

INSPECTION REPORT
Sedimentation Structure
WW-2
Kayenta Mine
Navajo County, Arizona
for
PEABODY COAL COMPANY



Dames & Moore
10139-011-22

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INTRODUCTION

Sedimentation Structure WW-2 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 WW-2 is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure WW-2. 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-2 was inspected on September 4, 1985 by an interdisciplinary 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-2 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-2 has a 17.4-acre tributary drainage area and is located near Wild Ram Valley at the Kayenta Mine. The watershed is classified as 55% Pinion/Juniper and 45% disturbed.

EMBANKMENT

Structure WW-2 is a homogeneous earthen embankment classified as a sidehill embankment. Physical characteristics of the embankment are listed in the following table:

Structure WW-2

Embankment	Residual Sandstone Soils
Foundation	Residual Sandstone Soils
Right Abutment	Residual Sandstone Soils
Left Abutment	Residual Sandstone Soils
Height	18.4 ft
Crest Width	18 ft
Upstream Slope	3.5 H : 1 V
Downstream Slope	3.7 H : 1 V

A cross-section of the embankment is shown on Plate 2, Existing Maximum Cross Section WW-2, A-A'.

ANALYSES

STABILITY

Structure WW-2 is a category A-1 embankment. A standard category A-1 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 = 4.0 H : 1 V
4. Normal pool with steady seepage saturation conditions

The WW-2 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 WW-2 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-2 was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1. Water Course length, L 0.129 mi
2. Elevation Difference, H 38 ft
3. Time of Concentration, T_c 0.060 h
4. Lag time, $0.6T_c$ 0.036 h
5. SCS Curve Number 90
6. Rainfall Depth, 10-year, 24-hour storm . 2.1 in.
25-year, 6-hour storm. . 1.9 in.
7. Drainage Area 17.4 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.

WW-2 HYDRAULICS

	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	44	56
Volume	acre-ft	1.80	1.52
Storage			
Peak Stage	ft	6522.97	--
Spillway Elevation . .	ft	6534.50	--
Peak Storage	acre-ft	1.80	--
Storage Capacity . . .	acre-ft	16.2	--
Outflow			
Peak Flow	cfs	0	3
Embankment Crest			
Elevation	ft	-	6536.10
Peak Stage	ft	--	6535.09
Freeboard	ft	--	1.01
Spillway Channel			
Flow Depth	ft	--	0.59
Critical Velocity . . .	fps	--	1.8
Manning's "n"		--	0.035
Outflow Channel			
			<u>Section I</u> <u>Section II</u>
Slope	%	--	4 10
Normal Velocity	fps	--	1.9 2.5
Normal Depth	ft	--	0.11 0.08
Manning's "n"		--	0.035 0.035

Spillway Channel

The existing spillway for WW-2 has a U-shaped channel with the following dimensions:

Channel depth	1.5 ft
Channel width	10 ft
Channel length	30 ft
Average exit slope	0 percent

There is presently no erosion protection within the channel.

Outflow Channel

The existing outflow channel for WW-2 has a U-shaped channel with the following dimensions:

Channel width	6-8 ft
Channel length	60 ft
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, WW-2.

The calculations for the sediment load entering Structure WW-2 were made utilizing the Universal Soil Loss Equation with the following parameters:

1. Rainfall Factor, R 40
2. Soil Erodibility Factor, K 0.20
3. Slope Factor, LS 1.51
4. Cover Factor, C 0.670
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-2 and the results of the sediment inflow analysis are summarized in the following table.

WW-2 STORAGE

Total Storage Capacity	16.2	acre-ft
10-year, 24-hour Storm Inflow	1.81	acre-ft
Available Sediment Storage Capacity	14.4	acre-ft
Sediment Inflow Rate	0.065	acre-ft/yr
Sediment Storage Life	221	yrs

Excess storage capacity in Structure WW-2 can be used for storing water produced during maintenance of the nearby water well.

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure WW-2 indicated that the only geotechnical problem is rill erosion on the upstream and downstream slopes. 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.

