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CONDITION SURVEY OF LOCK NO. 2 MONONGAHELA RIVER

by

G. S. Wong, R. L. Stowe, J. C. Anlym, J. G. Tuck

Structures Laboratory

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DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
PO Box 631, Vicksburg, Mississippi 39180-6631



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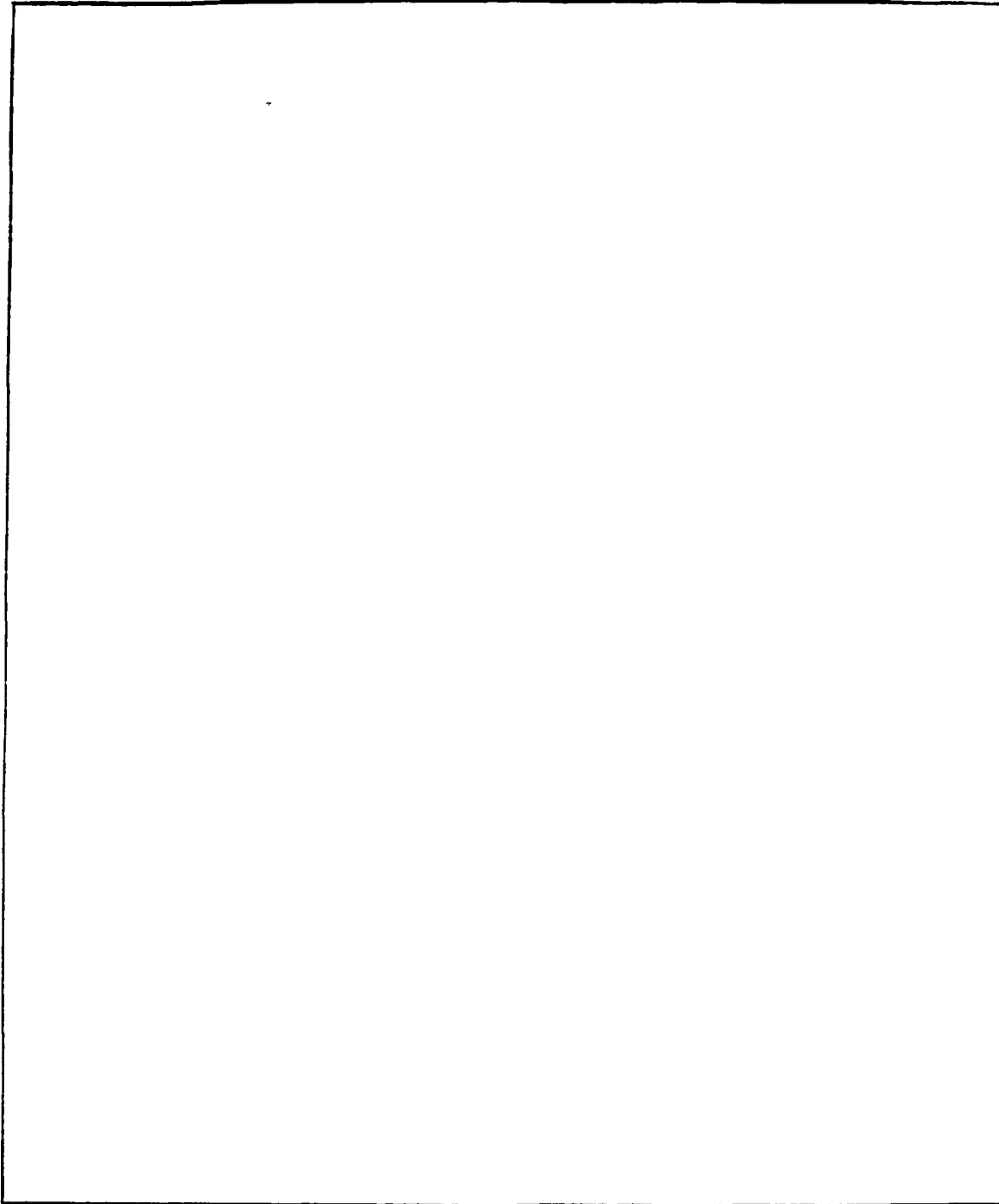
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19 ABSTRACT (Continue on reverse if necessary and identify by block number) A condition survey was performed at Locks and Dam No. 2 on the Monongahela River in Pennsylvania to determine the extent of possible concrete damage, processes causing distress of the concrete, selected physical and mechanical properties of the concrete and foundation materials, and the ability of the concrete to perform satisfactorily under anticipated conditions of future service. The field investigation included a visual inspection of the structure to determine the general condition of the concrete, and drilling operations to recover concrete and foundation core. Results of the field investigation and laboratory tests indicated that the concrete is generally in good condition, with dissolution of carbonate aggregate particles giving the appearance of exposed aggregate to the concrete. Some popouts, scaling, and spalling are also present. The near surface concrete contains some cracking not associated with any apparent chemical reaction. The cracks do not appear to be active. The concrete in this structure should remain serviceable for a period of 50 years from the date of this investigation.					
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PREFACE

The work described in this report was performed for the US Army Engineer District, Pittsburgh, by personnel of the US Army Engineer Waterways Experiment Station (WES). The work was authorized by DA Form 2544, No. ORPED-85-31, dated 16 May 1985.

The testing program was accomplished under the direction of Bryant Mather, Chief, Structures Laboratory (SL), WES, and Mr. John M. Scanlon, Jr., former Chief, Concrete Technology Division (CTD), and Mr. Ken Saucier, Chief, CTD. All of the core drilling was conducted by WES under the direction of Mr. Mark A. Vispi, Chief, Exploration Group. Laboratory work in the CTD was done with the assistance of Mr. Joe G. Tom, Mrs. Joyce C. Ahlvin, and Mr. J. Pete Burkes. This report was prepared by Messrs. Wong and Stowe with assistance from Mrs. Ahlvin and Mr. Tom.

COL Dwayne G. Lee, CE, is the Commander and Director of WES. Dr. Robert W. Whalin is Technical Director.



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EXHIBIT 1: PHOTOGRAPHIC RECORD OF DRILLED CORE*

* On file with US Army Engineer District, Pittsburgh.

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

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

<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>
degrees (angle)	0.1745329	radians
feet	0.3048	metres
feet per second	0.3048	metres per second
inches	25.4	millimetres
miles (US statute)	1.609344	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 LOCK NO. 2
MONONGAHELA RIVER

PART I: INTRODUCTION

Project Description

1. The following description of the project is taken from the first periodic inspection report of Locks and Dam 2 (US Army Engineer District, Pittsburgh, 1973). Locks and Dam 2 are located on the right bank of the Monongahela River 11.2 miles* above the mouth at Pittsburgh (Plate 1). The dam is a fixed crest weir with crest at elevation 718.7; the dam is part of the original structure constructed between 1902-1906. Of the existing locks, the 56-ft by 360-ft riverward lock was reconstructed riverward of the original locks and completed in 1951 using the original landward chamber to maintain traffic. The 110-ft by 720-ft landward chamber was constructed after completion of the new riverward chamber which was used to maintain traffic and was completed in 1953. A general plan view and cross-sectional view of the locks are presented in Plate 2. This plate is also taken from the first periodic inspection report.

Background

2. The Waterways Experiment Station (WES) was requested by the US Army Engineer District, Pittsburgh (ORP for Ohio River, Pittsburgh), to conduct a condition survey at Lock and Dam No. 2. The ORP provided design, construction, operation and maintenance information and data on the structures. The First Periodic Inspection Report dated 25 August 1973 and the Second Periodic Inspection Report dated 15-16 June 1978 were reviewed for information pertinent to the concrete. The survey consisted of a site inspection to determine the general condition of the concrete and to locate borings. Following the site visit, it was recommended that a crack survey not be performed at this time due to the relatively good condition of the concrete and the lack of

* A table of factor for converting non-SI units of measurement to SI (metric) units is presented on page 4.

cracking. The drilling program was approved by the District while some of the boring locations were approved during the drilling operation.

Objective

3. All efforts were limited to locks structure. The condition survey of the much older dam was not part of this effort. The dam is submerged at all times and did not lend itself to a detailed condition survey without major efforts to dewater the structure. The dam will be addressed by the District. The objectives of the condition survey are: (a) Identify the processes or materials causing distress or failure of the concrete and the probable extent of such damage, (b) determine the ability of the concrete to perform satisfactorily under anticipated conditions of future service, and (c) determine selected physical and mechanical properties of the foundation and associated materials as they relate to possible stability analysis of the structure. The District would perform a stability analysis if necessary.

Scope

4. This report presents: (a) The drilling effort involved in recovering samples of concrete, foundation rock, and backfill material associated with the project, and (b) the physical condition and extent of damage of in-place concrete using visual, petrographic and physical property information and data. Selected physical properties of core samples were determined using standard Corps of Engineers test methods.

PART II: PRELIMINARY STUDY

5. A WES geologist made a brief inspection of the lock structure to determine the general condition of the concrete* in the different elements of the lock and select boring locations. The guide walls, guard walls, and the lock walls were inspected for signs of concrete deterioration with special emphasis on cracking and possible chemical attack and aggregate reaction.

6. There was no intent during this initial inspection to provide details of where cracking occurred or specifically locating areas of distress in the structure. If a crack survey and surface mapping were thought necessary, such work was to be proposed. As a result of this preliminary inspection, it was determined that no further documentation of the concrete condition was necessary.

7. The lock crew provide a work barge to allow closer observation of the concrete within the lock chamber both at the upper and lower pool elevations. While on the barge, the upper and lower guide walls and the river side of the river lock wall were inspected.

Esplanade

8. The concrete is generally in good condition with the individual panels intact. Some relative displacement of panels is evident. The surfaces of the panels are similar in appearance to that of the mass concrete with some exposure of coarse limestone aggregate. Fifty percent aggregate exposure is evident in many of the panels.

Upper Guide Wall

9. The backfill from monolith 15 to monolith 24 is below the top of the guide wall while the backfill from monolith 25 to monolith 29 is above the top of the wall as it is for the rest of the guide wall. It is grassed and shows no signs of any depressions (Figure 1). There are fine-to-medium transverse cracks* at one-third points between the monolith joints. Surface

* See ref American Concrete Institute Committee 201, 1980, for definition of terms associated with the durability of concrete.



Figure 1. Grassed area behind upper guide wall

deterioration on the top of the wall is limited to exposure of the limestone coarse aggregate with approximately 15 percent of the surface affected.

10. The river face is armored from the service bridge for the emergency dam to the upstream end of the wall. The concrete is intact and only shows light weathering. There is some light scaling along the monolith joints.

Land Wall

11. Horizontal surface. The concrete on this surface is in good condition with approximately 15 percent of the surface displaying signs of aggregate dissolution in which the aggregate appears etched as the paste remains standing in relief. Short fine-to-medium cracks are found associated with structural features such as openings in the concrete and mooring pins.

12. River face. The surface is generally in good condition. Below the upper pool elevation there is some minor spalling of the monolith joints. Surface above the upper pool shows 20 percent exposed aggregate and small joint spalls (Figure 2).

13. Gate recesses. The upper gate recess has been refaced, and the concrete is in good condition. There is some cracking of the concrete around



Figure 2. River face of the land wall, large chamber

a recent concrete repair running diagonally from the pintle area near the opening winch recess. The concrete in the lower gate recess is similar to that in the upper gate recess. Some hairline cracks are present on the gate recess face below the gate machinery recess floor line.

Lower Guide Wall

14. The concrete is uniform along the entire wall. The concrete is in good condition with apparent solution of the crushed limestone coarse aggregate leaving the paste in relief. Some medium-to-fine transverse cracks are present in the monoliths. Alignment of the monoliths is good. Vegetation is growing from the joints on top and on the vertical faces in the settling basin for U.S. Steel Corp.

Middle Wall

15. Horizontal surface. The exposure of the limestone coarse aggregate was more pronounced than that of the land wall with an estimated 30 percent of the surface exposed (Figure 3). Popouts on the surface concrete were sometimes numerous (Figure 4) which lends some additional evidence to the possibility of

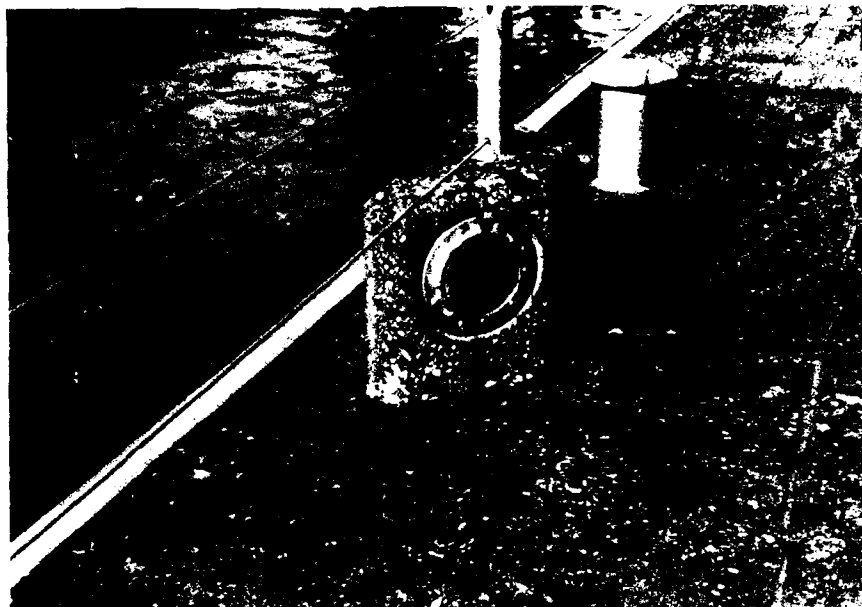


Figure 3. Solution of coarse aggregate particles gives an exposed aggregate appearance to the concrete



Figure 4. Pop-outs caused by nondurable aggregate particles

some low durability aggregate as "D" cracking was observed at monolith joint M-20/M-19 and monolith joint M-22/M-23 as well as around machinery openings in monoliths M-24 and M-25. Cracking of the concrete in monolith M-3 around the lock crane support was evident. Pattern cracking was present in many of the monoliths such as in monoliths 12, 16, and 19. The joint on the river side of monoliths M-24/M-25 was severely cracked with some indicated displacement.

16. Land face. The concrete above upper pool elevation is in good condition. The concrete below the upper pool elevation contained approximately 5 percent severely scaled concrete and approximately 30 percent lightly-scaled concrete. Severe spalling was present along the monolith joints (Figure 5).

17. Gate recesses, large lock. The upper-gate recess concrete is in good condition with little weathering. The joints are as cast. The concrete in monolith M-5 in the vicinity of the opening winch is severely scaled with efflorescence outlining numerous cracks contained in localized areas. The lower gate recess has some spalling of the concrete with some concrete in the process of falling off. In general, the concrete is in good condition.



Figure 5. Severe spalling along monolith joints in land face of middle wall

18. River face. The concrete above the upper pool elevation contains some medium scaling affecting 75 percent of the area. Some small spalls are

evident along joints below the upper pool elevation. There is some spalling between upper and lower pool elevations, but generally the concrete is in good condition.

19. Gate recesses, small lock. Some scaling is evident in the concrete especially below the upper pool elevation where 80 percent of the area is affected. Some cracking was observed near the corners of grated openings associated with the gate machinery. Minor spalling was observed.

River Wall

20. Horizontal surface. The concrete has an exposed aggregate appearance with 30 percent of the concrete affected. Seventy percent of the concrete surface is slightly eroded with some popouts. There are many incipient hairline cracks along the edge armor. The corners of the monoliths show signs of "D" cracking, but the surface concrete is generally in good condition.

21. Land face. Above the upper pool elevation, the concrete is generally in good condition. Ten percent of the surface has an exposed aggregate appearance. Some iron staining is present. The armor is in good condition and is in intimate contact with the concrete. The joints above the upper pool elevation are as cast while the monolith joints below upper pool elevation are commonly spalled especially in the non-armored areas. Ten percent of the surface is scaled below the upper pool elevation.

Upper Guard Wall

22. Cracking is common around the light posts. Exposed aggregate is visible over 30 percent of the surface. Some minor popouts are present, and fine healed hairline cracks parallel the corner armor. The land-wall face is armored from the upper gate recess to monolith No. 1. Exposed aggregate is evident for about the upper 2 ft of concrete and affect approximately 15 percent of the area. The concrete below 2 ft is in good condition.

Lower Guard Wall

23. Lower guard wall. The land face is armored from the lower gate to the downstream end of the wall and is in good condition. There is some slight

spalling of the joints generally near the lower pool elevation. About 15 percent of the surface has an exposed aggregate appearance. Efflorescence is present in the upper 1 ft of monoliths R-24 and R-29 through R-31. Cracking of the upper surface is present in monoliths R-29 through R-31. Severe scaling is present in 2 percent of monolith R-30.

PART III: DRILLING OPERATION

24. Following the on-site inspection, a drilling plan was formulated to investigate the different qualities of concrete represented in the lock walls, Plate 3. The requirements to obtain foundation samples for purposes of evaluating the foundation condition and conducting physical property tests were considered in locating the concrete borings. The borings were distributed as follows:

Location	Number of Borings	Core Size, in.	Depth, ft		Remarks
			Vertical	Horizontal	
Upper guide wall	1	4	10		Concrete
Land wall	3	6	80		Backfill & rock (omitted one)
Land wall	2	6		3	Concrete
Land wall	2	6	10		Concrete (R-17 Extended)
Lower guide wall	1	6	10		Concrete
Middle wall	2	6	80		Concrete & rock
Middle wall	4	6		3	Concrete
Upper guard wall	1	6	10		Concrete
River wall	1	6	10		Concrete (omitted)
River wall	1	6	80		Concrete & rock
River wall	2	6		3	Concrete
Lower guard wall	1	6		3*	Concrete
Lower guard wall	1	6	10		Concrete

* Inclined.

25. This plan was modified during the drilling program to accommodate unanticipated adverse drilling conditions and logistics in setting up at

several boring locations. One alternate boring was drilled (BR WES L-7A)* as a 5-in. (i.d.) steel pipe was intersected at approximately 5.4 ft. Two scheduled borings, L-8 into the backfill and foundation rock and R-2 adjacent to the service crane on the river wall, were not drilled because of logistics problems. Proposed boring L-8 was one of 3 borings into the backfill and foundation rock. There were difficulties encountered in drilling backfill borings L-2 and L-5; i.e. slag, silt, mud, sandstone boulders, brick and pieces of steel were frequently encountered in an unconsolidated state. Because it was difficult to drill and obtain samples of such a variety of materials, it was decided that the third boring would not be drilled. However, boring L-7A in the land wall was extended to include the foundation rock representing the downstream portion of the lock.

26. The drilling plan consisted of 21 borings with 8 horizontal borings into the lock walls, one inclined boring into the lower guard wall, and 12 vertical borings into the lock and backfill with six of the vertical borings going into foundation rock. Pertinent information concerning the boring number, depth of hole, core size, direction of boring, elevation top of hole, elevation top of rock, and elevation bottom of boring is presented in Table 1. General boring locations are illustrated in Plate 3; detailed locations are illustrated in the field logs, Appendix B.

27. WES provided two drill crews for the field operation. Two geologists from WES and one from the Pittsburgh District were present during the drilling. All concrete and foundation material were logged by the field geologists. Photographs were made of all cores soon after the cores were removed from the core barrel (Exhibit 1).

28. The drill crews and equipment arrived at Locks and Dam No. 2 on 18 October 1985. The district provided barge and crane support in moving the drill rigs from L/D No. 4 where a drilling program had just been completed.

29. Equipment used during this project included: a Failing 1500 truck mounted rig used to drill all the vertical borings on the land wall and into the backfill, an Acker skid rig and a Failing Model 43-6A skid rig used to drill the deep holes in the middle wall and river wall, and a KOR-IT

* Boring designation: BR for the town of Braddock in which the project is located; WES for the drilling agency; L-7A for land wall, number of boring and A for alternate boring. All other references to borings will be done using the wall designation letter and number of the boring.

Series K-100 portable rig used to drill the horizontal holes and vertical borings not accessible using the skid rigs or the truck-mounted rig.

30. The lockmaster provided a work flat for the drill crews to operate equipment while drilling the horizontal borings within the lock chambers. The vertical position of the work flat was positioned by raising and lowering the pool level within the lock chamber. Anchor bolts were placed into the concrete and held the drill to the wall during the drilling operation (Figure 6).



Figure 6.

31. The split-spoon samples were collected, placed, and sealed in 6 x 12-in. plastic concrete cylinder molds. The rock cores were wrapped and waxed to protect the core and prevent moisture loss. The cores were then placed in wooden core boxes and readied for shipment to WES. The concrete cores were put into wooden core boxes to prevent damage during transportation. All rock cores, concrete cores, and samples placed in the cylinder molds were shipped to WES for examination and testing.

32. Drill Manufacturers Association standard 6 x 7 3/4-in. and 4 x 5-in. double tube swivel tub core barrel was used with diamond bits to obtain the concrete and bedrock core in vertical borings. A single tube core barrel

with a diamond bit was used to take the horizontal cores and some of the shallow vertical cores.

33. Borings into the backfill were filled by allowing the surrounding material to slough when the casing was removed. All holes resulting from concrete borings were filled using a prepackaged concrete. The horizontal holes were filled with a relatively dry mixture while the vertical holes were filled using a more workable mixture of the same material.

34. Concrete core recovery was 100 percent for all concrete cores except one. A short interval in boring R-5 at approximately 55-ft depth was ground up during the drilling operation and was removed from the core barrel in fragments. The rock recovery was good for all cores into the foundation with an average recovery of 94 percent. Only 80 percent of the rock in boring L-5 was recovered while recovery in the other borings ranged from 92 to 99 percent.

35. Samples of backfill material were taken every 5 feet. The material ranged from loosely consolidated slag particles to zones of clay silt material (Figures 7 and 8). Approximately 115 ft of backfill was drilled and sampled, much of it required casing to prevent sloughing of adjacent material. A total of 328.8 ft of concrete core and 185.95 ft of foundation rock was cored.

36. The drilling program was completed 18 February 1986. During this field operation several days were lost due to subfreezing temperatures in which the wind chill factor went as low as -40°F. Other delays included two work stoppages due to flooding of the lock structure (Figure 9), once from 27 November through 29 November 1985 and once from 5 February through 7 February 1986.



Figure 7.



Figure 8.



Figure 9.

PART IV: GEOLOGY

37. The lock site geology is taken from the Periodic Inspection and Continuing Evaluation of Completed Civil Works and Structures "Monongahela Lock and Dam No. 2, Monongahela River, Pennsylvania First Periodic Inspection Report, 28 August 1973."

38. The basin of the Monongahela River is located in the Allegheny Plateau province and is carved out of gently folded shales, sandstones, thin limestones, and coals of the Carboniferous system. The basin is essentially a dissected plateau in which are developed in varying degrees the Schooly, Harrisburg and Worthington peneplains. The land slopes are steep except on a few terraces and relatively narrow flood plains within the main valley. The bedrock encountered in the borings belong to the middle members of the Conemaugh formation of the Pennsylvania series. Underlying the alluvial fill are the basal few feet of the Upper Pittsburgh redbeds member, the thin Jane Lew sandstone, not over 3 ft thick, the Lower Pittsburgh redbeds member, a siltstone, about 40 ft thick, and the extremely fossiliferous Wood Run limestone member.

39. Six borings were made into the foundation rock during the current project. Four borings were made through concrete walls, and two borings were made through the backfill behind the land wall. The deepest rock boring was L-7A taken to elevation 611 ft. The other cores were taken to obtain approximately 20 ft of rock core from each boring and were generally to elevations near 640 ft.

40. The backfill material consisted of a variety of different materials, most of which were clay, silt and pea-size gravel. Also included were flakes of steel, pieces of brick, particles of slag, large size sandstone pieces, and chunks of steel. These materials were common to both backfill holes. The foundation rock began at elevation 667.3 ft in boring L-2 and at elevation 675.6 ft in boring L-5. Boring L-2 consisted of shale to elevation 658.5 ft where the rock became more silty to the end of the boring at elevation 646.5 ft. Boring L-5 consisted of clay shale, fractured shale, and brown shale to the end of the boring at elevation 657.3 ft. Some soft-clay shale was present in both holes at the backfill to foundation rock contact.

41. Boring L-7A was the only boring drilled in the land wall, and it went into foundation rock. The concrete to foundation interface was intact at elevation 671.6 ft (56.9-ft depth). Foundation rock consisted of clay shale

rubble, silty shale, and clay shale with slickensides evident on break surfaces. The boring went to elevation 611 ft.

42. Foundation cores were taken at the upper and lower end in the middle wall. Two borings, M-1 and M-6, through the middle wall and into the foundation rock intersected the foundation at elevations 672.15 ft and 667.1 ft. The concrete to rock contact was not intact. Boring M-1 consisted of a mixture of soft to moderately hard clay shale, red shale, gray shales, and brown clay shale while the rock in boring M-6 was generally a gray moderately hard silty shale with numerous healed fractures.

43. Boring R-5 was the only hole drilled in the river wall that intersected the foundation rock. The concrete foundation interface at elevation 663 ft was not intact as the rock fragments were in contact with the concrete. The rock was generally intact and consisted of a moderately hard sandy shale with calcareous inclusions.

44. Previous boring data indicate the foundation rocks in this area consist of indurated clays, silty clay shale, moderately hard gray clayey siltstone, and medium hard to hard gray siltstone. The current description of the foundation cores parallels the descriptions of the rocks previously cored as described in the First Periodic Inspection Report.

PART V: TEST SPECIMENS AND TEST PROCEDURES

Cores Received

45. Approximately 630 ft of core was received at the WES from 21 total borings. Twelve of these borings were vertical, ranging in depth from 1.7-ft to 119-ft, for a total of 601 ft. There were 8 horizontal borings, all of approximately 3-ft depth, totaling 25 ft of core. One inclined boring was made to a depth of 3 ft.

46. Core boxes were stored in a local warehouse near the project site for protection from the weather until the job was completed, and they were shipped to WES. All the cores were received in good condition, and no sample damage due to rough handling was detected. Once the cores arrived at the WES, they were stored inside to minimize effects of exposure to normal weathering.

47. In addition to concrete and rock cores, samples in 8 plastic bags and 24 plastic cylinders were received. These samples consisted of material recovered from the backfill area of the land wall in two holes and rubble material from bedrock in one hole. These samples were sealed to prevent loss of moisture and were also received undamaged. Pertinent information concerning the concrete and rock samples as received is presented in Table 1.

Selection of Test Specimens

48. A visual examination of all cores received 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 location, depth, and physical condition. Representative properties throughout the structure could thus be obtained.

49. A total of 20 concrete specimens were selected for physical and mechanical property testing (see Table 2). These specimens represented concrete from 4 deep (35 ft +) vertical borings; representing each wall, 2 shallow vertical borings (10 to 20 ft), and 9 horizontal borings. These specimens represent all areas of each wall, including both damaged and sound concrete.

50. Nine concrete specimens were selected for petrographic examination. These specimens were selected from cores that represented the different

concrete types identified when logging in the cores. They also represented concrete from each area of each of the three lock walls.

51. Rock core specimens for both physical testing and petrographic examination were selected as best was possible from areas in close proximity to the base of the structure. All test specimens for direct shear testing were obtained within 8 ft of the concrete foundation contact; a fourth of the specimens were from within 3 ft of the contact. Each of two identifiable rock types were tested according to the availability of samples. Location of rock test specimens is indicated in the appropriate tables of test results.

52. The direct shear test specimens ranged in color and had different hardnesses. The majority of the specimens were gray shale with only 1 blue gray and three brown shales. The rock texture was similar throughout. The most noticeable difference between the specimens was hardness. Specimens were put into two groups based on whether they were soft to moderate hard or moderate hard regardless of other features such as color. None of the shale recovered contained detectable weak zones such as clay seams. Without the presence of naturally occurring potentially weak zones, selection of intact test specimens was made. Direct shear tests were conducted along horizontal bedding planes.

53. Two borings put into the backfill revealed that a predominance of waste products were placed as fill. Slag, silt, bricks, irregular pieces of steel, and sandstone boulder mixed with water made core recovery extremely difficult. Sandy clayey mud along with, and sometimes mixed with sand and gravel was recovered. Representative samples of the backfill were taken to the soils testing facility and in consultation with a soil specialist, it was decided not to attempt any soils testing. There was no structure left to the samples; and a repeated direct shear test was ruled out due to the mixed nature of the samples plus there was not any reasonable way to arrive at a moisture content and density which is required for reconstituting a repeated direct shear sample. It is thought that experience and engineering judgement available at the District could be used to approximate appropriate backfill properties for stability calculations.

Laboratory Test Program

Concrete cores

54. The testing program for the concrete cores consisted of the following:

- a. Petrographic examination.
- b. Unit weight, γ .
- c. Velocity, V_p .
- d. Compressive strength.
- e. Elastic modulus, E .
- f. Poisson's ratio, ν

Rock cores

55. The testing of the bedrock cores consisted of the following tests. The tests are grouped under either characterization tests or engineering design tests.

- a. Characterization tests.
 - (1) Effective (as-received) unit weight, γ_m .
 - (2) Water content, w .
- b. Engineering design tests.
 - (1) Direct shear strength, intact (peak and residual).

Test Procedures

Petrographic examination

56. The petrographic examination was performed using general guidance from "Standard Recommended Practice for Petrographic Examination of Hardened Concrete," CRD-C 57-78, ASTM C 856-77 (USAE WES, 1949). Concrete from locations where deterioration existed was examined and compared to concrete from locations where nondeteriorated concrete was recovered. This comparison provided information on types of deterioration mechanisms that acted upon the concrete and gave indication of the depth of deterioration.

57. The petrographic examination of the rock and river sediment was performed using general guidance from "Standard Practice for Petrographic Examination of Aggregates for Concrete," CRD-C 127-80 ASTM-C 295-79 (USAE WES, 1949). The river sediments were also examined visually and classified using

the "Soil Classification Chart" in "Standard Test Method for Classification of Soils for Engineering Purposes," ASTM-D 2487-69 (Reapproved 1975).

Unit weight (γ)

58. The unit weight of the concrete was determined according to "Standard Test Method for Specific Gravity, Absorption, and Voids in Hardened Concrete," CRD-C 23-84 ASTM-C 642-82 (USAE WES, 1949). The apparent specific gravity was determined for each selected test specimen. The specimens were weighed in water and in air. The unit weights were then calculated by multiplying the apparent specific gravities by 62.43 lb/ft³.

Pulse velocity (V_p)

59. The pulse velocity was determined for the concrete according to "Standard Method of Test for Pulse Velocity Through Concrete," CRD-C 51-70 ASTM-C 597-71 (USAE WES, 1949).

Compressive strength, elastic modulus (E), and Poisson's ratio (ν)

60. The compressive strength, elastic modulus, and Poisson's ratio were determined according to "Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression," CRD-C 19-83 ASTM-C 469-81 (USAE WES, 1949). Strain gages, 2 vertical and 2 horizontal, were bonded to the specimens for purposes of measuring the axial and diametrical strains. The electrical impulses were averaged for the two orientations of strain gages to minimize the affects of core imperfections. Strength corrections were made for specimens with L/D ratios less than 1.8.

61. The characterization properties tests and the engineering design properties tests of the foundation rock were conducted in accordance with the appropriate test method tabulated below:

<u>Property</u>	<u>Test Method</u>	
	<u>Rock</u>	<u>Concrete</u>
<u>Characterization</u>		
Effective Unit Weight (As-Received), γ_m	RTM 109-80	
Water Content, w	RTM 106-80	
<u>Engineering Design</u>		
Direct Shear Strength	RTM 203-80	

PART VI: TEST RESULTS AND DISCUSSION

Petrographic Examination

62. All of the concrete examined was air entrained. The concrete consisted of two distinct mixtures one using natural river gravel for coarse aggregate and another mixture using a crushed carbonate coarse aggregate. Both concrete mixtures used a natural fine aggregate. The concrete examined in the current program is as reported in the information provided in the First Periodic Inspection of Lock and Dam No. 2. Concrete above elevation 691.75 ft consisted of a 3-in. top size crushed gravel as the principal mixture.

63. The concrete was generally in good condition and intact with little or no evidence of internal cracking. Concrete from the various parts of the structure was generally hard, dense and well consolidated. A summary of the cores examined are presented in Plates 4 thru 20. Details of the petrographic examination of the concrete are presented in composite field and laboratory logging of the cores in Appendix B and in the petrographic examination of the concrete cores as presented in Appendix C.

64. The surface of the concrete was eroded in some areas while in other areas the surface remained intact. Some of the surface concrete appeared to have been attacked chemically as the surfaces appeared etched with the siliceous aggregate remaining in relief and the carbonate coarse aggregate etched away leaving slight depressions in the concrete. Some popouts were present in the concrete. The extent of any damage to the concrete seemed to be limited to the near surface region. The following sections summarize the concrete from the different locations of the lock structure.

Concrete Quality

Guide walls

65. The preliminary study indicated that the surface concrete was limited to some dissolution of the surface and exposure of the coarse aggregate. Some spalling was present along the monolith joints.

66. Two vertical borings were drilled in the guide walls, one in the upper guide wall and one in the lower guide wall. Only slight weathering of the surface concrete was observed in the cores. The concrete in these cores

contained 3-in. maximum size crushed limestone aggregate. The strength of the concrete was over 5,000 psi.

67. The boring drilled into the lower guide wall also showed surface weathering with some light scaling. The near surface concrete was 0.5-in. maximum size crushed limestone coarse aggregate to 1.5-ft depth where the concrete has 3-in. maximum size crushed limestone coarse aggregate. The boring was taken along a crack. The crack extends approximately 3 ft into the concrete. No chemical nor alkali-aggregate reaction was found associated with the crack.

68. The tabulation below summarizes the depth of damaged concrete for borings into the guide walls.

<u>Structural Element</u>	<u>Boring</u>	<u>Boring Direction</u>		<u>Damaged Concrete Depth, ft</u>
		<u>Horizontal</u>	<u>Vertical</u>	
Upper guide wall	L-1		X	none
Lower guide wall	L-9		X	none

Guard walls

69. Fine healed hairline cracks were common in the surface concrete of the guard walls. The concrete was slightly eroded with an exposed aggregate appearance. Some efflorescence and scaling were also present in some monoliths.

70. Three borings were drilled into the guard walls, two vertical borings and one inclined boring. Boring R-1 drilled into the upper guard wall consisted of a mixture of crushed and natural gravel coarse aggregate. The surface of the core was intact and showed no signs of deterioration.

71. Boring R-7 was a vertical boring drilled into the lower guard wall. The surface concrete was in good condition. Compressive strength of a test specimen taken from near the top of the boring was 4,480 psi. The inclined boring taken from the river side of the lower guard wall indicated some medium to severe scaling of the concrete at the surface. The interior concrete was in good condition.

72. The tabulation below summarizes the depth of damaged concrete for borings into the guard walls.

<u>Structural Element</u>	<u>Boring</u>	<u>Boring Direction</u>		<u>Damaged Concrete Depth, ft</u>
		<u>Horizontal</u>	<u>Vertical</u>	
Upper guard wall	R-1		X	none
Lower guard wall	R-6	inclined		none
Lower guard wall	R-7		X	none

Land wall

73. Top surfaces of the land wall showed signs of aggregate dissolution. Fine cracks were present around structural features such as openings and mooring pins.

74. All three vertical borings into the top surface of the land wall showed only surface deterioration of the concrete with the surfaces showing light and medium scaling. The concrete was generally dense with good consolidation and contained crushed limestone coarse aggregate.

75. The compressive strength of the near surface concrete in boring L-1 was 5,990 psi. The test of interior concrete from boring L-7A indicated concrete with compressive strength of 5,790 psi.

76. Two horizontal cores were taken from the river face of the land wall, one near the upper pool level at elevation 726.5 ft (L-4) and one near lower pool level at elevation 715.5 ft (L-6). Both cores showed moderate surface weathering with some exposed aggregate at the surface. The concrete cores from both borings consisted of air-entrained concrete composed of crushed limestone coarse aggregate. Only surface damage was evident in the cores. The compressive strength of the cores were 6,770 psi for near surface concrete from boring L-4 and 4,460 psi for interior concrete at a 2-ft depth from the beginning of boring L-6.

77. The tabulation below summarizes the depth of damaged concrete for borings into the land wall:

<u>Structural Element</u>	<u>Boring</u>	<u>Boring Direction</u>		<u>Damaged Concrete Depth, ft</u>
		<u>Horizontal</u>	<u>Vertical</u>	
Land wall	L-3		X	none
Esplanade/Backfill	L-5		X	none
Land wall	L-4	X		none
Land wall	L-6	X		none

(Continued)

<u>Structural Element</u>	<u>Boring</u>	<u>Boring Direction</u>		<u>Damaged Concrete Depth, ft</u>
		<u>Horizontal</u>	<u>Vertical</u>	
Land wall	L-7		X	none
Land wall	L-7A		X	none

Middle wall

78. Appearance of the concrete in the middle wall was similar to that in the land wall. Additionally, the concrete in the middle wall contained numerous popouts at times and also had some "D" cracking along some monolith joints indicating that some low durability aggregate was used in the concrete.

79. Two vertical borings were drilled into the top surface of the middle wall. Borings M-1 and M-6 consisted of concrete with a 1-in. maximum size aggregate to one foot depth. The remainder of the concrete for both holes to the full depth of the concrete contained 3-in. maximum size coarse aggregate. Only slight surface deterioration was present in the cores recovered from this lock wall.

80. Tests of near surface concrete and interior concrete indicated the concrete to have compressive strengths of over 6,000 psi. The near surface concrete with the smaller aggregate had strengths of 7,130 psi and 7,840 psi. The interior concrete had strengths of 6,480 psi, 6,950 psi, and 7,810 psi.

81. Concrete from the land face of the middle wall was similar to the concrete from the river face of the middle wall as described in the Preliminary Study section of this report. Scaling of the surface was the most common deficiency. Borings M-2 and M-5 were drilled into the land face with M-2 near the lower pool elevation at 717.1 ft and M-5 near the upper pool elevation at 723.9 ft. The surfaces appeared to have been eroded due to abrasion and dissolution. Cracking of the concrete at 0.1 ft below the surface in boring M-2 indicated depth of deteriorated concrete was more than only surficial.

82. Two borings made into the river face of the middle wall were made at elevations 716.3 ft and 725.3 ft for borings M-3 and M-4, respectively. Both cores consisted of air-entrained concrete composed of 4-in. maximum size coarse aggregate. Only surface deterioration of the concrete in the form of scaling was observed.

83. Compressive strengths determined for the concrete in both land and river faces of the middle wall were above 6,000 psi.

84. The tabulation below summarizes the depth of damaged concrete for borings into the middle wall:

<u>Structural Element</u>	<u>Boring</u>	<u>Boring Direction</u>		<u>Damaged Concrete Depth, ft</u>
		<u>Horizontal</u>	<u>Vertical</u>	
Middle wall	M-1		X	none
Middle wall	M-2	X		none
Middle wall	M-3	X		0.1
Middle wall	M-4	X		none
Middle wall	M-5	X		none
Middle wall	M-6		X	none

River wall

85. Light scaling was the major deficiency in the concrete from the river wall. The concrete was represented by one vertical boring the full depth of the concrete, boring R-5, and two borings into the land face drilled in the small lock chamber. Those borings were at elevations 725.3 ft and 715.0 ft for borings R-3 and R-4, respectively.

86. Concrete from boring R-5 contained 2.5-in. maximum size natural coarse aggregate throughout the length of the core which was unlike the other vertical cores taken in the other walls in which the upper foot consisted of concrete made using a smaller coarse aggregate. The concrete was intact, air entrained, and in good condition. Strengths determined for the concrete were 5,890 psi for the near surface concrete and 6,400 psi and 4,500 psi for interior concrete.

87. Boring R-3 was drilled near a monolith joint and a lift joint. The boring intersected some reinforcing steel at approximately 0.8-ft depth. The steel was in good condition. The surface concrete was slightly weathered with some medium scaling. Interior concrete was intact, contained 3-in. maximum size natural coarse aggregate, and was air entrained.

88. Boring R-4, representing concrete at the lower pool elevation, was slightly more eroded and weathered than the concrete in the upper pool elevation. However, the interior concrete was similar to the upper pool elevation concrete consisting of intact air-entrained concrete with 3-in. maximum size natural coarse aggregate. The concrete strengths determined for the upper and lower pool elevation concrete were 6,830 psi and 6,550 psi, respectively.

89. The tabulation below summarizes the depth of damaged concrete for borings into the river wall:

<u>Structural Element</u>	<u>Boring</u>	<u>Boring Direction</u>		<u>Damaged Concrete Depth, ft</u>
		<u>Horizontal</u>	<u>Vertical</u>	
River wall	R-3	X		none
River wall	R-4	X		none
River wall	R-5		X	none

90. The physical properties of the concrete are tabulated in Table 3. The unit weight of the concrete ranged from a low of 142.4 lb/ft³ to 151.9 lb/ft³. The average was 147.0 lb/ft³.

91. The pulse velocity of the concrete ranged from 13,486 ft/sec to 16,652 ft/sec. The average pulse velocity for this concrete was 15,125 ft/sec. Lower pulse velocities of 13,486 ft/sec, 13,801 ft/sec, and 13,912 ft/sec correlated with concrete having strengths of 4,480 psi, 4,500 psi, and 5,790 psi, respectively, which were some of the lower strength concrete measured. Two cores, one from boring L-1 and one from L-4 had strengths of 5,360 psi and 4,460 psi, respectively, which had pulse velocities above 16,000 ft/sec.

92. The compressive strength of the concrete was generally over 5,500 psi with only 3 of the 20 specimens tested below this figure. All strengths were above 4,500 psi with the average compressive strength for both interior concrete and exterior concrete at 6,190 psi. There was no significant difference between strengths of concrete from near the surface and concrete in the interior of the structure.

93. The principal concrete mixtures used in the construction of the lock walls were a 4-bag mixture using 3-in. nominal maximum size crushed gravel and a 5-bag mixture using 1 1/2-in. top size crushed gravel. The 28-day compressive strengths for the mixtures were 4,314 psi and 5,637 psi, respectively. The average strength of the concrete is above the 28-day strengths reported for the mixtures used in the lock wall construction.

94. The data for the Poisson's ratio and modulus of elasticity are presented in Table 3. The stress-strain curves are presented in Plates 33 to 38. Average Poisson's ratio for the concrete tested was 0.24 for the

specimens tested. Poisson's ratio ranged from 0.16 to 0.29. The average modulus of elasticity was 4.0×10^6 psi.

Peak and Residual Shear Strength

95. A limited number of intact shale specimens were tested for shear strength parameters. A summary of the direct shear test results, density, and water content of foundation core is presented in Table 4. The rock core was divided into two groups based upon hardness. A moderately hard shale, and a soft to moderately hard shale were identified.

96. The shear stress versus shear deformation and the normal versus shear deformation curves are presented in Plates 21 thru 34. Shear stress versus normal stress plots were drawn up for the two groups of rocks. The shear strengths obtained from the soft to moderate hard rocks plotted reasonable well considering the scatter in shear strength at a given normal load; an angle of internal friction for peak strengths (ϕ_p) and cohesion (C) was calculated and is 51.9° and 5.4 psi respectively. The residual shear angle (ϕ_r) for the soft to moderate hard rocks was calculated and is 25.0° with a $C = 2.1$ psi. Shear strength parameters were calculated by the method of linear regression.

97. When the peak shear strengths obtained from the moderately hard rocks were plotted, there was a wide scatter in the shear strengths for a given normal load. This indicates a variation between specimens which is probably due to differences in hardness between specimens within this group. The residual shear strength values plotted much closer together than did the peak shear strengths indicating relative consistency in this lower bound strength parameter.

98. After studying the similarity in the shape of the shear stress versus shear deformation curves, the specimen densities and moisture contents, and the peak and residual shear strengths, it was decided to plot all the shear test results together, and calculate a peak and residual failure envelope for all specimens. It was thought that the foundation rock within 8 ft of the concrete-foundation interface would be better represented by doing this. In making the calculation of shear strength parameters for both groups of rocks, a few data points were thrown out because they were widely scattered from the majority of the other data points. In other words the few data

points were thrown out because they were believed to belong to another rock population.

99. The stress stress versus normal stress plot for the two groups or rocks is presented in Figure 10. The peak shear strength parameters are, for the angle of internal friction (ϕ) and cohesion (C), 47.5° and 6.4 psi respectively. The residual shear strength parameters are 25.8° and 1.32 psi respectively for ϕ and C. These shear strength values are thought to be representative of the foundation rock in close proximity to the founding elevation of the lock walls.

Lock & Dam #2 Monogahela River Soft to Moderately & Moderately Hard shale

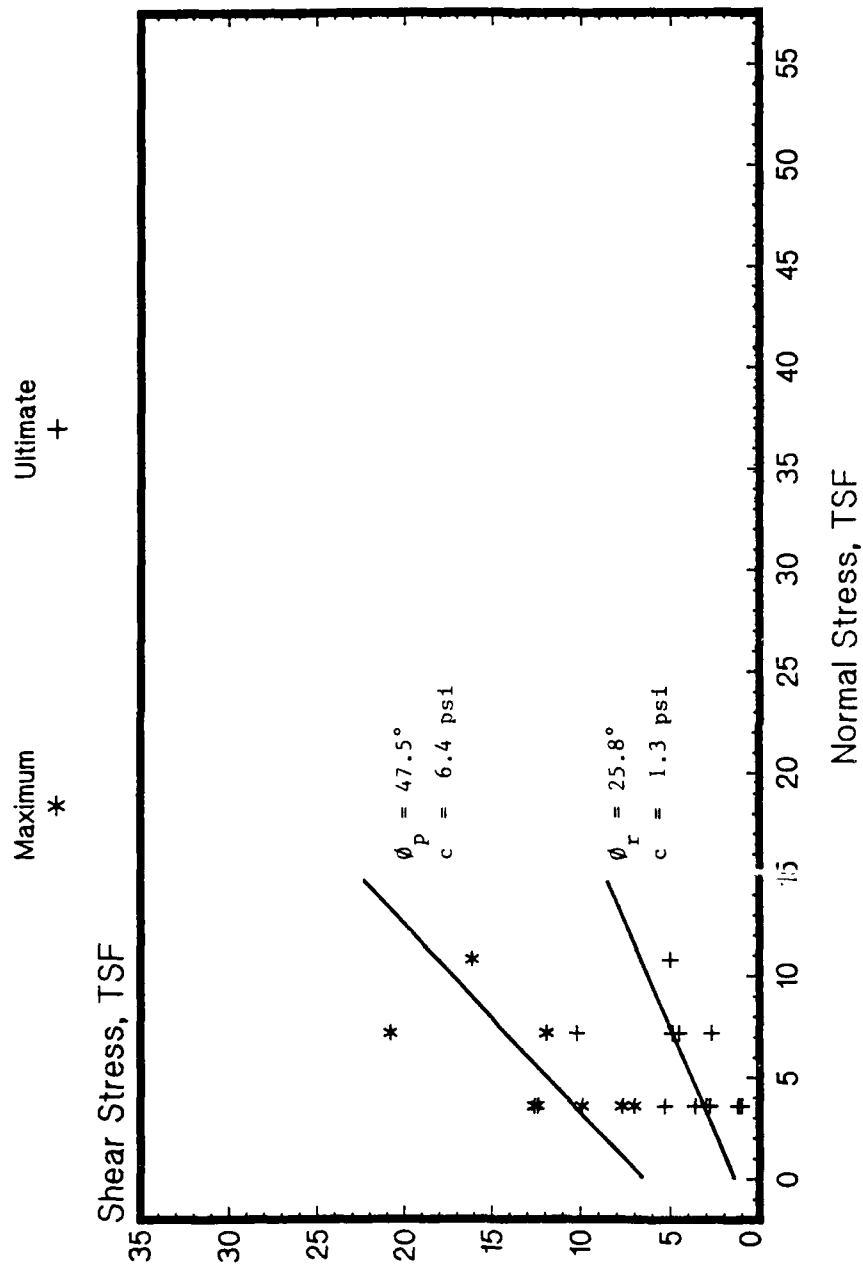


Figure 10. Failure envelopes for foundation rock

PART VII: CONCLUSIONS AND SUMMARY

100. The concrete at Locks and Dam No. 2 making up the lock walls, the guide walls, and guard walls is in fair to good condition. All of the concrete is air entrained which has protected the concrete from any major freeze-thaw damage. Some surface scaling is evident in most of the concrete, but the original surface is generally recognizable.

101. Dissolutioning of the limestone coarse aggregate is evident throughout the entire lock structure. The aggregate is partially dissolved thus weakening the support of the thin surface mortar which has eventually eroded away causing the concrete to have an exposed aggregate appearance. The phenomenon is widespread but is confined to the surface of the concrete and has not caused any deep penetrating damage to the concrete.

102. During the construction of the lock, the majority of the concrete was a 4-bag mixture using 3-in. maximum size coarse aggregate and then topped with a 5-bag mixture using 1 1/2-in. maximum size coarse aggregate. Both concretes were found to be in good condition, and interface between the two concretes was generally intact.

103. The steel armor has protected the guide walls, the guard walls, and the lock walls from abrasion due to the river traffic. The concrete associated with the armoring is in good condition.

104. Some "D" cracking was present along the monolith joints, but the cracks appeared healed. Hairline cracks were also common along the steel-edged plates along the river wall and the guard walls. These hairline cracks do not appear to be active.

105. Popouts are common on some of the surfaces. This indicates that some of the aggregate used in the construction was low-durability aggregate. Popouts are surface features and will not affect the internal integrity of the concrete.

106. Vertical cracking was present on the top of the guide walls at periodic intervals and was not associated with any apparent chemical reaction and did not appear to be active. The cracks may have been due to original shrinkage of the concrete.

107. Some vertical monolith joints have spalled. Borings made adjacent to these areas have indicated that the depth of deterioration is confined to

the visible spalled concrete. No damage due to the interior cracking was evident in the cores examined from these areas.

108. Some minor repairs have been made in the gate machinery area. The repaired concrete is generally in good condition. Some cracking of the concrete was noted in the vicinity of some of the operating winches. The concrete from borings adjacent to these areas indicates that the concrete is intact and in good condition.

109. The near surface concrete shows only minor surface deficiency. While at the present these surface defects are not currently a maintenance problem, as normal weathering progresses, the concrete surface will continue to deteriorate as it has in the past, which is essentially none at all. Vertical and horizontal core showed no signs of deterioration, and the exterior concrete has not deteriorated since construction.

110. The shale recovered from the lock wall foundation did not contain weak zones such as clay seams, therefore, intact specimens were tested in direct shear parallel to bedding. Two groups of shale were identified and tested separately. For the analysis of the direct shear strength parameters, the groups were combined due to similarities in the shear stress versus shear deformation curves and similarity of other key rock properties. The peak shear strength parameters are $\phi_p = 47.5^\circ$ and $C = 6.4$ psi. The residual strength values are $\phi_r = 25.8^\circ$ and $C = 1.32$ psi.

PART VIII: PROJECTED CONCRETE CONDITION

111. No major deteriorating mechanism was recognized in the laboratory investigation that was likely to degrade the concrete at the locks during the next 50 years.

112. The concrete surfaces, both vertical and horizontal, showed no sign of deterioration beyond normal weathering since construction, therefore a rate of deterioration was not calculated for Locks and Dam No. 2. Some cracking of the horizontal and vertical concrete surfaces was evident, however. These cracks, along with possible cracks in the galleries and the emptying and filling culverts, should be mapped for future reference. The concrete should remain in serviceable condition for a period extending on the order of 50 years from the date of this investigation.

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Table 1
Pertinent Boring Information

<u>Boring No. BR WES</u>	<u>Depth of Hole, ft</u>	<u>Core Size, in.</u>	<u>Direction of Boring</u>	<u>Elev Top of Boring, ft</u>	<u>Elev Top of Rock, ft</u>	<u>Elev Bottom of Boring, ft</u>
L-1	10.55	6	V	730.5	---	719.95
L-2	80.5	4	V	727.5	667.8	647.0
L-3	16.1	6	V	732.5	---	716.4
L-4	3.2	6	H	715.5	---	---
L-5	73.2	6	V	730.5	675.6	657.3
L-6	2.55	6	H	726.5	---	---
L-7	6.5	6	V	730.5	---	724.0
L-7A	119.5	6	V	730.5	671.6	611.0
L-9	10.65	6	V	730.5	---	719.85
M-1	97.1	6	V	732.5	672.2	635.4
M-2	3.2	6	H	717.1	---	---
M-3	3.2	6	H	716.3	---	---
M-4	2.9	6	H	725.3	---	---
M-5	3.3	6	H	723.9	---	---
M-6	91.7	6	V	732.5	667.1	640.8
R-1	1.6	6	V	730.5	---	728.9
R-3	3.1	6	H	725.3	---	---
R-4	3.1	6	H	715.0	---	---
R-5	90.7	6	V	730.5	663.0	639.8
R-6	3.3	6	I	715.5	---	---
R-7	3.0	6	V	730.5	---	727.5

Table 2
Core Received at WES from Locks and Dam No. 2, Monongahela River

Structures Lab		Core			
I.D.	Field I.D.	Location	Dia, in.	Material	Boxes
Pitts-13 CON-1 to CON-4	BR WES L-1	U.S. End of Guide Wall	6	Concrete	4
Pitts-13 DC-1, to DC-18	BR WES L-2	U.S. Land Wall Backfill	5, 2 1/2 4	Backfill & Rock	18
Pitts-13 CON-5 to CON-9	BR WES L-3	U.S. Land Wall Gate Recess	6	Concrete	5
Pitts-13 CON-10	BR WES L-4	Land Wall Lower Pool	6	Concrete	1
Pitts-13 CON-11 DC-19 to DC-33	BR WES L-5	Land Wall Esplanade	6 2 1/2	Concrete Backfill	1 5, 12*
Pitts-13 CON-12	BR WES L-6	Land Wall Upper Pool	6	Concrete	1
Pitts-13 CON-13 to CON-15	BR WES L-7	D.S. Land Wall	6	Concrete	3
Pitts-13 CON-16 to CON-35	BR WES L-7A	D.S. Land Wall	6	Concrete	20
DC-34 to DC-53				Rock	40
Pitts-13 CON-36 to CON-39	BR WES L-9	D.S. Guide Wall	6	Concrete	4
Pitts-13 CON-40 to CON-59	BR WES M-1	U.S. River Wall Gate Recess	6	Concrete	20
DC-54 to DC-65			6	Rock	12
Pitts-13 CON-60	BR WES M-2	U.S. Middle Wall Land Face	6	Concrete	1
Pitts-13 CON-61	BR WES M-3	Middle Wall River Face	6	Concrete	1
Pitts-13 CON-62	BR WES M-4	Middle Wall River Face	6	Concrete	1
Pitts-13 CON-63	BR WES M-5	D.S. Middle Wall Land Face	6	Concrete	1
Pitts-13 CON-64 to CON-86	BR WES M-6	D.S. Middle Wall	6	Concrete	23
DC-66 to DC-75			6	Rock	10
Pitts-13 CON-110	BR WES R-1	U.S. Guard Wall	6	Concrete	1
Pitts-13 CON-111	BR WES R-3	U.S. River Wall Land Face	6	Concrete	1
Pitts-13 CON-112	BR WES R-4	River Wall Land Face	6	Concrete	1
Pitts-13 CON-87 to CON-109	BR WES R-5	D.S. River Face Gate Recess	6	Concrete	23
DC-76 to DC-84			6	Rock	9
Pitts-13 CON-114	BR WES R-7	D.S. Guard Wall	6	Concrete	1

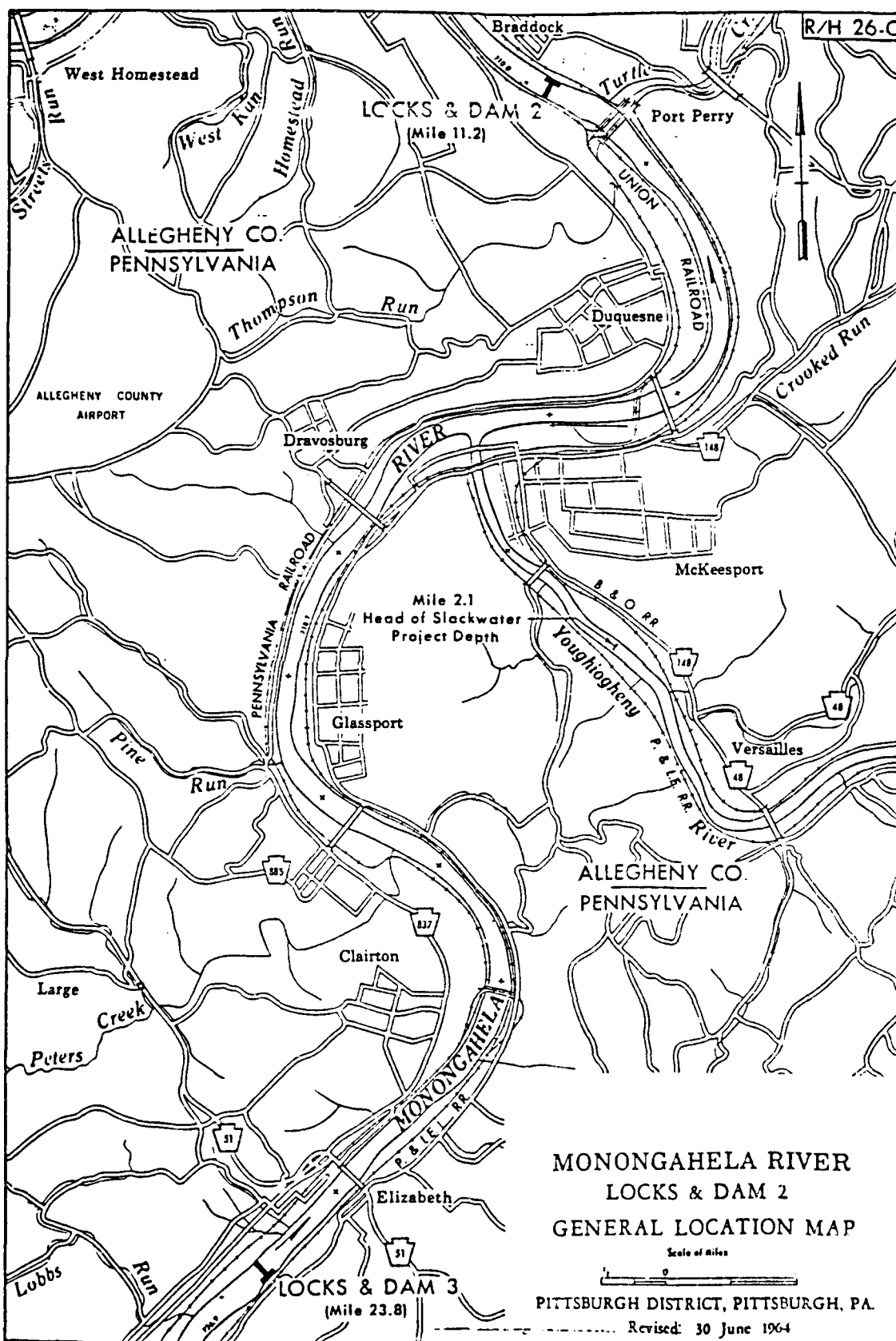
* Plastic cylinders.

