INSPECTION REPORT

Sedimentation Structure

N1-AC

Kayenta Mine

Navajo County, Arizona

for

PEABODY COAL COMPANY

Dames & Moore
10139-011-22

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INTRODUCTION

Sedimentation Structure N1-AC 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 Kayenta Mine. The location of Structure N1-AC is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure N1-AC. 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 N1-AC was inspected on September 5, 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 N1-AC 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 N1-AC has a 118.8-acre tributary drainage area and is located near Yellow Water Canyon at the Kayenta Mine. The watershed is classified as 45% Pinion/Juniper, 38% reclaimed, 17% disturbed.

EMBANKMENT

Structure N1-AC is a homogeneous earthen embankment classified as a in-wash embankment. Physical characteristics of the embankment are listed in the following table:

Structure N1-AC

Embankment	Residual Shale Soils
Foundation	Residual Shale Soils
Right Abutment	Residual Shale Soils
Left Abutment	Residual Shale Soils
Height	10.8 ft
Crest Width	17 ft
Upstream Slope	1.9 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 N1-AC, A-A'. Grass provides erosion protection on the upstream and downstream slopes of the embankment.

ANALYSES

STABILITY

Structure N1-AC 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 = 15 ft
2. Maximum upstream slope = 1.75 H : 1 V
3. Maximum downstream slope = 2.5 H : 1 V
4. Normal pool with steady seepage saturation conditions

The N1-AC embankment is lower in height and has flatter slopes than the category standard; therefore, the embankment has factors of safety greater 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 N1-AC is not in series with any other structure and therefore the spillway was analyzed using the 25-year, 6-hour storm. The storage capacity of Structure N1-AC was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1.	Water Course length, L	0.432	mi
2.	Elevation Difference, H	154	ft
3.	Time of Concentration, T_c	0.141	h
4.	Lag time, $0.6T_c$	0.085	h
5.	SCS Curve Number	87	
6.	Rainfall Depth, 10-year, 24-hour storm	2.1	in.
	25-year, 6-hour storm	1.9	in.
7.	Drainage Area	118.8	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.

N1-AC HYDRAULICS

	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	189	239
Volume	acre-ft	9.80	8.42
Storage			
Peak Stage	ft	6535.84	--
Spillway Elevation . .	ft	6538.80	--
Peak Storage	acre-ft	9.82	--
Storage Capacity . . .	acre-ft	16.3	--
Outflow			
Peak Flow	cfs	0	102
Embankment Crest Elevation	ft	--	6540.80
Peak Stage	ft	--	6540.46
Freeboard	ft	--	0.34

Spillway Channel

The existing spillway for N1-AC has a trapezoidal channel with the following dimensions:

Channel depth	8 ft
Channel width	45 ft
Channel length	60 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 N1-AC has a U-shaped channel with the following dimensions:

Channel width	45 ft
Channel length	140 ft
Average exit slope	2 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, N1-AC.

The calculations for the sediment load entering Structure N1-AC were made utilizing the Universal Soil Loss Equation with the following parameters:

1. Rainfall Factor, R 40
2. Soil Erodibility Factor, K 0.26
3. Slope Factor, LS 9.60
4. Cover Factor, C 0.31
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 N1-AC and the results of the sediment inflow analysis are summarized in the following table.

N1-AC STORAGE

Total Storage Capacity	16.3	acre-ft
10-year, 24-hour Storm Inflow	9.82	acre-ft
Available Sediment Storage Capacity . .	6.48	acre-ft
Sediment Inflow Rate	1.62	acre-ft/yr
Sediment Storage Life	4	yrs

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure N1-AC indicated that the geotechnical problems consist of rill on the upstream and downstream slopes; the side slopes of the spillway and outlet channel; and the right abutment and cracks at the upstream edge of the crest towards the left abutment. Correction of erosion is considered a periodic maintenance task and does not require

remedial action. The cracks in the crest should be repaired by excavating to the bottom of the cracks and replacing with compacted fill.

HYDRAULICS

The storage capacity of Structure N1-AC 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 6538.0 feet while maintaining the bottom width of 50 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 and Plate 6. The spillway, outflow channel and stilling basin should be protected against erosion using geotextile and riprap as shown in Plate 5.

Lowering the spillway elevation to 6538.0 feet decreases the storage capacity and increases the freeboard. The analysis of these conditions is summarized in the following table.

