JEORSE PARK ECOSYSTEM RESTORATION
SECTION 506
FEASIBILITY STUDY

APPENDIX B
ENGINEERING AND DESIGN

SEPTEMBER 2015

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INTRODUCTION

General

1. The purpose of this volume is to present the civil engineering analysis for the formation of FEASIBILITY STUDY plans for the various ecosystem restoration measures that make up the Jeorse Park project. The project area is an existing beach in East Chicago, IL. The project area consists of an existing breakwater, beach, and dune and swale area.

Purpose and Scope

2. The purpose of this section is to: 1) describe design criteria, engineering methods and procedures that were used to layout and perform preliminary design analysis of the measures; 2) present the methods used and calculations developed for quantities 3) present the requirements for the real estate needed; 4) present criteria and requirements for utility interferences; and 5) discuss the engineering design analysis requirements for the next phase of the project.

Previous Investigations

3. A Preliminary Restoration Plan (PRP)/Federal Interest Determination (FID) report by the US Army Corps of Engineers, Chicago District titled “Jeorse Park Beach Ecosystem Restoration – Section 506 Great Lakes Fishery & Ecosystem Restoration (GLFER) Federal Interest Determination)”, was completed in September 2013.

PROJECT AREA

General

4. In the PRP report, several ecosystem habitat types were identified by USACE biologists for restoration. The restoration area covers 14 acres of beach and 4500 feet of lacustrine habitat in East Chicago, IL. All acreage quantities were taken from ArcMap and CAD measurements. Tree and brush clearing quantities were

developed from norms (quantities per acre) provided by the Planning Branch as were the planting and plugging quantities. Earthwork and breakwater quantities were calculated using InRoads and CAD, combined with existing data about the breakwater. (See Attachment B-1.) The coordinate data used in this study are the North American Vertical Datum 1988 and the North American Datum 1983.

Beach Restoration

5. Restoration of the beach area will include Invasive species plant removal and dune and beach native plantings. Areas were provided by the planning branch and calculated in CAD. New plantings will cover most of the beach area with the exception of along the waterfront. Towards the back side of the beach, along the existing railroad tracks, a pine area will be planted. To ensure establishment, minor earthwork will be performed in this area to expose the existing sandy soils. Topsoil removed will remain on site.

Breakwater Measures

6. The existing breakwater is the subject of another, concurrent investigation by the EPA. If the project moves forward, the breakwater will be realigned to reduce E-Coli concentrations in the surrounding water. The measures for this project affected by the breakwater will be slightly revised, depending on the outcome of the concurrent breakwater project.

7. Along the breakwater, sand will be used to fill voids in the existing structure. It was assumed the existing breakwater consists of 30% voids to be filled with new material, which is consistent with an angular riprap. The fill will be placed only along the lakeside of the breakwater, in the alignment and location shown on the plan sheets in Appendix B-2. The Quantity of fill was estimated based on the breakwater cross section for this location shown in the breakwater permit drawings. It was also assumed based on site inspections of the breakwater that sheetpile is existing within the as built breakwater, providing a barrier for the fill. See plate 5 in Appendix B for the cross sectional details. Plantings will then be established along the breakwater along the alignment of the fill.

8. Rock reef placement is planned along the breakwater. Four small structures will be built using glacial stone, near the breakwater alignment. They will be spread out over an area of 2 acres.

9. Estimates for the stone size requirements for the rock reefs was completed for both and “with” and “without” breakwater modification conditions. Deepwater wave

parameters were estimated using Hubertz et. al (2011), Rezio and Vincent, and the WIS hindcast (2013) for the wave height, period, and approach direction, respectively. The nearshore wave transformation calculation was performed using Goda (2010). The required nominal stone size for the structures were determined using de Graauw (2013) and Burcharth (2003) and van der Meer (1994), assuming the structures perform as either a submerged or low-crested breakwater, respectively.

10. Given the orientation and cross-sectional profile of the proposed rock reefs and the lack of connectivity to the existing breakwater, significant accretion around the structures should not be anticipated. While there may be periodic depositions dependent on seasonal variations in wave conditions, these should not be long-term.

Real Estate

11. The Local Sponsor (LS) East Chicago most of the project area, as well as the parking lot just south of the site that would serve as an effective staging area. The proposed staging area is approximately 1 acre in the parking lot, adjacent to the project site. This may need to be relocated or revised based on other work the city will be doing in that area. The breakwater is owned by the City of East Chicago and leased to the Ameristar Casino, requiring coordination for the breakwater planting measure. The southernmost portion of the project is owned by the city of Gary, IN. Real Estate is working with the City to acquire this area, otherwise it will be removed from the total project area.

Utilities

12. It is not believed that any utilities conflicts exist. However, this will need to be verified with additional field visits and research during the design phase.

GEOTECHNICAL INVESTIGATIONS

General

13. No onsite subsurface investigations were completed for this study. Soil borings were sampled from nearby jobs that have similar geological conditions, and these borings were used to make assumptions of what the subsurface conditions are at Jeorse Park. See Attachment B-3 for a map and borehole logs.

14. In general, the soil borings encounter sandy soils underlain by stiff clayey soils, which is the expected condition at Jeorse Park. Bedrock is not anticipated.

Bedrock Geology

15. Like the majority of the Chicago regional bedrock system, Silurian dolomite underlies the overburden soils at Jeorse Park. This dolomite ages from the Niagaran Series and is commonly referred to as Wabash formation in Indiana, whereas this same formation is known as Racine Dolomite in Illinois. The bedrock in the area is primarily composed of dolomite, limestone, and shale. According to the map titled "Jeorse Park Bedrock Map" in Attachment B-3, bedrock is anticipated to be between 100 and 150 ft below grade at the project site, around elevation 450 ft. Therefore, bedrock will not be encountered during this project.

Glacial Stratigraphy and Overburden Geology

16. The overburden soils present in the Chicago region were deposited by various glacial movements. Indiana specifically has overburden soils that can be traced to the pre-Illinoian, Illinoian, and Wisconsin glaciations. Because of the intensity of the Wisconsin glaciation, unconsolidated soils in the Jeorse Park area are only from this glaciation. Surficial soils are comprised of artificial and manmade fill as well as beach and dune and along present and recently abandoned beaches. Natural dunes in Indiana were formed from glacial outwash, which include clay, silt, and sand that was transported and deposited by wind. Nearby subsurface investigation results are attached in B-3 and generally include sandy materials underlain by clayey materials. The four sites examined for nearby subsurface conditions include Burns Harbor, Indiana Dunes, Michigan City Harbor, and Indiana CDF and specific discussions are included below.

17. The Burns Harbor borings were taken over water within the channel and into the lake during 1981, and is about 13 miles east of Jeorse Park. These encountered approximately 15-50+ ft of sandy soils with various traces of gravel and silts. In borings that encountered the bottom of the sandy material, lean clay and silt was present. The shallowest clays were encountered approximately 20 ft below lake level.

18. The Indiana CDF borings were taken over land within the last 20 years about 3 miles west of Jeorse Park. A generalized soil column was prepared for a report on the Indiana CDF and is attached. It describes that the subsurface conditions at this site consist of a layer of fill materials underlain by silty sands. Silty clays are present about 30 ft below grade (~557 ft NAVD) before encountering another layer

of sands. Bedrock is around 100 ft below grade (~490 ft NAVD). Additional descriptions of these materials are in the attachment.

