

INSPECTION REPORT
Sedimentation Structure
N10-D
Kayenta Mine
Navajo County, Arizona

for
PEABODY COAL COMPANY



Dames & Moore
10139-011-22

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INTRODUCTION

Sedimentation Structure N10-D 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 N10-D is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure N10-D. 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 N10-D was inspected on September 7, 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 N10-D 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 N10-D has a 100.6-acre tributary drainage area and is located near Coal Mine Wash at the Kayenta Mine. The watershed is classified as 53% reclaimed, 35% Pinion/Juniper, and 10% disturbed.

EMBANKMENT

Structure N10-D is a homogeneous earthen embankment classified as a in-wash embankment. Physical characteristics of the embankment are listed in the following table:

Structure N10-D

Embankment	Residual Shale Soils
Foundation	Alluvium
Right Abutment	Haul Road Fill
Left Abutment	Residual Shale Soils
Height	10.3 ft
Crest Width	12 ft
Upstream Slope	2.0 H : 1 V
Downstream Slope . . .	2.9 H : 1 V

A cross-section of the embankment is shown on Plate 2, Existing Maximum Cross Section N10-D, A-A'. Grass provides erosion protection on the upstream and downstream slopes of the embankment.

ANALYSES

STABILITY

Structure N10-D is a category B-3 embankment. A standard category B-3 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 = 2.5 H : 1 V
4. Normal pool with steady seepage saturation conditions

The N10-D 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 N10-D is located downstream from Structure N10-D1. The two structures have a combined storage capacity that is greater than 20 acre-feet. Therefore, the spillway for N10-D was analyzed using the 100-year, 6-hour storm. The storage capacity of Structure N10-D was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

	<u>10-year, 24-hour Storm</u>	<u>100-year, 6-hour Storm</u>	
1. Water Course length, L	0.561	1.492	mi
2. Elevation Difference, H	168	278	ft
3. Time of Concentration, T	0.185	0.472	h
4. Lag time, $0.6T_c$	0.111	0.283	h
5. SCS Curve Number	86	84	
6. Rainfall Depth	2.1	2.4	in.
7. Drainage Area	100.6	286.8	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 10-year storm was routed through Structure N10-D1 and into Structure N10-D. The 100-year storm was analyzed without Structure N10-D1. The initial conditions and results of the analysis are summarized in the following table.

N10-D HYDRAULICS

	Units	10-year 24-hour Storm	100-year 6-hour Storm
<hr/>			
Initial Reservoir Volume			
Condition		Empty	Full to the spillway elevation
Inflow			
Peak Flow	cfs	145	428
Volume	acre-ft	7.91	8.30
Storage			
Peak Stage	ft	6579.49	6585.48
Spillway Elevation . .	ft	6582.37	—
Peak Storage	acre-ft	7.91	—
Storage Capacity . . .	acre-ft	14.8	--
Outflow			
Peak Flow	cfs	0	32
Embankment Crest			
Elevation	ft	—	6584.31
Peak Stage	ft	—	6585.48
Freeboard	ft	--	Overtop
<hr/>			

Spillway Channel

The existing spillway for N10-D has a trapezoidal channel with the following dimensions:

Channel depth	2 ft
Channel width	22 ft
Channel length	40 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 structure presently has no outflow 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, N10-D.

The calculations for the sediment load entering Structure N10-D were made utilizing the Universal Soil Loss Equation with the following parameters:

1. Rainfall Factor, R 40
2. Soil Erodibility Factor, K 0.326
3. Slope Factor, LS 9.00
4. Cover Factor, C 0.232
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 N10-D and the results of the sediment inflow analysis are summarized in the following table.

