

INSPECTION REPORT
Sedimentation Structure
N6-F
Black Mesa Mine
Navajo County, Arizona
for
PEABODY COAL COMPANY



Dames & Moore
10139-011-22

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INTRODUCTION

Sedimentation Structure N6-F 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 Black Mesa Mine. The location of Structure N6-F is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure N6-F. 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 N6-F was inspected on September 13, 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 N6-F 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 N6-F has a 88.2-acre tributary drainage area and is located near Moenkopi Wash at the Black Mesa Mine. The watershed is classified as 51% Pinion/Juniper and 49% reclaimed.

EMBANKMENT

Structure N6-F is a homogeneous earthen embankment classified as a cross-valley embankment. Physical characteristics of the embankment are listed in the following table:

<u>Structure N6-F</u>	
Embankment	Residual Shale Soils
Foundation	Residual Shale Soils/Alluvium
Right Abutment	Residual Shale Soils
Left Abutment	Residual Shale Soils
Height	12.8 ft
Crest Width	13 ft
Upstream Slope	2.4 H : 1 V
Downstream Slope	4.3 H : 1 V

A cross-section of the embankment is shown on Plate 2, Existing Maximum Cross Section N6-F, A-A'.

ANALYSES

STABILITY

Structure N6-F 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 = 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 N6-F 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 N6-F 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 N6-F was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1.	Water Course length, L	0.500	mi
2.	Elevation Difference, H	215	ft
3.	Time of Concentration, T_c	0.147	h
4.	Lag time, $0.6T_c$	0.088	h
5.	SCS Curve Number	86	
6.	Rainfall Depth, 10-year, 24-hour storm	2.1	in.
	25-year, 6-hour storm.	1.9	in.
7.	Drainage Area	88.2	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.

N6-F 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	130	161
Volume acre-ft	6.69	5.66
Storage		
Peak Stage ft	6755.55	6757.11
Spillway Elevation . . ft	6755.30	--
Peak Storage acre-ft	--	--
Storage Capacity . . . acre-ft	5.23	--
Outflow		
Peak Flow cfs	2	113
Embankment Crest		
Elevation ft	--	6760.08
Peak Stage ft	--	6757.11
Freeboard ft	--	2.97

Spillway Channel

The existing spillway for N6-F has a trapezoidal channel with the following dimensions:

Channel depth	5.8 ft
Channel width	36 ft
Channel length	36 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 N6-F has a trapezoidal channel with the following dimensions:

Channel width	36 ft
Channel length	150 ft
Side slopes (horizontal to vertical). .	2:1
Average exit slope	10 percent

Rock of D50 8-inch size provides some but inadequate 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, N6-F.

The calculations for the sediment load entering Structure N6-F were made utilizing the Universal Soil Loss Equation with the following parameters:

1. Rainfall Factor, R 40
2. Soil Erodibility Factor, K 0.318
3. Slope Factor, LS 5.64
4. Cover Factor, C 0.278
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 N6-F and the results of the sediment inflow analysis are summarized in the following table.

N6-F STORAGE

Total Storage Capacity	5.23	acre-ft
10-year, 24-hour Storm Inflow	6.69	acre-ft
Available Sediment Storage Capacity	0	acre-ft
Sediment Inflow Rate	0.816	acre-ft/yr
Sediment Storage Life	0	yrs

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure N6-F indicated that geotechnical problems consist of rill and gully erosion on the upstream and downstream slopes, the side slopes of the spillway channel and the right abutment and evidence of seepage below the toe of the downstream slope of the embankment. Correction of erosion is considered a periodic maintenance task and does not

require remedial action. The seepage does not present a problem at the present time, however, future inspections should record any changes in both the extent and/or sediment in the flow.

HYDRAULICS

The spillway capacity of Structure N6-F is adequate but the storage capacity is inadequate. The structure does not have an adequate outflow channel. The storage capacity should be increased to 10.49 acre-feet by raising the spillway crest elevation to 6756.0 feet and by excavating the pond as shown on Plates 1 and 4. A trapezoidal outflow channel and stilling basin should be constructed along the alignment shown in Plate 1. The channel profile and stilling basin are shown in Plate 4 and the required dimensions are shown in Plate 5 and Plate 6. The spillway, outflow channel and stilling basin should be protected against erosion using geotextile and riprap as shown in Plate 5.