19. The Indiana Dunes soil borings were taken on land in 1973 along the shoreline about 23 miles east of Jeorse Park. Each of these borings encountered about 30 to 40 ft of sandy soils before encountering silty clays. The silty clays are approximately at elevations 575 ft to lower than 560 ft NAVD.

20. The Michigan City Harbor borings were taken over water at the mouth of the harbor in 2013 about 28 miles east of Jeorse Park. These encountered sands about 20 ft thick before encountering silty clay at about elevation 544 ft NAVD.

Possible Variances

21. At this time, there is no reason to suspect the subsurface profile would vary from the adjacent sites. They are all in generally the same geologic area and are consistent between each other, so it is not anticipated that Jeorse Park would vary. A slightly thicker or thinner layer of sand would not affect the design of what is proposed for this project. What may affect the design is if the surface material varies from the assumed sand condition. To confirm the surface materials, it is recommended that during design phase, a bathymetric survey crew take ponar (clamshell) grab samples from the lake bottom.

Geotechnical Considerations

22. There are two major efforts of work proposed for the Jeorse Park project. The first is filling in the existing breakwater with sand to promote planting between the armor stone. The second is adding rock reefs in the lake to promote habitat.

23. Filling the existing breakwater with sand is one method to promote plant growth for this project. It can be assumed that the voids that would need to be filled are about 30% of the total volume, as the breakwater is constructed of large armor stones. The existing slopes of the breakwater are 1.5H: 1V, which if the sand was placed at this steep slope on its own, it would collapse. Mixed with the large stone, there will still be some sand loss as it migrates to a shallower slope. There are several methods to keep sand within the breakwater. These include planting thick-rooted vegetation, adding additional sand as an O&M need, and selectively placing sand on whichever side that would accrete sand per natural sand migration. An alternative to adding sand into the breakwater is constructing concrete planters, which could be considered in design phase.

24. Adding rock reefs into the lake would promote underwater habitat. They are anticipated to be constructed out of glacial cobbles, which is reportedly better for

habitat than angular stone. The glacial cobbles are more expensive than angular stone, and they are more difficult to stack as the rounded edges cannot lock together as tight as angular edges. With the lake bottom likely consisting of sands, there is little settlement expected, especially since the heights will be less than 5 ft tall. According to EM 1110-2-1601, underwater placement thicknesses should be increased by 50% to account for uncertainties. This should be applied to the cost estimate. The 1:1 slopes shown in the feasibility drawings are not sustainable for rounded cobbles, but some sloughing would not decrease the function of these rock reefs.

JEORSE PARK ECOSYSTEM RESTORATION
FEASIBILITY STUDY

APPENDIX B
ENGINEERING AND DESIGN

ATTACHMENT B-1: FINAL QUANTITIES

US Army Corps of Engineers, Chicago District	PROJECT TITLE: JEORSE PARK SECTION 506	COMPUTED BY: LAURA VANDENBERG
	COMPUTATION TITLE: FEASIBILITY QUANTITIES	CHECKED BY: ADAM TENNANT

Planting quantities - CLINS 0008, 0009, 0010

***Planting quantities provided by PM-PL-E**

Habitat type	Area (AC)	Shrub	Plugs	Jack Pine	White Pine
Dune and Beach Plantings	6.6	1500	33000		
Breakwater	1	5100	2000		
Pine Area (within dune and beach)	1.5	500	6000	25	80

Earthwork/Topsoil Removal - CLIN 0006

	Area (sf)	Depth (ft)	Volume (CY)
Remove Topsoil in Pine Area	63818	0.5	1182

*Based on aerial imagery and confirmed by site visit. Approximately 6 inches of existing topsoil covers the sandy soils needed for planting. Topsoil will be relocated to the southwest end of the site.

Invasive Species Removal

Habitat type	Area (AC)
Dune and Beach Plantings	14.8
Breakwater	1

*Based on Microstation measurements

Debris removal - CLIN 0007

	Area (sf)	Depth (ft)	Volume (CY)
Debris removal	14565	2	1079

*Based on aerial imagery and confirmed by site visit. Debris will be taken offsite.

Breakwater Fill - CLIN 0011

	Cross sectional Area (sf)	Length (ft)	Volume (CY)	Volume Fill (CY)	Volume plus 5%
Breakwater	648	800	19200	5760	6048

*Based on existing typical breakwater section on plan sheet C-301. Only Lake side of breakwater will be filled, as shown. Assumed 30% of stone riprap would be voids requiring fill.

*Based on visual inspection of existing breakwater, sheetpile exists along the existing concrete walkway. Geotextile is also installed along the bottom layer of C stone, based on breakwater as-builts. These items would help provide a barrier to keep fill on lake side of the breakwater.

Rock Reefs - CLIN 0012

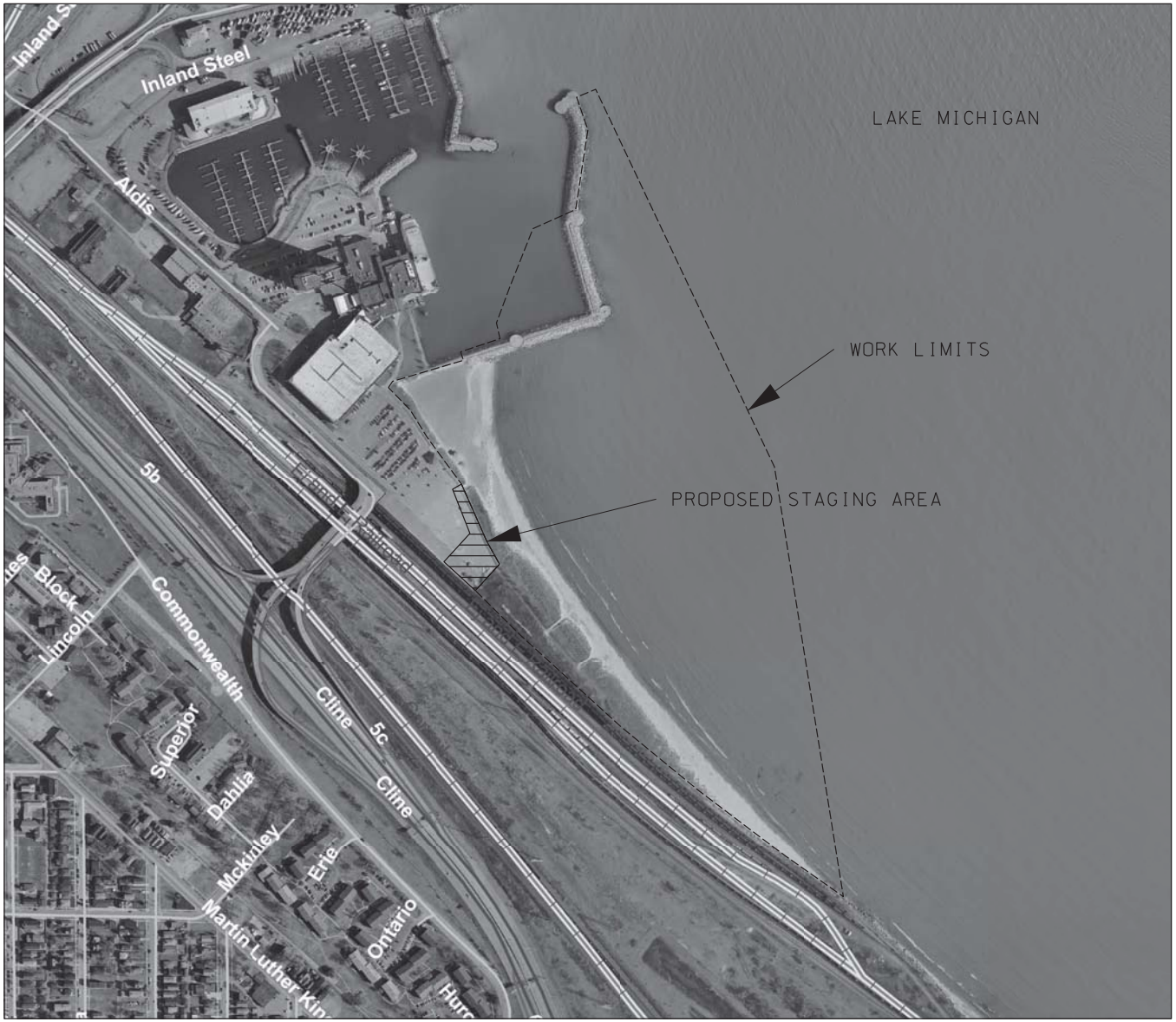
Height (ft)	Base Diameter (ft)	Top Diameter (ft)	Volume (CY)	# of Reefs	Total Volume (CY)	Total Weight (TONS)
4	9	3.6	132	4	529.03	714.18672

