INDIANA HARBOR AND CANAL MAINTENANCE DREDGING AND DISPOSAL ACTIVITIES – DESIGN DOCUMENTATION REPORT

DREDGING AND PLACEMENT PLAN

APPENDIX E

U.S. Army Corps of Engineers, Chicago District
Civil Design Section, Design Branch

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DREDGING AND PLACEMENT PLAN
APPENDIX E
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PURPOSE AND SCOPE

1. The purpose of this appendix is to present the design criteria, engineering methods and procedures that were used to provide the framework for the sediment dredging, transportation, and placement in the CDF, and subsequent material management of that dredged material. These four operations will be described in the following sections. – Dredging of Sediment, Rehandling and Transportation of Dredged Sediment Material, Dredged Material Placement and Dredged Material Management. There is also a glossary of terms at the end of the appendix. While this appendix provides an overview of the dredging and placement plan, a detailed dredging and placement plan will be covered during the development of plans and specifications for the dredging contract.

GENERAL

2. The bottom sediment of the Indiana Harbor and Canal project are contaminated and are not suitable for open water disposal. A confined disposal facility (CDF) is needed for containment.

3. The CDF is divided into three cells – southwest, southeast and north. Plate E-1 shows a plan view of the overall designed project site. The construction of the CDF will be phased in over a period of two years. During the first year of the CDF construction, the southwest cell dikes will be completed. A liner shall be installed on the interior sides of all the southwest cell dikes to provide containment during the initial placement period. In the second year, dredged material will be placed in the southwest cell while the dikes are being constructed for the southeast and north cells. Dredged material will be placed in the southeast and north cells during the third year, while the existing dredged material in the southwest cell is managed to promote drying and consolidation. Placement of the dredged material shall then alternate between the southwest cell one-year and the southeast and north cells the following year over the next 8 years. No dredging will be undertaken in the following or 12th year. Dredging and disposal shall subsequently be completed on a 4-year cycle. This cycle will consist of rotating the disposal on an annual basis between the three cells over 3 years followed by 1 year of no dredging in the fourth year (see Table E-1). TSCA material, PCB dredged materials from Reaches 6 and 13 will be placed in the southwest cell beginning in the 8th year and encapsulated with additional non-TSCA dredged material in the 10th year. When the three cells are filled to capacity, which would occur about the year 2033, the CDF will be capped with clay. For further information regarding the “Dikes, Cap and CDF Layout”, see Appendix A.

DREDGING OF SEDIMENT

General

4. Dredging at Indiana Harbor and Canal (IHC) will be performed using a closed-bucket mechanical dredge. The dredged material is to be loaded onto barges or scows and then moved to the CDF rehandling area.

Description of the Dredging Operation

5. Available dredging technologies were examined and their feasibility for the Indiana Harbor project was discussed in Appendix H (Dredging Technologies and Impacts) of the Comprehensive Management Plan (CMP). Based on this analysis, it was determined to use a mechanical dredge, specifically a closed-bucket clamshell dredge.

6. Sediments excavated with a mechanical dredge are placed into a barge or scow. The loaded barge or scow is transported to the CDF and is docked by the rehandling area. Prior to transferring the dredged material from the barge or scow, excess water will be decanted from the barge or scow and pumped or transported to the effluent treatment facility.

7. Because of its location, at times there is a necessity to pass under the Indianapolis Boulevard Bridge. There is no approved special regulation for the bridge therefore it is to be manned at all times to provide for navigation. The bridge has a vertical clearance in the closed position of 12' above low water datum at the center of a 64' wide span.

Description of the Dredging Quantities

8. Annual dredging quantities were developed with the aid of a computer model. The model takes into account the sedimentation rates, bank sloughing and the dredging volumes. In general, the model inputs a "Control" file, a file containing the geometry and sedimentation rate of the reaches and the dredging plan file. The model then goes through a series of accounting schemes to compute the changes in the elevation in each reach for each year. Finally, the model outputs detailed yearly values into an output file (Table E-2). Table E-2 shows the estimated dredge material quantities based on dredging the entire federal navigation project to authorized depth and dredging the listed berthing areas to depths ranging from -22 feet LWD to -28 feet LWD. All depths would also include an average of one-half foot overdepth. By the end of 2013, all of the navigation and heavily polluted areas are dredged to project depth at least once. After that, dredging is continued until the CDF is filled. For a complete discussion of dredge material quantities and associated assumptions, see Appendix Q of the CMP.

Discussion of Mechanical Dredging

9. Mechanical dredging is especially suited to CDF disposal because it minimizes the amount of water disposed. The less water associated with the sediments, the less water has to be collected and treated at the effluent treatment system near the disposal site.

10. This dredging method can work at high production rates, removes both fine-grained sediment and debris, is able to work in close quarters and around bridges, and requires equipment readily available on the Great Lakes. The clamshell dredge is used to excavate soft or cohesive sediments and is especially useful for deep digging and dredging in close quarters (USACE, 1969). Historically, it is the only dredging method used at IHC according to available records.

11. Mechanical dredges will cause sediment resuspension. The physical force of the bucket impacting the bottom and the loss of sediments as the bucket is raised through the water column and emptied into a scow will cause sediment resuspension. The standard clamshell was modified by the Japanese to reduce sediment resuspension. The modified bucket, referred to as a closed-bucket, has been demonstrated to reduce sediment resuspension by 30 to 70 percent (Barnard, 1978). This inexpensive modification involves the welding of plates on the top of the bucket and gaskets or seals on the sides to reduce the loss of sediments as the bucket is raised and moved over the scow. When used by an experienced operator, the amount of sediments resuspended by a closed-bucket clamshell can be reduced to levels similar to those obtained by a hydraulic dredge.

12. Based on the discussion in Appendix H of the CMP, several environmental controls are recommended for the IHC dredging. These controls include the use of closed-bucket clamshells to reduce the resuspension of sediments, as previously discussed; deployment of oil booms when oil slicks are produced by the dredging; and use of adsorbents to remove oil and grease contained by the oil booms. The sorbent materials will be disposed with the dredged materials as appropriate.

13. Other dredging methods are not excluded from later consideration and use at IHC, if these methods can be made to transport sediments at near in-situ water contents, as is the case for mechanical dredging. The Corps will continue to research innovative dredging equipment, and demonstrations of such equipment by the Corps may also be possible. When comparing the cost of mechanical dredging to other methods, the effluent treatment cost needs to be included with the dredging cost for overall analysis. Even though another dredging method may be less expensive, the combined dredging and treatment costs could be greater due to the additional water generated during the dredging process.

Personal Safety

14. A safety issue that has been considered in this project is the level of Personal Protective Equipment (PPE) necessary for the workers. As discussed in the CMP, it is considered that Level C will be required during the initial stages of the project for all workers involved in sediment dredging, hauling, truck unloading, and sediment handling operations. Acceptable air monitoring results may lead to the relaxation of the PPE requirements for all except those who are subject to potential skin contact with the sediment and are required to wear chemical resistant suits. A very limited probability exists that Level B PPE may be required at some time during the project. Refer to Appendix S (Safety and Health Considerations) of the CMP for a description of the PPE levels and requirements.

REHANDLING AND TRANSPORTATION OF DREDGED SEDIMENT MATERIAL

General

15. The dredged sediment material needs to be transferred from the barges/scows for transportation overland to the CDF. The transfer from the barges/scows to trucks occurs in the rehandling area and transport by the trucks to the unloading sites within the CDF is via the haul roads constructed on top of the dikes.

Rehandling of Dredged Material

16. At the CDF rehandling area, the dredged material will be loaded into trucks from the barges/scows (Plate E-2). A crane or a clamshell can be used for the loading procedure but provisions must be made to contain and control any spills. The specific transfer system and the associated docking facilities will be proposed by the contractor and is subject to approval by the contracting officer.

Structural Features of the Docking Facilities

General

17. The project structural feature consists of the slab design that will support the operation of a crane, clamshell or other material handling equipment such as a hopper. Any spilled contaminant will be contained within the slab by a curb along its perimeter and drained into a sump. The contaminant will be treated at the adjacent facility before release back to the canal. For details see plates E-3 and E-4. The specific transfer system and location of the crane operation shown may be revised during design of plans and specifications to optimize crane operation and to reduce the possibility of spillage outside

the rehandling area. For calculations, see Attachment E-1.

Structural Analysis and Design

18. The slab was designed using current Corps of Engineers and Industry standards. To avoid loading the existing steel sheet pile wall, the 1-1/2 foot thick slab, 50' x 180' with 3'-1" deep grade beams, will be founded on vertical H-piles. The slab is placed central relative to the CDF and is located near the bank for loading access. The slab will support its own weight plus the hopper weight as dead load. In addition the live load will be the lifted load plus the crane weight of 198 kips. Soil profile expected will consist of silty sand, silty clay and sand as shown in Appendix C. The parameters of this soil were developed by the Geotechnical Branch of the Chicago District. The slab will be designed with grade beams following the requirements of the ACI code during preparation of plans and specifications. The H-piles will be designed following the guidance of EM1110-2-2906, Structural Design of Pile Foundation by the Corps of Engineers.

19. Docking Facility: The existing steel sheet pile wall appears to be cantilevered PZ35's with no evidence of tiebacks and is assumed to be in good condition. Timber fenders, three rows of 12" x 12" x 200'-0", will be installed along the existing steel sheet pile channel wall to provide bumpers for the barge during berthing.

Transportation of Dredged Material

20. Trucks will transport the dredged material to the CDF by use of haul roads placed on the perimeter dikes of the CDF as well as haul roads on top of the interior and sub-cell dikes. Alternate methods of transport, such as use of a conveyor system or pumping through pipes, may be considered during the detailed design phase. Once placed in the CDF, the dredged sediment material will be managed to promote drying and consolidation.

21. Access ramps constructed at a 10% grade will provide vehicle access to the haul roads on top of the dikes. The ramps will be constructed along the side of the southwest cell perimeter dike wall. Each access ramps will handle 1-way traffic. One ramp will be designated for traffic onto the top of the dike walls and one ramp will be for traffic off the top of the dike walls. A crossing over the storm-water ditch will connect the access ramp to the haul road in the southern portion of the site (Plate E-5).

22. The dike top width will be 25 feet, sufficiently wide enough for one-way haul traffic. Compaction of the haul roads shall be accomplished by utilizing the trafficking of the haul and dredged sediment handling equipment. Subgrade material consisting of gravel or some similar material shall be placed on the surface for stability.

23. To prevent dusting and wind erosion of the haul roads, a water truck or something similar can periodically water the surface of the dry material. This should limit the amount of blowing material. If needed, similar controls can be used on the dikes. The watering process should be sufficient to prevent dusting but not excessive as to cause additional ponding.

DREDGED MATERIAL PLACEMENT

General

24. Placement of the dredged material is designed to facilitate the decanting of the water so that maximum storage benefits can be derived from the CDF. This includes increased capacity and supplying dry material to use for sub-cell dike wall construction.

Placement

25. Dredged material will be placed in the CDF in lifts of approximately 3 feet (Plate E-6). Such limited lifts will promote greater efficiency of the natural drainage/drying processes and greatly enhance potential gains in CDF capacity through consolidation. To allow for natural drying/drainage, not more than one 3-foot lift will be placed in a cell during any placement period. This placement period will be that portion of the cycle designated for dredged sediment material placement in a particular cell. During non-dredging periods, this 3-foot limit will allow sufficient time for that placed lift to dry. Lifts will continue to be placed until 3 to 4 feet of freeboard remained, at which time the perimeter/containment dikes will be raised. An estimate of anticipated annual dredging requirements for the period of analysis is given in Table E-2).

26. During operation and placement of material in the CDF, the freeboard above the elevation of material in the CDF must be kept at an elevation to contain a 100-year 24-hour storm event. The rainfall for a 100-year 24-hour event is 7.12 inches taken from Illinois State Water Survey Bulletin 71. The rainfall will require 75 acre-feet of storage in the CDF to contain the water without overtopping. 75 acre-feet correlates to approximately 1.0 foot of freeboard. The most critical periods for storage will be when the CDF is almost full with storage at a minimum. This occurs at two periods during the operation and maintenance. The first occurs at the end of filling the stage I dikes and before the stage II dikes are constructed. At the end of stage I, the whole CDF must have a minimum uniform freeboard of 1.0 feet. The freeboard is in addition to the height of the dredged material (both sediment and water). The second critical period occurs at the end of filling the CDF and prior to capping. Again, the CDF must have a minimum uniform freeboard of 1.0 feet. Storage capacity/freeboard will have to be maintained during the final filling stage, during the capping stage, and while the surface drainage system is being constructed. During the initial phase of the project, while the CDF is being

constructed, the site will drain as it has historically. After the CDF is constructed and prior to the placement of any dredged material, if necessary, pumps will be utilized to remove excess water. Drainage within the CDF will not require treatment until after dredged material is placed. Drainage that occurs outside of the CDF does not require treatment and will be discharged directly to the canal through the perimeter ditch. Final construction shall be sequenced so that storage capacity can be decreased as the 3-foot clay cover is installed and run-off is directed into the drainage system. Sequencing shall continue until coverage is complete.

27. The first placement of dredged material shall be placed on the bottom of the CDF. Subsequent lifts from future cycles will either be placed on the bottom if possible or dumped from the edge and mechanically distributed if necessary. Each cell shall be graded towards a decant structure to aid in dewatering the dredged material (Plate E-7). Further placement will begin at the high end of each cell and if possible continue towards the decant structure. It is recommended that the underdrainage system should be constructed prior to or at the same time as the initial placement. See the Dredged Material Management section for further details. To aid in the placement of material and to prevent degradation of haul road edges, short spur dikes (approximately 20' long) shall be constructed as needed off of the haul road (Plate E-8).

DREDGED MATERIAL MANAGEMENT

General

28. The management techniques include dividing the three main cells into sub-cells, decanting of the water off of the dredged sediment material, trenching, and an underdrainage system. These are described in the following sections. Decanting the water promotes consolidation of the material therefore increasing the CDF storage capacity. Decanting the water and managing the dredged material also produces dry material that is available to construct new dikes (sub-cell) and maintain and raise existing ones (interior and sub-cell).

Dredged Sediment Properties

29. There are two WES reports which characterize the dredged sediments from Indiana Harbor. These are:

1. WES, Aug. 1997, "Disposal Alternatives for PCV-Contaminated Sediments from Indiana Harbor, Indiana" Vol. I and Vol. II, Misc. Paper EL-87-9, Vicksburg, Miss.
2. WES, Oct 1997, "Transmittal of Results of Soil Tests, Indiana Harbor, ECI site " Letter Report, Vicksburg Miss. (see appendix C for this reference)

30. Reference 1 characterizes the sediment as a silty clay (CH). A previous laboratory report is referenced which is reported to have given a similar classification. Reference 2 characterizes the material as a sandy silt (MH). The sediments at the Indiana Harbor CDF site are fine grained, i.e. silt and clay.

31. The only strength parameters can be found in reference 2. The strength tests conducted were consolidated, undrained tests. It was determined that strength testing was not possible for densities less that 80 percent of the standard proctor densities. Two conditions were looked at; 80% and 100% relative density. The strength obtained were as follows:

@80 percent relative density –

γ = 106 pcf ϕ = 15° c = 0.27 TSF

γ = 106 pcf ϕ'= 35° c'= 0.1 TSF

@100 percent relative density -

γ = 113 pcf ϕ = 13.4° c= 0.63 TSF

γ = 113 pcf ϕ' = 40° c'= 0 TSF

32. If good CDF management practices for the CDF dredge sediments are assumed then most of the primary settlement in the CDF will be complete and the 80 percent relative density should be achievable. With additional work 100 percent standard proctor density can be achieved. This material can then be harvested and placed in lifts to construct the interior dykes. These dykes will be raised as required as the subcells are filled

33. The amount of consolidation in the CDF due to the weight of the dredged sediments was computed, and the calculations are attached (E – 2). The analysis was performed for 35 foot and 28 foot thick deposits. No crown on the CDF was assumed since the cap configuration detail had not been finalized at the time the analysis was completed. Settlement was estimated at 7.4 feet (21%) and 5.4 feet (19%) respectively. These calculations should be conservative values on which to determine site life. No additional testing of the dredged material is anticipated at this time.

Sub-Cell Dike Construction

34. Each of the three main cells is sub-divided into sub-cells. Each sub-cell is graded towards a decant structure located along a perimeter wall.

35. Each main cell is divided into sub-cells by constructing sub-cell dike walls connecting to the three main cell's (the north cell, southwest cell and the southeast cell) perimeter dike walls. The sub-cell dikes are constructed using dried dredged sediment material.

36. Sub-cell dike construction shall commence in the period prior to the next cycle of material placement. Dry dredged material will be used to construct the sub-cell interior dikes. Initial sequencing shall follow that given for the perimeter dikes. While the existing dredged material in the southwest cell is managed to promote drying and consolidation in year 7 (Table E-1), sub-cell dikes shall be constructed in the southeast and north cells. Construction of the sub-cell dikes will then alternate between the southwest cell one-year and the southeast and north cells the following year over the next 4 years. No dredging will be undertaken in the following or 12^{th} year. Interior sub-cell dike construction will subsequently be completed on a 4-year cycle until the three cells were filled to capacity, which will occur about the year 2033, then capped with clay. During the inactive periods (non-dredging years and drying periods) in each cell, existing dikes will also be maintained and upgraded with dried dredged material taken from areas adjacent to the dike alignment. One option for the sub-cell layout is shown in Plate E-9).

37. Seeding of exposed slopes should be done as needed to also help reduce the effects of wind erosion and dusting. Any growth, which might cause interruptions to flow, shall be removed prior to the next disposal operation cycle.

Decanting

38. Once the dredging operation period is completed and in conjunction with the trenching described below, ponding water must be removed to promote drying and consolidation of dredged material during the drying period of the cycle. The stop logs in the decant structure shall be removed one row at a time to slowly decant the ponded water (Plate E-10). A row of stop logs shall not be removed until the water level is drawn down close to the structure’s crest and outflow is low. This process will be continued during the drying period until the decanting is completed. It is desirable to eventually remove the stop logs below the dredged material surface so that rainwater can drain from the area. These stop logs shall be removed only after the material has consolidated sufficiently so that it will not flow from the cell. If it does, the logs shall be replaced. In the final stages of decanting the ponded water, notched stop logs may be placed in the decant structure, allowing low flow for slow removal of surface water. Prior to the placement of the next level of dredged material, stop logs shall be replaced to the appropriate height.

39. Liquid collected at a decant structure will drain by gravity through pipes to a central sump. From the central sump, the liquid will be pumped to the equalization basin and then to the treatment facility prior to discharge to the canal. A 2’ riser pipe is to be used for inclined installation of a submersible motor pump. The pump is located at the bottom of the riser pipe shaft and because of its weight requires no additional anchoring. Connected to the pump is a flexible hose. The decanted water is then pumped through the hose, from the bottom of the decant structure, and out of the riser. The hose can then be either connected to a portable tank on top of the perimeter dike wall or fed over the perimeter dike wall and into a coupling on the dewatering well piping system near the

exterior toe of the dike. Plate E-11 shows a cross-section of the piping system. For further details of the treatment system see appendix D.

Trenching and Underdrainage System

40. A combination of perimeter trenches, parallel interior trenches and a gravity-assisted underdrainage system will assist the dewatering process. All piping and trenches will direct the water to and tie into the decant structure located in each sub-cell.

41. The equipment used can be amphibious vehicle(s), dragline(s) or pontooned backhoe(s). In areas on soft to very soft ground, low ground pressure versions of construction equipment should be used. The manner described in the next few paragraphs can be adapted for any of the above vehicles since no specific guidance regarding the selection of equipment is available. The exact method for performing the work will be proposed by the contractor and is subject to approval by the contracting officer.

42. The underdrainage system will be installed on the base of the cell. The system shall consist of perforated drainage pipe surrounded by a suitable filter. The piping system should bisect the sub-cell starting from the decant structure to the high side of the sub-cell (see Plate E-12 for layout within the trench system and Plate E-10 for pipe cross-section). As considered necessary, piping may be incorporated into the dredge material as the elevation of the cell is raised to expedite drainage.

43. Immediately upon completion of placement of that cycle’s 3-foot lift within a cell, a wide and shallow perimeter trench shall be dug. The trench shall be lower than the surrounding dredged material. The appropriate depth will depend on the dredge sediment material properties. Initial dredged sediment material should be placed on the dikes to dry. The trenches will allow the dredged material near the trench edge to dry slightly faster than material located farther out in the cell and a crust will form. As the crust thickness grows, the ditches shall be dug to deeper depths. Drying times will vary and depend on the weather conditions and the dredged material properties. The second phase of the trenching shall be to a greater depth than the first. Again, the appropriate depth will depend on the weather conditions and the dredged material properties. Subsequent phases shall be continued as needed. This repeated trenching will cause progressively more crust development from the perimeter dikes towards the cell interior. After an appropriate minimal crust thickness has formed because of the perimeter trenching, trenches shall be constructed towards the interior using the same shallow trench technique. The trenches shall be placed parallel to each other and constructed so that runoff is directed to the perimeter trenches. Trenches shall be spaced so that the maximum effect of the rapid precipitation runoff and increased rate of evaporation can be taken advantage of. Trenching shall be constructed so that the water is directed into the decant sump. One option for the perimeter and interior trenching scheme is shown in Plate E-12. Perimeter trenches would be constructed parallel to the dikes leading to the decant structures.

Interior trenches would then be placed in a V-shaped pattern to take advantage of the slopes created by the grading.

