Calumet Harbor – Bedrock Removal to Authorized Depth
Draft Environmental Assessment

Appendix A - Section 404(b)(1) Analysis

Table of Contents

I. Project Description

a. Location

The general vicinity of the Calumet Harbor and River Federal navigation project is shown in Figure 1. Calumet Harbor is located near the border between Illinois and Indiana, along the southwestern shore of Lake Michigan, approximately 12 miles southeast of Chicago Harbor. Calumet Harbor and the harbor's breakwaters are primarily located in Lake County, Indiana, but the project crosses the Illinois-Indiana state boundary line east of the entrance to the Calumet River, and the western, Calumet River portion of the project is located in northeastern Illinois (Cook County), within the corporate limits of the City of Chicago.

b. General Description

Navigation is one of the primary civil works mission areas 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. Beneath the water surface of Calumet Harbor, a portion of the lake bottom has an outcrop of dolomitic limestone bedrock, and there is an area of roughly fifty (50) acres within Calumet Harbor where the elevation of the bedrock surface along the bottom extends above or near the authorized dredge depth. The authorized dredge depth in this area is 28 feet below Lake Michigan's low water datum (LWD) (577.5 feet International Great Lakes Datum (IGLD) 85). The proposed rock removal area is shown in Figure 2, and it is located roughly a mile lakeward from the shoreline. Since the elevation of the bedrock extends above or near the authorized dredge depth, the USACE, Chicago District, has been unable to achieve the full, required depth over the entire area during maintenance dredging operations. As a consequence, in order to maintain the authorized depth for safe and efficient navigation through the harbor, the upper layer of the bedrock needs to be removed. Removing the upper layer of bedrock in this area will help ensure that maintenance operations will be capable of achieving a depth throughout Calumet Harbor that will be greater than or equal to the authorized dredge depth.

The proposed method for removing the upper layer of bedrock is through the use of underwater explosives (blasting). 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 native fish populations, the blasting operations will be specifically scheduled to avoid time periods when native fish are typically spawning or migrating. Furthermore, additional measures may be taken to minimize the impacts to native fish, such as the use of repelling charges to scare away fish prior to the primary explosive charge, limits on the 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 native 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 mitigate impacts is through the performance of a thorough evaluation of the aquatic resources in the area, which was 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 (known as “vugs”), and it contained many fractures (GEI 2014). Nevertheless, the bedrock was still determined to be difficult, time consuming, and uneconomical to excavate using a mechanical, hydraulic hammer, so the proposed method for removal is blasting. Prior to any blasting work, a preliminary survey of conditions will be performed to verify the elevations of the harbor floor. Keevin and Hempen (1997) explain the complex mechanics of underwater blasting, and they discuss a number of factors that need to be taken into consideration. As a consequence, the actual details of the blasting plan and specific design parameters will need to be developed and determined by knowledgeable experts with extensive training and experience. Although these details are presently unknown, for a rough estimate, it was presumed that an array of holes around 15-feet deep, drilled in a grid pattern (borehole spacing distances) of approximately 15 feet by 15 feet may achieve rock fragmentation sufficient to remove the bedrock to the authorized elevation. The equipment necessary for drilling would include drill(s) capable of drilling 6-inch diameter holes 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. The actual borehole array, size, depth, blast design and specifics of the means, methods, and equipment will be developed with the assistance of knowledgeable experts with extensive training and experience following award of the contract. The equipment specifically for blasting would include all components of the explosive agents, safety equipment, storage and other equipment necessary to place the explosives in the boreholes.

After the boreholes have been drilled down into the bedrock, below the existing lake bottom, and the explosive material has been 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 stemming material locks in the top of the borehole so that the force from the explosion is directed toward breaking up the bedrock strata rather than being lost through the top of the borehole. By reducing the energy lost through the top of the borehole, stemming helps decrease adverse impacts to the aquatic environment. It is important to note that the maximum pressures are significantly reduced when explosives are confined and detonated within a rock borehole in comparison to the same explosive charge detonated in open water (Hempen et al. 2005 and 2007).

The gaseous products from blasting primarily consist of water, carbon dioxide, and nitrogen, but a few toxic gases, notably carbon monoxide (CO) and nitrogen oxides (NOx), are also produced (Mainiero et al. 2007). Mainiero et al. (2007) explain that the amount of toxic gas that is produced is affected by a number of factors, and potential ways to reduce it include following the manufacturer's recommended guidelines for storage and use, ensuring the explosives are properly formulated, and verifying that they are within the shelf life and not deteriorated. Although toxic gas production is a concern for confined environments, such as for underground mining, the concentrations are generally negligible when there is adequate ventilation to dilute the gases below harmful levels. In comparison to mining operations, the blasting performed in Calumet Harbor is expected to be relatively small, and one of the main objectives will be to minimize injuries to native fish. The toxic gases released from the underwater explosions should readily disperse and become diluted in a short period of time, so the concentrations are not anticipated to cause any long-term adverse impacts to the water quality or to aquatic life. Monitoring of the first three (3) blasting events by USACE fisheries biologists will also help identify adverse impacts to native fish.

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 (3) to five (5) 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 (50)-acre area is approximately 50,000 to 100,000 cubic yards (cy). 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 USACE, Chicago District subsequently plans to place the predominantly rocky material on both the Lake Michigan and Calumet Harbor sides of the breakwater, near the bottom (toe) of the structure. The placement of the predominantly rocky 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 help create additional shelter and habitat for certain aquatic plants and organisms.

c. Authority and Purpose

The Calumet Harbor project was originally adopted by the River and Harbor Act of July 11, 1870 and modified August 11, 1888 (USACE 1959). The purpose for the improvements at Calumet Harbor was to furnish a safe and practicable entrance to the Calumet River and the port of South Chicago (USACE 1895). The Calumet River project was originally adopted by the River and Harbor Act of July 5, 1884, and modified August 5, 1886 (USACE 1959).

The 1959 report of the Chief of Engineers recommended the modification of the project to increase the authorized project depths to 29 feet in the lake approach channel; 28 feet in outer harbor; and 27 feet in the river entrance up to the Elgin, Joliet & Eastern Railway Bridge. Project depths are referred to LWD for Lake Michigan. Work to deepen the outer harbor and channel was authorized by the River and Harbor Act of 1960 (USACE 1966).

The following table includes the dates of additional work that was authorized and associated documents through 1959 (USACE 1959), which covers the construction and improvements of Calumet Harbor:

Acts	Work authorized	Documents
Mar. 3, 1899 June 13, 1902	Outer harbor protected by breakwater.	Annual Report, 1896, pp. 2584, et seq., and H. Doc. 277, 54th Cong., 1st sess.
Mar. 3, 1905	5 turning basins	H. Doc. 172, 58th Cong., 2nd sess.
June 25, 1910	Provided for shape and dimensions of turning basins	H. Doc. 349, 60th Cong., 1st sess.
Sept. 22, 1922	Consolidated the 2 projects for Calumet Harbor and Calumet River.	
Aug. 30, 1935[1]	Detached breakwater; dredging the outer harbor to existing project depth and dimensions; deepening river-entrance channel and river to existing project depths; widening and straightening the river channel; deepening the 5 turning basins to the same depth as the adjacent channel.	H. Doc. 494, 72d Cong., 2d sess.[2]
Mar. 2, 1945	Provide an approach channel to the harbor 3,200 feet wide and 28 feet deep through the shoals outside the breakwater and for closing the existing gap between the breakwaters.	H. Doc. 233, 76th Cong., 1st sess.[3]

[1] Included in Public Works Administration program Sept. 6, 1943, and Dec. 16, 1933.
[2] Contains latest published map of the harbor.
[3] Contains latest published maps of the river.

