistle to establish. <u>May affect, but is not likely to adversely affect</u> piping plover and Pitcher's thistle as beach nourishment activities would result in habitat restoration. <u>No effect</u> on the Karner blue butterfly, Indiana bat, and eastern massasauga rattlesnake as beach nourishment activities would not affect their habitat.

Impact Topic	Alternative A (No-action Alternative)	Alternative B-1 (Beach Nourishment via Upland Sources, Annual Frequency)	Alternative B-5 (Beach Nourishment via Upland Sources, Five-Year Frequency)	Alternative C-1 (Beach Nourishment via Dredged Sources, Annual Frequency)	Alternative C-5 (Beach Nourishment via Dredged Sources, Five-Year Frequency)	Alternative D (Beach Nourishment via Permanent Bypass System)	Alternative E (Submerged Cobble Berm and Beach Nourishment, Annual Frequency) – Preferred Alternative
Wetlands and Pannes†	Not applicable (see note below).	Not applicable (see note below).	Not applicable (see note below).	Not applicable (see note below).	Not applicable (see note below).	Not applicable (see note below).	Not applicable (see note below).
Soundscape	<u>Minor, short-term adverse impacts</u> from beach nourishment activities related to sound generated from the trucks hauling the sediment and equipment grading the nourishment material along the beach.	<u>Negligible to minor, short-term, adverse impacts</u> from beach nourishment activities related to sound generated from the trucks hauling the sediment and equipment grading the nourishment material along the beach.	<u>Minor to moderate, long-term, adverse impacts</u> from beach nourishment activities related to sound generated from trucks hauling sediment and equipment grading the nourishment material along the beach.	<u>Negligible to minor, short-term, adverse impacts</u> from beach nourishment activities related to sound generated from barges and equipment grading the nourishment material along the beach.	<u>Minor to moderate, short-term, adverse impacts</u> from beach nourishment activities related to sound generated from equipment grading the nourishment material along the beach and from dredging operations.	<u>Negligible to minor, short-term, adverse impacts</u> from the sound that would be generated from construction and associated operations of the permanent bypass system.	<u>Negligible, short-term, adverse impacts</u> from the beach nourishment activities related to sound generated from construction and beach nourishment activities and equipment grading the nourishment material along the beach.
Visitor Experience	<u>Minor to moderate, short- and long-term, adverse impacts</u> from continued temporary beach closings and ongoing degradation of popular visitor amenities from continued shoreline erosion.	<u>Minor, short-term, adverse impacts</u> from temporary beach and trail closings for nourishment activities in reach 1, and the visual intrusions being introduced in to the park (i.e., grading equipment). <u>Minor, short-term, beneficial impacts</u> from the temporary increase in beach size, and the reduction in future trail closings.	<u>Minor to moderate, long-term, adverse impacts</u> from the visual intrusions being introduced into the park during beach nourishment activities (i.e., grading equipment), and from the beach and trail closings during placement work. <u>Minor, short- and long-term, beneficial impacts</u> from the temporary increase in beach size, and the future reduction in beach closings for nourishment activities due to the decrease in erosion.	<u>Minor, short-term, adverse impacts</u> from the temporary beach closings, and visual intrusions being introduced into the park during placement activities (i.e., grading equipment). <u>Minor, short-term, beneficial impacts</u> from the temporary increase in beach size, and the decrease in future beach closings that would result from less restoration work having to be performed (from reduced erosion).	<u>Moderate, short-term, adverse impacts</u> from temporary beach and trail closings during dredging and placement activities, and from the visual intrusions such activities and equipment would introduce into the visitor’s viewshed. <u>Minor, short- and long-term, beneficial impacts</u> from the temporary increase in beach size and the decrease in future beach closings that would result from reduced erosion (and thus reduced maintenance/restoration activities that require beach closings).	<u>Minor, short-term, adverse impacts</u> from temporary beach closings, construction of the permanent bypass system, and hazards posed to nonconfident swimmers by the lift and pump stations. <u>Minor, short-term, beneficial impacts</u> from the reduction in future beach closings that would result from less cyclic maintenance and restoration work needing to be performed from reduced erosion, as well as from the temporary increase in beach size. <u>Minor, long-term, adverse impacts</u> from the visual intrusion the small lift stations would introduce to the park.	<u>Minor, short- and long-term, adverse impacts</u> from the temporary beach closings during construction of the submerged cobble berm, and from the visual intrusion the submerged cobble berm would introduce into the park and the safety concerns it would pose before dissipation. The park would consider implementing mitigation measures to offset safety concerns. <u>Minor, short- and long-term, beneficial impacts</u> from the reduced maintenance demands and reduced restoration demands that would result in fewer beach and trail closings.

