INSPECTION REPORT

Sedimentation Structure

N12-M

Kayenta Mine

Navajo County, Arizona

for

PEABODY COAL COMPANY

Dames & Moore
10139-011-22

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INTRODUCTION

Sedimentation Structure N12-M is an earthen embankment, designed and constructed in 1981 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 N12-M is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure N12-M. 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 N12-M was inspected on September 9, 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 N12-M 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 N12-M has a 3.53-acre tributary drainage area and is located near Coal Mine Wash at the Kayenta Mine. The watershed is classified as 91% disturbed and 9% Pinion/Juniper.

EMBANKMENT

Structure N12-M is a homogeneous earthen embankment classified as a cross-valley embankment. Physical characteristics of the embankment are listed in the following table:

Structure N12-M

Embankment	Residual Sandstone Soils
Foundation	Residual Sandstone Soils
Right Abutment	Residual Sandstone Soils
Left Abutment	Residual Sandstone Soils
Height	17.1 ft
Crest Width	15 ft
Upstream Slope	2.6 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 N12-M, A-A'.

ANALYSES

STABILITY

Structure N12-M 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 N12-M 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 N12-M 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 N12-M was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1.	Water Course length, L	0.045	mi
2.	Elevation Difference, H	17	ft
3.	Time of Concentration, T_c	0.025	h
4.	Lag time, $0.6T_c$	0.015	h
5.	SCS Curve Number	94	
6.	Rainfall Depth, 10-year, 24-hour storm	2.1	in.
	25-year, 6-hour storm	1.9	in.
7.	Drainage Area	3.53	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	12	17
Volume	acre-ft	0.507	0.403
Storage			
Peak Stage	ft	6886.85	6899.05
Spillway Elevation . .	ft	6898.41	—
Peak Storage	acre-ft	0.507	—
Storage Capacity . . .	acre-ft	6.33	—
Outflow			
Peak Flow	cfs	0	—
Embankment Crest Elevation	ft	—	6899.01
Peak Stage	ft	—	6899.05
Freeboard	ft	—	Overtop
Mannings "n"		—	0.040

Spillway Channel

The existing spillway for N12-M has a trapezoidal channel with the following dimensions:

Channel depth	3.5	ft
Channel width	14	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 structure presently has no outflow 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, N12-M.

The calculations for the sediment load entering Structure N12-M were made utilizing the Universal Soil Loss Equation with the following parameters:

1. Rainfall Factor, R 40
2. Soil Erodibility Factor, K 0.22
3. Slope Factor, LS 2.60
4. Cover Factor, C 0.923
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 N12-M and the results of the sediment inflow analysis are summarized in the following table.

N12-M STORAGE

Total Storage Capacity	6.33	acre-ft
10-year, 24-hour Storm Inflow	0.507	acre-ft
Available Sediment Storage Capacity . .	5.82	acre-ft
Sediment Inflow Rate	0.035	acre-ft/yr
Sediment Storage Life	166	yrs

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure N12-M indicated that the geotechnical problems consist of rill and gully erosion on the upstream and downstream slopes, the side slopes of the spillway channel; and an uneven embankment crest. Correction of erosion is considered a periodic maintenance task and does not require remedial action. The crest of the embankment should be

trimmed smooth and level to prevent masking of potential future problems. The downstream slope should be flattened to 4.0 horizontal to 1 vertical to meet stability requirements.

HYDRAULICS

The storage capacity of Structure N12-M is adequate but the spillway capacity is inadequate. The structure does not have an outflow channel. The bottom elevation of the existing spillway channel should be lowered to elevation 6897.00 feet while maintaining the bottom width of 15 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 gravel as shown in Plate 5.

Lowering the spillway elevation to 6897.00 feet decreases the storage capacity and increases the freeboard. The analysis of these conditions is summarized in the following table.