ATTACHMENT E - 1

Structural Analysis Calculations

US Army Corps of Engineers Chicago District	PROJECT TITLE: INDIANA HARBOR	COMPUTED BY: SIL	DATE: 8/5/??	SHEET: 1
	STRUCTURE TITLE: BEAM-SLAB FOUNDATION	CHECKED BY: EGS	DATE: 8/24/??	CONTRACT NO:

Deadload -

Beam b = 1.25

t = 1.50

w = 1.25 × 1.50 × 0.15 = 0.28 klf

Liveload - 23.2^k crane capacity

Clamshell 3900 V CON

Track length = 20'-4"

Track width = 4'-0"

Crane wt. = 98.8^k

6 cu yd. (bucket) = 12,400#

10,800

Capacity = 23,200#

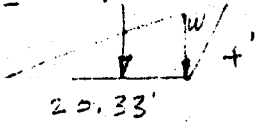
Common span length, L = 15

$$\text{Impact} = \frac{50}{L+125} = \frac{50}{15+125} = 0.36 \quad 0.3\ \text{max}$$

Impact load = 0.36 × 23.2 = 8.35^k

L + I = (198.8 + 23.2)(1.3) = 290.0^k

Distributed load, w



$$\frac{1}{2} \times w \times 20.33 = 290.0^k$$

$$w = \frac{2 \times 290.0}{20.33} = 28.5\ \text{klf}$$

US Army Corps of Engineers Chicago District	PROJECT TITLE: INDIANA HARBOR	COMPUTED BY:	DATE:	SHEET: 2
	STRUCTURE TITLE: BEAM-SLAB FOUNDATION	CHECKED BY: EGS	DATE:	CONTRACT NO

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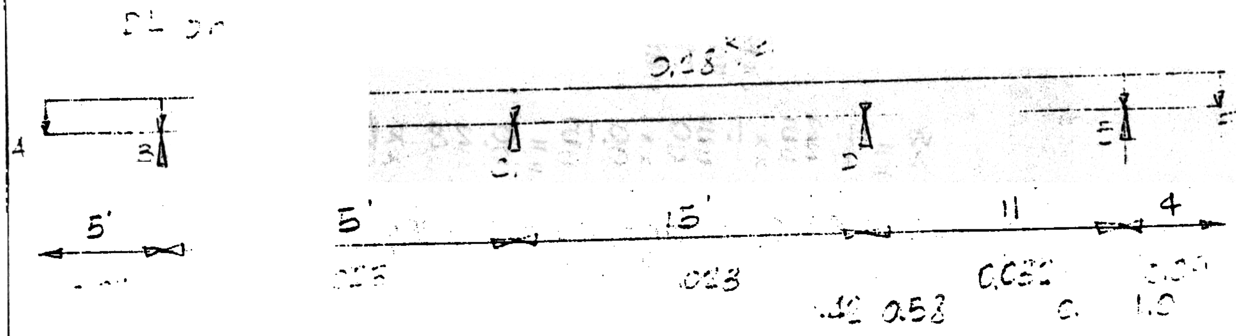


Relative stiffness: K

$I = \frac{1}{12} \times 1.05 \times 1.50^3 = 0.35 \text{ in}^4$

$K_{BA} = \frac{0.35}{5} = 0.07$, $K_{BC} = \frac{0.35}{5} = 0.023$, $K_{DE} = \frac{0.35}{11} = 0.032$

$K_{EF} = \frac{0.35}{4} = 0.09$

Distribution Factors:

BA = 1.0

BC = 0 … CB = $\frac{0.023}{0.023 + 0.023}$ = 0.50

CD = $\frac{0.023}{0.023 + 0.023}$ = 0.50

DC = $\frac{0.023}{0.023 + 0.032}$ = 0.42 DE = $\frac{0.032}{0.032 + 0.023}$ = 0.58

E = 1

US Army Corps of Engineers Chicago District	PROJECT TITLE: INDIANA HARBOR	COMPUTED BY:	DATE:	SHEET: 3
	STRUCTURE TITLE: BEAM-SLAB FOUNDATION	CHECKED BY: EGS	DATE: 9/x/95	CONTRACT NO:

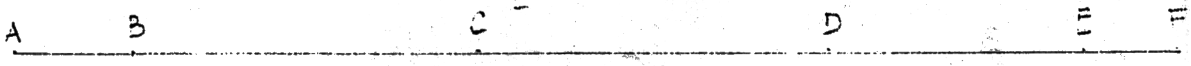
Fixed End Moment

$$M_{BA} = \frac{1}{2} \times 0.28 \times 5.0^2 = 3.5^{k-'}$$

$$M_{BC} = M_{CB} = M_{CD} = M_{DC} = \frac{1}{2} \times 0.28 \times 15^2 = 5.3^{k-'}$$

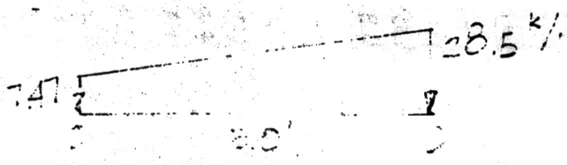
$$M_{DE} = M_{ED} = \frac{1}{12} \times 0.28 \times 11.0^2 = 2.8^{k-'}$$

$$M_{EF} = \frac{1}{2} \times 0.28 \times 4.0^2 = 2.2^{k-'}$$



	B		C		D		E	
D.F.	1.0		0.50	0.50	0.42	0.58	0	1.0
FEM	-3.5	5.3	-5.3	5.3	-5.3	2.8	-2.8	2.2
	-1.8		0	0	1.0	1.5		0.6
				0.5			0.8	
			-0.2	-0.5				-0.8
	0	-0.1			-0.2			
	0.1				0.1	0.1		
FM	-3.5	3.5	-5.5	5.5	-4.4	4.4	-2.8	2.8

Load on Span CD

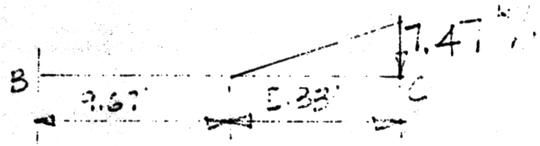


Fixed End Moment

$$M_{CD} = \frac{8^2}{60}[3 \times 7.47 + 2 \times 28.5] = 298^{k-'}$$

$$M_{DC} = \frac{15^2}{60}[3 \times 28.5) + (2 \times 7.47] = 377^{k-'}$$

Span BC



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	STRUCTURE TITLE: BEAM-SLAB FOUNDATION	CHECKED BY: [illegible]	DATE: 8/20/99	CONTRACT NO:

Fixed End Moment

Span BC- $k\ell = 5.33'$, $\ell = 15.0'$

$$k = \frac{5.33}{15.0} = 0.355$$

$$M_{BC} = \frac{7.47 \times 5.33^2 \times 0.355}{60}(5 - (3 \times 0.355)) = 4.9^{k-'}$$

$$M_{CB} = \frac{7.47 \times 5.33^2}{60}(10 - 10 \times 0.355 + 3 \times 0.355^2) = 21.5^{k-'}$$

A B C SLL on BC & CD D E F

	A	B		C		D		E	F
	1.0	C	0.50	0.50	0.42	0.58	0	1.0
		4.9	-21.5	29.8	-37.7			
D	-4.9		-138.3	-138.2	158.3	218.7		
C		-69.2		79.2	-69.1		109.4	
D	69.2		-39.6	-39.6	29.0	40.1		-109.4
C		-19.8		14.5	-19.8		20.1	
D	19.8		-7.25	-7.25	8.3	11.5		-20.1
FM	84.1	-84.1	-206.65	206.65	-270.3	270.3	129.5	-129.5
SDL	-5.3	5.3	-5.5	5.5	-4.4	4.4	-2.8	2.8
TSM	78.8	-78.8	-212.15	212.15	274.7	274.7	126.7	-126.7

say 275

Factored Load: $U = 1.4D + 1.7LL$

	A	B			D		E	
1.4D	-7.4	7.4	-7.7	7.7	-6.2	6.2	-3.9	3.9
1.7L	143.0	-143.0	-351.3	351.3	-459.2	459.2	220.2	-220.2
TFM	135.6	-135.6	-359.0	359.0	-465.7	465.7	224.1	-224.1

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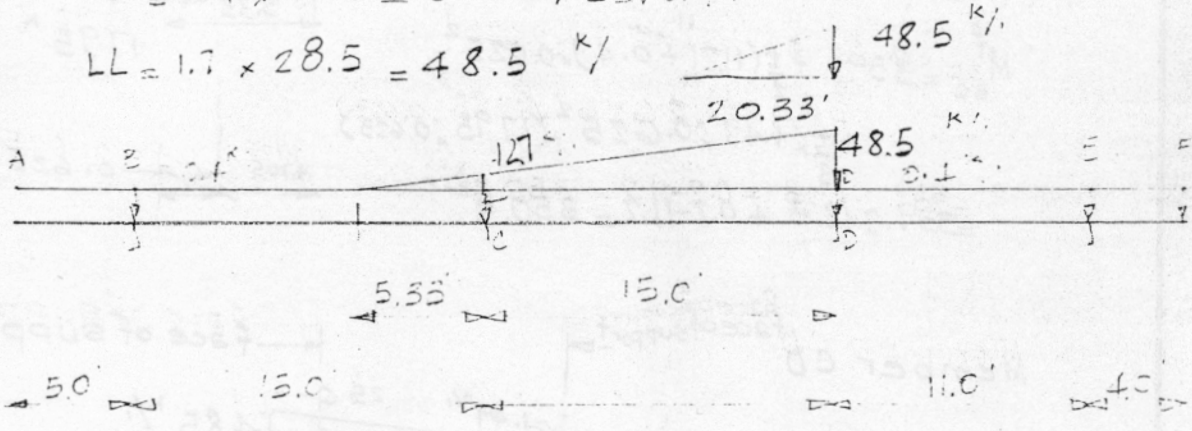
US Army Corps of Engineers Chicago District	PROJECT TITLE: [illegible]	COMPUTED BY: SB	DATE: 8/10/'00	SHEET: 5
	STRUCTURE TITLE: BEAM-SLAB FOUNDATION	CHECKED BY: [illegible]	DATE: [illegible]	CONTRACT NO:

Factored load- $U = 1.4D + 1.7LL$

$DL = 1.4 \times 0.28 = 0.39^{\#}/$, say $0.4^{k/}$

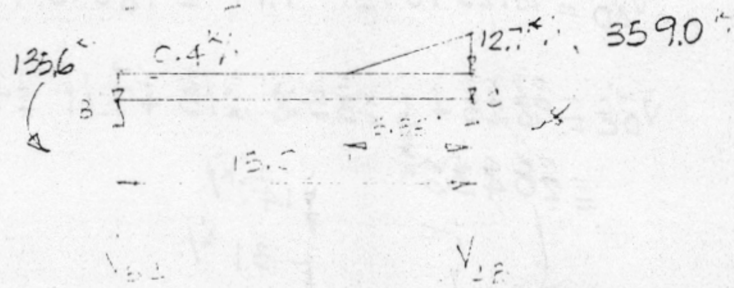
$LL = 1.7 \times 28.5 = 48.5^{k/}$



Forces on slab

At face of support $\frac{b_f}{2} = \frac{1.25}{2} = 0.625$

Member BC-



$V_{BC} = \frac{1}{2} \times 0.4 \times 15.0 + 12.7 \times \frac{5.33}{6 \times 15} + \frac{359 - 135.6}{15} = 3.0 + 4.01 + 14.89$

$V_{BC} = 21.90^{k}$

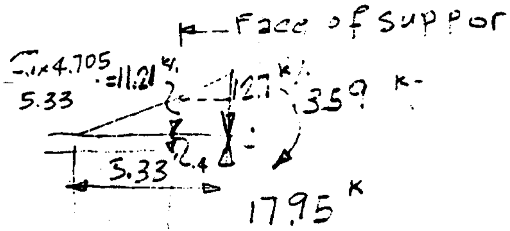
$V_{CB} = 3.0 + \frac{1}{2} \times 12.7 \times 5.33 - \ldots = 3.0 + 29.81 - 14.89$ ... $+14.89$

$V_{CB} = 17.95^{k}$

US Army Corps of Engineers Chicago District	PROJECT TITLE:	COMPUTED BY:	DATE:	SHEET: 6
	STRUCTURE TITLE: BEAM-SLAB FOUNDATION	CHECKED BY:	DATE: 3/24/96	CONTRACT NO:

M @ Face of support

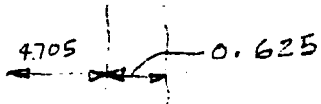
Member B



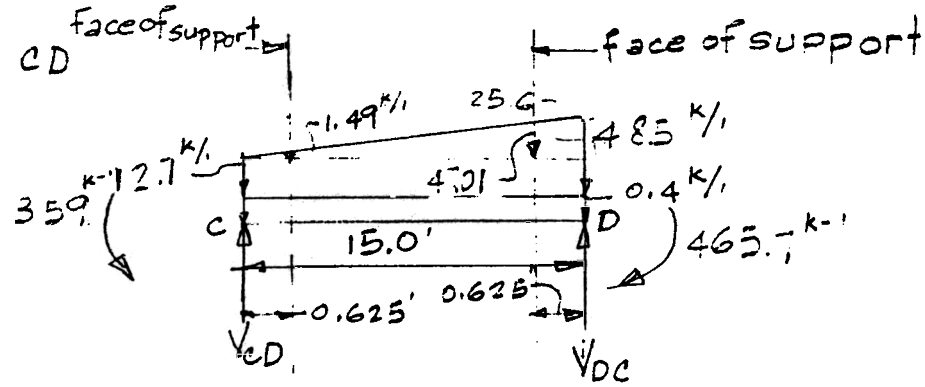
$M^{f}_{BC} = 359. + \frac{1}{2}(11.21 + 0.4) \times 0.625^2$

$+\frac{1}{3} \times 1.49 \times 0.625^2 - (17.95 \times 0.625)$

$= 359.0 + 2.3 + 0.2 - 11.2 = 350.3^{k-1}$



Member CD

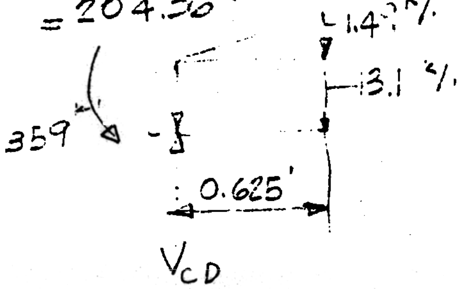


$V_{CD} = \frac{1}{2} \times (0.4 + 12.7)\, 15. + \frac{1}{6}(35.8 \times 15 - \frac{(359.0 - 465.7)}{15})$

$V_{CD} = 98.25 + 89.5 - 7.11 = 180.64^{k}$

$V_{DC} = 98.25 + \frac{1}{3} \times 35.8 \times 15 + 7.11 = 98.25 + 179.0 + 7.11$

$= 284.36^{k}$



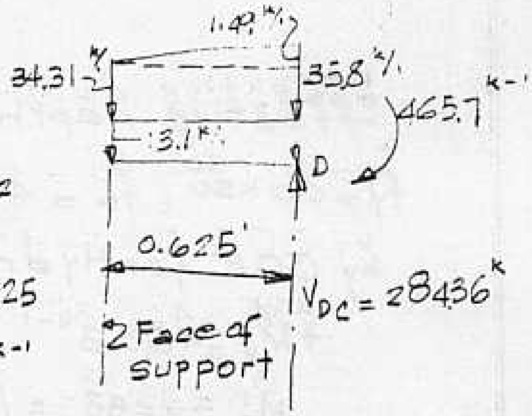
$M^{F}_{CD} = 359.0 + \frac{1}{2}(12.7 + 0.4) \times 0.625^2 + \frac{1}{6}(1.49 \times 0.625^2) - 180.64 \times 0.625$

$= 359.0 + 2.6 + 0.6 - 12.9 = 349.3^{k-1}$

US Army Corps of Engineers, Chicago District	PROJECT TITLE: INDIANA HARBOR	COMPUTED BY: SJC	DATE: 8/1/99	SHEET: -
	STRUCTURE TITLE: BEAM-SLAB FOUNDATION	CHECKED BY: EOS	DATE: 8/24/99	CONTRACT NO:

M_u @ face of support

Member CD

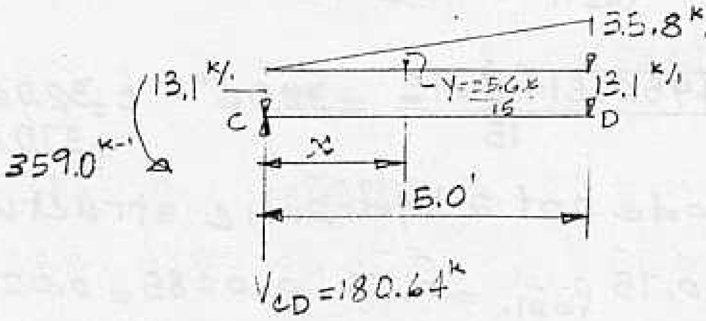


$M^F_{DC} = 465.7 + \frac{1}{2}(13.1 + 34.31)0.625^2 + \frac{1}{3}(1.49 \times 0.625^2) - 284.36 \times 0.625$

$= 465.7 + 9.3 + 0.2 - 178.0 = 297.2^{k\text{-}'}$

$+M_u$ where $V = 0$:

Let x be the distance from C where $V = 0$



$180.64 - 13.1x - \frac{1}{30} \times 35.8x^2 = 0$

$5{,}419.2 - 393.0x - 35.8x^2 = 0$

$35.8x^2 + 393.0x - 5{,}419.2 = 0$

$x = \frac{-393.0 \pm \sqrt{393.0^2 + 4(35.8 \times 5{,}419.2)}}{2 \times 35.8}$

$x = \frac{-393.0 \pm 964.613}{2 \times 35.8} = 7.98'$

$+M_u = (180.64 \times 7.98) - \frac{1}{2}(13.1 \times 7.98^2) - \frac{35.8 \times 7.98^3}{30 \times 3} - 359.0$

$+M_u = 1441.5 - 417.1 - 202.1 - 359.0 = 463.3^{k\text{-}'}$

US Army Corps of Engineers Chicago District	PROJECT TITLE: INDIANA HARBOR	COMPUTED BY: SJL	DATE: 8/11/99	SHEET: 8
	STRUCTURE TITLE: BEAM - SLAB FOUNDATION	CHECKED BY: EOK	DATE: 9/29/99	CONTRACT NO:

Effective depth b = 5"

$f_y = 60ksi \quad f_c' = 4ksi$

by COE for Hydraulic structures.

$+M_u = 463.3^{k-'}$

$M_n = \frac{463.3}{0.9} = 514.8^{k-'}$

$\rho_{max} = 0.25\rho_{bal.} \qquad K_d = 0.125765$

$d_d = \sqrt{\frac{2.4956 \times 514.8 \times 12}{15}} = 32.06" \qquad t = 32.06 + (4 + \frac{1}{2} + \frac{1}{2}) = 37.06"$ say 37"

by ACI Code not a Hydraulic structure

$\rho_{max} = 0.75\rho_{bal.} = 0.75 \times 0.0285 = 0.0214$

$R_n = 0.0214 \times 60{,}000 (1 - \frac{0.0214 \times 60{,}000}{0.85 \times 4{,}000}) = 1{,}042 psi$

$b.d^2_{req'd} = \frac{514.8 \times 12}{1.042} = 5{,}929 \; in^3$

$d = \sqrt{\frac{5{,}929}{15}} = 19.88"$

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US Army Corps of Engineers Chicago District	PROJECT TITLE: INDIANA ...	COMPUTED BY: [illegible]	DATE: 8/19/99	SHEET: 9
	STRUCTURE TITLE: BEAM-SLAB FOUNDATION	CHECKED BY: FEGS	DATE: 9/24/99	CONTRACT NO:

revised $d = 37 - 5 = 32''$

$M_n = 514.8^{k-1}$

$K_u = 1 - \sqrt{1 - \frac{514.8 \times 12}{0.425 \times 4 \times 15 \times 32^2}} = 0.12626$

$A_s = \frac{0.85 \times 4 \times 0.12626 \times 15 \times 32}{60} = 3.43^{\square''}$ 5 #8 = ($A_s = 3.95^{\square''}$)

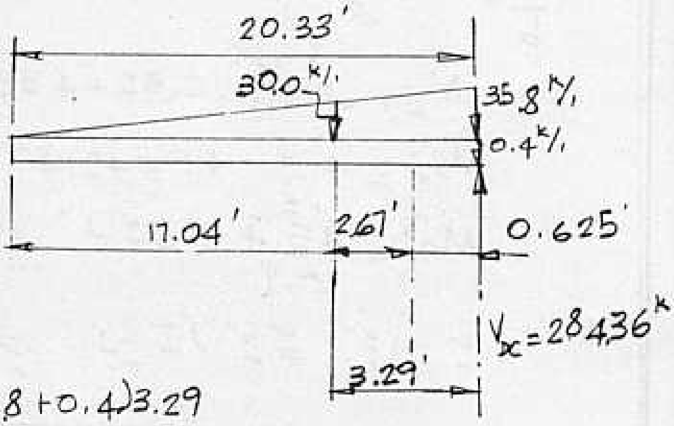
$n = \frac{3.43}{0.79} = 4.34$ say 5 #8

stirrups - $V = 204.53^k$

$b = 15''$

$d = 27'' = 2.25'$

V At 'd' distance from face of support



$y_{17.455} = 17.04 \frac{\times 35.8}{20.33} = 30.0^{k/l}$

$V_{u_d} = 284.36 - \frac{1}{2}(30.0 + 0.4 + 35.8 + 0.4)3.29$

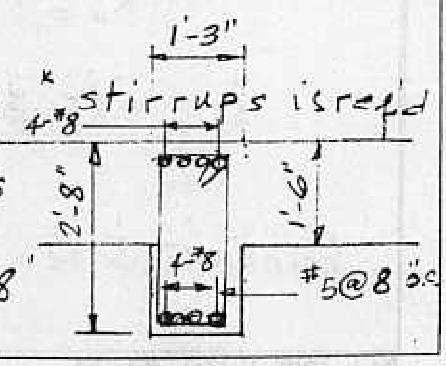
$V_{u_d} = 284.36 - 109.56 = 174.8^k$

$\phi V_c = \frac{0.85 \times 2 \times \sqrt{4{,}000} \times 15 \times 32}{1{,}000} = 51.61^k < 174.8^k$ stirrups is req'd

$V_{u_d} - \phi V_c = 174.8 - 51.61 = 123.19^k = \phi V_s$

Try #5 stirrups, $A_s = 0.31^{\square''}$

$S = \frac{(2 \times 0.31) 60 \times 32 \times 0.85}{123.19} = 8.21''$ say 8''



US Army Corps of Engineers Chicago District	PROJECT TITLE: [illegible]	COMPUTED BY: [illegible]	DATE: [illegible]	SHEET: [illegible]
	STRUCTURE TITLE: BEAM - SLAB FOUNDATION	CHECKED BY: EGS	DATE: 8/24/99	CONTRACT NO:

Slab [illegible]

DL $1.4 \times 1.5 \times 0.15 = 0.32$ ksf

LL $\frac{[illegible]}{4 \times 20.33} = 5.09$ ksf

$U = 1.7 \times 5.09 = 8.65$ ksf

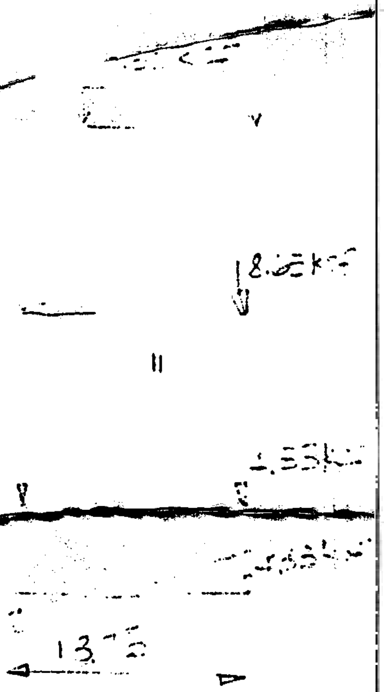


Fig. 34 & 35 of Eng'r Monograph
Bureau of Reclamation

$\frac{y}{b} = 0.4 \quad \frac{x}{a} = 0$

$M_x = (0.047 \times 20.33 + 4.33) \times 13.75^2 + 0.035 \times 4.33 \times 13.75$

$Mu_x = 41.3 + 4.1 = 45.4^{k-ft}$

$Mn_x = \frac{45.4}{0.9} = 50.4^{k-ft}$

$t = 18 \quad d = 18 - [illegible]$ [illegible]

$K_u = \sqrt{\frac{50.4 \times 12}{0.425 \times 4 \times 12 \times 13^2}} = 0.0919$

$A_s = \frac{0.85 \times 4 \times 0.0919 \times 12 \times 13}{60} = 0.81^{\square}$ Provide #8 @ 12" o.c. $A_s = 0.79^{\square''}$

Shrinkage & temperature reinf. - $A_s = 0.0014 \times 12 \times 13 = 0.22^{\square''}$

PROJECT TITLE: Indiana Harbor	COMPUTED BY: SU	DATE: 7-3-99	SHEET: 1
STRUCTURE TITLE: Design of pile	CHECKED BY: EGS	DATE: 8-25-99	CONTRACT NO:

US Army Corps of Engineers
Chicago District

Ref.: EM 1110-2-2906

pile width, $B = 15'' = 1.25$

Material - silty sand - medium dense $D_c = 15B$

Assume: $\gamma = 120$ pcf

$N = 15$

friction $= 500$ psf

$D_c = 15B = 15 \times 1.25 = 18.75'$

$f_s = K \sigma_v' \tan \delta$

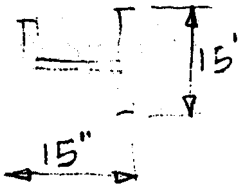
For $D < D_c$ $\sigma_v' = \gamma' D$

From table 4-3, page 4-12 of the above reference.

$\delta = 0.67\phi$ to 0.83ϕ, used $\delta = 0.75\phi = 22.5°$

$\sigma_v' = \frac{120}{1{,}000} \times 22.5 \times 1.25$ 3.38 ksf

$A_t = 15 \times 15 = 225^{\square''}$



Bearing pressure capacity factor, N_q

From Fig. 4-4, page 4-14.

Assume $\phi = 30°$; $N_q = 25$

Tip bearing capacity, $q = \sigma_v' N_q$

$q = 3.38 \times 25 = 84.5$ ksf

Tension Capacity of piles in Sand

From Table 4-4, page 4-12, K_t for silty sand

$K_t = 0.6$

US Army Corps of Engineers Chicago District	PROJECT TITLE: INDIANA HARBOR	COMPUTED BY: SIL	DATE: 7/13/99	SHEET: 2
	STRUCTURE TITLE: H-PILE DESIGN	CHECKED BY: BCS	DATE: 9/24/99	CONTRACT NO:

$K_t = 0.6$

$\sigma'_v = 3.38$ ksf

$\delta = 22.5°$

$f_s = 0.6 \times 3.38 \tan 22.5° = 0.84$ ksf

$A_s = 225^{\square''}$

Shaft resistance of the pile due to skin friction $= Q_s$

$Q_s = f_s A_s = 0.84 \times \frac{225}{144} = 1.3^k$

Unit tip bearing capacity, $q = \sigma'_v N_q$

$\sigma'_v = 3.38$ ksf , $N_q = 25$

$q = 3.38 \times 25 = 84.5$ ksf

Tip resistance of the pile due to end bearing $= Q_t$

$Q_t = A_t\, q$

A_t = effective (cross) area of the tip of the pile in contact with the soil

Assumed $A_t = 34.4^{\square''}$ for HP 14 x 117

$Q_t = \frac{34.4}{144} \times 84.5 = 20.2^k$

Ultimate pile capacity = Qult.