N1-AC HYDRAULICS FOR 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	189	239	
Volume	acre-ft	9.80	8.42	
Storage				
Peak Stage	ft	6538.81	6539.67	
Spillway Elevation	ft	6538.00	--	
Peak Storage	acre-ft	9.82	--	
Storage Capacity	acre-ft	14.53	--	
Available Sediment Storage Capacity	acre-ft	4.71	--	
Sediment Inflow Rate	acre-ft/yr	1.62	--	
Sediment Storage Life	yrs	3	--	
Outflow				
Peak Flow	cfs	--	107	
Embankment Crest Elevation	ft	--	6540.80	
Peak Stage	ft	--	6539.67	
Freeboard	ft	--	1.13	
Spillway Channel				
Flow Depth	ft	--	1.67	
Critical Velocity	fps	--	4.0	
Manning's "n"		--	0.040	
Outflow Channel			Section I	Section II
Slope	%	--	48	3
Normal Velocity	fps	--	9.3	4.0
Normal Depth	ft	--	0.22	0.51
Manning's "n"		--	0.040	0.040

* * *

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

Plate 1 - Site Plan N1-AC

Plate 2 - Existing Maximum Cross Section N1-AC, A-A'

Plate 3 - Volume-Elevation Curve N1-AC

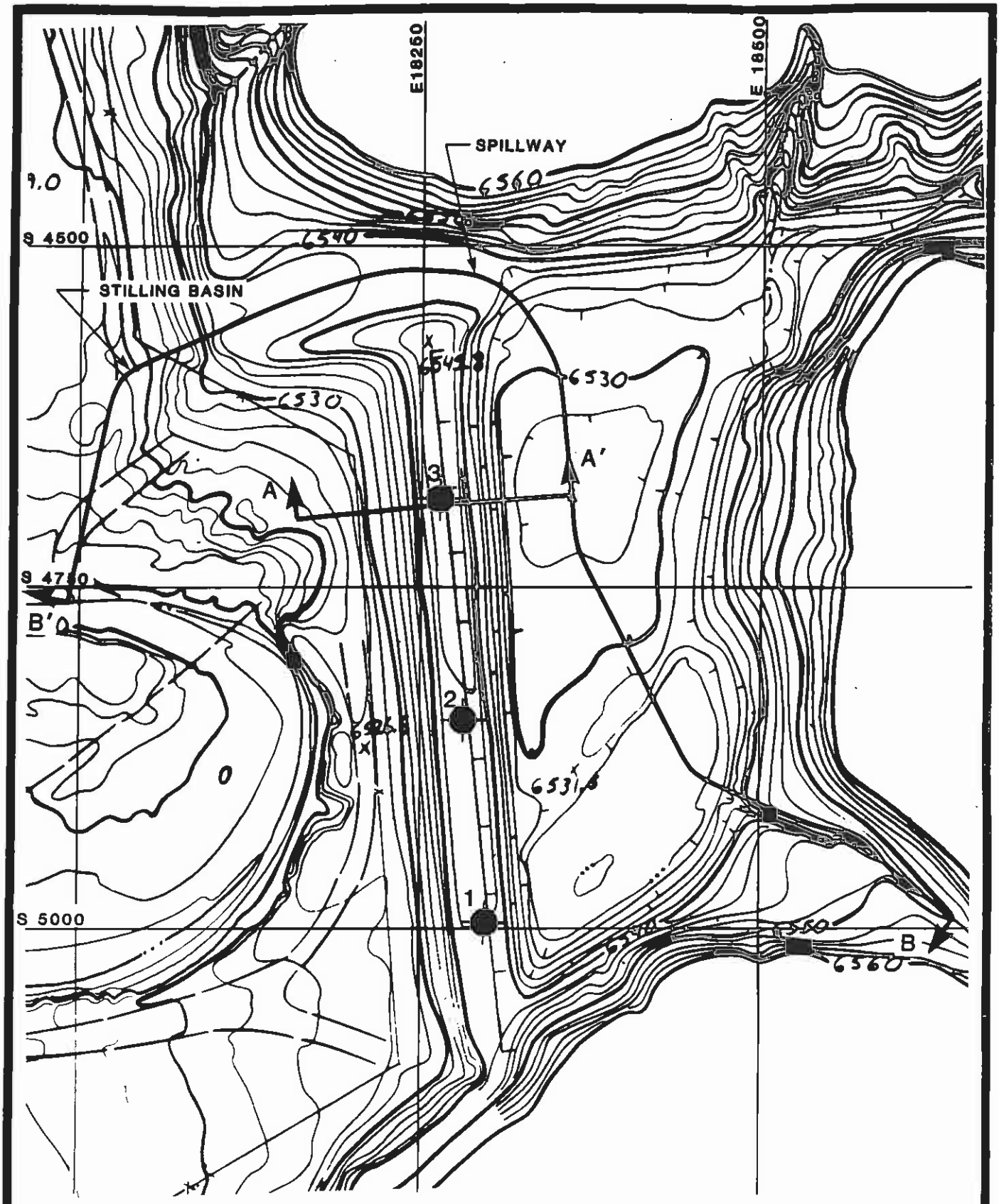
Plate 4 - Channel Profile N1-AC, B-B'