N12-M 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		17	
Volume	acre-ft		0.403	
Storage				
Peak Stage	ft	6886.85	6897.42	
Spillway Elevation . .	ft	6897.00	--	
Peak Storage	acre-ft	0.507	--	
Storage Capacity . . .	acre-ft	5.43	--	
Available Sediment Storage Capacity . .	acre-ft	4.92	--	
Sediment Inflow Rate .	acre-ft/yr	0.035	--	
Sediment Storage Life.	yrs	140	--	
Outflow				
Peak Flow	cfs	0	2	
Embankment Crest Elevation	ft	--	6899.01	
Peak Stage	ft	--	6897.42	
Freeboard	ft	--	1.59	
Spillway Channel				
Flow Depth	ft	--	0.42	
Critical Velocity. . .	fps	--	1.6	
Manning's "n"		--	0.035	
Outflow Channel			Section I	Section II
Slope	%	--	2	22
Normal Velocity. . . .	fps	--	1.3	2.7
Normal Depth	ft	--	0.10	0.05
Manning's "n"		--	0.035	0.035

* * *

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

Plate 1 - Site Plan N12-M

Plate 2 - Existing Maximum Cross Section N12-M, A-A'

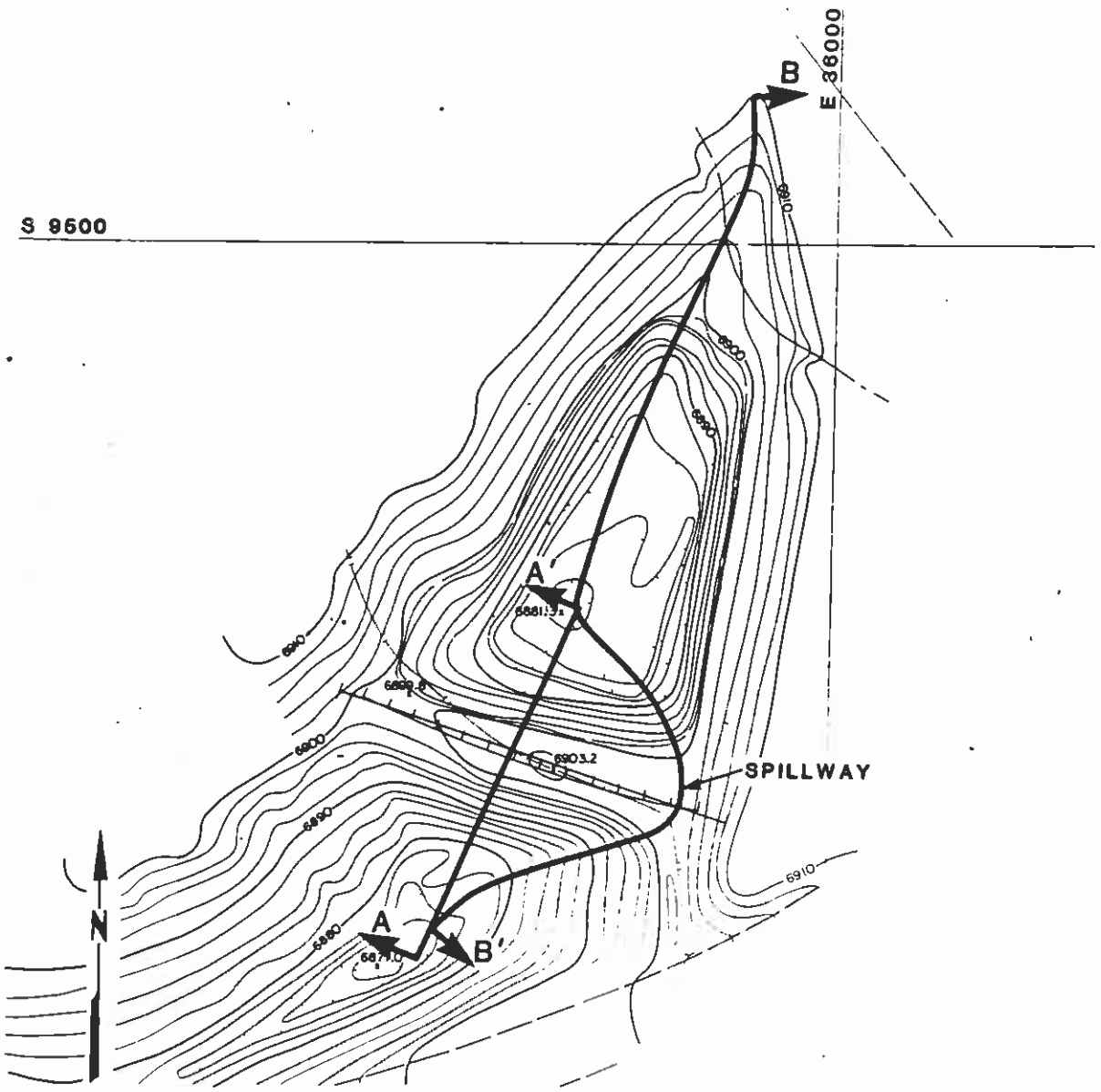
Plate 3 - Volume-Elevation Curve N12-M

Plate 4 - Channel Profile N12-M, B-B'

Plate 5 - Spillway and Outflow Channel Cross Section N12-M

Appendix A - Inspection Check List

Appendix B - Hydrology and Hydraulic Calculations



SCALE
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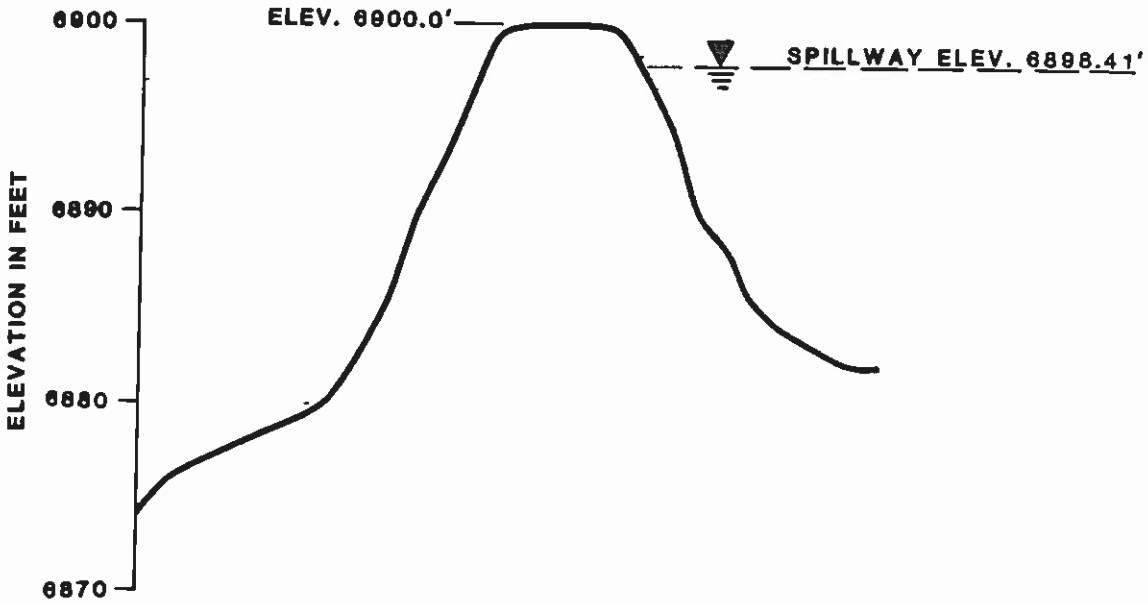
FEET