Enlarging the storage capacity to 10.49 acre-feet gives additional sediment storage. The analysis of these conditions is summarized in the following table.

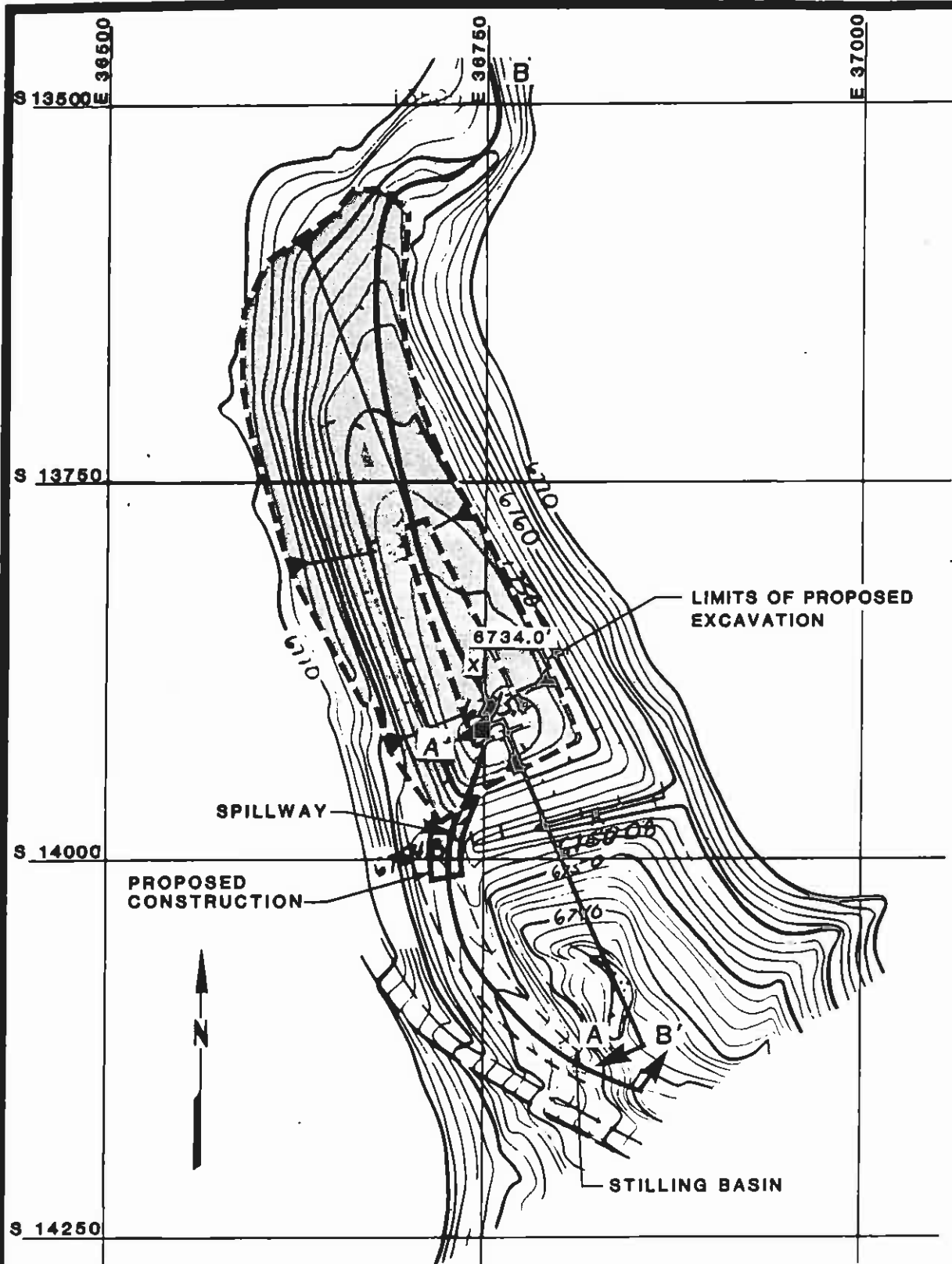
N6-F HYDRAULICS FOR REDESIGNED SPILLWAY
AND EXCAVATED IMPOUNDMENT

	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	130	161
Volume	acre-ft	6.69	5.66
Storage			
Peak Stage	ft	6751.77	6757.11
Spillway Elevation . .	ft	6756.00	--
Peak Storage	acre-ft	6.69	--
Storage Capacity . . .	acre-ft	10.49	--
Available Sediment			
Storage Capacity . .	acre-ft	3.80	--
