INSPECTION REPORT

Sedimentation Structure

KM-B

Kayenta Mine

Navajo County, Arizona

for

PEABODY COAL COMPANY

Dames & Moore
10139-011-22

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INTRODUCTION

Sedimentation Structure KM-B is an earthen embankment, designed and constructed in 1983 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 KM-B is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure KM-B. 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 KM-B 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 KM-B 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 KM-B has a 22.5-acre tributary drainage area and is located near the Yellow Water Canyon at the Kayenta Mine. The watershed is classified as 75% Pinion/Juniper and 25% disturbed.

EMBANKMENT

Structure KM-B is a homogeneous earthen embankment classified as a roadway embankment. Physical characteristics of the embankment are listed in the following table:

Structure KM-B

Embankment	Residual Shale Soils
Foundation	Alluvium
Right Abutment	Shale
Left Abutment	Shale
Height	12.4 ft
Crest Width	21 ft
Upstream Slope	1.9 H : 1 V
Downstream Slope	3.3 H : 1 V

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

ANALYSES

STABILITY

Structure KM-B is a category B-3 embankment. A standard category B-3 embankment has static and seismic factors of safety of 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 KM-B embankment is lower in height; however, the upstream 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 KM-B 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 KM-B was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1.	Water Course length, L	0.303	mi
2.	Elevation Difference, H	106	ft
3.	Time of Concentration, T_c	0.109	h
4.	Lag time, $0.6T_c$	0.065	h
5.	SCS Curve Number	85	
6.	Rainfall Depth, 10-year, 24-hour storm	2.1	in.
	25-year, 6-hour storm	1.9	in.
7.	Drainage Area	22.5	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	34	44	
Volume	acre-ft	1.66	1.35	
Storage				
Peak Stage	ft	6497.58	6505.42	
Spillway Elevation . .	ft	6504.10	—	
Peak Storage	acre-ft	1.66	—	
Storage Capacity . . .	acre-ft	4.40	--	
Outflow				
Peak Flow	cfs	0	7	
Embankment Crest Elevation	ft	—	6507.10	
Peak Stage	ft	--	6505.42	
Freeboard	ft	--	1.68	
Spillway				
Pipe Exit Velocity . .	fps	--	7.3	
Mannings "n"		--	0.024	
Outflow Channel			Section I	Section II
Slope	%	--	8	43
Normal Velocity. . . .	fps	—	2.9	4.8
Normal Depth	ft	--	0.15	0.09
Manning's "n"		—	0.040	0.040

Spillway

The existing spillway for KM-B is a 24-inch corrugated metal pipe (CMP).

Pipe length	42	ft
Pipe Invert Elevation Upstream	6504.10	ft
Pipe Invert Elevation Downstream	6502.00	ft
Pipe slope	5	percent

Outflow Channel

The existing outflow channel for KM-B has a U-shaped channel with the following dimensions:

Channel width	8 ft
Channel length	50 ft
Side slopes (horizontal to vertical)	2:1
Average exit slope	5 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, KM-B.

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

1. Rainfall Factor, R 40
2. Soil Erodibility Factor, K 0.16
3. Slope Factor, LS 19.42
4. Cover Factor, C 0.355
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 KM-B and the results of the sediment inflow analysis are summarized in the following table.

KM-B STORAGE

Total Storage Capacity	4.40	acre-ft
10-year, 24-hour Storm Inflow	1.66	acre-ft
Available Sediment Storage Capacity . .	2.74	acre-ft
Sediment Inflow Rate	0.46	acre-ft/yr
Sediment Storage Life	6	yrs

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure KM-B indicated that the only geotechnical problem is rill and gully erosion on the upstream and downstream slope and the right and left abutments. Correction of erosion is considered a periodic maintenance task and does not require remedial action.

The upstream slope should be flattened to 2.0 horizontal to 1 vertical to meet stability requirements.

