2016

Calumet Harbor – Bedrock Removal to Authorized Depth

Environmental Assessment

Lake County, IN

September 2016

US Army Corps of Engineers ®
Chicago District

ABSTRACT

Background

Calumet Harbor was authorized by Congress in 1899 and since that time the dimensions, shape, and depth of the Federal channel have been modified by subsequent acts. The authorized depth of Calumet Outer Harbor is set at 28 feet below Lake Michigan Low Water Datum (LWD). The Calumet Harbor and River, Illinois and Indiana Maintenance Dredging and Disposal EIS (USACE 1975 & 1982) assessed the environmental impacts that accompany routine dredging and maintenance efforts in Calumet Harbor and the Calumet River. Naturally occurring dolomitic bedrock outcropping in Calumet Harbor has prevented full maintenance of the shipping channel to the authorized depth, which prevents full use of the navigation channel by deep draft vessels during periods of low lake levels. More conventional alternatives of dredging and disposal were evaluated in prior project documents, but the removal of the bedrock shelf was not considered in either the 1975 or 1982 Environmental Impact Statements (EIS). The purpose of this Environmental Assessment is to evaluate additional alternatives for bedrock removal to achieve the authorized project depth in the Calumet Outer Harbor.

Five alternatives were considered by USACE for the removal of the bedrock outcrop in the Calumet Outer Harbor to achieve the authorized depth of minus 28 feet LWD. The alternatives are described below.

1. No Action – The "No Action" alternative would be to maintain dredging the harbor at the current levels. No attempts would be made to remove bedrock in the harbor to its authorized depth and the full navigation depth would not be available to deep draft vessels during periods of low lake levels. Under low lake level conditions, deep draft vessels would need to light load, which would result in reduced efficiencies.

2. Conventional Mechanical Dredging – This alternative consists of using conventional mechanical dredging equipment. Years of conventional dredging has demonstrated that this method is not effective at rock removal. The rock is not easily broken by conventional dredging equipment nor is there an adequate surface in the bed rock which could be gripped by mechanical equipment, broken off and removed. Because of these limitations, this alternative was eliminated from further consideration.

3. Mechanical Ripping of Bedrock and Removal – This alternative consists of using conventional dredging equipment modified as necessary to mount a pneumatic hammer on the arm of an excavator. The pneumatic hammer is then extended off the side of the barge into water. The hammer is fitted with a carbide-tipped chisel and hammers the bed rock. The excavation rate is usually slow and encounters frequent interruptions to repair the equipment and replace the chisel head. Because of these limitations, this alternative was eliminated from further consideration.

4. Shaped Charges – This alternative is typically used where preventing impacts beyond the area of blasting is not critical and where precision is vital to the success of the project. Blast-deflecting canisters are custom-designed, built and placed on the surface of the bedrock. The effectiveness of blasting on or near the surface with shaped charges is limited in the range of 1-3 feet into the bedrock. The identified need to remove rock varies from 1-5 feet in order to facilitate removal of the rock, provide for sufficient over depth dredging and reduce the frequency of maintenance dredging efforts. A minimum of 2 rounds of shaped charge blasting would be required with removal operations between blasts. All practicable steps to minimize injuries to fish in the area would be taken such as the blasting operations will be specifically scheduled to avoid time periods when fish are typically spawning or migrating. Additionally the use of minor in-water blasts to scare away fish prior to the primary explosive charge, limits on the average and/or peak pressure associated with the explosions, monitoring of the explosive pressure, and

surveillance of fish using vessels equipped with sonar (fish finders) prior to the use of explosives. However, the surface blasting is expected to cause adverse effects to natural resources, including injuries as well as mortality to some fish. Based upon an anticipated high level of environmental effects, cost and time requirements for a multi-pass operation, this alternative was eliminated from further consideration.

5. Drilling and Blasting – This alternative would remove the bedrock through the use of explosives placed in the bedrock. Holes would be drilled on an angle in the bedrock, explosives inserted, the hole capped, and ultimately the explosives would be detonated. The detonated bedrock would be mechanically removed and placed along the base of the breakwater. The bedrock needed to be removed varies from 1-5 feet in order to provide enough over-excavation to facilitate removal of the rock and reduce the frequency of maintenance dredging efforts. Staged removal of the bedrock outcropping would be accomplished through multiple construction events in the 50 acre site identified in Figure 3. The current plan would be to remove up to 17,500 cubic yards of rock from Calumet Outer Harbor. If additional funding becomes available in subsequent years more bedrock would be removed from the Outer Harbor. All practicable steps to minimize injuries to fish in the area would be taken such as scheduling the blasting operations to avoid time periods when native fish are typically spawning or migrating. Additional measures may be taken to minimize the impacts to fish, such as the use of minor in-water blasts to scare away fish prior to the primary explosive charge, limits on the average and/or peak pressure associated with the explosions, monitoring of the explosive pressure, and surveillance of fish using vessels equipped with sonar fish finders prior to the use of explosives. All practicable steps to minimize injuries to native fish in the area would be taken, but the blasting is likely to cause minor adverse effects, including injuries as well as some mortality of fish in the vicinity of the bedrock removal. However, because the blasts are within the bedrock, rather than on the surface of the bedrock, adverse effects to aquatic resources are expected to be substantially less than with the use of surface charges. A detailed blasting plan would be prepared by knowledgeable experts with extensive training and experience, particularly in regards to the chemical and physical effects of underwater blasting, the different blasting agents, materials, methods, and equipment, as well as potential mitigation measures. The timing of the removal would be coordinated with natural resource agencies as well, to further reduce potential impacts to aquatic species.

2.2 – The Preferred Alternative

The preferred alternative is Alternative 5, Drilling and Blasting

Summary of Findings

In accordance with the National Environmental Policy Act of 1969 and Section 122 of the River and Harbor and Flood Control Act of 1970, the U.S. Army Corps of Engineers (USACE) has assessed the environmental impacts associated with this project. The purpose of this Environmental Assessment (EA) is to evaluate the impacts that would be associated with the use of new alternatives to achieve the authorized depth at Calumet Harbor and to determine whether an Environmental Impact Statement needs to be prepared.

The preferred alternative, which includes the removal of bedrock via blasting and mechanical excavation, will result in effects to aquatic resources. While a robust plan will be developed to minimize impacts to the environment during plan execution, there can be impacts to aquatic species including fish and macroinvertebrates. These impacts could include mortality of species within the vicinity of blasting activity. In addition, there will be permanent impacts to local geology through the removal of the bedrock outcropping and temporary impacts to the aquatic environment during drilling, blasting and material removal/placement. While the bedrock removal is permanent, the quantity that will be blasted and excavated is small in comparison to the total volume of bedrock material underlying the Calumet Harbor. There will also be short-term, localized turbidity during blasting and is not expected to persist. Beneficial

impacts of the bedrock removal will facilitate commercial navigation and eliminate the need to light load barges during periods of low lake levels. In addition, bedrock removal will address potential safety and environmental issues associated with the potential for vessel grounding during periods of low lake levels.

The preferred alternative presented in this Environmental Assessment is in compliance with appropriate statutes and executive orders including the Natural Historic Preservation Act of 1966; the Endangered Species Act of 1973; the Fish and Wildlife Coordination Act; EO 12898 (environmental justice); EO 11990 (protection of wetlands); EO 11988 (floodplain management); Coastal Zone Management Plans, and the Rivers and Harbors Act of 1899. The potential project is in compliance with the Clean Air Act; the Clean Water Act, and the National Environmental Policy Act of 1969. There were no significant adverse environmental effects identified which cannot be avoided should the proposal be implemented. There have been no irreversible and irretrievable commitments of resources identified resulting from the proposed action should it be implemented.

The environmental effects of traditional alternatives of mechanical and hydraulic dredging Calumet Harbor were already assessed in the 1975 and 1982 Environmental Impact Statements; the alternative (drilling and blasting) discussed in this EA does not significantly change those identified overall effects. While the preferred plan can result in impacts to aquatic resources, every attempt would be made to reduce the impacts to resident aquatic species. These preliminary findings indicate that the proposed action is not a major Federal action significantly affecting the quality of the human environment. After public review and comments received an updated finding of impacts will be made to determine if an Environmental Impact Statement is necessary.

PLEASE SEND COMMENTS / CONCERNS NLT 01 September 2016 TO:

U.S. Army Corps of Engineers, Chicago District
ATTN: Alex Hoxsie
231 S. LaSalle St, Suite 1500
Chicago, Illinois 60604
or alex.hoxsie@usace.army.mil
312 846 5587

FINDING OF NO SIGNIFICANT IMPACT

Calumet Harbor – Bedrock Removal to Authorized Depth

September 2016

The U.S. Army Corps of Engineers Chicago District (Corps) has conducted an environmental analysis in accordance with the National Environmental Policy Act of 1969, as amended. The Corps assessed the effects of the following proposed action in the Calumet Harbor – Bedrock Removal to Authorized Depth Environmental Assessment dated June 2016, which is incorporated herein by reference:

Drilling and Blasting –
The preferred alternative, Drilling and Blasting includes the removal of the existing bedrock outcropping in the Calumet Outer Harbor through the use of explosives placed into the bedrock. Holes are drilled on an angle in the bedrock, explosives are inserted, the hole is capped and the explosives are detonated. The detonated bedrock would be mechanically removed and placed along the base of the breakwater. The bedrock needed to be removed varies from 1-5 feet in order to provide enough over-excavation to facilitate removal of the rock and reduce the frequency of maintenance dredging efforts. Staged removal of the bedrock outcropping will be accomplished through multiple construction events. The current plan is to remove up to 17,500 cubic yards of rock from Calumet Outer Harbor. If additional funding becomes available in subsequent years more bedrock will be removed from the Outer Harbor. All practicable steps to minimize injuries to fish in the area will be taken such as the blasting operations will be scheduled to avoid time periods when native fish are typically spawning or migrating. Additional measures may be taken to minimize the impacts to fish, such as the use of minor in-water blasts to scare away fish prior to the primary explosive charge, limits on the average and/or peak pressure associated with the explosions, monitoring of the explosive pressure, and surveillance of fish using vessels equipped with sonar fish finders prior to the use of explosives. All practicable steps to minimize injuries to native fish in the area will be taken, but the blasting is likely to cause minor adverse effects, including injuries as well as some mortality of fish in the vicinity of the bedrock removal. However, because the blasts are within the bedrock, rather than on the surface of the bedrock, adverse effects to aquatic resources are expected to be substantially less than with the use of other blasting methods. Use of traditional dredging equipment, or the use of pneumatic hammers were eliminated based on their ineffectiveness at removal. A detailed blasting plan will be prepared by knowledgeable experts with extensive training and experience, particularly in regards to the chemical and physical effects of underwater blasting, the different blasting agents, materials, methods, and equipment, as well as potential mitigation measures. The timing of the removal will be coordinated with natural resource agencies as well, to further reduce potential impacts to aquatic species.

All practicable means to avoid and minimize significant adverse environmental effects have been incorporated into the Preferred Alternative. The Preferred Alternative would not result in any impacts to federally-listed threatened or endangered species or their designated critical habitat, would have no impact to sites listed on or eligible for inclusion on the National Register of Historic Places, would not adversely affect any wetlands or water of the United States. The preferred alternative, which includes the removal of bedrock via blasting and mechanical excavation, will result in effects to aquatic resources. While a robust plan will be developed to minimize impacts to the environment during plan execution, there can be impacts to aquatic species. These impacts could include mortality of species within the vicinity of blasting activity. In addition, there will be permanent impacts to local geology through the removal of the bedrock outcropping and temporary impacts to the aquatic environment during drilling, blasting and material removal/placement. While the bedrock removal is permanent, the quantity that will be blasted and excavated is small in comparison to the total volume of bedrock material underlying the

Calumet Harbor. There will also be short-term, localized turbidity during blasting and is not expected to persist. Beneficial impacts of the bedrock removal will facilitate commercial navigation and eliminate the need to light load barges during periods of low lake levels. In addition, bedrock removal will address potential safety and environmental issues associated with the potential for vessel grounding during periods of low lake levels.

All applicable laws, executive orders, regulations, and local government plans were considered in the evaluation of the alternatives. It is my determination that the recommended alternative does not constitute a major federal action that would significantly affect the human environment; therefore, preparation of an Environmental Impact Statement is not required.

Date: 15 SEP 2016

Christopher T. Drew
Colonel, U.S. Army
District Commander

CALUMET HARBOR – BEDROCK REMOVAL TO AUTHORIZED DEPTH

ENVIRONMENTAL ASSESSMENT

September 2016

TABLE OF CONTENTS

2.2 – THE PREFERRED ALTERNATIVE II
CHAPTER 1 – PURPOSE & NEED 2
1.1 ENVIRONMENTAL ASSESSMENT STRUCTURE 2
1.2 AUTHORIZING LEGISLATION 2
1.3 PROJECT PURPOSE & NEED 3
1.4 STUDY AREA 4
1.5 PRIOR DOCUMENTS & ASSESSMENTS 7
1.5.1 – USACE NEPA Documents Covering O&M Activities 7
1.5.2 – Reference Documents for Effects Assessment 7
1.5.3 – Similar Topic Documents 7
CHAPTER 2 – ALTERNATIVES CONSIDERED 8
2.2 – THE PREFERRED ALTERNATIVE 9
CHAPTER 3 – AFFECTED ENVIRONMENT 11
3.1 HISTORIC SETTING 11
3.2 PHYSICAL RESOURCES 11
3.2.1 Geology 11
3.2.2 Coastal Hydraulics & the Littoral Drift 12
3.2.3 Water Quality 12
3.2.4 Substrate Types & Sediment Quality 12
3.2.5 HTRW Assessment 13
3.2.6 Air Quality 13
3.3 ECOLOGICAL RESOURCES 14
3.3.1 Lacustrine Habitat 14
3.3.2 Riverine Habitat 14
3.3.3 Aquatic Macroinvertebrates 14
3.3.4 Freshwater Mussels 15
3.3.5 Fishes 15
3.3.6 Reptiles & Amphibians 16
3.3.7 Birds 17
3.3.8 Mammals 17
3.3.9 Threatened and Endangered Species 17
3.4 CULTURAL & SOCIAL RESOURCES 18
3.4.1 Archaeological & Historical Properties 18
3.4.2 Social Setting 18
3.4.3 Native American Coordination 18
3.4.3 Recreation 19
CHAPTER 4 – EFFECTS ASSESSMENT 19
4.1 – NO ACTION ALTERNATIVE 19
4.2 DIRECT & INDIRECT EFFECTS OF THE PREFERRED ALTERNATIVE 19
4.2.1 Physical Resources 20
4.2.2 Ecological Resources 21
4.2.3 Cultural Resources 24
4.2.4 17 Points of Environmental Quality 25

