

AD-A119 696

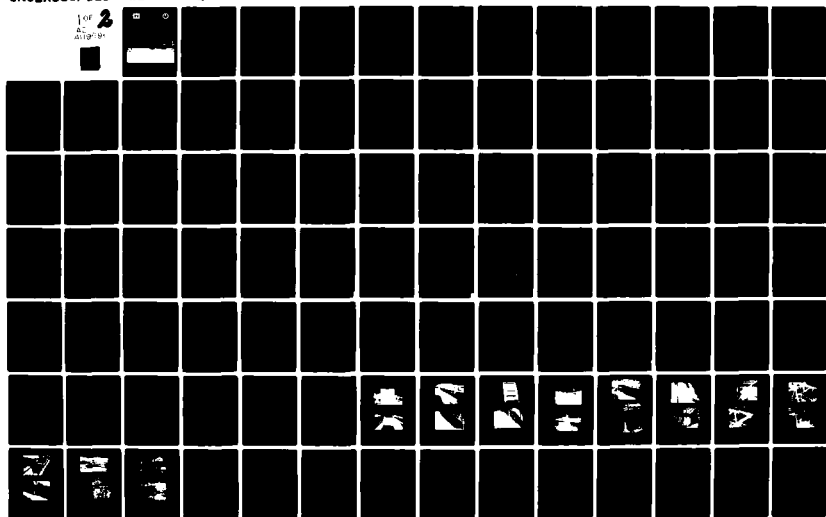
ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG--ETC F/6 13/2
CONDITION SURVEY OF CEDARS LOCK AND DAM, LOWER FOX RIVER, WISCO--ETC(U)
JUN 82 R L STOWE, J C AHLVIN
WES/MP/SL-82-4

CTIAC-52

NL

UNCLASSIFIED

1 of 2
AS
AD-A119 696



AD A119696



2



MISCELLANEOUS PAPER SL-82-4

CONDITION SURVEY OF CEDARS LOCK AND DAM LOWER FOX RIVER, WISCONSIN

by

Richard L. Stowe, Joyce C. Ahlvin

Structures Laboratory

U. S. Army Engineer Waterways Experiment Station
P. O. Box 631, Vicksburg, Miss. 39180

Copy available to DTIC does not
permit fully legible reproduction

June 1982

Final Report

Approved For Public Release; Distribution Unlimited

DTIC
ELECTE
SEP 28 1982
S D A



Prepared for U. S. Army Engineer District, Chicago
Chicago, Ill. 60604

DTIC FILE COPY

82 09 28 044

**Destroy this report when no longer needed. Do not return
it to the originator.**

**The findings in this report are not to be construed as an official
Department of the Army position unless so designated
by other authorized documents.**

**The contents of this report are not to be used for
advertising, publication, or promotional purposes.
Citation of trade names does not constitute an
official endorsement or approval of the use of
such commercial products.**

DISCLAIMER NOTICE

**THIS DOCUMENT IS BEST QUALITY
PRACTICABLE. THE COPY FURNISHED
TO DTIC CONTAINED A SIGNIFICANT
NUMBER OF PAGES WHICH DO NOT
REPRODUCE LEGIBLY.**

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Miscellaneous Paper SL-82-4	2. GOVT ACCESSION NO. AD-A119696	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) CONDITION SURVEY OF CEDARS LOCK AND DAM, LOWER FOX RIVER, WISCONSIN		5. TYPE OF REPORT & PERIOD COVERED Final report
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Richard L. Stowe Joyce C. Ahlvin		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U. S. Army Engineer Waterways Experiment Station Structures Laboratory P. O. Box 631, Vicksburg, Miss. 39180		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS U. S. Army Engineer District, Chicago Chicago, Ill. 60604		12. REPORT DATE June 1982
		13. NUMBER OF PAGES 114
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES Available from National Technical Information Service, 5285 Port Royal Road, Springfield, Va. 22151. This is CTIAC Report No. 52.		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Cedars Lock and Dam (Wis.) Lower Fox River (Wis.) Concrete Dams Dams--Inspection Locks (Hydraulic engineering)		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) A condition survey was performed at Cedars Lock and Dam on the Lower Fox River, Wisconsin. The field investigation included drilling for core samples of concrete, foundation rock, and backfill. Selected specimens of these materials were tested in the laboratory for certain physical and mechanical properties. Results of the field investigation and laboratory tests indicated that the concrete in the lock and dam is locally cracked and lightly deter- iorated but structurally sound. (Continued)		

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

20. ABSTRACT (Continued)

Rock masonry in the lock appears sound even though the outside surface is weathered. Cycles of freezing and thawing have caused the deterioration. The lock and dam is founded on competent bedrock. No soft or otherwise weak zones were detected in the bedrock. Soundings should be made to detect any scouring behind the dam. It is suggested that the reinforcing steel in the tainter gate piers, adjacent to the hinge pins, be examined for corrosion.

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

PREFACE

The investigation described herein was performed for the U. S. Army Engineer District, Chicago, by the U. S. Army Engineer Waterways Experiment Station (WES). The work was authorized by DA Form 2544, No. NCC-IA-80-57, dated 19 March 1980.

The testing program was accomplished under the direction of Mr. Bryant Mather, Chief of the Structures Laboratory (SL), WES, and Mr. John M. Scanlon, Jr., Chief of the Concrete Technology Division (CTD), SL. The core drilling was conducted by the Geotechnical Laboratory (GL), WES, under the direction of Mr. Mark A. Vispi. Laboratory work in the CTD was done with the assistance of Mr. F. S. Stewart and Mrs. Joyce C. Ahlvin. Mr. R. L. Stowe was Project Leader for the investigation. Mr. Stowe and Mrs. Ahlvin prepared this report.

Funds for publication of the report were provided from those made available for operation of the Concrete Technology Information Analysis Center (CTIAC). This is CTIAC Report No. 52.

Commanders and Directors of WES during the conduct of the investigation and the publication of this report were COL N. P. Conover, CE, and COL T. C. Greel, CE. Technical Director was Mr. F. R. Brown.



1. ☐ ☐ ☒ ☐ ☐
 2. ☐ ☐ ☐ ☐ ☐
 3. ☐ ☐ ☐ ☐ ☐
 4. ☐ ☐ ☐ ☐ ☐
 5. ☐ ☐ ☐ ☐ ☐
 6. ☐ ☐ ☐ ☐ ☐
 7. ☐ ☐ ☐ ☐ ☐
 8. ☐ ☐ ☐ ☐ ☐
 9. ☐ ☐ ☐ ☐ ☐
 10. ☐ ☐ ☐ ☐ ☐
 11. ☐ ☐ ☐ ☐ ☐
 12. ☐ ☐ ☐ ☐ ☐
 13. ☐ ☐ ☐ ☐ ☐
 14. ☐ ☐ ☐ ☐ ☐
 15. ☐ ☐ ☐ ☐ ☐
 16. ☐ ☐ ☐ ☐ ☐
 17. ☐ ☐ ☐ ☐ ☐
 18. ☐ ☐ ☐ ☐ ☐
 19. ☐ ☐ ☐ ☐ ☐
 20. ☐ ☐ ☐ ☐ ☐
 21. ☐ ☐ ☐ ☐ ☐
 22. ☐ ☐ ☐ ☐ ☐
 23. ☐ ☐ ☐ ☐ ☐
 24. ☐ ☐ ☐ ☐ ☐
 25. ☐ ☐ ☐ ☐ ☐
 26. ☐ ☐ ☐ ☐ ☐
 27. ☐ ☐ ☐ ☐ ☐
 28. ☐ ☐ ☐ ☐ ☐
 29. ☐ ☐ ☐ ☐ ☐
 30. ☐ ☐ ☐ ☐ ☐
 31. ☐ ☐ ☐ ☐ ☐
 32. ☐ ☐ ☐ ☐ ☐
 33. ☐ ☐ ☐ ☐ ☐
 34. ☐ ☐ ☐ ☐ ☐
 35. ☐ ☐ ☐ ☐ ☐
 36. ☐ ☐ ☐ ☐ ☐
 37. ☐ ☐ ☐ ☐ ☐
 38. ☐ ☐ ☐ ☐ ☐
 39. ☐ ☐ ☐ ☐ ☐
 40. ☐ ☐ ☐ ☐ ☐
 41. ☐ ☐ ☐ ☐ ☐
 42. ☐ ☐ ☐ ☐ ☐
 43. ☐ ☐ ☐ ☐ ☐
 44. ☐ ☐ ☐ ☐ ☐
 45. ☐ ☐ ☐ ☐ ☐
 46. ☐ ☐ ☐ ☐ ☐
 47. ☐ ☐ ☐ ☐ ☐
 48. ☐ ☐ ☐ ☐ ☐
 49. ☐ ☐ ☐ ☐ ☐
 50. ☐ ☐ ☐ ☐ ☐
 51. ☐ ☐ ☐ ☐ ☐
 52. ☐ ☐ ☐ ☐ ☐
 53. ☐ ☐ ☐ ☐ ☐
 54. ☐ ☐ ☐ ☐ ☐
 55. ☐ ☐ ☐ ☐ ☐
 56. ☐ ☐ ☐ ☐ ☐
 57. ☐ ☐ ☐ ☐ ☐
 58. ☐ ☐ ☐ ☐ ☐
 59. ☐ ☐ ☐ ☐ ☐
 60. ☐ ☐ ☐ ☐ ☐
 61. ☐ ☐ ☐ ☐ ☐
 62. ☐ ☐ ☐ ☐ ☐
 63. ☐ ☐ ☐ ☐ ☐
 64. ☐ ☐ ☐ ☐ ☐
 65. ☐ ☐ ☐ ☐ ☐
 66. ☐ ☐ ☐ ☐ ☐
 67. ☐ ☐ ☐ ☐ ☐
 68. ☐ ☐ ☐ ☐ ☐
 69. ☐ ☐ ☐ ☐ ☐
 70. ☐ ☐ ☐ ☐ ☐
 71. ☐ ☐ ☐ ☐ ☐
 72. ☐ ☐ ☐ ☐ ☐
 73. ☐ ☐ ☐ ☐ ☐
 74. ☐ ☐ ☐ ☐ ☐
 75. ☐ ☐ ☐ ☐ ☐
 76. ☐ ☐ ☐ ☐ ☐
 77. ☐ ☐ ☐ ☐ ☐
 78. ☐ ☐ ☐ ☐ ☐
 79. ☐ ☐ ☐ ☐ ☐
 80. ☐ ☐ ☐ ☐ ☐
 81. ☐ ☐ ☐ ☐ ☐
 82. ☐ ☐ ☐ ☐ ☐
 83. ☐ ☐ ☐ ☐ ☐
 84. ☐ ☐ ☐ ☐ ☐
 85. ☐ ☐ ☐ ☐ ☐
 86. ☐ ☐ ☐ ☐ ☐
 87. ☐ ☐ ☐ ☐ ☐
 88. ☐ ☐ ☐ ☐ ☐
 89. ☐ ☐ ☐ ☐ ☐
 90. ☐ ☐ ☐ ☐ ☐
 91. ☐ ☐ ☐ ☐ ☐
 92. ☐ ☐ ☐ ☐ ☐
 93. ☐ ☐ ☐ ☐ ☐
 94. ☐ ☐ ☐ ☐ ☐
 95. ☐ ☐ ☐ ☐ ☐
 96. ☐ ☐ ☐ ☐ ☐
 97. ☐ ☐ ☐ ☐ ☐
 98. ☐ ☐ ☐ ☐ ☐
 99. ☐ ☐ ☐ ☐ ☐
 100. ☐ ☐ ☐ ☐ ☐
 101. ☐ ☐ ☐ ☐ ☐
 102. ☐ ☐ ☐ ☐ ☐
 103. ☐ ☐ ☐ ☐ ☐
 104. ☐ ☐ ☐ ☐ ☐
 105. ☐ ☐ ☐ ☐ ☐
 106. ☐ ☐ ☐ ☐ ☐
 107. ☐ ☐ ☐ ☐ ☐
 108. ☐ ☐ ☐

CONTENTS

	<u>Page</u>
PREFACE	1
CONVERSION FACTORS, INCH-POUND TO METRIC (SI)	
UNITS OF MEASUREMENT	3
PART I: INTRODUCTION	4
Project Description	4
Location of Study Area	4
Background	5
Objective	6
Scope	6
PART II: PRELIMINARY STUDY	7
Review of Records and Drawings	7
Inspection of Lock and Dam	7
PART III: FOUNDATION EXPLORATION	10
Previous Exploration	10
Current Drilling	10
Scour Detection	11
PART IV: GEOLOGICAL CHARACTERISTICS	12
Geomorphology	12
Backfill	13
Bedrock Stratigraphy	13
Geologic Cross Section	14
Structure	14
PART V: TESTS, TEST RESULTS, AND DISCUSSION	16
Test Specimens and Test Procedures	16
Soil Properties	19
Concrete Test Results and Discussion	19
Rock Test Results and Discussion	20
Recommended Design Values for Rock	25
Conclusion and Recommendations	26
REFERENCES	27
TABLES 1-5	
PLATES 1-26	
APPENDIX A: PHOTOGRAPHS OF LOCK AND DAM	
APPENDIX B: DRILLING LOGS	
EXHIBIT A: CORE PHOTOGRAPHS	

CONVERSION FACTORS, INCH-POUND TO METRIC (SI)
UNITS OF MEASUREMENT

Inch-pound units of measurement used in this report can be converted to metric (SI) units as follows:

<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>
feet	0.3048	metres
feet per second	0.3048	metres per second
inches	0.0254	metres
miles (U. S. statute)	1.609347	kilometres
pounds (force) per square inch	0.006894757	megapascals
pounds (mass) per cubic foot	16.01846	kilograms per cubic metre
tons (force) per square foot	0.09576052	megapascals

CONDITION SURVEY OF CEDARS LOCK AND DAM

LOWER FOX RIVER, WISCONSIN

PART I: INTRODUCTION

Project Description

1. The following general description of the Cedars Lock and Dam is taken from Reference 1.

"The headwaters of the Fox River rise in Columbia County, Wisconsin, and flow in a Northeasterly direction for about 176 miles into Green Bay. The section of the river from Lake Winnebago to Green Bay is generally referred to as the Lower Fox River and is 39 miles long. It has a change in gradient of about 168 feet; channel widths are generally 500 to 1000 feet and minimum channel depths are 9.6 feet below Depere Lock and 6 feet below Menasha Lock. Upper pool El. 698.66 and lower pool El. 688.88 are referred to mean water level at Fathers Point, Quebec I.G.L.D. (1955) (International Great Lakes Datum)."

2. The Cedars lock is of masonry design and founded directly on dolomite. It has usable lock dimensions of 35 by 144 ft;* the lift is 9.8 ft at normal river stage.

3. The Cedars dam is of concrete gravity wall design and is keyed into the dolomite foundation. The dam consists of a 263.3-ft long spillway on the right side of the dam and a 211.0-ft long spillway on the left side of the dam. The midsection of the dam is a 180.0-ft long sluiceway containing seven tainter gates. Crest elevation** of the spillway sections is 698.66 (IGLD 1955); for prior datum planes, add 1.75 ft.

Location of Study Area

4. The Cedars Lock and Dam is located approximately 27.5 miles

* A table of factors for converting inch-pound units of measurement to metric (SI) units is presented on page 3.

** All elevations (el) cited herein are in feet referred to I.G.L.D. 1955 (International Great Lakes Datum).

from the mouth of the Fox River at Green Bay. The lock and dam is situated on the river between the towns of Little Chute and Kimberly. A general plan view of the site is given in Plate 1; this plate is duplicated from Reference 1.

Background

5. In March of 1980 the Waterways Experiment Station (WES) was requested by the U. S. Army Engineer District, Chicago (NCC for North Central Division, Chicago), to review a number of documents, References 1,2, and 3, and submit a proposal for a condition survey of Cedars Lock and Dam. Reference 3 contained a preliminary exploration and testing program which was used as guidance in developing the WES proposal. The amount of exploration and testing that could be accomplished was governed by available funding.

6. After the drilling was initiated, District technical staff increased the number of borings. The added borings were drilled and some of the funding allocated for laboratory testing and reporting was diverted to cover the increased drilling cost. The reasons for increasing the number of borings was twofold; first, additional foundation information would be obtained for developing geologic profiles. Secondly, by drilling additional borings with the on-site marine floating plant, crane, etc., cost of mobilization and demobilization would not be incurred for a second drilling effort. The bedrock core from these added borings is preserved at the WES in case further testing is required. It was decided not to drill the lock masonry for fear of creating leaks along the mortar joints.

7. Work on this project was initiated by the Chicago District prior to the 1980 realignment of North Central Division. Work continued under the direction of the Chicago District although the Detroit District is now responsible for the geographical area that includes the Lower Fox River.

Objective

8. The objectives of this study were to evaluate subsurface conditions, to assess the in-place concrete conditions, to ascertain selected physical properties of concrete and rock, and to evaluate this information in order that design parameters be presented as guidance for a structural stability analysis. In addition, selected physical properties of backfill materials are to be determined. The Detroit District is scheduled to perform the stability analysis.

Scope

9. The report discusses the drilling effort involved in obtaining samples of soil, concrete, and rock. The physical condition of the in-place exposed concrete is described using a limited amount of information. Selected physical properties of the core samples were determined using standard Corps of Engineers test methods. A limited number of borings were drilled behind the sluiceway dam section for purposes of detecting possible covered scouring. A study was made to consolidate and evaluate engineering information, geologic and boring data, and laboratory test data as they relate to the foundation condition. Available construction and engineering data records were reviewed.

PART II: PRELIMINARY STUDY

Review of Records and Drawings

10. The author made a visit to the Kaukauna Project Office to review available engineering and construction drawings in the hope of finding foundation information. Very little information was available. Construction drawings, records, and photographs do not provide much information about the foundation condition. The drawings and photographs indicated that the lock and dam was founded on "nearly horizontal limestone rock."

11. Right-of-way fly-over photographs of the Lower Fox River were studied for indications of geologic structures such as joint systems and faults. The photographs were helpful in showing the plate-like bedding near the lock and dam. No indications of faulting were detected in the photographs or on topographic maps of the area. To the Kaukauna Project Engineer's knowledge, scour profiles had not been taken at Cedars Lock and Dam; in addition, scour holes behind the dam had not been detected.

Inspection of Lock and Dam

12. The author and Mr. Steve Running of the Kaukauna Project Office made an inspection of the Cedars Lock and Dam site. The main purpose of the inspection was to determine if macroscopic misalignment, settlement, expansion, or contraction of the concrete and masonry structures could be detected. The lock backfill was observed for settlement. The surface condition of the concrete was observed and boring locations assigned.

Lock chamber walls

13. No misalignment, settlement, or contraction of the masonry walls was detected. Expansion of the masonry occurred at exposed edges of some of the rock blocks, the expanded portions of the blocks being adjacent to block joints. This expansion is not viewed as a problem.

The top of the lock walls has been resurfaced with concrete and is in good condition. The lock masonry walls appear structurally sound and should function for a long time as originally intended. The stairways at the downstream end of the lock are in poor condition.

Lock embankment

14. The grassed embankment adjacent to both lock walls appears in good condition. The grassed area between the toe of the embankment against the riverside lock wall and the river shows a little differential settlement in the order of 6 to 10 in. The lockmaster said that small holes occasionally developed in the area and that the ground becomes spongy to walk on. He did not specify what conditions prevailed when the ground was spongy. Photographs No. 1 through 8 (see Appendix A) show the general condition of the lock walls and the embankment.

Dam, left abutment
wall, and spillway

15. Photographs 9 and 10 show the frost damaged concrete in the left abutment wall. There was no evidence of misalignment, settlement, or contraction in the dam sections. Slight expansion of local areas exists in the concrete due to the results of freezing and thawing action.

Dam, left spillway

16. The concrete in the foot bridge piers appears in good condition. See Photograph 11.

Dam, sluiceway

17. The condition of the concrete in the sluiceway piers is generally good (see Photographs 12 through 15). Damage due to freezing and thawing is confined to local areas. Minor amounts of concrete in the piers at low pool elevation have been abraded by water and ice action. Cracking through the piers near the gate hinge piers is present in each pier. Some piers are cracked through near the steps. The Chicago District conducted an analysis of the cracked concrete piers and determined that reinforcement within the piers was effective for gate loads; see Reference 1, Appendix B, page 13.

18. It is suggested that a study be made to determine if the reinforcing steel in the sluiceway piers is rusted. Infiltrating water along

the cracks could have caused reinforcement to rust. The concrete from around the downstream side of the gate hinge pin could be excavated to examine the reinforcing steel.

Dam, right abutment wall

19. The concrete in the right abutment wall is in good condition. A diagonal crack exists in the upstream portion of the wall and a near vertical crack exists in the downstream portion of the wall. The cracks appear to go through the wall. See Photographs 16 through 18.

20. During the inspection trip a visit was made to a quarry about 1/4 mile from the Lower Fox River. The rock here is believed to belong to the same formation (Galena-Platteville Dolomite) that exists beneath the Cedars Lock and Dam. Photographs 21 and 22 give a general and close-up view, respectively, of the quarry rock. The quarry floor and benches are bedding planes which are nearly horizontal.

21. Photographs 21 and 22 were taken in the dry dock area at the Kaukauna Project Office. A gate wall is seen founded on the bedrock.

PART III: FOUNDATION EXPLORATION

Previous Exploration

22. Presumably borings were taken prior to construction in the early 1930's. However, no information derived from such borings was available for review.

Current Drilling

23. Drilling equipment consisted of an Acker Toredon Mark II and a Sprage and Henwood skid-mounted rotary drill rig. A Diamond Core Drill Manufacturers Association standard 4-in. by 5-1/2-in. double tube swivel tube core barrel was used with diamond bits to obtain the concrete and bedrock core. Access to the drill holes was by a marine floating plant and for holes on top of structures by crane. Floating plant was supplied by Kaukauna Project Office. Continuous samples were obtained in all borings. Appropriate size casing was set in the bedrock when necessary to keep a boring open. A Concord portable drill rig was used in drilling horizontal cores.

24. The boring location plan is presented in Plate 2. A summary of boring information is given in Table 1; presented is the type boring, the location by structure, the elevation of the top of boring, the elevation top of rock, the elevation bottom of rock, and the date when the boring was started. The number of borings and boring locations were determined through mutual agreement by the Chicago District and the WES technical staff. Specific boring locations at the lock and dam were assigned by Mr. Stowe of the WES.

25. Two borings were put through the backfill and into bedrock; one boring was drilled on either side of the lock walls. Bedrock was sampled to a depth of 5.1 ft in the landside boring and to a depth of 26.7 ft in the riverside boring. A piezometer was installed in the riverside boring (C WES El-80). It was set at el 682.2 (piezometer tip). Pertinent piezometer data were presented in Plate 3. Piezometer readings

were not taken by the WES drill crew. The deeper borings into bedrock were carried from 21 to 29 ft deep. The shorter scour borings were taken about 6 ft into rock.

26. Boring C WES D2-80 was left open while the drill crew remained on site. Water level readings were taken by the lockmaster for a short period of time. The water level readings are presented in Table 2.

27. Total footage drilled was 36.0, 68.75, and 157.5 ft, respectively, for soil, concrete, and bedrock. All soil, concrete, and bedrock was preserved for possible laboratory testing, the exception being the highly fractured, broken samples. Procedures for preserving and handling the samples are present in References 4 and 5. Color photographs of the core are presented in Exhibit A. Field drilling logs are presented in Appendix B.

28. Core recovery was good in all borings indicating the general good condition of the materials drilled at the lock and dam sites; core recovery averaged 98.4 percent. Drilling water loss was very small and restricted to several locations. In boring D3 at el 681.8 to 682.4 water loss occurred. This zone was bounded by shale seams with black surface staining.

Scour Detection

29. Scour borings were located behind the sluiceway dam section. It was felt that this section of the dam would likely contain covered scour areas if any exist. The four borings behind the sluiceway section did not reveal any covered scour areas; no evidence of displaced or recently (postdam construction) disoriented rock blocks was found.

30. Because of the limited number of borings drilled behind the dam and the fact that scour profiles have not been taken, scouring of the bedrock behind the dam could exist. It is suggested that scour profiles be made. Undercutting of the toe of the dam should likewise be studied.

PART IV: GEOLOGICAL CHARACTERISTICS

Geomorphology

31. Cedars Lock and Dam is located in Outagamie County, Wisconsin, in the lowland between Green Bay and Lake Winnebago. This geographic province of Wisconsin is termed the Eastern Ridges and Lowlands and covers an area of 21,000 square miles, including the 7,500 square miles under Green Bay and Lake Michigan. It is bounded on the east by the lowland of Devonian shale now submerged beneath Lake Michigan and on the north by Green Bay. The western border is found along the contact of the Cambrian sandstone with the lower Magnesian limestone from the Menominee River (Marinette County) to the Wisconsin River (Sauk and Columbia Counties). On the south the region is delineated by the terminal moraine at the edge of the most recent drift sheet and the Rock River below Jonesville.

32. Once much smaller than at present, the Lower Fox River valley was carved to its present size by the glacier. The immense ice sheet advanced southward cutting out the valley of Lake Michigan, while a tongue cut Green Bay Valley to its present dimensions. A medial moraine, the Kettle Range, was formed on the peninsula between Green Bay and Lake Michigan.

33. The retreat of the glacier, coupled with its cutting action, created a depression at Green Bay. The valley floor rises steeply with Lake Winnebago being 166.7 ft above Green Bay. This caused the Wolf and Upper Fox Rivers to change course and flow into the newly formed valley. Evidence of this can be seen in studies of the ancient shore of Lake Michigan by tracing red clay deposits. Lake Winnebago formed more recently by the deposition of glacial drift in the valley.

34. The western slope of the Upper Fox River valley is gentle, while the eastern slope is quite steep. Cliffs on the east are cut through the Cincinnati shales and Niagara dolomite and extend from Green Bay south past Lake Winnebago. The bedrock at the dam is the

Galena-Platteville dolomite of Ordovician age. All field boring logs identify bedrock as limestone; subsequent petrographic examination shows the bedrock to be dolomite.

Backfill

35. The backfill on either side of the lock is considered as construction fill. Profiles of borings E1 and E2 are presented in Plate 4. The backfill consists of inorganic clays, gravelly clays, and sandy clays; beneath these fine-grained soils is a strata (about 2.5 ft) of coarse-grained soil in the SC group. Beneath the soils is a layer of dolomite cobbles and boulders mixed with clay. The dolomite bedrock underlays the fill. The rock symbols used in the profiles in Plate 4 are for limestone; the symbols should be for dolomite.

Bedrock Stratigraphy

36. The bedrock beneath Cedars Lock and Dam is of the Galena-Platteville formation of the Champlainian series of the Ordovician system. This formation is between 120 and 155 ft thick in this area, as reported by the Wisconsin Geological and Natural History Survey.

37. The dolomite is gray-green, fine to medium grained, dense, moderately hard to hard, shaley, and fossiliferous in places. Bedding is massive. Thin shale beds, laminae, and stringers are part of the rock fabric. The shale is gray-green and quite hard. The shale features range in thickness from 0.01 ft to 0.08 ft and occur continuously to a maximum of 0.5-ft separation. The shale occurs parallel to bedding.

38. There appear to be two types of bedding surfaces in the core; they are designated Types A and B. Type A is irregular with semirounded peaks and valleys. Peak to valley distances range from 1/4 to 1/2 in.; periods are about 2 in. Type A surfaces are tightly interlocked and are the predominant type of bedding surface. Type B is almost planar, yet gently undulating with a few short asperities and steps; Type B bedding surfaces are interlocked. The thin hard shale is found on both types of

surfaces. A few stylolites exist in the core. Core breaks occur along the shale features. No soft, weak seams of shale or clay were detected in the core samples.

39. The dolomite contained infrequent solution cavities up to 0.05-ft diameter. With one exception, the cavities were filled with calcite. The cavities occurred between el 680 and el 684 and el 662 and el 670. One cavity in core D2 was filled with pyrite (at el 680.6). Staining appears in four of the cores (D4, D3, D5, E1) between el 666 and 667 and in three cores (D2, D3, D4) between el 684 and 685. In core D5 staining occurs from el 676.0 to 676.81. The staining and solution activity indicates that water has moved along bedding planes.

Geologic Cross Sections

40. Three geologic cross sections were drawn; sections A-A', B-B', and C-C' (see Plate 2 for cross section locations). Section A-A' (see Plates 5, 6, and 7) was drawn parallel to the dam axis and includes borings D3, D8, D2, D7, and D1. Section B-B' (see Plate 8) was drawn perpendicular to the lock, and section C-C' (see Plate 9) was drawn perpendicular to the dam at about its midlength. Section B-B' contains borings E1 and E2, and section C-C' contains borings D4, D2, D6, and D5.

Structure

41. The main structural feature in the bedrock is the nearly horizontal bedding. Hard shale beds, laminae, and stringers occur throughout the bedrock. However, the shale features are intact and intimately joined to the dolomite and considered a part of the rock fabric and are not considered individual troublesome units. There is no geologic feature within the bedrock that can be traced between borings.

42. The contact between the concrete and the bedrock core is well bonded except in cores D6 and D2. A complete separation exists in core D6 with brown calcite deposits on both surfaces. The calcite deposit indicates solution activity at the concrete-bedrock interface. Shale

pieces are embedded in the concrete to a shallow depth. A small amount of bedrock was probably left during cleanup prior to placing concrete. Evidence of solution activity is present in boring D2, again at the contact. Solution activity is present in the dam bedrock; however, it is not considered a problem at this time due to its apparent limited extent.

43. The extent of jointing in the bedrock could not be determined with the limited work done during this study. A total of four fractures (joints) were observed in the core. One short (1-ft long) vertical fracture exists in boring D3 at a midpoint el 684.2. Three fractures inclined at 45 deg from the horizontal were observed, one each in boring E2, D1, and D4. Jointing appears not to be a problem at the lock and dam in terms of stability of the two structures.

PART V: TESTS, TEST RESULTS, AND DISCUSSION

Test Specimens and Test Procedures

Cores received

44. Disturbed and undisturbed soil samples were recovered from the two backfill borings. The undisturbed samples consist of 14 steel tubes; the disturbed samples consist of 15 jars and 3 bags. Two boxes contained core samples. Table 3 describes the drill hole number, sample number, type sample, sample depth, and the material description of the soil samples received at the WES.

45. In addition to the soil samples, concrete and rock samples from 11 borings were received at the WES. Shipment of the materials was by government motor freight. All samples were received in good condition, and no sample breakage was detected. Pertinent information concerning the concrete and rock samples is presented in Table 4.

Selection of test specimens

46. Disturbed and undisturbed samples from borings E1-80 and E2-80 were examined and representative samples were chosen for general engineering type testing.

47. A detailed visual examination of core was made in the laboratory to supplement the field boring logs and to assist in the selection of representative test specimens. Concrete specimens were selected for testing based upon physical condition of the concrete and depth in order to obtain representative properties throughout the structure.

48. Three concrete specimens were selected from boring D2; one at the top, middle, and bottom of the boring. Test specimen depths shown in the tables of test results represent the midsection of the test specimen; e.g., el 696.5 is the midpoint of a piece of core with top el being 697.0 and the bottom el being 696.0. Both 6-in. and 4-in.-diameter concrete cores were used for testing. Four-inch-diameter rock cores were tested.

49. An attempt was made to select test specimens to be representative of the bedrock in close proximity to the base of the structure. The

test assignment locations can be obtained from appropriate tables of test results as well as from appropriate geologic cross sections.

50. Test specimens were selected for testing concurrent with the detailed logging of core; the logging began the day core arrived at the laboratory. The test specimens were rewrapped and stored in a moist curing room until time for testing; the moist room is maintained at 73.4 ± 3 F (23 ± 1.7 C).

Laboratory testing program

51. Soil samples. The testing of the soil samples consisted of the following.

- a. Gradation Curve.
- b. Atterberg Limits Testing.
- c. Triaxial, $\bar{R}$.
- d. Direct Shear.

52. Concrete cores. The testing program of the concrete cores consisted of the following tests on representative selected cores.

- a. Unit Weight, γ .
- b. Compression Wave Velocity, V_p .
- c. Compressive Strength.
- d. Water Content, w .
- e. Elastic Moduli, E .
- f. Poisson's Ratio, ν .

53. Rock cores. The testing of the bedrock cores consisted of the following tests on representative selected cores. The tests are grouped under either characterization tests or engineering design tests.

- a. Characterization tests.
 - (1) Effective (As Received) and Dry Unit Weight, γ_m and γ_d .
 - (2) Water Content, w .
 - (3) Compressive Strength, q_u .
- b. Engineering design tests.
 - (1) Elastic Moduli, E .
 - (2) Poisson's Ratio, ν .
 - (3) Triaxial Strength.

(4) Direct Shear Strength.

- (a) Concrete on rock, precut (residual).
- (b) Intact (maximum).
- (c) Rock on rock, precut (residual).
- (d) Cross bed (maximum).

Test procedures

54. The soil testing was accomplished according to EM 1110-2-1906, Laboratory Soils Testing. The characterization properties tests and the engineering design properties tests were conducted in accordance with the appropriate test method tabulated below:

<u>Property</u>	<u>Test Method</u>
<u>Characterization</u>	
Effective Unit Weight (As Received), γ_m	RTM 109-77*
Dry Unit Weight, γ_d	RTM 109-77
Water Content, w	RTM 106-77
Compressional Wave Velocity, V_p	RTM 110-77 (ASTM D 2845)
Compressive Strength, q_u	RTM 111-77 (ASTM D 2938)
<u>Engineering Design</u>	
Elastic Modulus, E	RTM 201-77 (ASTM D 2148)
Direct Shear Strength	RTM 203-77
Poisson's Ratio, ν	RTM 201-77
Triaxial Strength	RTM 202-77

* Reference 5.

55. For the compression and triaxial compression test, the specimens were cut with a diamond-blade saw and the cut surfaces were ground flat to 0.001 in.; specimens were checked for parallel ends and the perpendicularity of ends to the axis of the specimen. Electrical resistance strain-gages were used for strain measurements. Two each were used in the axial and horizontal directions. The modulus of elasticity and Poisson's ratio were computed from the strain measurements. Axial specimen load was applied with a 440,000-lbf capacity universal testing machine. Confining pressure during the triaxial tests was applied using an electro-hydraulic pump.

Soil Properties

56. All of the laboratory test data from soil samples are presented in Plates 10 through 18. The data consist of the following:

a. Boring E1-80.

- (1) One Atterberg Limits, classification (sieve analysis).
- (2) One $\bar{R}$ triaxial test.
- (3) One direct shear test.

b. Boring E2-80.

- (1) Three Atterberg limits, classification (sieve analysis).
- (2) One $\bar{R}$ triaxial test.

This report does not present an interpretation or recommended design parameters for the materials in the backfill because of various unknowns. We don't know what type of slope stability analysis will be used by the district, where the failure plane will be assumed within the backfill, and whether the bedrock will be incorporated in the analysis.

Concrete Test Results and Discussion

57. The following comments pertain to the condition of the concrete in the dam. These comments are the results of examination of the core recovered at the dam. The condition of the exposed concrete is discussed in Part II of this report. The concrete characterization and engineering design test results are presented in Table 5.

58. The concrete recovered from borings is nonair-entrained. It is light gray-brown, hard, dense, contains natural dolomite aggregate 1 in. in maximum size that is rounded to subangular. The concrete contains occasional entrapped air voids from 1/4 to 1/2 in. in size and is well consolidated. A few gravel pockets occur (honeycombed areas), but they do not affect the structural integrity of the concrete. Minor amounts of white reaction products were found throughout the concrete. The white reaction material probably resulted from alkali-silica reaction and is an alkali carbonate. At this time the concrete is not

adversely affected by the process producing the white reaction product, nor will it be in the near future. The concrete in the dam is structurally sound and should serve its intended purpose. The exceptions are those local areas where frost-damaged concrete exist.

