INSPECTION REPORT

Sedimentation Structure

J3-D

Black Mesa Mine

Navajo County, Arizona

for

PEABODY COAL COMPANY

Dames & Moore
10139-011-22

TABLE OF CONTENTS

INTRODUCTION

Sedimentation Structure J3-D is an earthen embankment, designed and constructed in 1980 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 J3-D is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure J3-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 J3-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 J3-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 J3-D has a 236.2-acre tributary drainage area and is located near Moenkopi Wash at the Black Mesa Mine. The watershed is classified as 32.4% Sagebrush/grass, 25.3% reclaimed, 24.9% Pinion/Juniper, and 17.4% disturbed.

EMBANKMENT

Structure J3-D is a homogeneous earthen embankment classified as a cross-valley embankment. Physical characteristics of the embankment are listed in the following table:

Structure J3-D

Embankment	Residual Shale Soils
Foundation	Sandstone
Right Abutment	Residual Shale Soils
Left Abutment	Residual Shale Soils
Height	11.6 ft
Crest Width	15 ft
Upstream Slope	1.8 H : 1 V
Downstream Slope	N/A*

A cross-section of the embankment is shown on Plate 2, Existing Maximum Cross Section J3-D, A-A'.

*Sediment removed from the structure has been placed against the downstream slope of the embankment and acts as a buttress fill against the dam.

ANALYSES

STABILITY

Structure J3-D is a category B-5 embankment. A standard category B-5 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 = 20 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 J3-D embankment is lower in height; however, the upstream slope is steeper than the category standard; therefore, the embankment has factors of safety less than the design minimum. The downstream slope is buttressed with material excavated from the impoundment. Although a stability analysis was not performed for this specific condition the fill acts as an added resisting force and, therefore, the downstream slope is considered stable.

HYDROLOGY

The hydrologic analysis was completed using the U.S. Army Corps of Engineers generalized computer program HEC-1, Flood Hydrograph Package. Structure J3-D is located downstream from Structure J3-B. The two structures have a combined storage capacity that is greater than 20 acre-feet. Therefore, the spillway for J3-D was analyzed using the 100-year, 6-hour storm. The storage capacity of Structure J3-D was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

		10-year, 24-hour Storm	100-year, 6-hour Storm	
1.	Water Course length, L	1.36	1.36	mi
2.	Elevation Difference, H	167	167	ft
3.	Time of Concentration, T_c . . .	0.516	0.516	h
4.	Lag time, $0.6T_c$	0.311	0.311	h
5.	SCS Curve Number	82	82	
6.	Rainfall Depth	2.1	2.4	in.
7.	Drainage Area	236.2	318.0	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	100-year 6-hour Storm
Initial Reservoir Volume Condition		Empty	Full to the spillway elevation
Inflow			
Peak Flow	cfs	151	385
Volume	acre-ft	13.44*	24.38
Storage			
Peak Stage	ft	6466.42	6471.62
Spillway Elevation . .	ft	6469.08	—
Peak Storage	acre-ft	13.44	--
Storage Capacity . . .	acre-ft	19.8	--
Outflow			
Peak Flow	cfs	0	288
Embankment Crest Elevation	ft	—	6473.10
Peak Stage	ft	--	6471.62
Freeboard	ft	--	1.48
Spillway Channel			
Flow Depth	ft	--	2.54
Critical Velocity. . .	fps	--	6.2
Manning's "n"		—	0.040
Outflow Channel			
Slope	%	--	33
Normal Velocity. . . .	fps	--	14.8
Normal Depth	ft	--	0.61
Manning's "n"		--	0.040

*Inflow volume for tributary drainage are between Structures J3-D and J3-B.

Spillway Channel

The existing spillway for J3-D has a trapezoidal channel with the following dimensions:

Channel depth	4 ft
Channel width	27 ft
Channel length	15 ft
Side slopes (horizontal to vertical)	2:1
Average exit slope	3 percent

Half the channel has rock providing some erosion protection within the channel, however the protection is inadequate based on the calculated velocities in the channel.

Outflow Channel

The existing outflow channel for J3-D has a trapezoidal channel with the following dimensions:

Channel width	27 ft
Channel length	90 ft
Side slopes (horizontal to vertical)	2:1
Average exit slope	20 percent

Rock provides some erosion protection within the channel, however the protection is inadequate based on the calculated velocities in 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, J3-D.

