INSPECTION REPORT

Sedimentation Structure

WW-6

Black Mesa Mine

Navajo County, Arizona

for

PEABODY COAL COMPANY

Dames & Moore
10139-011-22

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INTRODUCTION

Sedimentation Structure WW-6 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 Black Mesa Mine. The location of Structure WW-6 is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure WW-6. 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 WW-6 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 WW-6 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 WW-6 has a 57.0-acre tributary drainage area and is located near Moenkopi Wash at the Black Mesa Mine. The watershed is classified as 64% reclaimed, 21% Sagebrush/grass, and 15% Pinion/Juniper.

EMBANKMENT

Structure WW-6 is 80% incised with a small homogeneous earthen embankment classified as a cross-valley embankment. Physical characteristics of the embankment are listed in the following table:

Structure WW-6

Embankment	Residual Shale Soils
Foundation	Residual Shale Soils
Right Abutment	Residual Shale Soils
Left Abutment	Residual Shale Soils
Height	5.5 ft
Crest Width	16 ft
Upstream Slope	2.4 H : 1 V
Downstream Slope	5.7 H : 1 V

A cross-section of the embankment is shown on Plate 2, Existing Maximum Cross Section WW-6, A-A'. Grass provides erosion protection on the downstream slope of the embankment.

ANALYSES

STABILITY

Structure WW-6 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 = 10 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 WW-6 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 WW-6 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 WW-6 was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

		Pond 1	Pond 2	
1.	Water Course length, L	0.208	0.313	mi
2.	Elevation Difference, H	80	90	ft
3.	Time of Concentration, T_c	0.078	0.120	h
4.	Lag time, $0.6T_c$	0.047	0.072	h
5.	SCS Curve Number	81	82	
6.	Rainfall Depth, 10-year, 24-hour storm	2.1	2.1	in.
	25-year, 6-hour storm	1.9	1.9	in.
7.	Drainage Area	27.2	29.8	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.

	Units	10-year 24-hour Storm		25-year 6-hour Storm	
Initial Reservoir Volume Condition		Empty		Full to the spillway elevation	
		Pond 2	Pond 1	Pond 2	Pond 1
Inflow					
Peak Flow	cfs	35	37	46	49
Volume	acre-ft	1.91	1.66*	1.51	1.34*
Storage					
Peak Stage	ft	6666.34	6620.19	6672.56	6656.57
Spillway Elevation	ft	6672.03	6655.52	--	--
Peak Storage	acre-ft	1.91	1.66	--	--
Incised Storage Capacity	acre-ft	0	12.50	—	--
Active Storage Capacity	acre-ft	7.83	17.40	--	--
Total Storage Capacity	acre-ft	7.83	29.90	--	--
Outflow					
Peak Flow	cfs	0	0	12	5
Embankment Crest Elevation	ft	--	—	6673.50	6659.76
Peak Stage	ft	--	--	6672.56	6656.57
Freeboard	ft	—	--	0.94	3.19
Spillway Pipe					
Headwater	ft	--	--	0.53	--
Exit Velocity	fps	--	--	7.6	--
Mannings "n"		--	--	0.024	--
Spillway Channel					
Flow Depth	ft	--	--	--	1.05
Critical Velocity	fps	--	--	--	2.1
Manning's "n"		--	--	--	0.035
Outflow Channel					Sec. I / Sec. II
Slope	%	--	--	--	6 / 17
Normal Velocity	fps	--	--	—	2.2 / 2.8
Normal Depth	ft	--	--	--	0.12 / 0.08
Manning's "n"		--	--	--	0.040 / 0.040

*Inflow volume for tributary drainage area between Pond 1 and Pond 2.

Spillway Channel

The existing spillway for WW-6 has a trapezoidal channel with the following dimensions:

Channel depth	5.8	ft
Channel width	20	ft
Channel length	45	ft
Side slopes (horizontal to vertical)	2:1	
Average exit slope	0	percent

There is presently no erosion protection within the channel.

Pond 1 and Pond 2 are connected by a corrugated metal pipe with the following dimensions.