HYDRAULICS

The storage capacity and spillway capacity of Structure KM-B are adequate; however, the spillway does not have an adequate outflow channel or adequate erosion protection. There is no suitable location for an improved outflow channel along the existing alignment. Therefore, a new pipe spillway and outflow channel should be constructed along the alignment B-B' shown in Plate 1. The existing spillway should be abandoned. The spillway and outflow channel profile is shown in Plate 4 and the required dimensions are shown in Plate 5. The outflow channel should be protected against erosion using geotextile and riprap as shown in Plate 5. A trashrack should be installed on the inlet of the CMP to prevent clogging of the spillway.

* * *

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

Plate 1 - Site Plan KM-B

Plate 2 - Existing Maximum Cross Section KM-B, A-A'

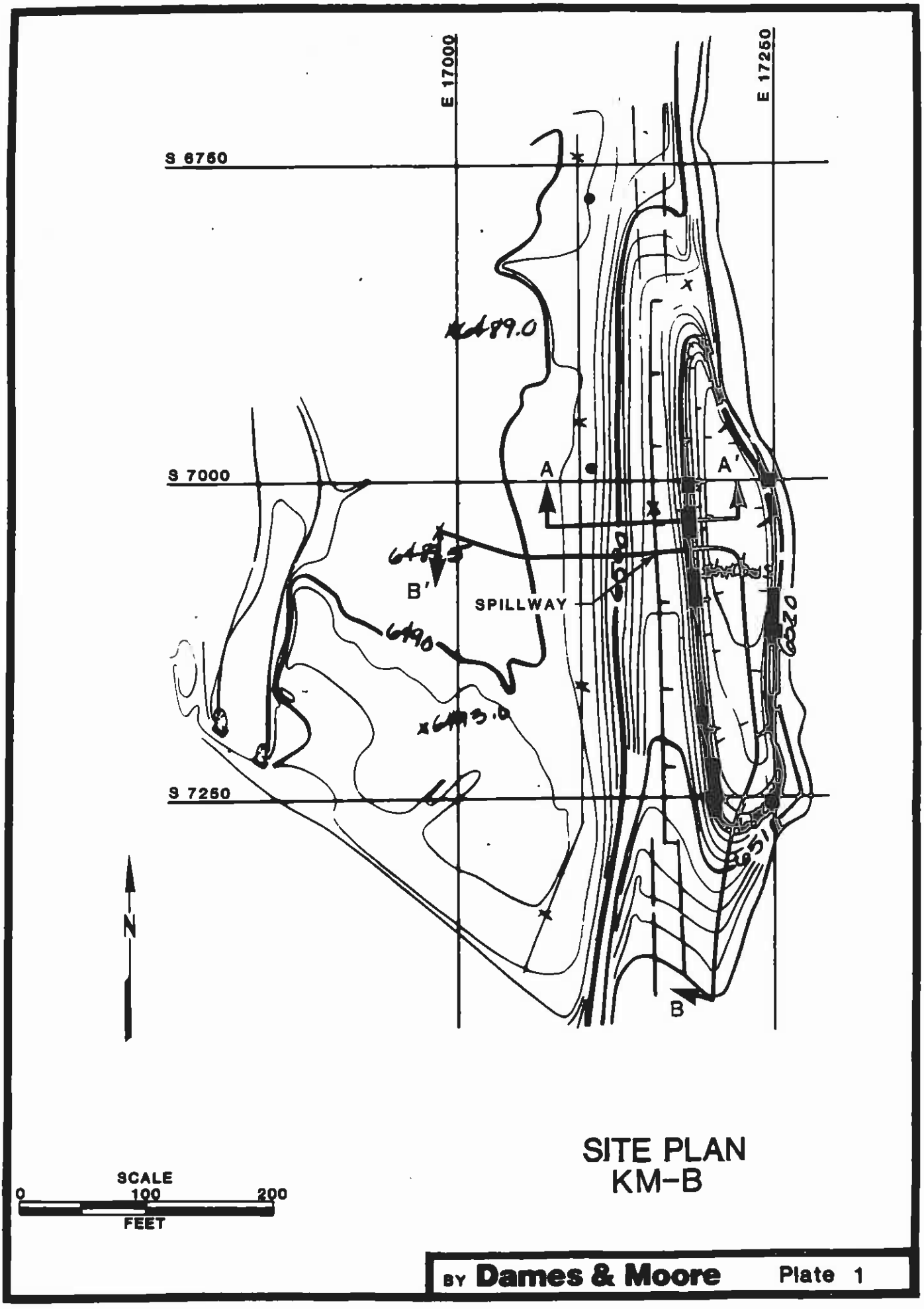
Plate 3 - Volume-Elevation Curve KM-B

Plate 4 - Channel Profile KM-B, B-B'