4.3 CUMULATIVE EFFECTS 26
4.3.1 Scope of Cumulative Effects Analysis 26
4.3.2 Cumulative Effects on Resources 27
CHAPTER 5 – COMPLIANCE & COORDINATION 29
CHAPTER 6 – MEASURES SUPPORTING THE PREFERRED ALTERNATIVE 34
6.1 – MEASURES DURING CONSTRUCTION 34
6.2 – MONITORING BEFORE, DURING & AFTER CONSTRUCTION 34
6.2.1 – Fish Monitoring 34
6.2.2 – Water Quality Monitoring 34
6.3 FINDING OF NO SIGNIFICANT IMPACT (FONSI) 35
BIBLIOGRAPHY 36

List of Figures

Figure 1: Location of Calumet Harbor within Illinois and Indiana 4
Figure 2 Calumet Harbor Federal Project Aerial View 5
Figure 3 Plan View of the Preferred Alternative 6
Figure 4: Screen Capture of USEPA's EJ Mapping Tool, 29 June 2016 30

List of Tables

Table 1: Calumet Harbor & River Authorization Timeline 3
Table 2: Fishes Recorded from within 2-mile Radius of Calumet Harbor 1878-2010. 15

List of Appendices

Appendix A: 404(b)(1) Analysis
Appendix B: Coordination Letters
Appendix C: Supporting Documents

List of Acronyms

CPD	Chicago Park District
DPR	Detailed Project Report
DO	Dissolved Oxygen
EOP	Environmental Operating Principals
FONSI	Finding of No Significant Impact
GIS	Geographic Information System
HSI	Habitat Suitability Index
ILDNR	Illinois Department of Natural Resources
INDNR	Indiana Department of Natural Resources
IDEM	Indiana Department of Environmental Management
IEPA	Illinois Environmental Protection Agency
MWRDGC	Metropolitan Water Reclamation District of Greater Chicago
NBCR	North Branch Chicago River
NSC	North Shore Channel
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
PMP	Project Management Plan
PPA	Project Partnership Agreement
SHPO	State Historic Preservation Office
TSA	Tentatively Selected Alternative
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
WRDA	Water Resources Development Act

CHAPTER 1 – Purpose & Need

1.1 Environmental Assessment Structure

This Environmental Assessment (EA) presents the assessment of ecological, cultural and social conditions affected by the Preferred Alternative and a cumulative effects determination. Prior project documents, including two Environmental Impact Statements (EIS) documented the environmental, cultural and social conditions associated with the operations and maintenance activities for the Calumet Harbor Federal project. This EA is limited to an analysis of the Preferred Alternative of Drilling and Blasting, which was not considered in earlier NEPA documents. This report describes historic and current site conditions of the project, along with the environmental effects. This EA contains the following chapters and appendices:

Chapter 1 – *Purpose & Need*: introduces the project, provides why this project is needed, provides a description of the study area, and provides a summary of NEPA documentation already covering various project activities

Chapter 2 – *Alternatives Considered:* provides the array of alternatives considered for the removal of bedrock to the congressionally authorized depth and identifies the Preferred Alternative

Chapter 3 – *Affected Environment:* contains an inventory or description of the study area, which includes an assessment of applicable historic and current conditions;

Chapter 4 – *Effects Assessment:* provides a description of potential effects and their significance to physical, ecological and cultural resources within the surrounding environment

Chapter 5 – *Compliance & Coordination:* provides summary of coordination with regulating agencies and the public and compliance with major environmental laws, statues, executive orders and principles

Chapter 6 – *Supportive Measures to the FONSI*: provides a description of those measures to be implemented for the purpose of offsetting minor environmental affects, these are preemptive measures to avoid or reduce injury to fish & wildlife resources

Appendix A- *404(b)(1) Analysis*: provides the anti-degradation assessment for subaqueous ordinance detonation and the placement of dolomitic bedrock rubble within the Waters of the Unites States

Appendix B- *Coordination Letters*: provides copies of all correspondence between the Corps, regulating agencies and the public

Appendix C- *Supporting Documents*: provides those documents incorporated by reference

1.2 Authorizing Legislation

Rivers and Harbors Acts of 1899, 1902, 1935, 1960, 1962, and 1965.

Originally authorized by the Rivers and Harbors Act of 1899, Calumet Harbor is a deep draft commercial harbor. The harbor is protected by 12,153 linear feet of steel sheet pile and timber crib breakwater structures. The Calumet Harbor and River is comprised of an Approach Channel, an Outer Harbor Channel, an Entrance Channel and a River Channel. Two miles of breakwater protect the Outer Harbor Channel. The Approach and Outer Harbor Channels are mainly in Indiana and span approximately 4.4

miles. The Entrance Channel and River Channel are in Illinois and extend approximately 6.7 miles up the Calumet River to Lake Calumet. There are three turning basins along the River Channel; numbered 1, 3 and 5. Authorized depths are 29 feet below Lake Michigan Low Water Datum (LWD) in the Approach Channel, 28 feet below LWD in the Outer Harbor and 27 feet below LWD in the River. This project is maintained by Chicago District, Corps of Engineers.

Table 1: Calumet Harbor & River Authorization Timeline

River & Harbor Act (Law)	Work Authorized	Documents
1899 (30 Stat 1121), 1902 (32 Stat 331)	Outer harbor protected by breakwaters (Calumet Harbor), deepening of entrance channel and 2 miles of river (Calumet River).	Annual Report, 1896 pp. 2584 et.seq. and H. Doc. 277, H.54th Congress, 1st Session
1905 (33 Stat 1117)	Five turning basins (Calumet River)	H. Doc. 172, 58th Congress, 2nd Session
1910 (36 Stat 630)	Provided shape and dimensions of turning basins (Calumet River)	H. Doc. 349, 60th Congress, 1st Session
1922 (43 Stat 1009)	Consolidation of Calumet Harbor and Calumet River	--
1935 (PL[1] 74-409)	Detached breakwater, deepening and widening of outer harbor; deepening, widening and straightening of river channel; authorization of turning basin depth equivalent to adjacent channel.	H. Doc 494, 72nd Congress, 2nd Session
1935 (PL 74-409)	Extension of channel to south end of Lake Calumet; deepening and widening of entrance channel.	H. Doc. 180, 73rd Congress, 2nd Session
1945 (PL 79-14)	Authorization of 3,200 ft wide and 28 ft deep approach channel to harbor through shoals outside breakwater; closing of existing gap between breakwaters	H. Doc. 233, 76th Congress, 1st Session
1960 (PL 86-645)	Authorization of 29-ft depth in approach channel, 28-ft depth in outer harbor, and 27-ft in river entrance channel (up to Elgin, Joliet and Eastern Railway (EJ&E) Bridge).	H. Doc. 149, 86th Congress, 1st Session
1962 (PL 87-874)	Deepening, widening, and straightening river channel, from EJ&E Bridge up to and including turning basin 5, to a depth of 27 ft in earth and 28 ft in rock; deepening turning basins 1, 3 and 5 to 27 ft; enlarge turning basins 3 and 5; a 3,000-ft long, 1,000-ft wide and 27-ft deep channel in Lake Calumet; de-authorization of turning basins 2 and 4.	H. Doc 581, 87th Congress, 2nd Session
1965 (PL 89-298)	Protection for EJ&E Bridge over the Calumet River, to permit dredging to full width of the south draw to depth of 27 ft, and temporary protection for the center pier and south abutment of the New York, Chicago and St. Louis Railroad Bridge to permit dredging of full width of south bridge draw to depth of 27 ft prior to its replacement	H. Report 973, 89th Congress, 1st Session

1.3 Project Purpose & Need

Navigation is one of the high priority civil works missions for the U.S. Army Corps of Engineers (USACE), and the overall goal of the navigation mission is to provide safe, reliable, and efficient waterborne transportation systems (i.e., channels, harbors, and waterways) for commerce, national security and recreation. The purpose and need of establishing the outer harbor depth at 28 feet below LWD is addressed in The Calumet Harbor and River, Illinois and Indiana Maintenance Dredging and Disposal EIS (USACE 1975). The harbor is a primary link between the Inland Waterway system, the Great Lakes, and foreign ports. From this harbor, deep-draft ships can reach the Atlantic Ocean through the St. Lawrence Seaway, and barges can reach the Gulf of Mexico through the Illinois and Mississippi Rivers. The harbor is the most accessible refuge on southern Lake Michigan due to its ease of entry during storms. It permits the safe operation of over 3,000 river barges annually between the Inland-

Waterway system and Indiana harbors. Major commodities are coal, limestone, petroleum products, cement and concrete. Nearly 3 million tons of coal is shipped from Calumet Harbor. Commercial navigation activities at Calumet Harbor and River support approximately 4,440 jobs and generate more than $260 million in labor income annually. The amount of goods is significant, with more than 12 million tons (5 year average) moved at Calumet Harbor between 2010 and 2014.

1.4 Study Area

The Calumet Harbor Federal Project is located on the southwest shore of Lake Michigan in Cook County, Illinois and Lake County, Indiana (Figure 1). The approach channel and outer harbor are located in Lake County, Indiana. Figure 2 depicts the federal project at Calumet Harbor. Figure 3 includes a plan view of the bedrock removal area and disposal location within the Outer Harbor.

The Calumet Outer Harbor is an area of approximately fifty (50) acres which includes a limestone outcropping where the elevation of the bedrock surface extends above or near the authorized dredge depth. This area is identified on Figure 3. Staged removal of the bedrock outcropping will be accomplished through multiple construction events. The current plan is to remove up to 17,500 cubic yards of rock from Calumet Outer Harbor which is located roughly a mile lakeward from the shoreline. This effort will remove rock starting at the center of the channel and working out towards the breakwater. Should future funding become available, additional efforts will be undertaken to complete the bedrock removal the authorized -28' LWD using Drilling and Blasting, as the Preferred Alternative.