$Q_{ult} = Q_s + Q_t = 1.3 + 20.2 = 21.5^k$

US Army Corps of Engineers Chicago District	PROJECT TITLE: INDIANA HARBOR [illegible]	COMPUTED BY: [illegible]	DATE: [illegible]	SHEET: 3
	STRUCTURE TITLE: DESIGN OF H-PILE	CHECKED BY: [illegible]	DATE: [illegible]	CONTRACT NO:

Materia - silty clay

$q_u = .0 - 1.5$ tsf

friction = 400 tsf

$c = 0.7$ tsf

Assumed $\gamma = 125$ pcf $\phi = 0°$

From Fig 4-5a: for [illegible] 0.7 tsf (Assumed undrained shear strength)

α = adhesion factor = 0.6

[illegible] f_r [illegible]

$f_s = [illegible]$

$f_a = \alpha c = 0.6 \times 0.7 = 0.42$ tsf

$A_s = 225^{\square''}$ (from page 1)

$Q_s = f_s A_s = \frac{[illegible] \times 225}{144} = 0.66$ ton $= 1.5^K$

By Semple & Rigden

Assumed $L = 582 - 506 = 76$

$\frac{L}{b} = \frac{76}{15} \times 12 = 6$

From Fig. 4-5b $\alpha_2 = 0.7$

$q = 9c = 9 \times 0.7 = 6.3$, $A_t = 34.4^{\square''}$ (from p 2)

$Q_t = A_t q = \frac{34.4}{144} \times 6.3 = 1.5^T = 3.4^K$

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US Army Corps of Engineers Chicago District	PROJECT TITLE: [illegible]	COMPUTED BY: [illegible]	DATE: [illegible]	SHEET: 4
	STRUCTURE TITLE: DESIGN OF [illegible]	CHECKED BY: EGS	DATE: 9 [illegible]	CONTRACT NO:

Axial Load

From p 1 of crane platform computation,

$P = \quad + LL = 23[illegible]^{k}$

A36 $\quad S = 172\ in^3$

$HP_{14\times117}$ $b \sim 15"$, $A = 34.4\ in^2$, $d = 14.21"$, $b_F = 14.885" \sim 15"$

$M_{in}\ e = 0.10t = 0.10 \times 15 = 1.5"$

$M = 23[illegible] \times \frac{1.5}{12} = 29.C^{k-1} < 198^{k-1/1} =$ (M Beam, see p4 of crane platform [illegible])

use 198^{k-1}

$f_a = \frac{20715}{34.4} = 602\ ksi$

$F_a = 18\ ksi$

$F_b = 18\ ksi$ (For A36 noncompact section)

$f_b = \frac{198 \times 12}{172} = 13.81\ ksi$

$\frac{f_a}{F_a} + \frac{f_{by}}{F_b} = \frac{6.02}{18} + \frac{13.81}{18} = 0.334 + 0.767 = 1.101 \sim 1.00$ O.K.

use HP14 x117

NCC Form 1272-1 May

ATTACHMENT E – 2

Backup for Estimate of the Dredged Sediment Consolidation

PROJECT TITLE: Indiana Harbor CDF	COMPUTED BY: DW	DATE: 26 Sept 1997	SHEET: 1	18
STRUCTURE TITLE: Confined Disposal Facility	CHECKED BY:	DATE:	CONTRACT NO:	

US Army Corps of Engineers
Chicago District

Purpose Estimate the consolidation of dredged sediment in the Indiana Harbor CDF up to the final stage of fill operations.

References:

- Lambe, T.W., 1951, "Soil Testing for Engineers" Chapt. 9 Consolidation Tests pp 82-87, New York, N.Y., Wiley and Sons.

2. WES, Dec 1997, "Letter Report and Soil Test Data, Indiana Harbor ECI Site"

Assumptions -

Filling of dredge sediment to crest of final stage of embankment.

2. Consolidation is due to self-weight only

3. Material properties in Ref. 2 above are typical of Indiana Harbor sediments

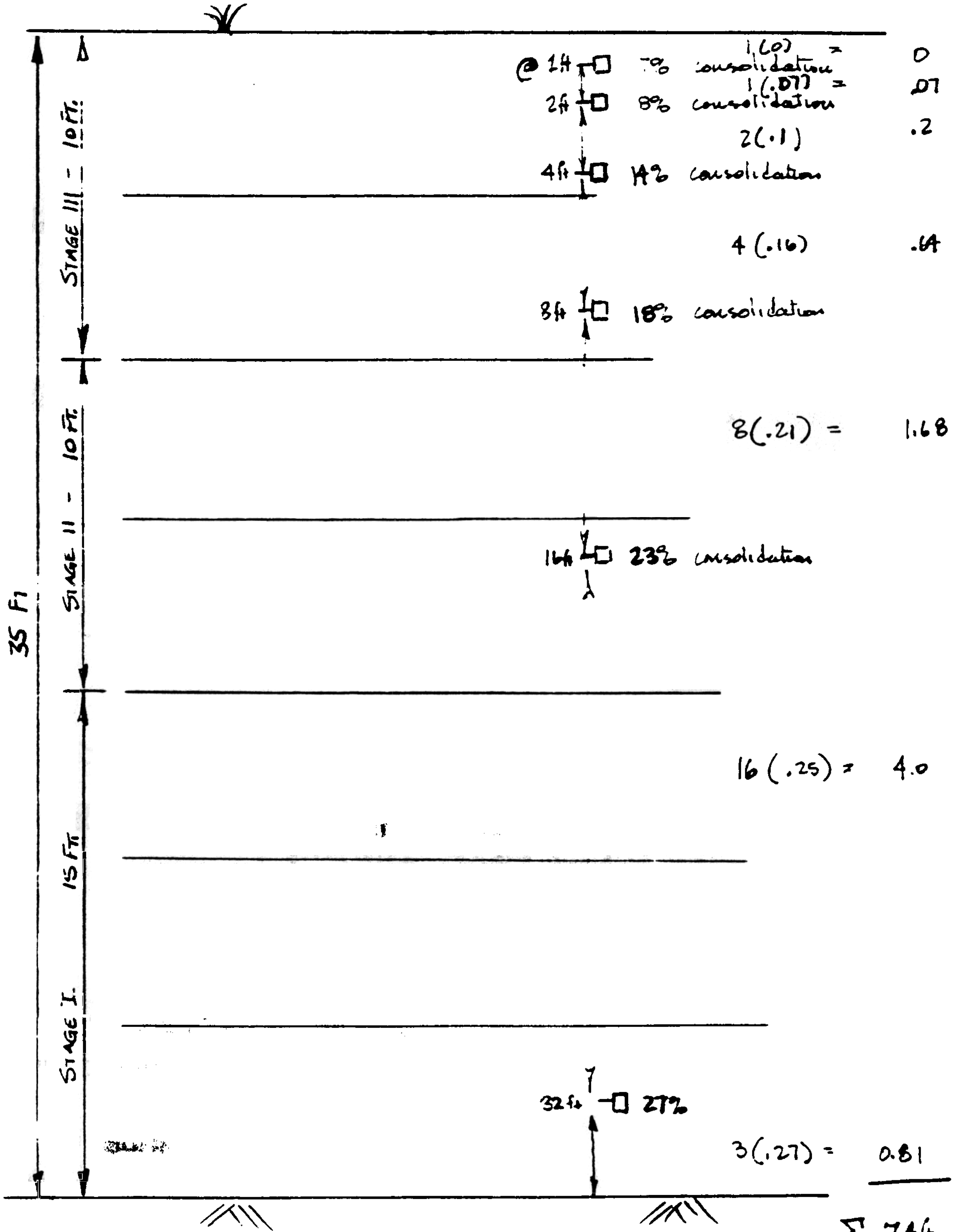
Analysis - Two cases were studied

Case A - Three Stage Development
Stage 1 = 15 ft Stage 2 = 10 ft Stage 3 = 10 ft

Case B - Two Stage Development
Stage 1 = 15 ft. Stage 2 = 8 ft.

US Army Corps of Engineers Chicago District	PROJECT TITLE: INDIANA HARBOR CDF	COMPUTED BY: OW	DATE: 26 Sep 1996	SHEET: 2. 18
	STRUCTURE TITLE: CONFINED DISPOSAL FACILITY	CHECKED BY:	DATE:	CONTRACT NO

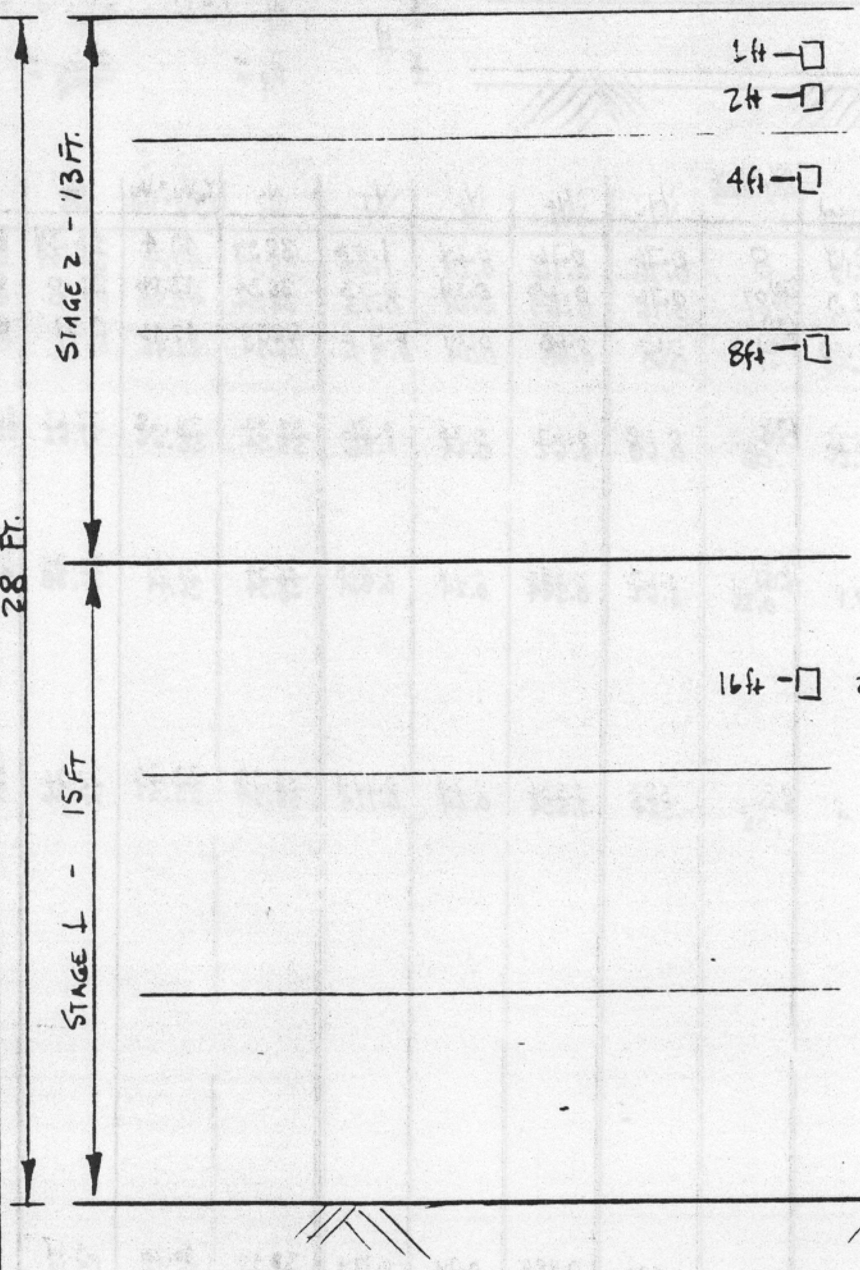
ESTIMATE AVERAGE CONSOLIDATION IN CDF BY COMPLETION OF FILL OPERATIONS –



Σ 7.4 ft.

RATIO OF CONSOLIDATION TO TOTAL DEPTH = $\frac{7.4}{35}$ = 0.21

US Army Corps of Engineers Chicago District	PROJECT TITLE: INDIANA CDF	COMPUTED BY: DW	DATE: 26 SEP 97	SHEET: 3	18
	STRUCTURE TITLE: CONFINED DISPOSAL FACILITY	CHECKED BY:	DATE:	CONTRACT NO:	



1ft — ☐ 7% consolidation

2ft — ☐ 8% consolidation

4ft — ☐ 14% consolidation.

8ft — ☐ 18% consolidation

16ft — ☐ 23% consolidation

	0
1(.07) =	.07
2(.1) =	.20
4(.16) =	.64
8(.21) =	1.68
12(.23) =	2.76

Σ 5.35 ft

RATIO OF CONSOLIDATION TO TOTAL DEPTH $\frac{5.35}{28}$ = 0.19

19%

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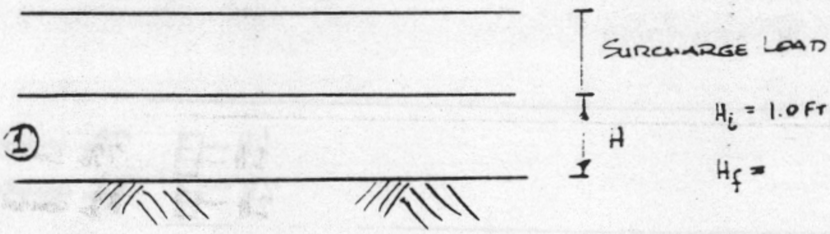
PROJECT TITLE: INDIANA HARBOR CDF	COMPUTED BY: OW	DATE: 26 Sept 97	SHEET: 4	18
STRUCTURE TITLE: CONFINED DISPOSAL FACILITY	CHECKED BY:	DATE:	CONTRACT NO:	

US Army Corps of Engineers
Chicago District



H_i = 1.0 Ft e_{ave_i} = 3.19

H_f = e_{ave_f} =

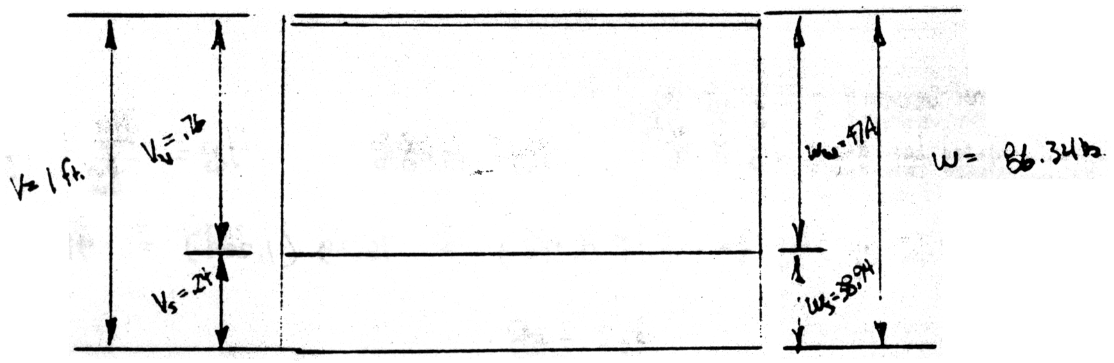
Layer No.	Surcharge Load Ft.	e_{ave} Initial	e_{ave} final	$\Delta V_v = \Delta e V_s$	V_{v_i}	V_{v_f}	V_s	V_{T_i}	W_s	$\gamma_w V_v = W_w$	W_t	γ_T	ΔV % Consolidated
①	0	3.19	3.19	0	0.76	0.76	0.24	1.00	38.94	47.4	86.34	86.34	0%
	1	3.19	2.9	(.29) .07	0.76	0.69	0.24	0.93	38.94	43.06	82.0	88.17	7%
	2	2.90	2.48	(.42) .1	0.69	0.68	0.24	0.92	38.94	42.43	81.37	88.45	8%
	3												
	4	2.48	2.25	(.23) .06	0.68	0.62	0.24	0.86	38.94	38.68	77.63	90.27	14%
	5												
	6												
	7												
	8	2.25	2.1	(0.15) 0.36	0.62	0.584	0.24	0.824	38.94	36.44	75.38	91.48	18%
	9												
	10												
	11												
	12												
	13												
	14												
	15												
	16	2.1	1.9	(0.2) .05	.584	0.534	0.24	0.774	38.94	33.32	72.26	93.4	23%
	17												
	18												
	19												
	20												
	21												
	22												
	23												
	24												
	25												
	26												
	27												
	28												
	29												
	30												
	31												
	32	1.9	1.7	(0.2) .05	0.534	0.484	0.24	0.724	38.94	30.20	69.14	95.5	27%
	64	1.7	1.5	(0.2) .05	0.484	0.434	0.24	0.674	38.94	27.08	66.02	97.95	33%

INDIANA HARBOR CDF

CONFINED DISPOSAL FACILITY

LOAD INCREMENT	EQUIVALENT SEDIMENT HEIGHT	C_c
0 - .02 tsf	0 - 2 ft	.86
.02 - .04 tsf	2 - 4 ft	0.89
.04 - 1.28 tsf	4 - 128 ft	0.76

COMPUTE UNIT WEIGHT OF DREDGE MATERIAL —



$S = \frac{V_w}{V_s} = 1.0$

$e = \frac{V_v}{V_s} \quad 3.19$

$V_v = e V_s = 3.19 V_s$

$V_T = V_s + V_v = (1 + 3.19) V_s \quad 4.19 V_s$

$V_s = \frac{1}{4.19} = 0.24 \text{ ft}^3$

$V_w = V_v = \frac{3.19}{4.19} = 0.76 \text{ ft}^3$

$W_w = \gamma V_w = 62.4 \text{ lb/ft}^3 (.76) = 47.4 \text{ lb}$

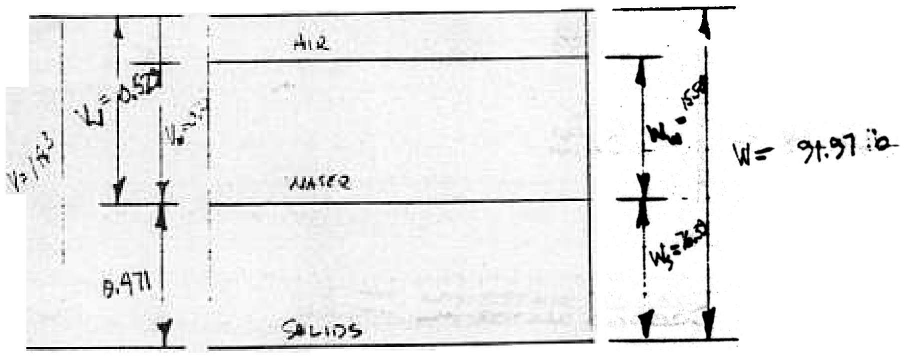
$W_s \quad G_s \gamma V_s = 2.6 (62.4 \text{ lb/ft}^3)(.24) = 38.9$

$W_T = W_w + W_s = 47.4 + 38.94 = 86$

INDIANA HARBOR CDF
CONFINED DISPOSAL FACILITY

6/18

STANDARD PROCTOR – COMPACTION TEST – DETERMINE VOID RATIO



Maximum Dry Density = 76.39 lb/ft³

Optimum Water Content = 20.4 % W_w = 15.58 lb $V_w = \frac{W_w}{\gamma_w} = \frac{15.58 \text{ lb}}{62.4 \text{ lb/ft}^3}$

Total Weight = W_s = 76.39 (1+ 0.204) = 76.39 (1.204) = 91.97 lbs

$G_s\ \gamma\ V_s$ G_s = 2.60

$\frac{W_s}{G_s\ \gamma}$ V_s $V_s = \frac{76.39}{2.6(62.4)}$ = 0.471

$S = \frac{V_w}{V_v} = \frac{0.25}{0.529} = 0.47$

$\frac{V_v}{V_s} = \frac{0.529}{0.471} = 1.12$

INDIANA HARBOR CDF

CONFINED DISPOSAL FACILITY

DETERMINE LOADING OF FINAL

DRAINAGE LAYER	
LINER (CLAY)	3 FT COMPACTED CLAY
TOP OF DREDGE MATERIAL	

ASSUME DENSITY OF TOPSOIL, CLEAN FILL, DRAINAGE LAYER 5 pcf

LINER (CLAY) 115 pcf

σ 5 lb/ft³ × ... = 690 psf (0.345 TSF)

DETERMINE LOADING OF SEDIMENT PER FOOT

1 FT SEDIMENT γ_s = 83.41 lb/ft³

∴ σ' = σ − u = γ_s − γ_w (1) = 83.41 ... − 62...

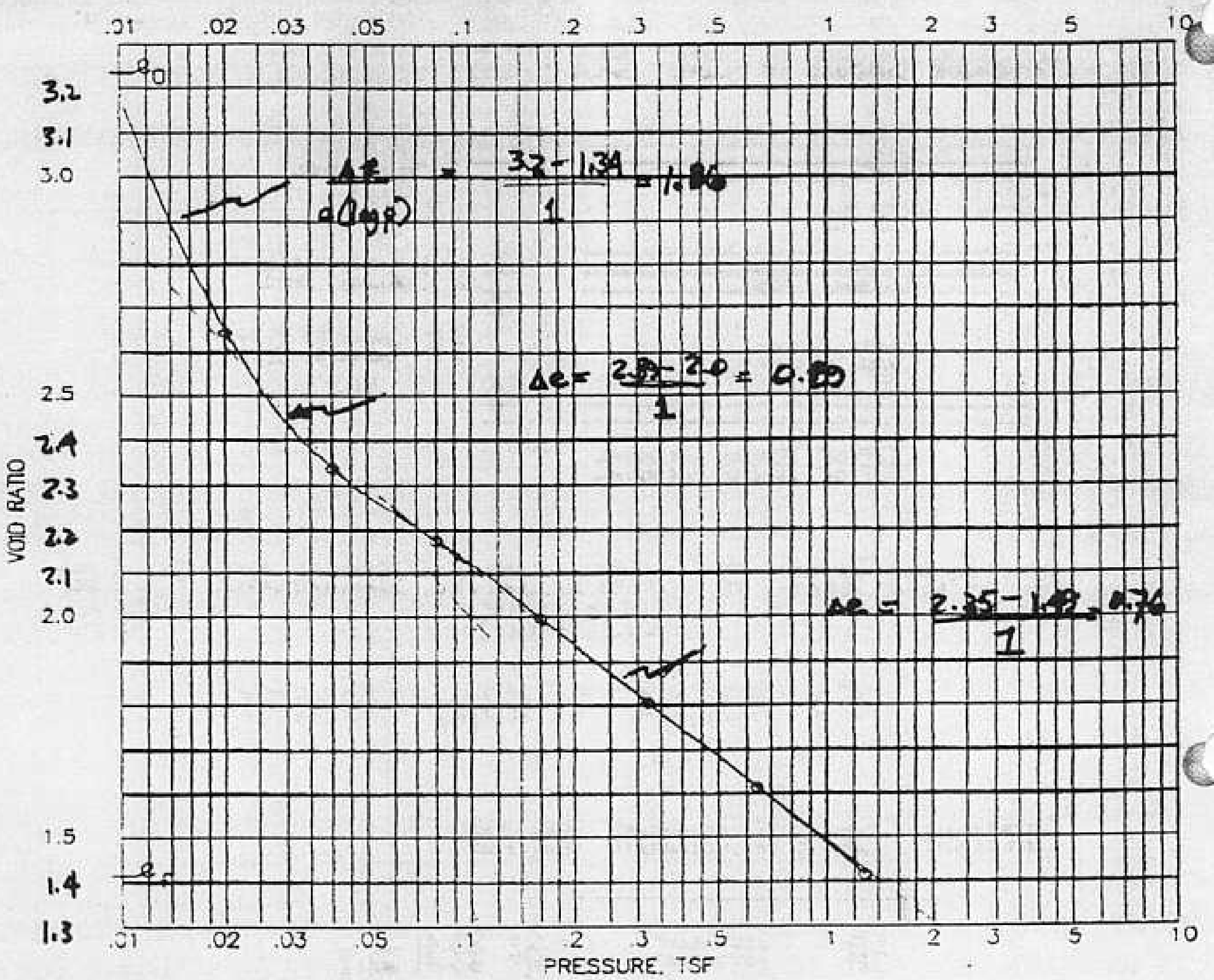
= 21.01 psf

= .01 tsf

EQUIVILENT SEDIMENT LOADING

LOADING tsf	SEDIMENT DEPTH ft
.01	1
.02	2
.04	4
.08	8
.16	16
.32	32
.64	64
.28	.28