59. The horizontal core recovered from boring D11 contains fractures throughout its 3-ft depth. The core was taken from the south side of sluiceway pier 3 about 1.5 ft downstream of the gate hinge pin. The fractures could have occurred when the through cracks in the pier, near the gate hinge pin, developed. Some of the fractures are closed while some are open. The open fractures could be filled with a sealing agent to prevent water from penetrating the concrete.

60. The author believes that there is no reason to immediately repair the cracked or frost-damaged concrete in the dam. Repair of these damaged areas could be performed during regular maintenance periods.

61. The average physical properties of the concrete are tabulated below along with selected statistics. Stress versus strain curves are presented in Plate 19 for the three concrete specimens tested:

<u>Test</u>	<u>Average Value</u>	<u>Standard Deviation</u>	<u>No. Specimens</u>
Wet Unit Weight, pcf	153.4	0.7	3
Water Content, %	5.1	0.2	3
Compressional Wave Velocity, fps	17,240	544	3
Compressive Strength, psi	7,602	1480	3
Modulus of Elasticity, $\times 10^6$ psi	4.69	0.42	3
Poisson's ratio	0.20	0.06	3

62. The physical properties of the concrete are characteristic of good quality concrete. The standard deviations are considered small and indicative of uniform concrete properties.

Rock Test Results and Discussion

63. The results of the characterization properties tests are presented in Table 4 for the bedrock. Stress versus strain curves are

presented in Plates 20 and 21. The following tabulation presents a summary of the average characterization properties and selected statistics for the bedrock.

<u>Test</u>	<u>Average Value</u>	<u>Standard Deviation</u>	<u>No. Specimens</u>
Effective Unit Weight, pcf	171.1	0.9	6
Dry Unit Weight, pcf	169.9	0.9	6
Water Content, %	0.7	0.2	6
Compressional Wave Velocity, fps	20,040	636	6
Compressive Strength, psi	20,050	2322	6
Modulus of Elasticity, $\times 10^6$ psi	7.35	1.40	6
Poisson's Ratio	0.28	0.06	6
Shear Modulus, $\times 10^6$ psi*	2.87	--	6

* Calculated using E and ν .

64. The tabulated rock properties are reasonable for the high quality bedrock beneath the Cedars Lock and Dam. The relatively low standard deviations for the different tests indicate consistency of the samples tested.

Maximum and residual
shear stress criteria

65. The following discussion of shear stress criteria is taken from Zeiglar (6) and is followed in this report.

66. Designers are commonly interested in the maximum available shear strength. The maximum shear stress points are identified as $\tau_{\max}$ in Figure 1. The maximum shear stress usually corresponds to the peak of the shear stress versus displacement plot (curve a of Figure 1); however, some confusion may arise where strain-hardening is encountered. When strain-hardening occurs, an initial peak usually occurs at a relatively small displacement, followed by an increase in shear stress to a value greater than the initial peak. When this happens, the first peak is termed the maximum shear stress corresponding to initial failure and the latter is the ultimate shear stress.

67. If the residual shear strength is to be determined from the intact specimens, then displacement is continued until the shear stress

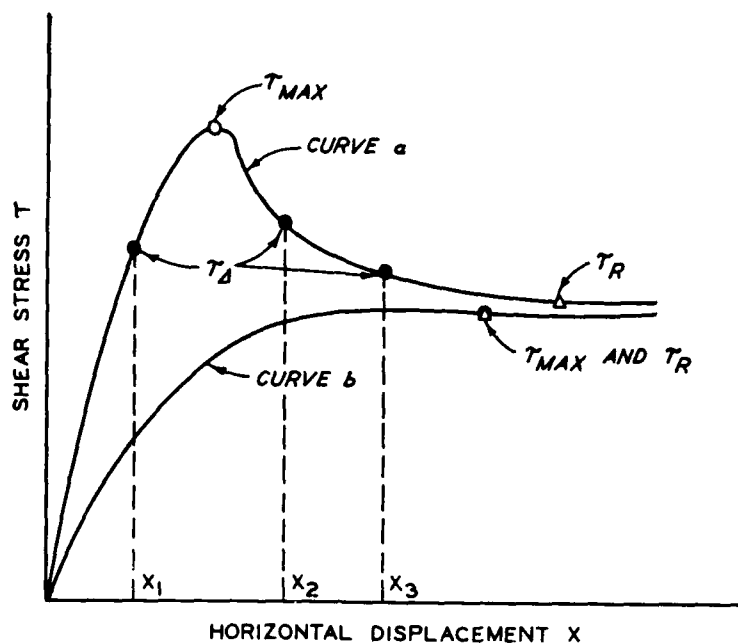


Figure 1. Maximum and residual shear stress, and displacement failure criteria, after Zeigler.

approaches the horizontal asymptotic value of residual shear stress τ_R (curve a of Figure 1). When the zone tested exhibits only a residual shear strength, curve b of Figure 1 may be obtained. In such cases, the maximum shear stress attained is the residual shear strength; precut specimens exhibit this type of curve. The shear strength obtained from precut specimens approaches the residual shear strength.

Maximum and residual shear strengths

68. Two types of direct shear tests were conducted to determine maximum strength of intact specimens and sliding friction properties of discontinuous specimens. Maximum strength was measured for intact dolomite parallel to and across bedding planes. Sliding friction properties were measured for specimens along precut surfaces, including concrete on rock and rock on rock. The direct shear test results of intact specimens are presented in Plate 22; shear stress values, load-deformation curves, and typical normal versus shear deformation curves are presented. The

direct shear test results from the discontinuous specimens tested as precut specimens are presented in Plates 23 and 24. Maximum and residual strength failure envelopes for the intact and discontinuous specimens are presented in Figure 2.

69. Intact specimens containing the two types of bedding surfaces were sheared parallel to bedding. The shear stress values obtained on specimens containing Type A surfaces were extremely high. The shear strength parameters for the Type A surfaces were $\phi = 81$ deg and $c = 198$ tsf. The shear strength parameters for the Type B surfaces are lower: $\phi = 56.2$ deg and $c = 45.6$ tsf. Specimens with both types of bedding surfaces had good shear breaks. The shear gap between the shear blocks was 1/16 in. The specimens sheared within this gap or within $\pm 3/16$ in. of the gap.

70. Triaxial (TX) tests were performed on the dolomite to compare the angle of internal friction from TX to the relatively high friction angles obtained from the direct shear tests on surface Type A. Values of $\phi = 62$ deg and $c = 198$ tsf were obtained from the TX test results; see Plate 25. The results from the direct shear tests on the Type B bedding were judged to be appropriate.

71. Almost all shear failures of the intact specimens tested parallel to bedding were by breaking through the hard, thin shale features. Only a few asperities on the Type A surfaces sheared at the base. None of the asperities on the Type B bedding surfaces were sheared. As shear deformation occurred dilation began and one-half of the specimen rode up over the other. Attempts were not made to determine residual friction from the intact specimens. Precut rock specimens were used to determine the residual strength values. The sliding friction values for precut dolomite are $\phi = 29.7$ deg and $c = 0$.

72. The interlocked bedding plane asperities and the inability to trace continuous bedding plane discontinuities across the site imply that any large-scale failure would involve substantial shearing of intact rock. Therefore, the residual value is not expected to control sliding beneath the lock or dam.

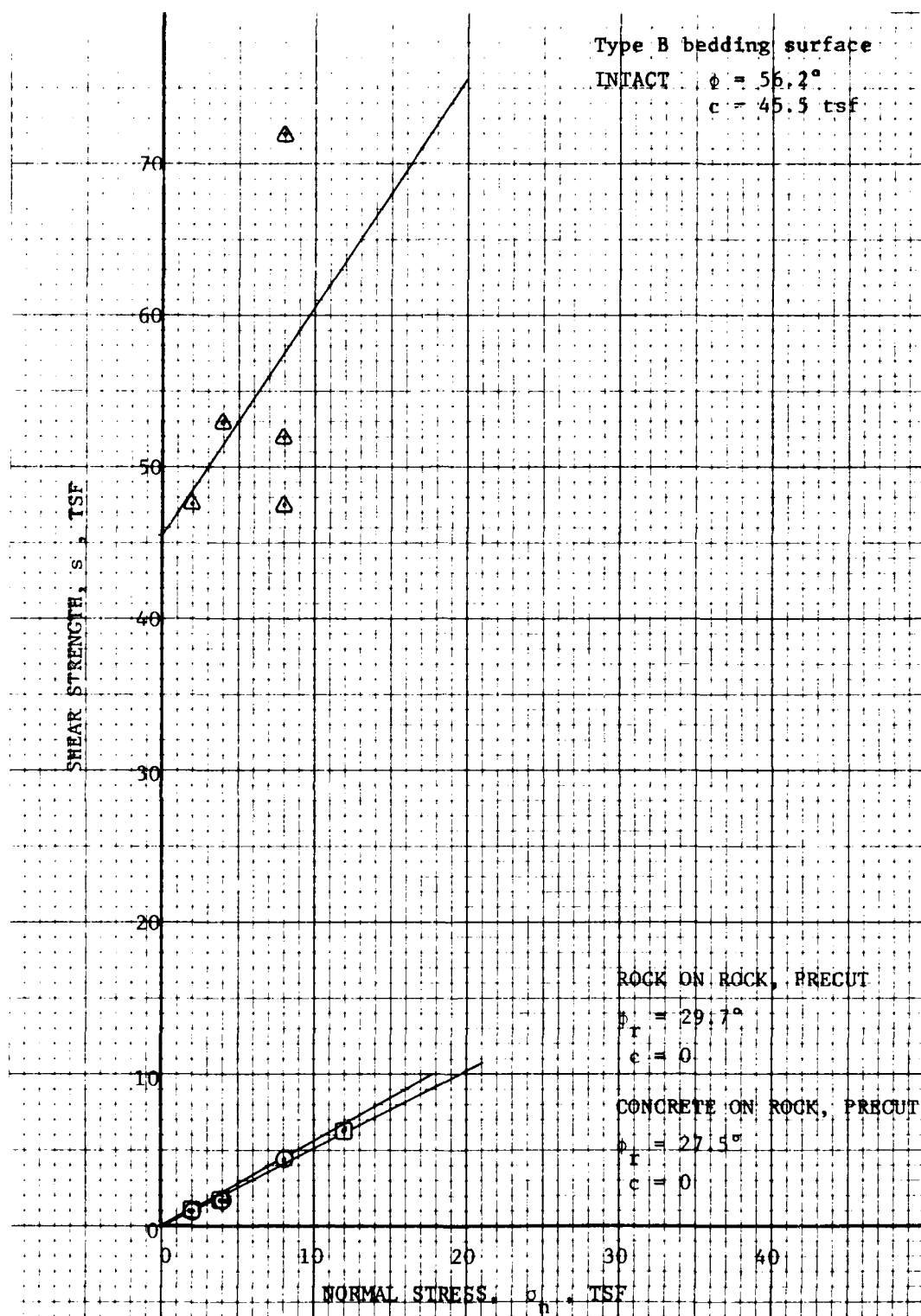


Figure 2. Direct shear test results, maximum and residual shear strength failure envelopes

73. After considering (a) the interlocking nature of the bedding surfaces, (b) the intimate and intact shale-dolomite rock fabric, and (c) because previously failed seams or indications of past horizontal movement in the bedrock were not observed, it is thought that peak shearing resistances of the shale features associated with the most nearly planar bedding surfaces (Type B) would control sliding. These peak shear strengths are recommended for computing stability, i.e., $\phi = 56$ deg and $c = 45.6$ tsf.

74. Cross-bed shear tests were conducted (see Plate 26). The test results are widely scattered and no failure envelope was determined. It is suggested that cross-bed shear tests be performed in the future to determine this shear strength value. However, at this time it is considered reasonable to use the intact shear strengths for cross-bed shear strengths. Stagg and Zienkiewicz⁷ state that:

"When the directions of loading are such that the potential failure surfaces must cut across the structural features, the shear strength will approach that of the intact rock material."

Structural features, as mentioned in the quote from Stagg and Zienkiewicz, typically include joints, shear zones, and faults. At this site, the ubiquity of tightly interlocked asperities on the bedding planes justifies their inclusion in the class of "structural features" across which shear must occur.

Recommended Design Values

75. Design should consider the rock and the bedrock structural characteristics described herein. Guidance is presented in the following tabulation as to proper choice of design parameters:

<u>Rock Property</u>	<u>Dolomite</u>
Effective Unit Weight, lb/ft ³	171.1
Dry Unit Weight, lb/ft ³	169.9
Compressive Strength, psi	20,050
Shear Strength	
Intact, Type B bedding	$\phi = 56.2^\circ$ $c = 45.6$ tsf

<u>Rock Property</u>	<u>Dolomite</u>
Precut, rock on rock	$\phi_r = 29.7^\circ$ $c = 0$
Precut, concrete on rock	$\phi_r = 27.5^\circ$ $c = 0$
Cross bedded	$\phi = 56.2^\circ$ $c = 45.6 \text{ tsf}$
Triaxial Strength	$\phi = 62^\circ$ $c = 198 \text{ tsf}$
Modulus of Elasticity, $\times 10^6 \text{ psi}$	7.35
Poisson's Ratio	0.28
Shear Modulus, $\times 10^6 \text{ psi}$	2.87

Conclusions and Recommendations

76. Based upon a visual inspection of the lock and dam, core samples, and laboratory test results, the following conclusions seem warranted:

- a. The rock masonry in the lock appears sound and has held up well in the severe winter conditions; it should continue to serve its original intended purpose, even though the outside surface is weathered.
- b. The concrete in the lock and dam is locally cracked and lightly deteriorated. The deterioration is due to cycles of freezing and thawing. Each tainter gate pier has cracks adjacent to the hinge pins that go through the piers. The cause of these cracks is not postulated. The concrete in the dam is structurally sound and should continue to serve its originally intended purpose.
- c. The lock and dam is founded on competent bedrock which contains a minimal number of discontinuities. Jointing is minimal. Shale features occur along irregular bedding planes; they are thin and considered as part of the rock fabric, and they should have no effect on sliding stability. No soft or otherwise weak zones were detected in the bedrock.
- d. It is our opinion that no significant scour has occurred behind the dam. Sounding behind the dam should be made to verify this opinion.
- e. We suggest that a study be conducted to ascertain if the reinforcing steel in the downstream portion of the tainter gate piers is badly corroded. An area around one of the hinge pins could be excavated for this purpose.

REFERENCES

1. U. S. Army Engineer District, Chicago, "Periodic Inspection Report No. 1," Cedars Lock and Dam, Lower Fox River, Wisconsin, Feb 1976.
2. Letter, NCCED-DC, dated 26 Dec 1979, subject "Periodic Inspection and Continuing Evaluation of Completed Civil Works Structures - Lower Fox River, Wisconsin, Appleton Locks and Dams;" attached to this letter is NCDED-T (26 Dec 79) 1st Ind, subject as above, and NCCED-DC (26 Dec 79) 2d Ind, subject as above.
3. Letter, NCCED-DC, dated 11 Mar 1976, subject "Periodic Inspection and Continuing Evaluation of Completed Civil Works Structures - Lower Fox River, Wisconsin, Cedars Lock and Dam;" attached to this letter is NCDED-T (11 Mar 76) 1st Ind, subject as above, DAEN-CWE-B (NCCED-DC, 11 Mar 76) 2d Ind, subject as above, NCDED-T (11 Mar 76) 3d Ind, subject as above, NCCED-DC (11 Mar 76) 4th Ind, subject as above, NCDED-T (11 Mar 76) 5th Ind, subject as above, NCCED-DC (11 Mar 76) 6th Ind, subject as above, NCDED-T (11 Mar 76) 7th Ind, subject as above.
4. U. S. Army, Office, Chief of Engineers, "Engineering and Design: Soil Sampling," EM 1110-2-1907, 31 Mar 72, U. S. Government Printing Office, Washington, D. C.
5. U. S. Army Engineer Waterways Experiment Station, CE, "Rock Testing Handbook," Test Standards - 1980, Vicksburg, Miss., Aug 1980.
6. Zeiglar, T. W., "In Situ Tests for the Determination of Rock Mass Shear Strength," TR No. S-72-12, Nov 1972, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.
7. Stagg, K. G. and Zienkiewicz, O. C., Rock Mechanics in Engineering Practice, John Wiley and Sons, London, 1968, p 46.

Table 1

Boring, Locations, Elevations, and Starting Date of Boring

Cedars Lock and Dam, Lower Fox River

Boring No.	Type of Boring	Location	El Top of Boring ft	El Top of Rock ft	El Bottom of Boring ft	Start Date
C WES E1-80	▲	Backfill, LLW	704.00	686.60	659.90	2 Aug 1980
C WES E2-80	▲	Backfill, RLW	702.80	684.20	679.10	16 Aug 1980
C WES D1-80	●	Spillway Pier 1	703.80	686.20	666.10	12 Aug 1980
C WES D2-80	●	Sluiceway Pier 4	706.97	683.02	656.97	8 Aug 1980
C WES D3-80	●	Spillway Pier 7	703.80	686.60	664.75	13 Aug 1980
C WES D4-80	●	US of Sluiceway Pier 4	687.10	687.10	665.35	16 Aug 1980
C WES D5-80	●	DS of Sluiceway Pier 5	683.41	683.41	662.21	22 Aug 1980
C WES D6-80	●	DS Sluiceway Apron, Gate 4	686.91	685.46	682.11	19 Aug 1980
C WES D7-80	●	DS of Sluiceway Gate 1	685.91	685.91	679.71	23 Aug 1980
C WES D8-80	●	DS of Sluiceway Gate 7	686.26	686.26	681.06	22 Aug 1980
C WES D9-80	●	Sluiceway Pier 4	697.33	--	697.33	22 Aug 1980
C WES D10-80	●	Left Abutment.	696.30	--	696.30	18 Aug 1980
C WES D11-80	●	Sluiceway Pier 3	697.73	--	697.73	22 Aug 1980

● Vertical 4-in. core hole.

● Horizontal 4-in. core hole.

▲ Combined drive sample and core.

▲ Combined drive sample and core with piezometer installed.

LLW, Landside lock wall.

RLW, Riverside lock wall.

US Upstream.

DS Downstream.

Table 2
Water Level Readings
C WES D2-80

<u>Time</u>	<u>Date</u>	<u>Upper Pool el, ft</u>	<u>Lower Pool el, ft</u>	<u>Top of Hole Elev, ft D2 (706.97) el, ft</u>	<u>Reading ft</u>
3:30	19 Aug	699.52	689.91	690.37	-16.6
9:25	20 Aug	699.52	690.11	690.63	-16.34
3:30	20 Aug	699.52	690.11	690.62	-16.35
3:00	21 Aug	699.42	690.11	690.00	-16.97
5:00	21 Aug	699.42	690.11	690.33	-16.64
8:30	22 Aug	699.32	690.01	690.27	-16.70
5:25	22 Aug	699.32	690.01	690.27	-16.70
8:25	23 Aug	699.52	690.01	690.37	-16.60
3:30	23 Aug	699.52	690.01	690.25	-16.72

Table 3

Soil Samples Received, Cedars Lock and Dam, Lower Fox River

Date	Drill Hole No.	Sample		Type Sample	Sample Depth, ft	Material	
		No.	5-in. Steel Tube, 5-in. Piston Sampler, and 5-1/2- x 4-in. Core			Field Nomenclature	
15 Aug 80	C WES E1-80	1A	5-in. steel tube	0.0 - 1.05	Organics, grass and roots		
15 Aug 80	C WES E1-80	1B	Jar	1.05- 1.15	Gravelly clay, reddish brown		
15 Aug 80	C WES E1-80	1C	5-in. steel tube	1.9 - 2.5	Gravelly clay, reddish brown		
15 Aug 80	C WES E1-80	2A	5-in. steel tube	2.5 - 3.4	Clay		
15 Aug 80	C WES E1-80	2B	Jar	3.4 - 3.5	Clay		
15 Aug 80	C WES E1-80	2C	5-in. steel tube	3.5 - 4.4	Clay		
15 Aug 80	C WES E1- 0	2D	Jar	4.4 - 4.5	Clay		
15 Aug 80	C WES E1-80	3A	Jar	4.5 - 4.6	Clay w/one piece gravel		
15 Aug 80	C WES E1-80	3B	5-in. steel tube	4.6 - 6.4	Clay		
15 Aug 80	C WES E1-80	3C	Jar	6.4 - 6.5	Clay		
15 Aug 80	C WES E1-80	4A	Jar	6.5 - 6.6	Clay		
15 Aug 80	C WES E1-80	4B	5-in. steel tube	6.6 - 7.5	Clay, crumbly		
15 Aug 80	C WES E1-80	4C	5-in. steel tube	7.5 - 8.4	Clay, crumbly		
15 Aug 80	C WES E1-80	4D	Jar	8.4 - 8.5	Clay, crumbly		
15 Aug 80	C WES E1-80	5A	5-in. steel tube	8.5 - 10.4	Gravelly sand, clay		
15 Aug 80	C WES E1-80	5B	Jar	10.4 - 10.5	Gravelly sand, clay		
15 Aug 80	C WES E1-80	6A	5-in. steel tube	10.7 - 12.4	Gravelly sand, brown, fine to coarse		
15 Aug 80	C WES E1-80	6B	Jar	12.4 - 12.5	Gravelly sand, brown, fine to coarse		
15 Aug 80	C WES E1-80	7	Splitspoon, jar	12.5 - 14	Coarse sand		
15 Aug 80	C WES E1-80		5-1/2- x 4-in. core	15.3 - 20.3	Dolomite		
15 Aug 80	C WES E2-80	1	5-in. steel tube	0.2 - 2.4	Organic matter, clay and silt, plastic, brown		
15 Aug 80	C WES E2-80	1A	Jar	2.4 - 2.5	Organic matter, clay and silt, plastic, brown		
15 Aug 80	C WES E2-80	2	5-in. steel tube	2.7 - 4.9	Clay/silt, brown, soft		
15 Aug 80	C WES E2-80	2A	Jar	4.9 - 5.0	Clay/silt, brown, soft		
15 Aug 80	C WES E2-80	3	5-in. steel tube	5.0 - 5.8	Clay, soft, reddish brown		
15 Aug 80	C WES E2-80	3A	Jar	5.8 - 6.1	Clay, soft, reddish brown		
15 Aug 80	C WES E2-80	3B	5-in. steel tube	6.1 - 7.2	Clay, soft, reddish brown		
15 Aug 80	C WES E2-80	3C	Jar	7.2 - 7.3	Clay, soft, reddish brown		

(Continued)

Table 3 (Concluded)

Date	Drill Hole No.	Sample		Type Sample	Sample Depth, ft	Material Field Nomenclature
		No.				
				5-in. Steel Tube, 5-in. Piston Sampler, and 5-1/2- x 4-in. Core		
15 Aug 80	C WES E2-80	4		5-in. steel tube	7.6 - 8.5	Clay, w/dolomite, cobbles, boulders, gravel
15 Aug 80	C WES E2-80	4A		Jar	7.5 - 7.6	Clay, w/dolomite, cobbles, boulders, gravel
15 Aug 80	C WES E2-80	5		Bag - piston sampler	8.7 -11.4	Clay, w/dolomite, cobbles, boulders, gravel
15 Aug 80	C WES E2-80	6		Bag - piston sampler	11.4 -16.4	Clay (20%) dolomite (80%)
15 Aug 80	C WES E2-80	7		Bag - piston sampler	16.4 -18.7	Clay (20%) dolomite (80%)
15 Aug 80	C WES E2-80			Box, 5-1/2- x 4-in. core	18.7 -23.8	

Table 4

Samples Received at WES, Cedars Lock and Dam, Lower Fox River

WES Reference No.	Drill Hole No.	Date Received	Box No.	Depth ft	Pieces	Core Diameter in.
DET-5 DC-1-A	C WES E1-80	15 Aug 80	1 of 6	17.4 → 20.3	(1-5)	4
B			2 of 6	20.4 → 25.85	(1-6)	
C			3 of 6	25.85 → 30.4	(1-5)	
D			4 of 6	30.4 → 34.75	(1-5)	
E			5 of 6	34.75 → 39.7	(1-5)	
F			6 of 6	39.7 → 44.1	(1-7)	
DET-5 DC-2-A	C WES E2-80		1 of 1	(18.65 → 23.8)	(1-7)	
DET-5 CON-1-A	C WES D1-80		1 of 9	0.0 → 4.3	(1-2)	6
B			2 of 9	4.3 → 8.45	(1-4)	4
C			3 of 9	8.45 → 12.7	(1-3)	4
D			4 of 9	12.7 → 17.0	(1-3)	4
CON-1						
DC-3-E			5 of 9	17.0 → 21.8	(1-6)	4
DET-5 DC-3-F			6 of 9	21.8 → 26.4	(1-6)	4
DC-3-G			7 of 9	26.4 → 30.3	(1-5)	4
DC-3-H			8 of 9	30.3 → 33.9	(1-4)	4
DC-3-I			9 of 9	33.9 → 37.3	(1-5)	4
DET-5 CON-2-A	C WES D2-80		1 of 11	0.00 → 4.55	(1-2)	6
B			2 of 11	4.55 → 9.10	(1-2)	4
C			3 of 11	9.10 → 14.10	(1)	4
D			4 of 11	14.10 → 19.15	(1-2)	4
E			5 of 11	19.15 → 23.95	(1)	4
DET-5 DC-4-F			6 of 11	23.95 → 29.20	(1-4)	4
G			7 of 11	29.20 → 33.80	(1-4)	4
H			8 of 11	33.80 → 38.20	(1-5)	4
I			9 of 11	38.20 → 42.00	(1-3)	4
J			10 of 11	42.00 → 46.50	(1-2)	4
K			11 of 11	46.50 → 50.00	(1-4)	4

(Continued)

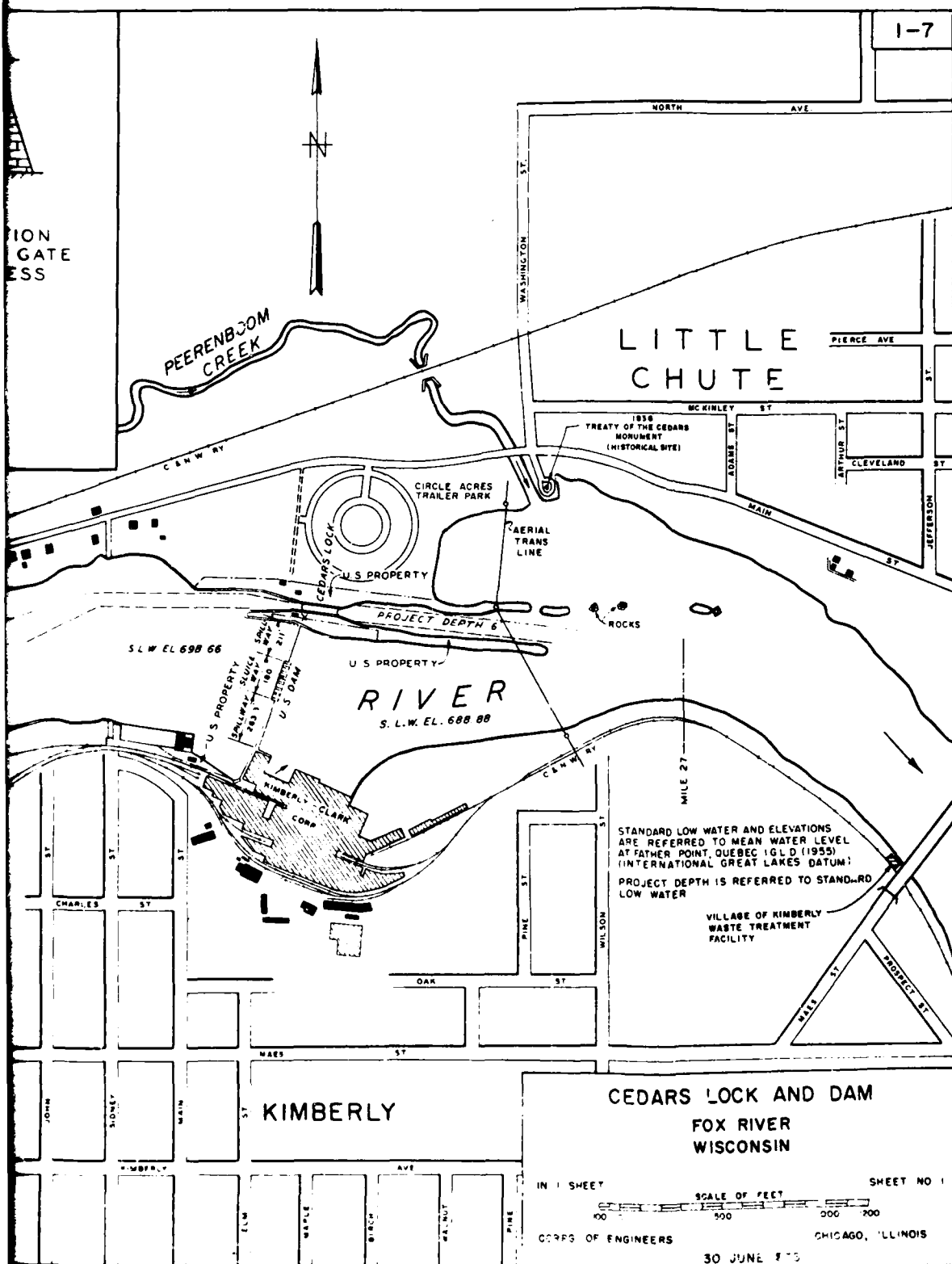
Table 4 (Concluded)

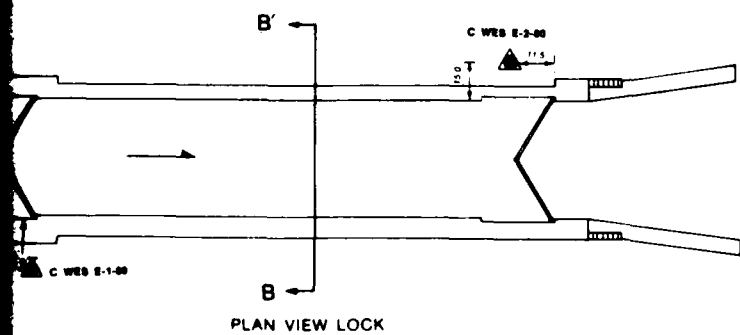
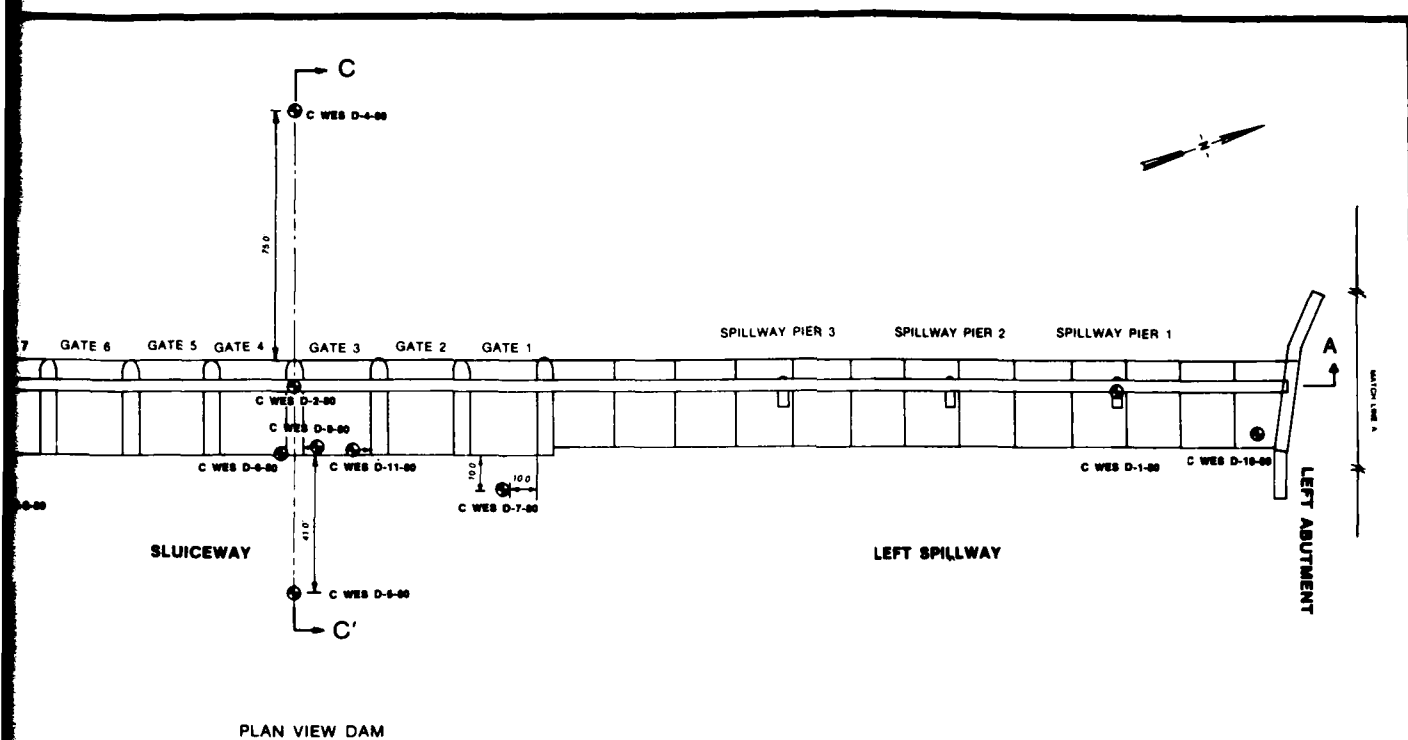
WES Reference No.	Drill Hole No.	Date Received	Box No.	Depth ft	Pieces	Core Diameter in.
DET-5 CON-3-A	C WES D3-80	15 Aug 80	1 of 9	0.0 → 3.45	(1-2)	6 and 4
B			2 of 9	3.45 → 8.1	(1-3)	4
C			3 of 9	8.1 → 11.2	(1-2)	4
D			4 of 9	11.2 → 15.75	(1-2)	4
CON-3-						
DC-5-E			5 of 9	15.75 → 20.6	(1-5)	4
DET-5 DC-5-F			6 of 9	20.6 → 24.5	(1-5)	4
G			7 of 9	24.5 → 29.5	(1-5)	4
H			8 of 9	29.5 → 34.4	(1-5)	4
I			9 of 9	34.4 → 38.6	(1-4)	4
DET-5 DC-6-A	C WES D4-80		1 of 5	0.0 → 4.9	(1-7)	4
B			2 of 5	4.9 → 9.4	(1-5)	4
C			3 of 5	9.4 → 13.95	(1-6)	4
D			4 of 5	13.95 → 18.2	(1-5)	4
E			5 of 5	18.2 → ?	(1-2)	4
DET-5 DC-7-A	C WES D5-80		1 of 5	0.0 → 4.40	(1-4)	4
B			2 of 5	4.40 → 9.4	(1-5)	4
C			3 of 5	9.4 → 14.45	(1-5)	4
D			4 of 5	14.95 → 17.95	(1-5)	4
E			5 of 5	17.95 → 21.2	(1-2)	4
DET-5 CON-4-A	C WES D6-80		1 of 1	0.0 → 4.85	(1-6)	4
DC-8-A						
DET-5 DC-9-A	C WES D7-80		1 of 2	0.0 → 3.55	(1-5)	4
B			2 of 2	3.55 → 6.2	(1-3)	4
DET-5 DC-10-A	C WES D8-80		1 of 1	(0.0 → 4.55)	(1-5)	4
DET-5 CON-5-A	C WES D9-80		1 of 1	0.0 → 2.85	(1-2)	4
DET-5 CON-6-A	C WES D10-80		1 of 1	0.0 → 2.85	(1-2)	4
DET-5 CON-7-A	C WES D11-80		1 of 1	0.0 → 2.95	(1-3)	4

Table 5
Concrete and Rock Core Test Results, Cedars Lock and Dam

Drill Hole No.	Elev ft	Characterization Tests					Engineering Design Tests			
		Depth of Core ft	Effective Unit Wt	Dry Unit Wt	Water Content	Comp Wave Velocity	Comp Strength	Elastic Modulus	Poisson's Ratio	
			γ_m , lb/ft ³	γ_d , lb/ft ³	w, pcf	V_p , fps				q_u , psi
<u>Concrete</u>										
C WES D2-80	706.5	0.5	153.0	145.9	4.9	16,640	5,920	4.29	0.14	
C WES D2-80	696.5	10.5	153.0	145.3	5.3	17,370	8,370	4.65	0.21	
C WES D2-80	689.3	17.7	154.2	146.9	5.0	17,705	8,570	5.13	0.26	
Avg			153.4	146.0	5.1	17,240	7,620	4.69	0.20	
S*			0.7	0.8	0.2	544	1,480	0.42	0.06	
<u>Rock</u>										
C WES D1-80	679.2	24.6	171.1	169.7	0.8	19,410	18,780	9.00	0.20	
C WES D1-80	676.9	26.9	169.8	168.8	0.6	20,780	20,160	8.00	0.38	
C WES D2-80	677.1	29.9	170.4	169.2	0.7	20,150	23,270	6.73	0.32	
C WES D2-80	675.8	31.2	171.1	169.6	0.9	20,780	21,840	7.20	0.23	
C WES D3-80	683.5	20.3	172.3	170.9	0.8	19,690	19,590	8.17	0.27	
C WES D3-80	681.6	22.2	171.7	171.0	0.4	19,410	16,650	5.00	0.27	
Avg			171.1	169.9	0.7	20,040	20,050	7.35	0.28	
S			0.9	0.9	0.2	636	2,322	1.40	0.06	

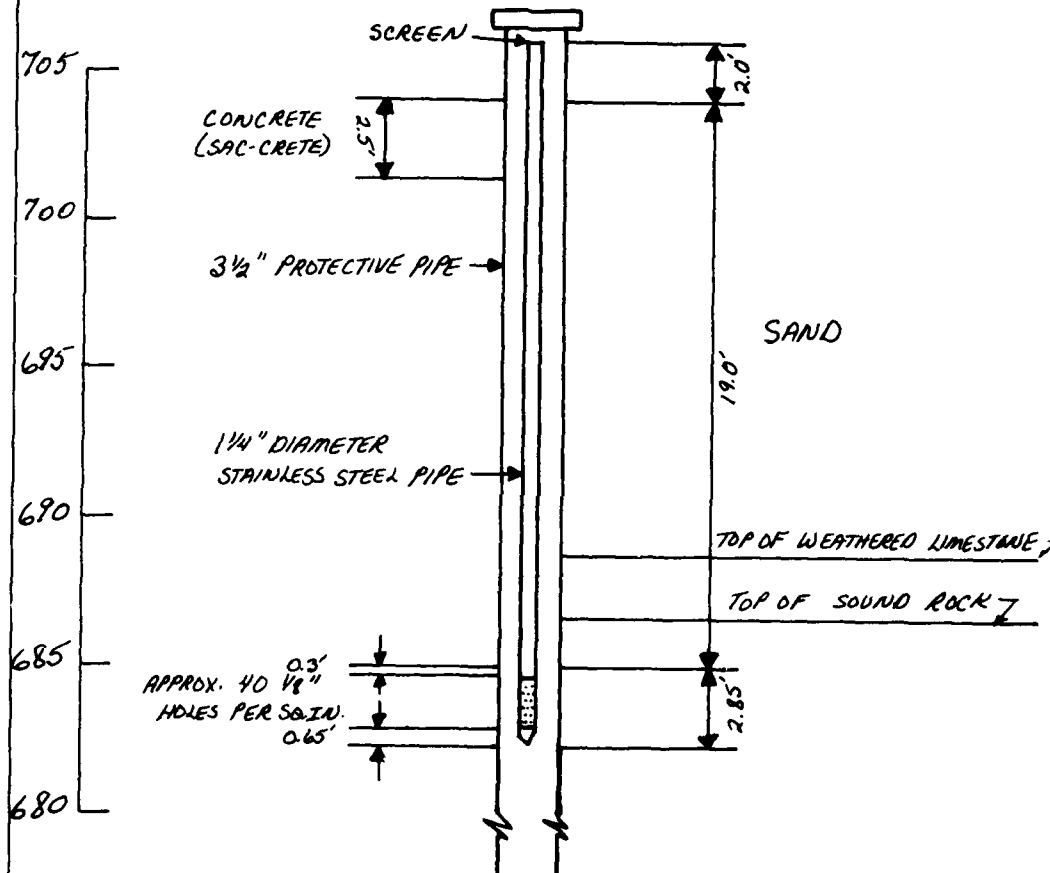
* Standard deviation.





