INSPECTION REPORT

Sedimentation Structure

N6-C

Black Mesa Mine

Navajo County, Arizona

for

PEABODY COAL COMPANY

Dames & Moore
10139-011-22

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INTRODUCTION

Sedimentation Structure N6-C 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-C is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure N6-C. 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-C 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-C 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-C has a 96.7-acre tributary drainage area and is located near Moenkopi Wash at the Black Mesa Mine. The watershed is classified as 61% Pinion/Juniper and 39% reclaimed.

EMBANKMENT

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

Structure N6-C

Embankment	Residual Shale Soils
Foundation	Sandstone
Right Abutment	Residual Shale Soils
Left Abutment	Residual Shale Soils
Height	17 ft
Crest Width	12 ft
Upstream Slope	2.4 H : 1 V
Downstream Slope	3.1 H : 1 V

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

ANALYSES

STABILITY

Structure N6-C 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 N6-C 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 N6-C 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 N6-C 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	158	ft
3.	Time of Concentration, T_c	0.140	h
4.	Lag time, $0.6T_c$	0.084	h
5.	SCS Curve Number	83	
6.	Rainfall Depth, 10-year, 24-hour storm	2.1	in.
	25-year, 6-hour storm	1.9	in.
7.	Drainage Area	96.7	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	116	142
Volume	acre-ft	6.04	4.75
Storage			
Peak Stage	ft	6575.21	—
Spillway Elevation . .	ft	6578.77	--
Peak Storage	acre-ft	6.04	—
Storage Capacity . . .	acre-ft	9.82	--
Outflow			
Peak Flow	cfs	0	21
Embankment Crest Elevation	ft	--	6579.32
Peak Stage	ft	--	6581.03
Freeboard	ft	--	Overtop

Spillway Channel

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

Channel depth	2.9	ft
Channel width	35	ft
Channel length	30	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-C has a trapezoidal channel with the following dimensions:

Channel width	35	ft
Channel length	30	ft
Side slopes (horizontal to vertical)	2:1	
Average exit slope	3-8	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-C.

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

1. Rainfall Factor, R 40
2. Soil Erodibility Factor, K 0.298
3. Slope Factor, LS 6.74
4. Cover Factor, C 0.144
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-C and the results of the sediment inflow analysis are summarized in the following table.

N6-C STORAGE

Total Storage Capacity	9.82	acre-ft
10-year, 24-hour Storm Inflow	6.04	acre-ft
Available Sediment Storage Capacity . .	3.78	acre-ft
Sediment Inflow Rate	0.519	acre-ft/yr
Sediment Storage Life	7	yrs

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure N6-C indicated that the geotechnical problem consist of rill and gully erosion on the upstream and downstream slopes, the side slopes of the spillway and outlet channel, and the right and left abutment and evidence of seepage through the bedrock below the downstream toe of the embankment. Correction of erosion is considered a

periodic maintenance task and does not require remedial action. The seepage through the bedrock beneath the embankment is not considered to be a problem at the present time, however, future inspections should note any increase or any sediment in the flow.

HYDRAULICS

The storage capacity of Structure N6-C 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 6576.70 feet while maintaining the bottom width of 30 feet as shown on Plate 5. A trapezoidal outflow channel with the same bottom width as the spillway and a stilling basin should be constructed along the alignment shown in Plate 1. The channel and stilling basin 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 6576.70 feet decreases the storage capacity and increases the freeboard. The analysis of these conditions is summarized in the following table.

