

INSPECTION REPORT
Sedimentation Structure
N14-M
Kayenta Mine
Navajo County, Arizona
for
PEABODY COAL COMPANY



Dames & Moore
10139-011-22

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INTRODUCTION

Sedimentation Structure N14-M is a partially incised structure with an earthen embankment, designed and constructed in 1982 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 N14-M is shown on Plate I, Site Plan.

This inspection report contains information specific to Structure N14-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 N14-M 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 N14-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 N14-M has a 26.3-acre tributary drainage area and is located near Moenkopi Wash at the Kayenta Mine. The watershed is classified as 54% reclaimed, 33% disturbed, and 13% Pinion/Juniper.

EMBANKMENT

Structure N14-M is a homogeneous earthen embankment classified as a in-wash embankment. Physical characteristics of the embankment are listed in the following table:

Structure N14-M

Embankment	Alluvial Soils
Foundation	Alluvium
Right Abutment	Scoria (Shale)
Left Abutment	Scoria (Shale)
Height	9.0 ft
Crest Width	18 ft
Upstream Slope	2.0 H : 1 V (toward right abutment)
	1.7 H : 1 V (toward left abutment)
Downstream Slope	5.7 H : 1 V

A cross-section of the embankment is shown on Plate 2, Existing Maximum Cross Section N14-M, A-A'. Grass provides erosion protection on the upstream and downstream slopes of the embankment.

ANALYSES

STABILITY

Structure N14-M is a category C-1 embankment. A standard category C-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 = 15 ft
2. Maximum upstream slope = 1.75 H : 1 V
3. Maximum downstream slope = 3.25 H : 1 V
4. Normal pool with steady seepage saturation conditions

The downstream slope is lower in height and has a flatter slope than the category standard. 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 N14-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 N14-M was analyzed using the 10-year, 24-hour storm.

N14-M 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	41	48
Volume acre-ft	1.67	1.34
Storage		
Peak Stage ft	6577.76	6586.44
Spillway Elevation . . ft	6585.00	—
Peak Storage acre-ft	1.67	—
Storage Capacity . . . acre-ft	4.75	—
Outflow		
Peak Flow cfs	0	7
Embankment Crest		
Elevation ft	—	6585.80
Peak Stage ft	—	6586.44
Spillway Bottom Width. ft	—	15*
Freeboard ft	—	Overtop
Mannings "n"	—	0.040

*Existing spillway dimension

Spillway Channel

The existing spillway for N14-M has a U-shaped channel with the following dimensions:

Channel depth 1 ft
Channel width 15 ft
Channel length 25 ft
Average exit slope 0 percent

There is presently no erosion protection within the channel.

Outflow Channel

The existing outflow channel for N14-M has a U-shaped channel with the following dimensions:

Channel width 15 ft
Channel length 95 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, N14-M.

The calculations for the sediment load entering Structure N14-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 4.60
4. Cover Factor, C 0.712
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 N14-M and the results of the sediment inflow analysis are summarized in the following table.

N14-M STORAGE

Total Storage Capacity	4.75	acre-ft
10-year, 24-hour Storm Inflow	1.67	acre-ft
Available Sediment Storage Capacity	3.08	acre-ft
Sediment Inflow Rate	0.352	acre-ft/yr
Sediment Storage Life	9	yrs

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure N14-M indicated that the only geotechnical problem is rill and gully erosion on the upstream slope, the side slopes of the outlet channel and the left abutment. Correction of erosion is considered a periodic maintenance task and does not require remedial action. The upstream slope should be flattened to 1.75 horizontal to 1 vertical to meet stability requirements.

HYDRAULICS

The storage capacity of Structure N14-M is adequate but the spillway capacity is inadequate. The structure does not have an adequate outflow channel. The bottom elevation of the existing spillway channel should be lowered to elevation 6583.5 feet and the bottom width increased to 30 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 6583.5 feet decreases the storage capacity and increases the freeboard. The analysis of these conditions is summarized in the following table.