Pipe diameter	24	in.
Pipe length	60	ft
Pipe slope	3.7	percent

Outflow Channel

The existing outflow channel for WW-6 has a trapezoidal channel with the following dimensions:

Channel width	20	ft
Channel length	150	ft
Side slopes (horizontal to vertical)	2:1	
Average exit slope	17	percent

Rock provides adequate 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 3A and 3B, Volume-Elevation Curve, WW-6.

The calculations for the sediment load entering Structure WW-6 were made utilizing the Universal Soil Loss Equation with the following parameters:

1. Rainfall Factor, R 40
2. Soil Erodibility Factor, K 0.348
3. Slope Factor, LS 6.31
4. Cover Factor, C 0.145
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 WW-6 and the results of the sediment inflow analysis are summarized in the following table.

WW-6 STORAGE

	Pond 1	Pond 2	Total	
Total Storage Capacity	7.83	29.90	37.73	acre-ft
10-year, 24-hour Storm Inflow	1.91	1.66	3.57	acre-ft
Total Storage Capacity	5.92	28.2	34.16	acre-ft
Sediment Inflow Rate	--	--	0.337	acre-ft/yr
Sediment Storage Life	--	—	101	yrs

Excess storage capacity in Structure WW-6 can be used for storing water produced during maintenance of the nearby water well.

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure WW-6 indicated that the only geotechnical problems are rill and gully erosion on the upstream slopes, the side slopes of the spillway channel and the right and left abutments. Correction of erosion is considered a periodic maintenance task and does not require remedial action.

HYDRAULICS

The storage capacity and spillway capacity of Structure WW-6 are adequate. The outflow channel of Pond 1 is protected with riprap but the spillway channel is not. The spillway channel should be protected against erosion using geotextile and gravel as shown in Plate 5. Plate 4 shows the existing spillway and outflow channel profile and Plate 5 shows the channel dimensions.

A trashrack should be installed on the inlet of the spillway pipe for Pond 2. The natural channel below the pipe should be lined with riprap to prevent erosion (see Plate 4).

* * *

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

Plate 1 - Site Plan WW-6

Plate 2 - Existing Maximum Cross Section WW-6, A-A'

Plate 3A - Volume-Elevation Curve WW-6, Pond No. 1

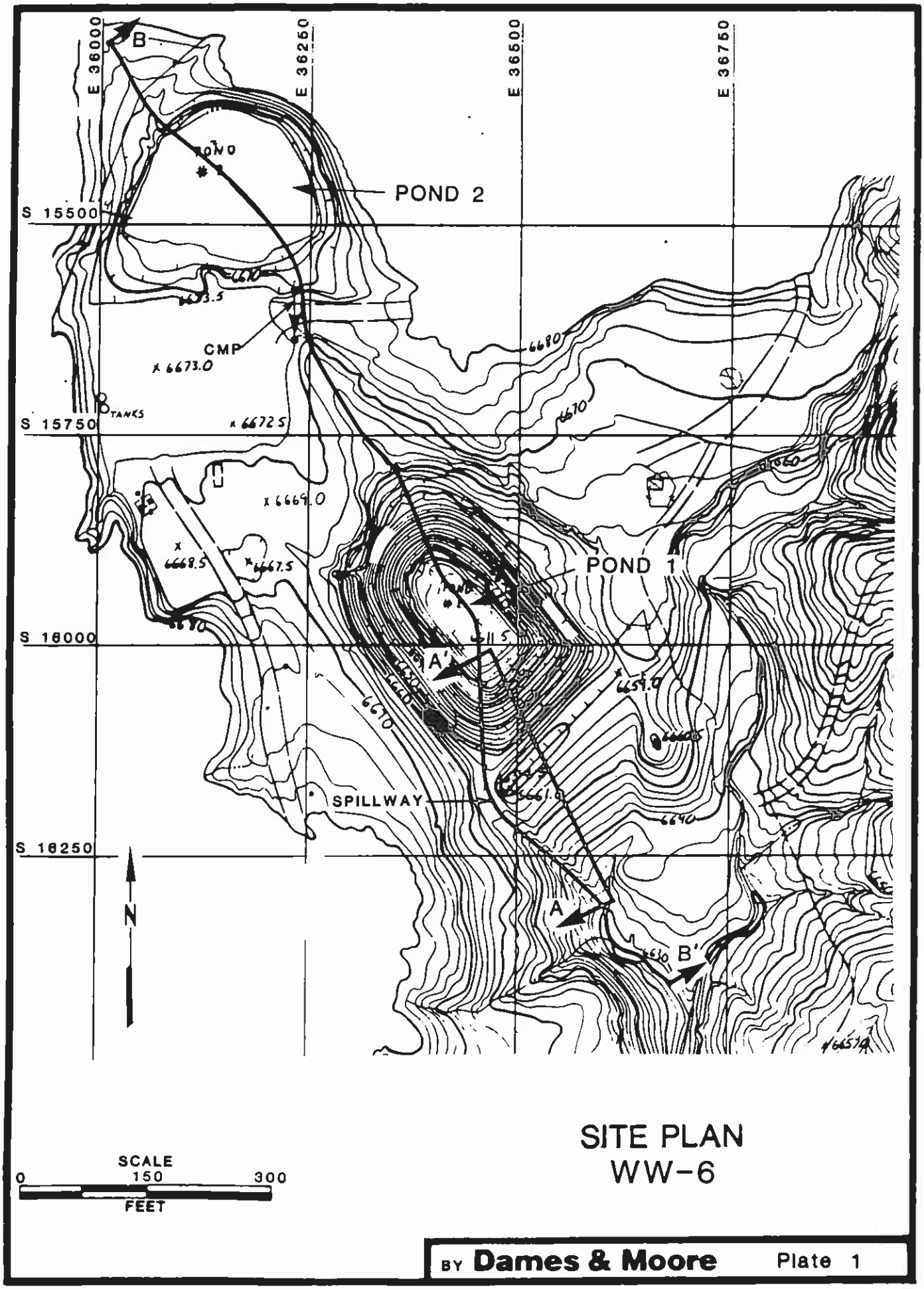
Plate 3B - Volume Elevation Curve WW-6, Pond No. 2