N6-C 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	116	142	
Volume	acre-ft	6.04	4.75	
Storage				
Peak Stage	ft	6575.21	—	
Spillway Elevation	ft	6576.70	--	
Peak Storage	acre-ft	6.04	—	
Storage Capacity	acre-ft	7.55	--	
Available Sediment Storage Capacity	acre-ft	1.51	—	
Sediment Inflow Rate	acre-ft/yr	0.519	--	
Sediment Storage Life.	yrs	3	—	
Outflow				
Peak Flow	cfs	0	84	
Embankment Crest Elevation	ft	--	6579.32	
Peak Stage	ft	--	6578.21	
Freeboard	ft	--	1.11	
Spillway Channel				
Flow Depth	ft	--	1.51	
Critical Velocity.	fps	--	4.3	
Manning's "n"		—	0.61	
Outflow Channel			Section I	Section II
Slope	%	--	2	16
Normal Velocity.	fps	--	3.9	7.4
Normal Depth	ft	--	0.68	0.36
Manning's "n"		--	0.040	0.040

* * *

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

Plate 1 - Site Plan N6-C

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

Plate 3 - Volume-Elevation Curve N6-C

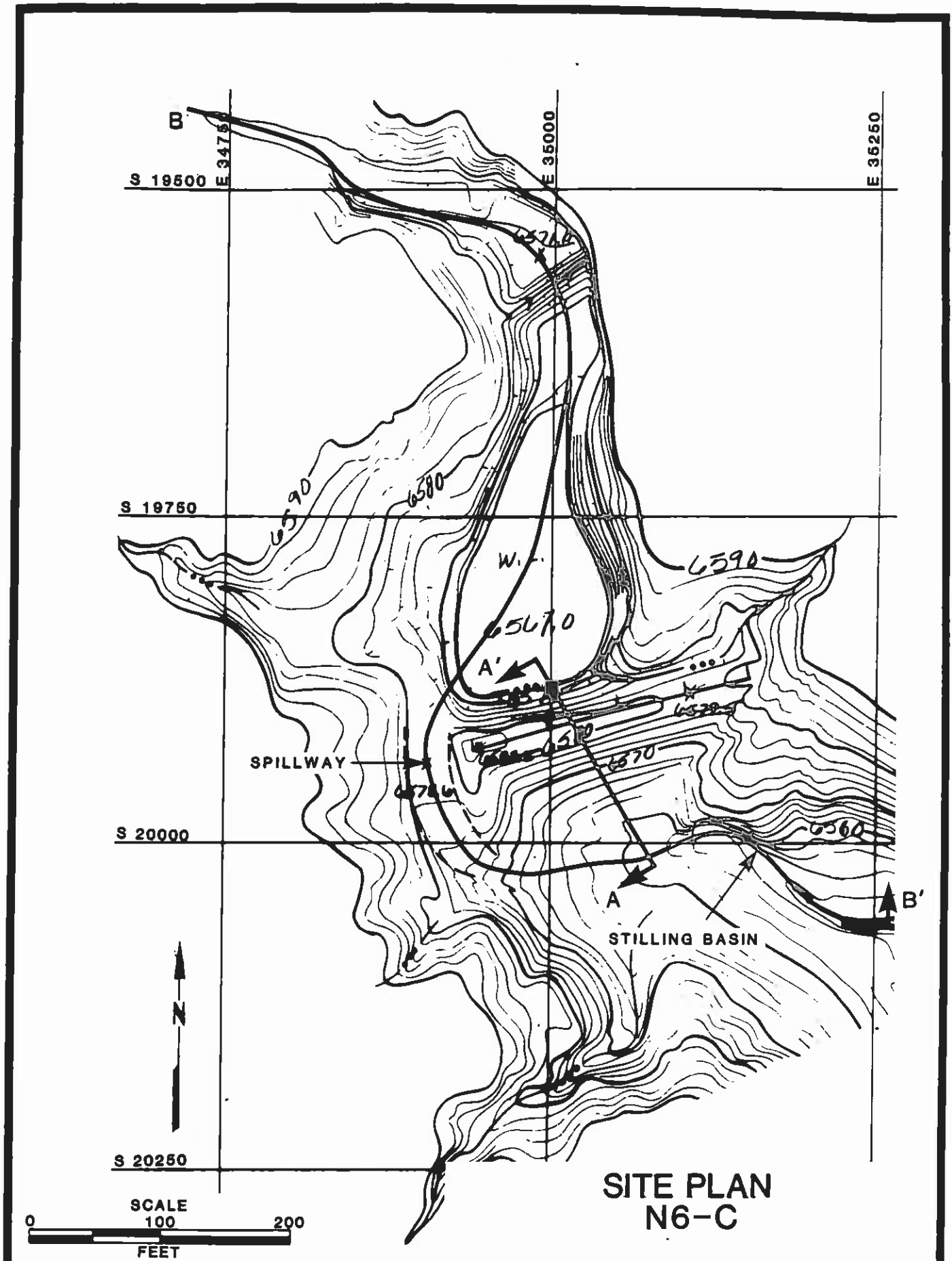
Plate 4 - Channel Profile N6-C, B-B'