N14-M HYDRAULICS FOR REDESIGNED SPILLWAY

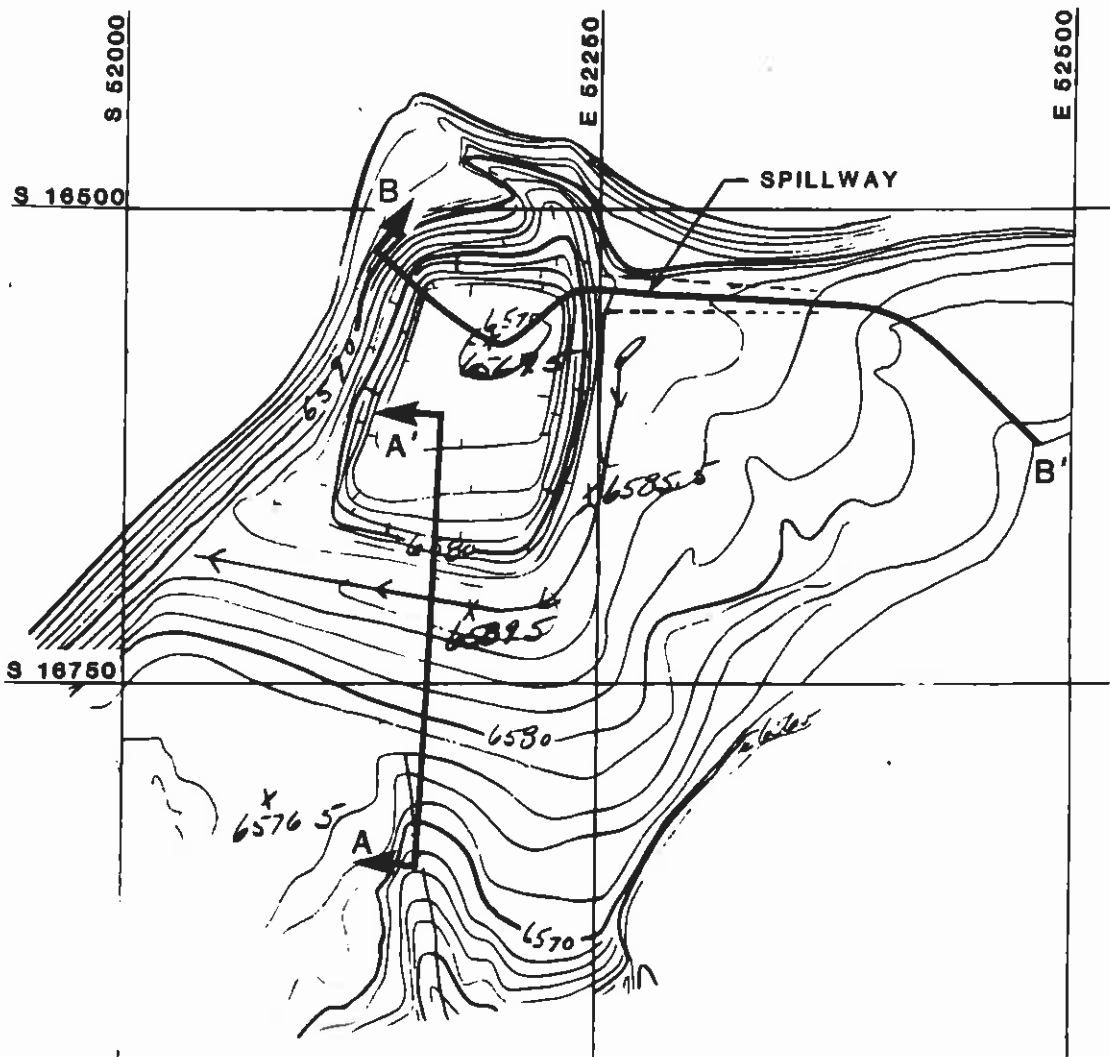
	Units	10-year 24-hour Storm	25-year 6-hour Storm
Initial Reservoir Volume			
Condition		Empty	Full to the spillway elevation
Inflow			
Peak Flow	cfs	41	48
Volume	acre-ft	1.67	1.34
Storage			
Peak Stage	ft	6577.76	6584.48
Spillway Elevation . .	ft	6583.50	—
Peak Storage	acre-ft	1.67	—
Storage Capacity . . .	acre-ft	4.00	—
Available Sediment			
Storage Capacity . .	acre-ft	2.33	—
Sediment Inflow Rate .	acre-ft/yr	0.352	—
Sediment Storage Life.	yrs	7	—
Outflow			
Peak Flow	cfs	0	18
Embankment Crest			
Elevation	ft	—	6585.80
Peak Stage	ft	—	6584.48
Freeboard	ft	—	1.32
Spillway Channel			
Flow Depth	ft	—	0.98
Critical Velocity . . .	fps	—	2.9
Bottom Width	ft	—	30*
Manning's "n"		—	0.035
Outflow Channel			
Slope	%	—	<u>Section I</u> <u>Section II</u> 1 7
Normal Velocity	fps	—	2.1 3.8
Normal Depth	ft	—	0.35 0.20
Manning's "n"		—	0.035 0.035