Plate 5 - Outflow Channel Cross Section KM-B

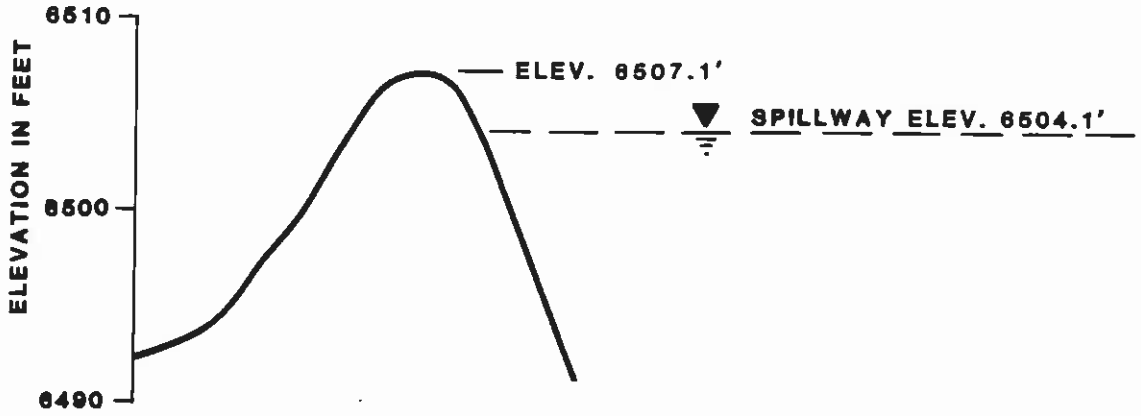
Appendix A - Inspection Check List

Appendix B - Hydrology and Hydraulic Calculations



SITE PLAN
KM-B

BY **Dames & Moore** Plate 1

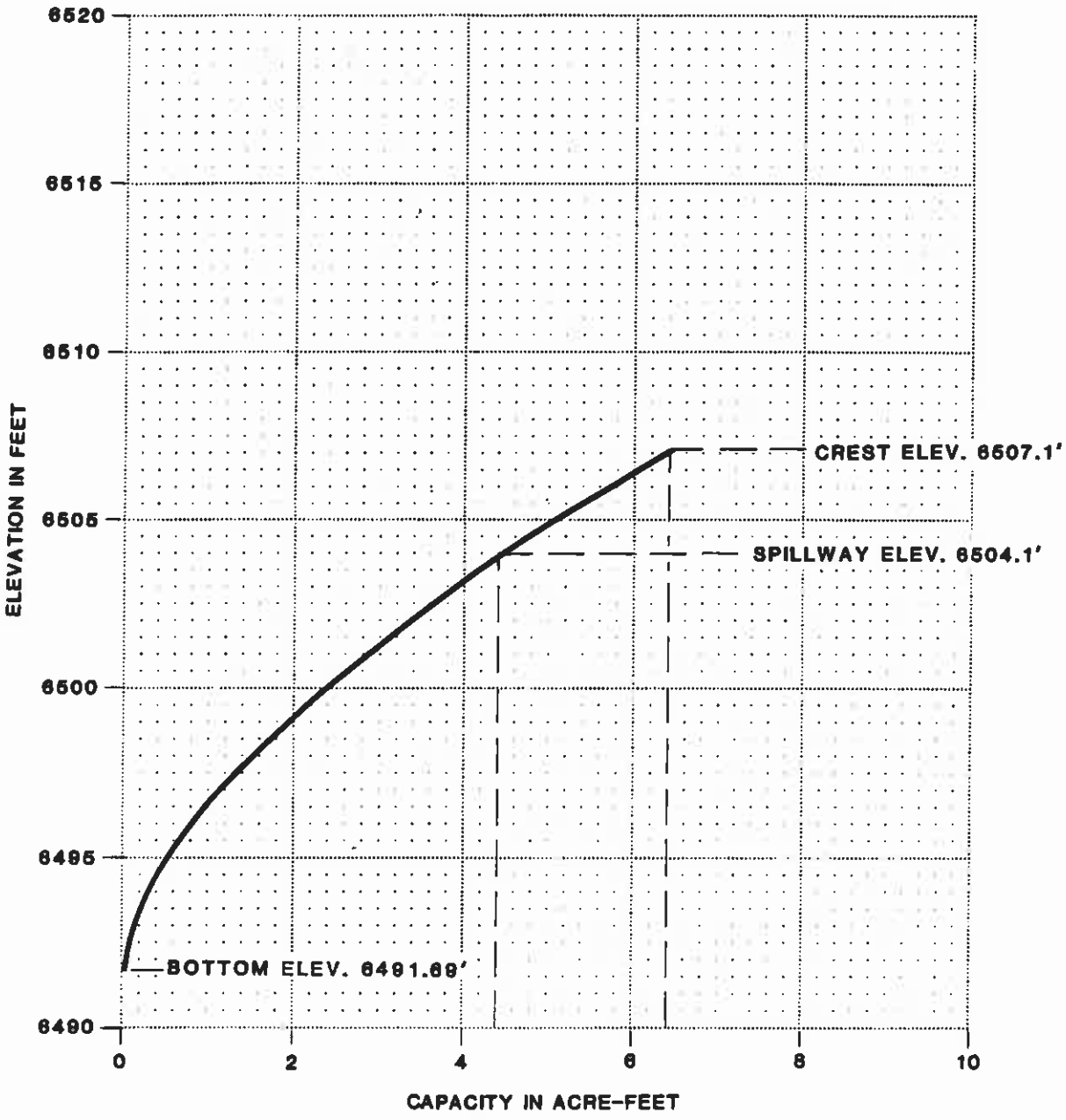


SCALE
0 50 100
FEET

MAXIMUM CROSS-SECTION
A-A'
KM-B

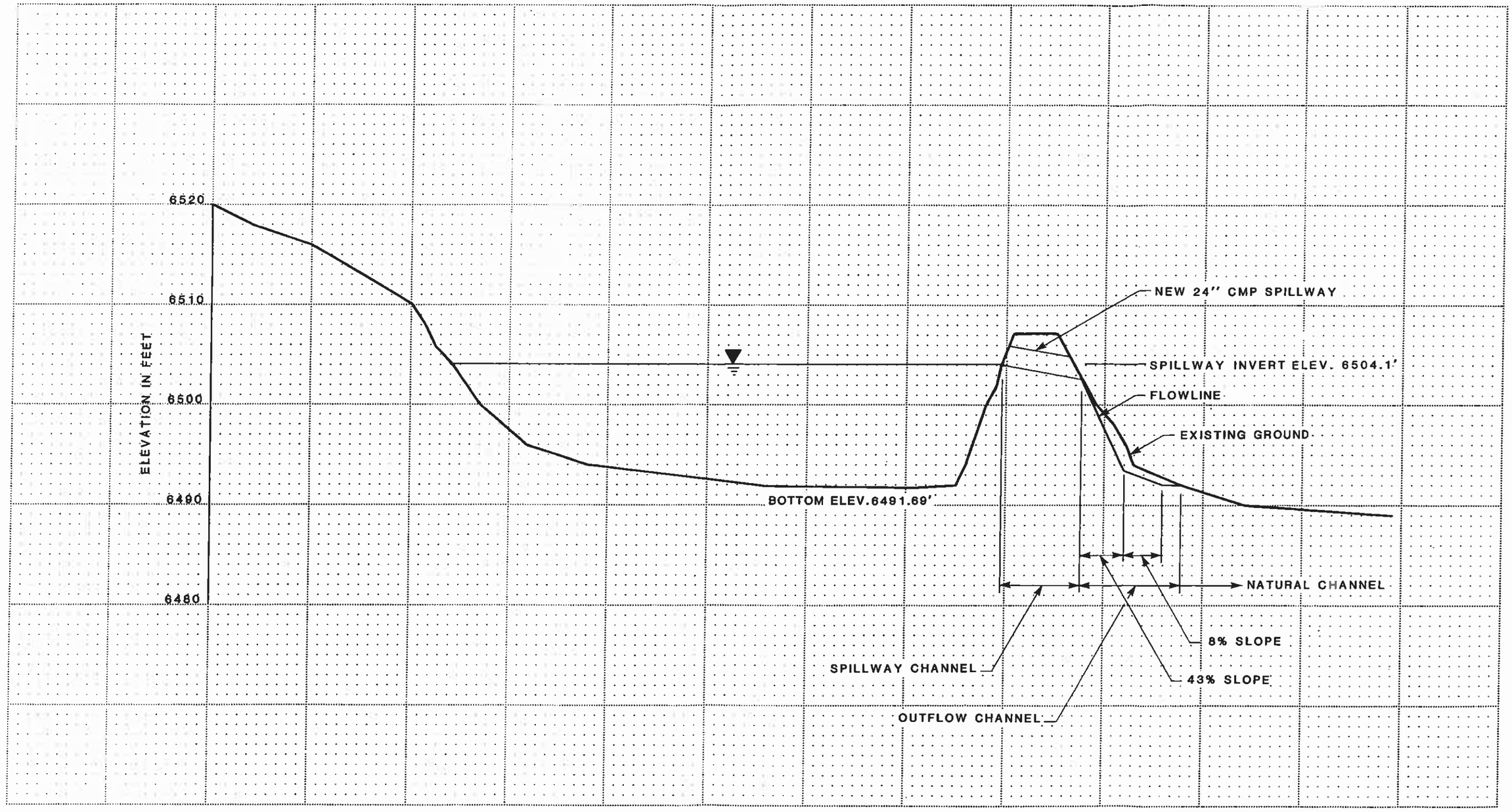
FOR LOCATION SEE PLATE 1

BY **Dames & Moore** Plate 2



VOLUME-ELEVATION CURVE
KM-B

BY **Dames & Moore** Plate 3

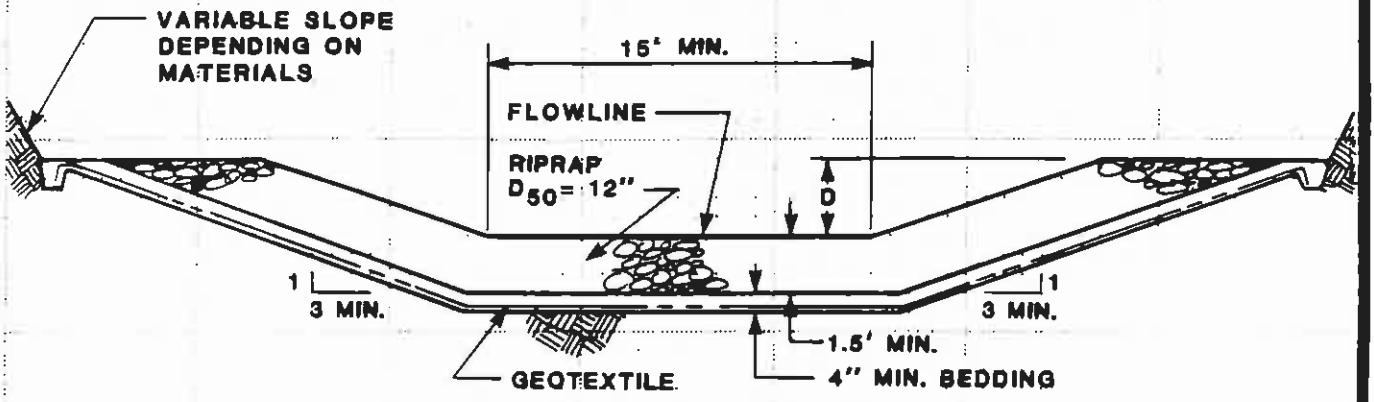


SCALE
0 50 100
FEET

CHANNEL PROFILE B-B'
KM-B

FOR LOCATION SEE PLATE 1

BY **Dames & Moore** Plate 4



OUTFLOW CHANNEL

D = 1'

OUTFLOW CHANNEL CROSS SECTION KM-B

BY **Dames & Moore** Plate 5

APPENDIX A

INSPECTION CHECK LIST

Sediment Impoundment Name: KM-B
Page: 4

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			21' WIDE