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

Plate 6 - Spillway Stilling Basin Plan N6-C

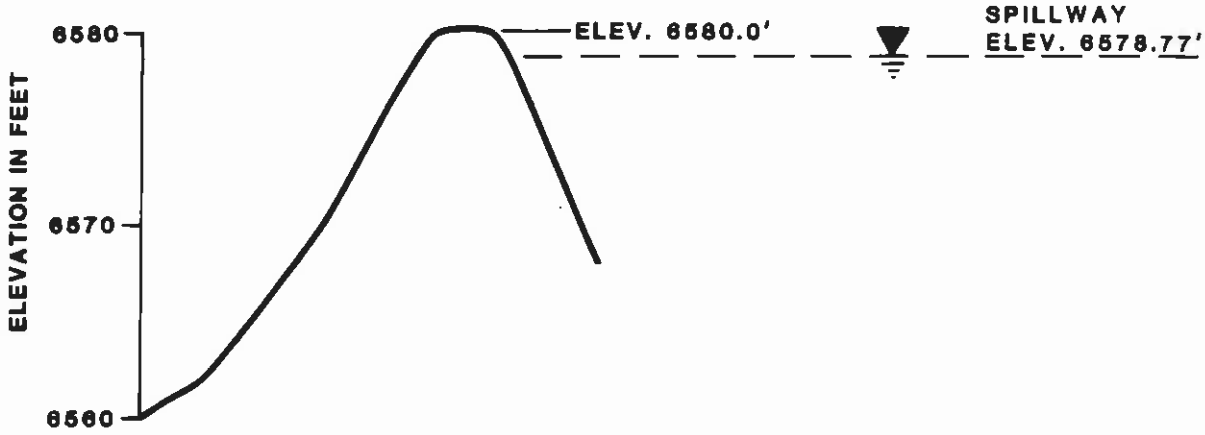
Appendix A - Inspection Check List