N10-D STORAGE

Total Storage Capacity	14.8	acre-ft
10-year, 24-hour Storm Inflow	7.91	acre-ft
Available Sediment Storage Capacity . .	6.89	acre-ft
Sediment Inflow Rate	1.21	acre-ft/yr
Sediment Storage Life	6	yrs

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure N10-D indicated that the geotechnical problems consist of rill erosion on the upstream and downstream slopes and an uneven embankment crest and downstream slope. Correction of erosion is considered a periodic maintenance task and does not require remedial action. The crest and the downstream slope should be trimmed level and smooth, respectively, to prevent masking of potential future problems.

HYDRAULICS

The storage capacity of Structure N10-D 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 6581.5 feet while maintaining the bottom width of 20 feet as shown on Plate 5. The pond should be excavated to maintain the storage capacity. The embankment crest should be raised to elevation 6586.00 feet. 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 riprap as shown in Plate 5.

Lowering the spillway elevation to 6581.5 feet, along with excavating the pond and raising the embankment changes the storage capacity and the freeboard. The analysis of these conditions is summarized in the following table.

N10-D HYDRAULICS FOR REDESIGNED SPILLWAY,
EXCAVATED POND AND RAISED EMBANKMENT

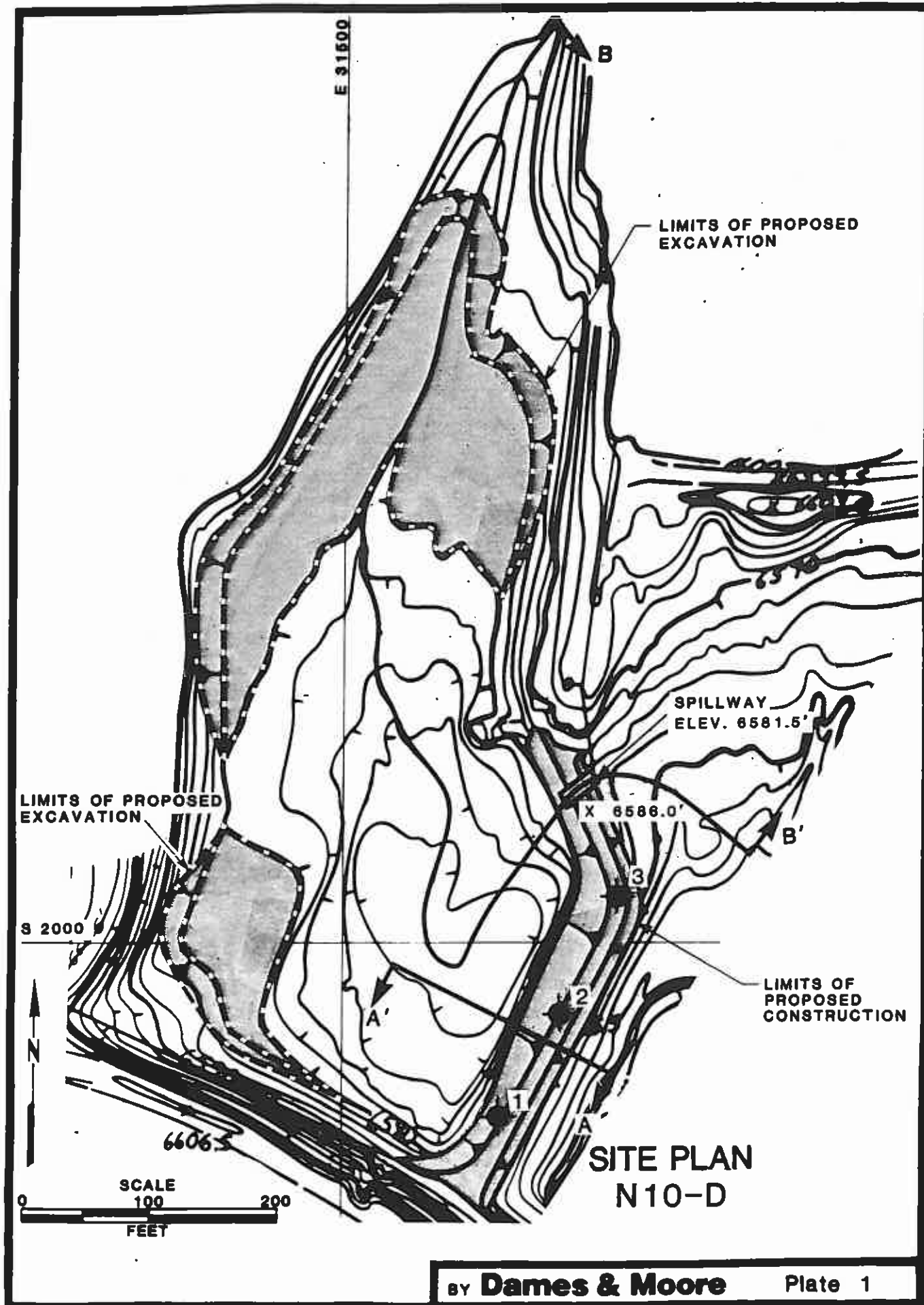
		10-year 24-hour Storm	100-year 6-hour Storm
Units			
<hr/>			
Initial Reservoir Volume			
Condition		Empty	Full to the spillway elevation
Inflow			
Peak Flow	cfs	145	428
Volume	acre-ft	7.88*	8.30
Storage			
Peak Stage	ft	6579.18	6584.47
Spillway Elevation . .	ft	6581.50	—
Peak Storage	acre-ft	7.88	—
Storage Capacity . . .	acre-ft	14.70	--
Available Sediment			
Storage Capacity . .	acre-ft	6.82	—
Sediment Inflow Rate .	acre-ft/yr	1.21	--
Sediment Storage Life.	yr	6	--
Outflow			
Peak Flow	cfs	0	41
Embankment Crest			
Elevation	ft	--	6586.00
Peak Stage	ft	--	6584.47
Freeboard	ft	—	1.53
Spillway Channel			
Flow Depth	ft	—	2.97
Critical Velocity. . .	fps	--	6.5
Manning's "n"		—	0.040
Outflow Channel			
Slope	%	--	6
Normal Velocity. . . .	fps	—	9.1
Normal Depth	ft	—	1.17
Manning's "n"		—	0.040