Table 3
Concrete and Rock Core Test Results Locks and Dam No. 2, Monongahela River

CTD Specimen No.	BR WES Boring No.	Direction of Boring	Core Depth, ft	Dia., in.	Length, in.	Unit Weight, pcf	Pulse Velocity, fps	Comp Strength, psi	Elastic Modulus $\times 10^6$ psi	Poisson's Ratio
Pitts-13										
CON-1	L-1	V	0.00- 3.15	5.94	12.25	150.7	16,366	5,360	4.9	0.21
CON-5	L-3	V	0.00- 3.75	5.95	12.35	151.9	16,129	5,990		
CON-10	L-4	H	0.00- 3.15	5.90	12.40	150.6	16,652	4,460		
CON-12	L-6	H	0.00- 2.55	5.90	12.50	149.0	15,755	6,770		
CON-29	L-7A	V	39.50-43.10	5.94	12.25	146.4	13,912	5,790	3.0	0.16
CON-40	M-1	V	0.00- 2.30	5.95	12.40	149.0	15,349	7,840		
CON-51	M-1	V	32.60-35.75	5.94	12.25	147.4	14,875	6,480	4.2	0.26
CON-61	M-3	H	0.00- 3.15	5.90	12.25	145.2	14,925	6,020	4.4	0.29
CON-62	M-4	H	0.00- 2.95	5.85	12.35	147.8	15,487	6,440		
CON-63	M-5	H	0.00- 3.30	5.88	12.30	146.7	15,282	6,560		
CON-64	M-6	V	0.00- 2.30	5.90	11.80	145.6	15,105	7,130		
CON-74	M-6	V	26.20-28.90	5.90	12.25	145.2	14,705	6,950		
CON-86	M-6	V	61.10-63.30	5.92	12.30	145.1	14,309	7,810		
CON-110	R-1	V	0.00- 1.65	5.83	12.25	143.5	13,486	4,480	2.9	0.25
CON-111	R-3	H	0.00- 3.10	5.88	12.35	148.3	15,487	6,830		
CON-112	R-4	H	0.00- 3.10	5.90	12.25	147.5	15,994	6,550	4.5	0.24
CON-87	R-5	V	16.10-19.20	5.88	12.35	144.1	14,492	5,890		
CON-97	R-5	V	35.00-	5.90	12.40	146.7	15,755	6,400		
CON-109	R-5	V	60.40-63.40	5.95	12.35	142.4	13,801	4,500		
CON-113	R-6	I	0.00- 3.30	5.88	12.40	146.1	14,925	5,520		
					$\bar{X}$	147.0	15,125	6,190	4.0	0.24
					SD	2.5	875	980	0.8	0.05
					n	20	20	20	6	6

Table 4
Lock and Dam No. 2, Mon River
Summary Direct-Shear Test Results

Hardness	Boring No. BR WES	Depth ft	Density pcf	Water Content %	Normal Stress tsf	Maximum Shear Stress tsf	Residual Shear Stress tsf	Color
Soft to Mod Hard	L-2	63.9-64.2	166.1	--	3.6	7.7	3.0	Brown
	M-1	60.4-60.6	166.7	1.0	7.2	44.6	10.2	Gray
	M-1	64.1-64.5	166.1	1.7	10.8	16.1	5.0	Gray
	M-1	64.5-64.8	166.7	1.8	3.6	12.4	5.3	Gray
	M-1	65.5-65.7	166.7	1.9	3.6	7.0	3.6	Gray
	M-1	65.7-66.0	166.7	1.7	7.2	20.8	4.9	Gray
	L-7A	65.7-66.0	166.1	2.4	3.6	9.9	1.0	Gray
Moderately Hard	L-5	65.8-66.0	159.8	--	3.6	12.6	3.0	Blue Gray
	M-1	69.2-69.4	163.6	3.5	7.2	11.9	2.7	Brown
	M-1	71.1-71.5	166.7	2.4	3.6	17.3	1.2	Brown
	M-6	66.9-67.3	166.1	2.3	3.6	19.5	2.8	Gray
	M-6	74.9-75.1	167.3	1.3	3.6	27.0	4.0	Gray
	R-5	67.7-68.0	166.1	1.8	7.2	24.0	4.5	Gray
	R-5	68.6-69.0	167.9	1.5	10.8	44.8	16.5	Gray
Mean			165.5	1.9				
Standard Deviation			2.5	0.6				
Number of Specimens			17.0	12.0				



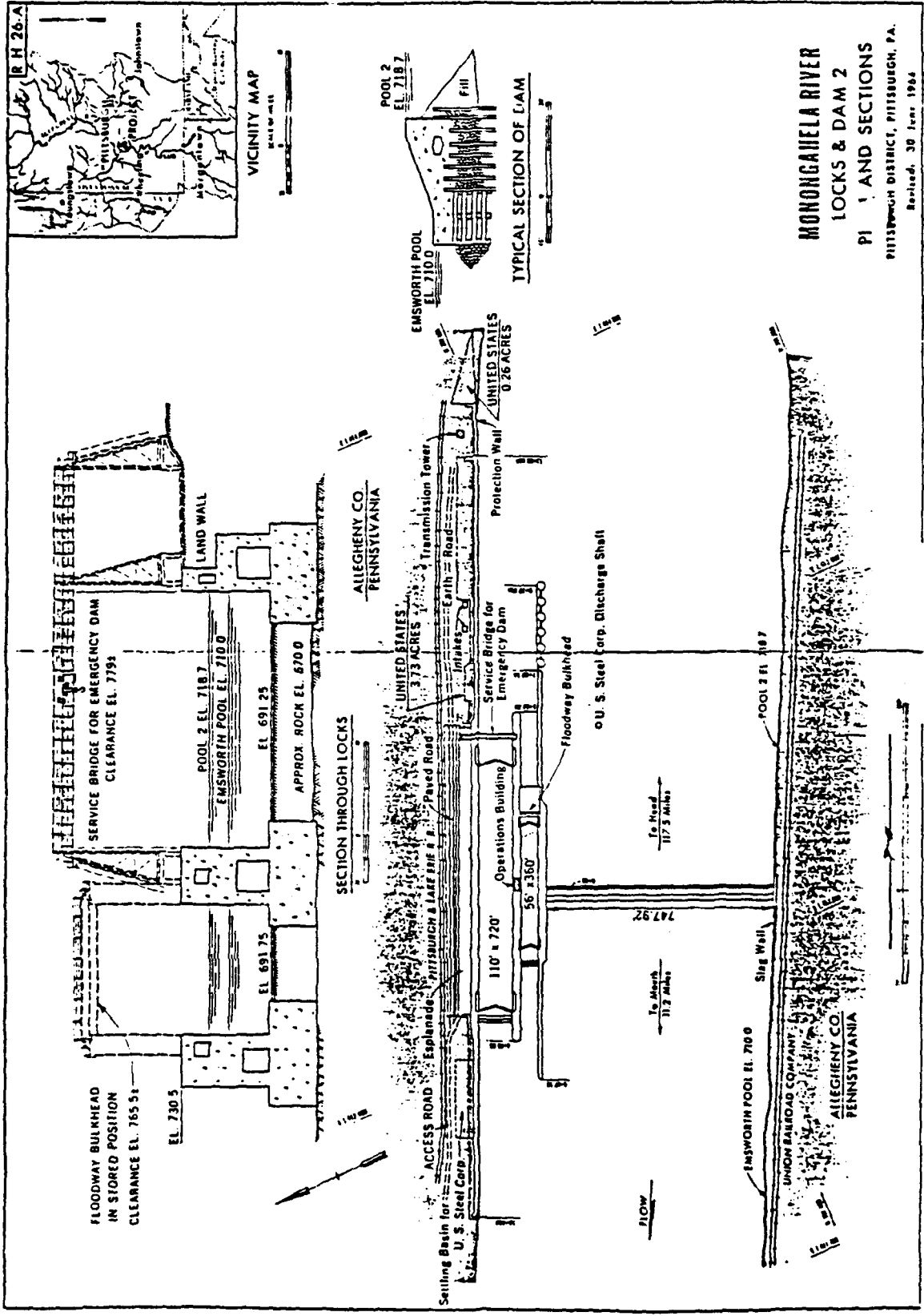
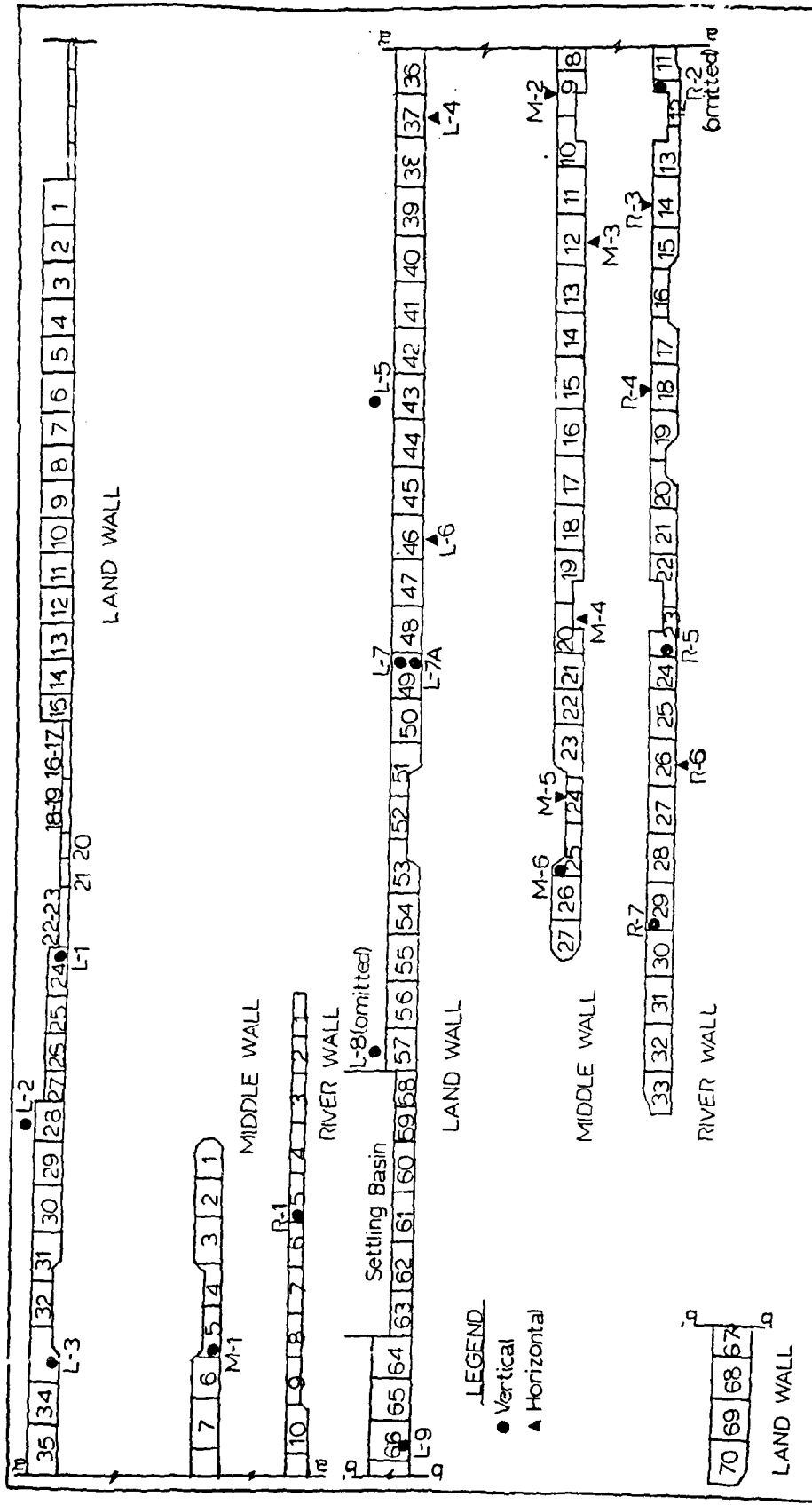
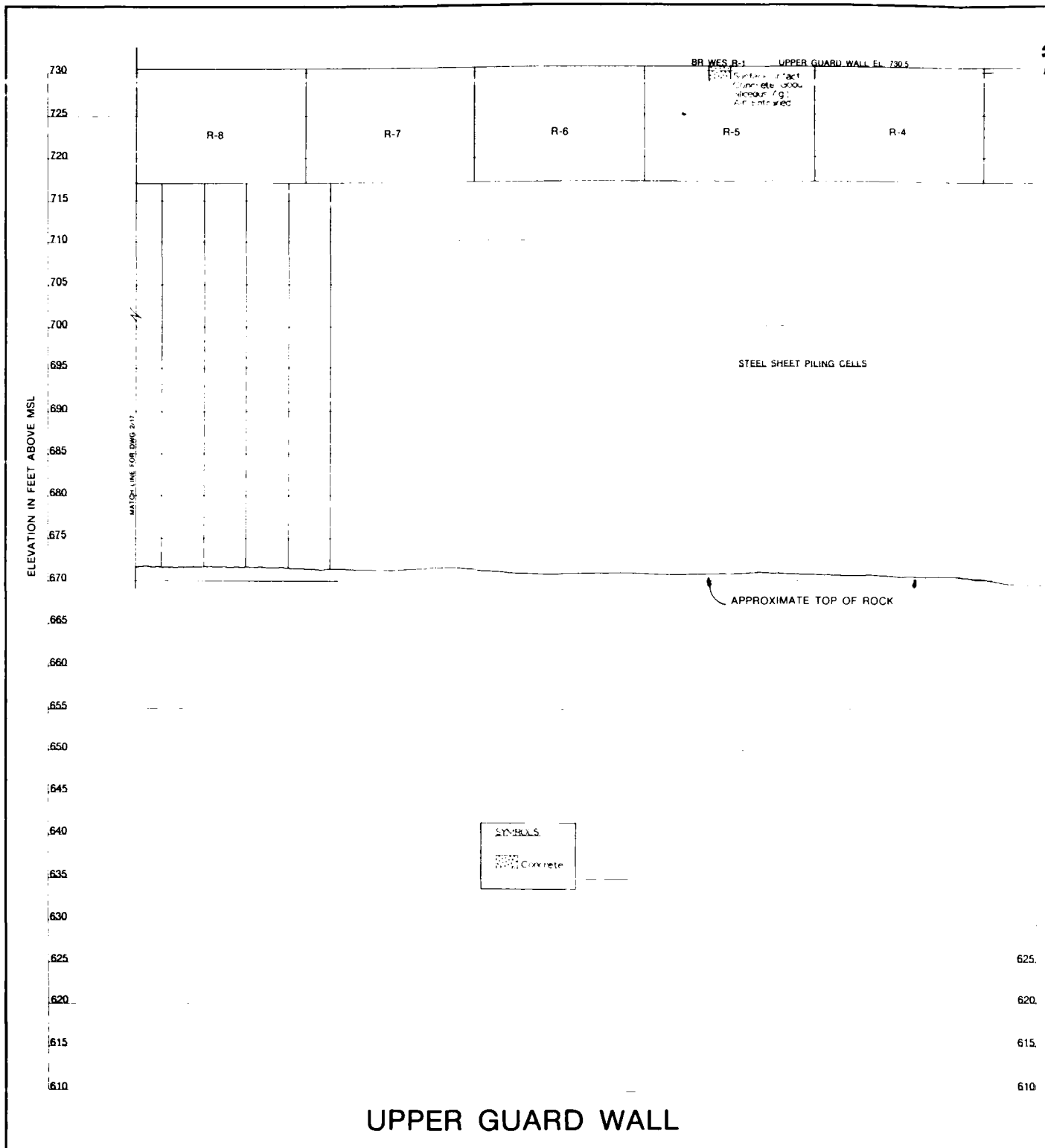


Plate 2

MONONGAHELA RIVER, LOCKS AND DAM NO. 2

BORING LOCATION PLAN VIEW





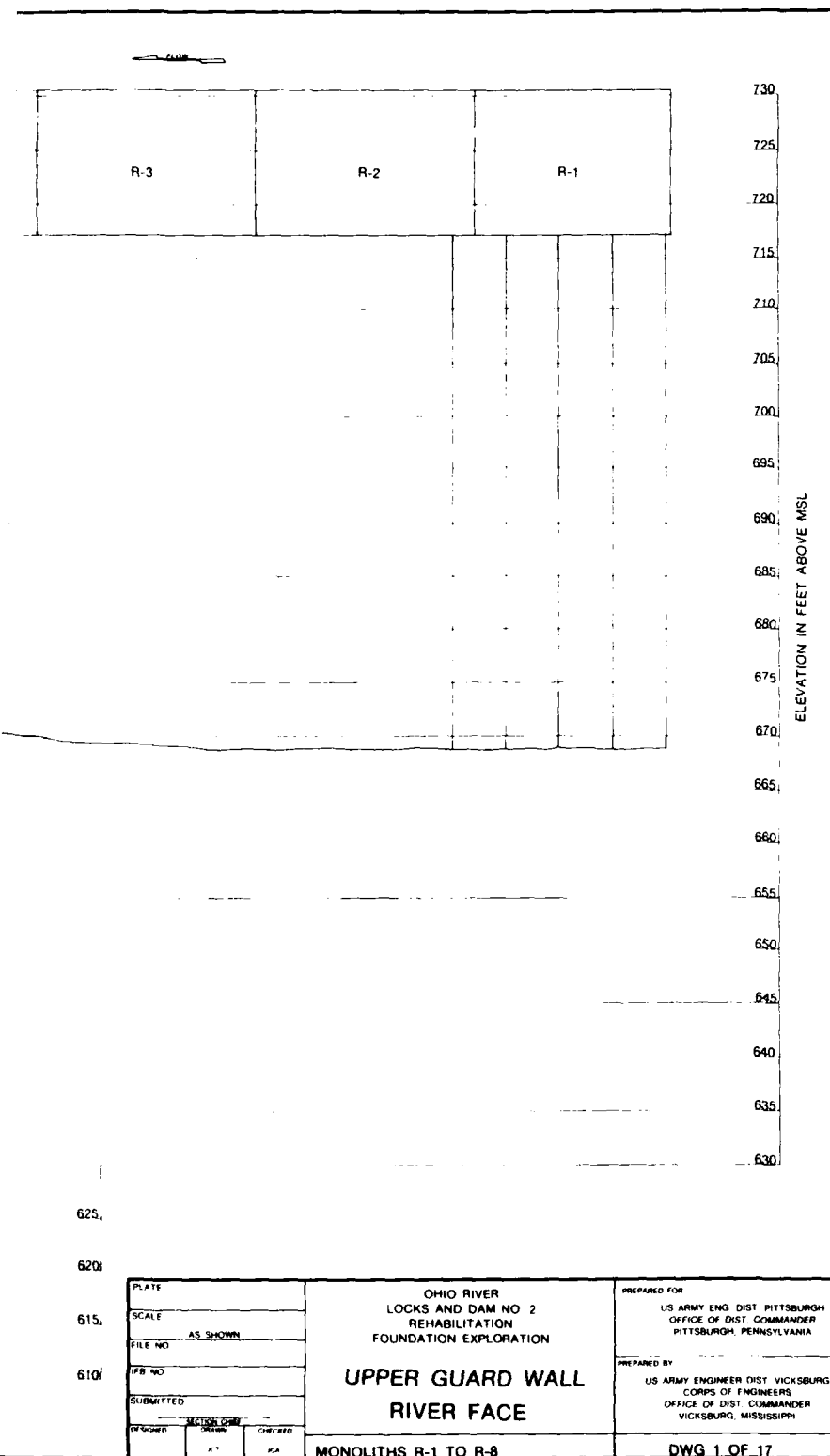
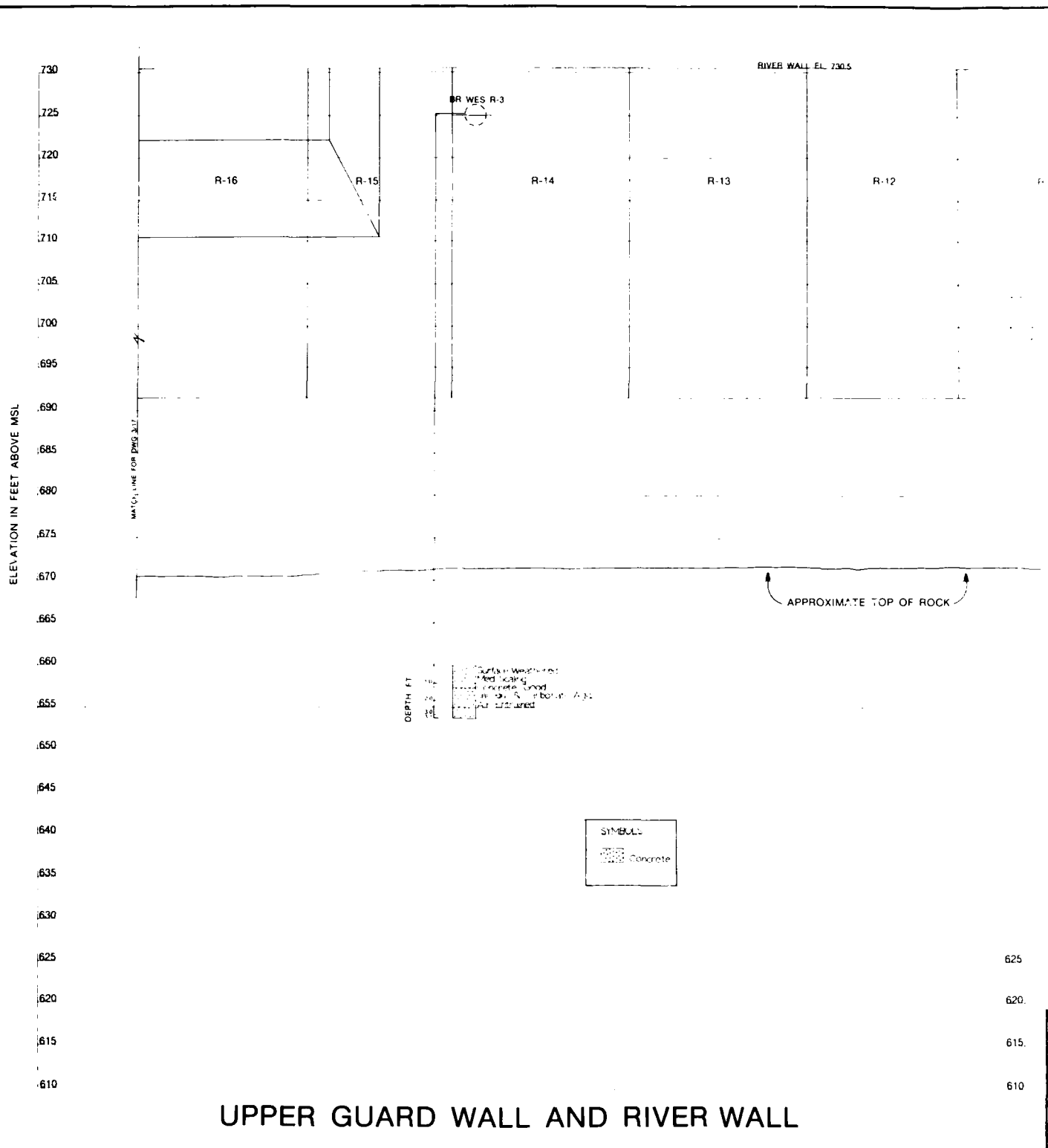
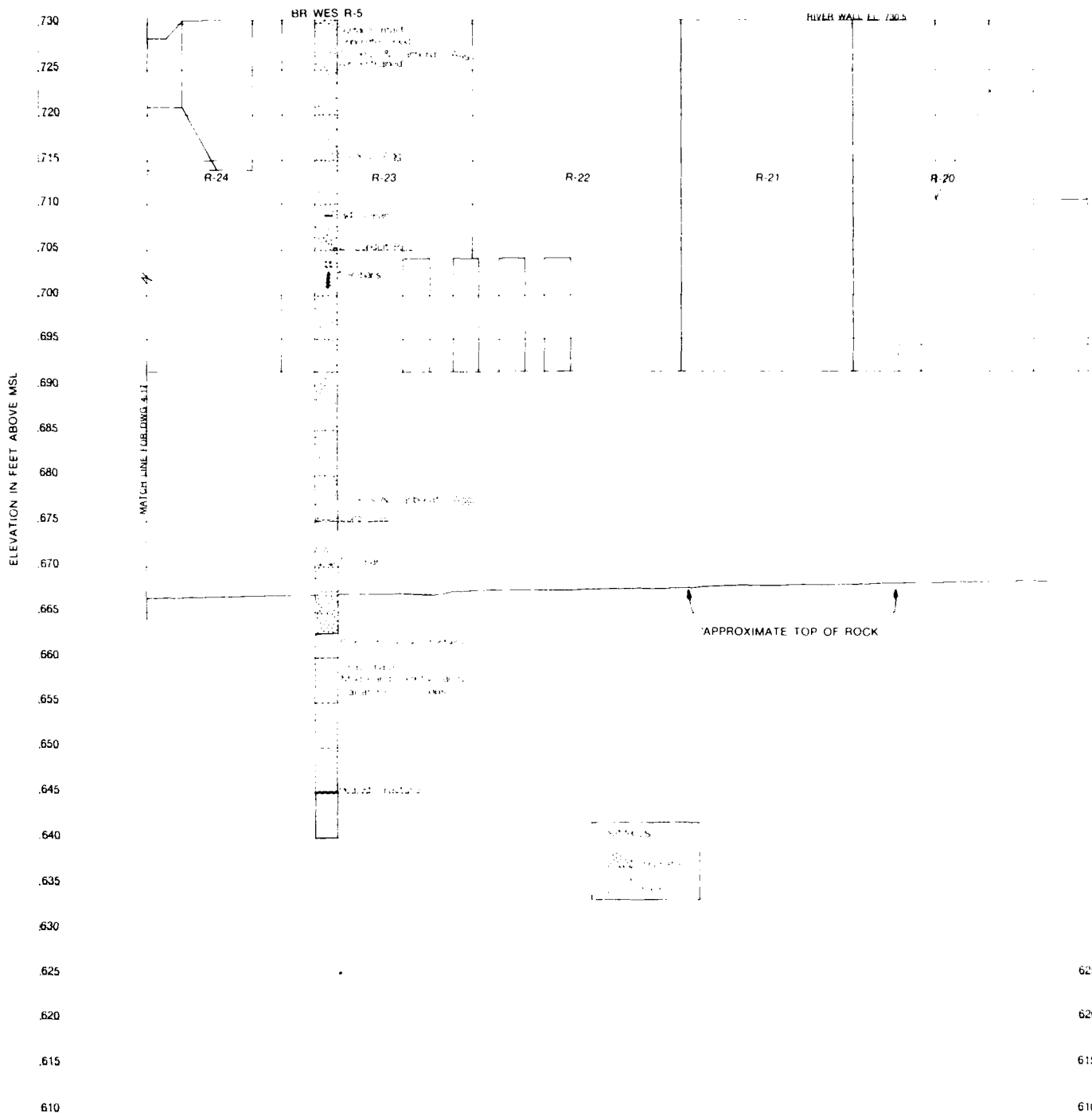


PLATE 4





RIVER WALL

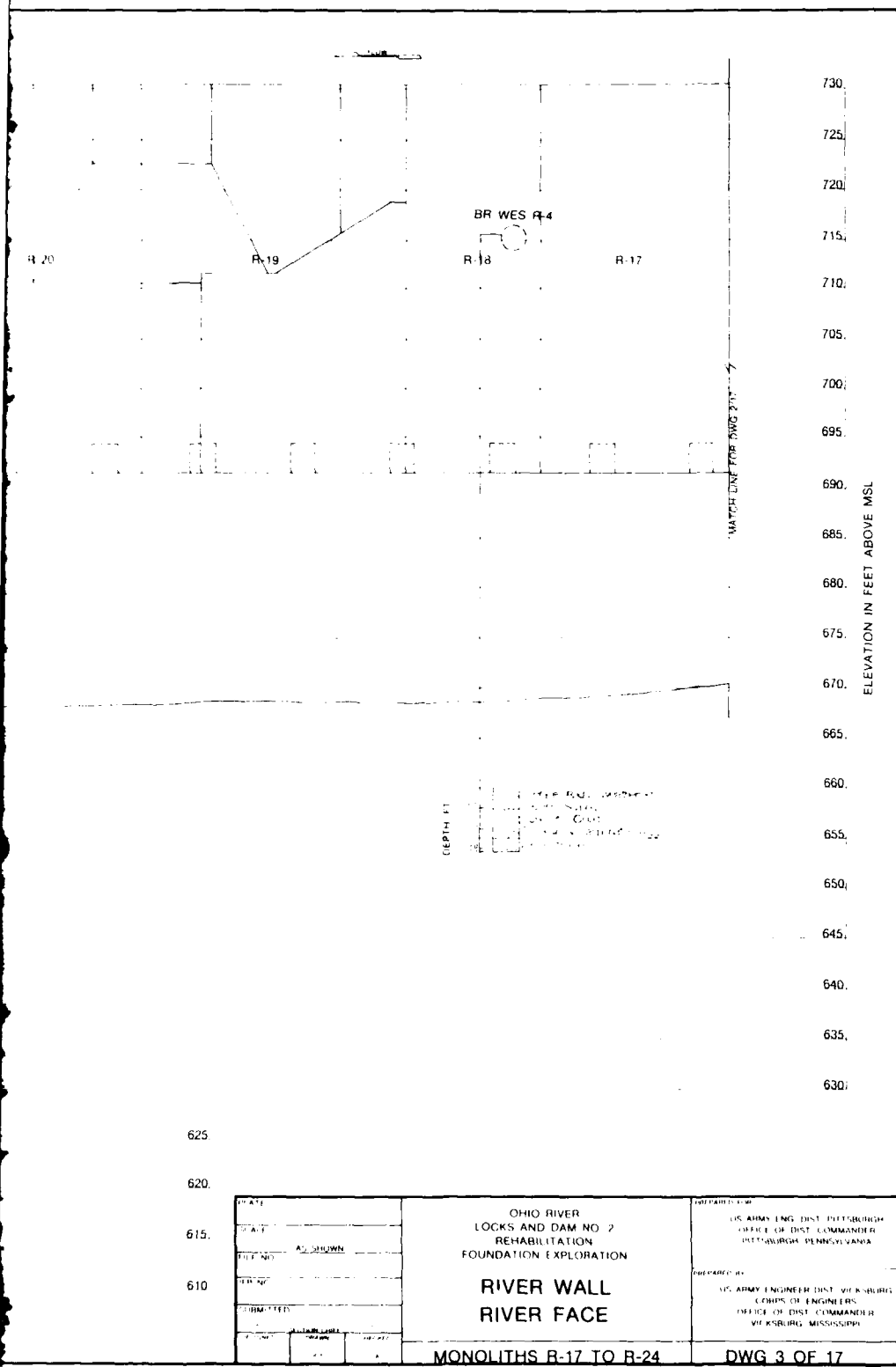
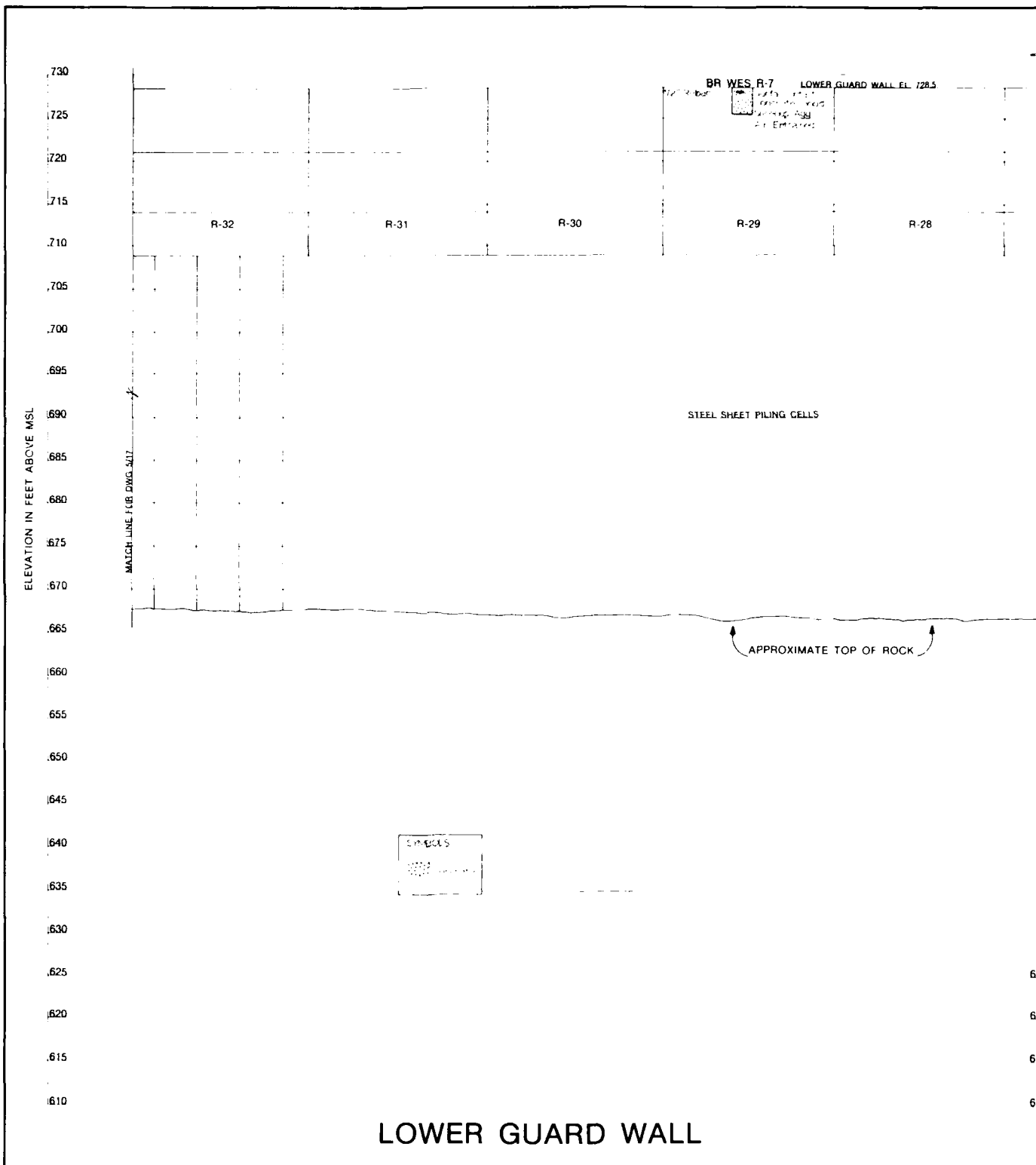
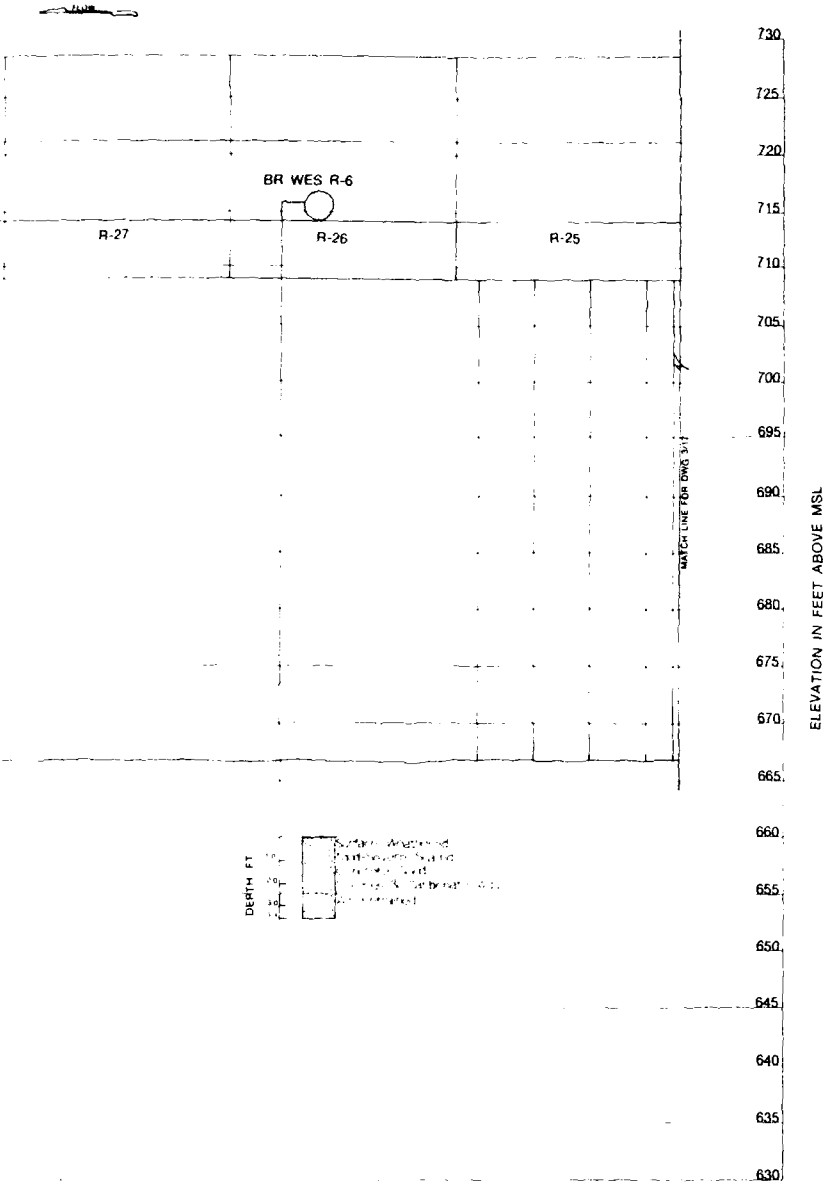


PLATE 6





DEPTH FT

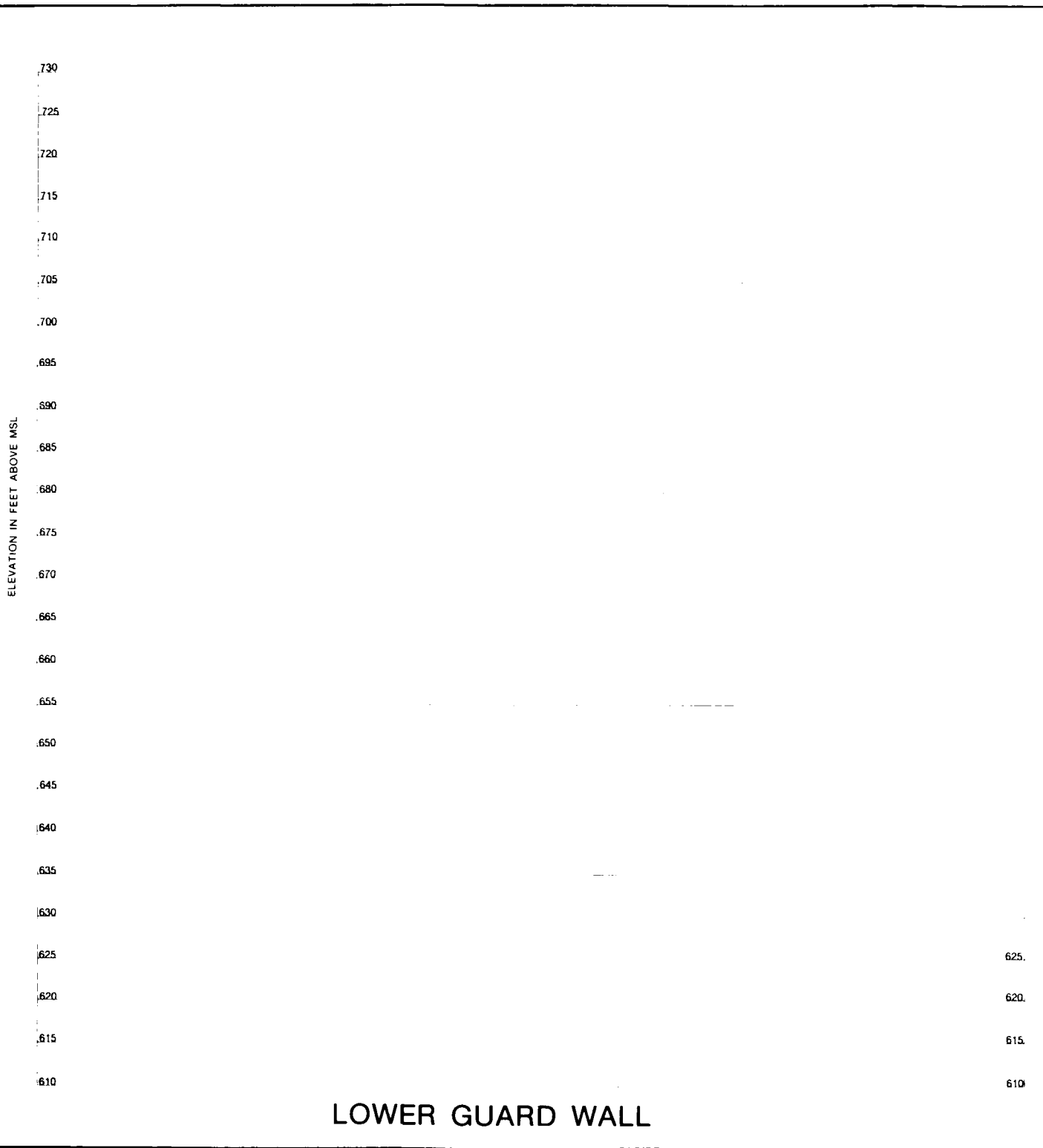
10
20
30

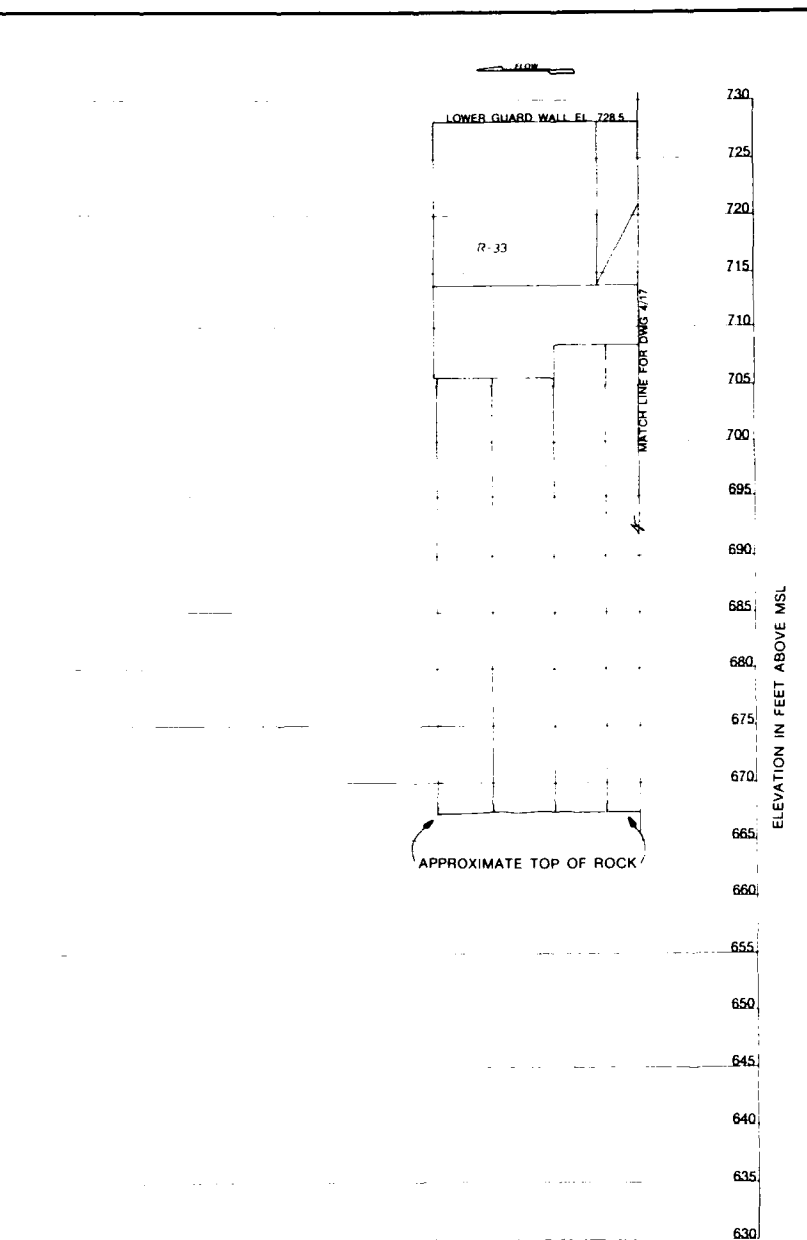
Surface Weathered
Subsurface Sound
Subsurface Sound
Subsurface Sound
Subsurface Sound
Subsurface Sound

625:
620:
615:
610:

PLATE SCALE AS SHOWN FILE NO IFR NO SUBMITTED DATE BY FOR		OHIO RIVER LOCKS AND DAM NO 2 REHABILITATION FOUNDATION EXPLORATION LOWER GUARD WALL RIVER FACE MONOLITHS R-25 TO R-32	PREPARED FOR US ARMY ENG DIST PITTSBURGH OFFICE OF DIST COMMANDER PITTSBURGH PENNSYLVANIA PREPARED BY US ARMY ENGINEER DIST VICKSBURG CORPS OF ENGINEERS OFFICE OF DIST COMMANDER VICKSBURG MISSISSIPPI DWG 4 OF 17
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PLATE 7





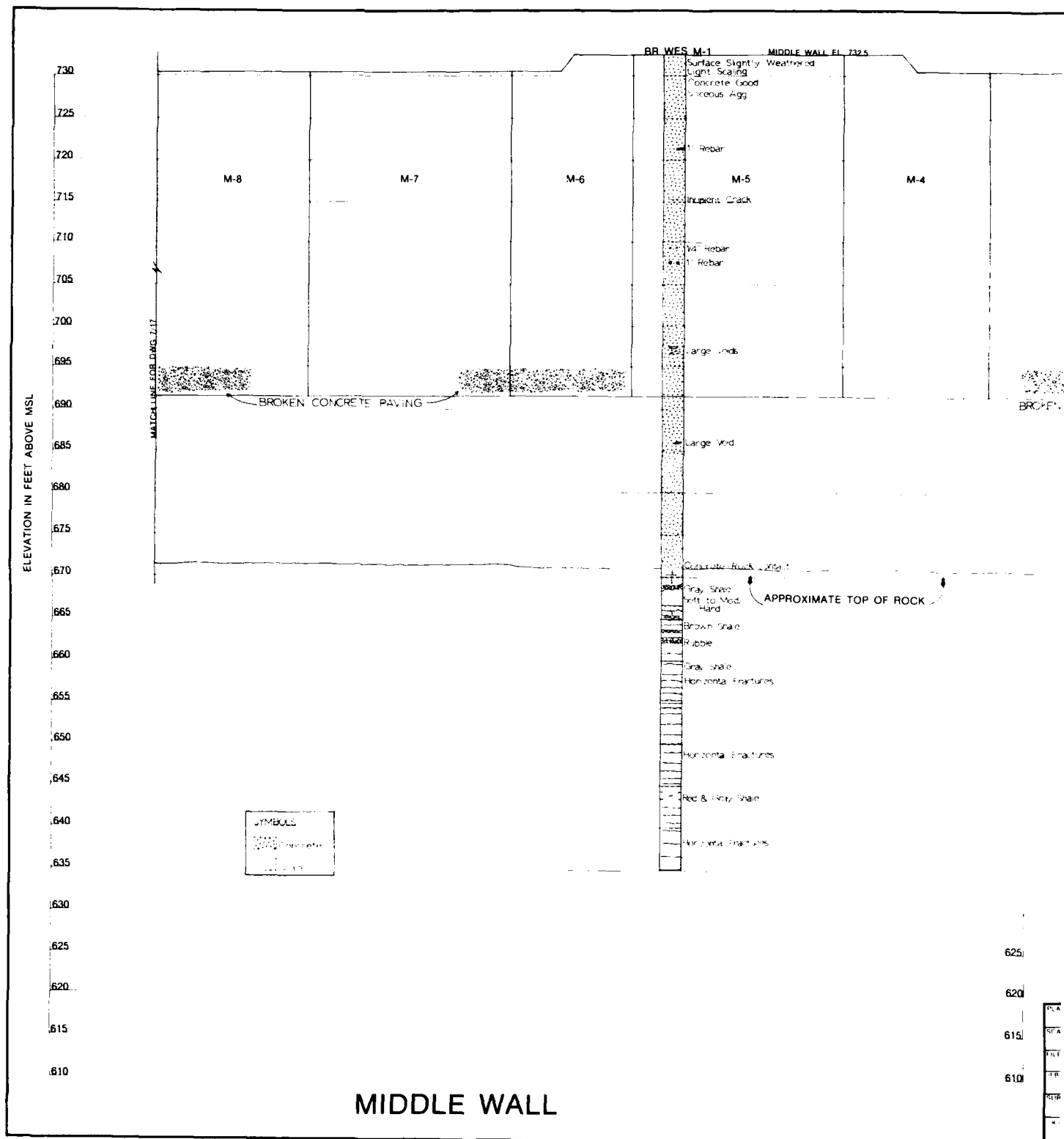
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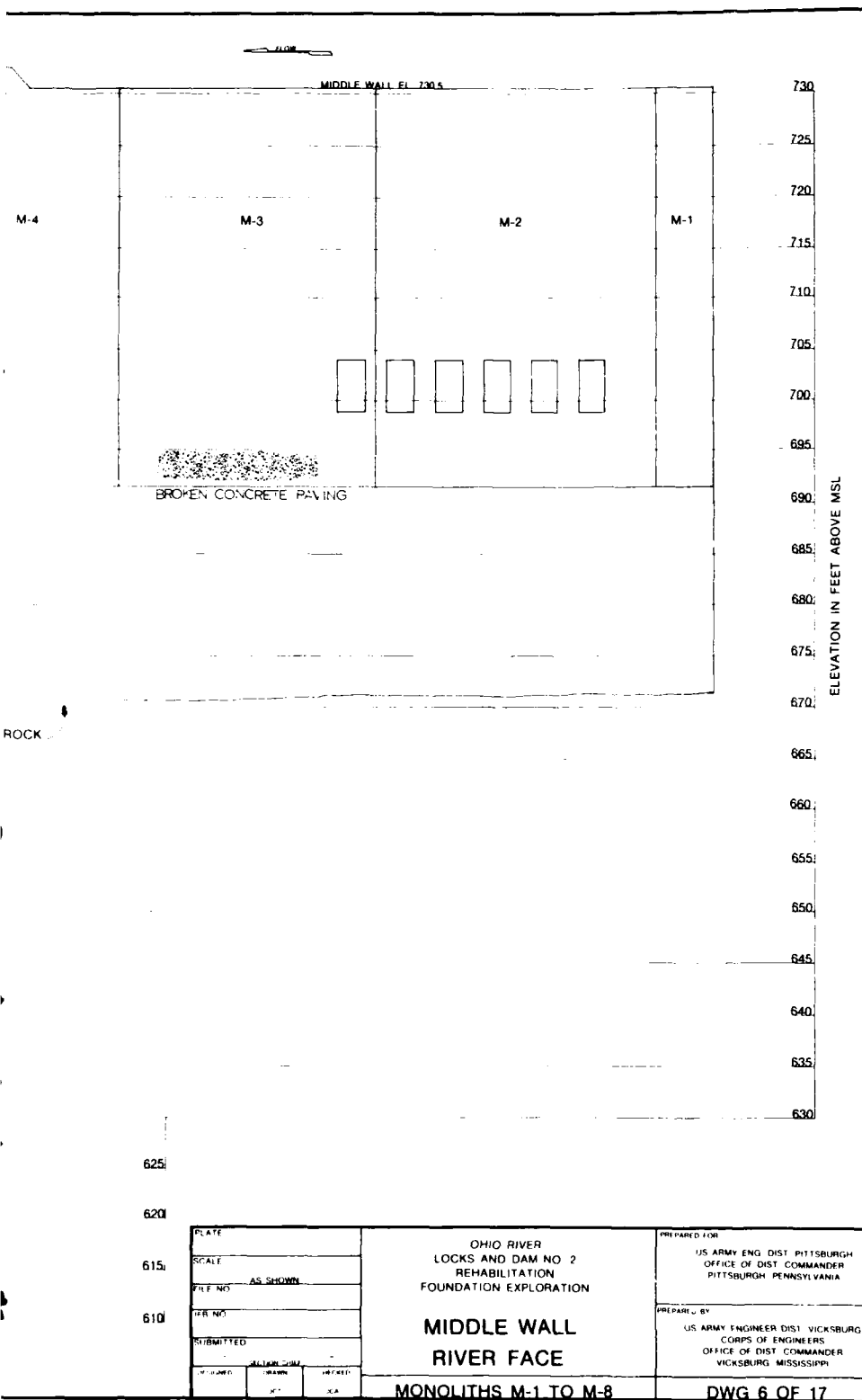
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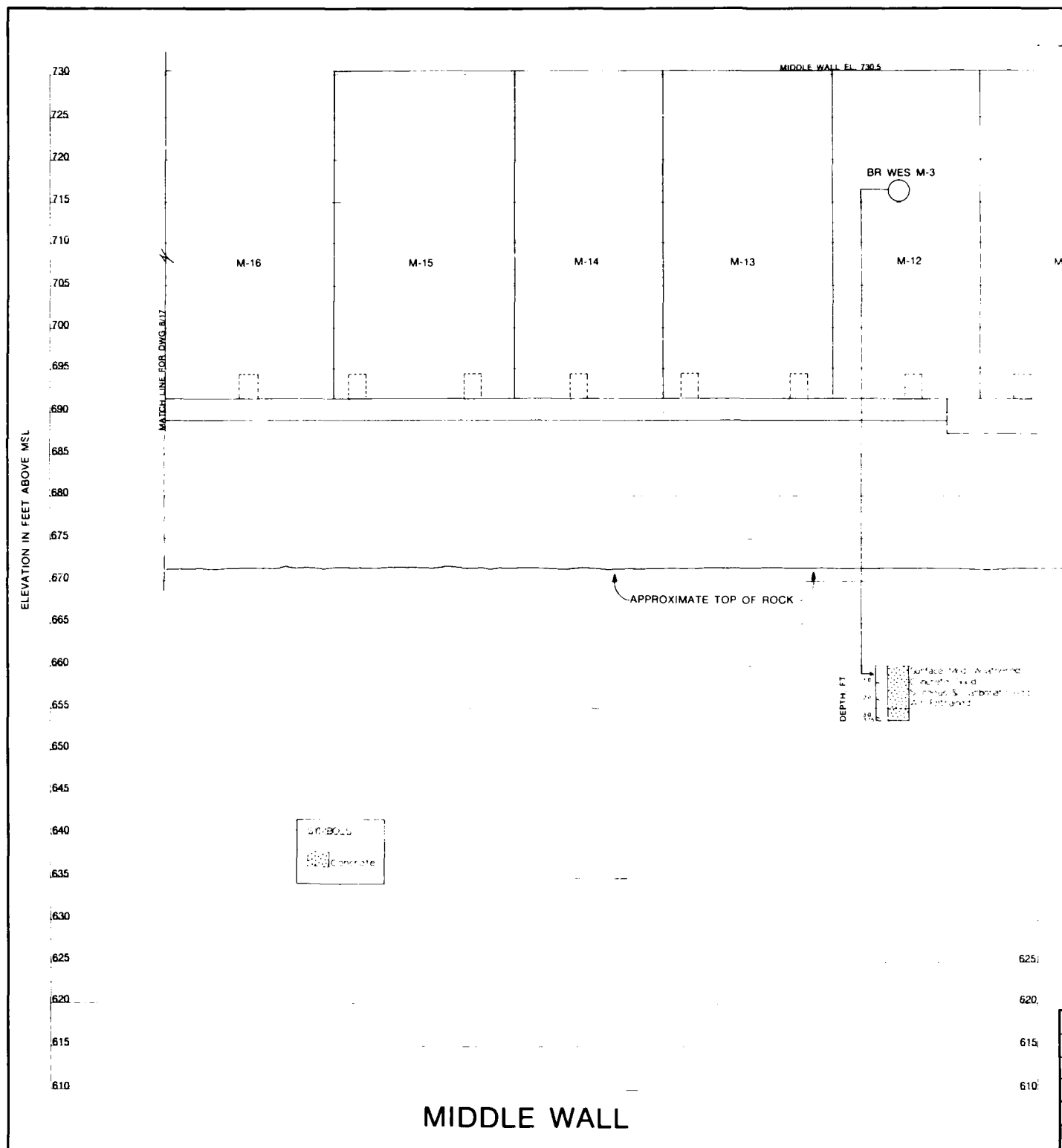
615

610

PLATE SCALE FILE NO. AS SHOWN (P.B. NO.) SUBMITTED DATE DRAWN CHECKED		OHIO RIVER LOCKS AND DAM NO. 2 REHABILITATION FOUNDATION EXPLORATION LOWER GUARD WALL RIVER FACE MONOLITH R-33	PREPARED BY US ARMY ENG. DIST. PITTSBURGH OFFICE OF DIST. COMMANDER PITTSBURGH, PENNSYLVANIA PREPARED BY US ARMY ENGINEER DIST. VICKSBURG CORPS OF ENGINEERS OFFICE OF DIST. COMMANDER VICKSBURG, MISSISSIPPI DWG. 5 OF 17
--	--	--	--







