INSPECTION REPORT

Sedimentation Structure

N1-F

Kayenta Mine

Navajo County, Arizona

for

PEABODY COAL COMPANY

Dames & Moore
10139-011-22

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INTRODUCTION

Sedimentation Structure N1-F 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-F is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure N1-F. 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-F was inspected on September 6, 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-F 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-F has a 105.7-acre tributary drainage area and is located near Coal Mine Wash at the Kayenta Mine. The watershed is classified as 58% reclaimed, 36% Pinion/Juniper, and 6% disturbed.

EMBANKMENT

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

Structure N1-F

Embankment	Residual Sandstone Soils
Foundation	Residual Sandstone Soils
Right Abutment	Residual Sandstone Soils
Left Abutment	Residual Sandstone Soils
Height	16.7 ft
Crest Width	24 ft
Upstream Slope	3.5 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 N1-F, A-A'.

ANALYSES

STABILITY

Structure N1-F is a category A-1 embankment. A standard category A-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 = 20 ft
2. Maximum upstream slope = 2.0 H : 1 V
3. Maximum downstream slope = 4.0 H : 1 V
4. Normal pool with steady seepage saturation conditions

The N1-F 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 N1-F 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-F was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1.	Water Course length, L	0.364	mi
2.	Elevation Difference, H	100	ft
3.	Time of Concentration, T_c	0.137	h
4.	Lag time, $0.6T_c$	0.082	h
5.	SCS Curve Number	84	
6.	Rainfall Depth, 10-year, 24-hour storm	2.1	in.
	25-year, 6-hour storm	1.9	in.
7.	Drainage Area	105.7	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	136	171
Volume	acre-ft	7.05	5.64
Storage			
Peak Stage	ft	6492.54	—
Spillway Elevation . .	ft	6494.20	--
Peak Storage	acre-ft	7.05	—
Storage Capacity . . .	acre-ft	8.58	--
Outflow			
Peak Flow	cfs	0	81
Embankment Crest Elevation	ft	--	6496.20
Peak Stage	ft	—	6496.25
Freeboard	ft	--	Overtop

Spillway Channel

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

Channel depth	2 ft
Channel width	15 ft
Channel length	35 ft
Side slopes (horizontal to vertical)	2:1
Average exit slope	2 percent

There is presently no erosion protection within the channel.

Outflow Channel

The existing outflow channel for N1-F has a U-shaped channel with the following dimensions:

	Sec. I	Sec. II	
Channel width	15	6	ft
Channel length	35	100	ft
Side slopes (horizontal to vertical)	2:1	2:1	
Average exit slope	6	20	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-F.

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

1. Rainfall Factor, R 40
2. Soil Erodibility Factor, K 0.36
3. Slope Factor, LS 4.68
4. Cover Factor, C 0.200
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-F and the results of the sediment inflow analysis are summarized in the following table.

N1-F STORAGE

Total Storage Capacity	8.58	acre-ft
10-year, 24-hour Storm Inflow	7.04	acre-ft
Available Sediment Storage Capacity . .	1.53	acre-ft
Sediment Inflow Rate	0.627	acre-ft/yr
Sediment Storage Life	2	yrs

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure N1-F indicated that the only geotechnical problem is rill and gully erosion on the upstream slope 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 4.0 horizontal to 1 vertical to meet stability requirements.

HYDRAULICS

The storage capacity of Structure N1-F is adequate but the spillway capacity is inadequate. The structure does not have an adequate outflow channel. The embankment crest should be raised to elevation 6497.30 feet. The existing outflow channel should be extended and improved 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.

Raising the embankment crest increases the freeboard. The analysis of these conditions is summarized in the following table.