Plate 4 - Channel Profile WW-6, B-B'

Plate 5 - Spillway and Outflow Channel Cross Section WW-6

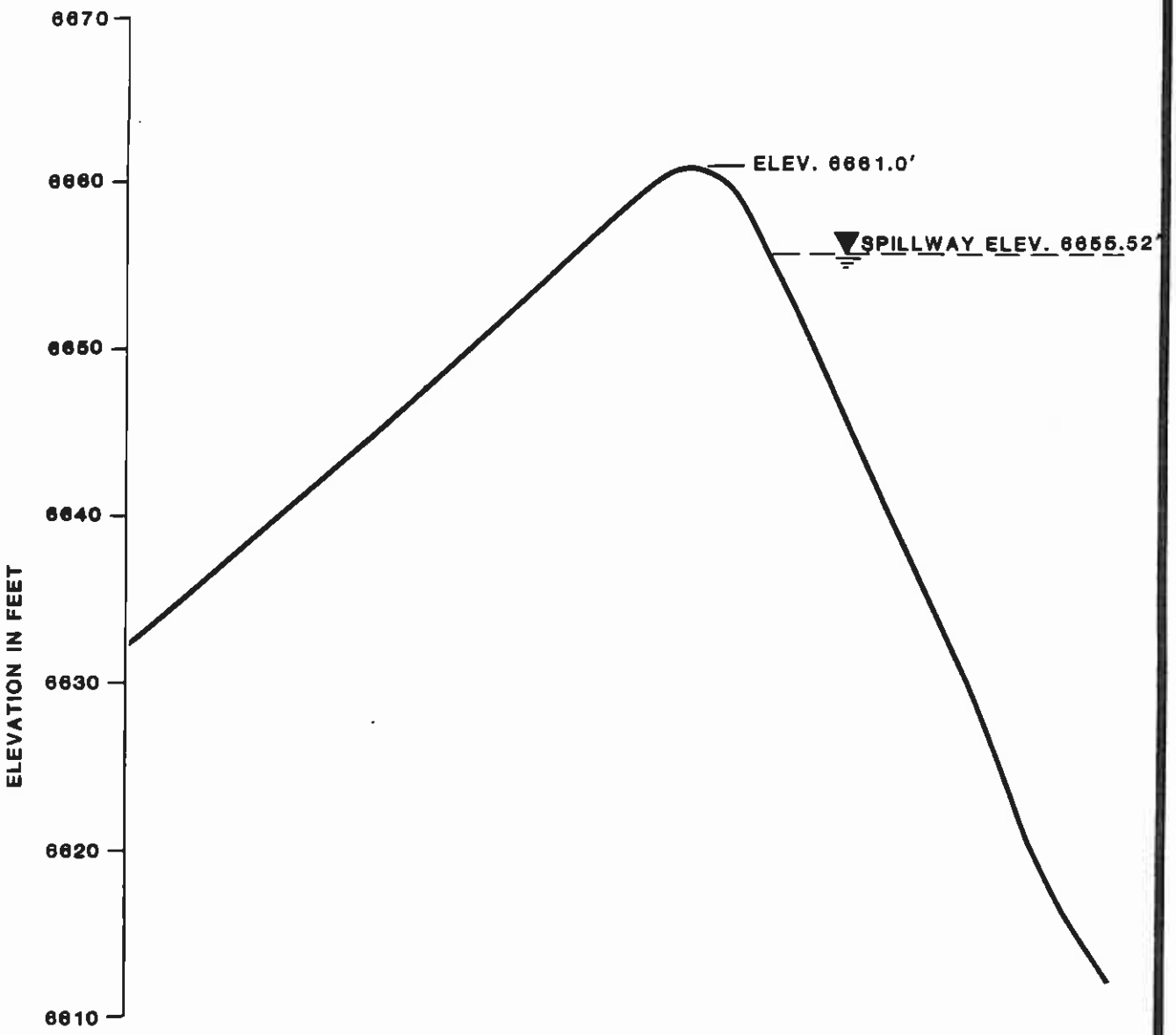
Appendix A - Inspection Check List