Plate 5 - Spillway and Outflow Channel Cross Section N1-AC

Plate 6 - Spillway Stilling Basin Plan N1-AC

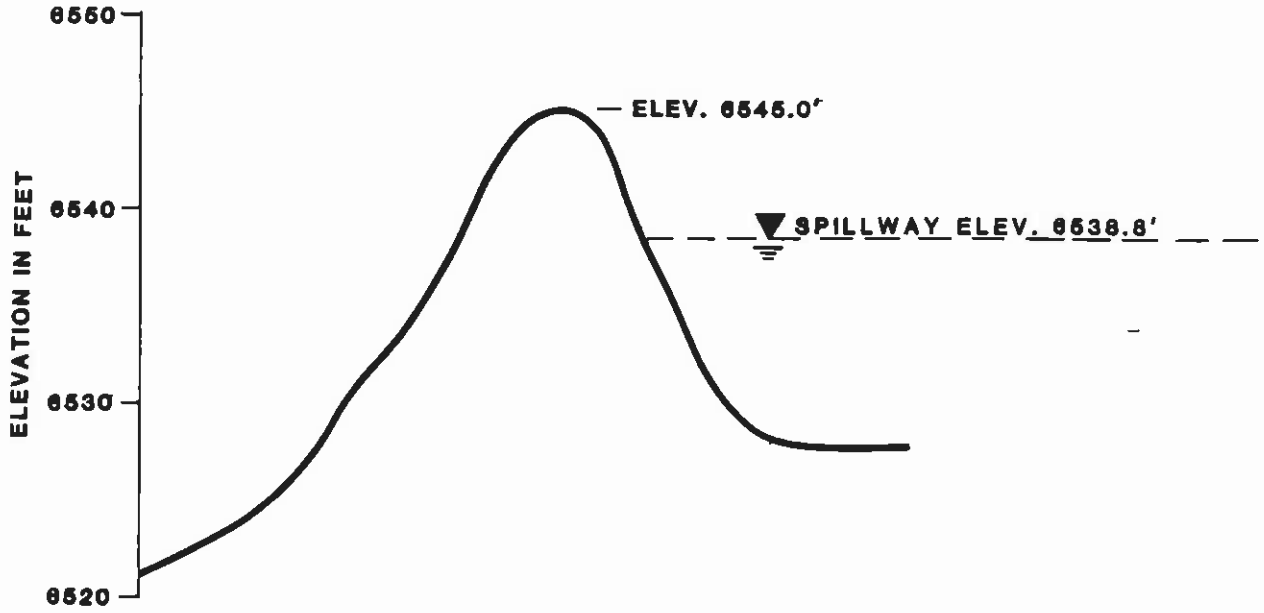
Appendix A - Inspection Check List