*Proposed spillway dimension

* * *

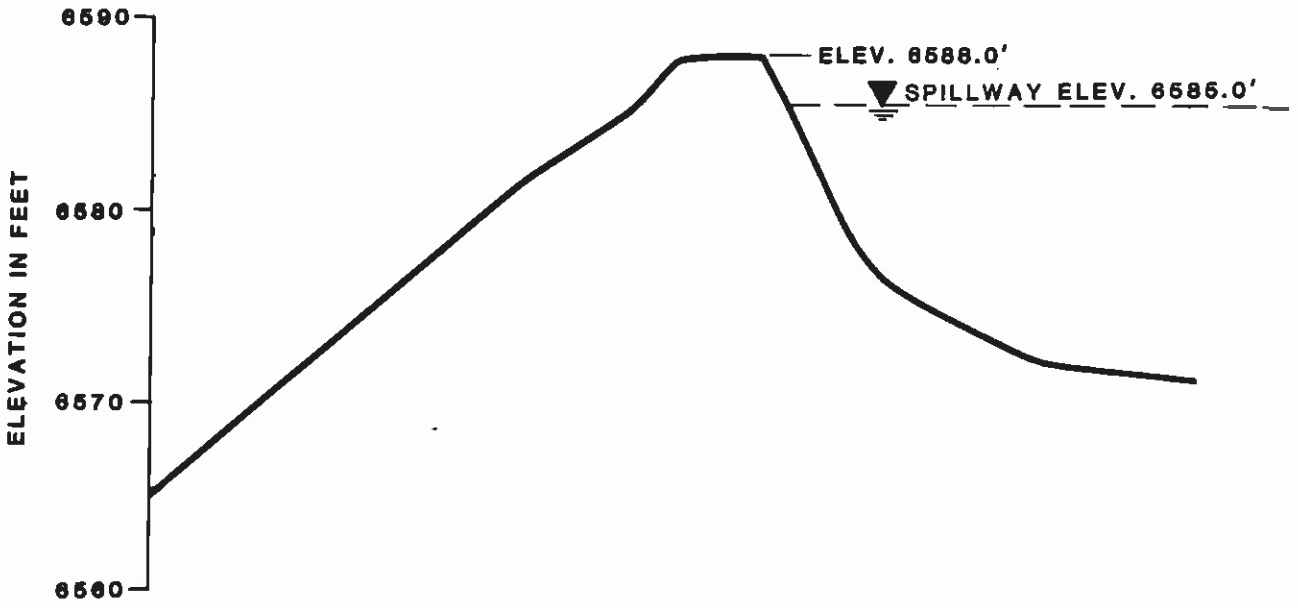
The following plates and appendix are attached and complete this inspection report.

- Plate 1 - Site Plan N14-M
- Plate 2 - Existing Maximum Cross Section N14-M, A-A'
- Plate 3 - Volume-Elevation Curve N14-M
- Plate 4 - Channel Profile N14-M, B-B'
- Plate 5 - Spillway and Outflow Channel Cross Section N14-M
- Appendix A - Inspection Check List
- Appendix B - Hydrology and Hydraulic Calculations