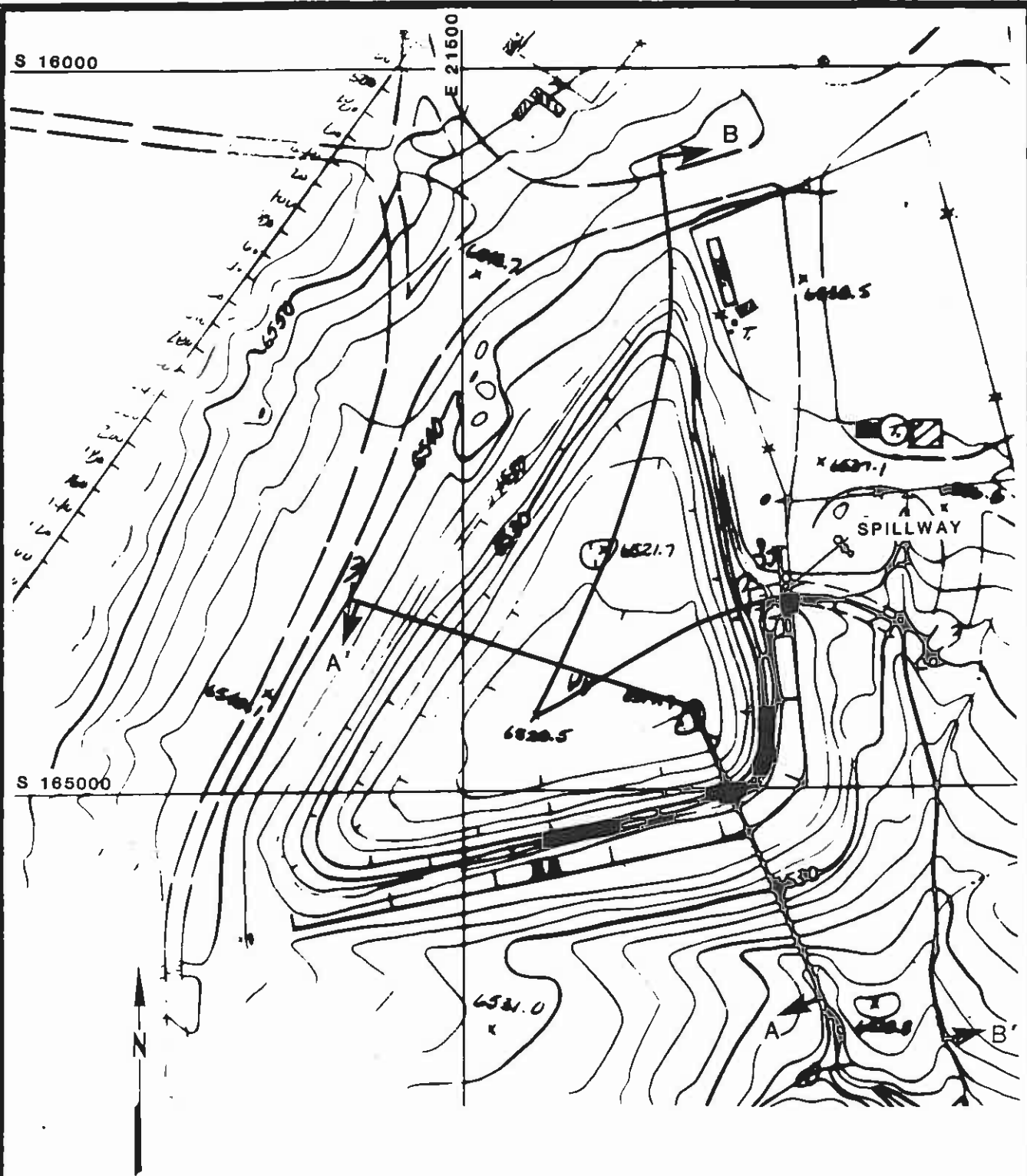
HYDRAULICS

The storage capacity and spillway capacity of Structure WW-2 are adequate; however, the spillway does not have an adequate outflow channel or adequate erosion protection. A trapezoidal outflow channel should be constructed along the alignment B-B' shown in Plate 1. The channel profile is shown in Plate 4 and the 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.