The calculations for the sediment load entering Structure J3-D were made utilizing the Universal Soil Loss Equation with the following parameters:

1. Rainfall Factor, R 40
2. Soil Erodibility Factor, K 0.258
3. Slope Factor, LS 2.22
4. Cover Factor, C 0.289
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 J3-D and the results of the sediment inflow analysis are summarized in the following table.

J3-D STORAGE

Total Storage Capacity	19.8	acre-ft
10-year, 24-hour Storm Inflow	13.44	acre-ft
Available Sediment Storage Capacity . .	6.36	acre-ft
Sediment Inflow Rate	0.687	acre-ft/yr
Sediment Storage Life	9	yrs

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure J3-D indicated that the only geotechnical problem is rill and gully erosion on the upstream slope. Correction of erosion is considered a periodic maintenance task and does not require remedial action. The upstream slope should be flattened to 2.0 horizontal to 1 vertical to meet stability requirements.

HYDRAULICS

The storage capacity and spillway capacity of Structure J3-D are adequate; however, the spillway does not have an adequate outflow channel or adequate erosion protection. A trapezoidal outflow channel and a stilling basin should be constructed along the alignment B-B' shown in Plate 1. The channel and stilling basin profile is shown in Plate 4 and the required dimensions are shown in Plate 5 and Plate 6. The spillway, outflow channel and stilling basin should be protected against erosion using geotextile and riprap as shown in Plate 5.

* * *

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

Plate 1 - Site Plan J3-D

Plate 2 - Existing Maximum Cross Section J3-D, A-A'

Plate 3 - Volume-Elevation Curve J3-D

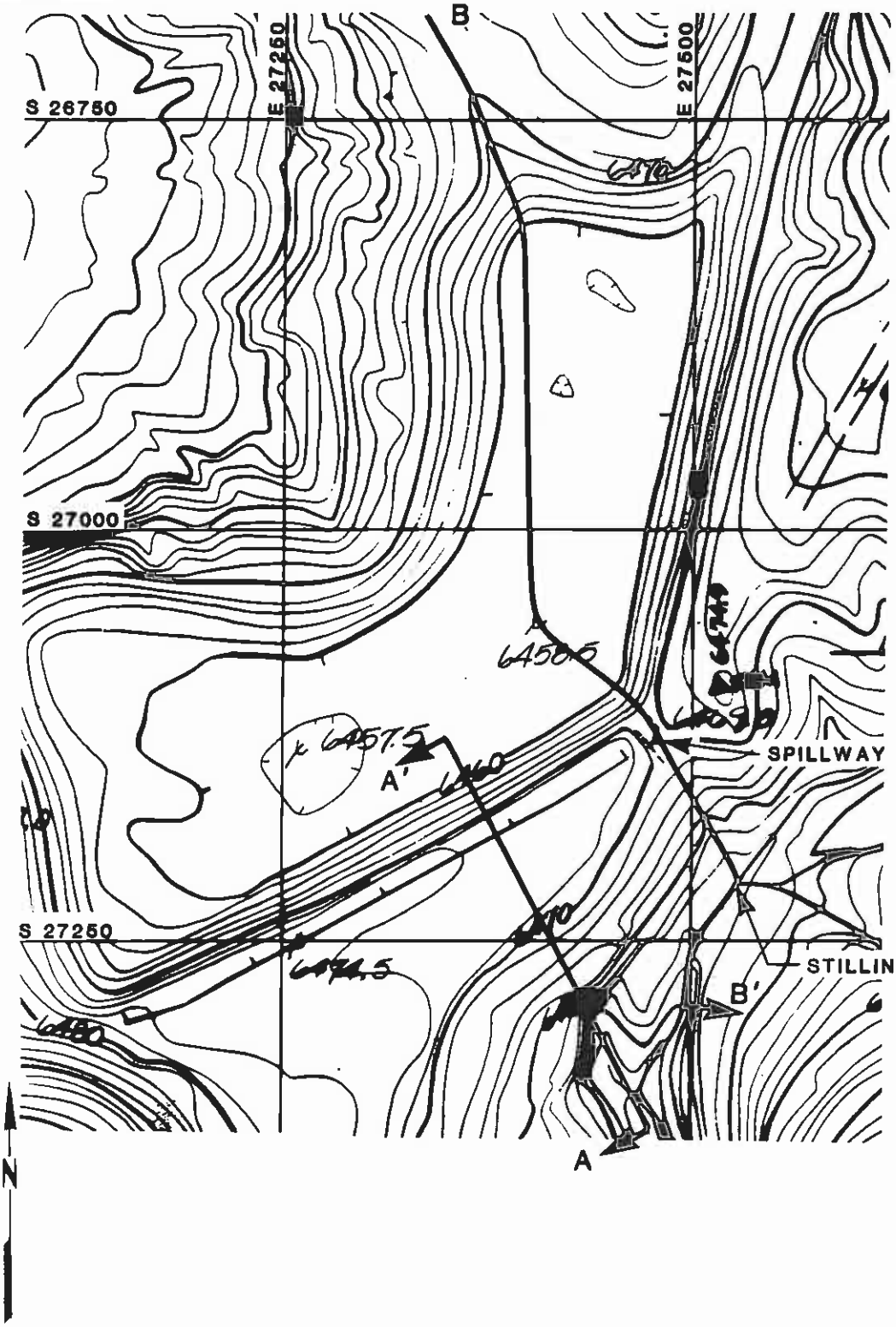
Plate 4 - Channel Profile J3-D, B-B'