As indicated earlier, the purpose of the current project is to improve navigation through Calumet Harbor by removing the upper layer of bedrock in an approximately fifty (50)-acre area, so that the USACE, Chicago District will be able to maintain the authorized dredge depth throughout the harbor. Large, commercial vessels need adequate depths in order to navigate safely through the harbor, provide economical and cost-effective

waterborne transportation of cargo, and ensure Calumet Harbor is a safe harbor of refuge during severe weather conditions.

Although this evaluation is for the removal and in-water placement of the bedrock material, it is relevant to note that the finer-grained sediment that accumulates in the Calumet Harbor and River Federal navigation channel is mechanically dredged to maintain navigation. This finer-grained Calumet Harbor material that accumulates within the bedrock outcropping area is considered suitable for unconfined upland use, and the dredged material is stockpiled outside of the Chicago Area Confined Disposal Facility (CDF). The Chicago Area CDF is used to confine the sediment from the Calumet River, which is not suitable for beneficial use or open water placement. The Chicago Area CDF was constructed between 1982 and 1983, and the final Environmental Impact Statement (EIS) for the facility and maintenance dredging of the navigation channel was completed in 1982 (USACE 1982).

The Section 404(b)(1) guidelines for the specification of disposal sites for dredged or fill material are in Title 40, Chapter I, Subchapter H, Part 203 of the Code of Federal Regulations (CFR).

d. General Description of Dredged or Fill Material

(1) General Characteristics of Material

Attachment No. 1 to this evaluation provides the details of a geotechnical investigation of the bedrock in Calumet Harbor that was performed by GEI Consultants, Inc. (GEI 2014) for the USACE, Chicago District. This report describes the bedrock as “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 (8) borings, and the intent was to drill to a depth of ten (10) 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 (6) of the borings reached the planned depth. The report from GEI Consultants, Inc. (2014) contains the boring logs and photographs of the rock cores collected from the borings. This report also mentions that the bedrock was overlain by a layer of sediment that ranged from one inch to three (3) feet in thickness and consisted of soft silty gray clay, with some sand, and fine gravel.

Attachment No. 2 to this evaluation consists of a narrative report describing a pilot scale study performed by Luhr Bros. Inc. in 2015 to investigate the removal of the bedrock from a 2,500 square foot area using a mechanical, hydraulic hammer. This narrative report provides photographs of the rock fragments dredged from the bottom of Calumet Harbor after the hammer detached the bedrock from the formation.

As noted above, the geotechnical investigation by GEI Consultants Inc. determined that the bedrock was overlain by a layer of sediment that ranged from one inch to

three (3) feet in thickness and consisted of soft silty gray clay, with some sand, and fine gravel. Although this current evaluation is primarily for the removal and in-water placement of the bedrock material, a minor amount of the fine-grained sediment from Calumet Harbor will be resuspended and entrained with the rocky material. The figures included with the report by Luhr Bros Inc. (Attachment 2) provide some indication of the percentage of finer-grained sediment that may be associated with the fragments of rock. The material is considered to be "predominantly rocky material", and this terminology is used in the remainder of this evaluation to acknowledge that finer-grained material will become resuspended during the drilling, blasting, and dredging operations, as well as by the placement of the material along the breakwater.

As mentioned earlier, 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 Confined Disposal Facility (CDF). The reason that this finer-grained material was considered to be suitable for unconfined upland use is provided in the Dredged Material Management Plan (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).

(2) Quantity of Material

The total estimated volume of bedrock that will be removed from the fifty (50)-acre area in Calumet Harbor is 50,000 to 100,000 cubic yards.

(3) Source of Material

The material proposed for placement along the breakwater is largely composed of fragments of naturally-occurring Silurian-aged Racine dolomite bedrock that will be removed from the bottom of Lake Michigan in Calumet Harbor. A minor amount of finer-grained sediment within the area will be mixed with the fractured rock during placement along the breakwaters.

e. Description of the Proposed Discharge Site(s)

(1) Location

Figure 3 shows the Calumet Harbor breakwater. A stone filled timber crib breakwater protects the inner portion of the harbor, and this breakwater extends eastward from the shoreline 4,262 linear feet, where it then bends toward the southeast for another 2,452 feet. There is a 616 foot gap between the inner, attached timber crib breakwater and outer, detached steel sheet pile breakwater. The detached breakwater is constructed with stone filled double row steel sheet piles, and it protects the outer harbor area and extends another 5,006 feet towards the southeast.

(2) Size

The bedrock fragments will be dredged from Calumet Harbor using mechanical dredging equipment, and the dredged material will be placed into a barge. After the barge has been filled, the loads of dredged material will be transported by a tug boat to either the Lake Michigan or Calumet Harbor side of the breakwater in the State of Indiana. The loads of dredged material (bedrock fragments including any sediment mixed with the rock) will then be placed back into the water along the length of the breakwater. Approximately 10,000 linear feet of the Calumet Harbor breakwater is located in the State of Indiana. Presuming the bedrock fragments are placed along either the Lake Michigan or Calumet Harbor sides of the breakwater, approximately within 150 feet of the breakwater, the total area is estimated to be three (3) million square feet (10,000 ft. x 2 sides x 150 ft.), or an area of roughly 69 acres.

(3) Type of Site

The type of site is open water habitat.

(4) Type of Habitat

Seasonably cold, freshwater ecosystem, coastal aquatic habitat in Lake Michigan.

(5) Timing and Duration of Discharge

It is anticipated that the bedrock removal project will start in the spring or early summer of 2017, and it may take several years or longer because of the detailed plans, stringent safety precautions, and time-consuming nature of the work. It is important to note that this project, as well as the extent of the work that will be performed each year, is contingent upon the contract price and budget constraints. As a consequence, portions of the work may need to be delayed until subsequent years when adequate funding has been appropriated for additional bedrock removal.

f. Description of Placement Method

After the bedrock fragments are mechanically dredged from Calumet Harbor, the dredged material will be placed into split-hull scow / barge. A tug boat will transport the split-hull scow / barge to the designated area along the breakwater for placement by opening the split-hull or by using other mechanical methods.

II. Factual Determinations

a. Physical Substrate Determinations

(1) Substrate Elevation and Slope

The elevation of the bedrock proposed for removal in the fifty (50)-acre area in Calumet Harbor is approximately 28 feet below Lake Michigan's low water datum (LWD) (577.5 feet IGLD 85), which is equivalent to the authorized dredge depth. Based on the latest hydrographic survey, which was performed in April 2015, the level of the lake bottom approximately 300 feet south of the breakwater, on the Calumet Harbor side, was roughly three (3) to five (5) feet shallower than the authorized dredge depth. At some locations along the northern perimeter of the navigation channel in Calumet Harbor, around 300 feet south of the breakwater, the survey indicated that the elevation of the lake bottom was approximately 23 feet below LWD. Although no hydrographic survey data were available for the elevation of the lake bottom directly adjacent to the breakwater, or for the Lake Michigan side of the breakwater, it is likely that the bottom slopes gently downward from the breakwater towards Calumet Harbor. On both sides of the breakwater, there is existing armor stone (riprap) along the toe that slopes down from the breakwater towards the lake bottom at roughly a 1:2 (vertical to horizontal) slope. Maintenance and repairs to the breakwater have been performed, and additional stone has been placed in a few areas.