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE			28°
a. Adequate grass cover?	X		75%
b. Any erosion?	X		1 Gulley / 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			17°
a. Adequate grass cover?	X		50%
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		Some Sloughing of Steep ABUT. in POND
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			Rock / brown SM
5. ABUTMENT CONTACT. LEFT			
a. Any erosion?	X		Major Gulley into POND - U.S
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			Fill from Navajo 41 / Rock

ITEM	YES	NO	REMARKS
6. SPILLWAY/NORMAL			
a. Location:			
Left abutment?			
Right abutment?			
Crest of Embankments?	X		Near RA
b. Approach Channel:		X	
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			NA
Obstructed?			
Erosion protection?			
c. Spillway Channel:	X		24" CMP
Are side slopes eroding?			NA
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?	X		ENTRANCE RIPRAP
d. Outflow Channel:	X		8 WIDE 50 LONG
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?	X		GRASS 80% + ROCK
e. Weir:			
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
GROUND COVER

APPENDIX B

HYDROLOGY AND HYDRAULIC CALCULATIONS

FILE PEABODY COAL CO. 10139 011-22
SUBJECT SEDIMENT POND HYDROLOGY
KM-B SHEET ___ OF ___

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 6610 − 6504 = 106 ft.

WATER COURSE LENGTH = 4.0 (400) = 1600 ft. = 0.303 mi.

$$T_c = \left(\frac{11.9\,(0.303)^3}{106}\right)^{0.385} = 0.109 \text{ hr.}$$

LAG TIME = $0.6\,T_c$ = 0.065 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
5.7 (25%)	DISTURBED	—	D	0.25 (91) = 22.75
16.8 (75%)	P-J	ave.	D EH #24	0.75 (83) = 62.25
				85.0