N1-F HYDRAULICS FOR RAISED EMBANKMENT

	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	136	171	
Volume	acre-ft	7.05	5.64	
Storage				
Peak Stage	ft	6492.54	6496.25	
Spillway Elevation	ft	6494.20	—	
Peak Storage	acre-ft	7.05	—	
Storage Capacity	acre-ft	8.58	--	
Available Sediment Storage Capacity	acre-ft	1.53	--	
Sediment Inflow Rate	acre-ft/yr	0.627	--	
Sediment Storage Life.	yrs	2	--	
Outflow				
Peak Flow	cfs	0	81	
Embankment Crest Elevation	ft	--	6497.30	
Peak Stage	ft	--	6496.25	
Freeboard	ft	—	1.05	
Spillway Channel				
Flow Depth	ft	--	2.05	
Critical Velocity.	fps	--	5.0	
Manning's "n"		—	0.040	
Outflow Channel			Section I	Section II
Slope	%	--	6	15
Normal Velocity.	fps	--	6.7	8.9
Normal Depth	ft	—	0.71	0.54
Manning's "n"		--	0.040	0.040

* * *

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

Plate 1 - Site Plan N1-F

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

Plate 3 - Volume-Elevation Curve N1-F

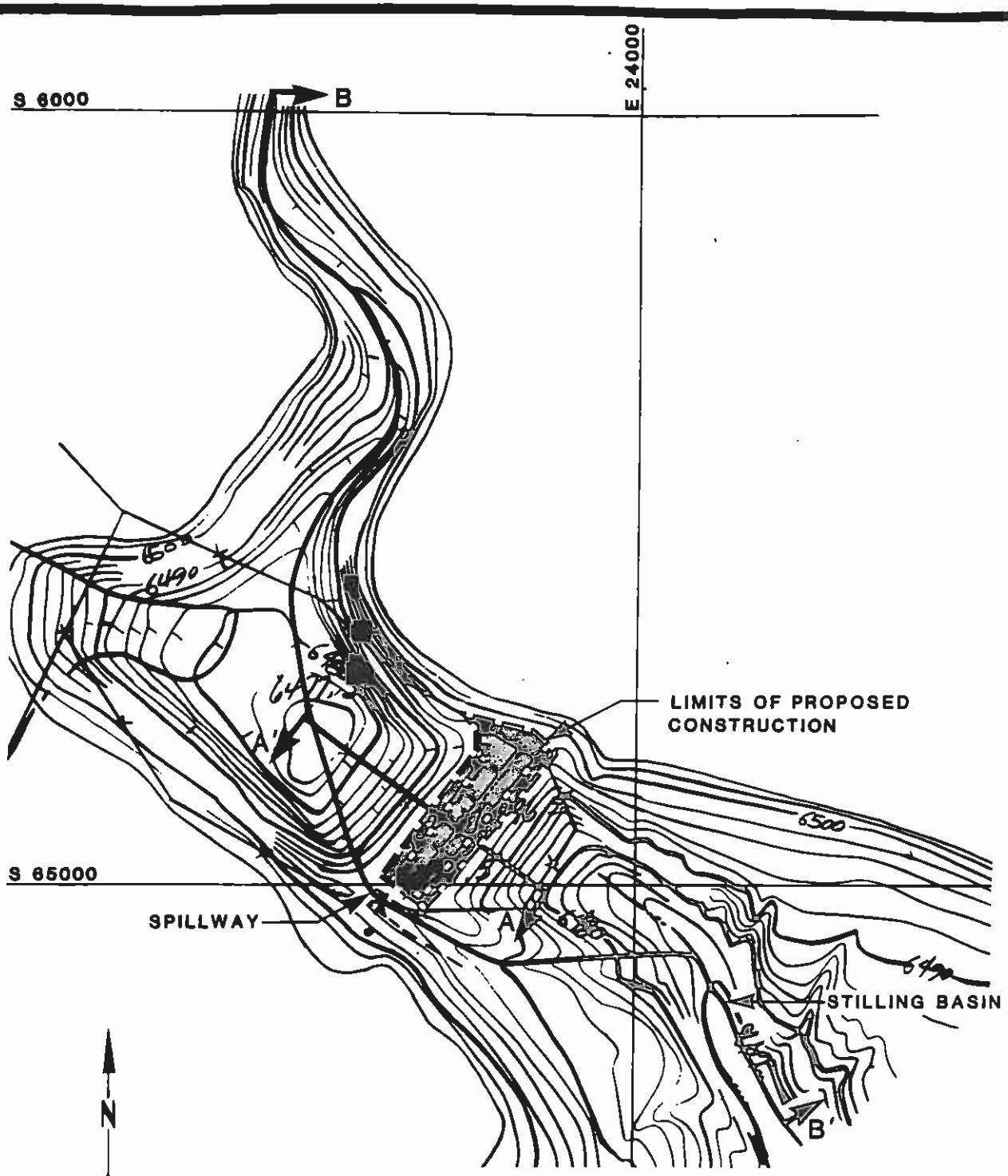
Plate 4 - Channel Profile N1-F, B-B'