Impact Topic	Alternative A (No-action Alternative)	Alternative B-1 (Beach Nourishment via Upland Sources, Annual Frequency)	Alternative B-5 (Beach Nourishment via Upland Sources, Five-Year Frequency)	Alternative C-1 (Beach Nourishment via Dredged Sources, Annual Frequency)	Alternative C-5 (Beach Nourishment via Dredged Sources, Five-Year Frequency)	Alternative D (Beach Nourishment via Permanent Bypass System)	Alternative E (Submerged Cobble Berm and Beach Nourishment, Annual Frequency) – Preferred Alternative
Park Operations	<u>Minor, long-term, adverse impacts</u> from taking no new actions in the park and continuing with the existing clean sediment beach nourishment in reach 1, resulting in growing workload demands and maintenance operation costs for park staff.	<u>Minor, short-term, adverse impacts</u> from the increased demands that would be placed on park staff and budgets annually. <u>Minor, short-term, beneficial impacts</u> from the resulting reductions in annual cyclic maintenance/restoration work that the park performs.	<u>Moderate, long-term, adverse impacts</u> from the additional planning, execution, and monitoring tasks that would tax employees and operating budgets for approximately 18 months every five years during beach nourishment activities. <u>Minor, long-term, beneficial impacts</u> from reduced cyclic maintenance/restoration demands on park staff and park dollars over each five-year period.	<u>Minor, short-term, adverse impacts</u> from the increased demands that would be placed on staff and budgets each year during the approximate two-month period for beach nourishment activities. <u>Minor, short-term, beneficial impacts</u> from the annual decrease in maintenance/restoration work required by park staff and of park budgets.	<u>Moderate, short-term, adverse impacts</u> from the demands the associated beach nourishment activities would place on park staff and budgets. <u>Minor, long-term, beneficial impacts</u> from the resulting decrease in cyclic maintenance/restoration work performed in the park from the decrease in erosion.	<u>Minor to moderate, short- and long-term, adverse impacts</u> from the additional staff time and operating dollars the associated beach nourishment actions would require, especially the routine monitoring and maintenance of the permanent bypass system for the life of this plan. <u>Minor, short-term, beneficial impacts</u> from the decrease in maintenance/restoration work that would result from the decrease in erosion that would occur from the annual beach nourishment activities.	<u>Minor, short-term, adverse impacts</u> from the increase in park staff responsibilities and the increased demands placed on the park's operating budget during construction of the submerged cobble berm. <u>Moderate, long-term, beneficial impacts</u> from the reduced maintenance demands, reduced restoration demands, and lower operating budgets over the life of this plan.

Notes:

Short-term: days up to one year.

Long-term: greater than one year.

Additional impacts on the impact topics would result from the proposed management actions specific to the foredune and dune complex (as discussed in "The Alternatives" chapter). The proposed management actions would result in long-term, beneficial impacts as they are intended to improve the ecological quality of the terrestrial environment along Indiana Dunes National Lakeshore.

† The overall acreage or type of wetlands and pannes either within or outside of the project area would not be impacted by the shoreline and beach complex nourishment alternatives listed; rather, impacts on wetlands and pannes as a result of the proposed management actions (as discussed in "The Alternatives" chapter) would be long-term and beneficial.