CONDITION SURVEY
AUGUST 1960
CEDARS LOCK AND DAM
BORING LOCATION PLAN &
GEOLOGIC CROSS SECTIONS

C WES-E1-80
PIEZOMETER LOG
 EL. TOP OF HOLE 704.0'

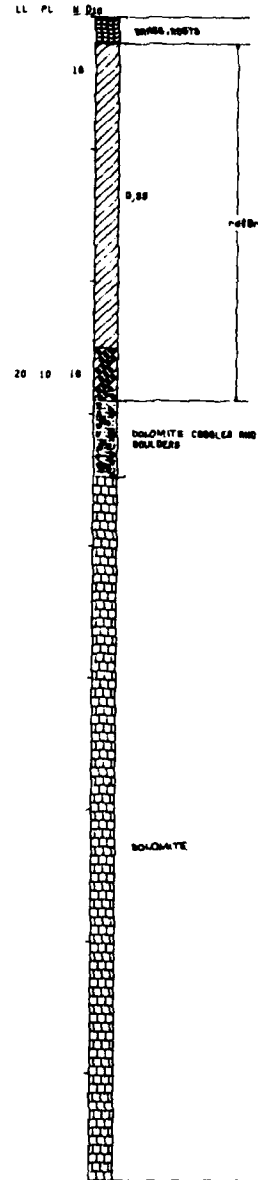


CWES-E1-80
CEDARS LOCK AND DAM
LITTLE CHUTE, WISCONSIN
AUGUST 02, 1980

CWE
CEDARS
LITTLE
AUG

0
-5
-10
-15
-20
-25
-30
-35
-40
-45

DEPTH IN FEET



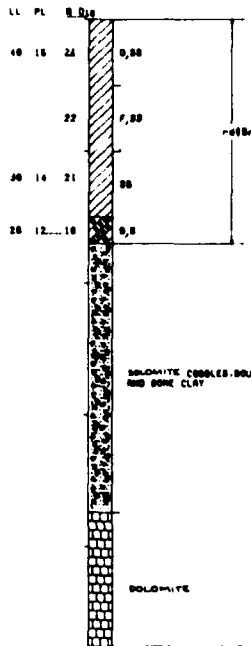
LL PL 16 16
40 16 20
20
40 14 21
20 12 10

HORIZONTAL 5

VERTICAL 3

ALL SYMBOLS IN
UNIFIED SOILS

CEDARS LOCK AND DAM
LITTLE CHUTE, WISCONSIN
AUGUST 16, 1960



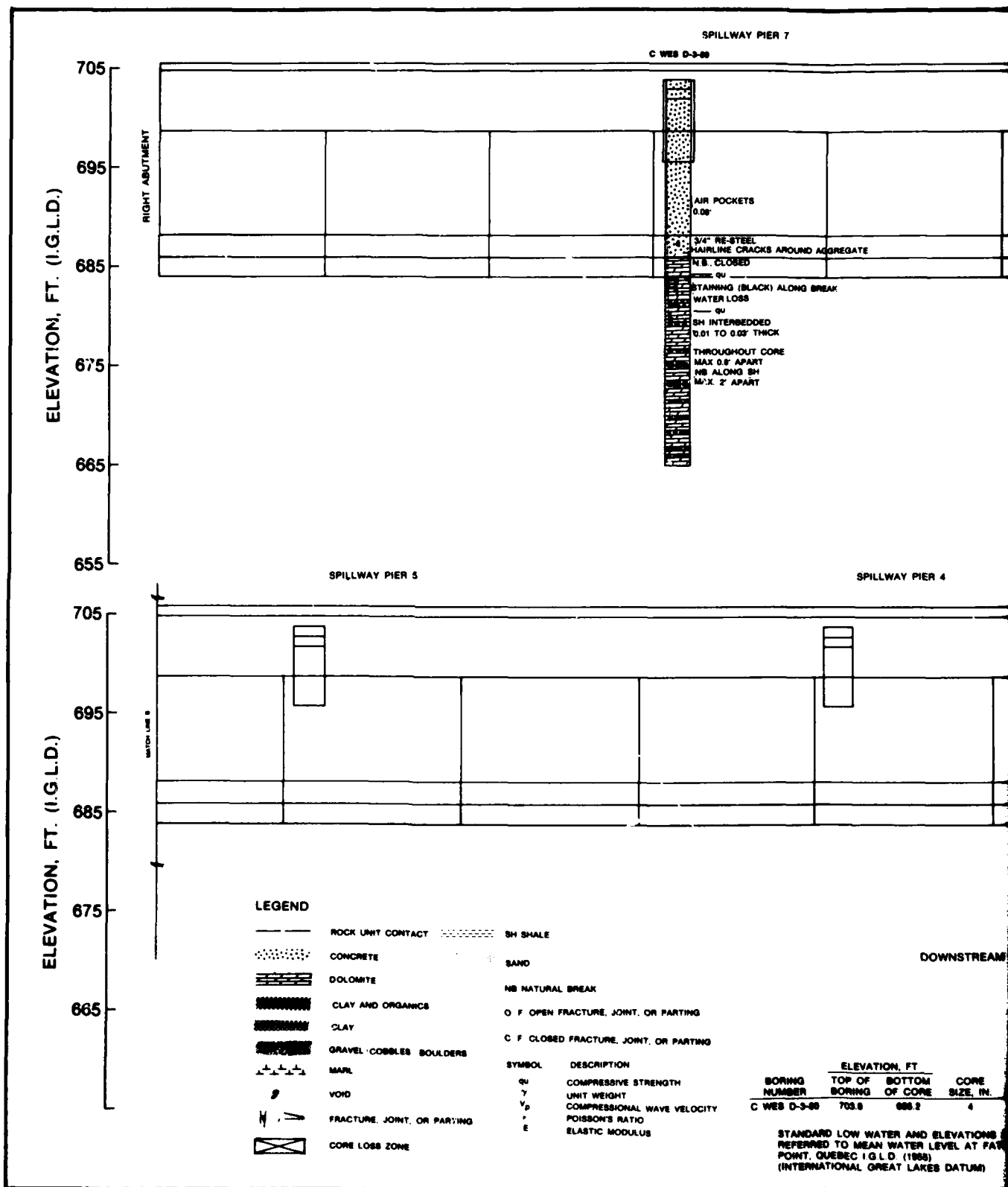
HORIZONTAL 5 0 5 10 FT

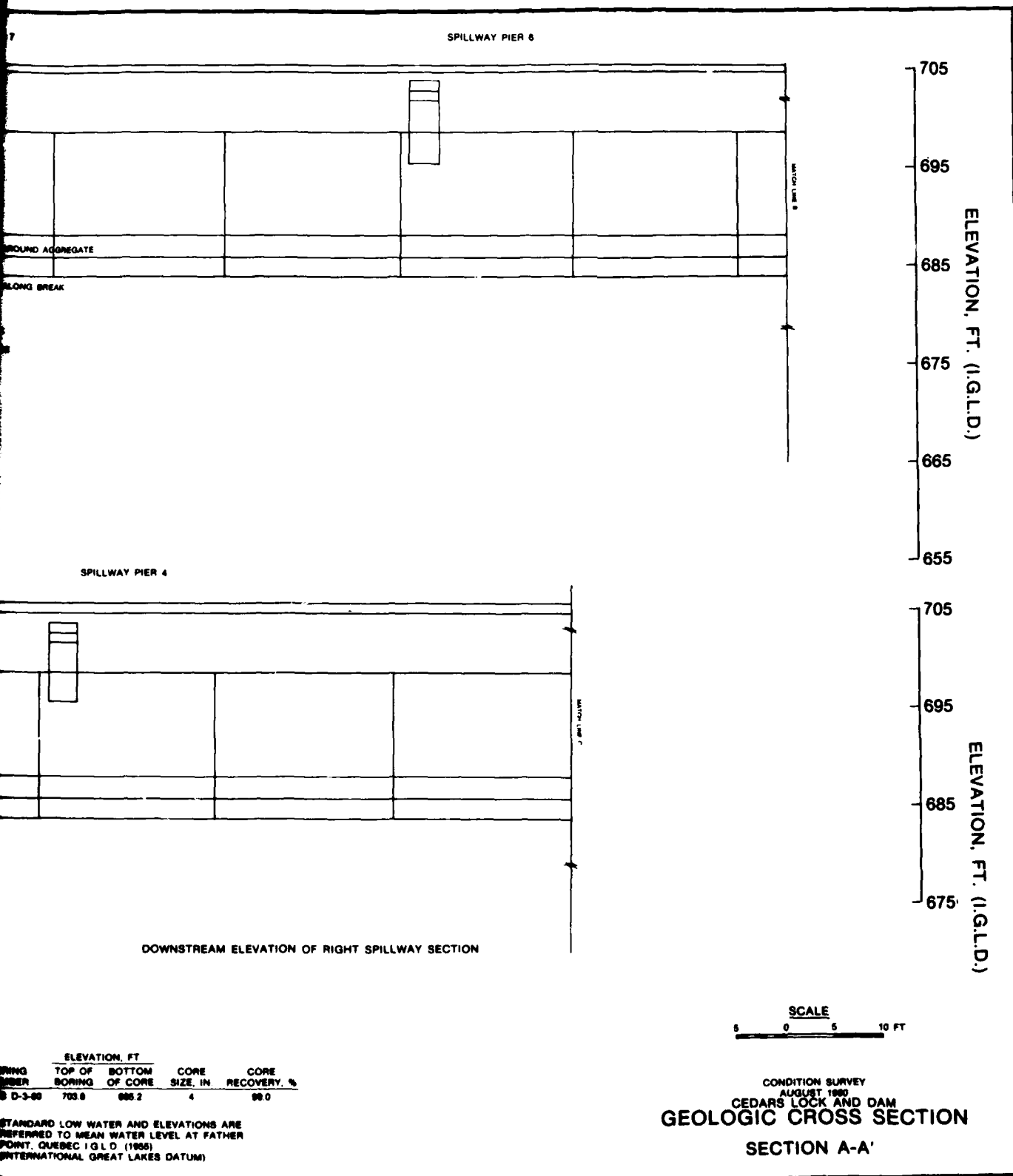
VERTICAL 3 0 3 6 FT

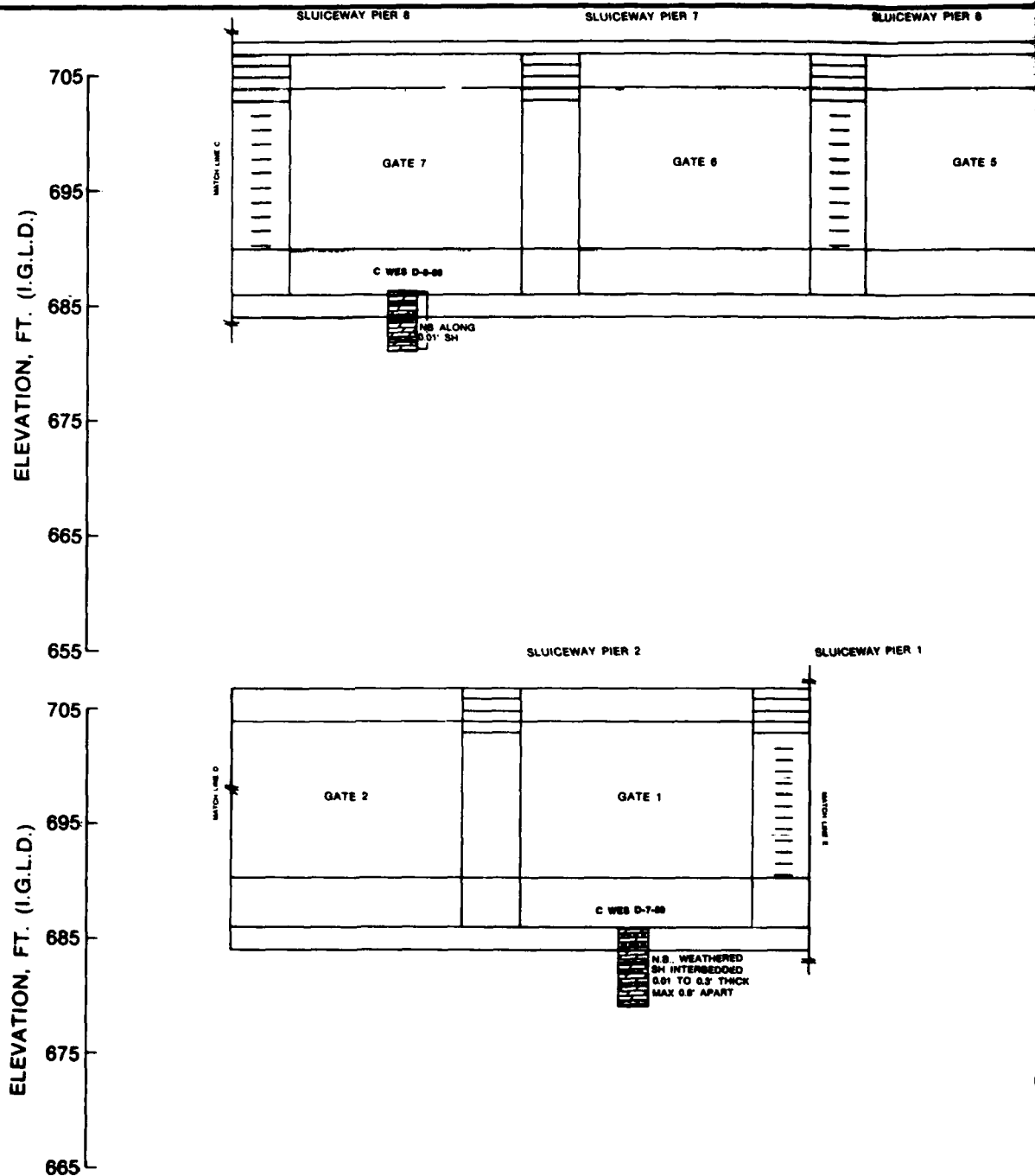
ALL SYMBOLS AND CHARACTERS CONFORM TO THE
UNIFIED SILD CLASSIFICATION SYSTEM

CEDARS LOCK AND DAM

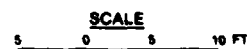
PLATE 4

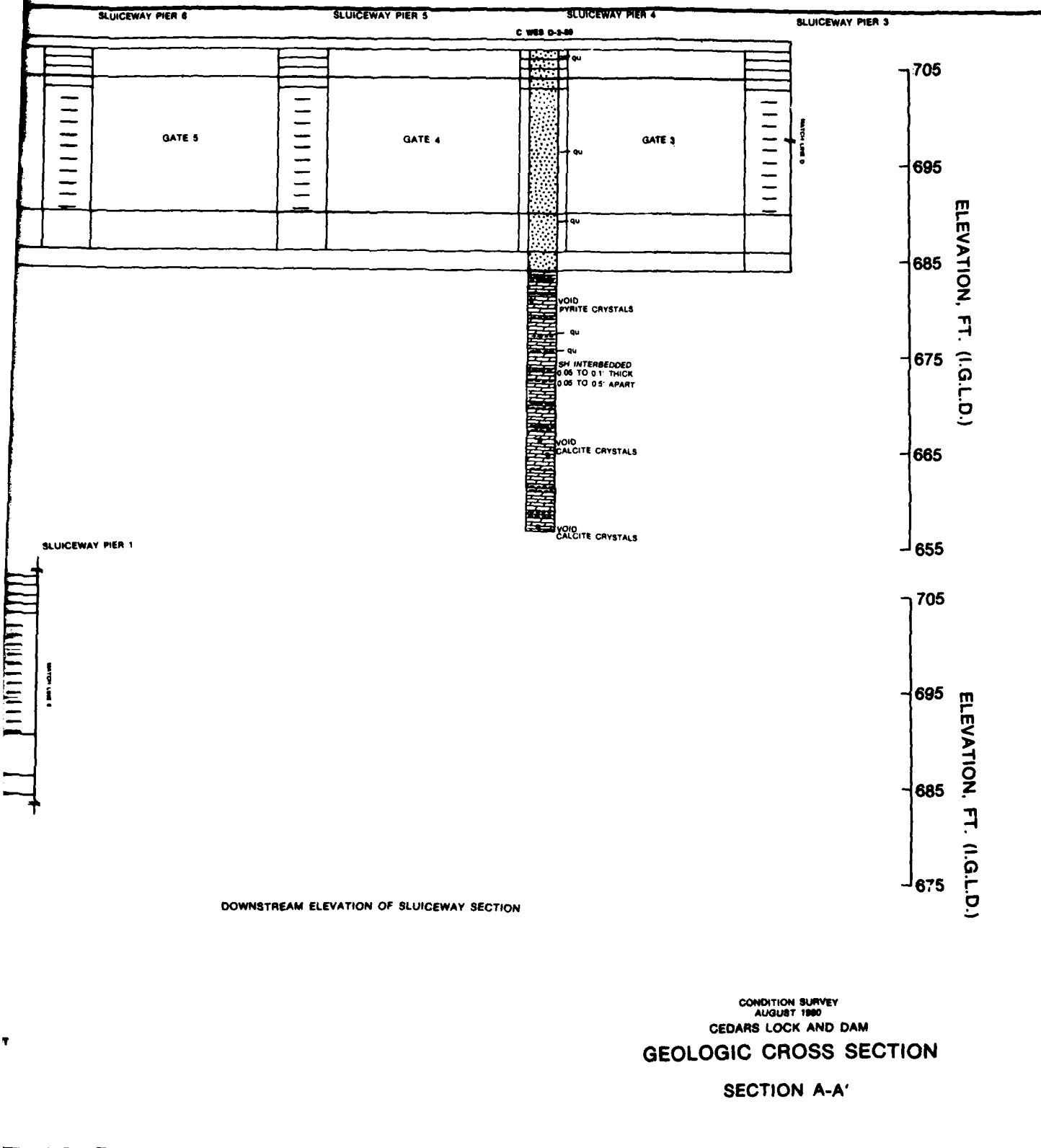






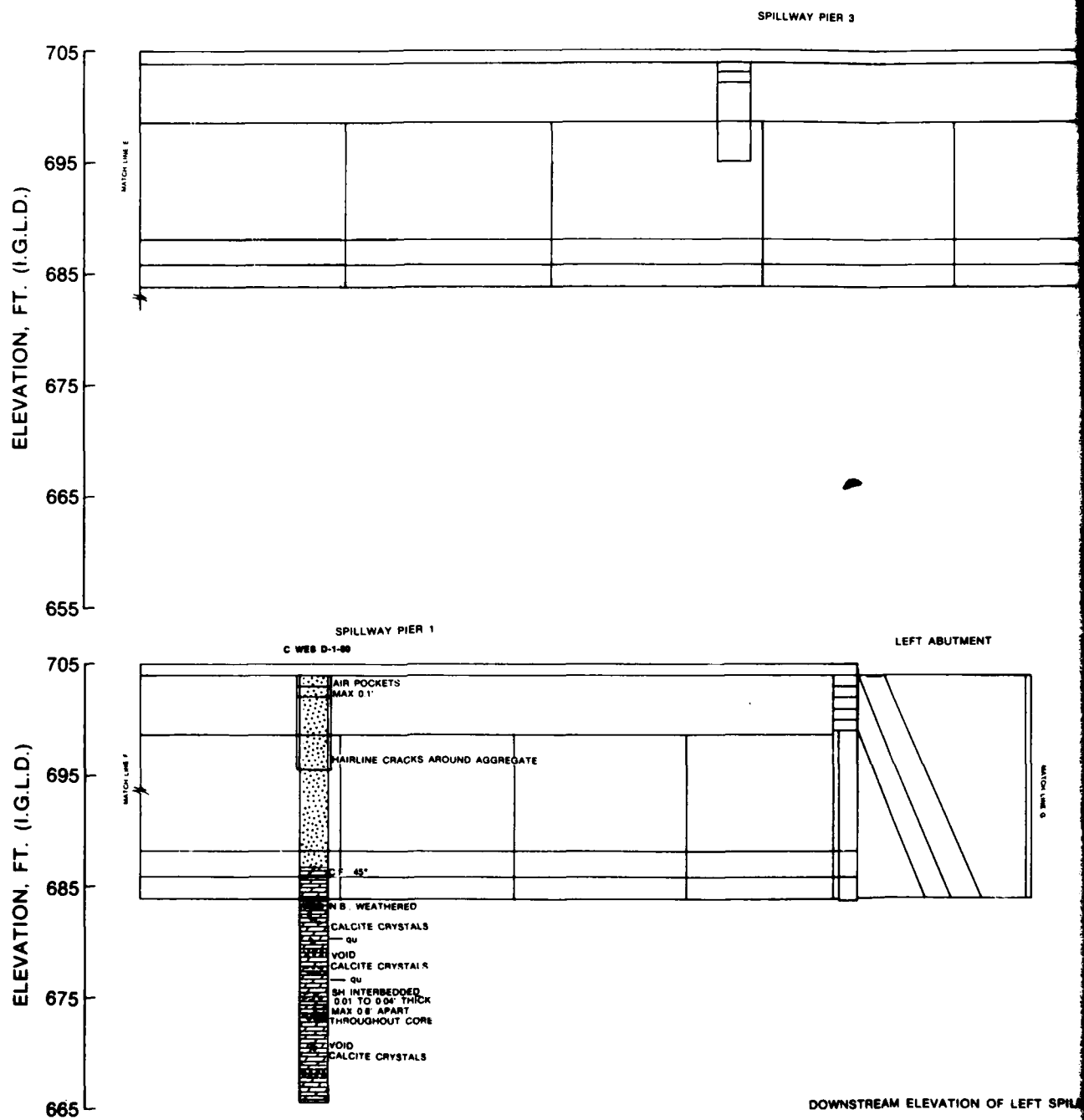
BORING NUMBER	ELEVATION, FT		CORE SIZE, IN.	CORE RECOVERY, %
	TOP OF BORING	BOTTOM OF CORE		
C WES D-2-80	708.97	686.97	4	100
C WES D-7-80	680.01	679.00	4	100
C WES D-8-80	680.01	681.08	4	87.5



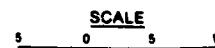


2

PLATE 6

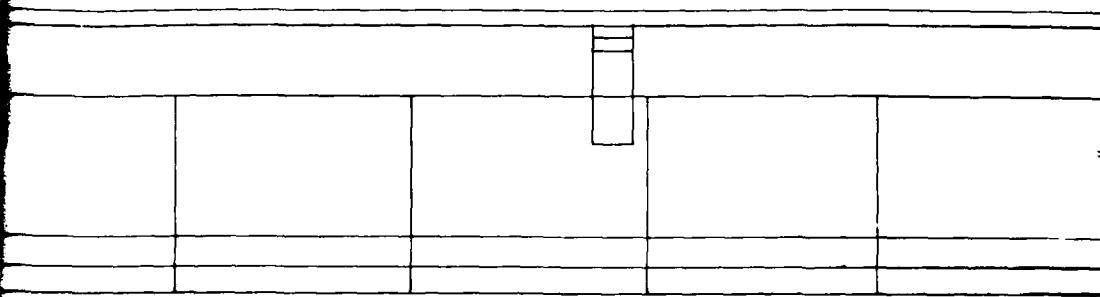


BORING NUMBER	ELEVATION, FT.		CORE SIZE, IN.	CORE RECOVERY, %
	TOP OF BORING	BOTTOM OF CORE		
C WES D-1-80	703.8	666.5	4	99.3



PIER 3

SPILLWAY PIER 2



705

695

685

675

665

655

ELEVATION, FT. (I.G.L.D.)

705

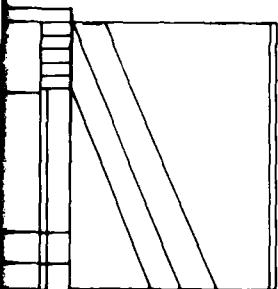
695

685

675

ELEVATION, FT. (I.G.L.D.)

LEFT ABUTMENT



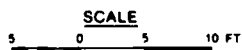
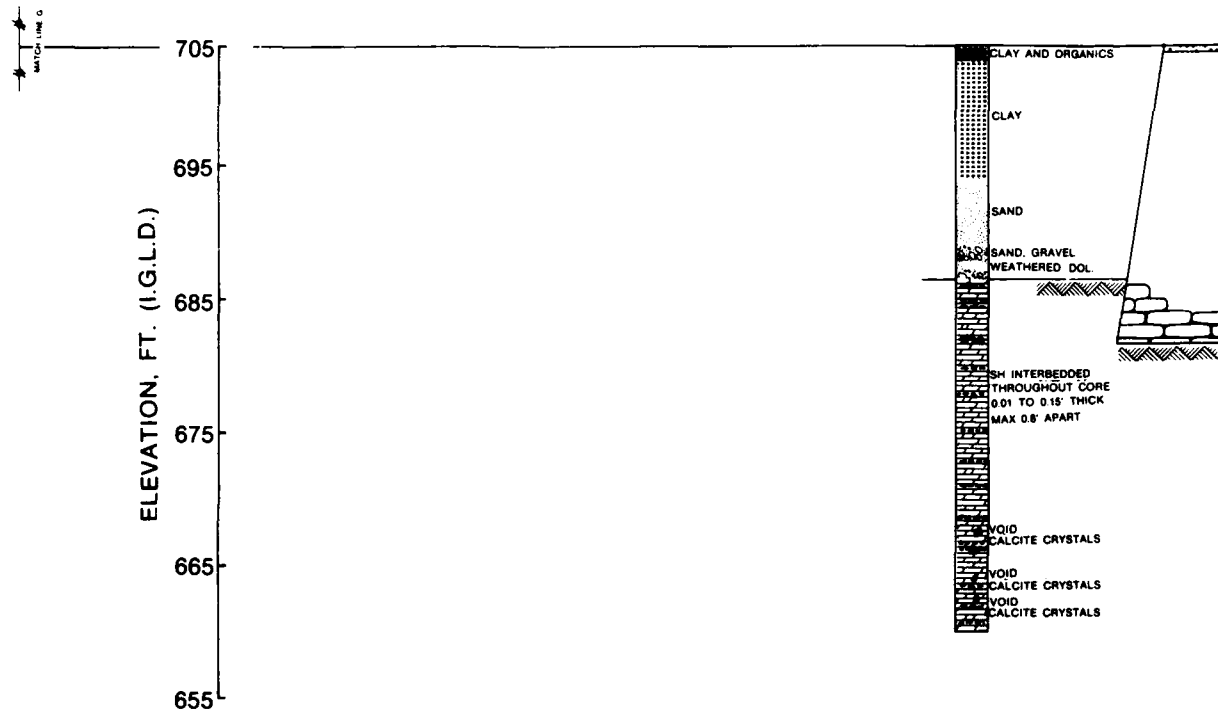
DOWNSTREAM ELEVATION OF LEFT SPILLWAY SECTION



CONDITION SURVEY
AUGUST 1980
CEDARS LOCK AND DAM
GEOLOGIC CROSS SECTION
SECTION A-A'

PLATE 7

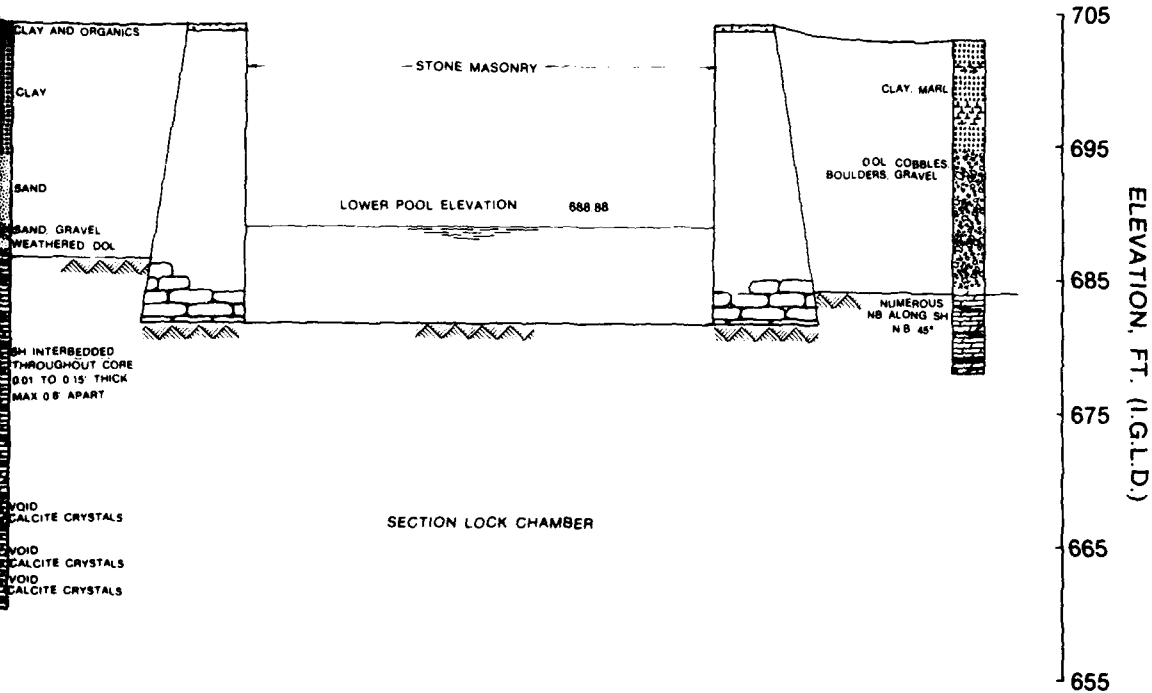
C WES E-1-80



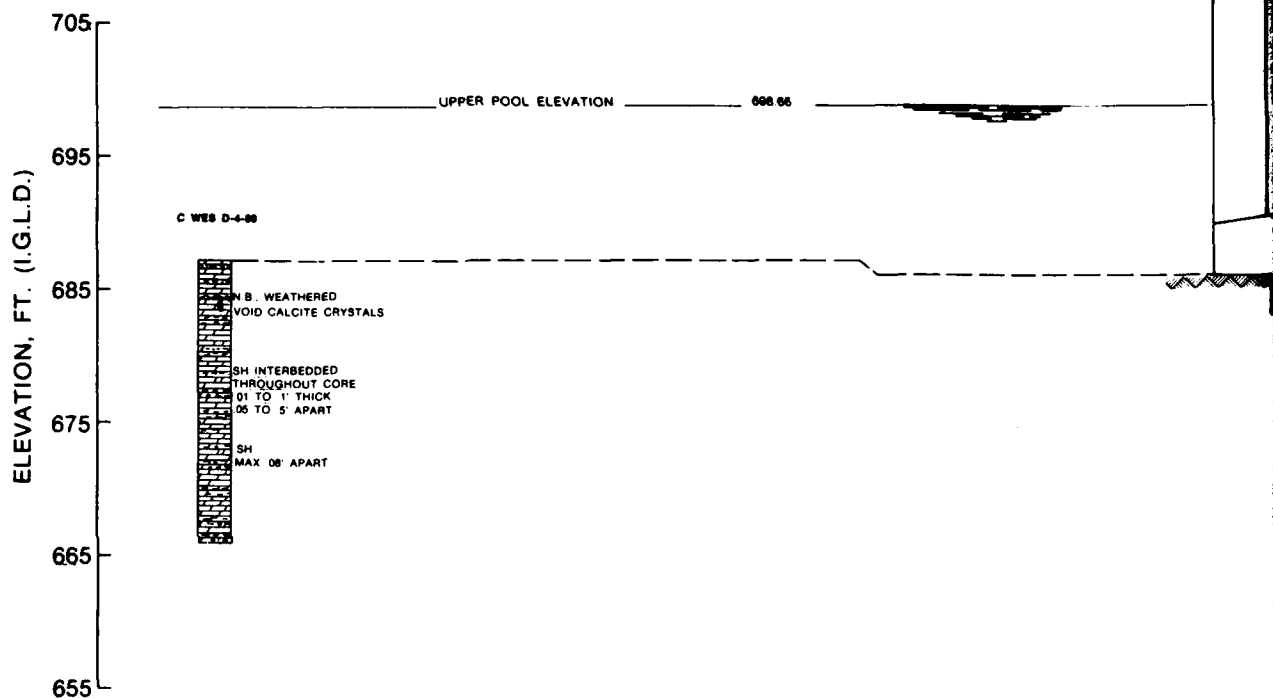
BORING NUMBER	ELEVATION, FT		CORE SIZE, IN	CORE RECOVERY, %
	TOP OF BORING	BOTTOM OF CORE		
C WES E-1-80	704.0	656.9	4	100
C WES E-2-80	702.8	679.0	NX	100