(2) Sediment Type

An investigation performed in 2014 determined that the bedrock was "Silurian-aged Racine Dolomite" (GEI 2014). Dolomite refers to a calcium magnesium carbonate mineral with chemical composition of $CaMg(CO_3)_2$, but the term "dolomite" also refers to the sedimentary carbonate rock that is predominately composed of this mineral. The dolomitic bedrock was described as being 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 2014).

Title 40 of the Code of Federal Regulations (CFR), § 230.60 (a), explains that "Dredged or fill material is most likely to be free from chemical, biological, or other pollutants where it is composed primarily of sand, gravel, or other naturally occurring inert material," which suggests that the large fragments of naturally occurring, inert dolomitic bedrock that will be dredged after the blasting should not be a source of contamination. Chemical testing of the rock was not conducted.

The geotechnical investigation by GEI Consultants Inc. determined that the bedrock was overlain by a layer of sediment that ranged from one inch to three (3) feet in thickness and consisted of soft silty gray clay, with some sand, and fine gravel. This current evaluation is primarily for the removal and in-water placement of the bedrock material, but a minor amount of the fine-grained sediment from Calumet Harbor will be resuspended and entrained with the rocky material. The figures included with the report by Luhr Bros Inc. (Attachment 2) provide some indication of the percentage of finer-grained sediment that may be associated with the fragments of rock. The material is considered to be predominantly rocky material in order to acknowledge that finer-grained material will become resuspended during the drilling, blasting, and

dredging operations, as well as by the placement of the material along the breakwater.

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 Plan (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) Dredged/Fill Material Movement

The plan is to place the predominantly rocky material along the Calumet Harbor breakwater. Due to the large size of the rock fragments, considerable depth at the placement location, and the presence of the breakwater to help absorb high wave energy, the material is anticipated to largely remain in place and should be resistant to movement from currents and waves.

(4) Physical Effects on Benthos

A portion of the existing periphyton, epibenthic plankton, and benthic macroinvertebrate habitat and organisms at the placement site, adjacent to the Calumet Harbor breakwater, will be buried and destroyed due to the placement of the predominantly rocky material. However, the lost habitat is expected to recover, and the plants and organisms should grow and recolonize on the material. The existing timber crib and steel breakwaters have armor and toe stone, but the cavities and fractures in the proposed rock material will provide additional shelter for many plants and organisms. As a consequence, the placement of the predominantly rocky material may improve the habitat over time for the periphyton, epibenthic plankton, and benthic macroinvertebrates and other organisms.

(5) Other Effects

The placement of the predominantly rocky material along the breakwater will cause short-term increases in the concentration of suspended solids, but the plants and animals that typically reside in dynamic, high wave energy environments near breakwaters are generally tolerant of turbid waters and adapted to elevated suspended solids concentrations. Thus, the environmental impacts caused by the short-term increases in suspended solids due to the placement of the predominantly rocky material are anticipated to be temporary and minimal.

(6) Actions Taken to Minimize Impacts

The objective will be to place the predominantly rocky dredged material in a uniform manner by the split-hull scow / barge, and attempts will be made to distribute the material evenly, so there is a ridge / small mound of material along the interior and exterior sides of the existing Calumet Harbor breakwater. Since the dredged material will be placed parallel to the existing breakwater, and will not be placed in a large mound, the material will not obstruct water currents or alter circulations patterns. The presence of the rock fragments near the toe of the breakwater is expected to help improve the resilience of the breakwater by reducing the scouring of sediment near the toe of breakwater by waves and currents. The reduction of sediment scouring by waves and currents would help decrease the resuspension of sediment and turbidity along the breakwater during adverse weather conditions.

b. Water Circulation, Fluctuation and Salinity Determinations

(1) Water

(a) Salinity

Lake Michigan is a fresh water lake. The proposed work will not increase or decrease the salinity of the water and will not add salts to the system.

(b) Water Chemistry

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. 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.

(c) Clarity

As discussed above, 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 the water clarity. Short-term effects on clarity are expected because of temporary increases in the concentration of suspended solids and turbidity following the drilling, blasting, and dredging operations, and the 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.

(d) Color

The material would not be anticipated to cause any considerable long-term effects on, or changes to, the water color, but a temporary increase of suspended solids is expected to cause short-term and minor changes to the color of the water.

(e) Odor

The material would not be anticipated to cause any considerable long-term effects on, or changes to, the odor of the water, but a temporary increase of suspended solids might cause short-term and minor changes to the odor of the water for organisms in the immediate vicinity.

(f) Taste

The material would not be anticipated to cause any considerable long-term effects on, or changes to, the taste of the water, but a temporary increase of suspended solids might cause short-term and minor changes to the taste of the water for organisms in the immediate vicinity. According to the Indiana Department of Natural Resources (DNR) map of significant water withdrawal facilities, the nearest public water supply intake is owned by Hammond Water Works, and this intake is located approximately 1.5 miles southeast of Calumet Harbor. The 68th Street water intake crib for the City of Chicago is roughly three (3) miles northwest of the Calumet Harbor breakwater. Impacts of the blasting are not expected to be noticeable at those distances.

(g) Dissolved Gas Levels

Temporary increases of turbidity could produce minor, localized effects on the dissolved gas and nutrient levels in the water column. The energy and mixing caused by the explosions are also expected to cause increased dissolved gases in the local areas near the detonations. These effects are primarily expected to be short-term, minor, and aesthetic impacts, but the turbid water could cause minor, short-term adverse impacts to aquatic plants and organisms in the vicinity. The toxic gases released from the underwater explosions are expected to readily disperse and become diluted in a short period of time, and the concentrations are not anticipated to cause any long-term adverse impacts to the water quality or to aquatic life. Monitoring of the first three (3) blasting events by USACE fisheries biologists will also help assess adverse impacts to native fish.

(h) Nutrients

Temporary increases of turbidity could produce minor, localized effects on nutrient levels in the water column. These effects are primarily expected to be short-term, minor, and aesthetic impacts, but the turbid water could cause minor, short-term adverse impacts to aquatic plants and organisms in the vicinity.

(i) Eutrophication

Eutrophication is typically caused by excessive nutrient levels. As discussed above, temporary increases of turbidity could produce minor, localized effects on nutrient levels in the water column, but these effects are expected to be short-

term, minor, and aesthetic impacts. The turbid water could cause minor, short-term adverse impacts to aquatic plants and organisms in the vicinity, but persistently elevated levels of nutrients or eutrophication is not anticipated.

(j) Others as Appropriate

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. 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.