TABLE 2-4: ALTERNATIVES IMPACTS TABLE, REACHES 3 AND 4

Impact Topic	Alternative A (No-action Alternative)	Alternative C-1 (Beach Nourishment via Dredged Sources, Annual Frequency)	Alternative C-5 (Beach Nourishment via Dredged Sources, Five-Year Frequency) – Preferred Alternative	Alternative D (Beach Nourishment via Permanent Bypass System)
Coastal Processes				
Sediment Transport Process	<u>Minor to moderate, long-term, adverse impacts</u> from the continuation of an overall sediment budget deficit.	<u>Moderate, long-term, beneficial impacts</u> as the sediment budget deficit would be provided from an updrift source, that would more closely mimic natural processes.	<u>Moderate, long-term, beneficial impacts</u> as the sediment budget deficit would be provided from an updrift source, that would more closely mimic natural processes.	<u>Moderate, long-term, beneficial impacts</u> as the sediment budget deficit would be provided from an updrift source, that would more closely mimic natural processes.
Foredune and Dune Formation Process	<u>Moderate, long-term, adverse impacts</u> due to a lack of beach sediment for foredune formation.	<u>Moderate, long-term, beneficial impacts</u> as the sediment placed on the beach would allow for additional sediment supply to create foredunes.	<u>Moderate to major, long-term, beneficial impacts</u> as the additional quantity of material on the beach would foster foredune development.	<u>Moderate, long-term, beneficial impacts</u> as the sediment placed on the beach would allow for additional sediment supply to create foredunes.
Aquatic Fauna	<u>Minor, short-term, adverse impacts</u> as fish would be temporarily displaced due to turbidity, and the benthic communities would be smothered during the placement of sediment. Impacts would be localized to the placement area. <u>Negligible, short-term, adverse impacts</u> as nourishment activities would result in a disrupted environment, which would allow for the introduction/establishment of invasive and nonnative species.	<u>Minor, short-term, adverse impacts</u> as fish would be temporarily displaced due to turbidity. The benthic communities would be temporarily smothered during placement of sediment. <u>Negligible, short-term, adverse impacts</u> as nourishment activities would result in a disrupted environment, which would allow for the introduction/establishment of invasive and nonnative species. <u>Minor, long-term, beneficial effects</u> from reducing erosion in the area and enhancing the fish and benthic habitat.	<u>Moderate to major, short- and long-term, adverse impacts</u> due to the nourishment placement activities. Fish would be displaced, and fish life cycles would be interrupted. The larger footprint of the placement area would result in smothering of the benthic communities along most of reach 3. <u>Negligible, short-term, adverse impacts</u> as nourishment activities would result in a disrupted environment, which would allow for the introduction/establishment of invasive and nonnative species. <u>Minor, long-term, beneficial effects</u> from reducing erosion in the area and enhancing the fish and benthic habitat.	<u>Minor, short-term, adverse impacts</u> as fish would be temporarily displaced due to turbidity. The benthic communities would be temporarily smothered during placement of sediment. <u>Negligible, short-term, adverse impacts</u> as nourishment activities would result in a disrupted environment, which would allow for the introduction/establishment of invasive and nonnative species. <u>Minor, long-term, beneficial effects</u> from reducing erosion in the area and enhancing the benthic and fish habitat.
Terrestrial Habitat	<u>Minor, short- and long-term, adverse impacts</u> from the erosion and destabilization of habitat that would continue from taking no new actions in the park, including any actions to invite or deter invasive and nonnative plants. Taking no new actions in the park would not improve the ability of the beach to withstand storm events and preserve habitat for plants and animals.	<u>Negligible to minor, short-term, adverse effects</u> from re-vegetation that would affect sensitive habitat and as some beach vegetation would be smothered during placement. <u>Minor, short-term, beneficial impacts</u> from nourishment of the park shoreline, particularly in areas of accelerated erosion. <u>Negligible to minor, short-term, beneficial impacts</u> since material dredged from the lake bottom would have no or limited viable nonnative invasive plant species seedbank, and from the improved ability of the beach to withstand storm events and preserve terrestrial habitat for plants and animals.	<u>Negligible to minor, short-term, adverse impacts</u> from re-vegetation that would affect sensitive habitats. <u>Moderate, short-term, beneficial impacts</u> from nourishment of the park shoreline, particularly in areas of accelerated erosion. <u>Moderate, long-term, adverse effects</u> from the approximate six-month duration of placement activities every five years and the larger placement footprint. <u>Negligible to minor, long-term, beneficial impacts</u> since material dredged from the lake bottom would have no or limited viable nonnative invasive plant species seedbank, and from the improved ability of the beach to withstand storm events and preserve terrestrial habitat for plants and animals.	<u>Negligible, short-term, adverse impacts</u> from re-vegetation that would affect sensitive habitats. <u>Minor, short-term, beneficial impacts</u> from nourishment of the park shoreline, particularly in areas of accelerated erosion, and decreased degradation of the beach and consequently the foredune plant communities, resulting in improved terrestrial habitat for native plants and animals to thrive on. <u>Minor, short-term, adverse impacts</u> as some beach vegetation would be smothered during placement. <u>Negligible to minor, short-term, beneficial impacts</u> since material from an updrift location would have no or limited viable nonnative invasive plant species seedbank, and from the improved ability of the beach to withstand storm events and preserve terrestrial habitat for plants and animals.