Appendix B - Hydrology and Hydraulic Calculations



SITE PLAN
N1-AC

BY **Dames & Moore** Plate 1

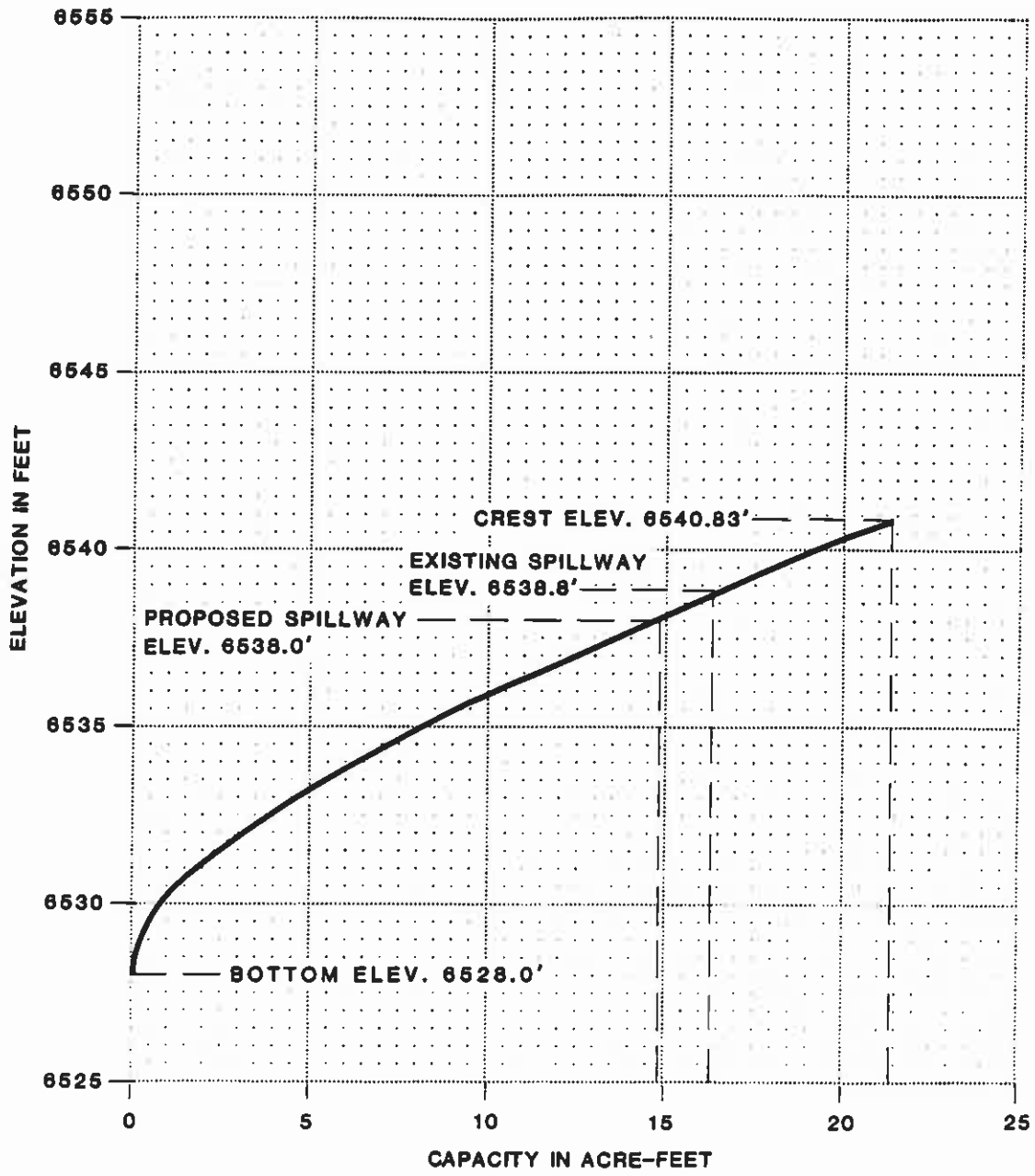


SCALE
0 50 100
FEET

EXISTING MAXIMUM CROSS-SECTION A-A' N1-AC