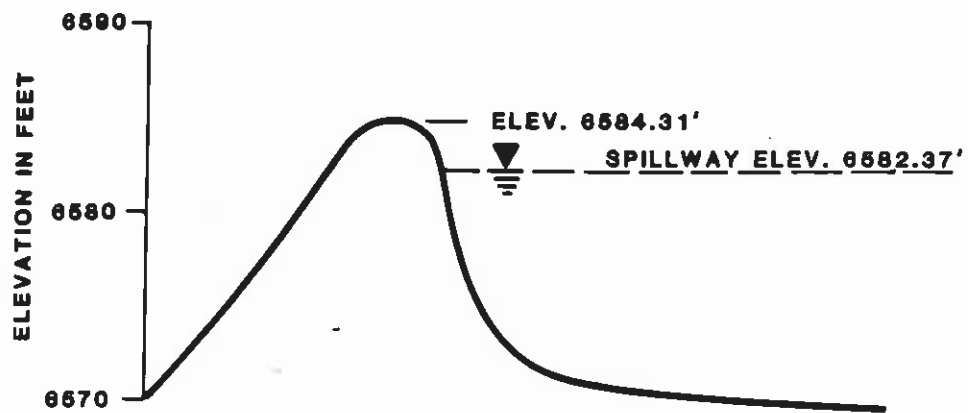
*Inflow volume for the area between Structures N10-D and N10-D1.
Structure N10-D1 contains the 10-year storm and does not
contribute flow to N10-D.