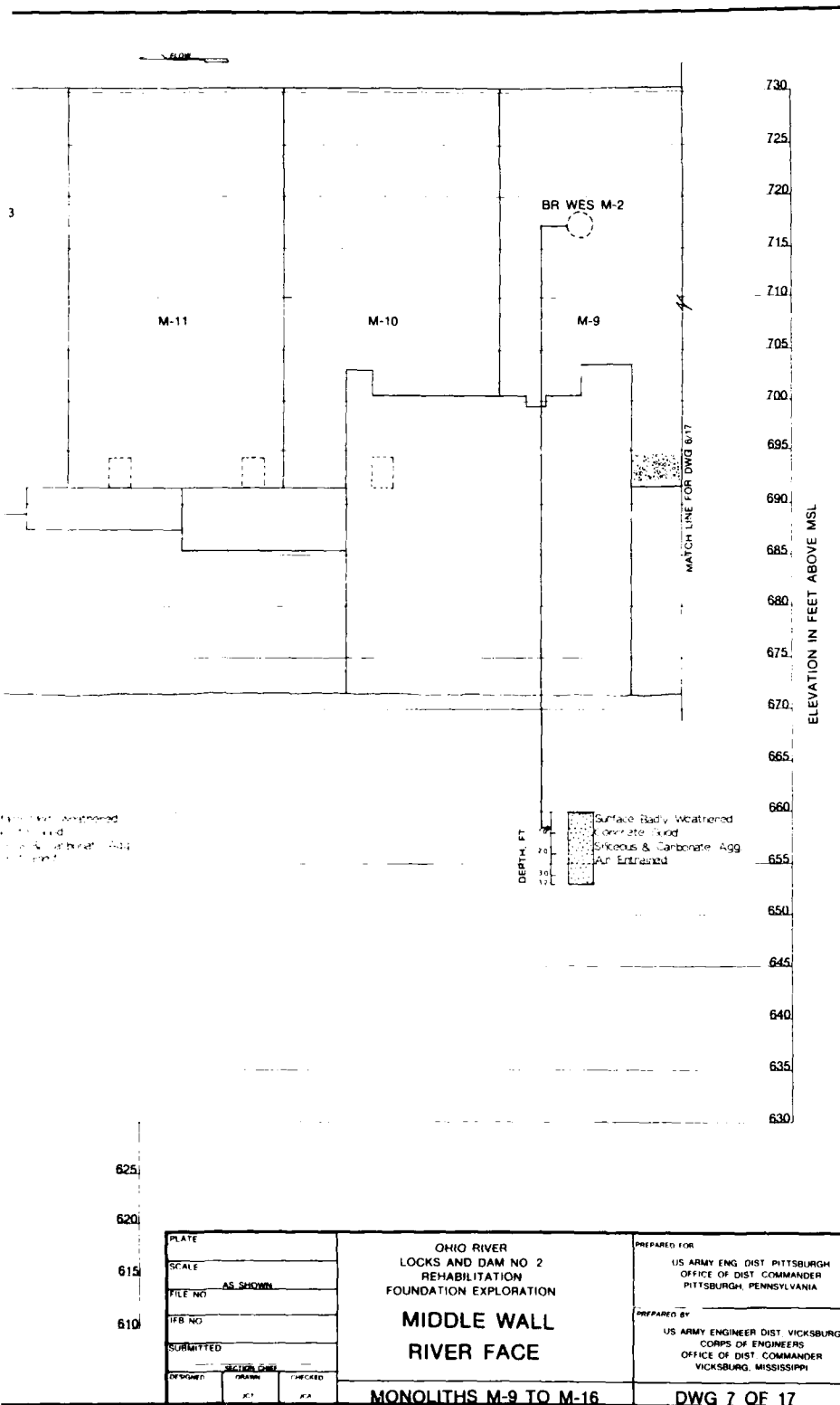
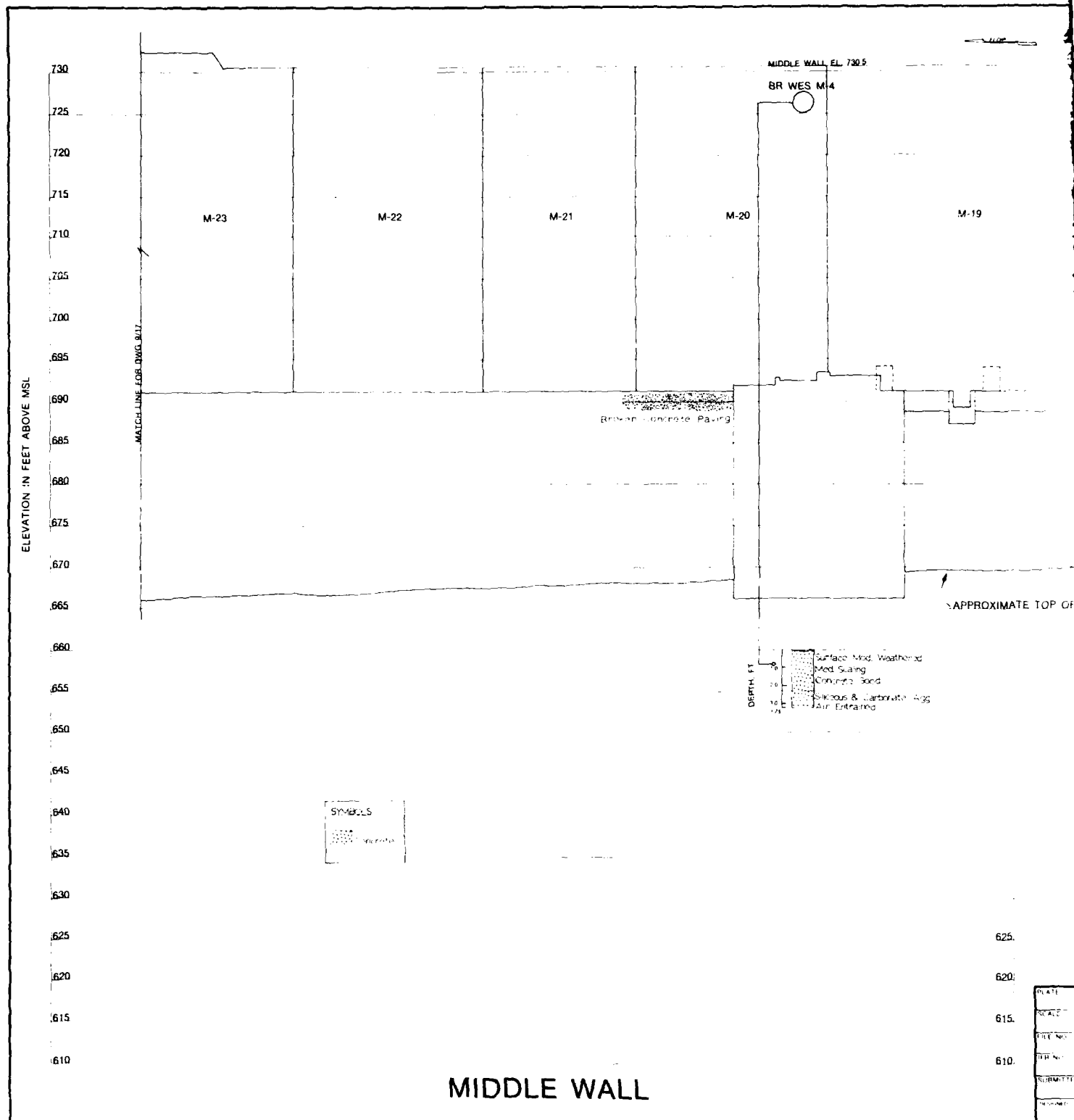
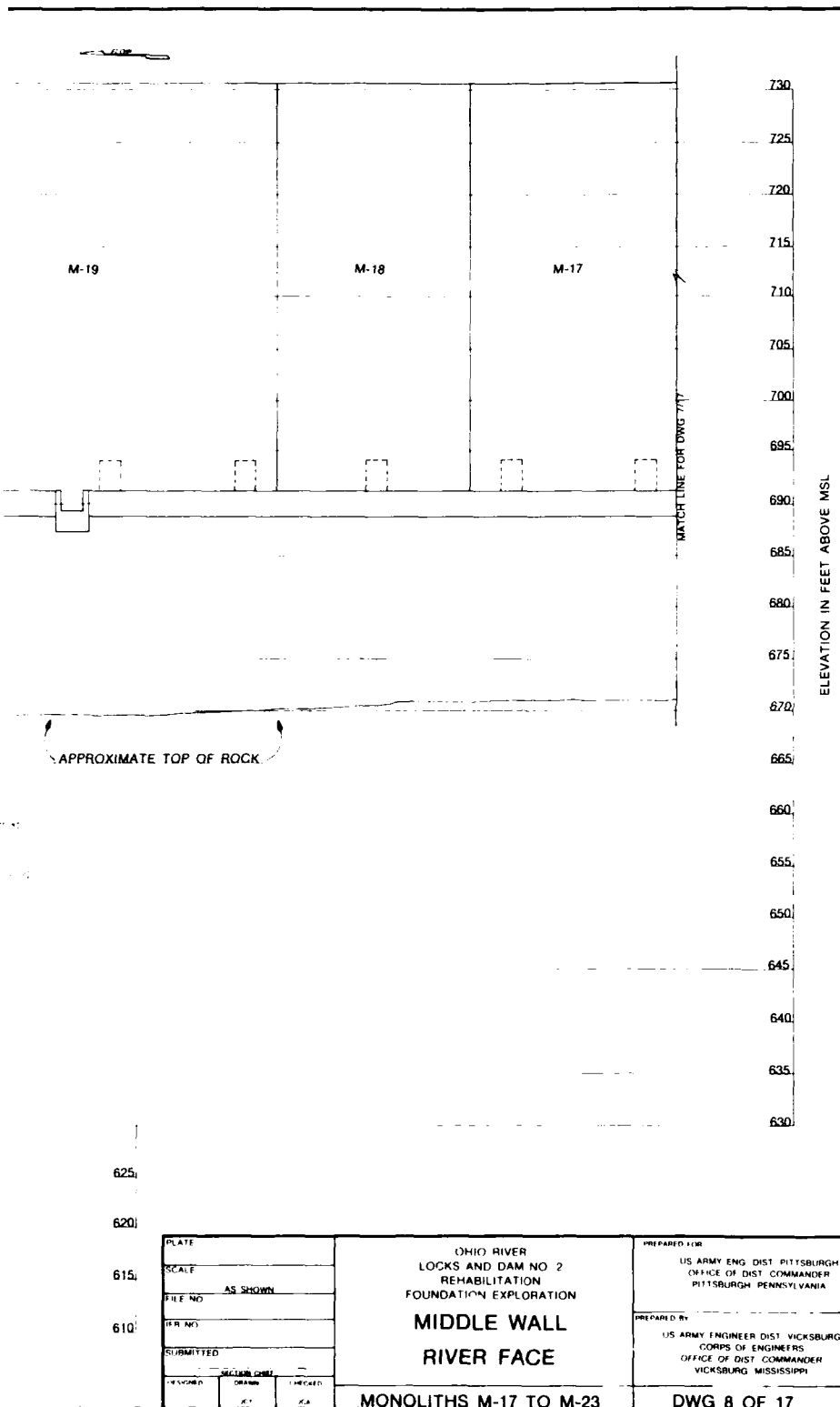


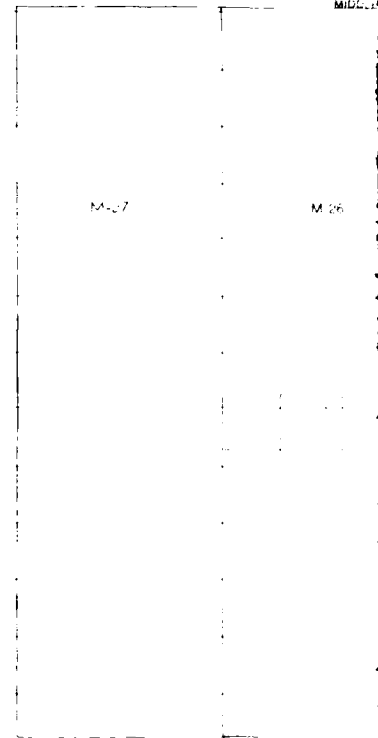
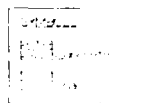
PLATE 10





ELEVATION IN FEET ABOVE MSL

730
725
720
715
710
705
700
695
690
685
680
675
670
665
660
655
650
645
640
635
630
625
620
615
610



MIDDLE

APPROXIMATE

MIDDLE WALL

625
620
615
610

PLATE
SCALE
DATE
BY
CHECKED
APPROVED
REVISION

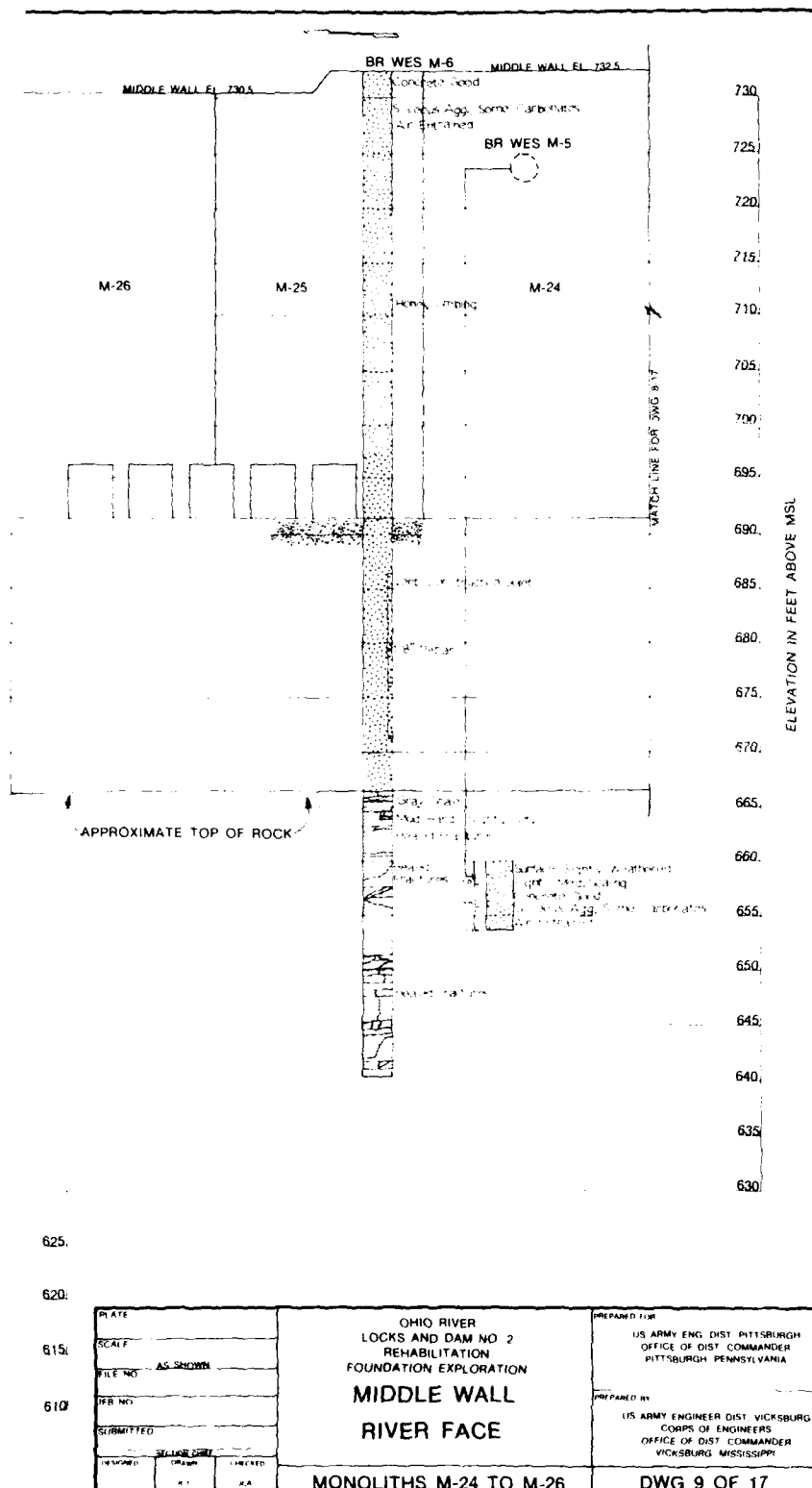
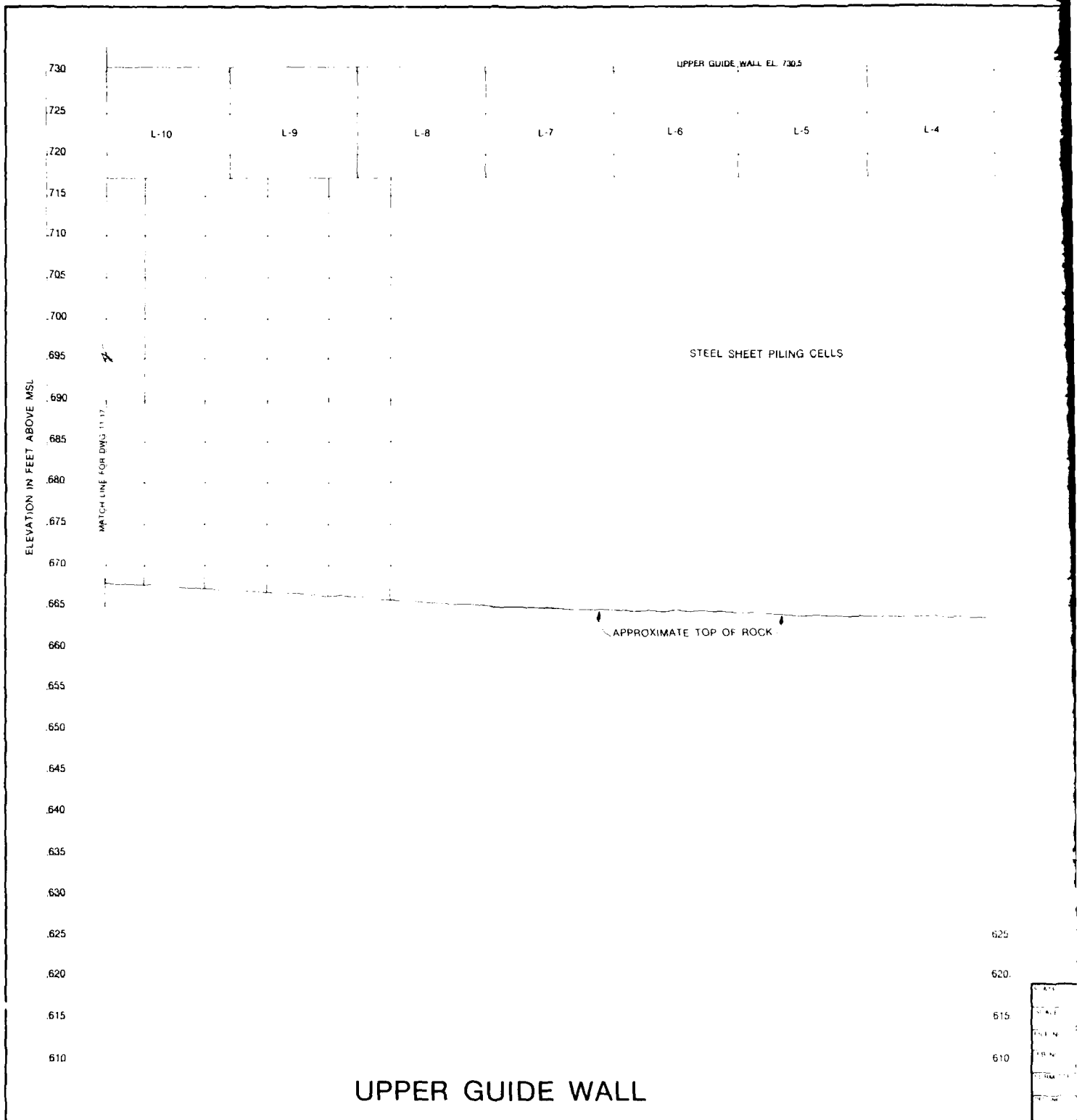
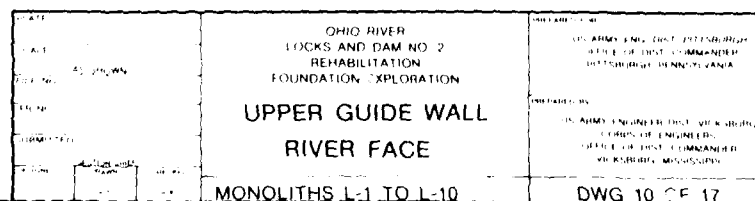
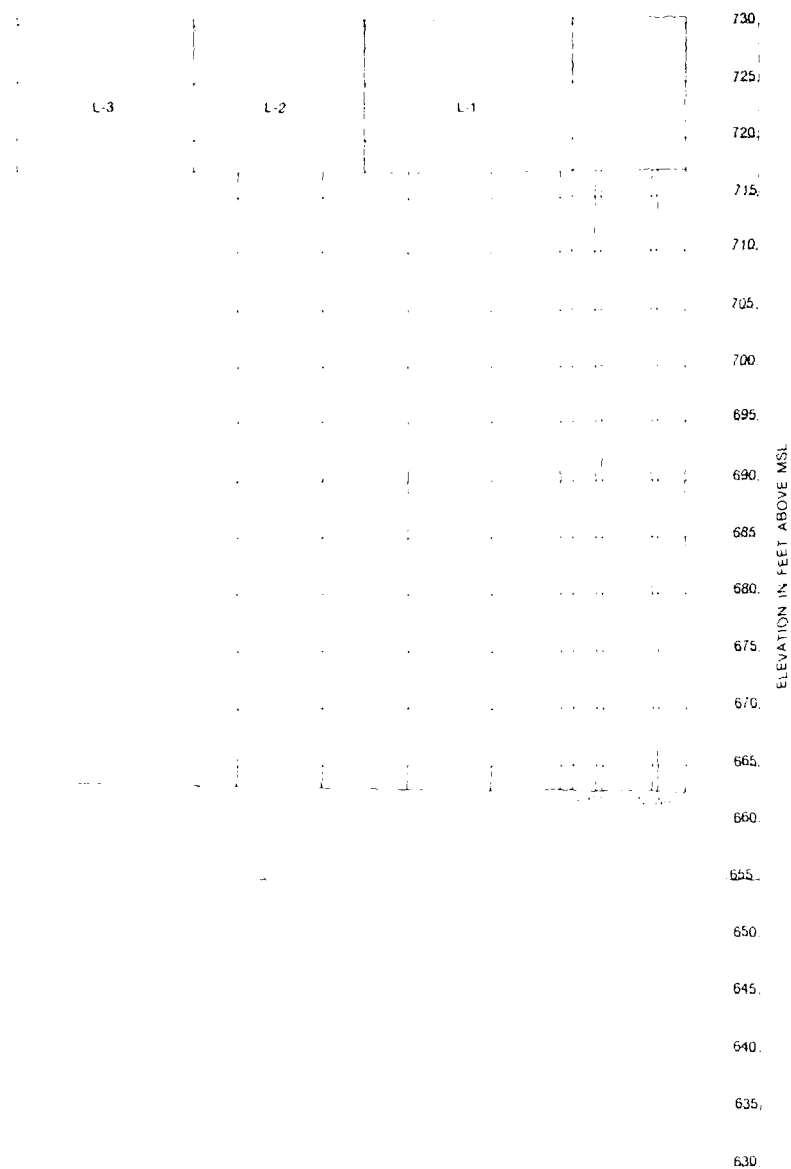
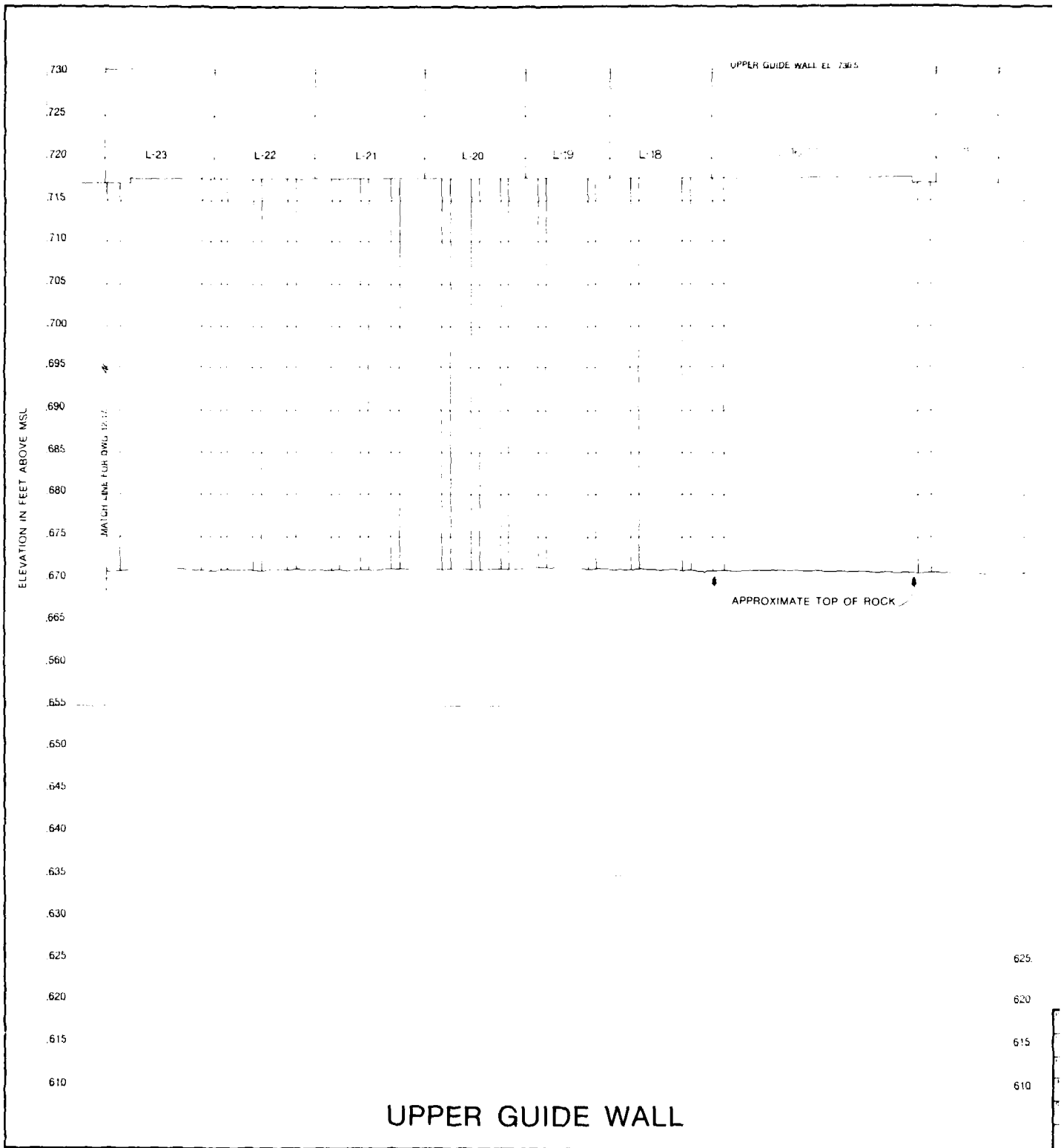
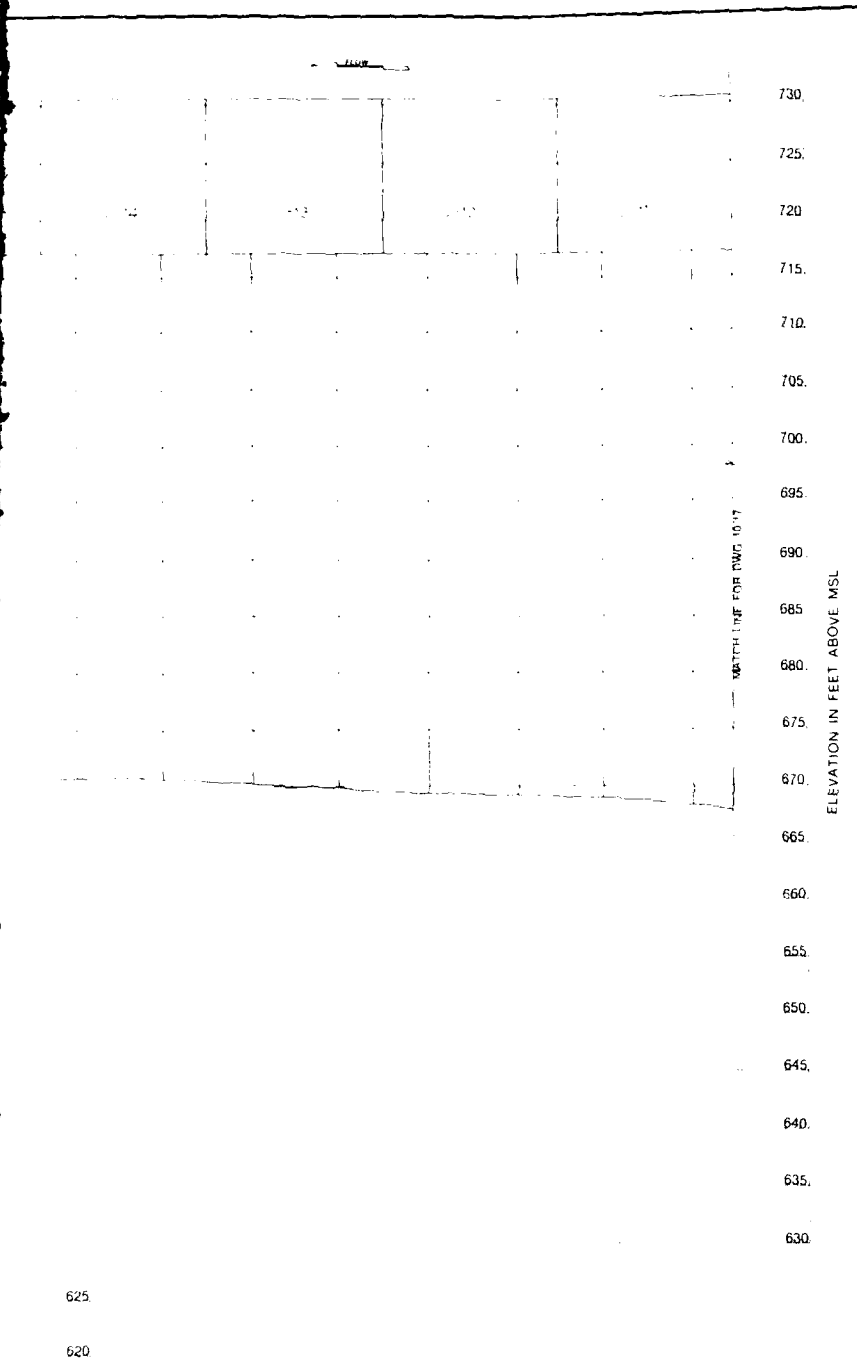


PLATE 12

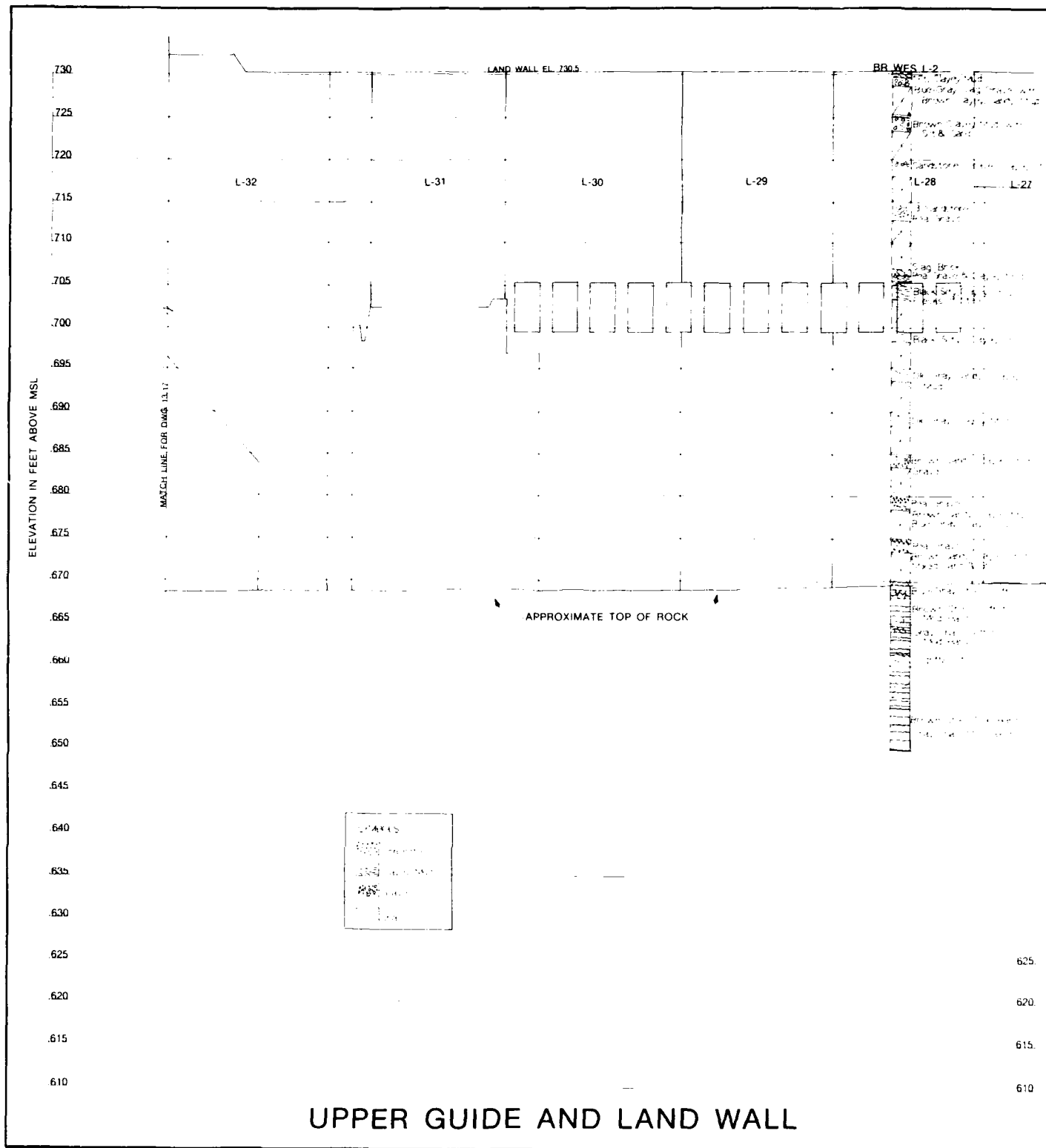




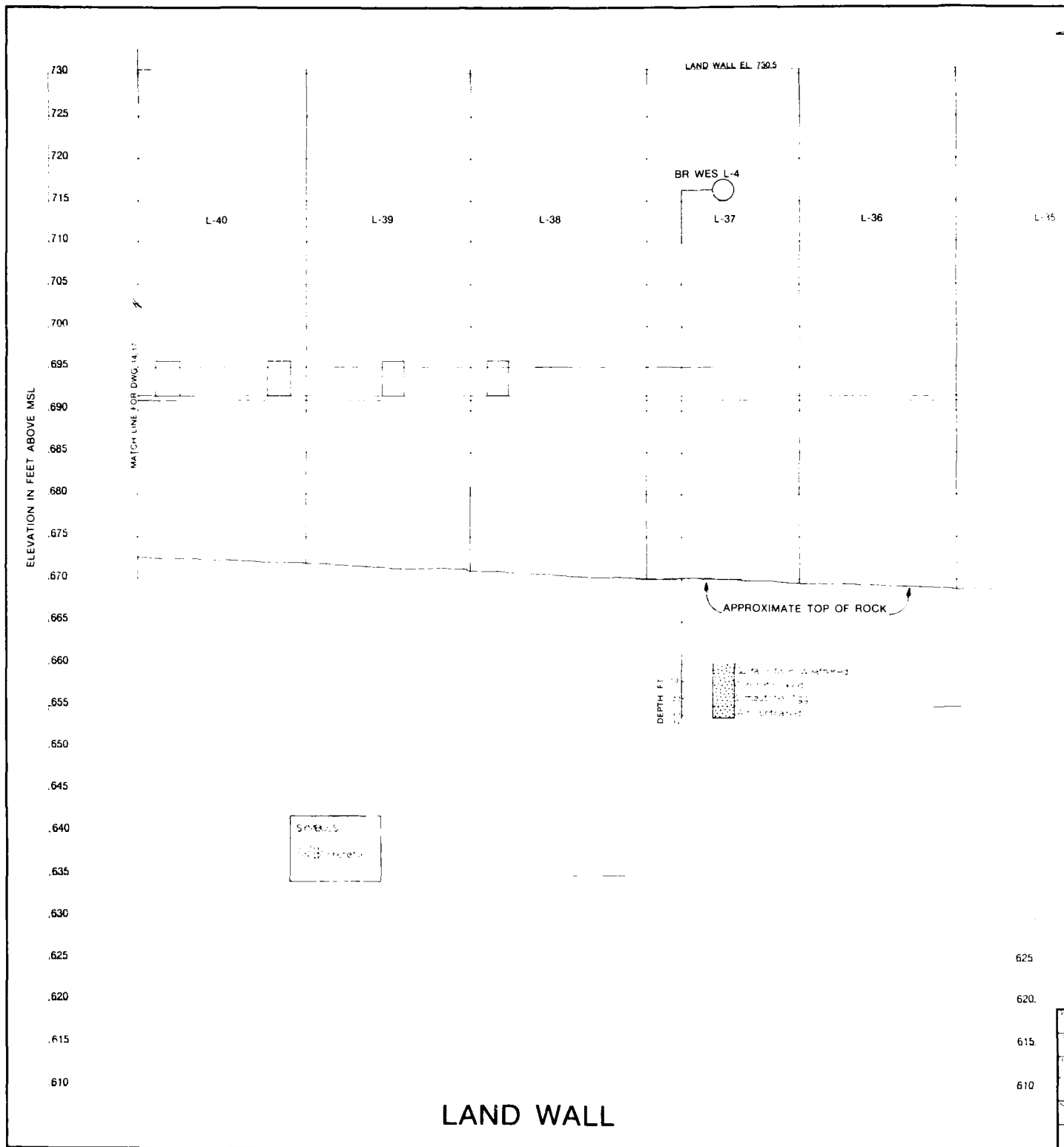




DATE	OHIO RIVER	PROJECT NO.
DRAWN BY	LOCKS AND DAM NO. 2	US ARMY ENG. DIST. PITTSBURGH
CHECKED BY	REHABILITATION	OFFICE OF DIST. COMMANDER
APPROVED BY	FOUNDATION EXPLORATION	PITTSBURGH, PENNSYLVANIA
REVISIONS	UPPER GUIDE WALL	PROJECT NO.
BY	RIVER FACE	US ARMY ENGINEER DIST. VICKSBURG
DATE	MONOLITHS L-11 TO L-23	CORPS OF ENGINEERS
SCALE	DWG. 11 OF 17	OFFICE OF DIST. COMMANDER
SHEET NO.		VICKSBURG, MISSISSIPPI



UPPER GUIDE AND LAND WALL



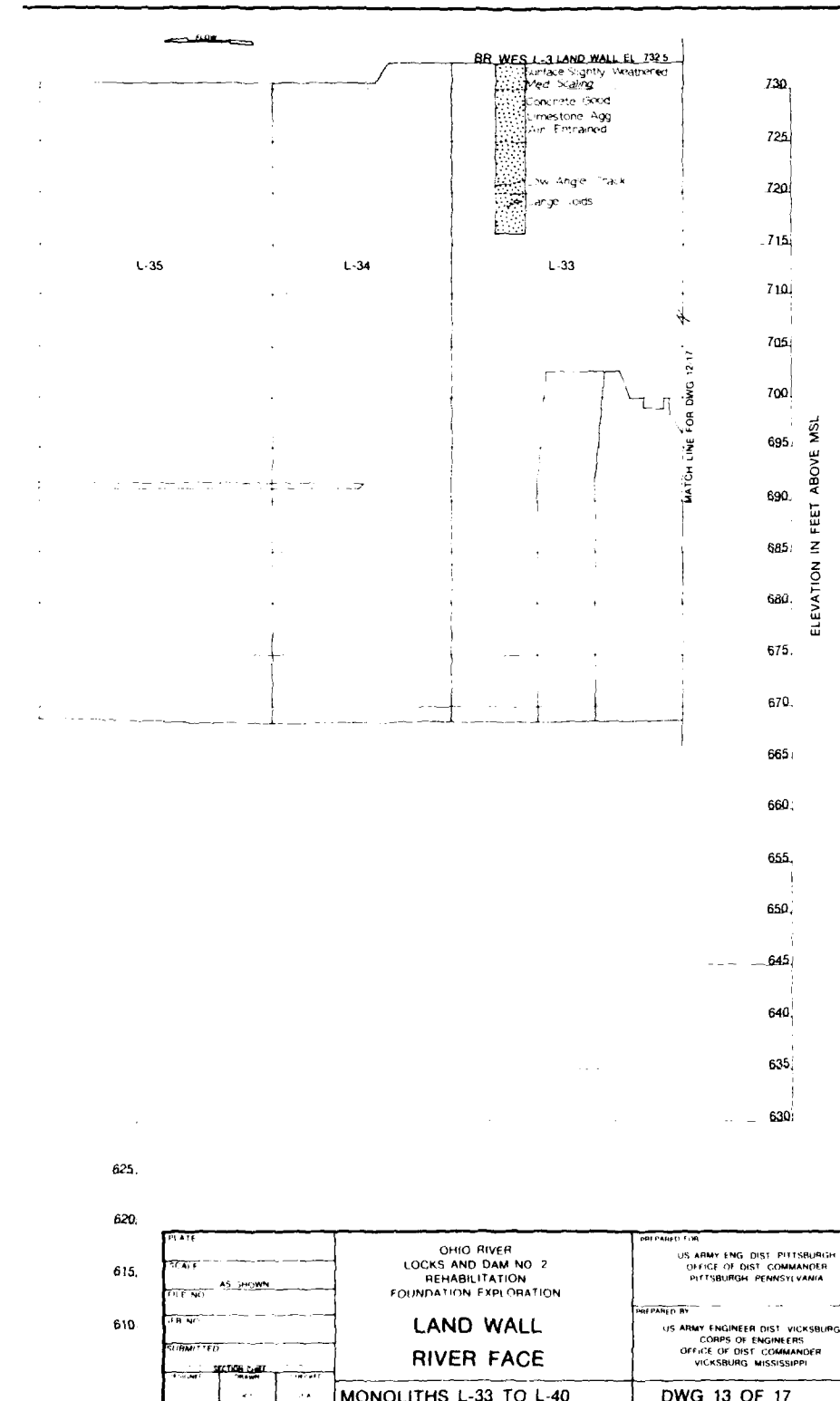
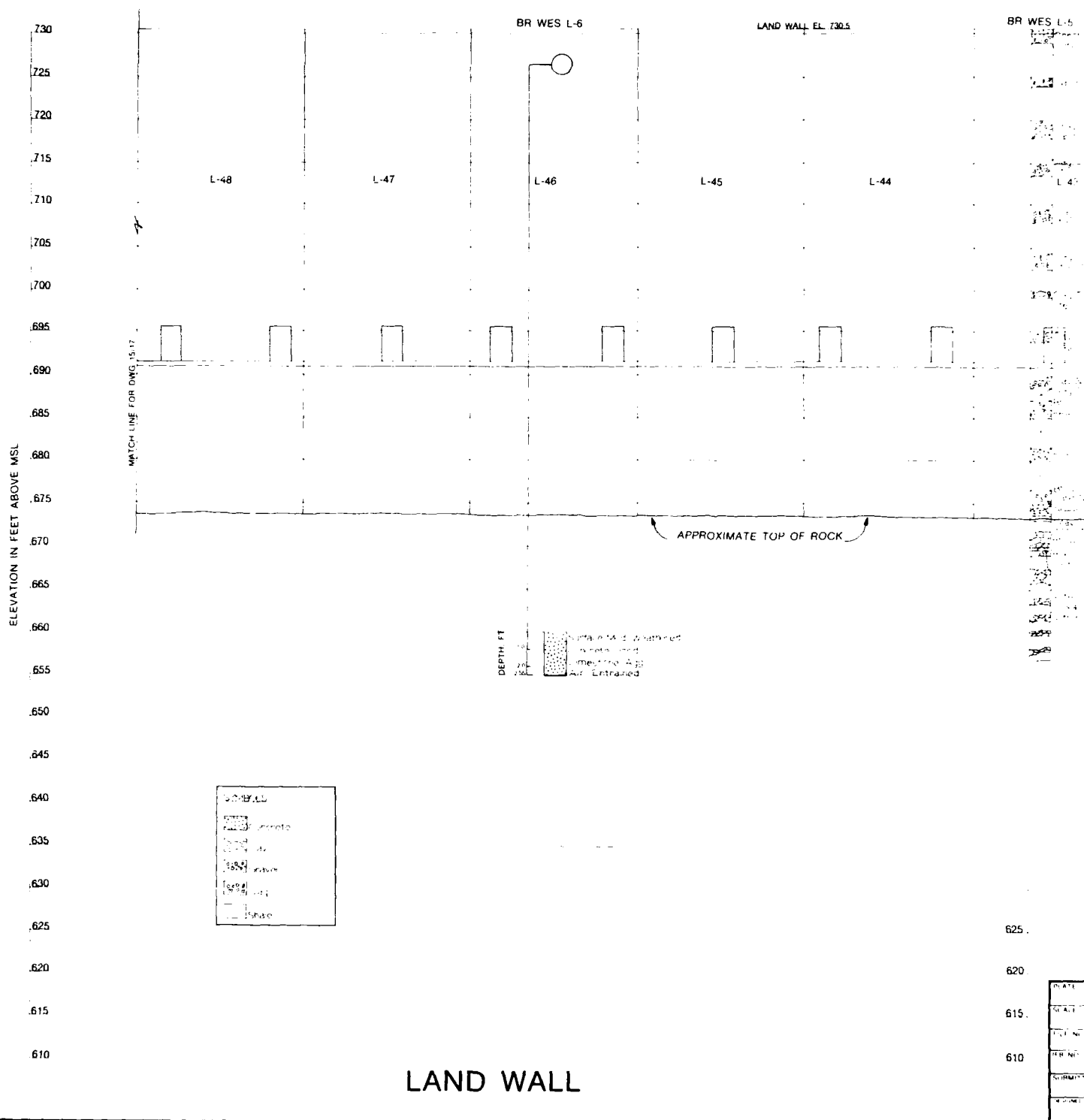


PLATE 16



BR WES L-5

Concrete
Gravel Gravel

Gravel Gravel

Gravel Gravel

Gravel Gravel

Gravel Gravel

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Gravel Gravel

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L-42

L-41

MATCH LINE FOR DWG 13-17

ELEVATION IN FEET ABOVE MSL

625

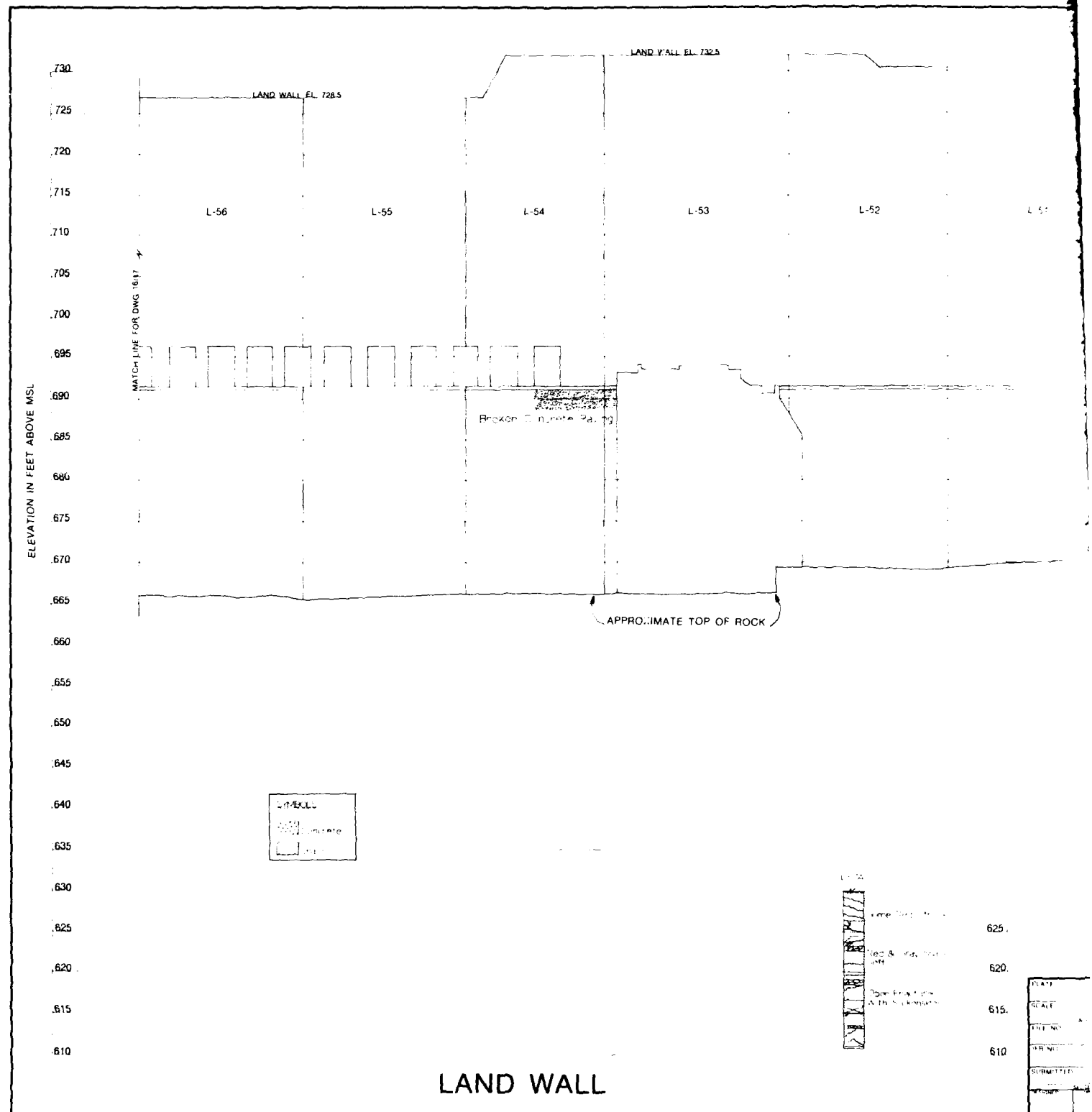
620

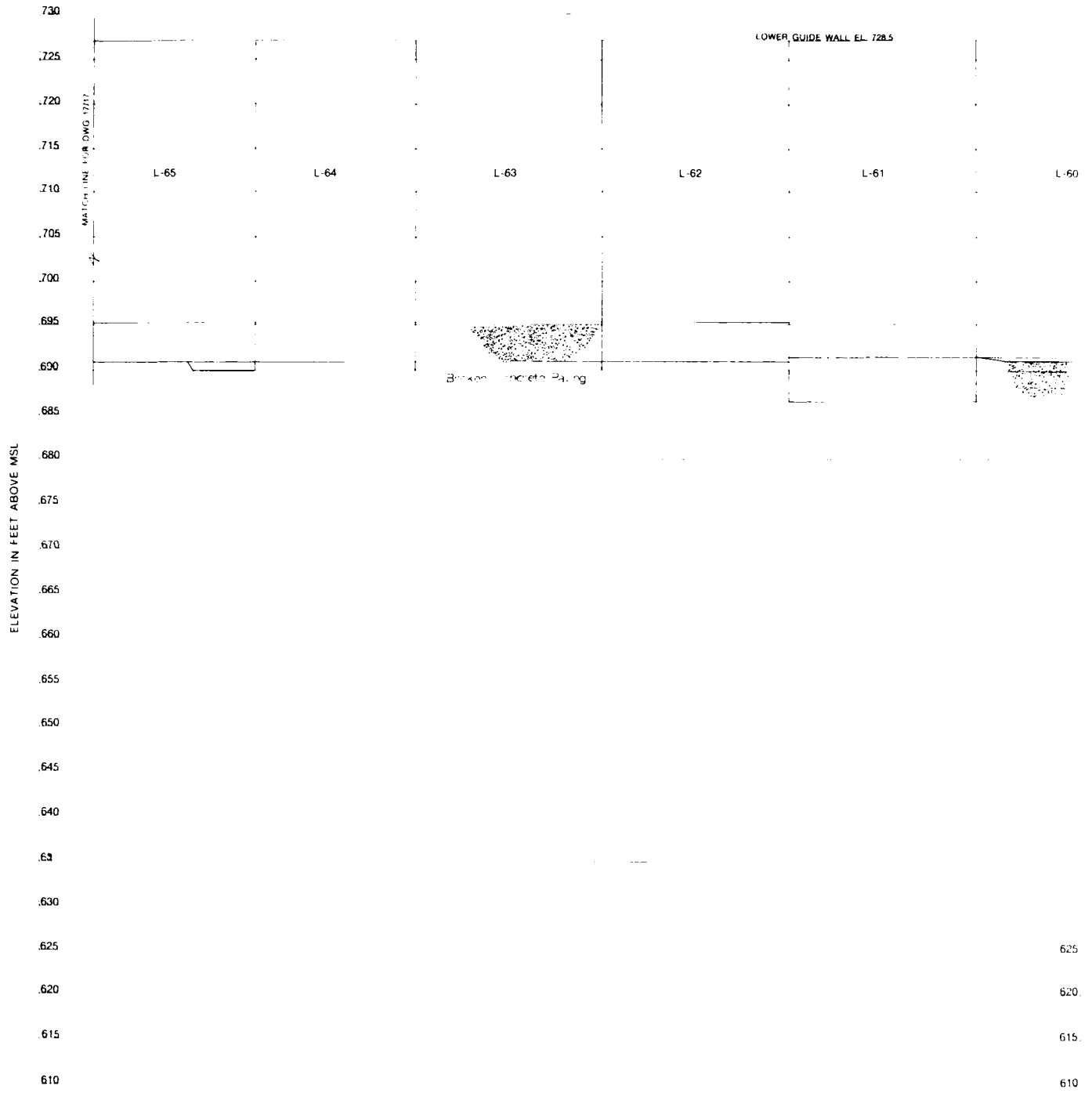
615

610

PLATE	OHIO RIVER LOCKS AND DAM NO 2 REHABILITATION FOUNDATION EXPLORATION	PREPARED FOR U.S. ARMY ENG. DIST. PITTSBURGH OFFICE OF DIST. COMMANDER PITTSBURGH, PENNSYLVANIA
SCALE AS SHOWN	LAND WALL RIVER FACE	PREPARED BY U.S. ARMY ENGINEER DIST. VICKSBURG CORPS OF ENGINEERS OFFICE OF DIST. COMMANDER VICKSBURG, MISSISSIPPI
TITLE NO.		
TR NO.		
SUBMITTED		
REVISIONS	MONOLITHS L-41 TO L-48	DWG 14 OF 17

PLATE 17





LOWER GUIDE WALL

625
620
615
610

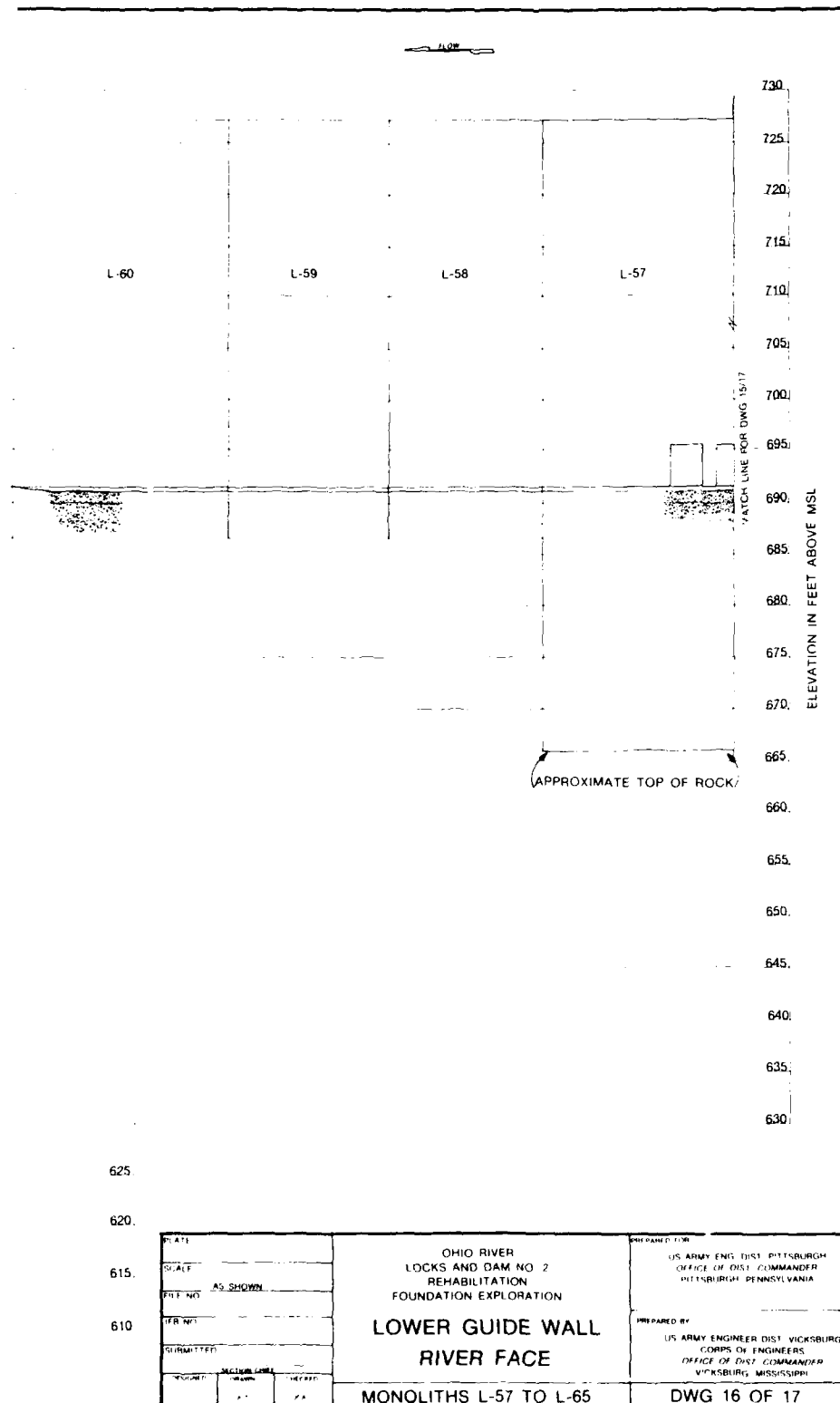
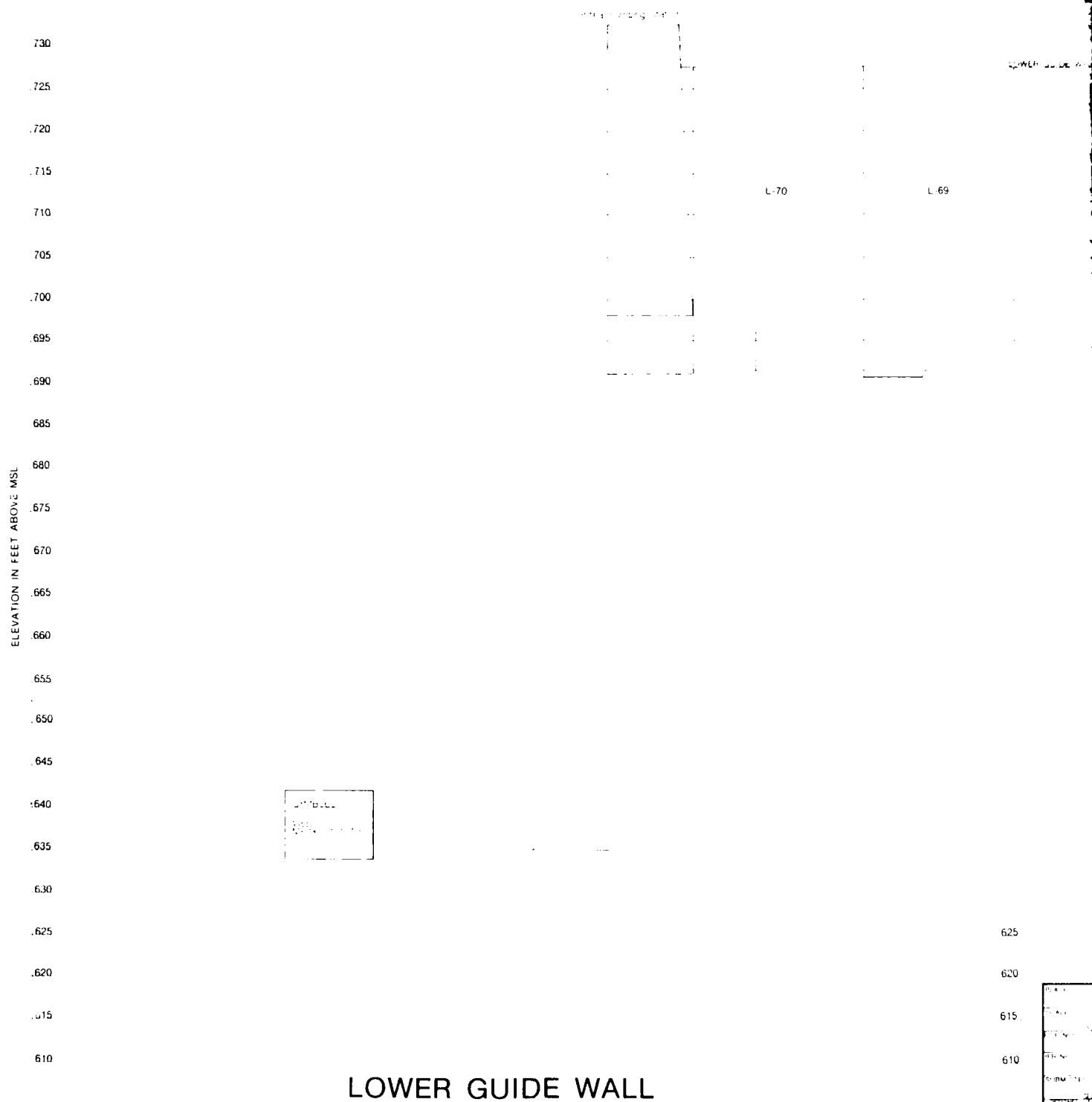


