

INSPECTION REPORT  
Sedimentation Structure  
J16-K  
Kayenta Mine  
Navajo County, Arizona  
for  
PEABODY COAL COMPANY



Dames & Moore  
10139-011-22

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## INTRODUCTION

Sedimentation Structure J16-K 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 J16-K is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure J16-K. 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 J16-K was inspected on September 10, 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 J16-K 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 J16-K has a 45.0-acre tributary drainage area and is located near Reed Valley at the Kayenta Mine. The watershed is classified as 60% disturbed, 26% Pinion/Juniper, and 14% Sagebrush/grass.

EMBANKMENT

Structure J16-K is a homogeneous earthen embankment classified as a cross-valley embankment. Physical characteristics of the embankment are listed in the following table:

Structure J16-K

Embankment . . . . .	Residual Sandstone Soils
Foundation . . . . .	Residual Sandstone Soils
Right Abutment . . . . .	Residual Sandstone Soils
Left Abutment . . . . .	Sandstone
Height . . . . .	13.3 ft
Crest Width . . . . .	12 ft
Upstream Slope . . . . .	2.15 H : 1 V
Downstream Slope . . . . .	3.2 H : 1 V

A cross-section of the embankment is shown on Plate 2, Existing Maximum Cross Section J16-K, A-A'.

## ANALYSES

### STABILITY

Structure J16-K 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 = 4.25 H : 1 V
4. Normal pool with steady seepage saturation conditions

The J16-K 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 J16-K 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 J16-K was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1. Water Course length, L . . . . . 0.311 mi
2. Elevation Difference, H . . . . . 97 ft
3. Time of Concentration, T . . . . . 0.116 h
4. Lag time,  $0.6T_c$  . . . . . 0.069 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 . . . . . 45.0 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.

J16-K HYDRAULICS

	Units	10-year 24-hour Storm	25-year 6-hour Storm
<b>Initial Reservoir Volume</b>			
Condition		Empty	Full to the spillway elevation
<b>Inflow</b>			
Peak Flow . . . . .	cfs	90	121
Volume . . . . .	acre-ft	4.44	3.71
<b>Storage</b>			
Peak Stage . . . . .	ft	6595.87	6604.95
Spillway Elevation . .	ft	6603.30	—
Peak Storage . . . . .	acre-ft	4.44	—
Storage Capacity . . .	acre-ft	11.20	—
<b>Outflow</b>			
Peak Flow . . . . .	cfs	0	40
Embankment Crest			
Elevation . . . . .	ft	—	6609.20
Peak Stage . . . . .	ft	—	6604.95
Freeboard . . . . .	ft	—	4.25
<b>Spillway Channel</b>			
Flow Depth . . . . .	ft	—	1.65
Critical Velocity . . .	fps	—	3.8
Manning's "n" . . . . .		—	0.040
<b>Outflow Channel</b>			
			<u>Section I</u> <u>Section II</u>
Slope . . . . .	%	—	24 10
Normal Velocity . . . .	fps	—	7.2 5.5
Normal Depth . . . . .	ft	—	0.26 0.34
Manning's "n" . . . . .		—	0.040 0.040

Spillway Channel

The existing spillway for J16-K has a trapezoidal channel with the following dimensions:

Channel depth . . . . .	8.1 ft
Channel width . . . . .	25 ft
Channel length . . . . .	50 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 existing outflow channel for J16-K has a trapezoidal channel with the following dimensions:

Channel width . . . . .	35 ft
Channel length . . . . .	140 ft
Side slopes (horizontal to vertical). . .	2:1
Average exit slope . . . . .	31 percent upper section
	10 percent lower section

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 3, Volume-Elevation Curve, J16-K.



The calculations for the sediment load entering Structure J16-K 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 . . . . . 6.19
4. Cover Factor, C . . . . . 0.655
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 J16-K and the results of the sediment inflow analysis are summarized in the following table.