FOR LOCATION SEE PLATE 1

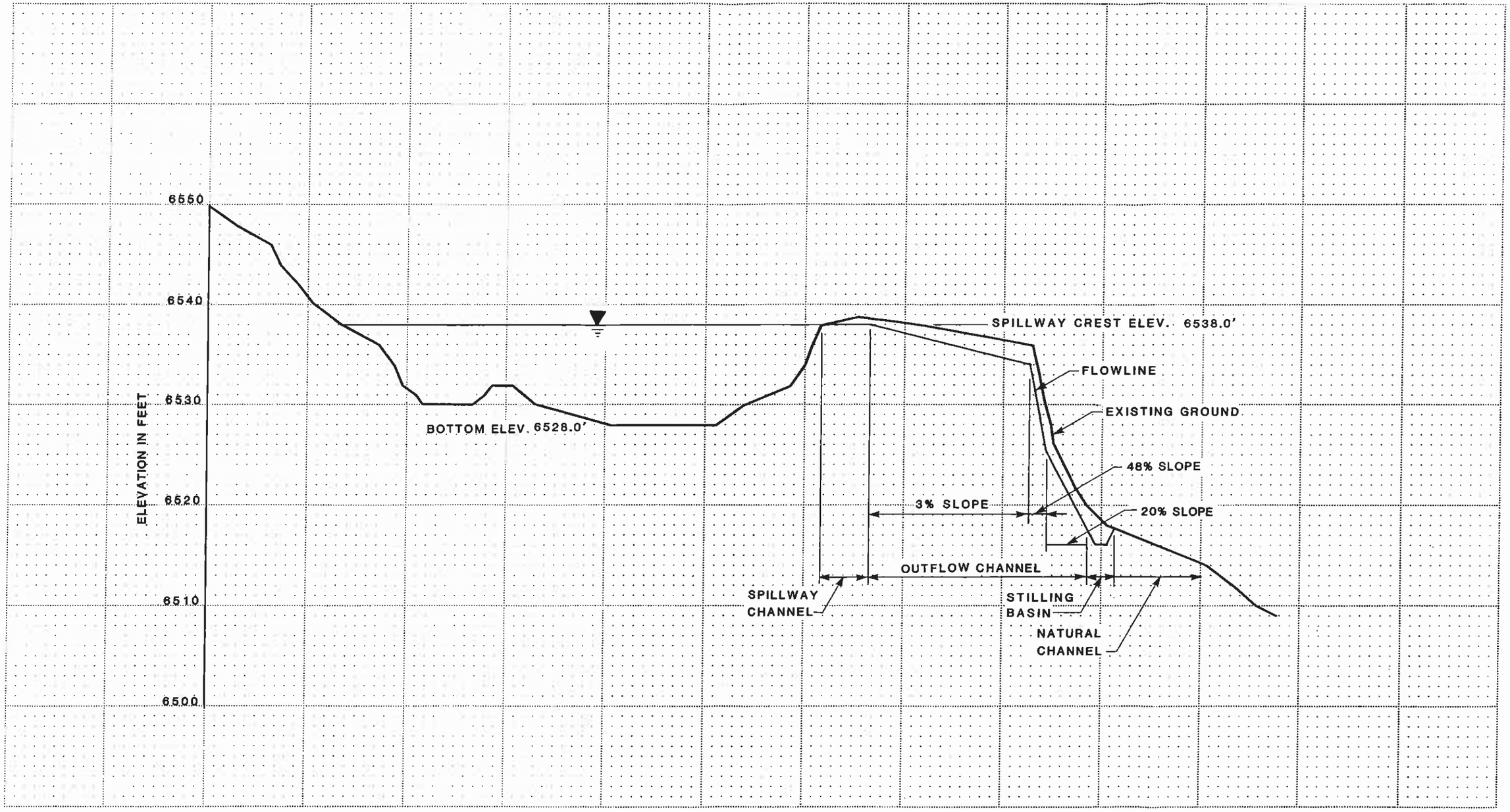
BY **Dames & Moore** Plate 2



VOLUME-ELEVATION CURVE

N1-AC

BY **Dames & Moore** Plate 3

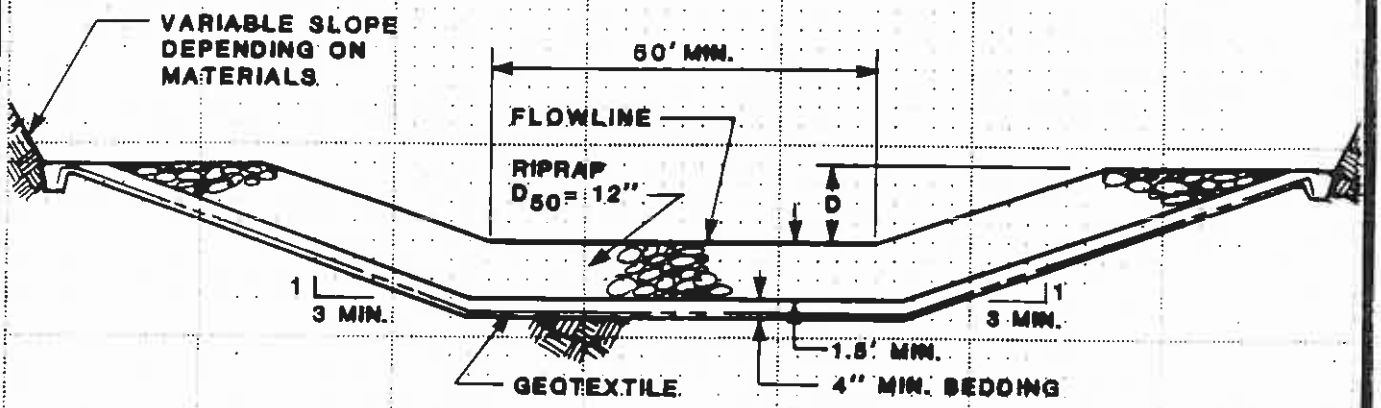