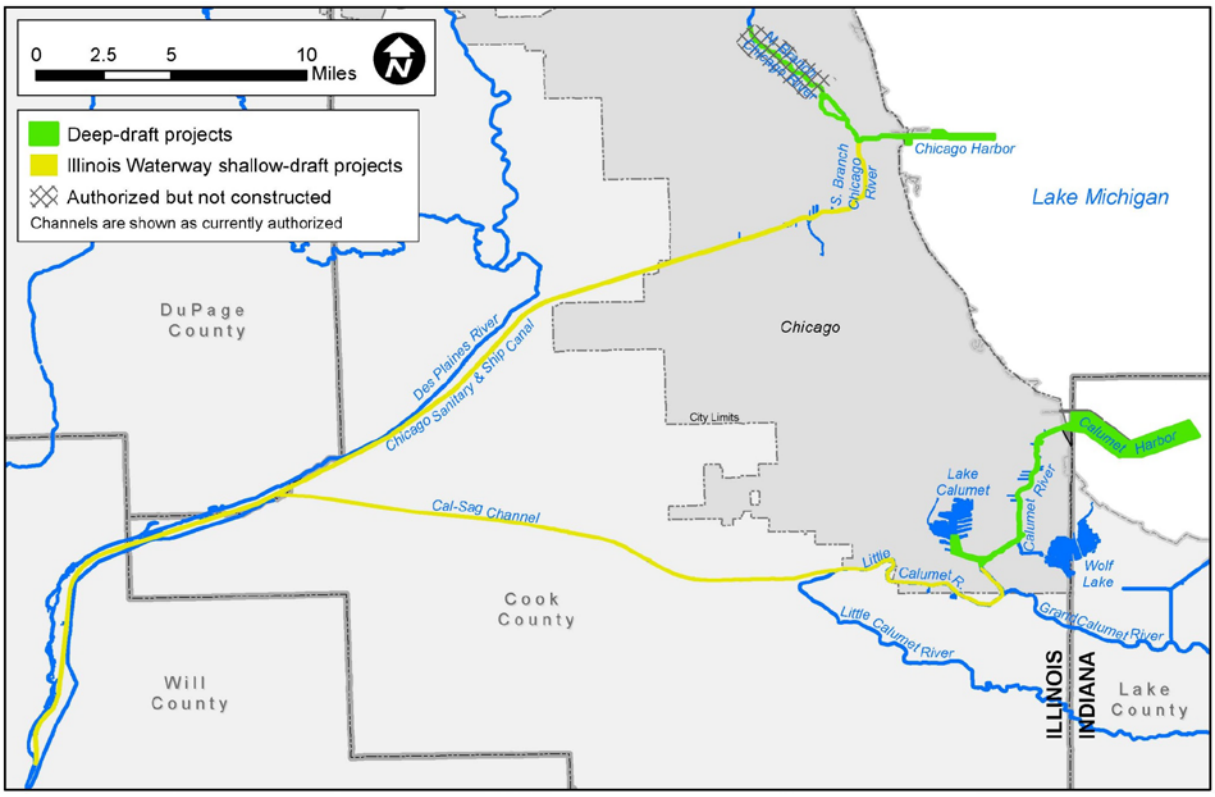

Figure 1: Location of Calumet Harbor within Illinois and Indiana

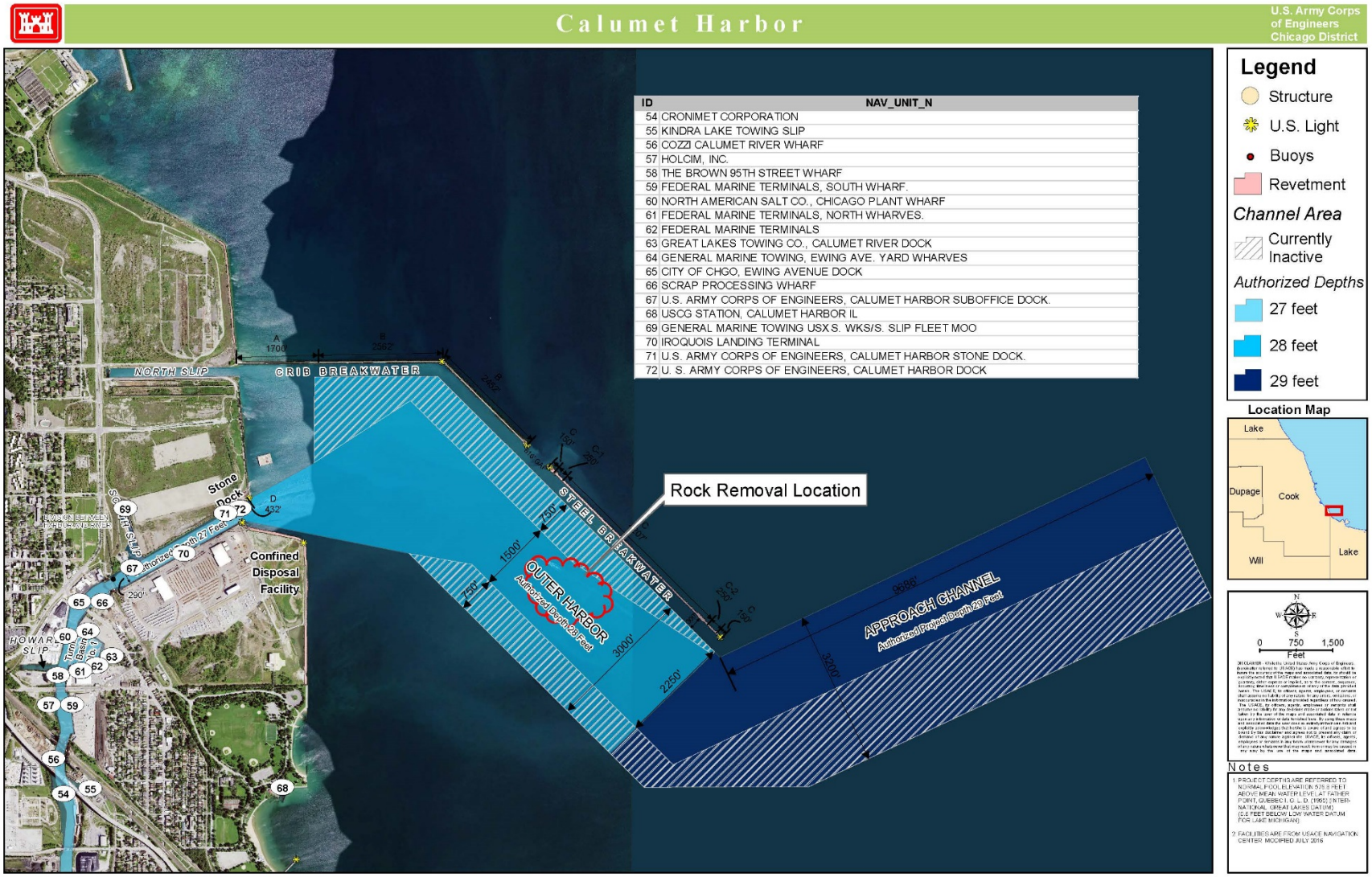

Figure 2 Calumet Harbor Federal Project Aerial View

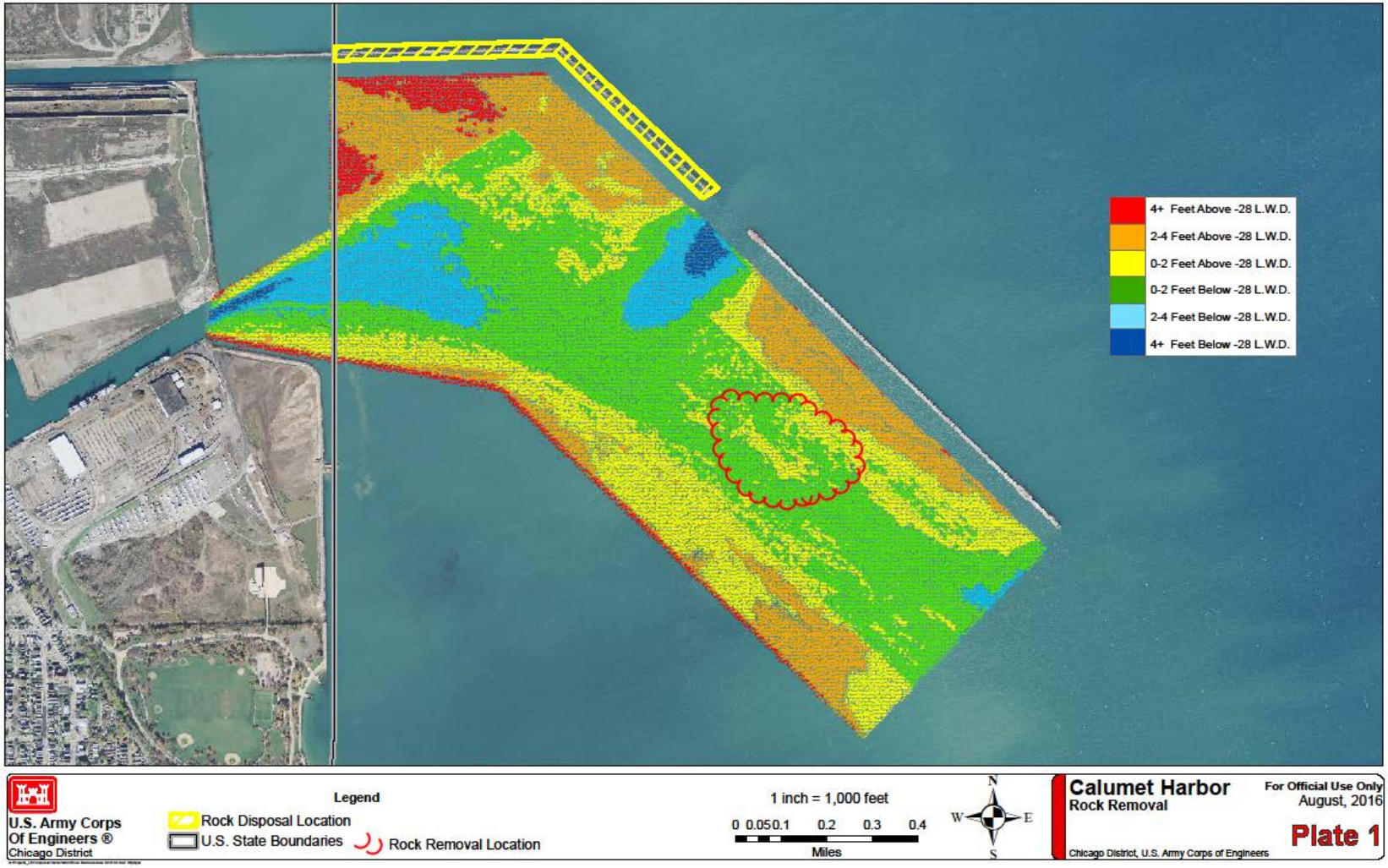

Figure 3 Plan View of the Preferred Alternative

1.5 Prior Documents & Assessments

1.5.1 – USACE NEPA Documents Covering O&M Activities

The following documents cover all of the operation and maintenance activities for the Calumet Harbor Federal project to date. This Environmental Assessment covers the Preferred Alternative of Drilling and Blasting to remove the remaining material in the authorized channel, which was not covered under previous NEPA documents.

- USACE. 1975. Environmental Impact Statement for the Calumet Harbor and River, Illinois and Indiana Maintenance Dredging and Disposal.

- USACE. 1982. Environmental Impact Statement (Final) for the Chicago Area Confined Disposal Facility & Maintenance Dredging in Cook County.

- USACE. 1988. Environmental Assessment for Proposed Breakwater Rehabilitation at Calumet Harbor, Lake County, Indiana and Cook County, Illinois.

- USACE. 1989. Calumet Harbor Lighthouse Foundation Repair: Compliance with National Historic Preservation Act of 1966.

- USACE. 1889. Calumet Harbor Breakwater Major Rehabilitation Borrow Area, Dodge County, Wisconsin.

- USACE. 1998. Record of Decision for the Chicago Area Confined Disposal Facility Supplemental Environmental Impact Statement.

1.5.2 – Reference Documents for Effects Assessment

- Young, G.A. 1973. Guide-Lines for Evaluating the Environmental Effects of Underwater Explosion Tests. Naval Ordnance Laboratory, White Oak, Silver Spring, Maryland.

- Keevin, T.M. & G.L. Hempen. 1997. The Environmental Effects of Underwater Explosions with Methods to Mitigate Impacts. USACE, St. Louis District.

1.5.3 – Similar Topic Documents

- USACE. 1991. ETL 1110-8-11(FR). Engineering and Design: Underwater Blast Monitoring.

- Hempen, G. L., T. M. Keevin, M. T. Rodgers, and B. M. Schneider. 2014. Mechanical rock grinding in the Mississippi River: Anthropogenic noise production and implications for the federally endangered Pallid Sturgeon, *Scaphirhynchus albus*. Journal of Applied Ichthyology 30:1492-1496.

CHAPTER 2 – Alternatives Considered

Five alternatives were considered by USACE for the removal of the bedrock outcrop in the Calumet Outer Harbor to achieve the authorized depth of minus 28 feet LWD. The alternatives are described below.

1. No Action – The "No Action" alternative would be to maintain dredging the harbor at the current levels. No attempts would be made to remove bedrock in the harbor to its authorized depth and the full navigation depth would not be available to deep draft vessels during periods of low lake levels. Under low lake level conditions, deep draft vessels would need to light load, which would result in reduced efficiencies.

2. Conventional Mechanical Dredging – This alternative consists of using conventional mechanical dredging equipment. Years of conventional dredging has demonstrated that this method is not effective at rock removal. The rock is not easily broken by conventional dredging equipment nor is there an adequate surface in the bedrock that could be gripped by mechanical equipment, broken off and removed. Because of these limitations, this alternative was eliminated from further consideration.

3. Mechanical Ripping of Bedrock and Removal – This alternative consists of using conventional dredging equipment modified as necessary to mount a pneumatic hammer on the arm of an excavator. The pneumatic hammer would be then extended off the side of the barge into water. The hammer would be fitted with a carbide-tipped chisel and hammers the bedrock. The excavation rate is usually slow and encounters frequent interruptions to repair the equipment and replace the chisel head. Because of these limitations, this alternative was eliminated from further consideration.

4. Shaped Charges – This alternative is typically used where preventing impacts beyond the area of blasting is not critical and where precision is vital to the success of the project. Blast-deflecting canisters would be custom-designed, built and placed on the surface of the bedrock. The effectiveness of blasting on or near the surface with shaped charges is limited in the range of 1-3 feet into the bedrock. The identified need to remove rock varies from 1-5 feet in order to facilitate removal of the rock, provide for sufficient over-depth dredging and reduce the frequency of maintenance dredging efforts. A minimum of two rounds of shaped charge blasting would be required with removal operations between blasts. All practicable steps to minimize injuries to fish in the area would be taken such as the blasting operations specifically scheduled to avoid time periods when fish are typically spawning or migrating. Additionally the use of minor in-water blasts to scare away fish prior to the primary explosive charge, limits on the average and/or peak pressure associated with the explosions, monitoring of the explosive pressure, and surveillance of fish using vessels equipped with sonar (fish finders) prior to the use of explosives would be considered. However, the surface blasting is expected to cause adverse effects to natural resources, including injuries as well as mortality to some fish. Based upon an anticipated high level of environmental effects, cost and time requirements for a multi-pass operation, this alternative was eliminated from further consideration.

5. Drilling and Blasting – This alternative removes the bedrock through the use of explosives placed in the bedrock. Holes would be drilled on an angle in the bedrock, explosives inserted, the hole capped, and ultimately the explosives would be detonated. The detonated bedrock would be mechanically removed and placed along the base of the breakwater. The bedrock needed to be removed varies from 1-5 feet in order to provide enough over-excavation to facilitate removal of the rock and reduce the frequency of maintenance dredging efforts. Staged removal of the bedrock outcropping would be accomplished through multiple construction events in the 50-acre site identified in Figure 3. The current plan is to remove up to 17,500 cubic yards of rock from Calumet Outer Harbor. If additional funding becomes

available in subsequent years more bedrock would be removed from the Outer Harbor. All practicable steps to minimize injuries to fish in the area would be taken such as scheduling the blasting operations to avoid time periods when native fish are typically spawning or migrating. Additional measures may be taken to minimize the impacts to fish, such as the use of minor in-water blasts to scare away fish prior to the primary explosive charge, limits on the average and/or peak pressure associated with the explosions, monitoring of the explosive pressure, and surveillance of fish using vessels equipped with sonar fish finders prior to the use of explosives. All practicable steps to minimize injuries to native fish in the area would be taken, but the blasting would be likely to cause minor adverse effects, including injuries as well as some mortality of fish in the vicinity of the bedrock removal. However, because the blasts are within the bedrock, rather than on the surface of the bedrock, adverse effects to aquatic resources are expected to be substantially less than with the use of surface charges. A detailed blasting plan would be prepared by knowledgeable experts with extensive training and experience, particularly in regards to the chemical and physical effects of underwater blasting, the different blasting agents, materials, methods, and equipment, as well as potential mitigation measures. The timing of the removal would be coordinated with natural resource agencies as well, to further reduce potential impacts to aquatic species.

2.2 – The Preferred Alternative

Drilling and Blasting – The Preferred Alternative for removing the upper layer of bedrock is through the use of underwater explosives (blasting). Holes are drilled on an angle in the bedrock and explosives are inserted and the hole is capped and ultimately the explosives are detonated. The detonated bedrock is then mechanically removed and placed along the base of the breakwater. The rock needed to be removed varies from 1-5 feet, in order to provide enough over-excavation to facilitate removal of the rock and reduce the frequency of maintenance dredging efforts. Staged removal of the bedrock outcropping will be accomplished through multiple construction events in the 50 acre site identified in Figure 3. The current plan is to remove up to 17,500 cubic yards of rock from Calumet Outer Harbor. If additional funding becomes available in subsequent years more bedrock will be removed from the Outer Harbor. The USACE, Chicago District will strictly enforce safe work practices to help ensure worker safety and several protective measures will be implemented in order to minimize adverse effects to environmental and aquatic resources in the vicinity. In order to minimize the adverse effects of blasting on fish populations, the blasting operations will be specifically scheduled to avoid time periods when fish are typically spawning or migrating. Furthermore, additional measures may be taken to minimize the impacts to fish, such as the use of minor in water blasts to scare away fish prior to the primary explosive charge, limits on the average and/or peak pressure associated with the explosions, monitoring of the explosive pressure, and surveillance of fish using vessels equipped with sonar fish finders prior to the use of explosives. All practicable steps to minimize injuries to fish in the area will be taken, but the blasting is likely to cause minor adverse effects, including injuries as well as some mortality of fish. A detailed blasting plan will be prepared by knowledgeable experts with extensive training and experience, particularly in regards to the chemical and physical effects of underwater blasting, the different blasting agents, materials, methods, and equipment, as well as potential mitigation measures. Another important component of the effort to minimize impacts is the thorough evaluation of the aquatic resources in the area that is described in the Environmental Assessment. This evaluation helps to identify practicable and protective steps that can be taken to limit the mortality or potential injuries to aquatic life.