SITE PLAN
N12-M

BY **Dames & Moore** Plate 1



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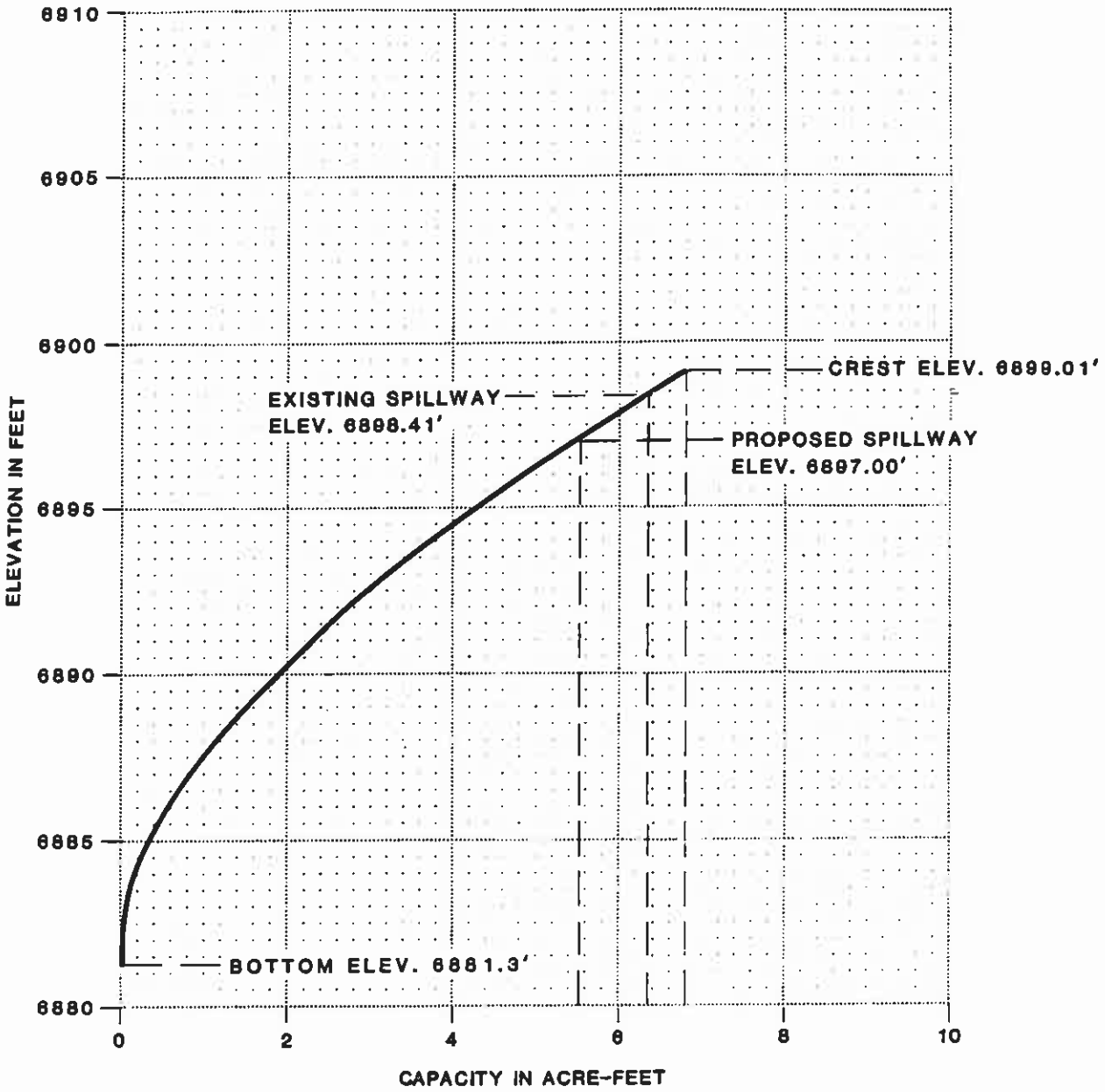
EXISTING MAXIMUM CROSS-SECTION A-A' N12-M