B-1-80

C WEB 6-2-80

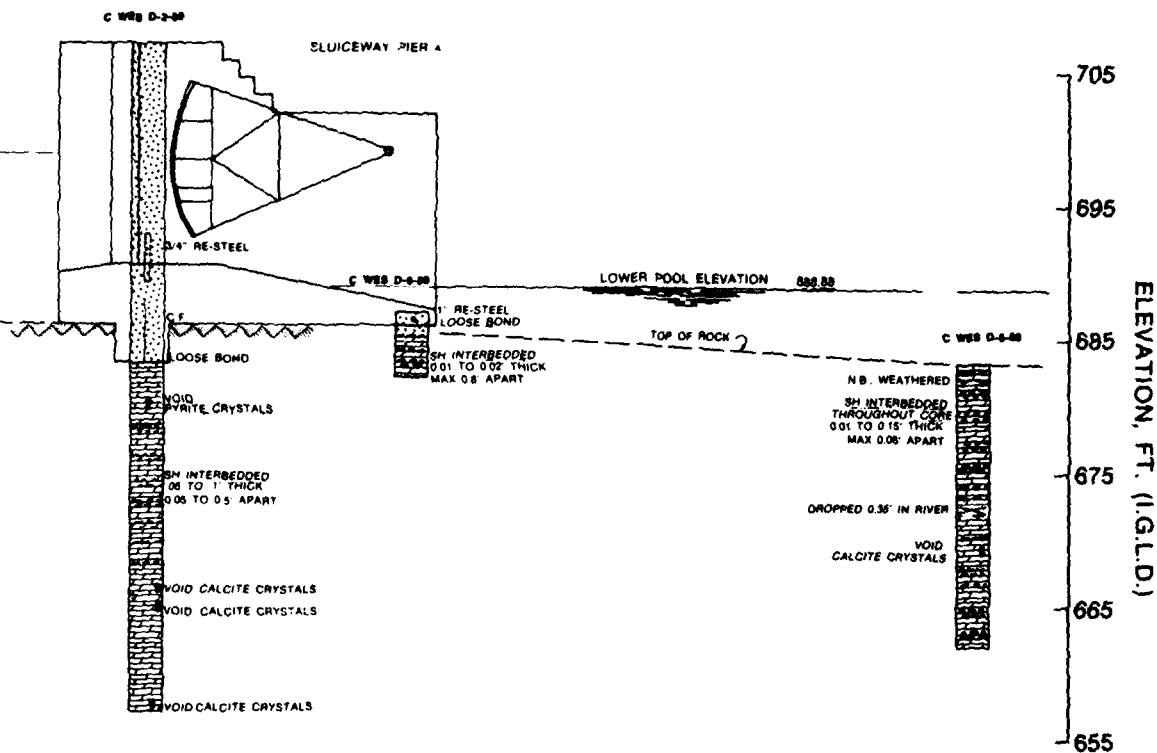


CONDITION SURVEY
AUGUST 1980
CEDARS LOCK AND DAM
GEOLOGIC CROSS SECTION
SECTION B-B'



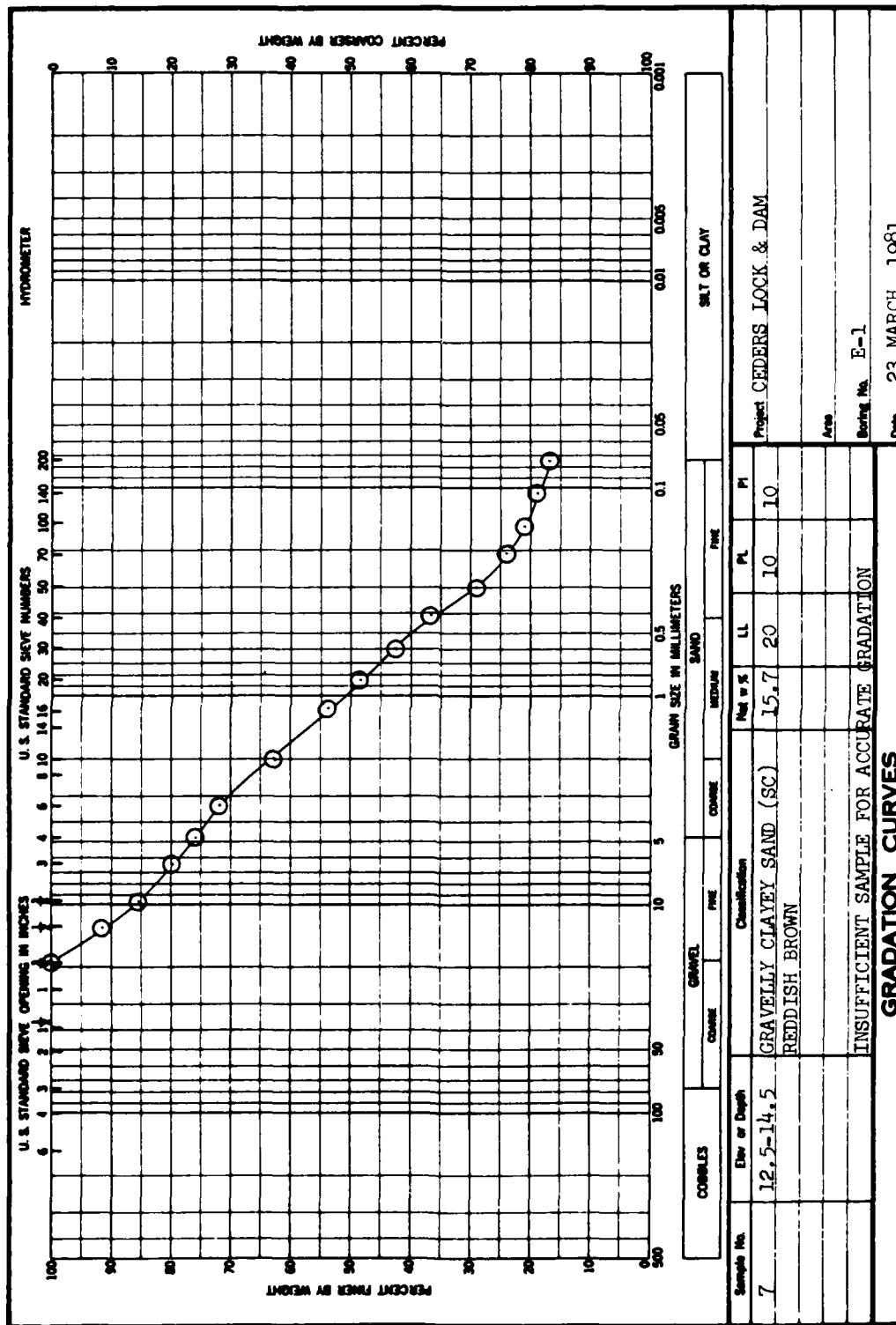
SECTION C

BORING NUMBER	ELEVATION, FT		CORE SIZE, IN.	CORE RECOVERY, %
	TOP OF BORING	BOTTOM OF CORE		
C WES D-2-80	706.97	656.97	4	100
C WES D-4-80	687.1	665.9	4	98
C WES D-5-80	691.41	662.21	4	100
C WES D-6-80	689.91	662.11	4	100



SECTION OF TAINTER GATE PIER
SCALE 1" = 5'

CONDITION SURVEY
AUGUST 1960
CEDARS LOCK AND DAM
GEOLOGIC CROSS SECTION
SECTION C-C'



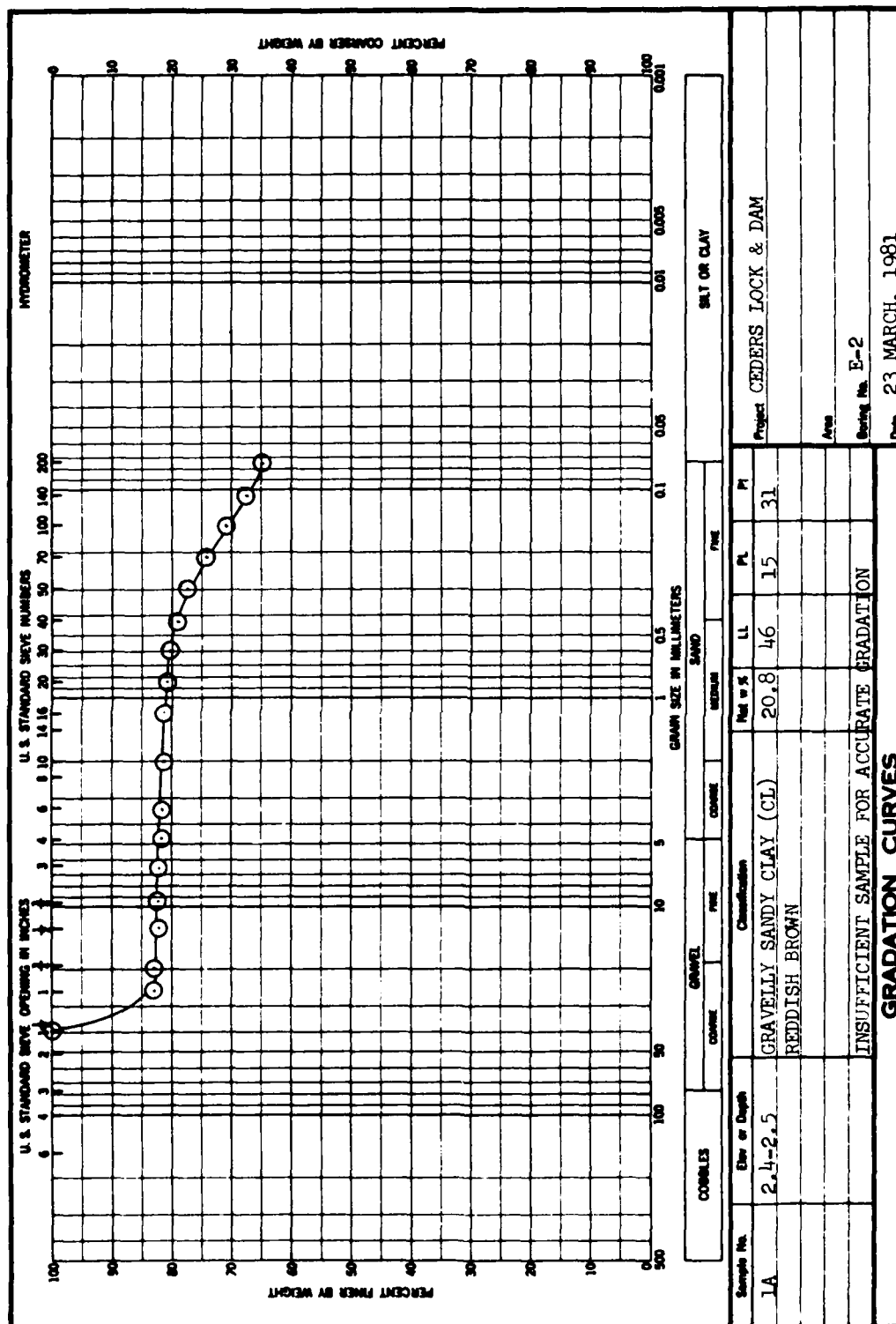


PLATE 11

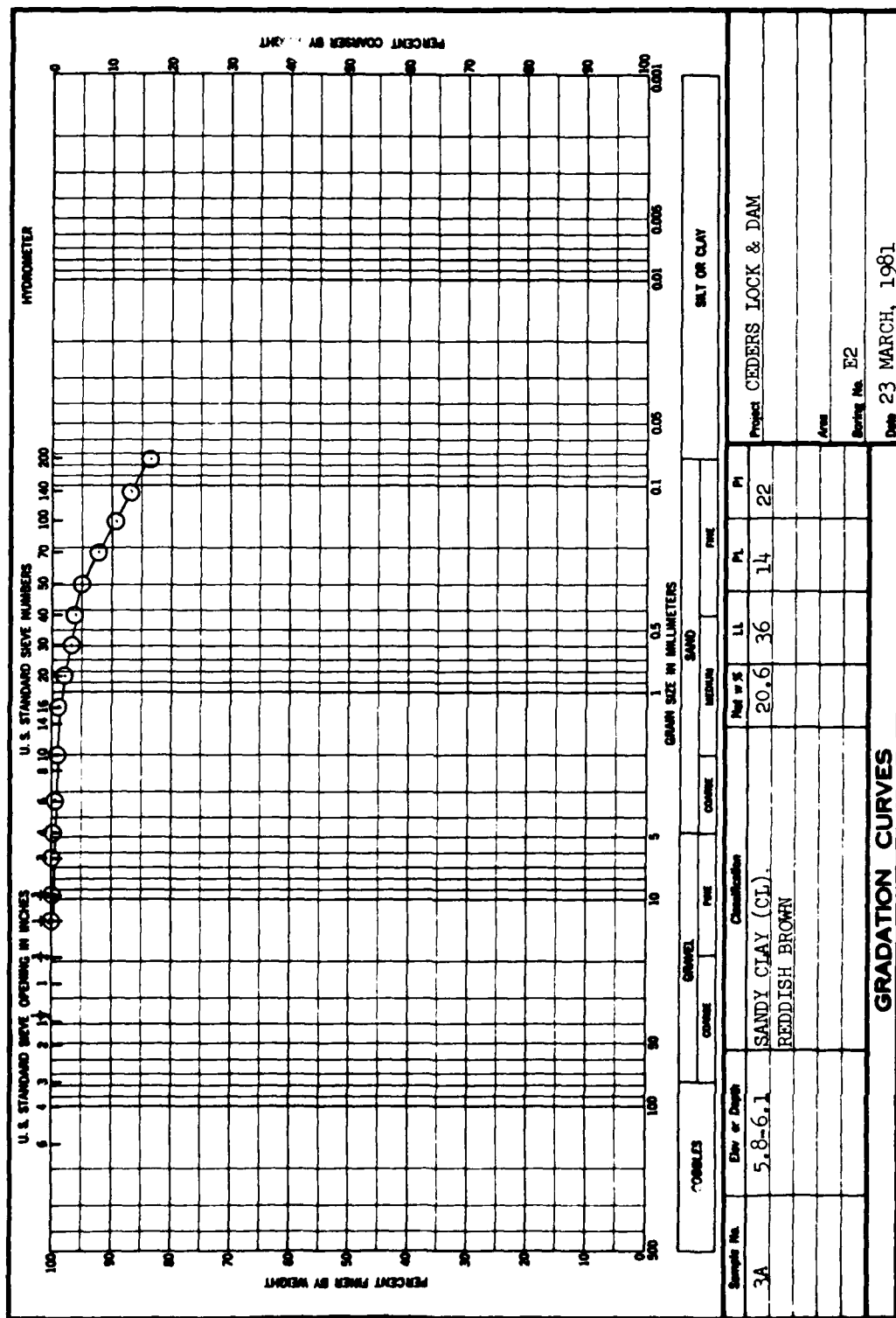


PLATE 12

ENG FORM
1 MAY 63 2087

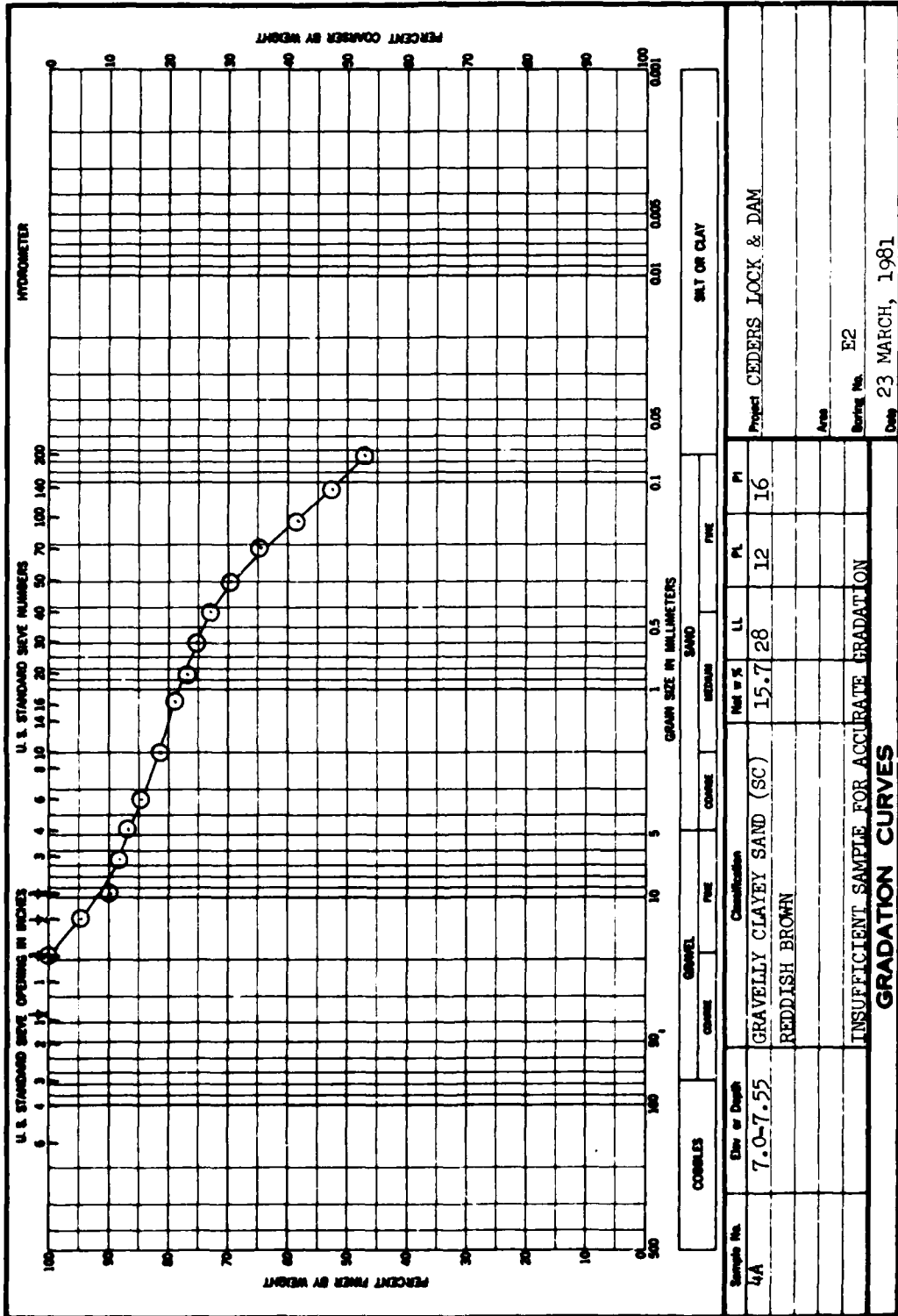
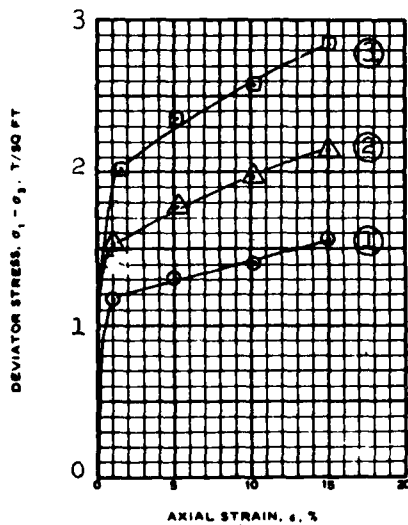
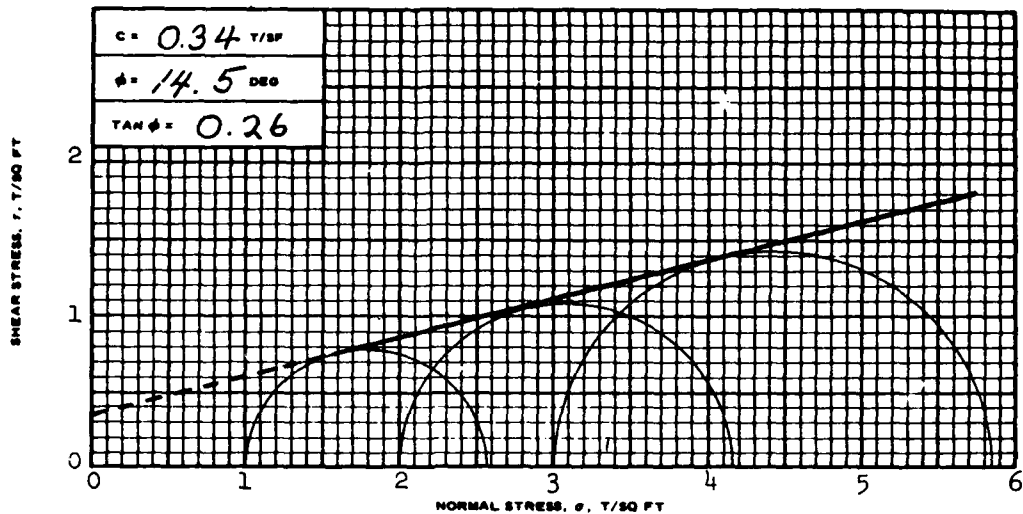


PLATE 13

ENG FORM 1 MAY 63 2087



SPECIMEN NO.		1	2	3
INITIAL	WATER CONTENT, %	w_o 17.0	15.9	15.8
	DRY DENSITY LB/ CU FT	γ_d 104.2	106.2	105.8
	SATURATION, %	s_o 73.5	72.2	71.1
	VOID RATIO	e_o 0.630	0.599	0.604
BEFORE SHEAR	WATER CONTENT, %	w_c 21.4	19.8	19.1
	DRY DENSITY LB/ CU FT	γ_d 106.3	110.5	112.7
	SATURATION, %	s_c 97.4	100+	100+
	VOID RATIO	e_c 0.598	0.537	0.506
FINAL BACK PRESSURE, T/SQ FT		u_o 5.04	5.04	5.04
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3 1.0	2.0	3.0
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$ 1.56	2.16	2.84
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f 1071	1071	1071
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$		
INITIAL DIAMETER, IN.		D_o 1.42	1.40	1.42
INITIAL HEIGHT, IN.		H_o 3.00	3.00	3.00

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS CLAY (CL), REDDISH BROWN; COARSE SAND

LL	PL	PI	G _s	TYPE OF SPECIMEN	UNDISTURBED	TYPE OF TEST	R
REMARKS:				PROJECT CEDARS LOCK & DAM			
				BORING NO.	E-1	SAMPLE NO.	1-C
				DEPTH/ELEV			
				LABORATORY	USAEWES	DATE	24 JAN 81
SHEET 1 OF 2				JMS TRIAXIAL COMPRESSION TEST REPORT			

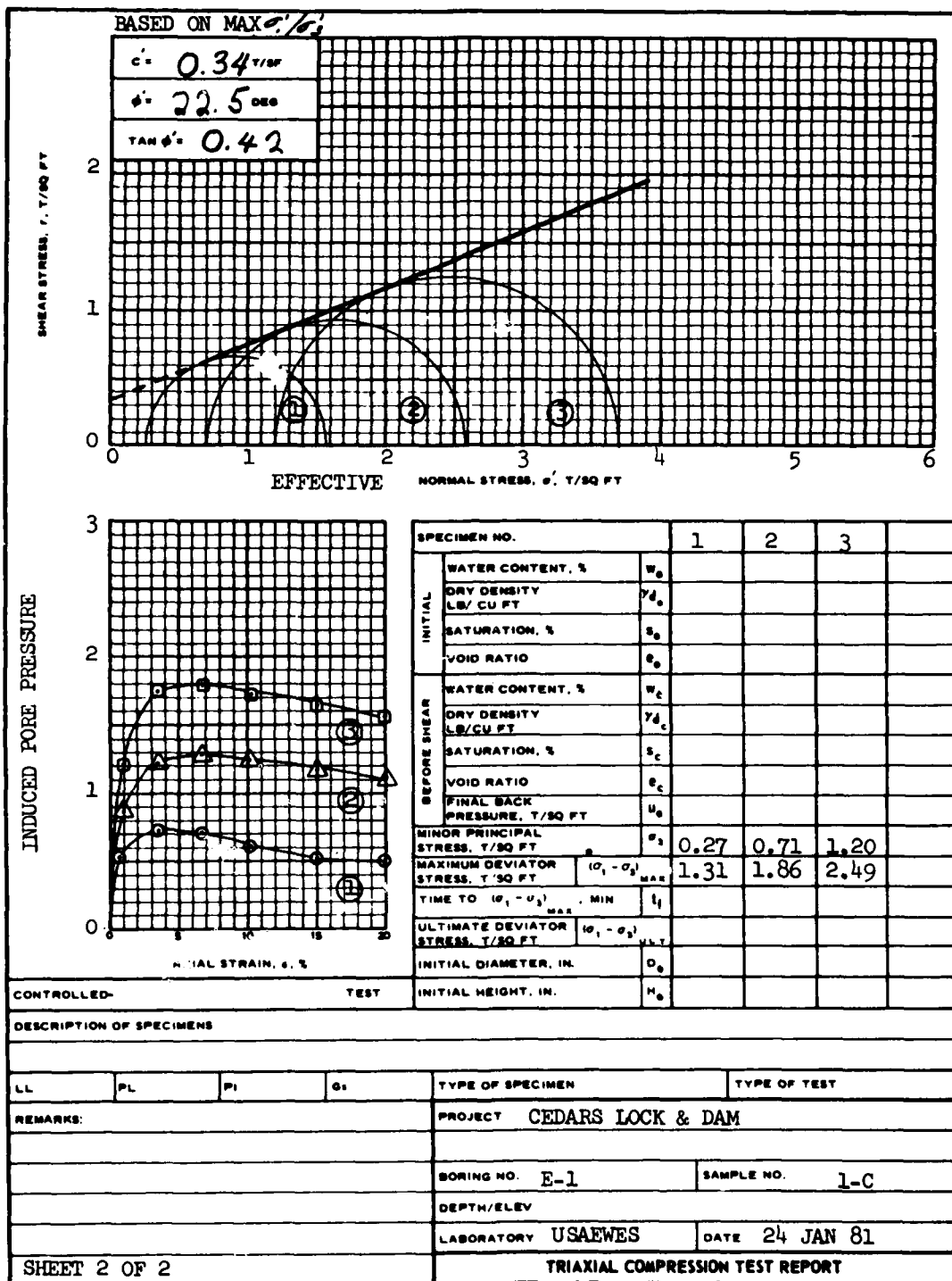
ENG FORM NO. 2080
REV JUNE 1970

PREVIOUS EDITION IS OBSOLETE

TRANSLUCENT

(EM 1110-2-1906)

PLATE 14

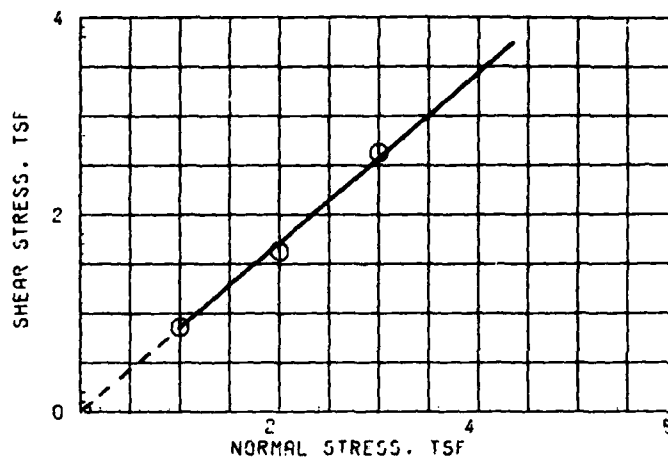
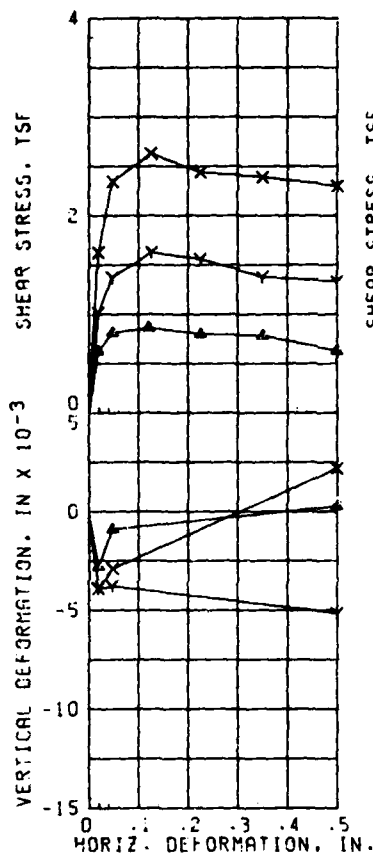


ENG FORM NO. 2089
REV JUNE 1970

PREVIOUS EDITION IS OBSOLETE

TRANSLUCENT

(EM 1110-2-1906)



$\phi = 40.5^\circ$
 $\tan \phi = 0.86$
 $c = 0$

TEST NO.		1 Δ	2 Y	3 X
INITIAL	WATER CONTENT, %	10.5	10.6	9.9
	VOID RATIO	0.189	0.175	0.176
	SATURATION, %	100 +	100 +	100 +
	DRY DENSITY, PCF	141.1	142.9	142.7
VOID RATIO AFTER CONSOL				
FIFTY PERCENT CONSOL. MIN		< 1	< 1	< 1
FINAL	WATER CONTENT, %	10.9	10.4	10.1
	VOID RATIO			
	SATURATION, %			
NORMAL STRESS, TSF		1.0	2.0	3.0
MAXIMUM SHEAR STRESS, TSF		0.96	1.62	2.63
TIME TO FAILURE, MIN		564	594	594
RATE OF STRAIN, IN/MIN		.00019	.00019	.00019
ULTIMATE SHEAR STRESS, TSF				

TYPE SPECIMEN UNDISTURBED 3.00 IN. SQUARE 0.594 IN. THICK

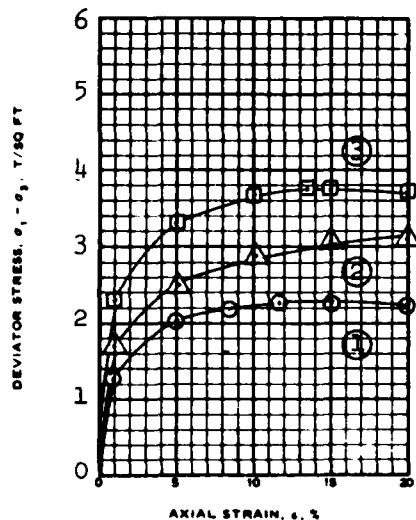
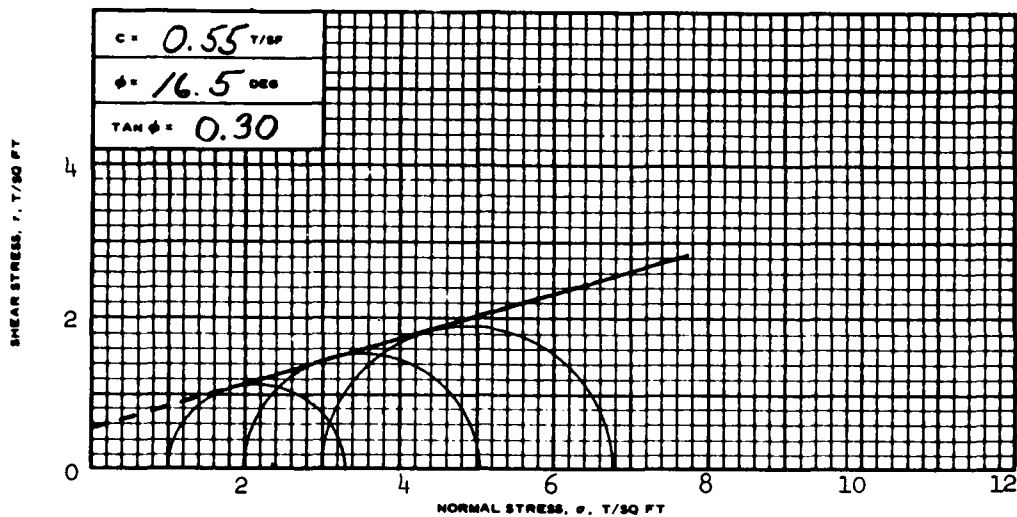
CLASSIFICATION GRAVELLY SANDY CLAY (CL). BROWNISH RED

LL PL PI OS 2.59 (EST)

REMARKS. PROJECT CEDARS LOCK & DAM

BORING NO. E-1 SAMPLE 6-A
 DEPTH/ELEV - DATE 20 MAR 81

DIRECT SHEAR TEST REPORT



SPECIMEN NO.		1	2	3
INITIAL	WATER CONTENT, %	w_o 20.4	23.0	22.2
	DRY DENSITY LB/ CU FT	γ_d 105.2	100.6	101.7
	SATURATION, %	s_o 90.3	90.9	90.2
	VOID RATIO	e_o 0.615	0.688	0.669
BEFORE SHEAR	WATER CONTENT, %	w_c 21.2	23.3	21.5
	DRY DENSITY LB/ CU FT	γ_d 107.7	105.7	107.4
	SATURATION, %	s_c 100	100+	100+
	VOID RATIO	e_c 0.577	0.607	0.582
FINAL BACK PRESSURE, T/SQ FT		u_o 5.04	5.04	5.04
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3 1.0	2.0	3.0
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$ 2.28	3.04	3.77
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_1 836	1071	964
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$		
INITIAL DIAMETER, IN.		D_o 1.41	1.41	1.42
INITIAL HEIGHT, IN.		H_o 3.00	3.00	3.00

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS SANDY CLAY (CL), REDDISH BROWN; FINE SAND