* * *

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

- Plate 1 - Site Plan N10-D
- Plate 2 - Existing Maximum Cross Section N10-D, A-A'
- Plate 3 - Volume-Elevation Curve N10-D
- Plate 4 - Channel Profile N10-D, B-B'
- Plate 5 - Spillway and Outflow Channel Cross Section N10-D
- Appendix A - Inspection Check List
- Appendix B - Hydrology and Hydraulic Calculations



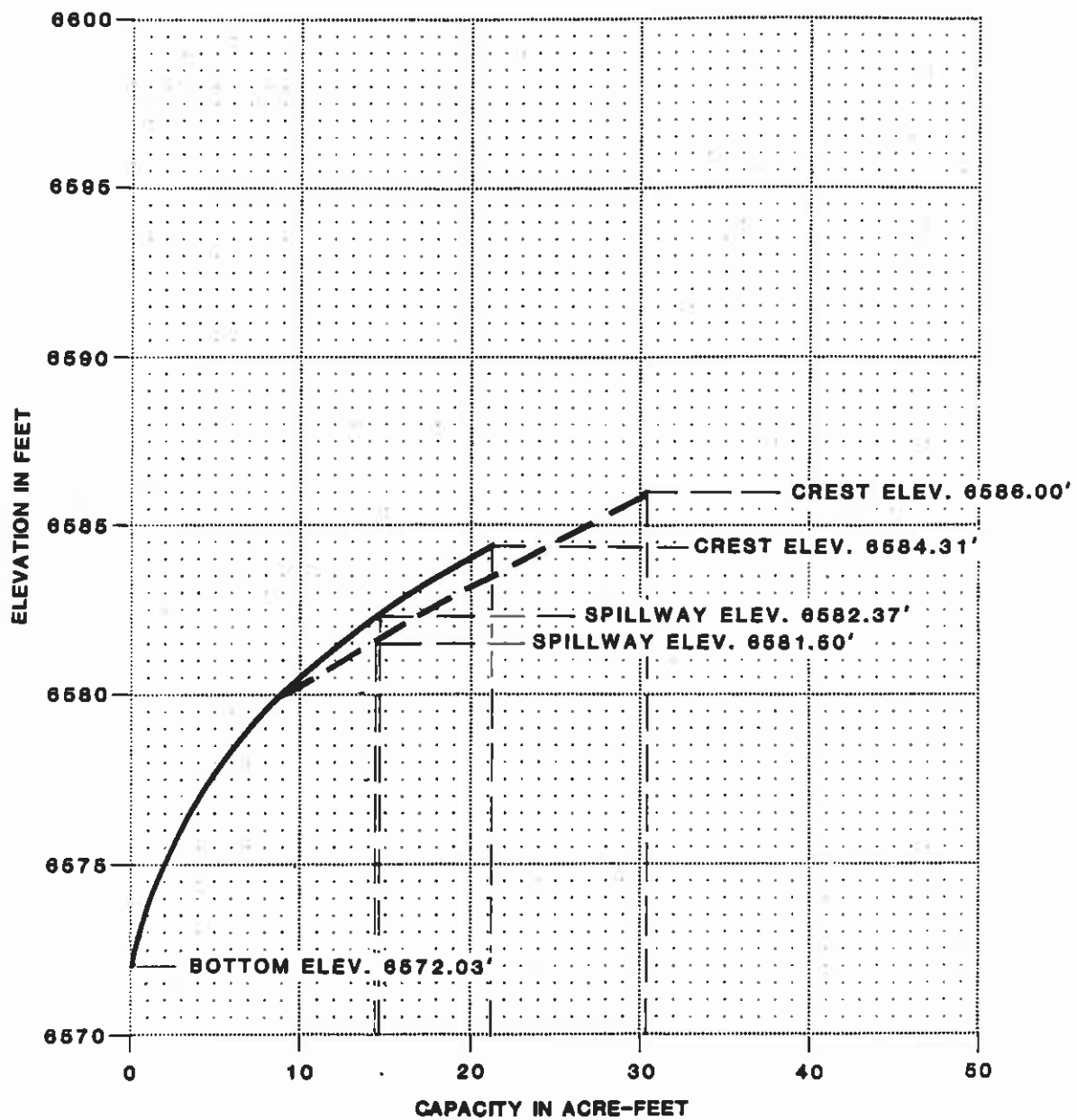


EXISTING
MAXIMUM CROSS-SECTION
A-A'
N10-D

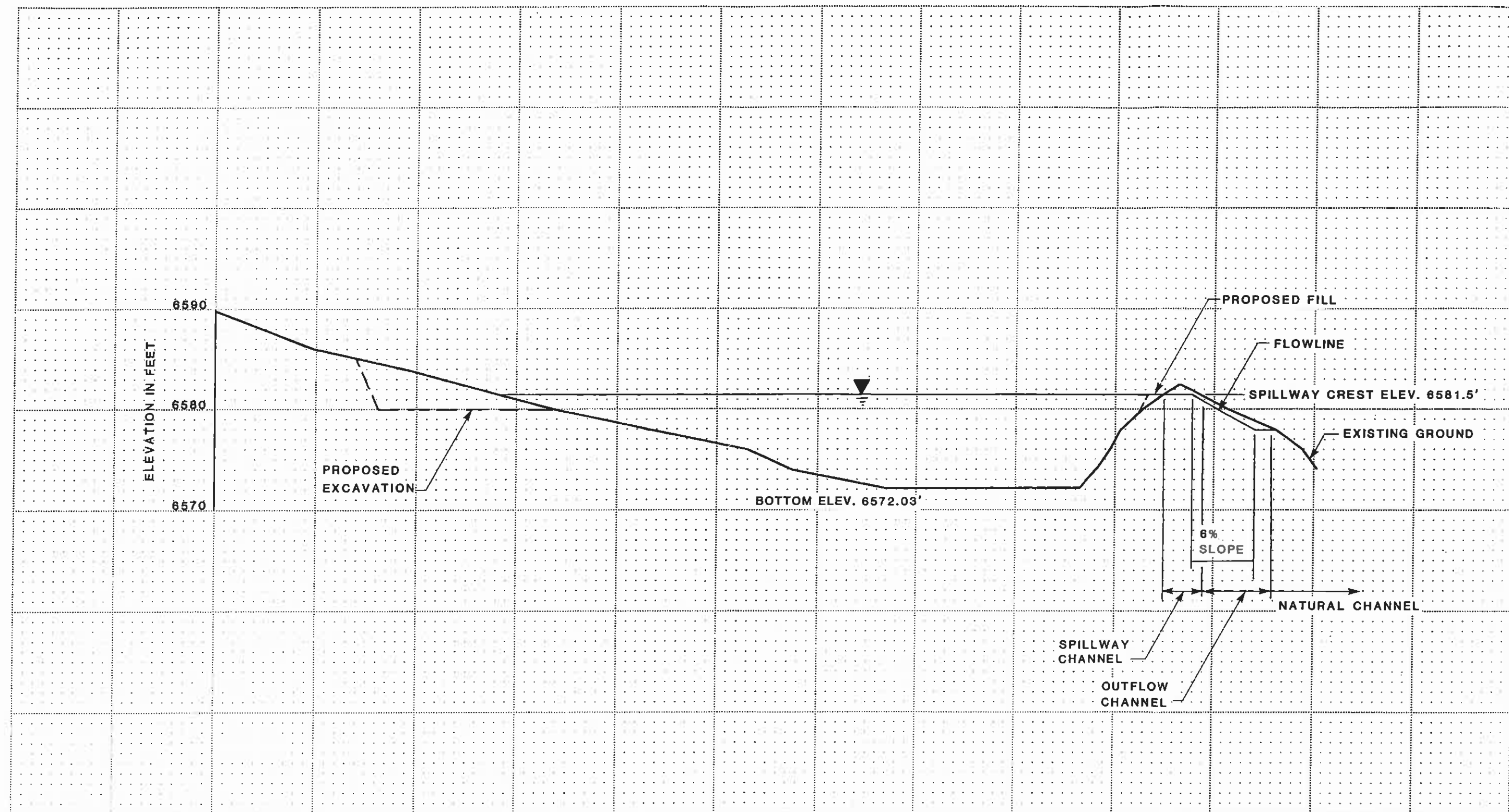
FOR LOCATION SEE PLATE 1

BY **Dames & Moore**

Plate 2



VOLUME-ELEVATION CURVE N10-D



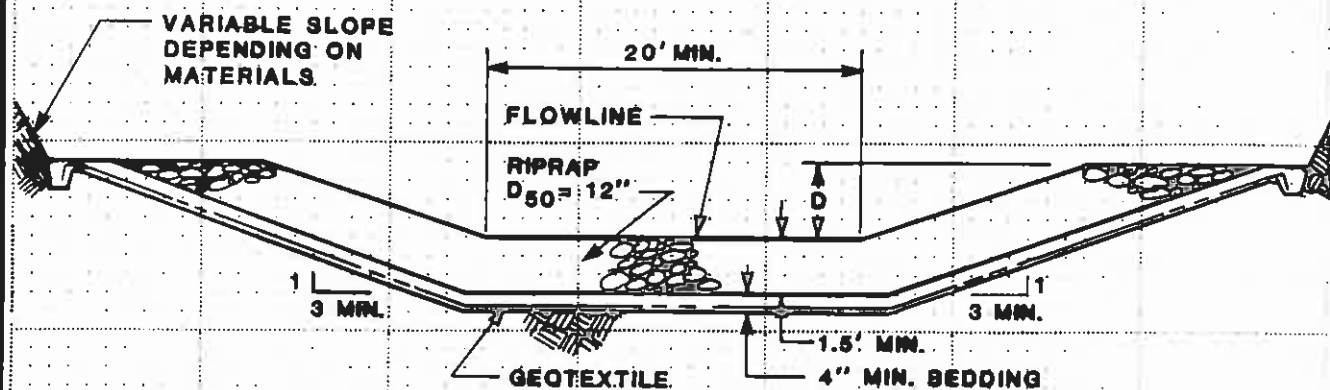
SCALE
0 100 200
FEET

CHANNEL PROFILE B-B'
N10-D

FOR LOCATION SEE PLATE 1

BY **Dames & Moore**

Plate 4



SPILLWAY CHANNEL

$D = 2.6'$