Based on a preliminary investigation, the existing dolomitic limestone bedrock was found to be porous due to abundant small cavities and it contained many fractures (GEI Consultants 2014). Prior to any blasting work, a preliminary survey of conditions will be performed to verify the elevations of the harbor floor. It has been estimated that an array of 15-foot deep holes diagonally drilled in a grid pattern 15 by 15 feet will be necessary to achieve rock fragmentation sufficient to remove the necessary rock to the authorized elevation. The equipment necessary for drilling would include drill(s) capable of drilling 6-

inch diameter holes on an angle a minimum of 25 feet into rock, a spud or jack-up barge, compressors, other supporting equipment, and a tow boat to move the work plant. Necessary equipment specifically for blasting would include all components of the explosive agents, safety equipment, storage and equipment necessary to place the explosives in the holes. The exact borehole array, size, depth, blast design and specifics of the means and methods and equipment used will be developed by the contractor with an approved Blasting Consultant, and submitted for USACE approval following award of the contract.

Due to the porosity and fractures contained in the bedrock and the imprecision of using underwater explosives, it has been estimated that the proposed blasting will likely result in the removal of the upper three to five feet of bedrock, which is sufficient to allow future navigational maintenance dredging to the authorized channel depth. The total estimated volume of bedrock that is anticipated to be removed from the entire fifty -acre area is approximately 50,000 to 100,000 cubic yards. The bulk quantity of this broken bedrock would subsequently be dredged using conventional mechanical dredging equipment. After the predominantly rocky material is dredged and placed into a split-hull scow/barge, the material would then be transported to locations along and adjacent to the Calumet Harbor breakwater in the State of Indiana. The predominantly rocky material will be placed on both the Lake Michigan and Calumet Harbor sides of the breakwater, near the toe of the structure. The placement of the material near the toe of the breakwater is expected to increase the stability and resilience of the structure since the rock material could dissipate some of the wave energy and reduce scouring that occurs as a result of adverse weather conditions, when high winds, large waves, and/or powerful currents are generated. Although there is existing armor rock along sides and toe of the breakwater, it is anticipated that the placement of the predominantly rocky material will create additional shelter and habitat for certain aquatic plants and organisms.

CHAPTER 3 – AFFECTED ENVIRONMENT

The purpose of this step is to develop an inventory and forecast of critical resources (physical, environmental, social, etc.) relevant to the Preferred Alternative under consideration. This information is used to define and characterize direct, indirect and cumulative effects. A qualitative description of these resources is made for past, current and future with project conditions. Current conditions are those at the time the study is conducted, where past conditions are those that led up to the present within documented history. The forecast of the future with-project condition predicts the most likely conditions expected as result of the Preferred Alternative.

3.1 Historic Setting

The portion of Lake Michigan in which Calumet Harbor now resides was extremely modified from the natural condition in some aspects, and relatively similar in others. Before the late 1800s, the area was a freshwater estuarine system of the Calumet River, and the littoral zone of a large, oligotrophic lacustrine system called Lake Michigan. These two systems had interfaced to create a highly diverse aquatic ecosystem for plants and a multitude of resident and migratory fishes and birds. As the mid-1800s dawned, the City of Chicago began to be developed, which included navigation systems within Lake Michigan and confluent streams. As a result, the freshwater estuarine system was irretrievably altered within the river and river mouth, containing little to none of the aquatic bed, hemi-marsh and meadow habitats that were historically present. The lacustrine system has also been irretrievably altered through extensive shoreline hardening and the placement of engineered structures within the littoral drift zone. Remaining natural features of the Calumet Harbor and River include the sandy substrates with intermittent outcroppings of dolomitic limestone (Niagara Escarpment) within the deeper littoral zone.

Due to the significant modification of historic natural processes, alternation or destruction of habitat structure, non-sustainable overfishing (Smiley 1882; Koelz 1927), discharge of contaminants, and the introduction of a large number of non-native and invasive species the Calumet Harbor and River bear little resemblance to the ecosystem present prior to development.

Based on decades of environmental impacts to the Calumet Harbor and surrounding area of assessment, the current focus is to protect clean water for drinking, support the moderately healthy population of Yellow Perch (*Perca flavescens*), support an increasing population of Smallmouth Bass (*Micropterus dolomieu*), ensuring populations of Whitefish and Chubs (Salmonidae:Coregoninae) are not further damaged, supporting the significant Lake Michigan route of the Mississippi flyway, and providing protection to what seems to be a wider spread population of the State (IL) protected Mudpuppy (*Necturus maculosus*). Calumet Harbor is also utilized heavily for recreation, including beach going, swimming, boating, hunting and fishing.

3.2 Physical Resources

The following information is on the physical, chemical and other abiotic resources pertinent to bedrock removal within Calumet Harbor.

3.2.1 Geology

Geology – The underlying regional bedrock is Silurian-age dolomite of the Niagaran Series. This rock resulted from marine deposition when all of northeastern Illinois and much of the neighboring Great Lakes region was the floor of a tropical sea from about 440 to 410 million years ago. This formation is the

foundations for Great Lakes alvars and reefs. This is the bedrock that would be removed to the authorized navigation depths under the Preferred Alternative.

3.2.2 Coastal Hydraulics & the Littoral Drift

The coastal wave climates and subsequent littoral drift was studied and characterized in the past by Chrzastowski & Trask (1995). In summary, waves generated by large storms are attenuated and/or blocked by the outer breakwaters of Calumet Harbor. This provides a relatively calm aquatic area within the harbor. The resulting littoral drift from continuous wave action moves in an easterly direction within this zone. The littoral sands are not sequestered by Calumet Harbor structures, but they are attenuated. This is provided by evidence that the navigation channel continually fills with lacustrine sands. This is the main type of material dredged/removed to keep the navigation channel clear for use by commercial ships.

3.2.3 Water Quality

Section 303(d) of the Clean Water Act (CWA) requires states, territories, and authorized tribes to report to the U.S. Environmental Protection Agency (USEPA) on the quality of surface waters (e.g. lakes, streams, Lake Michigan, wetlands). "Impaired" waters are defined as those not meeting water quality standards, and "threatened" waters are those not expected to meet water quality standards by the next listing cycle. The Illinois Environmental Protection Agency (EPA) prepares a 303(d) report every other year and has delineated impairments to designated uses in Calumet Harbor.

In 2014, the Illinois EPA Lake Michigan Monitoring Program (LMMP) assessed all 196 mi^2 of Lake Michigan open-waters and rated them as Fully Supporting for the following uses: Aquatic Life, Primary Contact (e.g., swimming, water skiing), Secondary Contact, and Public and Food Processing Water Supplies. However, Fish Consumption use in the Illinois portion of Lake Michigan was assessed as Not Supporting (Poor) due to contamination from polychlorinated biphenyls (PCBs) and mercury. The sources for this contamination were identified as atmospheric deposition and unknown sources. Aesthetic quality use was assessed as Not Supporting due to exceedances of the Lake Michigan open water standard for total phosphorus. In addition, all Lake Michigan beaches in Illinois were assessed as Not Supporting (Poor) for Primary Contact use as determined by testing for the presence of *Escherichia coli* bacteria (Illinois EPA 2014). As of the 2014 303(d) report Calumet Harbor was Fully Supporting of Aquatic Life but Not Supporting for Fish Consumption due to mercury and PCBs.

3.2.4 Substrate Types & Sediment Quality

Substrate types within the Calumet Harbor are predominantly littoral sands. Intermittent clay and gravel/cobble lenses may be present as well. The substrates of the Calumet River are sandy, with certain areas heavily laden with industrial silts, foreign materials and debris.

A geotechnical investigation of the bedrock in Calumet Harbor was performed by GEI Consultants, Inc. for the USACE, Chicago District in 2014. The bedrock was determined to be composed of "Silurian-aged Racine Dolomite" that is gray to cream-colored and vuggy, or full of small pores or cavities. The grain size was reportedly "granular to micritic (aphanitic)," and the rock was found to contain abundant fractures, mostly in the horizontal direction. GEI Consultants, Inc. performed eight borings, and the intent was to drill to a depth of ten feet into the bedrock. However, as a result of problems with the weather conditions as well as with the barge and drilling equipment, only six of the borings reached the planned depth. The report from GEI also mentions that the bedrock was overlain by a layer of sediment that ranged from one inch to three feet in thickness and consisted of soft silty gray clay, with some sand, and fine gravel.

Based upon this field investigation, it is likely that a minor amount of the fine-grained sediment from Calumet Harbor will be re-suspended and entrained with the rocky material after blasting is complete. The material to be removed after blasting would be predominantly rocky material interspersed with finer-grained material which could become suspended during the drilling, blasting, and dredging operations, as well as during the placement of the material along the breakwater. The suspension of these fine grained materials are expected to be result in short-term turbidity that will dissipate. No long term water quality impacts from the actions associated with the preferred alternative are anticipated.

The finer-grained Calumet Harbor sediment that accumulates within the bedrock outcropping area has been previously characterized and is considered suitable for unconfined upland use, and this material is stockpiled outside of the Chicago Area CDF. The reason that this finer-grained material was considered to be suitable for unconfined upland use is provided in the Dredged Material Management Alternative (USACE 2015a) and other memoranda (USACE 2015b and USACE 2014). In addition, sediment samples are collected and analyzed on a routine basis during maintenance dredging events, and the analytical results are included with the dredging reports (USACE 2016).

3.2.5 HTRW Assessment

The location for the bedrock removal project is in Calumet Harbor, Lake Michigan, and the predominantly rocky material will be placed along the adjacent Calumet Harbor breakwater. There are no Hazardous, Toxic, or Radioactive Waste (HTRW) issues associated with this project.

3.2.6 Air Quality

The study area, Cook County, Illinois and Lake County, Indiana, is within a non-attainment area for lead and ozone.

Congress established the basic structure of the Clean Air Act (CAA) in 1970, and then made major revisions in 1977 and 1990. It is a comprehensive law that regulates emissions from stationary and mobile sources of air pollution. One of the key provisions concerns the control of common, widespread air pollutants, known as “criteria” pollutants, and the CAA directs the USEPA to set and revise the national ambient air quality standards (NAAQS) for these pollutants. Presently, there are NAAQS for the following six criteria pollutants: sulfur dioxide, carbon monoxide, particulate matter (PM), nitrogen dioxide (one of a group of highly reactive gasses known as “nitrogen oxides (NOx))”, ozone, and lead. The USEPA also has the authority to add additional pollutants.

Implementing the air quality standards is a joint responsibility of the states and USEPA. States are responsible for the development of state implementation plans (SIPs), and the USEPA assists the states by providing technical and policy guidance. The CAA has minimum requirements for SIPs to achieve the NAAQS, and the states are required to develop and manage the SIPs to improve areas with poor air quality and protect clean air from degradation. The USEPA issues national emission standards for new stationary sources and reviews the SIPs to ensure compliance. Geographical areas that do not meet the NAAQS are designated as “nonattainment areas,” and, conversely, areas that meet the NAAQS are called “attainment areas.”

There are National Ambient Air Quality Standards (NAAQS) for six principal or “criteria” pollutants; particulate matter (PM_{10} and $PM_{2.5}$), ozone, sulfur oxides, nitrogen oxides, carbon monoxide, and lead. According to the USEPA Green Book, as of June 17, 2016, Chicago was listed as a non-attainment area for lead (2008 standard). Furthermore, the Green Book listed the Chicago-Naperville area in Illinois, Indiana, and Wisconsin as a non-attainment area for 8-hour ozone (2008) (classification – moderate).

Ozone is a secondary pollutant formed primarily by chemical reactions from emissions of oxides of nitrogen (NOx) and volatile organic compounds (VOCs) that occur in the presence of sunlight, and NOx and VOCs are referred to as precursors of ozone.

Although the trends overall show improvement over the last 10 years, individual measurements and monitoring stations still have measurements that exceed the national standards. The existing air quality should be considered marginal, but gradually improving over time.

3.3 Ecological Resources

The following provides pertinent information on ecological, biological and habitat resources within the Calumet Harbor.

3.3.1 Lacustrine Habitat

Natural lacustrine functions and structure of the Calumet Harbor and River are impaired; however the project does provide similar habitats in the form of a large sandy expanse on the lakebottom. Manmade structures, such as the breakwaters also provide shelter for various aquatic organisms. The outer breakwaters serve as a rocky, dolomitic habitat. The navigation channel forms a unique non-conformity with drop-offs in the flat sand surface. The clearing of the channel via O&M dredging (USACE 1975, 1982) also exposes the dolomitic bedrock that naturally forms reefs and alvars across the Great Lakes. The combination of the breakwaters and navigation channel seem to provide a desired habitat for the Yellow Perch (*Perca flacvescens*) and Smallmouth Bass (*Micropterus dolomieu*), which are native species of concern within Lake Michigan in terms of ecology and fisheries. Most aquatic vegetation isabsent within the Calumet Harbor, as shifting sands do not allow for aquatic beds to form.

3.3.2 Riverine Habitat

Natural riverine functions and structure have been removed from the Calumet River system within the study area. The river is currently designed and maintained to be a large navigation channel with straight walls for commercial shipping activities. Various turning basins, slips and rock revetments provide limited habitat structure. There are also a few sand bars with aquatic vegetation, primarily located under the I-90 tollway, in which Yellow Perch and Northern Pike (*Esox lucius*) species have been observed by USACE biologists in the past.

3.3.3 Aquatic Macroinvertebrates

Several studies on aquatic macroinvertebrates in Southern Lake Michigan have been completed as well as a few within the Grand Calumet River and Indiana Harbor Canal. Garza & Whitman (2004) of the United States Geological Survey investigated macroinvertebrate assemblages of Southern Lake Michigan and observed macroinvertebrates from forty taxa. Approximately 81% of the observed taxa consisted of a species of segmented worm (*Chaetogaster diastrophus)* and a variety of round worms (*Nematoda spp*). Nalepa et al. (1998) also conducted surveys throughout southern Lake Michigan that encompassed areas adjacent to the City of Chicago. The study identified three main groups of macroinvertebrates including Amphipods (*Diporeia*), worms (*Oligochaeta*), and bivalves (*Sphaeriidae*). Another study investigating the diet of Lake Whitefish (*Coregonus clupeaformis*) from 1985 to 2000 revealed a shift in the macroinvertebrate prey items with the establishment of the Zebra and Quagga mussels (*Dreissena polymorpha* and *Dreissena burgensis)*. As *Dreissena spp*. filtered the water of Southern Lake Michigan it reduced the food availability to native macroinvertebrates and severely impacted populations of amphipods (*Diporeia spp*), the dominant food source for Lake Whitefish. At the turn of the century, Lake

Whitefish along the southeast coast of Lake Michigan had turned to consuming *Chironomidae* as their primary prey item with *Dreissena polymorpha*, *Mysis relicta* and *Spaeriidae* supplementing the diet. Yellow Perch diets were analyzed under yet another study in southeast Lake Michigan in 1998 and 1999. These fish were found to be consuming primarily *Mysis relicta*, *Chironomidae*, *Gammarus spp*. and *Isopoda*.