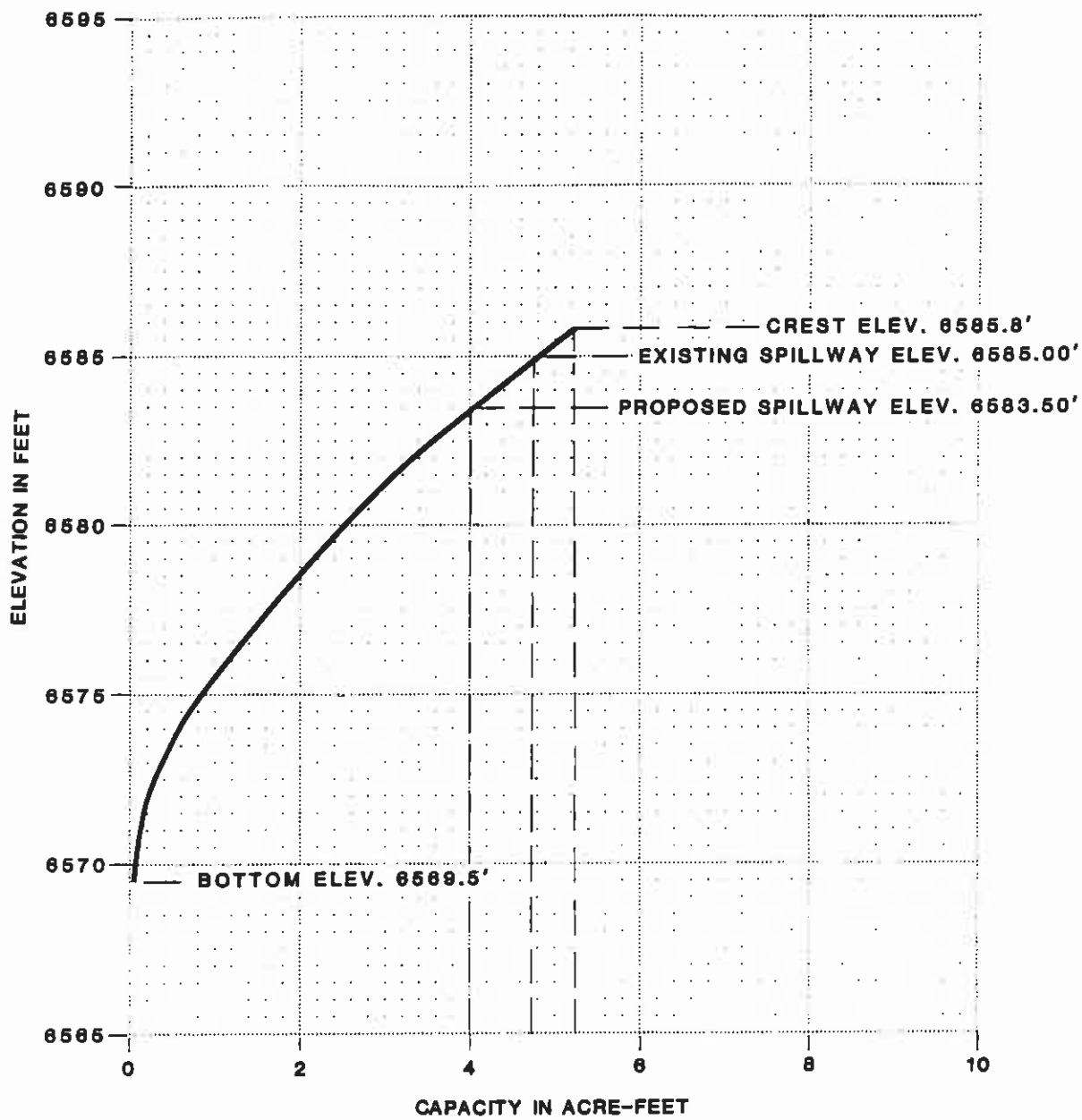
SITE PLAN
N14-M



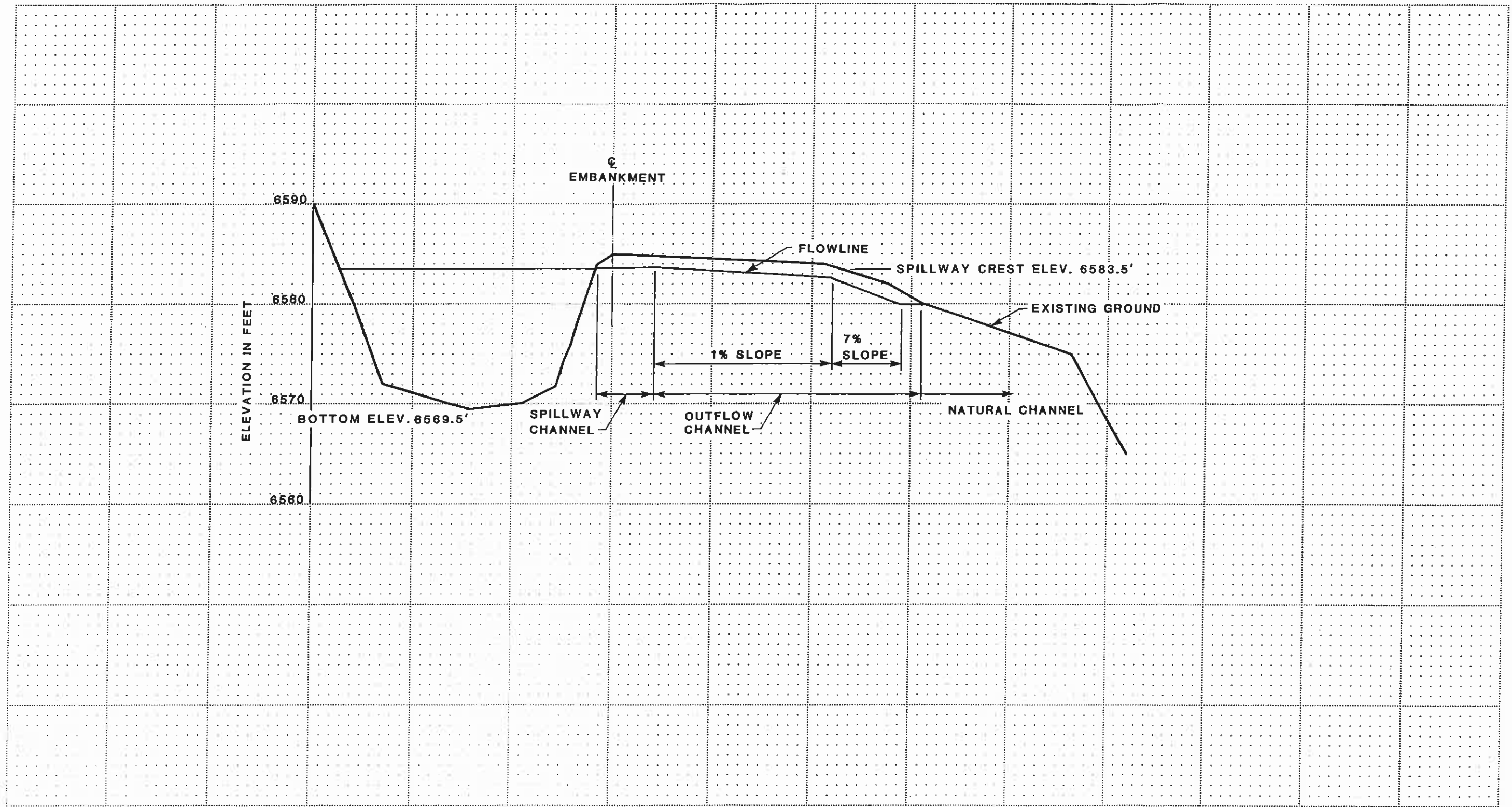


EXISTING
MAXIMUM CROSS-SECTION
A-A'
N14-M

FOR LOCATION SEE PLATE 1



VOLUME-ELEVATION