FOR LOCATION SEE PLATE 1

BY **Dames & Moore**

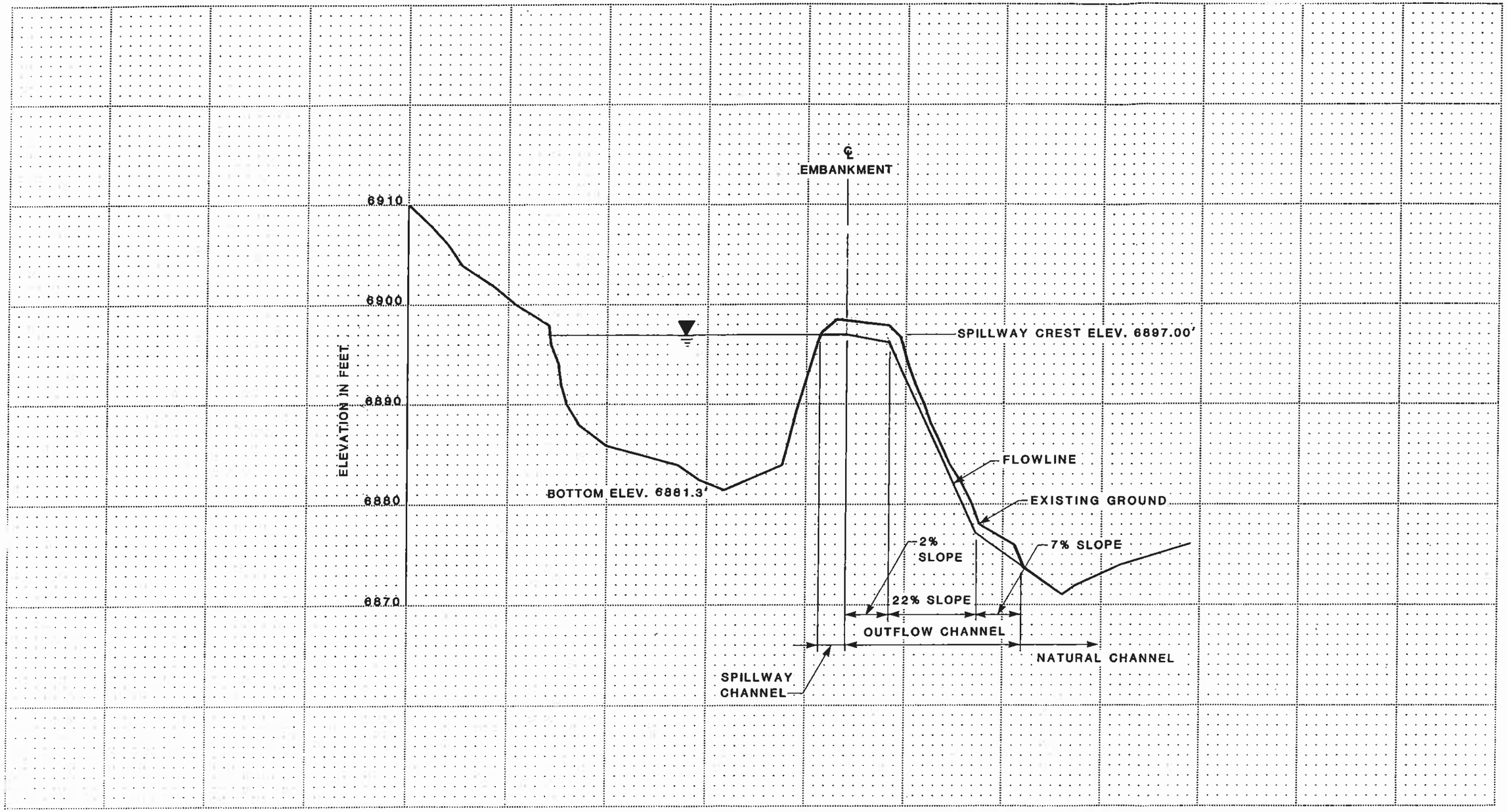
Plate 2



VOLUME-ELEVATION CURVE

N12-M

BY **Dames & Moore** Plate 3



SCALE
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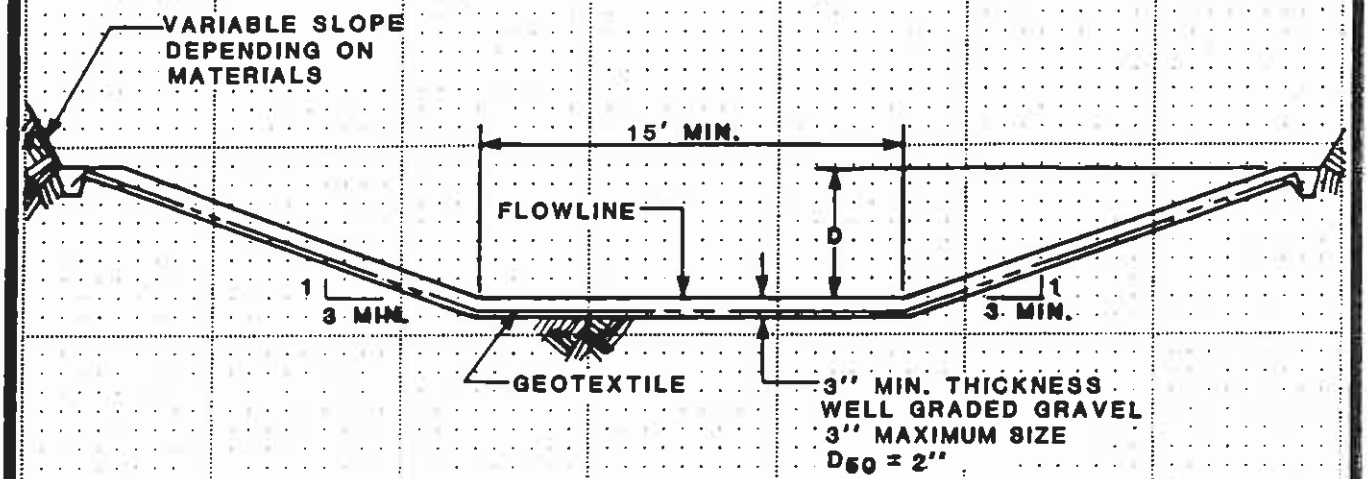
FEET