(2) Current Patterns and Circulation, Current Flow and Water Circulation

(a) Current Patterns and Flow

The predominantly rocky material will be placed mechanically using a split hull scow / barge, and the project will create a ridge / small mound of material adjacent and parallel to the breakwater. The material will slightly modify the contours along bottom of Lake Michigan near the breakwater, but, due to the depth and placement of the material, the project is not expected to alter current patterns or flow and should not have any noticeable short- or long-term, individual or cumulative effects on the local or regional currents in Lake Michigan or on the circulation patterns or normal water level fluctuations.

(b) Velocity

The placement of the predominantly rocky material along the Calumet Harbor breakwater is not expected to alter the direction or velocity of the flow (current or waves), but the material may help the breakwater adsorb the wave energy and reduce scouring due to the strong currents that develop during adverse weather conditions.

(c) Stratification

Lake Michigan is a huge lake and the presence of the predominantly rocky material along the Calumet Harbor breakwater is not expected to cause any considerable long-term effects on the thermal stratification of the water column. The wind, waves, and water currents that flow along the breakwater generally allow sufficient mixing of the water column and adequate oxygen levels for fish and other aquatic organisms. The presence of the predominantly rocky material is not expected to cause any noticeable effects or changes to the water stratification.

(d) Hydrologic Regime

Since the project is not expected to alter current patterns or flow and should not have any noticeable short- or long-term, individual or cumulative effects on the local or regional currents in Lake Michigan, or on the circulation patterns, water

level fluctuations, or stratification, it should not cause any considerable effects on, or changes to, the hydrologic regime.

(3) Normal Water Level Fluctuations

Lake Michigan is an extremely large lake that has a huge surface area and contains an immense volume of water. According to the Great Lakes Atlas, (Government of Canada and USEPA 1995), Lake Michigan has a water surface area of 22,300 square miles (57,800 square kilometers) and a volume of 1,180 cubic miles (4,920 cubic kilometers). It can take multiple months, seasons, or even years of persistent wet/dry conditions to cause an impact to the water levels of the Great Lakes (USACE 2013). The USACE, Detroit District, has been tracking the water levels in each of the Great Lakes, and, they found that the primary factors that determine water level changes are precipitation falling on the lake surface, runoff draining to the lake, evaporation from the lake surface, diversions into or out of the lake, and connecting channel inflows and outflows (USACE 2013). Since the rock will be removed from the bottom of the Calumet Harbor navigation channel in Lake Michigan and promptly placed back into the water along the Calumet Harbor breakwater, any effects on the normal water level fluctuation are expected to be negligible.

(4) Salinity Gradients

Lake Michigan is a fresh water lake, so the effect of the project on salinity gradients is not applicable. The blasting and subsequent in-water placement of fractured rock is not expected to add salt to the lake.

(5) Actions That Will Be Taken to Minimize Impacts

The removal of bedrock from the Calumet Harbor navigation channel and subsequent placement of the predominantly rocky material at locations along the Calumet Harbor breakwater is not anticipated to result in any long-term effects on, or changes to, the water quality, current patterns or flow, water circulation, or the normal water level fluctuation of Lake Michigan. Since no long-term effects are anticipated, there are no actions that need to be taken to minimize impacts.

c. Suspended Particulate/Turbidity Determinations

(1) Expected Changes in Suspended Particulates and Turbidity Levels in Vicinity of Disposal Site

The project is expected to produce minor and temporary increases of suspended solids and turbidity in the local vicinity of the bedrock removal and placement sites. Plumes of suspended particles will likely be visible and aesthetically displeasing until the particles gradually settle and the plumes dissipate.

(2) Effects (degree and duration) on Chemical and Physical Properties of the Water Column

(a) Light Penetration

The project is expected to cause minor, temporary, and localized increases of suspended solids at the rock removal and placement sites that in turn cause a temporary decrease the clarity of the water and reduce the penetration of light through the water column. If the penetration of light is reduced for an extended period of time, it can lower the rate of photosynthesis and "primary productivity" of an aquatic area. Primary productivity generally refers to the fixation of solar energy by green plants (i.e., autotrophs) in a terrestrial ecosystem, or phytoplankton for an aquatic ecosystem. Persistently high turbidity can cause adverse impacts to sight-dependent species because the reduced clarity can hinder the feeding ability of these species, and thereby limit their growth and increase their susceptibility to disease.

In regards to elevated suspended solids concentrations, it explains the following in 40 CFR 230.21:

> "The extent and persistence of these adverse impacts caused by discharges depend upon the relative increase in suspended particulates above the amount occurring naturally, the duration of the higher levels, the current patterns, water level, and fluctuations present when such discharges occur, the volume, rate, and duration of the discharge, particulate deposition, and the seasonal timing of the discharge."

Since the minor, temporary, and localized increases of suspended solids at the rock removal and placement sites are anticipated to be low relative to the increased levels of suspended solids that typically result from storm events and adverse weather conditions, the project is not expected to cause any long-term adverse impacts on the chemical or physical properties of the water column.

(b) Dissolved Oxygen

Minor, temporary, and localized increases of suspended solids at the rock removal and placement sites will likely result in slight reductions in the level of dissolved oxygen water in the column. This is because the biological and chemical content of the suspended material may react and in turn deplete some of the dissolved oxygen in the water column.

(c) Toxic Metals and Organics

As noted in 40 CFR Part 230.60(a), "Dredged or fill material is most likely to be free from chemical, biological, or other pollutants where it is composed primarily of sand, gravel, or other naturally occurring inert material." The predominantly rocky rock material is mostly naturally occurring inert material and will mainly be

composed of large particles of rock. As a consequence, the material is unlikely to be a carrier of toxic metals or organics and these contaminants should not cause any adverse impacts. In addition, as noted above, as part of the DMMP process, the environmental quality of the Calumet Harbor sediment was investigated, and the sediment was determined to be suitable for unconfined upland placement (USACE 2015a and 2015b).

In 40 CFR Part 230(c), it also explains the following:

> "Where the discharge site is adjacent to the extraction site and subject to the same sources of contaminants, and materials at the two sites are substantially similar, the fact that the material to be discharged may be a carrier of contaminants is not likely to result in degradation of the disposal site."

The site in Calumet Harbor from which the predominantly rocky material will be removed is nearly adjacent to the placement site along the breakwater. Thus, although the material is expected to be mainly composed of large particles of rock, due to the close proximity of the removal and placement sites, if more fine-grained dredged material was present, it would still be unlikely to cause degradation of the placement site.

(d) Pathogens

There are Chicago Park District public beaches located north and south of Calumet Harbor. Pathogens, particularly disease-causing bacteria and other germs, are a major concern for beaches in the area. The Chicago Park District routinely tests the water for *Escherichia coli* (*E. coli* for short) bacteria during the swimming and recreational boating season. Although *E. coli* is not harmful itself and is naturally occurring in the environment, the bacteria is an indicator of sewage contamination and the possible presence of human pathogens (bacteria, protozoa, and viruses) (Whitman and Nevers 2003). Whitman and Nevers (2003) suggest that potential sources include stormwater (sewage) overflows, leaking septic systems, and birds occupying the beach. The large masses of inert, naturally occurring predominantly rocky material are not expected be a source pathogens, and the removal and placement of the dredged material along the breakwater is not anticipated to cause any adverse impacts associated with pathogens.