J16-K STORAGE

Total Storage Capacity . . . . .	11.20	acre-ft
10-year, 24-hour Storm Inflow . . . . .	4.44	acre-ft
Available Sediment Storage Capacity . . . . .	6.76	acre-ft
Sediment Inflow Rate . . . . .	0.745	acre-ft/yr
Sediment Storage Life . . . . .	9	yrs

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure J16-K indicated that the only geotechnical problem is rill and gully erosion on the upstream and downstream slopes, the side slopes of the spillway channel and the right abutment. Correction of erosion is considered a periodic maintenance task

and does not require remedial action. The downstream slope should be flattened to 4.25 horizontal to 1 vertical to meet stability requirements.

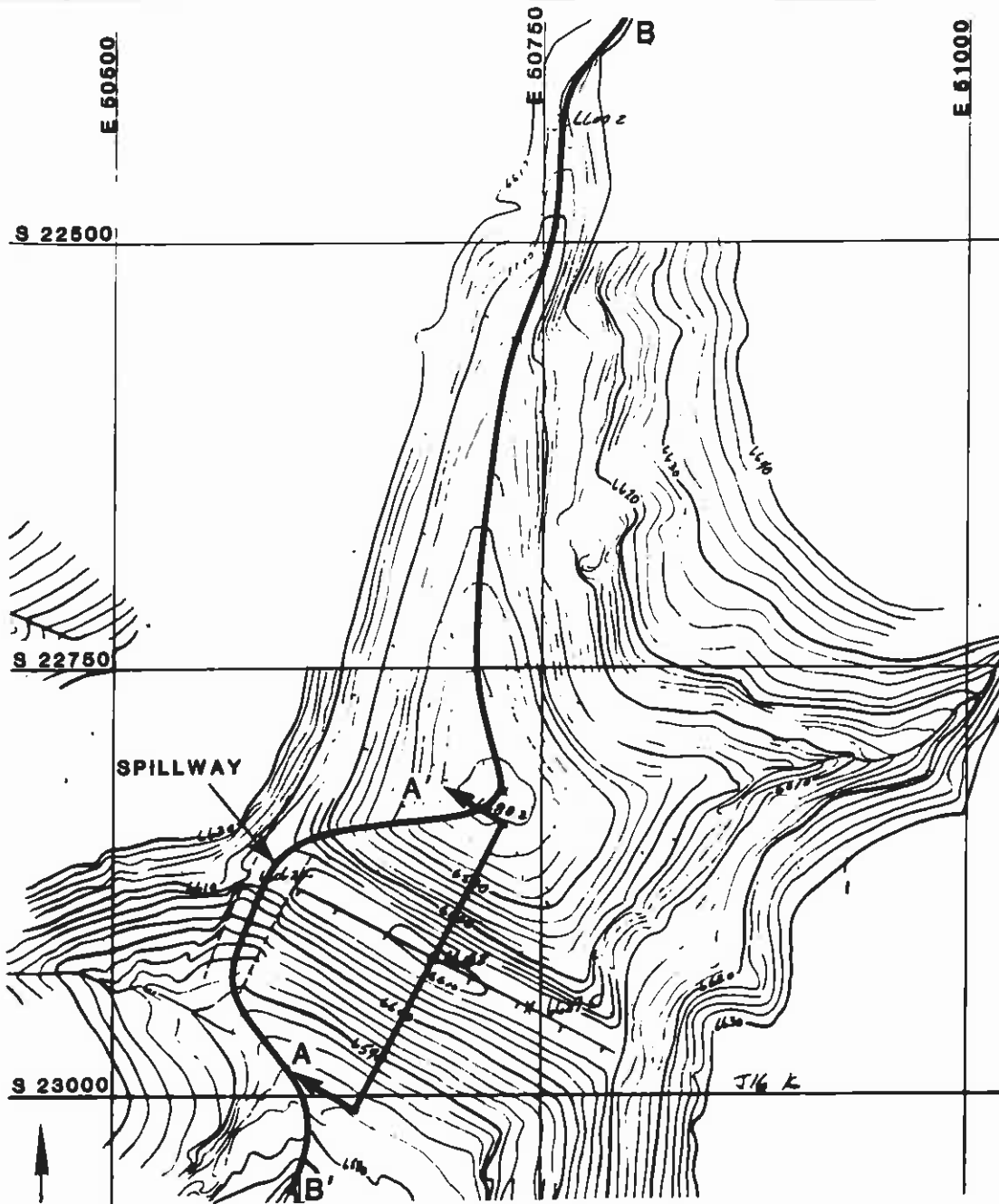
### HYDRAULICS

The storage capacity and spillway capacity of Structure J16-K are adequate. The outflow channel is protected with riprap but the spillway channel is not. The spillway channel should be protected against erosion using geotextile and riprap as shown in Plate 5. Plate 4 shows the existing spillway and outflow channel profile and Plate 5 shows the channel dimensions.

\* \* \*

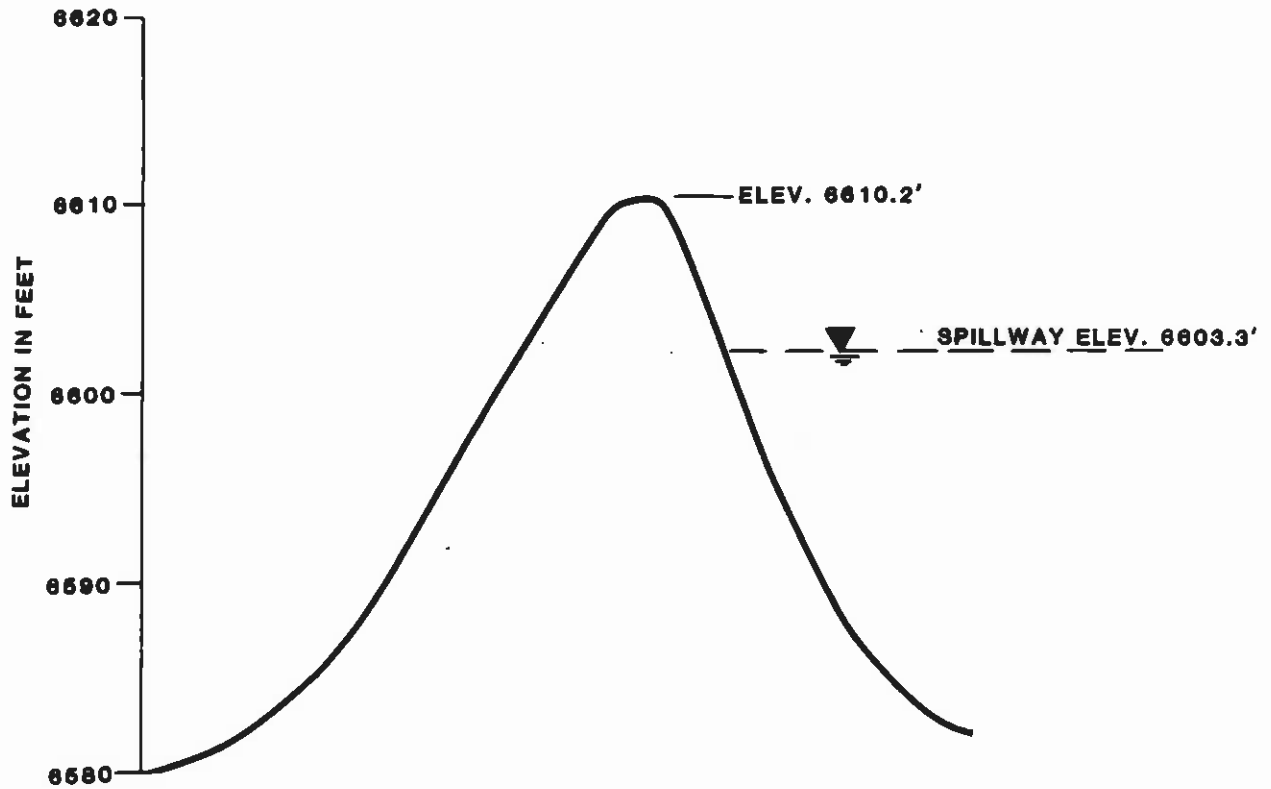
The following plates and appendix are attached and complete this inspection report.