Assumed Rock is glacial cobble, nominal size 1.2 feet

JEORSE PARK ECOSYSTEM RESTORATION
FEASIBILITY STUDY

APPENDIX B
ENGINEERING AND DESIGN

ATTACHMENT B-2: PLATES



PLAN VIEW

0 50' 100'

N

U.S. Army Corps of Engineers
Chicago District

JEORSE PARK 506
EAST CHICAGO, IL
FEASIBILITY STUDY

PROJECT AREA

SCALE:	DATE:	DRAWING CODE:
SCALE	DATE	FILENAME.DGN

PLATE 01

PLAN VIEW: INVASIVE SPECIES REMOVAL AREAS

LEGEND

DUNE AND BEACH (14.8 AC)

BREAKWATER PLANTINGS (1 AC)

N

NOTES:

1. BREAKWATER PLANTINGS ARE SHOWN ASSUMING THE BREAKWATER IS REALGINED BY THE EPA AS PLANNED. IF THE EPA WORK DOES NOT GO FORWARD, PLANTINGS WILL BE PLACED ALONG THE EXISTING BREAKWATER.
2. BREAKWATER PLANTINGS WILL BE INSTALLED ONLY ALONG THE LAKE SIDE OF THE BREAKWATER.

0 50' 100'

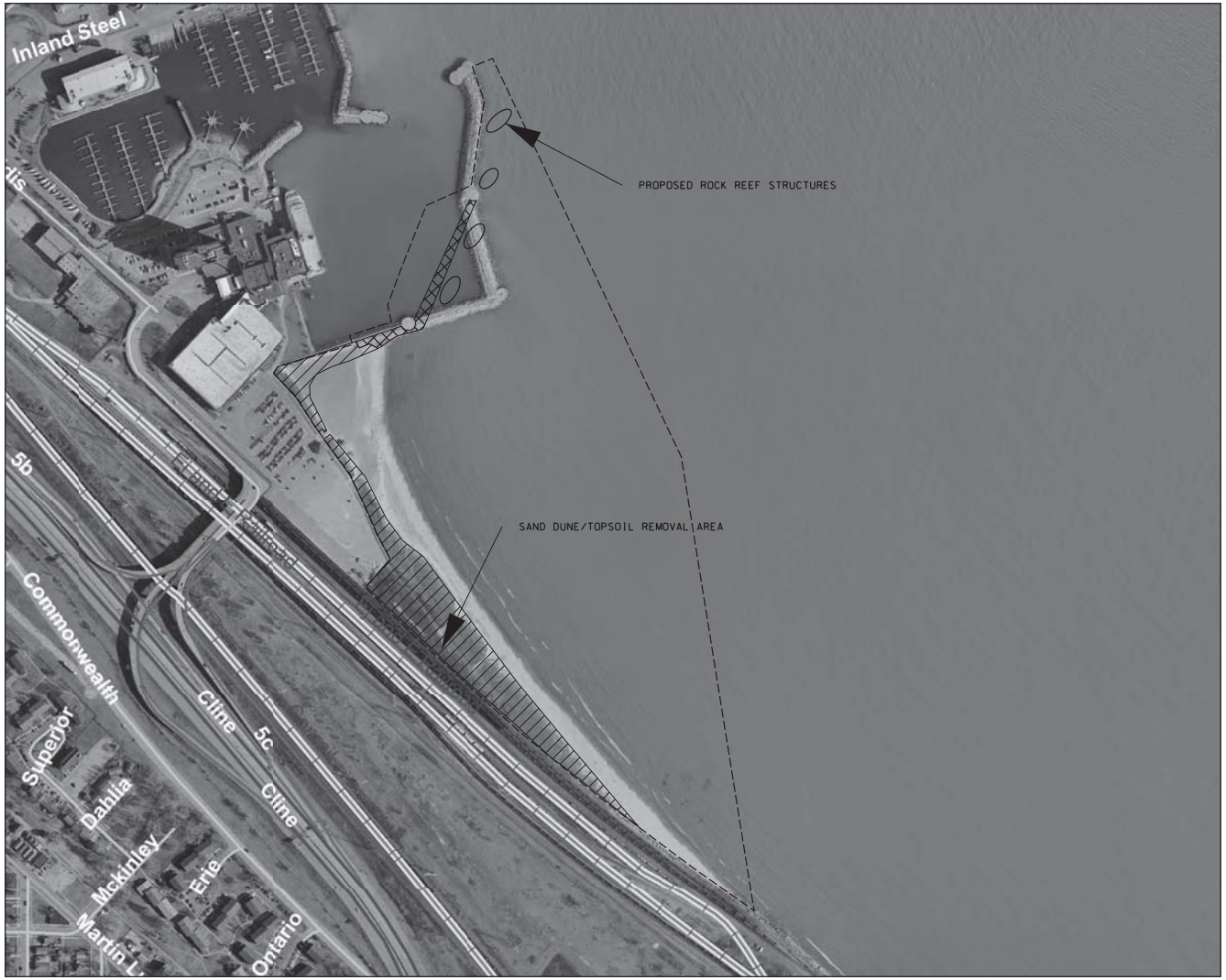
U.S. Army Corps of Engineers Chicago District

JEORSE PARK 506
EAST CHICAGO, IL
FEASIBILITY STUDY

INVASIVE SPECIES REMOVAL

SCALE:	DATE:	DRAWING CODE:
1" = 50'	JUNE 23, 2015	FILENAME.DGN

PLATE 02



PLAN VIEW: NATIVE PLANTING AREAS

LEGEND

BREAKWATER PLANTINGS

BEACH AND DUNE PLANTINGS

N

NOTES:

1. BREAKWATER TO BE FILLED WITH RIPRAP AND SAND PRIOR TO PLANTING.
2. PROPOSED BREAKWATER PLANTINGS ARE SHOWN ON THE PROPOSED BREAKWATER REALIGNMENT, WHICH WILL BE COMPLETED BY OTHERS.
3. ROCK REEF LOCATIONS WILL CHANGE IF BREAKWATER REALIGNMENT IS NOT COMPLETED.