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

Plate 6 - Spillway Stilling Basin Plan N1-F

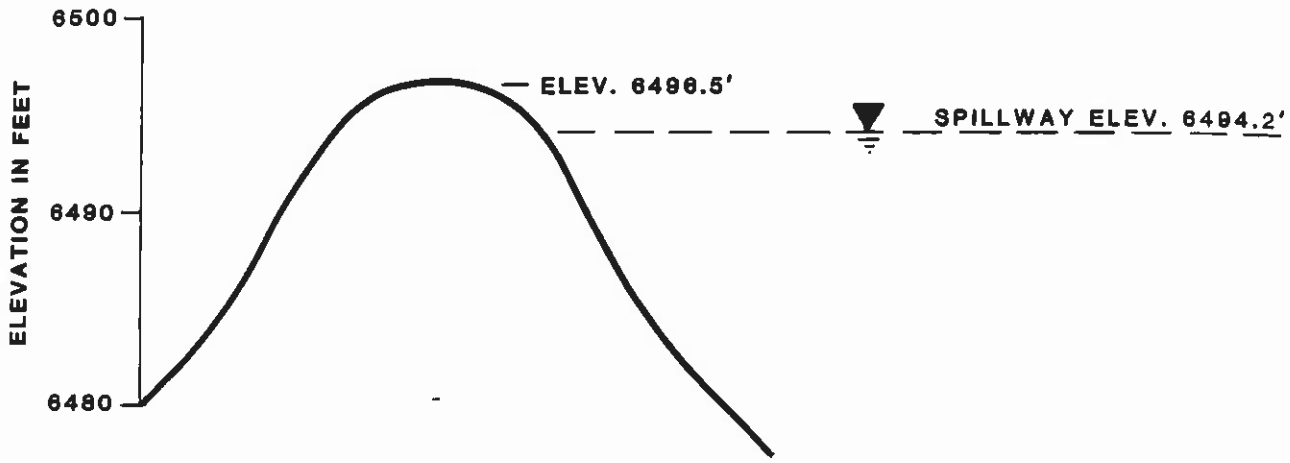
Appendix A - Inspection Check List

Appendix B - Hydrology and Hydraulic Calculations



SITE PLAN
N1-F