3.3.4 Freshwater Mussels

Native freshwater mussels that may occur within the Calumet Harbor and Calumet River mouth include Giant Floater (*Pyganodon grandis*), Paper Pondshell (*Uterbackia imbecillis*), Fat Mucket (*Lampsillis siliquoidea*), and Lilliput (*Toxolasma parvum*). All of these mussel species are indicative of low gradient riverine or lacustrine, sandy and silty habitats. The Three-Ridge (*Amblema plicata*) was recently discovered in historic side-cast dredge materials at the mouth of the Burns Harbor in Indiana by USACE biologists. Consequently, there is potential for this species to be present in Lake Michigan and tributaries; however, because the condition of the mussel shell was that of a very old specimen, the potential is considered very small.

3.3.5 Fishes

A total of 48 species has been recorded within a 2-mile radius of the Calumet Harbor and River mouth, (riverine records included). Records were queried from the Fishes of Chicago Region Fish Database (CRFD) (in publishing process, University of Chicago Press), which have voucher specimens housed at the Illinois Natural History Survey, Field Museum of Natural History and Southern Illinois University (Table 2). Data provided by the USFWS 2015 invasive species sampling are anecdotal with no voucher specimens provided; however, the species list corroborates with the CRFD with a few exceptions. Species of concern within the study area include Longnose Sucker (*Catostomus catostomus*), Mottled Sculpin (*Cottus bairdii*), Chestnut Lamprey (*Ichthyomyzon casteneus*), Smallmouth Bass (*Micropterus dolomieu*), and Yellow Perch (*Perca flavescens*), due to low abundance and occurrence, importance to fisheries, or are considered a “species in decline”. Three species have been extirpated from Southern Lake Michigan: Lake Char (*Salvelinus namaycush*); the Brook Char Coaster strain (*Salvelinus fontinalis*); and, the Northern Longear Sunfish (*Lepomis peltastes*) (however there is a recent collection of *L. peltastes* in confluent Wolf Lake by Dr. Willink from Shedd Aquarium). Nine of the 48 species recorded are non-native, these include the three Pacific Salmonids (*Oncorhynchus* spp.), the European Brown Trout (*Salmo trutta*), Common Carp (*Cyprinus carpio*), Goldfish (*Carrassius auratus*), Alewife (*Alosa psuedoharengus*), White Perch (Morone americana), and Round Goby (*Neogobius melanostomus*). Although the Banded Killifish (*Fundulus diaphanus*) is listed as State Threatened (ST) in Illinois, it is extremely abundant and tolerant within the Calumet Region.

Table 2: Fishes Recorded from within 2-mile Radius of Calumet Harbor 1878-2010.

Common Name	Species	CRFD[1]	USFWS[2]	Status
Alewife	*Alosa pseudoharengus*		X	non-native
Rock Bass	*Ambloplites rupestris*	X	X	abundant
Black Bullhead	*Ameiurus melas*	X	X	abundant
Brown Bullhead	*Ameiurus nebulosus*		X	rare
Freshwater Drum	*Aplodinotus grunniens*	X	X	abundant
Goldfish	*Carassius auratus*	X	X	non-native
Longnose Sucker	*Catostomus catostomus*	X		SE (IL)
White Sucker	*Catostomus commersonii*		X	abundant
Mottled Sculpin	*Cottus bairdii*	X		species of concern
Common Carp	*Cyprinus carpio*	X	X	non-native

Gizzard Shad	*Dorosoma cepedianum*	X	X	abundant
Banded Killifish	*Fundulus diaphanus*	X	X	ST (IL)
Nine-Spine Stickleback	*Gasterosteus aculeatus*	X		common
Chestnut Lamprey	*Ichthyomyzon castaneus*		X	species of concern
Channel Catfish	*Ictalurus punctatus*		X	common
Smallmouth Buffalo	*Ictiobus bubalus*		X	common
Black Buffalo	*Ictiobus niger*	X		common
Brook Silverside	*Labidesthes sicculus*	X	X	common
Green Sunfish	*Lepomis cyanellus*		X	abundant
Pumpkinseed	*Lepomis gibbosus*	X	X	abundant
Bluegill	*Lepomis macrochirus*	X	X	abundant
Northern Longear Sunfish	*Lepomis peltastes*	X		extirpated
Smallmouth Bass	*Micropterus dolomieu*	X	X	common
Largemouth Bass	*Micropterus salmoides*	X	X	common
White Perch	*Morone americana*	X	X	non-native
White Bass	*Morone chrysops*	X	X	common
Shorthead Redhorse	*Moxostoma macrolepidotum*	X	X	common
Round Goby	*Neogobius melanostomus*	X	X	non-native
Golden Shiner	*Notemigonus crysoleucas*	X		common
Emerald Shiner	*Notropis atherinoides*	X	X	common
Spottail Shiner	*Notropis hudsonius*	X	X	abundant
Sand Shiner	*Notropis stramineus*	X		abundant
Coho Salmon	*Oncorhynchus kisutch*	X		non-native
Rainbow Trout	*Oncorhynchus mykiss*	X	X	non-native
Chinook Salmon	*Oncorhynchus tshawytscha*	X	X	non-native
Yellow Perch	*Perca flavescens*	X	X	common
Bluntnose Minnow	*Pimephales notatus*	X	X	abundant
Fathead Minnow	*Pimephales promelas*	X		common
White Crappie	*Pomoxis annularis*	X		rare
Black Crappie	*Pomoxis nigromaculatus*		X	common
Three-Spine Stickleback	*Pungitius pungitius*	X		common
Flathead Catfish	*Pylodictis olivaris*		X	rare
Longnose Dace	*Rhinichthys cataractae*	X		common
European Brown Trout	*Salmo trutta*	X	X	non-native
Brook Char	*Salvelinus fontinalis*	X		extirpated
Lake Char	*Salvelinus namaycush*	X		extirpated
Walleye	*Sander vitreus*		X	common
Central Mudminnow	*Umbra limi*	X		common

1 Chicago Region Fish Database (Veraldi/Pescitelli/Willink, under publication review)
2 USFWS invasive species survey of Calumet Harbor 2015

3.3.6 Reptiles & Amphibians

A few native amphibians and reptiles occur within the waters of the Calumet Harbor and River mouth. The most important species, which is a species of concern in Indiana and listed as Threatened in Illinois, is the Mudpuppy (*Necturus maculosus*) salamander. This species is a permanently aquatic species with external gills. This salamander is known to occur in dolomitic rock habitats, both natural and manmade, along the entire coast of Lake Michigan. This species has temporal aspects of occupying nearshore littoral habitats during the winter, and then deeper offshore habitats in the summer due to water temperature

affinities. Native amphibians that may be found in the area could include common species such as Bullfrog (*Rana catesbiana*) and Leopard Frog (*Rana pipiens*). Common native reptiles that may be found in Calumet Harbor and River include Snapping Turtle (*Chelydra serpentina*), Painted Turtle (*Chrysemys picta*), Red-eared Slider (*Trachemys scripta elegans*) and Northern Water Snake (*Nerodia sipedon*).

3.3.7 Birds

The study area offers refugia habitat for a variety of resident and migratory birds. The harbored lacustrine zone provides safe resting and foraging habitat. It is also important to note that the study area is within the Great Lakes route of the Mississippi Flyway, a globally significant migration route for hundreds of bird species and in particular, migratory song birds. Additional detail on birds within the Calumet region is provided by Brock (1999), where a minimum of 163 species were identified to utilize the nearby Grand Calumet River watershed. Common birds directly using the immediate study area over the affected work zone would be water fowl, which could include at different times of the year, but not limited to Coot (*Fulica americana*), Mallard Duck (*Anas platyrhynchos*), Common Loon (*Gavia immer*), Northern Shovler (*Anas clypeata*), Black Duck (*Anas rubripes*), Merganser (*Mergus merganser*), Teal (*Anas carolinensis*), and Canvasback (*Aythya valisneria*). Certain wading birds utilize the breakwaters for foraging, which include Great Blue Heron (*Ardea herodias*) and Black-Crown Night-Heron (*Nycticorax nycticorax*). Birds of prey observed by USACE biologists in the past have included Red Tail Hawk (*Buteo jamaicensis*), Cooper's Hawk (*Accipiter cooperi*), Osprey (*Pandieon haliaetus*) and Snowy Owl (*Bubo scandiacus*).

3.3.8 Mammals

Common native mammals that have been observed in Calumet Harbor and River mouth include Eastern Cottontail (*Sylvilagus floridanus*), Gray Squirrel (*Sciurus carolinensis*), Oppossum (*Didelphis virginiana*), Racoon (*Procyon lotor*) and Coyote (*Canis latrans*). Coyotes have actually been observed on breakwaters in the past. Non-native, invasive mammals include Norwegian Rat (*Rattus norvegicus*), Black Rat (*Rattus rattus*), European House Mouse (*Mus musculus*), Feral Dog (*Canis familiaris*) and Feral Cat (*Felis domesticus*)

3.3.9 Threatened and Endangered Species

Federal T&E Species

The proposed project is within the range of the Federally endangered Indiana Bat (*Myotis sodalis*), Piping Plover (*Charadrius melodus*), and Karner Blue Butterfly (*Lycaeides Melissa samuelis*), and the threatened Northern Long-eared Bat (*Myotis septentrionalis*), Rufa Red Knot (*Calidris canutus rufa*), Pitcher's Thistle (*Cirsium pitcheri*) and Mead's Milkweed (*Asclepias meadii*). These species or their critical habitats do not exist in Calumet Harbor and River mouth, as noted by USFWS.

State T&E Species

Indiana – The Indiana Department of Natural Resources scoping response letter dated 10 June 2016 provides that the Indiana Natural Heritage Database has no records of State or Federally listed species within the study area.

Illinois – The Illinois Department of Natural Resources scoping response letter dated 20 June 2016 identified the State Threatened Mudpuppy as being present within the study area. The USACE has

identified the occurrence of the Black-Crown Night-Heron, Longnose Sucker and Banded Killifish as well.

3.4 Cultural & Social Resources

3.4.1 Archaeological & Historical Properties

The shoreline of the Calumet River has been heavily modified over the years through repeated cycles of river reconfiguration combined with industrial development and decline. The Calumet River has been repeatedly dredged, deepened, and straightened from the 1870's to the present time. The area contains no known archaeological properties.

Historic structures in the general project area include three properties on the National Register of Historic Properties: AVR 661, a 1925-1949 naval defense structure, located in Calumet Harbor (added to the National Register in 1980), Calumet Park located on the Lake Michigan shoreline just south of Calumet Harbor (added to the National Register in 2003), and the Material Service, a barge constructed in 1929 that sank off the coast of Indiana in 1936. The Calumet Park field house was made a Chicago City Landmark in 2006. To the southeast of Calumet Harbor, near Avenue G and 102nd Street, is the oldest structure within the City of Chicago, the Illinois-Indiana Boundary Marker. Dating to 1833, this stone obelisk was made a Chicago City Landmark in 2002. The Calumet Harbor Lighthouse is also located within the harbor, atop the outer breakwater.

3.4.2 Social Setting

The City of Chicago is located in Cook County, Illinois. The city has an estimated population of 2,712,608. Chicago is a racially and ethnically mixed city with the biggest racial groups being white (50%), black or African American (33%), and Latino or Hispanic (29%). The population within two miles of the Calumet Harbor project area is 46,212. The area has a 94% minority population with 51% black or African American residents and 45% Latino or Hispanic. In the area within 2 miles of the Calumet Harbor Federal channel, 43% of the households have an income of less than $25,000. In contrast, 29% of households across Chicago have an income of less than $25,000. (Sources: American Community Survey 2014 estimates, accessed through American Fact Finder and EJSCREEN: Environmental Justice Screening and Mapping Tool)

Before the 1870's, the Calumet River was a series of marshes, beach ridges, and shallow lakes. Since the 1870's the Calumet River shoreline has been dominated by steel mills, grain elevators, railyards and factories. The steel industry dominated the area until the1980s. The Chicago neighborhoods of South Chicago, South Deering, East Side, and Hegewisch were built as residential housing for the immigrant workers for these industries. Modern waterfront use is almost entirely industrial, consisting of steel mills, railyards, tank farms, scrap yards, and abandoned factories.

3.4.3 Native American Coordination

The following Native American tribes were contacted by letter dated 17 May 2016 regarding the proposed project. Tribes contacted by letter included Kickapoo Tribe of Oklahoma, Kickapoo of Kansas, Miami Tribe of Oklahoma, Citizen Potawatomi Nation, Forest County Potawatomi Executive Council, Nottawaseppi Huron Potawatomi Tribal Office, Hannahville Potawatomi Community Council, Prairie Band Potawatomi Tribal Council, Pokagon Band of Band of Potawatomi Indians, and the Miami Nation in Indiana. Mailing list and coordination letters are in **Appendix B**.

3.4.3 Recreation

Two large city parks are near the project area, providing swimming, soccer and softball fields for area residents. Rainbow Park and Beach is located to the north of Calumet Harbor. Just south of Calumet Harbor is Calumet Park with its historic field house. Located on the Illinois portion of Wolf Lake to the east-southeast is the William W. Powers Recreation Area, a popular birdwatching, boating, and fishing area.

Calumet Harbor and River provide access to Lake Michigan from mooring and storage areas on the Cal-Sag Channel. Recreation lockages through the O'Brien Lock on the Calumet River exceed 7,000 craft annually. Recreational traffic is primarily privately owned vessels docked at marinas on the Cal-Sag Channel using the Calumet River for access to Lake Michigan.

CHAPTER 4 – EFFECTS ASSESSMENT

4.1 – No Action Alternative

The "No Action" Alternative would include no additional Federal action regarding the maintenance of the navigation channel. There would be no change from the current conditions. Under low lake level conditions, the full navigation depth would not be available to deep draft vessels. There would a higher risk of vessel grounding with the potential for a spill occurring if the hull is ruptured. To mitigate this risk, operators would likely light-load their vessels. Although the risk is probably minimal, the environmental impacts of a grounding could be significant, depending on the cargo. There are also potentially significant economic implications of the No Action Alternative under prolonged low lake levels/light load conditions. Light loading would result in cost increases to shippers, thus potentially affecting the economic viability of the harbor and could result in the goods being moved by other, less fuel efficient means.