Sediment Inflow Rate .	acre-ft/yr	0.816	--
Sediment Storage Life.	yrs	5	--
Outflow			
Peak Flow	cfs	0	102
Embankment Crest			
Elevation	ft	--	6760.08
Peak Stage	ft	--	6757.75
Freeboard	ft	--	2.33
Spillway Channel			
Flow Depth	ft	--	1.75
Critical Velocity . . .	fps	--	4.6
Manning's "n"		--	0.040
Outflow Channel			
Slope	%	--	<u>9</u> <u>39</u>
Normal Velocity	fps	--	6.6 10.6
Normal Depth	ft	--	0.48 0.32
Manning's "n"		--	0.040 0.040

* * *

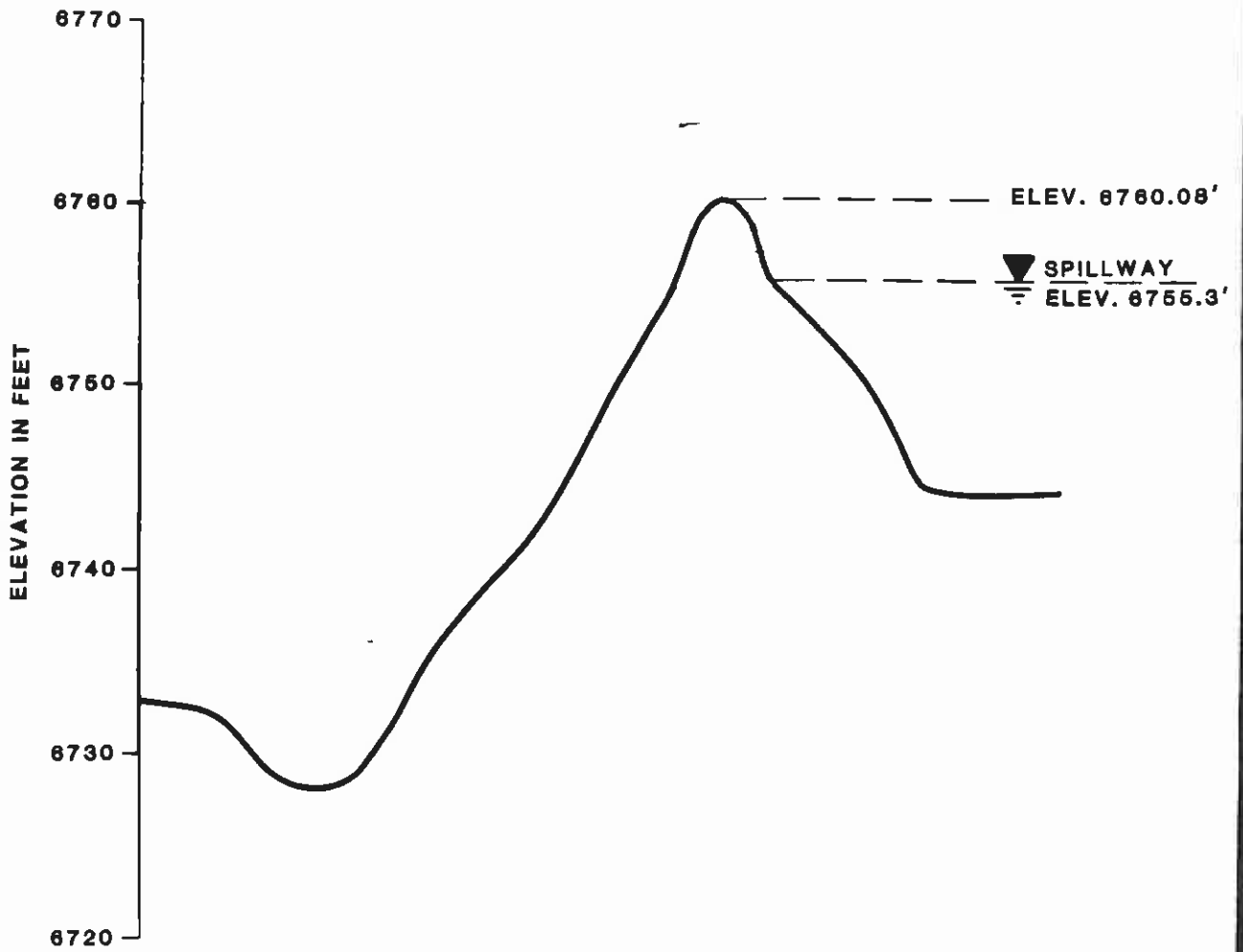
The following plates and appendix are attached and complete this inspection report.