CHANNEL PROFILE B-B'
N12-M

FOR LOCATION SEE PLATE 1

BY **Dames & Moore** Plate 4



SPILLWAY CHANNEL

D = 1.5'

LENGTH = 30'

FLOWLINE ELEV.= 6897.00'

OUTFLOW CHANNEL

D = 1'

SPILLWAY AND OUTFLOW CHANNEL CROSS SECTION N12-M

BY **Dames & Moore** Plate 5

APPENDIX A

INSPECTION CHECK LIST

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			bumpy - not trimmed 15' w
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE			21°
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			22°
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	
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	
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			brow SM

Sediment Impoundment Name: N12-M
Page: 5

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?			Erosion gully in this area.
Obstructed?			
Erosion protection?			
c. Spillway Channel:			14' W 30' L 0% slope 3.5' below crest
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?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
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

CANOPY COVER 10%
GROUND COVER 35%

APPENDIX B

HYDROLOGY AND HYDRAULIC CALCULATIONS

FILE PEABODY COAL CO J.59-011-2
SUBJECT SEDIMENT POND HYDROLOGY
N12-M SHEET ___ OF

REVISIONS
BY ____ DATE ____ TO EO ____
BY ____ DATE ____ TO EO ____

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 6915 − 6898 = 17 ft.

WATER COURSE LENGTH = 0.6(400) = 240 ft. = 0.045 mi.

$$T_c = \left(\frac{11.9\,(0.045)^3}{17}\right)^{0.385} = 0.025 \text{ hr.}$$

LAG TIME = $0.6\,T_c$ = 0.015 hr.

SCS CURVE NUMBER

DRAINAGE AREA (ac)	COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
.31	P-J	average	D	83 (.09)
3.22	disturbed		D	94 (.91)
				93.01

100% ≈ 25

use 94

DRAINAGE BASIN AREA

3.53 ACRE 0.006 SQ MILE

BY S. DOLAN DATE 9-23-85
CHECKED BY ____
COPY TO EO ____

FILE FEARLEY JAM CO 1039-011-22
SUBJECT SEDIMENT INFLOW
NIZ-M SHEET ___ OF ___

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

UNIVERSAL SOIL LOSS EQUATION

RAINFALL FACTOR

R = 47

SOIL ERODIBILITY FACTOR

SOIL TYPE = 100% EH #25 .22

K = .22

SLOPE FACTOR

LENGTH (ft.)	Δ ELEV (ft.)	SLOPE (%)	LS
150	20	13.3	2.6

use 2.6

COVER FACTOR

AREA (ac)	COVER TYPE	% COVER	CANOPY (%)	WEIGHTED C
91%	disturbed	—	—	.91 (1.0)
9%	P-J	40	25	.09 (.14)
				.923

EROSION CONTROL FACTOR

P = 1.0

SEDIMENT INFLOW

$A = 40(.22)(2.6)(.923)(1.0) = 21.12$ ton/acre/year

$A = 21.12\left(\frac{1}{2047}\right)(3.53)(.95) = 0.035$ acre-feet/year

BY ___ DATE ___
CHECKED BY ___
COPY TO EO ___

Dames & Moore