 CURVE
 N14-M



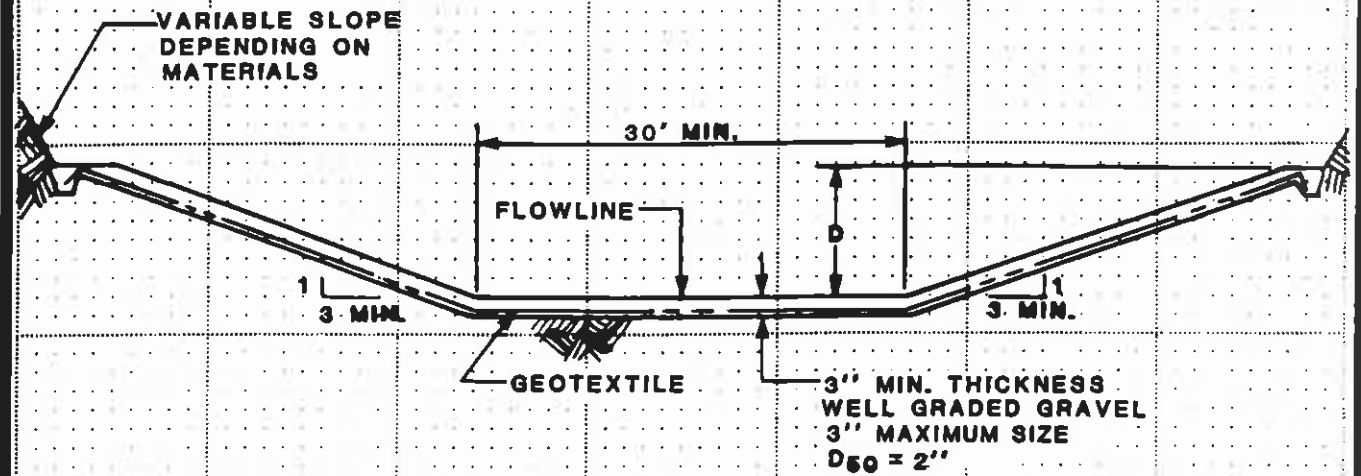
CHANNEL PROFILE B-B'
N14-M



FOR LOCATION SEE PLATE 1

BY **Dames & Moore**

Plate 4



SPILLWAY CHANNEL

D = 2.0'