8/18



				BEFORE TEST	AFTER TEST
OVERBURDEN PRESSURE, TSF			WATER CONTENT, %	117.6	54.2
PRECONSOL. PRESSURE, TSF			DRY DENSITY, PCF	38.4	67.4
COMPRESSION INDEX			SATURATION, %	94.6	100.0
TYPE SPECIMEN	UNDISTURBED		VOID RATIO	3.231	1.409
DIA. IN 2.50	HT. IN 1.500		BACK PRESSURE, TSF		

CLASSIFICATION	SANDY SILT (MH), DARK GRAY		
LL 76	PL 38	PI 38	PROJECT INDIANA HARBOR ECI SITE
GS 2.60	D_{10}		
REMARKS:		BORING NO. DM	SAMPLE NO. 1
		DEPTH/ELEV	TECH. JL
		LABORATORY USAE WES – STF/GL	DATE 06 DEC 96
		CONSOLIDATION TEST REPORT	

SHEET 1 OF 9

COMP BY DW DATE 3 Apr 1997

CHKD. BY ______ DATE ______

SUBJECT Indiana Harbor CDF

US Army Corps of Engineers
Chicago District

STRUCTURE Dredge Sediment Consolidation Characteristics

Applied Pressure TSF	Final Dial In.	Dial Change In.	2H from Dial Change	H ?	Void Height 2H-2Ho	Void Ratio e = (2H-2Ho)/2Ho	Avg e	1+e	t_{50}
0	.1000		1.5000	.3750	1.1955	3.2313			
		.0204					3.1134	4.1934	4200
0.01	.1204		1.4796	.3699	1.1251	3.1738			
		.1961					2.8972	3.8972	3060
0.02	.3165		1.2835	.3209	0.9230	2.6206			
		.1024					2.4762	3.4762	3960
0.04	.4189		1.1811	.2953	0.8266	2.3317			
		.0574					2.2508	3.2508	2160
0.08	.4763		1.1237	.2809	0.7652	2.1698			
		.0626					2.0815	3.0815	1680
0.16	.5389		1.0611	.2653	0.7066	1.9932			
		.0675					1.898	2.898	1080
0.32	.6064		0.9936	.2484	0.6391	1.8028			
		.0683					1.7065	2.7065	900
0.64	.6747		0.9252	.2313	0.5708	1.6102			
		.0715					1.5091	2.5091	660
1.28	.7462		0.8538	.2135	0.4993	1.408			

Solids Height = $2H_0 = \frac{W_s}{G_s \gamma_w A} = \frac{19.14\ g}{2.6(1)(31.67)}$ 0.900 cm 0.3546 in

ICC FORM (1 OCT 82)

COMP BY DW DATE 3 Apr 1997 SHEET 10 OF 18

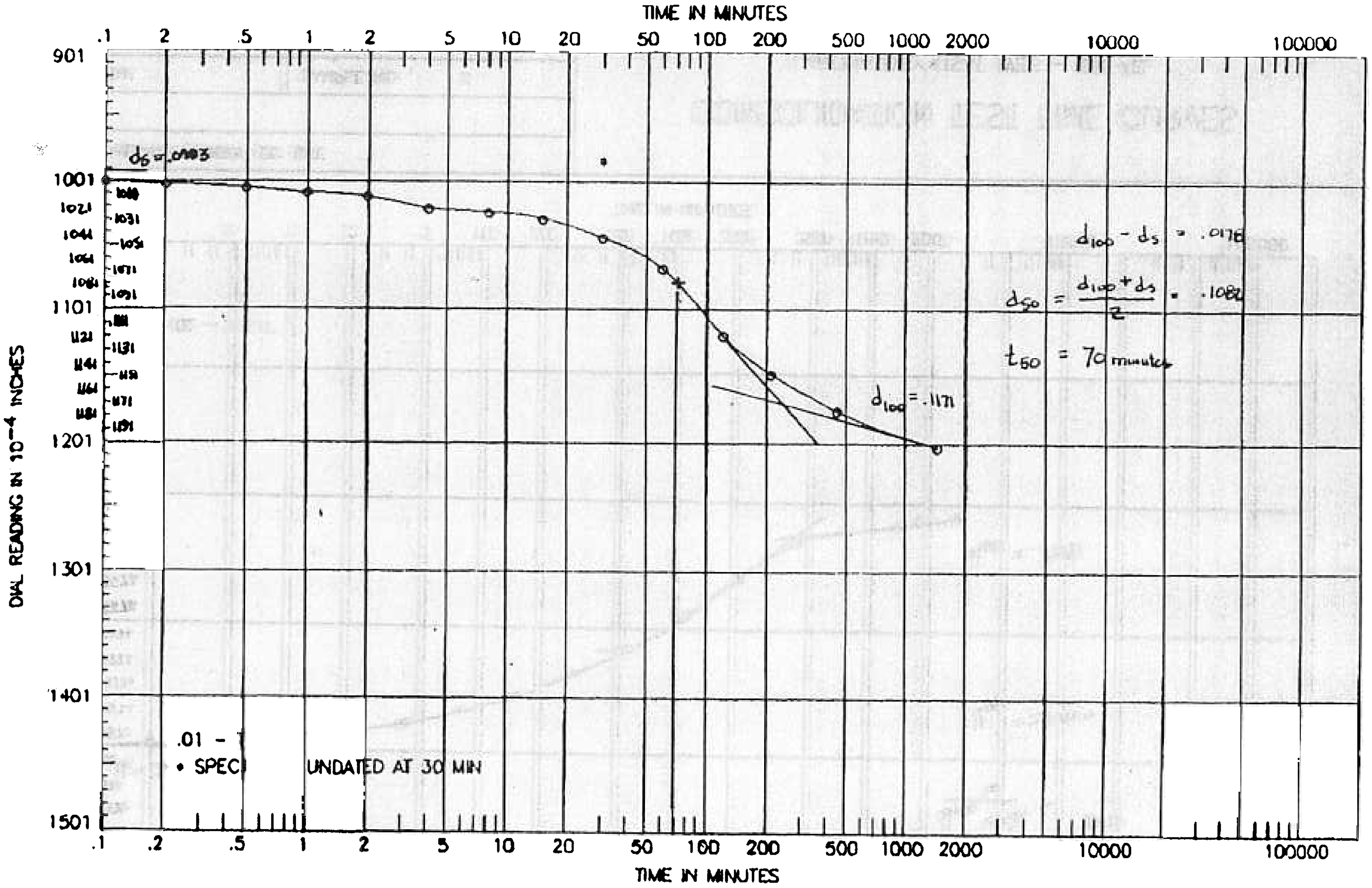
CHKD. BY ______ DATE ______

US Army Corps of Engineers
Chicago District

PROJECT INDIANA HARBOR CDF STRUCTURE DREDGE SEDIMENT CONSOLIDATION CHARACTERISTICS

Load tsf	Load Kg/cm²	ΔVs	2H inches	2H cm	H cm	H' cm²	t_{50} sec	C_v = $0.197H'/t_{50}$	C_c	$a_v = \frac{.435 C_c}{\bar{p}}$	$k = \frac{C_v a_v \gamma_w}{1+e}$ cm/sec
0	0		1.500	3.81					1.86		
		0.0488			1.8921	3.5800	4200	1.6792×10^{-4}		16.5999	6.639×10^{-4}
0.01	.00976		1.4796	3.7582					1.86		
		.01464			1.7546	3.0786	3060	1.9820×10^{-4}		55.2669	2.8107×10^{-3}
0.02	.01953		1.2835	3.2601					1.86		
		.02930			1.5650	2.4492	3960	1.2184×10^{-4}	(1.315)	20.4138	7.155×10^{-4}
0.04	.03906		1.1811	3.0000					0.89		
		.0586			1.4636	2.1421	2160	1.9537×10^{-4}	(0.865)	6.1241	3.681×10^{-4}
0.08	.07812		1.1237	2.8542					0.76		
		.11716			1.3874	1.9249	1680	2.2572×10^{-4}		2.8218	2.067×10^{-4}
0.16	.1562		1.0611	2.6952					0.76		
		.2344			1.3047	1.7022	1080	3.1049×10^{-4}		1.4104	1.511×10^{-4}
0.32	.3125		0.9936	2.5237					0.76		
		.4688			1.2185	1.4847	900	3.2498×10^{-4}		0.7052	8.468×10^{-5}
0.64	.6250		0.9253	2.3503					0.76		
		.9375			1.1298	1.2764	660	3.8099×10^{-4}		0.3526	5.354×10^{-5}
1.28	1.2499		0.8538	2.1687					0.76		

NCC FORM 1696
(1 OCT 92)