LL	PL	P ₁	G _s	TYPE OF SPECIMEN	UNDISTURBED	TYPE OF TEST	R
REMARKS:				PROJECT CEDARS LOCK & DAM			
				BORING NO.	E-2	SAMPLE NO.	2
				DEPTH/ELEV			
				LABORATORY	USAEWES	DATE	26 JAN 81
SHEET 1 OF 2				JMS	TRIAXIAL COMPRESSION TEST REPORT		

ENG FORM NO. 2088 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE

TRANSLUCENT

(EM 1110-2-1906)

PLATE 17

BASED ON MAX σ_1/σ_3

$c = 0.20$ T/SQ FT

$\phi = 31.0$ DEG

$\tan \phi = 0.60$

SHEAR STRESS, τ , T/SQ FT

EFFECTIVE NORMAL STRESS, σ' , T/SQ FT

INDUCED PORE PRESSURE

AXIAL STRAIN, ϵ , %

SPECIMEN NO.		1	2	3	
INITIAL	WATER CONTENT, %	w_o			
	DRY DENSITY LB/ CU FT	γ_{d_o}			
	SATURATION, %	s_o			
	VOID RATIO	e_o			
BEFORE SHEAR	WATER CONTENT, %	w_c			
	DRY DENSITY LB/ CU FT	γ_{d_c}			
	SATURATION, %	s_c			
	VOID RATIO	e_c			
	FINAL BACK PRESSURE, T/SQ FT	u_o			
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.57	0.88	1.39
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	1.82	2.54	3.43
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f			
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$			
INITIAL DIAMETER, IN.		D_o			
INITIAL HEIGHT, IN.		H_o			

LL	PL	PI	G _s	TYPE OF SPECIMEN	TYPE OF TEST
REMARKS:				PROJECT CEDARS LOCK & DAM	
				BORING NO. E-2 SAMPLE NO. 2	
				DEPTH/ELEV	
				LABORATORY USAEWES DATE 26 JAN 81	
SHEET 2 OF 2				JMS TRIAXIAL COMPRESSION TEST REPORT	

ENG FORM NO. 2088
REV JUNE 1970

PREVIOUS EDITION IS OBSOLETE

TRANSLUCENT

(EM 1110-2-1906)

PLATE 18

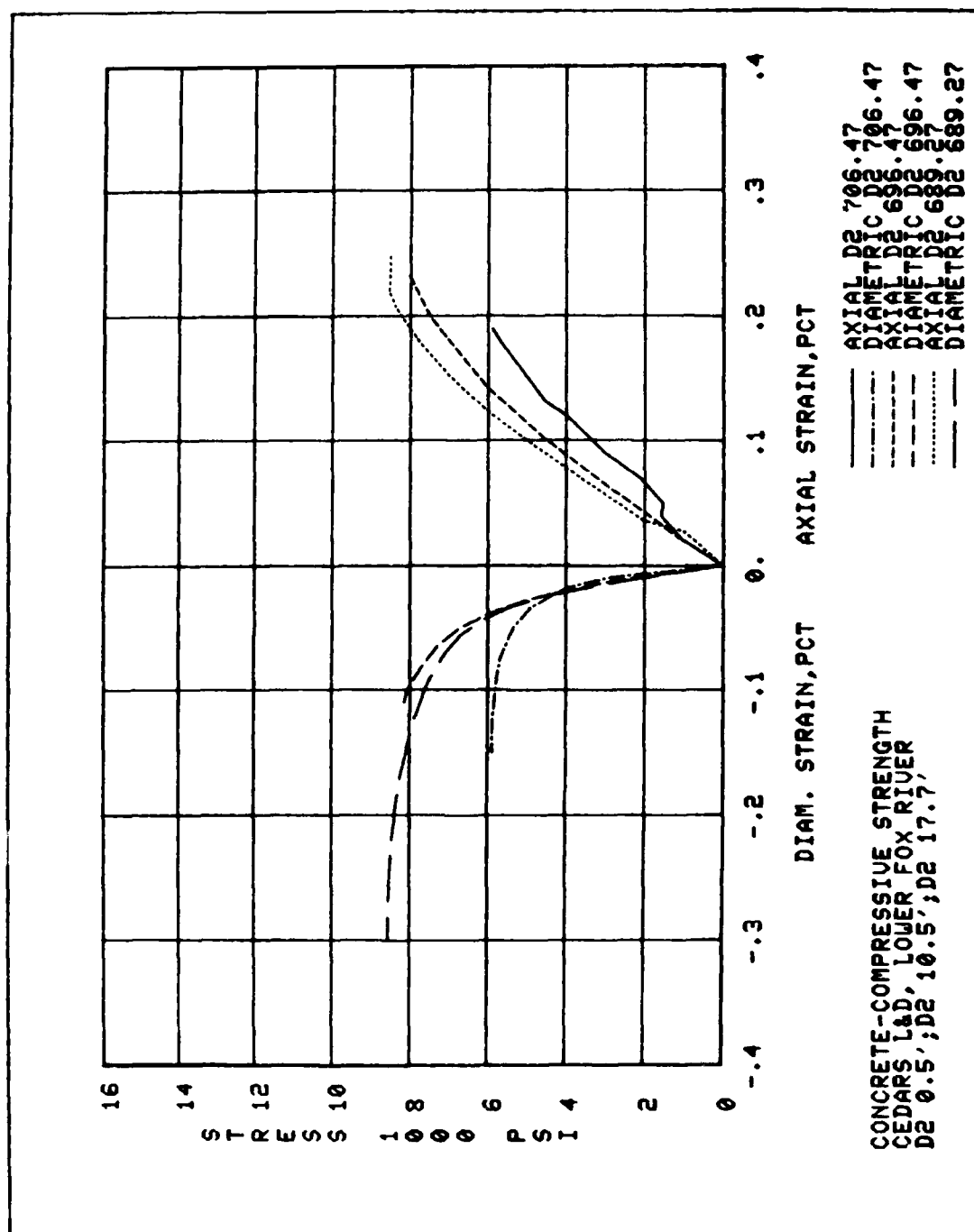


PLATE 19

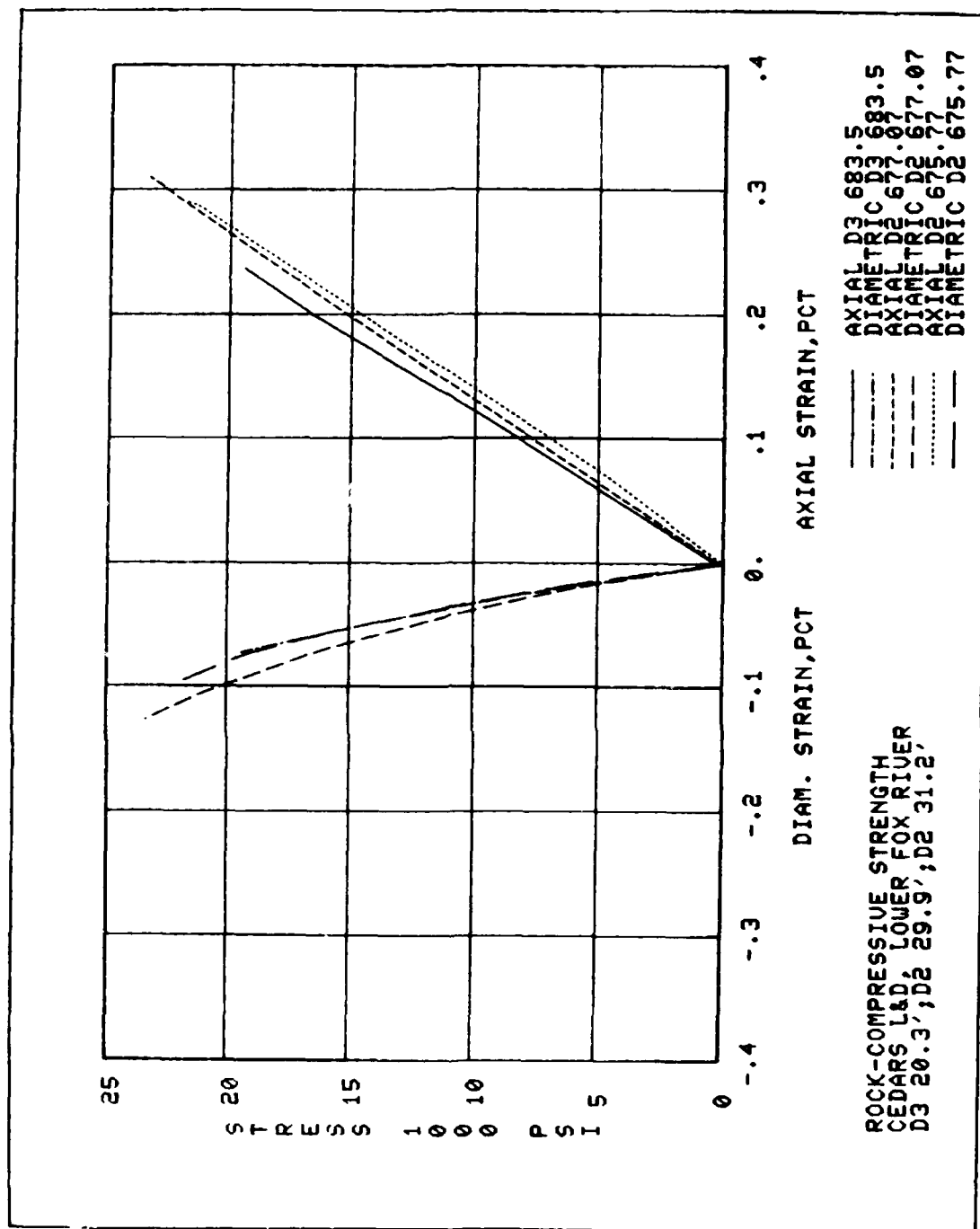
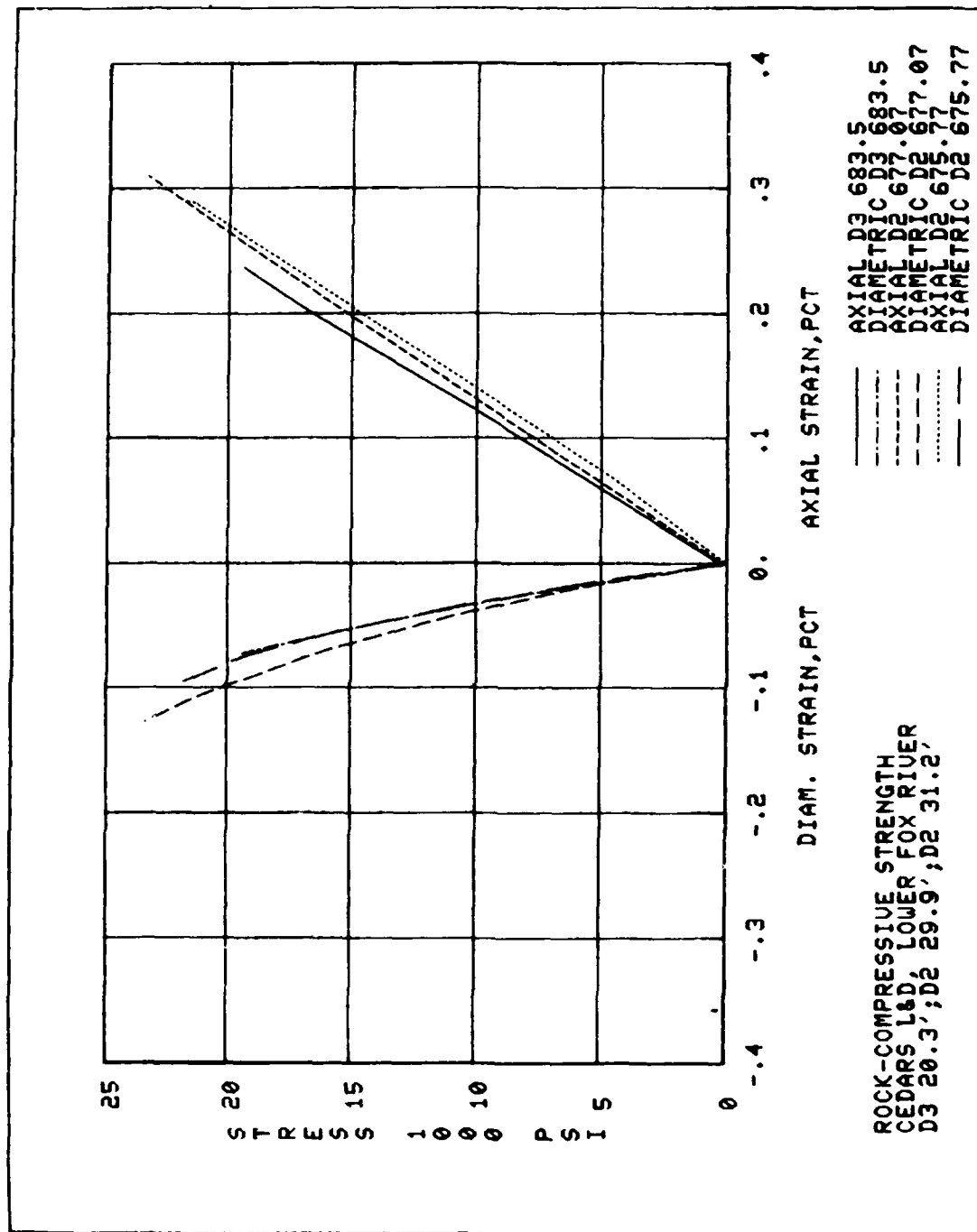
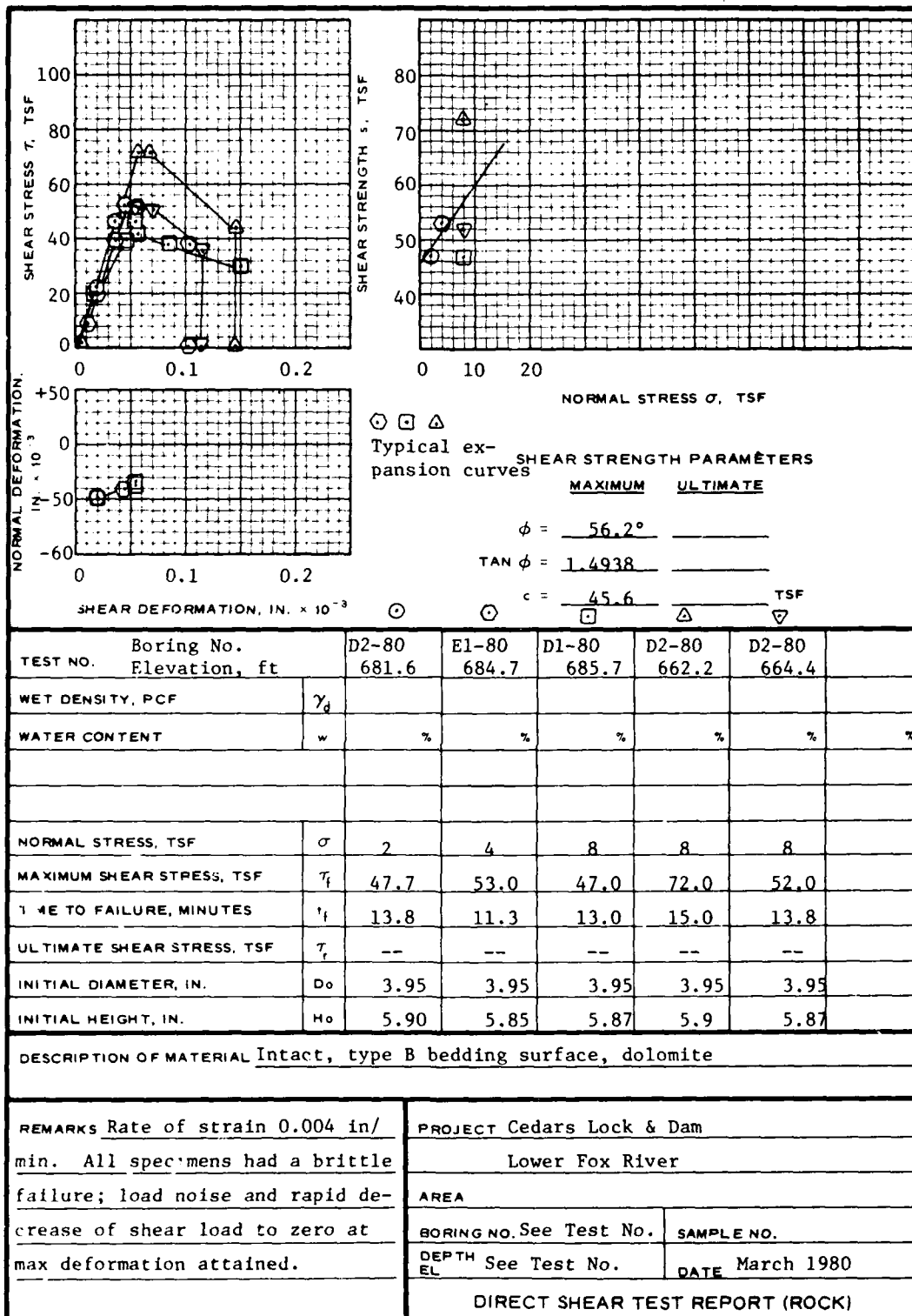
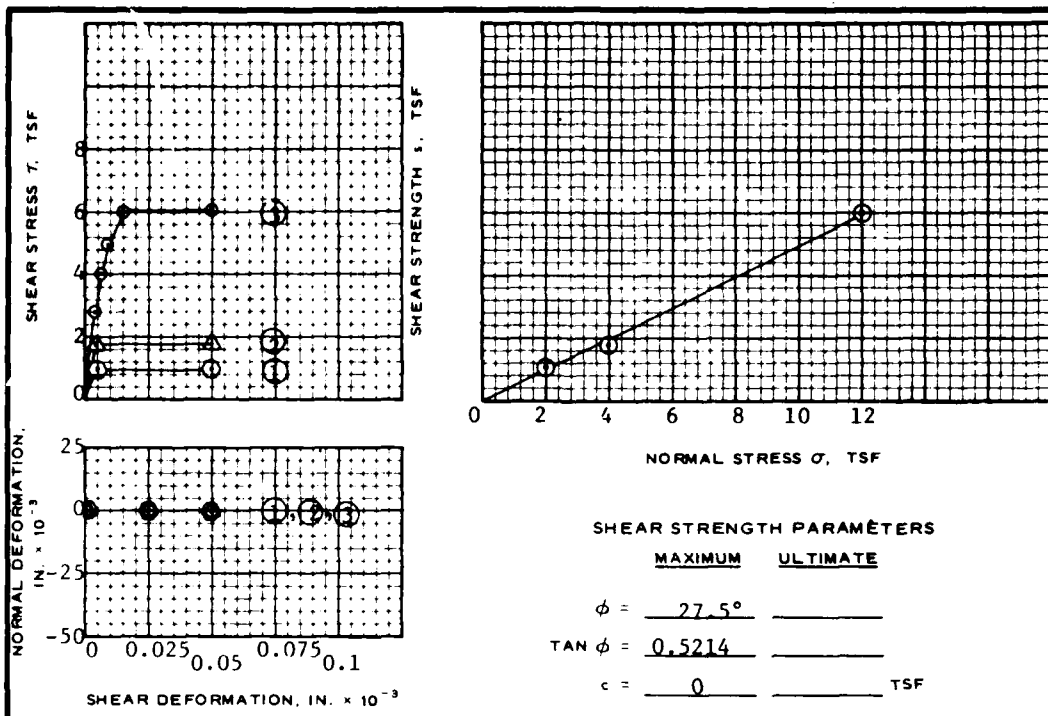


PLATE 21







TEST NO.		1	2	3			
WET DENSITY, PCF	Concrete	153.0	153.4	154.0			
	Rock	171.0	170.3	171.7			
WATER CONTENT	Concrete	5.1	5.2	4.8			
	Rock	0.5%	0.6%	0.6%	%	%	%
NORMAL STRESS, TSF		σ	2.0	4.0	12.0		
MAXIMUM SHEAR STRESS, TSF		τ_f	1.1	1.8	6.2		
TIME TO FAILURE, MINUTES		t_f	8.5	35.0	23.0		
ULTIMATE SHEAR STRESS, TSF		τ_r	1.1	1.8	6.2		
INITIAL DIAMETER, IN.		D_o	3.95	3.95	3.95		
INITIAL HEIGHT, IN.		H_o	5.90	5.91	5.90		

DESCRIPTION OF MATERIAL Concrete on rock, precut, dolomite

REMARKS				PROJECT Cedars Lock & Dam	
Test No.	Boring No.	Elevation		Lower Fox River	
		Concrete	Rock	AREA	
1	D1-80	686.6	683.1	BORING NO.	SAMPLE NO.
2	D1-80	687.8	682.2	DEPTH EL	DATE 2/20, 24, 26/81
3	D2-80	692.9	683.0	DIRECT SHEAR TEST REPORT (ROCK)	

Rate of strain = 0.004 in/min

WES FORM 1490

EDITION OF JUN 65 IS OBSOLETE

PLATE 23

SHEAR STRESS τ , TSF

SHEAR STRENGTH s , TSF

NORMAL DEFORMATION, IN. $\times 10^{-3}$

SHEAR STRENGTH PARAMETERS

MAXIMUM ULTIMATE

$\phi = 29.7^\circ$

$\text{TAN } \phi = 0.5711$

$c = 0$ TSF

TEST NO.		1	2	3			
WET DENSITY, PCF	γ_d	170.8	172.4	171.5			
WATER CONTENT	w	0.7%	0.6%	0.6%	%	%	%
NORMAL STRESS, TSF	σ	2.0	4.0	8.0			
MAXIMUM SHEAR STRESS, TSF	τ_f	1.0	1.76	4.35			
TIME TO FAILURE, MINUTES	t_f	8.0	26.0	35.0			
ULTIMATE SHEAR STRESS, TSF	τ_r	1.0	1.76	4.35			
INITIAL DIAMETER, IN.	D_o	3.95	3.95	3.95			
INITIAL HEIGHT, IN.	H_o	5.50	5.53	5.53			
DESCRIPTION OF MATERIAL <u>Rock on rock, precut, dolomite</u>							

REMARKS		
Test No.	Boring No.	Elevation ft
1	D2-80	676.6
2	D3-80	677.3
3	D3-80	678.1

PROJECT <u>Cedars Lock and Dam</u>	
<u>Lower Fox River</u>	
AREA	
BORING NO.	SAMPLE NO.
DEPTH EL	DATE <u>2/2/81</u>

Rate of strain = 0.004 in/min

DIRECT SHEAR TEST REPORT (ROCK)

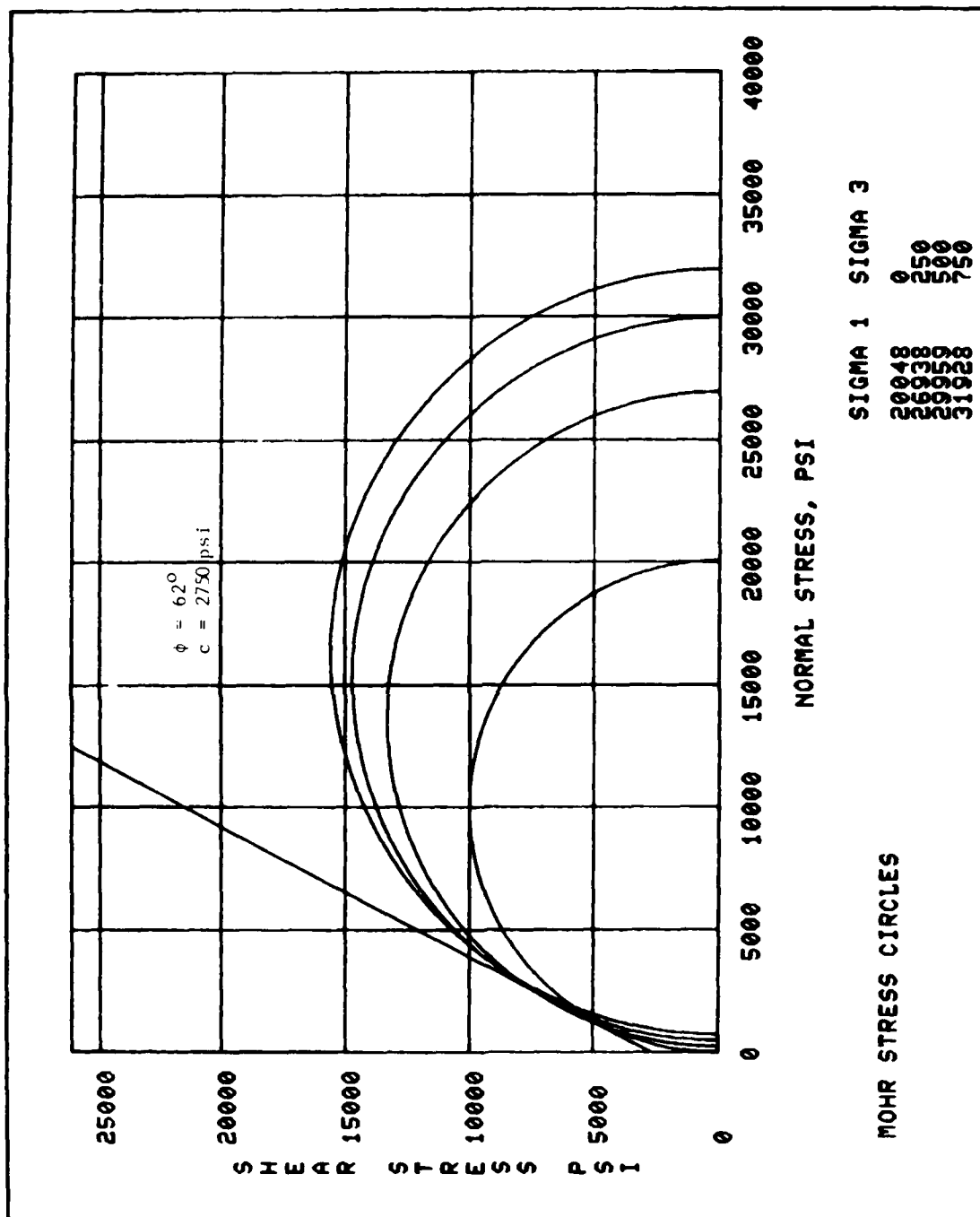
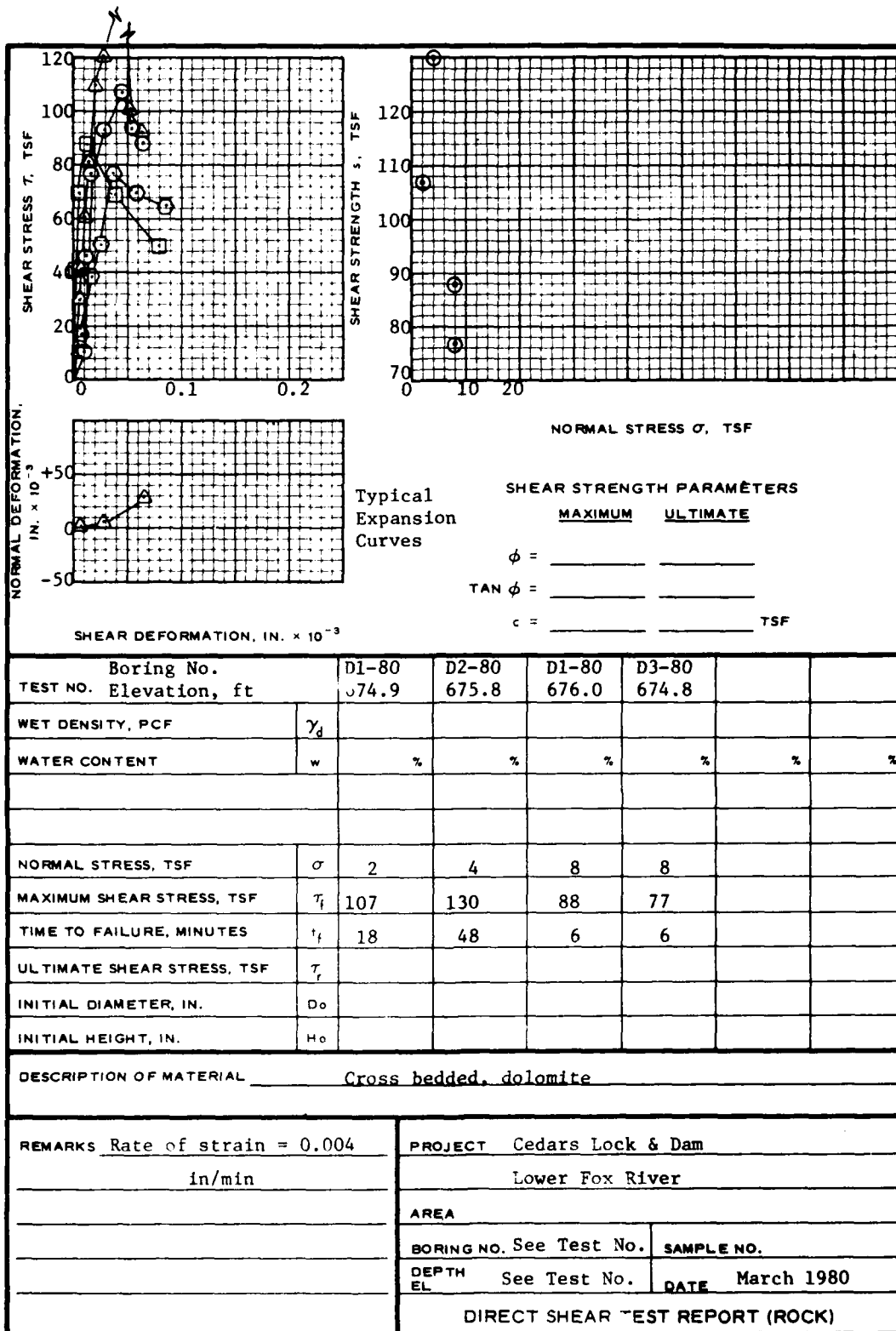


PLATE 25



APPENDIX A
PHOTOGRAPHS OF LOCK AND DAM

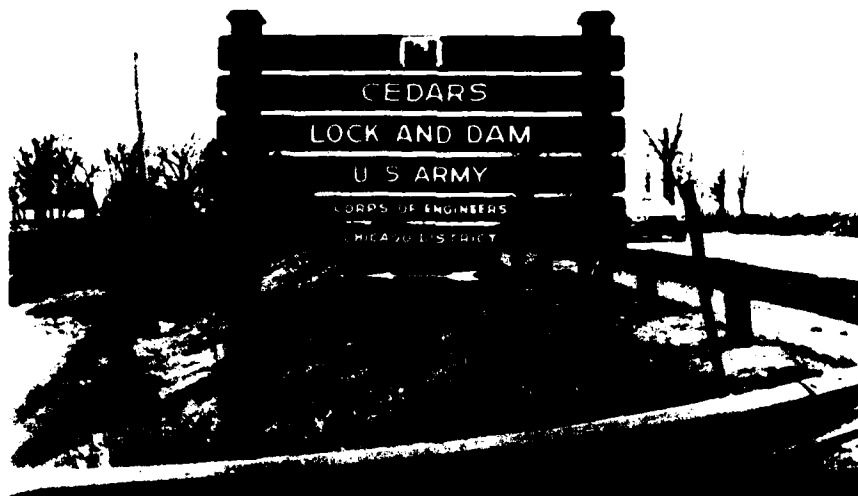


Photo 1. Entrance sign to Cedars Lock and Dam site

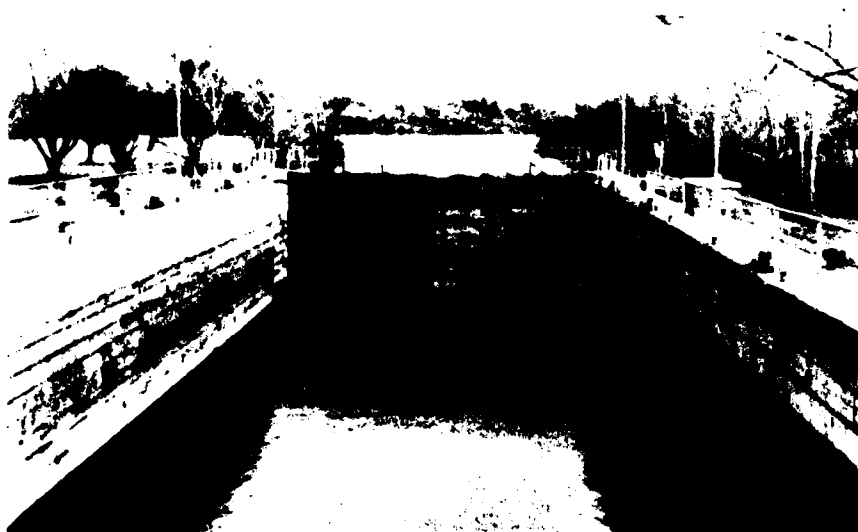


Photo 2. Taken from upstream gate looking downstream.
Lock in empty stage

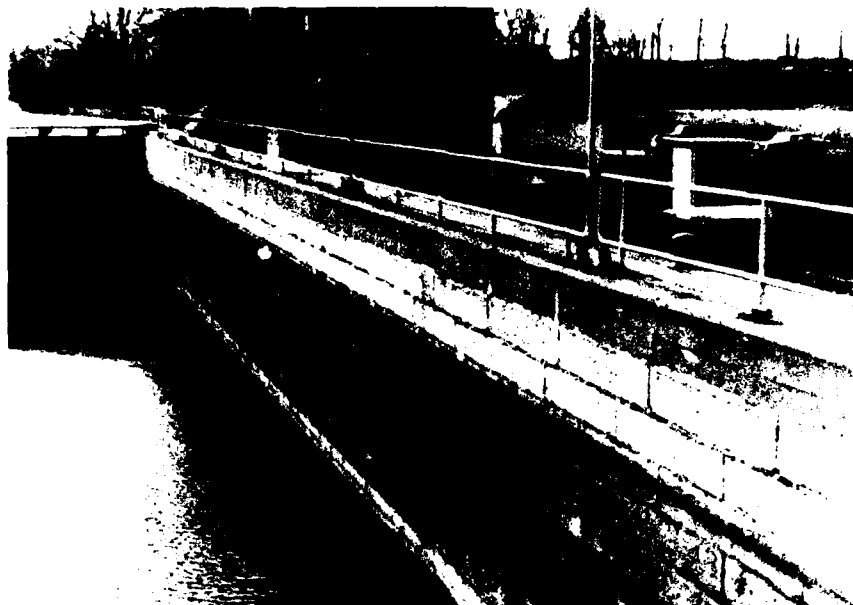


Photo 3. Taken from downstream gate looking upstream at the left lockwall. Close up showing good condition of masonry.
Some joint mortar missing



Photo 4. Taken from right downstream bank, showing portion of downstream wooden gate and downstream lockwall. Masonry shown in good condition



Photo 5. Taken from right downstream bank, showing stairway at end of right lockwall

