INSPECTION REPORT

Sedimentation Structure

N6-D

Black Mesa Mine

Navajo County, Arizona

for

PEABODY COAL COMPANY

Dames & Moore
10139-011-22

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INTRODUCTION

Sedimentation Structure N6-D is an earthen embankment, designed and constructed in 1979 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 N6-D is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure N6-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 N6-D was inspected on September 13, 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 N6-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 N6-D has a 32.3-acre tributary drainage area and is located near Moenkopi Wash at the Black Mesa Mine. The watershed is classified as 55% Pinion/Juniper and 45% reclaimed.

EMBANKMENT

Structure N6-D is a homogeneous earthen embankment classified as a cross-valley embankment. Physical characteristics of the embankment are listed in the following table:

Structure N6-D

Embankment	Residual Sandstone Soils
Foundation	Sandstone
Right Abutment	Residual Sandstone Soils
Left Abutment	Residual Sandstone Soils
Height	10.0 ft
Crest Width	14 ft
Upstream Slope	3.3 H : 1 V
Downstream Slope	2.5 H : 1 V

A cross-section of the embankment is shown on Plate 2, Existing Maximum Cross Section N6-D, A-A'. Grass provides erosion protection on the upstream slope of the embankment.

ANALYSES

STABILITY

Structure N6-D is a category A-4 embankment. A standard category A-4 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 = 15 ft
2. Maximum upstream slope = 1.75 H : 1 V
3. Maximum downstream slope = 3.25 H : 1 V
4. Normal pool with steady seepage saturation conditions

The N6-D embankment is lower in height; however, the downstream slope is 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 N6-D is located downstream from Structure N6-D1. The two structures have a combined storage capacity that is greater than 20 acre-feet. Therefore, the spillway for N6-D was analyzed using the 100-year, 6-hour storm. The storage capacity of Structure N6-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	0.258	1.705	mi
2.	Elevation Difference, H	83	293	ft
3.	Time of Concentration, T_c	0.099	0.539	h
4.	Lag time, $0.6T_c$	0.059	0.324	h
5.	SCS Curve Number	83	84	
6.	Rainfall Depth	2.1	2.4	in.
7.	Drainage Area	32.3	375.3	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 10-year storm was routed through Structure N10-D1 and into N10-D. The 100-year storm was analyzed without Structure N10-D1. 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	45	516
Volume	acre-ft	2.13	30.96
Storage			
Peak Stage	ft	6617.42	6621.60
Spillway Elevation . .	ft	6621.60	--
Peak Storage	acre-ft	2.13	--
Storage Capacity . . .	acre-ft	5.26	--
Outflow			
Peak Flow	cfs	0	476
Embankment Crest Elevation	ft	--	6623.40
Peak Stage	ft	--	6626.40
Freeboard	ft	--	Overtop

Spillway Channel

The existing spillway for N6-D has a trapezoidal channel with the following dimensions:

Channel depth	3.3	ft
Channel width	22	ft
Channel length	25	ft
Side slopes (horizontal to vertical)	2:1	
Average exit slope	0	percent

There is presently no erosion protection within the channel.

Outflow Channel

The existing outflow channel for N6-D has a trapezoidal channel with the following dimensions:

Channel width	21	ft
Channel length	35	ft
Side slopes (horizontal to vertical)	2:1	
Average exit slope	1.0	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, N6-D.

The calculations for the sediment load entering Structure N6-D were made utilizing the Universal Soil Loss Equation with the following parameters:

1. Rainfall Factor, R 40
2. Soil Erodibility Factor, K 0.31
3. Slope Factor, LS 6.13
4. Cover Factor, C 0.145
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 N6-D and the results of the sediment inflow analysis are summarized in the following table.

N6-D STORAGE

Total Storage Capacity	5.26	acre-ft
10-year, 24-hour Storm Inflow	2.13	acre-ft
Available Sediment Storage Capacity . .	3.13	acre-ft
Sediment Inflow Rate	0.165	acre-ft/yr
Sediment Storage Life	19	yrs

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure N6-D indicated that the only geotechnical problem is rill and gully erosion on the upstream and downstream slopes, the side slopes of the spillway channel, the bottom of the outlet channel and the right and left abutments. Correction of erosion is considered a periodic maintenance task and does not require remedial action.