- Plate 1 - Site Plan N6-F
- Plate 2 - Existing Maximum Cross Section N6-F, A-A'
- Plate 3 - Volume-Elevation Curve N6-F
- Plate 4 - Channel Profile N6-F, B-B'
- Plate 5 - Spillway and Outflow Channel Cross Section N6-F
- Plate 6 - Spillway Stilling Basin Plan N6-F
- Appendix A - Inspection Check List
- Appendix B - Hydrology and Hydraulic Calculations



**SITE PLAN
N6-F**





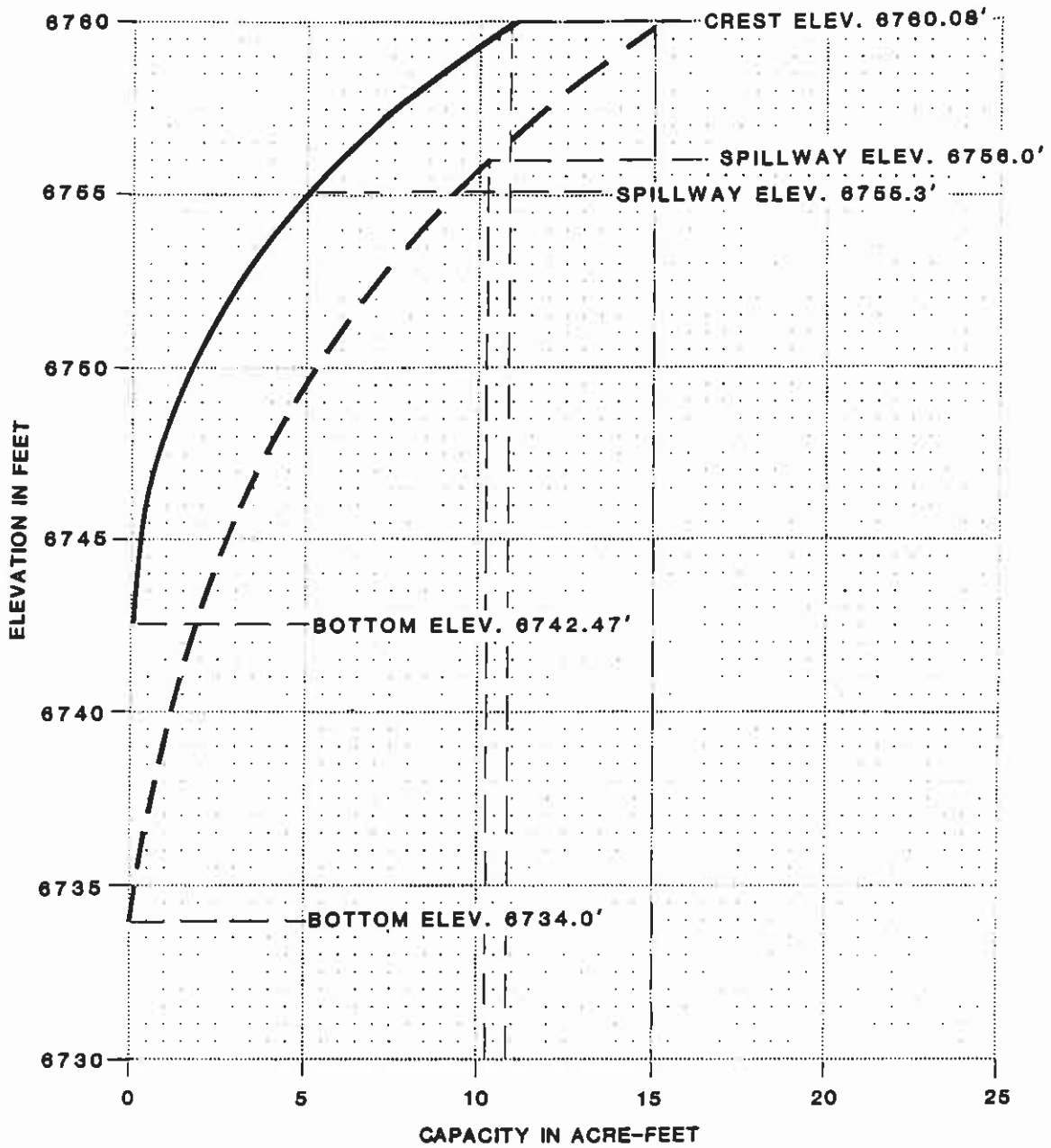
EXISTING
 MAXIMUM CROSS-SECTION
 A-A'
 N6-F