Impact Topic	Alternative A (No-action Alternative)	Alternative C-1 (Beach Nourishment via Dredged Sources, Annual Frequency)	Alternative C-5 (Beach Nourishment via Dredged Sources, Five-Year Frequency) – Preferred Alternative	Alternative D (Beach Nourishment via Permanent Bypass System)
Threatened and Endangered Species and Species of Concern	<u>Moderate, short-term, adverse impacts</u> from continued erosion, loss of habitat for piping plover and Pitcher’s thistle, and continued sediment budget deficit. <u>May affect, and is likely to adversely affect</u> piping plover and Pitcher’s thistle because development of future habitat is not addressed and substantial erosion would continue. <u>No effect</u> on the Karner blue butterfly, Indiana bat, and eastern massasauga rattlesnake as beach nourishment activities would not affect their habitat.	<u>Moderate to major, short-term, beneficial impacts</u> from the habitat restoration that would result from the expanded beach nourishment activities. Coupled with beach nourishment, dredging would not be an adverse modification to the piping plover habitat. <u>Minor, short-term, adverse impacts</u> as placement of nourishment material would temporarily disturb the ability of piping plover to nest and for Pitcher’s thistle to establish. <u>May affect, but is not likely to adversely affect</u> piping plover and Pitcher’s thistle as beach nourishment activities would result in habitat restoration. <u>No effect</u> on the Karner blue butterfly, Indiana bat, and eastern massasauga rattlesnake as beach nourishment activities would not affect their habitat.	<u>Moderate to major, long-term, beneficial impacts</u> from the habitat restoration that would result from the expanded beach nourishment activities. Coupled with beach nourishment, dredging would not be an adverse modification to the piping plover habitat. <u>Minor to moderate, short-term, adverse impacts</u> on these species as placement of nourishment material would disturb the ability of piping plover to nest and for Pitcher’s thistle to establish. <u>May affect, but is not likely to adversely affect</u> piping plover and Pitcher’s thistle as beach nourishment activities would result in habitat restoration. <u>No effect</u> on the Karner blue butterfly, Indiana bat, and eastern massasauga rattlesnake as beach nourishment activities would not affect their habitat.	<u>Moderate to major, short-term, beneficial impacts</u> as habitat loss would diminish and the possibility of the establishment of a natural ecosystem would be likely. <u>Minor, short-term, adverse impacts</u> during placement activities from the temporary disturbance to habitat, and from the visual intrusions being introduced in to the park during construction of the permanent bypass system. Coupled with beach nourishment, a permanent bypass system would not be an adverse modification to the piping plover habitat. <u>May affect, but is not likely to adversely affect</u> piping plover and Pitcher’s thistle as beach nourishment activities would result in habitat restoration. <u>No effect</u> on the Karner blue butterfly, Indiana bat, and eastern massasauga rattlesnake as beach nourishment activities would not affect their habitat.
Wetlands and Pannes†	Not applicable (see note below).	Not applicable (see note below).	Not applicable (see note below).	Not applicable (see note below).
Soundscape	<u>Minor, short-term adverse impacts</u> from beach nourishment activities related to sound generated from the equipment grading the nourishment material along the beach.	<u>Negligible to minor, short-term, adverse impacts</u> from sound generated by barges and equipment grading the nourishment material along the beach.	<u>Minor to moderate, short-term, adverse impacts</u> from sound generated by barges and equipment grading the nourishment material along the beach.	<u>Negligible to minor, short-term, adverse impacts</u> from the sound that would be generated from construction and associated operation of the permanent bypass system.