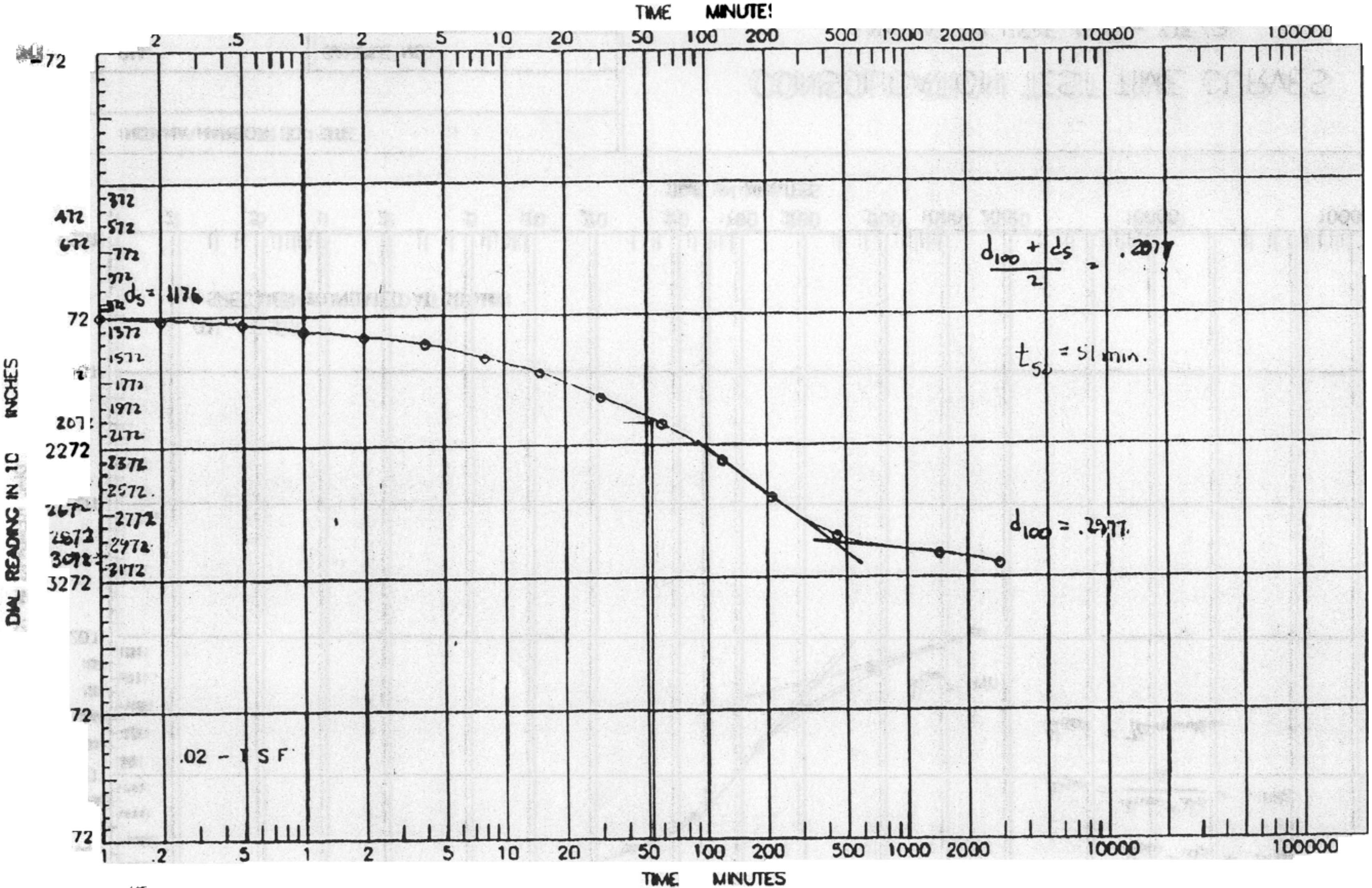


PROJECT	INDIANA HARBOR ECI SITE		
BORING	DM	SAMPLE NO.	1
DEPTH/ELEV		DATE	06 DEC 96

CONSOLIDATION TEST TIME CURVES

LABORATORY USAE WES – STF/GL

SHEET 2 OF 9

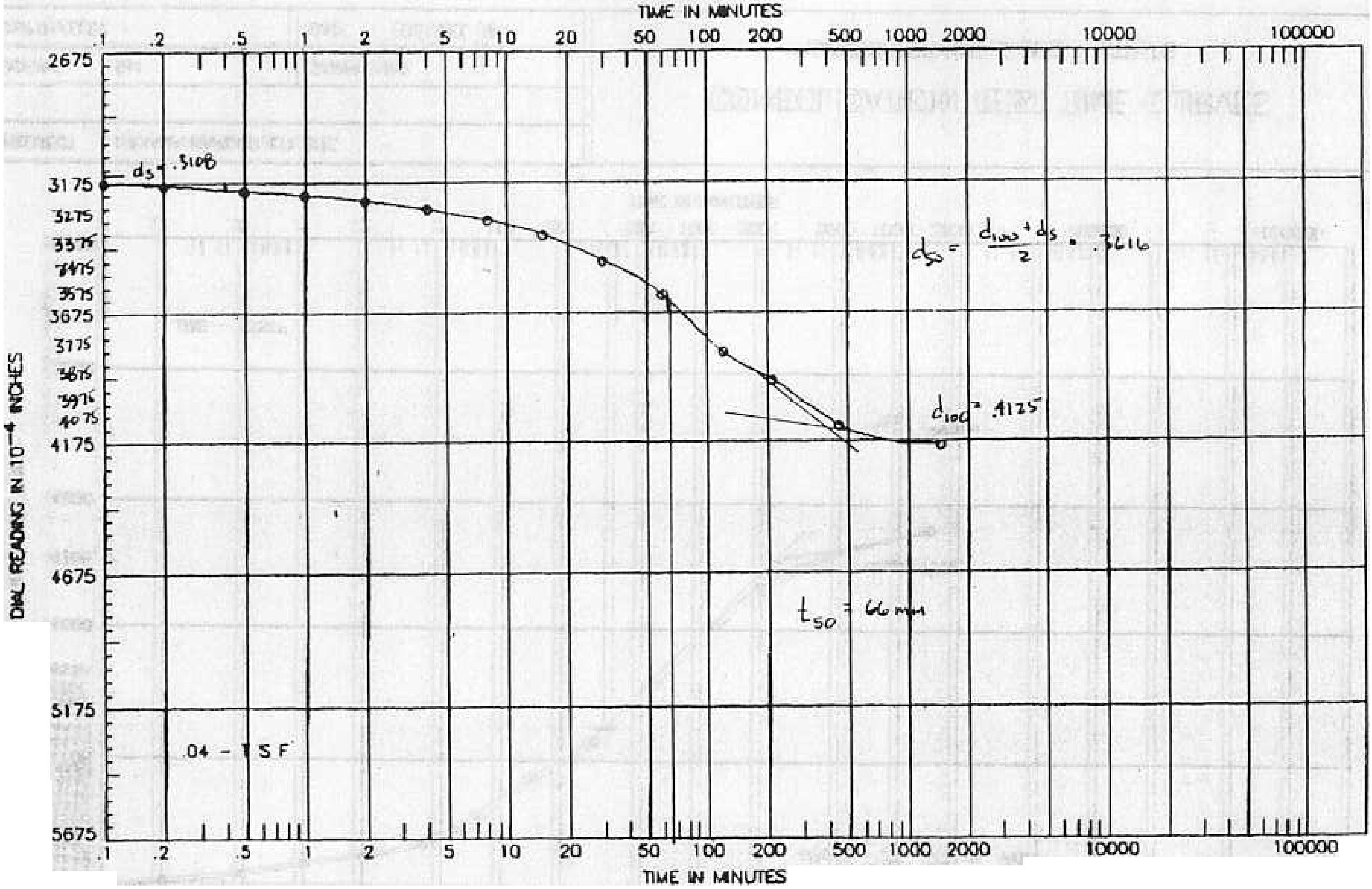


PROJECT	INDIANA HARBOR ECI SITE		
BORING	DM	SAMPLE NO.	1
DEPTH/ELEV		DATE	06 DEC 96

CONSOLIDATION TEST TIME CURVES

LABORATORY USAE WES – STF/GL

SHEET 3 OF

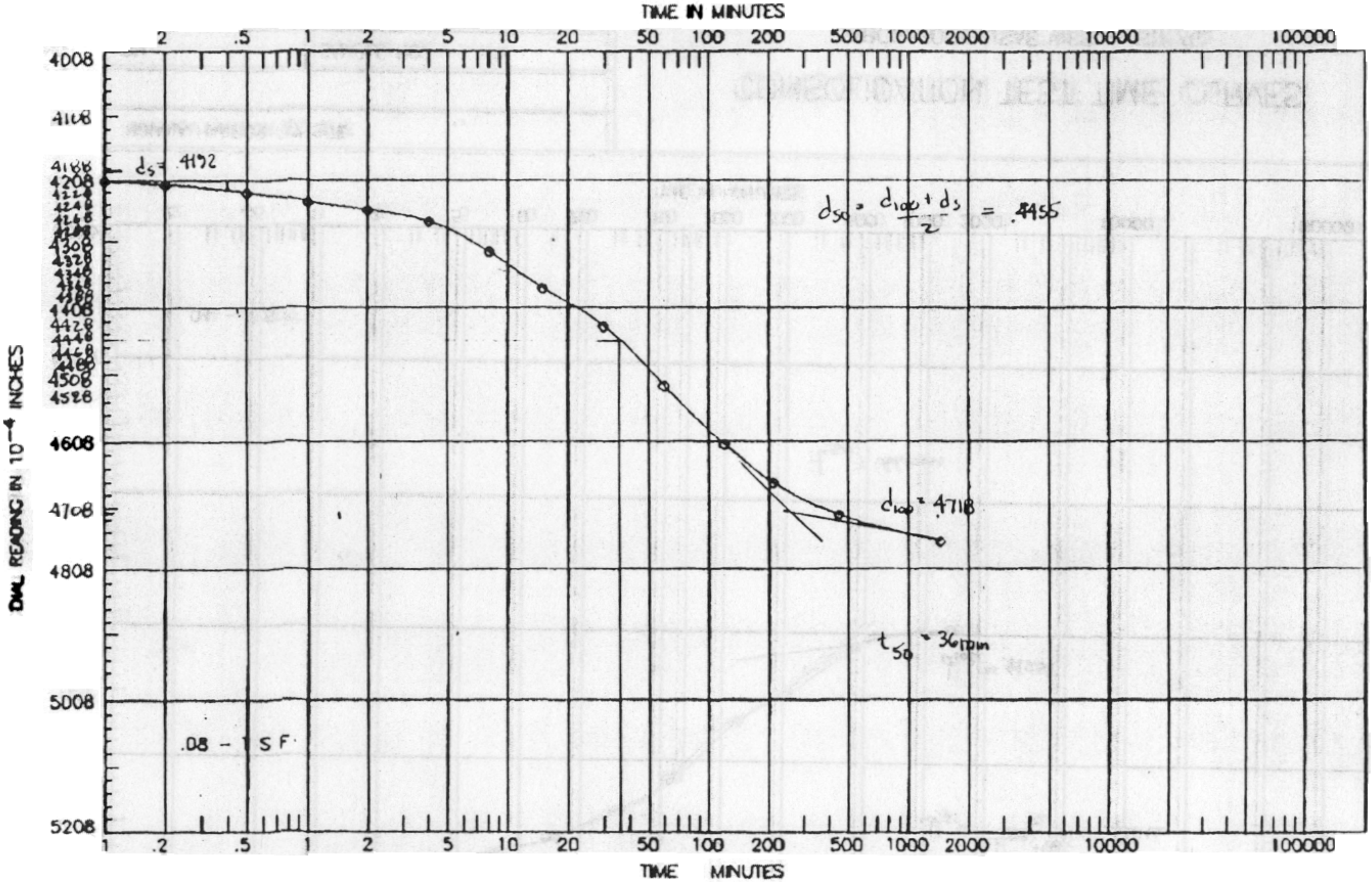


PROJECT INDIANA HARBOR ECI SITE	
BORING DM	SAMPLE NO. 1
DEPTH/ELEV	DATE 06 DEC 96

CONSOLIDATION TEST TIME CURVES

LABORATORY USAE WES - STF/GL

SHEET 4 OF 9

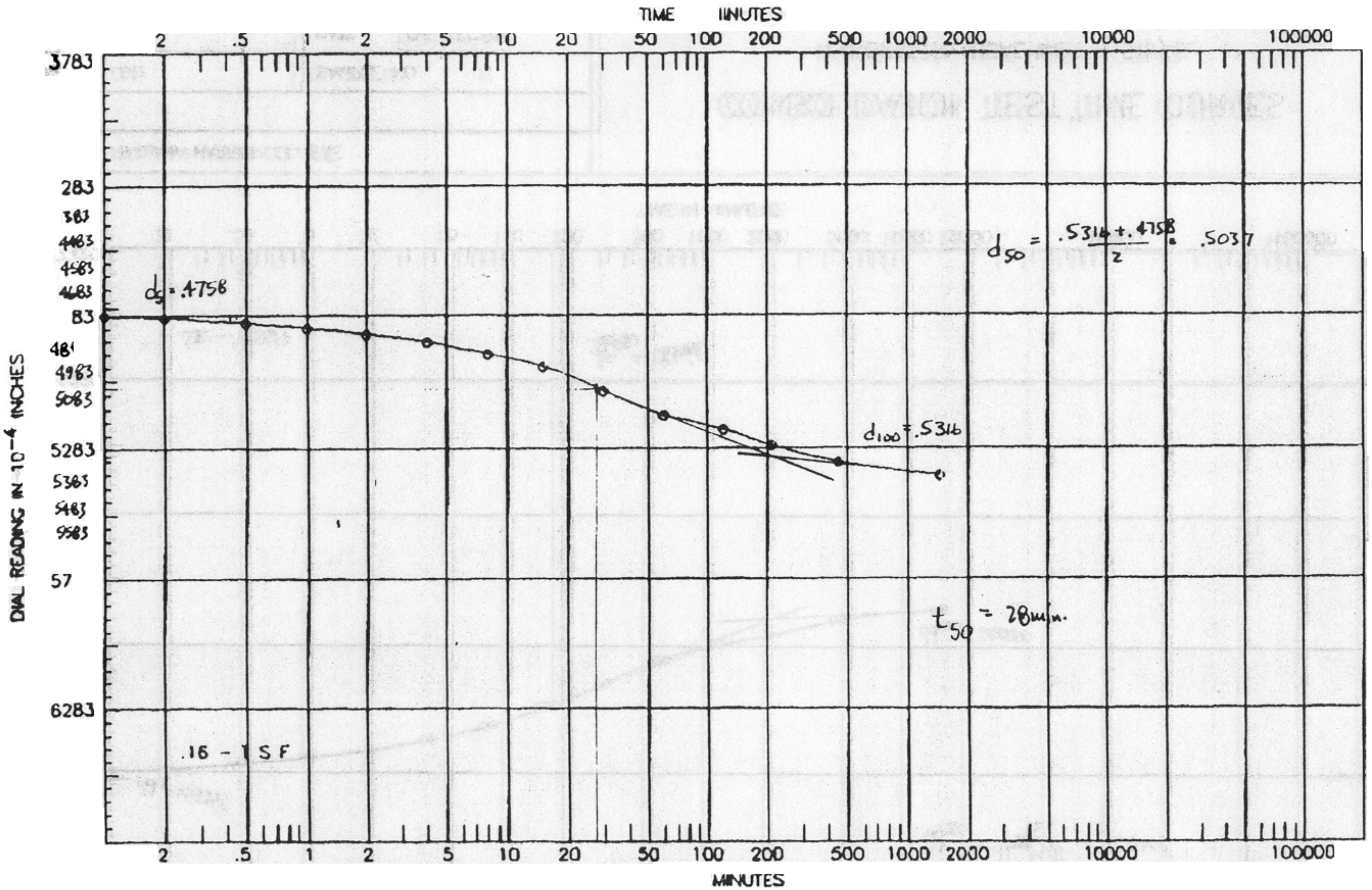


PROJECT	INDIANA HARBOR ECI SITE		
BORING	DM	SAMPLE NO.	1
DEPTH/ELEV		DATE	06 DEC 96

CONSOLIDATION TEST TIME CURVES

LABORATORY USAE WES - STF/GL

SHEET 5 OF



PROJECT INDIANA HARBOR ECI SITE

BORING DM

SAMPLE NO. 1

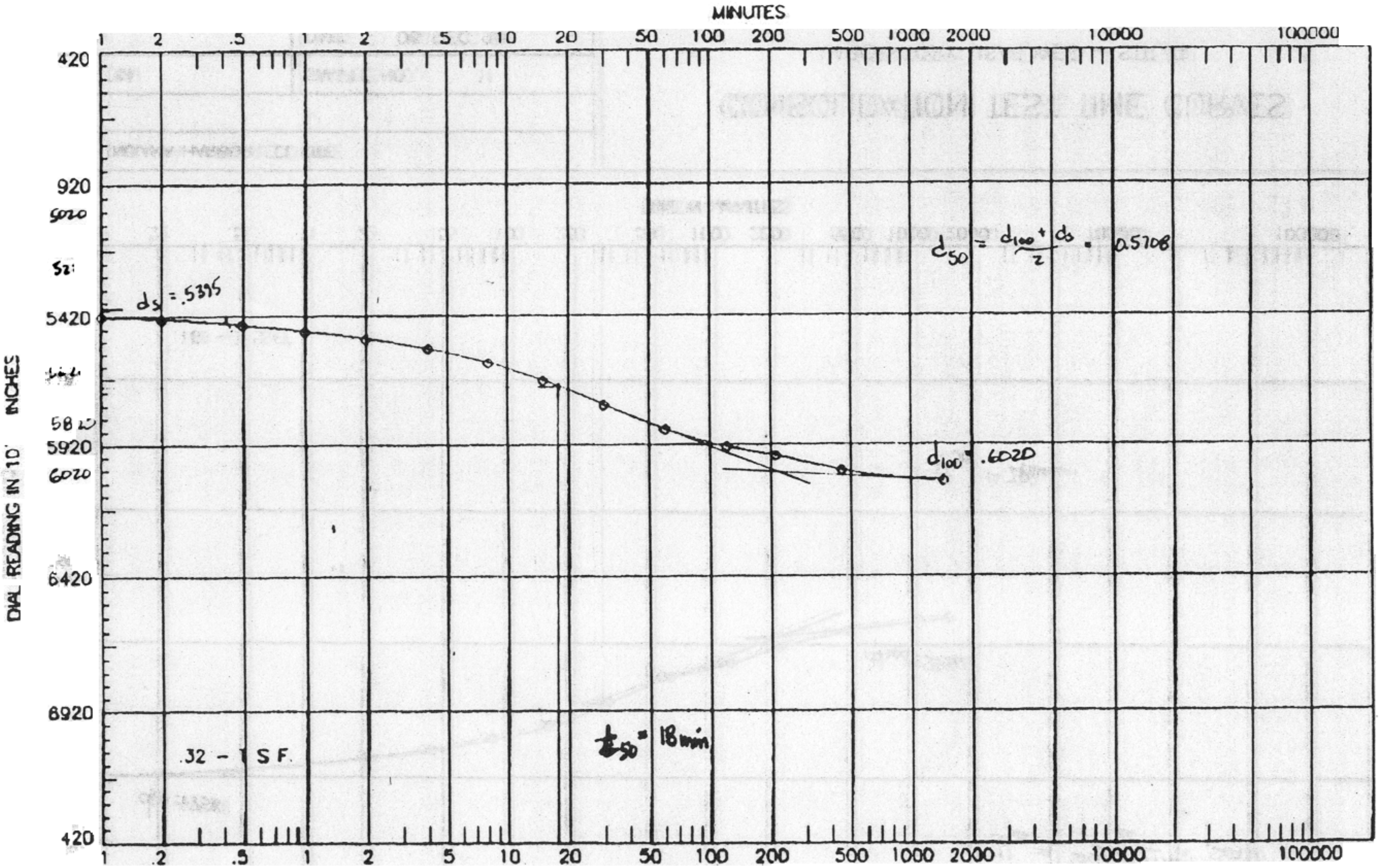
DEPTH/ELEV

DATE 06 DEC 96

SHEET OF

CONSOLIDATION TEST TIME CURVES

LABORATORY USAE WES - STF/GL



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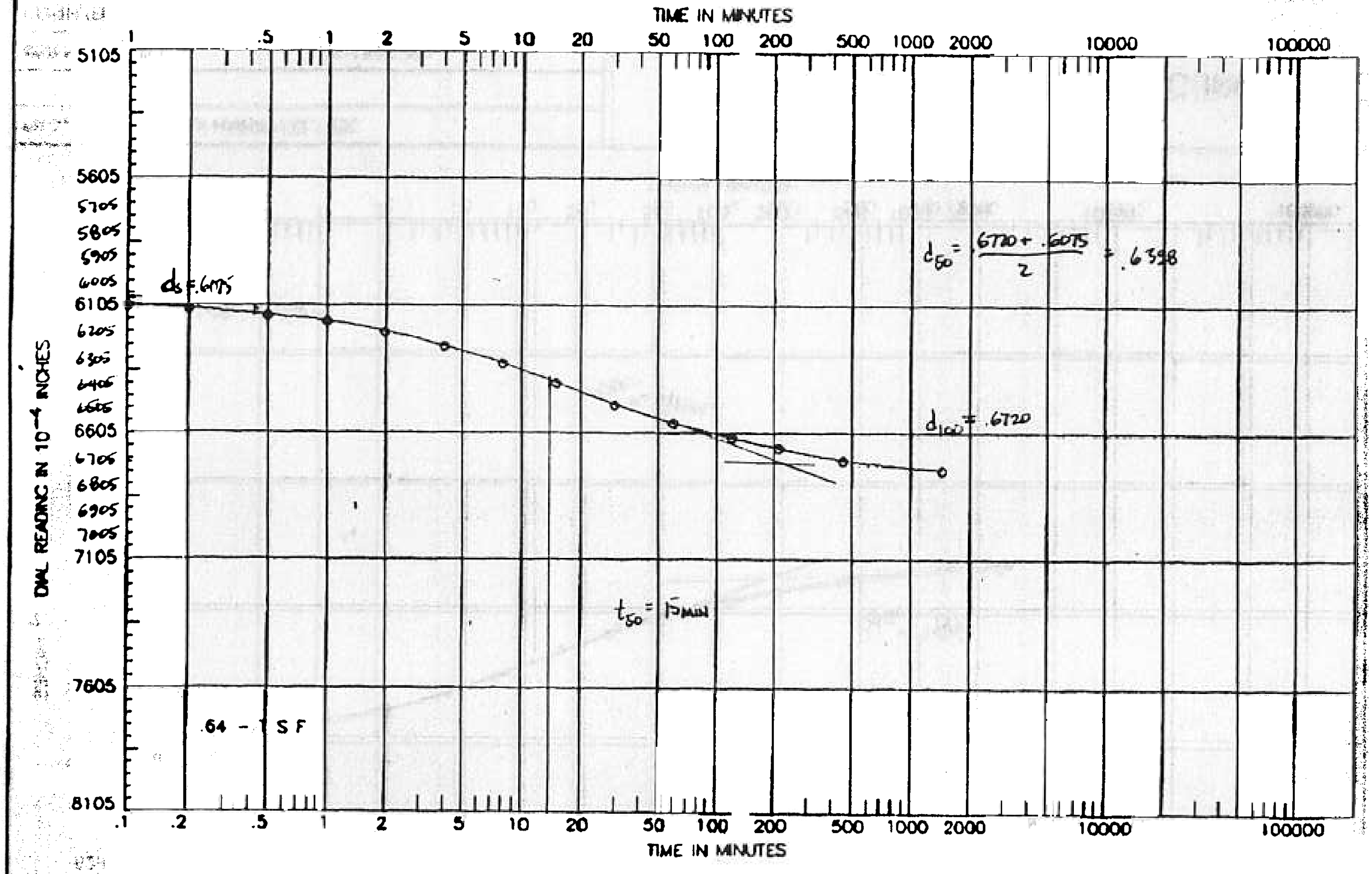
BORING	DM	SAMPLE NO. 1
DEPTH/ELEV		DATE 06 DEC 96

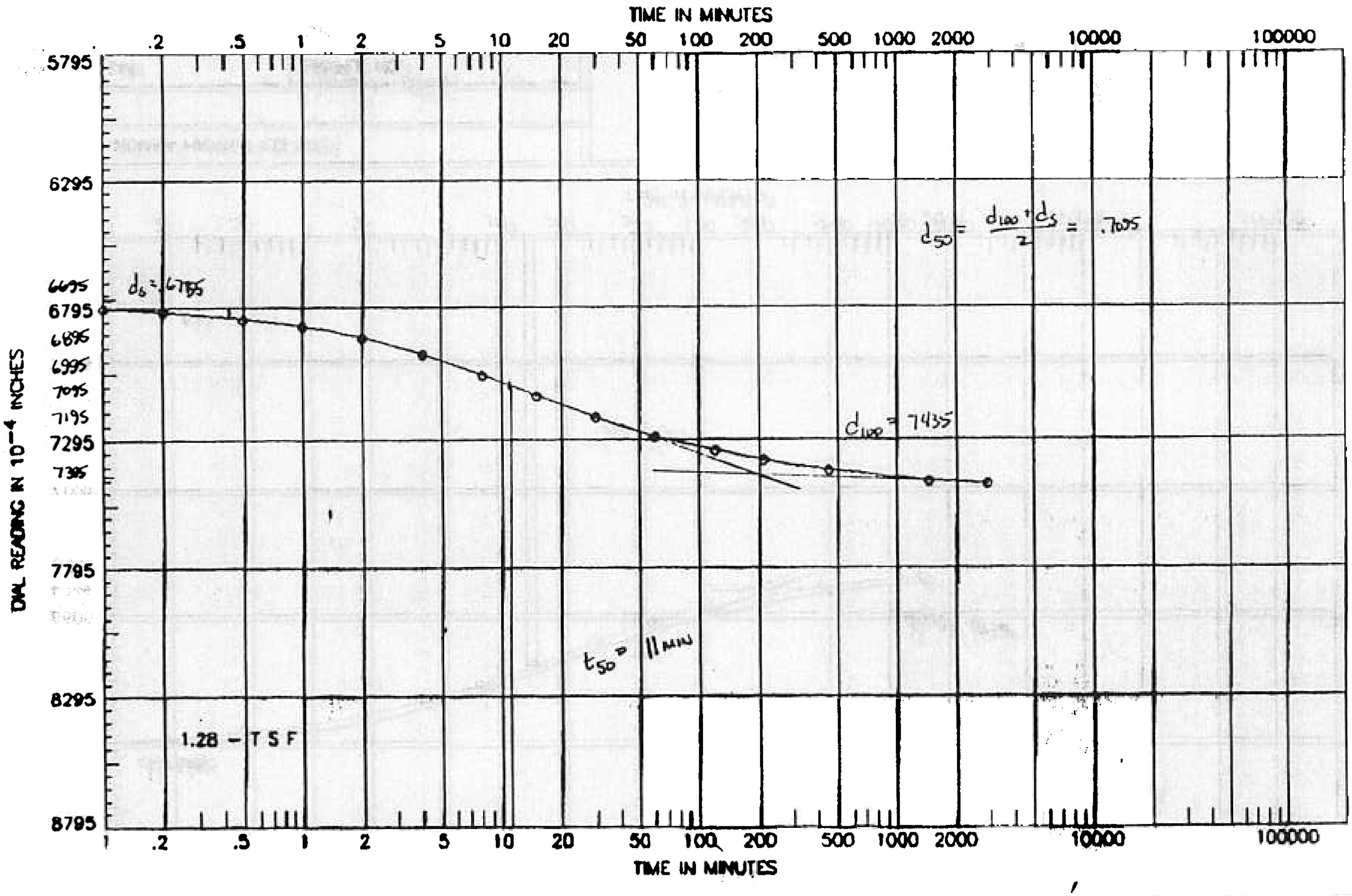
CONSOLIDATION TEST TIME CURVES

LABORATORY USAE WES - STF/GL

SHEE 7



JECT INDIANA HARBOR ECI SITE		CONSOLIDATION TEST TIME CURVES
		LABORATORY USAE WES - STF/GL
BORING DM	SAMPLE NO. 1	
DEPTH/ELEV	DATE 06 DEC 96	
SHEET 8		



PROJECT	INDIANA HARBOR ECI SITE		
BORING	DM	SAMPLE NO.	1
DEPTH/ELEV		DATE	06 DEC 96

SHEET [illegible] OF 9

CONSOLIDATION TEST TIME CURVES

LABORATORY USAE WES - STF/GL

Glossary

Cell – One of three major areas that divide the CDF into a north portion, a south-east portion and a south- west portion. Dikes that define these areas are constructed out of off-site material.

Sub-cell – Subdivisions of the three major areas (north cell, east cell and west cell) used for dredge material management. Each sub-cell dike wall is constructed of dried dredged material on the interior of the sub-cell. On the perimeter, the sub-cell utilizes the surrounding perimeter wall(s). Sub-cell is graded towards a decant structure located on a perimeter wall.

Perimeter Dike – Those dikes running around the perimeter of the CDF and built with 1:1 sides on their interior (facing into the CDF) face, 3:1 sides on their exterior (facing out from the CDF) face and 25' top widths. They are constructed of off-site material.

Interior Dike – The two cross dikes that are constructed from on-site material and are used to define the southwest cell with the western perimeter dike. They are built with two 3:1 sides and 25' top widths.

Sub-cell Dike – Interior dikes that are constructed out of available dried dredged sediment material and have two 3:1 sides and 25' top widths.

Decant Structure – A structure located in a sub-cell designed to assist in dewatering the cell.

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Huff, Floyd A., and Angel, James R., Rainfall Frequency Atlas of the Midwest, Illinois State Water Survey Bulletin 71, Champaign, Illinois, 1992

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USACE, 1969, Dredging and Water Quality Problems in the Great Lakes, Volume 1, Buffalo District, Buffalo, N.Y.

Table E - 1 Dredging Placement Plan

	Dredge Placement Plan	Projected Fill Height (ft)	Differential Volume (1000 CY)	Total Volume (1000 CY)
Year 1	SW-cell dikes constructed			
Year 2	Dredge material placed in SW-cell, dikes constructed for SE-cell & N-cell		128	128
Year 3	Dredge material placed in SE-cell & N cell	3	295	423
Year 4	Dredge material placed in SW-cell		134	
Year 5	Dredge material placed in SE-cell & N cell	6	306	863
Year 6	Dredged material placed in SW-cell		140	
Year 7	Dredge material placed in SE-cell & N cell	9	318	1,321
Year 8	Dredged material placed in SW-cell (Cell filled with TSCA sediment)		146	
Year 9	Dredge material placed in SE-cell & N cell	12	330	1,798
Year 10	Dredged material placed in SW-cell (TSCA capped with existing sediment)		153	
Year 11	Dredge material placed in SE-cell & N cell	15	342	2,292
Year 12				
Year 13	Dredged material placed in SW-cell		159	
Year 14	Dredged material placed in SE-cell		159	
Year 15	Dredged material placed in N-cell	18	196	2,806
Year 16				
Year 17	Dredged material placed in SW-cell		160	
Year 18	Dredged material placed in SE-cell		160	
Year 19	Dredged material placed in N-cell	21	194	3,320
Year 20				
Year 21	Dredged material placed in SW-cell		152	
Year 22	Dredged material placed in SE-cell		152	
Year 23	*Dredged material placed in N-cell*	24	193	3,817
Year 24				
Year 25	Dredged material placed in SW-cell		154	
Year 26	*Dredged material placed in SE-cell*		154	
Year 27	Dredged material placed in N-cell	27	195	4,320
Year 28				
Year 29	Dredged material placed in SW-cell		156	
Year 30	Dredged material placed in SE-cell		156	
Year 31	Dredged material placed in N-cell	30	198	4,829

Key:

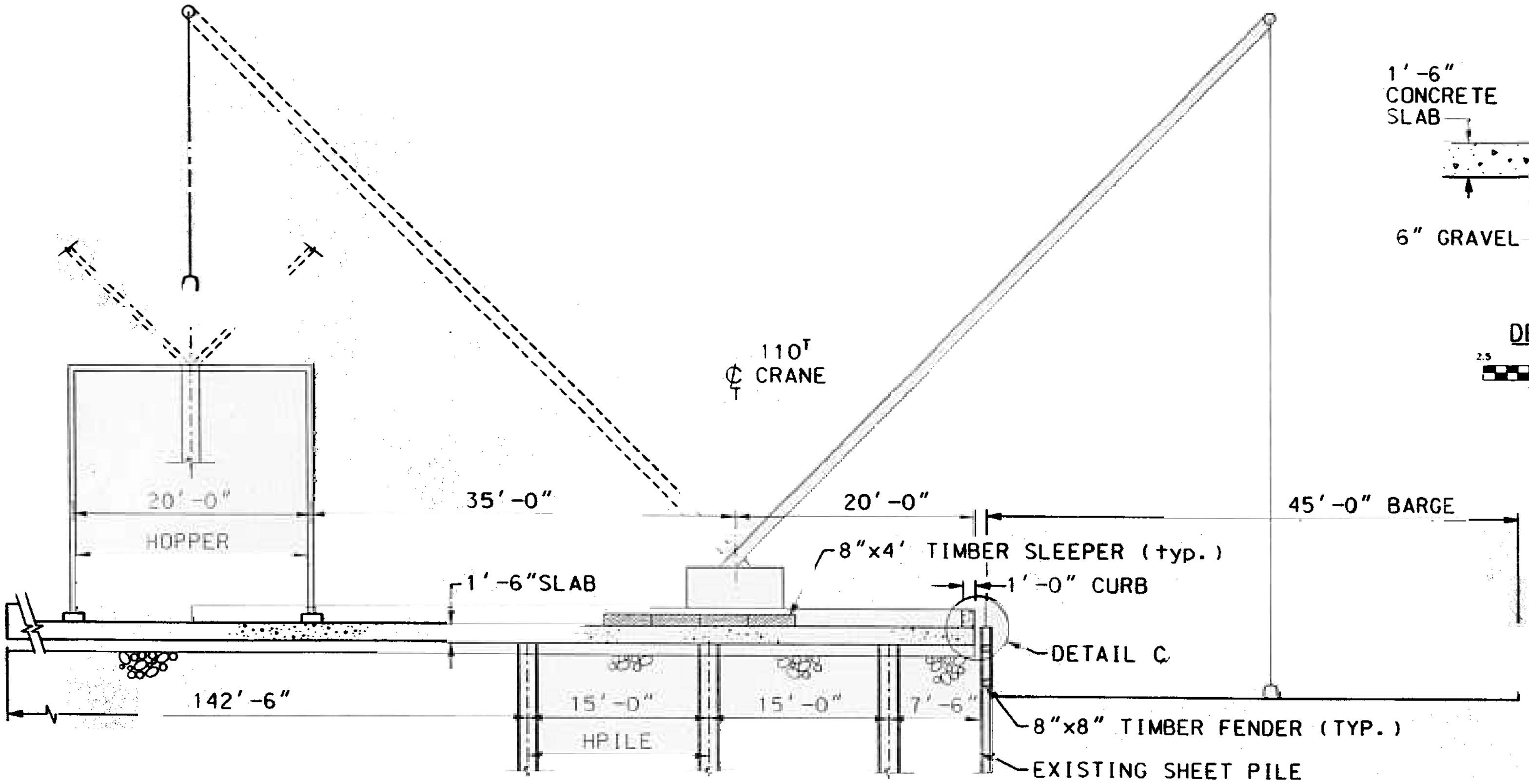
SW-Cell = Southwest Cell
SE-Cell = Southeast Cell
N-Cell = North Cell

Table E - 2 Revised Q-A-4

Estimated Dredge Material Qunatities by Channel Reach in Thousands of Cubic Yards (note 3)

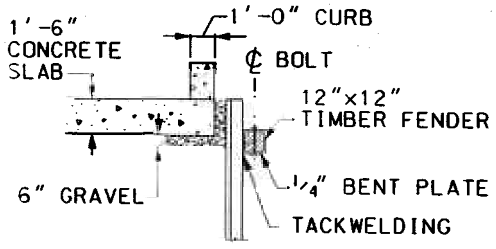
	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9	Reach 10	Reach 11	Reach 12	Reach 13	Reach R03	Reach R04	Reach R05	Reach L05	Reach R06	Reach L06	Reach R07	Reach 08	Reach L11	Reach U13	Yearly Totals
	Federal Channel													Berthing Areas					PCB Hot Spot	Berthing Areas			PCB Hot Spot	
	Outer Harbor Approach Channel		Anchorage & Maneuver Channel		Canal Entrance Channel	Inner Harbor Channel				Lake George Branch			Calumet River Branch, Lower Reach	Inland Steel Hopper & Stone Docks	Inland Steel Dock No. 4 & Adjacent Dockface	Inland Steel Dock No. 2	LTV Steel Ore Dock	Inland Steel Consent Decree Dockface	PCB Hot Spot	Inland Steel Dock No. 3	Inland Steel Consent Decree Dockface	Amoco Dock	Calumet River Branch, PCB	(1,000 CY)
1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	126.5	0	0	0	0	0	0	0	0	127
2005	0		0	99.9	0	0	0	0	0	0	0	0	0	0	189.4	0	2.8	0	0	0	0	0	0	292
2006	0	35.3	0	71.5	0	0	0	0	0	0	0	0	0	0	18.7	0	4.3	0	0	0	0	0	0	130
2007	0	106	0	137.1	0	0	0	0	0	0	0	0	0	5.5	36	4.8	8.2	0	0	0	0	0	0	298
2008	0	48.3	10.5	45.1	0	0	0	0	0	0	0	0	0	12.9	11.7	1.7	2.7	0	0	0	0	0	0	133
2009	20.5	78.6	43.2	97	0	0	0	0	0	0	0	0	0	28.4	25.7	3.7	5.9	0	0	0	0	0	0	303
2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9.1	0	0	0	126.2	135
2011	0	0	0	0	0	0	0	33.3	34.4	0	0	28	102	0	0	0	0	4	0	0	105.7	2.2	0	310
2012	0	0	0	0	0	0	0	48.8	0	0	0	36.4	0	0	0	0	0	0	5.3	0	0	0	48	139
2013	0	12.3	0	0	0	0	5.3	45.7	69.2	9.5	42.7	13.8	68.9	0	0	0	0	3.2	0	8	33.5	3	0	315
Sum	20.5	280.5	53.7	450.6	0	0	5.3	127.8	103.6	9.5	42.7	78.2	170.9	46.8	408	10.2	23.9	7.2	14.4	8	139.2	5.2	174.2	2,180
2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	27.1	38.2	14.4	33.3	8.4	0	0	0	0	0	0	0	0	9.5	8.6	1.2	2	0	0	0	0	0	0	143
2016	26.3	35.3	16.6	31.3	11.7	0	0	0	0	0	0	0	0	9.2	8.3	1.2	1.9	0	0	0	0	0	0	142
2017	33.7	41.1	23.1	40.2	15	0	0	0	0	0	0	0	0	11.8	10.6	1.5	2.4	0	0	0	0	0	0	179
2018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2019	25.5	36.1	20.9	30.4	11.3	0	0	0	0	0	0	0	0	8.9	8.6	1.2	1.8	0	0	0	0	0	0	145
2020	26.3	34.6	20.5	31.3	11.7	0	0	0	0	0	0	0	0	9.2	8.3	1.2	1.9	0	0	0	0	0	0	145
2021	33.7	41.1	24.4	41.1	15	0	0	0	0	0	0	0	0	11.8	10.6	1.5	2.4	0	0	0	0	0	0	182
2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2023	25.5	36.1	21.4	31.3	11.3	0	0	0	0	0	0	0	0	8.9	8	1.2	1.8	0	0	0	0	0	0	146
2024	26.3	35.3	20.9	31.3	11.7	0	0	0	0	0	0	0	0	9.2	8.3	1.2	1.9	0	0	0	0	0	0	146
2025	23	27.4	16.1	22.5	8	0	0	17.5	54.2	0	0	0	0	6.3	5.7	0.8	1.3	0	3.9	0	0	0	15.9	203
2026	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2027	31.2	32.5	19.2	31.3	11.7	0	0	1	0	0	0	0	0	9.2	8.3	1.2	1.9	0	0	0	0	0	0	148
2028	18.9	22.4	13.1	15.7	5.9	0	0	45.6	0	0	0	0	15	4.6	4.1	0.6	0.9	2.4	0	6.3	25.3	2.3	0	183
2029	17.2	18.8	10.9	15.7	5.9	0	0	0	0	17.5	46	22.6	0	4.6	4.1	0.6	0.9	0	0	0	0	0	0	165
2030	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2031	29.6	29.6	17.4	31.3	11.7	0	7.6	0	0	0	0	0	0	9.2	8.3	1.2	1.9	0	0	0	0	0	0	148
2032	18.9	20.9	12.6	15.7	5.9	0	0	0	0	0	0	0	26.7	4.6	4.1	0.6	0.9	0	0	0	0	0	0	111
2033	17.2	18.8	10.9	15.7	5.9	27.5	7.2	33.7	39.3	0	0	0	0	4.6	4.1	0.6	0.9	0	0	0	0	0	0	186
2034	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2035	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2036	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2037	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2038	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2039	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2040	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2041	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2042	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2043	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2044	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2045	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2046	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2047	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2048	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2049	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sum	380.4	468.2	262.4	418.1	151.1	27.5	14.8	97.8	93.5	17.5	46	22.6	41.7	121.6	110	15.8	24.8	2.4	3.9	6.3	25.3	2.3	15.9	2,370
Reach Totals	400.9	748.7	316.1	868.7	151.1	27.5	20.1	225.6	197.1	27.0	88.7	100.8	212.6	168.4	518.0	26.0	48.7	9.6	18.3	14.3	164.5	7.5	190.1	4,550
															note 1	note 2								