The downstream slope should be flattened to 3.25 horizontal to 1 vertical to meet stability requirements. The crest and both slopes of the embankment are uneven and should be trimmed flat and smooth, respectively. While this situation is, in our opinion due to a lack of fine grading at the time of construction and not critical at the present time, it may mask potential future problems and therefore, should be corrected.

HYDRAULICS

The storage capacity of Structure N6-D is adequate but the spillway capacity is inadequate. The structure does not have an adequate outflow channel. The bottom elevation of the existing spillway channel should be lowered to elevation 6620.00 feet while maintaining the bottom width of 20 feet as shown on Plate 5. A trapezoidal outflow channel with the same bottom width as the spillway should be constructed along the alignment shown in Plate 1. The channel profile is shown in Plate 4 and 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.

Lowering the spillway elevation to 6620.00 feet decreases the storage capacity and increases the freeboard. The analysis of these conditions is summarized in the following table.

N6-D HYDRAULICS FOR REDESIGNED SPILLWAY

	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	45	516	
Volume	acre-ft	2.13	--	
Storage				
Peak Stage	ft	6617.42	6620.00	
Spillway Elevation	ft	6620.00	--	
Peak Storage	acre-ft	2.13	--	
Storage Capacity	acre-ft.	3.85	--	
Available Sediment Storage Capacity	acre-ft	1.72	--	
Sediment Inflow Rate	acre-ft/yr	0.165	--	
Sediment Storage Life.	yrs	10	--	
Outflow				
Peak Flow	cfs	0	514	
Embankment Crest Elevation	ft	--	6625.00	
Peak Stage	ft	--	6623.98	
Freeboard	ft	--	1.02	
Spillway Channel				
Flow Depth	ft	--	3.98	
Critical Velocity.	fps	--	7.8	
Manning's "n"		--	0.040	
Outflow Channel			Section I	Section II
Slope	%	--	5	34
Normal Velocity.	fps	--	10.9	20.7
Normal Depth	ft	--	1.85	1.07
Manning's "n"		--	0.040	0.040

* * *

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

Plate 1 - Site Plan N6-D

Plate 2 - Existing Maximum Cross Section N6-D, A-A'