0 50' 100'

U.S. Army Corps of Engineers Chicago District

JEORSE PARK 506
EAST CHICAGO, IL
FEASIBILITY REPORT

HABITAT RESTORATION

SCALE:	DATE:	DRAWING CODE:
1" = 50'	JUNE 23, 2015	FILENAME.DGN

PLATE 03

N

NOTES:

1. WITHIN PINE PLANTING AREA, REMOVE TOP 6" OF TOPSOIL PRIOR TO PLANTING AND PLACE AS BERM AT ALONG RAILROAD TRACKS.
2. REMOVE DEBRIS ALONG ROADWAY IN PINE AREA.

0 50' 100'

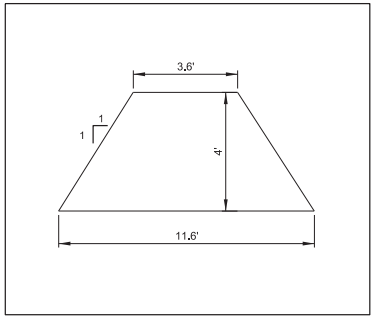
U.S. Army Corps of Engineers
Chicago District

JEORSE PARK
EAST CHICAGO, IL
FEASIBILITY REPORT

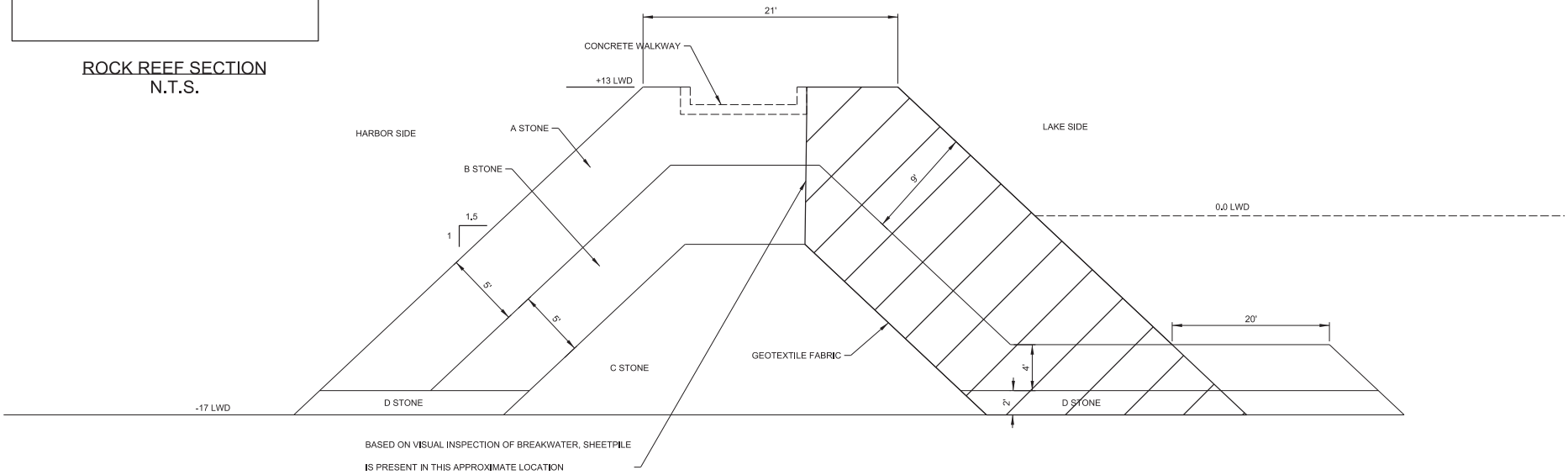
OTHER MEASURES

SCALE:	DATE:	DRAWING CODE:
1" = 50'	JUNE 24, 2015	FILENAME.DGN

PLATE 04



ROCK REEF SECTION
N.T.S.



BREAKWATER FILL AREA

TYPICAL SECTION OF EXISTING BREAKWATER
N.T.S.

NOTES

1. ROCK REEF WILL BE COMPOSED OF GLACIAL COBBLE, WITH A NOMIAL 1.2' SIZE. CREST OF REEF SHALL BE 3 STONES WIDE.

U.S. Army Corps of Engineers Chicago District	JEORSE PARK 506 EAST CHICAGO, IL FEASIBILITY REPORT
EXISTING BREAKWATER TYPICAL SECTION	
SCALE: NTS	DATE: 9/08/2015
DRAWING CODE: FILENAME.DGN	

PLATE 05

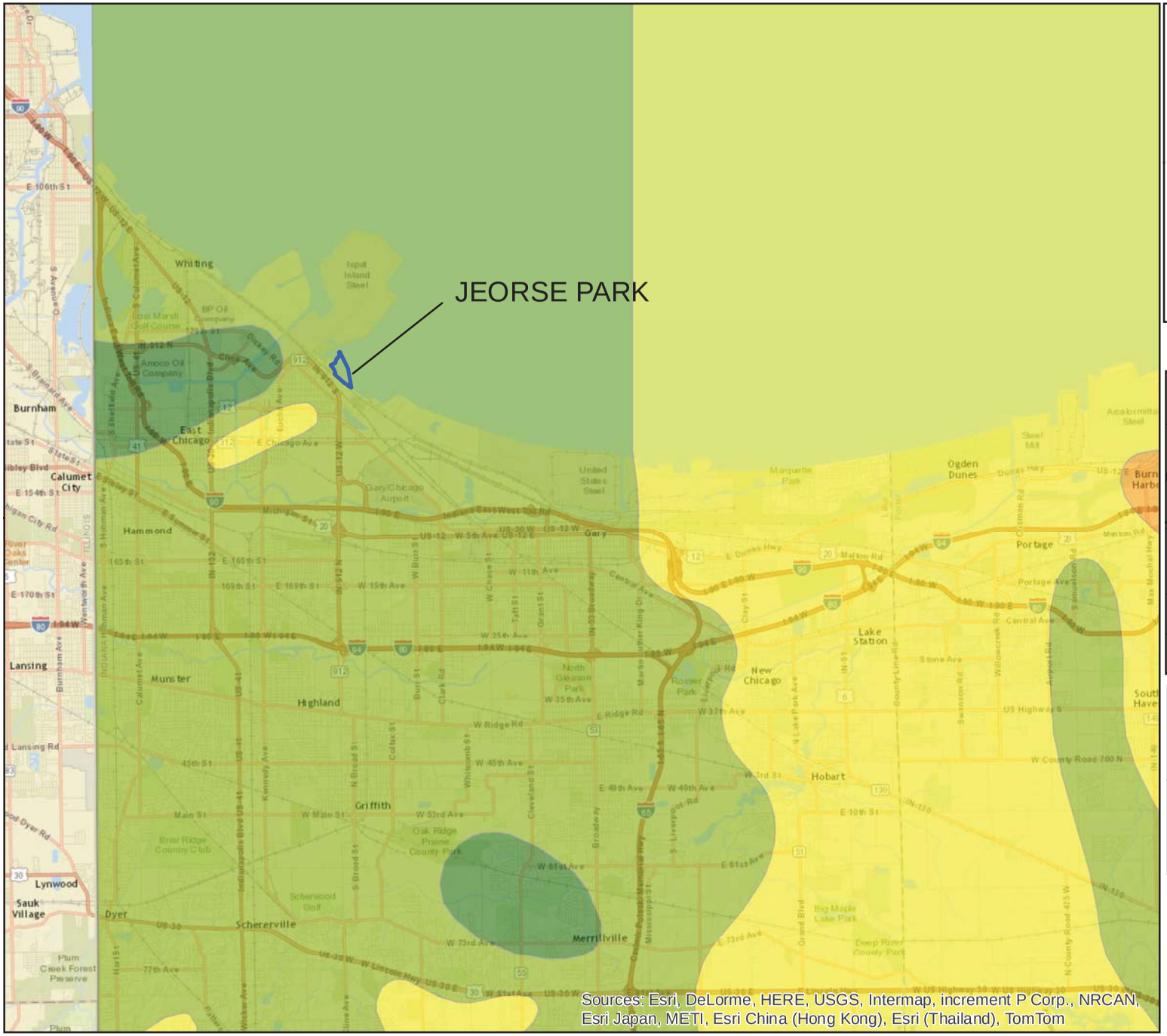
JEORSE PARK ECOSYSTEM RESTORATION
FEASIBILITY STUDY

