INSPECTION REPORT

Sedimentation Structure

N5-D

Black Mesa Mine

Navajo County, Arizona

for

PEABODY COAL COMPANY

Dames & Moore
10139-011-22

TABLE OF CONTENTS

INTRODUCTION

Sedimentation Structure N5-D is an earthen embankment, designed and constructed in 1983 by Peabody Coal Company as a temporary sedimentation structure to control runoff and sediment from the disturbed mining areas of the Black Mesa Mine. The location of Structure N5-D is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure N5-D. Regional site information is presented in the "General Report, Kayenta and Black Mesa Mines, Navajo County, Arizona for Peabody Coal Company," along with the methods and results of analyses used for slope stability, hydrology and hydraulics.

INSPECTION

Structure N5-D was inspected on September 4, 1985 by an inter-disciplinary team of engineers from Dames & Moore. The purpose of the inspection was to assess the safety and general condition of the structure with respect to United States Department of Interior, Office of Surface Mining (OSM) regulations.

Dames & Moore's inspection was performed in accordance with applicable 30 CFR 780 and 816 regulations and included a review of the N5-D project files and a field inspection of the structure. The most current information contained in the Peabody Coal Company files includes the 1984 and current survey data and inspections performed in 1984 and 1985 by

Peabody Coal Company. The survey data developed in August 1984 was used in the analyses of the structure. Results of the field inspection are included in this report as Appendix A.

SITE DESCRIPTION

LAND USE

Structure N5-D has a 69.2-acre tributary drainage area and is located near Coal Mine Wash at the Black Mesa Mine. The watershed is classified as 100% disturbed.

EMBANKMENT

Structure N5-D is a homogeneous earthen embankment classified as a cross-valley embankment. Physical characteristics of the embankment are listed in the following table:

Structure N5-D

Embankment	Residual Shale Soils
Foundation	Residual Shale Soils
Right Abutment	Residual Shale Soils
Left Abutment	Residual Shale Soils
Height	17.6 ft
Crest Width	25 ft
Upstream Slope	1.7 H : 1 V
Downstream Slope	2.4 H : 1 V

A cross-section of the embankment is shown on Plate 2, Existing Maximum Cross Section N5-D, A-A'.

ANALYSES

STABILITY

Structure N5-D is a category B-1 embankment. A standard category B-1 embankment has static and seismic factors of safety equal to or greater than 1.5 and 1.2, respectively, under the following conditions:

1. Maximum height = 30 ft
2. Maximum upstream slope = 2.0 H : 1 V
3. Maximum downstream slope = 2.5 H : 1 V
4. Normal pool with steady seepage saturation conditions

The N5-D embankment is lower in height; however, the downstream and upstream slopes are steeper than the category standard; therefore, the embankment has factors of safety less than the design minimum.

HYDROLOGY

The hydrologic analysis was completed using the U.S. Army Corps of Engineers generalized computer program HEC-1, Flood Hydrograph Package. Structure N5-D is located upstream from Structure N5-E. The two structures have a combined storage capacity that is less than 20 acre-feet. Therefore, the spillway for N5-D was analyzed using the 25-year, 6-hour storm. The storage capacity of Structure N5-D was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1.	Water Course length, L	0.795	mi
2.	Elevation Difference, H	59	ft
3.	Time of Concentration, T_c	0.414	h
4.	Lag time, $0.6T_c$	0.249	h
5.	SCS Curve Number	94	
6.	Rainfall Depth, 10-year, 24-hour storm	2.1	in.
	25-year, 6-hour storm	1.9	in.
7.	Drainage Area	69.2	acres

HYDRAULICS

The HEC-1 program was used to evaluate inflow to the sedimentation structure, outflow from the structure and the resulting water surface elevations. The initial conditions and results of the analysis are summarized in the following table.