BY **Dames & Moore** Plate 1



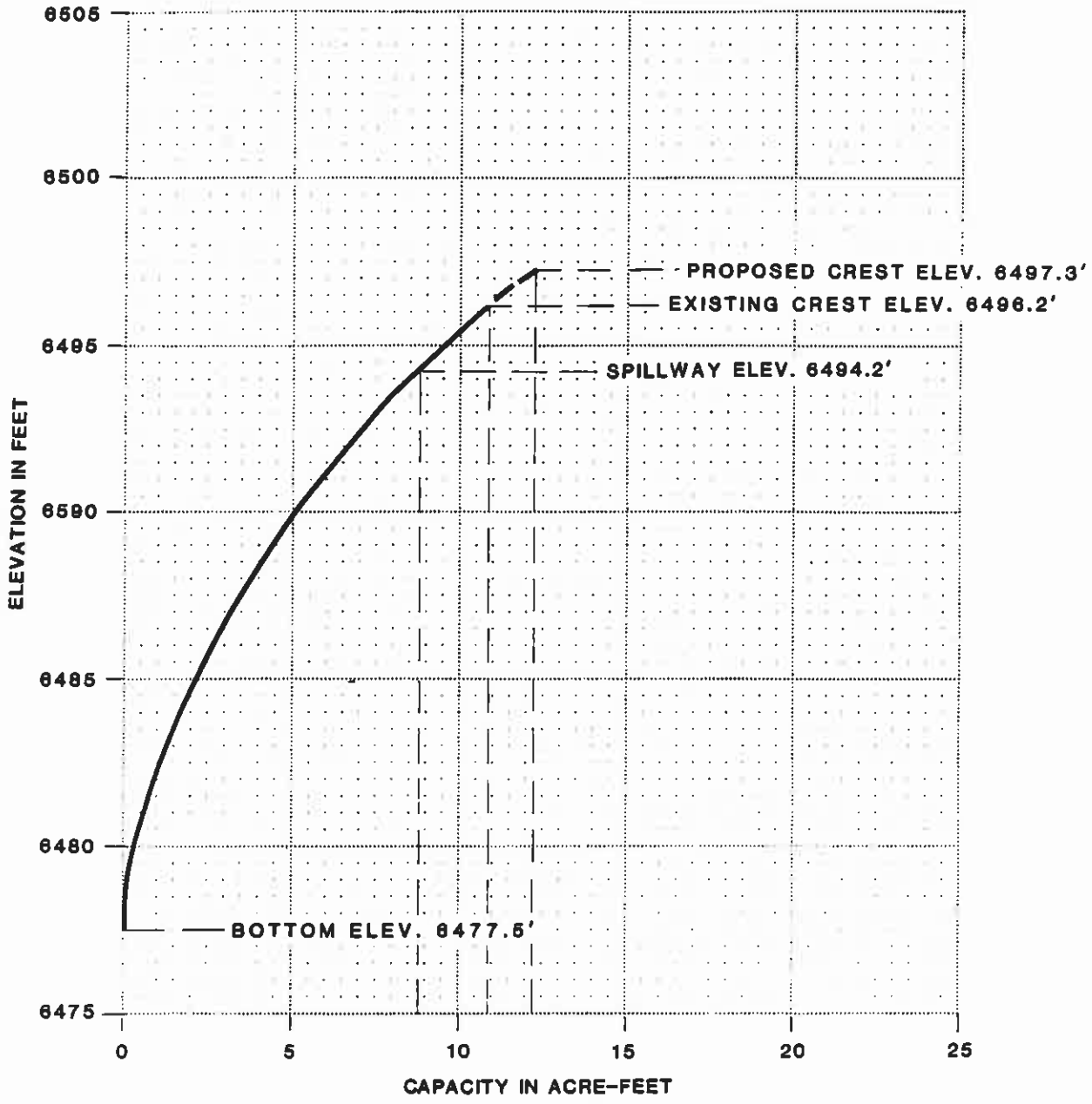
SCALE
0 50 100
FEET

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

FOR LOCATION SEE PLATE 1

BY **Dames & Moore**

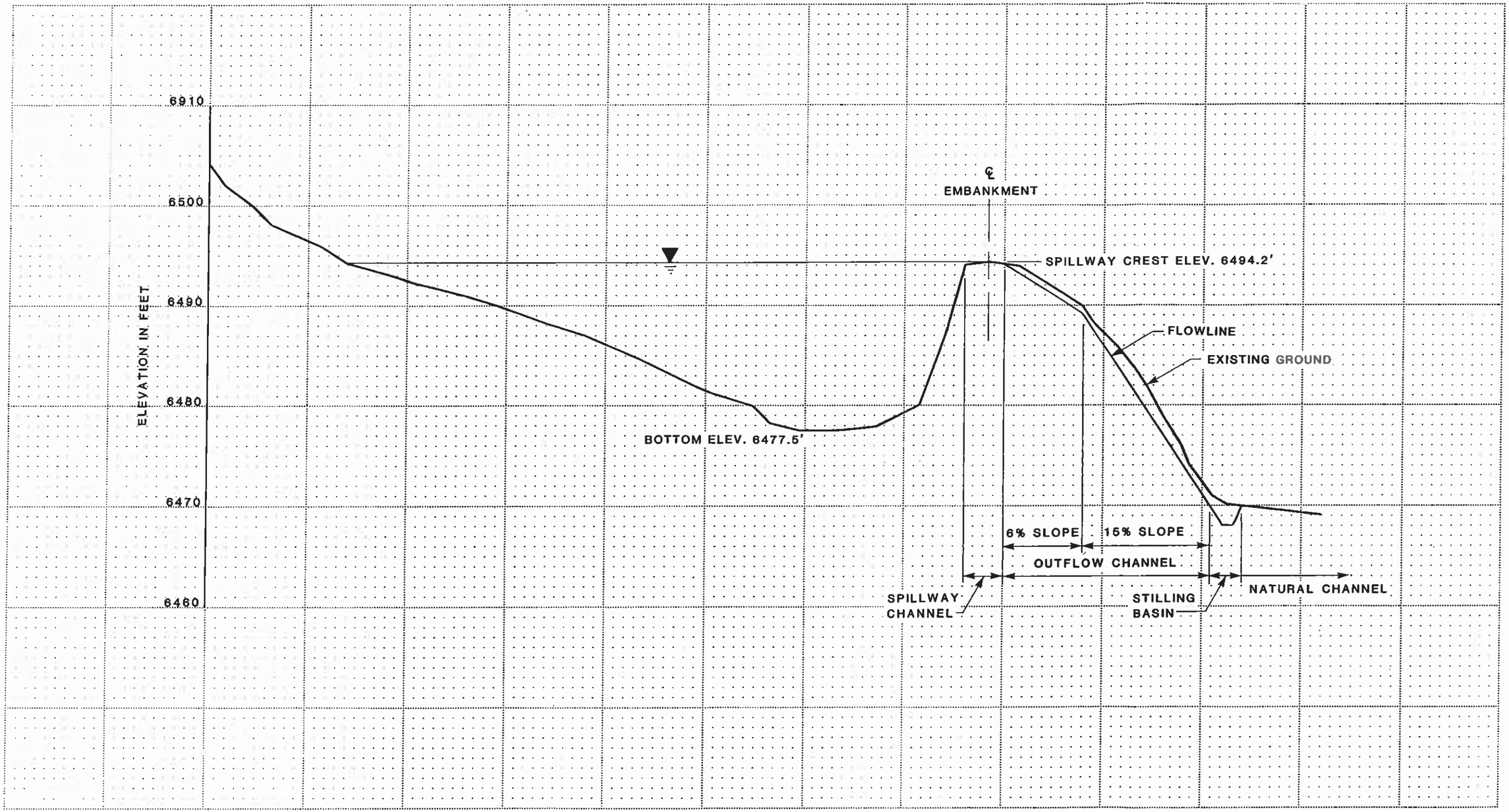
Plate 2



EXISTING VOLUME