4.2 Direct & Indirect Effects of the Preferred Alternative

In addition to the effects discussed in the following sections, a 404(b)(1) analysis is provided in **Appendix A**. This anti-degradation assessment further documents whether or not there are effects to the aquatic environment resulting from the placement of rubble materials along the toe of the existing breakwater. Wherever the Preferred Alternative is referenced (see section 2.2 – The Preferred Alternative Drilling and Blasting) this implies the use of drilling, blasting, mechanical harvesting of fragmented rubble and placing the rubble along the toe of the existing breakwaters (see Figure 3). The method of blasting involves charges implanted into boreholes drilled into the bedrock itself. This detailed method would avoid and minimize adverse effects to surrounding infrastructure, biota, and other parameters of concern. Some variations from the project as described may occur with respect to sequence of activities, method of operation, or design details as a result of unanticipated improvements, site conditions or cost-saving measures. Any variations that would result in significant changes to either the overall project design or environmental impact would be further evaluated under NEPA.

4.2.1 Physical Resources

Geology

The natural Niagara Escarpment dolomitic limestone bedrock ledge is currently intact. This small outcropping is only exposed from beneath littoral sands in the study area due to creation and maintenance of the navigation channel. The Preferred Alternative assuming sufficient funding proposes to remove enough rock to achieve the authorized navigation depths. In terms of geology, the method of removal doesn't matter, it is the fact the natural geologic bedrock member is being modified. The removal of a small portion of rock is not recoverable; however, the effect to local and regional geology are comparatively so minor, that the economic benefits of transcontinental shipping of goods far outweigh the loss of an extremely small portion of the entire Niagara Escarpment. Therefore, there are no expected long term, adverse effects to local or regional geologic functions, structure, resource production or aesthetics resulting from the Preferred Alternative.

Coastal Hydraulics & the Littoral Drift

The littoral drift of southern Lake Michigan has been modified through both the artificial extension of the shoreline, as well as the construction of numerous structures including groins, breakwaters and revetments. As a result the historic littoral patterns have been modified resulting in both erosion and accretion at various points along the shoreline. While there would be some infilling of littoral material after the bedrock removal in the navigation channel (USACE 1975, 1982), there will be no long term affect to the current local and regional littoral processes from the Preferred Alternative.

Water Quality

The predominantly rocky material is mostly coarse and inert, and the bedrock removal and placement sites are within close proximity to each other. As a consequence, the material is not expected to be a source of contamination, and the placement of the material would not be anticipated to cause any considerable long-term effects on, or changes to, the water chemistry or quality. Short-term effects on the water quality are expected because of temporary increases in the concentration of suspended solids and turbidity following the drilling, blasting, and dredging operations, and placement of the predominantly rocky material along the Calumet Harbor breakwater. These effects are expected to be similar to sediment resuspension with the resultant increase in turbidity caused by storm events or passing vessels. Since the materials are predominantly inorganic, resettlement should be anticipated when the ambient conditions in the Outer Harbor return to a more quiescent state. The temporary increase of suspended solids is expected to cause short-term decreases in water clarity and minor changes to the color of the water. See Appendix A – 404(b)(1) analysis for additional details on water quality determinations.

Any short-term effects on the public water supply intakes near the project are anticipated to be negligible, and there should be no effect on the odor or taste of the water. The nearest water intake facility for drinking water is located at the 79th Street Filtration Plant, which is 2.5 miles to the north of the blasting zone. It is important to stress that the minor and temporary increases of suspended solids concentrations produced by the drilling, blasting, and dredging operations, as well as by the placement operations, are expected to be considerably lower than the increased turbidity that typically results from adverse weather conditions.

Moreover, in regards to the blasting procedure, holes will be drilled down into the bedrock well below the existing lake bottom, and the explosive material will be placed within the holes. The drill holes will then be filled at the top by "stemming" material. Stemming is typically angular gravel or crushed stone that is

used to fill the hole above the explosive (Keevin and Hempen 1997). The vast majority of the force from the explosion is expected to be directed toward breaking up the bedrock. Residual gases or chemicals from the explosions are not expected to be toxic and are not anticipated to cause any adverse effects on the water quality.

Hazardous, Toxic and Radioactive Wastes

The location for the bedrock removal project is in Calumet Harbor, Lake Michigan, and the predominantly rocky material will be placed along the adjacent Calumet Harbor breakwater. There are no Hazardous, Toxic, or Radioactive Waste (HTRW) issues associated with this project.

Air Quality

The local air quality in the study area is considered 'non-attainment' under the Clean Air Act for ozone, and lead. The project is within the non-attainment zone. Once implemented, the project itself will be neutral in terms of air quality, with no features that either emit or sequester air pollutants to a large degree. During the project construction, heavy equipment would cause minor, temporary air quality impacts; however, all equipment will be in compliance with current air quality control requirements for diesel exhaust, fuels, and similar requirements. A general conformity analysis was not conducted due to the short and temporary nature of any air quality impacts. The vast majority of the force from the explosion is expected to be directed toward breaking up the bedrock. Residual gases or chemicals from the explosions are not expected to be toxic and are not anticipated to cause any adverse effects on the air quality. Beyond temporary vehicle emissions, the project will not contribute to greenhouse gas emissions.

4.2.2 Ecological Resources

Lacustrine Habitat

The current lake habitat within the Calumet Harbor results from a combination of natural features and substrates, and manmade structures and activities. Natural bedrock outcropping would not naturally be part of the Calumet Harbor since this littoral drift zone has a typically thick layer of sand continually moving through. Exposing the bedrock through navigation channel creation and maintenance is the means by which the dolomitic bedrock ledge has become exposed. Removal of a relatively small portion of the bedrock would therefore have no effects on the current predominant habitat conditions of the Calumet Harbor. Therefore, there are no expected long term, adverse effects to local or regional lacustrine habitat resulting from the Preferred Alternative.

Riverine Habitat

The current riverine habitat within the Calumet River mouth has been greatly modified from the natural conditions for purposes of a large navigation project. Drilling, blasting and rock placement are not expected to significantly impact this area. Therefore, there are no expected long term, adverse effects to local riverine habitat resulting from the Preferred Alternative.

Macroinvertebrates

The potential for injury and mortality to aquatic invertebrates resulting from underwater blasts is documented in Keevin & Hempen (1997). The results of studies reviewed indicate that invertebrates are insensitive to pressure related damage from underwater explosions. This may be due to the fact that most invertebrate species lack gas-containing organs which have been implicated in internal damage and mortality in vertebrates. Those macroinvertebrates within the immediate blast zone could be physically

impacted; however, little adverse impact would be realized beyond this zone. Also, the macroinvertebrates within the study area are widespread and abundant throughout Lake Michigan, in which the effected zone would be recolonized shortly after the blasting, drilling and placement activities. Therefore, there are no expected long term, adverse effects to the local macroinvertebrate populations in Calumet Harbor resulting from the Preferred Alternative.

Freshwater Mussels

The potential for injury and mortality to the four (4) freshwater mussel species resulting from underwater blasts is herein incorporated by reference to Keevin & Hempen (1997) via presenting studies conducted on marine oysters. Just as other macroinvertebrates, this taxa is relatively resistant to effects of underwater explosions, exhibiting low mortality rates. Those freshwater mussels within the immediate blast zone would be physically taken; however, limited adverse impact would be realized beyond this zone. Also, the freshwater mussels within the study area are widespread throughout Lake Michigan, in which the small effected zone would be recolonized after activities. The placement of dolomitic limestone at the sandy toe of the existing breakwater would have negligible effects on freshwater mussels as well. Therefore, there are no expected long term, adverse effects to the local freshwater, lacustrine populations of mussels in Calumet Harbor resulting from the Preferred Alternative.

Fishes

The potential for injury and mortality to freshwater Fishes (Pisces) resulting from underwater blasts is documented in Keevin & Hempen (1997). Fishes are the major group of concern for activities of subaqueous detonation of explosives. These are the most abundant taxa group within the Calumet Harbor aquatic zone. In fish, the swimbladder, a gas-containing organ, is the most frequently damaged organ (Christian 1973; Faulk and Lawrence 1973; Kearns and Boyd 1965; Linton et al. 1985a; Yelverton et al. 1975). It is subject to rapid contraction and overextension in response to the explosive shock waveform (Wiley et al. 1981). Species lacking swimbladders or with small swimbladders are highly resistant to explosive pressures (Aplin 1947; Fitch and Young 1948; Goertner 1994). For example, Wiley et al. (1981) and Goertner et al. (1994) noted that hogchokers (*Trinectes maculatus*), which lack swimbladders, were extremely tolerant of underwater explosions, and greatly exceeded the tolerance of any species with swimbladders that they had tested. Goertner et al. (1994) found that hogchokers were not killed beyond a distance of 1 m from a 4.5 kg charge of pentolite." (taken directly from Keevin & Hempen 1997).

Fish Injury & Mortality: General Overview of Confined Rock Removal: There is considerable published information concerning the pressure wave from explosive charges detonated in free water while there is little documentation concerning embedded charges. This becomes important in evaluating the effects of blasting operations on aquatic life. Fish mortality studies are based on open-water testing programs (Anonymous 1948; Ferguson 1962; Hubbs & Rechnitzer 1952; Teleki and Chamberlain 1978). The use of existing mortality data would greatly overestimate mortality for shots confined within solid material (e.g., the rock to be removed). Explosives in open water, which are not contained completely within rigid structures, will produce both higher amplitude and higher frequency shock waves, than confined detonations. The energy consumed by the rock and radiation of the wave energy into rock reduces the available energy reaching the water column.

The use of blasting in rock removal, when the explosives are enclosed within the stemmed borehole, will result in lower fish mortality than the same explosive charge size detonated in open water (Keevin 1998). For example, Nedwell and Thandavamoorthy (1992) evaluated the pressure time histories from the detonation of small explosive charges from both free water and embedded explosions under laboratory conditions. They found that the peak pressure of the water-borne shock wave following the detonation of an explosive charge embedded in a borehole was about 6% (94% reduction) of that occurring for the same

charge at the same distance, when it was freely suspended in water. Hempen et al. (2005) evaluated pressure reductions during channel deepening for the Kill Van Kull (New York Harbor) Deepening Project. They compared pressures from four confined shots with computed open-water pressures and found that the confined pressures were only 19 to 41% (81 to 59% reductions) of open-water pressures. The mortality radius was 30% of the open-water shot and the mortality area of the confined shot would be only 9% of the mortality area for the open-water shot.

It is anticipated that approximately 5 pounds of "confined" explosives will be used in each borehole (5 pounds per delay). Bluegill (*Lepomis macrochirus)* exposed to 4.5 pounds, (for all practical purposes a 4.5 lb. and a 5 lb. charge produce the same pressures.) of high explosives shot in "open-water" experience 0% mortality at between 140 and 150 feet (Keevin 1995). However, using confined charges, the pressures and associated safe zone would be reduced somewhere between 59 to 96 percent. As such, the actual kill radius would be small. In addition, the majority of the blasting shots will have a small blasting pattern (blast footprint), and associated fish kill radii, because the USACE is removing top layers of rock rather than deepening an entire harbor channel as was the case for Kill Van Kull.

It is expected there would be minor effects to fishes at the meta-population level, but those impacts are expected to be less than the impacts associated with overfishing that occurs within Calumet Harbor. Species of concern due to their continual abundance within Calumet Harbor & River mouth are the Yellow Perch and Smallmouth Bass. Two methods would be used to minimize effects to these two species. Timing of the blasting work would be adjusted via coordination with state resources agencies and USACE ecologists; it is well known that winter, spring and early summer are the best time to fish the navigation channel for Yellow Perch. Smallmouth bass are present all year along the breakwaters, so temporal aspects for this species are not helpful. Second, there would also be pre-detonation avoidance measures, such as loud but non-injurious, subaqueous sounds to clear fish and wildlife out of the area of blasting zone, or other methods proposed by the contractor that would be effective, but non-injurious. During the actual activities for a bedrock removal event, USACE fisheries biologists would be monitoring the Calumet Harbor & River mouth for terminated, moribund or unconscious fishes. All fishes would be collected, recorded and those that revive would be released back to the harbor.

Therefore, there are no expected long term, adverse effects to the local native fish populations, inclusive of Yellow Perch, Smallmouth Bass and Longnose Sucker in Calumet Harbor & River resulting from the Preferred Alternative.

Reptiles & Amphibians

The only reptiles of concern for the Calumet Harbor would be turtles, Resident species are very abundant and tolerant: Snapping, Painted and Red-eared Slider. Observations and studies of Sea Turtles (Keevin & Hempen 1997) indicate that turtles can be rendered unconscious or become injured due to shockwaves, where they can subsequently drown and perish. While it is very unlikely that small, freshwater turtles would be diving this deep for foraging, it is possible that freshwater turtles could be affected by the underwater blasting.

There currently is no data available on the effects of underwater explosions on amphibians (i.e., frogs, salamanders, etc.) Kevin & Hempen (1997). Although untested, amphibians with air-containing organs, such as lungs, probably have mortality comparable to fish with swimbladders. For impact assessment purposes, the relationship between distance/pressure and fish mortality/injury are probably fairly close. Although untested, amphibians without air-containing organs, are probably immune to underwater explosives as are benthic fish species without swimbladders (Goertner et al. 1994). The only species of concern for underwater detonation in the Illinois State Threatened Mudpuppy.

It is expected there would be minor effects to reptiles and amphibians for a few reasons. Due to the deeper benthic zone and the distance from nearby structures, turtles and Mudpuppies, if present at all, would be present in very small numbers. There would also be pre-detonation avoidance measures, such as loud but non-injurious, subaqueous sounds to clear fish and wildlife out of the area of blasting zone. In the case of the Mudpuppy, these animals would most likely be found along the existing breakwater structures during colder months of December, January, February and early March. To minimize any potential adverse effects to the Mudpuppy, timing of the blasting and disposal work would be adjusted via coordination with state resources agencies and USACE ecologists. In summary, therefore, there are no expected long term, adverse effects to the local reptile and amphibian populations in Calumet Harbor resulting from the Preferred Alternative.

Birds

The group of concern within the Calumet Harbor with potential to be effected by underwater blasting would be diving water fowl. These could include Cormorants, Mergansers, Grebes, and others. However, these groups of birds are very adverse to human activities and typically fly away when humans approach too close. It is also likely that noises associated with the project equipment/work plant and associated human activities during implementation of the Preferred Alternative would be sufficient to drive these birds from the affected zone. Therefore, there are no expected long term, adverse effects to the migratory or residential populations of birds within Calumet Harbor resulting from the Preferred Alternative.

Mammals

Mammals typically do not utilize the aquatic portions of Calumet Harbor and River mouth. Therefore, there are no expected long term, adverse effects to the local freshwater, lacustrine populations of mammals in Calumet Harbor resulting from the Preferred Alternative.