- Plate 1 - Site Plan J16-K
- Plate 2 - Existing Maximum Cross Section J16-K, A-A'
- Plate 3 - Volume-Elevation Curve J16-K
- Plate 4 - Channel Profile J16-K, B-B'
- Plate 5 - Spillway Channel Cross Section J16-K
- Appendix A - Inspection Check List
- Appendix B - Hydrology and Hydraulic Calculations



**SITE PLAN  
J16-K**



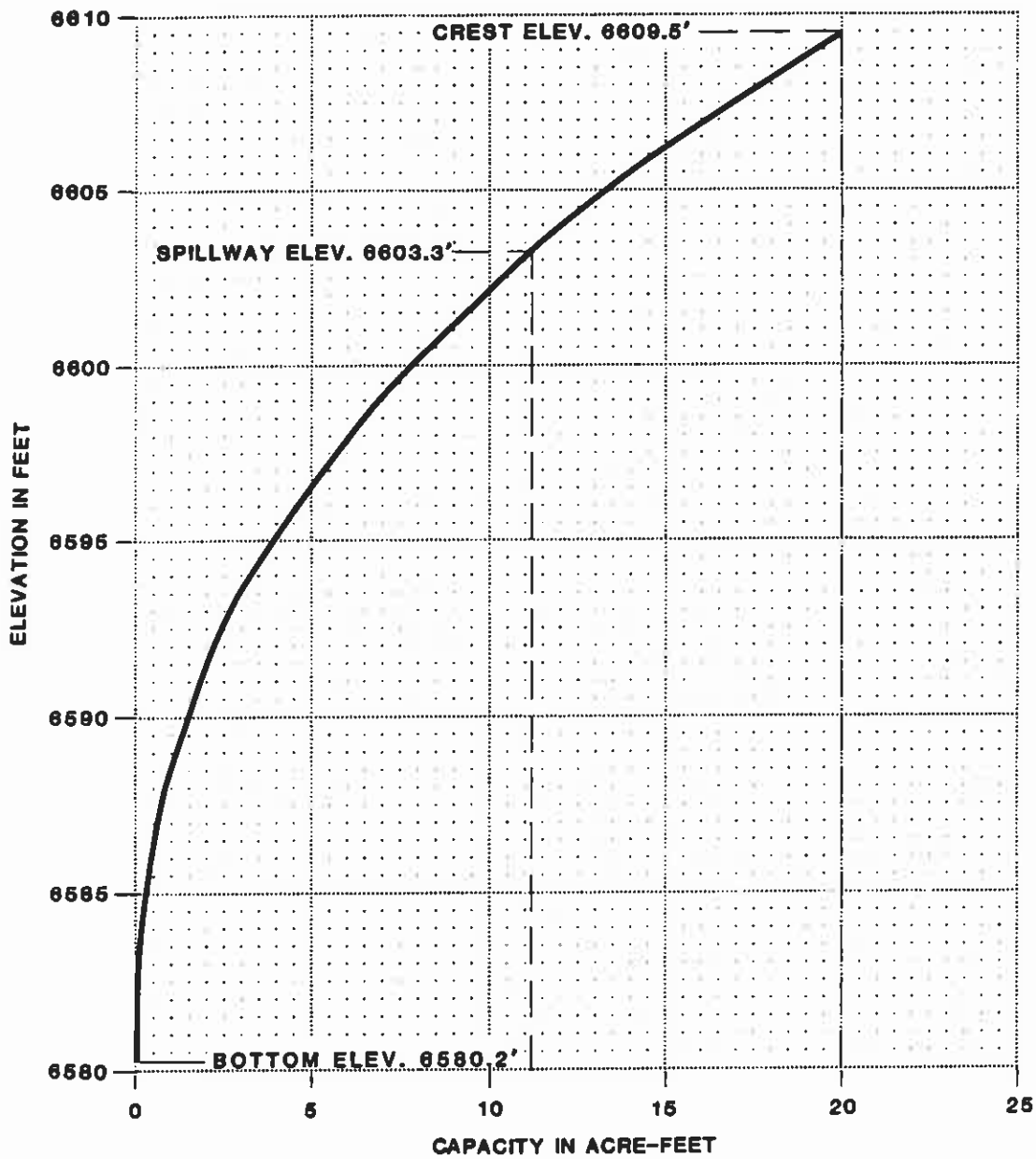


EXISTING  
 MAXIMUM CROSS-SECTION  
 A-A'  
 J16-K