APPENDIX B
ENGINEERING AND DESIGN

ATTACHMENT B-3: GEOTECHNICAL MAPS & LOGS

JEORSE PARK BEDROCK DEPTH

U.S. Army Corps of Engineers
Chicago District



Legend

Project Boundary

Min Depth to Bedrock

- 50'
- 100'
- 150'
- 200'
- 250'

Location Map

N
W E
S

0 0.75 1.5 3 Miles

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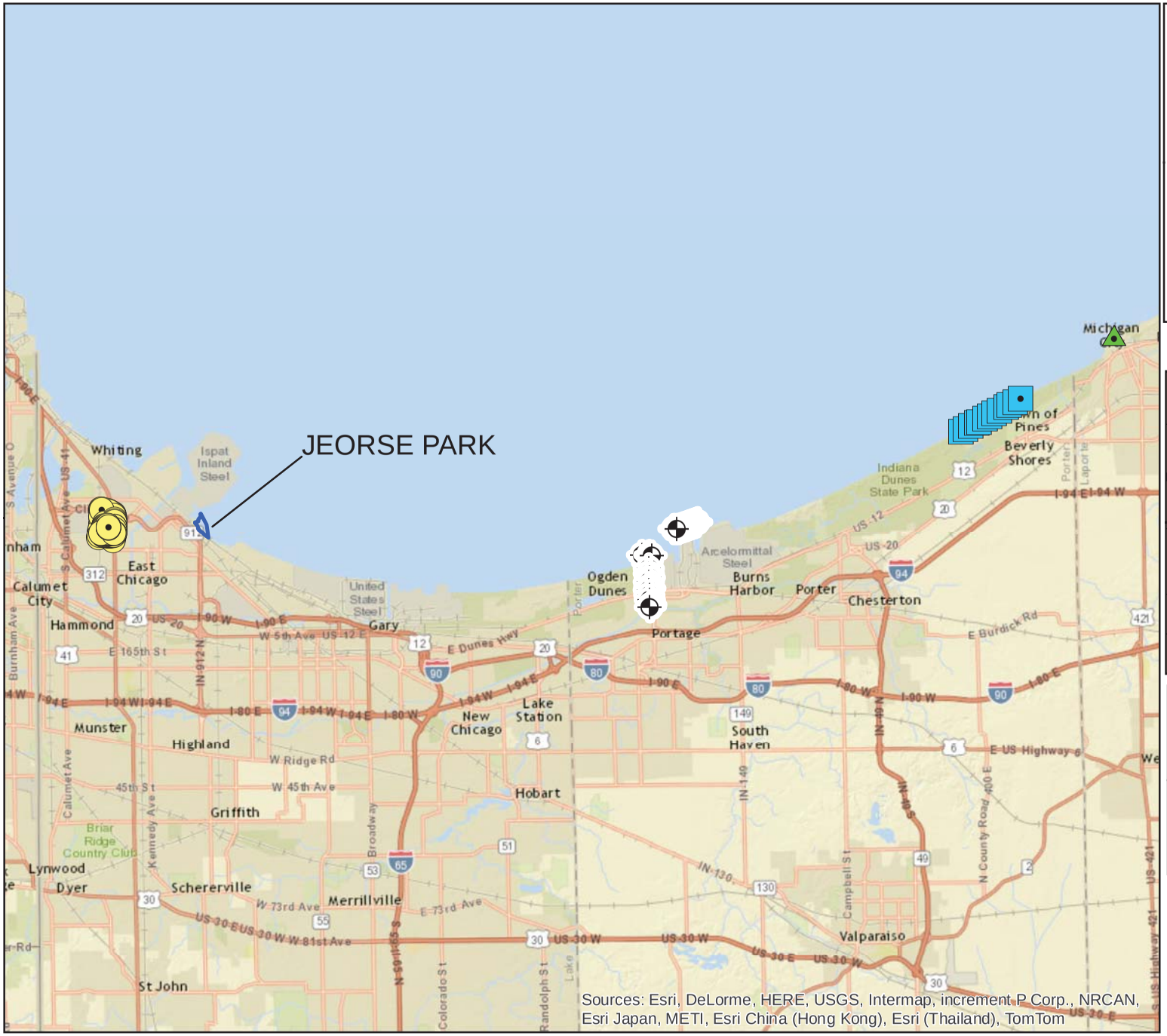
Thursday, February 19, 2009 J:\Templates\GN_Landscape_A_Size93.mxt

JEORSE PARK NEARBY SOIL BORING MAP

U.S. Army Corps of Engineers
Chicago District



Legend

- Project Boundary
- Burns Harbor Boring
- Indiana Dunes Boring
- Indiana CDF Boring
- Michigan City Boring

Location Map

N
W E
S

0 1.25 2.5 5 Miles

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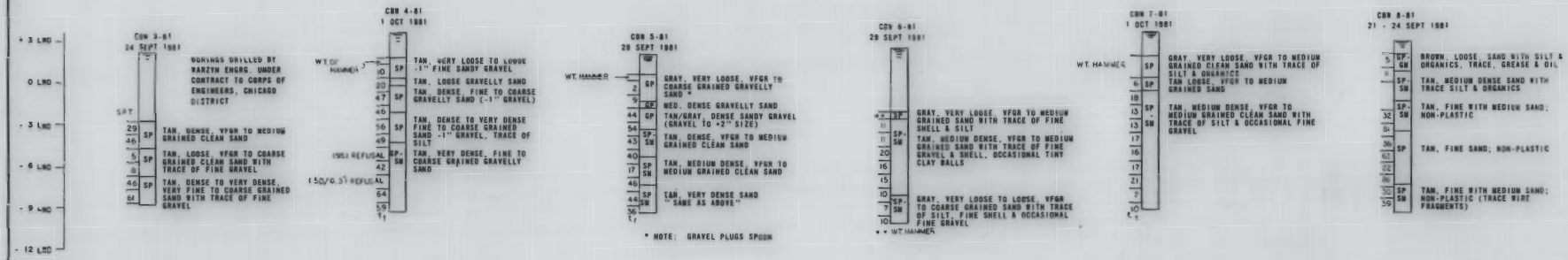
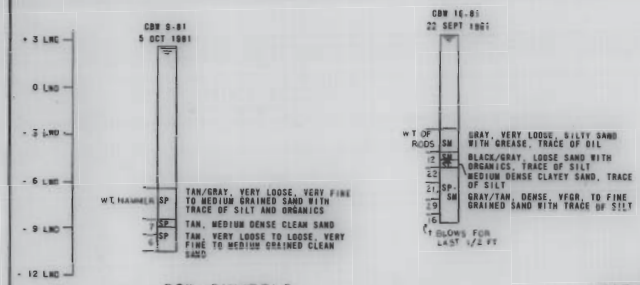
Thursday, February 19, 2009 J:\Templates\GN_Landscape_A_Size93.mxt