PLATE 19



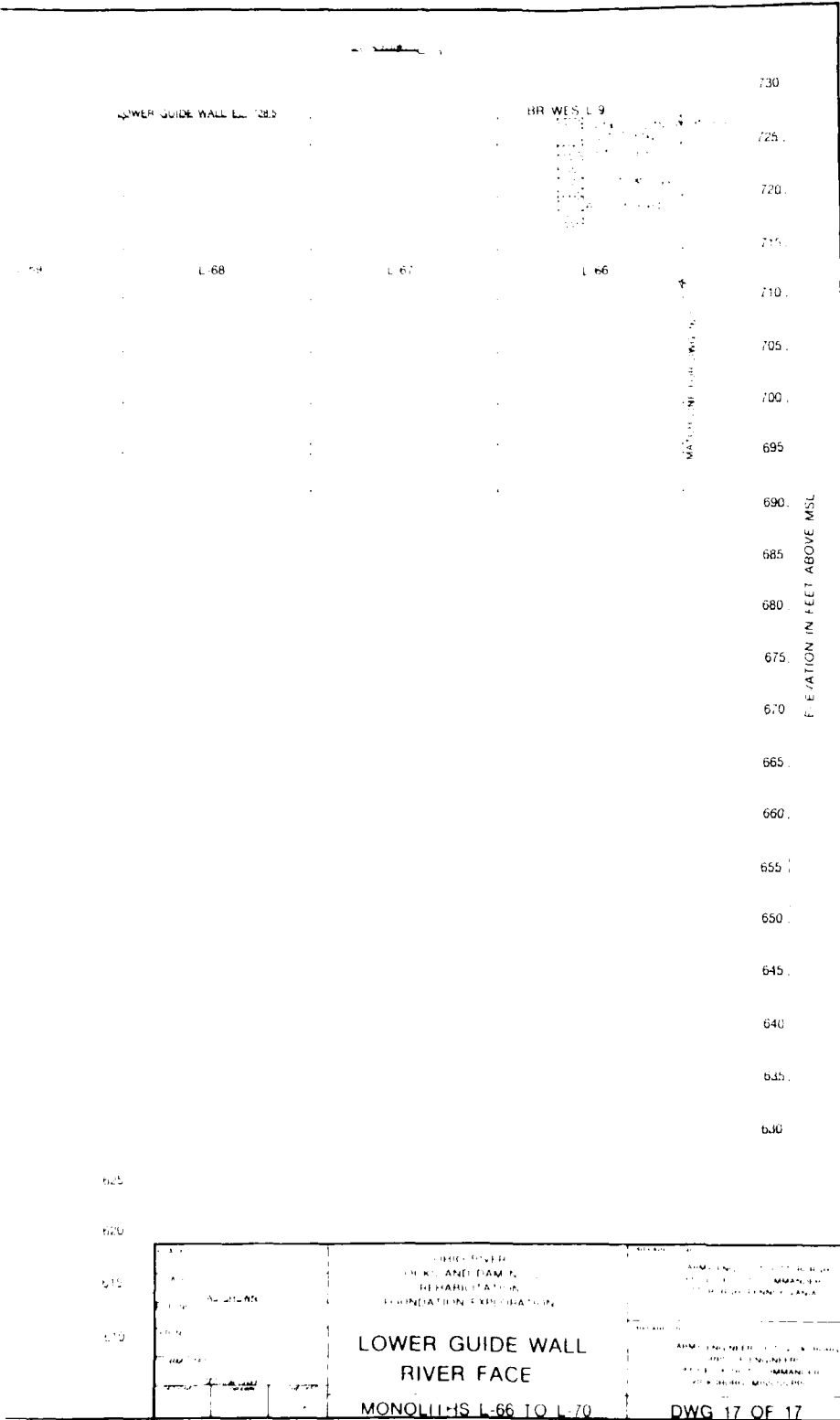
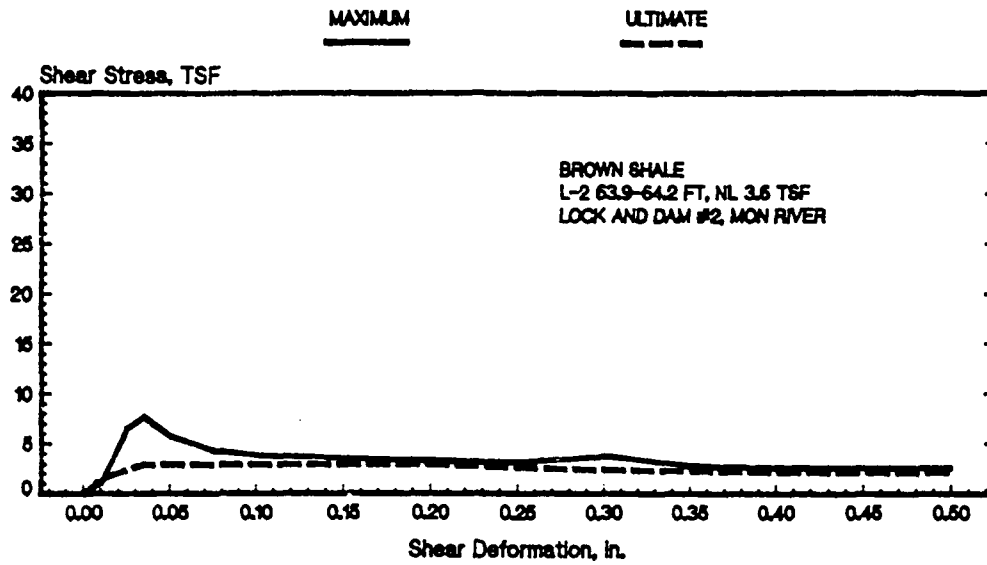
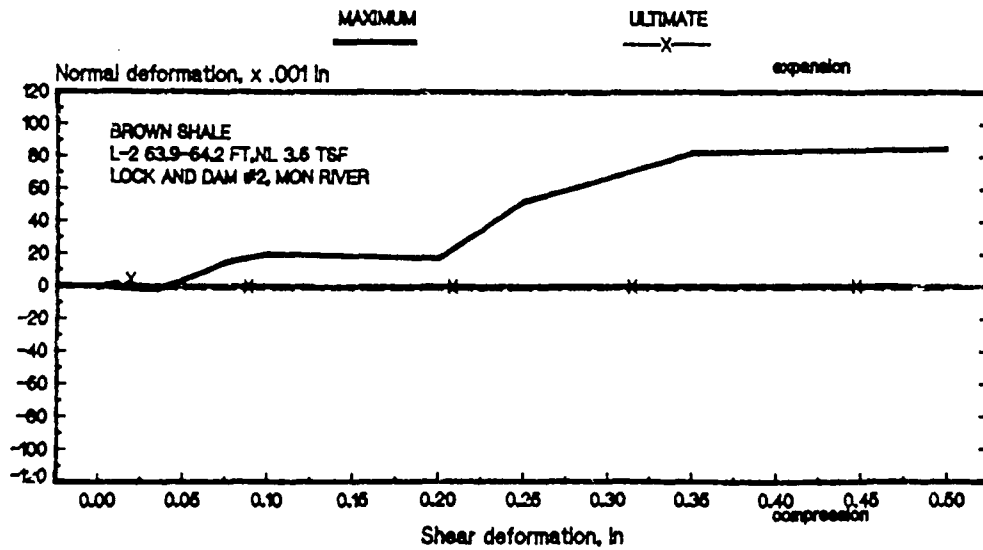


PLATE 20

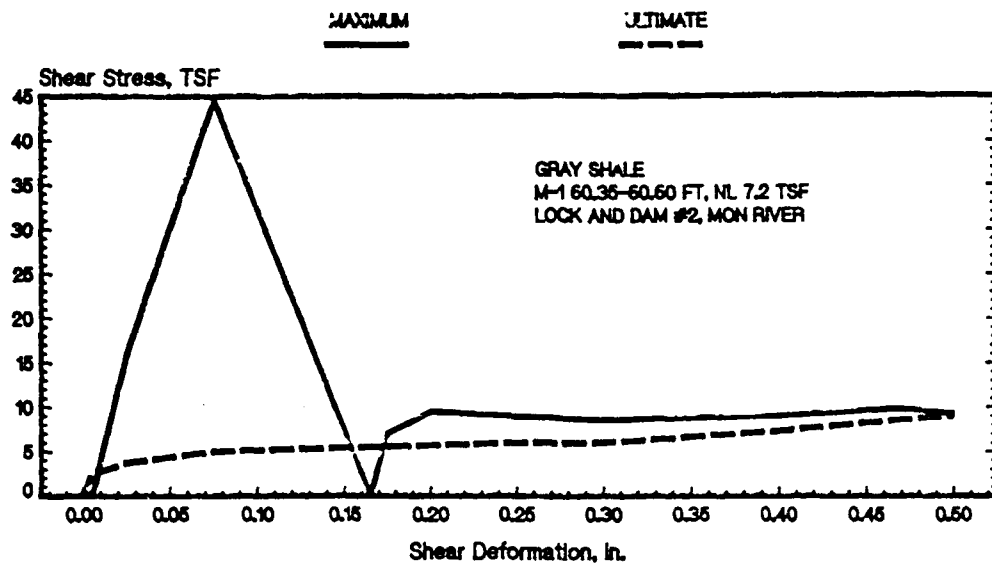
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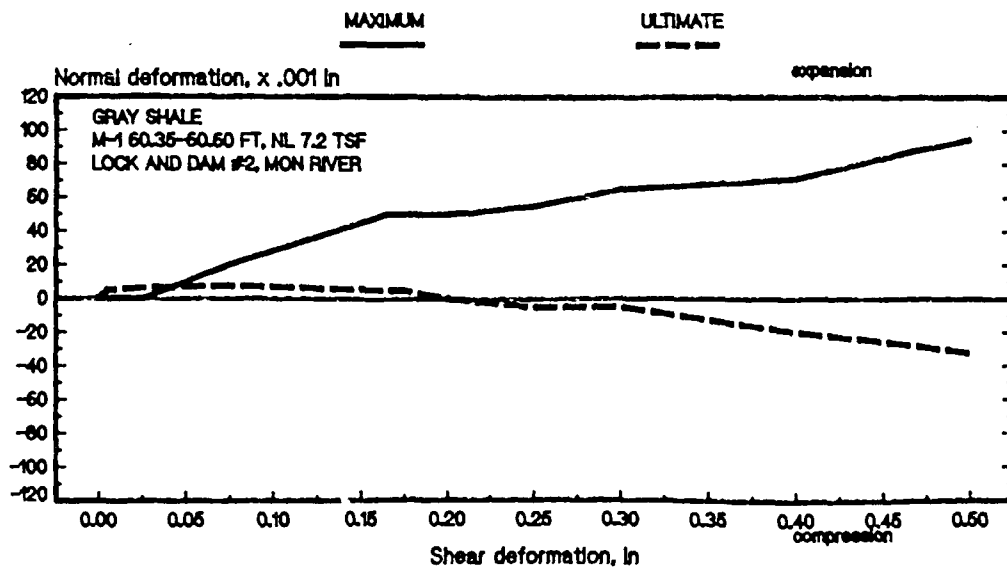
DIRECT SHEAR NORMAL vs SHEAR DEFORMATION CURVES



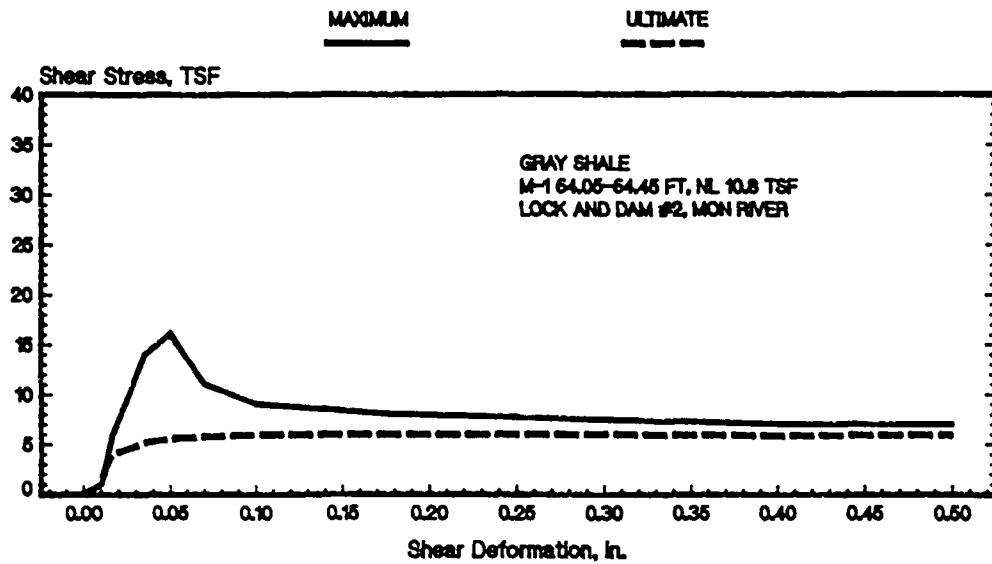
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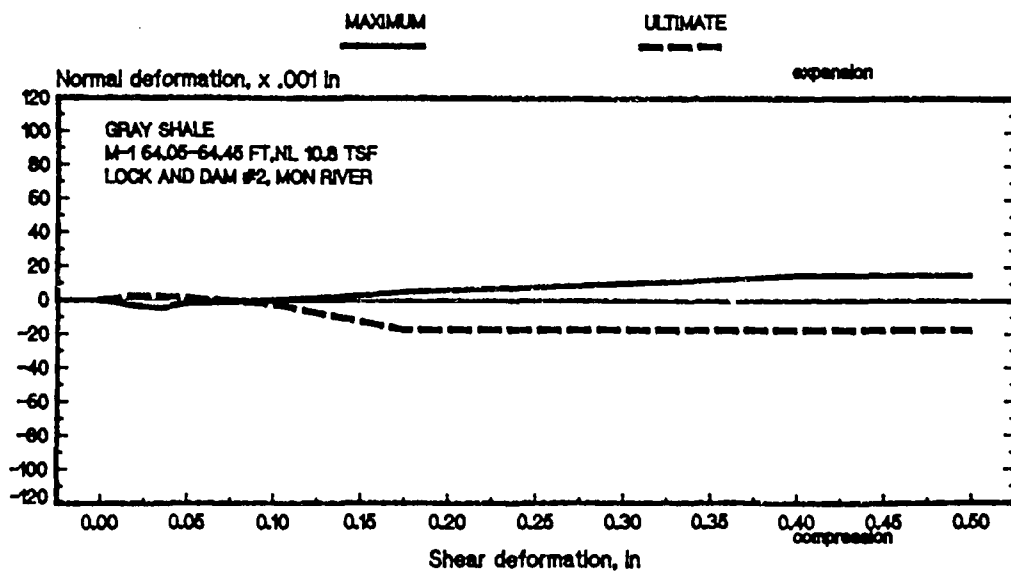
DIRECT SHEAR NORMAL vs SHEAR DEFORMATION CURVES



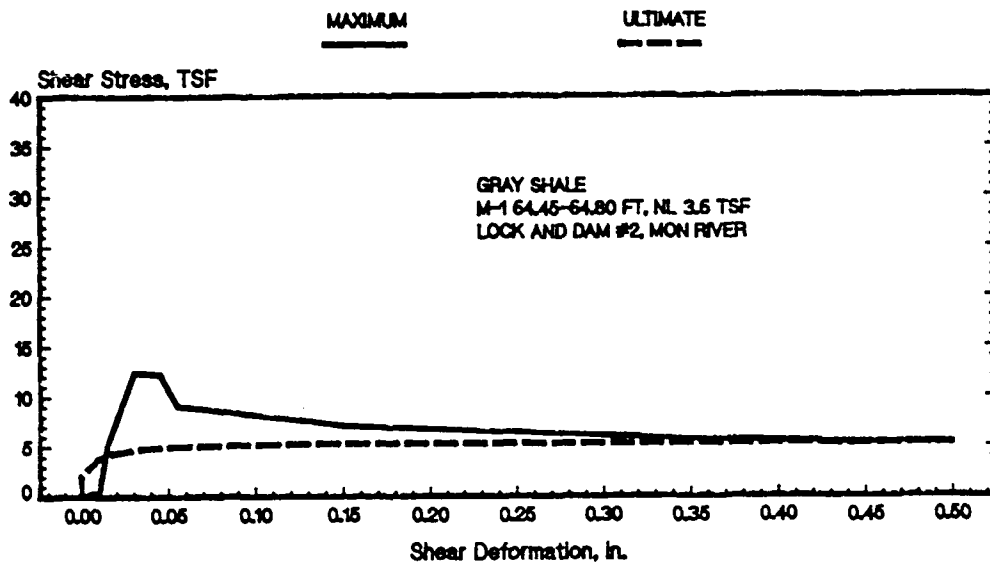
DIRECT SHEAR STRESS vs DEFORMATION CURVES



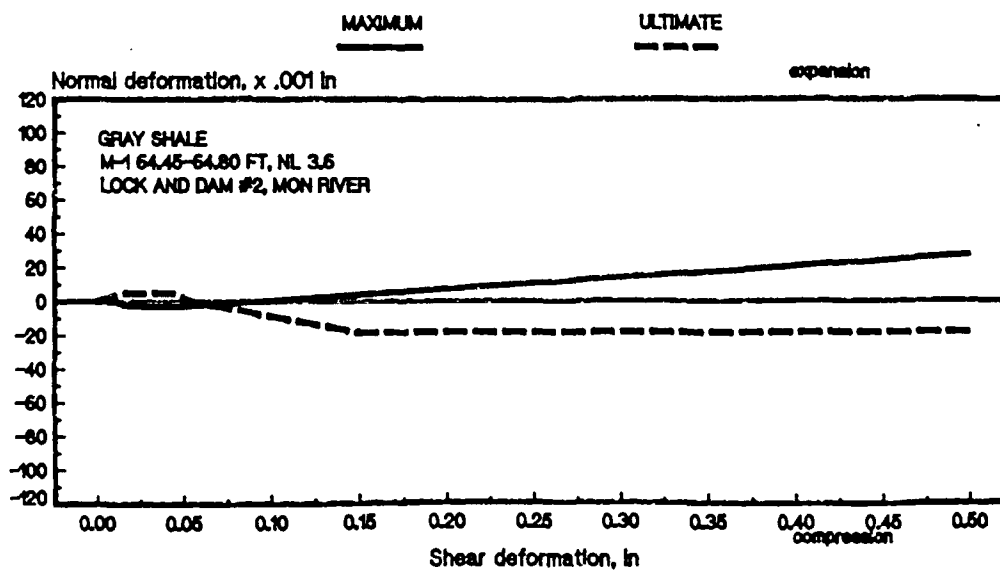
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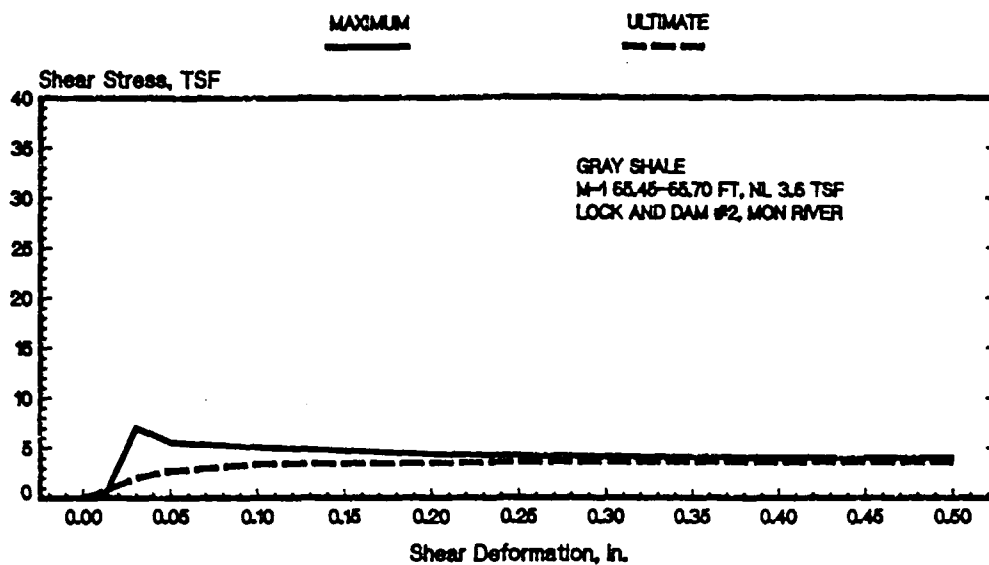
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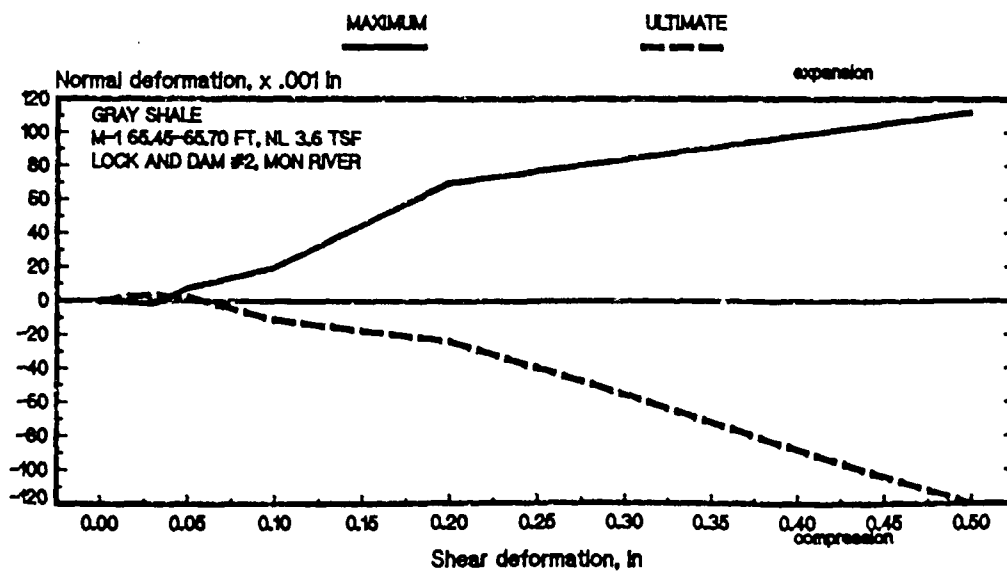
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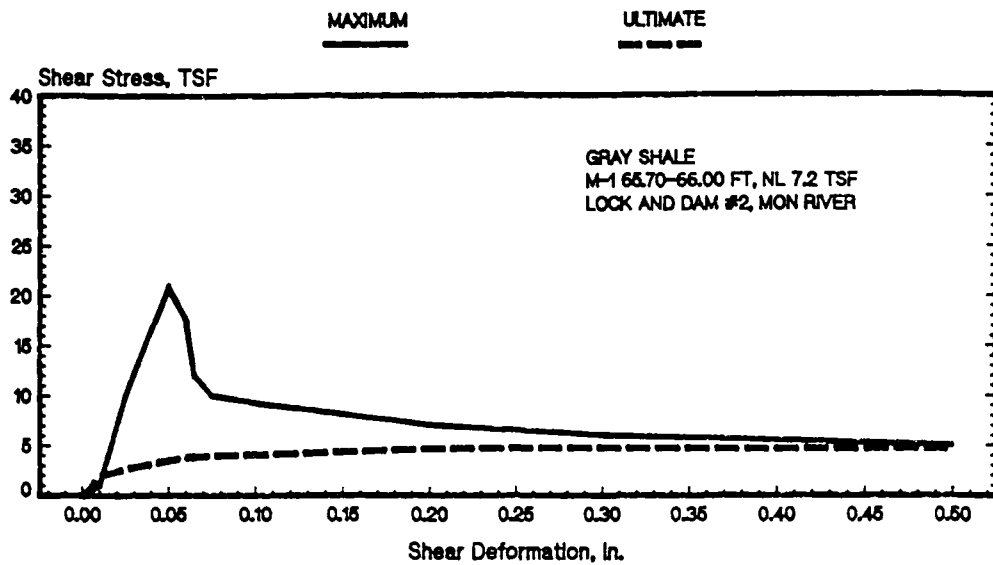
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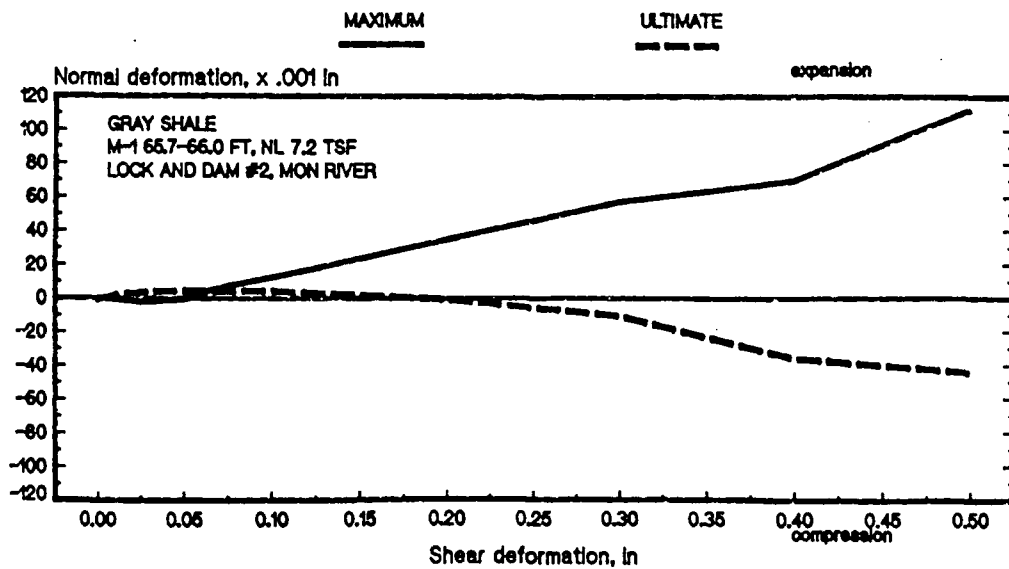
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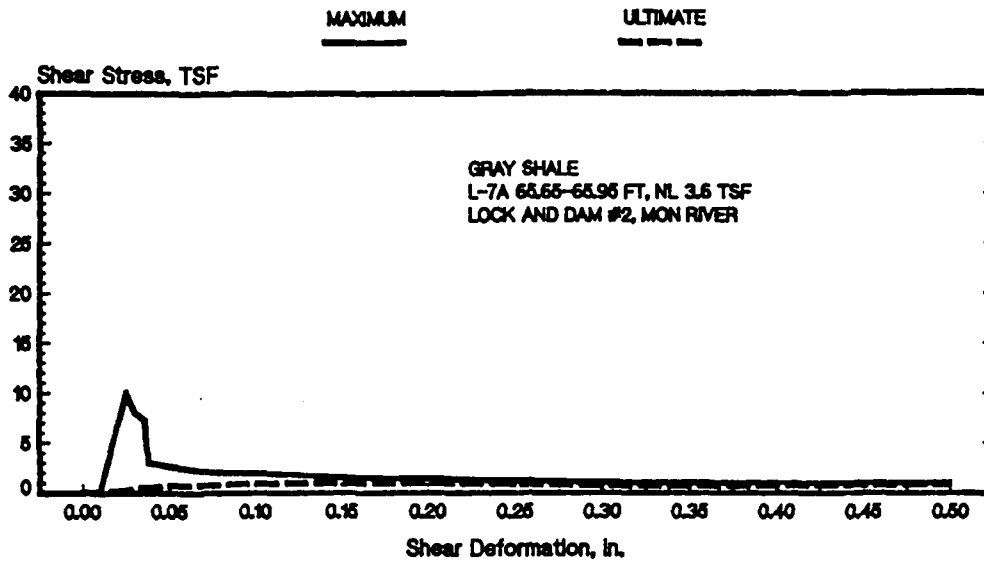
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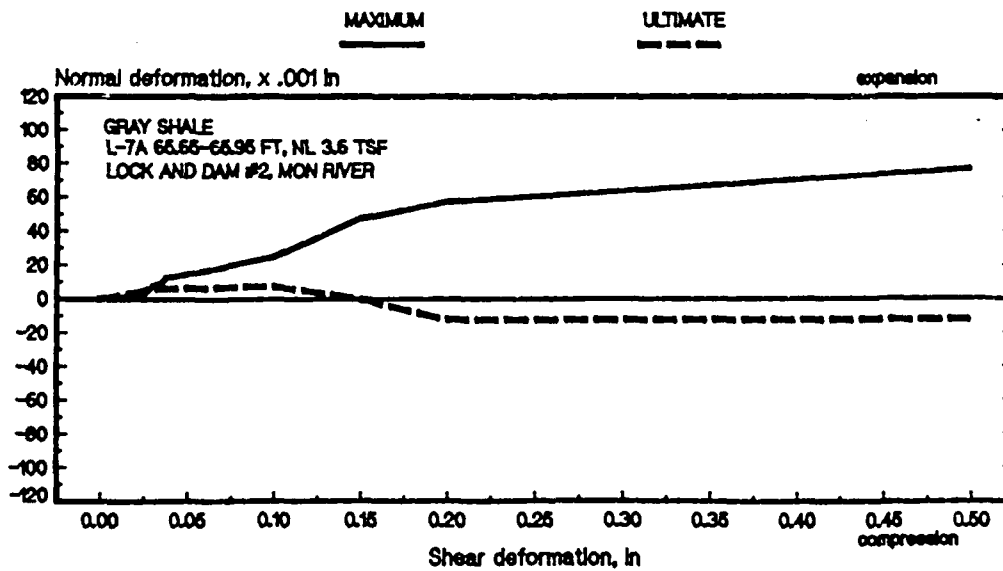
DIRECT SHEAR NORMAL vs SHEAR DEFORMATION CURVES



DIRECT SHEAR STRESS vs DEFORMATION CURVES

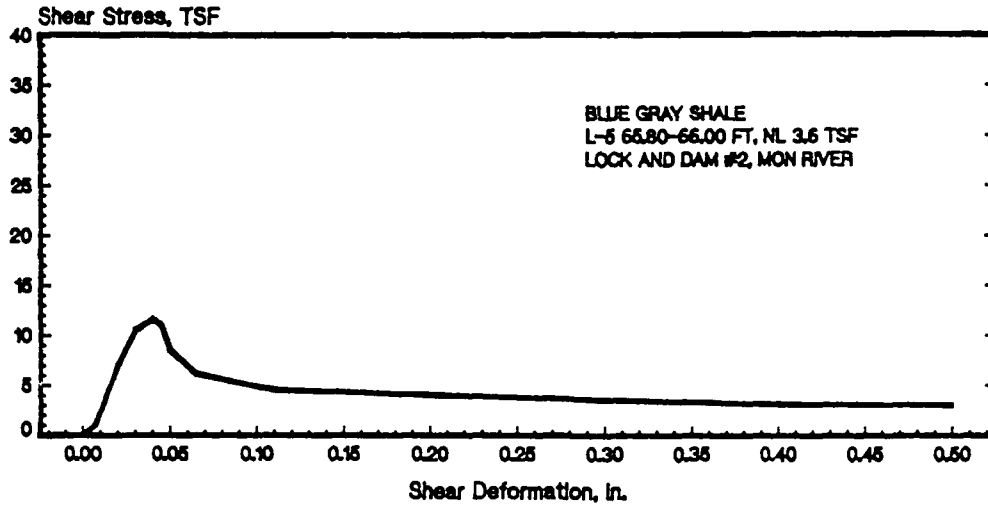


DIRECT SHEAR NORMAL vs SHEAR DEFORMATION CURVES

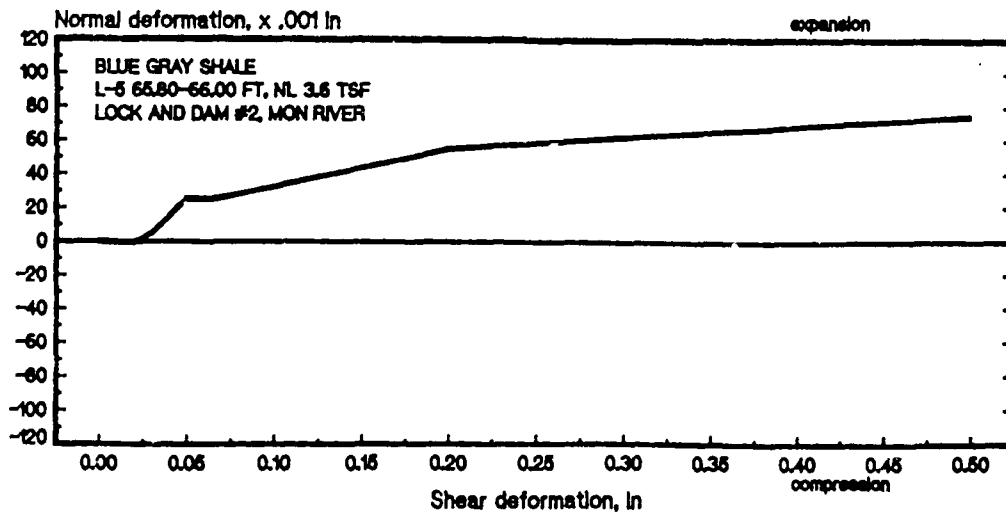


DIRECT SHEAR
STRESS vs DEFORMATION CURVES

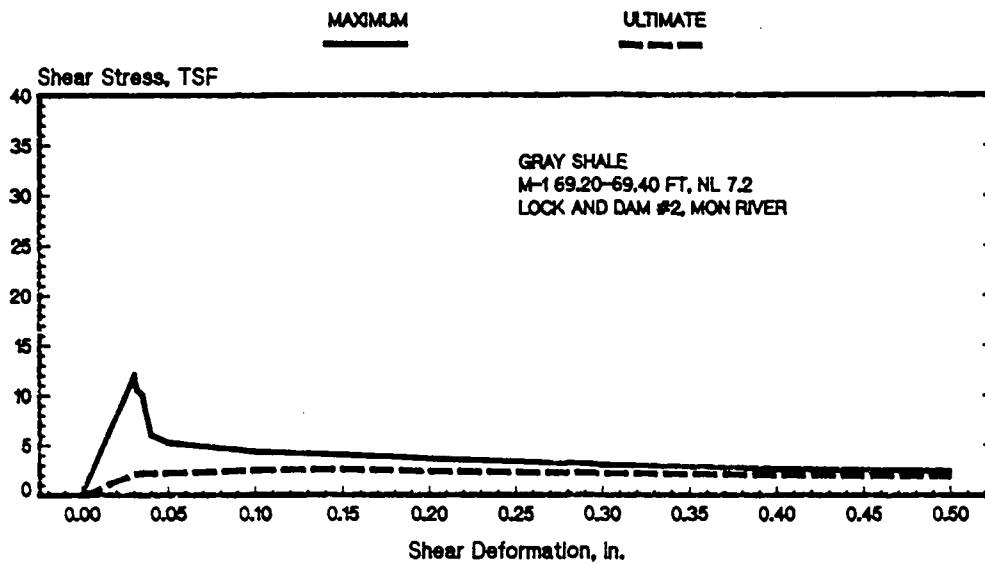
MAXIMUM



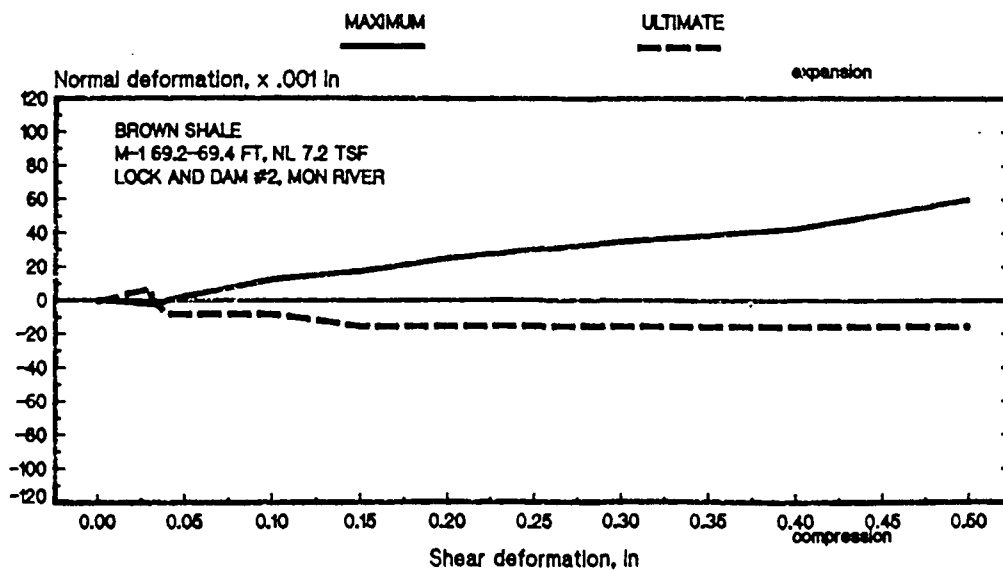
DIRECT SHEAR
NORMAL vs SHEAR DEFORMATION CURVES



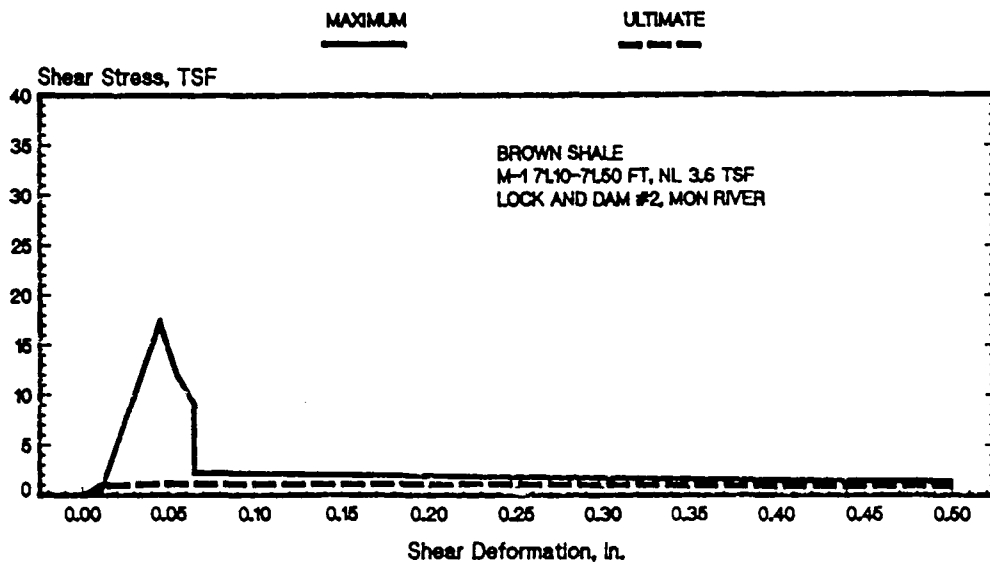
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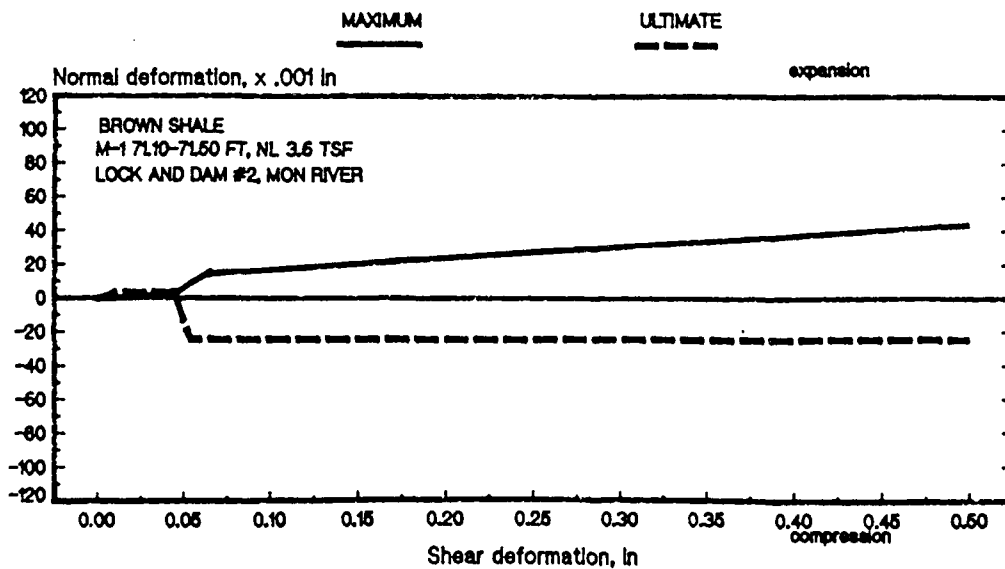
DIRECT SHEAR NORMAL vs SHEAR DEFORMATION CURVES



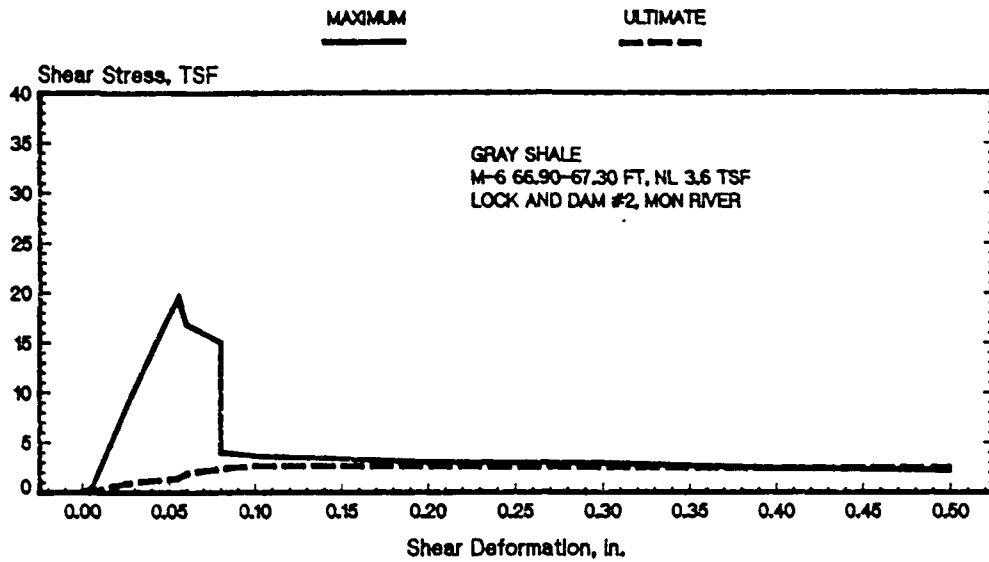
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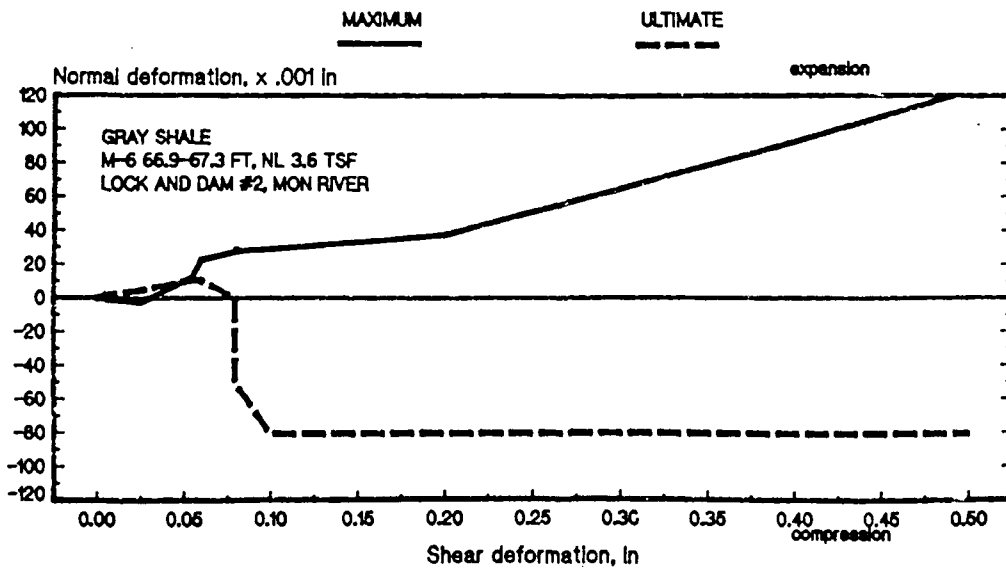
DIRECT SHEAR NORMAL vs SHEAR DEFORMATION CURVES



DIRECT SHEAR STRESS vs DEFORMATION CURVES



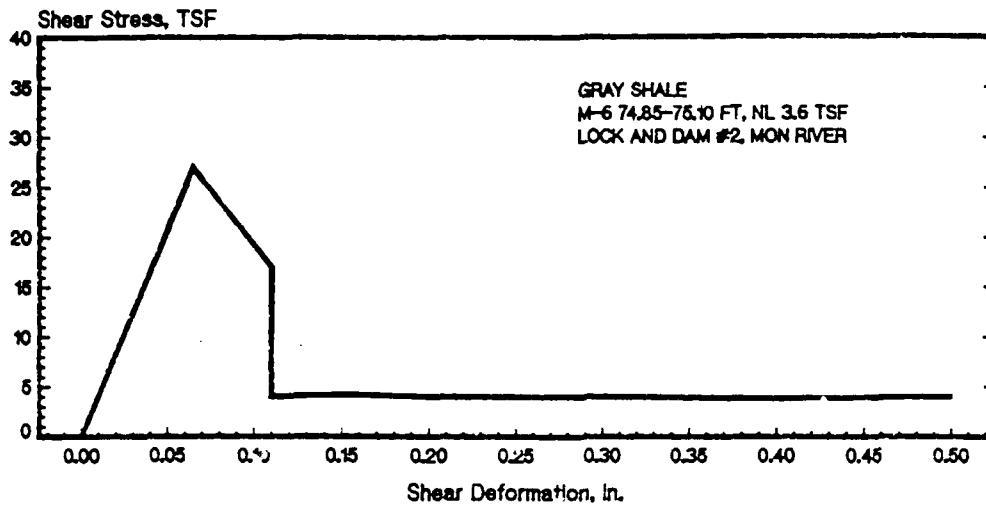
DIRECT SHEAR NORMAL vs SHEAR DEFORMATION CURVES



DIRECT SHEAR STRESS vs DEFORMATION CURVES

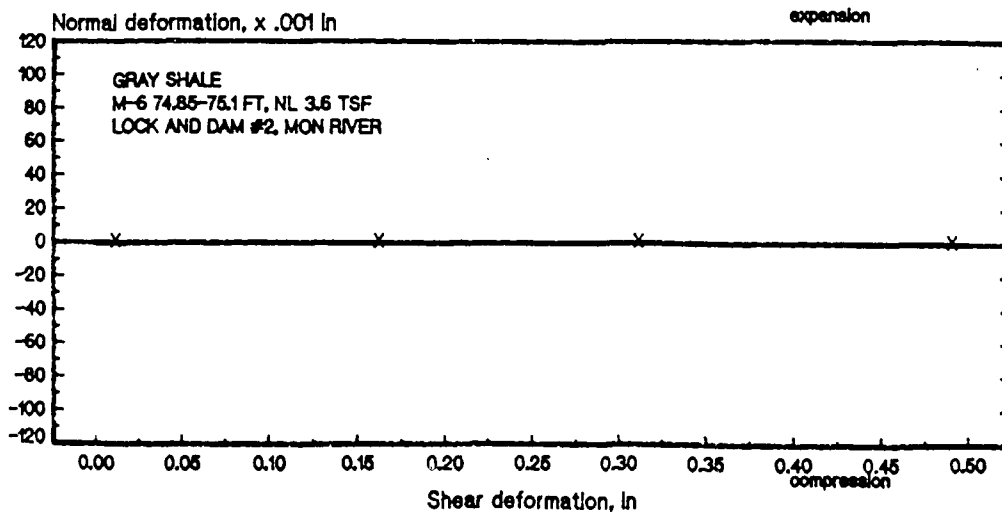
MAXIMUM

*NOTE- NO
SECOND RUN

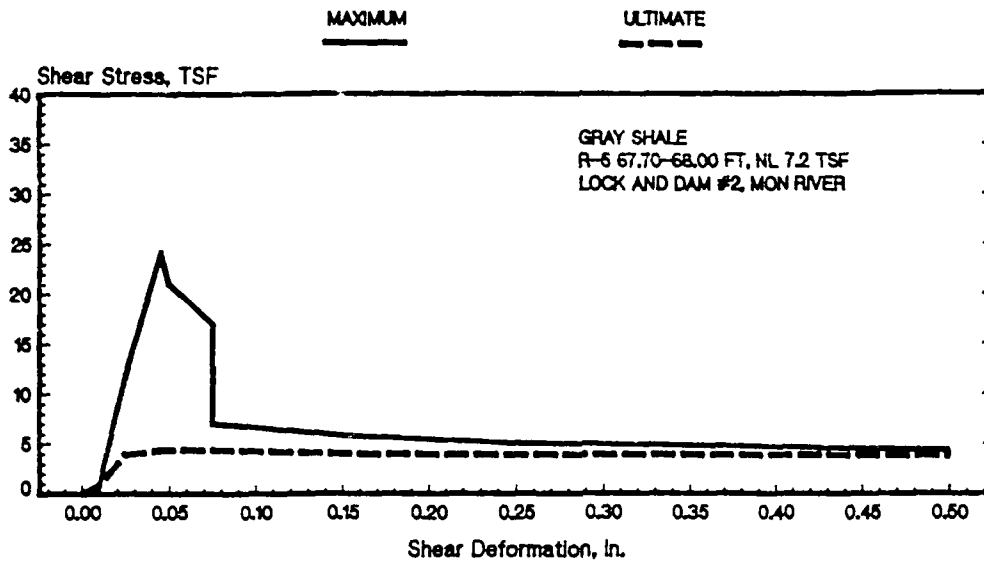


DIRECT SHEAR NORMAL vs SHEAR DEFORMATION CURVES

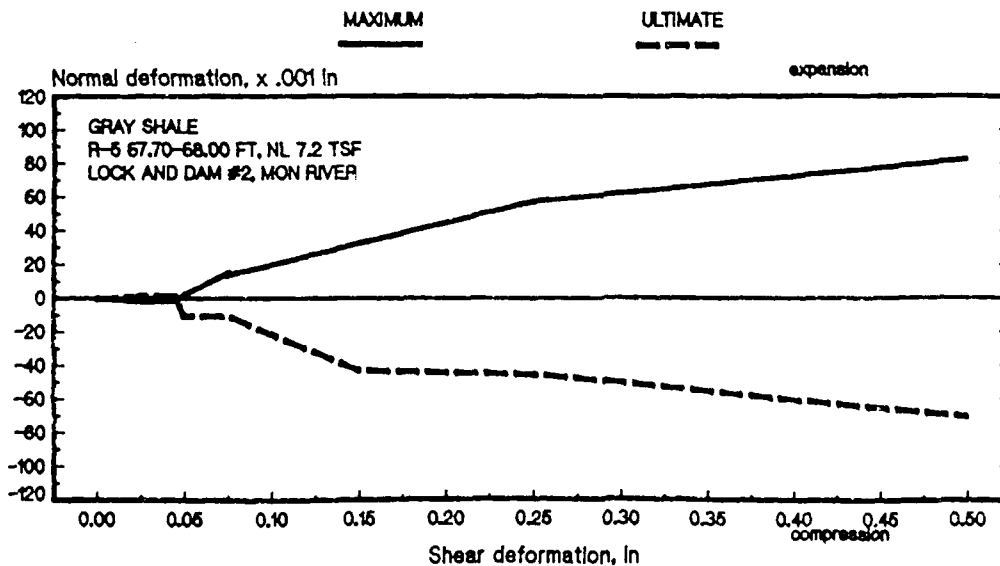
MAXIMUM



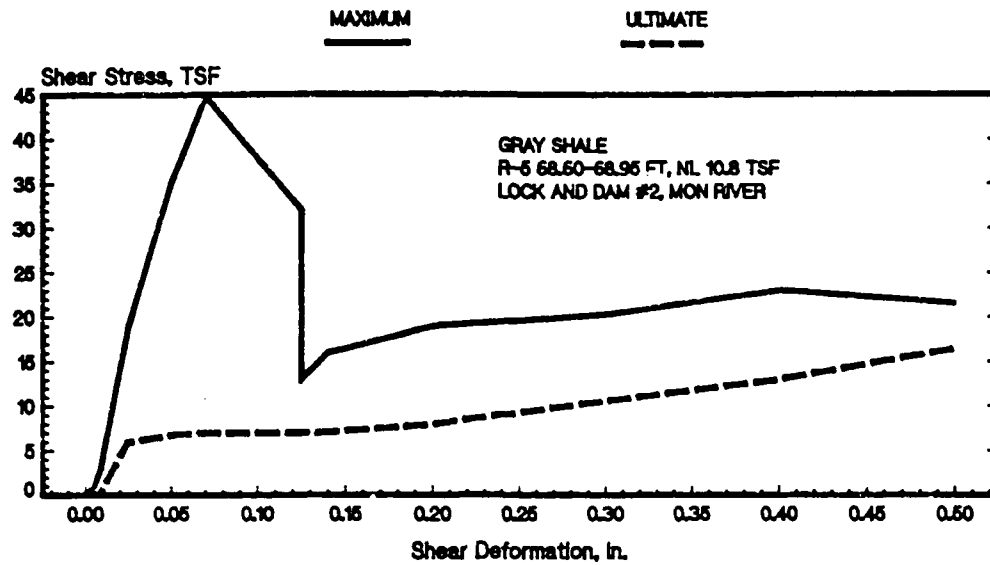
DIRECT SHEAR STRESS vs DEFORMATION CURVES



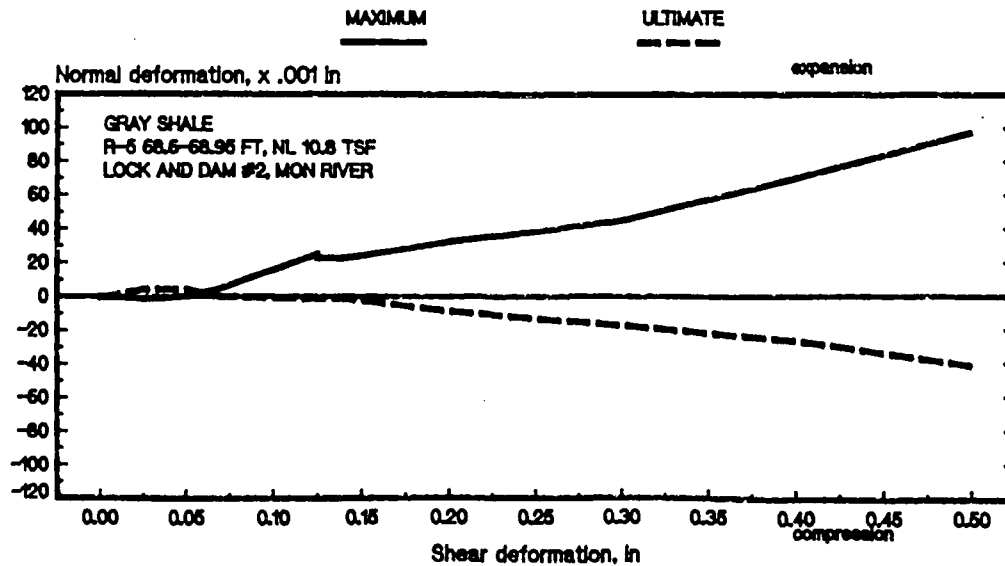
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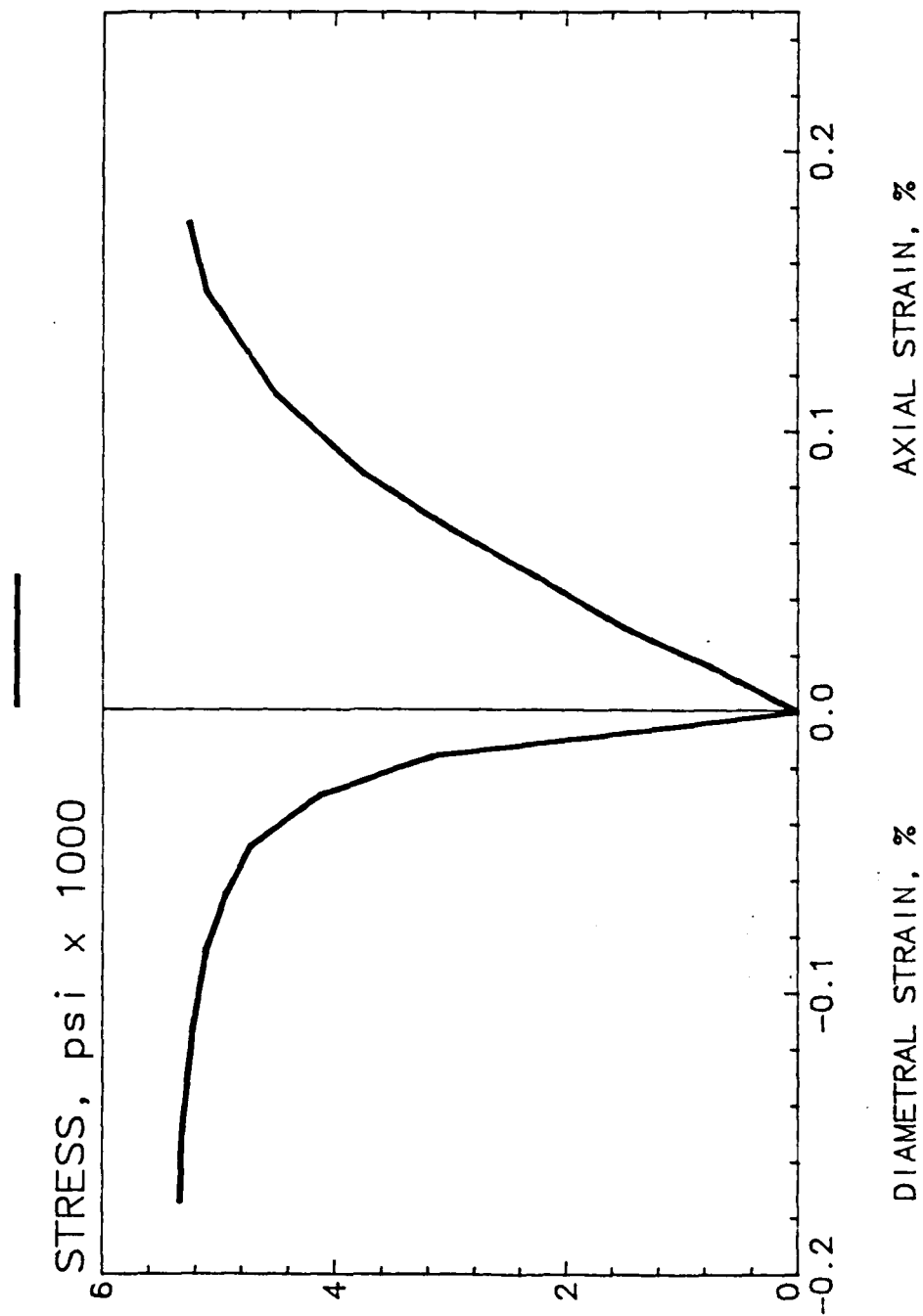
DIRECT SHEAR STRESS vs DEFORMATION CURVES



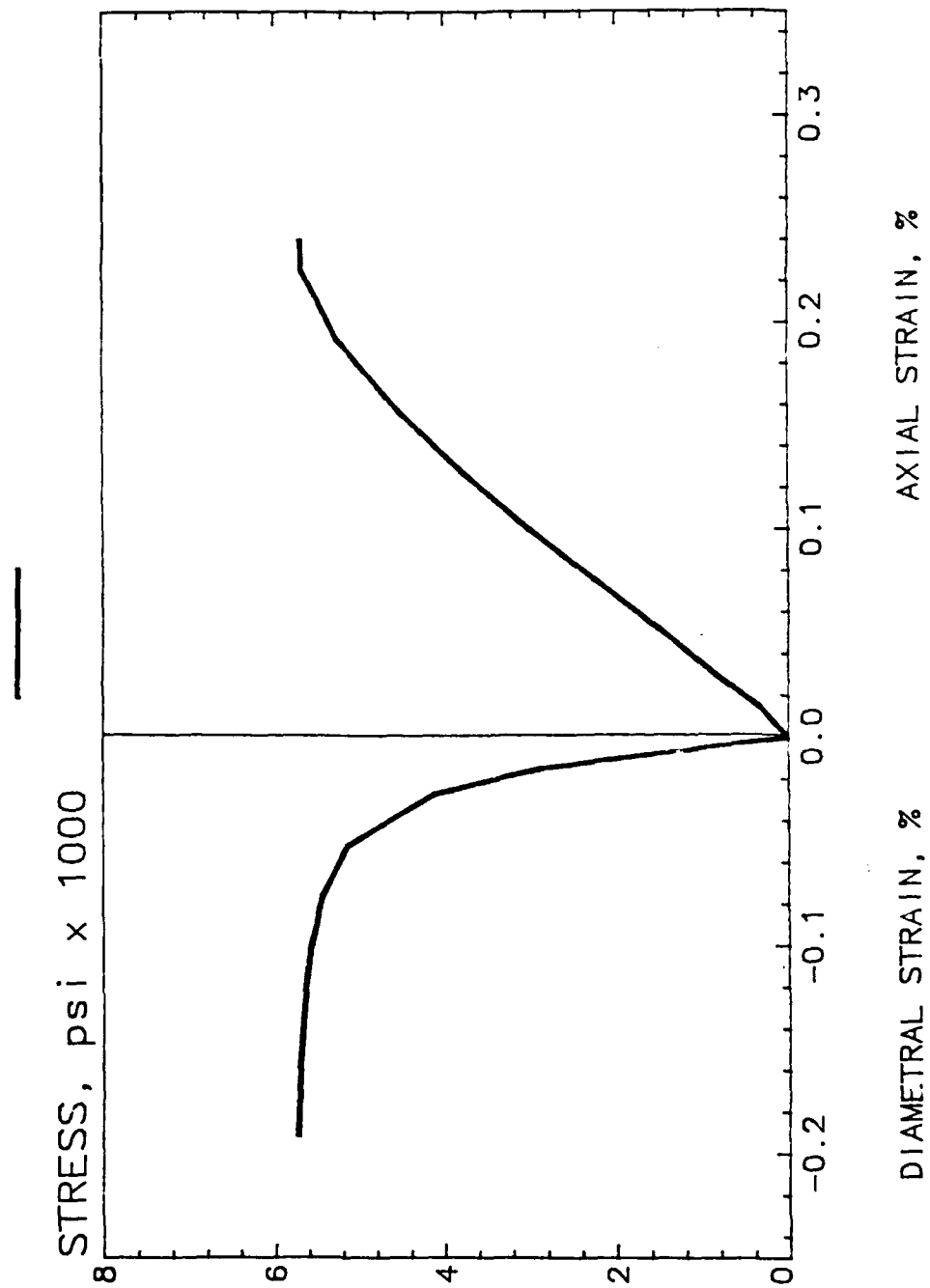
DIRECT SHEAR NORMAL vs SHEAR DEFORMATION CURVES