SCALE
0 100 200
FEET

CHANNEL PROFILE B-B'
N1-AC

FOR LOCATION SEE PLATE 1

BY **Dames & Moore** Plate 4



SPILLWAY CHANNEL

D = 2.7'

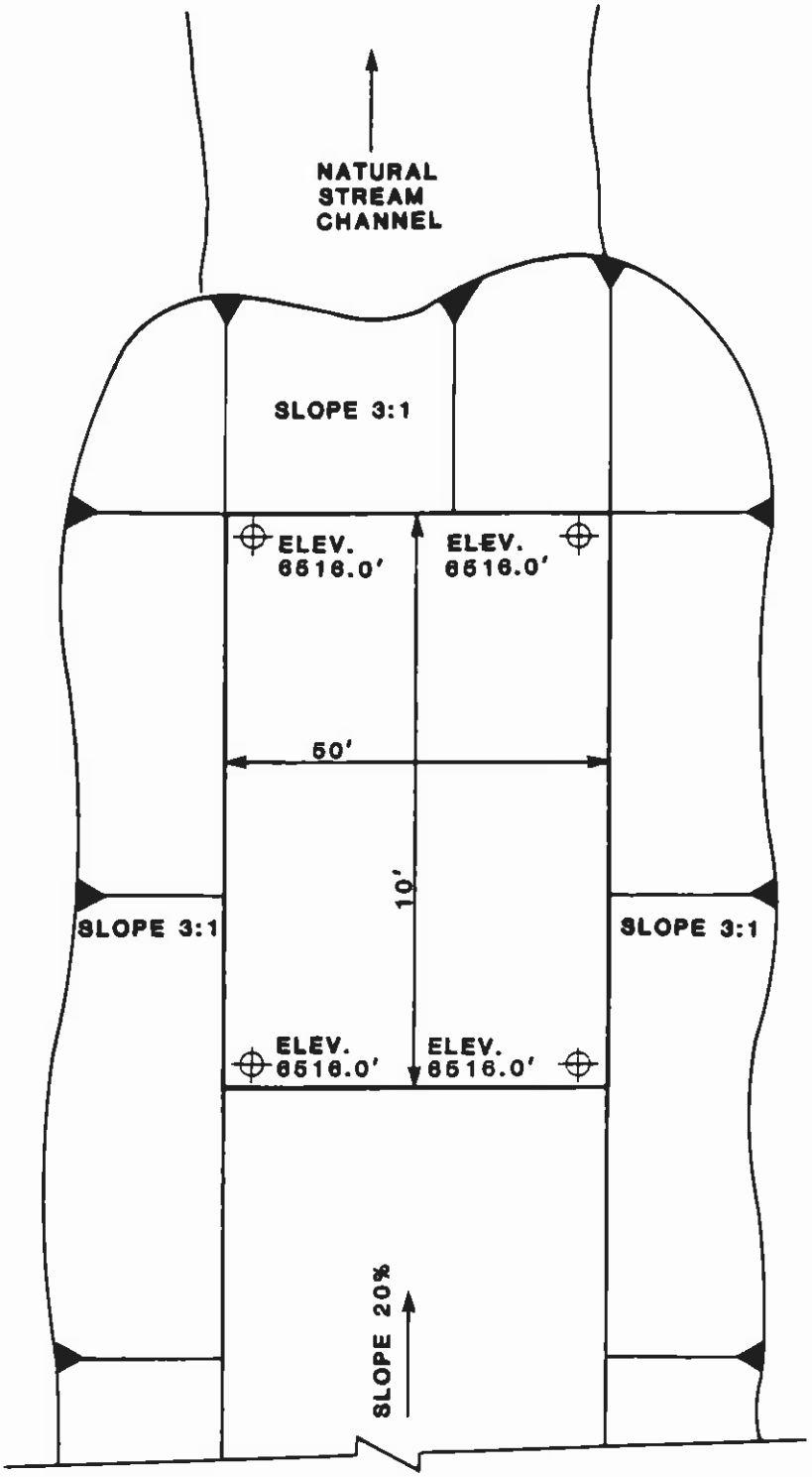
LENGTH = 50'