Notes: 1 - Includes both berthing areas and Consent Decree dockfaces.
2 - Includes both Berthing areas and Consent Decree dredging.
3 - Source: Appendix Q Addendum, Sedimentation Investigation and Dredging Plans



SECTION C-C

SCALE IN FEET



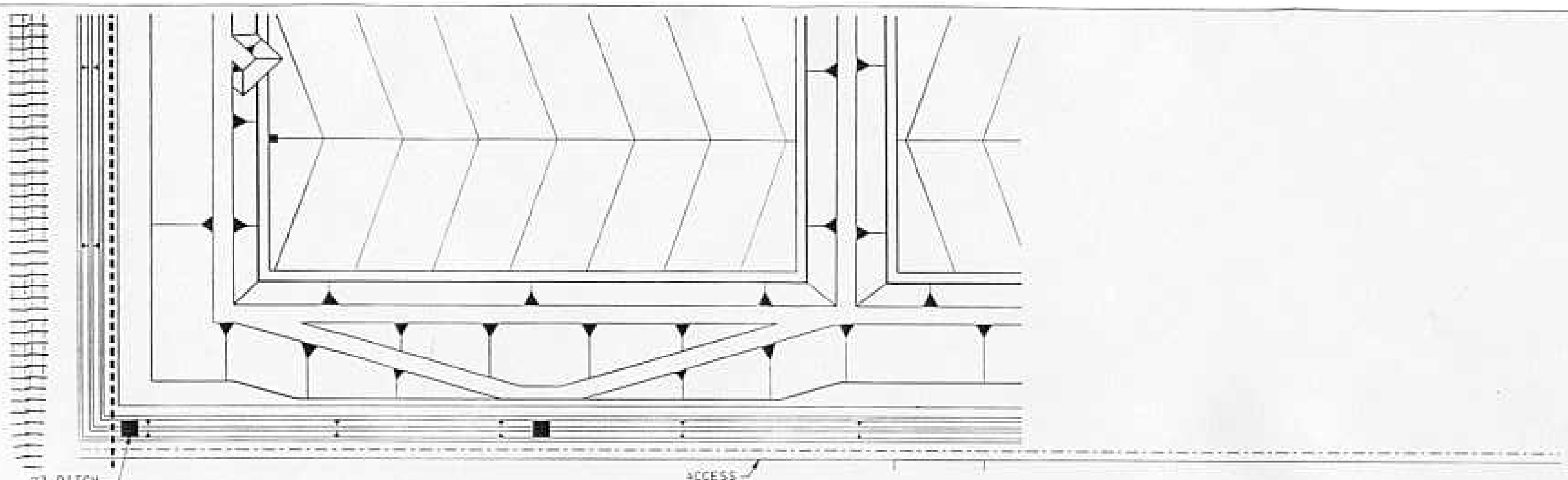
DETAIL C

SCALE IN FEET

INDIANA HARBOR AND CANAL
EAST CHICAGO, INDIANA
DESIGN DOCUMENTATION REPORT

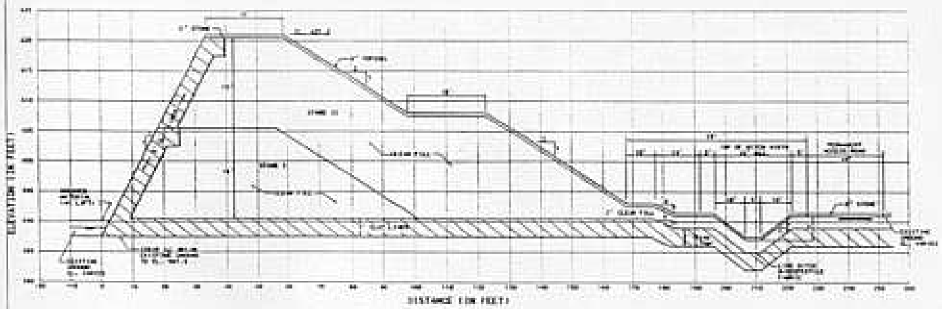
FOUNDATION PLAN

Scale	Date	Drawing
AS SHOWN	DECEMBER 1999	PLATE_E4.DGN

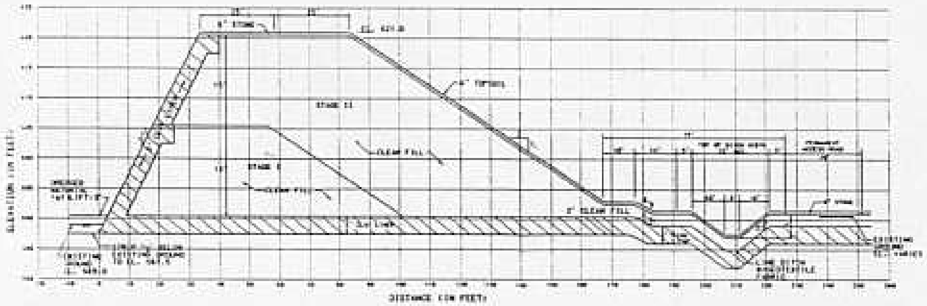


ACCESS RAMP
PLAN VIEW

SCALE IN FEET



SOUTH SIDE
DIKE & DITCH SECTION
AT ACCESS RAMP



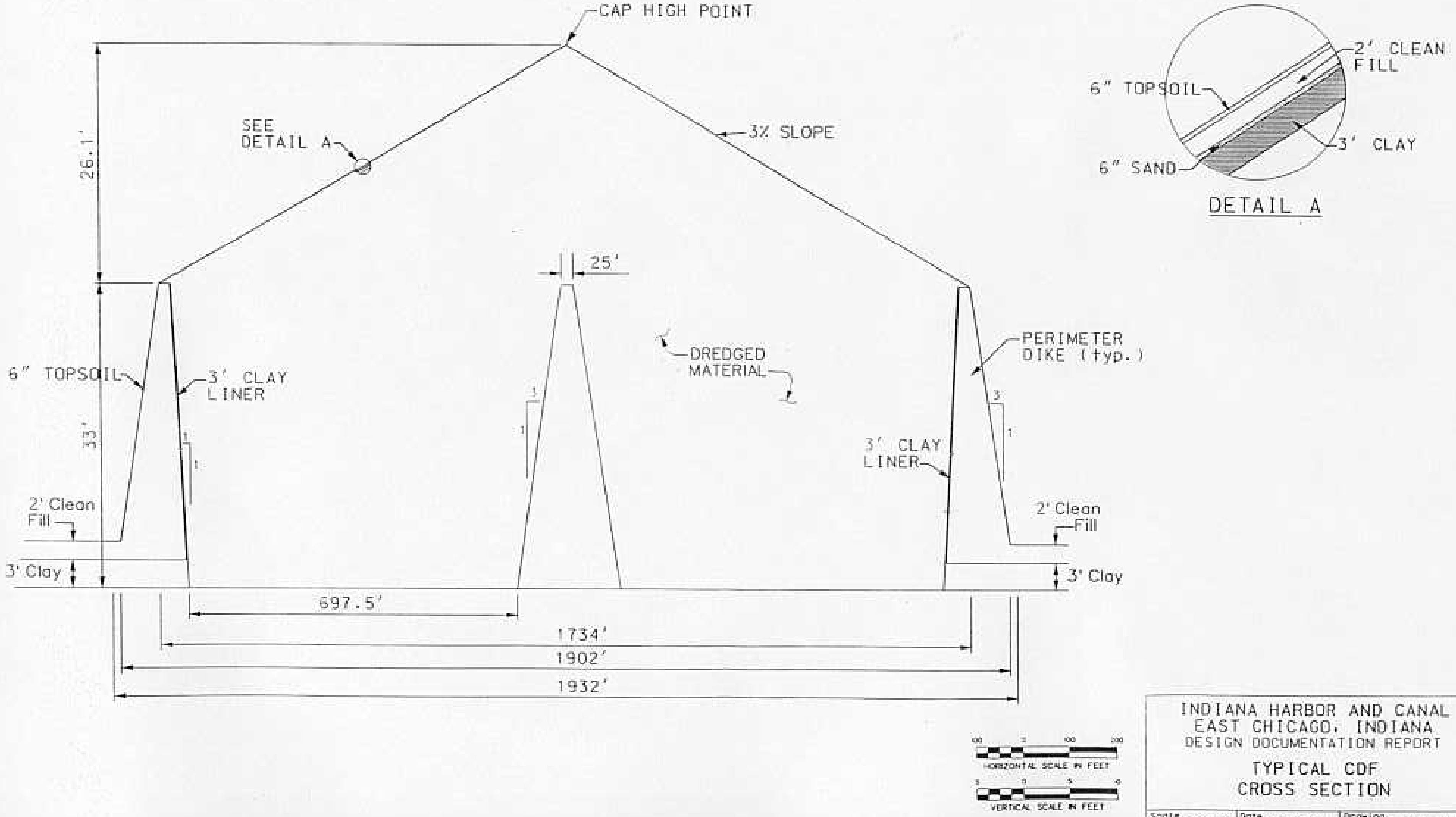
SOUTH SIDE
DIKE & DITCH SECTION
AT TOP OF ACCESS RAMP

VERTICAL SCALE IN FEET

HORIZONTAL SCALE IN FEET

INDIANA HARBOR AND CANAL
EAST CHICAGO, INDIANA
DESIGN DOCUMENTATION REPORT
TYPICAL DIKE & DITCH
CROSS SECTIONS
THRU ACCESS RAMP

Scale	Date	Drawing
AS SHOWN	DECEMBER 1999	PLATE_E5.DGN

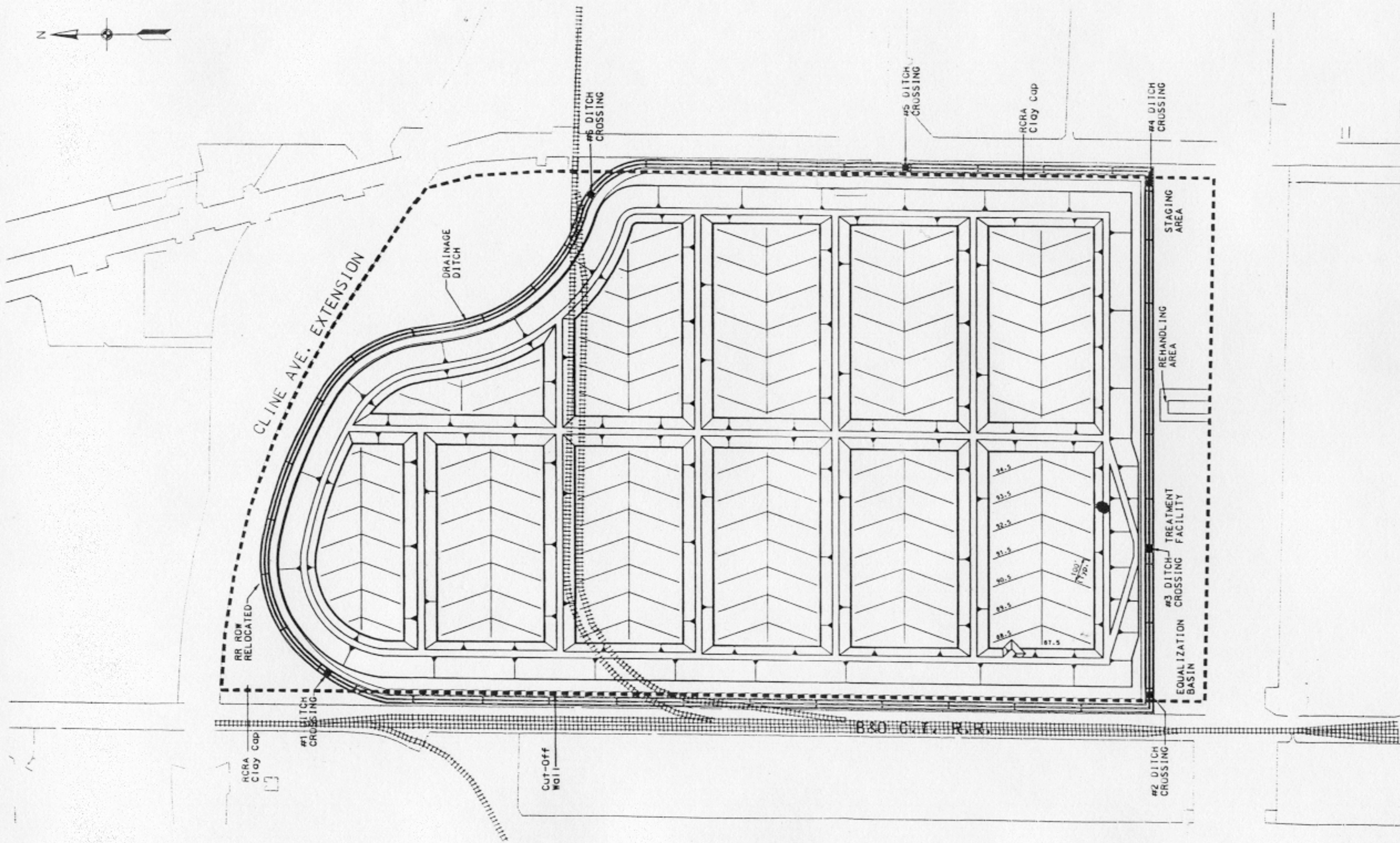


INDIANA HARBOR AND CANAL
EAST CHICAGO, INDIANA
DESIGN DOCUMENTATION REPORT

TYPICAL CDF
CROSS SECTION

Scale	Date	Drawing
AS SHOWN	DECEMBER 1999	PLATE_E6.DGN

PLATE E-6



NOTE:

FOR CULVERT SIZES SEE SHEET E-1.

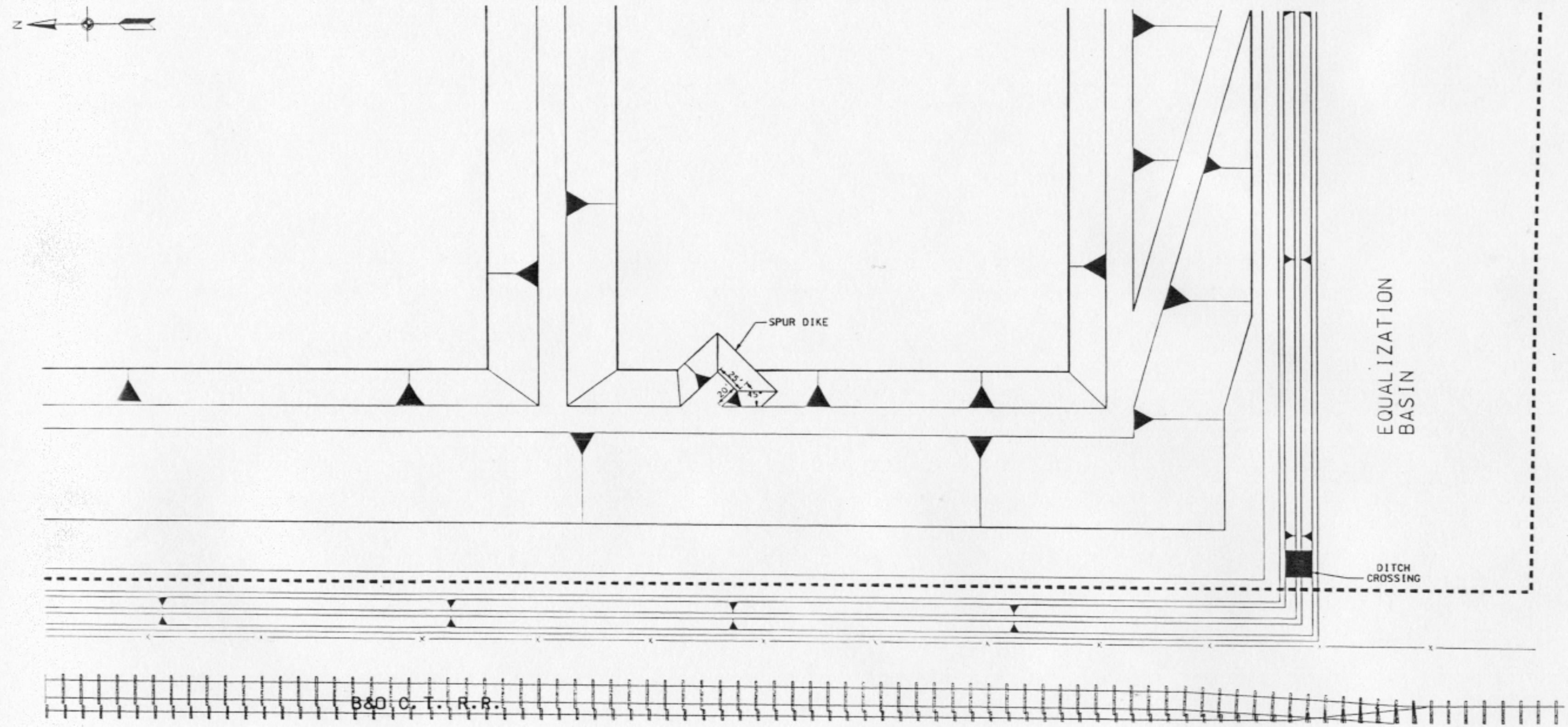
200 100 0 200 400

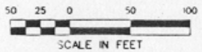
SCALE IN FEET

INDIANA HARBOR AND CANAL
EAST CHICAGO, INDIANA
DESIGN DOCUMENTATION REPORT

PLAN VIEW
INITIAL GRADE

Scale	Date	Drawing
AS SHOWN	DECEMBER 1999	PLATE_E7.DGN

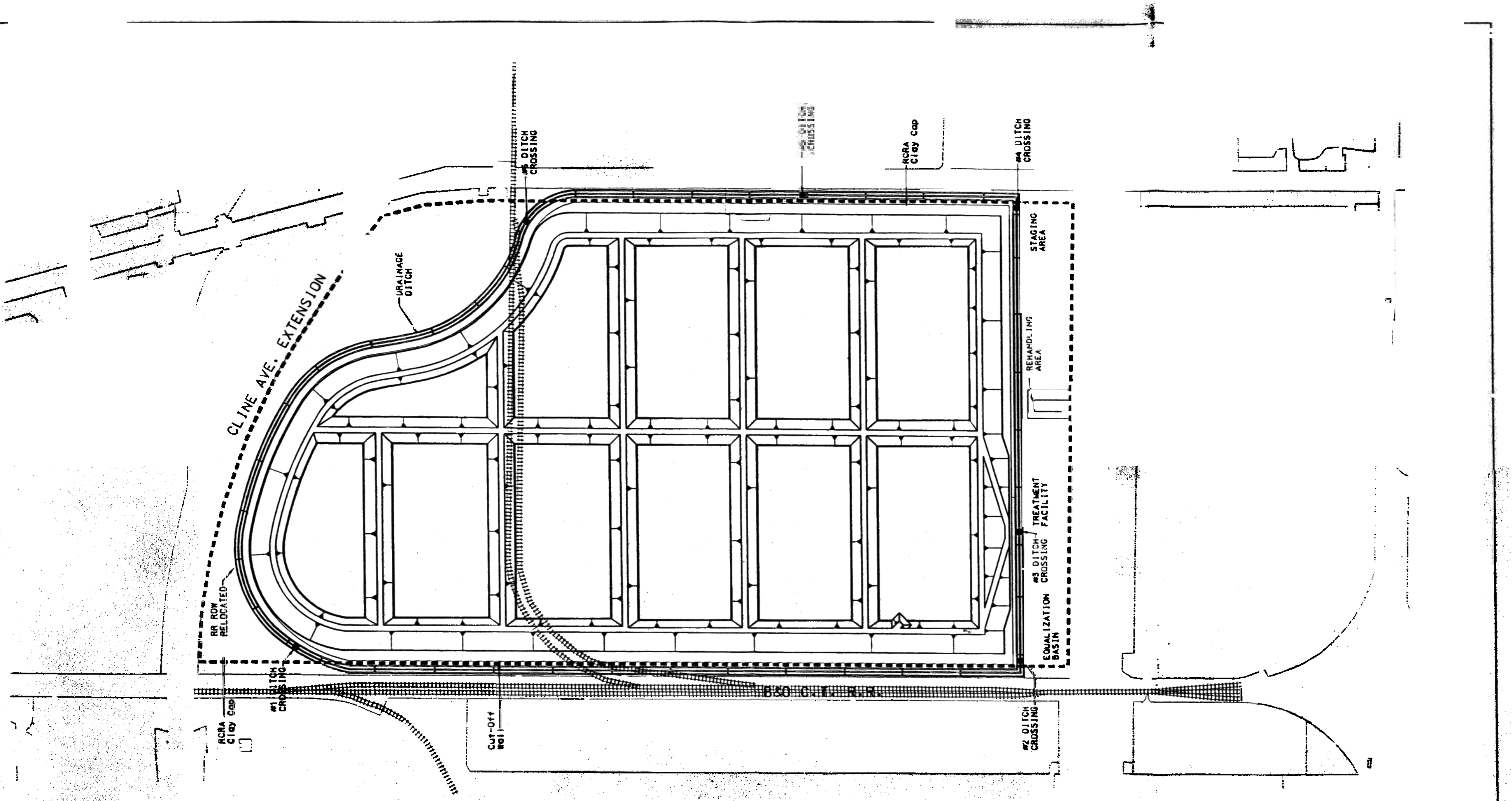




INDIANA HARBOR AND CANAL
EAST CHICAGO, INDIANA
DESIGN DOCUMENTATION REPORT

PLAN VIEW
20' SPUR DIKE

Scale	Date	Drawing
AS SHOWN	DECEMBER 1999	PLATE_E8.DGN



NOTE:

FOR CULVERT SIZES SEE SHEET E-1.