Plate 5 - Spillway and Outflow Channel Cross Section J3-D

Plate 6 - Spillway Stilling Basin Plan J3-D

Appendix A - Inspection Check List

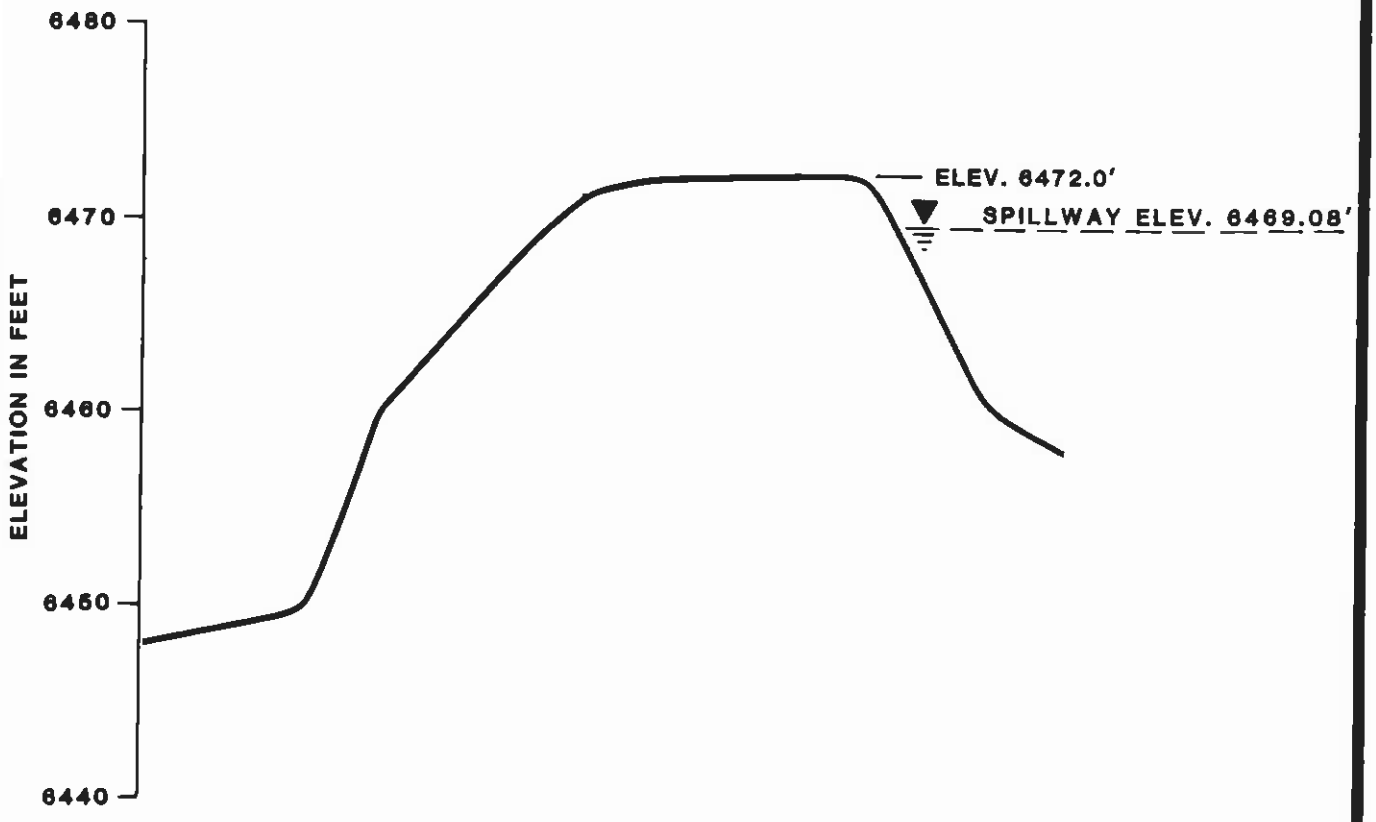
Appendix B - Hydrology and Hydraulic Calculations