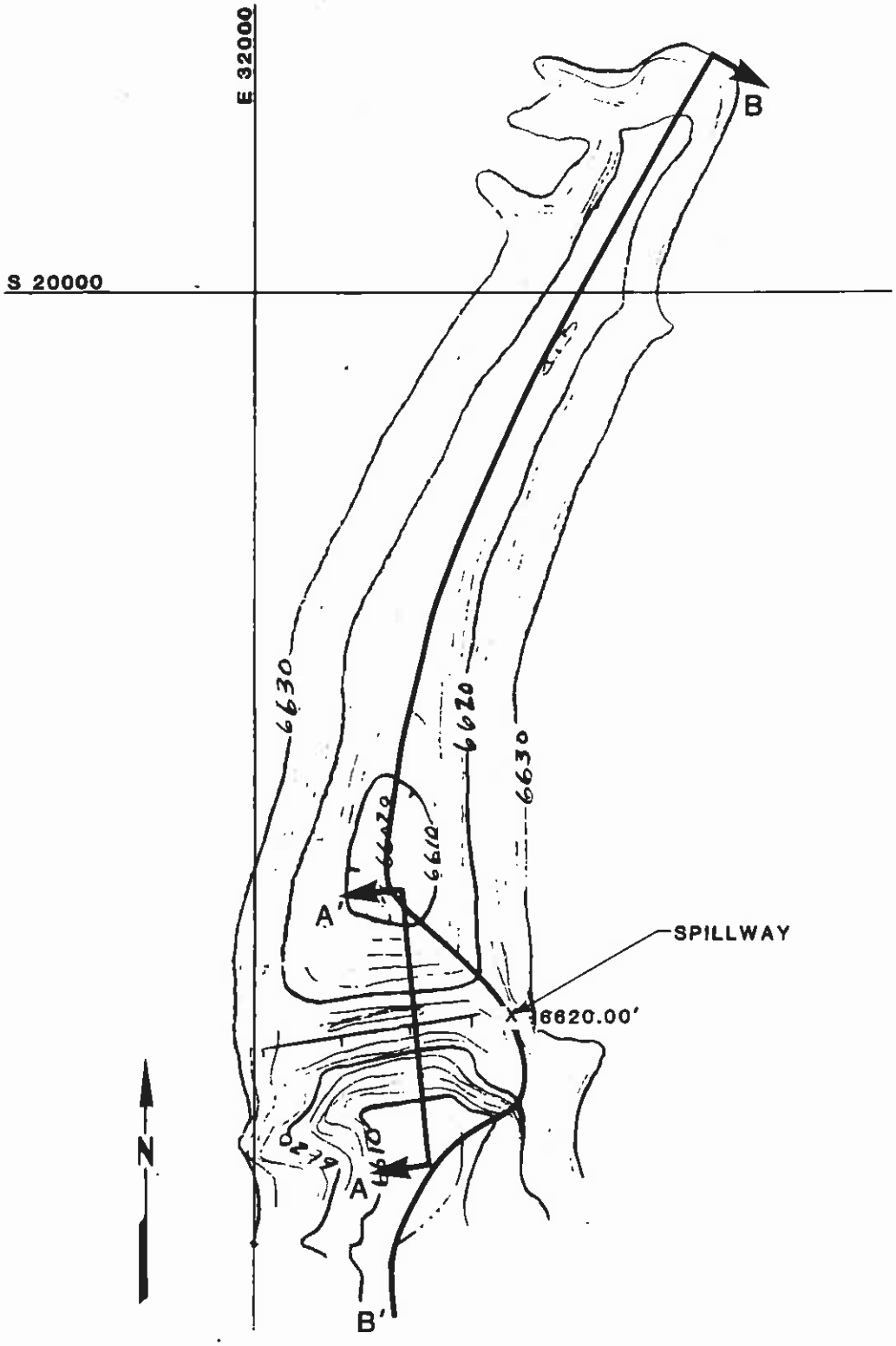
Plate 3 - Volume-Elevation Curve N6-D

Plate 4 - Channel Profile N6-D, B-B'

Plate 5 - Spillway and Outflow Channel Cross Section N6-D

Appendix A - Inspection Check List

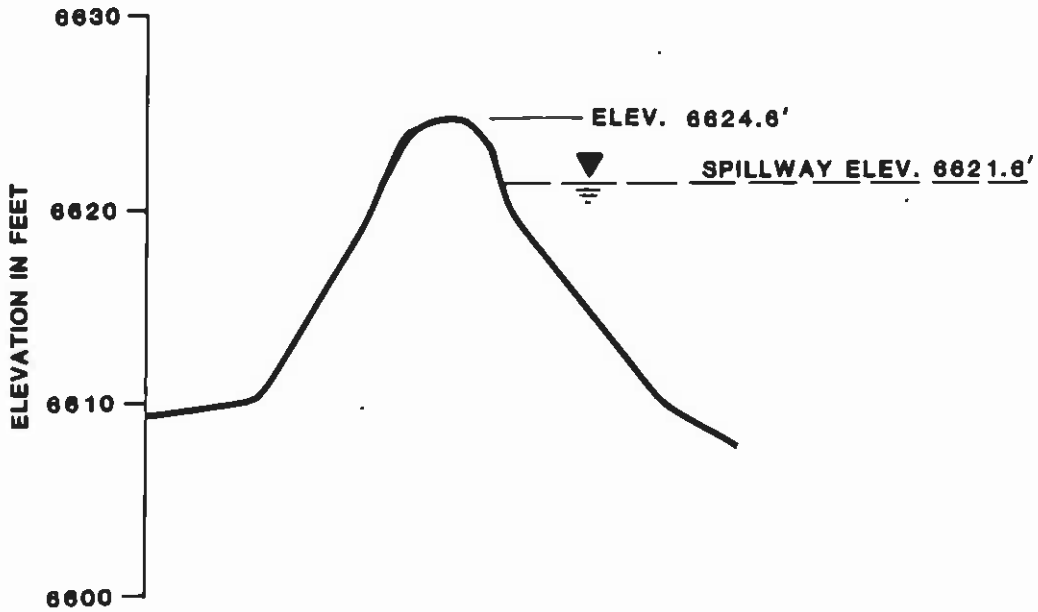
Appendix B - Hydrology and Hydraulic Calculations