 LENGTH = 40'
 FLOWLINE ELEV. = 8581.50'

OUTFLOW CHANNEL

$D = 1.5'$

**SPILLWAY AND
 OUTFLOW CHANNEL
 CROSS SECTION
 N10-D**

APPENDIX A

INSPECTION CHECK LIST

INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			12'W. Uneven top-bumpy
a.. Any visual settlements?			
b. Misalignment?			
c. Cracking?			
2. UPSTREAM SLOPE			27°
a. Adequate grass cover?	X		75-80
b. Any erosion?	X		12ills
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Adequate riprap protection?	X		Grass
g. Any stone deterioration?			NA
h. Visual depressions or bulges?		X	
i. Visual settlements?		X	
j. Animal burrows?		X	
3. DOWNSTREAM SLOPE			19°
a. Adequate grass cover?		X	uneven slope bumpy
b. Any erosion?	X		12ills
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?			Fill of Haul Road
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 silty

ITEM	YES	NO	REMARKS
6. SPILLWAY/NORMAL			Old gaging station U.S. of POWR
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		Partly defined $\approx 22'$ w 40' L 2' below crest Slope 0
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?	X		Partly overgrown with bushes
Erosion protection?		X	
d. Outflow Channel:		X	
Are side slopes eroding?			
Are side slopes sloughing?			
Bottom of channel eroding?			
Obstructed?			
Erosion protection?			
e. Weir:		X	
Condition?			
7. SPILLWAY/EMERGENCY			NH
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

Note: Looked for and did not find transverse crack reported 3-18-85. Crest very uneven - could be due to settlement or poor construction. Spillway poorly defined.