USE 85

DRAINAGE BASIN AREA

22.5 ACRE 0.035 SQ MILE

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

FILE KEARNY GAL CO 1029-01-22
SUBJECT SEDIMENT INFLOW
EM-B SHEET ___ OF ___

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

BY ___ DATE ___ CHECKED BY ___ COPY TO EO ___

UNIVERSAL SOIL LOSS EQUATION

RAINFALL FACTOR

K = 47

SOIL ERODIBILITY FACTOR

SOIL TYPE = 100% EH # 24 1.0 (.16)

K = 0.16

SLOPE FACTOR

LENGTH (ft.)	Δ ELEV (ft.)	SLOPE (%)	LS
500	160	32	19.8 (.8)
200	80	40	17.9 (.2)

use 19.4

COVER FACTOR

AREA (ac)	COVER TYPE	% COVER	CANOPY (%)	WEIGHTED C
25% disturbed	—	—	—	.25 (1.0)
.75	P-J	40	25	.75 (.14)

C = 0.355

EROSION CONTROL FACTOR

P = 1.0

SEDIMENT INFLOW

$A = 40(.16)(19.4)(.355)(1.0) = 44.08$ ton/acre/year

$A = 44.08\left(\frac{1}{2047}\right)(22.5)(.95) = .46$ acre-feet/year

Dames & Moore