FOR LOCATION SEE PLATE 1

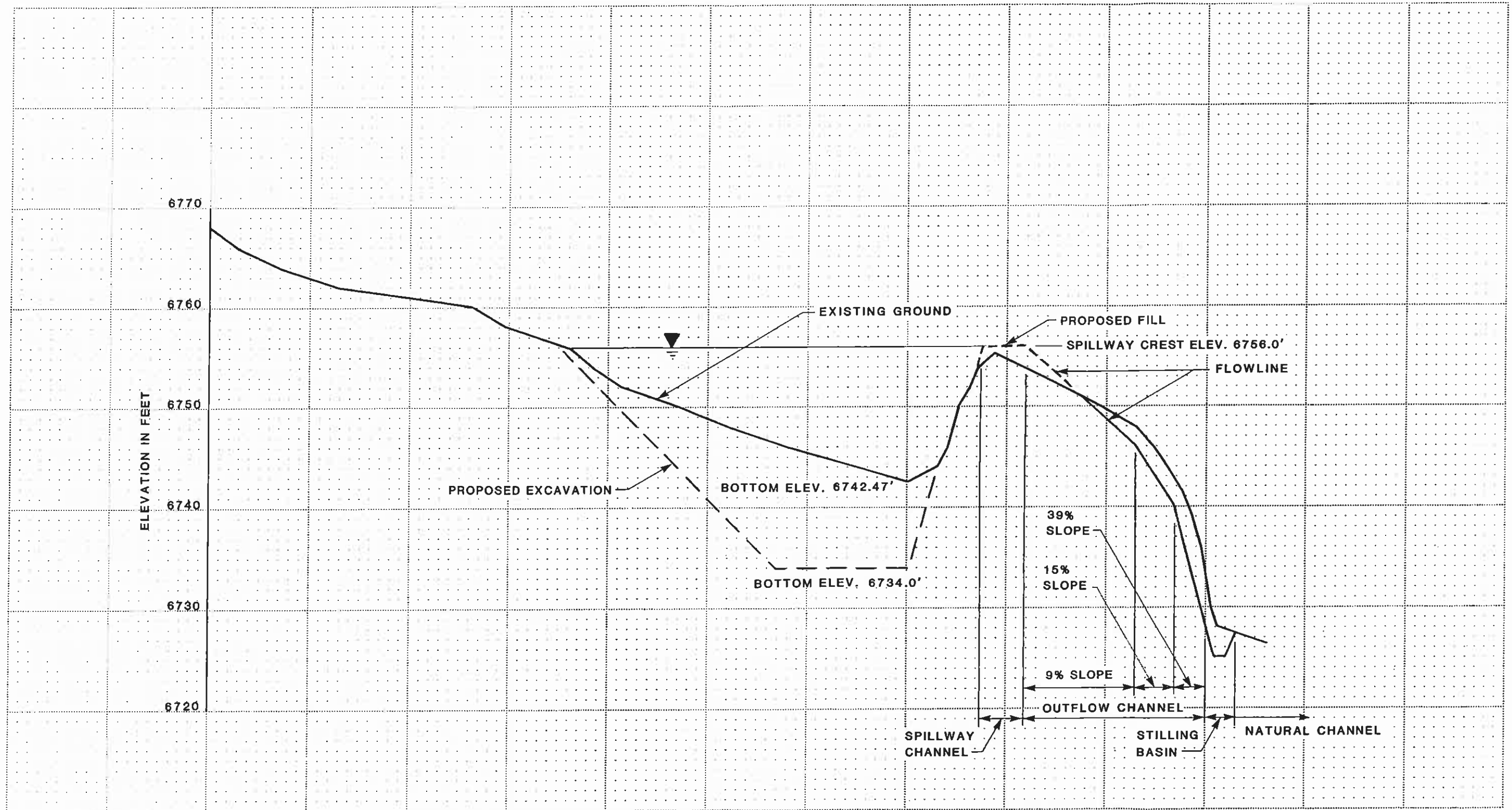
BY **Dames & Moore**

Plate 2

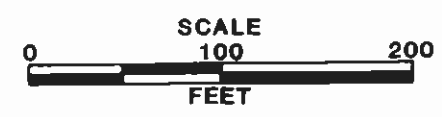


— EXISTING VOLUME