Appendix B - Hydrology and Hydraulic Calculations



SITE PLAN
WW-6

BY **Dames & Moore** Plate 1



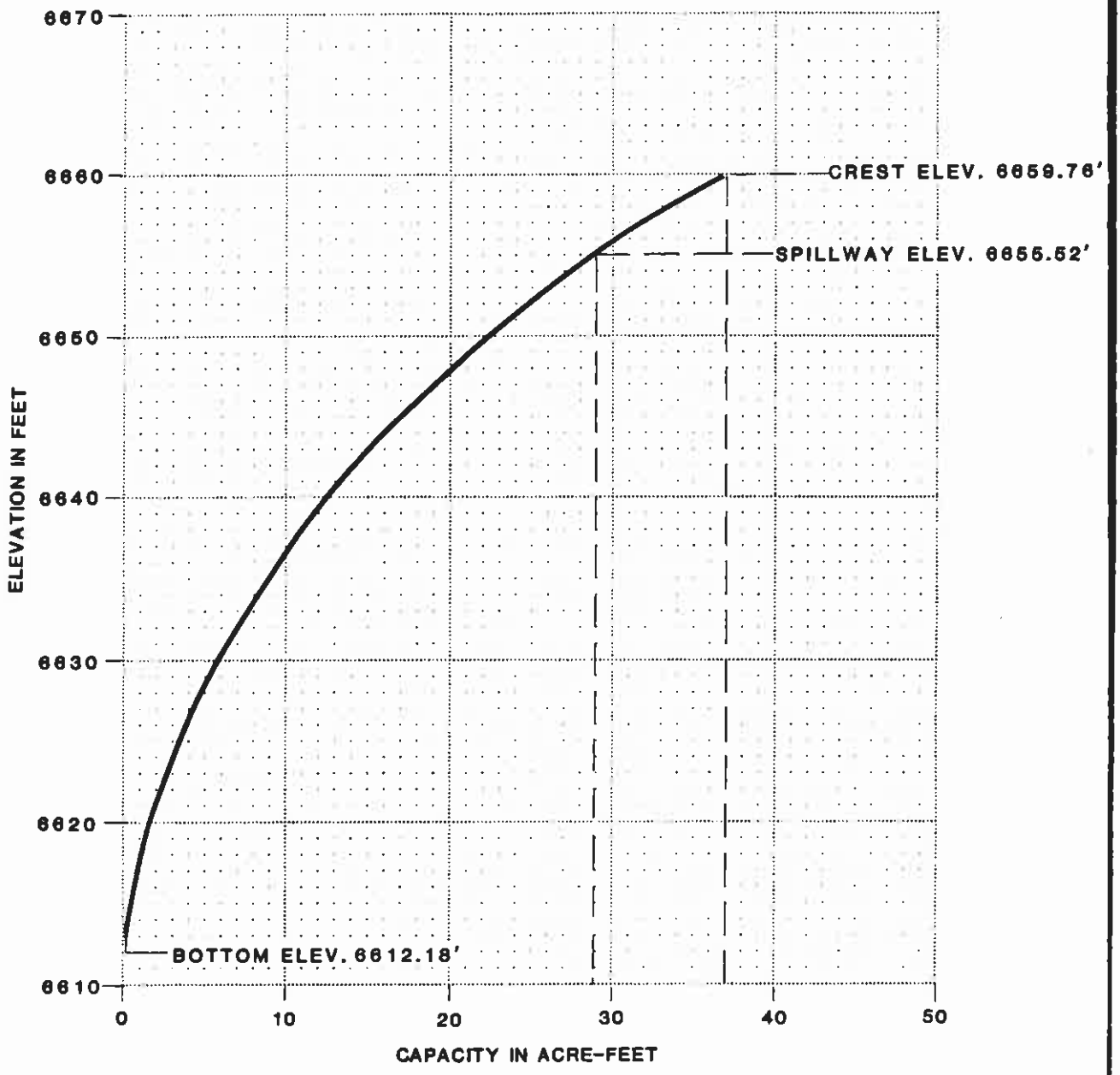
SCALE
0 50 100
FEET