	Units	10-year 24-hour Storm	25-year 6-hour Storm
Initial Reservoir Volume Condition		Empty	Full to the spillway elevation
Inflow			
Peak Flow	cfs	110	137
Volume	acre-ft	8.48	7.21
Storage			
Peak Stage	ft	6480.66	6485.21
Spillway Elevation . .	ft	6475.07	--
Peak Storage	acre-ft	—	--
Storage Capacity . . .	acre-ft	2.92	--
Outflow			
Peak Flow	cfs	24	45
Embankment Crest Elevation	ft	--	6475.77
Peak Stage	ft	--	6485.21
Freeboard	ft	--	Overtop

Approach Channel

The existing approach channel for N5-D has a U-shaped channel with following dimensions:

Channel width	15-20	ft
Slope	15	percent

There is presently no erosion protection within the channel.

Spillway Channel

The existing spillway for N5-D has a U-shaped channel with the following dimensions:

Channel depth	4.5	ft
Channel width	15-20	ft
Channel length	50	ft
Average exit slope	0	percent

There is presently no erosion protection within the channel.

Outflow Channel

The existing outflow channel for N5-D has a trapezoidal channel with the following dimensions:

Channel width	20	ft
Average exit slope	10	percent

There is presently no erosion protection within the channel.

STORAGE CAPACITY

The impoundment volume-elevation curve is based on site specific surveys conducted for Peabody Coal Company's August 1984 inspection, and 1985 resurveys, where available. Additionally, the most current topographic maps available were used in developing Plate 3, Volume-Elevation Curve, N5-D.

The calculations for the sediment load entering Structure N5-D were made utilizing the Universal Soil Loss Equation with the following parameters:

1. Rainfall Factor, R 40
2. Soil Erodibility Factor, K 0.16
3. Slope Factor, LS 1.31
4. Cover Factor, C 1.00
5. Erosion Control Factor, P 1.0

The hydrologic analysis gives the storage volume required to contain the 10-year, 24-hour storm, and the remaining storage volume available for storing sediment. The existing storage capacity of N5-D and the results of the sediment inflow analysis are summarized in the following table.

N5-D STORAGE

Total Storage Capacity	2.92	acre-ft
10-year, 24-hour Storm Inflow	8.48	acre-ft
Available Sediment Storage Capacity . .	0	acre-ft
Sediment Inflow Rate	0.27	acre-ft/yr
Sediment Storage Life	0	yrs

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure N5-D indicated that the only geotechnical problem is rill and gully erosion on the upstream and downstream slopes and the bottom of the approach channel. Correction of erosion is considered a periodic maintenance task and does not require remedial action. The downstream and upstream slopes should be flattened to 2.0 horizontal to 1 vertical and 2.5 horizontal to 1 vertical, respectively, to meet stability requirements.

HYDRAULICS

The spillway capacity and storage capacity of Structure N5-D are inadequate. The structure does not have an adequate outflow channel. The storage capacity should be increased to 5.36 acre-feet by excavating the pond and lowering the spillway elevations as shown on Plates 1 and 4. The embankment crest should be raised to elevation 6476.00 feet. A trapezoidal outflow channel should be constructed along the alignment shown in Plate 1. The channel profile is shown in Plate 4 and the required dimensions are shown in Plate 5. Both the spillway and outflow channel should be protected against erosion using geotextile and riprap as shown in Plate 5.

The hydraulic analysis of the revised storage capacity is summarized in the following table.

N5-D HYDRAULICS FOR EXCAVATED IMPOUNDMENT
AND REDESIGNED SPILLWAY

	Units	10-year 24-hour Storm	25-year 6-hour Storm
Initial Reservoir Volume Condition		Empty	Full to the spillway elevation
Inflow			
Peak Flow	cfs	110	137
Volume	acre-ft	8.48	7.21
Storage			
Peak Stage	ft	6473.74	—
Spillway Elevation . .	ft	6472.50	--
Peak Storage	acre-ft	--	--
Storage Capacity . . .	acre-ft	5.36	--
Available Sediment Storage Capacity . .	acre-ft	--	--
Sediment Inflow Rate .	acre-ft/yr	0.27	--
Sediment Storage Life.	yrs	--	--
Outflow			
Peak Flow	cfs	6	127
Embankment Crest Elevation	ft	--	6476.00
Peak Stage	ft	—	6474.85
Freeboard	ft	--	1.15
Spillway Channel			
Flow Depth	ft	--	2.35
Critical Velocity. . .	fps	--	5.4
Manning's "n"		--	0.040
Outflow Channel			
Slope	%	--	11
Normal Velocity. . . .	fps	--	8.8
Normal Depth	ft	--	0.66
Manning's "n"		--	0.040