SITE PLAN
N6-D

SCALE
0 100 200
FEET

BY **Dames & Moore** Plate 1

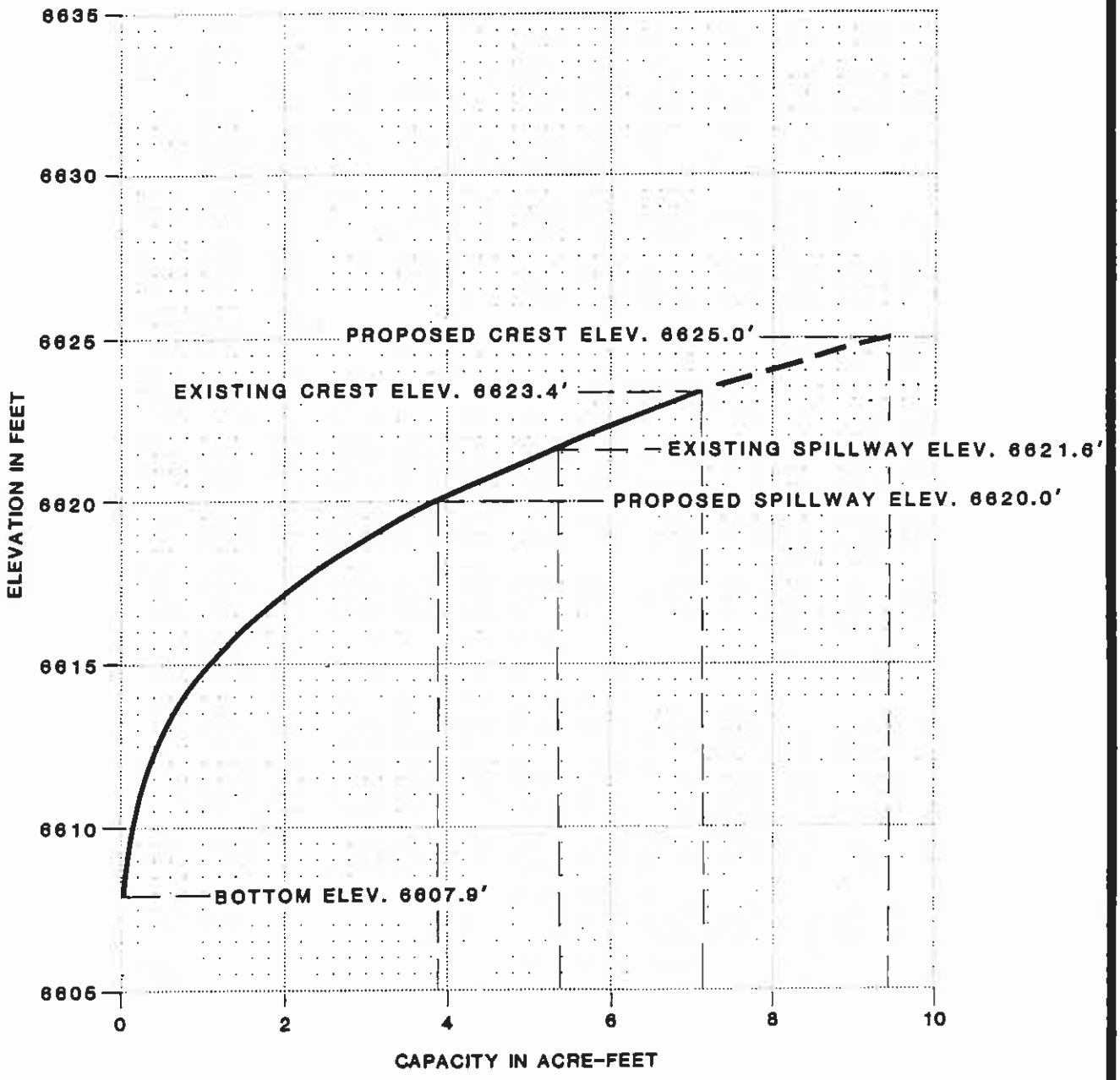


SCALE
0 50 100
FEET

EXISTING MAXIMUM CROSS-SECTION A-A' N6-D

FOR LOCATION SEE PLATE 1

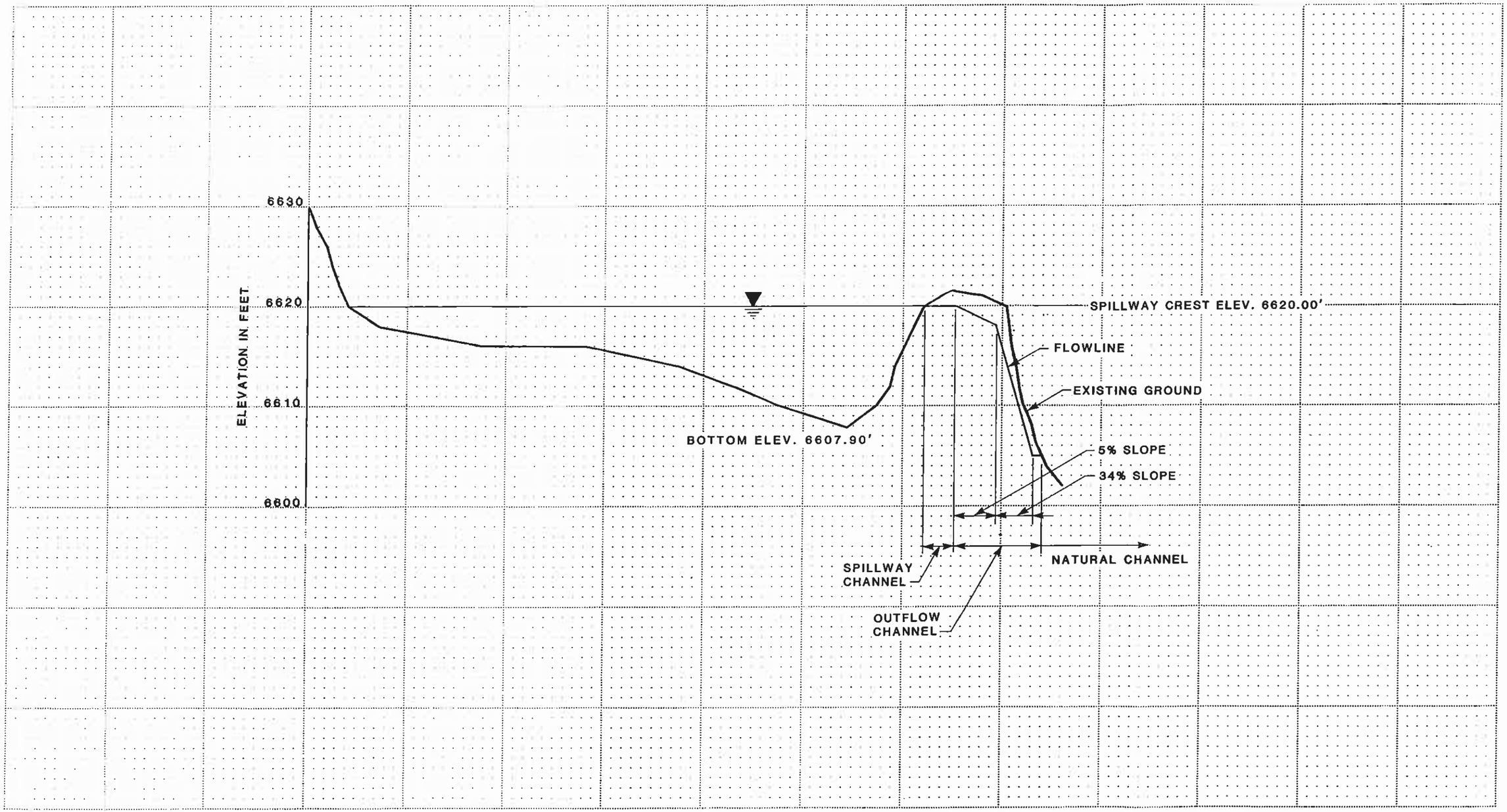
BY **Dames & Moore** Plate 2



VOLUME-ELEVATION CURVE

N6-D

BY **Dames & Moore** Plate 3

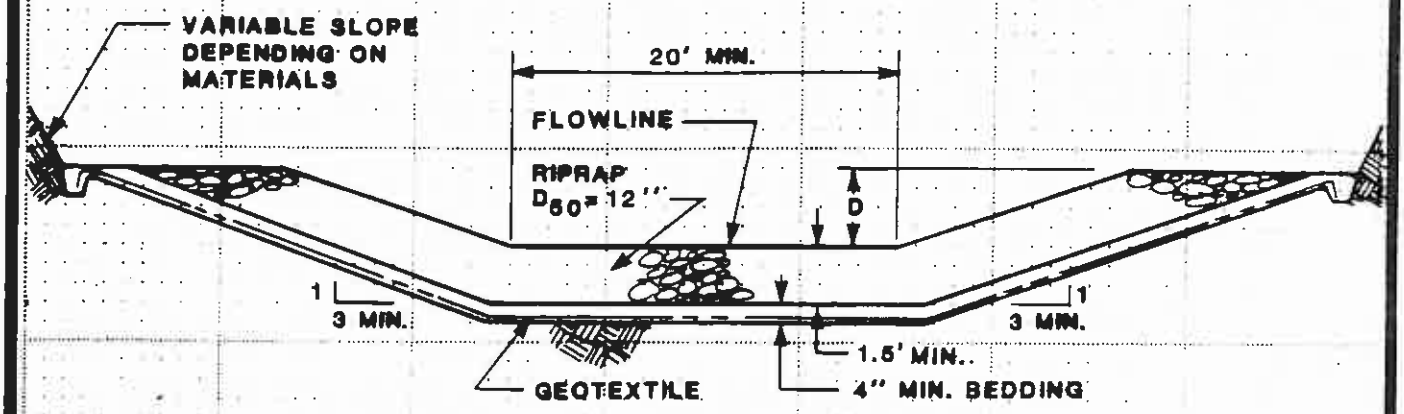


SCALE
0 100 200
FEET

CHANNEL PROFILE B-B'
N6-D

FOR LOCATION SEE PLATE 1

BY **Dames & Moore** Plate 4



SPILLWAY CHANNEL

D = 6.0'

LENGTH = 30'

FLOWLINE ELEV.= 6620.00'

OUTFLOW CHANNEL

D = 3.0'

SPILLWAY AND OUTFLOW CHANNEL CROSS SECTION N6-D

APPENDIX A

INSPECTION CHECK LIST

Sediment Impoundment Name: NG-D
Page: 4

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			Crest uneven 14' W
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE			Rough slope 17° uneven constr. not trimmed
a. Adequate grass cover?	X		60%
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		Grass
g. Any stone deterioration?			NA
h. Visual depressions or bulges?		X	
i. Visual settlements?		X	
j. Animal burrows?		X	
3. DOWNSTREAM SLOPE			Rough slope 22° uneven const. not trimmed
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		into paved sm gulleys & rills
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			Brown SM with gravel
5. ABUTMENT CONTACT. LEFT			
a. Any erosion?	X		into spillway sm. gulleys
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			brown SM w/gravel