EXISTING MAXIMUM CROSS-SECTION A-A' WW-6

FOR LOCATION SEE PLATE 1

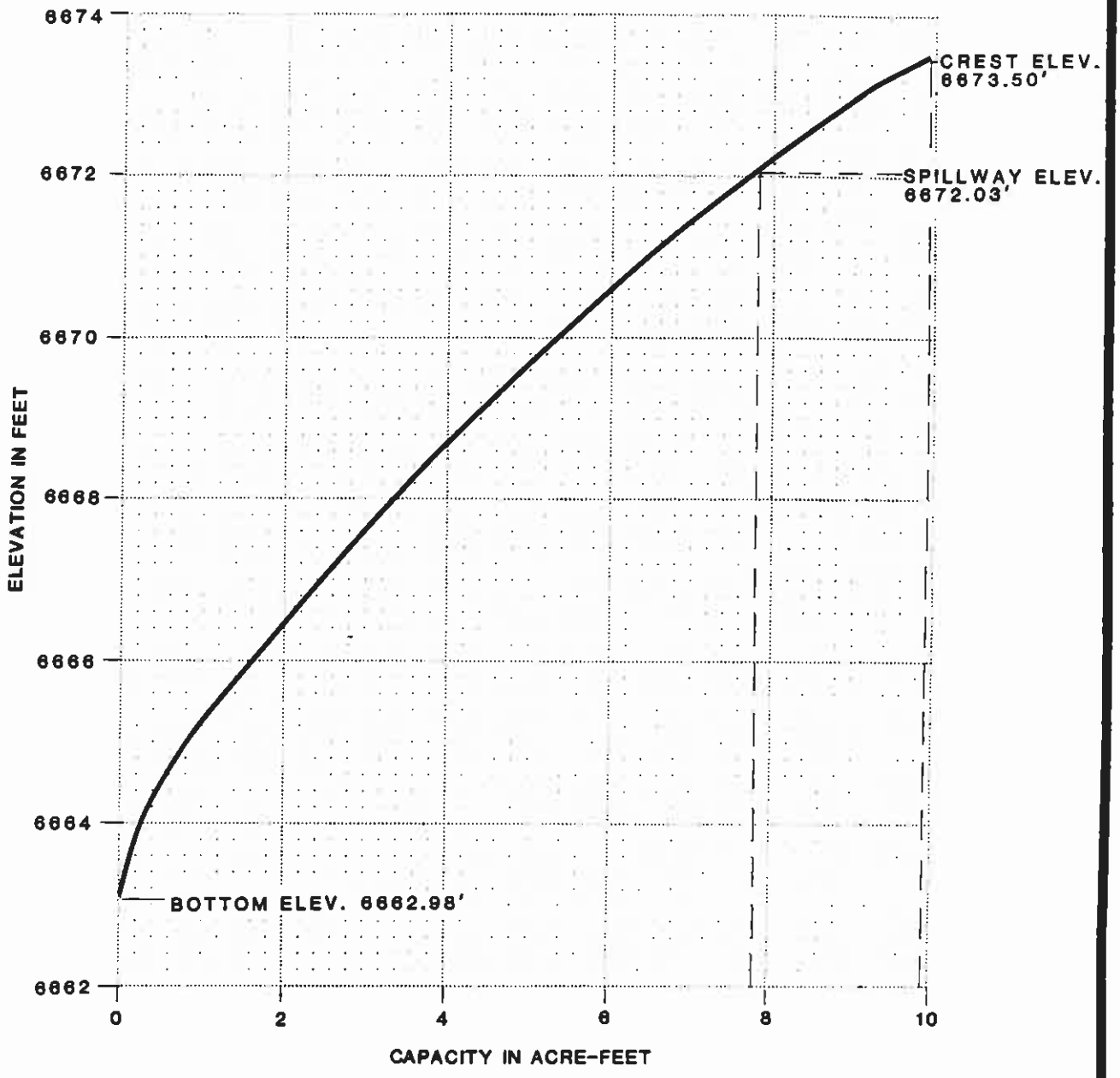
BY **Dames & Moore**

Plate 2



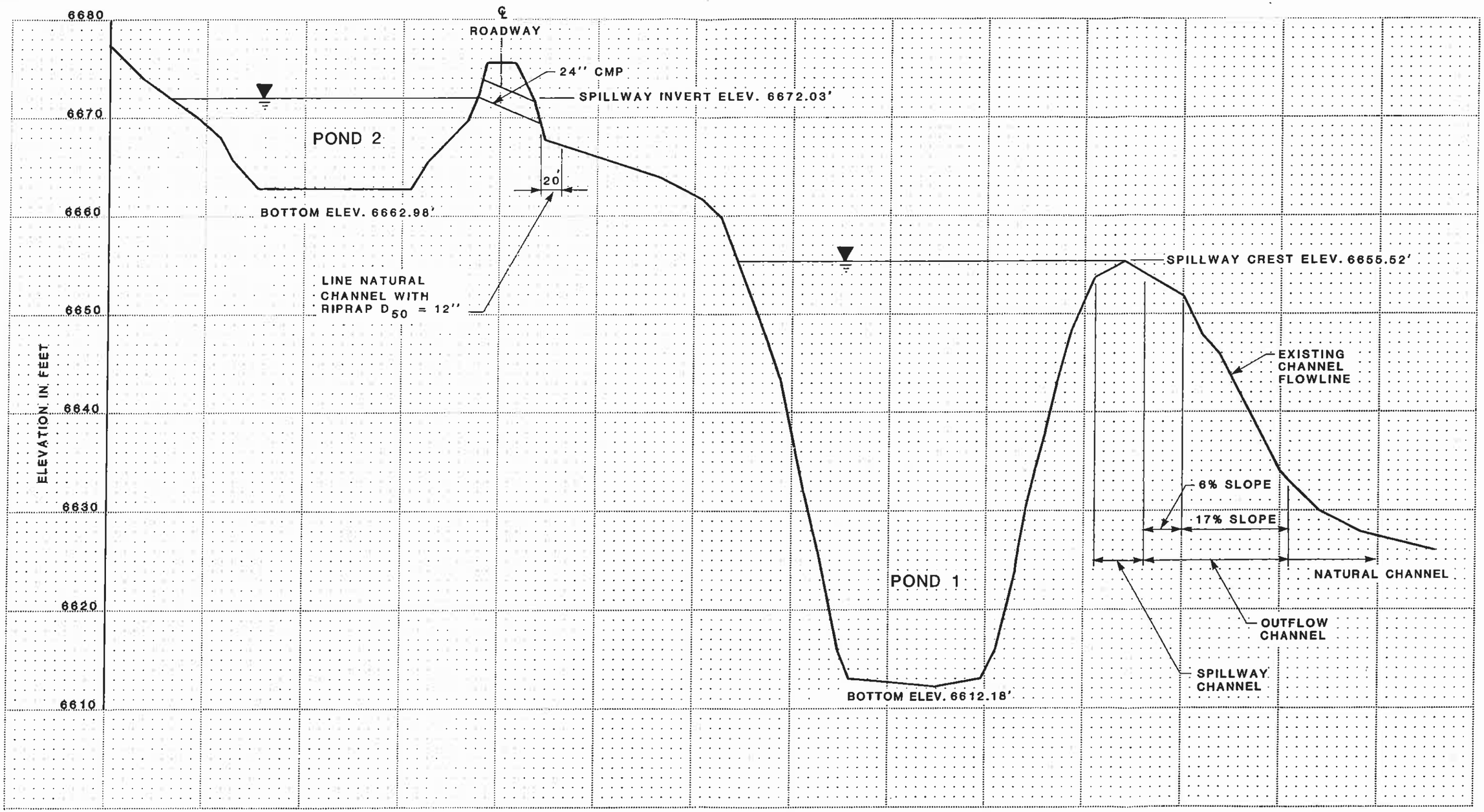