SCALE
0 100 200
FEET

SITE PLAN
J3-D

BY **Dames & Moore** Plate 1



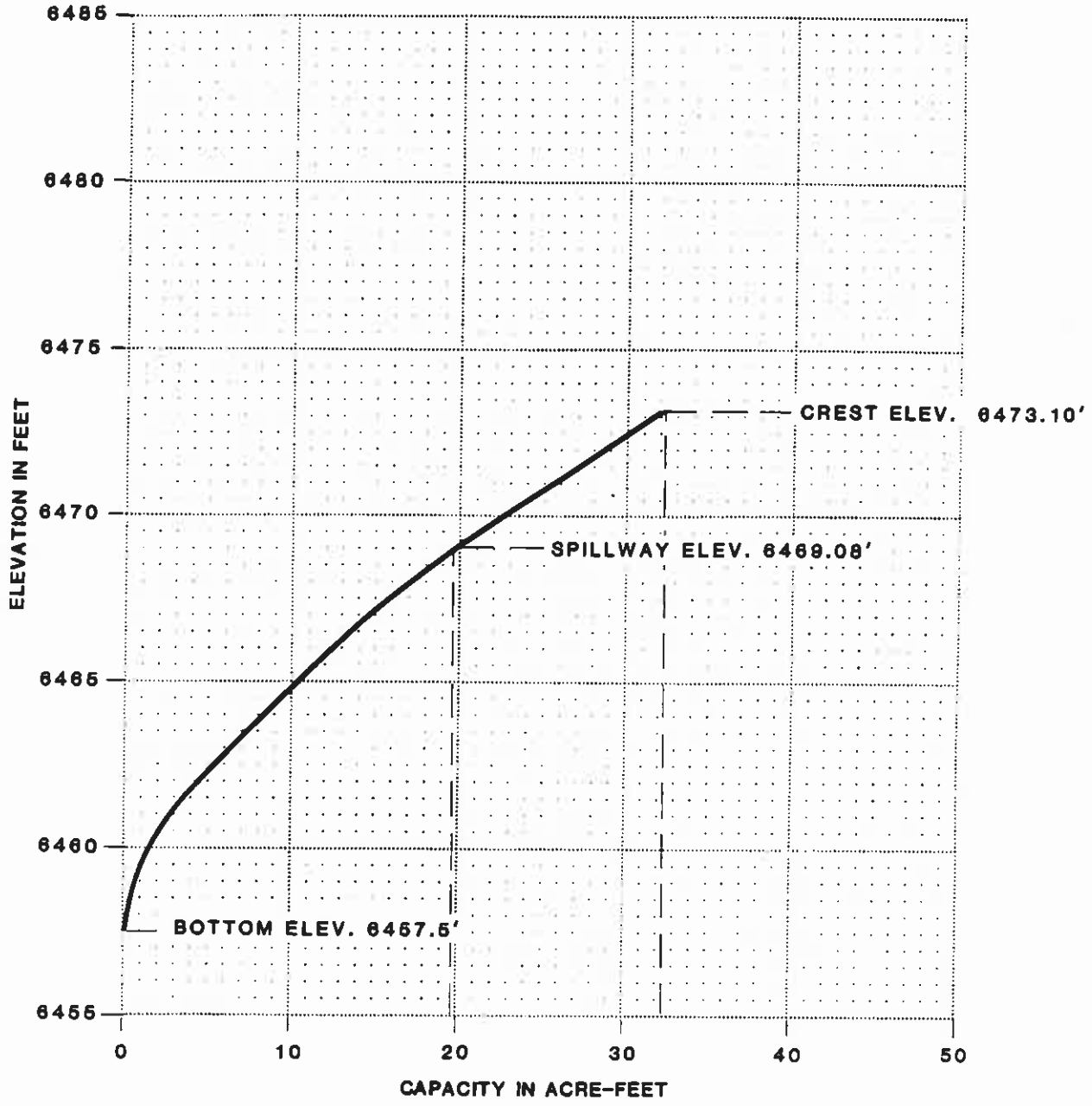
SCALE
0 50 100
FEET

EXISTING MAXIMUM CROSS-SECTION A-A' J3-D