PROPOSED VOLUME

VOLUME-ELEVATION CURVE
N1-F

BY **Dames & Moore** Plate 3

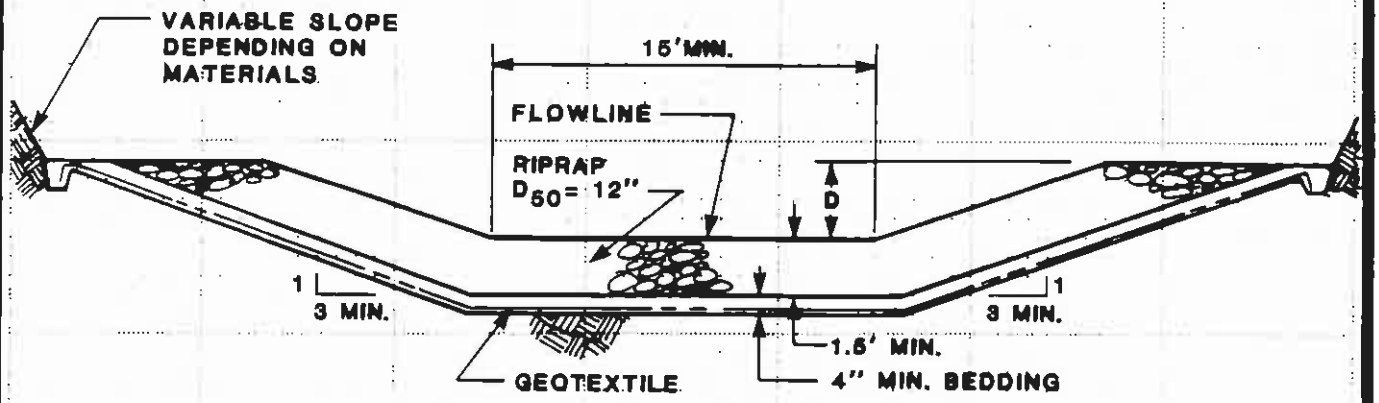


SCALE
0 100 200
FEET

CHANNEL PROFILE B-B'
N1-F

FOR LOCATION SEE PLATE 1

BY **Dames & Moore** Plate 4



SPILLWAY CHANNEL

D = 3.1'