(e) Aesthetics

As discussed earlier, the temporary increase of suspended solids is expected to cause a short-term decrease of water clarity and minor changes to the color of the water, and these effects are primarily expected to cause short-term, minor, and aesthetic impacts. In addition, for recreational boaters and the aquatic resources in the vicinity there will be loud noises associated with the blasting, dredging, and placement activities, and the visual presence of the barges and

marine construction vessels and equipment will have a temporary and minor adverse impact to the aesthetic beauty of the water surface along the Lake Michigan shoreline.

(f) Others as Appropriate

The removal of the bedrock from Calumet Harbor and placement of the predominantly rocky material along the breakwater is not expected to cause any other adverse effects on the chemical and physical properties of the water column.

(3) Effects on Biota

(a) Primary Production, Photosynthesis

As mentioned earlier, in the discussion of light penetration, primary production generally refers to the fixation of solar energy by phytoplankton for an aquatic ecosystem. The project will cause some minor, temporary, and localized increases of suspended solids, but the effects are anticipated to be low relative to the increased levels of suspended solids that typically result from storm events and adverse weather conditions. As a consequence, the project is not expected to cause any long-term adverse impacts to the harbor environment.

(b) Suspension/Filter Feeders

The project will cause some minor, temporary, and localized increases of suspended solids, which could benefit suspension/filter feeders, but, since the effects are anticipated to be low relative to the increased levels of suspended solids that typically result from storm events and adverse weather conditions, the project is not expected to cause any long-term effects on the suspension/filter feeders.

(c) Sight Feeders

Persistently high turbidity can cause adverse impacts to sight-dependent species because the reduced clarity can hinder the feeding ability of these species, and thereby limit their growth and increase their susceptibility to disease. The project will cause minor, temporary, and localized increases of suspended solids, but, as mentioned previously, the effects are anticipated to be low relative to the increased levels of suspended solids that typically result from storm events and adverse weather conditions. Although there may be minor, temporary, and localized impacts, the project is not expected to cause persistent, long-term adverse effects on the sight feeders.

(4) Actions taken to Minimize Impacts

In order to minimize the adverse effects of blasting on native fish populations, the blasting operations will be specifically scheduled to avoid time periods when native fish are typically spawning or migrating. Furthermore, additional measures may be taken to minimize the impacts to native fish, such as the use of repelling

charges 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 native 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 mitigate 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.

d. Contaminant Determinations

The predominantly rocky material is not expected to introduce any new contaminants into Calumet Harbor or release existing contaminants through bottom disturbance in the removal or placement areas. As discussed previously in the discussion of water, 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 new contamination, and the placement of the material would not be anticipated to cause any considerable long-term effects on, or changes to, the existing water quality or cause effects on biota.

e. Aquatic Ecosystem and Organism Determinations

(1) Effects on Plankton

Plankton are pelagic, which means they live within the water column itself, as opposed to benthic organisms that live along the bottom (Water Encyclopedia 2016). Plankton generally drift along with the water currents and/or float on or near the water surface, as opposed to nekton, which are active swimmers that can propel themselves through water currents. Plankton are typically divided into phytoplankton, which includes photosynthesizing species like algae that derive energy from sunlight, water, and carbon dioxide, and zooplankton, which consume food in order to derive energy. Although most planktonic species are small and often microscopic, there are large plankton organisms that are still considered to be plankton because they drift with the water current.

Researchers have found that Lake Michigan has experienced substantial and complex changes to the food-web structure since the 1980s (Vanderploeg et al. 2012, Makarewicz et al. 1998, and Scavia et al. 1988). The paper by Vanderploeg et al. (2012) lists the following changes: (1) a decrease in

phosphorus loading, (2) increased control of planktivorous alewife (*Alosa pseudoharengus*) by the introduction of Pacific salmon, (3) the invasion of the visual-feeding spined predatory cladoceran *Bythotrephes longimanus* in the mid 1980s from northern Europe, (4) invasion by a host of Ponto-Caspian species, including zebra (*Dreissena polymorphia*) and quagga mussels (*Dreissena rostiformis bugensis*) during the 1990s, and (5) loss of the spring phytoplankton bloom in 2007 and 2008 likely caused by intense filtering during winter and spring by quagga mussels following their massive population expansion into deep water starting in 2004.

The many changes, invasive or non-native species, and complex interactions that have occurred in Lake Michigan makes it difficult to assess and/or quantify the effects on different species and the food-web (Vanderploeg et al. 2012). The proposed rock removal project will cause some minor, temporary, and localized impacts to some phytoplankton and zooplankton, but, due to the nature of these organisms and large scale of Lake Michigan in comparison to the project, it is likely that the impacted populations of plankton in the vicinity will quickly recover, and no considerable long-term effects on plankton communities are anticipated.

(2) Effects on Benthos

Benthos refers to the organisms (plants and animals) that inhabit the bottom of a sea, stream or lake. For the current project, the benthos includes organisms that live on, in, or near the bottom of Lake Michigan. The removal of bedrock from the bottom of the lake and the placement of predominantly rocky material along the Calumet Harbor breakwater will cause minor destruction and temporary effects on the existing benthic community in the local area. However, these communities are generally tolerant and would be expected to become reestablished over the long-term. As a consequence, the project will not cause any considerable, long-term effects on the benthos communities in this region of Lake Michigan.

(3) Effects on Nekton

Nekton refers to the aquatic life (organisms) that can swim freely and are generally independent of the water currents. This includes fish eggs and larvae. The primary concern for this project is the adverse effects on native fish from the blasting operations. In order to minimize the adverse effects of blasting, the operations will be specifically scheduled to avoid time periods when native fish are typically spawning or migrating. Furthermore, additional measures may be taken to minimize the impacts to native fish, such as the use of repelling charges 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 native fish.

(4) Effects on Aquatic Food Web

As discussed earlier under the effects on plankton, researchers have found that Lake Michigan has experienced substantial and complex changes to the food-web structure since the 1980s (Vanderploeg et al. 2012, Makarewicz et al. 1998, and Scavia et al. 1988), and, as a result of these changes, there have been substantial effects on the Lake Michigan aquatic life ecosystem. In comparison to these changes, the blasting, dredging, and placement operations will only cause some minor, temporary, and localized adverse impacts. These impacts will likely include the debilitation and death of some food web organisms in the vicinity, particularly sedentary organisms along the lake bottom. Nevertheless, Lake Michigan is extremely large lake, and the project is not expected to cause any considerable, long-term effects on the food-web structure.

(5) Effects on Special Aquatic Sites

(a) Sanctuaries and Refuges
There are no sanctuaries or refuges in the vicinity, so this topic is not applicable.

(b) Wetlands
The project is for deep water habitat, so there are no wetlands present in the vicinity and this topic is not applicable.

(c) Mud Flats
There are no mud flats present in the vicinity of the project, so this topic is not applicable.

(d) Vegetated Shallows
No vegetated shallows are present in the vicinity of the project, so this topic is not applicable.

(e) Coral Reefs
There are no coral reefs are applicable for freshwater environments, so this topic is not applicable.

(f) Riffle and Pool Complexes
There are no riffle and pool complexes present in the vicinity of the project, so this topic is not applicable.

(6) Threatened and Endangered Species

Currently, there are no Federally Endangered or Threatened Species, or their critical habitats within the study area. Based on this, there would be no adverse effects to Federally Listed Species resulting from implementation of the project.