 - - - PROPOSED VOLUME

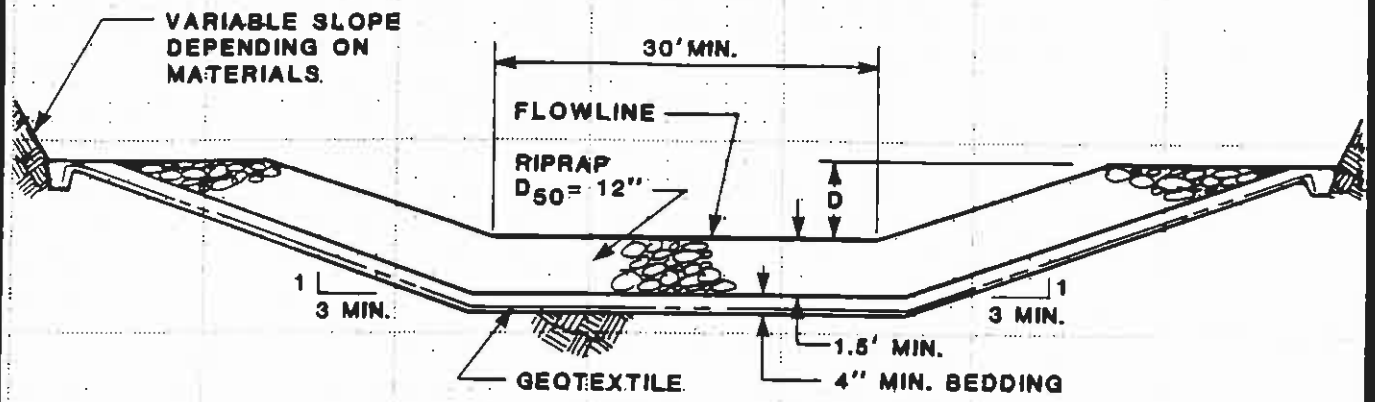
VOLUME-ELEVATION CURVE N6-F



CHANNEL PROFILE B-B'
N6-F



FOR LOCATION SEE PLATE 1



SPILLWAY CHANNEL

D = 2.8'