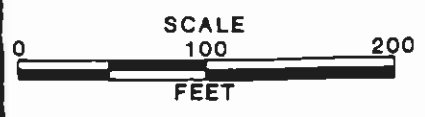
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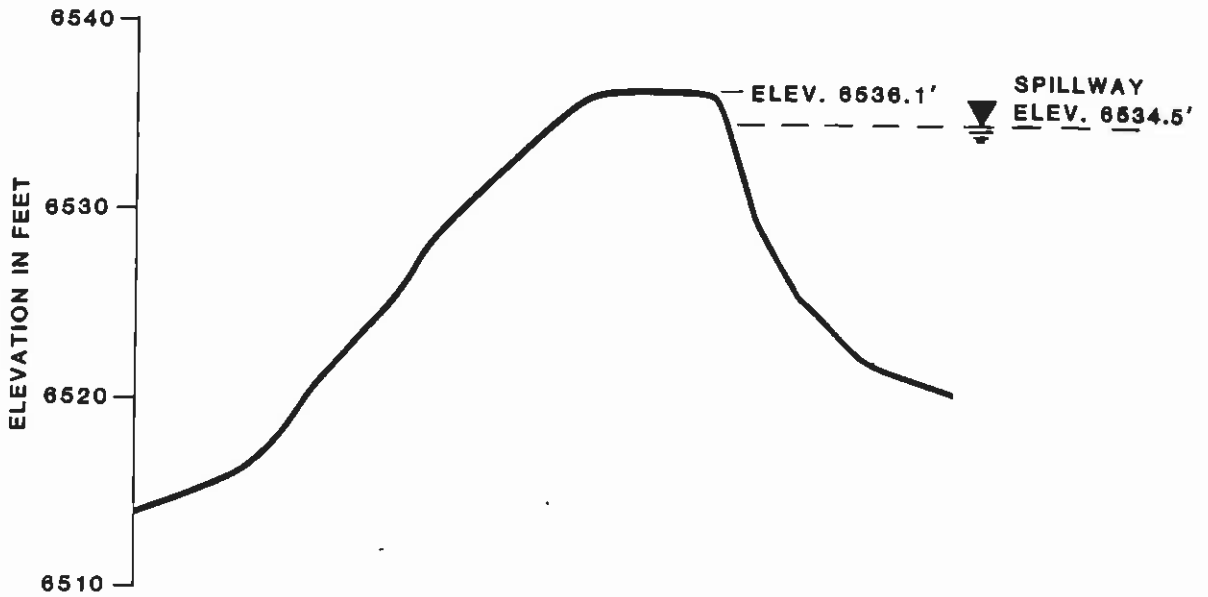
The following plates and appendix are attached and complete this inspection report.

- Plate 1 - Site Plan WW-2
- Plate 2 - Existing Maximum Cross Section WW-2, A-A'
- Plate 3 - Volume-Elevation Curve WW-2
- Plate 4 - Channel Profile WW-2, B-B'
- Plate 5 - Spillway and Outflow Channel Cross Section WW-2
- Appendix A - Inspection Check List
- Appendix B - Hydrology and Hydraulic Calculations