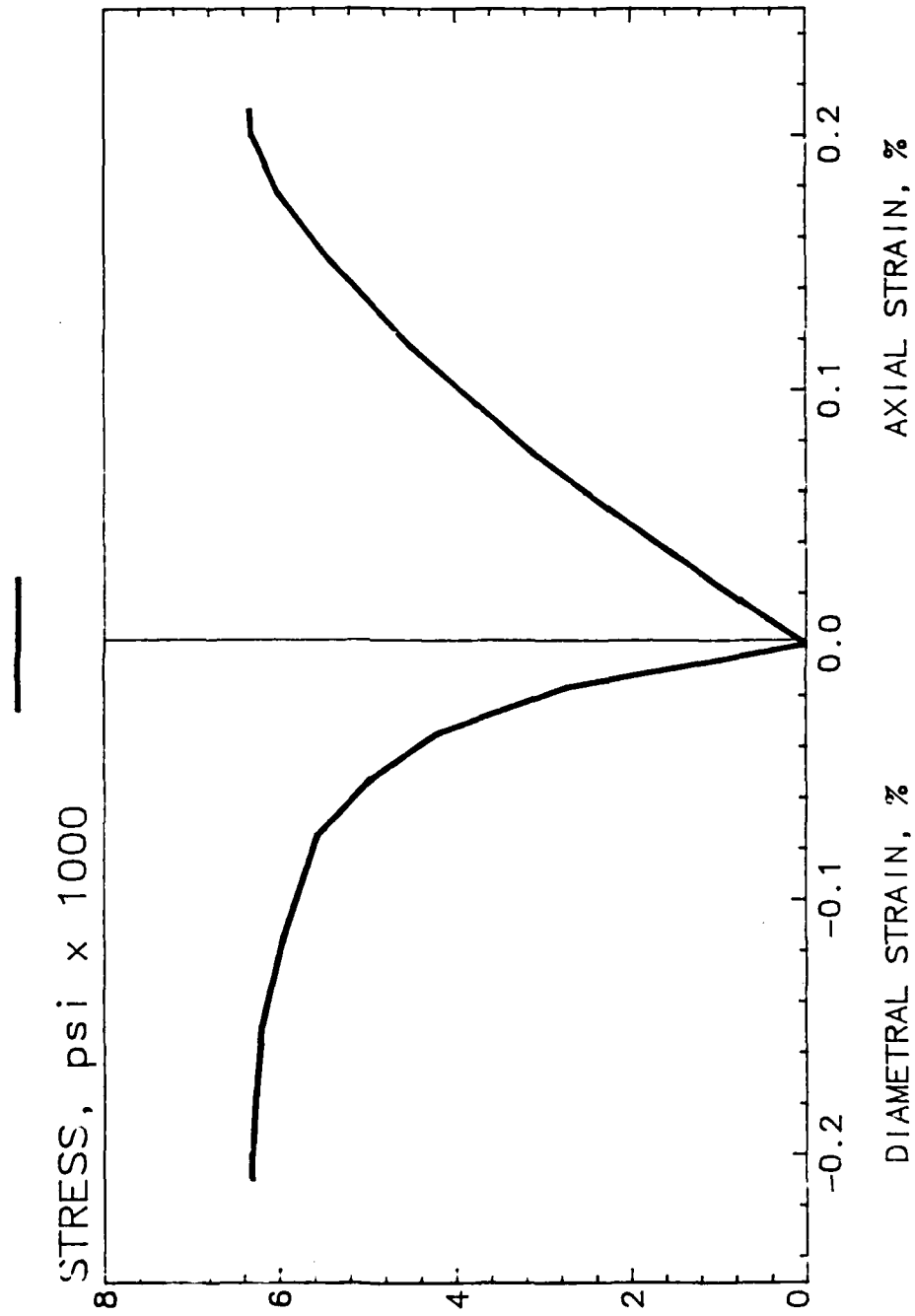
CONCRETE, COMPRESSIVE STRESS vs STRAIN
PITTS-13 CON-1



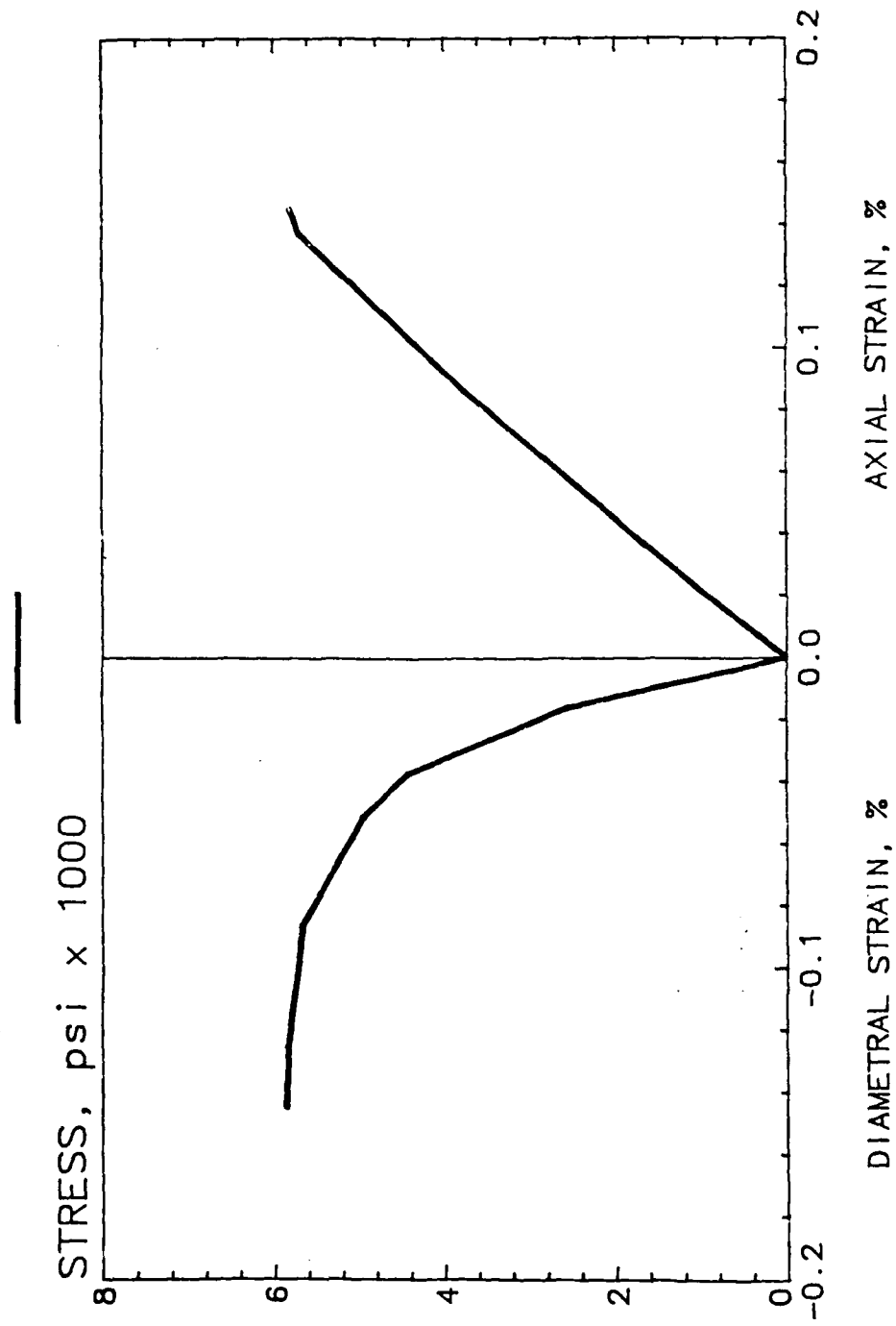
CONCRETE, COMPRESSIVE STRESS vs STRAIN
PITTS-13 CON-29



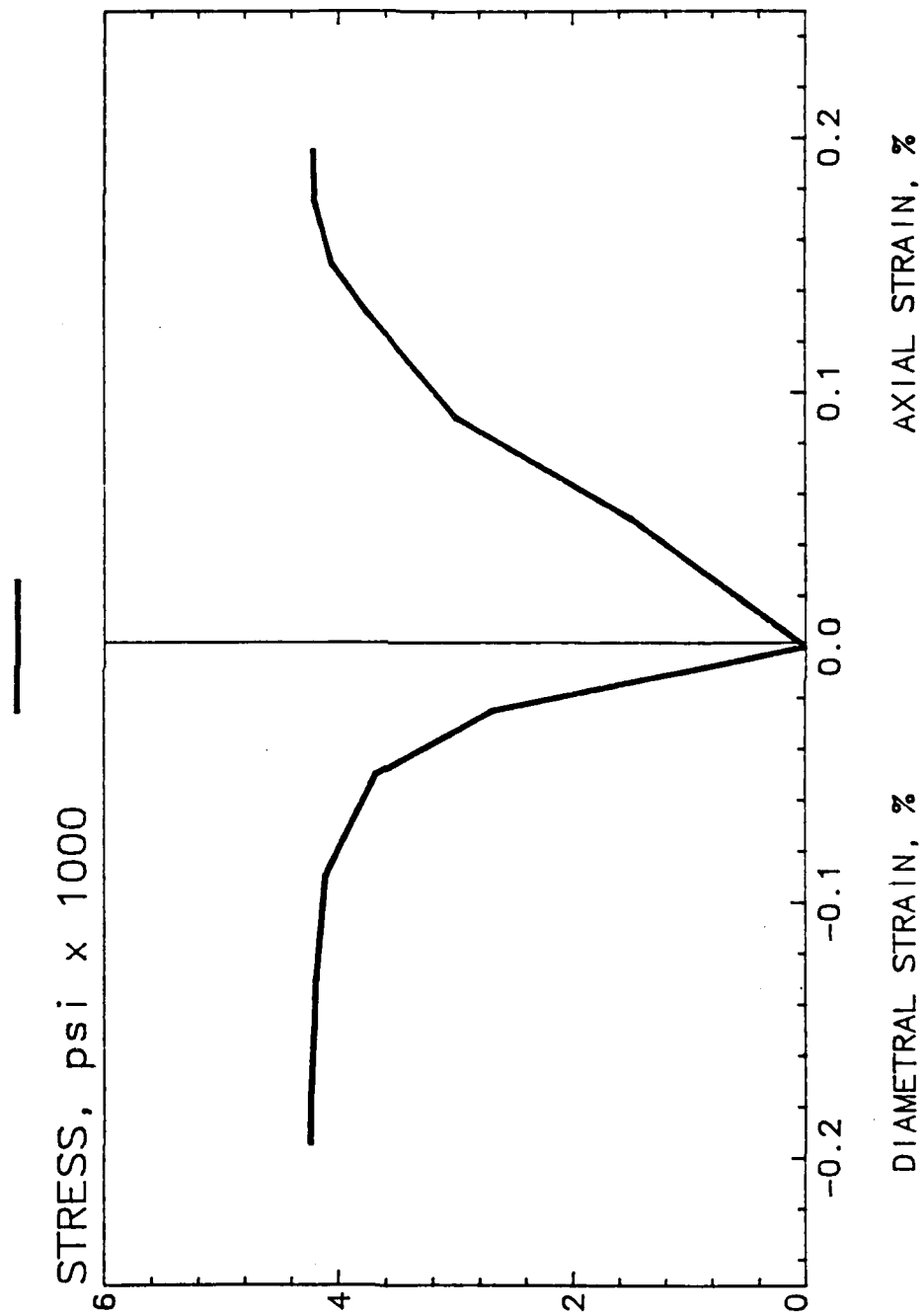
CONCRETE, COMPRESSIVE STRESS vs STRAIN
PITTS-13 CON-51



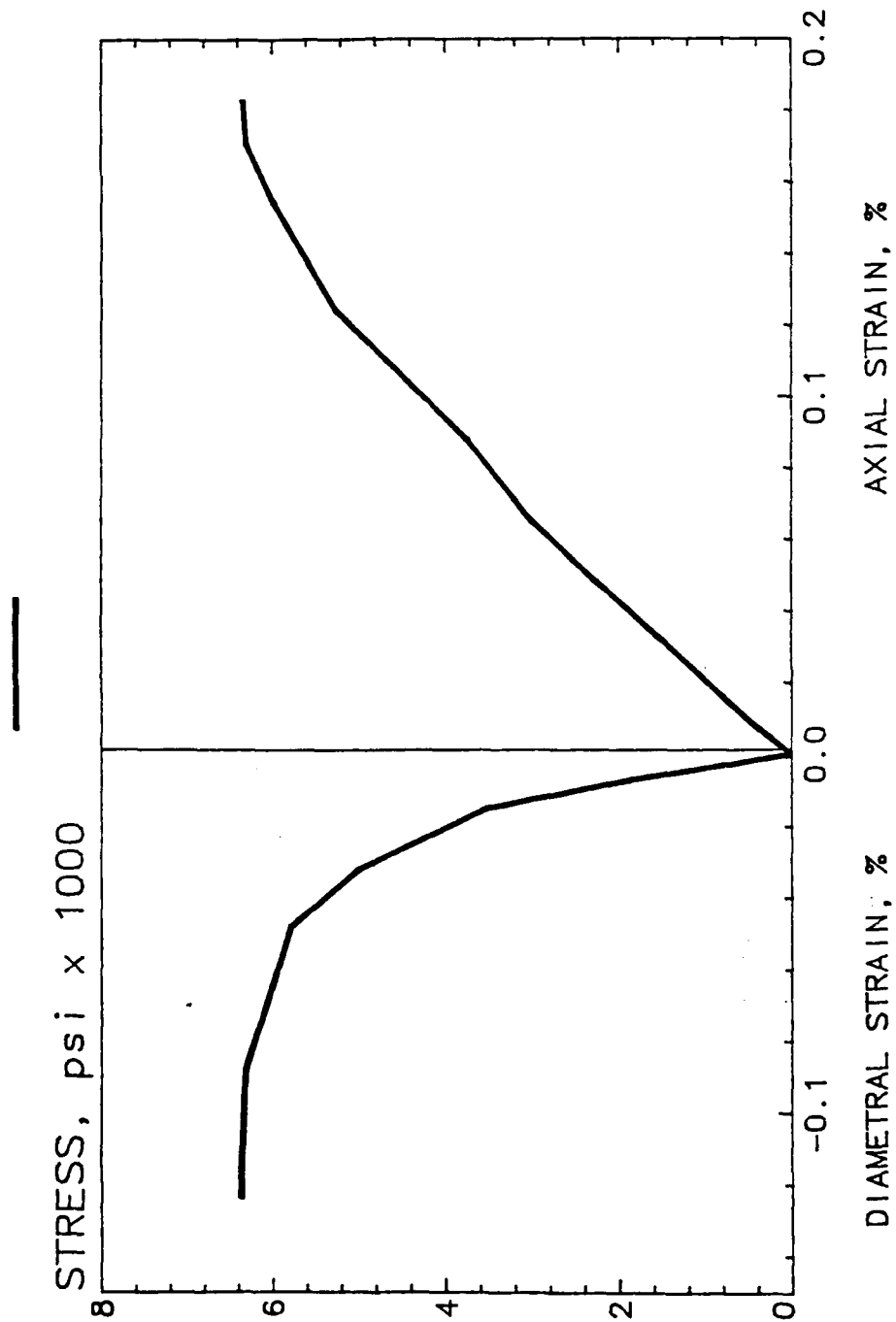
CONCRETE, COMPRESSIVE STRESS vs STRAIN
PITTS-13 CON-61



CONCRETE, COMPRESSIVE STRESS vs STRAIN
PITTS-13 CON-110



CONCRETE. COMPRESSIVE STRESS vs STRAIN
PITTS-13 CON-112



Monongahela River L-3

Landwall

1-1

Flow

Vertical Boring Locations

No Scale

Boring No. BR WES L-1										Boring No. BR WES L-3									
Elev 730.5	Depth ft	Leg- end	Material	Unit Wt pcf	Vp fps	Comp STRR psi	E x 10 ⁶ psi	v		Elev 732.5	Depth	Leg- end	Material	Unit Wt pcf	Vp fps	Comp STRR psi	E x 10 ⁶ psi	v	
			Surface scaled Concrete good	150.7	16366	5360	4.9	0.21					Surface scaled Concrete good	151.9	16129	5990			
	2.0									2.0									
	4.0		LS agg, max 3", crushed							4.0			LS agg, max 3", crushed						
	6.0		Air entrained							6.0			Air entrained						
	8.0		1" rebar							8.0									
	10.0									10.0									
										12.0									
										14.0									
										16.0									

Monongahela River

Landwall

1-

L-2

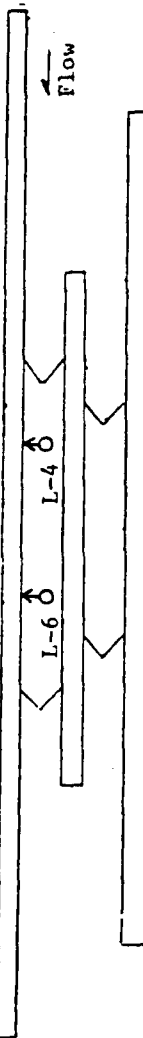
Flow

Vertical Boring Locations

No Scale

Boring No. BR WES L-2									Boring No. BR WES L-5								
Elev 727.0	Depth ft	Log- end	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E 6 x 10 ⁶ psi	v	Elev	Depth	Log- end	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E 6 x 10 ⁶ psi	v
			Mud and Sand							30.5		Concrete, 1.0' LS agg Air Entrained					
	1.0		Clayey mud							1.0		SS gravel and clay					
	2.0		Slay and SS gravel							2.0		Slay and Steel 1 1/2" - 4"					
	3.0									3.0		Mud, pea gravel, slag, SS Shale- blue-gray					
	4.0		Sandy mud with pea gravel							4.0		Soft to mod. hard					
	5.0									5.0		Low angle breaks					
	6.0		Shale-gray and brown							6.0							
	7.0		Soft to mod. hard							7.0							
	8.0		Low angle breaks														

Landwall

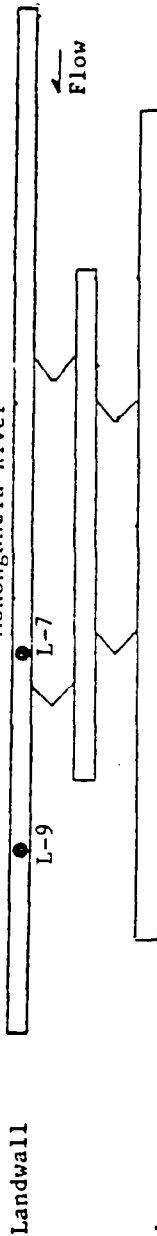


No Scale

Horizontal Boring Locations

Boring No. BR WES L-4									Boring No. BR WES L-6								
Elev	Depth	Leg- end	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10 ⁶ psi	v	Elev	Depth	Leg- end	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10 ⁶ psi	v
715.5			Surface Weathered Concrete good						726.5			Surface Weathered Concrete good	149.0	15755	6770		
	1.0									1.0							
	2.0		LS. agg, max 2", crushed	150.6	16652	4460				2.0		LS agg, max 3", crushed					
	3.0		Air entrained									Air entrained					

Monongahela River

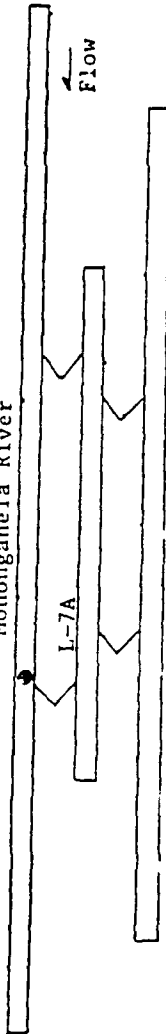


No Scale

Boring No. BR WES L-7				Boring No. BR WES L-9			
Elev	Depth	Leg-end	Material	Unit	Vp	Comp	E
730.5	ft			pcf	fps	psi	$\times 10^6$ psi
	1.0		Surface Scaled Concrete good				
	2.0		LS agg, max 3", crushed				
	3.0		Air entrained				
	4.0						
	5.0						
	6.0		5" pipe				

CONCRETE PROPERTIES
Locks and Dam No. 2
Monongahela River

Landwall



Vertical Boring
Locations

No Scale

Boring No.		Boring No.	
Elev 730.5	Depth ft	Elev 732.5	Depth
	5.0		
	10.0		
	15.0		
	20.0		
	25.0		
	30.0		
	35.0		
	40.0		
	45.0		
	50.0		
	55.0		
	60.0		
	65.0		
	70.0		
	75.0		
	80.0		
	85.0		
	90.0		
	95.0		
	100.0		
	105.0		
	110.0		
	115.0		
	120.0		

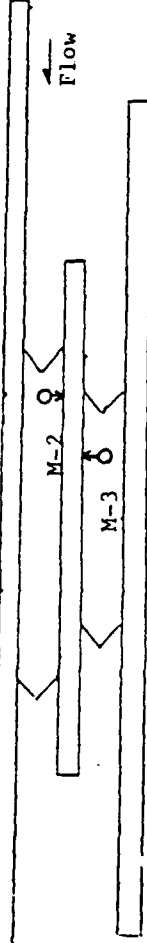
Vertical Boring Locations



Boring No. BR WES M-1		Boring No. BR WES M-6					
Elev	Depth ft	Leg- end	Material	Unit wt pcf	Vp fps	Comp Strg psi	E 6 x 10 ⁶ psi
	15.0		Concrete good	149.0	15349	7840	
	30.0		LS and Sil- iceous agg, max 3"	147.4	14875	6480	4.2 0.26
	45.0		Air entrained				
	60.0		Shale-gray and brown				
	75.0		Soft to mod. hard				
	90.0						

CONCRETE PROPERTIES
Locks and Dam No. 2
Monongahela River

Landwall



Horizontal Boring
Locations

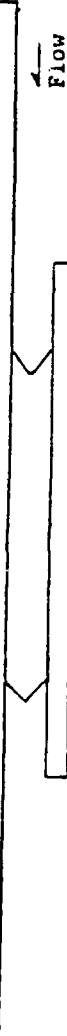
Boring No. BR WES M-2					Boring No. BR WES M-3				
Elev	Depth	Leg- end	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10 ⁶ psi	v	
717.1	1.0		Surface Weathered Concrete good	145.2	14925	6020	4.4	0.52	
	2.0		LS and Siliceous agg, max 4"						
	3.0		Air entrained						

Horizontal Boring Locations

Plate 48

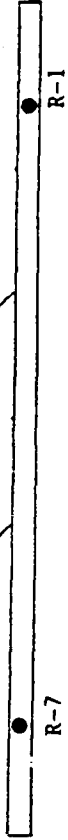
CONCRETE PROPERTIES
Locks and Dam No. 2
Monongahela River

Landwall



Flow

Vertical Boring
Locations



No Scale

Boring No. BR WES R-1									Boring No. BR WES R-7								
Elev	Depth ft	Leg- end	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10 ⁶ psi	v	Elev	Depth	Leg- end	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10 ⁶ psi	v
	1.0		Surface intact Concrete good	143.5	13486	4480	2.9	0.25		1.0		Surface intact Concrete good					
			Siliceous agg, max 1½"							2.0		Siliceous agg, max 1½"					
			Air entrained									Air entrained					
										3.0		Rebar at 1.1'					

Horizontal Boring
Locations

No Scale

Elev ft	Depth ft	Log- end	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E 6 x 10 ⁶ psi	v
730.5			Concrete good	144.1	14492	5890		
	15.0		Siliceous agg, max 3"					
	30.0		Air entrained	146.7	15755	6400		
	45.0		Rebar in 6 places					
	60.0			142.4	13801	4500		
	75.0		Shale-gray mod. hard					
	90.0		silty					

Landwall

No Scale

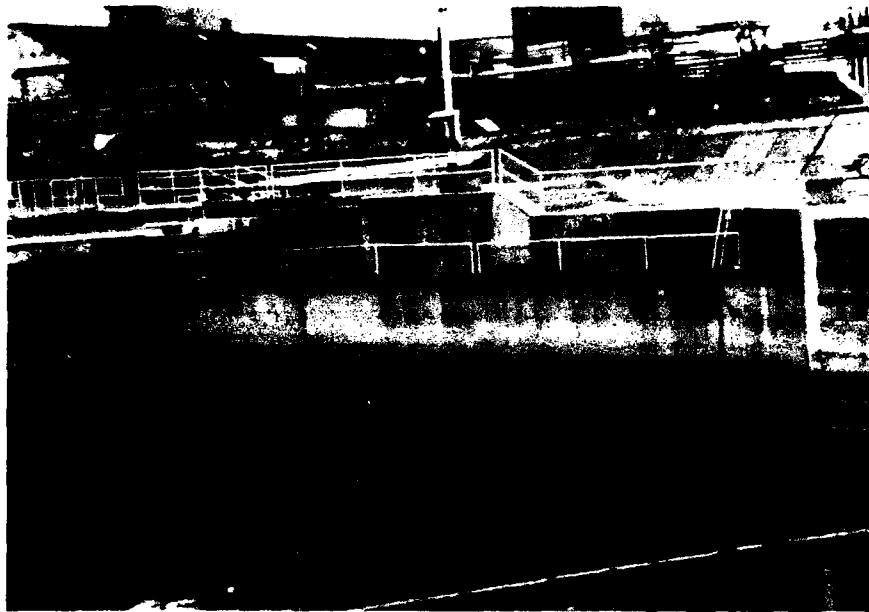
 R-6

Inclined Boring Locations

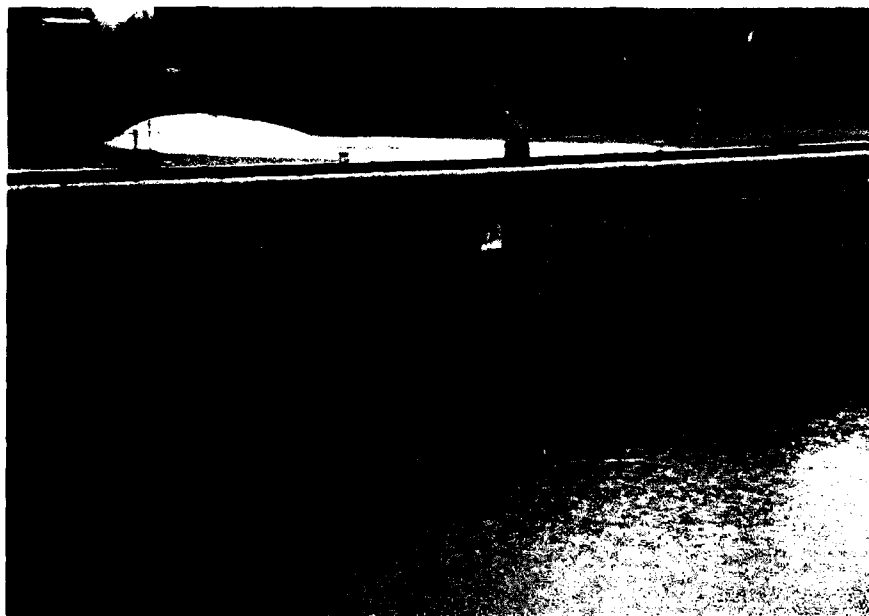
Boring No. BR WFS R-6										
Elev	Depth ft	Leg- end	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10 ⁶ psi	v		
	1.0		Surface scaled LS and siliceous agg, max 3" Air entrained							
	2.0									
	3.0									

Boring No.									
Elev	Depth	Leg- end	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10 ⁶ psi	v	

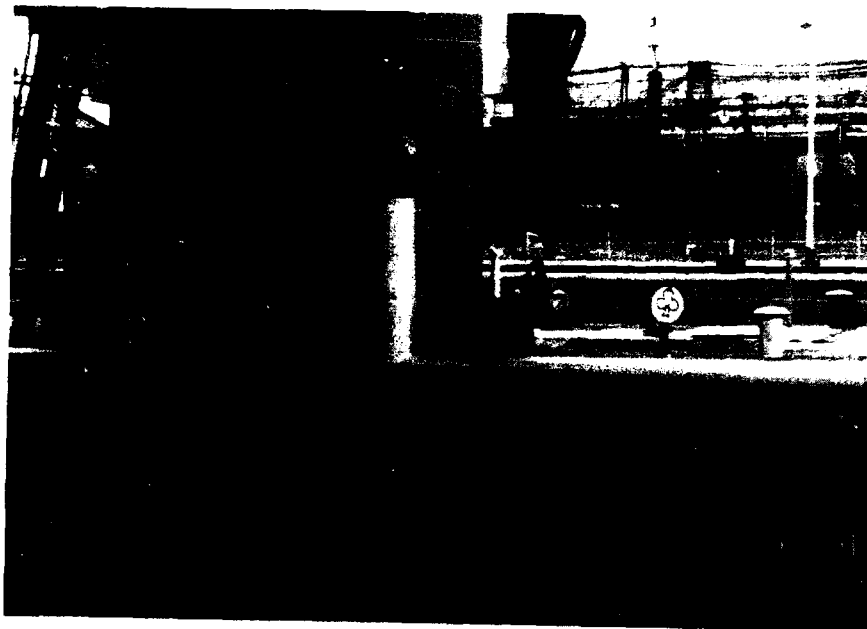
APPENDIX A: PHOTOGRAPHS TAKEN DURING PRELIMINARY STUDY



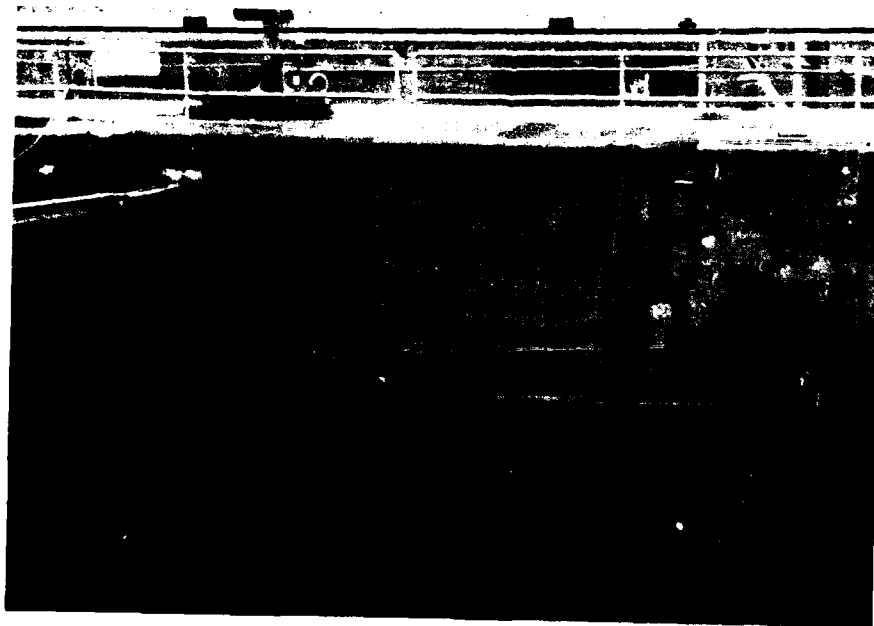
Photograph A1. Land wall lower gate recess



Photograph A2. Land wall lock chamber of large lock



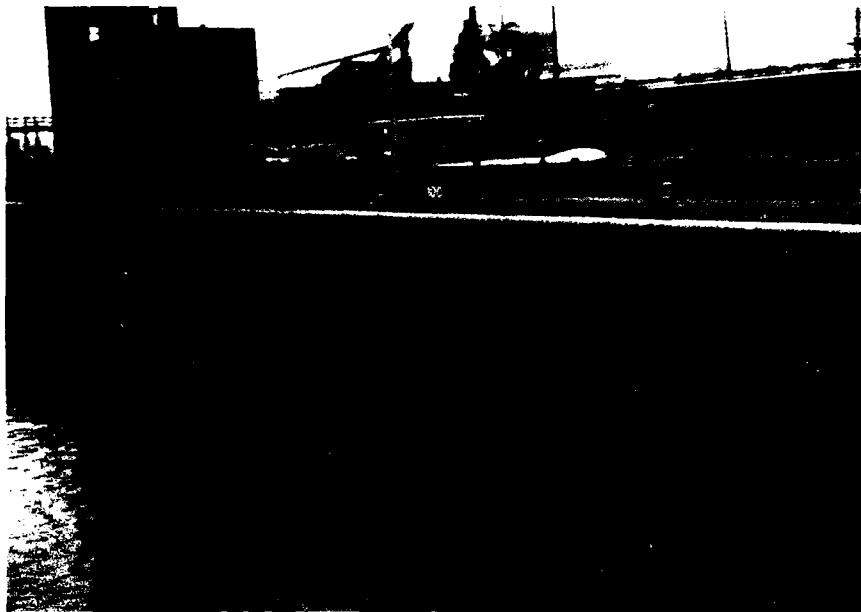
Photograph A3. River face middle wall at monolith M-5



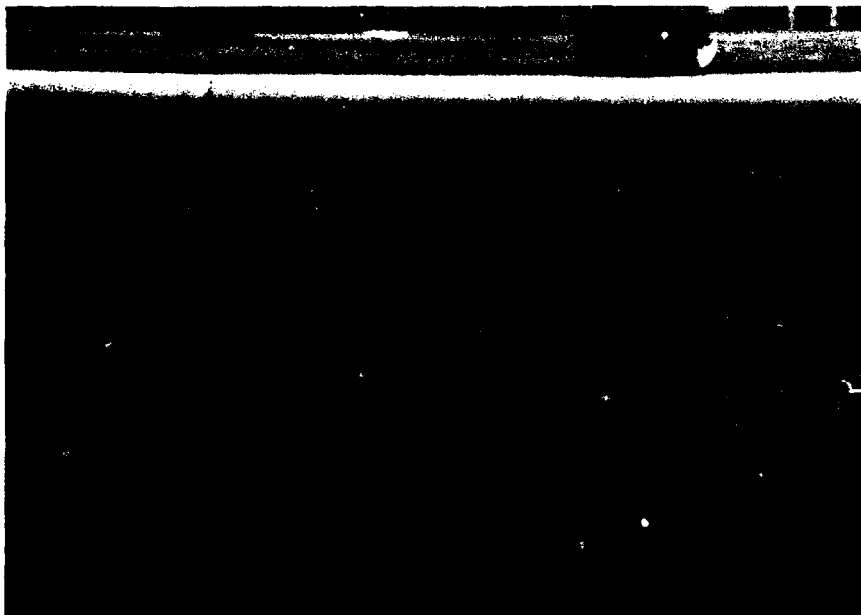
Photograph A4. Gate recess river face middle wall of upper gate in small chamber



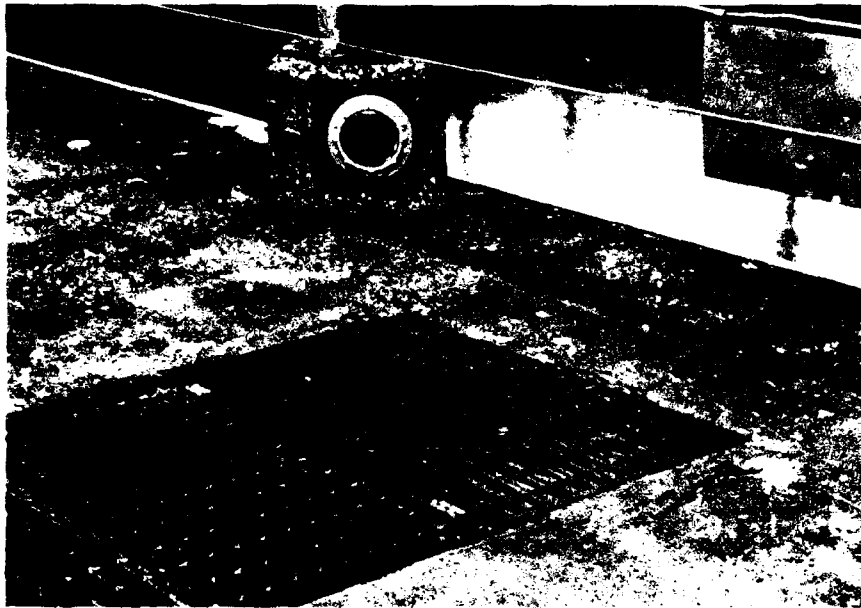
Photograph A5. Downstream of upper gate middle wall in
small lock chamber



Photograph A6. Middle wall small lock chamber



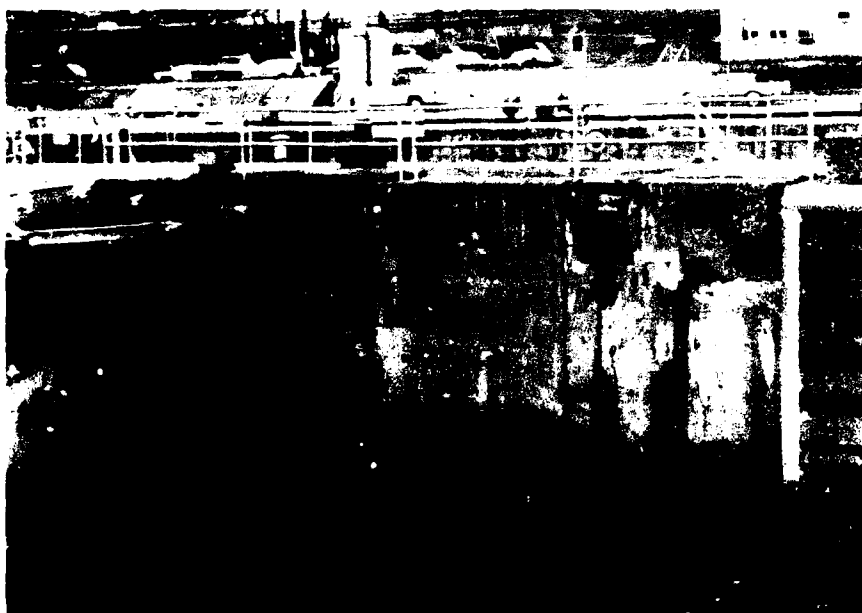
Photograph A7. Middle wall small lock chamber monolith M-16



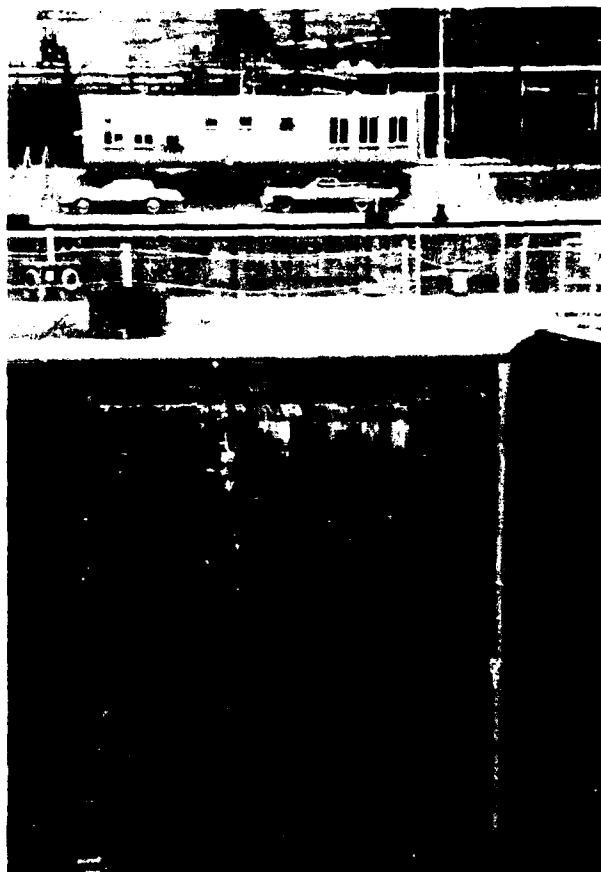
Photographs A8 & A9. Middle wall monolith M-22



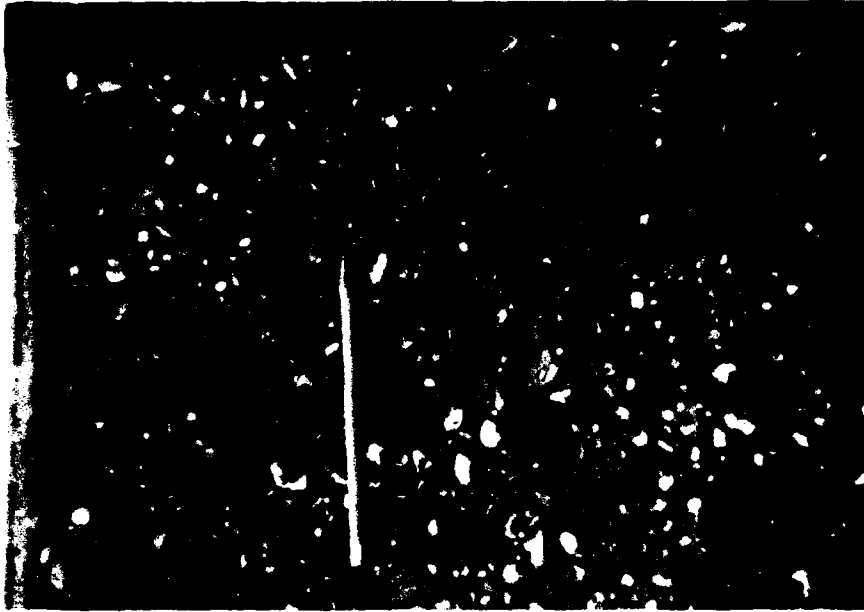
Photograph A10. Downstream of lower gates small lock chamber
middle wall



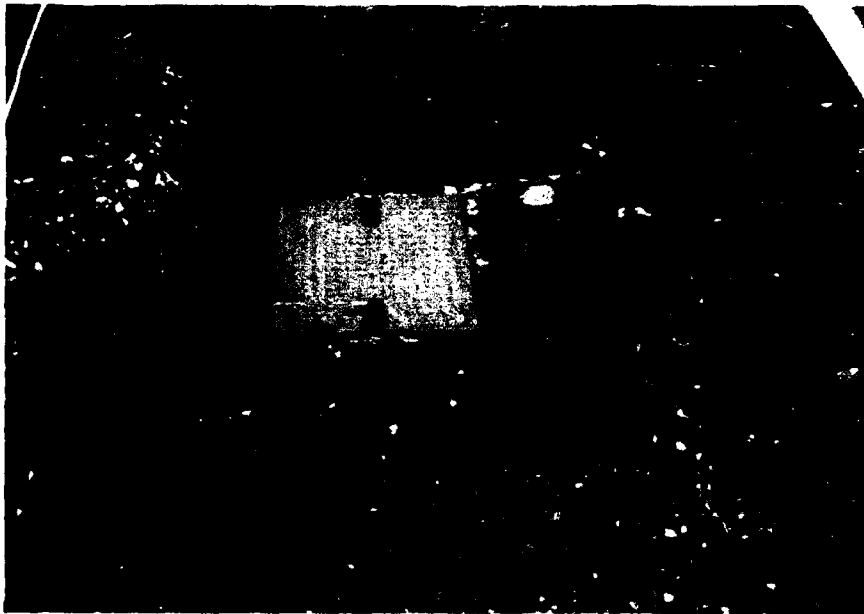
Photograph A11. Lower gate recess middle wall small lock
chamber



Photograph A12. Downstream of lower gates of small
lock chamber in middle wall



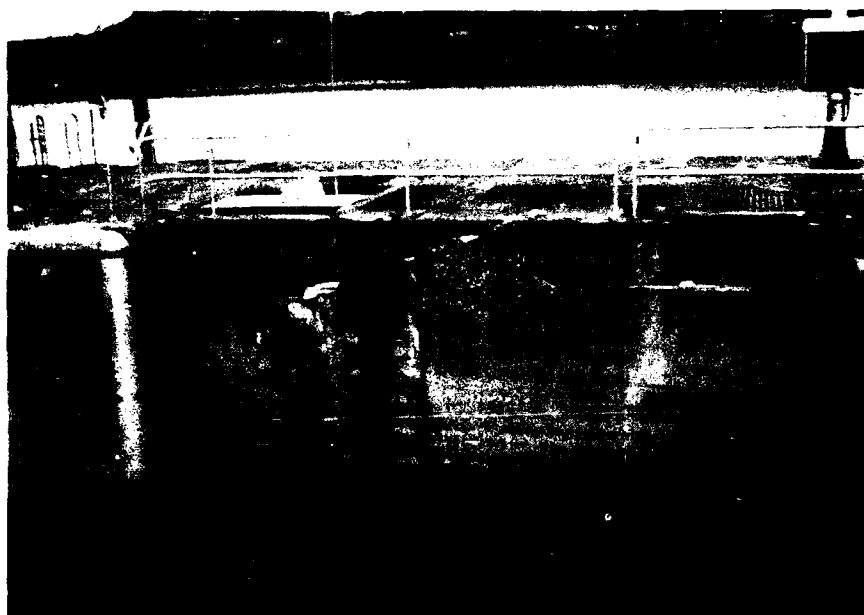
Photograph A13. Top of upper guard wall joint between
monolith No. 8 and No. 7



Photograph A14. Top of upper guard wall monolith R-5



Photograph A15. River side upper guard wall



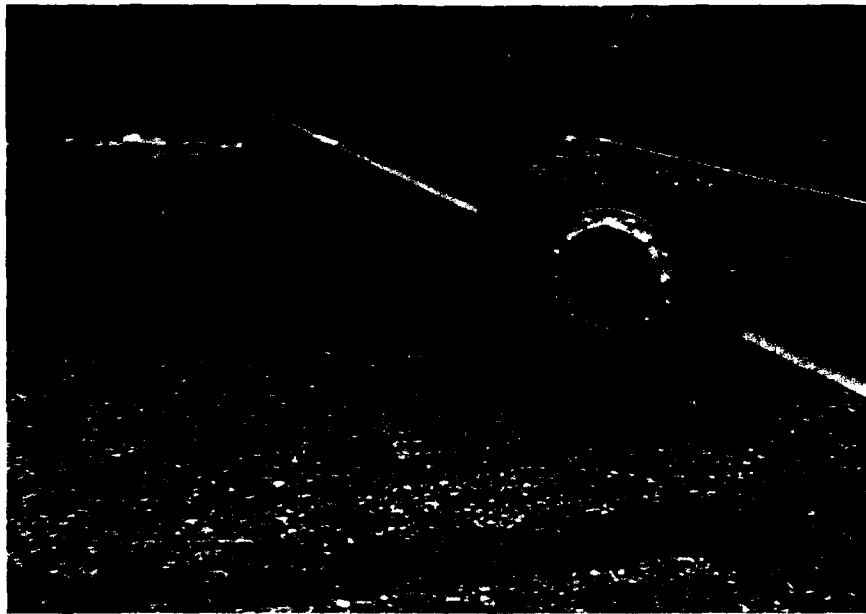
Photograph A16. Upper gate recess river wall



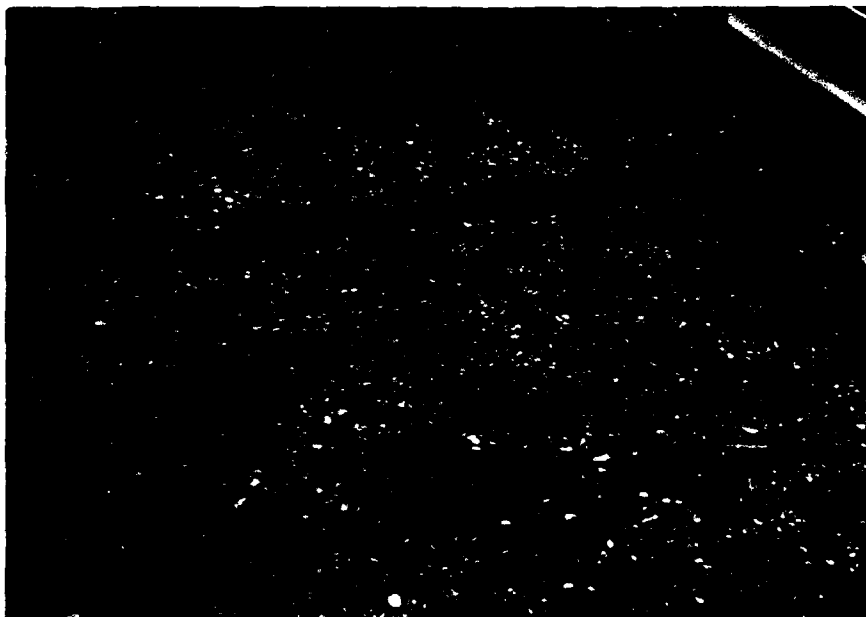
Photograph A17. Cracking near gate recess monolith R-12 of river wall



Photograph A18. Top of monolith R-13 river wall near upper gate recess



Photograph A19. Top monolith R-15 pop out



Photograph A20. Top monolith R-16 dissolution of aggregate



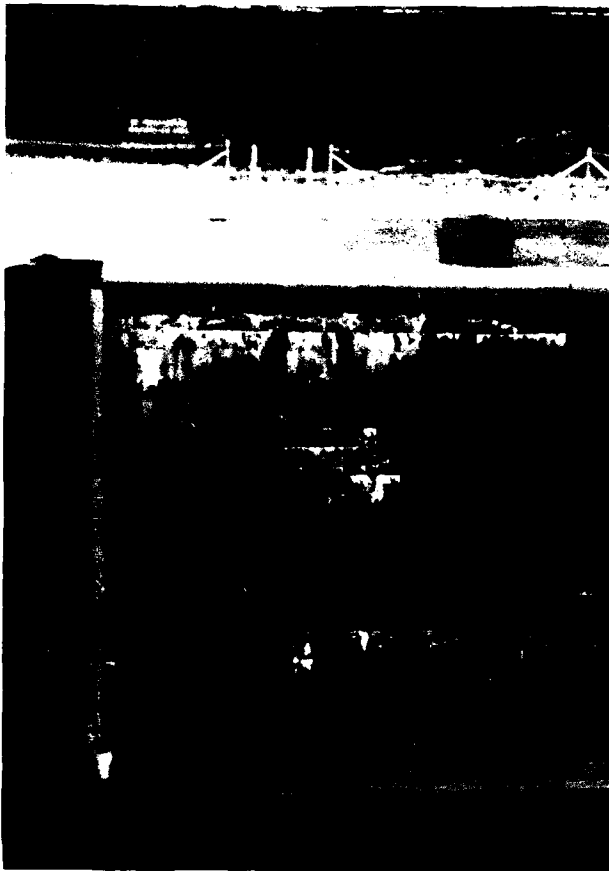
Photograph A21.



Photograph A22. River wall
monolith R-23. Cracking and
repairs of concrete in lower
gate recess



Photograph A23. River wall lower gate recess



Photograph A24. River wall
below lower gate



Photograph A25. Lower guard wall

APPENDIX B: FIELD DRILL LOGS

DRILLING LOG		DIVISION		INSTALLATION		SHEET	
Ohio River		Lock & Dam #2		Lock & Dam #2		1 OF 2 SHEETS	
1. PROJECT Rehab. of Lock & Dam 2, Mon. River				10. SIZE AND TYPE OF BIT Diamond			
2. LOCATION (Coordinates or Station)				11. STATUS FOR ELEVATION SHOWN (YES or NO) MSL			
3. DRILLING AGENCY USACE-123				12. MANUFACTURER'S DESIGNATION OF DRILL Falling 1500			
4. HOLE NO. (As shown on drawing title and site number) BR WES L-1				13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN 0			
5. NAME OF DRILLER Warhurst				14. TOTAL NUMBER CORE BOXES 1			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				15. ELEVATION GROUND WATER n/a			
7. THICKNESS OF OVERBURDEN 0.0				16. DATE HOLE 17 Dec 85			
8. DEPTH DRILLED INTO ROCK 0.0				17. ELEVATION TOP OF HOLE 770.51			
9. TOTAL DEPTH OF HOLE 10.55' in Concrete				18. TOTAL CORE RECOVERY FOR BORING 100%			
19. SIGNATURE OF INSPECTOR <i>[Signature]</i>							

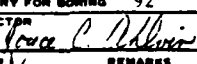
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water level, depth of monitoring, etc., if significant)
0.0	0.0		Surface Condition: slightly weathered with light scaling, maximum exposed aggregate size is 1/2".			Run: 1 Begin: 0.0 End: 2.25 D.T: 15 min. Rec: 2.05 Remarks: Pulled off .2'.
1.0	0.0 - 10.4		Concrete: gray, predominately crushed limestone aggregate, maximum aggregate size is 3", subangular to angular, has entrained air, has entrapped air, many voids generally less than 1/2" diameter & deep, some aggregate are cracked, @ 3.15: man made break.	100%	Box 1	
2.0					Run 1	Run: 2 Begin: 2.25 End: 7.2 D.T: 45 min. Rec: 5.0 Remarks: Picked up .2' from run 1, pulled off .15' this run.
3.0						
4.0				100%	Box 2	
5.0			@ 5.0: man made break.			
6.0						
7.0			@ 6.55: man made break.			
8.0					Run 2	Run: 3 Begin: 7.2 End: 10.55 D.T: 35 min. Rec: 3.35 Remarks: Picked up .15' from run 2, pulled off .15' this run & left it in the hole
9.0			@ 8.75: 1" steel. @ 9.0: machine break. @ 9.4 & 9.8: 1" long void.	100%	Box 3	
					Box 4	

DRILLING LOG		DIVISION Ohio River		INSTALLATION Lock & Dam #2		Hole No. L-1 SHEET 2 OF 2 SHEETS	
1. PROJECT Rehab. of Lock & Dam 2, Mon. River				10. SIZE AND TYPE OF BIT 6" Diamond			
2. LOCATION (Continuation of Station)				11. DAYON FOR ELEVATION SHOWN (TYPED OR HAND)			
See Remarks				MSL			
3. DRILLING AGENCY USAE WES				12. MANUFACTURER'S DESIGNATION OF DRILL Falling 1500			
4. HOLE NO. (As shown on drawing sheet and file number) BR WES L-1				13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN		DISTURBED 0	
5. NAME OF DRILLER Warhurst				14. TOTAL NUMBER CORE BOXES 4		UNDISTURBED 0	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				15. ELEVATION GROUND WATER n/a			
7. THICKNESS OF OVERBURDEN 0.0				16. DATE HOLE 17 Dec 85		STARTED 17 Dec 85	
8. DEPTH DRILLED INTO ROCK 0.0				17. ELEVATION TOP OF HOLE 730.5'		COMPLETED	
9. TOTAL DEPTH OF HOLE 10.55' in Concrete				18. TOTAL CORE RECOVERY FOR BORING 100 %		19. SIGNATURE OF INSPECTOR <i>[Signature]</i>	
ELEVATION •	DEPTH •	LEGEND •	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVER- ERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)	
	10.0					BOXES:	
	10.0		3.0.B. @ 10.55	Run 3		1. 0.0 - 3.15	
						2. 3.15 - 6.55	
						3. 6.55 - 9.0	
						4. 9.0 - 10.4	
						LOCATION:	
						MON 24 ↓ L A N D W A L L ↑ MON 25 R I V E R ↓ F L O W	
						ABBREVIATIONS D.T: drill time Rec: recovery E.O.B: end of boring.	