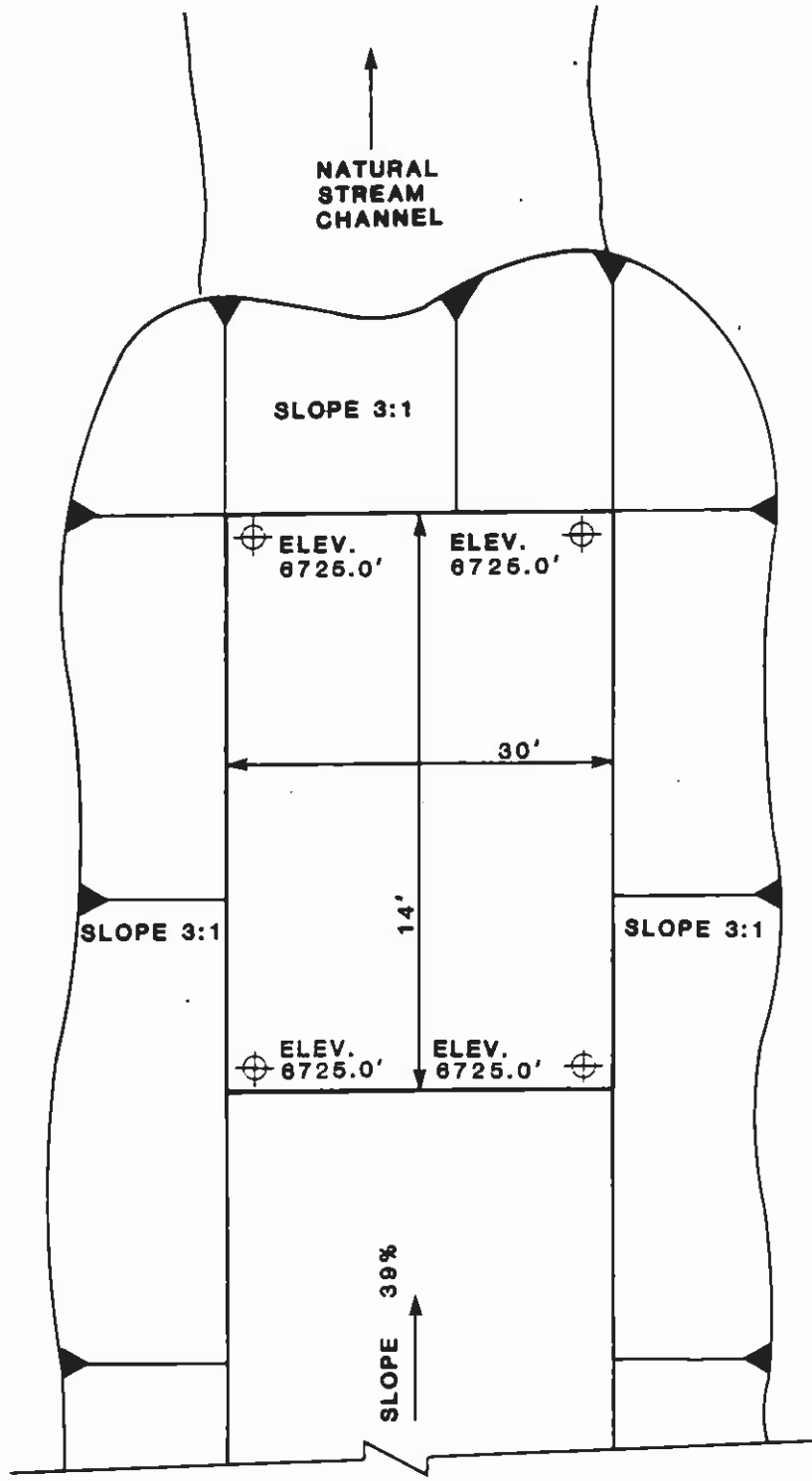
LENGTH = 40'