FOR LOCATION SEE PLATE 1

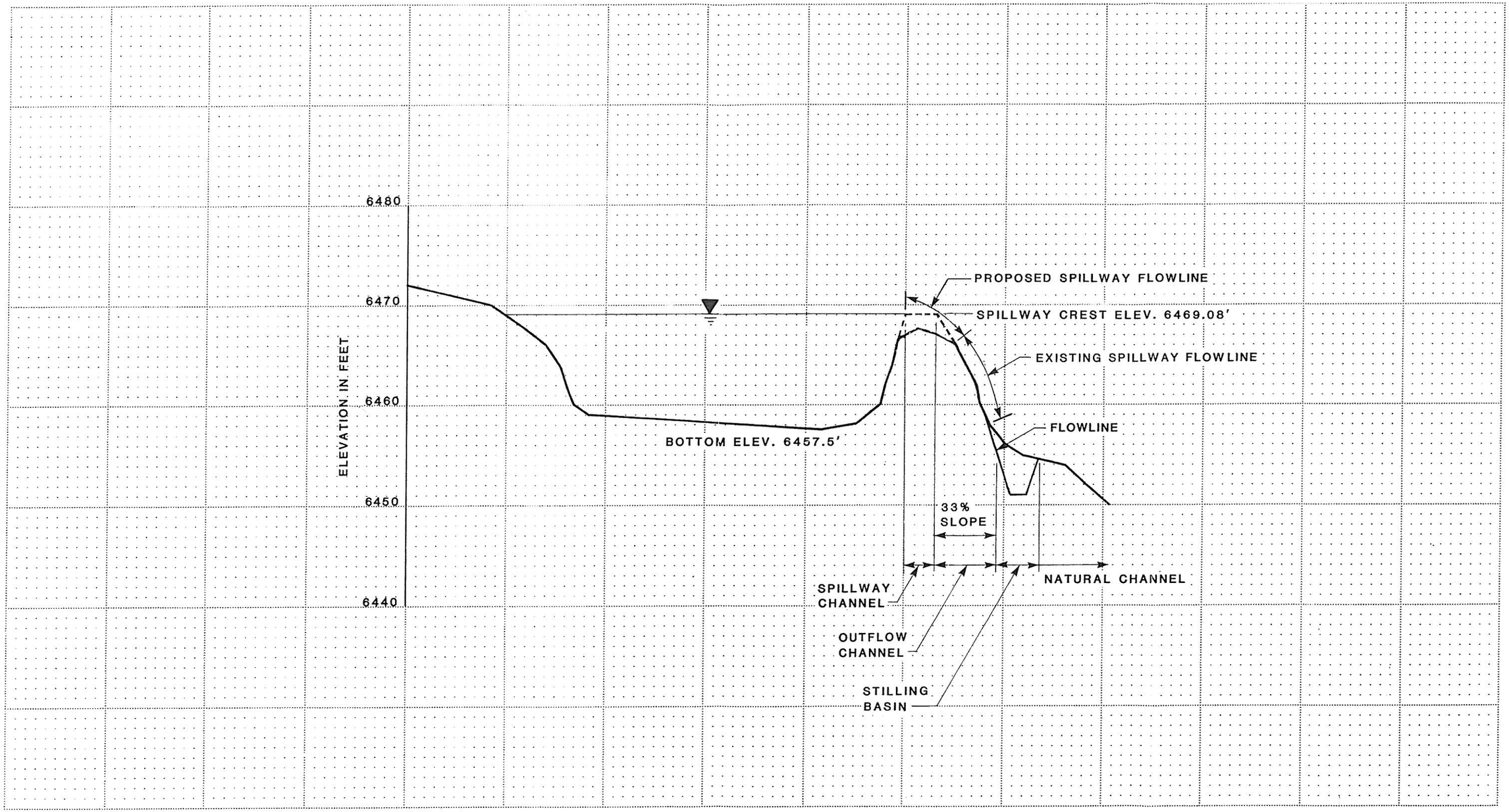
BY **Dames & Moore**

Plate 2



VOLUME-ELEVATION CURVE J3-D

BY **Dames & Moore** Plate 3