Even after excavation, Structure N5-D does not have enough capacity to store the 10-year, 24-hour storm. However, Structure N5-D is located upstream from Structure N5-E and contributes excess flow to N5-E during the 10-year, 24-hour storm. Therefore, the storage capacity of the two structures must be combined to determine the available sediment storage life. The 10-year, 24-hour storm was routed through N5-D and N5-E. The results of this analysis are summarized below.

N5-D AND N5-E COMBINED STORAGE

	N5-D	N5-E	Total	
Total Storage Capacity	5.36	8.70	14.06	acre-ft
10-year, 24-hour Storm Inflow	8.48	1.89	10.37	acre-ft
Available Sediment Storage Capacity . .	—	—	3.69	acre-ft
Sediment Inflow Rate	0.27	0.122	0.392	acre-ft/yr
Sediment Storage Life	—	—	9	yrs

* * *

The following plates and appendix are attached and complete this inspection report.

Plate 1 - Site Plan N5-D

Plate 2 - Existing Maximum Cross Section N5-D, A-A'

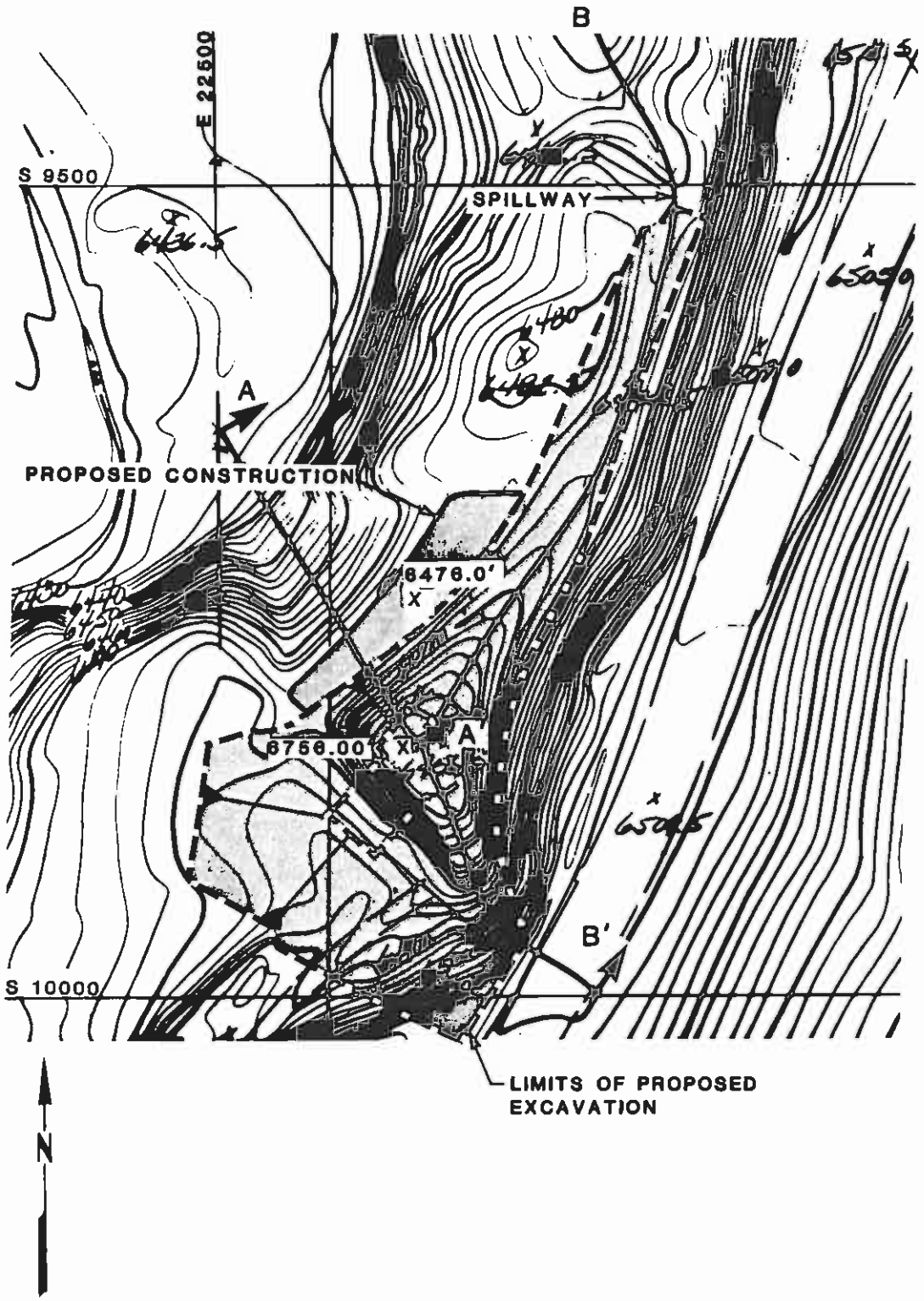
Plate 3 - Volume-Elevation Curve N5-D

Plate 4 - Channel Profile N5-D, B-B'

Plate 5 - Spillway and Outflow Channel Cross Section N5-D

Appendix A - Inspection Check List

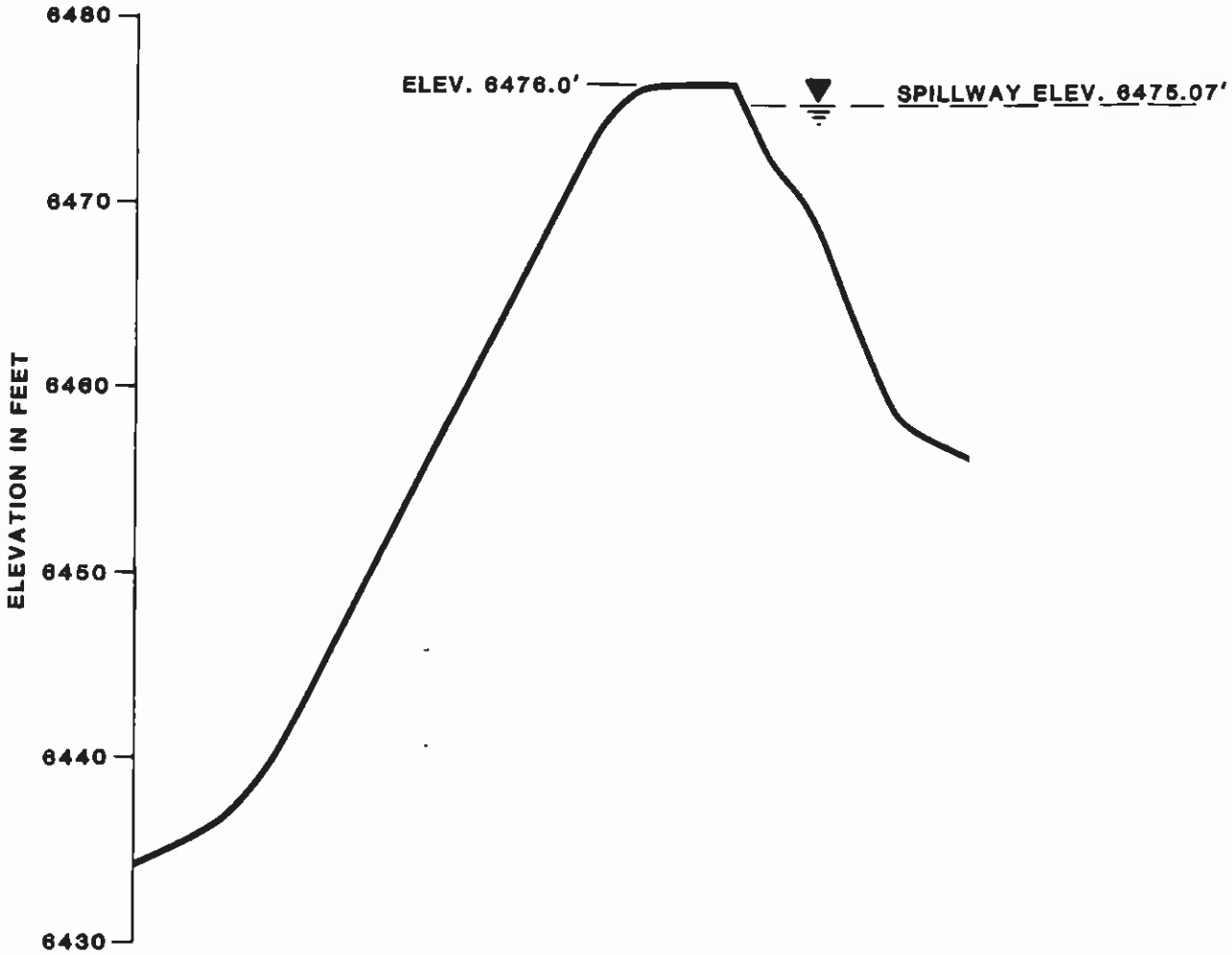
Appendix B - Hydrology and Hydraulic Calculations