FLOWLINE ELEV. = 6756.00'

OUTFLOW CHANNEL

D = 1.5'

SPILLWAY AND
OUTFLOW CHANNEL
CROSS SECTION
N6-F



MINIMUM HEIGHT OF RIPRAP
ALONG SIDEWALLS ABOVE
THE BASIN FLOOR = 4.3'

MINIMUM DEPTH OF BASIN FLOOR
BELOW NATURAL STREAMBED = 2.2'

SPILLWAY STILLING BASIN PLAN N6-F

APPENDIX A
INSPECTION CHECK LIST

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			13' W
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE			somewhat uneven 23°
a. Adequate grass cover?		X	
b. Any erosion?	X		Rills + 1 sur. gully
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			13°
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		evidence of past seepage
l. Animal burrows?		X	
4. ABUTMENT CONTACT. RIGHT			
a. Any erosion?	X		Gullies + Rills into spillway
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			gray 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?	X		
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?	X		36' W 36' L 0° Slope 5.8' below Crest
Are side slopes sloughing?	X		Bills from RA & DAM
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?		X	
d. Outflow Channel:			
Are side slopes eroding?	X		36' W 10° Slope ± 150' Long
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?	X		Rock 0.50 - 8" breaking up
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		
d. Watershed matches soil map?		X	
9. GENERAL COMMENTS			

Canopy 30%
 Ground 30%

APPENDIX B
HYDROLOGY AND HYDRAULIC CALCULATIONS

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 6970 - 6755 = 215 ft.

WATER COURSE LENGTH = 6.6(400) = 2640 ft. = 0.500 mi.

$T_c = \left(\frac{11.9 (0.500)^3}{215} \right)^{0.385} = 0.147 \text{ hr.}$

LAG TIME = 0.6 T_c = 0.088 hr.

SCS CURVE NUMBER

<u>DRAINAGE AREA (ac)</u>	<u>COVER TYPE</u>	<u>HYDROLOGIC CONDITION</u>	<u>SOIL TYPE</u>	<u>WEIGHTED CURVE NUMBER</u>
44.8	P-J	poor	D	89(.51)
43.4	retained (post law)	fair	D	81(.49)
				<u>85.08</u>
			49% ET #35	
			51% ET #33	use <u>86</u>

DRAINAGE BASIN AREA

88.2 ACRES 0.138 SQ MILES

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

BY S. DOLAN DATE 10.2.15
 CHECKED BY _____
 COPY TO EO _____

UNIVERSAL SOIL LOSS EQUATION

RAINFALL FACTOR

$R = 40$

SOIL ERODIBILITY FACTOR

SOIL TYPE =	49% EH #35	.49 (.42)
	51% EH #33	.51 (.22)
		<u>.318</u>

$K = \underline{\underline{.318}}$

SLOPE FACTOR

<u>LENGTH (ft.)</u>	<u>Δ ELEV (ft.)</u>	<u>SLOPE (%)</u>	<u>LS</u>
600	30	5%	1.31 (.3)
500	120	24	12.3 (.3)
300	80	26.7	11.35 (.1)
400	25	6.25	1.42 (.3)
			<u>5.64</u>

COVER FACTOR

<u>AREA (ac.)</u>	<u>COVER TYPE</u>	<u>% COVER</u>	<u>CANOPY (%)</u>	<u>WEIGHTED C</u>
51%	P-J	10	25	.51 (.40)
49%	reclaimed	—	—	.49 (.15)
				<u>C = .278</u>

EROSION CONTROL FACTOR

$P = 1.0$

SEDIMENT INFLOW

$A = 40 (.318) (5.64) (.278) (1.0) = 19.94 \text{ ton/acre/year}$

$A = (19.94) \left(\frac{1}{2047} \right) (88.2) (.95) = .816 \text{ acre-feet/year}$

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

BY _____ DATE _____
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