FLOWLINE ELEV. = 6538.00'

OUTFLOW CHANNEL

D = 1.5'

SPILLWAY AND OUTFLOW CHANNEL CROSS SECTION N1-AC



MINIMUM HEIGHT OF RIPRAP ALONG SIDEWALLS ABOVE THE BASIN FLOOR = 2.9'

MINIMUM DEPTH OF BASIN FLOOR BELOW NATURAL STREAMBED = 1.5'

SPILLWAY STILLING BASIN PLAN N1-AC

BY **Dames & Moore** Plate 6

APPENDIX A

INSPECTION CHECK LIST

Sediment Impoundment Name: N1-AC
Page: 4

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			17'
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE			28° Ragged uneven
a. Adequate grass cover?	X		60% Co
b. Any erosion?	X		Rills
c. Are trees growing on slope?		X	
d. Longitudinal cracks?	X		At edge of crest 12" deep
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			22°
a. Adequate grass cover?	X		75%
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			Rills
a. Any erosion?	X		↓ INTO Spillway
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?			
Are side slopes sloughing?			No
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
c. Spillway Channel:	X		8' below crest 45' w.
Are side slopes eroding?	X		Rills
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?		X	
d. Outflow Channel:	X		
Are side slopes eroding?	X		Rills
Are side slopes sloughing?		X	
Bottom of channel eroding?	X		at end
Obstructed?		X	
Erosion protection?		X	some rock at end
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		moderate
d. Watershed matches soil map?		X	

9. GENERAL COMMENTS

Found cracks at U.S. edge of crest 12" deep. May be due to poor edge compaction of crest or no trimming after building crest.

Ground cover ≤75 %
Canopy cover ≤25 %

APPENDIX B

HYDROLOGY AND HYDRAULIC CALCULATIONS

FILE PEABODY COAL CO. 10139-011-2
SUBJECT SEDIMENT POND HYDROLOGY
NI-AC SHEET ___ OF

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

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 6693 − 6539 = 154 ft.

WATER COURSE LENGTH = 5.7(400) = 2280 ft = 0.432 mi.

$$T_c = \left(\frac{11.9\,(0.432)^3}{154}\right)^{0.385} = 0.141 \text{ hr.}$$

LAG TIME = $0.6 T_c$ = 0.085 hr.

Note: SEE CALCULATIONS ON BACK.

SCS CURVE NUMBER

DRAINAGE AREA (ac)	COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
7.4	Disturbed pre-law Reclaimed		D	(.06) 94
45.2				(.38) 87
52.9	P-J	average	D	(.45) 83
13.3	Gravel Road		D	(.11) 91

38% #35
62% #24

use 87

DRAINAGE BASIN AREA

118.8 ACRE 0.186 SQ MILE

S. DOLAN DATE 9-12-85
CHECKED BY ___
COPY TO EO ___

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

UNIVERSAL SOIL LOSS EQUATION

RAINFALL FACTOR

R = 40

SOIL ERODIBILITY FACTOR

SOIL TYPE =	38%	reclaimed	.38 (.42)
	62%	EH # 24	.62 (.16)
			.26

K = .26

SLOPE FACTOR

LENGTH (ft.)	Δ ELEV (ft)	SLOPE (%)	LS
1100	30	3%	.59 (.3)
400	30	8%	1.98 (.2)
400	180	45%	22.00 (.1)
300	30	10%	2.37 (.1)

use 9.6

COVER FACTOR

AREA (ac.)	COVER TYPE	% COVER	CANOPY (%)	WEIGHTED C
6%	disturbed			(.06)(1.0)
38%	reclaimed			(.38)(.15)
45%	P-J	40	25	(.45)(.14)
13%	road			(.13)(1.0)
				.31

EROSION CONTROL FACTOR

P = 1.0

BY ___ DATE ___ CHECKED BY ___ COPY TO EO ___

SEDIMENT INFLOW

$A = 40(.26)(9.6)(.31)(1.0) = 30.95$ ton/acre/year

$A = 30.95\left(\frac{1}{2047}\right)(118.8)(.9) = 1.62$ acre-feet/year