SITE PLAN
N5-D

SCALE
0 100 200
FEET

BY **Dames & Moore** Plate 1



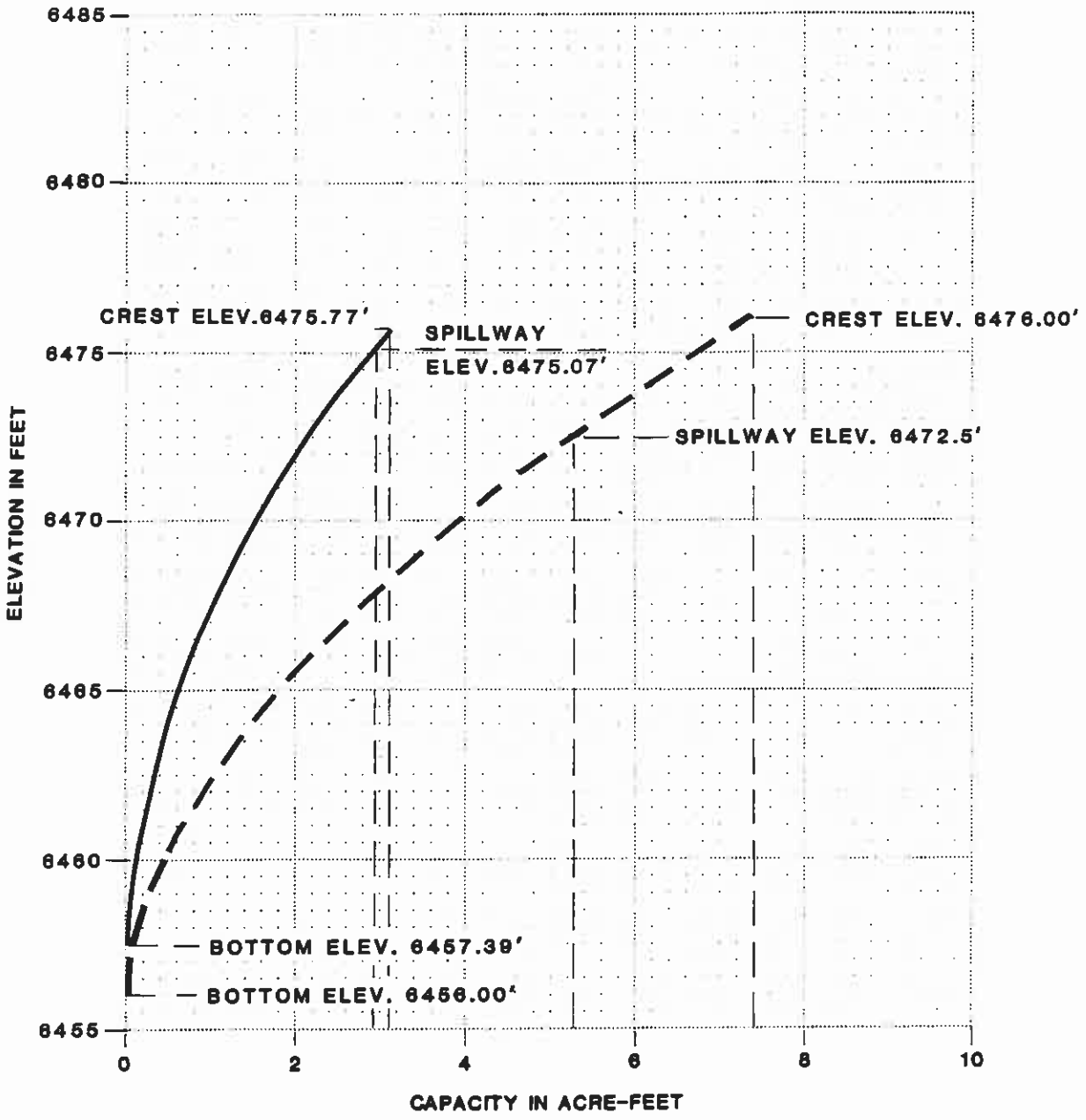
SCALE
0 50 100
FEET

EXISTING MAXIMUM CROSS-SECTION A-A' N5-D

FOR LOCATION SEE PLATE 1