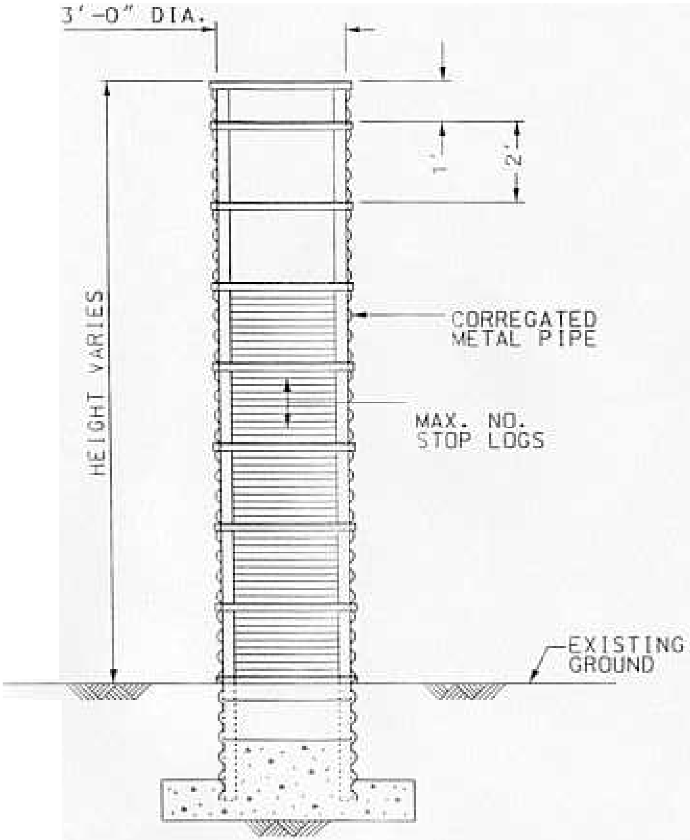
200 100 0 200 400
SCALE IN FEET

INDIANA HARBOR AND CANAL
EAST CHICAGO, INDIANA
DESIGN DOCUMENTATION REPORT

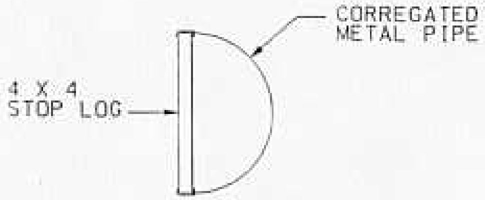
PLAN VIEW OF
SUB-CELL LAYOUT

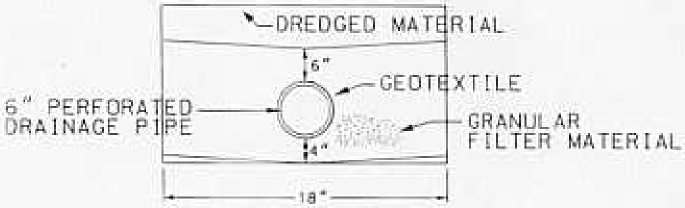
Scale	Date	Drawing
AS SHOWN	DECEMBER 1999	PLATE_E9.DGN

PLATE E-9



DETAILS OF DECANT STRUCTURE

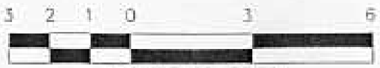




UNDER DRAINAGE PIPE CROSS-SECTION
NOT TO SCALE

NOTE:

PIPE & FILTER MATERIAL RUN THE LENGTH OF THE CELL



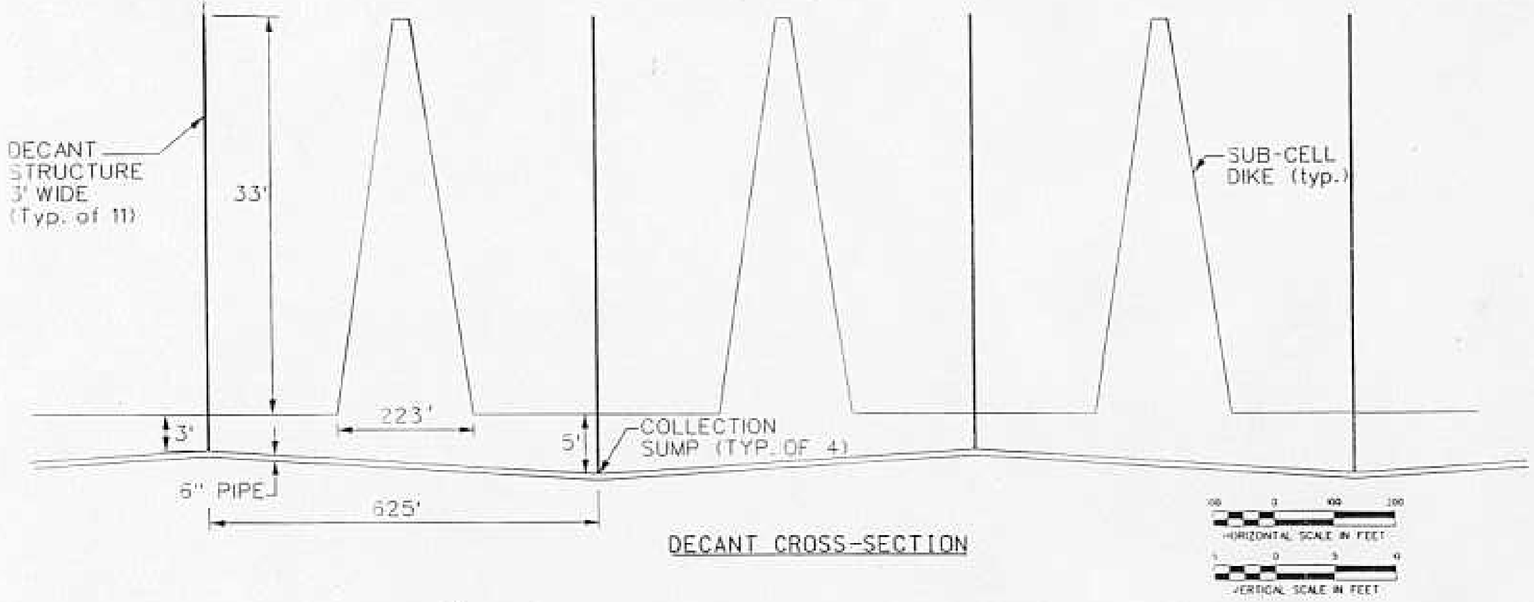
SCALE IN FEET

INDIANA HARBOR AND CANAL
EAST CHICAGO, INDIANA
DESIGN DOCUMENTATION REPORT

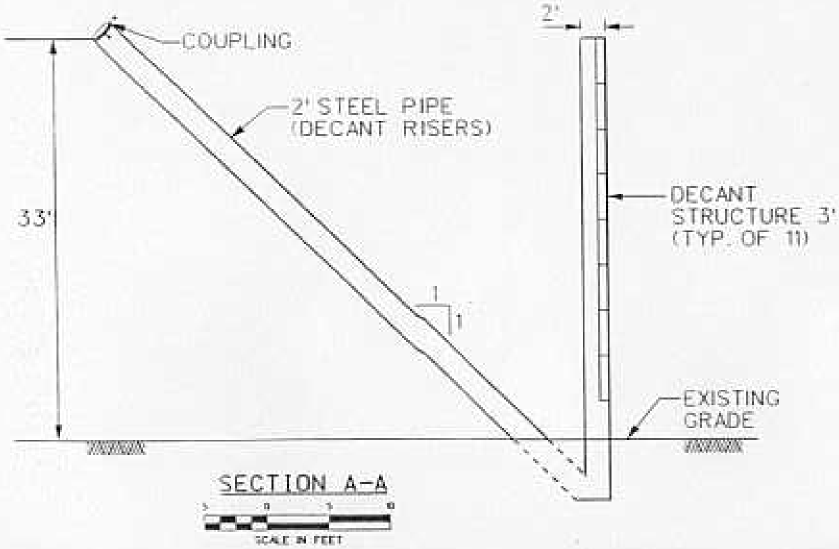
DECANT STRUCTURE
DETAIL & MISC. DETAILS

Scale	Date	Drawing
AS SHOWN	DECEMBER 1999	PLATE_E10.DGN

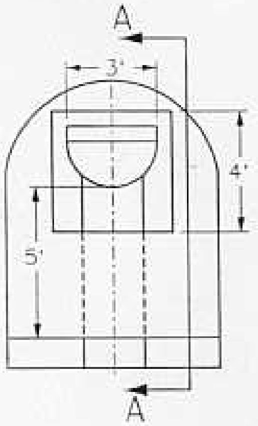
PLATE E-10



DECANT CROSS-SECTION



SECTION A-A



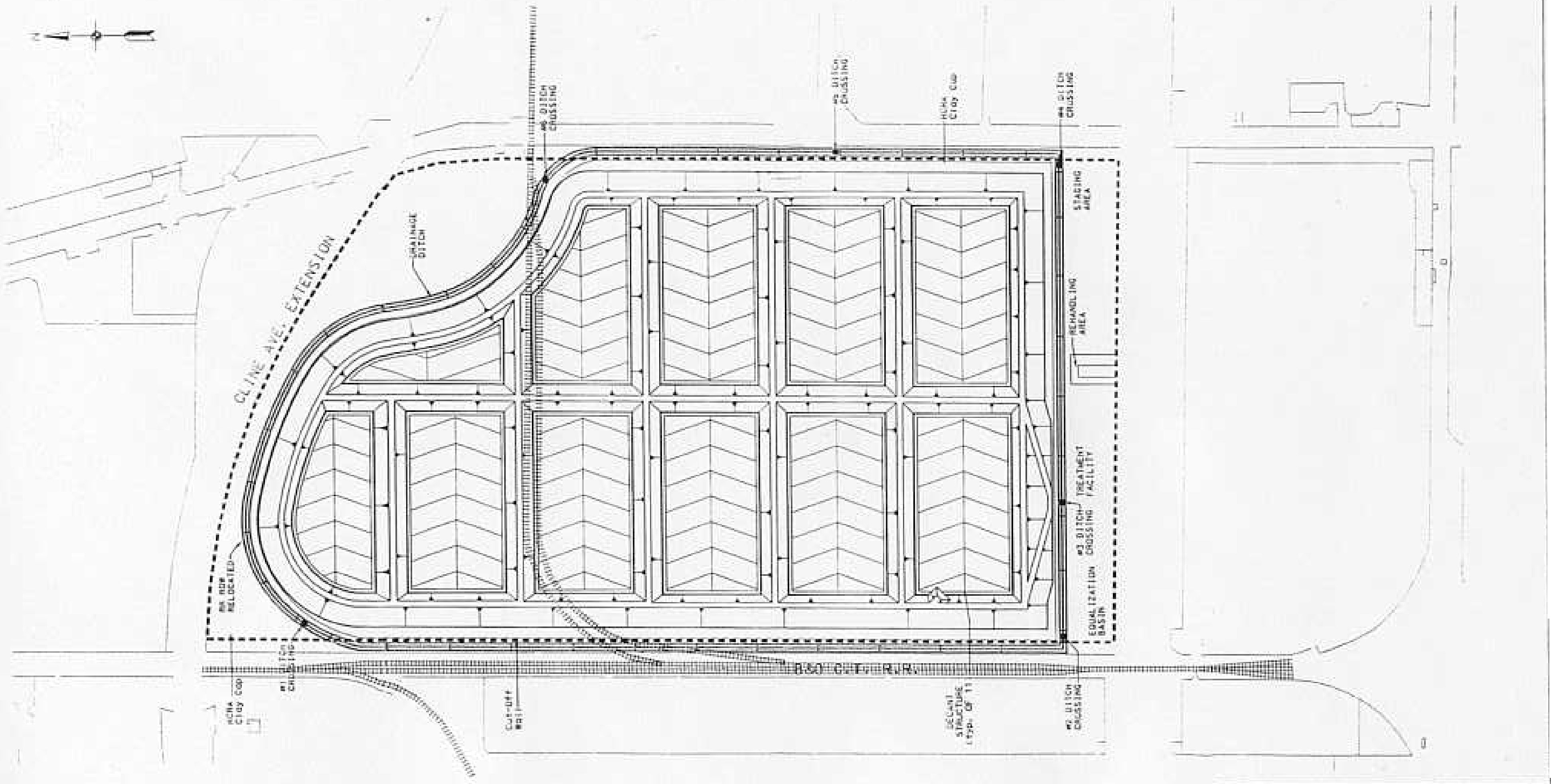
PLAN VIEW OF COLLECTION SUMP

INDIANA HARBOR AND CANAL
EAST CHICAGO, INDIANA
DESIGN DOCUMENTATION REPORT

CROSS-SECTION
DECANT STRUCTURE
W/PIPING TIE-IN

Scale	Date	Drawing
AS SHOWN	DECEMBER 1999	PLATE_E11.DGN

PLATE E-11



NOTE:

FOR CULVERT SIZES SEE SHEET E-1.

200 100 0 200 400
SCALE IN FEET

INDIANA HARBOR AND CANAL
EAST CHICAGO, INDIANA
DESIGN DOCUMENTATION REPORT

PLAN VIEW
TRENCH LAYOUT

Scale	Date	Drawing
AS SHOWN	DECEMBER 1999	PLATE_E12.DGN

PLATE E-12

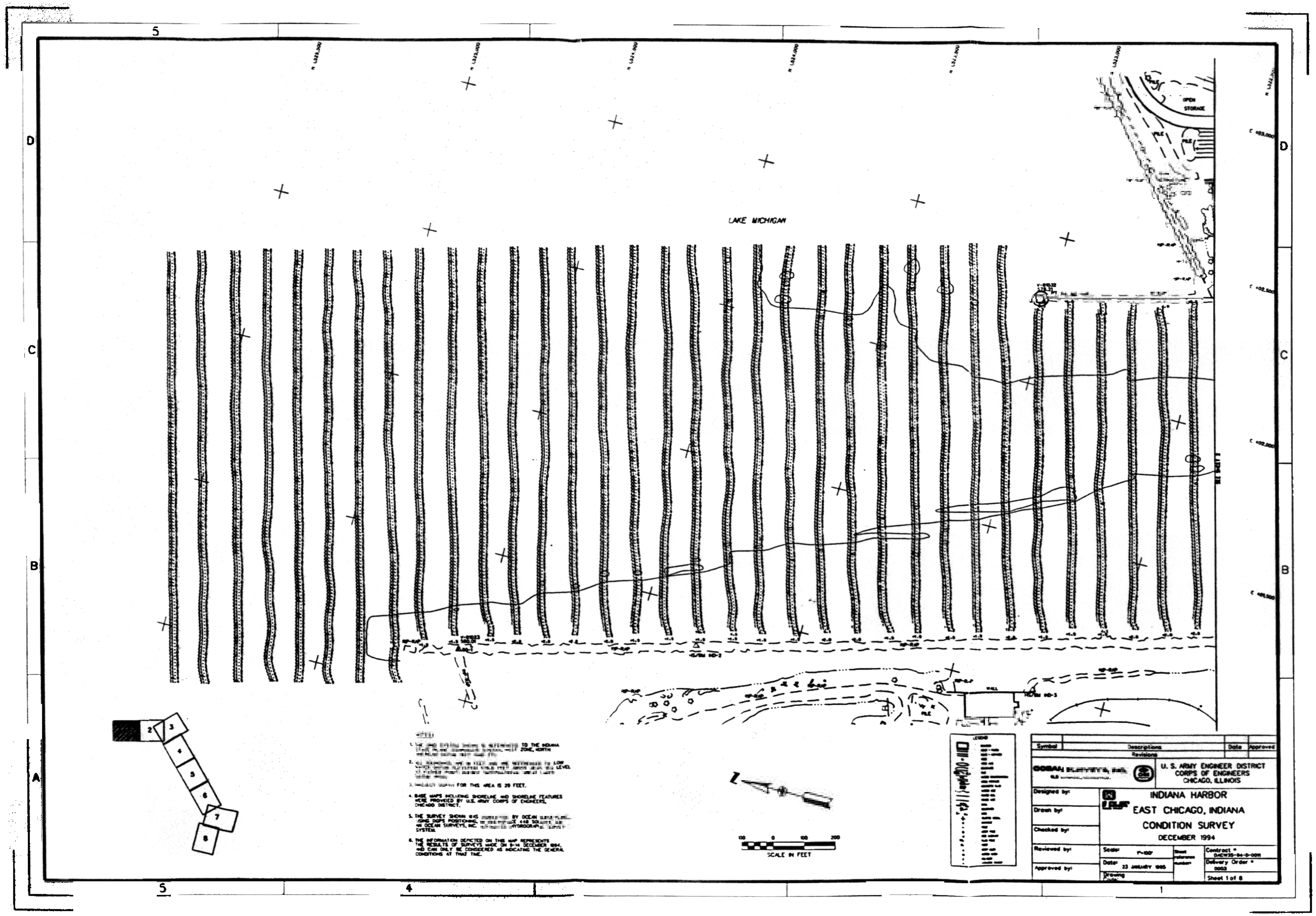
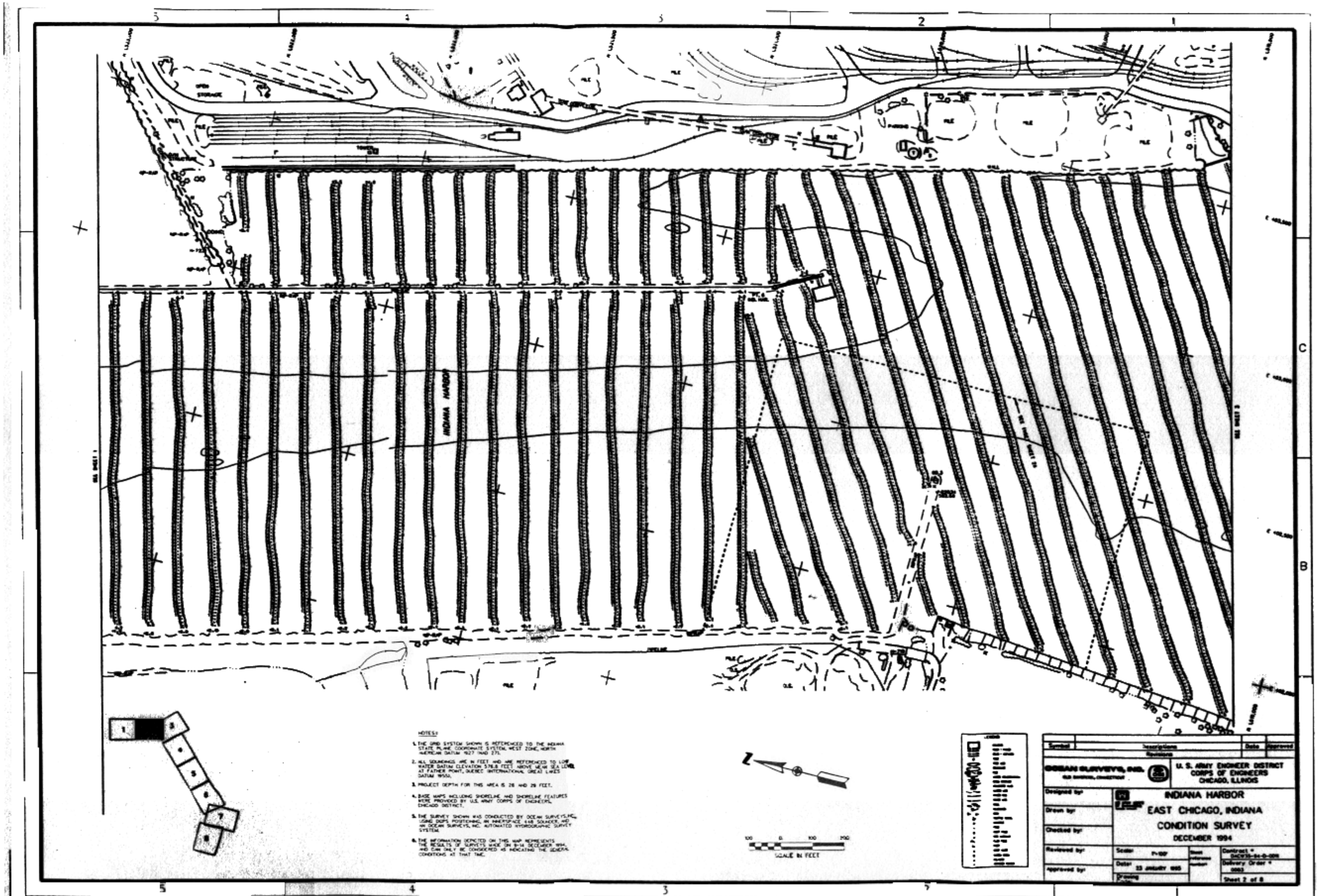

LAKE MICHIGAN
4. BASE MAPS INCLUDING SHORELINE AND SHORELINE FEATURES WERE PROVIDED BY U.S. ARMY CORPS OF ENGINEERS, CHICAGO DISTRICT.
6. THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON 9-14 DECEMBER 1994, AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS AT THAT TIME.
SCALE IN FEET
Symbol
Descriptions
Date
Approved
Revisions
U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
CHICAGO, ILLINOIS
Designed by:
Drawn by:
Checked by:
Reviewed by:
Approved by:
INDIANA HARBOR
EAST CHICAGO, INDIANA
CONDITION SURVEY
DECEMBER 1994
Scale: 1"=100'
Date: 23 JANUARY 1995
Contract # DACW35-94-D-0011
Delivery Order # 0003
Sheet 1 of 8

PLATE E-13


INDIANA HARBOR
NOTES:
1. THE GRID SYSTEM SHOWN IS REFERENCED TO THE INDIANA STATE PLANE COORDINATE SYSTEM, WEST ZONE, NORTH AMERICAN DATUM 1927 (NAD 27).
2. ALL SOUNDINGS ARE IN FEET AND ARE REFERENCED TO LOW WATER DATUM ELEVATION 576.8 FEET ABOVE MEAN SEA LEVEL AT FATHER POINT, QUEBEC (INTERNATIONAL GREAT LAKES DATUM 1955).
3. PROJECT DEPTH FOR THIS AREA IS 28 AND 29 FEET.
4. BASE MAPS INCLUDING SHORELINE AND SHORELINE FEATURES WERE PROVIDED BY U.S. ARMY CORPS OF ENGINEERS, CHICAGO DISTRICT.
5. THE SURVEY SHOWN WAS CONDUCTED BY OCEAN SURVEYS, INC., USING DGPS POSITIONING, AN INNERSPACE 448 SOUNDER, AND AN OCEAN SURVEYS, INC. AUTOMATED HYDROGRAPHIC SURVEY SYSTEM.
6. THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON 8-14 DECEMBER 1994, AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS AT THAT TIME.
SCALE IN FEET
Symbol
Descriptions
Date
Approved
Revisions
OCEAN SURVEYS, INC.
U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
CHICAGO, ILLINOIS
Designed by:
Drawn by:
Checked by:
Reviewed by:
Approved by:
INDIANA HARBOR
EAST CHICAGO, INDIANA
CONDITION SURVEY
DECEMBER 1994
Scale:
Date:
Contract #
Delivery Order #
Sheet 2 of 8

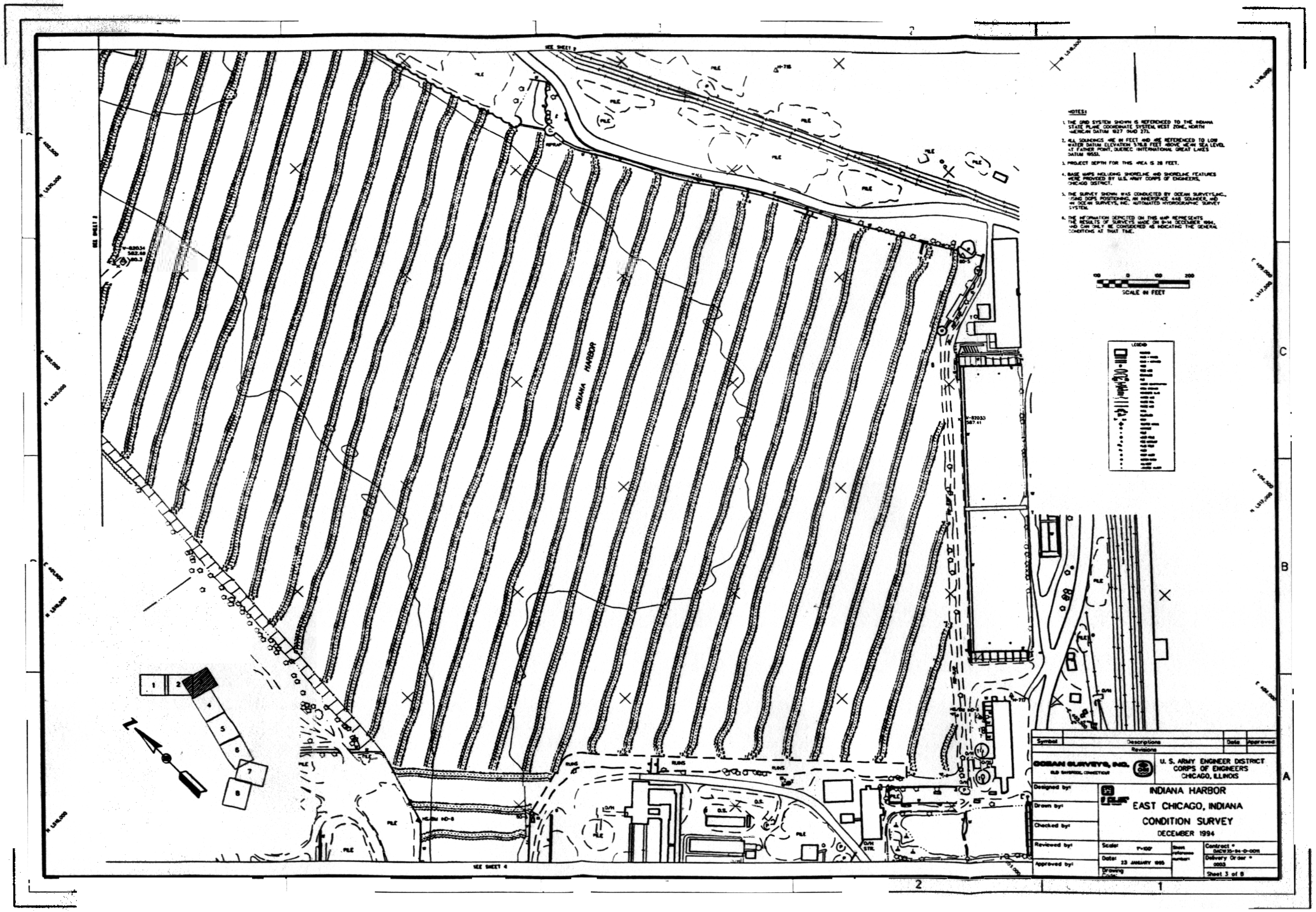

INDIANA HARBOR
U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
CHICAGO, ILLINOIS
INDIANA HARBOR
EAST CHICAGO, INDIANA
CONDITION SURVEY
DECEMBER 1994
Symbol
Descriptions
Date
Approved
Revisions
Designed by:
Drawn by:
Checked by:
Reviewed by:
Approved by:
Scale: 1"=100'
Date: 23 JANUARY 1995
Drawing Code:
Delivery Order # 0003
Sheet 3 of 8
SCALE IN FEET