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MAR 71 (TRANSLUCENT)

PROJECT Rehab. of Lock &
Dam 2, Mon. River

HOLE NO.
BR WES L-1

DRILLING LOG			DIVISION	INSTALLATION	Locks & Dam No. 2.	SHEET 1
			Ohio River	Monongahela River		OF 9 SHEETS
1. PROJECT Rehabilitation of Locks & Dam No. 2						
2. LOCATION (Continuation of Station) Landwall, Monolith						
28. 2.4' U.S. of Marker pen. 30.0' in from						
3. DRILLING AGENCY River face.						
4. HOLE NO. (As shown on drawing title and site number)			BR WES L-2-86			
5. NAME OF DRILLER			Gene Warhurst			
6. DIRECTION OF HOLE			☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.			
7. THICKNESS OF OVERBURDEN			59.7'			
8. DEPTH DRILLED INTO ROCK			20.8'			
9. TOTAL DEPTH OF HOLE			80.5'			
10. SIZE AND TYPE OF BIT			4 X 5"			
11. DAY OF ELEVATION SHOWN (TBM or MSL)			MSL			
12. MANUFACTURER'S DESIGNATION OF DRILL			Falling Truck - Mounted Rig			
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN			14			
14. TOTAL NUMBER CORE BOXES			5			
15. ELEVATION GROUND WATER						
16. DATE HOLE			STARTED 12 Feb 86 COMPLETED 17 Feb 86			
17. ELEVATION TOP OF HOLE			770.5'			
18. TOTAL CORE RECOVERY FOR BORING			92			
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)
a	b	c	d	e	f	g
1.0			Clayey mud, brown, slightly sandy	90	1	5-in. drive sample, using 300-lb hammer
2.0			Blue-gray slag gravel with brown, clayey, sandy mud		2	
3.0						Grind to 5.0 ft using 8 in. rock bit
4.0						
5.0						
6.0			Clayey mud, brown, w/silt and sand mixed with black slag and sandstone gravel to 1-1/2 in., some blue-gray slag	70	3	5-in. drive sample, using 300-lb hammer
7.0						
8.0						Grind to 10.0 ft using 8 in. rock bit
9.0						
10.0						

Hole No. BR WES L-2-86

DRILLING LOG		DIVISION	INSTALLATION Locks & Dam No. 2, Monongahela River		SHEET 2 OF 9 SHEETS	
1. PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River			10. SIZE AND TYPE OF BIT 1 X 5"			
2. LOCATION (Coordinates or distance Landwall monolith 28.4' U.S. of marker pen. 30.0' in from)			11. DATUM FOR ELEVATION SHOWING (MSL)			
3. DRILLING AGENCY (FVET face)			12. MANUFACTURER'S DESIGNATION OF DRILL			
4. HOLE NO. (As shown on drawing title and this number)			13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN			
5. NAME OF DRILLER Gene Warhurst			14. TOTAL NUMBER CORE BOXES 5			
6. DIRECTION OF HOLE			15. ELEVATION GROUND WATER			
7. THICKNESS OF OVERBURDEN 59.7'			16. DATE HOLE			
8. DEPTH DRILLED INTO ROCK 20.8'			17. ELEVATION TOP OF HOLE 727.0'			
9. TOTAL DEPTH OF HOLE 80.5'			18. TOTAL CORE RECOVERY FOR BORING 92			
			19. SIGNATURE OF INSPECTOR			
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (See legend)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of penetration, etc., if significant)
11.0			Sandstone gravel to 1-1/2 in. maximum diameter, pieces of orange brick, some 1/2 in. black slag	70	4	5-in. drive sample, using 300-lb hammer
12.0			Clayey mud, brown, silty			
13.0						Grind to 15.0-A, using 8-in. rock bit
14.0						
15.0						
16.0			3-in. diameter piece of sandstone, smaller sandstone and mixed pea gravel	20	5	5-in. drive sample, using 300-lb hammer
17.0						
18.0						Grind to 20.0 ft. using 8-in. rock bit
19.0						
20.0						

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

PROJECT Rehabilitation of Locks and Dam No. 2, Monongahela River

HOLE NO. BR WES L-2-

DRILLING LOG		DIVISION	INSTALLATION Locks & Dam No. 2, Monongahela River	SHEET 3 OF 9 SHEETS		
1. PROJECT Rehabilitation of Locks and Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT 4 X 5"				
2. LOCATION (Coordinates or Station) Landwall monolith 28 2.4' U.S. of marker pen. 30.5' in r-r. river		11. DAY FOR ELEVATION SHOWN (Tide or MSL)				
3. DRILLING AGENCY USACE - WES		12. MANUFACTURER'S DESIGNATION OF DRILL				
4. HOLE NO. (As shown on drawing title) and file number BR WES L-2-86		13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN				
5. NAME OF DRILLER Gene Warhurst		14. TOTAL NUMBER CORE BOXES 5				
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED DEG. FROM VERT.		15. ELEVATION GROUND WATER				
7. THICKNESS OF OVERBURDEN 59.7'		16. DATE HOLE STARTED 12 Feb 86 COMPLETED 17 Feb 86				
8. DEPTH DRILLED INTO ROCK 20.8'		17. ELEVATION TOP OF HOLE 727.0'				
9. TOTAL DEPTH OF HOLE 80.5'		18. TOTAL CORE RECOVERY FOR BORING 92				
		19. SIGNATURE OF INSPECTOR <i>George C. Palmer</i>				
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS d (Description)	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS g (Logging time, water level, depth of weathering, etc., if significant)
21.0						5-in. drive sample, using 300-lb hammer
22.0				25	6	
23.0			Large "brick" of slag material, 3 X 4 X 6-in. Pea gravel to 1 in. maximum, mixed with slag with clayey mud clayey mud, gray-brown, silty			
24.0						Grind to 25.0 ft, using 8-in. rock bit
25.0						
26.0			Silty, clayey mud, black, with numerous flecks of steel throughout	100	7	2-1/2 in. splitspoon, using 300 lb hammer. Weight of hammer pushes sampler. No blows needed.
27.0						
28.0						
29.0						
30.0						

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PROJECT Rehabilitation of
Locks and Dam No. 2,
Monongahela River

HOLE NO.
BR WES L-2-8

DRILLING LOG			DIVISION Ohio River		INSTALLATION Locks & Dam No. 2. Monongahela River		SHEET 4 OF 9 SHEETS	
1. PROJECT Rehabilitation of Locks and Dam No. 2, Monongahela River					10. SIZE AND TYPE OF BIT 4 X 5"			
2. LOCATION (County, State or Section) Landwall, Monolith 28.2.4' U.S. of marker per. 10.0' in from					11. DAYUM FOR ELEVATION SHOWN (YES or NO) YES			
3. DRILLING AGENCY USAE - WES					12. MANUFACTURER'S DESIGNATION OF DRILL Falling Truck - Mounted Rig			
4. HOLE NO. (As shown on drawing title) and file number BR WES L-2-86					13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN UNDISTURBED			
5. NAME OF DRILLER Gene Warhurst					14. TOTAL NUMBER CORE BOXES 5			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.					15. ELEVATION GROUND WATER			
7. THICKNESS OF OVERBURDEN 59.7'					16. DATE HOLE STARTED 12 Feb 86 COMPLETED 17 Feb 86			
8. DEPTH DRILLED INTO ROCK 20.8'					17. ELEVATION TOP OF HOLE 727.0'			
9. TOTAL DEPTH OF HOLE 80.5'					18. TOTAL CORE RECOVERY FOR BORING 92 %			
					19. SIGNATURE OF INSPECTOR <i>James C. Allen</i>			
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water level, depth of overburden, etc., if significant) g		
31.0			Clayey mud, black to dark gray, with some silt	100	8	2-1/2 in. splitspoon, using 300-lb hammer, 4 blows		
32.0						Grind to 35.0 ft. using 8-in. rock bit		
33.0								
34.0								
35.0								
36.0			Clayey mud, dark gray, sandy	100	9			
37.0								
38.0						Grind to 40.0 ft. using 8-in. rock bit		
39.0								
40.0								

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PROJECT Rehabilitation of Locks & Dam No 2, Monongahela River
HOLE NO. BR WES L-2-86

DRILLING LOG		DIVISION Ohio River		INSTALLATION Locks & Dam No. 2, Monongahela River		SHEET 5 OF 9 SHEETS	
1. PROJECT Renadillitation of Locks and Dam No. 2, Monongahela River				10. SIZE AND TYPE OF BIT 4 X 5"			
2. LOCATION (Ground surface or Station) Landwall, monolith 28, 2.4' U.S. of marker pen. 30.0' in from				11. DAY OF ELEVATION SHOWN (Y/N or A/B)			
3. DRILLING AGENCY River Gate				12. MANUFACTURER'S DESIGNATION OF DRILL VCI			
4. HOLE NO. (As shown on drawing title) and file number BR WES L-2-86				13. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN 1 DISTURBED UNDISTURBED			
5. NAME OF DRILLER Gene Warhurst				14. TOTAL NUMBER CORE BOXES 5			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				15. ELEVATION GROUND WATER			
7. THICKNESS OF OVERBURDEN 59.7'				16. DATE HOLE STARTED 12 Feb 86 COMPLETED 17 Feb 86			
8. DEPTH DRILLED INTO ROCK 20.8'				17. ELEVATION TOP OF HOLE 727.0'			
9. TOTAL DEPTH OF HOLE 80.5'				18. TOTAL CORE RECOVERY FOR BORING 92 %			
				19. SIGNATURE OF INSPECTOR <i>Eric C. Allen</i>			
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV- ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water level, depth of penetration, etc., if significant) g	
41.0			Clayey mud, dark gray	100	10	2-1/2 in. splitspoon, using 300-lb hammer 4 blows	
42.0						Grind to 45.0 ft. using 8-in. rock bit	
43.0							
44.0							
45.0							
46.0			Very sandy, brown clayey mud with gravel to 1 in. maximum diameter on bottom	35	11	2-1/2 in. splitspoon, using 300-lb hammer 27 blows	
47.0						Grind to 50.0 ft using 8-in. rock bit	
48.0							
49.0							
50.0							

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PROJECT Renadillitation of
Locks and Dam No. 2, Monon-
gahela River HOLE NO. BR WES L-2-86

DRILLING LOG		DIVISION Ohio River		INSTALLATION Locks & Dam No. 2, Monongahela River		SHEET 6 OF 9 SHEETS	
1. PROJECT Rehabilitation of Locks and Dam No. 2, Monongahela River				10. SIZE AND TYPE OF BIT 4 X 5"			
2. LOCATION (Coordinates or Station) Landwall, 28.2.4' U.S. of marker pen. 30.0' in from				11. DATUM FOR ELEVATION SHOWN (FSM or MSL) MSL			
3. DRILLING AGENCY USACE WES				12. MANUFACTURER'S DESIGNATION OF DRILL Falling Truck - Mounted Rig			
4. HOLE NO. (As shown on drawing title) BR WES L-2-86				13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN			
5. NAME OF DRILLER Gene Warhurst				14. TOTAL NUMBER CORE SORES 5			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED DES. FROM VERT.				15. ELEVATION GROUND WATER			
7. THICKNESS OF OVERBURDEN 59.7'				16. DATE HOLE STARTED 12 Feb 86 COMPLETED 17 Feb 86			
8. DEPTH DRILLED INTO ROCK 20.8'				17. ELEVATION TOP OF HOLE 737.0'			
9. TOTAL DEPTH OF HOLE 80.5'				18. TOTAL CORE RECOVERY FOR BORING 92%			
				19. SIGNATURE OF INSPECTOR <i>James P. Miller</i>			
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	
			Mixed gravel, pea size	80	12	2-1/2 in. splitspoon, using 300-lb hammer 31 blows	
51.0			Clayey mud, brown, very sandy, w/some blue-gray clay lumps				
52.0						Grind to 55.0-ft, using 8-in. rock bit	
53.0							
54.0							
55.0			Mixed gravel, pea size	80	13	2-1/2 in. splitspoon, using 300-lb hammer 31 blows	
56.0			Clayey mud, brown, sandy				
57.0			Sand and pea gravel, mixed				
58.0						Grind to 60.0 ft, using 8.0-in. rock bit	
59.0							
60.0			Backfill-rock contact			59.7'-drill action becomes smooth, mud brings up clay-shale fragments	

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PROJECT Rehabilitation of Locks and Dam No. 2, Monongahela River
HOLE NO. BR WES L-2-

DRILLING LOG		DIVISION		INSTALLATION		SHEET	
		Ohio River		Locks & Dam No. 2, Monongahela River		7 OF 9 SHEETS	
1. PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River				10. SIZE AND TYPE OF BIT 4 x 5"			
2. LOCATION (Coordinates or Station) Landwall, monolith 28.24' U.S. of marker pen—30.0' in from				11. DAYUM FOR ELEVATION SHOWN (YES or NO) MSL			
3. DRILLING AGENCY LIVE LOG USAE WES				12. MANUFACTURER'S DESIGNATION OF DRILL Failing Truck - Mounted Rig			
4. HOLE NO. (As shown on drawing title) and file number BR WES L-2-86				13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: ☐ DISTURBED ☐ UNDISTURBED			
5. NAME OF DRILLER Gene Warhurst				14. TOTAL NUMBER CORE BOXES 5			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				15. ELEVATION GROUND WATER			
7. THICKNESS OF OVERBURDEN 59.7'				16. DATE HOLE STARTED 12 Feb 86 COMPLETED 17 Feb 86			
8. DEPTH DRILLED INTO ROCK 20.8'				17. ELEVATION TOP OF HOLE 727.0'			
9. TOTAL DEPTH OF HOLE 80.5'				18. TOTAL CORE RECOVERY FOR BORING 92%			
				19. SIGNATURE OF INSPECTOR <i>James P. Blinn</i>			
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drifting time, water loss, depth of penetration, etc., if significant)	
			Blue-gray clayey shale, soft	0	14	2-1/2 in. split spoon, using 300-lb hammer 48 blows	
61.0						Run: 1 Begin: 60.3' End: 64.55 D.T.: 2 hr 6 min Rec: 4.25'	
62.0				85			
63.0			Mottled gray and brown shale calcareous module				
64.0			Brown shale, soft to moderately hard				
65.0							
66.0			Gray shale, soft to moderately hard	80	Box 2	Run: 2 Begin: 64.55' End: 68.20' D.T.: 1 hr 50 min Rec: 3.65'	
67.0							
68.0							
69.0			Gray shale, moderately hard, slightly silty				
70.0							

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PROJECT Rehabilitation of
Locks & Dam No. 2,
Monongahela River

HOLE NO.
BR WES L-2-86

DRILLING LOG		Division		INSTALLATION		SHEET	
		Ohio River		Locks & Dam No. 2, Monongahela River		0 OF 9 SHEETS	
1. PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River				10. SIZE AND TYPE OF BIT 4 X 5"			
2. LOCATION (Coordinate or Station) Landwall, monolith 28, 2.4' U.S. of marker pen, 30.0' in from river face				11. DAY OF ELEVATION SHOWN (YES or NO) MSL			
3. DRILLING AGENCY USAE WES				12. MANUFACTURER'S DESIGNATION OF DRILL Failing Truck - Mounted Rig			
4. HOLE NO. (As shown on drawing title) and its number BR WES L-2-86				13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN 1			
5. NAME OF DRILLER Gene WarhuTst				14. TOTAL NUMBER CORE BOXES 5			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				15. ELEVATION GROUND WATER			
7. THICKNESS OF OVERBURDEN 59.7'				16. DATE HOLE STARTED 12 Feb 86 COMPLETED 17 Feb 86			
8. DEPTH DRILLED INTO ROCK 20.8'				17. ELEVATION TOP OF HOLE 727.0'			
9. TOTAL DEPTH OF HOLE 80.5'				18. TOTAL CORE RECOVERY FOR BORING 92			
				19. SIGNATURE OF INSPECTOR <i>James P. Miller</i>			

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVER- Y e	BOX OR SAMPLE NO. f	REMARKS g (Drilling time, water loss, depth of mudlogging, etc., if significant)
71.0			Gray shale, w/band of brown shale, moderately hard, slightly silty, some calcareous modules	95	Box 3	Run: 3 Begin: 68.2' End: 73.2' D.T.: 1 hr 18 min Rec: 4.45'
72.0						
73.0						
74.0						
75.0			Gray shale, moderately hard, some brown bands, slightly silty, some calcareous modules	100	Box 4	Run: 4 Begin: 72.65 End: 77.7 D.T.: 1 hr 10 min Rec: 4.85
76.0						
77.0						
78.0			Brown shale, moderately hard			
79.0			Gray shale, moderately hard, slightly silty	99	Box 5	Run: 5 Begin: 77.5' End: 80.5' D.T.: 51 min Rec: 3.0'
80.0						

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PROJECT Rehabilitation of
Locks & Dam No. 2,
Monongahela River

HOLE NO.
BR WES L-2-86

Hole No. BR WES L-2-86

DRILLING LOG		DIVISION		INSTALLATION		SHEET	
Ohio River		Locks & Dam No. 2,		Monongahela River		9	
PROJECT Rehabilitation of Locks and Dam No. 2, Monongahela River		SIZE AND TYPE OF BIT		4 X 5"		OF 9 SHEETS	
LOCATION (Continuation of Station) Landwall, monolith 28, 2.4' U.S. of marker pen, 30.0' in from		DATUM FOR ELEVATION (FOOT/FEET or M/L)		WSI			
DRILLING AGENCY FIVE TACE		MANUFACTURER'S DESIGNATION OF DRILL		Falling Truck - Mounted Rig			
HOLE NO. (As shown on drawing title) and file number		TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN		DISTURBED		UNDISTURBED	
BR WES L-2-86		TOTAL NUMBER CORE BORES		5			
NAME OF DRILLER		ELEVATION GROUND WATER					
Gene Warhurst		DATE NOLE		STARTED		COMPLETED	
DIRECTION OF HOLE				12 Feb 86		17 Feb 86	
☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		ELEVATION TOP OF HOLE		727.0'			
THICKNESS OF OVERBURDEN		TOTAL CORE RECOVERY FOR BORING		92			
59.7'		SIGNATURE OF INSPECTOR		M. P. Miller			
DEPTH DRILLED INTO ROCK							
20.8'							
TOTAL DEPTH OF HOLE							
80.5'							
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water level, depth of overburden, etc., if significant)	
			E.O.B. 80.5'				

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(TRANSLUCENT)PROJECT Rehabilitation of
Locks & Dam No. 2,
Monongahela RiverHOLE NO.
BR WES L-2-86

DRILLING LOG		DIVISION	INSTALLATION	SHEET		
Rehad. of Lock & Dam 2, Mon. River		Union River	Lock & Dam #2	1 of 2 SHEETS		
1. PROJECT		10. SIZE AND TYPE OF BIT				
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)				
3. DRILLING AGENCY		12. MANUFACTURER'S DESIGNATION OF DRILL				
4. HOLE NO. (As shown on drawing title)		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN				
5. NAME OF DRILLER		14. TOTAL NUMBER CORE BOXES				
6. DIRECTION OF HOLE		15. ELEVATION GROUND WATER				
7. THICKNESS OF OVERBURDEN		16. DATE HOLE				
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE				
9. TOTAL DEPTH OF HOLE		18. TOTAL CORE RECOVERY FOR BORING				
		19. SIGNATURE OF INSPECTOR				
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Designation)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of overburden, etc., if significant)
0.0	0.0		Surface Condition: slightly weathered with medium scaling - maximum exposed aggregate size is 2". Surface crack with slight separation is within 3'.	100%		Run: 1 Begin: 0.0 End: 2.3 D.T: 50 min. Rec: 1.8 Remarks: Pulled off .5'.
1.0	1.0					
2.0	2.0		0.0 - 16.0 Concrete: gray, predominately crushed limestone aggregate, maximum aggregate size is 3", predominately subangular, good consolidation, entrapped and entrained air, many voids generally less than 2" diameter & deep, some cracked aggregate.	100%	Box 1	Run: 2 Begin: 2.3 End: 4.1 D.T: 35 min. Rec: 1.25 Remarks: Picked up .5' from run 1, pulled off .55' this run.
3.0	3.0					
4.0	4.0					
5.0	5.0					
6.0	6.0					
7.0	7.0		@ 6.65: manmade break.			Run: 3 Begin: 4.1 End: 6.2 D.T: 50 min. Rec: 2.25 Remarks: Picked up .35' from run 2, pulled off .2' this run.
8.0	8.0		@ 7.3: manmade break.			Run: 4 Begin: 6.2 End: 11.2 D.T: 3 hrs 30 min. Rec: 4.4 Remarks: Picked up .2' from run 3, pulled off .3' this run.
9.0	9.0		@ 9.4: manmade break.			

DRILLING LOG		DIVISION Ohio River		INSTALLATION Lock & Dam #2		SHEET 2 OF 2 SHEETS	
1. PROJECT Rehab. of Lock & Dam 2, Mon. River				10. SIZE AND TYPE OF BIT 4" diamond Bit			
2. LOCATION (Coordinates or Station)				11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL			
3. DRILLING AGENCY USAE WES				12. MANUFACTURER'S DESIGNATION OF DRILL Acker Skid Rig			
4. HOLE NO. (As shown on drawing title and file number) BR WES L-3				13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN		14. TOTAL NUMBER CORE BOXES	
5. NAME OF DRILLER Dan Taylor				15. ELEVATION GROUND WATER -7.2		16. DATE HOLE 21 Oct 85	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				17. ELEVATION TOP OF HOLE 732.5'		18. TOTAL CORE RECOVERY FOR BORING 100 %	
7. THICKNESS OF OVERBURDEN 0.0'				19. SIGNATURE OF INSPECTOR <i>[Signature]</i>			
8. DEPTH DRILLED INTO ROCK 0.0'							
9. TOTAL DEPTH OF HOLE 16.1'							
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling tool, water loss, depth of penetration, etc., if significant)	
10.0							
11.0					Run 4		
12.0			11.45: low angle crack.			Run: 5 Begin: 11.2 End: 15.1 D.T: 1 hr 40 min. Rec: 5.1	
13.0			12.95: manmade break.		Box 4	Remarks: Picked up .3' from run 4, pulled off .1' this run. Drill action was smooth throughout boring. 100% of water was retained.	
14.0			13.7: 1 1/2" long void. 14.0: 1" long void. 14.15: manmade break.	100%		ABBREVIATIONS: D.T: drill time Rec: recovery E.O.B: end of boring.	
15.0					Box 5	BOXES: 1. 0.0 - 3.75 2. 3.75 - 7.3 3. 7.3 - 10.9 4. 10.9 - 14.15 5. 14.15 - 16.0	
16.0			E.O.B. @ 16.1'		Run 5	LOCATION: Large Chamber flow → mono. 33 mono. 34 Landwall	

DRILLING LOG		DIVISION Ohio River		INSTALLATION Lock & Dam #2		Hole No. BR WES L-4		SHEET OF 1 SHEETS	
1. PROJECT Rehab. of Lock & Dam 2, Mon. River				10. SIZE AND TYPE OF BIT 1 1/2" Diamond Bit					
2. LOCATION (Coordinates or Station)				11. DAY USE FOR ELEVATION SHOWN (TBM or GTS) MSL					
3. DRILLING AGENCY USACE-MS				12. MANUFACTURER'S DESIGNATION OF DRILL KOR-11, Series A-100, 110 volt					
4. HOLE NO. (As shown on drawing title and file number)				13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN Disturbed: 0 Undisturbed: 0					
5. NAME OF DRILLER Dan Taylor				14. TOTAL NUMBER CORE BOXES 1					
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ☒ Horizontal DEG. FROM VERT. 00				15. ELEVATION GROUND WATER 17.6					
7. THICKNESS OF OVERBURDEN 0.0				16. DATE HOLE STARTED: 21 Oct 35 COMPLETED: 21 Oct 35					
8. DEPTH DRILLED INTO ROCK 0.0				17. ELEVATION TOP OF HOLE 17.6					
9. TOTAL DEPTH OF HOLE 3.2' in concrete				18. TOTAL CORE RECOVERY FOR BORING 100%					
19. SIGNATURE OF INSPECTOR <i>[Signature]</i>									
ELEVATION f	DEPTH d	LEGEND e	CLASSIFICATION OF MATERIALS (Description) f	% CORE RECOV- ERY g	BOX OR SAMPLE NO. h	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) i			
	0.0		Surface Condition: Moderately weathered with some exposed agg. - max. agg. size is 2".	100%		Run: 1 Begin: 0.0 End: 1.15 D.T.: 55 min. Rec: 1.05 Remarks: Pulled off .1'.			
	1.0		0.0 - 3.15 Concrete: gray with darker gray agg., predominately crushed limestone agg., max. agg. size is 2", predominately subangular, good consolidation, entrapped & entrained air, many voids - none greater than 1/2" diameter & deep, 2.0: void is filled with wood.	Run 1	Box 1	Run: 2 Begin: 1.15 End: 3.2 D.T.: 1hr 10min. Rec: 2.1 Remarks: Picked up .1' from run 1, pulled off .05' this run. 100% of water was retained throughout boring. Drill action was smooth throughout boring.			
	2.0			100%					
	3.0			Run 2					
			2.0.B. & 3.2'						
LOCATION: Middlewall Large Chamber — flow → 15' mono. 18' — mono. 38' 37 Landwall 38									
ABBREVIATIONS: max: maximum agg: aggregate D.T: drill time Rec: recovery 2.0.B: end of boring.									

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PROJECT Rehab. of Lock & Dam 2, Mon. River
HOLE NO. BR WES L-4

DRILLING LOG		Division	INSTALLATION Locks & Dam No. . .	SHEET 1
		Ohio River	Monongahela River	OF 8 SHEETS
1. PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River			10. SIZE AND TYPE OF BIT 4 X 5"	
2. LOCATION (Coordinates or Station) Landwall, monolith 43, 42' in from river face and 12' U.S. of			11. DATUM FOR ELEVATION (NGVD 77 or MSL)	
3. DRILLING AGENCY monolith joint			MSL	
4. HOLE NO. (As shown on drawing title) and file number BR WES L-85			12. MANUFACTURER'S DESIGNATION OF DRILL	
			Falling Truck - Mounted Rig	
			13. TOTAL NO. OF OVER- DISTURBED UNDISTURBED	
			BURDEN SAMPLES TAKEN 12	
5. NAME OF DRILLER			14. TOTAL NUMBER CORE BOXES 7	
Gene Warhurst			15. ELEVATION GROUND WATER	
6. DIRECTION OF HOLE			16. DATE HOLE	
☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.			STARTED 18 Jan 86 COMPLETED 10 Feb 86	
7. THICKNESS OF OVERBURDEN 54.9'			17. ELEVATION TOP OF HOLE 770.5'	
8. DEPTH DRILLED INTO ROCK 18.3'			18. TOTAL CORE RECOVERY FOR BORING Rock 30	
9. TOTAL DEPTH OF HOLE 73.2'			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)
a	b	c	d	e	f	g
			Concrete, surface intact, crushed L.S. agg, maximum 1", concrete brown w/dark gray bank 0.5-0.6'. Entrapped air voids, maximum 1/4", no entrained air.	100	Box 1	Run: 1 Begin: 0.0' End: 0.6'
	1.0		Clayey gravel, some slag, brown, maximum	10	Sample 1	D.T.: 3 min Rec: 0.6'
	2.0					Comments: water runs out of cracks between slabs
	3.0					2-1/2" splitspoon pushed pushed in w/kelly
	4.0					Grind to 5.1-ft using 8-in. rock bit. Expect to hit second slab, but do not
	5.0					
	6.0		Clayey gravel, 2 pieces sandstone, brown, maximum 1-1/2 in.	20	Sample 2	2-1/2" splitspoon using 150-lb hammer
	7.0					
	8.0					Grind to 10.0-ft using 8" rock bit
	9.0					
	10.0					

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PROJECT Rehabilitation of
Locks & Dam No. 2,
Monongahela River

HOLE NO.
BR WES L-5-8

DRILLING LOG		DIVISION	INSTALLATION	SHEET
Ohio River		Locks & Dam No. 2,	Monongahela River	2
PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River		OF 8 SHEETS		
1. LOCATION (Coordinate or Station) Landwall, Monolith 43, 42' in from river face, 12' U.S. of		10. SIZE AND TYPE OF BIT 4 X 5"		
2. DRILLING AGENCY USAE WES		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL		
3. HOLE NO. (As shown on drawing title) and site number BR WES L-5-86		12. MANUFACTURER'S DESIGNATION OF DRILL Falling Truck - Mounted Rig		
4. NAME OF DRILLER Gene Washurst		13. TOTAL NO. OF OVER- DISTURBED BURDEN SAMPLES TAKEN 12 UNDISTURBED		
5. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		14. TOTAL NUMBER CORE BOXES 7		
6. THICKNESS OF OVERBURDEN 54.9'		15. ELEVATION GROUND WATER		
7. DEPTH DRILLED INTO ROCK 18.3'		16. DATE HOLE STARTED 18 Jan 86 COMPLETED 10 Feb 86		
8. TOTAL DEPTH OF HOLE 73.2'		17. ELEVATION TOP OF HOLE 730.5'		
		18. TOTAL CORE RECOVERY FOR BORING Rock 80 %		
		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)
a	b	c	d	e	f	g
11.0			Gray clay, S.S. gravel, maximum size 1", some slag, pieces of broken bricks	80	Sample 3	5" drive sample, using 300-lb hammer
12.0						
13.0						Grind to 15.0' using 8" rock bit Bit brings up slag, 2-4" in diameter and 1/2" to 1" pieces of steel
14.0						
15.0						
16.0			Slag and steel pieces Slag 3-4-1/2" diameter Steel 1/2-1-1/4" diameter	50	Sample 4	5" drive sample, using 300-lb hammer
17.0						Grind to 20.0', using 8" rock bit
18.0						
19.0						
20.0						

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PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River
HOLE NO. BR WES L-5-

DRILLING LOG			DIVISION	INSTALLATION	Locks & Dam No. 2.	SHEET 3
			Ohio River	Monongahela River		OF 8 SHEETS
1. PROJECT			Rehabilitation of Locks & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT 4 X 5"	
2. LOCATION			43, 42' in from river face, 12' U.S. of		11. DATUM FOR ELEVATION SHOWN (FSM or MSL) MSL	
3. DRILLING AGENCY			USAE WES		12. MANUFACTURER'S DESIGNATION OF DRILL Falling Truck - Mounted Rig	
4. HOLE NO. (As shown on drawing 11101 and file number)			BR WES L-5-86		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN 12	
5. NAME OF DRILLER			Gene Warhurst		14. TOTAL NUMBER CORE BOXES 7	
6. DIRECTION OF HOLE			☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN			54.9'		16. DATE HOLE STARTED 18 Jan 86 COMPLETED 10 Feb 86	
8. DEPTH DRILLED INTO ROCK			18.3'		17. ELEVATION TOP OF HOLE 730.5'	
9. TOTAL DEPTH OF HOLE			73.2'		18. TOTAL CORE RECOVERY FOR BORING Rock 80 %	
19. SIGNATURE OF INSPECTOR						

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of casing, etc., if significant)
a	b	c	d	e	f	g
						Grind out casing with 8" rock bit
21.0			Slag, 3-4" in diameter, steel fragments to 1-1/2" diameter	75	Sample 5	5" drive sample, using 300-lb hammer
22.0						
23.0						
24.0						Grind to 25.6", using 8" rock bit
25.0						
26.0			Slag, 2-3" diameter, steel fragments to 1-1/2" diameter	75	Sample 6	5" drive sample, using 300-lb hammer
27.0						
28.0						
29.0						Grind to 30.0', using 8" rock bit
30.0						

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PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River

HOLE NO. BR WES L-5-86

DRILLING LOG		DIVISION Ohio River		INSTALLATION Locks & Dam No. 2, Monongahela River		SHEET 4 OF 8 SHEETS	
1. PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River				10. SIZE AND TYPE OF BIT 4 x 5"			
2. LOCATION (Coordinates or Station) Landward, monolith 43, 42' in from river face, 12' U.S. of				11. DATUM FOR ELEVATION SHOWN (FSM or MSL) MSL			
3. DRILLING AGENCY Mononeth Joint USAE WES				12. MANUFACTURER'S DESIGNATION OF DRILL Falling Truck - Mounted Rig			
4. HOLE NO. (As shown on drawing title) and Site Number BR WES L-5-86				13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN 12			
5. NAME OF DRILLER Gene Warhurst				14. TOTAL NUMBER CORE BOXES 7			
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				15. ELEVATION GROUND WATER			
7. THICKNESS OF OVERBURDEN 54.9'				16. DATE HOLE STARTED 18 Jan 86 COMPLETED 10 Feb 86			
8. DEPTH DRILLED INTO ROCK 18.3'				17. ELEVATION TOP OF HOLE 730.5'			
9. TOTAL DEPTH OF HOLE 73.2'				18. TOTAL CORE RECOVERY FOR BORING Rock 80 %			
				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	
31.0			One large piece of slag, 5" diameter, steel fragments to 2" diameter	75	Sample 7	5" drive sample using 300-lb hammer	
32.0						Grind to 35.2' using 8" rock bit	
33.0							
34.0							
35.0							
36.0			Silty clay, grayish-brown, slag pieces to 2" maximum diameter	90	Sample 8	5" drive sample, using 300-lb hammer	
37.0							
38.0						Grind to 40' using 8" rock bit	
39.0							
40.0							

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PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River

HOLE NO. BR WES L-5-

DRILLING LOG		DIVISION		INSTALLATION		SHEET	
		Ohio River		Locks & Dam No. 2, Monongahela River		5 OF 8 SHEETS	
1. PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River				10. SIZE AND TYPE OF BIT 1 1/2"			
2. LOCATION (Coordinate or Station) Landwall, Monolith 43, 42' in from river face, 12' U.S. of				11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL			
3. DRILLING AGENCY USAE WES				12. MANUFACTURER'S DESIGNATION OF DRILL Falling Truck - Mounted Rig			
4. HOLE NO. (As shown on drawing title) and file number BR WES L-5-86				13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN 12 UNDISTURBED			
5. NAME OF DRILLER Gene Wathurst				14. TOTAL NUMBER CORE BOXES -			
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCL. MED. _____ DES. FROM VERT.				15. ELEVATION GROUND WATER			
7. THICKNESS OF OVERBURDEN 54.9'				16. DATE HOLE STARTED 19 Jan 86 COMPLETED 10 Feb 86			
8. DEPTH DRILLED INTO ROCK 18.3'				17. ELEVATION TOP OF HOLE 770.5'			
9. TOTAL DEPTH OF HOLE 73.2'				18. TOTAL CORE RECOVERY FOR BORING ROCK 80 %			
				19. SIGNATURE OF INSPECTOR			

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling logs, notes on logs, depth of overburden, etc., if significant)
71.0			Clay, s.s. gravel to 1-1/2", small slag pieces, to 1/2" maximum	75	Sample 9	2-1/2 in. splitspoon using 300-lb hammer
72.0			Brown clay, mixed gravel, pea size to 1-1/2", s.s., some crushed	75	Sample 10	2-1/2" drive sample using 300-lb hammer
73.0			Pea gravel, siliceous, may be fall-in. One large piece of sandstone	50	Sample 11	

DRILLING LOG			DIVISION		INSTALLATION		SHEET	
			Ohio River		Locks & Dam No. 2, Monongahela River		d OF 8 SHEETS	
1. PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River					10. SIZE AND TYPE OF BIT 4 X 5"			
2. LOCATION (Commenced at Station) Landwall, monolith 43.42' in from river face, 15' U.S. of					11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL			
3. DRILLING AGENCY Monolith joint USAE WES					12. MANUFACTURER'S DESIGNATION OF DRILL Falling Truck - Mounted Rig			
4. HOLE NO. (As shown on drawing title) and file number BR WES L-5-86					13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN 12 UNDISTURBED			
5. NAME OF DRILLER Gene Waghurst					14. TOTAL NUMBER CORE BOXES 7			
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.					15. ELEVATION GROUND WATER			
7. THICKNESS OF OVERBURDEN 54.9'					16. DATE HOLE STARTED 18 Jan 86 COMPLETED 10 Feb 86			
8. DEPTH DRILLED INTO ROCK 18.3'					17. ELEVATION TOP OF HOLE 730.5'			
9. TOTAL DEPTH OF HOLE 73.2'					18. TOTAL CORE RECOVERY FOR BORING Rock 80			
					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)		
51.0						Grind to 53.5' using 8" rock bit		
52.0								
53.0								
54.0			Clayey mud, brownish-gray, w/sand and s.s. gravel to maximum 1" diameter	85	Sample 12	2-1/2" drive sample using 300-lb hammer		
55.0			Clayey shale, greenish-blue, soft Rubble-gray shale w/iron staining, moderately hard, friable			Run: 2 Begin: 55.0' End: 57.0' D.T.: 33 min Rec: 1.4'		
56.0			Gray shale, moderately hard, breaks at 20° angle along iron-stained bands.	80				
57.0			cored over		Box 2			
58.0			Iron-stained crumbly, broken up, brown shale Healed verticle joint	80		Run: 3 Begin: 56.4' End: 58.5' D.T.: 25 min Rec: 2.0'		
59.0			Vertical joint, open, hori- zontal crack, open			Run: 4 Begin: 58.4' End: 59.5' D.T.: 54 min Rec: 1.4'		
60.0			Shale, blue-gray, soft, clayey Vertical joint-all rubble	80				

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PROJECT Rehabilitation of
Locks & Dam No. 2, Monon-
gahela River

HOLE NO.
BR WES L-5-

DRILLING LOG		DIVISION Ohio River		INSTALLATION LOCKS & Dam NO. 2, Monongahela River		SHEET 7 OF 8 SHEETS	
1. PROJECT Renadilatation of Locks & Dam No. 2, Monongahela River				10. SIZE AND TYPE OF BIT 4 A 5"			
2. LOCATION (Continuation of Station Landwall, monolith 43.42' in from river face, 1st U.S. of				11. DATUM FOR ELEVATION SHOWN (MSL or MLL) MSL			
3. DRILLING AGENCY Monolith Joint USAE WES				12. MANUFACTURER'S DESIGNATION OF DRILL Falling Truck - Mounted Rig			
4. HOLE NO. (As shown on drawing title) and file number BR WES L-5-86				13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN: 2 UNDISTURBED			
5. NAME OF DRILLER Gene Warhurst				14. TOTAL NUMBER CORE BOXES 7			
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				15. ELEVATION GROUND WATER			
7. THICKNESS OF OVERBURDEN 54.9'				16. DATE HOLE STARTED 18 Jan 86 COMPLETED 10 Feb 86			
8. DEPTH DRILLED INTO ROCK 18.3'				17. ELEVATION TOP OF HOLE 730.5'			
9. TOTAL DEPTH OF HOLE 73.2'				18. TOTAL CORE RECOVERY FOR BORING ROCK 80			
				19. SIGNATURE OF INSPECTOR			
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV- ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of penetration, etc., if significant) g	
			Shale, blue-gray, soft, ver- tical joint-open	80	Box 3	Run: 5 Begin: 59.5' End: 61.0' D.T.: 1 hr 8 min Rec: 1.0'	
	61.0		Rubble				
			Calcareous nodules	80		Run: 6 Begin: 60.5' End: 62.5' D.T.: 59 min Rec: 1.7'	
	62.0		Rubble				
				80		Run: 7 Begin: 62.2' End: 63.75' D.T.: 1 hr 1 min Rec: 1.1'	
	63.0		Rubble		Box 4		
				80		Run: 8 Begin: 63.75 End: 65.80 D.T.: 39 min Rec: 1.58'	
	64.0						
			Brown-stained area, calca- reous nodules, healed hori- zontal fractures	80		Run: 9 Begin: 65.33 End: 66.91 D.T.: 51 min Rec: 1.58'	
	65.0						
			Blue-gray shale, soft to moderately hard, numerous healed horizontal fractures, brown staining and calca- reous inclusions	80		Run: 10 Begin: 66.91 End: 67.41 D.T.: 25 min Rec: 0.49'	
	66.0				Box 5		
			Shale, brown, moderately hard	80		Run: 11 Begin: 67.41' End: 70.0' D.T.: 53 min Rec: 1.39'	
	67.0		Rubble				
				80			
	68.0						
			Shale, blue-gray, moderately hard	80			
	69.0		Brown shale, rubble				
			Gray shale, soft to moder- ately hard	80			
	70.0				Box		

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PROJECT Renadilatation of
Locks & Dam No. 2, Monon-
gahela River

HOLE NO.
BR WES L-5-8

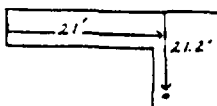
DRILLING LOG		DIVISION		INSTALLATION		SHEET	
		Ohio River		Locks & Dam No. 2, Monongahela River		8 OF 8 SHEETS	
1. PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River				10. SIZE AND TYPE OF BIT 1 1/2" V			
2. LOCATION (Continuation of Station Landwall, Monolith 43, 42' in from river face, 12' U.S. of				11. DATUM FOR ELEVATION SHOWN (TBM or MSL)			
3. DRILLING AGENCY Monolith joint USAE WES				MSL			
4. HOLE NO. (As shown on drawing title) and file number				12. MANUFACTURER'S DESIGNATION OF DRILL			
BR WES L-5-86				Falling Truck - Mounted Rig			
5. NAME OF DRILLER Gene Warhurst				13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN 12			
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				14. TOTAL NUMBER CORE BOXES -			
7. THICKNESS OF OVERBURDEN 54.9'				15. ELEVATION GROUND WATER			
8. DEPTH DRILLED INTO ROCK 18.3'				16. DATE HOLE STARTED 18 Jan 86 COMPLETED 10 Feb 86			
9. TOTAL DEPTH OF HOLE 73.2'				17. ELEVATION TOP OF HOLE 730.5'			
				18. TOTAL CORE RECOVERY FOR BORING Rock 80			
				19. SIGNATURE OF INSPECTOR			
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVER- ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water used, depth of weathering, etc., if significant) g	
			Brown & gray rubble Gray shale Brown shale, rubble Gray shale, soft to moder- ately hard Brown shale, rubble, mottled with gray Gray shale, soft to moder- ately hard		6 80 Box 7 80	Run: 12 Begin: 68.8' End: 70.4' D.T.: 49 min Rec: 1.6' Run: 13 Begin: 70.4' End: 71.7' D.T.: 40 min Rec: 1.3' Run: 14 Begin: 71.7' End: 73.2' D.T.: 45 min Rec: 1.5'	

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PROJECT Rehabilitation of
Locks & Dam No. 2, Monon-
gahela River

HOLE NO.
BR WES L-5-8

DRILLING LOG		DIVISION	INSTALLATION	SHEET		
		Ohio River	Lock & Dam #2	1 OF 1 SHEETS		
1. PROJECT Rehab. of Lock & Dam 2, Mon. River						
2. LOCATION (Continuation of Station)						
See Remarks						
3. DRILLING AGENCY USAE-WES						
4. HOLE NO. (As shown on drawing (1111) and file number) BR WES L-6						
5. NAME OF DRILLER Dan Pavlor						
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ☒ HORIZONTAL DES. FROM VERT.						
7. THICKNESS OF OVERBURDEN						
8. DEPTH DRILLED INTO ROCK						
9. TOTAL DEPTH OF HOLE						
10. SIZE AND TYPE OF BIT						
11. DAY/IN FOR ELEVATION SHOWN (TYPE OF LOG)						
12. MANUFACTURER'S DESIGNATION OF DRILL KVA-12, Series A-100, 110 volt						
13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN						
14. TOTAL NUMBER CORE BOXES						
15. ELEVATION GROUND WATER						
16. DATE HOLE STARTED 127 Oct 25 COMPLETED 27 Oct 25						
17. ELEVATION TOP OF HOLE						
18. TOTAL CORE RECOVERY FOR BORING						
19. SIGNATURE OF INSPECTOR						
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVER- ERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	0.0		Surface Condition: moderately weathered with exposed agg. - max. agg. size is 2". Few cracks with slight separation are nearby.	100%		Run: 1 Begin: 0.0 End: 1.15 D.T.: 40 min. Rec: 1.15 Remarks: -
	1.0					
	2.0		3.0 - 2.55 Concrete: gray, pre- dominately crushed limestone agg., max. agg. size is 3", pre- dominately subangular; good consolidation, entrapped air, en- trained air, many voids - none greater than 1/4" diameter & deep, some agg. are cracked.	100%	Box 1	Run: 2 Begin: 1.15 End: 2.55 D.T.: 1 hr 20 min Rec: 1.4' Remarks: Drill ac- tion was smooth throughout boring. 100% of water was retained.
	2.5				Run 2	
			B.O.B. = 2.55'			ABBREVIATIONS: agg: aggregate max: maximum D.T.: drill time Rec: recovery B.O.B.: end of boring. LOCATION: Large Chamber — flow → K-212-1 mono. 47 BAND TALL

DRILLING LOG		DIVISION Ohio River	INSTALLATION Lock & Dam #2	Hole No. L-7 SHEET 1 OF 1 SHEETS		
1. PROJECT Rehab. of Lock & Dam 2, Mon. River			10. SIZE AND TYPE OF BIT 7" Diamond Bit			
2. LOCATION (Coordinates or Station) See Remarks			11. DATUM FOR ELEVATION BROWN (1985 = MSL)			
3. DRILLING AGENCY USAE-WES			12. MANUFACTURER'S DESIGNATION OF DRILL Pilling 1500			
4. HOLE NO. (As shown on drawing title) and Site Number BR WES L-7			13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN: 0 DISTURBED 0 UNDISTURBED			
5. NAME OF DRILLER Wernhurst			14. TOTAL NUMBER CORE BOXES 3			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.			15. ELEVATION GROUND WATER n/a			
7. THICKNESS OF OVERBURDEN			16. DATE HOLE 126 NOV 85 2 DEC 85			
8. DEPTH DRILLED INTO ROCK			17. ELEVATION TOP OF HOLE 730.5'			
9. TOTAL DEPTH OF HOLE 6.5' into Concrete			18. TOTAL CORE RECOVERY FOR BORING 100%			
19. SIGNATURE OF INSPECTOR <i>Michael M. [Signature]</i>						
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of penetration, etc., if significant)
	0.0		Surface Condition: slightly weathered with light scal- ing. Exposed aggregate generally less than 1/2".			RUN: 1 Begin: 0.0 End: 2.25 D.T: 20 min. Rec: 2.15
	1.0		0.0 - 6.5 Concrete: gray, pre- dominately crushed limestone aggregate, maximum aggregate size is 3", subangul- ar to angular, good consolidation, en- trapped & entrained air, some aggregate are cracked, scatter- ed voids - none larger than 1/4" deep & diameter unless noted.	100%	Box 1	Remarks: Pulled off hole without pull- ing core on 27 Nov 85. On 2 Dec 85 pulled run 1, 2.15' Pulled off .1'.
	2.0				Run 1	Run: 2 Begin: 2.25 End: 4.35 D.T: 20 min. Rec: 2.2
	3.0			100%	Box 2	Remarks: Picked up .1' from run 1.
	4.0				Run 2	Run: 3 Begin: 4.35 End: 6.5 D.T: 2 hrs. Rec: 2.15
	5.0		5.4 - 6.5: encounter- 5" pipe (i.d.) with 3/8" steel wall.	100%	Box 3	Remarks: Water loss beginning @ 5.5'; encountered drain pipe (steel walled) @ 5.4'.
	6.0				Run 3	BOXES: 1. 0.0 - 2.15 2. 2.15 - 4.35 3. 4.35 - 6.5
	6.5		E.O.B. @ 6.5'			Note: Hole abandoned & relocated 2.5' downstream, see hole L-7A. LOCATION: Large Chamber Flow Monolith 49 

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PROJECT Rehab of Lock &
Dam 2, Mon. River
HOLE NO.
BR WES L-7A

DRILLING LOG		DIVISION	INSTALLATION	SHEET		
		Ohio River	LOCK & DAM #2	OF 12 SHEETS		
1. PROJECT Rehab. of Lock & Dam 2, Mon. River		10. SIZE AND TYPE OF BIT 1 1/2" HSS				
2. LOCATION (Coordinates or Station) See Remarks		11. DATUM FOR ELEVATION SHOWN (TBM or B.M.) +57				
3. DRILLING AGENCY USACE - LOS		12. MANUFACTURER'S DESIGNATION OF DRILL Halling 1000				
4. HOLE NO. (As shown on drawing title) and file number BR WES L-7A		13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN 1 DISTURBED 0 UNDISTURBED				
5. NAME OF DRILLER Wainwright		14. TOTAL NUMBER CORE BOXES				
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER				
7. THICKNESS OF OVERBURDEN 58.9' Concrete		16. DATE HOLE 15 Dec 85				
8. DEPTH DRILLED INTO ROCK 60.6'		17. ELEVATION TOP OF HOLE 750.5'				
9. TOTAL DEPTH OF HOLE 119.5'		18. TOTAL CORE RECOVERY FOR BORING Rock 98 %				
		19. SIGNATURE OF INSPECTOR				
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling run, water level, depth of weathering, etc., if significant)
	0.0		Surface Condition: slightly weathered with light scaling. Maximum aggregate size is generally less than 1" (exposed).	100%	Box 1	Run: 1 Begin: 0.0 End: 2.2 D.T.: 15 min. Rec: 2.2 Remarks: --
	1.0		0.0 - Concrete: gray, maxi- mum aggregate size is 3", good consolida- tion, entrapped air.		Run 1	
	2.0		0.0 - 38.5: predomi- nantly crushed lime- stone aggregate, subangular to angu- lar, entrained air, many voids generally less than 1" dia- meter & deep, some aggregate are crack- ed.	100%	Box 2	Run: 2 Begin: 2.2 End: 4.35 D.T.: 25 min. Rec: 2.1 Remarks: forked on the catcher. Pulled off .05'.
	3.0				Run 2	
	4.0		2.4: 1" long void.			
	5.0			100%	Box 3	Run: 3 Begin: 4.35 End: 9.2 D.T.: 30 min. Rec: 4.85 Remarks: Picked up .05' from run 2, pulled off .05' this run.
	6.0					
	7.0				Box 4	
	8.0		3 7.95: man made break.		Run 3	

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PROJECT Rehab. of Lock &
Dam 2, Mon. River

HOLE NO.
BR WES L-7A

DRILLING LOG			DIVISION Main River	INSTALLATION Lock & Dam #2	Hole No. SHEET 2 OF 12 SHEETS
1. PROJECT Rehab. of Lock & Dam 2, Mon. River			10. SIZE AND TYPE OF BIT 6" Diamond Bit		
2. LOCATION (Coordinates or Station) See Remarks			11. DATUM FOR ELEVATION SHOWN (MSL or GLL) MSL		
3. DRILLING AGENCY USAF WES			12. MANUFACTURER'S DESIGNATION OF DRILL Falling 1500		
4. HOLE NO. (As shown on drawing title) and HSE Number BR WES L-7A			13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0 UNDISTURBED 0		
5. NAME OF DRILLER Warhurst			14. TOTAL NUMBER CORE BOXES		
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.			15. ELEVATION GROUND WATER		
7. THICKNESS OF OVERBURDEN 58.9' Concrete			16. DATE HOLE STARTED 3 Dec 85 COMPLETED		
8. DEPTH DRILLED INTO ROCK 60.6'			17. ELEVATION TOP OF HOLE 770.5'		
9. TOTAL DEPTH OF HOLE 119.5'			18. TOTAL CORE RECOVERY FOR BORING Rock 98		
			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)
11.0	11.0	[Symbol]	3 11.35: man made break.	100%		Run: 4 Begin: 9.2 End: 14.2 D.T: 25 min. Rec: 5.05 Remarks: Picked up .35' from run 3.
12.0	12.0					
13.0	13.0	[Symbol]	3 13.1: man made break during retrieval.	Box 5		
14.0	14.0					
15.0	15.0	[Symbol]	3 15.2: man made break.	Box 6		Run: 5 Begin: 14.2 End: 19.2 D.T: 20 min. Rec: 4.75 Remarks: Pulled off .25'.
16.0	16.0					
17.0	17.0	[Symbol]	3 17.85: man made break.	100%		
18.0	18.0					
19.0	19.0	[Symbol]	3 18.35: man made break.	Box 7		
				Run 5		

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MAR 71 (TRANSLUCENT)

PROJECT Rehab. of Lock & Dam 2, Mon. River
HOLE NO. BR WES L-7A

Hole No. C-71

DRILLING LOG		DIVISION Ohio River		INSTALLATION Lock 2, Dam 2		SHEET 7 OF 12 SHEETS	
1. PROJECT Rehab. of Lock & Dam 2, Mon. River				10. SIZE AND TYPE OF BIT 4" Diamond Bit			
2. LOCATION (Coordinates or Station)				11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL			
3. DRILLING AGENCY USAE WES				12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500			
4. HOLE NO. (As shown on drawing 11261 and file number) BR WES C-71				13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN DISTURBED 0 UNDISTURBED 0			
5. NAME OF DRILLER Warhurst				14. TOTAL NUMBER CORE BOXES			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				15. ELEVATION GROUND WATER			
7. THICKNESS OF EVIDENCE 58.9' Concrete				16. DATE HOLE STARTED 3 Dec 85 COMPLETED			
8. DEPTH DRILLED INTO ROCK 60.6'				17. ELEVATION TOP OF HOLE 730.5'			
9. TOTAL DEPTH OF HOLE 119.5'				18. TOTAL CORE RECOVERY FOR BORING Rock 98 %			
19. SIGNATURE OF INSPECTOR							
ELEVATION •	DEPTH •	LEGEND •	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOV- ERY •	BOX OR SAMPLE NO. •	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)	
20.0						Run: 6 Begin: 19.2 End: 24.1 D.T: 25 min. Rec: 4.7 Remarks: Picked up .25' from run 5, pulled off .45' this run.	
21.0			20.4: man made break.	100%	Box 8		
22.0			21.05: man made break.				
23.0							
24.0				Run 6			
25.0			24.75: man made break.		Box 9	Run: 7 Begin: 24.1 End: 28.7 D.T: 25 min. Rec: 4.9 Remarks: Picked up .45' from run 6, pulled off .15' this run.	
26.0				100%			
27.0			27.25: man made break.				
28.0							
29.0			29.7: man made break.	Run 7	Box 10		

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(TRANSLUCENT)

PROJECT Rehab. of Lock & Dam 2, Mon. River
HOLE NO. BR WES L-7A

DRILLING LOG		DIVISION		INSTALLATION		SHEET 4	
PROJECT		Ohio River		Lock & Dam 2		OF 12 SHEETS	
1. PROJECT		2. LOCATION (Coordinates or Station)		10. SIZE AND TYPE OF BIT		11. DAYUM FOR ELEVATION SHOWN (FSM or MSL)	
Rehab. of Lock & Dam 2, Mon. River		See Remarks		5" Diamond Bit		MSL	
3. DRILLING AGENCY		4. HOLE NO. (As shown on drawing title) and file number		12. MANUFACTURER'S DESIGNATION OF DRILL		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	
USAE WES		BR WES L-7A		Falling 1500		0 0	
5. NAME OF DRILLER		6. DIRECTION OF HOLE		14. TOTAL NUMBER CORE BOXES		15. ELEVATION GROUND WATER	
Warhurst		☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		16. DATE HOLE		STARTED 3 Dec 85 COMPLETED	
7. THICKNESS OF OVERBURDEN		8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE		18. TOTAL CORE RECOVERY FOR BORING	
58.9' Concrete		50.6'		730.5'		Rock 98	
9. TOTAL DEPTH OF HOLE		19. SIGNATURE OF INSPECTOR					
119.5'							
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling run, motor loss, depth of overrunning, etc., if significant)	
30.0						Run: 3 Begin: 28.7 End: 33.5 D.T.: 25 min. Rec: 4.85 Remarks: Picked up .15' from run 7, pulled off .3' this run.	
31.0			30.9: man made break.		Box 11		
32.0			31.0: man made break.	100%			
33.0							
34.0						Run: 9 Begin: 33.5 End: 38.3 D.T.: 25 min. Rec: 4.85 Remarks: Picked up .3' from run 8, pulled off .25' this run.	
35.0			35.6: man made break.	100%	Box 12		
36.0			36.5: man made break.				
37.0			37.55: man made break retrieving core from the barrel.		Box 13		
38.0			39.5 - 38.9: aggregate becomes siliceous with some carbonates, rounded to subrounded, scattered voids generally less than 1".	Run 9			
39.0							

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PROJECT Rehab. of Lock & Dam 2, Mon. River

HOLE NO. BR WES L-7A

DRILLING LOG		DIVISION Ohio River	INSTALLATION Lock & Dam 2	SHEET 5 OF 12 SHEETS
1. PROJECT Rehab. of Lock & Dam 2, Mon. River		10. SIZE AND TYPE OF BIT 1" Diamond Bit		
2. LOCATION (Coordinates or Station) See Remarks		11. DATUM FOR ELEVATION SHOW (TSS or MSL) MSL		
3. DRILLING AGENCY USAE WES		12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500		
4. HOLE NO. (As shown on drawing title and file number) BR WES L-7A		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN DISTURBED: 0 UNDISTURBED: 0		
5. NAME OF DRILLER Warhurst		14. TOTAL NUMBER CORE BOXES		
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER		
7. THICKNESS OF CONCRETE 38.9'		16. DATE HOLE STARTED: 3 Dec 85 COMPLETED:		
8. DEPTH DRILLED INTO ROCK 60.6'		17. ELEVATION TOP OF HOLE 730.5'		
9. TOTAL DEPTH OF HOLE 119.5'		18. TOTAL CORE RECOVERY FOR BORING ROCK 98%		
		19. SIGNATURE OF INSPECTOR		

ELEVATION +	DEPTH +	LEGEND +	CLASSIFICATION OF MATERIALS (Description) +	% CORE RECOV- ERY +	BOX OR SAMPLE NO. +	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) +
40.0				100%		
41					Box 14	Run: 10 Begin: 38.3 End: 43.1 D.T: 25 min. Rec: 5.05 Remarks: Picked up .25' from run 9, hole is clean. Drill action became rough near 39.5' - probably due to the change in ag- gregate.
42			42.4: man made break retrieving core from barrel.	Run 10		
44					Box 15	Run: 11 Begin: 43.1 End: 48.0 D.T: 35 min. Rec: 4.6 Remarks: Pulled off .1'.
45			45.0: horizontal fracture - possi- bly due to rough drill action.	100%		
46			46.5: man made break.			
47			47.1: man made break retrieving core from barrel.	Run 11		
48					Box 16	
49			49.6: man made break retrieving core from barrel.			