In addition, at the present time, there are no State of Indiana Endangered or Threatened Species, or their critical habitats within the study area. Based on this, there would be no adverse effects to State of Indiana Listed Species resulting from implementation of the project.

Adverse impacts to the State of Illinois Threatened Mudpuppy is a concern. As indicated in the Environmental Assessment, Mudpuppies would mostly likely be found along the existing breakwater structure during the colder months of December, January, February, and early March. The USACE, Chicago District, will coordinate with other regulatory agencies to determine appropriate environmental windows to avoid adverse impacts to native fish.

(7) Other Wildlife

No other wildlife would be adversely impacted by the proposed drilling, blasting, dredging, or placement operations.

(8) Actions to Minimize Impacts

In order to minimize the adverse effects of blasting on native fish populations, the blasting operations will be specifically scheduled to avoid time periods when native fish are typically spawning or migrating. Additional measures may be taken to minimize the impacts to native fish, such as the use of repelling charges 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 native 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 mitigate 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.

f. Proposed Disposal Site Determinations

(1) Mixing Zone Determination

A mixing zone is not applicable because a violation of applicable water quality standards is not expected.

(2) Determination of Compliance with Applicable Water Quality Standards

As discussed earlier in the discussion of water, the predominantly rocky material will be 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. 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. However, overall, the project is expected to comply with all applicable water quality standards and no violations are anticipated.

(3) Potential Effects on Human Use Characteristic

(a) Municipal and Private Water Supply

The Indiana DNR map of significant water withdrawal facilities shows the nearest public water supply intake is owned by Hammond Water Works, and this intake is located approximately 1.5 miles southeast of Calumet Harbor. The 68th Street water intake crib for the City of Chicago is roughly three (3) miles northwest of the Calumet Harbor breakwater. The magnitude of any effects on the water quality are anticipated to be minor, temporary, and localized, and, since these municipal or private water supply intakes are located a considerable distance away from the project location, no adverse effects are anticipated.

(b) Recreational and Commercial Fisheries

No effects on commercial fisheries will occur in regards to the proposed project since commercial fishing does not occur within the vicinity of Calumet Harbor. The proposed action would cause only a minor, temporary, and localized disruption to sport fishing access since access to the proposed site will be restricted during drilling, blasting, and dredging operations, and predominantly rocky material placement activities along the Calumet Harbor breakwater.

(c) Water Related Recreation

As mentioned above, there will be minor and temporary adverse impacts for sport fishing as well as for recreational boat users, because access to Calumet Harbor will be restricted during the drilling, blasting, and dredging operations, as well as areas along the breakwater during the placement of the predominantly rocky material.

(d) Aesthetics

The drilling, blasting, and dredging operations, as well as the placement of the predominantly rocky material along the breakwater will result in various adverse effects on the aesthetic quality in the area close to the project site. There may be

minor and temporary effects on the aesthetic quality of the air, water, and visual quality. Increases in noise levels due to the operations will also occur, but they are expected to be relatively minor compared to the noise from the nearby highways and various industrial activities in the area. The aesthetic effects will be temporary and will only impact those people in the immediate vicinity. Since there are only a small number of private residences in the area and the work will be restricted to the daylight hours, the adverse aesthetic impacts are anticipated to be minimal.

(e) Parks, National and Historical Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves

No Parks, National and historical monuments, national seashores, wilderness areas, research sites, and similar preserves are present in the vicinity of the project, so this topic is not applicable.

g. Determination of Cumulative Effects on the Aquatic Ecosystem

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. A considerable amount of time will be required to perform the drilling and blasting operations, and additional time will be required to dredge the predominantly rocky material and place it along the Calumet Harbor breakwater. It should be recognized that the aquatic ecosystem in the area is likely comprised of aquatic plants and animals that typically reside in dynamic, high wave energy environments near breakwaters and are generally tolerant of turbid waters and adapted to elevated suspended solids concentrations. In addition to the breakwater, the area is frequently impacted by ship traffic through the navigation channel and the associated impacts from the propellers on these vessels. The elevated levels of suspended solids would be expected to settle or dissipate within a relatively short time period, and the minor and temporary increases of suspended solids concentrations produced by the drilling, blasting, and dredging operations, as well as the placement operations, are expected to be considerably lower than the increased turbidity that would typically result from adverse weather conditions. As a consequence of the factors described above, cumulative effects are extremely unlikely.

h. Determination of Secondary Effects on the Aquatic Ecosystem

No secondary effects are anticipated as a result the drilling, blasting, and dredging operations, or the placement of the predominantly rocky material along the Calumet Harbor breakwater.

III. Findings of Compliance or Non-Compliance with the Restrictions on Discharge

a. Adaptation of the Section 404(b)(l) Guidelines to this Evaluation

There were no adaptations of the Section 404(b)(l) guidelines for this evaluation.

b. Evaluation of Availability of Practicable Alternatives to the Proposed Discharge Site Which Would Have Less Adverse Impact on the Aquatic Ecosystem

In Chapter 2, Alternatives Considered, of the Environmental Assessment (EA), the document discusses the practicable alternatives that were evaluated. The EA considered the "no action" alternative, conventional dredging, mechanical ripping of bedrock and removal, drilling and blasting, and shaped charges. Drilling and blasting were selected because the technology is common place and used in coastal underwater demolition projects worldwide. This method was also selected because it was the most effective alternative in terms of constructability and cost. It is expected that all of the alternatives considered, besides the "no action" alternative, would have similar minor impacts.

c. Compliance with Applicable State Water Quality Standards

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. 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. However, overall, the project is expected to comply with all applicable water quality standards and no violations are anticipated.

d. Compliance with Applicable Toxic Effluent Standard or Prohibition Under Section 307 Of the Clean Water Act

The project is in compliance with applicable Toxic Effluent Standards under Section 307 of the Clean Water Act; with the Endangered Species Act of 1973; with the National Historic Preservation Act of 1966; and with the Marine Protection, Research, and Sanctuaries Act of 1972.

e. Compliance with Endangered Species Act of 1973

As noted earlier, currently, there are no Federally Endangered or Threatened Species, or their critical habitats within the study area. Based on this, there would be no adverse effects to Federally Listed Species resulting from implementation of the project. In addition, at the present time, there are no State of Indiana Endangered or Threatened Species, or their critical habitats within the study area. Based on this, there would be no

adverse effects to State of Indiana Listed Species resulting from implementation of the project.

f. Compliance with Specified Protection Measures for Marine Sanctuaries Designated by the Marine Protection, Research, and Sanctuaries Act of 1972

The proposed project is for Lake Michigan and the Great Lakes are not included by the Marine Protection, Research, and Sanctuaries Act of 1972.

g. Evaluation of Extent of Degradation of the Waters of the United States

(1) Significant Adverse Effects on Human Health and Welfare

The proposed fill activity is not expected to have any long-term adverse impacts on human health or welfare, including;
(a) Municipal and private water supplies,
(b) Recreational and commercial fisheries,
(c) Plankton,
(d) Fish,
(e) Shellfish,
(f) Wildlife communities (including community diversity, productivity, and stability), or
(g) Special aquatic sites

(2) Significant Adverse Effects on Life Stages of Aquatic Life and Other Wildlife Dependent on Aquatic Ecosystems

As discussed earlier in the description of the effects on nekton, the primary concern for this project is the adverse effects on native fish from the blasting operations. All practicable steps will be taken to minimize injuries to native fish in the area, but the blasting is likely to cause minor adverse effects, including injuries as well as some mortality of native fish in different stages of life. In order to minimize the adverse effects of blasting, the operations will be specifically scheduled to avoid time periods when native fish are typically spawning or migrating.