CORPS OF ENGINEERS

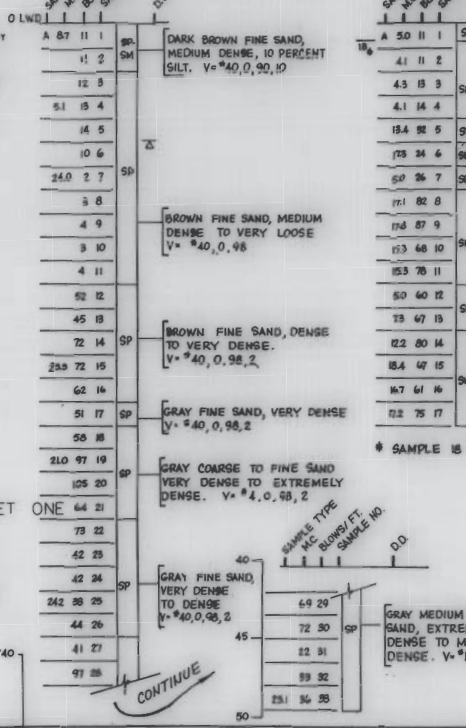
U. S. ARMY

Soil Borings from Burns Harbor





LC-44-79
AUGUST 23 THRU AUGUST 28,1979
ELEV. 601.67



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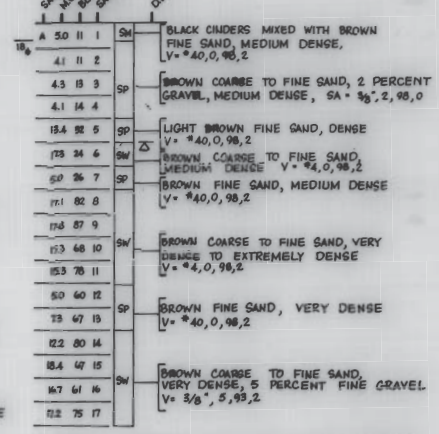
ELEV. 589.29



* SAMPLE IS OBTAINED USING HAND DIGGING METHODS

SOIL SYMBOLS

- (GP) POORLY GRADED GRAVEL-SAND MIXTURES, GRAVELS, LITTLE OR NO FINES.
- (GM) SILTY GRAVELS. GRAVEL-SAND-SILT MIXTURES.
- (SP) POORLY-GRADED SANDS OR GRAVELLY SANDS, LITTLE OR NO FINES.
- (SM) SILTY SANDS, SAND-SILT MIXTURES.
- (SC) CLAYEY SANDS, SAND-CLAY MIXTURES
- (SW) WELL-GRADED SANDS OR GRAVELLY SANDS, LITTLE OR NO FINES.
- (ML) INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
- (CL) INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS.
- (CH) INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS.

LEGEND

SPT	STANDARD PENETRATION RESISTANCE 140 LB HAMMER 30" DROP 1 5/8" I.D 2" OD. SPLIT SPOON SAMPLER
34	BLOW COUNT PER FOOT
†	BLOW COUNT FOR LAST HALF FOOT
**	WT. SPT. HAMMER ALL BLOW COUNTS ARE SPT PER FOOT UNLESS † APPEARS RE LAST HALF FT.
LL	LIQUID LIMIT
PL	PLASTIC LIMIT
MC	MOISTURE CONTENT
DD	DRY DENSITY

NOTE

BORING LOCATIONS CAN BE FOUND ON SHEET ONE

CBW-CORPS BURNS WATERWAY (WARZYN CONTRACT)

LC - LITTLE CALUMET (SOIL ENGINEERING & EXPLORATION CO. INC. CONTRACT)

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT, CHICAGO
CORPS OF ENGINEERS
CHICAGO, ILLINOIS

BURNS WATERWAY, PORTER COUNTY INDIANA
SMALL BOAT HARBOR

LOGS OF CHANNEL BORINGS

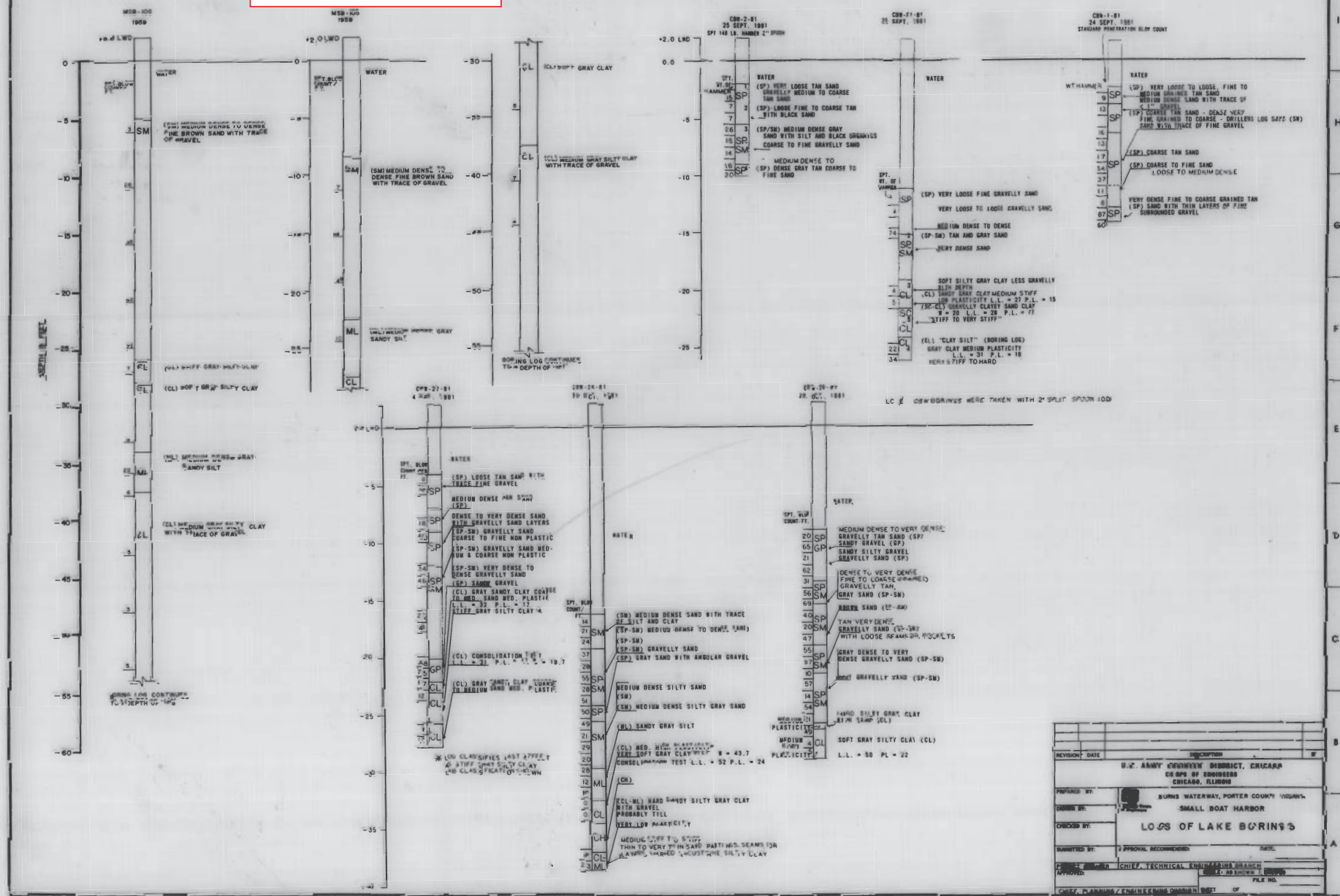
SCALE AS SHOWN | DACW 23 | FILE NO.