SITE PLAN
WW-2



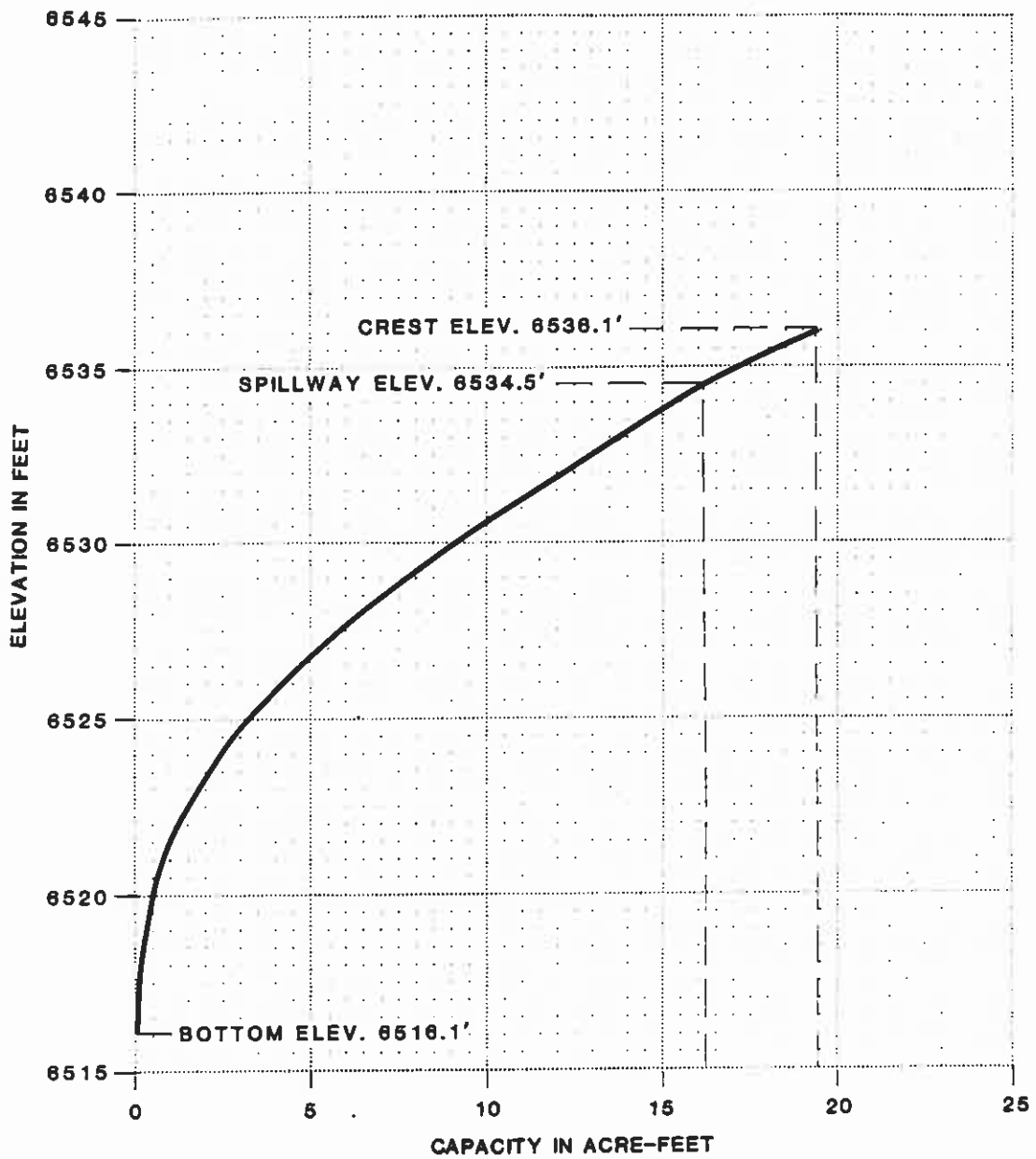


EXISTING
MAXIMUM CROSS-SECTION
A-A'
WW-2

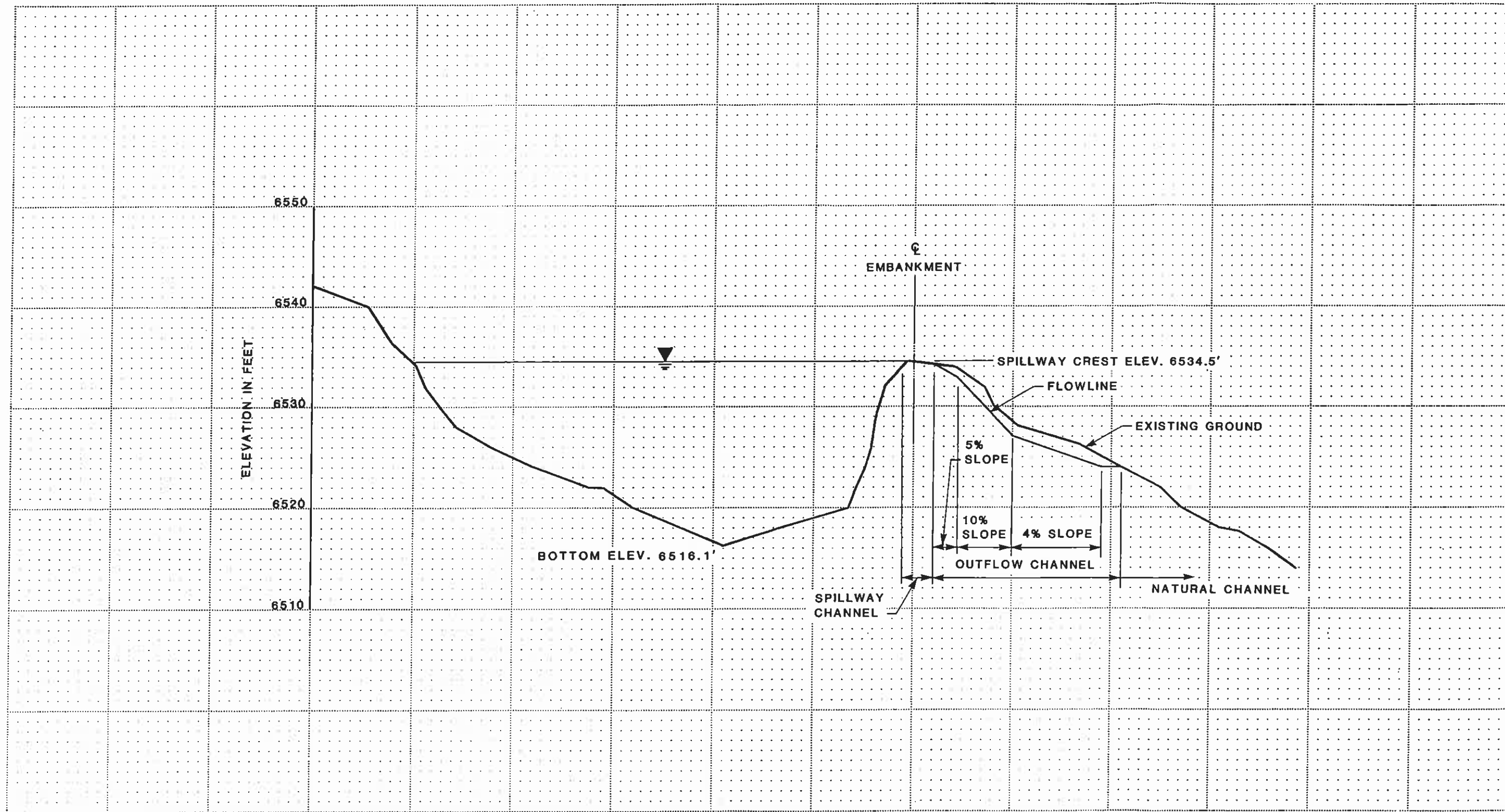
FOR LOCATION SEE PLATE 1

BY **Dames & Moore**

Plate 2



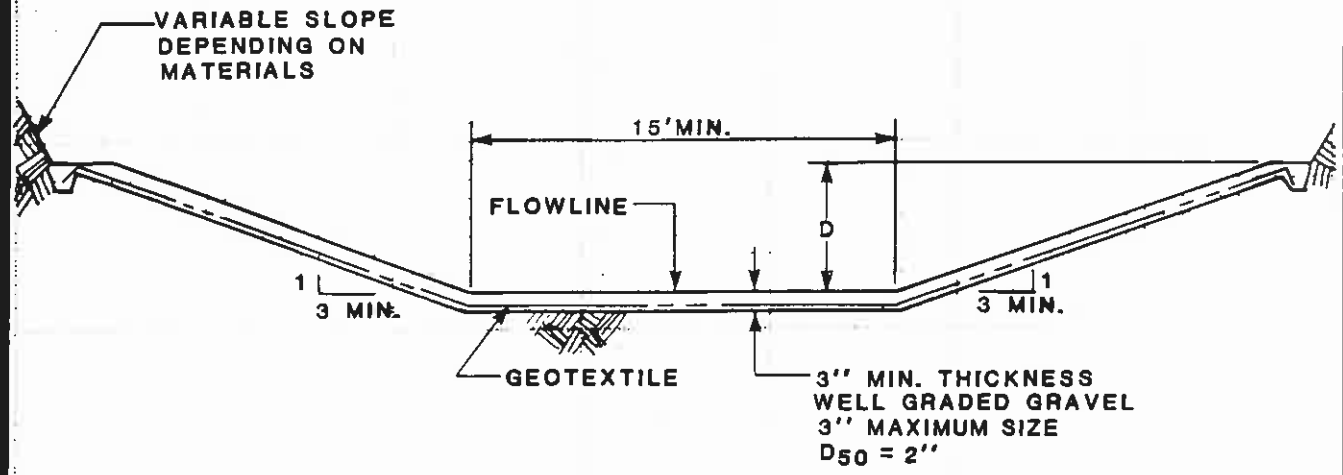
VOLUME-ELEVATION
CURVE
WW-2



CHANNEL PROFILE B-B'
WW-2



FOR LOCATION SEE PLATE 1



SPILLWAY CHANNEL

D = 1.8'
 LENGTH = 30'
 FLOWLINE ELEV. = 6534.50'

OUTFLOW CHANNEL

D = 1'

SPILLWAY AND
 OUTFLOW CHANNEL
 CROSS SECTION
 WW-2

APPENDIX A
INSPECTION CHECK LIST

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			18'
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE			16°
a. Adequate grass cover?		X	35%
b. Any erosion?	X		Kills
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			15°
a. Adequate grass cover?		X	35%
b. Any erosion?	X		Kills
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?			brown SM

ITEM	YES	NO	REMARKS	
6. SPILLWAY/NORMAL				
a. Location:				
Left abutment?				
Right abutment?				
Crest of Embankments?	X		Near LA	
b. Approach Channel:				