PLATE E-15

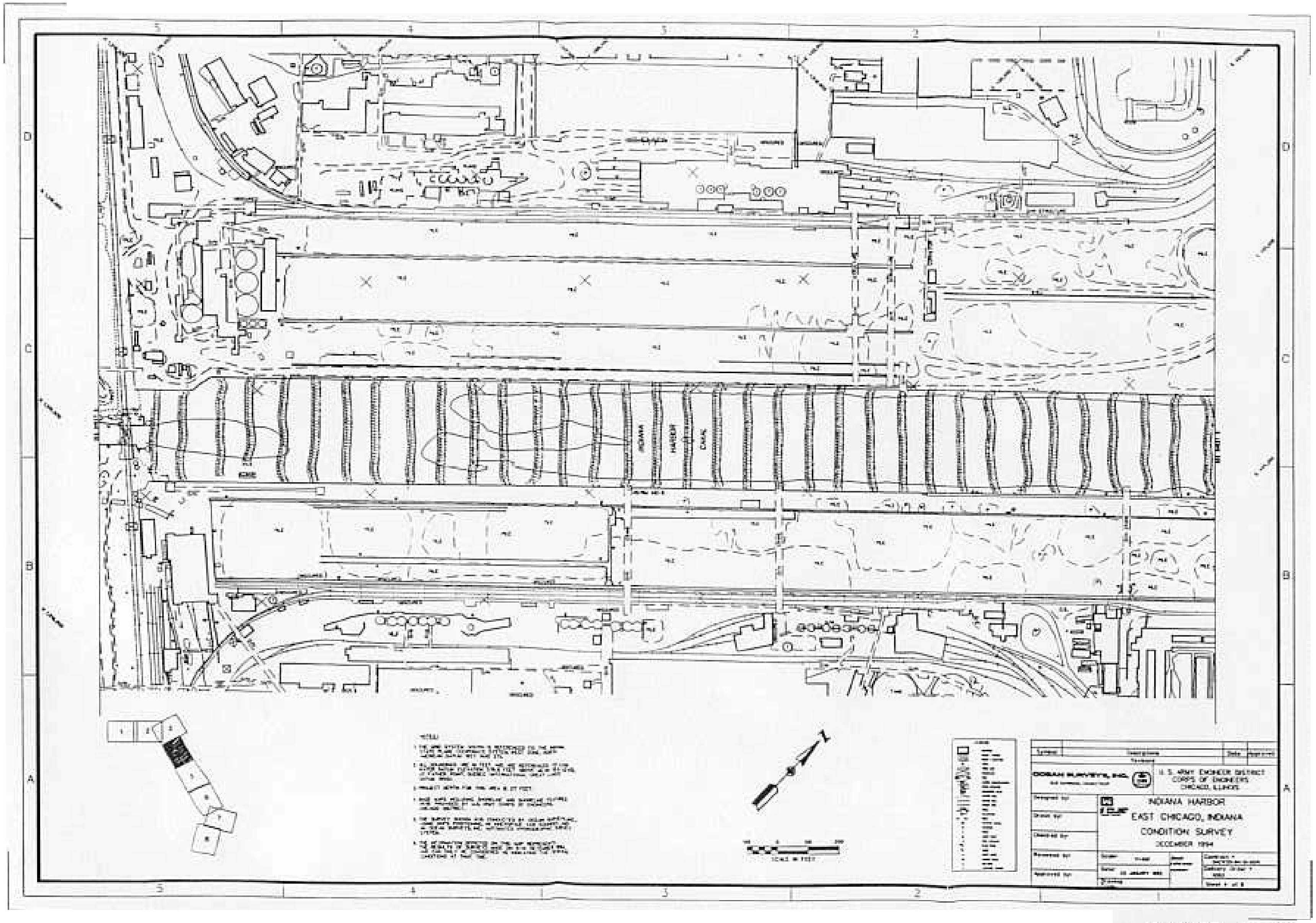

INDIANA HARBOR CANAL
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
CHICAGO, ILLINOIS
INDIANA HARBOR
EAST CHICAGO, INDIANA
CONDITION SURVEY
DECEMBER 1994

PLATE E-16

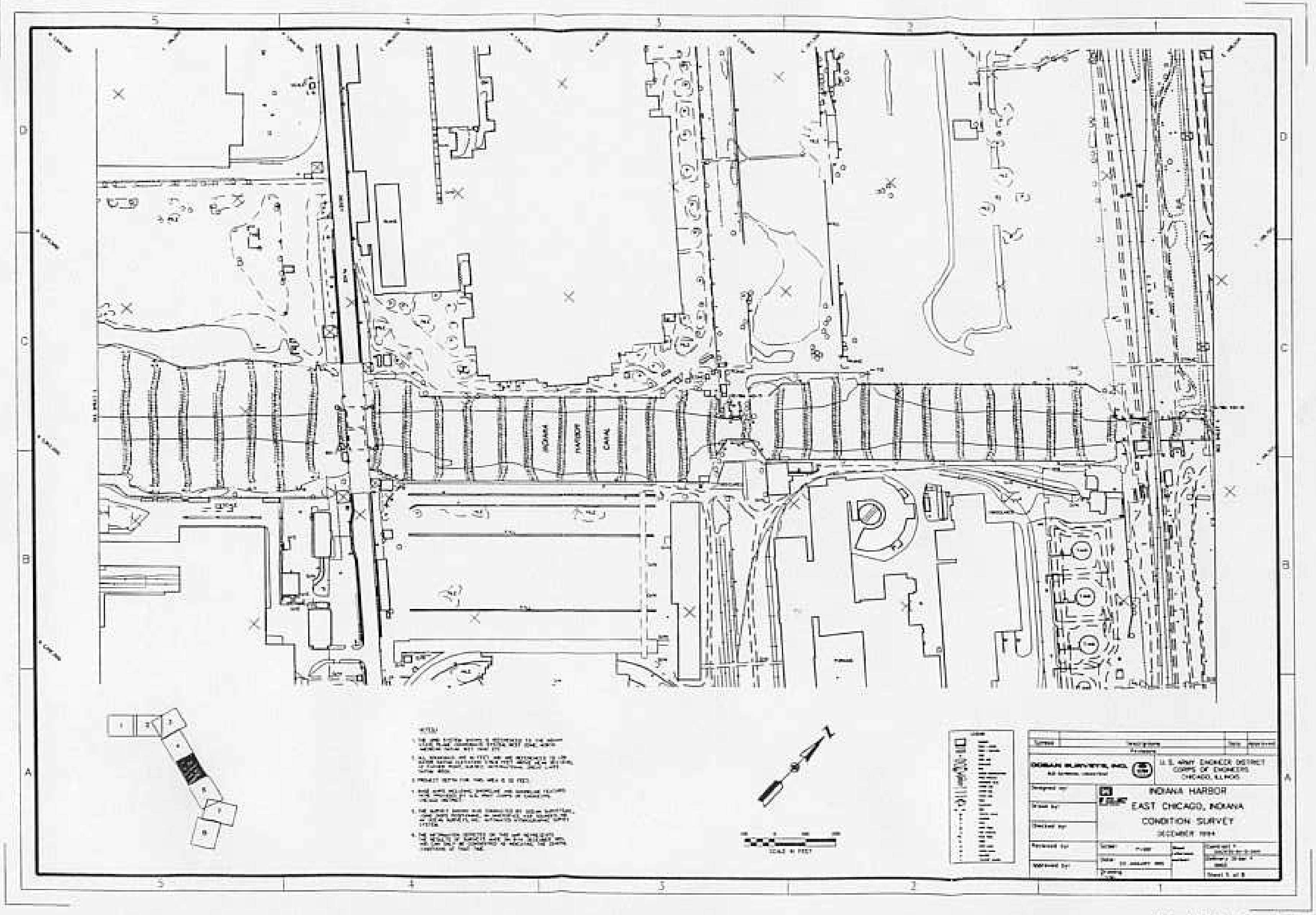
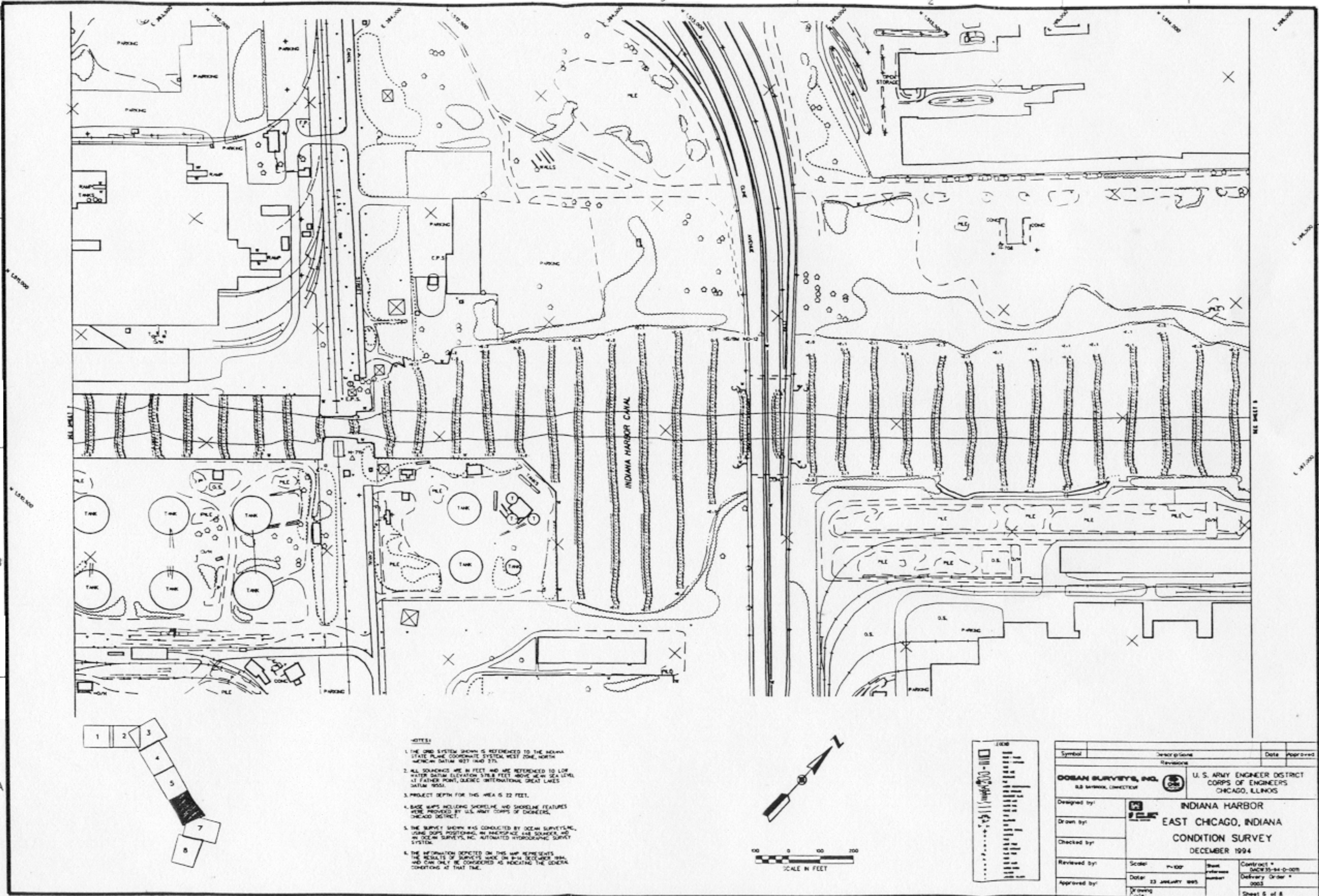

INDIANA HARBOR CANAL
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
CHICAGO, ILLINOIS
INDIANA HARBOR
EAST CHICAGO, INDIANA
CONDITION SURVEY
DECEMBER 1994
SCALE IN FEET

PLATE E-17



NOTES:

1. THE GRID SYSTEM SHOWN IS REFERENCED TO THE INDIANA STATE PLANE COORDINATE SYSTEM, WEST ZONE, NORTH AMERICAN DATUM 1927 (NAD 27).
2. ALL SOUNDINGS ARE IN FEET AND ARE REFERENCED TO LOW WATER DATUM ELEVATION 576.8 FEET ABOVE MEAN SEA LEVEL AT FATHER POINT, QUEBEC (INTERNATIONAL GREAT LAKES DATUM 1955).
3. PROJECT DEPTH FOR THIS AREA IS 22 FEET.
4. BASE MAPS INCLUDING SHORELINE AND SHORELINE FEATURES WERE PROVIDED BY U.S. ARMY CORPS OF ENGINEERS, CHICAGO DISTRICT.
5. THE SURVEY SHOWN WAS CONDUCTED BY OCEAN SURVEYS, INC., USING DGPS POSITIONING, AN INNERSPACE 448 SOUNDER, AND AN OCEAN SURVEYS, INC. AUTOMATED HYDROGRAPHIC SURVEY SYSTEM.
6. THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON 8-14 DECEMBER 1994, AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS AT THAT TIME.

Symbol	Descriptions	Date	Approved
	Revisions		

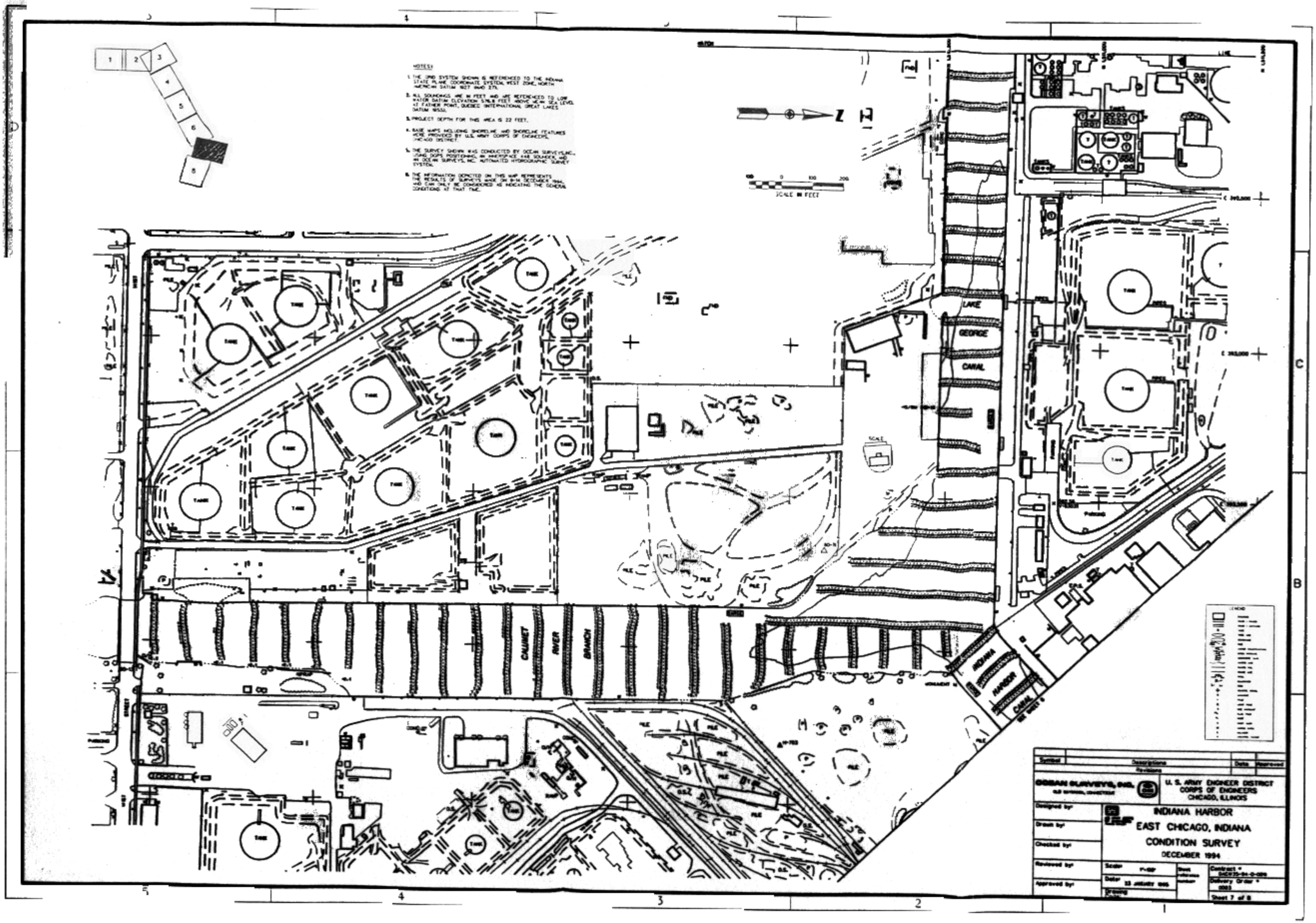
OCEAN SURVEYS, INC.
OLD SAYBROOK, CONNECTICUT

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

Designed by:
Drawn by:
Checked by:
Reviewed by:
Approved by:

INDIANA HARBOR
EAST CHICAGO, INDIANA
CONDITION SURVEY
DECEMBER 1994

Scale: 1"=100'
Date: 23 JANUARY 1995
Drawing Code:
Sheet reference number
Contract # DACW35-94-D-0011
Delivery Order # 0003
Sheet 6 of 8


NOTES:
1. THE GRID SYSTEM SHOWN IS REFERENCED TO THE INDIANA STATE PLANE COORDINATE SYSTEM, WEST ZONE, NORTH AMERICAN DATUM 1927 (NAD 27).
2. ALL SOUNDINGS ARE IN FEET AND ARE REFERENCED TO LOW WATER DATUM ELEVATION 576.8 FEET ABOVE MEAN SEA LEVEL AT FATHER POINT, QUEBEC (INTERNATIONAL GREAT LAKES DATUM 1955).
3. PROJECT DEPTH FOR THIS AREA IS 22 FEET.
4. BASE MAPS INCLUDING SHORELINE AND SHORELINE FEATURES WERE PROVIDED BY U.S. ARMY CORPS OF ENGINEERS, CHICAGO DISTRICT.
5. THE SURVEY SHOWN WAS CONDUCTED BY OCEAN SURVEYS, INC., USING DGPS POSITIONING, AN INNERSPACE 448 SOUNDER, AND AN OCEAN SURVEYS, INC. AUTOMATED HYDROGRAPHIC SURVEY SYSTEM.
6. THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON 9-14 DECEMBER 1994, AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS AT THAT TIME.
SCALE IN FEET
LAKE
GEORGE
CANAL
CALUMET
RIVER
BRANCH
INDIANA
HARBOR
CANAL
TANK
Symbol
Descriptions
Date
Approved
Revisions
OCEAN SURVEYS, INC.
U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
CHICAGO, ILLINOIS
Designed by:
Drawn by:
Checked by:
Reviewed by:
Approved by:
INDIANA HARBOR
EAST CHICAGO, INDIANA
CONDITION SURVEY
DECEMBER 1994
Scale:
Date:
Drawing
Sheet
Contract #
Delivery Order #
Sheet 7 of 8

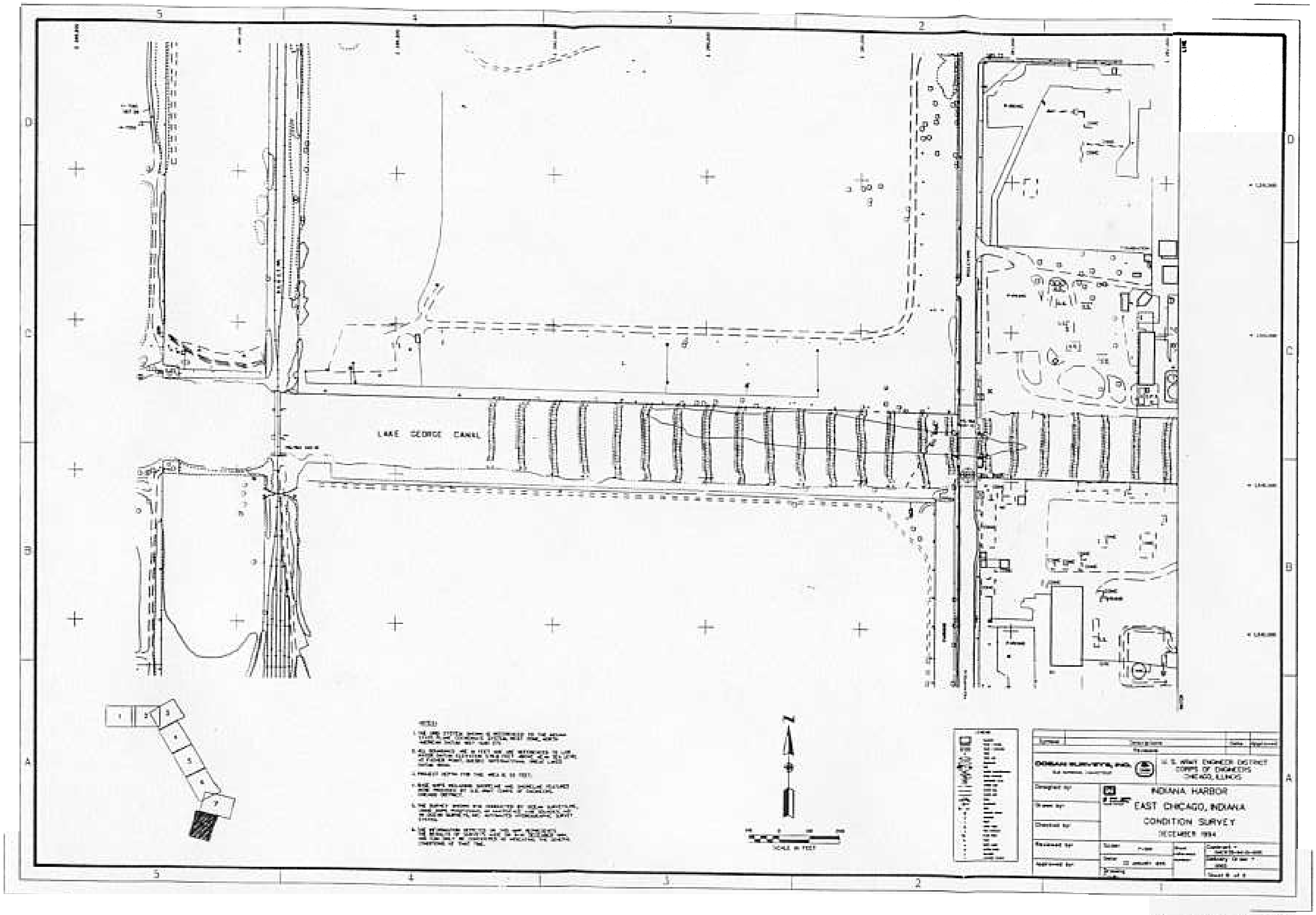

LAKE GEORGE CANAL
INDIANA HARBOR
EAST CHICAGO, INDIANA
CONDITION SURVEY
DECEMBER 1994
SCALE IN FEET

PLATE E-20