CHIEF, PLANNING/ENGINEERING DIVISION

CORPS OF ENGINEERS

U.S. ARMY

Soil Borings from Burns Harbor



Soil Borings from Indiana Dunes

EXHIBIT 2

SOIL SYMBOLS

(SP) Poorly graded Sand or gravelly Sand with trace of or no fines

(SW) Well graded Sand or gravelly Sand

(SM) Silty Sand

(ML) Inorganic Silt

(CL) Inorganic Clay or Silty Clay low to medium plasticity

LEGEND

Standard Penetration Blow Count per foot

Sample tested for grain size

2" Sealby Tube sample taken

Density test in Sand Bank, Sand-cone method

Sand sample for modified Proctor Test (ASTM D-1557-67T) taken at bank share

Ground water levels

LL - Liquid Limit

PL - Plasticity Index

DD - Natural dry density, PCF

PD - Modified Proctor, dry density, PCF

MC - Natural moisture content in percent

Qu - Unconfined Compressive Strength, PSF

L-D-P-I - Laboratory penetration test and percentage for sands, Sand Cone (gravel Sieve larger than sieve #4)

NOTE: All soils classified according to Unified Soil Classification.

PREPARED FOR:
RALPH H. BURKE, INC.
20 N. WACKER DRIVE
CHICAGO, ILLINOIS

BY:
SALISBURY ENGINEERING INC.
1501 E. MAIN STREET
GRIFFITH, INDIANA

INDIANA DUNES
NATIONAL LAKESHORE PROTECTION
PORTER & LAPORTE COUNTIES, INDIANA

DRWN. CK. DATE FILE

Excerpt from Indiana CDF generalized subsurface conditions

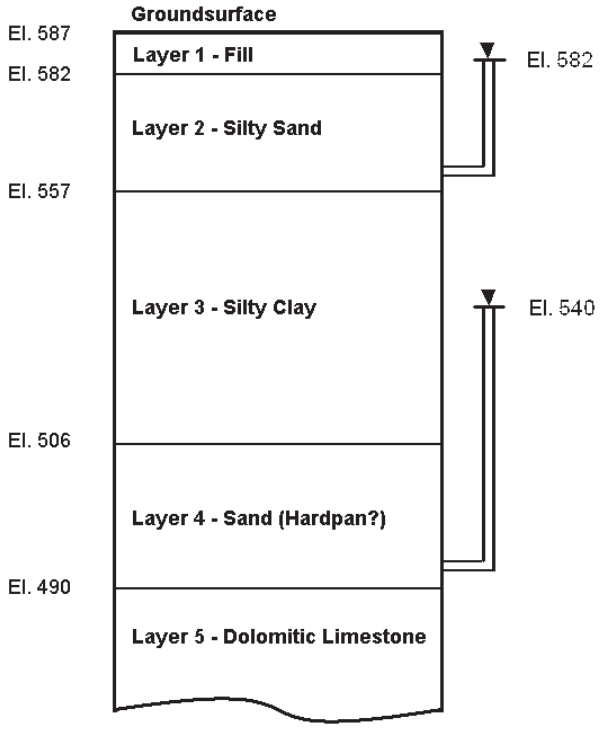


Figure C-6. Generalized Soil Column

Layer 1 – Fill Materials

61. Several inches to twelve feet of fill are present on the site. This fill was not sampled during the subsurface investigations, but was reported as clean gray to black fine to medium silty sand with occasional gravel in borings CE-101 through CE-106. Also noted, some construction debris including broken concrete and rebar is present on the site. The USCS designation for the predominate fill soil is silty sand (SM).

62. Seven borings (CE-109 through CE-115) encountered an approximate 2-foot-thick layer of silty clay and slag fill. Below the silty clay and slag fill these borings, except CE-115, encountered an approximate 1-foot-thick concrete slab (possibly reinforced).

Layer 2 – Silty Sand

63. The uppermost natural material encountered consisted of a medium dense to dense gray silty coarse to fine sand that extended to a depth of approximately 30 feet below groundsurface (elevation 557 NGVD). The sand is most likely of the Atherton Formation (Toleston Relic Beach). The sand is typically poorly graded (Cu<6) and in general the upper 15 to 20 feet of the sand contained fewer than 10% fines (d_{10}~0.15 mm), whereas the bottom 10 to 15 feet of the deposit contained 10 to 30% fines (d_{10}<0.07 mm). It is noted that boring CE-111 encountered several silt layers within the sand deposit. N-Values for Layer 2 averaged 18 ranging from 4 to 34. The USCS designation for this layer is silty sand (SM).

Layer 3 – Silty Clay

64. Stiff, dark gray silty clay was encountered below the silty sand layer. Contour plots of the depth from the existing groundsurface to the top of this layer (figure C1-1) and the elevation of the top of this layer (figure C1-2) are included in attachment C-1. This silty clay layer was probably formed as part of the Valparaiso Moraine. Only boring CE-103 completely penetrated this layer. The bottom of Layer 3 was encountered at a depth of about 80 feet (elevation 506 NGVD).

65. This silty clay has an average moisture content of about 25%, and Atterberg Limits of approximately LL = 40 and PI = 21. The USCS designation for this layer is lean clay (CL). The average dry density of this low plasticity clay is about 101 pcf with shear strength values of c = 7 psi (c' = 0 psi) and ϕ = 15° (ϕ' = 28°). Consolidation tests performed on this clay indicate an average compressive index of 0.150 and c_v ranging from 0.00008 to 0.00027. Also, laboratory hydraulic conductivity tests were performed with results ranging from 1.1×10^{-8} to 1.9×10^{-7} cm/sec.

Layer 4 – Sand (Hardpan?)

66. Below the silty clay of Layer 3 is an extremely dense, gray and olive coarse to fine sand, possibly of the Lagro Formation. This layer is approximately 16 feet thick in boring CE-103. Samples collected in this layer had very poor recovery and extremely high blow counts (>100 per inch). Limestone chips were noted in the samples recovered. Insufficient samples were obtained to perform any laboratory testing or even provide a confident visual classification. This layer may be a unit locally described as *hardpan*, a highly overconsolidated glacial till that is clayey, very silty and contains an abundance of limestone gravel and boulders. Unconfined compressive strengths of *hardpan* have been noted to exceed 10 tsf.