Appendix B - Hydrology and Hydraulic Calculations



SITE PLAN
N6-C

BY **Dames & Moore** Plate 1

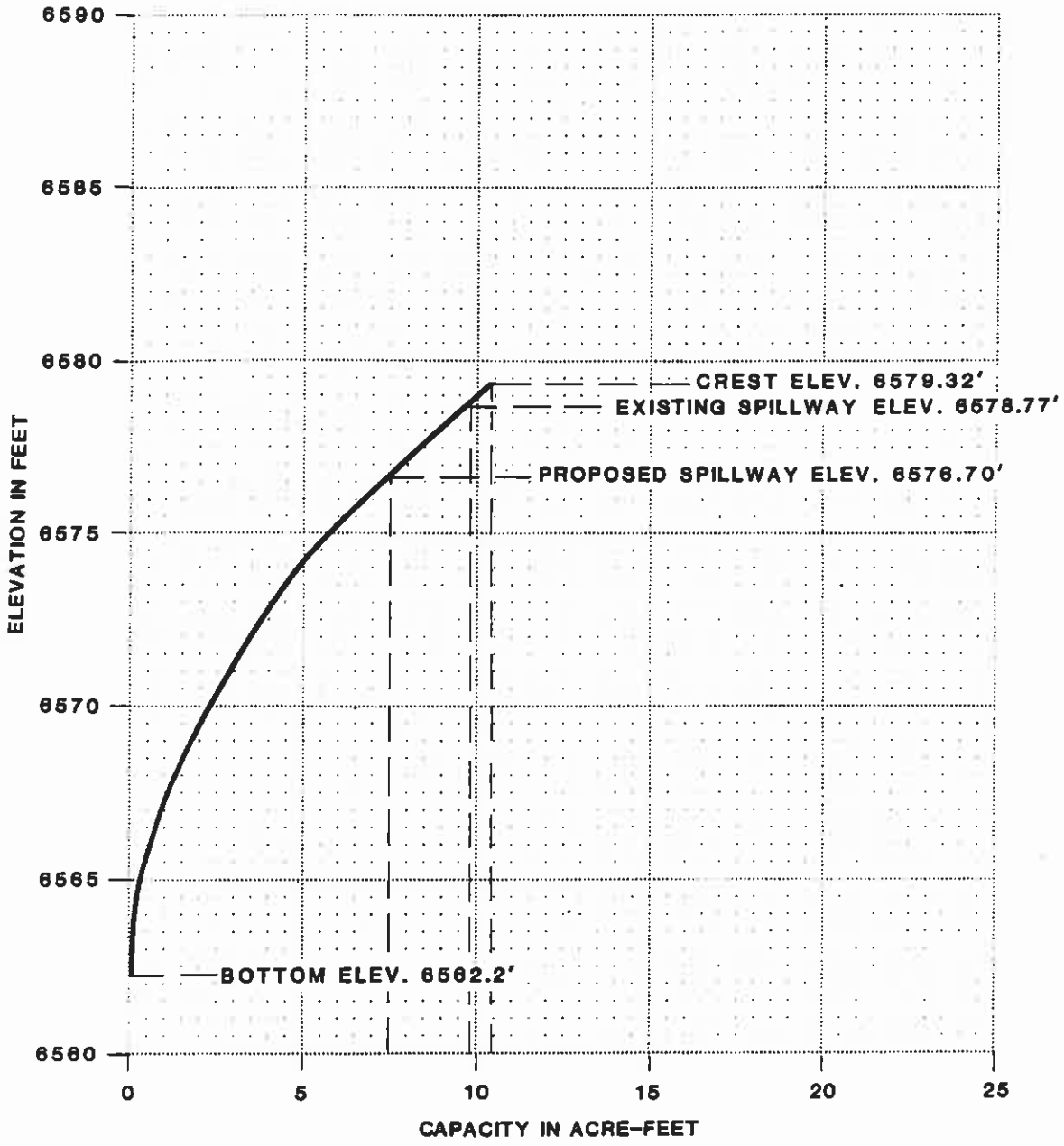


SCALE
0 50 100
FEET

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