DRILLING LOG		DIVISION	INSTALLATION	SHEET 6 OF 12 SHEETS		
1. PROJECT Rehab. of Lock & Dam 2, Mon. River			Lock 2 Dam 2	10. SIZE AND TYPE OF BIT A" Diamond Bit		
2. LOCATION (Compass or Station) See Remarks				11. DAY OF ELEVATION SHOWN (TYP. or MSL) MSL		
3. DRILLING AGENCY USAE WES				12. MANUFACTURER'S DESIGNATION OF DRILL Falling 1500		
4. HOLE NO. (As shown on drawing title and file number) BR WES L-7A				13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN DISTURBED 0 UNDISTURBED 0		
5. NAME OF DRILLER Wathurst				14. TOTAL NUMBER CORE BOXES		
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED DES. FROM VERT.				15. ELEVATION GROUND WATER		
7. THICKNESS OF OVERBURDEN 58.9' Concrete				16. DATE HOLE STARTED 3 Dec 85 COMPLETED		
8. DEPTH DRILLED INTO ROCK 60.6'				17. ELEVATION TOP OF HOLE 730.5'		
9. TOTAL DEPTH OF HOLE 119.5'				18. TOTAL CORE RECOVERY FOR BORING Rock 98 %		
				19. SIGNATURE OF INSPECTOR		
ELEVATION =	DEPTH =	LEGEND =	CLASSIFICATION OF MATERIALS (Description) =	% CORE RECOV- ERY =	BOX OR SAMPLE NO. =	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) =
50.0				100%		Run: 12 Begin: 48.0 End: 52.8 D.T: 35 min. Rec: 2.55 Remarks: Picked up .1' from run 11, pulled off 2.35' this run.
51.0					Box 17	
52.0			@ 52.0: man made break retrieving core from barrel.	Run 12		
53.0			@ 53.15: horizontal fracture - possibly a machine break.			
54.0				100%	Box 18	Run: 13 Begin: 52.6 End: 55.3 D.T: 30 min. Rec: 4.5 Remarks: Picked up 2.55' from run 12, pulled off .35' this run.
55.0						
56.0				Run 13		
57.0			@ 56.75: 4" aggre- gate. 56.85 - 57.1: man made rubble getting the core out of the catcher.		Box 19	Run: 14 Begin: 55.3 End: 56.3 D.T: 30 min. Rec: 3.0 Remarks: Picked up .35' from run 13, pulled off 1.45' this run. Went back in the hole & tried to pull the rest of the core - retrieved .25', therefore leaving 1.2' in the hole.
58.0			@ 56.45: man made break.	Run 14		
59.0			58.9: contact of Con- crete & Shale is indist.		Box 20	
					Tag 1	

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PROJECT Rehab. of Lock & Dam 2, Mon. River HOLE NO. BR WES L-7A

DRILLING LOG		DIVISION	INSTALLATION	LOCK & DAM NO.	SHEET
Ohio River		Monongahela River	LOCK & DAM NO. 2	2	OF 12 SHEETS
1. PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River			10. SIZE AND TYPE OF BIT 4" X 7-3/4"		
2. LOCATION (Coordinates or Station)			11. DAYUM FOR ELEVATION (HBM or MSL)		
See Remarks			MSL		
3. DRILLING AGENCY USAE WES			12. MANUFACTURER'S DESIGNATION OF DRILL		
4. HOLE NO. (As shown on drawing title and file number) BR WES L-7A			Failing 1500		
5. NAME OF DRILLER Warhurst			13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: 0 0		
6. DIRECTION OF HOLE			14. TOTAL NUMBER CORE BOXES 40		
☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.			15. ELEVATION GROUND WATER		
7. THICKNESS OF OVERBURDEN 58.9' concrete			16. DATE HOLE STARTED 1 Dec 85 COMPLETED		
8. DEPTH DRILLED INTO ROCK 60.6'			17. ELEVATION TOP OF HOLE 730.5'		
9. TOTAL DEPTH OF HOLE 119.5'			18. TOTAL CORE RECOVERY FOR BORING Rock 98 %		
			19. SIGNATURE OF INSPECTOR		

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Describe here)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
60.0			58.9-64.5: Clay Shale: Weathered gray w/occ red, thinly bedded, soft, becoming soft to moderately hard @ 62.7', dense, flat bedding solid, silty to very silty highly fractured w/slicken-sides.		Bag 1	Run: 15 Begin: 58.3' End: 61.8' D.T.: 2 hr Rec.: 3.8 Remarks: Taped hole to 60.9'. Drill action was smooth in clay shale.
61.0			58.9-62.7: Essentially rubble due to separation of bedding planes, occ. gravel size siltstone (2").			
62.0			62.3-62.7': Many open fractures-essentially rubble.			Run: 16 Begin: 61.8' End: 65.5' D.T.: 2 hr 30 min Rec.: 3.6 Remarks: Taped hole to 64.5'.
63.0			@ 62.7': Open Ht < fracture @ 63.3': Open Horizontal fracture.		20	
64.0			@ 63.5': Well healed siltstone filled fracture.			
65.0			@ 63.9': Well healed siltstone filled fracture.			
66.0			@ 64.15': Open horizontal fracture after reaching surface.		Carton 1	
67.0			64.5': Silty Shale: Weathered gray with very little red, thinly bedded, moderately hard to hard, flat bedding gen. solid, highly fractured (3" sp) with gouges (gen. silt filled), slicken-sides.			Run: 17 Begin: 65.5' End: 69.3' D.T.: 2 hr 10 min Rec.: 4.0 Remarks: Taped hole to 68.5'.
68.0			64.5-65.5': Rubble: As a result of cutting over the core w/ the core bbl., occ. siltstone gravels (2").		21	
69.0			65.5-68.5': Many fractures, well healed and open, 2-3" sp., open fractures as follows: @ 65.5': Ht < @ 66.1': Horizontal w/a few fractures just above. @ 67.35': Horizontal			
70.0						

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MAR 71 (TRANSLUCENT)

PROJECT Rehabilitation of
Locks & Dam No. 2, Monon-
gahela River

HOLE NO.
L-7A

Hole No. L-7A

DRILLING LOG		DIVISION	INSTALLATION	LOCK & DAM NO.	SHEET
Ohio River		Monongahela River	Lock & Dam No. 2	8	OF 12 SHEETS
1. PROJECT: Rehabilitation of Lock & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT 6" X 7-3/4"			
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (FWS or MSL)			
See Remarks		MSL			
3. DRILLING AGENCY USAE WES		12. MANUFACTURER'S DESIGNATION OF DRILL Falling 1500			
4. HOLE NO. (As shown on drawing (1110) and file number)		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN			
BR WES L-7A		DISTURBED 0 UNDISTURBED 0			
5. NAME OF DRILLER Warhurst		14. TOTAL NUMBER CORE BOXES 40			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER			
7. THICKNESS OF OVERBURDEN 58.9' CONCRETE		16. DATE HOLE STARTED 3 Dec 85 COMPLETED			
8. DEPTH DRILLED INTO ROCK 80.6'		17. ELEVATION TOP OF HOLE 730.5'			
9. TOTAL DEPTH OF HOLE 119.5'		18. TOTAL CORE RECOVERY FOR BORING Rock 98 %			
19. SIGNATURE OF INSPECTOR					

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Designations)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, major loss, depth of overburden, etc., if significant)
70.0			68.5-69.2': 1 side of vertical fracture is rubble due to cutting over core.		22	Run: 18 Begin: 69.3' End: 73.3' D.T.: 1 hr 50 min Rec.: 4.2
71.0			@ 69.2': Machine break.			
			@ 69.55': Horizontal fracture.			Remarks: Taped hole to 72.7'.
72.0			@ 69.7-69.9': Irregular well healed fracture.			Drill action became rough near 71.5'.
			@ 70.2-70.6': Well healed vertical fracture.			
73.0			@ 71.5': Irregular well healed fracture.			
			@ 73.1': Machine break.		23	
74.0			@ 74.55: Machine break.			Run: 19 Begin: 73.3' End: 77.5' D.T.: 1 hr Rec.: 5.0
75.0			@ 75.7': Machine break.			Remarks: Taped hole to 77.1'.
			75.7': Well healed vertical fracture.			
76.0			@ 76.6': MMB		24	
77.0						77.1
78.0			@ 78.3': Open horizontal fracture. Probably a machine break.			Run: 20 Begin: 77.5' End: 81.7' D.T.: 1 hr Rec.: 4.1
79.0			@ 78.95': Open horizontal fracture. Probably a machine break.		25	Remarks: Taped hole to 81.2'.
80.0						

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MAR 71

(TRANSLUCENT)

PROJECT Rehabilitation of
Locks & Dam No. 2, Monongahela RiverHOLE NO.
L-7A

DRILLING LOG		DIVISION Ohio River	INSTALLATION Lock & Dam No. 2, Monongahela River	Hole No. L-7A SHEET 9 OF 12 SHEETS
1. PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT 5" X 3/4"		
2. LOCATION (Compliance or Station) See Remarks		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL		
3. DRILLING AGENCY USAE WES		12. MANUFACTURER'S DESIGNATION OF DRILL Failine 1500		
4. HOLE NO. (As shown on drawing 11101) and file number BR WES L-7A		13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN: DISTURBED 0 UNDISTURBED 0		
5. NAME OF DRILLER Wathurst		14. TOTAL NUMBER CORE BOXES 40		
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER —		
7. THICKNESS OF OVERBURDEN 58.9' concrete		16. DATE HOLE STARTED 15 Dec 85 COMPLETED		
8. DEPTH DRILLED INTO ROCK 20.6'		17. ELEVATION TOP OF HOLE 730.5'		
9. TOTAL DEPTH OF HOLE 119.5'		18. TOTAL CORE RECOVERY FOR BORING Rock 98 %		
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)
80.0			80.1' - MB			
81.0					26	
82.0			82.1' - MB			Run: 21 Begin: 81.7' End: 85.9' D.T.: 1 hr 20 min Rec.: 4.0
83.0			83.0 - MB			Remarks: Taped hole to 85.3'.
84.0			83.8' - MMB Removing catcher.		27	
85.0						85.3'
86.0			86.2-86.6': Machine cut over this part of core. 86.6-89.3': Well healed vertical fracture.			86.0'
87.0						Run: 22 Begin: 85.9' End: 90.1' D.T.: 1 hr 15 min Rec.: 3.3
88.0			87.7' - MB 87.7-87.9': Low $\angle$ well healed fracture. 88.4-88.7': H1 $\angle$ well healed fracture.		28	Remarks: Taped hole to 89.3'.
89.0			89.3' slick at bottom of recovery.			89.3'
90.0			Broken from going over the core with the barrel.		29	

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PROJECT Rehabilitation of
Locks & Dam No. 2, Monon-
gahela River

HOLE NO.
L-7A

DRILLING LOG		DIVISION	INSTALLATION	LOCK & DAM NO.	SHEET
Ohio River		Monongahela River	LOCK & DAM NO. 2	Monongahela River	11 OF 12 SHEETS
1. PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT 7-3/4"			
2. LOCATION (Continuation of Station)		11. DATE FOR ELEVATION SHOWN (FSM or MSL)			
See Remarks		MSL			
3. DRILLING AGENCY USAE WES		12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500			
4. HOLE NO. (As shown on drawing title) and Ht. Number BR WES L-7A		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN 0 UNDISTURBED 0			
5. NAME OF DRILLER Warhurst		14. TOTAL NUMBER CORE BOXES 40			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER ---			
7. THICKNESS OF OVERBURDEN 58.9' concrete		16. DATE HOLE STARTED 15 Dec 85 COMPLETED			
8. DEPTH DRILLED INTO ROCK 60.6'		17. ELEVATION TOP OF HOLE 730.5'			
9. TOTAL DEPTH OF HOLE 119.5'		18. TOTAL CORE RECOVERY FOR BORING Rock 98 %			
		19. SIGNATURE OF INSPECTOR			

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Designation)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
100.0			99.9-100.2': Ht < open fracture w/slick.		33	Run: 25 Begin: 96.8' End: 100.6' D.T.: 1 hr 10 min Rec: 4.45 Remarks: Taped 101.3' hole to 100.15'
101.0			100.4-100.8': Ht < open fracture w/slick.			
			100.9-101.3': Ht < open fracture w/slick.			
102.0			101.9-102.3': Ht < open fracture w/slick.		34	Run: 26 Begin: 100.6' End: 104.7' D.T.: 1 hr Rec: 3.15
103.0			102.5-102.8': Ht < open fracture w/slick.			
			102.8-103.3': Becomes harder w/silty pockets or gouges.			103.3'
104.0			103.3-107.2': Clay shale: Weathered, highly fractured space generally 4-6", gray becoming red near 105.0', soft, gravel size silt, stone filled gouges, thinly bedded, flat bedding, very silty.		35	
105.0			103.3-103.6': fractured rubble.			
106.0		Partially healed Fracture	@ 105.8 low open fracture.		36	Run: 27 Begin: 104.7' End: 103.0 D.T.: 2 hr Rec: 3.7 Remarks: Taped hole to 107.2'
107.0			@ 106.5-106.8': Low open fracture w/slick.			107.2'
108.0			107.2-111.0': Clay shale: gray, weathered, fractured, moderately hard, thinly bedded, flat bedding, solid dense.		37	
109.0			107.2-107.9': Fractured to a rubble; went over with core barrel.			
			@ 107.9': Open horizontal fracture.			
			@ 109.5': Open horizontal fracture.			
110.0						

ENG FORM 1836
MAR 71PREVIOUS EDITIONS ARE OBSOLETE
(TRANSLUCENT)PROJECT Rehabilitation of
Locks & Dam No. 2, Monon-
gahela RiverHOLE NO.
L-7A

Hole No. L-7A

DRILLING LOG		DIVISION Ohio River	INSTALLATION Lock & Dam No. 2, Monongahela River	SHEET 12 OF 14 SHEETS
1. PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River			10. SIZE AND TYPE OF BIT O A 1-3/4	
2. LOCATION (Coordinates or Station)			11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USAE WES			12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500	
4. HOLE NO. (As shown on drawing title) and file number BR WES L-7A			13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN DISTURBED 0 UNDISTURBED 0	
5. NAME OF DRILLER Warhurst			14. TOTAL NUMBER CORE BOXES 40	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.			15. ELEVATION GROUND WATER —	
7. THICKNESS OF OVERBURDEN 58.9' concrete			16. DATE HOLE STARTED 3 Dec 85 COMPLETED	
8. DEPTH DRILLED INTO ROCK 50.0'			17. ELEVATION TOP OF HOLE 730.5'	
9. TOTAL DEPTH OF HOLE 119.5'			18. TOTAL CORE RECOVERY FOR BORING Rock 98 %	
			19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV- ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water level, depth of weathering, etc., if significant) g
110.0			110.4-110.5': Fractured to a rubble. @ 110.5' open horizontal fracture.		38	Run: 28 Begin: 108.0' End: 112.0' D.T.: 2 hr 10 min Rec.: 3.8'
111.0			111.0-113.9': Clay shale: Red with some gray, soft, weathered, highly fractured with some slicks, thinly bedded. flat bedding, dense, solid		carton 2	Remarks: Taped hole to 111.0'.
112.0			111.0-112.0': Rubble due to drilling over. @ 112.0' open horizontal fracture.			Run: 29 Begin: 112.0' End: 115.8' D.T.: 2 hr Rec.: 2.9'
113.0			112.1-112.25': open low angle fractures. @ 113.2' open horizontal fractures. @ 113.65' open fracture with slick.		38	Remarks: Taped hole to 113.9'.
114.0			113.65-113.9': fractured to a rubble.		Bag 4	113.65'
115.0			113.9-117.0': Clay shale: Highly frac- tured, weathered, soft, mottled, flat bedding, thinly bedded, solid, dense.		Bag 5	113.9'
116.0			113.9-114.8': rubble due to drilling over. 114.8-115.1': low angle partially healed frac- ture.		Bag 6	114.3'
117.0			@ 115.6' open horizontal fracture. 116.6-117.0': highly fractured to a rubble.		Bag 7	114.6'
118.0			117.0-119.5': Clay shale: Highly frac- tured, weathered, soft, mottled, flat bedding, thinly bedded, dense, solid.		39	Run: 30 Begin: 115.8' End: 118.0' D.T.: 3 hr Rec.: 3.1'
119.0			@ 117.6' low angle open fracture. @ 117.8' low angle open fracture. 117.8-117.9' fractured to a rubble.		Bag 8	116.6'
120.0			117.9-118.2' high angle open fracture. 118.4-118.8' clay filled low angle fracture. @ 119.2' low angle open fracture with slick. @ 119.5' E.O.B.		40	117.0'
						Run: 31 Begin: 118.0' End: 120.7' D.T.: 1 hr 30 min Rec.: 2.5'
						Remarks: Taped hole to 120.7'.

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PROJECT Rehabilitation of
Locks & Dam No. 2, Monon-
gahela River

HOLE NO.
L-7A

DRILLING LOG		DIVISION	INSTALLATION	Hole No.		
1. PROJECT Rehab. of Lock & Dam 2, Mon. River		Ohio River	Lock & Dam #2	SHEET 1 OF 2 SHEETS		
2. LOCATION (Coordinates or Station) See Remarks		10. SIZE AND TYPE OF BIT				
3. DRILLING AGENCY USAB-453		11. DATUM FOR ELEVATION SHOWN (FEM - ASL) MSL				
4. HOLE NO. (As shown on drawing title) and file number BR WES L-9		12. MANUFACTURER'S DESIGNATION OF DRILL Dilling 1500				
5. NAME OF DRILLER Warrust		13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN				
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED		14. TOTAL NUMBER CORE BOXES				
7. THICKNESS OF OVERBURDEN		15. ELEVATION GROUND WATER				
8. DEPTH DRILLED INTO ROCK		16. DATE HOLE				
9. TOTAL DEPTH OF HOLE		17. ELEVATION TOP OF HOLE				
		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 weathering, etc., if significant)
	0.0		Surface Condition: slightly weathered with light scaling. Maximum exposed aggregate size is 1/2". Hole is located on a surface crack - note to what depth it extends.			Run: 1 Begin: 0.0 End: 2.2 D.T.: 15 min. Rec: 2.2 Remarks: Started hole with a thin- walled diamond bit
	1.0		Concrete: gray, pre- dominately crushed limestone aggregate, subangular to angular, has entrained air, many voids generally less than 1/4" diameter & deep, some aggregate are cracked, 0.0 - 1.5: maximum aggregate size is 1/2". 1.5 - 10.0: maximum aggregate size is 3/4". 0.0 - 2.85: vertical crack in core - becomes open @ 2.2'. 2.4 - 2.9: incipient vertical crack. @ 3.75: copper wire in core.	100%	Box 1	
	2.0				Run 1	
	3.0					Run: 2 Begin: 2.2 End: 7.15 D.T.: 50 min. Rec: 4.95 Remarks: --
	4.0				Box 2	
	5.0			100%		
	6.0		@ 5.75: man made break.		Box 3	
	7.0				Run 2	
	8.0					Run: 3 Begin: 7.15 End: 10.65 D.T.: 55 min. Rec: 2.85 Remarks: Pulled off .05'.
	9.0			100%	Box 1	
ABBREVIATIONS: D.T: drill time Rec: recovery C.C.B: end of boring.						

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PROJECT Rehab. of Lock &
Dam 2, Mon. River

HOLE NO.
BR WES L-9

Hole No. 0-1

DRILLING LOG		DIVISION		INSTALLATION		SHEET 2 OF 2 SHEETS	
1. PROJECT Rehab. of Lock & Dam 2, Mon. River		Ohio River		Lock & Dam 2			
2. LOCATION (Coordinates or Station)		See Remarks		10. SIZE AND TYPE OF BIT 6" diamond			
3. DRILLING AGENCY USAF WES				11. DATUM FOR ELEVATION SHOWN (MSL or MLL)		MSL	
4. HOLE NO. (As shown on drawing title) and file number BR WES L-9				12. MANUFACTURER'S DESIGNATION OF DRILL Falling 1500			
5. NAME OF DRILLER Warhurst				13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN		DISTURBED 0 UNDISTURBED 0	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				14. TOTAL NUMBER CORE BOXES 4			
7. THICKNESS OF OVERBURDEN 0.0				15. ELEVATION GROUND WATER n/a			
8. DEPTH DRILLED INTO ROCK 0.0				16. DATE HOLE 18 Dec 85		STARTED 18 Dec 85 COMPLETED 18 Dec 85	
9. TOTAL DEPTH OF HOLE 10.65' in Concrete				17. ELEVATION TOP OF HOLE 730.5'			
				18. TOTAL CORE RECOVERY FOR BORING 100 %			
				19. SIGNATURE OF INSPECTOR <i>[Signature]</i>			
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	1. CORE RECOVERY e	2. BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of overburden, etc., if significant) g	
	10.0					LOCATION:	
	10.65		B.O.B. - 10.65				

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PROJECT Rehab. of Lock & Dam 2, Mon. River HOLE NO. BR WES L-9

DRILLING LOG			DIVISION	INSTALLATION	SHEET	
1. PROJECT			1010 ALVER	LOCK 2	OF 10 SHEETS	
2. LOCATION (Coordinates or Station)			10. SIZE AND TYPE OF BIT			
3. DRILLING AGENCY			11. DATUM FOR ELEVATION SHOWN (ITEM 10)			
4. HOLE NO. (As shown on drawing title and file number)			12. MANUFACTURER'S DESIGNATION OF DRILL			
5. NAME OF DRILLER			13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN			
6. DIRECTION OF HOLE			14. TOTAL NUMBER CORE BOXES			
7. THICKNESS OF OVERLIE/ROCK			15. ELEVATION GROUND WATER			
8. DEPTH DRILLED INTO ROCK			16. DATE HOLE			
9. TOTAL DEPTH OF HOLE			17. ELEVATION TOP OF HOLE			
			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 overburden, etc., if significant)
	0.0		Surface Condition: slightly weathered with light scaling. Maximum exposed aggregate size is 2".			Run: 1 Begin: 0.0 End: 2.3 D.T.: 45 min. Rec: 2.3 Remarks: --
	1.0		0.0 - Concrete: gray, siliceous with occasional carbonates, maximum aggregate size is 3", river gravel, sub-rounded to subangular, good consolidation, has entrained air, no entrained air, scattered voids generally less than 1/4" diameter & deep.	100%	Box 1	
	2.0					
	3.0		1.0: man made break retrieving core.			Run: 2 Begin: 2.3 End: 4.6 D.T.: 30 min. Rec: 2.3 Remarks: --
	4.0		1.0 - 1.2: man made chip in the side of the core.	100%	Box 2	
	5.0		4.6 - 5.3: side of core is cracked removing catcher.			Run: 3 Begin: 4.6 End: 6.6 D.T.: 55 min. Rec: 2.2 Remarks: --
	6.0			100%	Box 3	
	7.0		7.6: man made break			Run: 4 Begin: 6.6 End: 11.6 D.T.: 1 hr 50 min Rec: 4.75 Remarks: Pulled off .25'.
	8.0					
	9.0		9.6: low angle fracture with 1" steel, possibly due to 1961 action	100%		

DRILLING LOG		DIVISION	INSTALLATION	Hole No.	SHEET	
Ohio River		Lock 2 Dam 2	Lock 2 Dam 2		OF 10 SHEETS	
1. PROJECT Rehab. of Lock 2 Dam 2, Mon. River		10. SIZE AND TYPE OF BIT				
2. LOCATION (Coordinates or Stationing)		11. DAYUM FOR ELEVATION SHOWN (TBM or BELL)				
3. DRILLING AGENCY		12. MANUFACTURER'S DESIGNATION OF DRILL				
4. HOLE NO. (As shown on drawing title) and file number		13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN				
5. NAME OF DRILLER		14. TOTAL NUMBER CORE BOXES				
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER				
7. THICKNESS OF OVERBURDEN		16. DATE HOLE ☐ STARTED ☐ COMPLETED				
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE				
9. TOTAL DEPTH OF HOLE		18. TOTAL CORE RECOVERY FOR BORING Rock 98				
		19. SIGNATURE OF INSPECTOR				
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Describe material)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
10.0	11				Box 5	
	12				Run 4	
	13		12.65: man made break.			Run: 5 Begin: 11.8 End: 17.0 D.T.: 1 hr 40 min Rec: 5.05 Remarks: Picked up .25' from run 4, pulled off .4' this run.
	14				Box 6	
	15					
	16					
	17		17.2: incipient crack.		Run 5	
	18				Box 7	Run: 6 Begin: 17.0 End: 22.0 D.T.: 1 hr 40 min Rec: 5.0 Remarks: Picked up .4' from run 5, pulled off .4' this run.
	19					

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PROJECT

HOLE NO.

DRILLING LOG		DIVISION Ohio River	INSTALLATION Lock & Dam #2	Hole No. _____ SHEET 4 OF 10 SHEETS
1. PROJECT Rehab. of Lock & Dam 2, Ohio River		10. SIZE AND TYPE OF BIT		
2. LOCATION (Coordinates or Station)		11. DAY OF YEAR FOR ELEVATION SHOWN (T.M. or M.S.)		
3. DRILLING AGENCY		12. MANUFACTURER'S DESIGNATION OF DRILL		
4. HOLE NO. (As shown on drawing title) and file number ER 785 M-1		13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN: DISTURBED _____ UNDISTURBED _____		
5. NAME OF DRILLER		14. TOTAL NUMBER CORE BOXES		
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER		
7. THICKNESS OF OVERBURDEN		16. DATE HOLE: STARTED _____ COMPLETED _____		
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE		
9. TOTAL DEPTH OF HOLE		18. TOTAL CORE RECOVERY FOR BORING Rock 98 %		
		19. SIGNATURE OF INSPECTOR <i>[Signature]</i>		

ELEVATION +	DEPTH -	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, meter loss, depth of penetration, etc., if significant)
30.40						Run: 6 Begin: 27.0 End: 31.1 D.T.: 1 hr 5 min Rec: 5.1 Remarks: Picked up .3' from run 7.
31.0			30.35: man made break.	Run 6	Box 11	
32.0				100%		Run: 9 Begin: 31.1 End: 35.1 D.T.: 1 hr Rec: 3.6 Remarks: Pulled off .4' this run.
33.0			32.6: machine break.			
34.0					Box 12	
35.0			34.8: 1" long x 1/2" wide void.	Run 9		
36.0			35.5: 1" long x 3/4" wide & deep void. 35.75: machine break. 35.9: 2" long x 1/2" deep void. 36.75: man made break. 37.75: man made break.			Run: 10 Begin: 35.1 End: 38.9 D.T.: 1 hr 10 min Rec: 5.2 Remarks: Picked up .4' from run 9.
37.0				100%	Box 13	
38.0						
39.0			38.9: man made break.	Run 10		

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PROJECT

HOLE NO.

DRILLING LOG		DIVISION Ohio River		INSTALLATION Lock & Dam 2		Hole No. SHEET 5 OF 10 SHEETS	
1. PROJECT Rehao. of Lock & Dam 2, Mon. River				10. SIZE AND TYPE OF BIT			
2. LOCATION (Comptrol or Station)				11. DAYUM FOR ELEVATION SHOWN (TYP or MSL)			
3. DRILLING AGENCY				12. MANUFACTURER'S DESIGNATION OF DRILL			
4. HOLE NO. (As shown on drawing title and file number) BR WBS M-1				13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN		14. TOTAL NUMBER CORE BOXES	
5. NAME OF DRILLER				15. ELEVATION GROUND WATER		16. DATE HOLE	
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				17. ELEVATION TOP OF HOLE		18. TOTAL CORE RECOVERY FOR BORING. Rock 98	
7. THICKNESS OF OVERBURDEN				19. SIGNATURE OF INSPECTOR		100% 1/25/54	
8. DEPTH DRILLED INTO ROCK							
9. TOTAL DEPTH OF HOLE							

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOV- ERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	40.0				Box 14	Run: 11 Begin: 39.9 End: 44.95 D.T: 1 hr 50 min Rec: 5.05 Remarks: --
	41		@ 41.05: man made break.			
	42		@ 42.25: man made break.	100%		
	43				Box 15	
	44					
	45			Run 11		
	46		@ 45.5: 1 1/2" long x 3/4" diameter & deep weathered out concretion. @ 46.5: 1" long & deep void.	100%		Run: 12 Begin: 44.95 End: 49.9 D.T: 1 hr 25 min Rec: 4.0 Remarks: Pulled off .95' this run. Driller overloaded core barrel causing mechanical breaks.
	47		@ 46.9: machine break.		Box 16	
	48		@ 47.65: machine break. @ 48.35: machine break.			
	49		@ 48.95: machine break.	Run 12		

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PROJECT

HOLE NO.

DRILLING LOG		DIVISION Ohio River	INSTALLATION Lock & Dam No. 2	Hole No. M-1 SHEET b OF 10 SHEETS
1. PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT 1" Diamond		
2. LOCATION (Coordinates or Station) See Remarks		11. DAYUM FOR ELEVATION SHOWN (TBM or MSL) MSL		
3. DRILLING AGENCY USAE-WES		12. MANUFACTURER'S DESIGNATION OF DRILL Falling, Model 43-6A, Skid Rig		
4. HOLE NO. (As shown on drawing title) BR WES M-1		13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN		
5. NAME OF DRILLER Dan Taylor		14. TOTAL NUMBER CORE BOXES		
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER		
7. THICKNESS OF OVERBURDEN Concrete 60.35		16. DATE HOLE STARTED 6 Dec 85 COMPLETED 17 Dec 85		
8. DEPTH DRILLED INTO ROCK 36.75		17. ELEVATION TOP OF HOLE 732.5'		
9. TOTAL DEPTH OF HOLE 97.1'		18. TOTAL CORE RECOVERY FOR BORING Rock 98 %		
		19. SIGNATURE OF INSPECTOR Hershel McGinty		

ELEVATION e	DEPTH d	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling comp., water loss, depth of weathering, etc., if significant) g
50.0		△	@ 50.1: machine break.		Box 17	Run: 13 Begin: 49.9 End: 54.0 D.T.: 2 hrs Rec: 5.05 Remarks: Picked up .95' from run 12. Driller overloaded core barrel causing mechanical breaks.
51.0		△	@ 51.35: machine break. @ 51.95: machine break. @ 52.3: machine break.			
52.0		△	@ 52.6: machine break. @ 53.0: machine break. @ 53.35: machine break.		Box 18	
53.0		△				
54.0		△			Run 13	
55.0		△	@ 55.05: machine break.		Box 19	Run: 14 Begin: 54.0 End: 58.9 D.T.: 2 hr 25 min Rec: 4.9' Loss: 0.0'
56.0		△				
57.0		△	@ 57.20: machine break.			
58.0		△	@ 57.7: machine break.			
59.0		△			Run 14 Box 20	
60.0		△				

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PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River
HOLE NO. M-1

DRILLING LOG		DIVISION Ohio River	INSTALLATION Lock & Dam No. 2	Hole No. M-1 SHEET 7 OF 10 SHEETS
1. PROJECT: Rehabilitation of Lock & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT: 4" Diamond		
2. LOCATION (Coordinates or Station) See Remarks		11. GAYUN FOR ELEVATION SHOWN (TSS or MSL) MSL		
3. DRILLING AGENCY USAE-WES		12. MANUFACTURER'S DESIGNATION OF DRILL Falling Model 43-6A Skid Rig		
4. HOLE NO. (As shown on drawing title) and file number BR WES M-1		13. TOTAL NO. OF OVER- : DISTURBED : UNDISTURBED BURDEN SAMPLES TAKEN : 0 : 0		
5. NAME OF DRILLER Dan Taylor		14. TOTAL NUMBER CORE BOXES		
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER		
7. THICKNESS OF OVERBURDEN Concrete 60.35		16. DATE HOLE : STARTED : COMPLETED 6 Dec 85 : 17 Dec 85		
8. DEPTH DRILLED INTO ROCK 36.75		17. ELEVATION TOP OF HOLE 732.5'		
9. TOTAL DEPTH OF HOLE 97.1'		18. TOTAL CORE RECOVERY FOR BORING Rock 98 %		
		19. SIGNATURE OF INSPECTOR Hershel McGinty		

ELEVATION "	DEPTH "	LEGEND	CLASSIFICATION OF MATERIALS (Designation)	% CORE RECOV- ERY %	BOX OR SAMPLE NO. I	REMARKS (Drilling time, water loss, depth of monitoring, etc., if significant) Y
60.0			Concrete-rock contact, low angle break.			@ 60.35' concrete-rock contact.
61.0			Clay shale, light gray, soft to moderately hard.			Run: 15 Begin: 60.35 End: 63.65 D.T.: 1 hr 45 min Rec: 3.15'
62.0			61.1' - horizontal fracture w/brown staining. 60.7-61.1 - vertical fracture. 62.15-62.3 - tract of coal. 62.7 - horizontal fracture.		Box 21	
63.0			Rubble	Run 15		
64.0			Horizontal fracture.		Box 22	Run: 16 Begin: 63.65 End: 67.4 D.T.: 2 hr 15 min Rec: 2.50' Loss: 1.55'
65.0			Overcored - numerous horizontal fractures, spaced 1-2" apart.	Run 16		
66.0			Horizontal fracture.		Box 23	Run: 17 Begin: 67.4 End: 69.4 D.T.: 1 hr 20 min Rec: 3.75' Gain: 1.55'
67.0			Horizontal fracture.			
68.0			Horizontal fracture.			
69.0			Clay shale, brown, soft to moderately hard. Horizontal fractures.			
70.0			Rubble	Run 17		

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PROJECT REHABILITATION OF
Lock & Dam No. 2, Monon-
gahela River HOLE NO.
M-1

Hole No.

DRILLING LOG		DIVISION	INSTALLATION	SHEET		
Ohio River		Lock & Dam #2	8	OF 10 SHEETS		
1. PROJECT Rehab of Lock & Dam 2, Mon. River						
2. LOCATION (Coordinates or Station) See Remarks						
3. DRILLING AGENCY USAE WES						
4. HOLE NO. (As shown on drawing title and file number) BR WES M-1						
5. NAME OF DRILLER Dan Taylor						
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.						
7. THICKNESS OF OVERBURDEN Concrete 00.35'						
8. DEPTH DRILLED INTO ROCK 36.75'						
9. TOTAL DEPTH OF HOLE 97.1'						
10. SIZE AND TYPE OF BIT 2" Diamond						
11. DATUM FOR ELEVATION SHOWN/TSS or MSL						
12. MANUFACTURER'S DESIGNATION OF DRILL Falling Model 43-6A, Skid Rig						
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN 0 UNDISTURBED						
14. TOTAL NUMBER CORE BOXES						
15. ELEVATION GROUND WATER						
16. DATE HOLE STARTED 6 Dec 85 COMPLETED 7 Dec 85						
17. ELEVATION TOP OF HOLE 732.5'						
18. TOTAL CORE RECOVERY FOR BORING Rock 98 %						
19. SIGNATURE OF INSPECTOR						
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, motor loss, depth of overburden, etc., if significant)
			Horizontal fracture		27	
81.0			Horizontal fracture			Run: 20 Begin: 79.1 End: 83.7 D.T.: 1 hr 30 min Rec: 5.1' Gain: 0.1'
82.0			Horizontal fracture			
			Horizontal fracture		Box 28	
83.0			Horizontal fracture			
			Horizontal fracture	Run 20		
84.0						
85.0			Horizontal fracture		Box 29	Run: 21 Begin: 83.7 End: 88.7 D.T.: 1 hr 40 min Rec: 4.9' Loss: 0.1'
86.0			Horizontal fracture			
87.0			Horizontal fracture			
88.0			Horizontal fracture		Box 30	
			Horizontal fracture	Run 21		
89.0			Horizontal fracture			
90.0			Clay shale, red and gray			

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PROJECT Rehab of Lock & Dam 2, Mon. River

HOLE NO.
BR WES M-1

Hole No.

DRILLING LOG		DIVISION		INSTALLATION		SHEET 9 OF 10 SHEETS	
1. PROJECT Rehab. of Lock & Dam 2, Mon. River		Ohio River		Lock & Dam #2			
2. LOCATION (Coordinates or Station) See Remarks				10. SIZE AND TYPE OF BIT Diamond			
3. DRILLING AGENCY USAE WES				11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL			
4. HOLE NO. (As shown on drawing title) and file number		BR WES M-1		12. MANUFACTURER'S DESIGNATION OF DRILL Falling, Model 43-6A, Skid Rig			
5. NAME OF DRILLER Dan Taylor				13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN		0 0	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				14. TOTAL NUMBER CORE BOXES			
7. THICKNESS OF OVERBURDEN Concrete 60.35'				15. ELEVATION GROUND WATER			
8. DEPTH DRILLED INTO ROCK 36.75'				16. DATE HOLE STARTED 6 Dec 85 COMPLETED 7 Dec 85			
9. TOTAL DEPTH OF HOLE 97.1'				17. ELEVATION TOP OF HOLE 732.5'			
				18. TOTAL CORE RECOVERY FOR BORING Rock 98 %			
				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 measuring, etc., if significant) g	
71.0			Horizontal Fractures		Box 24	Run: 18 Begin: 69.4 End: 74.5 D.T.: 2 hr 10 min Rec: 5.0' Loss: 0.0' Comments: Core froze during wrapping	
72.0			Clay shale, brown and gray, soft to moderately hard				
			Low angle fracture				
			Low angle fracture				
			Clay shale, gray				
73.0							
74.0			Horizontal fractures	Run 18	Box 25		
75.0							
			Horizontal fracture				
76.0							
			Horizontal fracture				
77.0					Box 26	Run: 19 Begin: 74.5 End: 79.1 D.T.: 1 hr 30 min Rec: 4.6' Loss: 0.0'	
			Horizontal fracture				
78.0							
			Horizontal fracture				
79.0			Slipped over	Run 19			
			Horizontal fracture				
80.0					Box		

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PROJECT Rehab of Lock & Dam 2, Mon. River

HOLE NO.
BR WES M-1

DRILLING LOG		DIVISION	INSTALLATION	SHEET	
		Ohio River	Lock & Dam No. 2	10	
1. PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT 1 1/2" Diamond			
2. LOCATION (Continuation of Station)		11. DATUM FOR ELEVATION SHOWN (798 = MSL)			
See Remarks		MSL			
3. DRILLING AGENCY USAE-WES		12. MANUFACTURER'S DESIGNATION OF DRILL			
		Failing, Model 43-6A, Skid Rig			
4. HOLE NO. (As shown on drawing title) and file number		13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN: 0			
BR WES M-1		14. TOTAL NUMBER CORE BOXES			
5. NAME OF DRILLER Dan Taylor		15. ELEVATION GROUND WATER			
6. DIRECTION OF HOLE		16. DATE HOLE			
☐ VERTICAL ☐ INCLINED DES. FROM VERT.		STARTED 16 Dec 85 COMPLETED 17 Dec 85			
7. THICKNESS OF OVERBURDEN Concrete 60.35		17. ELEVATION TOP OF HOLE 732.5'			
8. DEPTH DRILLED INTO ROCK 36.75		18. TOTAL CORE RECOVERY FOR BORING Rock 98 %			
9. TOTAL DEPTH OF HOLE 97.1'		19. SIGNATURE OF INSPECTOR			
		Hershel McGinty			
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Describe)	% CORE (BOX OR RECOVERY) SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc. if significant)
			Horizontal fracture.		
91.0			Horizontal fracture.	Box 31	Run: 22 Begin: 88.7 End: 93.7 D.T.: 1 hr 50 min Rec: 4.35' Loss: 0.65'
92.0			Horizontal fracture.		
93.0			Horizontal fracture.		
94.0			Horizontal fracture.	Run 22	
95.0			Horizontal fracture.		Run: 23 Begin: 93.7 End: 97.1 D.T.: 1 hr 44 min Rec: 3.25' Loss: 0.15'
96.0			Horizontal fracture.	Box 32	
97.0			E.O.B. @ 97.1	Run 23	
98.0					ABBREVIATIONS: H.F.: Horizontal Fracture D.T.: Drill Time Rec.: Recovery E.O.B.: End of Boring
99.0					
100.0					

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(TRANSLUCENT)

PROJECT Rehabilitation of
Lock & Dam No. 2, Monon-
ahela River

HOLE NO.
M-1

DRILLING LOG		DIVISION		INSTALLATION		Hole No.	
Rehab. of Lock & Dam 2, Mon. River		Bio River		Lock & Dam 2		SHEET OF 1 SHEETS	
1. PROJECT		2. LOCATION (Coordinates or Station)		10. SIZE AND TYPE OF BIT		11. DAY OF ELEVATION SHOWN (YES or NO)	
See Remarks		MSL		MSL			
3. DRILLING AGENCY		4. HOLE NO. (As shown on drawing title and file number)		12. MANUFACTURER'S DESIGNATION OF DRILL		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	
USAS-193		BR WES M-2		HCR-12, Series M-100, 110 volt		Disturbed UNDISTURBED	
5. NAME OF DRILLER		6. DIRECTION OF HOLE		14. TOTAL NUMBER CORE BOXES		15. ELEVATION GROUND WATER	
Dan Taylor		Horizontal		0		0	
7. THICKNESS OF OVERBURDEN		8. DEPTH DRILLED INTO ROCK		16. DATE HOLE		17. ELEVATION TOP OF HOLE	
0.0		0.0		STARTED COMPLETED		12 Oct 65 12 Oct 65	
9. TOTAL DEPTH OF HOLE		18. TOTAL CORE RECOVERY FOR BORING		19. SIGNATURE OF INSPECTOR			
3.2' in concrete		100 %					

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
0.0	0.0		Surface Conditions: badly weathered with exposed agg. - max. agg. size is 4".	100%		Run: 1 Begin: 0.0 End: 1.15 D.T.: 25 min. Rec: 1.15 Remarks: -
1.0	0.0 - 3.15		Concrete: gray, siliceous with some carbonates, max. agg. size is 1", river gravel, subrounded to subangular, good consolidation, entrapped air, entrained air, many voids - none greater than 1/2" diameter & deep unless noted.	100%	Box 1	Run: 2 Begin: 1.15 End: 3.2 D.T.: 2 hrs 5 min. Rec: 2.0 Remarks: Pulled off .05' this run. Drill action was smooth throughout boring. 100% of water was retained
2.0						
3.0						
			.1: manmade break during retrieval. .7: manmade break during retrieval. 1.8: 1" long void.		Run 2	
			B.O.B. = 3.2'			

ABBREVIATIONS:
agg: aggregate
max: maximum
D.T.: drill time
Rec: recovery
B.O.B.: end of boring.

LOCATION:

14.5' mono

mono. 9' 10

13.4'

LARGE CHAMBER

—flow—

LANDFILL

14.5' mono

mono. 9' 10

13.4'

LARGE CHAMBER

—flow—

LANDFILL

DRILLING LOG		DIVISION		INSTALLATION		Hole No.	
Ohio River		Lock & Dam #2		SHEET		OF 1 SHEETS	
1. PROJECT				10. SIZE AND TYPE OF BIT			
Rehab. of Lock & Dam #2, Mon. River				11. DATUM FOR ELEVATION SHOWN (FMS or MSL)			
2. LOCATION (Coordinates or Station)				MSL			
3. DRILLING AGENCY				12. MANUFACTURER'S DESIGNATION OF DRILL			
USAB-753				MCA-12, Series M-120, 110 volt			
4. HOLE NO. (As shown on drawing title and file number)				13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN			
SR WES M-3				14. TOTAL NUMBER CORE BOXES			
5. NAME OF DRILLER				15. ELEVATION GROUND WATER			
Dan Taylor				16. DATE HOLE			
6. DIRECTION OF HOLE				17. ELEVATION TOP OF HOLE			
☐ VERTICAL ☐ INCLINED				18. TOTAL CORE RECOVERY FOR BORING			
7. THICKNESS OF OVERBURDEN				19. SIGNATURE OF INSPECTOR			
8. DEPTH DRILLED INTO ROCK							
9. TOTAL DEPTH OF HOLE							
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of monitoring, etc., if significant)	
0.0	0.0		Surface Condition: moderately weathered with exposed agg. - max. agg. size 1 1/2".	100%		Run: 1 Begin: 0.0 End: 1.2 D.T.: 30 min. Rec: 1.1 Remarks: Pulled off 1' this run.	
1.0	1.0		C.C. - 3.15		Box 1	Run: 2 Begin: 1.2 End: 3.15 D.T.: 1 hr 20 min Rec: 2.05 Remarks: Picked up 1' from run 1; 100% water retained. Drill action was smooth throughout boring.	
2.0	2.0		Concrete: gray, siliceous with some carbonates, max. agg. size 1 1/2", river gravel, subrounded to subangular, good consolidation, entrapped air, entrained air, many voids - none greater than 3/8", + .5" manmade crack during retrieval.	100%		ABBREVIATIONS: agg: aggregate max: maximum D.T.: drill time Rec: recovery E.O.B.: end of boring.	
3.0	3.0		E.O.B. @ 3.15'			LOCATION: Small Chamber flow → Middlewall mono. 12 mono. 13	

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PROJECT Rehab. of Lock & Dam #2, Mon. River

HOLE NO. SR WES M-3

DRILLING LOG			DIVISION	INSTALLATION	SHEET	
1. PROJECT Rehab. of Lock & Dam 2, Mon. River			Ohio River	Lock & Dam 2	OF 1 SHEETS	
2. LOCATION (Continuation of Sheet)			10. SIZE AND TYPE OF BIT 5" Diamond Bit			
See Remarks			11. DATUM FOR ELEVATION SHOWN (TBM or MSL)			
3. DRILLING AGENCY USAR-425			MSL			
4. HOLE NO. (As shown on drawing title and file number) BR WES M-4			12. MANUFACTURER'S DESIGNATION OF DRILL KOA-11, Series A-100, 110 volt			
5. NAME OF DRILLER Dan Taylor			13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN			
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED 30° Horizontal			14. TOTAL NUMBER CORE BOXES 1			
7. THICKNESS OF OVERBURDEN 0.0			15. ELEVATION GROUND WATER 712			
8. DEPTH DRILLED INTO ROCK 0.0			16. DATE HOLE STARTED 125 Oct 85 COMPLETED 25 Oct 85			
9. TOTAL DEPTH OF HOLE 3.25' in Concrete			17. ELEVATION TOP OF HOLE 725.31			
			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)
	0.0		Surface Condition: moderately weathered with medium scaling from 725.3' to 730.5'. Maximum exposed aggregate size is 1".			Run: 1 Begin: 0.0 End: 3.25 D.T.: 2 hrs 5 min. Rec: 2.95 Remarks: Pulled off 3'. Drill action was smooth. 100% of water was retained.
	0.0 - 2.95		Concrete: gray, siliceous with some carbonates, maximum aggregate size is 1", river gravel, sub-rounded to subangular, good consolidation, entrapped air, many voids generally less than 1/2" diameter & deep.	100%	Box 1	ABBREVIATIONS: D.T.: drill time Rec: recovery E.O.B.: end of boring
	3.25		E.O.B. @ 3.25'	Run 1		LOCATION: Middlewall mono. 20' - 57' mono. 10' 55.2' Small Chamber ← flow Riverwall

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PROJECT Rehab. of Lock & Dam 2, Mon. River

HOLE NO. BR WES M-4

DRILLING LOG		DIVISION	INSTALLATION	SHEET		
1. PROJECT Rehab. of Lock & Dam 2, Mon. River		Ohio River	Lock & Dam 2	OF 1 SHEETS		
2. LOCATION (Coordinates or Station) See remarks		10. SIZE AND TYPE OF BIT HSD				
3. DRILLING AGENCY USACE-WSS		11. DATUM FOR ELEVATION SHOWN (TBM or MLL) MSL				
4. HOLE NO. (As shown on drawing title) and file number BR WES M-5		12. MANUFACTURER'S DESIGNATION OF DRILL KOL-10, Series A-100, 110 volt				
5. NAME OF DRILLER Dan Taylor		13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN: DISTURBED 1 UNDISTURBED 0				
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED 90 DEG. FROM VERT.		14. TOTAL NUMBER CORE BOXES 1				
7. THICKNESS OF OVERBURDEN 0.3		15. ELEVATION GROUND WATER 27.9				
8. DEPTH DRILLED INTO ROCK 0.3		16. DATE HOLE STARTED 128 Oct 65 COMPLETED 129 Oct 65				
9. TOTAL DEPTH OF HOLE 3.3' IN CONCRETE		17. ELEVATION TOP OF HOLE 707.1				
		18. TOTAL CORE RECOVERY FOR BORING 100%				
		19. SIGNATURE OF INSPECTOR <i>James M. McNeil</i>				
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Designation)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	0.3		Surface Condition: slightly weathered with scaling as fol- lows: medium: 724.9 - 732.3 light: 739.6 - 724.9 1.5' downstream from boring: vertical crack with slight separation.	100%	Box 1	Run: 1 Begin: 0.0 End: 3.3 D.R.: 1 hr 15 min. Rec: 3.05 Remarks: Pulled off .27'. Drill action was smooth. 100% of water was re- tained.
	2.0		3.0 - 3.05 Concrete: gray, sili- ceous with some car- bonates, maximum ag- gregate size is 3", river gravel, sub- rounded to subangular, good consolidation, entrapped air, en- trained air, many voids generally less than 3/8" diameter & deep.			ABBREVIATIONS: D.R.: drill time rec: recovery E.O.B.: end of boring
	3.0					LOCATION: LANDFALL Large Chamber ← flow → 6.6 f 70no. 24 MIDDLEWELL

Hole No. BR WES M-6-86

DRILLING LOG		DIVISION	INSTALLATION	SHEET		
Ohio River		Lock & Dam No. 2	Monongahela River	1 OF 10 SHEETS		
1. PROJECT Rehabilitation Lock & Dam No. 2, Monongahela River						
2. LOCATION (Continuation of Section Middle Wall Monolith 25.5' in from land face, 10' U.S. of steps)						
3. DRILLING AGENCY USAE WES						
4. HOLE NO. (As shown on drawing title and file number) BR WES M-6-86						
5. NAME OF DRILLER Dan Taylor						
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.						
7. THICKNESS OF OVERBURDEN Concrete 03.4'						
8. DEPTH DRILLED INTO ROCK 26.3' shale						
9. TOTAL DEPTH OF HOLE 91.7'						
10. SIZE AND TYPE OF BIT 5" X 7 3/4"						
11. DATUM FOR ELEVATION SHOWING MSL						
12. MANUFACTURER'S DESIGNATION OF DRILL Failing Skid Rig						
13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN 1						
14. TOTAL NUMBER CORE BOXES 33						
15. ELEVATION GROUND WATER --						
16. DATE HOLE STARTED 29 Jan 86 COMPLETED 11 Feb 86						
17. ELEVATION TOP OF HOLE 732.5'						
18. TOTAL CORE RECOVERY FOR BORING Rock 97%						
19. SIGNATURE OF INSPECTOR Scott Murrell						
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
0.0	0.0	△	Concrete:	100	Box 1	Run: 1 Begin: 0.0' End: 2.3' D.T.: 0 hr, 55 min D. Press: 220 RPM: 100 REC: 2.3' Loss: --
1.0	1.0	△	Looks good, sounds good, entrapped air, maximum size 1/4", entrained air.			
2.0	2.0	△	Aggregate - siliceous with some calcareous, natural and crushed, maximum 2".			
3.0	3.0	△	Concrete:	100	Box 2	Run: 2 Begin: 2.3' End: 4.6' D.T.: 0 hr 43 min D. Press: 220 RPM: 100 Rec: 2.3' Loss: --
4.0	4.0	△	Looks good, sounds good, entrained air, entrapped air, maximum size 1/4".			
5.0	5.0	△	Aggregate - siliceous with some calcareous, natural and crushed, maximum size 2 1/2".			
6.0	6.0	△	Concrete:	100	Box 3	Run: 3 Begin: 4.6' End: 6.2' D.T.: 47 min Loss: -- D. Press: 220 RPM: 100 Rec: 1.8'
7.0	7.0	△	Looks good, sounds good, entrained air, entrapped air, maximum size 1/4".			
8.0	8.0	△	Aggregate - siliceous with some calcareous, natural and crushed, maximum size 2 1/2".			
9.0	9.0	△	Concrete:	100	Box 4	Run: 4 Begin: 6.2' End: 11.25' D.T.: 1 hr 15 min D. Press: 200 RPM: 60 Rec: 5.05' Loss: --
10.0	10.0	△	Looks good, sounds good, entrained air, entrapped air, maximum size 1/4".			
		△	Aggregate - siliceous with some calcareous, natural and crushed, maximum size 2 1/2".			

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PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River
HOLE NO. BR WES M-6-86

DRILLING LOG		DIVISION Ohio River		INSTALLATION Lock & Dam No. 2 Monongahela River		SHEET 2 OF 10 SHEETS	
1. PROJECT Rehabilitation Lock & Dam No. 2, Monongahela River				10. SIZE AND TYPE OF BIT 4" x 7 3/4"			
2. LOCATION (Coordinates or stream, Middle Mill Monolith 25.5' in from land face, 10' U.S. of steps)				11. DATUM FOR ELEVATION SHOWN MSL			
3. DRILLING AGENCY USAE WES				12. MANUFACTURER'S DESIGNATION OF DRILL Falling Skid Rig			
4. HOLE NO. (As shown on drawing title) and file number BR WES M-6-86				13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN DISTURBED UNDISTURBED			
5. NAME OF DRILLER Dan Taylor				14. TOTAL NUMBER CORE BOXES 33			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED DES. FROM VERY.				15. ELEVATION GROUND WATER --			
7. THICKNESS OF OVERBURDEN Concrete 05.4'				16. DATE HOLE STARTED 129 Jan 86 COMPLETED 11 Feb 86			
8. DEPTH DRILLED INTO ROCK 26.3' shale				17. ELEVATION TOP OF HOLE -77.5'			
9. TOTAL DEPTH OF HOLE 91.7'				18. TOTAL CORE RECOVERY FOR BORING Rock 97 %			
				19. SIGNATURE OF INSPECTOR Scott Murrell			
ELEVATION "	DEPTH '	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV- ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
0.0	0.0	△			Box 5		
11.0	11.0	△	Concrete: Looks good, sounds good. entrained air, entrapped air. Maximum size 1/4". Aggregate - siliceous with some calcareous, natural and crushed, maximum size 2 1/2".	100	Box 6	Run: 5 Begin: 11.25' End: 16.3' D.T.: 0 hr 35 min D. Press: 200 RPM: 100 Rec: 5.05' Loss: -- Comments:	
13.0	13.0	△					
14.0	14.0	△					
15.0	15.0	△	To get in box.		Box 7		
16.0	16.0	△					
17.0	17.0	△	Concrete: Looks good, sounds good. entrained air, entrapped air. Maximum size 1/4". Aggregate - siliceous and calcareous, natural and crushed. Maximum size 2 1/2".	100	Box 8	Run: 6 Begin: 16.3' End: 21.4' D.T.: 1 hr 0 min D. Press: 200 RPM: 100 Rec: 4.9' Loss: 02.' in hole Comments: Some large limestone aggregate in core sample.	
18.0	18.0	△	To get in box				
19.0	19.0	△					
20.0	20.0	△					

ENG FORM 1836
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PREVIOUS EDITIONS ARE OBSOLETE
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PROJECT
Rehabilitation of
Lock & Dam No. 2, Monon-
gahela River

HOLE NO.
BR WES M-6-

DRILLING LOG		DIVISION Ohio River		INSTALLATION Lock & Dam No. 2 Monongahela River		SHEET 3 OF 10 SHEETS	
1. PROJECT Rehabilitation Lock & Dam No. 2, Monongahela River				10. SIZE AND TYPE OF BIT 5" X 7 3/4"			
2. LOCATION (Coordinates or Station) Middle Wall Monolith 25.5' in from land race, 10' U.S. or steps				11. DATUM FOR ELEVATION SHOWN (FSM or MSL) MSL			
3. DRILLING AGENCY USAE WES				12. MANUFACTURER'S DESIGNATION OF DRILL Falling Skid Rig			
4. HOLE NO. (As shown on drawing title) and file number BR WES M-6-86				13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN: DISTURBED UNDISTURBED			
5. NAME OF DRILLER Dan Taylor				14. TOTAL NUMBER CORE BOXES 33			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				15. ELEVATION GROUND WATER --			
7. THICKNESS OF OVERBURDEN Concrete 65.4'				16. DATE HOLE STARTED 29 Jan 86 COMPLETED 11 Feb 86			
8. DEPTH DRILLED INTO ROCK 26.3' shale				17. ELEVATION TOP OF HOLE 732.5'			
9. TOTAL DEPTH OF HOLE 91.7'				18. TOTAL CORE RECOVERY FOR BORING Rock 97 %			
				19. SIGNATURE OF INSPECTOR Scott Murrell			
ELEVATION c	DEPTH d	LEGEND e	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	
20.0		△					
21.0		△	Many small air voids honeycombing at 21.0'- 21.2'			Run: 7 Begin: 21.4' End: 26.2' D.T.: 0 hr 50 min D. Press: 200 RPM: 100 Rec: 5.0' Loss: --	
22.0		△	Concrete: Looks good, sounds good, entrapped air, maximum size 1/2", entrained air. Aggregate - siliceous and some calcareous, natural and crushed, maximum size 3".		Box 9		
23.0		△	Good consolidation.	100			
24.0		△					
25.0		△			Box 10		
26.0		△					
26.0		△	MB Vuggy at 26.2'				
27.0		△	Concrete: Looks good, sounds good, entrained air, lot of entrapped air, maximum size 1/2".		Box 11	Run: 8 Begin: 26.2' End: 31.2' D.T.: 0 hr 51 min D. Press: 200 RPM: 100 Rec: 5.0' Loss: --	
28.0		△	Aggregate - siliceous with some calcareous, natural and some crushed, maximum size 3".				
29.0		△					
30.0		△					

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PROJECT Rehabilitation of
Lock & Dam No. 2, Monon-
gahela River

HOLE NO.
BR WES M-6-

DRILLING LOG		DIVISION	INSTALLATION	SHEET 4 OF 10 SHEETS		
1. PROJECT Renovation Lock & Dam No. 2, Monongahela River		Ohio River	Lock & Dam No. 2, Monongahela River			
2. LOCATION (Coordinates or Station) Middle wall Monolith 25.5' in from land face, 10' U.S. of steps			10. SIZE AND TYPE OF BIT 4" X 7 3/4"			
3. DRILLING AGENCY USAE WES			11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL			
4. HOLE NO. (As shown on drawing (title) and file number)		BR WES M-6-86	12. MANUFACTURER'S DESIGNATION OF DRILL Falling Skid Rize			
5. NAME OF DRILLER Dan Taylor			13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN	DISTURBED	UNDISTURBED	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.			14. TOTAL NUMBER CORE BOXES 33			
7. THICKNESS OF QUARRYWASH CONCRETE 45.4'			15. ELEVATION GROUND WATER			
8. DEPTH DRILLED INTO ROCK 26.3' shale			16. DATE HOLE STARTED 29 Jan 86 COMPLETED 11 Feb 86			
9. TOTAL DEPTH OF HOLE 91.7'			17. ELEVATION TOP OF HOLE 732.5'			
			18. TOTAL CORE RECOVERY FOR BORING Rock 97 %			
			19. SIGNATURE OF INSPECTOR Scott Murrell			
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of monitoring, etc., if significant)
30.0		△			Box 12	
31.0		△				
32.0		△	Concrete: Looks good, sounds good, entrained air, entrapped air, maximum size 1/2". Aggregate - siliceous with some calcareous, natural and crushed, maximum size 3".	100	Box 13	Run: 9 Begin: 31.2' End: 36.3" D.T.: 1 hr 00 min D. Press: 200 RPM: 100 Rec: 5.1' Loss: --
33.0		△				
34.0		△				
35.0		△			Box 14	
36.0		△				
37.0		△	Concrete: Looks good, sounds good, entrained air, entrapped air, maximum size 1/2". Aggregate - siliceous with some calcareous, natural and crushed, maximum size 3 1/2".	100	15	Run: 10 Begin: 36.3' End: 41.5' D.T.: 1 hr 05 min D. Press: 200 RPM: 100 Rec: 4.9' Loss: 0.3 in hole Comments: Construction joint at 40.8', pieces separated when removed from core barrel.
38.0		△				
39.0		△				
40.0		△				

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PROJECT Renovation of
Lock & Dam No. 2, Monon-
gahela River

HOLE NO.
BR WES M-6-8

DRILLING LOG		DIVISION Ohio River		INSTALLATION LOCK & DAM NO. 2 Monongahela River		SHEET 5 OF 10 SHEETS	
1. PROJECT Rehabilitation Lock & Dam No. 2, Monongahela River				10. SIZE AND TYPE OF BIT 5" X 7 3/4"			
2. LOCATION (Continuation of Stationary Middle Wall Monolith 25.5' in from land face, 10' U.S. of steps)				11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL			
3. DRILLING AGENCY USAE WES				12. MANUFACTURER'S DESIGNATION OF DRILL Failing Skid Rig			
4. HOLE NO. (As shown on drawing title) and file number BR WES M-6-86				13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN: DISTURBED UNDISTURBED			
5. NAME OF DRILLER Dan Taylor				14. TOTAL NUMBER CORE BOXES 33			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				15. ELEVATION GROUND WATER --			
7. THICKNESS OF EXPOSURE Concrete 65.4'				16. DATE MOLE STARTED COMPLETED 29 Jan 86 11 Feb 86			
8. DEPTH DRILLED INTO ROCK 26.3' shale				17. ELEVATION TOP OF HOLE 732.5'			
9. TOTAL DEPTH OF HOLE 91.7'				18. TOTAL CORE RECOVERY FOR BORING Rock 97 %			
				19. SIGNATURE OF INSPECTOR Scott Murrell			
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)	
40.0	A						
41.0			Construction joint.			Run: 11 Begin: 41.5' End: 46.4' D.T.: 1 hr 47 min D. Press: 200 RPM: 100 Rec: 5.1' Loss: --	
42.0			Concrete: Looks good, sounds good, entrained air, entrapped air, maximum size 1/2". Aggregate - siliceous and calcareous, natural and crushed, maximum size 3".		Box 16	Comments: Encountered construction joint at 45.0' on side of core.	
43.0				100			
44.0							
45.0			To get in box.				
46.0			Construction joint on side.		Box 17		
47.0			Concrete: Looks good, sounds good, entrained air, entrapped air, maximum size 1/2". Aggregate - siliceous and calcareous, natural and crushed, maximum size 2-1/2".			Run: 12 Begin: 46.4' End: 51.45' D.T.: 2 hr 30 min D. Press: 200 RPM: 100 Rec: 5.1' Loss: --	
48.0						Comments: Joint still present.	
49.0				100	Box 18		
50.0							

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PROJECT Rehabilitation of
Lock & Dam No. 2, Monon-
gahela River

HOLE NO.
BR WES M-6-86

DRILLING LOG		DIVISION Ohio River		INSTALLATION Lock & Dam No. 2 Monongahela River		SHEET OF 10, 6 SHEETS	
1. PROJECT Rehabilitation Lock & Dam No. 2, Monongahela River				10. SIZE AND TYPE OF BIT 4" x 7 3/4"			
2. LOCATION (Coordinates or Station) Middle Wall Monolith 25.5' in from land face, 10' U.S. of steps				11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL			
3. DRILLING AGENCY USAE WES				12. MANUFACTURER'S DESIGNATION OF DRILL Falling Skid Rig			
4. HOLE NO. (As shown on drawing title) and file number BR WES M-6-86				13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED UNDISTURBED			
5. NAME OF DRILLER Dan Taylor				14. TOTAL NUMBER CORE BOXES 33			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				15. ELEVATION GROUND WATER			
7. THICKNESS OF OVERBURDEN Concrete 65.4'				16. DATE HOLE STARTED COMPLETED 29 Jan 86 11 Feb 86			
8. DEPTH DRILLED INTO ROCK 26.3' shale				17. ELEVATION TOP OF HOLE 772.5'			
9. TOTAL DEPTH OF HOLE 91.7'				18. TOTAL CORE RECOVERY FOR BORING Rock 97 %			
				19. SIGNATURE OF INSPECTOR Scott Murrell			
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	
50.0		MB			Box 18		
51.0		MB					
52.0		MB	Concrete: Looks good, sounds good, entrained air, entrapped air, maximum size 1/2".		Box 19	Run: 13 Began: 51.4' End: 56.5' D.T.: 1 hr 10 min D. Press: 200 RPM: 100 Rec: 5.1' Loss: ---	
53.0		MB		100		Comments: Joint still present.	
54.0		MB	To get in box. 1/8" rebar in strip at 54.2'.				
55.0		MB	Joint on strip at 54.95'.		Box 20		
56.0		MB					
57.0		MB	Concrete: Looks good, sounds good, entrapped air, entrained air, maximum size 1/2".		Box 21	Run: 14 Begin: 56.5' End: 61.6' D.T.: 1 hr 33 min D. Press: 200 RPM: 100 Rec: 4.6' Loss: 0.5 in hole	
58.0		MB	Aggregate - siliceous and calcareous, natural and crushed, maximum size 2-1/2".	100		Comments: Joint still present.	
59.0		MB					
60.0		MB					

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PROJECT Rehabilitation of
Lock & Dam No. 2, Monon-
gahela River

HOLE NO.
BR WES M-6-86

Hole No. BR WES M-6-86

DRILLING LOG		DIVISION Ohio River	INSTALLATION LOCK & DAM NO. Monongahela River	SHEET 7 OF 10 SHEETS		
1. PROJECT Renovation Lock & Dam No. 2, Monongahela River			10. SIZE AND TYPE OF BIT A" X 7 1/2"			
2. LOCATION (Continuation of Station) 25.5' in from land face, 10' U.S. of Steps			11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL			
3. DRILLING AGENCY USAE WES			12. MANUFACTURER'S DESIGNATION OF DRILL Falling Skid Rig			
4. HOLE NO. (As shown on drawing title) BR WES M-6-86			13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN: DISTURBED UNDISTURBED			
5. NAME OF DRILLER Dan Taylor			14. TOTAL NUMBER CORE BOXES 33			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.			15. ELEVATION GROUND WATER			
7. THICKNESS OF CONCRETE 65.4'			16. DATE HOLE STARTED COMPLETED 29 Jan 86 11 Feb 86			
8. DEPTH DRILLED INTO ROCK 6.3' shale			17. ELEVATION TOP OF HOLE 732.5'			
9. TOTAL DEPTH OF HOLE 91.7'			18. TOTAL CORE RECOVERY FOR BORING Rock 97			
			19. SIGNATURE OF INSPECTOR Scott Murrell			
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, motor logs, depth of weathering, etc., if significant) g
60.0						
61.0			Joint fades out in this area			
62.0			Concrete: Looks good, sounds good, entrained air, entrapped air, maximum size 1/2".		Box 22	Run: 15 Begin: 61.6' End: 66.0' D.T.: 3 hr 10 min D. Press: 200 RPM: 100 Rec: 4.6' Loss: 0.3' in hole
63.0			Aggregate - siliceous and calcareous, natural and crushed, maximum size 2-1/2".	98		Comments: Water turned a gray-blue milky color indicating shale was reached. 0.3' of gray shale was pulled up with concrete. Closed contact.
64.0					Box 23	
65.0						
66.0			MB's 65.4'-67.7'			Run: 16 Begin: 66.0' End: 71.0' D.T.: 2 hr 10 min D. Press: 200 RPM: 100 Rec.: 4.5' Loss: 0.6' in hole 0.2' ground up
67.0			Shale, gray, moderately hard, slightly silty.	96	Box 24	Comments: Top 0.2' fragmented and washed away when drilling started.
68.0			Healed fracture. Healed fracture.			
69.0						
70.0						

ENG FORM 1836
MAR 71

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PROJECT Renovation of
Lock & Dam No. 2, Monon-
gahela River

HOLE NO.
BR WES M-6-8

DRILLING LOG		DIVISION	INSTALLATION	SHEET		
		Ohio River	Lock & Dam No. 2	8		
		Monongahela River	Monongahela River	OF 10 SHEETS		
1. PROJECT Rehabilitation Lock & Dam No. 2, Monongahela River			10. SIZE AND TYPE OF BIT 2 X 7 1/2"			
2. LOCATION (Coordinates or Station) Middle wall Monolith 25.5' in from land face, 10' U.S. of steps			11. DATUM FOR ELEVATION SHOWN (FBN or MSL) MSL			
3. DRILLING AGENCY USAE WES			12. MANUFACTURER'S DESIGNATION OF DRILL Falling Skid Rig			
4. HOLE NO. (As shown on drawing title) and Site number BR WES M-6-86			13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN 1 UNDISTURBED			
5. NAME OF DRILLER Dan Taylor			14. TOTAL NUMBER CORE BOXES 33			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED DES. FROM VERT.			15. ELEVATION GROUND WATER --			
7. THICKNESS OF OVERBURDEN Concrete 65.4'			16. DATE HOLE STARTED 29 Jan 86 COMPLETED 11 Feb 86			
8. DEPTH DRILLED INTO ROCK 26.3' shale			17. ELEVATION TOP OF HOLE 772.5'			
9. TOTAL DEPTH OF HOLE 91.7'			18. TOTAL CORE RECOVERY FOR BORING 1			
			19. SIGNATURE OF INSPECTOR Scott Murrell			
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
70.0		MB			25	
71.0		MB	Natural break.			
		MB	Natural break.			
		MB	Shale, gray, moderately hard, slightly silty.	98		Run: 17 Begin: 70.4' End: 74.4' D.T.: 2 hr 20 min Rec: 3.4' Loss: 0.5', in hole 0.1' fragmented and lost from top of core sample by drilling action.
72.0		MB	Brown sandy siliceous inclusion.			
73.0		MB	Healed Fracture.		26	
74.0		MB				
75.0		MB	Shale gray, moderately hard, slightly silty.		27	Run: 18 Begin: 74.4' End: 79.2' D.T.: 1 hr 47 min Rec: 4.8' Loss: 0.2' in hole
76.0		MB	Healed vertical fractures.	99		
77.0		MB				
78.0		MB			28	
79.0		MB				
80.0		MB				

ENG FORM 18-76

PROJECT Rehabilitation of HOLE NO.