Layer 5 – Bedrock

67. Gray dolomitic limestone was encountered at elevation 490 NGVD in boring CE-103 and penetrated 16 feet. The bedrock was described as moderately hard, moderately to slightly weathered, and slightly fractured. Horizontal to nearly horizontal fractures were noted which are considered to be bedding planes. This is typical of the Racine Formation of the Silurian System found as the upper rock formation in the nearby Thornton Quarry. RQD for the two core samples collected ranged were 80 and 97.

DRILLING LOG

DIVISION	Great Lakes and Ohio River
INSTALLATION	Chicago District
SHEET	1 OF 2 SHEETS
1. PROJECT	Michigan City East Pier Repair
2. LOCATION (Coordinates or Station)	Michigan City, IN N 2,359,497.9 E 3,000,374.2
3. DRILLING AGENCY	STRATA
4. HOLE NO. (As shown on drawing title and file number)	MC-13-01
5. NAME OF DRILLER	Bill McCarthy
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	22.0
10. SIZE AND TYPE OF BIT	3-7/8" RB
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	NAD 83 (horiz) NAVD88 (vert)
12. MANUFACTURER'S DESIGNATION OF DRILL	D-25 Barge
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 2 / UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	577.83
16. DATE HOLE	STARTED 10/22/2013 / COMPLETED 10/22/2013
17. ELEVATION TOP OF HOLE	+579.3
18. TOTAL CORE RECOVERY FOR BORING	%
19. GEOLOGIST	J. Toonen

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
+579.3	0.0		Barge Deck (1.5')			
577.8			Water			
	2					
	4					
	6					
	8					
	10					
	12					
	14					
	16					
	18					
559.8	20		Fine to coarse sand, little silt, trace fine gravel, with wood, roots, shells and organic material noted - dark gray - very loose - wet (SM)	100 40	1 19.5 20.0 1A 20.0 22.0	NOTE: All depths are reported form barge surface which was 1.5' above water level. 10/6" N = 20* (Spoon bouncing on possible rock) WOH/18" N = 0 w = 46.1%
557.3	22		End of boring at 22 feet. Borehole allowed to collapse.			SPT Sampling with 140 lb. Auto Hammer 30" of Fall 2" O.D. Split Spoon Sampler *: SPT-N value based on 6" or less of penetration w = moisture content Boring advanced with split spoon sampler to 22 feet. Boring was abandoned due to

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE 579.3

Hole No. MC-13-01

PROJECT Michigan City East Pier Repair

INSTALLATION Chicago District

SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
						unfavorable weather conditions and unsafe shifting and movement of barge. Firm soil encountered at 22 feet. W.L. @ 1.5' (Harbor Level)

DRILLING LOG

DIVISION	Great Lakes and Ohio River
INSTALLATION	Chicago District
SHEET	1 OF 3 SHEETS
1. PROJECT	Michigan City East Pier Repair
2. LOCATION (Coordinates or Station)	Michigan City, IN N 2,359,522.3 E 3,000,421.9
3. DRILLING AGENCY	STRATA
4. HOLE NO. *(As shown on drawing title and file number)*	MC-13-02
5. NAME OF DRILLER	Bill McCarthy
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	61.5
10. SIZE AND TYPE OF BIT	3-7/8" RB
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*	NAD 83 (horiz) NAVD88 (vert)
12. MANUFACTURER'S DESIGNATION OF DRILL	D-25 Barge
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 15 / UNDISTURBED 1
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	577.83
16. DATE HOLE	STARTED 10/22/2013 / COMPLETED 10/22/2013
17. ELEVATION TOP OF HOLE	+579.3
18. TOTAL CORE RECOVERY FOR BORING	%
19. GEOLOGIST	J. Toonen

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
+579.3	0.0		Barge Deck (1.5')			
577.8			Water			
	2					
	4					
	6					
	8					
	10					
567.8	12		Organic silt, trace fine to coarse sand, trace fine gravel, shell noted - dark gray - very loose - wet (OL)	25	S1 11.5 13.5	NOTE: All depths are reported form barge surface which was 1.5' above water level. W.O.R./24" N = 0 w = 110.5%
565.8	14		Fine to coarse sand, little fine gravel, trace silt, trace clay - dark brownish gray - medium dense - wet (SP-SM)	33	S2 13.5 15.0	5, 6, 7 N = 13 w = 30.6%
564.3	16		Fine to coarse sand, trace to little fine to coarse gravel, trace silt - light brown to gray - medium dense to dense - wet (SP)	60	S3 15.0 16.5	7, 5, 5 N = 10 w = 21.8%
	18			53	S4 17.5 19.0	6, 8, 8 N = 16 w = 20.6%
	20			93	S5 20.0 21.5	12, 17, 19 N = 36 w = 20.9%
	22					
556.8	24		Fine to coarse sand, trace silt, trace fine gravel - gray - medium dense - wet (SP-SM)	100	S6 22.5 24.0	8, 12, 13 N = 25 w = 18.7%

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE 579.3

Hole No. MC-13-02

PROJECT: Michigan City East Pier Repair

INSTALLATION: Chicago District

SHEET 2 OF 3 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
554.3			Fine to medium sand, trace silt - light brown - dense - wet (SP)	60	S7 25.0 26.5	9, 26, 15 N = 41 w = 21.2%
	26					
	28					
549.3	30		Fine sand, little to some silt, trace clay - gray - medium dense - wet (SM)	100	S8 30.0 31.0	9, 12/6" N = 24* w = 16.5%
				100	S8A 31.0 31.5	12/6" N = 24* w = 27.0%
	32					
	34					
544.3			Silty clay, trace fine to coarse sand, trace fine gravel, trace shale - gray - very stiff to hard (CL)	53	S9 35.0 36.5	3, 7, 9 N = 16 Qp = 2.75-3.0 tsf w = 16.0%
	36					
	38					
	40			100	S10 40.0 41.3	3" Shelby Tube Qp = 4.0 tsf w = 16.4%
	42					
	44					
				100	S11 45.0 46.5	12, 20, 25 N = 45 Qp = 4.75-5.0 tsf w = 15.6%
	46					
	48					
	50			100	S12 50.0 51.5	7, 16, 28 N = 44 Qp = 4.0 tsf w = 19.1%
	52					
	54					

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE 579.3

Hole No. MC-13-02

PROJECT: Michigan City East Pier Repair

INSTALLATION: Chicago District

SHEET 3 OF 3 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
524.3			Silt, some fine sand, little clay, layer of silty sand noted - gray - medium dense - wet (ML)	100	S13 55.0 56.0	17, 10/6" N = 20* w = 14.7%
523.3	56		Silty clay, trace fine to coars sand, trace shale, with occassional seams of silt noted - gray - very stiff to hard (CL)	33	S13A 56.0 57.5	17/6" N = 34* Qp = 2.75-3.0 tsf w = 24.7%
	58					
	60			80	S14 60.0 61.5	10, 25, 25 N = 50 Qp = 7.0+ tsf w = 16.0% A 3" Shelby Tube was attempted but was unable to be pushed.
517.8			End of boring at 61.5 feet. Borehole allowed to collapse.			

SPT Sampling with 140 lb. Auto Hammer 30" of Fall
2" O.D. Split Spoon Sampler
*: SPT-N value based on 6" or less of penetration
w = moisture content

Boring advanced with split spoon sampler to 11.5 feet.
4" HW casing installed to 15 feet, and incrementally driven to 30' as needed to maintain borehole integrity.
Boring advanced with 3-7/8" RB to 60 feet.

W.L. @ 1.5' (Harbor Level)