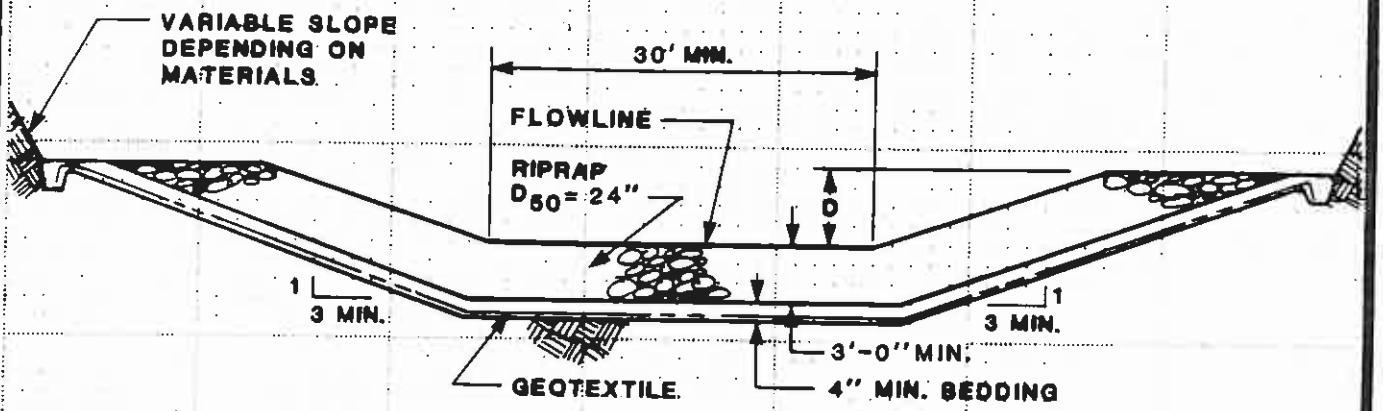


SCALE
0 100 200
FEET

CHANNEL PROFILE B-B'
J3-D

FOR LOCATION SEE PLATE 1

BY **Dames & Moore** Plate 4



SPILLWAY CHANNEL

D = 3.6'

LENGTH = 30'