(3) Significant Adverse Effects on Aquatic Ecosystem Diversity, Productivity and Stability

The size of Lake Michigan is huge in comparison to the size of the project site and no long-term adverse effects are expected on aquatic ecosystem diversity, productivity or stability. Furthermore, it should be noted that the elevated levels of suspended solids would be expected to settle or dissipate within a relatively short time period, and the minor and temporary increases of suspended solids concentrations produced by the drilling, blasting, and dredging operations, as well as the placement operations, are expected to be considerably lower than the increased turbidity that would typically result from adverse weather conditions.

(4) Significant Adverse Effects on Recreational, Aesthetic, and Economic Values

As described earlier, the project will have some minor and temporary effects on recreational, aesthetic, and economic values. In regards to recreation, there will be minor and temporary adverse impacts for sport fishing as well as for recreational boat users, because access to Calumet Harbor will be restricted during the drilling, blasting, and dredging operations, as well as areas along the breakwater during the placement of the predominantly rocky material. The project will also cause minor and temporary effects on the aesthetic quality of the air, water, and visual quality in the area close to the project site. Increases in noise levels due to the operations will also occur, but they are expected to be relatively minor compared to the noise from the nearby highways and various industrial activities in the area. The aesthetic effects will be temporary and will only impact those people in the immediate vicinity. Since there are only a small number of private residences in the area and the work will likely be restricted to the daylight hours, the adverse aesthetic impacts are anticipated to be minimal. No adverse effects on economic values are anticipated, but the removal of the bedrock is expected to improve maintenance operations so commercial vessels will have adequate depths to navigate safety and transport cargo more efficiently.

h. Appropriate and Practicable Steps Taken to Minimize Potential Adverse Impacts of the Discharge on the Aquatic Ecosystem

In addition to scheduling the blasting activities to avoid time periods when native fish are typically spawning or migrating, additional measures may be taken to minimize the impacts to native fish, such as the use of repelling charges 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 will be taken to minimize injuries to native fish in the area.

i. On the basis of the guidelines, the proposed disposal site for the discharge of the dredged material is specified as complying with the requirements of these guidelines, with the inclusion of appropriate and practical conditions to minimize adverse impacts to the aquatic ecosystem.