Ground Cover 85 %
 Canopy Cover 15 %

APPENDIX B
HYDROLOGY AND HYDRAULIC CALCULATIONS

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 6750 - 6582 = 168 ft.

WATER COURSE LENGTH = 7.4(400) = 2960 ft. = 0.561 mi.

$T_c = \left(\frac{11.9 (0.561)^3}{168} \right)^{0.385} = 0.185 \text{ hr.}$

LAG TIME = $0.6 T_c = 0.111 \text{ hr.}$

SCS CURVE NUMBER

DRAINAGE AREA (ac)	COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
37.8	P-J	average	D	83 (.37)
9.8	Gravel Road		D	91 (.10)
53.0	pre-law Reclaimed	poor		87 (.53)
				<u>85.92</u>
53% #35				
47% #25				
				use <u><u>86</u></u>

DRAINAGE BASIN AREA

100.6 ACRES 0.157 SQ MILE

REVISIONS

BY DATE TO EO
 BY DATE TO EO

BY S. DOLAN DATE 9-23-85
 CHECKED BY
 COPY TO EO

100yr 6hr EVENT
 (EXCLUDES N10-D1 POND UPSTREAM
 BUT INCLUDES N10-D1 AREA)

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 6860 - 6582 = 278 ft.

WATER COURSE LENGTH = 19.7(400) = 7880 ft. = 1.492 mi.

$T_c = \left(\frac{11.9 (1.492)^3}{278} \right)^{0.385} = 0.472 \text{ hr.}$

Lag Time = $0.6 T_c = 0.283 \text{ hr.}$

SCS CURVE NUMBER

	DRAINAGE AREA (ac)	COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
N10-D {	37.8				83 (0.13)
	9.8				91 (0.03)
	53.0				87 (0.30)
N10-D1 {	55.9	15-17			87 (0.30)
	130.3				81 (0.46)
					<u>83.4</u>
					use <u><u>84</u></u>

DRAINAGE BASIN AREA

286.8 ACRES 0.448 SQ MILE

REVISIONS

BY DATE TO EO
 BY DATE TO EO

BY S. DCLAN DATE 11-6-85
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UNIVERSAL SOIL LOSS EQUATION

RAINFALL FACTOR

$$K = 40$$

SOIL ERODIBILITY FACTOR

SOIL TYPE =	53% reclaimed	.53 (.42)
	47% #25	.47 (.22)
		<u>.326</u>

$$K = \underline{\underline{.326}}$$

SLOPE FACTOR

LENGTH (ft)	Δ ELEV (ft)	SLOPE (%)	LS
440	110	25	12.4 (.3)
500	100	12.5	5.5 (.4)
700	135	19.3	<u>10.2 (.3)</u>

use 9.0

COVER FACTOR

AREA (ac)	COVER TYPE	% COVER	CANOPY (%)	WEIGHTED C
53%	reclaimed	—	—	.53 (.15)
10%	disturbed	—	—	.10 (.10)
37%	P-J	40%	25%	<u>.37 (.14)</u>

$$C = \underline{\underline{.232}}$$

EROSION CONTROL FACTOR

$$P = 1.0$$

SEDIMENT INFLOW

$$A = 40 (.326) (9.) (.232) (1.0) = 27.23 \quad \text{ton/acre/year}$$

$$A = (27.23) \left(\frac{1}{2047} \right) (100.6) (.9) = 1.21 \quad \text{acre-feet/year}$$

Dames & Moore

REVISIONS

BY DATE TO EO
 BY DATE TO EO

BY DATE
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