LENGTH = 30'

FLOWLINE ELEV. = 6583.50'

OUTFLOW CHANNEL

D = 1.5'

**SPILLWAY AND
OUTFLOW CHANNEL
CROSS SECTION
N14-M**

APPENDIX A
INSPECTION CHECK LIST

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			18' w
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE			Left side 30° Right side 27°
a. Adequate grass cover?			No Yes 30%
b. Any erosion?			Yes Gulleys Yes Rills
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Adequate riprap protection?			No Yes
g. Any stone deterioration?			NA
h. Visual depressions or bulges?		X	
i. Visual settlements?		X	
j. Animal burrows?		X	
3. DOWNSTREAM SLOPE			70% 10°
a. Adequate grass cover?	X		
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	Note: No downstream slope left side
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?			Skoria Talus slope
5. ABUTMENT CONTACT. LEFT			
a. Any erosion?	X		3 large gulleys into spillway
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			Reclaim Fill slope

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?			
Obstructed?			
Erosion protection?			
c. Spillway Channel:	X		Poorly defined 1' below Crest
Are side slopes eroding?		X	15' W 25' L
Are side slopes sloughing?		X	Slope 0%
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?	X		Grass (partial)
d. Outflow Channel:	X		Poorly defined 15' W 95' L
Are side slopes eroding?	X		Rills from reclaim slope
Are side slopes sloughing?		X	Slope 5%
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?		X	
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

Spillway need checking + grading Outlet channel
 needs grading - runs into another pond at 100'
 from spillway should be turned into wash
 before that (at 90')

Canopy = 5%

Grass 30%

APPENDIX B
HYDROLOGY AND HYDRAULIC CALCULATIONS

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 6725 - 6585 = 140 ft.

WATER COURSE LENGTH = 3.0(400) = 1200 ft. = 0.227 mi.

$$T_c = \left(\frac{11.9 (0.227)^3}{140} \right)^{0.385} = 0.070 \text{ hr.}$$

LAG TIME = 0.6 T_c = 0.042 hr.

SCS CURVE NUMBER

DRAINAGE AREA (ac)	COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
14.3	post law reclaimed	fair	D	81 (.51)
6.6	road	—	D	89 (.25)
3.4	P-J	poor	D	89 (.13)
2.0	disturbed	—	—	94 (.08)
100% EM # 25				850

use 85

DRAINAGE BASIN AREA

26.3 ACRES 0.0411 SQ. MILE

REVISIONS

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

BY S. DALAN DATE 10-2-85
 CHECKED BY _____ COPY TO EO _____

UNIVERSAL SOIL LOSS EQUATION

RAINFALL FACTOR

$R = 40$

SOIL ERODIBILITY FACTOR

SOIL TYPE = 100% EH #25 = .22

$K = \underline{\underline{.22}}$

SLOPE FACTOR

<u>LENGTH (ft.)</u>	<u>Δ ELEV (ft.)</u>	<u>SLOPE (%)</u>	<u>LS</u>
250	25	10'	2.17 (.15)
600	70	11.7	4.23 (.8)
200	80	40	17.84 (.05)
			<u>4.60</u>

COVER FACTOR

<u>AREA (ac.)</u>	<u>COVER TYPE</u>	<u>% COVER</u>	<u>CANOPY (%)</u>	<u>WEIGHTED C</u>
54%	reclaimed	—	—	.54 (.15)
33%	disturbed	—	—	.33 (.10)
13%	P-J	10	25	.13 (.40)
				<u>C = .712</u>

EROSION CONTROL FACTOR

$P = 1.0$

SEDIMENT INFLOW

$A = 40(.22)(4.60)(.712)(1.0) = 23.8 \text{ ton/acre/year}$

$A = (23.8) \left(\frac{1}{2047} \right) (26.3)(.95) = 0.352 \text{ acre-feet/year}$

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

BY _____ DATE _____
 CHECKED BY _____
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