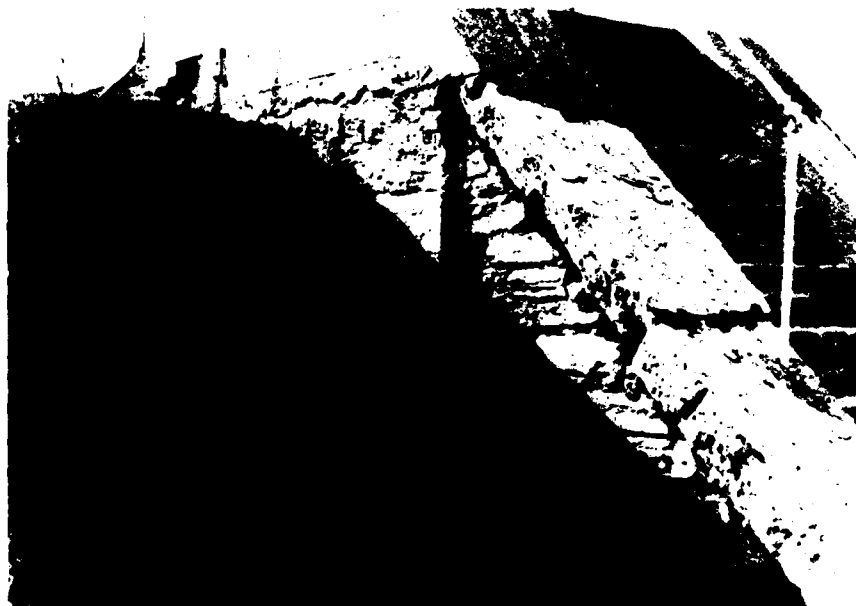


Photo 6. Taken from right downstream embankment showing portion of stairway and embankment of right lockwall



Photo 7. Taken from upper right side of lock embankment, showing embankment slope and flat between embankment and river



Photo 8. Taken from upper left bank looking downstream, showing right approach wall and upper gate

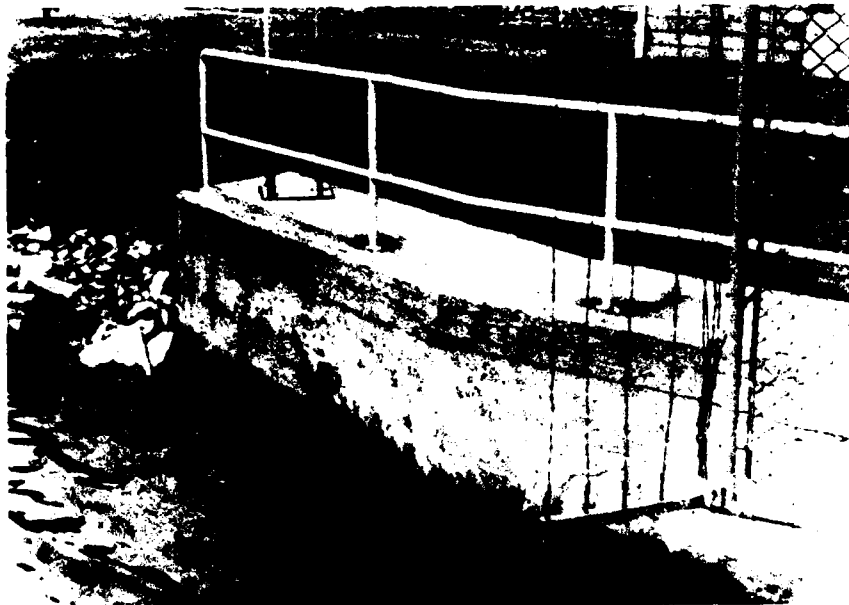


Photo 9. Taken from left spillway, looking at upstream portion of left abutment wall. Resurfaced and original concrete shows evidence of frost damage



Photo 10. Taken from foot bridge atop of left spillway, looking at downstream portion of left abutment wall. Resurfaced and original concrete shows evidence of frost damage



Photo 11. Taken from left spillway foot bridge looking north, pier No. 2, concrete in good condition

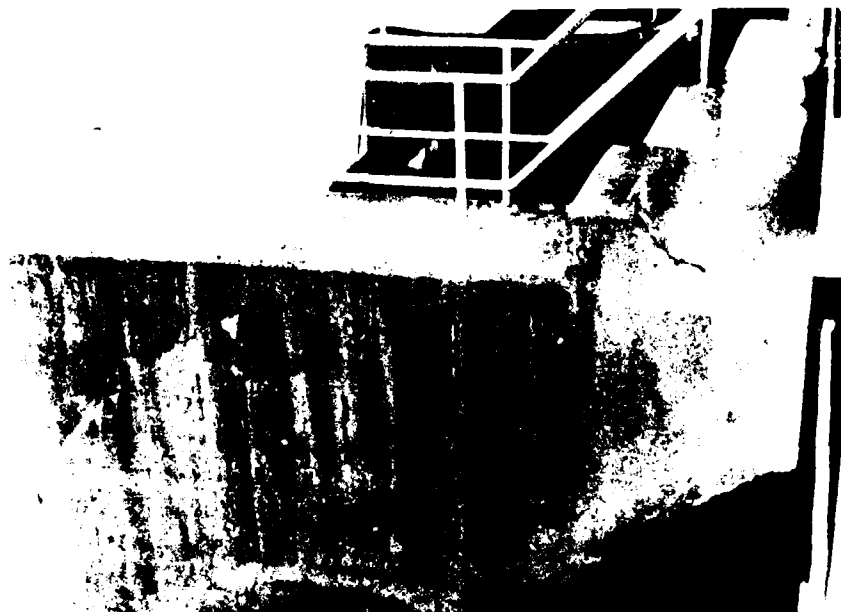


Photo 12. Taken from left spillway foot bridge, looking south, north side of sluiceway pier No. 1

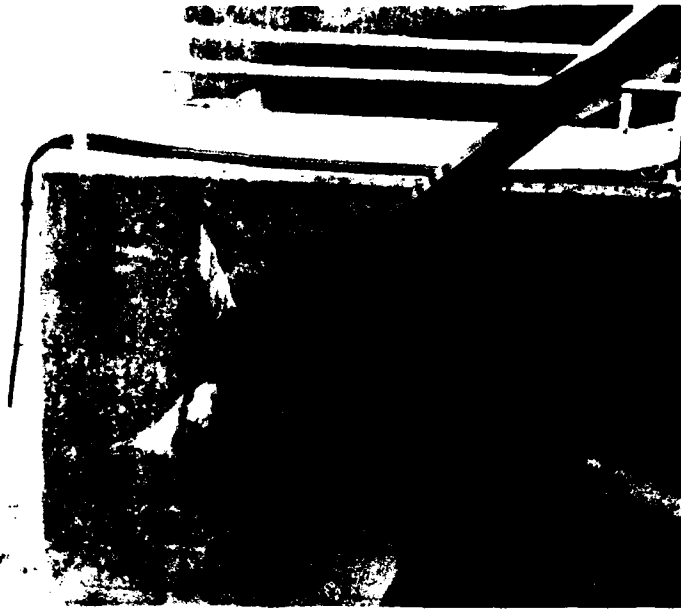


Photo 13. Taken from tainter gate pier No. 1, looking at north side of pier No. 2. Typical cracking through concrete pier at gate hinge pin



Photo 14. Taken from tainter gate pier No. 3, looking at south side of pier No. 2. Crack at gate hinge pin goes through pier

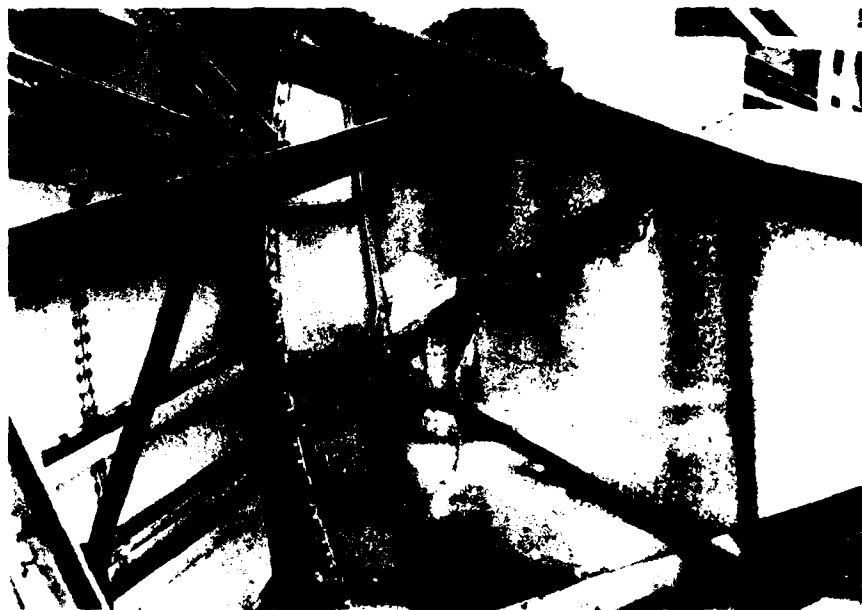


Photo 15. Taken from tainter gate pier No. 8, looking at south side of pier No. 7 showing crack through step of seventh pier



Photo 16. Taken from right spillway, looking at upstream portion of right abutment. Wide diagonal crack in concrete pier. Right dam abutment adjacent to Kimberly Clarke property

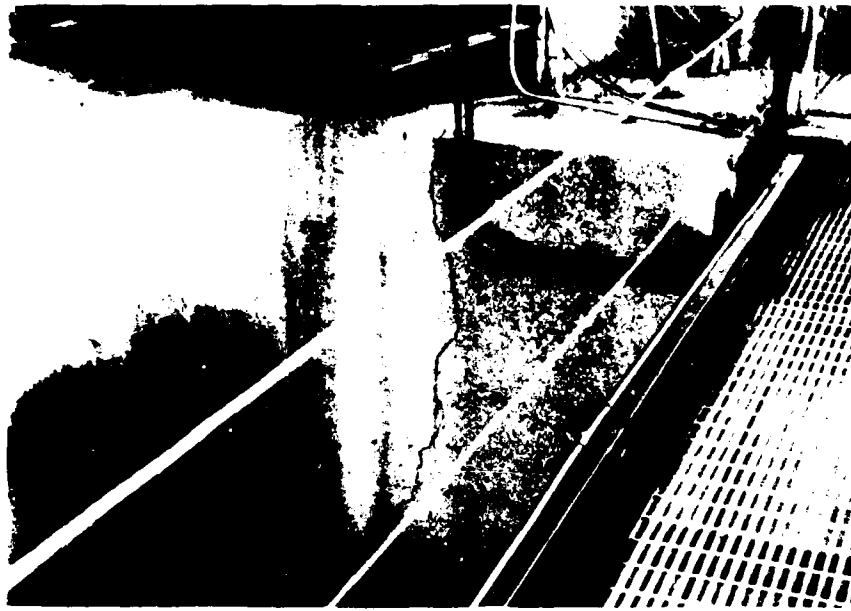


Photo 17. Taken from right spillway, looking at downstream portion of right abutment. Vertical crack to waterline in concrete pier

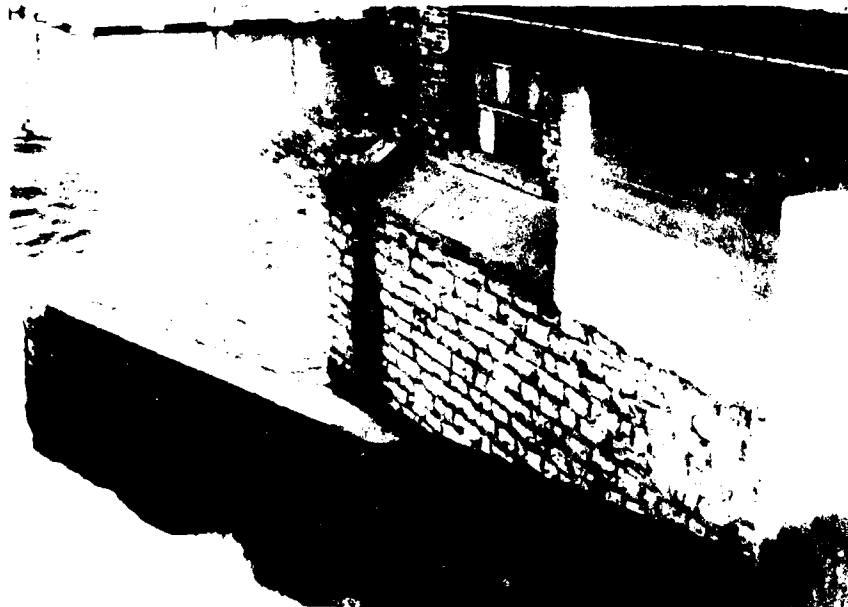


Photo 18. Taken from right spillway, looking at downstream portion of right abutment and masonry foundation wall of Kimberly Clarke plant



Photo 19. View of Murphy Concrete Co. Quarry about 1/4-mile from Kankauna Project Office, left side of Lower Fox River. The rock in the quarry is believed to be the Galena-Platteville dolomite. Horizontal bedding evident



Photo 20. Close-up view of quarry wall



Photo 21. View of dry dock area at the Kankauna Project Office. Downstream of wooden gate showing masonry construction of wall founded on horizontal rock foundation



Photo 22. View just downstream of Photo 21 showing typical bedding structure of founding rock. This rock formation is believed to exist beneath the Cedars Dam

APPENDIX B
DRILLING LOGS

NOTE: All field boring logs identify bedrock as limestone; subsequent petrographic examination shows the bedrock to be dolomite.

BORING LOG FIELD DATA											
Project <u>Bones back - Day</u>		Site <u>Cranks back - Day - Little Creek</u>		Date <u>28 August 1980</u>							
Location <u>SEE PAGE # 10</u>		Job No. <u>441-5763.100022</u>		Boring No. <u>441-5763.30022</u>							
Drill Rig <u>Skid</u>		Inspector <u>Joe Duane</u>		Operator <u>C. Deane</u>							
Surface El <u>709.0</u>		Surface El <u>709.0</u>		Surface El <u>709.0</u>							
DATE TAKEN <u>1980</u>		STRATUM		DRIVE		SAMPLE		TYPE OF SAMPLER		CLASSIFICATION AND REMARKS	
SAMPLE NUMBER	DATE TAKEN	FROM	TO	FROM	TO	FROM	TO	FROM	TO	TYPE OF SAMPLER	CLASSIFICATION AND REMARKS
✓ 1A	2 Aug	0.0	1.0	0.0	0.5	0.0	1.05	0.0	1.05	SHALLOW TUBE	250 TUBE OCEANIC MARINE (GENSS - ROOTS)
1B		1.0		0.5	1.0	1.05	1.15	1.05	1.15		300 TUBE Generally Clay - Reddish Brown
✓ 1C				1.0	1.5	1.9	2.5	1.9	2.5		380 TUBE Color with V. Little Concentration.
				1.5	2.0						300 TUBE V. Dry Push: 2.5' Comp. 0.4'
				2.0	2.5						340 TUBE SPL 2.1'
				0.0	2.5					6" FISH TAIL	CLEANOUT
✓ 2A	2 Aug			2.5	3.0	2.5	3.4	2.5	3.4	5" HVERSLOV	100 TUBE CLAY (CL) - Same as above -
✓ 2B				3.0	3.5	3.4	3.5	3.4	3.5		120 TUBE Moisture content increasing
✓ 2C				3.5	4.0	3.5	4.4	3.5	4.4		140 TUBE
✓ 2D				4.0	4.5	4.4	4.5	4.4	4.5		250 TUBE
				2.5	4.5					6" FISH TAIL	CLEANOUT
✓ 3A	4 Aug			4.5	5.0	4.5	4.6	4.5	4.6	5" HVERSLOV	60 TUBE CLAY (CL) - Same - 1/2 Pipe of
✓ 3B				5.0	5.5	4.6	6.1	4.6	6.1		100 TUBE Gravel at top (2" x 1")

WES FORM 819 JAN 74 EDITION OF NOV 1971 MAY BE USED

Sheet 1 of 10 Sheets

BORING LOG FIELD DATA											
Project <u>Cedars Lock & Dam</u>		Site <u>Cedar Lock Dam - Little Chute, Wisconsin</u> Date <u>2 Aug 1980</u>									
Location <u>See Page #10</u>		Job No. <u>SWL 5762-30 CR22</u>									
Drill Rig <u>SH-1000</u> Inspector <u>Joe Dunbar</u> Operator <u>C. Drake</u> Surface El <u>704.0</u> Boring No. <u>CUES-61-80</u>											
SAMPLE NUMBER	DATE TAKEN	STRATUM		DRIVE		SAMPLE		TYPE OF SAMPLER	PASS. CONT.	CLASSIFICATION AND REMARKS	
		FROM	TO	FROM	TO	FROM	TO				
✓ 3C				5.5	6.0	6.4	6.5		✓ JAC		
				6.0	6.5				500	PUSH 2.0 Comp. 0.45 SPL 1.35'	
				6.5	6.5			6" Fishman	—	CLEANOUT	
✓ 4A	4 AUG			6.5	7.0	6.5	6.6	Hoppers	275 JAC	CLAY & SAME 2 POOL SPR. "Crumbly"	
✓ 4B				7.0	7.5	6.6	7.5		325 JAC		
✓ 4C				7.5	8.0	7.5	8.4		410 JAC	PUSH 2.0 Comp. 0.3'	
✓ 4D				8.0	8.5	8.4	8.5		500 JAC	SPL 1.5'	
				6.5	8.5			6" Fishman	—	CLEANOUT	
✓ 5A				8.5	9.0	8.5	10.4	Hoppers	180 TUB	GENUINE SAND. CLAY - (CL)	
✓ 5B				9.0	9.5	10.4	10.5		280 JAC	POORLY SORTED IN SIZE - GENUINE	
				9.5	10.0				300	CHANGE WITH TOP 10%: GRUEL IS	
				10.0	10.5				250	MED IN SIZE & APPROX 10%	
										PUSH: 2.0 Comp. 0.45' SPL 1.45'	

BORING LOG FIELD DATA											
SAMPLE NUMBER		DATE TAKEN	STRATUM		DRIVE		SAMPLE		TYPE OF SAMPLER	CLASSIFICATION AND REMARKS	
			FROM	TO	FROM	TO	FROM	TO			
Project <u>Cedar's Lock & Dam</u> Site <u>Cedar's Lock & Dam</u> Date <u>2 August 80</u>											
Location <u>See page #10</u> Job No. <u>4815713 So. 6222</u>											
Drill Rig <u>5th. Skidg</u> Inspector <u>Joe Quabul</u> Operator <u>C. Drake</u> Surface El <u>744.0</u> Boring No. <u>CHES-E-1-80</u>											
					8.5	10.5			6" Fishtail		CLAYNOV.
✓ 6A	4 Aug		10.0	10.5	10.5	11.0	10.7	12.4	5" Hoop	170	TUBE GRAVELLY SAND - BROWN
✓ 6B			10.0	11.0	11.0	11.5	12.4	12.5		140	JAK FINE TO COARSE GRND, MODERATE
					11.5	12.0				500	COHESION, GRNDEL IS FINE TO MED. N
					12.0	12.5				450	SIZE (LWS) STRUTUM CHANGE DEPTH
											IS GRNDEL - PUSH: 2.0'
											Comp. 0.55' SPL 1.30'
					10.5	12.0			6" Fishtail		CLAYNOV
					12.0	12.5					
	4 Aug				12.0	12.5			5" Hoop	390	
					12.5	13.0				250	
					13.0	13.5				300	
					13.5	14.0				325	
✓ 17	4 Aug				12.5	14.5			Smithson		CLAYNOV. SAND (SPL)

WES FORM 819 JAN 74 EDITION OF NOV 1971 MAY BE USED

Sheet 3 of 16 Sheets

BORING LOG FIELD DATA									
Project Cedar Lock + Dam		Site Cedar Lock + Dam		Date 2 Aug 1980		Job No. 441.5763.30.6 Q22		Boring No. 2443-E1-80	
Location See page #10		Inspector Joe Dunbar		Operator C. Drake		Surface El 704.1			
SAMPLE NUMBER	DATE TAKEN 7/10	STRATUM		DRIVE		SAMPLE		TYPE OF SAMPLER	CLASSIFICATION AND REMARKS
		FROM	TO	FROM	TO	FROM	TO		
								FISH TAIL	CRANOUT - HERE KNOT FREQUENT
				145					INT
				125	130			5" DRIVE BBL	CUTTINGS
	5 Aug								
					147			5 1/2" x 4" CORE BBL	Blocked off on LMS rubble -
									BOUNDARY - Bd Rk.
				0.0	1465			8 3/4" Rock B.	Bd Rk starts at 14.35'
				0.0	146			8" Core	TOTAL 16.45' PICKUP: 185
					15.3			6 1/2" Rock B.	CRANOUT
				15.3	16.5			5 1/2" x 4" Core Barrel	LMS -> (See other logs)
					17.9			6 1/2" Rock B.	Rk B.
					20.7			5 1/2" x 4" Core BBL	LMS - Ca. 0.45 - Blocked off

WES FORM 819 JAN 74 EDITION OF NOV 1971 MAY BE USED

Sheet 4 of 10 Sheets

✓ Fell in.

[illegible]

Sheet 3 of 10 Sheets

Cedars
Hole No. E-1-1960

DRILLING LOG		INSTALLATION	
1. PROJECT Cedars Lock Dam		10. SIZE AND TYPE OF BIT MSL	
2. LOCATION (County, Range, Section) SEE PAGE TEN		11. DAY OF YEAR FOR ELEVATION SHOWN (YEN or MSL) MSL	
3. DRILLING AGENCY CWES		12. MANUFACTURER'S DESIGNATION OF DRILL S-H	
4. HOLE NO. (As shown on drawing title and also marked) CWES-E1-86		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN SIX	
5. NAME OF DRILLER C. DRAKE		14. TOTAL NUMBER CORE BOXES SIX	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER _____	
7. THICKNESS OF OVERBURDEN 17.4'		16. DATE HOLE 2 Aug 60	
8. DEPTH DRILLED INTO ROCK 26.7'		17. ELEVATION TOP OF HOLE 704.0	
9. TOTAL DEPTH OF HOLE 44.1'		18. TOTAL CORE RECOVERY FOR BORING 100%	
		19. SIGNATURE OF INSPECTOR [Signature]	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	1. CORE RECOVERED FEET	2. BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
704.0	0.0		CLAY + ORGANIC MATTER			Note: Rock type is Dolomite, not Limestone as shown on field logs.
703.0	1.0		CLAY (CL)			
694.0	10.0		SAND - (SW)			
689.0	15.0		SAND GRAVEL & WEATHERED LIMESTONE			
688.0	16.0		Recovered Average 10' of Coarse Gravel & Fine Coarse			WL — Run 4.9' Begin 13.5' Rec 2.8' End 13.1' Loss — Time 40 min Gain — Dr. time 40 min Hy. press 30-200 PSI Water press — R/W 30-200 PSI Dr. Action Suction Water ret L. Sealed/wh. L. Remarks
687.0	17.0		NO CORE STARTS HERE			
686.0	18.0		— REMAINED —			
685.0	19.0		LIMESTONE			
684.0	20.0		R&D = 64' (Based on white core starts)			See Bbl. on Second this encountered Fall in Run Rock B. - Back in and cleared out, (see Soil boring logs)

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT)

B7

C-1000
Hole No. E1-1960

DRILLING LOG		DIVISION DETROIT	INSTALLATION CEDARS LOCK & DAM		SHEET 7 OF 10 SHEETS
1. PROJECT CEDARS LOCK & DAM			10. SIZE AND TYPE OF BIT MSL		
2. LOCATION (Commodity or Station) SEE PAGE TEN -			11. DATE FOR ELEVATION SHOWN (FWS or MSL) MSL		
3. DRILLING AGENCY CNECS			12. MANUFACTURER'S DESIGNATION OF DRILL S&H		
4. HOLE NO. (As shown on drawing (Hole and Site number) CNECS-E1-80			13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN DISTURBED: SIX Pushes UNDISTURBED: ONE		
5. NAME OF DRILLER C. ORAKE			14. TOTAL NUMBER CORE BOXES SIX		
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.			15. ELEVATION GROUND WATER		
7. THICKNESS OF OVERBURDEN 17.4'			16. DATE HOLE STARTED: 2 Aug 80 COMPLETED: 7 Aug 80		
8. DEPTH DRILLED INTO ROCK 26.7'			17. ELEVATION TOP OF HOLE 704.0		
9. TOTAL DEPTH OF HOLE 44.1			18. TOTAL CORE RECOVERY FOR BORING 100%		
			19. SIGNATURE OF INSPECTOR		

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
684.0	7.0'		RUN #1			
			RUN #2		Box	
683.0	21.0'		NO CORE - Rock Bit		1	RUN #2
			SHALEY LIMESTONE		203	WL Began 3:51 Run 45' End 4:10 Rec 45' Time 29min Loss - Time 29min Gain - Pressure 200psi Water press - Action Small Water ret. 1.1 lb/gal Remarks Blacken off - Fall in 11"
682.0	22.0'		RQD = 88.9%	100%	Box	
			FINE GRAINED, GRAY IN COLOR, DARK SUGARY TEXTURE, FOSSILIFEROUS, WITH SHALE (V. COMPACT) LAYERS/BIOS/LAMINA/STRENDERS - brought out cores Length - Breaks ALL CAUSED BY SWALSY AREAS		2	
681.0	23.0'					
680.0	24.0'		RUN #3			
						WL Began 9:53 Run 4.2 End 10:40 Rec 4.2 Time 46min Loss - Time 46min Gain - Pressure 80-120psi Water press - Action Small Water ret. 1.1 lb/gal Remarks
679.0	25.0'					
678.0	26.0'		SHALEY LMS		255	
677.0	27.0'		RQD = 70.7%	100%	Box	
					3	RUN #4
676.0	28.0'					WL Began 11:02 Run 9.5 End 11:47 Rec 9.5 Time 45min Loss - Time 45min Gain - Pressure 80-120psi Water press - Action Small Water ret. 1.1 lb/gal Remarks
675.0	29.0'		RUN 4			
674.0	30.0'					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT)

PROJECT HOLE NO.

Hole No. **C22005**
E1-1850

DRILLING LOG		DIVISION Detroit		INSTALLATION Cedars Lock Dam		SHEET 8 OF 10 SHEETS	
1. PROJECT CEDARS LOCK DAM				10. SIZE AND TYPE OF BIT MSL			
2. LOCATION (Coordinates or Station) SEE PAGE TEN				11. DAY OF ELEVATION SHOWN (PM or AM) MSL			
3. DRILLING AGENCY CENES				12. MANUFACTURER'S DESIGNATION OF DRILL SM			
4. HOLE NO. (As shown on drawing title and file number) CNES-E1-80				13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN SIX Pushes		14. TOTAL NUMBER CORE BOXES SIX	
5. NAME OF DRILLER L. DRALL				15. ELEVATION GROUND WATER		16. DATE HOLE 2 Aug 80	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				17. ELEVATION TOP OF HOLE 704.0		18. TOTAL CORE RECOVERY FOR BORING 100%	
7. THICKNESS OF OVERBURDEN 17.4'				19. SIGNATURE OF INSPECTOR			
8. DEPTH DRILLED INTO ROCK 26.7'							
9. TOTAL DEPTH OF HOLE 44.1'							

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 of weathering, etc., if significant) g
674.0	30	MS N/A NO			30.3	
673.0	31	MS	Silty Lim:			
			LN?			
672.0	32	MS	RQD-93.5%	100%	Box 4	Run #5 WL Began 42 hrd 46 End 42 Reo 46 Loss - Gain - T. e. 40 min Est. time 40 min Est. loss 60-120 Water loss Smooth Est. Act. Smooth Water re. 1.65 gal/100 lb wt. 1 Remarks
671.0	33	MS				
670.0	34	MS	Run #5			
667.0	35	MS N/A N/A	LIMESTONE		34.75	
668.0	36	MS N/A N/A	SHALE (GREY GRAY)			
			SHALE (GREY GRAY)			
			SHALE (GREY GRAY) STAIN AT BASE			
			SHARP CONTACT (WELL DEFINED)			
667.0	37	MS	DARK GREY IN COLOR	100%	Box 5	Run #6 WL Began 52 hrd 52 End 52 Reo 52 Loss - Gain - T. e. 40 min Est. time 40 min Est. loss 60-120 Water loss Smooth Est. Act. Smooth Water re. 1.65 gal/100 lb wt. 1 Remarks
666.0	38	MS	LIMESTONE			
			RQD-48.1%			
665.0	39	MS	Run #6		39.2	
664.0	40	MS	Limestone			

ENG FORM 1836
MAR 71

PREVIOUS EDITIONS ARE OBSOLETE
(TRANSLUCENT)

PROJECT

HOLE NO

C. 11111111
Hole No. E-1-1986

DRILLING LOG		DIVISION		INSTALLATION		SHEET	
1. PROJECT <u>Cedars Rock & Dam</u>				10. SIZE AND TYPE OF BIT <u>M32</u>		11. DAYUM FOR ELEVATION SHOWN (FT or M) <u>1132</u>	
2. LOCATION (Coordinates or Station) <u>SEE PAGE TEN -</u>				12. MANUFACTURER'S DESIGNATION OF DRILL <u>S&H</u>		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN <u>Six Pushes</u>	
3. DRILLING AGENCY <u>GENES</u>				14. TOTAL NUMBER CORE BOXES <u>Six</u>		15. ELEVATION GROUND WATER <u>---</u>	
4. HOLE NO. (As shown on drawing title and file number) <u>CHES-EI-80</u>				16. DATE HOLE <u>12 Aug 80</u>		17. ELEVATION TOP OF HOLE <u>704.0</u>	
5. NAME OF DRILLER <u>C. DRAKE</u>				18. TOTAL CORE RECOVERY FOR BORING <u>100%</u>		19. SIGNATURE OF INSPECTOR <u>---</u>	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED <u>---</u> DEG. FROM VERT.				16. DATE HOLE <u>12 Aug 80</u>		17. ELEVATION TOP OF HOLE <u>704.0</u>	
7. THICKNESS OF OVERBURDEN <u>17.4'</u>				18. TOTAL CORE RECOVERY FOR BORING <u>100%</u>		19. SIGNATURE OF INSPECTOR <u>---</u>	
8. DEPTH DRILLED INTO ROCK <u>26.7'</u>				16. DATE HOLE <u>12 Aug 80</u>		17. ELEVATION TOP OF HOLE <u>704.0</u>	
9. TOTAL DEPTH OF HOLE <u>44.1'</u>				18. TOTAL CORE RECOVERY FOR BORING <u>100%</u>		19. SIGNATURE OF INSPECTOR <u>---</u>	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
6640.400			Run #7	216%		WL Run 7 Began 335 Run 49 End 420 Rec 185 Loss 355 Gain 450 Lith: no Bedrock Water: no Firm 75 Lith: Action Smooth Water: no Lith: no Bedrock Remarks: Slipped - Workman held back
6630.410			Shale Limestone		Box 6	
6620.420			"	100%		
6610.430			"			
6600.440			Run #7+8	END		Run 8 Began 435 Run 355 End 455 Rec 355 Loss 455 Gain 455 Lith: no Bedrock Water: no Firm 75 Lith: Action Smooth Water: no Lith: no Bedrock Remarks: Slipped - Workman held back
6590.450			Total Core Recovery is 100%			
6580.460						
6570.470						
6560.480						
6550.490						

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE
(TRANSLUCENT)

PROJECT

HOLE NO

BORING LOG FIELD DATA											
Project <u>Cedar Lake Dam</u>		Site <u>Cedar Lake, Little Auau, WE</u>		Date <u>16 August 80</u>							
Location <u>See Note #1</u>		Job No. <u>441-5767-30622</u>									
Drill Rig <u>ACK</u>		Inspector <u>J. Dunbar</u>		Operator <u>Clyde Hawk</u>							
		Surface El <u>702.8'</u>		Boring No. <u>441-5767-30622</u>							
SAMPLE NUMBER	DATE TAKEN	STRATUM		DRIVE		SAMPLE		TYPE OF SAMPLER	PASS COUNT	CLASSIFICATION AND REMARKS	
		FROM	TO	FROM	TO	FROM	TO				
#1	16 Aug	0.0	1.0	0.0	0.5	0.2	2.4	5" Drive Sampler	235	CLAY SILT - Clay Silt, low	
#2A		1.0		0.5	1.0	2.4	2.5	Tube	400	Plasticity, Brown, dry, little cohesion	
				1.0	1.5				450	Push 2.5' Comp 0.8' SPL 1.7'	
				1.5	2.0				550		
				2.0	2.5				700		
				2.5							
				3.0							
				3.5							
				4.0							
				4.5							
				5.0							
				5.5							
				6.0							
				6.5							
				7.0							
				7.5							
				8.0							
				8.5							
				9.0							
				9.5							
				10.0							
				10.5							
				11.0							
				11.5							
				12.0							
				12.5							
				13.0							
				13.5							
				14.0							
				14.5							
				15.0							
				15.5							
				16.0							
				16.5							
				17.0							
				17.5							
				18.0							
				18.5							
				19.0							
				19.5							
				20.0							
				20.5							
				21.0							
				21.5							
				22.0							
				22.5							
				23.0							
				23.5							
				24.0							
				24.5							
				25.0							
				25.5							
				26.0							
				26.5							
				27.0							
				27.5							
				28.0							
				28.5							
				29.0							
				29.5							
				30.0							
				30.5							
				31.0							
				31.5							
				32.0							
				32.5							
				33.0							
				33.5							
				34.0							
				34.5							
				35.0							
				35.5							
				36.0							
				36.5							
				37.0							
				37.5							
				38.0							
				38.5							
				39.0							
				39.5							
				40.0							
				40.5							
				41.0							
				41.5							
				42.0							
				42.5							
				43.0							
				43.5							
				44.0							
				44.5							
				45.0							
				45.5							
				46.0							
				46.5							
				47.0							
				47.5							
				48.0							
				48.5							
				49.0							
				49.5							
				50.0							
				50.5							
				51.0							
				51.5							
				52.0							
				52.5							
				53.0							
				53.5							
				54.0							
				54.5							
				55.0							
				55.5							
				56.0							
				56.5							
				57.0							
				57.5							
				58.0							
				58.5							
				59.0							
				59.5							
				60.0							
				60.5							
				61.0							
				61.5							
				62.0							
				62.5							
				63.0							
				63.5							
				64.0							
				64.5							
				65.0							
				65.5							
				66.0							
				66.5							
				67.0							
				67.5							
				68.0							
				68.5							
				69.0							
				69.5							
				70.0							
				70.5							
				71.0							
				71.5							
				72.0							
				72.5							
				73.0							
				73.5							
				74.0							
				74.5							
				75.0							
				75.5							
				76.0							
				76.5							
				77.0							
				77.5							
				78.0							
				78.5							
				79.0							
				79.5							
				80.0							
				80.5							
				81.0							
				81.5							
				82.0							
				82.5							
				83.0							
				83.5							
				84.0							
				84.5							
				85.0							
				85.5							
				86.0							
				86.5							
				87.0							
				87.5							

AD-A119 696

ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG--ETC F/6 13/2
CONDITION SURVEY OF CEDARS LOCK AND DAM, LOWER FOX RIVER, WISCO--ETC(U)
JUN 82 R L STOWE, J C AHLVIN
WES/MP/SL-82-4

UNCLASSIFIED

CTIAC-52

NL

2 of 2
2
2



END
DATE
FILMED
11.82
DTIC

BORING LOG FIELD DATA													
Project <u>Cedars Lock & Dam</u>		Location <u>See Page #4</u>		Site <u>Cedar Lock & Dam</u>		Date <u>16 August 1990</u>		Job No. <u>481.570.3.30.0.0.0</u>		Boring No. <u>C481-02-80</u>			
Drill Rig <u>Acker</u>		Inspector <u>Joe Dunbar</u>		Operator <u>L. L. YDE</u>		Drill Surface El <u>702.5'</u>							
SAMPLE NUMBER	DATE TAKEN	STRATUM		DRIVE		SAMPLE		TYPE OF SAMPLER	Penetration	CLASSIFICATION AND REMARKS			
		FROM	TO	FROM	TO	FROM	TO						
3	18 Aug			5.0	5.5	5.0	5.6	5" HISSCOV.	500	Clay - Reddish Brown Silt			
3A				5.5	6.0	5.8	6.1		525	Little to no cohesion, low plastic.			
3B				6.0	6.5	6.1	7.2		650	Sample fell apart in handling			
3C				6.5	7.0	7.2	7.3		700	Pushed 2.5 Comp. 0.2' Sp. 2.5			
				7.0	7.5				850				
				5.0	7.5			6" FISHTAIL		CLAY - SAND - LMS COBBLES - BOULDERS - GRAVEL			
4	19 Aug	8.4	8.4	7.5	8.0	7.55	8.5	5" HISSCOV.	500				
4A				8.0	8.5	7.5	7.85		700				
				8.5	8.65				1000				
5	18 Aug			8.65	11.35	8.65	11.35	DRIVE BBL		CLAY + LMS RIP RAP (GRAVEL - BOULDERS + BOULDERS)			
6	18 Aug			11.35	16.35	11.35	16.35	DRIVE BBL		CLAY (20% LMS (80%)) RIP RAP. RECOVERED APPROX 1/4 TO 1/2 BAC.			