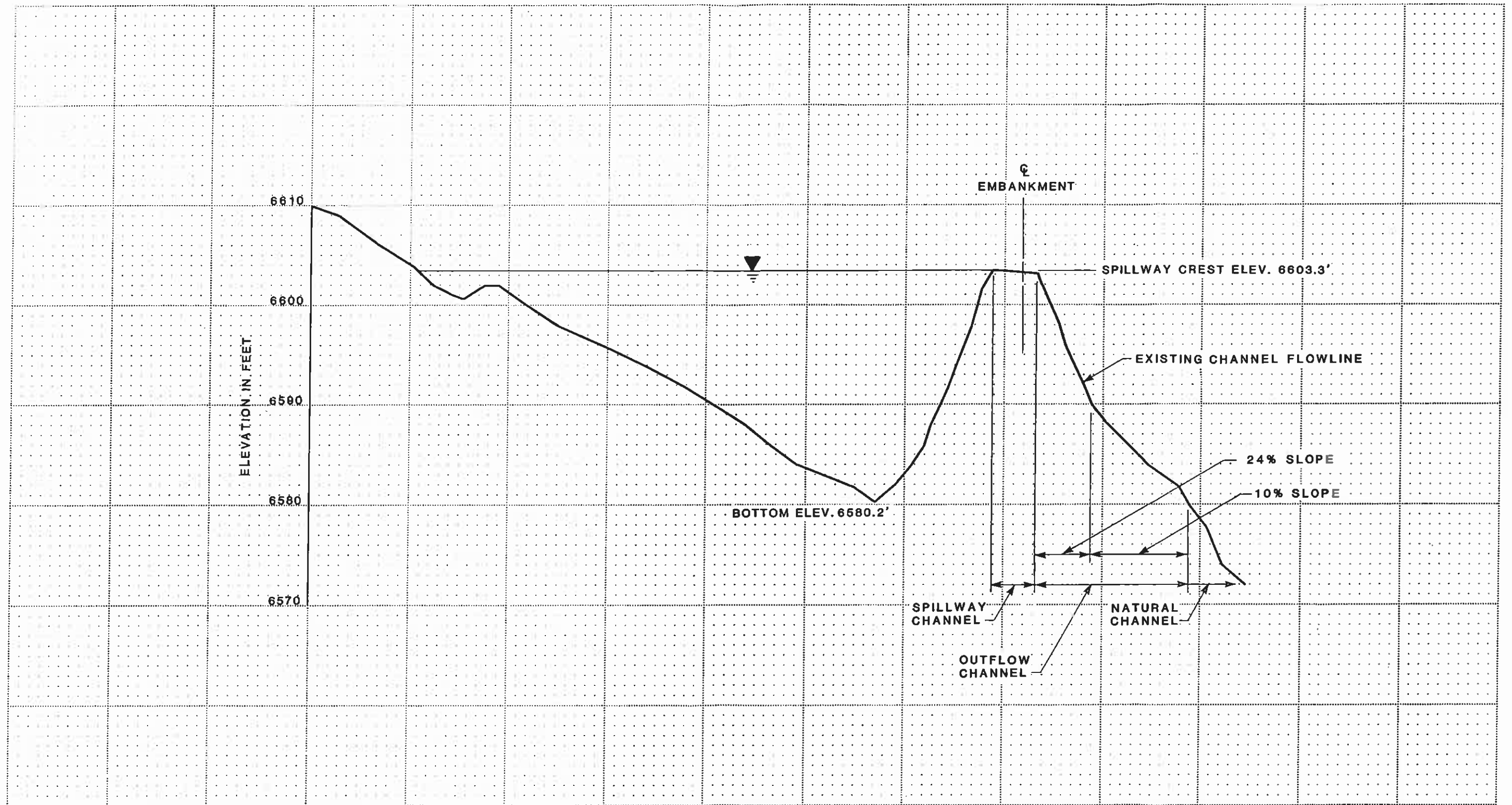
FOR LOCATION SEE PLATE 1

BY **Dames & Moore**

Plate 2



VOLUME-ELEVATION  
CURVE  
J16-K

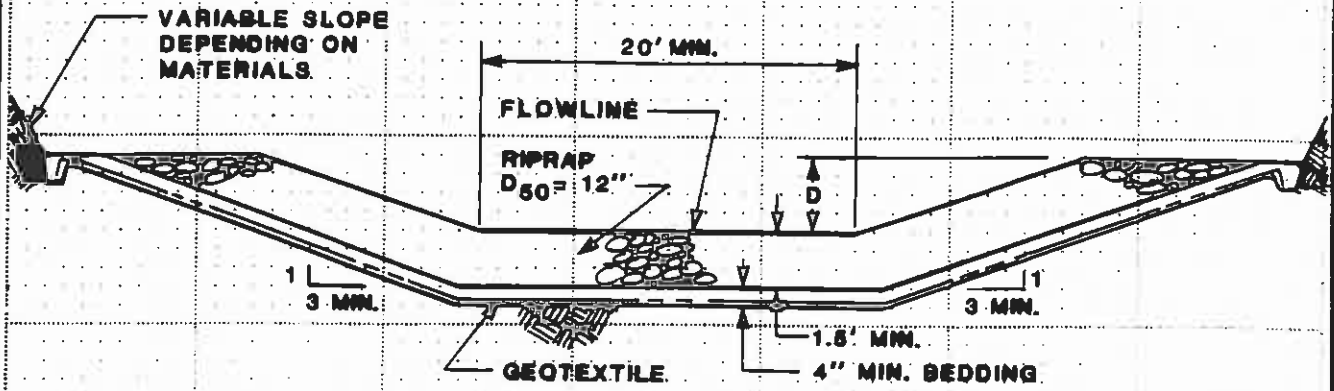


CHANNEL PROFILE B-B'  
J16-K



FOR LOCATION SEE PLATE 1

BY **Dames & Moore** Plate 4



**SPILLWAY CHANNEL**  
 D = 2.7'  
 LENGTH = 60'  
 FLOWLINE ELEV. = 6603.30'

**SPILLWAY CHANNEL  
 CROSS SECTION  
 J16-K**

**APPENDIX A**  
**INSPECTION CHECK LIST**



INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			12' w
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE			25° bit uneven - not tripping
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			17.5°
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		Rills into spillway
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			brnwy SM rock shallow
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?			gray SM Rock shallow