FOR LOCATION SEE PLATE 1

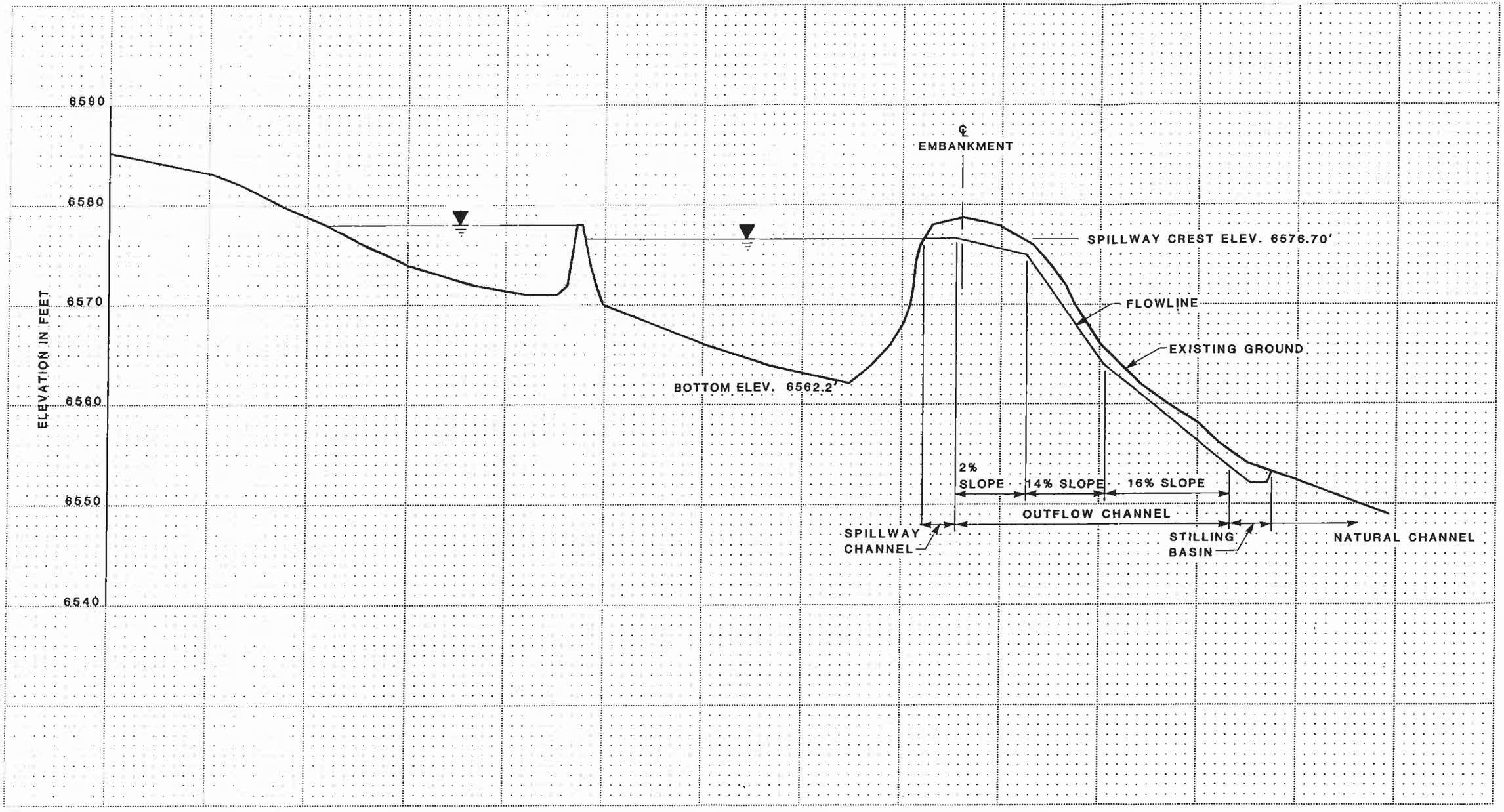
BY **Dames & Moore** Plate 2



VOLUME-ELEVATION CURVE

N6-C

BY **Dames & Moore** Plate 3

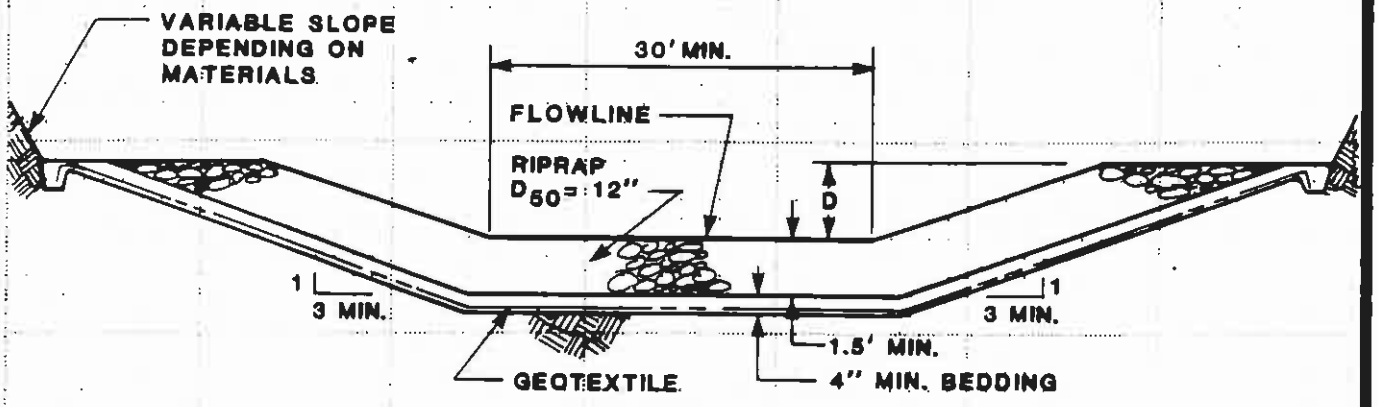


SCALE
0 100 200