Visitor Experience	<u>Minor to moderate, short- and long-term, adverse impacts</u> from continued temporary beach closings and ongoing degradation of popular visitor amenities from continued shoreline erosion.	<u>Minor, short-term, adverse impacts</u> from the visual intrusions introduced into the park (i.e., barges and grading equipment), and from the annual beach and trail closings that would be required during nourishment activities for safety reasons. <u>Minor, short-term, beneficial impacts</u> from the temporary increase in beach size in reach 3 (resulting in an expanded area for visitor use and enjoyment), and from reductions in the amount of maintenance/ restoration work required from decreased erosion (resulting in fewer beach closings).	<u>Moderate, short-term, adverse impacts</u> from extended beach closings, and from visual intrusions being introduced into the visitors’ viewshed (i.e., barges and grading equipment). <u>Minor, short- and long-term, beneficial impacts</u> from the temporary increase in beach size (resulting in an expanded area for visitor use and enjoyment), providing visitors with an expanded area to use and enjoy, and from the reduction in future maintenance/restoration work in the park (which would reduce the number of beach and trail closings).	<u>Minor, short-term, adverse impacts</u> from temporary beach closings, and from the visual intrusions being introduced into the park during construction of the permanent bypass system. <u>Minor, short-term, beneficial impacts</u> from the reduction in future beach closings that would result from less cyclic maintenance and restoration work needing to be performed from reduced erosion, as well as from the temporary increase in beach size (resulting in an expanded area for visitor use and enjoyment). <u>Minor, long-term, adverse impacts</u> from the visual intrusion the pump and lift stations would introduce to the park.
Park Operations	<u>Minor, long-term, adverse impacts</u> from taking no new actions in the park and continuing with the existing clean sediment beach nourishment in reach 3, resulting in growing workload demands and maintenance operation costs for park staff.	<u>Minor, short-term, adverse impacts</u> from the additional demands that would be placed on park staff and park operating budgets to plan and carry out the required actions annually over an approximate two-month period. <u>Minor, short-term, beneficial impacts</u> from the savings and decreased workloads that would result from the reduced maintenance/restoration demands that would come with less shoreline erosion.	<u>Moderate, short-term, adverse impacts</u> from the additional demands that would be placed on park staff and park budgets (for approximately 10 months every five years) to carry out the actions associated with this alternative. <u>Minor, long-term, beneficial impacts</u> from the reductions in maintenance/ restoration work as the actions associated with this alternative would decrease erosion in the park.	<u>Minor to moderate, short- and long-term, adverse impacts</u> from the additional staff time and operating dollars the associated beach nourishment actions would require, especially the routine monitoring and maintenance of the permanent bypass system for the life of this plan. <u>Minor, short-term, beneficial impacts</u> from the associated erosion decrease and resultant decrease in required maintenance/restoration work by park staff (reducing operating budget drains).

Notes:

Short-term: days up to one year.

Long-term: greater than one year.

Additional impacts on the impact topics would result from the proposed management actions specific to the foredune and dune complex (as discussed in “The Alternatives” chapter). The proposed management actions would result in long-term, beneficial impacts as they are intended to improve the ecological quality of the terrestrial environment along Indiana Dunes National Lakeshore.

† The overall acreage or type of wetlands and pannes either within or outside of the project area would not be impacted by the shoreline and beach complex nourishment alternatives listed; rather, impacts on wetlands and pannes as a result of the proposed management actions (as discussed in “The Alternatives” chapter) would be long-term and beneficial.