VOLUME-ELEVATION CURVE WW-6 POND #1

BY **Dames & Moore** Plate 3A



VOLUME-ELEVATION CURVE WW-6 POND #2

BY **Dames & Moore** Plate 3B

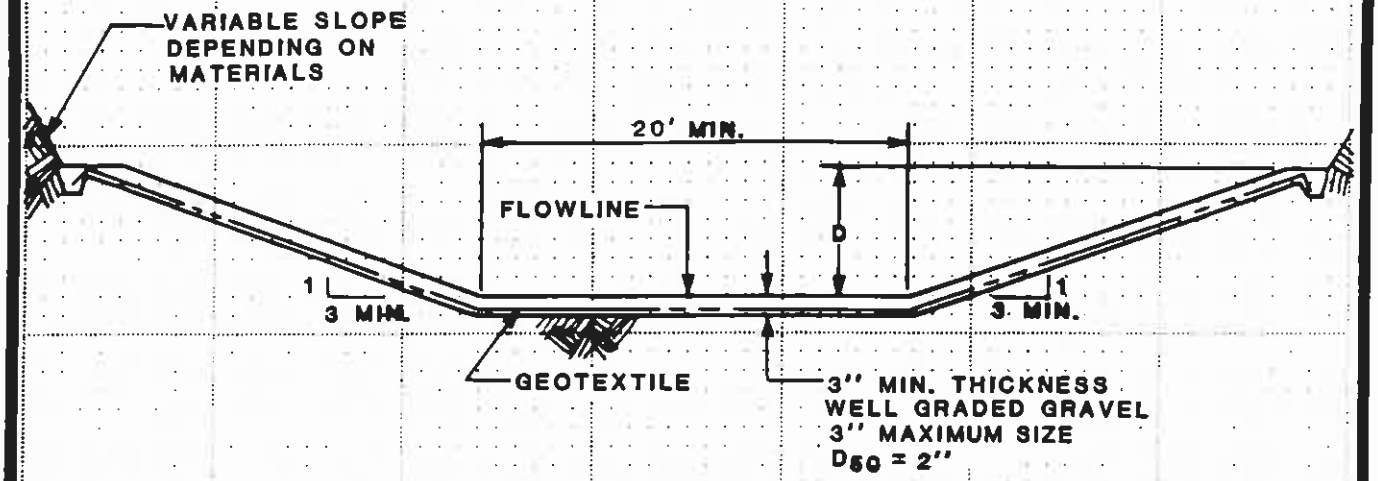


SCALE
0 100 200
FEET

CHANNEL PROFILE B-B'
WW-6

FOR LOCATION SEE PLATE 1

BY **Dames & Moore** Plate 4



SPILLWAY CHANNEL

D = 2.1'