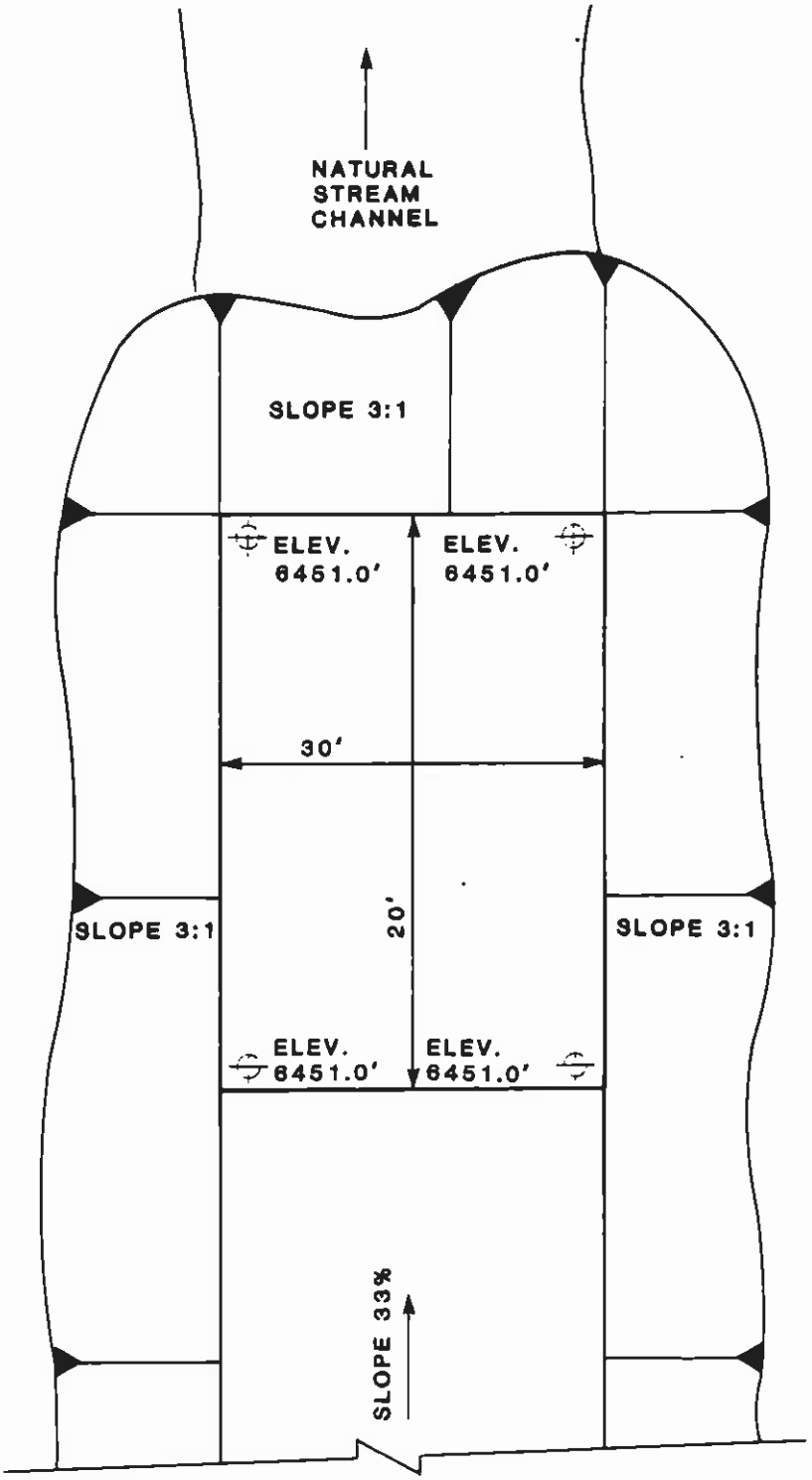
FLOWLINE ELEV. = 6469.08'

OUTFLOW CHANNEL

D = 2.0'

SPILLWAY AND OUTFLOW CHANNEL CROSS SECTION J3-D

BY **Dames & Moore** Plate 5



MINIMUM HEIGHT OF RIPRAP ALONG SIDEWALLS ABOVE THE BASIN FLOOR = 6.1'

MINIMUM DEPTH OF BASIN FLOOR BELOW NATURAL STREAMBED = 2.7'

SPILLWAY STILLING BASIN PLAN J3-D

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		minor / 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			NA
a. Adequate grass cover?			Material from pond placed downstream of crest.
b. Any erosion?			
c. Are trees growing on slope?			
d. Longitudinal cracks?			
e. Transverse cracks?			
f. Visual depressions or bulges?			N/A
g. Visual settlements?			
h. Is the toe drain dry?			
i. Are the relief wells flowing?			
j. Are boils present at the toe?			
k. Is seepage present?			
l. Animal burrows?			
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?			reddish brown SM
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?			brown SM

ITEM	YES	NO	REMARKS
6. SPILLWAY/NORMAL			
a. Location:			
Left abutment?	X		
Right abutment?			
Crest of Embankments?			
b. Approach Channel:		X	
Are side slopes eroding?			NA
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
c. Spillway Channel:	X		
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?	X		½ Rock
d. Outflow Channel:	X		
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?	X		Fully Rock
e. Weir:		X	
Condition?			
7. SPILLWAY/EMERGENCY			NA
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	Evidence of past siltation
d. Watershed matches soil map?		X	

9. GENERAL COMMENTS

Evidence of past seepage (water loving plants & wet looking channel) downstream of outflow channel.