Are side slopes eroding?				
Are side slopes sloughing?			NA	
Bottom of channel eroding?				
Obstructed?				
Erosion protection?			↓ 10' wide	
c. Spillway Channel:				
Are side slopes eroding?		X	Needs reshaping	
Are side slopes sloughing?		X		
Bottom of channel eroding?		X		
Obstructed?		X		
Erosion protection?		X		
d. Outflow Channel:				
Are side slopes eroding?	X		6-8 wide	
Are side slopes sloughing?		X		
Bottom of channel eroding?		X		
Obstructed?		X		
Erosion protection?		X		
e. Weir:				
Condition?		X		
7. SPILLWAY/EMERGENCY				
a. Location:				
Left abutment?			NA	
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		SOME
d. Watershed matches soil map?	X	X	
9. GENERAL COMMENTS			

Canopy cover $\leq 10\%$
 Ground cover 25%

APPENDIX B
HYDROLOGY AND HYDRAULIC CALCULATIONS

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 6573 - 6535 = 38 ft.

WATER COURSE LENGTH = 1.7(400) = 680 ft. = 0.129 mi.

$$T_c = \left(\frac{11.9 (0.129)^3}{38} \right)^{0.385} = 0.060 \text{ hr. } \approx$$

Lag Time = 0.6 T_c = 0.036 hr. ≈