DRILLING LOG		DIVISION	INSTALLATION LOCK & DAM NO.	SHEET		
		Ohio River	Monongahela River	9		
1. PROJECT Rehabilitation Lock & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT 4 X 7 3/4"				
2. LOCATION (Commence or Station Middle Wall Monolith 25.5' in from land face, 10 U.S. of steps)		11. DATUM FOR ELEVATION KNOWN (792' or MSL)				
3. DRILLING AGENCY USAE WES		12. MANUFACTURER'S DESIGNATION OF DRILL				
4. HOLE NO. (As shown on drawing sheet and site number) BR WES M-6-86		13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN: DISTURBED UNDISTURBED				
5. NAME OF DRILLER Dan Taylor		14. TOTAL NUMBER CORE CORES 33				
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER --				
7. THICKNESS OF OVERBURDEN Concrete 65.4'		16. DATE HOLE STARTED 19 Jan 86 COMPLETED 11 Feb 86				
8. DEPTH DRILLED INTO ROCK 26.3' shale		17. ELEVATION TOP OF HOLE 732.5'				
9. TOTAL DEPTH OF HOLE 91.7'		18. TOTAL CORE RECOVERY FOR BORING Rock 97 %				
		19. SIGNATURE OF INSPECTOR Scott Murrell				
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of overburden, etc., if significant)
81.0			Shale, gray, moderately hard, slightly silty.		29	Run: 19 Begin: 79.2' End: 84.5' Rec: 5.0' D.T.: 2 hr Loss: 0.3' left in hole.
82.0			Open vertical fractures.	98		
83.0				30		
84.0						
85.0			Shale gray, moderately hard, slightly silty. Healed vertical fracture.	90	31	Run: 20 Begin: 84.5' End: 87.0' Rec: 2.6' D.T.: 50 min Loss: 0.2' left in hole
86.0						
87.0						
88.0			Shale gray, moderately hard, slightly silty.		32	Run: 21 Begin: 87.0' End: 91.7' Rec: 4.7' D.T.: 2 hr 40 min
89.0			Healed fractures.	100		
90.0						

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PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River

HOLE NO. BR WES M-6-86

Hole No. BR WES M-6-86

DRILLING LOG			DIVISION Ohio River	INSTALLATION LOCK & DAM NO. 2 Monongahela River	SHEET 10 OF 10 SHEETS	
1. PROJECT Rehabilitation Lock & Dam No. 2, Monongahela River			10. SIZE AND TYPE OF BIT 6 X 7 3/4"			
2. LOCATION (Coordinates or Station) Middle Wall Monolith 25.5' in from land face, 10' U.S. of steps			11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL			
3. DRILLING AGENCY USAE WES			12. MANUFACTURER'S DESIGNATION OF DRILL Failing Skid Rig			
4. HOLE NO. (As shown on drawing sheet and site number) BR WES M-6-86			13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN DISTURBED UNDISTURBED			
5. NAME OF DRILLER Dan Taylor			14. TOTAL NUMBER CORE BOXES 33			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.			15. ELEVATION GROUND WATER _____			
7. THICKNESS OF SKIN (If known) Concrete 65.4'			16. DATE HOLE STARTED COMPLETED 29 Jan 86 11 Feb 86			
8. DEPTH DRILLED INTO ROCK 6.1' shale			17. ELEVATION TOP OF HOLE 772.5'			
9. TOTAL DEPTH OF HOLE 91.7'			18. TOTAL CORE RECOVERY FOR BORING Rock 97 %			
			19. SIGNATURE OF INSPECTOR Scott Murrell			
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Designation) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, motor loss, depth of monitoring, etc., if significant) g
91.0			Shale, gray, moderately hard, slightly silty.		33	
92.0			E.O.B. @ 91.7'.			
Abbreviations D.T. - Drill time D. Press - Drill pressure Rec. - Recovery E.O.B. - End of Boring M.B. - Mechanical break N.B. - Natural break U.S. - Upstream Mod. - Moderately						

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(TRANSLUCENT)

PROJECT Rehabilitation of
Lock & Dam No. 2, Monon-
gahela River

HOLE NO.
BR WES M-6-86

DRILLING LOG		DIVISION Ohio River		INSTALLATION Lock & Dam No. 2, Monongahela River		SHEET 1 OF 1 SHEETS	
1. PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River				10. SIZE AND TYPE OF BIT 4" - thin wall			
2. LOCATION (Continuation of Station) Upper guard wall, monolith R-5, in line w/monolith R-2 joint.				11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL			
3. DRILLING AGENCY J-0 in from land face USAE WES				12. MANUFACTURER'S DESIGNATION OF DRILL Kor-It, Series K-100, 110 volts			
4. HOLE NO. (As shown on drawing title) and file number BR WES R-1-86				13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN 1			
5. NAME OF DRILLER Dar. Taylor				14. TOTAL NUMBER CORE BOXES 1			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				15. ELEVATION GROUND WATER			
7. THICKNESS OF OVERBURDEN				16. DATE HOLE STARTED 12 Feb 86 COMPLETED 13 Feb 86			
8. DEPTH DRILLED INTO ROCK CONCRETE 1.7'				17. ELEVATION TOP OF HOLE 730.5'			
9. TOTAL DEPTH OF HOLE 1.7'				18. TOTAL CORE RECOVERY FOR BORING 100%			
19. SIGNATURE OF INSPECTOR							

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Designation) d	% CORE RECOV- ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
		△	Top surface intact, broken on removal from hole.			
	1.0	△	Concrete good, natural and crushed siliceous aggregate, maximum 1-1/2".	100	Box 1	
	2.0	△	Has entrapped and entrained air.			

DRILLING LOG		DIVISION	INSTALLATION	Hole No.	SHEET
		Ohio River	Lock & Dam #2		OF 1 SHEETS
1. PROJECT Rehab. of Lock & Dam 2, Mon. River			10. SIZE AND TYPE OF BIT 5" HSS 110° bit		
2. LOCATION (Coordinates or Station) See Remarks			11. DAY OF YEAR FOR ELEVATION SHOWN (1958 or 1959) 1958		
3. DRILLING AGENCY USAB-WES			12. MANUFACTURER'S DESIGNATION OF DRILL ROR-12, Series A-100, 110 volt		
4. HOLE NO. (As shown on drawing title and file number) BR WES R-3			13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN		
			14. TOTAL NUMBER CORE BOXES 1		
5. NAME OF DRILLER Dan Taylor			15. ELEVATION GROUND WATER 4/2		
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED 90 Horizontal DES. FROM VERT.			16. DATE HOLE STARTED 25 Oct 55 COMPLETED 25 Oct 55		
7. THICKNESS OF OVERBURDEN 0.0			17. ELEVATION TOP OF HOLE 725.71		
8. DEPTH DRILLED INTO ROCK 0.0			18. TOTAL CORE RECOVERY FOR BORING 100%		
9. TOTAL DEPTH OF HOLE 3.1' in concrete			19. SIGNATURE OF INSPECTOR <i>[Signature]</i>		

ELEVATION +	DEPTH +	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY %	BOX OR SAMPLE NO. 1	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
0.0	0.0		Surface Condition: Moderately weathered with medium scaling - max. agg. size is 2". Severe scaling is at joints.	100%		Run: 1 Begin: 0.0 End: 1.15 D.T.: 1 hr. Rec: 1.1 Remarks: Pulled off .05'.
1.0	1.0		0.0 - 3.1 Concrete: gray, siliceous with some carbonates, max. agg. size is 3", river gravel, subrounded to subangular, good consolidation, good entrapped air, entrained air, many voids - none greater than 1" diameter & deep unless noted, @ .75: 1" steel. @ .65: 1" steel. @ 2.1: void - 3/8" diameter, 3/4" deep. 3/4" long.	100%	Box 1	Run: 2 Begin: 1.15 End: 3.1 D.T.: 1 hr 45 min. Rec: 2.0 Remarks: Picked up .05' from run 1. Drill action was smooth throughout boring. 100% of water was retained.
2.0	2.0					
3.0	3.0					
			B.O.B. @ 3.1'			

mono. 14

mono. 15

↑ 14' RIVERWALL

↑ 5.2'

Small Chamber

→ flow →

MIDDLEWALL

ABBREVIATIONS:
agg: aggregate
max: maximum
D.T.: drill time
Rec: recovery
B.O.B.: end of boring.

LOCATION:

DRILLING LOG		DIVISION	INSTALLATION	Hole No. _____	SHEET OF 1 SHEETS
1. PROJECT Rehab. of Lock & Dam 2, Mon. River		US10 River	Lock & Dam #2	10. SIZE AND TYPE OF BIT Diamond bit	
2. LOCATION (Coordinates or Station) See Remarks				11. DAY OF YEAR FOR ELEVATION SHOWN (T.M. or A.M.)	
3. DRILLING AGENCY USAR-VES				12. MANUFACTURER'S DESIGNATION OF DRILL KOR-11, Series A-100, 112	
4. HOLE NO. (As shown on drawing title) and file number BR WES R-4				13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN: UNOBTAINED 0	
5. NAME OF DRILLER Dan Taylor				14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ☒ HORIZONTAL OBS. FROM VERT.				15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN 0.0				16. DATE HOLE STARTED: 124 Oct 55 COMPLETED: 24 Oct 55	
8. DEPTH DRILLED INTO ROCK 0.0				17. ELEVATION TOP OF HOLE 717.0	
9. TOTAL DEPTH OF HOLE 3.1' in Concrete				18. TOTAL CORE RECOVERY FOR BORING 100 %	
				19. SIGNATURE OF INSPECTOR	

ELEVATION ft	DEPTH ft	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	0.0		Surface Condition: badly weathered with severe scaling - max. agg. size is 3".	100%		Run: 1 Begin: 0.0 End: 1.15 D.T.: 40 min. Rec: 1.15 Remarks: -
	1.0		0.0 - 3.1 Concrete: gray, sili- ceous with some car- bonates, max. agg. size is 3", river gravel, subrounded to subangular, good con- solidation, entrapped air, entrained air, many voids - none greater than 1/2" dia- meter & deep unless noted, @ .1: 3/4" long & 1/2" deep void. @ .2: incipient cracks - through some agg. @ .35: manmade break during retrieval. @ .5: manmade break during retrieval.	Run 1	Box 1	Run: 2 Begin: 1.15 End: 3.1 D.T.: 1 hr 45 min. Rec: 1.95 Remarks: 100% of water was retained. Drill action was smooth throughout boring.
	2.0			100%		
	3.0			Run 2		
			E.O.B. @ 3.1'			ABBREVIATIONS: agg: aggregate max: maximum D.T: drill time Rec: recovery E.O.B: end of boring. LOCATION: Riverwall mono. mono. 17 18 15.5' Small Chamber — flow → MIDDLEWALL

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PROJECT Rehab. of Lock & Dam 2, Mon. River HOLE NO. BR WES R-4

DRILLING LOG			DIVISION Ohio River	INSTALLATION Lock & Dam No. 2, Monongahela River.	SHEET 1 OF 10 SHEETS	
1. PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River			10. SIZE AND TYPE OF BIT 2" x 7 7/8"			
2. LOCATION (Coordinates or Station) River wall Monolith R-23, 6.7' U.S. of R-24 Joint and 5.8'			11. DAY ON FOR ELEVATION SIGHTING (if any) MSL			
3. DRILLING AGENCY USAE-WES			12. MANUFACTURER'S DESIGNATION OF DRILL Falling Skid Rig			
4. HOLE NO. (As shown on drawing title and file number) BR WES R-5-86			13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN DISTURBED UNDISTURBED			
5. NAME OF DRILLER Dan Taylor			14. TOTAL NUMBER CORE BOXES 17			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.			15. ELEVATION GROUND WATER			
7. THICKNESS OF OVERBURDEN 67.5' concrete			16. DATE HOLE STARTED 18 Dec 85 COMPLETED 24 Jan 86			
8. DEPTH DRILLED INTO ROCK 23.2' shale			17. ELEVATION TOP OF HOLE 730.5'			
9. TOTAL DEPTH OF HOLE 90.7'			18. TOTAL CORE RECOVERY FOR BORING Rock 99			
			19. SIGNATURE OF INSPECTOR Scott Murrell			
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV- ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of monitoring, etc., if significant) g
	1.0	△	Concrete: Looks good. Entrained air, entrapped air. maximum size 1/2".		1	
	2.0	△	Aggregate - natural and crushed, siliceous and calcareous, maximum size 2".			
	3.0	△				
	4.0	△				
	5.0	△			2	
	6.0	△				
	7.0	△	Concrete: Looks good. Entrained air, entrapped air. Maximum size 1/4".			
	8.0	△	Aggregate - natural and crushed siliceous and cal- careous, maximum size 2 1/4".		3	
	9.0	△				

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PROJECT Rehabilitation of
Lock & Dam No. 2, Monon-
ahela River

HOLE NO.
BR WES R-5-86

DRILLING LOG		DIVISION Ohio River		INSTALLATION Lock & Dam No. 2, Monongahela River:		SHEET 2 OF 10 SHEETS	
1. PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River				10. SIZE AND TYPE OF BIT 2" x 7/8"			
2. LOCATION (Coordinate or Station) R-23, 6.7' U.S. of R-24 Joint and 5.8'				11. DAY OF YEAR FOR ELEVATION THROWN (TSM or MSL)			
3. DRILLING AGENCY USAF-WES				12. MANUFACTURER'S DESIGNATION OF DRILL Falling Skid R1			
4. HOLE NO. (As shown on drawing title) BR WES R-5-86				13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN			
5. NAME OF DRILLER Dan Taylor				14. TOTAL NUMBER CORE BOXES 32			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED DEG. FROM VERT.				15. ELEVATION GROUND WATER			
7. THICKNESS OF OVERBURDEN 67.5' concrete				16. DATE HOLE STARTED 18 Dec 85 COMPLETED 24 Jan 86			
8. DEPTH DRILLED INTO ROCK 23.2' shale				17. ELEVATION TOP OF HOLE 730.5'			
9. TOTAL DEPTH OF HOLE 90.7'				18. TOTAL CORE RECOVERY FOR BORING Rock 99			
				19. SIGNATURE OF INSPECTOR Scott Murrell			
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of penetration, etc., if significant)	
10.0		△	Concrete: Looks good, sounds good. entrained air, entrapped air, maximum size 1/4".		4		
11.0		△	Aggregate - natural and crushed, maximum size 2-1/4", siliceous and calcareous.				
12.0		△			5		
13.0		△					
14.0		△					
15.0		△					
16.0		△	MB Concrete: Looks good, sounds good. Entrained air, entrapped air, maximum size 1/4".			Run: 1 Begin: 16.1' End: 21.3' D.T.: 1 hr 21 min D. Press: 220 RPM: ≈100 Rec: 5.0' Loss: 0.2' in hole	
17.0		△	Aggregate natural and crushed, maximum size 2-1/2", siliceous.	100	6		
18.0		△					
19.0		△					
20.0		△					

DRILLING LOG		DIVISION		INSTALLATION LOCK & DAM NO. 2, Monongahela River		SHEET 5 OF 10 SHEETS	
1. PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River				10. SIZE AND TYPE OF BIT 6" X 7 3/4"			
2. LOCATION (Continuation of Station) River Wall Monolith R-23, 6.7' U.S. of R-24 Joint and 5.8'				11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL			
3. DRILLING AGENCY landward from river face USAF-WES				12. MANUFACTURER'S DESIGNATION OF DRILL Falling Skid R1			
4. HOLE NO. (As shown on drawing title) and its number BR WES R-5-86				13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN			
5. NAME OF DRILLER Dan Taylor				14. TOTAL NUMBER CORE BOXES 32			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				15. ELEVATION GROUND WATER			
7. THICKNESS OF OVERBURDEN 57.5' concrete				16. DATE HOLE STARTED 18 Dec 85 COMPLETED 24 Jan 86			
8. DEPTH DRILLED INTO ROCK 23.2' shale				17. ELEVATION TOP OF HOLE 730.5'			
9. TOTAL DEPTH OF HOLE 90.7'				18. TOTAL CORE RECOVERY FOR BORING Rock 99			
				19. SIGNATURE OF INSPECTOR Scott Murrell			
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of overburden, etc., if significant)	
20.0				100			
21.0		MB			7		
22.0						Run: 2 Begin: 21.3' End: 26.2' D.T.: 2 hr 00 min Rec: 5.0' Loss: 0.2' in hole D. Press: 220 RPM: $\approx$ 100	
23.0		MB Rebar, 3/4" at 22.8'.	Concrete: Looks good, sounds good. Entrained air, entrapped air, maximum size 1/2".	100			
24.0			Aggregate - siliceous, natural and crushed, maximum size 1-1/2".		8		
25.0							
26.0		MB 2" Conduit pipe.					
27.0		MB	Concrete: Looks good, sounds good. Entrained air, entrapped air, maximum size 1/2".				
28.0			Aggregate - siliceous, natural and crushed, maximum size 2-1/4".	100	9	Run: 3 Begin: 26.2' End: 31.0' D.T.: 2 hr 00 min D. Press: 220 RPM: $\approx$ 100 Rec: 5.0' Loss: ---	
29.0		MB Rebar, 1" diameter, at 27.0', 27.2', and 27.5'-28.0'.					
30.0					10		

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PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River

HOLE NO. BR WES R-5-

DRILLING LOG		DIVISION	INSTALLATION LOCK & DAM NO.	SHEET		
		Ohio River	Monongahela River	OF 10 SHEETS		
1. PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River			10. SIZE AND TYPE OF BIT 6" X 7 3/4"			
2. LOCATION (Coordinates or Station) River Wall Monolith R-23, 6.7' U.S. of R-24 Joint and 5.8' landward from river face			11. DATUM FOR ELEVATION SHOWN (MSL or MLL)			
3. DRILLING AGENCY USAF-WES			12. MANUFACTURER'S DESIGNATION OF DRILL Falling Skid Rig			
4. HOLE NO. (As shown on drawing title) and file number BR WES R-5-86			13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN			
5. NAME OF DRILLER Dan Taylor			14. TOTAL NUMBER CORE BOXES 32			
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.			15. ELEVATION GROUND WATER			
7. THICKNESS OF OVERBURDEN 67.5' concrete			16. DATE HOLE STARTED 18 Dec 85 COMPLETED 24 Jan 86			
8. DEPTH DRILLED INTO ROCK 23.2' shale			17. ELEVATION TOP OF HOLE 730.5'			
9. TOTAL DEPTH OF HOLE 90.7'			18. TOTAL CORE RECOVERY FOR BORING Rock 99 %			
			19. SIGNATURE OF INSPECTOR Scott Murrell			
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of overburden, etc., if significant)
30.0		△			10	
31.0		△	MB			
		△	Concrete: Looks good, sounds good. Entrained air, entrapped air, maximum size 1/2".			
32.0		△	Aggregate - siliceous, natural and crushed, maximum size 2".		11	
		△		100		Run: 4 Begin: 31.0' End: 36.2' D.T.: 2 hr 42 min D. Press: 220 RPM: ≈100 Rec: 5.1' Loss: 0.1' in hole
33.0		△				
		△	MB			
34.0		△				
		△			12	
35.0		△	MB			
		△				
36.0		△	MB			
		△	Concrete: Looks good, sounds good. Entrained air, entrapped air, maximum size 1/4".			
37.0		△	Aggregate - siliceous, natural and crushed, maximum size 2".		13	
		△		100		Run: 5 Begin: 36.2' End: 41.2' D.T.: 0 hr 57 min D. Press: 240 RPM: ≈100 Rec: 5.1' Loss: —
38.0		△				
		△				
39.0		△				
		△				
40.0		△				

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PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River

HOLE NO. BR WES R-5-8

DRILLING LOG		DIVISION Ohio River		INSTALLATION LOCK & DAM NO. 2, Monongahela River		SHEET 5 OF 10 SHEETS	
1. PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River				10. SIZE AND TYPE OF BIT 5" X 7 3/4"			
2. LOCATION (Coordinates or Station) River wall Monolith R-23, 6.7' U.S. of R-24 Joint and 5.8'				11. DATUM FOR ELEVATION SHOWN MSL			
3. DRILLING AGENCY USAE-WES				12. MANUFACTURER'S DESIGNATION OF DRILL Falling Skid R.			
4. HOLE NO. (As shown on drawing title and file number) BR WES R-5-86				13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN DISTURBED UNDISTURBED			
5. NAME OF DRILLER Dan Taylor				14. TOTAL NUMBER CORE BOXES 32			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				15. ELEVATION GROUND WATER			
7. THICKNESS OF OVERBURDEN 67.5' concrete				16. DATE HOLE STARTED 19 Dec 85 COMPLETED 24 Jan 86			
8. DEPTH DRILLED INTO ROCK 23.2' shale				17. ELEVATION TOP OF HOLE 730.5'			
9. TOTAL DEPTH OF HOLE 90.7'				18. TOTAL CORE RECOVERY FOR BORING Rock 99 %			
				19. SIGNATURE OF INSPECTOR Scott Murrell			
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, motor loss, depth of weathering, etc., if significant)	
40.0					14		
41.0			Concrete: Looks good, sounds good. Entrained air, entrapped air, maximum size 5/8".		15	Run: 6 Begin: 41.2' End: 46.2' D.T.: 2 hr 42 min RPM: ~100 D. Press: 240 Rec: 5.0' Loss: 0.1' Comments: Barrel came up without core. Fished for it without success. Tried again 21 Jan and recovered core.	
42.0			Aggregate - siliceous, natural and crushed, max- imum size 2-1/4".	100			
43.0					16		
44.0							
45.0							
46.0							
47.0			Concrete: Looks good, sounds good. Entrained air, entrapped air, maximum size 1/4".	100		Run: 7 Begin: 46.2' End: 47.5' D.T.: 1 hr 08 min D. Press: 240 RPM: ~100 Rec: 1.3' Loss: --- Comments: Striations on core caused by retrieval.	
48.0					17		
49.0							
50.0					100		

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PROJECT Rehabilitation of
Lock & Dam No. 2, Monon-
gahela River

HOLE NO.
BR WES R-5-86

DRILLING LOG		DIVISION Ohio River		INSTALLATION LOCK & DAM NO. 2, Monongahela River		SHEET 0 OF 10 SHEETS	
1. PROJECT Renabilitation of Lock & Dam No. 2, Monongahela River				10. SIZE AND TYPE OF BIT 6" X 7 1/4"			
2. LOCATION (Commence or Station) R-23, 6.7' U.S. or R-24 Joint and 5:8'				11. DATUM FOR ELEVATION (HIGHTEN or MSL)			
3. DRILLING AGENCY USAE-WES				12. MANUFACTURER'S DESIGNATION OF DRILL Failing Skid Rig			
4. HOLE NO. (As shown on drawing title) SR WES R-5-86				13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN			
5. NAME OF DRILLER Dan Taylor				14. TOTAL NUMBER CORE BOXES 32			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				15. ELEVATION GROUND WATER			
7. THICKNESS OF OVERBURDEN 67.5' concrete				16. DATE HOLE STARTED 19 Dec 85 COMPLETED 24 Jan 86			
8. DEPTH DRILLED INTO ROCK 33.2' shale				17. ELEVATION TOP OF HOLE 730.5'			
9. TOTAL DEPTH OF HOLE 90.7'				18. TOTAL CORE RECOVERY FOR BORING Rock 99			
				19. SIGNATURE OF INSPECTOR Scott Murrell			
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVER- ED	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of penetration, etc., if significant)	
50.0		△	Concrete: Looks good, sounds good. Entrained air, entrapped air, maximum size 1/2".	100	18	Run: 8 Begin: 47.5' End: 52.3' D.T.: 1 hr 11 min D. Press: 240 RPM: ≈100 Rec: 4.8' Loss: —	
51.0		△	Aggregate - siliceous, natural and crushed, maximum MB size 2-1/2".				
52.0		△					
53.0		△	Concrete: Looks good, sounds good. Entrained air, entrapped air, maximum size 1/2".	90	19	Run: 9 Begin: 52.3' End: 57.1' D.T.: 2 hr 21 min D. Press: 240 RPM: ≈100 Rec: 4.5' Loss: 0.4' ground up Comments: Break at 55' had missing section approximately 0.4' due to section being broken up. This section was removed from core barrel as aggregate and loose pieces of con- crete. This is best estimate of length of section. Measuring tape lowered to bottom of hole read 57.1'.	
54.0		△	Aggregate - siliceous and calcareous, natural and crushed, maximum size 2-1/4".				
55.0		△					
56.0		△			20		
57.0		△					
58.0		△	Concrete: Looks good, sounds good. Entrained air, entrapped air, maximum size 1/4".			Run: 10 Begin: 57.1' End: 62.3' D.T.: 1 hr 45 min D. Press: 240 RPM: ≈100 Rec: 5.1' Loss: 0.1' in hole	
59.0		△	Aggregate - siliceous and calcareous, natural and crushed, maximum size 2-1/4".		21		
60.0		△					

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PROJECT Renabilitation of
Lock & Dam No. 2, Monon-
gahela River

HOLE NO.
BR WES R-5-

DRILLING LOG		DIVISION	INSTALLATION LOCK & DAM NO. 2, Monongahela River	SHEET 7 OF 10 SHEETS		
1. PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River		Ohio River	10. SIZE AND TYPE OF BIT 6" X 7 3/4"			
2. LOCATION (Coordinate or Station) River-Wall Monolith R-23, 6.7' U.S. of R-24 Joint and 5.8'			11. DATUM FOR ELEVATION SHOWN (FMS = MSL)			
3. DRILLING AGENCY Landward from river face USAE-WES			12. MANUFACTURER'S DESIGNATION OF DRILL Falling Skid Rig			
4. HOLE NO. (As shown on drawing title) and site number BR WES R-5-86			13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN			
5. NAME OF DRILLER Dan Taylor			14. TOTAL NUMBER CORE BOXES 32			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.			15. ELEVATION GROUND WATER			
7. THICKNESS OF OVERBURDEN 57.5' concrete			16. DATE HOLE STARTED 8 Dec 85 COMPLETED 24 Jan 86			
8. DEPTH DRILLED INTO ROCK 33.2' shale			17. ELEVATION TOP OF HOLE 730.5'			
9. TOTAL DEPTH OF HOLE 90.7'			18. TOTAL CORE RECOVERY FOR BORING Rock 99			
			19. SIGNATURE OF INSPECTOR Scott Murrell			
ELEVATION f	DEPTH d	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV- ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of penetration, etc., if significant) g
60.0			MB - 2 pieces 1" rebar at 60.4'.			
61.0				100	22	
62.0			MB Concrete: Looks good, sounds good. entrained air, entrapped air, maximum size 1/2".			Run: 11 Begin: 62.3' End: 66.5' D.T.: 3 hr 00 min D. Press: 240 RPM: $\approx$ 100 Rec: 4.2' Loss: 0.1' in hole Comments:
63.0			MB Aggregate - siliceous and calcareous, natural and crushed, max num size 2-3/4".	100	23	
64.0						
65.0						
66.0						
67.0						
68.0			MB Concrete rock interface.			Run: 12 Begin: 66.5' End: 71.6' D.T.: 2 hr 55 min D. Press: 240 RPM: $\approx$ 100 Rec: 5.1' Loss: --- Comments: Reached concrete - rock open interface. Rock is gray shale, sandy. Layer of gravel between concrete and rock. Layer of burlap on bot- tom of concrete. Gravel is siliceous with a waxy coating.
69.0			MB Gray shale, moderately hard, slightly sandy, with calcareous in- clusions.	98	24	
70.0						

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PROJECT Rehabilitation of
Locks & Dam No. 2, Monon-
gahela River HOLE NO.
BR WES R-5-

DRILLING LOG		DIVISION Ohio River		INSTALLATION Lock & Dam No. 2, Monongahela River		SHEET 3 OF 10 SHEETS	
1. PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River				10. SIZE AND TYPE OF BIT 4" X 3/4"			
2. LOCATION (Continuation of Station) River wall Monolith R-21, 4.7' U.S. of R-24 Joint and 5.8'				11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL			
3. DRILLING AGENCY USAF-WES landward from river face				12. MANUFACTURER'S DESIGNATION OF DRILL Falling Jkid R12			
4. HOLE NO. (As shown on drawing title) BR WES R-5-86				13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN 1			
5. NAME OF DRILLER Dan Taylor				14. TOTAL NUMBER CORE BOXES 32			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				15. ELEVATION GROUND WATER			
7. THICKNESS OF OVERBURDEN 57.5' concrete				16. DATE HOLE STARTED 18 Dec 85 COMPLETED 24 Jan 86			
8. DEPTH DRILLED INTO ROCK 22.2' shale				17. ELEVATION TOP OF HOLE 730.5'			
9. TOTAL DEPTH OF HOLE 80.7'				18. TOTAL CORE RECOVERY FOR BORING Rock 99 %			
				19. SIGNATURE OF INSPECTOR Scott Murrell			
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	1. CORE BOX OR RECOV. SAMPLE ERY NO.	2. SAMPLE NO.	REMARKS (Drilling time, water loss, depth of underburden, etc., if significant)	
70.0		MB	Calcareous inclusions.		25		
71.0		MB					
72.0		MB	Gray shale with calcareous inclusions. siliceous, slightly sandy, moderately hard.	98	26	Run: 13 Begin: 71.6', 72.1' End: 76.7' D.T.: 2 hr 18 min D. Press: 240 RPM: 100 Rec: 4.8' Loss: 0.1'	
73.0		MB				Comments: Some frag- ments lost at breaks.	
74.0		MB				Calcareous patches turned into seam down center of core.	
75.0		MB			27		
76.0		MB					
77.0		MB	Gray shale, slightly sandy, moderately hard. siliceous, with calcareous inclusions.			Run: 14 Begin: 76.7' End: 80.8' D.T.: 1 hr 55 min D. Press: 240 RPM: 100 Rec: 4.2' Loss: 0.1'	
78.0		MB		100	28	Comments: Calcareous seam still present.	
79.0		MB					
80.0		MB					

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PROJECT Rehabilitation of
Lock & Dam No. 2, Monon-
gahela River

HOLE NO.
BR WES R-5-86

DRILLING LOG		DIVISION	INSTALLATION	SHEET
		Ohio River	Lock & Dam No. 2, Monongahela River	9
				OF 10 SHEETS
1. PROJECT		Rehabilitation of Lock & Dam No. 2, Monongahela River		
2. LOCATION (Coordinates of Station)		River wall Monongahela R-23, 6.7' U.S. or R-24 Joint and 5.8'		
3. DRILLING AGENCY		USAE-WES		
4. HOLE NO. (As shown on drawing title and file number)		BR WES R-5-86		
5. NAME OF DRILLER		Dan Taylor		
6. DIRECTION OF HOLE		☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		
7. THICKNESS OF OVERBURDEN		67.5' concrete		
8. DEPTH DRILLED INTO ROCK		23.2' shale		
9. TOTAL DEPTH OF HOLE		90.7'		
10. SIZE AND TYPE OF BIT		6" X 7 1/4"		
11. DAY OF ELEVATION SHOWN (TYPED)		MSL		
12. MANUFACTURER'S DESIGNATION OF DRILL		Falling Skid Rig		
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN		☐ DISTURBED ☐ UNDISTURBED		
14. TOTAL NUMBER CORE BOXES		32		
15. ELEVATION GROUND WATER				
16. DATE HOLE		STARTED 18 Dec 85 COMPLETED 24 Jan 86		
17. ELEVATION TOP OF HOLE		730.5'		
18. TOTAL CORE RECOVERY FOR BORING		Rock 99 %		
19. SIGNATURE OF INSPECTOR		Scott Murrell		

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, mud loss, depth of weathering, etc., if significant)
80.8		MB				
81.0		MB	Gray shale, siliceous with calcareous inclusions, moderately hard, slightly sandy.	29		Run: 15 Begin: 80.8' End: 85.5' D.T.: 2 hr 23 min D. Press: 240 RPM: $\approx$ 100 Rec: 3.7' Loss: 1.0' Comments: Seam still present.
82.0		MB		100		
83.0		MB			30	
84.0		MB				
85.0		MB	Healed fracture.			Run: 16 Begin: 85.5' End: 89.6 D.T.: 2 hr 10 min D. Press: 240 RPM: $\approx$ 100 Rec: 4.7' Loss: 0.4' Comments: Seam still present.
86.0		MB		31		
87.0		MB	Gray shale, moderately hard, slightly sandy, siliceous with calcareous inclusions.	100		
88.0		MB			32	
89.0		MB				
90.0						

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PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River

HOLE NO. BR WES R-5-8

DRILLING LOG		DIVISION Ohio River		INSTALLATION Lock & Dam No. 2 Monongahela River		SHEET 10 OF 10 SHEETS	
1. PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River				10. SIZE AND TYPE OF BIT 4" V 7/4"			
2. LOCATION (Coordinate or Station) River wall Monolith R-23, 6.7' U.S. of R-24 Joint and 5.8'				11. DATUM FOR ELEVATION SHOWN (TBM or MSL) h MSL			
3. DRILLING AGENCY Landward from river face USAE-WES				12. MANUFACTURER'S DESIGNATION OF DRILL Falling Skid Rig			
4. HOLE NO. (As shown on drawing title) and file number BR WES R-5-86				13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN 1 DISTURBED UNDISTURBED			
5. NAME OF DRILLER Dan Taylor				14. TOTAL NUMBER CORE BOXES 1			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				15. ELEVATION GROUND WATER			
7. THICKNESS OF OVERBURDEN 47.5' concrete				16. DATE HOLE STARTED 13 Dec 85 COMPLETED 24 Jan 86			
8. DEPTH DRILLED INTO ROCK 33.2' shale				17. ELEVATION TOP OF HOLE 730.5'			
9. TOTAL DEPTH OF HOLE on 7'				18. TOTAL CORE RECOVERY FOR BORING ROCK 99 %			
				19. SIGNATURE OF INSPECTOR Scott Murrell			
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE (BOX OR RECOV- SAMPLE ERY NO.)	REMARKS (Drilling time, water loss, depth of measuring, etc., if significant)		
90.0			Gray shale, siliceous with calcareous inclusions, moderately hard, slightly sandy E.O.B. @ 90.7'.	100	Run: 17 Begin: 89.6 End: 90.7 D.T.: 245 min D. Press: 240 RPM: 100 Rec: 1.5' Loss: — Comments: Clutch broke on drill rig. Aban- doned hole at 90.7' depth.		
					Abbreviations: D.T.: Drill Time D. Press: Drill Pressure Rec: Recovery E.O.B.: End of Boring M.B.: Mechanical Break N.B.: Natural Break U.S.: Upstream		

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PROJECT Rehabilitation of
Lock & Dam No. 2, Monon-
gahela River

HOLE NO.
BR WES R-5-86

DRILLING LOG		DIVISION	INSTALLATION	SHEET OF 1 SHEETS
1. PROJECT Rehab. of Lock & Dam 2, Mon. River		Ohio River	Lock & Dam 2	1
2. LOCATION (Compliance or Station)			10. SIZE AND TYPE OF BIT	11. DAY USE FOR ELEVATION SHOWN (FSM or MSL)
3. DRILLING AGENCY US-3-403			MSD	
4. HOLE NO. (As shown on drawing title and file number)		BR WES R-6	12. MANUFACTURER'S DESIGNATION OF DRILL MCN-12, Series R-10, 115 volt	13. TOTAL NO. OF OVER- BURDEN SAMPLES TAKEN
5. NAME OF DRILLER Dan Taylor			14. TOTAL NUMBER CORE BOXES	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE ☐ VERTICAL ☒ INCLINED		See Remarks	16. DATE HOLE STARTED 20 Oct 35 COMPLETED 20 Oct 35	17. ELEVATION TOP OF HOLE
7. THICKNESS OF OVERBURDEN		0.0	18. TOTAL CORE RECOVERY FOR BORING	19. SIGNATURE OF INSPECTOR
8. DEPTH DRILLED INTO ROCK		0.0	100%	
9. TOTAL DEPTH OF HOLE		3.3' in concrete		

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOV- ERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
0.0	0.0		Surface Condition: mod- erately weathered with medium to severe scal- ing. Maximum exposed aggregate size is 2".			Run: 1 Begin: 0.0 End: 3.3 D.T.: 1 hr 55 min. Rec: 3.25'
1.0	0.0 - 3.25		Concrete: gray, sili- ceous with some car- bonates, maximum ag- gregate size is 3", river gravel, sub- rounded to subangular, good consolidation, entrapped air and en- trained air, many voids generally less than 1/2" diameter & deep.	100%	Box 1	Remarks: Filled of .05". Drill action was smooth. 100% of water was re- tained.
2.0						ABBREVIATIONS: D.T.: drill time Rec: recovery E.O.B.: end of boring
3.0						LOCATION:
			E.O.B. = 3.3'			
						Direction of Hole: Perpendicular to the surface.

DRILLING LOG		DIVISION		INSTALLATION		SHEET	
		Ohio River		Locks & Dam No. 2, Mon River		1 of 1 SHEETS	
1. PROJECT Rehabilitation of Locks and Dam No. 2, Monongahela River				10. SIZE AND TYPE OF BIT 1 1/2 in. thin wall			
2. LOCATION (Coordinate or Station) Lower Guard Wall, Monolith 29, 20 ft from U.S. joint, 3 ft from F.S. line				11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL			
3. DRILLING AGENCY USAE WES				12. MANUFACTURER'S DESIGNATION OF DRILL Kor-Tr. Series K-100, 110 volts			
4. HOLE NO. (As shown on drawing title and file number) BR WES R-7-86				13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN			
				14. TOTAL NUMBER CORE BOXES			
5. NAME OF DRILLER Dan Taylor				15. ELEVATION GROUND WATER			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				16. DATE HOLE STARTED 15 Feb 86 COMPLETED 15 Feb 86			
7. THICKNESS OF OVERBURDEN 0.0 ft				17. ELEVATION TOP OF HOLE 724.5 ft			
8. DEPTH DRILLED INTO REIN. CONCRETE 3.0 ft				18. TOTAL CORE RECOVERY FOR BORING 100 %			
9. TOTAL DEPTH OF HOLE 3.0 ft				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)	
			Surface intact				
	1.0		Concrete good, natural and crushed siliceous aggregate, maximum size 1-1/2 in.				
			1/2 in. rebar				
	2.0		Has entrapped and entrained air	100	Box 1		
	3.0						

APPENDIX C: PETROGRAPHIC REPORT, CONCRETE

Corps of Engineers, USAE Waterways Experiment Station	Concrete Report	Structures Laboratory P. O. Box 631 Vicksburg, Mississippi
Project Examination of Concrete, L/D #2 Monongahela River		Date 15 March 1988

Samples

1. Twenty-one cores were taken from the concrete at Locks and Dam No. 2 on the Monongahela River. One core was drilled into the backfill area beyond the concrete esplanade.

2. Nine of the cores were taken from horizontal holes. The remaining twelve cores were taken from vertical holes. Five of the vertical cores were drilled through concrete and into foundation rock. The cores are identified in Table 2 (with Cores Received Section).

Test procedures

3. All of the material from the twenty-one cores was examined in the field and again in the laboratory. The quality and condition of both the concrete and the foundation rock were noted. Representative samples of both material types were selected for more detailed examination and testing. Pieces of concrete that contained visible evidence of poorer-quality or significant reaction products were specifically chosen. The concrete samples examined in detail are identified below:

<u>Field Id.</u>	<u>Orientation in Wall</u>	<u>Depth of Sample</u>	<u>Concrete Technology Division Serial No.</u>
L-1	vertical	0.0- 3.15-ft	Pitts-13 CON-1
L-6	horizontal	1.2- 1.40-ft	Pitts-13 CON-12
L-7A	vertical	39.5-43.1-ft	Pitts-13 CON-29
M-1	vertical	32.6-35.75-ft	Pitts-13 CON-51
M-2	horizontal	0.0- 1.0-ft	Pitts-13 CON-60
M-5	horizontal	0.0- 3.3-ft	Pitts-13 CON-63
R-1	vertical	0.0- 1.65-ft	Pitts-13 CON-110
R-4	horizontal	0.0- 3.1-ft	Pitts-13 CON-112
R-5	vertical	31.0-33.2-ft	Pitts-13 CON-97

4. Samples for physical tests of the concrete were taken from both sound and poorer quality material. This was done to obtain the information on the "best case" and "worst case" material in order to ascertain just how bad the "bad" concrete was.

5. Samples from six of the cores were cut, ground smooth, and photographed. They were examined both visually and with the aid of a stereomicroscope.

6. The exterior surface of cores Pitts-13 CON-1, CON-60 and CON-112 were photographed.

7. A sawed slab from the top portion of sample Pitts-13 CON-112 was etched in dilute hydrochloric (HCl) acid to expose reaction rims present on some of the coarse aggregate. The etched surface was then examined both visually and with a stereomicroscope.

8. Cement paste concentrates were prepared from all six core samples. These were examined as tight-packed powder samples by X-ray diffraction (XRD).

9. Fine-grained white material was noted at the border of a piece of porous limestone coarse aggregate in sample Pitts-13 CON-112. The aggregate was located in a preexisting fracture surface. A small portion of the powder was collected and examined by XRD; the aggregate and surrounding paste were photographed.

10. Representative pieces of each coarse aggregate type were selected and examined by XRD.

11. Thin sections from four cores (Pitts-13 CON-1, CON-29, CON-60, and CON-112) were prepared and examined using a polarizing microscope. The thin sections were chosen from areas of the cores that represented typical concrete. Sections from cores Pitts-13 CON-60 and CON-112 contained coarse aggregate with rims.

12. All X-ray diffraction patterns were made using an X-ray diffractometer with nickel-filtered copper radiation.

Results

13. The concrete placed at the lower elevations in the three lock walls was easily distinguished from the concrete placed at the upper elevations. Aggregate used in the concrete at lower elevations was natural river sand and gravel with well rounded edges. Photograph C1 represents concrete placed at the lower elevations in all three walls. The natural river gravel was composed of coarse and fine-grained sandstone, siltstone, igneous and gneissic rock particles and some carbonate rock. Some of these particles were fractured, and several had either reaction or weathering rims. A few particles has siderite cores with a rim of goethite. The fine aggregate consisted of a

mixed composition. The mineral composition of eight typical coarse aggregates is shown in Table C1.

14. The concrete paste in the lower elevations of all three walls was a dark grayish color, except in areas where carbonation had occurred. The concrete is air-entrained and contains some entrapped air voids (voids >1 mm in diameter). No cracks were noted in the paste.

15. A general description of the concrete from the upper level each wall follows:

Land Wall Cores

16. The concrete placed at the upper elevations in the land wall (Pitts-13 CON-1, CON-5, CON-10, CON-12, and CON-29) was made using crushed limestone coarse aggregate and a natural, mixed composition fine aggregate. The coarse aggregate was a dense, dark colored material, consisting of calcite and trace amounts of clay (Table C1). No reaction rims were noted in this aggregate (Photograph C2).

17. The concrete paste in the upper elevations of the land wall was a dark grayish color, except for areas where carbonation had occurred (Photograph C2). It was air-entrained and contained some entrapped air. No cracks were noted. Photograph C3 shows the surface concrete condition at boring L-1 (Pitts-13 CON-1). The surface concrete of the other borings in the land wall was similar.

Middle and River Wall Cores

18. The concrete at the upper elevations of the middle and river walls was made using natural river gravel as coarse aggregate and a natural, mixed composition fine aggregate. The predominant rock type was dolomite, with some particles of igneous and metamorphic rock. The dolomite had well rounded edges, reaction rims (Photograph C4), and some weathering rims. Horizontal cores taken from above the upper pool level in both locks had good exterior surfaces; no cracking was noted. Hairline cracks in both paste and aggregate were present to a depth of approximately 0.4-ft in cores Pitts-13 CON-60, CON-110, and CON-112. Cores Pitts-13 CON-60 and CON-112 were taken from below the upper pool level on the land face of the middle wall and the land face of

the river wall, respectively. The exposed surfaces of these two cores were moderately weathered with exposed aggregate. Photograph C5 shows the condition of the Pitts-13 CON-112; CON-60 was similar.

19. The concrete paste in the upper elevations of the middle and river walls was a light gray color. Entrained and entrapped air were present. Concrete from boring M-1 (Pitts-13 CON-51) contained entrained air although it was reported in the field logs that it was not air-entrained.

20. The slab of concrete from core Pitts-13 CON-112 that was etched in dilute HCl showed that the rimmed areas on coarse dolomite aggregate dissolved at the same rate as the nonrimmed areas.

21. The paste concentrates of cores Pitts-13 CON-1, CON-29, CON-51, CON-60, CON-110, and CON-112 showed similar compositions by XRD. Calcium silicate hydrate (C-S-H), calcium hydroxide (CH), ettringite, and tetracalcium aluminate carbonate-11-hydrate (monocarboaluminate) phases of hydrated portland cement were present in each sample. Hydrogarnet was also identified in Pitts-13 CON-29. Unhydrated portland cement was detected by XRD in the paste concentrates, occurring as one or more of the calcium aluminoferrite solid solution series.

22. The white powder found around the coarse aggregate (Photograph C6) in sample Pitts-13 CON-112 contained calcium carbonate as three different minerals; calcite, aragonite, and vaterite. No other crystalline phases were identified in the powder.

23. Table C1 gives the mineralogical data for several coarse aggregates examined by XRD. The sandstones examined from concrete in lower elevations contained mainly quartz, feldspar, mica, and clays. One igneous particle also contained a monoclinic amphibole. The dark, dense, crushed limestone rock used in the upper elevations of the land wall was mainly calcite. A trace of clay mica was also present. The brownish coarse carbonate rock used in the upper elevations of the middle and river walls contained a large amount of dolomite. In every case but one, the carbonates (calcite and dolomite) were about equal in amount, or there was more dolomite. Clay was also present in these rocks.

24. The examination of petrographic thin sections made from four concrete samples showed both normal hydrated cement paste with C-S-H and CH present, and paste that was highly carbonated. The amount of CH present in the concrete was fairly high for areas that were not carbonated. Isotropic

material that was probably C-S-H gel was abundant in the paste. Unhydrated portland cement was identified in the thin sections as calcium silicates and calcium aluminoferrites. The sections made from samples Pitts-13 CON-60 and CON-112 showed coarse aggregate with euhedral and subhedral crystals of dolomite in a fine-grained calcite matrix. The section made from sample Pitts-13 CON-112 had a portion of the large aggregate seen in the lower center of Photograph C4. The rock has a reaction rim, but no visible damage or reaction product at the rock-paste interface was found in the thin section.

Discussion

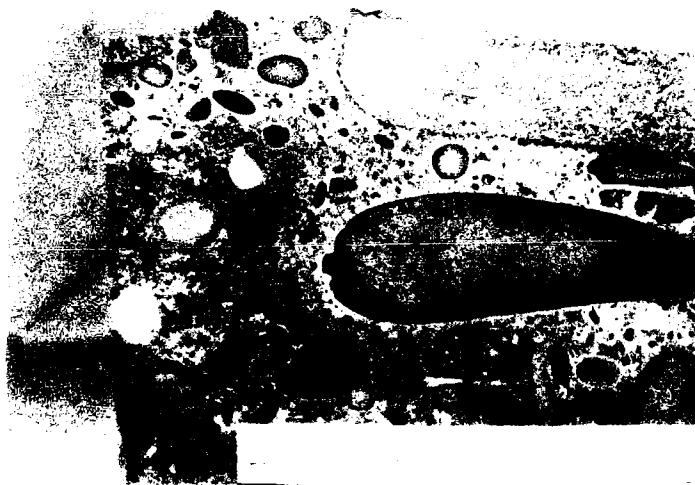
25. In general, the concrete in the three lock walls appears to be in good condition and is competent. The damaged concrete is confined to the lock walls below the upper pool level, and this is minor.

26. The damaged areas are in the exposed ends of the horizontal cores taken from areas below the upper pool level in the locks. The damage consisted of etched surfaces, leaving aggregate exposed, and as hairline cracks normal to the direction of coring that extended to a depth of 0.4-ft. The etching is probably due to chemical action.

27. The XRD results of examination of paste concentrates and the examination of thin sections using a polarizing microscope showed that some carbonation of the paste had occurred. The extent of carbonation is minor, except in areas near the surface of lock walls where the carbonation occurs mainly as calcite. Some carbonation has occurred throughout the paste as indicated by the presence of monocarboaluminate. The resulting hairline cracks may be due to this carbonation of the paste causing carbonation shrinkage.

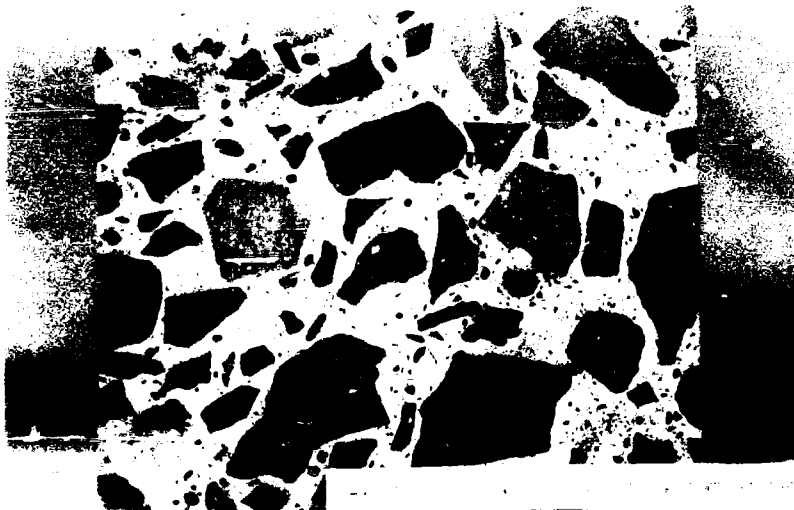
Table C1
Mineralogical Composition of Selected Coarse Aggregate from
Locks No. 2 Concrete by X-ray Diffraction

	<u>Sample Identification</u>							
	<u>Pitts-13 CON-</u>							
	<u>1</u>	<u>29</u>	<u>29</u>	<u>51</u>	<u>60</u>	<u>60</u>	<u>110</u>	<u>112</u>
<u>Minerals</u>	Agg. 2	1	4	1	1	2	2	2
<u>Clays</u>								
Kaolinite	X	X					X	X
Clay-Mica	X	X		X	X	X		X
14A Material		X						
<u>Nonclays</u>								
Quartz	X	X		X		X	X	X
Feldspar		X						
Mica		X						
Calcite	X			X	X	X	X	X
Dolomite				X	X	X	X	X
Siderite			X					
Goethite			X					



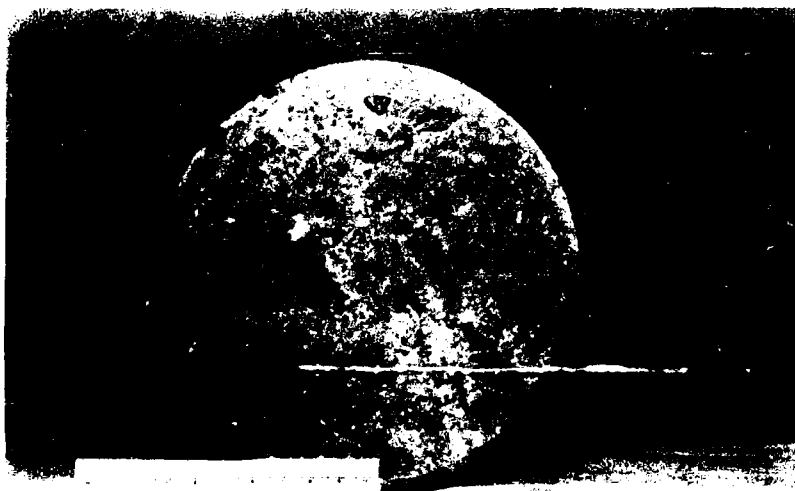
PITTS -13 CON - 29

Photograph C1. Concrete from L-7A. The coarse aggregate is mainly coarse and fine-grained sandstone. The dark particle near the lower center has a rim of goethite and a core of siderite. The dark rims are mainly weathered rims. Some rims are reaction rims



PITTS-13 CON-1

Photograph C2. Concrete from L-1. The coarse aggregate is crushed limestone. No reaction rims are present



PITTS -13 CON - 1

Photograph C3. Surface concrete at L-1. The surface concrete is in good condition



TS-13 CON-112

Photograph C4. Concrete from R-4. Hairline cracks are through coarse aggregate and paste. Note the reaction rim around the aggregate at the bottom center. The texture of this aggregate is crystalline dolomite with a matrix of fine-grained calcite



PITTS -13 CON - 112

Photograph C5. Concrete from R-4. This shows the surface concrete in the lock walls. The surface has been etched. Coarse aggregate is exposed



Photograph C6. Concrete from R-4. Note the white powder around the coarse aggregate. The composition of the powder is calcite, aragonite, and vaterite

APPENDIX D: PETROGRAPHIC REPORT, RIVER SEDIMENTS AND FOUNDATION ROCK

Corps of Engineers, USAE Waterways Experiment Station	Petrographic Report	Structures Laboratory P. O. Box 631 Vicksburg, Mississippi
Project Examination of Rock from Locks and Dam No. 2, Monongahela River		Date 1 December 1986

Samples

1. Six cores were drilled into foundation material at the site; two of these cores were drilled through backfill material beyond the land wall. This material was received at the Structures Laboratory (SL) on 26 February 1986. Descriptions of the material received are shown below:

<u>Field Location and Id.</u>	<u>CTD Id. No.</u>	<u>Sample Types</u>
Land Wall Backfill BR WES L-2	Pitts-13 DC-1 to DC-18	Slag and gravel backfill. Blue-gray, brown, and gray shale; soft to mod. hard.
Land Wall Backfill BR WES L-5	Pitts-13 DC-19 to DC-33	Slag, steel, gravel, and clay backfill. Blue-gray, brown, and gray shale; soft to mod. hard.
Land Wall BR WES L-7A	Pitts-13 DC-34 to DC-53	Shale, gray and red, soft to mod. hard. Gray shale, silty, mod. hard to hard.
Middle Wall BR WES M-1	Pitts-13 DC-54 to DC-65	Gray shale, soft to mod. hard. Brown shale, soft to mod. hard. Red and gray shale, soft to mod. hard.
Middle Wall BR WES M-6	Pitts-13 DC-66 to DC-75	Gray shale, silty, mod. hard.
River Wall BR WES R-5	Pitts-13 DC-76 to DC-84	Gray shale, silty, mod. hard.

Samples representing three types of shale, distinguished by color, were selected for testing from the six cores.

Test Procedures

2. All of the cores were inspected in the laboratory, and hand samples were taken to verify field descriptions. Each sample was then inspected visually and with a stereomicroscope to determine physical characteristics.

3. A portion of each rock type sample was air dried, ground to pass a 45- μ m (No. 325) sieve, and examined by X-ray diffraction (XRD).

4. Two sedimented slides of clay-sized material ($<2 \mu$ m e.s.d.*) were made from the samples containing predominantly clay minerals. Both slides were examined by XRD following air drying. One slide was X-rayed again after saturation with glycerol. The remaining slide was heat treated at 350°C for one hour to dehydrate clay minerals and examined by XRD in a static nitrogen atmosphere in order to prevent rehydration of the clay minerals during examination.

5. An X-ray diffractometer with nickel-filtered copper radiation was used for all XRD work.

Results

6. Blue-gray shale. The sample consisted of bluish-gray (dusky blue-green, 5 BG 3/2) (The Rock Color Chart Committee 1975)** shale that was soft to moderately hard, moderately weathered, and very fine grained (<0.1 mm) (Headquarters, US Army Corps of Engineers (HQUSACE) 1975). The rock contained numerous healed horizontal fractures and an open vertical joint. Some areas contained calcareous nodules and iron staining. Major mineral constituents of the rock were quartz, plagioclase feldspar, and clays. The clay minerals present were kaolinite, clay-mica, chlorite, and vermiculite.

7. Brown shale. This sample consisted of a moderate brown (5 YR 3/4) (The Rock Color Chart Committee 1975) shale that was soft to moderately hard, slightly weathered, and very fine grained (<0.1 mm) (HQUSACE 1975). The rock contained numerous open horizontal fractures and occasional calcareous nodules. Major mineral constituents of the sample were quartz, plagioclase feldspar, and clays. The clay minerals identified were kaolinite, clay-mica, chlorite, and vermiculite.

8. Gray shale. By far the most abundant of the three rock types, this sample was an olive gray (5 Y 4/1) (The Rock Color Chart Committee 1975), silty, moderately hard to hard shale. It was slightly weathered and very fine grained (<0.1 mm) to fine grained (0.1-0.4 mm) (HQUSACE 1975).

* Equivalent Spherical Diameter

** See References at the end of the main text.

It remained intact when submerged in water. The rock had some iron staining and contained numerous calcareous nodules. Major mineral constituents were quartz, plagioclase feldspar, and clay minerals. The clay minerals present were kaolinite, clay-mica, chlorite, and vermiculite.

9. The mineral composition of all three samples is shown in Table 1.

Table 1
Mineralogical Composition of Three Samples by X-Ray Diffraction

<u>Constituents</u>	<u>Blue-Gray Shale</u>	<u>Brown Shale</u>	<u>Gray Shale</u>
Quartz	X	X	X
Plag. Feldspar	X	X	X
Kaolinite	X	X	X
Clay-Mica*	X	X	X
Chlorite	X	X	X
Vermiculite	X	X	X

* Clay-sized mica.