FEET

CHANNEL PROFILE B-B'
N6-C

FOR LOCATION SEE PLATE 1

BY **Dames & Moore** Plate 4



SPILLWAY CHANNEL

D = 2.6'

LENGTH = 30'

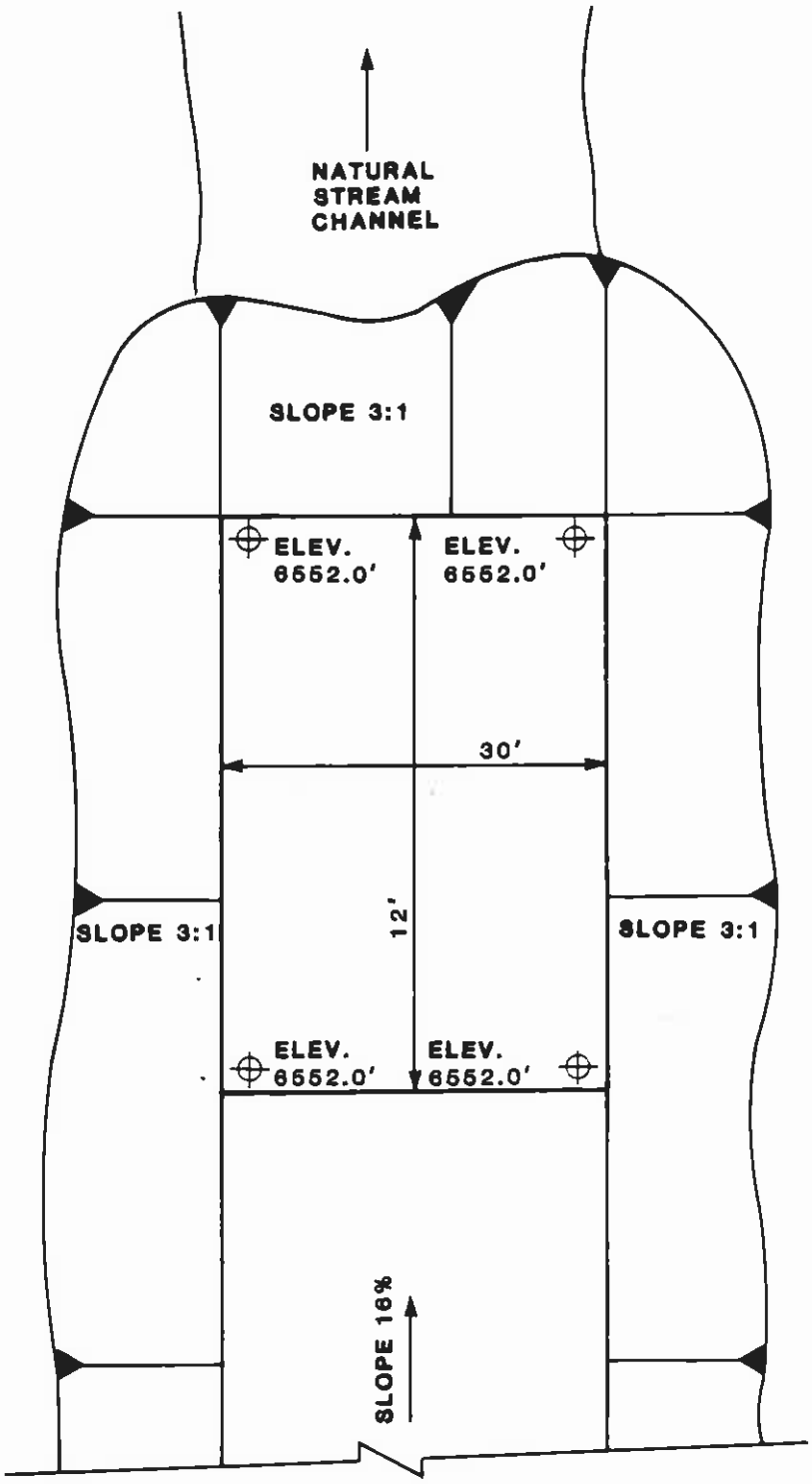
FLOWLINE ELEV. = 6576.70'