Threatened and Endangered Species

Federal – The proposed project is within the range of the Federally endangered Indiana bat (*Myotis sodalis*), piping plover (*Charadrius melodus*), and Karner blue butterfly (*Lycaeides Melissa samuelis*), and the threatened northern long-eared bat (*Myotis septentrionalis*), rufa red knot (*Calidris canutus rufa*), Pitcher's thistle (*Cirsium pitcheri*) and Mead's milkweed (*Asclepias meadii*). The USACE and USFWS agree that there is no habitat for any of these species within the proposed project area, and concur that the proposed project is not likely to adversely affect these endangered and threatened species. This precludes the need for further consultation on this project as required under Section 7 of the Endangered Species Act of l973, as amended.

State – Illinois State listed species present within the Calumet Harbor & River mouth include Mudpuppy, Longnose Sucker, Banded Killifish and the Black-Crown Night-Heron. Effects assessment on these species are provided in their respective taxa sections. It was determined that there would be no effects to the Black-Crown Night-Heron, and minor, short term meta-population effects to the Mudpuppy, Longnose Sucker and Banded Killifish.

4.2.3 Cultural Resources

Archaeological and Historical Properties

The proposed construction would have no adverse effect on archaeological or historic properties, as defined by the National Historic Preservation Act of 1966. The Indiana State Historic Preservation Officer has concurred with this determination (letter dated 8 June 2016).

Social Properties

The preferred alternative would have no direct or indirect impacts on social resources in the project area.

Native American Coordination

Native American groups having an historic cultural interest in northeast Illinois have been notified via the scoping letter dated 17 May 2016. The Miami Tribe of Oklahoma responded by e-mail (28 June 2016) to indicate that they have no objections to the project.

Recreation

The preferred alternative would have no direct or indirect impacts on recreation resources in the project area.

4.2.4 17 Points of Environmental Quality

The 17 points are defined by Section 122 of the Rivers, Harbors and Flood Control Act of 1970 (P.L. 91-611) from (ER 1105-2-240 of 13 July 1978). Effects to these points are discussed as follows:

Noise – The Preferred Alternative would obviously require blasting, which would make a singular event shockwave; however, due to it being contained in the bedrock about 40-feet below the surface of Lake Michigan waters, the noise would be limited and muffled to a negligible and anti-climactic pop.

Displacement of People – The Preferred Alternative would not displace people.

Aesthetic Values – The Preferred Alternative would not affect aesthetic values.

Community Cohesion – The Preferred Alternative would not disrupt community cohesion.

Desirable Community Growth – The Preferred Alternative would not adversely affect community growth.

Desirable Regional Growth – The Preferred Alternative would not adversely or beneficially affect regional growth. The No Action Alternative could adversely affect local and regional economies.

Tax Revenues – The Preferred Alternative would not adversely or beneficially affect tax revenues.

Property Values – The Preferred Alternative would not have adverse effects on property values.

Public Facilities – The Preferred Alternative would not adversely affect public facilities within the study area.

Public Services – The Preferred Alternative would not affect public services.

Employment – The Preferred Alternative would not adversely affect employment and could support regional employment during construction activities.

Business and Industrial Activity – The Preferred Alternative would positively affect local commerce by helping maintain a reliable navigation channel under all lake level conditions. The No Action Alternative would adversely affect local and regional business and industrial activities.

Displacement of Farms – There are no farms within the study area.

Man-made Resources – The Preferred Alternative would not adversely or beneficially affect man-made resources.

Natural Resources – The Preferred Alternative would have minor, short term affects to local geology, fishes, amphibians, and reptiles, as discussed in their respective sections.

Air Quality – The Preferred Alternative would be de minimis in terms of CAA compliance. Construction equipment and vessels used to accomplish the work will meet current federal regulations. The project does not cause greenhouse gas emissions.

Water Quality – The Preferred Alternative would cause minor, short-term and localized increases of suspended solids and dissolved gases, but it would not adversely affect long-term water quality.

4.3 Cumulative Effects

Consideration of cumulative effects requires a broader perspective than examining just the direct and indirect effects of a proposed action. It requires that reasonably foreseeable future impacts be assessed in the context of past and present effects to important resources. Often it requires consideration of a larger geographic area than just the immediate "project" area. One of the most important aspects of cumulative effects assessment is that it requires consideration of how actions by others (including those actions completely unrelated to the proposed action) have and will affect the same resources. In assessing cumulative effects, the key determinant of importance or significance is whether the incremental effect of the proposed action will alter the sustainability of resources when added to other present and reasonably foreseeable future actions. Cumulative environmental effects for the Preferred Alternative were assessed in accordance with guidance provided by the Council on Environmental Quality (CEQ) and the U.S. Environmental Protection Agency (USEPA 315-R-99-002). This guidance provides an eleven-step process for identifying and evaluating cumulative effects in NEPA analyses.

4.3.1 Scope of Cumulative Effects Analysis

Through this Environmental Assessment, the cumulative effects issues and assessment goals are established, the spatial and temporal boundaries are determined, and the reasonably foreseeable future actions are identified. Cumulative effects are assessed to determine if the sustainability of any of the resources is adversely affected with the goal of determining the incremental impact to key resources that would occur should the proposal be permitted. The spatial boundary for the assessment was broadened to consider watershed effects. The spatial boundary being considered is normally in the general area of the proposed activities; however, the area may be expanded on a case-by-case basis if some particular resource condition necessitates broadening the boundary. The analysis will consider the southern rim of Lake Michigan for cumulative effects analysis.

Three temporal boundaries were considered:

- Past – mid to late1800s because this is the approximate time that the Lake Michigan coast was developed for industrial use and the build-out of Chicago

- Present – 2016 when the decision is being made on acute geologic and biologic resources
- Future – 2066, the year used for determining project life end, although the removal of bedrock would be permanent

Projecting the reasonably foreseeable future actions is difficult. The proposed action (limited subaqueous bedrock removal) is reasonably foreseeable; however, the actions by others that may affect the same resources are not as clear. Projections of those actions must rely on judgment as to what are reasonable based on existing trends and where available, projections from qualified sources. Reasonably foreseeable does not include unfounded or speculative projections. In this case, currently ongoing and reasonably foreseeable future actions within the cumulative effects zone include:

- Continued operation and maintenance of the navigation project at Calumet Harbor
- Further improvements in water and habitat quality due to large-scale remediation and ecosystem restoration projects, and improvements to best management practices (BMPs), laws and policies, and education
- Further improvements in aquatic and riparian habitat in and along the Lake Michigan system
- Further improvements in connectivity between Lake Michigan buffering habitats
- Continued stocking of unsustainable, non-native Pacific and European Salmonids
- Continued stocking of native, but non-regional genetic fishes within Lake Michigan and tributaries
- Continued pressures on native fisheries population via the stocking of unsustainable, non-native fisheries species
- Continued fragmentation of confluent Lake Michigan streams as a hands-off, single species management action for Sea Lamprey
- Continued termination of the 3 native Lamprey species as by-catch of Sea Lamprey prevention actions
- Continued issues in regulating the overfishing of native fisheries population, specifically the Yellow Perch (*Perca flavescens*) and Whitefishes (Salmonidae: Coregoninae)

4.3.2 Cumulative Effects on Resources

Physical Resources

The entire natural geology and geologic processes of the southern Lake Michigan rim have nearly been erased, with the exception a few reaches of High Dune region along the Indiana Shoreline. Exposed dolomitic alvars and reefs, natural beach and ridge shorelines, moraine bluffs, ravines, stream mouths, and estuaries have all been removed in the past to support anthropogenic activities. The Preferred Alternative would remove an insignificant portion of Niagara Escarpment that is usually buried beneath sand on the lake bottom. Due to the relatively small amount of material to be removed in comparison to the existing escarpment, it is determined that the cumulative effects of the Preferred Alternative on the physical resources of Lake Michigan's southern rim are considered negligible and insignificant.

Ecological Resources

Lake Michigan, and the Great Lakes as a whole, in terms of ecology and biological integrity, have already been severely modified, degraded and suppressed through past and ongoing human activities. These activities have degraded and removed coastal, littoral and profundal zone habitats, contaminated sediments used by aquatic species for spawning and other life requisites, halted natural processes that sustain and create new habitats, and resulted in the introduction of alien and non-native species. In contrast to the breadth of past impacts, and the continuing effects which serve to suppresses natural processes and species diversification, the potential impacts to a small number fishes and Mudpuppies, is

not considered significant. Activities associated with the Preferred Alternative will include techniques to minimize the number of aquatic species that could be affected and the timing of the blasting will be coordinated with resource agencies to avoid spawning or other windows for Fishes and Mudpuppies. Therefore, it is determined that Preferred Alternative will not result in any additional, significant long-term cumulative effects on the Ecological Resources of Lake Michigan's southern rim.

Cultural and Historic Resources

There are no properties or structures within the study area that are currently protected, or listed on the National Register of Historic Properties; therefore, no cumulative effects are expected to archaeological or cultural resources resulting from implementation of the Preferred Alternative.

Social Resources

The activities associated with the Preferred Alternative will not result in impacts to social resources.

Cumulative Effects Summary

The effects stemming from the Preferred Alternative, removing bed rock via drilling, blasting and mechanical excavation, are considered minor in comparison to the adverse effects that have occurred in the past, or currently ongoing. Due to the contained nature of the blasting charges, fish mortality is expected to be minimal. The Niagara Escarpment would have an insignificant portion of its total rock removed, which the area would subsequently be covered up by sand again within a short period of time. The local and regional economies dependent on navigation would be fully supported by the Federal navigation project. Everyday activities of the local community, no matter the social class, race or creed would not be affected due to the activities taking place well away from any human populated areas. Therefore, it is determined that the cumulative effects of the Preferred Alternative are considered negligible and insignificant.

Chapter 5 – Compliance & Coordination

The Preferred Alternative presented in this Environmental Assessment is in compliance with appropriate statutes and executive orders including the Natural Historic Preservation Act of 1966; the Endangered Species Act of 1973; the Fish and Wildlife Coordination Act; EO 12898 (environmental justice); EO 11990 (protection of wetlands); EO 11988 (floodplain management); and the Rivers and Harbors Act of 1899. The potential project is in compliance with the Clean Air Act; the Clean Water Act, and the National Environmental Policy Act of 1969. There were no adverse environmental effects identified which cannot be avoided should the proposal be implemented. There have been no irreversible and irretrievable commitments of resources identified resulting from the proposed action should it be implemented.

Energy Requirements & Natural or Depletable Resources

All machinery used during the Preferred Alternative would comply with current fuel and emission laws and regulations. No depletable resources would be utilized by activities under the Preferred Alternative except for fossil fuels to power machinery.

Environmental Justice

EO 12898 (environmental justice or EJ) requires that, to the greatest extent practicable and permitted by law, and consistent with the principles set forth in the report on the National Performance Review, each Federal agency make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions, the District of Columbia, the Commonwealth of Puerto Rico, and the Commonwealth of the Mariana Islands.

The USEPA's Environmental Justice web mapping tool was consulted on 29 June 2016. There are EJ populations that occur within a 2-mile radius of the Preferred Alternative's proposed activities (Figure 4). The Preferred Alternative not would adversely affect the nearby disadvantaged populations, as the activities of the Preferred Alternative are offshore, beneath 28 feet of water. Results from implementation of the Preferred Alternative would support local and regional economies depending on navigation, which is considered a benefit to neighboring communities.

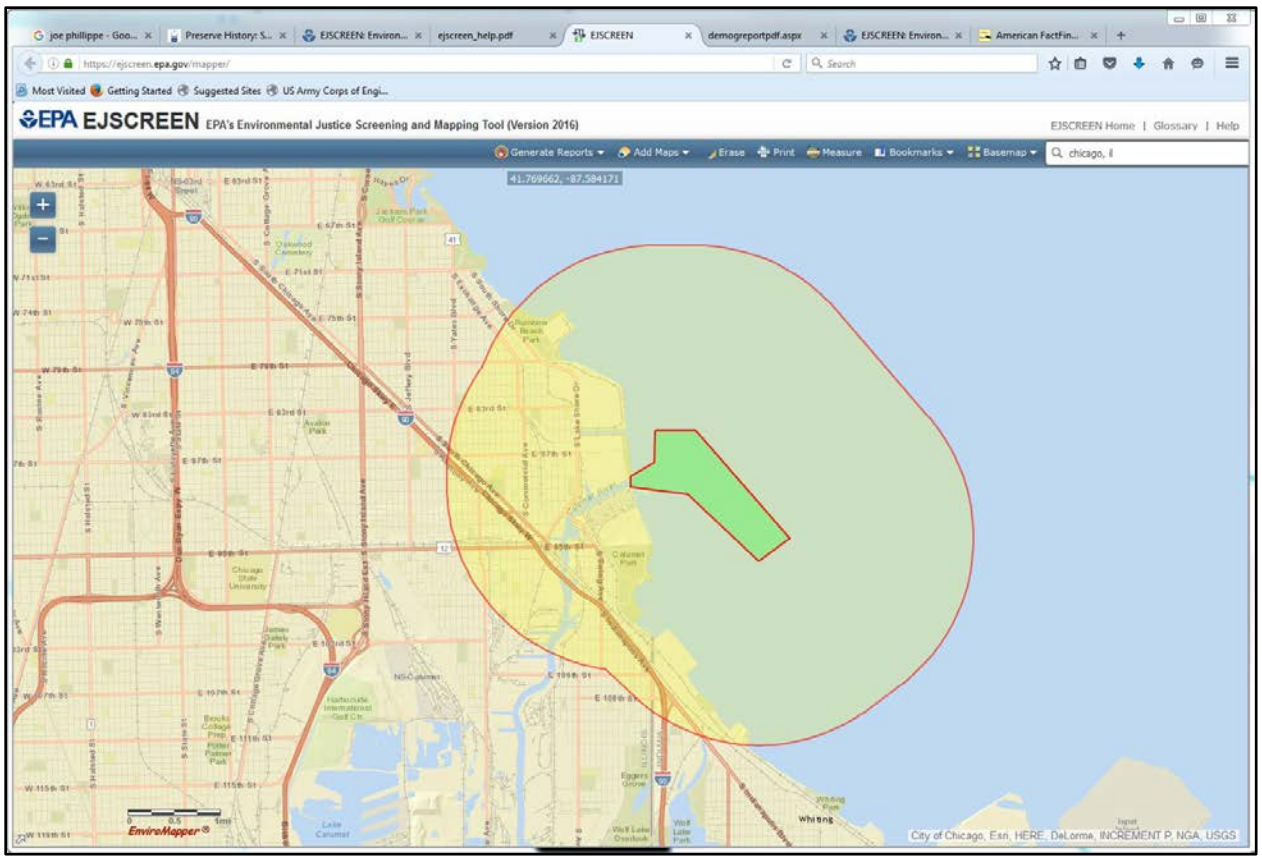

Figure 4: Screen Capture of USEPA's EJ Mapping Tool, 29 June 2016

Clean Air Act

The local air quality in Chicago and Cook County are considered 'non-attainment' under the Clean Air Act for ozone, and lead. The project is within the non-attainment zone. Due to the small scale and short duration of this project, the main sources of emissions would be vehicle emissions and dust associated with the construction activities. The project does not include any stationary sources of air emissions, and a General Conformity Analysis was not completed. The temporary mobile source emissions from this project are de minimis in terms of the National Ambient Air Quality Standards and the State Implementation Plan. All construction vehicles will comply with Federal vehicle emission standards. USACE and its Contractors comply with all Federal vehicle emissions requirements. USACE follows EM 385-1-1 for worker health and safety, and requires all construction activities to be completed in compliance with Federal health and safety requirements.