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?			
Are side slopes sloughing?			
Bottom of channel eroding?			NA
Obstructed?			
Erosion protection?			
c. Spillway Channel:	X		22'W 33' below crest 0% slope 25'L
Are side slopes eroding?	X		Rills & sm. gullys
Are side slopes sloughing?	X		From LA
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?		X	
d. Outflow Channel:	X		35'L 21'W 1% slope / at exit 27°
Are side slopes eroding?	X		
Are side slopes sloughing?	X		
Bottom of channel eroding?	X		At exit 2 lg. gullys
Obstructed?		X	
Erosion protection?		X	
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		
d. Watershed matches soil map?		x	

9. GENERAL COMMENTS

Both Slopes are rough and uneven (opinion) due to construction

Canopy 5
Ground 40

APPENDIX B

HYDROLOGY AND HYDRAULIC CALCULATIONS

FILE PEABODY COAL CO 10134-011-22
SUBJECT SEDIMENT POND HYDROLOGY
N6-D SHEET ___ OF ___

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

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 6705 − 6622 = 83 ft.

WATER COURSE LENGTH = 3.4(400) = 1360 ft. = 0.258 mi.

$$T_c = \left(\frac{11.9\ (0.258)^3}{83}\right)^{0.385} = 0.099 \text{ hr.}$$

LAG TIME = $0.6 T_c$ = 0.059 hr

SCS CURVE NUMBER

DRAINAGE AREA (ac)	COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
14.7	reclaimed (post-law)	fair	—	81 (.45)
17.6	P-J	average	D	83 (.55)
				82.1

55% EH #33
45% EH #35

use 83

DRAINAGE BASIN AREA

32.3 ACRES 0.051 SQ. MILE

BY S. Dalton DATE 10-2-85
CHECKED BY ___
COPY TO EO ___

FILE PEABODY COAL CO 1039-011-23
SUBJECT SEDIMENT INFLOW
NG-D SHEET ___ OF ___

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

BY ___ DATE ___ CHECKED BY ___ COPY TO EO ___

UNIVERSAL SOIL LOSS EQUATION

RAINFALL FACTOR

R = 40

SOIL ERODIBILITY FACTOR

SOIL TYPE = 55% EH #33 .55 (.22)
45% EH #35 .45 (.42)
.31

K = .31

SLOPE FACTOR

LENGTH (ft.)	Δ ELEV (ft.)	SLOPE (%)	LS
700	65	9.3	3.25 (.3)
300	75	25	10.2 (.3)
300	50	16.7	5.25 (.4)
			= 6.13

COVER FACTOR

AREA (ac.)	COVER TYPE	% COVER	CANOPY (%)	WEIGHTED C
45%	reclaimed	—	—	.45 (.15)
55%	P-J	40	25	.55 (.14)
				C = .145

EROSION CONTROL FACTOR

P = 1.0

SEDIMENT INFLOW

$A = 40(.31)(6.13)(.145)(1.0) = 11.02$ ton/acre/year

$A = (11.02)\left(\frac{1}{2047}\right)(32.3)(.95) = .165$ acre-feet/year

Dames & Moore

FILE PEABODY COAL CO 10139-011-22
SUBJECT SEDIMENT POND HYDROLOGY
N6-D SHEET ___ OF ___

100yr - Excludes N6-D1 upstream 6hr

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 6915 − 6622 = 293 ft.

WATER COURSE LENGTH = 22.5(400) = 9000 ft. = 1.705 hr.

$$T_c = \left(\frac{11.9\,(1.705)^3}{293}\right)^{0.385} = 0.539 \text{ hr.}$$

LAG TIME = $0.6 T_c$ = 0.324 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
- D	32.3				83 (.09)
- D1	343.0				84 (.91)
					83.9

use 84

DRAINAGE BASIN AREA

375.3 ACRE 0.586 SQ MILE

BY ____ DATE ____
CHECKED BY ____
COPY TO EO ____

Dames & Moore

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