ITEM	YES	NO	REMARKS	
<b>6. SPILLWAY/NORMAL</b>				
<b>a. Location:</b>				
Left abutment?				
Right abutment?	X			
Crest of Embankments?				
<b>b. Approach Channel:</b>				
Are side slopes eroding?			NA	
Are side slopes sloughing?				
Bottom of channel eroding?				
Obstructed?				
Erosion protection?				
<b>c. Spillway Channel:</b>				
Are side slopes eroding?	X		25' W. 50' L 0% Slope 8.1' below crest gullies from dam kills from RA	
Are side slopes sloughing?		X		
Bottom of channel eroding?		X		
Obstructed?		X		
Erosion protection?		X		
<b>d. Outflow Channel:</b>				
Are side slopes eroding?	X		Upper   lower 17° Slope   6° 25' W ~ 60' L to turn ± 80' L to bottom	
Are side slopes sloughing?		X		
Bottom of channel eroding?		X		
Obstructed?		X		
Erosion protection?				Sandstone DSD-12" some deterioration
<b>e. Weir:</b>				
Condition?				
<b>7. SPILLWAY/EMERGENCY</b>				
<b>a. Location:</b>				
Left abutment?			NA	
Right abutment?				
Crest of Embankments?				
<b>b. Approach Channel:</b>				
Are side slopes eroding?				
Are side slopes sloughing?				
Bottom of channel eroding?				
Obstructed?				
Erosion protection?				
<b>c. Spillway Channel:</b>				
Are side slopes eroding?				
Are side slopes sloughing?				
Bottom of channel eroding?				
Obstructed?				
Erosion protection?				
<b>d. Outflow Channel:</b>				
Are side slopes eroding?				
Are side slopes sloughing?				
Bottom of channel eroding?				
Obstructed?				
Erosion protection?				
<b>e. Weir:</b>				
Condition?				

ITEM	YES	NO	REMARKS
<b>8. IMPOUNDMENT</b>			
a. Sinkholes?		X	(Elev.) feet
b. Water present?		X	(Elev.) feet
c. Siltation?	X		
d. Watershed matches soil map?	X	X	

**9. GENERAL COMMENTS**

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Canopy Cover 20%  
 Ground Cover 35%

**APPENDIX B**  
**HYDROLOGY AND HYDRAULIC CALCULATIONS**

TIME OF CONCENTRATION

ELEVATION DIFFERENCE =  $6700 - 6603 = 97$  ft.

WATER COURSE LENGTH =  $4.1 (400) = 1640$  ft. = 0.311 mi.

$T_c = \left( \frac{11.9 (0.311)^3}{97} \right)^{0.385} = 0.116$  hr.

LAG TIME =  $0.6 T_c = 0.069$  hr.

SCS CURVE NUMBER

DRAINAGE AREA (ac)	COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
6.2	S-G	average	D	79 (.14)
11.7	P-J	average	D	83 (.26)
27.1	disturbed	—	D	94 (.60)
				89.04

100% ET #22

90

DRAINAGE BASIN AREA

45.0 ACRES

0.070 SQ. MILES

REVISIONS  
BY \_\_\_\_\_ DATE \_\_\_\_\_ TO EO \_\_\_\_\_  
BY \_\_\_\_\_ DATE \_\_\_\_\_ TO EO \_\_\_\_\_

BY \_\_\_\_\_ DATE 10-2-85  
CHECKED BY \_\_\_\_\_  
COPY TO EO \_\_\_\_\_

REVISIONS  
 BY      DATE      TO EO       
 BY      DATE      TO EO     

BY      DATE       
 CHECKED BY       
 COPY TO EO     

UNIVERSAL SOIL LOSS EQUATION

RAINFALL FACTOR

$R = 40$

SOIL ERODIBILITY FACTOR

SOIL TYPE = 100% EH #22 = .22

$K = 0.22$

SLOPE FACTOR

LENGTH (ft.)	Δ ELEV (ft.)	SLOPE (%)	LS
300	90	30	13.8 (.2)
800	110	13.8	6.31 (.5)
300	15	5	.93 (.3)
			<u><u>= 6.19</u></u>

COVER FACTOR

AREA (ac.)	COVER TYPE	% COVER	CANOPY (%)	WEIGHTED C
14%	S-G	40	25	.14 (.13)
26%	P-J	40	25	.26 (.14)
60%	disturbed	—	—	.60 (1.0)
				<u><u>C = .655</u></u>

EROSION CONTROL FACTOR

$P = 1.0$

SEDIMENT INFLOW

$A = 40 (.22) (6.19) (.655) (1.0) = 35.68 \text{ ton/acre/year}$

$A = (35.68) \left( \frac{1}{2047} \right) (45) (.95) = 0.745 \text{ acre-feet/year}$