Section 401 of the Clean Water Act

The project requires coordination with the Indiana Department of Environmental Management (IDEM) for Water Quality Certification in accordance with Section 401 of the Clean Water Act (CWA). Coordination with the IDEM commenced with a project scoping letter dated 17 May 2016. The predominantly rocky material is mostly coarse and inert, and the bedrock removal and placement sites are within close proximity to each other. As a consequence, the material is not expected to be a source of contamination, and the placement of the material would not be anticipated to cause any considerable long-term effects on, or changes to, the water chemistry or quality. Short-term effects on the water quality are expected because of temporary increases in the concentration of suspended solids and turbidity following the drilling, blasting, and dredging operations, and by placement of the predominantly rocky material

along the Calumet Harbor breakwater. The temporary increase of suspended solids is expected to cause short-term decreases in water clarity and minor changes to the color of the water.

USEPA Coordination

The U.S. Environmental Protection Agency provided guidance on what the Draft EA should cover in a letter dated 20 June 2016. All of the guidance items suggested are covered within this EA. The USEPA reviewed the Draft EA during the 30-day Agency & Public review period, with no substantial comments received in a letter dated 22 August 2016.

USFWS Coordination

Coordination with the USFWS commenced with a project scoping letter dated 17 May 2016. This environmental assessment identified the NER/Preferred Alternative to have "no effects" on Federally endangered species or their habitats as determined by following the protocol and guidelines provided by Region 3 Fish & Wildlife Service (http://www.fws.gov/midwest/endangered/section7/index.html). The letter provided by the USFWS dated 16 June 2016 precludes the need for further consultation under Section 7. Coordination under the FWCA of the Preferred Alternative was completed during the Agency and public review period. USFWS reviewed the document during the 30-day Agency Review period and found that the EA adequately addresses the likely environmental impacts of the proposed action in a letter dated 25 August 2016.

State of Illinois Historic Preservation Act

The IHPA was provided a scoping letter on 17 May 2016. The IHPA indicated on 20 May 2016 that they would not be reviewing this project due to it mostly being in Indiana and the absence of any cultural or archaeological resources within the study area. The IHPA was provided the draft EA during the 30-day Agency & Public review period.

State of Illinois Department of Natural Resources Coordination

The Impact Assessment Section coordination commenced with a project scoping letter dated 17 May 2016, with reply by the State on 20 June 2016. The State Threatened Mudpuppy was the only item of concern for the State of Illinois. This species is addressed in this Environmental Assessment. The State of Illinois Department of Natural Resources concurred with the findings on Mudpuppies provided in this document in their response letter dated 31 August 2016. IL DNR requests avoiding disposal of rock on the breakwater during the colder winter months (December-March) and that USACE continue to coordinate with Dr. Phil Willink of the Shedd Aquarium.

The Coastal Zone Management Program Section indicated in an email dated 06 June 2016 that a Federal Consistency Determination would be required. This determination was provided to the State during the 30-day Agency & Public Review. There are no aspects of the Preferred Alternative that are in conflict with the Illinois Coastal Zone Management Plan due to the activities taking place solely within Indiana waters of Lake Michigan.

Division of Historic Preservation & Archaeology, Indiana

The DHPA provided scoping response dated 08 June 2016 indicating that the affected area is clear of historic or archaeological artifacts or sites. The USACE is in concurrence and has determined that "no historic properties would be affected" as provided in this Environmental Assessment; set forth in 36

C.F.R. § 800.11 per the Indiana SHPO. All consulting parties have been notified via this documentation, which is available for public inspection (36 C.F.R. §§ 800.4[d][l] and 800.2[d][2]).

State of Indiana Department of Natural Resources

The Division of Fish & Wildlife provided response to the 17 May 2016 scoping letter on 10 June 2016. The letter indicated various concerns for fish and wildlife injury due to implementation of the Preferred Alternative. These items have been addressed within this EA. The main requested activity would be to monitor and report terminated, moribund and affected organisms. The USACE will monitor during and after the Preferred Alternative's blasting activities, document all affected organisms, and provide the Division of Fish & Wildlife and the public with a full disclosure report. The USACE will not be contacting the Division of Law Enforcement for these activities, which are out of context of a highly regulated Federal project. The USACE will also not be applying for a "Permit to Blast within Waterways" due to the state having no sovereignty over the Federal government per this activity; however, the USACE has provided all required information in this EA that the permit requires. USACE received comments from IN DNR in a letter dated 31 August 2016. USACE addressed these comments in a letter dated 9 September 2016 but did not find that they necessitated changes to the EA.

The Indiana Coastal Zone Management Program has indicated that this project falls within the Lake Michigan Coastal Program's boundary; therefore, it may be subject to Federal Consistency (FC) review. According to the Indiana State's Information Bulletin #43 (Second Amendment), which provides guidance for application of consistency per the coastal zone program, the draft of this EA was provided to the Environmental Review Coordinator at environmentalreview@dnr.in.gov, fulfilling the requirement. The Federal Consistency Review was received from IN DNR on 31 August 2016.

Public & Agency Coordination

Scoping

Scoping letters were provided on 17 May 2016 to all State and Federal resource agencies, State and Federal congressional and Senate members, and local governmental agencies. The distribution list and all scoping letter responses are provided in Appendix B.

Pre-Construction Public Meetings

The contractor would be required to schedule, publicize, coordinate, secure adequate facilities for, and conduct Pre-Blast Public Information Meetings prior to finalizing the Operational Blasting Plan. As a minimum, the meetings shall be publicized in advertisements in local newspapers not less than two weeks prior to the scheduled meeting for a period of not less than one week. State and local agencies likely to express an interest in the project shall be contacted in writing directly, including law enforcement, fire prevention, and environmental authorities. The Contracting Officer will solicit interest from appropriate Federal agencies. In addition, all property owners whose properties border a portion of the contract limits shall be contacted in writing directly. A post-test blast public information meeting shall be conducted at the above location, if requested by the Contracting Officer based on previous public comments, interest and public feedback.

The purpose of the meetings is to disseminate basic project information to interested members of the public, to solicit comments from the public and evaluate proposed blasting methods in light of any valid concerns, and to identify key Contractor and Corps of Engineers representatives who may be contacted for current project information or to report complaints. The Contractor, in conjunction with the Contracting Officer, or representative, shall prepare an agenda for each meeting to address these

purposes. A public question-and-answer period shall be held at the conclusion of the public presentation, if required by the Contracting Officer.

The proceedings of each meeting shall be recorded verbatim by the Contractor, and transcripts thereof shall be provided to the Contracting Officer. The Contracting Officer, or his representative, will review the transcripts, as well as any written comments that may be received, with the Contractor, and may require the Contractor to address specific comments in his Operational Blasting Plan prior to submission.

CHAPTER 6 – Measures Supporting the Preferred Alternative

6.1 – Measures During Construction

Non-injurious deterrents would be used before each blast. A repelling charge is a non-injurious action immediately prior to a blast for the purpose of scaring aquatic organisms away from the effected zone. Multiple repelling charges would be employed at timed intervals for each blast. As example, the detonation of the first repelling charge could be at 45 seconds prior to the blast, with the second at 30 seconds prior to the blast. Some fish may not locate the origin of the first repelling charge, where the second allows fish to better locate the source of the charge and maneuver away from the source.

6.2 – Monitoring Before, During & After Construction

6.2.1 – Fish Monitoring

Although all feasible measures to prevent the termination of fish in underwater blasting, this is sometimes unavoidable. In some cases, the number and species of fish terminated are estimated visually. However, a preferable method is to net all fish from the site.

Initial Fish Inventory

A preliminary visual survey would be conducted during 2 hours before and up until the blasting activities. Sonar and an underwater camera would be utilized to observe the area for schools of fishes or other organisms occupying the blasting zone. This will provide information on how effective the fish and wildlife deterrent methods are moments before the blasting occurs.

During Construction Fish & Wildlife Counts

The USACE will monitor fish and wildlife during and after the Preferred Alternative's blasting activities, document all affected organisms, and provide the Division of Fish & Wildlife and the public with a full disclosure report. All fishes and wildlife would be identified to species and enumerated. All terminated and moribund individuals would be collected and disposed of properly. All unconscious organisms capable of returning to the wild would be released once fully conscious. Photo vouchers of specimens would be taken as proof of species affected. Underwater cameras would also be utilized to investigate the water column and benthic zone for additional affected organisms. A full disclosure report would then be furnished, provided to the resource agencies, and posted on the USACE Civil Works page for maximum distribution.

6.2.2 – Water Quality Monitoring

The fragmented rock material is coarse and inert, and the bedrock removal and disposal sites are within close proximity to each other. As a consequence, the material is not expected to be a source of contamination, and the placement of the material would not be anticipated to cause any considerable long-term effects on, or changes to, the water chemistry or quality. Short-term effects on the water quality are expected because of temporary increases in the concentration of suspended solids and turbidity following the drilling, blasting, and dredging operations, as well as during placement of the fragmented rock material along the Calumet Harbor breakwater. The temporary increase of suspended solids is expected to cause short-term decreases in water clarity and minor changes to the color of the water. The minor and

temporary increases of suspended solids concentrations produced by this project are expected to be considerably lower than the increased turbidity that typically results from adverse weather conditions.

In regards to the blasting procedure, holes will be drilled down into the bedrock well below the existing lake bottom, and the explosive material will be placed within the holes. The drill holes will then be filled at the top by "stemming" material. Stemming is typically angular gravel or crushed stone that is used to fill the hole above the explosive (Keevin and Hempen 1997). The vast majority of the force from the explosion is expected to be directed toward breaking up the bedrock. Residual gases or chemicals from the explosions are not expected to be toxic and are not anticipated to cause any adverse effects to the existing water quality. There should be no long-term impacts to the water quality, and no violations of the water quality standards are anticipated. Since the only adverse water quality impacts for this project are expected to be minor, temporary, and localized impacts due to elevated levels of suspended solids, no monitoring of water quality is planned.

6.3 Finding of No Significant Impact (FONSI)

The Finding of No Significant Impact (FONSI) may be found at the front of this document. A Draft Environmental Assessment was completed that found that there would be no long term, adverse effects resulting from implementation of the Preferred Alternative. A 30-day Agency and Public Review period was held from 03 August 2016 to 01 September 2016. All pertinent comments received during the public review period were reviewed and included in this EA. The District Engineer made a final decision regarding the necessity of preparing an Environmental Impact Statement (EIS) for the proposed project. Based on the conclusions of this EA, preparation of an EIS will not be required.

Bibliography

Brock, K.J. 1999. Birds of the Grand Calumet River Basin. 1999/2000 Proceedings of the Indiana Academy of Science 108/109; 145-162.

Chrzastowski, M. J. and C. B. Trask, 1995, Nearshore geology and geologic processes along the Illinois shore of Lake Michigan from Waukegan Harbor to Wilmette Harbor: Illinois State Geological Survey, Open File Series 1995-19, Champaign, IL, 93 p.

Garza, E.L., Whitman, R.L., 2004. The nearshore benthic invertebrate community of southern Lake Michigan and its response to beach nourishment. *J. Great Lakes Res.* 30, 114–122.

GEI Consultants, Inc. 2014. "Subsurface Investigation Report – Calumet Harbor Bedrock Investigation – FY 2014. Libertyville, Illinois.

Hempen, G. L., T. M. Keevin, M. T. Rodgers, and B. M. Schneider. 2014. Mechanical rock grinding in the Mississippi River: Anthropogenic noise production and implications for the federally endangered Pallid Sturgeon, *Scaphirhynchus albus*. Journal of Applied Ichthyology 30:1492-1496.

Illinois Environmental Protection Agency, Bureau of Water, *Integrated Water Quality Report and Section 303(d) List*. 2014. Clean Water Act Sections 303(d), 305(b) and 314, Vol. I: Surface Water.

Keevin, T.M. and Hempen, G.L. 1997. "The Environmental Effects of Underwater Explosions with Methods to Mitigate Impacts." Manual prepared for the U.S. Army Corps of Engineers, St. Louis District, St. Louis MO.

Nalepa, T.F., Hartson, D.J., Fanslow, D.L., Lang, G.A., and Lozano, S.J. 1998. Declines in benthic macroinvertebrate populations in southern Lake Michigan, 1980–1993. *Can. J. Fish. Aquat. Sci.* 55:2402–2413.

USACE. 1975. Environmental Impact Statement for the Calumet Harbor and River, Illinois and Indiana Maintenance Dredging and Disposal.

USACE 1982. "Chicago Area Confined Disposal Facility and Maintenance Dredging in Cook County, Illinois," U.S. Army Engineer Division, North Central Corps of Engineers, Chicago, IL.

USACE 2014. "Calumet Harbor Dredged Material Human Health Risk-Based Screening for Upland Beneficial Use Determination." Chicago District, Chicago, IL.

USACE 2015b. Memorandum for Commander, Great Lakes and Ohio River Division (CELRD-PDS-G, Ms. Boccieri) Subject: Calumet Harbor and River, Illinois & Indiana – Determination of Federal Standard for Beneficial Use of Material", Chicago District, Chicago, IL.

USACE 2015a. Chicago Area Waterway System (CAWS) Dredged Material Management Plan & Integrated Environmental Assessment, Chicago District, Chicago, IL.

USACE 2016. Maintenance Dredging Report for Calumet Harbor and River, Water Quality Monitoring Year 2015, Chicago District, Chicago, IL.

Young, G.A. 1973. Guide-Lines for Evaluating the Environmental Effects of Underwater Explosion Tests. Naval Ordnance Laboratory, White Oak, Silver Spring, Maryland.