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Figures

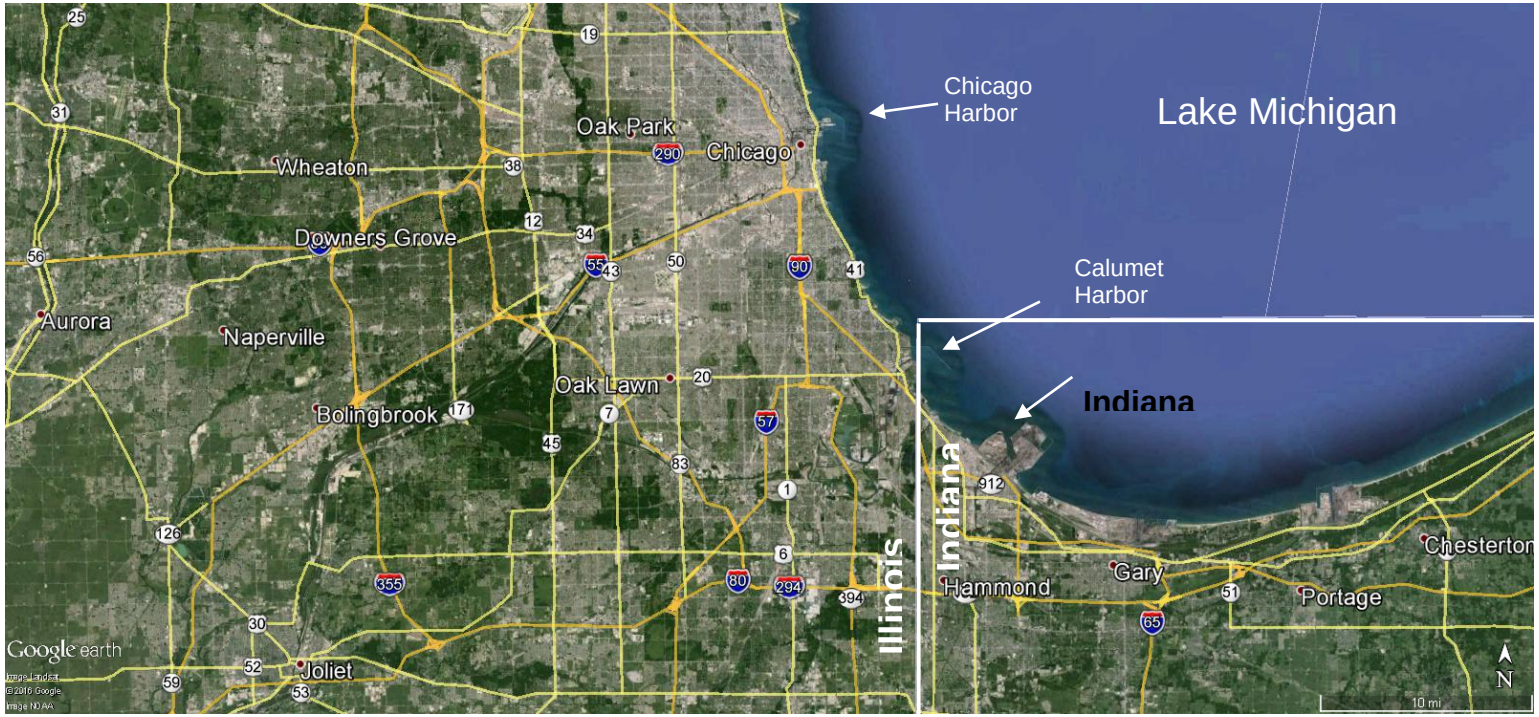

Figure 1: General Vicinity of Calumet Harbor

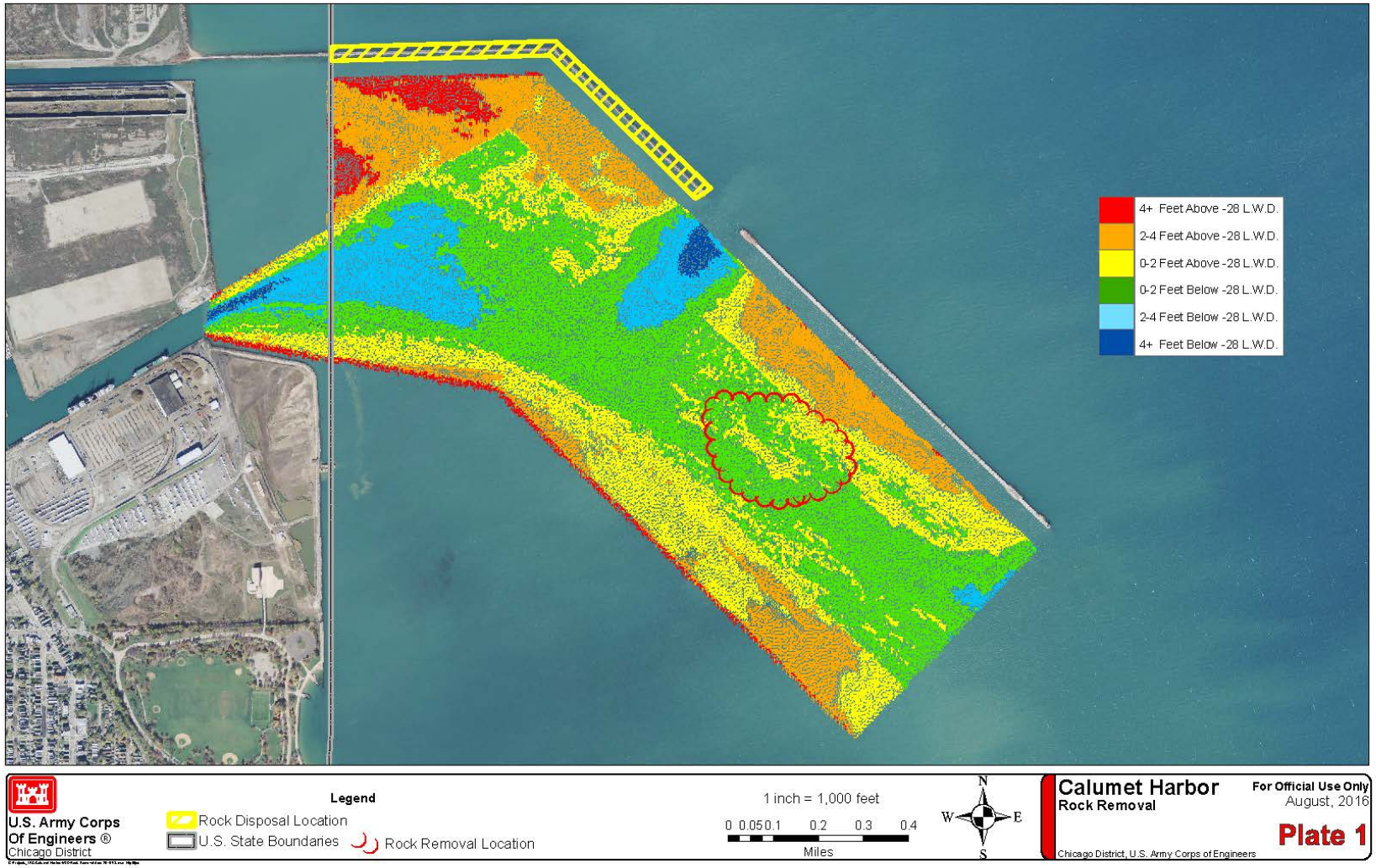

Figure 2: Calumet Harbor Rock Removal Area

Figure 3: Calumet Harbor Breakwater

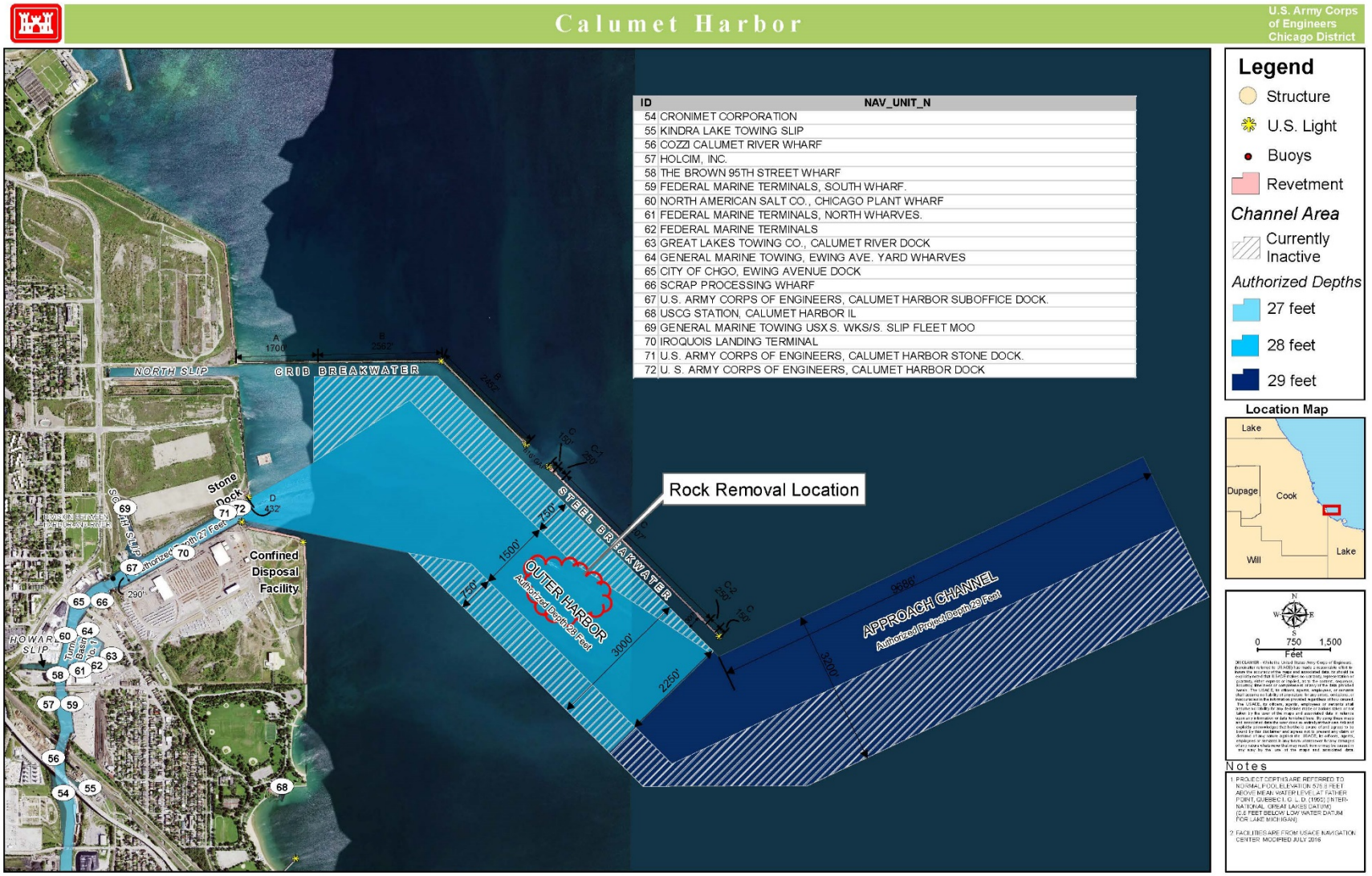

Figure 4: Calumet Harbor Functional Map

Attachment 1

Calumet Harbor Bedrock Investigation by GEI Consultants – FY 2014

Attachment 2

Narrative from Pilot-Scale Study of Rock Removal
from Calumet Harbor by Luhr Bros Inc. – FY2015