Sandstone outcropping d.s. of dam

Canopy cover - 20%
ground cover - 90%

APPENDIX B

HYDROLOGY AND HYDRAULIC CALCULATIONS

FILE [illegible]
SUBJECT Sediment Yield Hydrology
J3-D SHEET ___ OF ___

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

Time of Concentration

Elev. Difference = 6635 − 6468 = 167'

Water Course Length = 18 (400) = 7200' = 1.36 mi

$$T_c = \left[\frac{11.9\,(1.36)^3}{167}\right]^{.385} = 0.516$$

Lag = .6 T_c = .310 hr

SCS Curve Number

Drainage Area (Ac.)	Cover Type	Hydrologic Condition	Soil Type	Weighted Curve Number
59.7 (25.2%)	Reclaim	Poor	D	87 (.253)
41.2 (17.4%)	Disturbed		D	94 (.174)
76.5 (32.4%)	S-G	Average	C	73 (.324)
58.8 (24.8%)	P-J	Average	C	78 (.249)
236.2				81.4

CN = 82

Drainage Basin Area

236.2 Ac = 0.369 Sq. Miles

BY ___ DATE ___
CHECKED BY ___
COPY TO EO ___

Dames & Moore

FILE Peabody Coal Co
SUBJECT Sediment Inflow
J3-D SHEET ___ OF ___

UNIVERSAL SOIL LOSS EQUATION

Rainfall Factor

K = 40

Soil Erodibility Factor

Soil Type = .253 (.42)
.573 (.21)
.174 (.18)

K = .258

Slope Factor

Length (FT)	ΔElev (FT)	Slope (%)	LS
500	55	11	.25
1000	40	4	.20
1400	40	2.9	.20
1200	85	7.1	.35
			2.22

Cover Factor

Area (Ac)	Cover Type	%Cover	Canop. (%)	Weighted C
25.3%	Reclaimed	—	—	.253 (.15)
17.4%	Disturbed	—	—	.174 (1.0)
32.4%	S-G	40	25	.[illegible] .013
24.9%	P-F	40	25	.249 (.14

C = .289

Erosion Control Factor

P = 1.0

Sediment Inflow

A = 40 (.258) (2.22) (.289) (1.0) = 6.62 Ton/Acre/Year

A = 6.62 (1/2547) (236.2) (.9) = 0.687 A-F/Year

REVISIONS
BY ___ DATE ___ TO EO ___
BY ___ DATE ___ TO EO ___
BY ___ DATE ___
CHECKED BY ___
COPY TO EO ___

Dames & Moore

9451 (3-72) PRINTED IN U.S.A.

FILE _____
SUBJECT LAG TIME J3-B TO J3-D
_____ SHEET ___ OF ___

Pond J3-B Flows into Pond J3-D

Watercourse Length Between Ponds = 1440' = 0.273 miles

Elev. Diff. = 6510 − 6468 = 42'

Slope = 42/1440 = 3%

$$T_c = \left[\frac{11.9\,(.273)^3}{42}\right]^{.385} = .137\,hr = 8.2\,MIN$$

Velocity = $\frac{1440}{8.2(60)}$ = 2.9 FPS Reasonable For 3% Slope

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

BY _____ DATE _____
CHECKED BY _____
COPY TO EO _____

Dames & Moore

J3-D COMBINED WITH J3-B

FILE PEABODY COAL CO 10139-011-22
SUBJECT SEDIMENT POND HYDROLOGY
J3-D SHEET ___ OF ___

SPILLWAY DESIGN FOR 100-YR · 6-HR

TIME OF CONCENTRATION

ELEVATION DIFFERENCE =

WATER COURSE LENGTH =

T_c =

LAG TIME = $0.6 T_c$ = Use J3-D LAG TIME

0.311 hr

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

SCS CURVE NUMBER

	DRAINAGE AREA (ac)	COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
J3-B	3.9	P-J	ave.	C	78 (0.01) = 0.78
	15.9	S-G	ave.	C	73 (0.05) = 3.65
	4.5	Haul Road	—	C	91 (0.01) = 0.91
J3-D	117.7	Reclaim (pre law)	poor	D	87 (0.37) = 32.19
	41.2	Disturbed	—	D	94 (0.13) = 12.22
	76.5	S-G	ave.	C	73 (0.24) = 17.52
	58.8	P-I	ave	C	78 (0.18) = 14.04
					81.3

Use 82

DRAINAGE BASIN AREA

318.0 ACRES 0.497 SQ MILES

J3-B 81.8
J3-D 236.2
318.0

BY GDeWolf DATE 10/9/85
CHECKED BY ___
COPY TO EO ___