OUTFLOW CHANNEL

D = 2.0'

SPILLWAY AND OUTFLOW CHANNEL CROSS SECTION N6-C

BY **Dames & Moore** Plate 5



MINIMUM HEIGHT OF RIPRAP ALONG SIDEWALLS ABOVE THE BASIN FLOOR = 3.4'

MINIMUM DEPTH OF BASIN FLOOR BELOW NATURAL STREAMBED = 1.8'

SPILLWAY STILLING BASIN PLAN N6-C

BY Dames & Moore Plate 6

APPENDIX A

INSPECTION CHECK LIST

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			12' w.
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE			23°
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			18°
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		beyond toe, thru Rock lush vegetation
l. Animal burrows?		X	
4. ABUTMENT CONTACT. RIGHT			
a. Any erosion?	X		Into spillway Rills + 1 gulley sm.
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			gray SM
5. ABUTMENT CONTACT. LEFT			
a. Any erosion?	X		1 gulley into pond u.s. of dam
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?			
Right abutment?	X		
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		35'W 0% Slope 2.9' below Crest 30'L
Are side slopes eroding?	X		Rills from RA
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?		X	
d. Outflow Channel:	X		35'W. 30 From 3 to 8%
Are side slopes eroding?	X		Gulley from RA
Are side slopes sloughing?		X	
Bottom of channel eroding?	X		Rills
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

A small berm (7.5' High) is located u.s of N6-C

Evidence of past seepage thru Rock evident beyond toe of dam

Canopy 35 %
Ground 55 %

APPENDIX B

HYDROLOGY AND HYDRAULIC CALCULATIONS

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

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 6737 - 6579 = 158 ft.

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

$$T_c = \left(\frac{11.9\ (0.432)^3}{158}\right)^{0.385} = 0.140 \text{ hr.}$$

LAG TIME = $0.6\ T_c$ = 0.084 hr.

SCS CURVE NUMBER

DRAINAGE AREA (ac)	COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
58.5	P-J	average	D	83 (.61)
38.2	reclaimed (post law)	fair	—	81 (.39)
				82.2
				use 83

61% EH #33
39% EH #35

DRAINAGE BASIN AREA

96.7 ACRES 0.151 SQ. MILES

FILE PEABODY COAL CO [illegible]
SUBJECT SEDIMENT INFLOW
N6-C SHEET ___ OF ___

UNIVERSAL SOIL LOSS EQUATION

RAINFALL FACTOR

R = 40

SOIL ERODIBILITY FACTOR

SOIL TYPE = 61% EH #33 .61 (.22)
39% EH #35 .39 (.42)
.298

K = .298

SLOPE FACTOR

LENGTH (ft.)	Δ ELEV (ft.)	SLOPE (%)	LS
450	60	13.3	4.51 (.2)
700	110	15.7	7.30 (.2)
750	230	30.7	22.58 (.1)
600	70	11.7	4.23 (.5)
			= 6.74

COVER FACTOR

AREA (ac)	COVER TYPE	% COVER	CANOPY (%)	WEIGHTED C
61%	P-J	40	25	.61 (.14)
39%	reclaimed	—	—	.39 (.15)
				C = .144

EROSION CONTROL FACTOR

P = 1.0

SEDIMENT INFLOW

$A = 40(.298)(6.74)(.144)(1.0) = 11.57$ ton/acre/year

$A = (11.57)\left(\frac{1}{264.7}\right)(96.7)(.95) = .519$ acre-feet/year

Dames & Moore