LENGTH = 50'

FLOWLINE ELEV.= 6655.52'

SPILLWAY CHANNEL CROSS SECTION WW-6

BY **Dames & Moore** Plate 5

APPENDIX A

INSPECTION CHECK LIST

Sediment Impoundment Name: WW6
Page: 4

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			16' 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 & gullys
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			10°
a. Adequate grass cover?	X		75%
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		gullys & rills into spillway
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			gray & brown sm
5. ABUTMENT CONTACT. LEFT			
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

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		20'W 45'L 0 Slope 5.8' below crest
Are side slopes eroding?	X		Rills & sm gullys from RA
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?		X	
d. Outflow Channel:	X		20'W ≈150'L 9° slope
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?	X		Rock D50 - 8"
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?		(Elev.)	feet
b. Water present?		(Elev.)	feet
c. Siltation?			
d. Watershed matches soil map?			

9. GENERAL COMMENTS

Two large gulley at rear of pond from settling pond area, erosion also at both sides

Canopy 5%
Ground 50%

Note: Hydrology should take into account capacity of U.S. settling pond.

APPENDIX B

HYDROLOGY AND HYDRAULIC CALCULATIONS

FILE PEABODY COAL CO 10139-011-22
SUBJECT SEDIMENT POND HYDROLOGY
WW-6 POND 1 SHEET ___ OF ___

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

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 80'

WATER COURSE LENGTH = 1100' = .208

T_c = .078

LAG TIME = $0.6 T_c$ = .047 hr.

SCS CURVE NUMBER

DRAINAGE AREA (ac)	COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
10.9	reclaimed	fair	D	81. (.4)
10.1	S-G	ave	D	79 (.37)
6.2	P-J	ave	D	83 (.23)
				80.7

use 81

DRAINAGE BASIN AREA

27.2 ACRES 0.042 SQ. MILES

BY ___ DATE ___ CHECKED BY ___ COPY TO EO ___

Dames & Moore

FILE PEABODY COAL CO 10139-011-22
SUBJECT SEDIMENT POND HYDROLOGY
WW-6 POND 2 SHEET ___ OF ___

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

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 90'

WATER COURSE LENGTH = 1650 = .3125 mi

T_c = .120

LAG TIME = $0.6 T_c$ = .072 hr.

SCS CURVE NUMBER

DRAINAGE AREA (ac)	COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
25.7	reclaimed	fair	D	81 (.86)
2.3	P-J	ave	D	83 (.08)
1.8	S-G	ave.	D	79 (.06)
				81.04

use 82

BY ___ DATE ___
CHECKED BY ___
COPY TO EO ___

DRAINAGE BASIN AREA

29.8 ACRE 0.0466 SQ MILE

FILE KEARSE COAL CO 1039-011-22
SUBJECT SEDIMENT INFLOW
WW-6 SHEET ___ OF ___

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

CHECKED BY BHM 10/28/88
COPY TO EO ___

UNIVERSAL SOIL LOSS EQUATION

RAINFALL FACTOR

R = 40

SOIL ERODIBILITY FACTOR

SOIL TYPE =	64%	EH #35	.64 (.42)
	21%	EH #33	.21 (.22)
	15%	EH #34	.15 (.22)
			.348 ✓

K = .348

SLOPE FACTOR

LENGTH (ft.)	Δ ELEV (ft.)	SLOPE (%)	LS
400	90	22.5	9.9 (.1)
500	100	20.	9.1 (.4)
600	60	10	3.36 (.5)
			= 6.31 ✓

COVER FACTOR

AREA (ac.)	COVER TYPE	% COVER	CANOPY (%)	WEIGHTED C
64%	reclaimed	—	—	.64 (.15)
15%	P-J	40	25	.15 (.14)
21%	S-G	40	25	.21 (.13)
				C = .145 ✓

EROSION CONTROL FACTOR

P = 1.0

SEDIMENT INFLOW

$A = 40(.348)(6.31)(.145)(1.0) = 12.74$ ton/acre/year ✓

$A = (12.74)\left(\frac{1}{2047}\right)(57.0)(.95) = .337$ acre-feet/year ✓

Dames & Moore