LENGTH = 40'

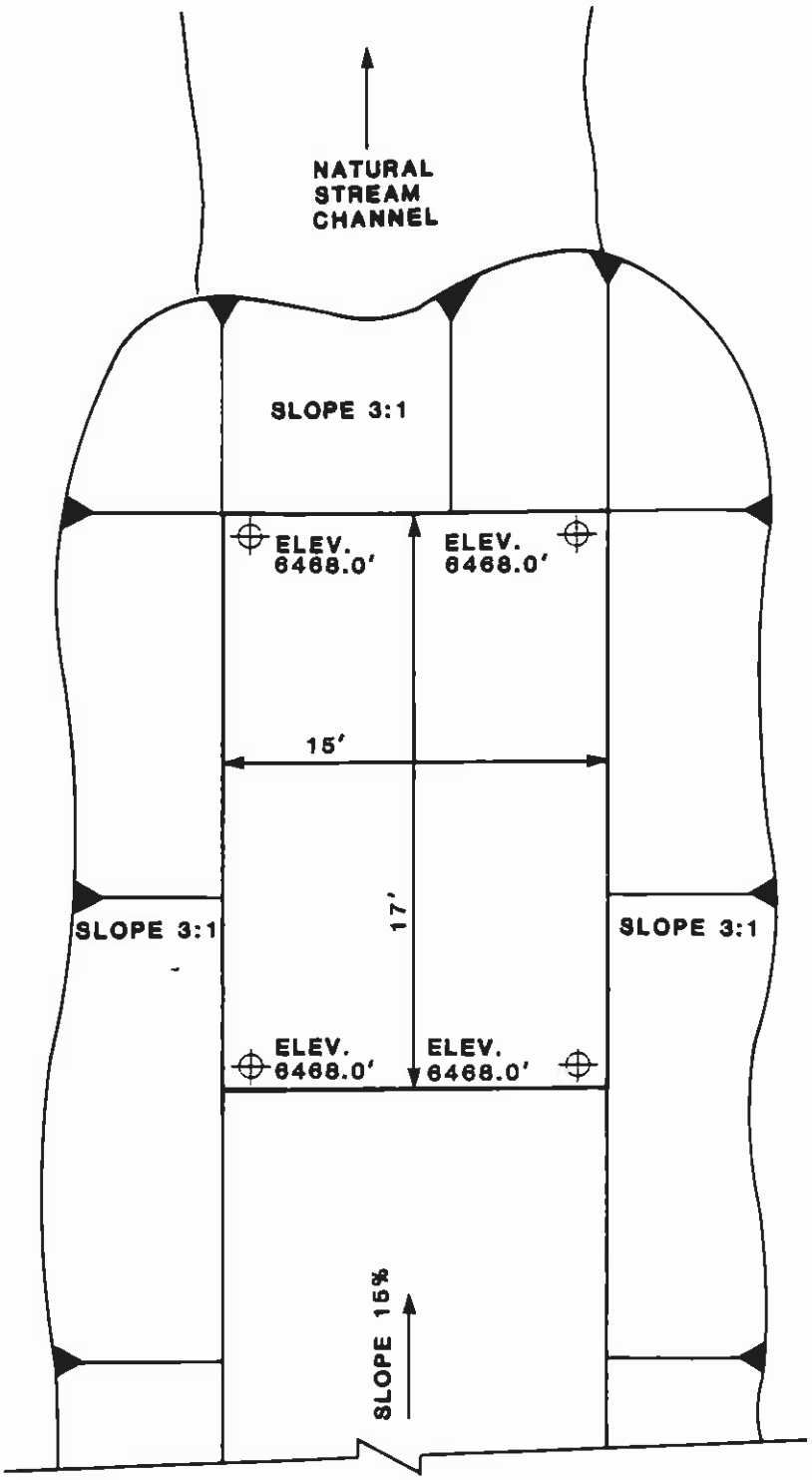
FLOWLINE ELEV. = 6494.2'