BY **Dames & Moore**

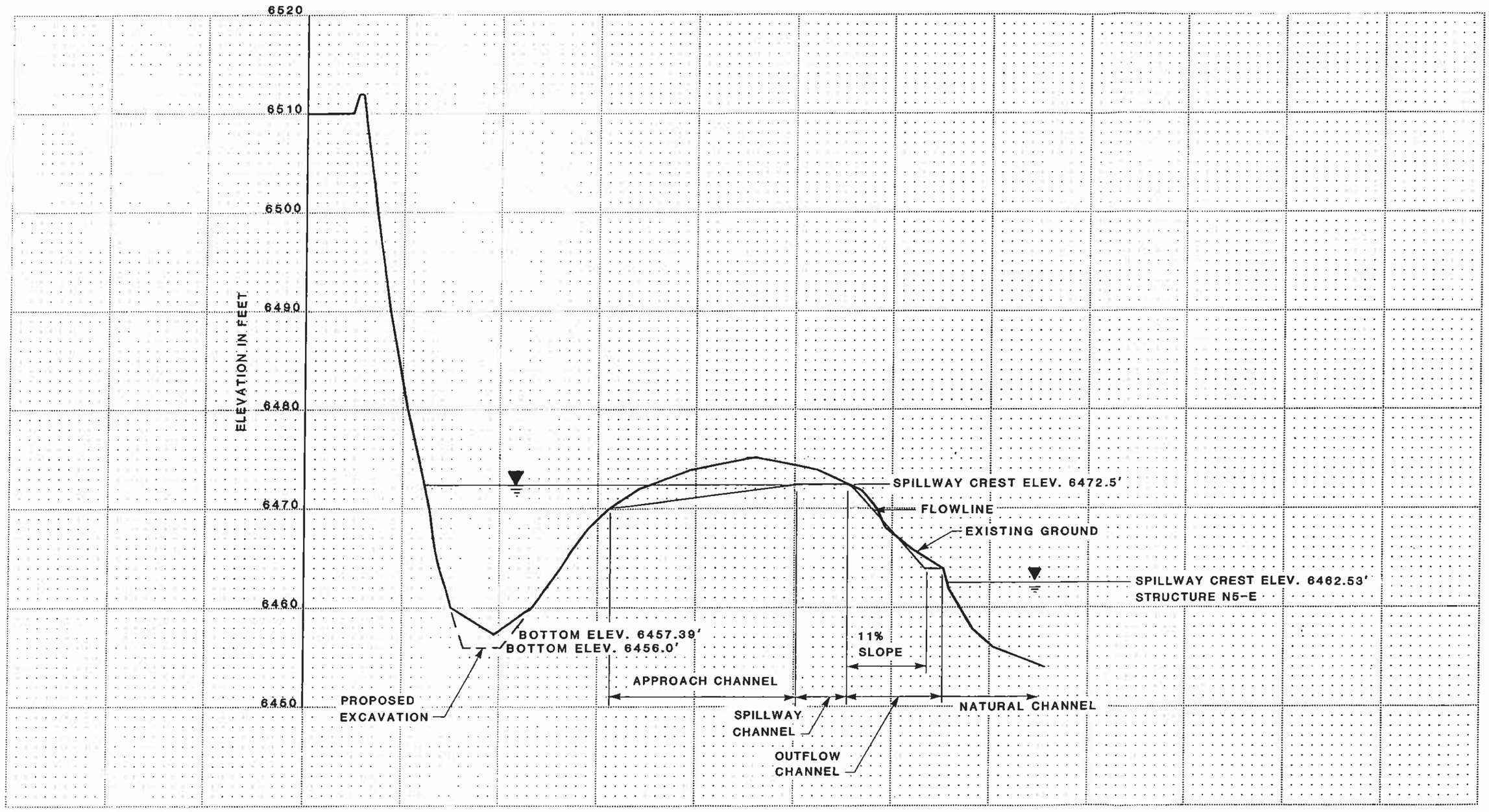
Plate 2



EXISTING VOLUME
PROPOSED VOLUME

VOLUME-ELEVATION CURVE N-5D

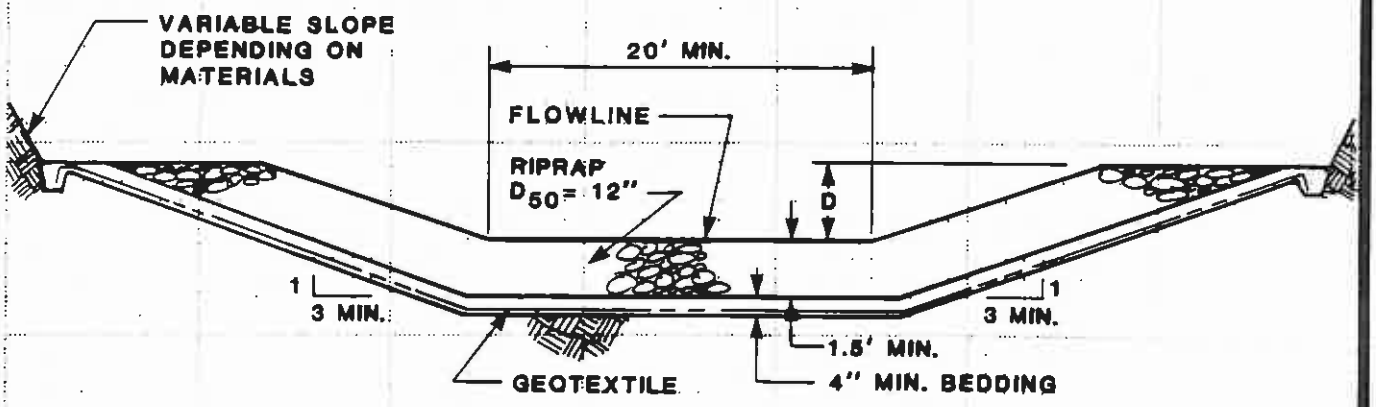
BY **Dames & Moore** Plate 3



CHANNEL PROFILE B-B'
N5-D

FOR LOCATION SEE PLATE 1

BY **Dames & Moore** Plate 4



SPILLWAY CHANNEL

D = 2.2'

LENGTH = 50'

FLOWLINE ELEV. = 6472.50'

OUTFLOW CHANNEL

D = 2.0'