WES FORM JAN 74 819 EDITION OF NOV 1971 MAY BE USED

Sheet 2 of 4 Sheets

[illegible]

FORM 819
JAN 74

Hole No. QW-1-40-60 ^{E2}

DRILLING LOG		DIVISION <u>Detroit</u>		INSTALLATION <u>Cedars Lock Dam</u>		SHEET <u>2</u> OF <u>4</u> SHEETS	
1. PROJECT <u>CEDARS LOCK DAM</u>				10. SIZE AND TYPE OF BIT <u>5" H.A. 21/32" / 1/4" / 1/8"</u>			
2. LOCATION (Coordinate or Station) <u>See In the</u>				11. DATE FOR ELEVATION <u>11/5/80</u>			
3. DRILLING AGENCY <u>C.E.W.I.S.</u>				12. MANUFACTURER'S DESIGNATION OF DRILL <u>WALKER</u>			
4. HOLE NO. (As shown on drawing title and file number) <u>CWIS-E2-80</u>				13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN <u>0</u> DISTURBED <u>0</u> UNDISTURBED <u>0</u>			
5. NAME OF DRILLER <u>CLIFFE PEAKS</u>				14. TOTAL NUMBER CORE BOXES <u>one</u>			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				15. ELEVATION GROUND WATER _____			
7. THICKNESS OF OVERBURDEN <u>1865</u>				16. DATE HOLE <u>16 Aug 80</u> <u>18 Aug 80</u>			
8. DEPTH DRILLED INTO ROCK <u>5'</u>				17. ELEVATION TOP OF HOLE <u>762.61</u>			
9. TOTAL DEPTH OF HOLE <u>23.75</u>				18. TOTAL CORE RECOVERY FOR BORING _____			
				19. SIGNATURE OF INSPECTOR _____			

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of penetration, etc., if significant)
762.8	6.0		CL/ml			
	8.4		LMS Cabbles-Boulders-Gravel			
	1865		LMS 60 to 80% cl/ml 20 to 40%			
6838	190					
6828	200		SWISSY LMS			Run #1 NL Run 51 Began 1:00 Rec 5:1 End 1:30 Loss - Time 3:30 Gain - Drl time 35 min Hyd press 150 PSI Water press - RPM 701 Drl Action Smooth Water ret ✓ Remarks ✓
6818	210		Finest med grad, gray to greenish gray in color, moderately hard, dense & contains numerous shaly zones/bands/lenses which control breaks in core.			
6808	220					
6798	230					
6788	240					

LEGEND

LT - Limestones

NA - Natural Bank

LOCATION

Left lower gate hand crank post

LOCK WHEEL

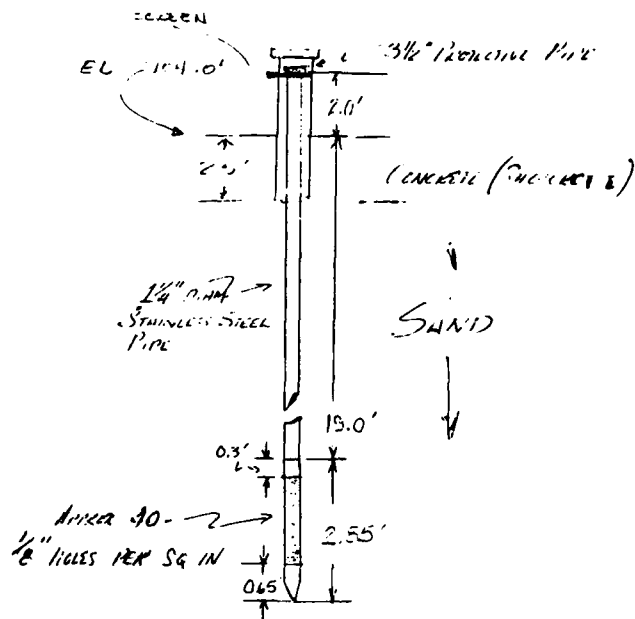
ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.
(TRANSLUCENT)

PROJECT

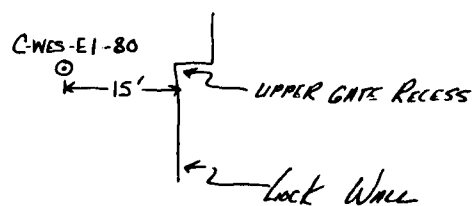
HOLE NO.

CEDARS LOCK DAY 10 OF 10

Recommendation B.1 - CEDARS Lock and DAM



LOCATION



Hole No. CUES-DI-80

DRILLING LOG		DIVISION		INSTALLATION		SHEET	
1. PROJECT ADAMS Locks Dam		2. LOCATION (Coordinates or Map) SEE BOTTOM OF Page #4		3. DRILLING AGENCY C.E.W.E.S.		4. HOLE NO. (As shown on drawing title) CUES-DI-80	
5. NAME OF DRILLER CLIVE DEAKE		6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		7. THICKNESS OF OVERBURDEN CONCRETE 17.65		8. DEPTH DRILLED INTO ROCK 20.10	
9. TOTAL DEPTH OF HOLE 37.75'		10. SIZE AND TYPE OF BIT 6 7/8" - 8 1/2" RS		11. DAY ON FOR ELEVATION BROWN (Type - BMS) MSL		12. MANUFACTURER'S DESIGNATION OF DRILL Sinclair-Harnwood	
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN		14. TOTAL NUMBER CORE BOXES NONE		15. ELEVATION GROUND WATER Lake Level		16. DATE HOLE 11 AUGUST 80	
17. ELEVATION TOP OF HOLE 703.8		18. TOTAL CORE RECOVERY FOR BORING 99.3%		19. SIGNATURE OF INSPECTOR John L. B. Tumbler		20. REMARKS (Drilling time, water loss, depth of overburden, etc., if significant)	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS
703.8	0.0	Δ	CONCRETE	100%	Box 1	Run #1 WL — Rec 2.55 Began 3.05 Rec 2.35 End 3.30 Loss — Time 25 min Gain — Drl time 25 min Hyd press 80-125 PSI Water press — RPM 702 Drl Action Smooth Water ret L. Brown Remarks 6" x 7 1/4" B/L
702.8	1.0	Δ				
701.8	2.0	Δ				
700.8	3.0	Δ	Run #2 RQD 100%	100%	Box 1	Run #2 WL — Rec 2.35 Began 3.35 Rec 1.95 End 4.10 Loss 0.4 Time 35 min Gain — Drl time 35 min Hyd press 80-125 PSI Water press — RPM 705 Drl Action Smooth Water ret L. Brown Remarks 6" x 7 1/4" B/L BRKE OFF.
699.6	4.0	Δ	Run #3	100%	43	Run #3 WL — Rec 3.5 Began 4.22 Rec 3.5 End 4.37 Loss — Time 15 min Gain — Drl time 10 min Hyd press 80-100 PSI Water press — RPM 705 Drl Action Smooth Water ret L. Brown Remarks Run #4 WL — Rec 4.85 Began 4.45 Rec 4.85 End 5.14 Loss — Time 29 min Gain — Drl time 29 min Hyd press 60 PSI Water press — RPM 602 Drl Action Smooth Water ret L. Brown Remarks
698.8	5.0	Δ	CONCRETE: Gray Brown in color with Natural App. Reaction Product visible - slight.	100%	Box 2	Run #4 WL — Rec 4.85 Began 4.45 Rec 4.85 End 5.14 Loss — Time 29 min Gain — Drl time 29 min Hyd press 60 PSI Water press — RPM 602 Drl Action Smooth Water ret L. Brown Remarks
697.8	6.0	Δ				
696.8	7.0	Δ				
695.8	8.0	Δ	Run #4 RQD 100%			
694.8	9.0	Δ				
693.8	10.0	Δ				

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE.
MAR 71 (TRANSLUCENT)

PROJECT _____ HOLE NO. _____

Hole No. CWES-DI-80

DRILLING LOG		Division Detroit		INSTALLATION Cedars Lock Dam		Sheet of 4	
1. PROJECT Cedars Lock Dam		10. SIZE AND TYPE OF BIT 6 x 7 3/4" - 1-15		11. DATE FOR ELEVATION SHOWN 11.5.1. 5/12/80		12. MANUFACTURER'S DESIGNATION OF DRILL Spring & Harwood	
2. LOCATION (Coordinates of location) See bottom of page #4		13. TOTAL NO. OF OVER-BOREDEN SAMPLES TAKEN DISTURBED UNDISTURBED		14. TOTAL NUMBER CORE BOXES N/A		15. ELEVATION GROUND WATER Lake Level	
3. DRILLING AGENCY C.E. W.E.S.		16. DATE HOLE 11 August 80		17. ELEVATION TOP OF HOLE 703.8		18. TOTAL CORE RECOVERY FOR BORING 99.3	
4. HOLE NO. (As shown on drawing sheet and this number) CWES-DI-80		19. SIGNATURE OF INSPECTOR					
5. NAME OF DRILLER CLYDE DRAKE							
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.							
7. THICKNESS OF OVERBURDEN CONCRETE 17.65'							
8. DEPTH DRILLED INTO ROCK 20.10'							
9. TOTAL DEPTH OF HOLE 37.75'							

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OF SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if applicable)
6938	10	Δ				12 AUGUST 1980 Run #5
6928	11	Δ	CONCRETE		Box 3	WL - Run 505' Began 746 Rec 505' End 8:16 Loss - Time 30 min Gain - Drl time 28 min Hyd press 80-100 psi Water press - RPM 702 Drl Action Smooth Water ret Lt. Green/White Remarks
6918	12	Δ	NB	100%		
6908	13	Δ	NB		12.7	
6898	14	Δ	NB		Box 4	
6888	15	Δ	Run #5 RQD = 100% 2 closed			Run #6 WL - Run 505' Began 8:27 Rec 505' End 9:00 Loss - Time 33 min Gain - Drl time 33 min Hyd press 100 PSI Water press - RPM 702 Drl Action Smooth Water ret Lt. Green/White Remarks
6878	16	Δ	CONCRETE		Box 4	
6868	17	Δ	NB	100%	170	Falling Head Test 0.05 at 3 min - 6.7% Hole
6858	18	Δ	TIGHT BOND CLOSED FRACTURE N.B. SHALY LIMESTONE N.B. SURFACE STAINING (BROWN)		Box 5	
6848	19	Δ	N.B. FRACTURED & SURFACE STAINING			
6838	20	Δ	Run #6 RQD = 79%			

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE
MAR 71 (TRANSLUCENT)

B17

Hole No. **CNES-DI-80**

DRILLING LOG		DRILLER D. J. H. E. S.	LOCATION CEDARS LOCK & DAM	WELL ALLIANCE Pears Lock & Dam	SHEET 3 OF 4
1. PROJECT CEDARS LOCK & DAM		10. SIZE AND TYPE OF BIT 6" 7/8" - BIT - R3		11. DAYTON FOR ELEVATION M.S.L. 54" X 4" B-782848580	
2. LOCATION SEE BOTTOM OF PAGE #4		12. MANUFACTURER'S DESIGNATION OF DRILL SPRAGUE & HENWOOD		13. TOTAL NO. OF OVER-DRIVEN SAMPLES TAKEN DISTURBED _____ UNDISTURBED _____	
3. DRILLING AGENCY C. E. H. E. S.		14. TOTAL NUMBER CORE BOXES NINE		15. ELEVATION GROUND WATER LAKE LEVEL	
4. HOLE NO. CNES-DI-80		16. DATE HOLE 11 AUGUST 80		17. ELEVATION TOP OF HOLE 703.8	
5. NAME OF DRILLER CLYDE DRAKE		18. TOTAL CORE RECOVERY FOR BORING 99.37%		19. SIGNATURE OF INSPECTOR	
6. DIRECTION OF HOLE VERTICAL ☒ INCLINED _____ DEG. FROM VERT.		7. THICKNESS OF SUBSTRATE CONCRETE 17.65		8. DEPTH DRILLED INTO ROCK 20.10	
9. TOTAL DEPTH OF HOLE 37.75'					

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	BOX OR RECOVER NO.	REMARKS (Drilling time, water loss, depth of penetration, etc., if applicable)
6838	20	NS	LAKE		Run #7
		NS			WL - Run 5.2
		NS			Began 9.09
		NS			End 10.00
		NS			Time 51 min.
		NS			Drl time
		NS			Hyd press 1000
		NS			Water press -
		NS			RPM 75
		NS			Drl Action Smooth
		NS			Water ret
		NS			1.6 min
		NS			1.6 min
		NS			Falling Head Test
		NS			6" x 7/8" hole
		NS			10' in 20 sec
		NS			2.0' in 75 sec
		NS			3.0' in 120 sec
6808	23	NS	SHALEY LIMESTONE	Box 6	
		NS	Fine to med grad, gray to		
		NS	grayish green in color, moderately		
		NS	hard, dense, fossiliferous, silty (Pyrite)		
		NS	and contains numerous interbedded shaley		
		NS	beds - some of which are silty		
		NS	Run #7 R.R.D. = 59.6%		
6788	25	NS		Box 6	
		NS			Run #8
		NS			WL - Run 4.9
		NS			Began 10.45
		NS			End 11.26
		NS			Time 41 min
		NS			Drl time 11 min
		NS			Hyd press 1000
		NS			Water press -
		NS			RPM 75
		NS			Drl Action Smooth
		NS			Water ret
		NS			Grayish
		NS			1.6 min
		NS			Falling Hl Test
		NS			6.78" hole
		NS			10' in 20 sec
		NS			2.0' in 1 min
6748	29	NS		Box 7	
		NS			Run #8 R.R.D. = 70.4%
6738	30	NS			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT HOLE NO.

Hole No. CUES-DI-80

DRILLING LOG		INSTALLATION	
1. PROJECT DETROIT		10. HOLE AND TYPE OF BIT Cedars Lock - Dam	
2. LOCATION (City, State, County) SEE BOTTOM OF PAGE #4		11. DAY AND TIME 11 AUG. 80	
3. DRILLING AGENCY CUES		12. MANUFACTURER'S DESIGNATION OF DRILL SPRAGGS HENWOOD	
4. HOLE NO. (As shown on drawing title and site number) CUES-DI-80		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN DISTURBED ☐ UNDISTURBED ☐	
5. NAME OF DRILLER CLIFF ORAKE		14. TOTAL NUMBER CORE BOXES NINE	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER LAKE LEVEL	
7. THICKNESS OF OVERBURDEN CONCRETE 17.65		16. DATE HOLE STARTED 11 AUG. 80 COMPLETED 12 AUG. 80	
8. DEPTH DRILLED INTO ROCK 20.10		17. ELEVATION TOP OF HOLE 703.8	
9. TOTAL DEPTH OF HOLE 47.75'		18. TOTAL CORE RECOVERY FOR BORING 99.3%	
		19. SIGNATURE OF INSPECTOR	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of overburden, etc., if significant)
673.8	30				30.3	
672.8	31		SHALEY LIMESTONE		Box 1	Run #9 RL - F. ran 12.01 Run 4.5 End 12.37 Rec 4.8 Time 36 min Lusc - Drl time 36 min Gain - Hyd press 100 PSI Water press - RIM 75.5 Drl Action Smooth Water ret 1.0' in 270 PSI 2.0' in 64 sec 3.0' in 110 sec
671.8	32					
670.8	33					
669.8	34		Run #9 RQD 83.7% 33.9			Run #10 WL Began 1.13 Run 3.85 End 2.00 Rec 3.4 Time 77 min Loss 0.4 Drl time 40 min Gain - Hyd press 100 PSI Water press - RIM 75.5 Drl Action Smooth Water ret 1.0' in 270 PSI 2.0' in 64 sec 3.0' in 110 sec
668.8	35		Shaley LMS		Box 9	Run #10 WL Began 1.13 Run 3.85 End 2.00 Rec 3.4 Time 77 min Loss 0.4 Drl time 40 min Gain - Hyd press 100 PSI Water press - RIM 75.5 Drl Action Smooth Water ret 1.0' in 270 PSI 2.0' in 64 sec 3.0' in 110 sec
667.8	36					Lost water at 56.0'
666.8	37		Run #10 RQD 87.0% 37.3			Core broke
665.8	38		LEGEND			LOCATION
664.8	39		CONCRETE			CUES-DI-80
663.8	40		LIMESTONE			Conts
			NA NATURAL BREAK			Spinning Part #1
			MB Machine Break			
			FF - FRACTURE			

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE
 MAR 77 (TRANSLUCENT)

Hole No. 8-WES-02-80

DRILLING LOG			DIVISION		INSTALLATION		SHEET	
PROJECT			DETROIT		CEDARS LOCK & DAM		OF 6 SHEETS	
LOCATION (Coordinates or Station)			C-1155-D-2-80		10. SIZE AND TYPE OF BIT 1 7/8" B.T. - RS		11. DAY ON ELEVATION SHOWN (FROM C. 1155)	
DRILLING AGENCY			CE WES		12. MANUFACTURER'S DESIGNATION OF DRILL		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	
HOLE NO. (As shown on drawing title and file number)			C-1155-D-2-80		ALXSE		DISTURBED	
NAME OF CRILLER			URAKE		14. TOTAL NUMBER CORE BOXES ELEVEN		15. ELEVATION GROUND WATER	
DIRECTION OF HOLE			VERTICAL		16. DATE HOLE		17. ELEVATION TOP OF HOLE	
THICKNESS OF OVERBURDEN			CONCRETE 23.95		31 JULY 80		8 AUGUST 1980	
DEPTH DRILLED INTO ROCK			26.05		18. TOTAL CORE RECOVERY FOR BORING		100%	
TOTAL DEPTH OF HOLE			50.0		19. SIGNATURE OF INSPECTOR		JAY L. B. Kunkin	
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of penetration, etc., if significant)		
706.97	0	Δ	CONCRETE GREY BROWN IN COLOR, CONTAINS MED SIZED NATURAL AGG. AND REACTION PRODUCT VISIBLE	100%	Box #1	Run #1 WL — Run 2.2' Began 3.03 Rec 2.2' End 3:57 Loss — Time 54 min Gain — Dri time 49 min Hyd press 250 PSI Water press — RPM 150± Dri Action Smooth Water ret Lt Brown/White Remarks 6" 7 3/4" Bbl.		
705.97	10	Δ						
704.97	20	Δ	Run #1 RQD=100%					
703.97	30	Δ	CONCRETE SAME	100%	Box #1	Run #2 WL — Run 2.35 Began 4.01 Rec 2.35 End 4.51 Loss — Time 50 min Gain — Dri time 45 min Hyd press 250± Water press — RPM 150± Dri Action Smooth Water ret Lt Brown/White Remarks 6" x 7 3/4" Bbl.		
702.97	40	Δ	Run #2 RQD=100%	100%	455			
701.97	50	Δ	CONCRETE SAME		Box 2	Run #3 WL — Run 4.55 Began 4.58 Rec 4.55 End 5:15 Loss — Time 17 min Gain — Dri time 17 min Hyd press 250± Water press — RPM 150± Dri Action Smooth Water ret Lt Brown/White Remarks 4" x 5 1/2" Bbl.		
700.97	60	Δ	RQD=100%	100%				
699.97	70	Δ						
698.97	80	Δ						
697.97	90	Δ	Run #3		9.1			
696.97	100	Δ	CONCRETE: SAME					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.
(TRANSLUCENT)

PROJECT

HOLE NO.

Hole No. **CEDARS**
D-7-80

DRILLING LOG		INSTALLATION	
1. PROJECT CEDARS LOCK & DAM		10. SIZE AND TYPE OF BIT 6 7/8" BIT - RS	
2. LOCATION (Completions or Station) SEE PAGE 516		11. DATUM FOR ELEVATION SHOWN (FSM or MSL) MSL 5'26.4" BIT 782841PS 74PN1568	
3. DRILLING AGENCY CE WES		12. MANUFACTURER'S DESIGNATION OF DRILL ACKER	
4. HOLE NO. (As shown on drawing title and file number) C-WES-D-2-80		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN DISTURBED UNDISTURBED	
5. NAME OF DRILLER C. DRAKE		14. TOTAL NUMBER CORE BOXES ELEVEN	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED DES. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN Concrete 23.95		16. DATE HOLE STARTED 31 July 80 COMPLETED 8 Aug 80	
8. DEPTH DRILLED INTO ROCK 26.05		17. ELEVATION TOP OF HOLE 706.97	
9. TOTAL DEPTH OF HOLE 50.0		18. TOTAL CORE RECOVERY FOR BORING 100%	
19. SIGNATURE OF INSPECTOR			

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	SCORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of penetration, etc., if significant)
696.97	10	Δ		100%	Box 1	Run #4 Rec 5.0' End 7.45 Time 35min Drl time 35min Hyd press 2752 Water press 1502 Drl Action Smooth Water ret 1.80min/ft Remarks
695.97	11	Δ	Concrete Same	100%	Box 3	
694.97	12	Δ				
693.97	13	Δ				
692.97	14	Δ	Run #4 RQD=100%	14.1		
691.97	15	Δ				Run #5 WL - Run 5.05 Began 8.55 Rec 5.55 End 9.50 Loss - Time 57min Gain - Drl time 50min Hyd press 2752 Water press - RPM 1502 Drl Action Smooth Water ret 1.80min/ft Remarks
690.97	16	Δ	Concrete Same		Box 4	
689.97	17	Δ	3/4" RE STEEL	100%		
688.97	18	Δ				
687.97	19	Δ	Run #5 RQD=100%	19.0		
686.97	20	Δ	Concrete		Box 5	

END FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT HOLE NO.

Hole No. 02-80

DRILLING LOG		DIVISION <u>DETROIT</u>		INSTALLATION <u>REDARS LOCK & DAM</u>		SHEET <u>3</u> OF <u>6</u> SHEETS	
1. PROJECT <u>Redars Lock & Dam</u>				10. SIZE AND TYPE OF BIT <u>6 1/2" BIT - RS</u>			
2. LOCATION (Coordinates or Station) <u>SEE PAGE SIX</u>				11. DAY ON FOR ELEVATION SHOWN (TIME OF DAY) <u>11:50</u>			
3. DRILLING AGENCY <u>C.F. WIES</u>				12. MANUFACTURER'S DESIGNATION OF DRILL <u>ACKER</u>			
4. HOLE NO. (As shown on drawing title) and file number <u>CWES-D-2-80</u>				13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN <u>100%</u>			
5. NAME OF DRILLER <u>P. DRAKE</u>				14. TOTAL NUMBER CORE BOXES <u>EIGHTEN</u>			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				15. ELEVATION GROUND WATER _____			
7. THICKNESS OF OVERBURDEN <u>CONCRETE 23.95</u>				16. DATE HOLE <u>9/30/48</u> <u>8 AUGUST 10</u>			
8. DEPTH DRILLED INTO ROCK <u>26.05</u>				17. ELEVATION TOP OF HOLE <u>706.97</u>			
9. TOTAL DEPTH OF HOLE <u>50.0</u>				18. TOTAL CORE RECOVERY FOR BORING <u>100%</u>			
				19. SIGNATURE OF INSPECTOR _____			

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
686.97	13.0		CONCRETE SAME			Run #6 #L — Run 48 Began 10:05 Rec 48 End 11:10 Loss — Time 65 min Gain — Drill time 55 min Hrd. press 20-55 psi Water press — Mud 1/2 sec Mud Action Smooth Water ret 1. Brown/white Remarks No water loss on FALLING HEAD TEST.
685.77	21.0					
684.57	22.0					
683.57	23.0					
682.77	24.0					
681.97	25.0		NO LIMESTONE	100%	Box 5	Run #7 #L — Run 13 Began 11:47 Rec 13 End 1:20 Loss — Time 93 min Gain — Drill time 50 min 250-300 PSI Mud 150 s Mud Action Smooth Water ret 1. Brown/white Remarks From Shavings from B. STEEL TIME UP B. REACHED B. W. TH.
680.77	26.0		SHALEY LIMESTONE			
679.77	27.0		Solution Activity - FERRIC XLS			
678.77	28.0		SHALE			
677.77	29.0		SHALEY LMS - Fm to med. grnd. Grey in color, sugary texture and contains shale layers/Beds/laminar through out cores length.	100%	Box 6	
676.77	30.0		Breaks are governed by these shaley areas - Limestone is also fairly dense		Box 7	

END FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT _____ HOLE NO. _____

Hole No. Cedars
DL-81

DRILLING LOG		INSTALLATION	
1. PROJECT <u>Cedars Lock & Dam</u>		10. SIZE AND TYPE OF BIT <u>6 1/2" BIT - R5 -</u>	
2. LOCATION (Coordinate or Station) <u>See Page SIX -</u>		11. DAY OF YEAR ELEVATION SHOWN (YR - MM) <u>M.S.L. 5644' 617 78 28 14 15 14 PM 1568</u>	
3. DRILLING AGENCY <u>CE NES</u>		12. MANUFACTURER'S DESIGNATION OF DRILL <u>AGKER</u>	
4. HOLE NO. (As shown on drawing title) and file number <u>CNES 0-2 80</u>		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN <u>UNDISTURBED</u>	
5. NAME OF DRILLER <u>C. DRAKE</u>		14. TOTAL NUMBER CORE BORES <u>UNDISTURBED</u>	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG FROM VERT		15. ELEVATION GROUND WATER <u>UNDISTURBED</u>	
7. THICKNESS OF OVERBURDEN <u>CONCRETE 22.95</u>		16. DATE HOLE STARTED <u>31 July 80</u> COMPLETED <u>8 Aug 1980</u>	
8. DEPTH DRILLED INTO ROCK <u>26.95</u>		17. ELEVATION TOP OF HOLE <u>706.27</u>	
9. TOTAL DEPTH OF HOLE <u>50.0</u>		18. TOTAL CORE RECOVERY FOR BORING <u>100%</u>	
		19. SIGNATURE OF INSPECTOR <u>100%</u>	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of penetration, etc., if significant)
676.97	30'		<u>RUN #8</u>			<u>RUN #8</u> WL - <u>RUN 495</u> Began <u>154</u> Rec <u>485</u> End <u>220</u> Loss - Time <u>26 min</u> Gain - Drl time <u>2 min</u> Hyp. press <u>275+</u> Water press - Rt. <u>150+</u> Drl Action <u>Smooth</u> Water ret <u>21 Brown/wh. h</u> Remarks <u>Falling Ho Test</u> <u>1.0' in 175 sec</u>
675.97	310'		<u>SHALEY LMS</u>			
674.97	320'		<u>SHALE</u>	<u>100%</u>	<u>Box 7</u>	
673.97	330'		<u>Rad-89 6%</u>			
672.97	340'		<u>SHALE STAIN</u>		<u>338</u>	
671.97	350'		<u>RUN #9</u>		<u>Box 8</u>	<u>RUN #9</u> WL - <u>RUN 40'</u> Began <u>241</u> Rec <u>48</u> End <u>315</u> Loss - Time <u>3 min</u> Gain - Drl time <u>3 min</u> Hyp. press <u>275+</u> Water press - Rt. <u>150+</u> Drl Action <u>Smooth</u> Water ret <u>21 Brown/wh. h</u> Remarks <u>Falling Ho Test</u> <u>0.5' in 175 sec</u>
670.97	360'		<u>SHALEY LMS</u>		<u>Box 8</u>	
669.97	370'		<u>Rad-93 9%</u>	<u>100%</u>		
668.97	380'		<u>SHALE</u>		<u>382</u>	
667.97	390'		<u>SHALE</u>		<u>Box 9</u>	
666.97	400'		<u>Rad-93 9%</u>			
665.97	410'		<u>SHALE</u>			
664.97	420'		<u>SHALE</u>			
663.97	430'		<u>SHALE</u>			
662.97	440'		<u>SHALE</u>			
661.97	450'		<u>SHALE</u>			
660.97	460'		<u>SHALE</u>			
659.97	470'		<u>SHALE</u>			
658.97	480'		<u>SHALE</u>			
657.97	490'		<u>SHALE</u>			
656.97	500'		<u>SHALE</u>			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT)

C-10445
Hole No. DE-1980

DRILLING LOG		DIVISION <u>DETROIT</u>		INSTALLATION <u>CEDARS LOCK & DAM</u>		SHEET <u>3</u> OF <u>6</u> SHEETS	
1. PROJECT <u>Cedars Lock & Dam</u>				10. SIZE AND TYPE OF BIT <u>6 1/4" BIT - R5</u>			
2. LOCATION (Coordinate or Station) <u>SEE PAGE SIX</u>				11. DAYUM FOR ELEVATION (Brown Type - <u>MS</u>) <u>M.S. 6 5/8" x 4" BIT 7824H R5 79PW568</u>			
3. DRILLING AGENCY <u>CENES</u>				12. MANUFACTURER'S DESIGNATION OF DRILL <u>ACKER</u>			
4. HOLE NO. (As shown on drawing title and file number) <u>C-NES-D-2-80</u>				13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN DISTURBED _____ UNDISTURBED _____			
5. NAME OF DRILLER <u>C. DRAGO</u>				14. TOTAL NUMBER CORE BOXES <u>ELEVEN</u>			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				15. ELEVATION GROUND WATER _____			
7. THICKNESS OF OVERBURDEN <u>CONCRETE 23.45</u>				16. DATE HOLE STARTED _____ COMPLETED <u>31 July 80 8 Aug 80</u>			
8. DEPTH DRILLED INTO ROCK <u>26.05</u>				17. ELEVATION TOP OF HOLE <u>706.97</u>			
9. TOTAL DEPTH OF HOLE <u>50.0</u>				18. TOTAL CORE RECOVERY FOR BORING <u>100%</u>			
				19. SIGNATURE OF INSPECTOR _____			

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 of weathering, etc., if significant) g
666.9742		NO	Shaley LIMESTONE RQD=100%	100%	Box 9	Run #11 Run 2.1 Began 4.31 End 5.05 Time 34 min Drl time 10 min Hyd press 80-200 lb Water press - RPH 100+ Drl Action Smooth Water ret 11 Brown/White Remarks
664.9742			Run #11		420	
663.9743			Shaley LIMESTONE RQD=100%		Box 10	Run #12 Run 4.5' Began 10:10 End 10:45 Time 35 min Drl time 10 min Hyd press 200 lb Water press - RPH 150+ Drl Action Smooth Water ret Overly white Remarks
662.9744			Run #12		465	
661.9745		NO	Shaley Lms RQD=100%	100%	Box 11	Run #13 Run 3.5' Began 11:01 End 11:30 Time 29 min Drl time 10 min Hyd press 200 lb Water press - RPH 150+ Drl Action Smooth Water ret White/gray Remarks
660.9746			Run #13			
659.9747		NO	Shaley Lms RQD=100%	100%	Box 11	Run 3.5' Began 11:01 End 11:30 Time 29 min Drl time 10 min Hyd press 200 lb Water press - RPH 150+ Drl Action Smooth Water ret White/gray Remarks
658.9748		NO	Shaley Lms RQD=100%	100%	Box 11	Run 3.5' Began 11:01 End 11:30 Time 29 min Drl time 10 min Hyd press 200 lb Water press - RPH 150+ Drl Action Smooth Water ret White/gray Remarks
657.9749		NO	Shaley Lms RQD=100%	100%	Box 11	Run 3.5' Began 11:01 End 11:30 Time 29 min Drl time 10 min Hyd press 200 lb Water press - RPH 150+ Drl Action Smooth Water ret White/gray Remarks
656.9750		NO	Shaley Lms RQD=100%	100%	Box 11	Run 3.5' Began 11:01 End 11:30 Time 29 min Drl time 10 min Hyd press 200 lb Water press - RPH 150+ Drl Action Smooth Water ret White/gray Remarks

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT)

B24

CEDARS
Hole No. C-DR-90

DRILLING LOG			DIVISION	INSTALLATION	SHEET	
1. PROJECT CEDARS Lock & Dam			Detroit	CEDARS Lock 3 Dam	8 OF 6 SHEETS	
2. LOCATION (Coordinates or Station) SEE PAGE SIX				10. SIZE AND TYPE OF BIT 6 1/2" BIT - RS		
3. DRILLING AGENCY CEMS				11. DATUM FOR ELEVATION SHOWN (TBM or MSL) M.S.L. 572.40		
4. HOLE NO. (As shown on drawing title and file number) C-MS-D-2-80				12. MANUFACTURER'S DESIGNATION OF DRILL ACKER		
5. NAME OF DRILLER L. DRAKE				13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN	DISTURBED UNDISTURBED	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED			DES. FROM VERT.	14. TOTAL NUMBER CORE BOXES ELEVEN		
7. THICKNESS OF OVERBURDEN CONCRETE 23.95				15. ELEVATION GROUND WATER ELEVEN		
8. DEPTH DRILLED INTO ROCK 26.05				16. DATE HOLE STARTED 31 July 80 COMPLETED 8 Aug 80		
9. TOTAL DEPTH OF HOLE 50.0				17. ELEVATION TOP OF HOLE 706.97		
				18. TOTAL CORE RECOVERY FOR BORING 100%		
				19. SIGNATURE OF INSPECTOR		
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drifting down, water level, depth of weathering, etc., if significant)
			LEGEND			
			CONCRETE			
			LIMESTONE			
			N.B. NATURAL BSAK			
			M.B. MACHINE BSAK			
			LOCATION			
						
			CENTER OF PIER #4			

ENG FORM 1836
MAR 71

PREVIOUS EDITIONS ARE OBSOLETE
(TRANSLUCENT)

PROJECT

HOLE NO.