OUTFLOW CHANNEL

D = 2.0'

SPILLWAY AND OUTFLOW CHANNEL CROSS SECTION N1-F

BY **Dames & Moore** Plate 5



MINIMUM HEIGHT OF RIPRAP ALONG SIDEWALLS ABOVE THE BASIN FLOOR = 4.9'

MINIMUM DEPTH OF BASIN FLOOR BELOW NATURAL STREAMBED = 2.2'

SPILLWAY STILLING BASIN PLAN N1-F

BY **Dames & Moore** Plate 6

APPENDIX A

INSPECTION CHECK LIST

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			24' W
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE			16°
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° Note There is a lot of sediment at downstream toe
a. Adequate grass cover?		X	
b. Any erosion?		X	
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		gulley into pond
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			brown SM
5. ABUTMENT CONTACT. LEFT			
a. Any erosion?	X		gulley into pond at contact
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			Rock & 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?			
Are side slopes sloughing?			
Bottom of channel eroding?			NA
Obstructed?			
Erosion protection?			
c. Spillway Channel:	X		15'W/35'L 7 2%
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?		X	1st: 55'L 15'W 6% / 2nd: 100'L 6' 10%
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			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

Lot of sediment in channel d.s. of toe. Towards coal mine waste.

Canopy Cover 10 %
Ground Cover 80 %

APPENDIX B

HYDROLOGY AND HYDRAULIC CALCULATIONS

FILE PEABODY COAL CO. 10139-C11-22
SUBJECT SEDIMENT POND HYDROLOGY
N1-F SHEET ___ OF ___

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

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 6594 − 6494 = 100 ft.

WATER COURSE LENGTH = 4.8(400) = 1920 ft. = 0.364 mi.

$$T_c = \left(\frac{11.9\ (0.364)^3}{100}\right)^{0.385} = 0.137 \text{ hr.}$$

LAG TIME = $0.6 T_c$ = 0.082 hr.

Note: USED MAX. T_c ON BACK

SCS CURVE NUMBER

DRAINAGE AREA (ac)		COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
37.6	(36%)	P-J	average	C	0.36(78) = 28.1
44.4	(42%)	RECLAIM (pre law)	—	—	0.42(87) = 36.5
6.7	(6%)	Haul Road	—	C	0.06 (89) = 5.3
					83.9

P-J EH #21
reclaimed EH #35

USE 84

DRAINAGE BASIN AREA

105.7 ACRE 0.165 SQ MILE

BY S. DOLAN DATE 9-10-85
CHECKED BY ___
COPY TO EO ___

FILE _____

SUBJECT SEDIMENT INFLOW

N1-F SHEET ___ OF ___

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

UNIVERSAL SOIL LOSS EQUATION

RAINFALL FACTOR

R = 40

SOIL ERODIBILITY FACTOR

SOIL TYPE = 42% EH #24 .42 (.27)
58% EH #35 .58 (.42)
.36

K = .36

SLOPE FACTOR

LENGTH (ft.)	Δ ELEV (ft.)	SLOPE (%)	LS
300 A	40	14	3.98 (30%)
200 A	80	40	17.90 (10%)
1700	80	5	2.21 (30%)
1700	110	7	3.43 (30%)

use 4.68

COVER FACTOR

AREA (ac)	COVER TYPE	% COVER	CANOPY (%)	WEIGHTED C
58%	reclaimed	—	—	.58 (.15)
36%	P-J	40	25	.36 (.14)
6%	disturbed	—	—	.06 (1.0)
				C = .200

EROSION CONTROL FACTOR

P = 1.0

SEDIMENT INFLOW

$A = 40(.36)(4.68)(.200)(1.0) = 13.48$ ton/acre/year

$A = 13.48\left(\frac{1}{2047}\right)(105.7)(.9) = .627$ acre-feet/year

BY ___ DATE ___ CHECKED BY ___ COPY TO EO ___

Dames & Moore