SCS CURVE NUMBER

DRAINAGE AREA (ac)	COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
7.8 (45%)	DISTURBED	—	D	0.45(94) = 42.3
9.6 (55%)	P-J	poor	C EH#28	0.55(85) = 46.8
				<u>89.1</u>

USE 90

DRAINAGE BASIN AREA

17.4 ACRE 0.027 SQ MILE

REVISIONS
 BY _____ DATE _____ TO EO _____
 BY _____ DATE _____ TO EO _____

JY S. DOLAN DATE 9-9-85
 CHECKED BY _____
 COPY TO EO _____

UNIVERSAL SOIL LOSS EQUATION

RAINFALL FACTOR

$R = 40$

SOIL ERODIBILITY FACTOR

SOIL TYPE = 100% EH # 2B = .20

$K = \underline{\underline{.20}}$

SLOPE FACTOR

LENGTH (ft.)	Δ ELEV (ft.)	SLOPE (%)	LS
500	30	6	1.51

use 1.51

COVER FACTOR

AREA (ac)	COVER TYPE	% COVER	CANOPY (%)	WEIGHTED C
45%	disturbed	—	—	.45 (1.0)
55%	P-J	10	25	.55 (.40)
				<u>C = .67</u>

EROSION CONTROL FACTOR

$P = 1.0$

SEDIMENT INFLOW

$A = 40 (.2) (1.51) (.67) (1.0) = 8.09$ ton/acre/year

$A = 8.09 \left(\frac{1}{2047} \right) (17.4) (.95) = .065$ acre-feet/year

REVISIONS
 BY _____ TO EO _____
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