Hole No. **CAES-D3-80**

DRILLING LOG		DIVISION	INSTALLATION	SHEET
1. PROJECT CEADIS Lock & Dam		DETROIT	CEADIS Lock & Dam	1
2. LOCATION (Coordinates or Station) See Page 5			10. SIZE AND TYPE OF BIT 6" x 1 1/2" RS - B-1	OF 5 SHEETS
3. DRILLING AGENCY CINES			11. DAYUM FOR ELEVATION SHOWN MSL	21A52
4. HOLE NO. (As shown on drawing title and file number) CAES-D3-80			12. MANUFACTURER'S DESIGNATION OF DRILL ACKER	
5. NAME OF DRILLER CLYDE DRAKE			13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	0
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED		DES. FROM VERT.	14. TOTAL NUMBER CORE BOXES N/A	
7. THICKNESS OF CONCRETE: 172'			15. ELEVATION GROUND WATER NOL LEVEL	
8. DEPTH DRILLED INTO ROCK 21.85			16. DATE HOLE 8 AUG 80	STARTED 13 AUG 1980
9. TOTAL DEPTH OF HOLE 39.05			17. ELEVATION TOP OF HOLE 703.8	
			18. TOTAL CORE RECOVERY FOR BORING 99.0%	
			19. SIGNATURE OF INSPECTOR James B. Vanhook	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	BOX OR RECOVERY	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
703.8	0	Δ	CONCRETE: GREY BROWN IN COLOR, NATURAL AGGREGATE. SIZE FROM 1/8" to 3/4" WITH AVG AT 1/2". SOME REACTION PRODUCT VISIBLE.	Box 1	RUN #1 8 AUG 80 WL — Run 1.55' Began 4:30-5:01 Rec 1.55' End 7:30-8:20 Loss — Time 81 min Gain — Drl time 20 min Hyd press 200 PSI Water press — RPM 75 ± Drl Action Smooth Water ret Li. Brown/white Remarks 6" x 7 1/4" BBL.
702.8	1	Δ			
701.8	2	Δ			
700.8	5	Δ	CONCRETE	Box 1	RUN #2 8 AUG 80 WL — Run 4.7' Began 8:35 Rec 4.7' End 9:05 Loss — Time 30 min Gain — Drl time 30 min Hyd press 250 PSI Water press — RPM 75 ± Drl Action Smooth Water ret Li. Brown/white Remarks
699.8	4	Δ		Box 2	
698.8	5	Δ			RUN #3 WL — Run 4.9' Began 9:37 Rec 4.9' End 10:05 Loss — Time 28 min Gain — Drl time 25 min Hyd press 200 PSI Water press — RPM 75-100 Drl Action Smooth Water ret Li. Brown/white Remarks
697.8	6	Δ	RUN #2 RRD=100%		
696.8	7	Δ	CONCRETE	Box 2	
695.8	8	Δ		Box 3	
694.8	9	Δ			
693.8	10	Δ			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT)

PROJECT

Hole No. CNE5-03-80

DRILLING LOG		DIVISION	INSTALLATION	SHEET
PROJECT CEDARS LOCK + Dam		DISCOIT	CEDARS LOCK + Dam	05
LOCATION (Coordinates or Station) See Page 5			NO. SIZE AND TYPE OF BIT MSL 5/2" X 1.25" O.P. 1234-BIT 702041	
DRILLING AGENCY CEWES			MANUFACTURER'S DESIGNATION OF DRILL ACKER	
HOLE NO. (As shown on drawing title) and Holes Number CNE5-03-80			TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN 13	
NAME OF DRILLER CLYDE ORAKE			TOTAL NUMBER CORE BOXES N/C	
DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED DEG. FROM VERT.			ELEVATION GROUND WATER POOL LEVEL	
THICKNESS OF OVERBURDEN CONCRETE 17.2'			DATE HOLE 5 Aug 80	
DEPTH DRILLED INTO ROCK 21.85			ELEVATION TOP OF HOLE 729.8	
TOTAL DEPTH OF HOLE 39.05			TOTAL CORE RECOVERY FOR BORING 99.0%	
			SIGNATURE OF INSPECTOR	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
6938	10	Δ				
6928	11	Δ	RUN #3			RQD = 100% Box 3
6918	12	Δ	CONCRETE			RUN #4
6908	13	Δ				WL - Run 455 Began 10:19 Rec 455 End 11:00 Loss - Time 41 min Gain - Drl time 30 min Hyd press 200 Water press - RPM 1800 Drl Action Smooth Water ret 21 Barrels/hour Remarks
6898	14	Δ				
6888	15	Δ	RUN #4			RQD = 100% 155.75
6878	16	Δ	1/4" RE-STEEL			RUN #5
6868	17	Δ	CONCRETE			WL - Run 465 Began 11:14 Rec 465 End 11:55 Loss - Time 41 min Gain - Drl time 30 min Hyd press 200 Water press - RPM 1800 Drl Action Smooth Water ret 21 Barrels/hour Remarks
6858	18	Δ	SHALEY LIMESTONE			Falling Head Test 6.25" dia Fall 10' IN 20 sec
6848	19	Δ	OPEN VERTICLE FEATURE			
6838	20	Δ	STAINING ALONG BACK SURFACE			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT _____ HOLE NO. _____

Mele No. CWS-03-60

DRILLING LOG		INSTALLATION	
PROJECT Cedars Lock & Dam See Page 5		CEMARS LOCK & DAM	
LOCATION (Coordinate or Station) CEWES		DATE 12 AUG 1980	
HOLE NO. (As shown on drawing info and file number) CWS-03-80		TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN	
NAME OF DRILLER CLYDE DRAKE		TOTAL NUMBER CORE BOXES NONE	
DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		ELEVATION GROUND WATER FEDL LEVEL	
THICKNESS OF OVERBURDEN COMPLETE 17.2'		DATE HOLE 12 AUG 1980	
DEPTH DRILLED INTO ROCK 21.55		ELEVATION TOP OF HOLE 703.8	
TOTAL DEPTH OF HOLE 39.05		TOTAL CORE RECOVERY FOR BORING 99.47	
SIGNATURE OF INSPECTOR			

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
688.8	20.2	NA	Run #5 RQD=69.1%	100%	Box 6	Run #6 NL 100% Began 140 End 230 Loss Time Dri time Hyd press 200t Water press RPM 100t Dri Action Smooth Water rot M. G. 100% / G. 100%
682.8	21.0	NA	LIMESTONE			Run #6 RQD=45.8%
681.8	21.0	NA	WATER LOSS			Lost after circulation at 235 ft.
680.8	21.0	NA	Run #6 RQD=45.8%			Controlled Area Area
679.8	21.0	NA	LIMESTONE			Run #7 RQD=100%
678.8	21.0	NA	Run #7 RQD=100%			Run #7 RQD=100%
677.8	21.0	NA	LIMESTONE			Run #8 RQD=93.0%
676.8	21.0	NA	Run #8 RQD=93.0%			Run #8 RQD=93.0%
675.8	21.0	NA	Run #8 RQD=93.0%			Run #8 RQD=93.0%
674.8	21.0	NA	Run #8 RQD=93.0%			Run #8 RQD=93.0%
673.8	21.0	NA	Run #8 RQD=93.0%			Run #8 RQD=93.0%

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE
MAR 71 (TRANSLUCENT)

PROJECT

HOLE NO.

Hole No. **CWGS-0350**

DRILLING LOG		DIVISION Detroit	INSTALLATION CEDARS LOCK & DAM	SHEET 4 OF 5 SHEETS
1. PROJECT CEDARS LOCK & DAM		10. SIZE AND TYPE OF BIT 6 1/2" R5 - 8 1/2"		
2. LOCATION (Coordinates or Station) See Page 5		11. DAYUM FOR ELEVATION SHOWN (Feet) M.S.L. 56.44" R581 R5 1234 - 617 722 244		
3. DRILLING AGENCY CENES		12. MANUFACTURER'S DESIGNATION OF DRILL ACKER		
4. HOLE NO. (As shown on drawing title and life number) CWGS-03-80		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN DISTURBED _____ UNDISTURBED _____		
5. NAME OF DRILLER NINE DRAKE		14. TOTAL NUMBER CORE BOXES NINE		
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER Pool Level		
7. THICKNESS OF SUBSTRATE Concrete: 122'		16. DATE HOLE STARTED 8 Aug 80 COMPLETED 13 Aug 81		
8. DEPTH DRILLED INTO ROCK 26.85		17. ELEVATION TOP OF HOLE 703.8		
9. TOTAL DEPTH OF HOLE 39.05		18. TOTAL CORE RECOVERY FOR BORING 99.070 %		
		19. SIGNATURE OF INSPECTOR		

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS g (Drilling time, water loss, depth of weathering, etc., if significant)
673.8	30	NS				Run #9 WL — Run 4.4 Began 9.52 Reo 4.4 End 10.33 Loss — Time 4.1 min Gain — Est time 4.1 min Hyd press 200 PSI Water press — RPM 1000 Drl Action Smooth Water ret 1/2 Gray / white Remarks Falling Head Test 0.35' in 125 min
672.8	31	NS	SHALEY LIMESTONE	100%	Box 8	
671.8	32	NS				
670.8	33	NS				
669.8	34	NS				
668.8	35	NS	SHALE - Reddish stain			Run #10 WL — Run 4.65 Began 10.57 Reo 4.75 End 11.30 Loss 4.0 Time 3.7 min Gain — Est time 3.7 min Hyd press 200 PSI Water press — RPM 1000 Drl Action Smooth Water ret 1/2 Gray / white Remarks Falling Head Test 0.10' in 1 min Hws Depth 39.05 Core to 38.6'
667.8	36	NS	SHALEY LIMESTONE	91%	Box 9	
666.8	37	NS				
665.8	38	NS				
664.8	39	NS	Left in hole			
663.8	40	NS				

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT)

Hole No. **CWES-D4-60**

DRILLING LOG		DIVISION		INSTALLATION		SHEET	
PROJECT		DEPT.		CEDARS LOCK + DAY		OF SHEETS	
1. PROJECT CEDARS LOCK AND DAY		2. LOCATION (Coordinates or Station) See Page THREE		10. SIZE AND TYPE OF BIT 2.75"		11. SAYUR FOR ELEVATION ABOVE (FEET - MSL) 1174.00 (MSL) STATION 8.721 ASSE	
3. DRILLING AGENCY CWES		4. HOLE NO. (As shown on drawing title and file number) CWES-D4-60		12. MANUFACTURER'S DESIGNATION OF DRILL S+H		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN DISTURBED ☐ UNDISTURBED ☐	
5. NAME OF DRILLER CLYDE DRAKE		6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ☐ DES. FROM VERT.		14. TOTAL NUMBER CORE BOXES FIVE		15. ELEVATION GROUND WATER UPPER POOL	
7. THICKNESS OF ~~GROUND~~ WATER 1.0		8. DEPTH DRILLED INTO ROCK 21.75'		16. DATE HOLE 15 AUGUST 60		17. ELEVATION TOP OF HOLE 687.1	
9. TOTAL DEPTH OF HOLE 21.75'		18. TOTAL CORE RECOVERY FOR BORING 98%		19. SIGNATURE OF INSPECTOR Frank B. Venable			

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of penetration, etc., if significant)
687.1	0	NO	RUN #1		Box 1	RUN #1 Run 0.5' End 4.30 Rec 0.5' Loss 5.00 Gain 30 min 35 min 50 to 100 PSI 35 min Action Smooth Water ret
686.1	1	NO				
685.1	2	NO	Shale Lms			
684.1	3	NO	weathered	100%	Box 1	6" x 7 3/4" B&I to make room for 8" C's
683.1	4	NO				RUN #2 Run 4.7' End 8.25 Rec 4.7' Loss 9.02 Gain 35 min 100 PSI 75 min Action Smooth Water ret
682.1	5	NO	2 SPIN RUN #2	49		
681.1	6	NO	Shale, Limestone			
680.1	7	NO	Fine to med grain, gray to greenish gray in color, moderately hard, dense, and contains numerous small, lenses, beds, laminae, of interbedded shales (green in color). Limestone is also fossiliferous.	100%	Box 2	RUN #3 Run 4.2' End 9.20 Rec 4.2' Loss 16.30 Gain 50 min 75 min Action Smooth Water ret
679.1	8	NO				
678.1	9	NO	RUN #3	94		
677.1	10	NO				

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

B31

Note No. CUES-D4-80

DRILLING LOG		DIVISION		INSTALLATION	
1. PROJECT CEARS Lock and Dam		2. LOCATION (Coordinates or Station) See Page Three		3. DRILLING AGENCY CUES	
4. HOLE NO. (As shown on drawing and site number) CUES-D4-80		5. NAME OF DRILLER CLYDE DRAKE		6. DATE HOLE 15 Aug 1980	
7. THICKNESS OF OVERBURDEN Water 12.1		8. DEPTH DRILLED INTO ROCK 21.75'		9. TOTAL DEPTH OF HOLE 21.75'	
10. SIZE AND TYPE OF BIT 6 X 7 3/4"		11. DAY ON FOR ELEVATION BROWN (F.W. or B.W.) UPPER PIR (MSL) 54.14" 85228.1234		12. MANUFACTURER'S DESIGNATION OF DRILL SWH	
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN		14. TOTAL NUMBER CORE BOXES Five		15. ELEVATION GROUND WATER Upper Pool	
16. DATE HOLE 15 Aug 1980		17. ELEVATION TOP OF HOLE 687.1		18. TOTAL CORE RECOVERY FOR BORING 98%	
19. SIGNATURE OF INSPECTOR					

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	3 CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of penetration, etc., if significant)
677.1	10	NO				
676.1	11	NO	SHALY LIMESTONE	100%		Run #4 WL 10.50 455' 11.37 Lost 456' 47 min Gain 43 min 100% 75% 50- Location Smith Water not
675.1	12	NO			Box 3	
674.1	13	NO				
673.1	14	NO	Run #4 RRD= 92.3% 1395			
672.1	15	NO	SHALY LIMESTONE	100%	Box 4	Run #5 WL 12.40 435' 1:08 435' 38 min 27 min 100% 50- 75% 50- Location Smith Water not
671.1	16	NO				
670.1	17	NO				
669.1	18	NO	Run #5 RRD= 97.7%		182	Run #6 WL 13.35 Run 335 Bore 1.35 Rec 70 201 Loss 6.5 26 min Gain 26 min 100% 50- 75% 50- Location Smith Water not
668.1	19	NO	Shaly Limestone	84%	Box #5	
667.1	20	NO				

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT)

Note No. CUES-D4-80

DRILLING LOG		DIVISION <u>Detroit</u>		INSTALLATION <u>Cadars Lock + Dam</u>		SHEET <u>3</u> OF <u>3</u> SHEETS	
1. PROJECT <u>Cadars Lock and Dam</u>				10. SIZE AND TYPE OF BIT <u>6 1/2" H</u>			
2. LOCATION (Coordinates or Station) <u>See Page Three</u>				11. DATUM FOR ELEVATION BROWN (1985) <u>21162</u>			
3. DRILLING AGENCY <u>CUES</u>				12. MANUFACTURER'S DESIGNATION OF DRILL <u>S&H</u>			
4. HOLE NO. (As shown on drawing title and file number) <u>CUES-D4-80</u>				13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN		14. TOTAL NUMBER CORE BOXES <u>FIVE</u>	
5. NAME OF DRILLER <u>CLYDE Drake</u>				15. ELEVATION GROUND WATER <u>UPPER POOL</u>		16. DATE HOLE STARTED <u>15 Aug 80</u> COMPLETED <u>16 Aug 80</u>	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				17. ELEVATION TOP OF HOLE <u>667.1</u>		18. TOTAL CORE RECOVERY FOR BORING <u>98%</u>	
7. THICKNESS OF OVERBURDEN <u>water 15.1</u>				19. SIGNATURE OF INSPECTOR _____			
8. DEPTH DRILLED INTO ROCK <u>21.75'</u>							
9. TOTAL DEPTH OF HOLE <u>21.75'</u>							

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 of weathering, etc., if significant) g
667.1	20	T			Box 5	
666.1	21	T				
			Run #6 RPD-107			
			Left in hole			
			LEGEND			
			□ Limestone			
			□ Concrete			
			MB Machine Break			
			NB Natural Break			
			LOCATION			

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE.
MAR 71 (TRANSLUCENT)

PROJECT

NUMBER

Hole No. C.E.S.-D5-80

DRILLING LOG		DIVISION		INSTALLATION		SHEET	
1. PROJECT Cedars Lock 3 Dam		DETROIT		Cedars Lock 3 Dam		1 OF 3 SHEETS	
2. LOCATION (Continuation of Region) 41st Ferry, Prec 4, DJS and on center				10. SIZE AND TYPE OF BIT 3 1/2" 21A52-BOKH34			
3. DRILLING AGENCY C.E.S.		HMC		11. MANUFACTURER'S DESIGNATION OF DRILL BIT TRK55			
4. HOLE NO. (As shown on drawing title and file number) CWES-D5-80				12. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN		DISTURBED _____ UNDISTURBED _____	
5. NAME OF DRILLER PLYDE DRAKE				13. TOTAL NUMBER CORE BOXES FIVE			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				14. ELEVATION GROUND WATER Lower Pool			
7. THICKNESS OF OVERBURDEN Water 6.2'				15. DATE HOLE 8/20/80		COMPLETED 8/22/80	
8. DEPTH DRILLED INTO ROCK LMS 21.2'				16. ELEVATION TOP OF HOLE 683.41			
9. TOTAL DEPTH OF HOLE				17. TOTAL CORE RECOVERY FOR BORING 100%			
				18. SIGNATURE OF INSPECTOR <i>[Signature]</i>			

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
683.41	0.0		SCOURED			
			NO			
			NO			
682.41	1.0		NO weathered			
			LIMESTONE			
681.41	2.0		NO Fine to med grained, moderately hard, dense	100%	Box 1	
			NO fossiliferous, grey to greenish green, in color with shale lenses, laminae, seams, etc.			
680.41	3.0		NO through core's length. Shelly regions give core breaks.			
679.41	4.0		NO			
			REMARKS Run #1 RRD 41.9% 44'			
678.41	5.0		LIMESTONE			
			NO	100%	Box 2	
677.41	6.0		NO			
676.41	7.0		Run #2 RRD 100%			
675.41	8.0		LIMESTONE			
			NO	91.7%	Box 2	
674.41	9.0		NO			
673.41	10.0		NO			

B34 FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

Hole No. **CMS-DS-8**

DRILLING LOG		DIVISION	INSTALLATION	SHEET
1. PROJECT CEDARS LOCK + DAM		Detroit	Cedars Lock + Dam	2 OF 3 SHEETS
2. LOCATION (Coordinates or Station) 41 EL From Pier No. 4, D/S and on center		10. SIZE AND TYPE OF BIT 5 IN. 4 1/2 IN. 2 IN. 1 1/2 IN.		
3. DRILLING AGENCY C.E.N.E.S.		11. DATE FOR ELEVATION GROUND (Type in mm) 8/22/80		
4. HOLE NO. (As shown on drawing title and site number) CMS-DS-80		12. MANUFACTURER'S DESIGNATION OF DRILL S.H.		
5. NAME OF DRILLER CLYDE DRAKE		13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN		
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		14. TOTAL NUMBER CORE BOXES FIVE		
7. THICKNESS OF OVERBURDEN Water 6.7'		15. ELEVATION GROUND WATER LOWER PUL		
8. DEPTH DRILLED INTO ROCK LMS. 242'		16. DATE HOLE 8/20/80		
9. TOTAL DEPTH OF HOLE		17. ELEVATION TOP OF HOLE 663.41		
		18. TOTAL CORE RECOVERY FOR BORING 100%		
		19. SIGNATURE OF INSPECTOR		

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	1. CORE RECOVERY %	2. BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of penetration, etc., if significant)
673.41	10				Box 3	
672.41	11		RQD = 91.2% DIPPED LAST 0.35 into Rock			
			Run #3 NO CORE			Run #4
670.41	12				Box 3	Run 5:1 Began 9:20 End 9:55 Time 35 min Dri time 30 min Hyd press 100 PSI Water press - R.R. 75% Dri Action Smooth Water ret
670.41	13					
669.41	14		LIMESTONE		1495	
668.41	15					
667.41	16				Box 4	Run 5:1 Began 7:45 End 8:15 Time 30 min Dri time 30 min Hyd press 100 PSI Water press - R.R. 75% Dri Action Smooth Water ret
			Run #4 RQD = 88.2%			Run #5
666.41	17					
665.41	18		Limestone		1795	
664.41	19				Box 5	
663.41	20					

BING FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT HOLE NO.

DRILLING LOG		DIVISION		INSTALLATION		Hole No. <i>CNES-DS-80</i>	
1. PROJECT <i>Cedars Lock + Dam</i>		2. LOCATION (Coordinates or Station) <i>NEE FOR PIER #4 DIS AND CONCRETE LEE</i>		3. DATE AND TYPE OF BIT <i>5/14/80 2 1/2" DISC</i>		4. DATE AND TYPE OF ELEVATION <i>8/20/80</i>	
5. DRILLING AGENCY <i>GENES</i>		6. HOLE NO. (As shown on drawing title and file number) <i>CNES-DS-80</i>		7. MANUFACTURER'S DESIGNATION OF DRILL <i>54</i>		8. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN <i>54</i>	
9. NAME OF DRILLER <i>CLYDE ORRICK</i>		10. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		11. TOTAL NUMBER CORE BOXES <i>FIVE</i>		12. ELEVATION GROUND WATER <i>LOWER POOL</i>	
13. THICKNESS OF OVERBURDEN <i>NATURAL 6.7'</i>		14. DEPTH DRILLED INTO ROCK <i>CMs. 21.2'</i>		15. DATE HOLE <i>8/20/80</i>		16. ELEVATION TOP OF HOLE <i>663.41</i>	
17. TOTAL DEPTH OF HOLE		18. TOTAL CORE RECOVERY FOR BORING <i>100%</i>		19. SIGNATURE OF INSPECTOR		20. REMARKS (Distinguishing name, water level, depth of overburden, etc., if significant)	
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS	
663.4120							
662.4121			<i>Run #5 RRD-100%</i>		<i>Box 5</i>		
			<i>END</i>				
			<i>LOCATION</i>				
			<i>SLUICeway</i>				
			<i>410'</i>				
			<i>42-PIER #4</i>				
			<i>CNES-DS-80</i>				
			<i>LEGEND</i>				
			<i>LM Limestone</i>				
			<i>NB NATURAL BREAK</i>				
			<i>MB MACHINE BREAK</i>				

ENG FORM 1836
MAR 71

PREVIOUS EDITIONS ARE OBSOLETE.
(TRANSLUCENT)

PROJECT

HOLE NO.

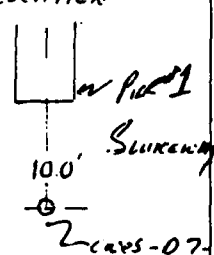
Notes No. COKS-06-80

DRILLING LOG		DIVISION		INSTALLATION		SHEET	
1. PROJECT CEDARS LOCK + DAM		DETROIT		CEDARS LOCK + DAM		SHEET 1 OF 1 SHEETS	
2. LOCATION (Coordinates or Station) SEE BELOW		3. DRILLING AGENCY CE U.S.		10. SIZE AND TYPE OF BIT 5/16" x 4"		11. DAY OF YEAR ELEVATION SHOWN (TYPE = ME)	
4. HOLE NO. (As shown on drawing title and file number) COKS-06-80		5. NAME OF DRILLER CLYDE ORACE		12. MANUFACTURER'S DESIGNATION OF DRILL SPINNING + HANDWOOD		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	
6. DIRECTION OF HOLE VERTICAL ☒ INCLINED ☐ DES. FROM VERT.		7. THICKNESS OF CRUST 1.45		14. TOTAL NUMBER CORE BOXES ONE		15. ELEVATION GROUND WATER LOWER POOL - 689.91	
8. DEPTH DRILLED INTO ROCK 3.35		9. TOTAL DEPTH OF HOLE 4.8		16. DATE HOLE 19 AUGUST 80		17. ELEVATION TOP OF HOLE 689.91	
18. TOTAL CORE RECOVERY FOR BORING 100%		19. SIGNATURE OF INSPECTOR J. B. B...		20. SIGNATURE OF DRILLER Clyde Orace			
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	BOX OR RECOVER	REMARKS		
686.91	0	Δ	1" PE-STEEL		Run #1		
		●	CONCRETE: NATURAL		Run #1		
		Δ	AGGREGATE (SIZE 1/2" TO 3/4")		Run #1		
685.91	1	Δ	Reaction Product		Run #1		
		Δ	VISIBLE (SLIGHT)		Run #1		
684.91	2		SHALEY LIMESTONE	100% Box #1	Run #1		
683.91	3		NS		Run #1		
682.91	4		NS		Run #1		
681.91	5		NS		Run #1		
680.91	6		NS		Run #1		
679.91	7		NS		Run #1		
LEGEND Δ Limestone ● Limestone Δ NATURAL BRINK LOCATION: CEDARS LOCK + DAM COKS-06-80 11.2 x No. 4							

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT)

Hole No. **CUES-D7-80**

DRILLING LOG		DIVISION		INSTALLATION		SHEET	
1. PROJECT CEDARS LOCK 3 DAM		DETROIT		CEDARS LOCK 3 DAM		OF 1 SHEETS	
2. LOCATION (Coordinates or Station) SEE BELOW		3. DRILLING AGENCY CERES		10. SIZE AND TYPE OF BIT 5 1/4" B.P. 1157		11. DAY OF ELEVATION SHOWN (Y or M or D) 1151 8.7 794615	
4. HOLE NO. (As shown on drawing title) CUES-D7-80		5. NAME OF DRILLER CLYDE DRAKE		12. MANUFACTURER'S DESIGNATION OF DRILL SMITH & HENCOCK		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN DISTURBED _____ UNDISTURBED _____	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		7. THICKNESS OF OVERBURDEN WATER 4.1		14. TOTAL NUMBER CORE BOXES TWO		15. ELEVATION GROUND WATER LOWER POOL	
8. DEPTH DRILLED INTO ROCK 6.2		9. TOTAL DEPTH OF HOLE 6.2		16. DATE HOLE 28 AUGUST 60		17. ELEVATION TOP OF HOLE 690.01	
18. DATE HOLE 28 AUGUST 60		19. ELEVATION TOP OF HOLE 690.01		20. TOTAL CORE RECOVERY FOR BORING 100%		21. SIGNATURE OF INSPECTOR James P. [Signature]	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	1. CORE RECOVERY %	2. BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
685.91	0.0	NS				Run #1 Run 3.55 Rec 3.55 Loss — Gain — Time 6.0 min Press 100 PSI Action Smooth Water ret Remarks Blocked off
684.91	1.0	NS	LIMESTONE	100%	Box #1	
683.91	2.0	NS	NS - weathered			
682.91	3.0	NS				
681.91	4.0	NS	LIMESTONE	100%	Box 2	Run #2 Run 2.6 Rec 2.6 Loss — Gain — Time 2.0 min Press 100 PSI Action Smooth Water ret Remarks Run #1
680.91	5.0	NS				
679.91	6.0	NS				
678.91	6.2	NS				
LOCATION 						

ENG FORM 1036
MAR 71

PREVIOUS EDITIONS ARE OBSOLETE
(TRANSLUCENT)

PROJECT

HOLE NO.

Note No. CWES-DB-80

DRILLING LOG		DIVISION		INSTALLATION		SHEET	
1. PROJECT CEARES Lock + Dam		DETROIT		Pedals Lock + Dam		1 OF 1 SHEETS	
2. LOCATION (Contingency or Station) See below				10. SIZE AND TYPE OF BIT 4" 7/8" 115.1		11. DAYTON ELEVATION 676.55-8.7	
3. DRILLING AGENCY CWES				12. MANUFACTURER'S DESIGNATION OF DRILL SAGEVE + HENWOOD		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN 0	
4. HOLE NO. (As shown on drawing title and file number) CWES-DB-80				14. TOTAL NUMBER CORE BOXES 1		15. ELEVATION GROUND WATER Loxpool	
5. NAME OF DRILLER CLYDE DRAKE				16. DATE HOLE 22 AUGUST 60		17. ELEVATION TOP OF HOLE 670.01	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				18. THICKNESS OF OVERBURDEN Water 3.75'		19. TOTAL CORE RECOVERY FOR BORING 87.5%	
7. DEPTH DRILLED INTO ROCK 5.2'				19. SIGNATURE OF INSPECTOR George B. Barker			
8. TOTAL DEPTH OF HOLE 5.2'							

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of monitoring, etc., if significant)
686.26	0.0		SCALLOP			
685.26	1.0		NS			
			NS			
			NS			
			LIMESTONE			
684.26	2.0		NS Fine to med. grained, grey to greenish grey in color, med. hard, dense, fossiliferous, contains numerous shale streaks, lenses, laminar etc. - Shaly regions contain core breaks	87.5%	Box 1	
683.26	3.0		NS			
682.26	4.0		NS			
681.26	5.0		NS			
			Left in hole Run #1 RQD: 57.7%			

LOCATION

SLUICeway GATE 7
PIER #8
10.0'
CWES-DB-80

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE.
MAR 71 (TRANSLUCENT)

Note No. CWES-D9-80

DRILLING LOG		DIVISION DETROIT	INSTALLATION CEDARS Lock & Dam	SHEET OF 1 SHEETS
1. PROJECT CEDARS Lock & Dam		10. SIZE AND TYPE OF BIT 6 1/2" 79 Mod 85		
2. LOCATION (Coordinate or Station) SEE BELOW		11. DAY ON FOR ELEVATION ABOVE (FM = 100) MSL		
3. DRILLING AGENCY C.E.W.E.S.		12. MANUFACTURER'S DESIGNATION OF DRILL ASCATIC		
4. HOLE NO. (As shown on drawing Note) and file number CWES-D9-80		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN DISTURBED UNDISTURBED		
5. NAME OF DRILLER CLYDE DRAKE		14. TOTAL NUMBER CORE BOXES ONE		
6. DIRECTION OF HOLE ☐ VERTICAL ☒ INCLINED 90° DEG. FROM VERT.		15. ELEVATION GROUND WATER Lower Pool		
7. THICKNESS OF OVERBURDEN CONCRETE 2.85'		16. DATE HOLE STARTED 22 August 80 COMPLETED 22 August 80		
8. DEPTH DRILLED INTO ROCK 2.85'		17. ELEVATION TOP OF HOLE 697.33		
9. TOTAL DEPTH OF HOLE 2.85'		18. TOTAL CORE RECOVERY FOR BORING 100%		
		19. SIGNATURE OF INSPECTOR J. L. B. [Signature]		

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 of penetration, etc., if significant) g
697.33	00	Δ	CONCRETE Natural Aggregate, Reaction product visible, and slightly porous.	100%	Box 1	Run #1 WL ——— R 2.85 Began 4.30 R 2.85 End 11.55 L — Time 25 min G — Drl time 2 min Hyd press — Water press — RPM 150 f Drl Action Smooth Water re- 1.5 Re-um/Lt Remarks /
	10	Δ				
	20	Δ				
	30	Δ				
			LOCATION 			

ENG FORM 1036 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.
(TRANSLUCENT)

PROJECT

HOLE NO.

Hole No. CWES-D10-80

DRILLING LOG			DIVISION		INSTALLATION		SHEET	
1. PROJECT <i>Edwards Lock & Dam</i>			<i>Detroit</i>		<i>Edwards Lock & Dam</i>		<i>1</i>	
2. LOCATION (Coordinate or Station) <i>See Bottom of Page</i>					10. SIZE AND TYPE OF BIT <i>2 1/2" 7920-475</i>		11. DAYUM FOR ELEVATION BROWN (Type or Size) <i>MSL</i>	
3. DRILLING AGENCY <i>C.E.H.E.S.</i>					12. MANUFACTURER'S DESIGNATION OF DRILL <i>QUESTER R16</i>		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN <i>DISTURBED</i> <i>UNDISTURBED</i>	
4. HOLE NO. (As shown on drawing title and file number) <i>CWES-D10-80</i>					14. TOTAL NUMBER CORE BOXES <i>ONE</i>		15. ELEVATION GROUND WATER	
5. NAME OF DRILLER <i>CLYDE ORAKE</i>					16. DATE HOLE <i>16 AUGUST 60</i>		17. ELEVATION TOP OF HOLE <i>696.3'</i>	
6. DIRECTION OF HOLE ☐ VERTICAL ☒ INCLINED <i>90°</i> DEG. FROM VERT.					18. TOTAL CORE RECOVERY FOR BORING <i>76.5%</i>		19. SIGNATURE OF INSPECTOR <i>James L. B. Smith</i>	
7. THICKNESS OF OVERBURDEN					20. SIGNATURE OF DRILLER <i>CLYDE ORAKE</i>			
8. DEPTH DRILLED INTO ROCK <i>3.15'</i>								
9. TOTAL DEPTH OF HOLE <i>3.15'</i>								
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	5. CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water flow, depth of penetration, etc., if significant)		
696.3	0.0	Δ	CONCRETE, CRUSHED AGGREGATE WITH SIZE FROM SAND TO SEVERAL IN. PIECES 7"x2". FILL MATERIAL IS PRIMARILY IGNORED IN NOTICE	76.5%	BX #1	WL — Run 3.15 Began 2.30 Rec 2.85 End 3.10 Loss 0.30 Time 40 min Drl time 2 min Hyd press — Water press — RPM 150 Drl Action Smooth Water re- 15 Gpm/Barrel Remarks		
696.3	1.0	Δ						
696.3	2.0	Δ						
696.3	3.0	Δ						
696.3	3.15	Δ						
Run #1 RQD=100%								
Lost								
LEGEND [Δ] CONCRETE NO MINING BESS.								
LOCATION 								

 ENG FORM 1836
 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE
 (TRANSLUCENT)

PROJECT

HOLE NO.

Hole No. CWES-D11-80

DRILLING LOG		DIVISION		INSTALLATION		SHEET	
1. PROJECT Cedar's Lock & Dam		2. LOCATION (Coordinate or Station) See Below		3. SIZE AND TYPE OF BIT 1 1/2" 29/64" S		4. DAY OF ELEVATION 29/64" S	
5. DRILLING AGENCY SWES		6. NAME OF DRILLER CLYDE DEAKE		7. MANUFACTURER'S DESIGNATION OF DRILL ELITE		8. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN ONE	
9. HOLE NO. (As shown on opening note and file number) CWES-D11-80		10. DIRECTION OF HOLE VERTICAL ☒ INCLINED ☐ 90° DEG. FROM VERT.		11. ELEVATION GROUND WATER 22 Aug 80		12. ELEVATION TOP OF HOLE 6977.3	
13. THICKNESS OF OVERBURDEN CONCRETE 295		14. DATE HOLE 22 Aug 80		15. ELEVATION GROUND WATER 22 Aug 80		16. ELEVATION TOP OF HOLE 6977.3	
17. DEPTH DRILLED INTO ROCK 295'		18. TOTAL CORE RECOVERY FOR BORING 100%		19. SIGNATURE OF INSPECTOR Joseph B. Bunch		20. REMARKS (Drilling time, water loss, depth of overburden, etc., if significant)	
21. TOTAL DEPTH OF HOLE 295'		22. CORE RECOVERY 100%		23. BOX OR SAMPLE NO. Box 1		24. REMARKS (Drilling time, water loss, depth of overburden, etc., if significant)	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS
6977.3	00	Δ	CLOSED FRACTURE			Run #1
	10	Δ	CONCRETE	100%	Box 1	Run 295' Reo 275' Loss 10' 1/6 Gals 14 and 15 Action Smooth Water set by Bunch ph. E
	20	Δ	NS			
	30	Δ	Run #1			

LOCATION

W/ CRACK

VIEW LOOKING NE

NS →

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE
(TRANSLUCENT)

PROJECT

HOLE NO.

In accordance with letter from DAEN-RDC, DAEN-ASI dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

Stowe, Richard L.

Condition survey of Cedars Lock and Dam Lower Fox River, Wisconsin / by Richard L. Stowe, Joyce C. Ahlvin (Structures Laboratory, U.S. Army Engineer Waterways Experiment Station). -- Vicksburg, Miss. : The Station ; Springfield, Va. : available from NTIS, 1982.

89 p. in various pagings, 26 p. of plates ; ill. ; 27 cm. -- (Miscellaneous paper ; SL-82-4)

Cover title.

"June 1982."

Final report.

"Prepared for U.S. Army Engineer District, Chicago."

Bibliography: p. 27.

1. Cedars Lock and Dam (Wis.)
2. Concrete dams.
3. Dams--Inspection.
4. Locks (Hydraulic engineering).
5. Lower Fox River (Wis.)
- I. Ahlvin, Joyce C.
- II. United States. Army. Corps of Engineers. Chicago District.
- II. U.S. Army Engineer Waterways Experiment

Stowe, Richard L.

Condition survey of Cedars Lock and Dam : ... 1982.
(Card 2)

Station. Structures Laboratory. III. Title

IV. Series: Miscellaneous paper (U.S. Army Engineer Waterways Experiment Station) ; SL-82-4.

TA7.W34m no.SL-82-4

LMEI
-8