SPILLWAY AND OUTFLOW CHANNEL CROSS SECTION N5-D

BY **Dames & Moore** Plate 5

APPENDIX A

INSPECTION CHECK LIST

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE			
a. Adequate grass cover?		X	
b. Any erosion?	X		Rills
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Adequate riprap protection?		X	
g. Any stone deterioration?			NA
h. Visual depressions or bulges?		X	
i. Visual settlements?		X	
j. Animal burrows?		X	
3. DOWNSTREAM SLOPE			
a. Adequate grass cover?		X	
b. Any erosion?	X		Rills
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Visual depressions or bulges?		X	
g. Visual settlements?		X	
h. Is the toe drain dry?			NA
i. Are the relief wells flowing?			NA
j. Are boils present at the toe?		X	
k. Is seepage present?		X	
l. Animal burrows?		X	
4. ABUTMENT CONTACT. RIGHT			
a. Any erosion?		X	
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			Rock
5. ABUTMENT CONTACT. LEFT			
a. Any erosion?		X	
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			Rock

ITEM	YES	NO	REMARKS
6. SPILLWAY/NORMAL			
a. Location:			
Left abutment?			
Right abutment?	X		
Crest of Embankments?			
b. Approach Channel:	X		
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?	X		gully
Obstructed?		X	
Erosion protection?		X	
c. Spillway Channel:	X		
Are side slopes eroding?		X	Swale
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?		X	
d. Outflow Channel:	X		
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?		X	
e. Weir:		X	
Condition?			
7. SPILLWAY/EMERGENCY			
a. Location:			
Left abutment?			
Right abutment?			
Crest of Embankments?			
b. Approach Channel:			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
c. Spillway Channel:			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
d. Outflow Channel:			
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
e. Weir:			
Condition?			

ITEM	YES	NO	REMARKS
8. IMPOUNDMENT			
a. Sinkholes?		X	(Elev.) feet
b. Water present?		X	(Elev.) feet
c. Siltation?	X		
d. Watershed matches soil map?		X	All Bare

9. GENERAL COMMENTS

APPENDIX B

HYDROLOGY AND HYDRAULIC CALCULATIONS

FILE Peabody Coal Co. 1-139-011-22
SUBJECT Sediment Pond Hydrology
N5-D SHEET ___ OF ___

REVISIONS BY ___ DATE ___ TO EO ___ BY ___ DATE ___ TO EO ___

Time of Concentration

Elevation Difference = 6582 - 6523 = 59'

Water Course Length = 4200' = 0.795 mi

$$T_c = \left(\frac{11.9 (0.795)^3}{59}\right)^{0.385} = 0.414 \text{ hr}$$

Lag Time = $0.6 T_c$ = 0.249 hr

SCS Curve Number

Drainage Area (ac)	Cover Type	Hydrologic Condition	Soil Type	Weighted Curve Number
100%	Disturbed	—	D	94

94 before disturbance

Use 91

Drainage Basin Area

69.2 acre 0.108 sq mile

1600
7500

BY ___ DATE ___ CHECKED BY ___ COPY TO EO ___

Dames & Moore

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POND

N5-D

MEAS. @ CALCOMP 9100

DRAINAGE BASIN AREA

			(FT²)	(AC)
CALIBRATE	1.000	1.052	168341.000	3.865
	2.000	18.831	3012991.000	69.169

FILE PEABODY COAL CO 10134-011-22
SUBJECT SEDIMENT INFLOW
N5-D SHEET ___ OF ___

REVISIONS BY ___ DATE ___ TO EO ___ BY ___ DATE ___ TO EO ___

UNIVERSAL SOIL LOSS EQUATION

RAINFALL FACTOR

R = 40

SOIL ERODIBILITY FACTOR

SOIL TYPE = 100% EH #24 = .16

K = .16

SLOPE FACTOR

LENGTH (ft.)	Δ ELEV (ft.)	SLOPE (%)	LS
600	30 (assumed)	5%	1.31

use 1.31

COVER FACTOR

AREA (ac.)	COVER TYPE	% COVER	CANOPY (%)	WEIGHTED C
100%	disturbed	—	—	1.0

C = 1.0

EROSION CONTROL FACTOR

P = 1.0

SEDIMENT INFLOW

$A = 40(.16)(1.31)(1.0)(1.0) = 8.39$ ton/acre/year

$A = 8.39\left(\frac{1}{2047}\right)(69.2)(.95) = .270$ acre-feet/year

BY ___ DATE ___ CHECKED BY ___ COPY TO EO ___

Dames & Moore