

DESIGN REPORT

Temporary Sedimentation Structure

J7-U -

Black Mesa Mine

Navajo County, Arizona

For

PEABODY WESTERN COAL COMPANY



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INTRODUCTION

Sedimentation Structure J7-U will be an earthen embankment, designed and constructed by Peabody Western Coal Company as a temporary sedimentation structure designed to control runoff and sediment from portions of J7 disturbed surface mining area at the Black Mesa Mine. The location of Structure J7-U and its watershed boundary are shown on Drawing No. 85400 (Sheet K-11) and Drawing No. 85405. The site-specific general construction plans are shown on the attached Exhibit 1.

This design report contains information specific to Structure J7-U. Mine-wide design, construction, and reclamation information is presented in the "General Report, Kayenta and Black Mesa Mines, Navajo County, Arizona, for Peabody Western Coal Company", December, 1985 (PAP), Chapter 6, Attachment D, Volume 2, along with the methods and results of analyses used for slope stability, hydrology, and hydraulics, and in Chapter 6, Pages 11 to 42, "Sediment and Water Control Facility Plan".

INSPECTION

The construction site of the proposed Structure J7-U was inspected in August, 1997 by a Registered Professional Engineer from Peabody Western Coal Company, to assure that the site is suitable and no adverse conditions exist to prevent the successful construction of this structure. A detailed geotechnical investigation was not performed, rather, the information in Chapter 6, Attachment D was utilized for embankment design and will be utilized during construction to construct a stable embankment.

SITE DESCRIPTION

LAND USE

Structure J7-U has an 18.2-acre drainage area and is located on a tributary upstream of Yucca Flat Wash at the Black Mesa Mine. The watershed is classified as 50% spoil and 50% disturbed.

DESIGN ANALYSES

GENERAL

Structure J7-U was designed under the supervision of a Registered Professional Engineer from Peabody Western Coal Company. The design was performed in accordance with applicable 30 CFR 780 and 816 regulations of the United States Department of Interior, Office of Surface Mining (OSM) and included a review of available project files. The most current information contained in the Peabody Western Coal Company files includes topographic maps developed from aerial photography flown in 1992 for Peabody Western Coal Company and was used in the analyses of the structure.

STABILITY

Structure J7-U is a Category A-3 embankment. A homogeneous earthen embankment, compacted in lifts to design specifications, and approximately 15 feet wide on top will be constructed. An upstream slope of 2:1 (horizontal to vertical) and a downstream slope of 3.25:1 were assumed. Based on the total embankment height of approximately 12 feet, these slopes are equal to or flatter than the recommended "worst case" embankment/foundation condition slopes in Table 3-6, Attachment D, Chapter 6; therefore, the embankment will be stable. The emergency spillway will be a minimum 10-foot wide riprap-lined trapezoidal channel.

HYDROLOGY

The hydrologic analysis was completed using the computer program SEDCAD+ (see Appendices A, B, and C). Structure J7-U is classified as a low hazard structure (see Drawing No. 85408). In addition, the mine area is sparsely populated with no one living in the downstream floodplain. The structure will impound less than 20 acre-feet and be less than 20 vertical feet in height from the upstream toe of the embankment of the natural stream elevation to the emergency spillway invert elevation. The spillway for the J7-U pond was analyzed using the 25-year, 6-hour storm. Structure J7-U was conservatively assumed to be full to the emergency spillway prior to the time of the 25-year storm event. The storage capacity of structure J7-U was analyzed using the 10-year, 24-hour storm. The pond was verified to completely contain the 10-year, 24-hour storm event, and provide adequate sediment storage volume, without discharging into the Yucca Flat Wash.

The following parameters were used in the hydrologic analysis:

	<u>10yr-24hr Storm</u>
1. Water Course length, L	0.284 mi.
2. Elevation Difference, H	140 ft
3. Time of Concentration, T _c	0.090 hr
4. SCS Curve Number	89
5. Rainfall Depth, 10-year, 24-hour storm	2.1 in
25-year, 6-hour storm	1.9 in
6. Drainage Area	18.2 acres

HYDRAULICS

The SEDCAD+ and Flow Master computer programs were 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 (supporting calculations are presented in Appendices A, B, and C).

J7-U SEDIMENTATION POND HYDRAULICS TABLE

	Units	10-Yr, 24-Hr Storm	25-Yr, 6-Hr Storm
Initial Reservoir Volume Condition		Empty	Full to emergency spillway
Inflow			
Peak Flow	cfs	20.8	26.4
Volume	ac-ft	1.7	1.4
Storage			
Peak Stage	msl	N/A	6350.8
Emerg. Spillway Elev.	msl	6350	6350
Peak Storage	ac-ft	N/A	3.9
Storage Capacity	ac-ft	3.4	3.4
Outflow			
Peak Flow	cfs	N/A	17.7
Spillway Elevation	msl	6364	6350
Embankment Crest Elev.	msl	6367	6352
Peak Stage	msl	--	6350.8
Freeboard	ft	--	1.2
Emergency Spillway Channel			
Flow Depth	ft	--	0.8
Critical Velocity	fps	--	3.6
Mannings "n"	--	--	.031
Width	ft	--	10
Outflow Channel			
Slope	%	--	31
Normal Velocity	fps	--	6.0
Normal Depth	ft	--	0.3
Mannings "n"	--	--	.055
Riprap D ₅₀	in	--	3

EMERGENCY SPILLWAY AND OUTLET CHANNEL

The emergency spillway and outlet channel for J7-U will be a trapezoidal channel with dimensions listed below. The alignment and dimensions are shown on Exhibit 1.

Minimum Channel Depth	(Spillway)	2.0	ft
	(Outflow)	2.0	ft
Channel Width		10	ft
Channel Length	(Spillway)	20	ft
	(Outflow)	20	ft
Sideslopes (Horizontal to Vertical)		3:1	or flatter
Average Slope	(Spillway)	0	%
Maximum Slope	(Outflow)	31	%
Spillway Elevation		6350.0	ft

A minimum 15-foot long riprap-lined channel will be constructed beyond the toe of the embankment as a transition into the downstream channel.

STORAGE CAPACITY

The impoundment stage-capacity table (see Exhibit 1) is based on the 1992 aerial topographic mapping conducted for Peabody Western Coal Company. Structure J7-U is designed to contain approximately 3.4 acre-feet.

The calculations for the sediment load entering structure J7-U were made utilizing the Revised Universal Soil Loss Equation with the following parameters:

1.	Rainfall Factor, R	40
2.	Soil Erodibility Factor, K	0.17
3.	Slope Factor, LS	4.39
4.	Cover Factor, C	1.0
5.	Erosion Control Factor, P	0.9

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 storage capacity for J7-U is shown on Exhibit 1, J7-U Stage Capacity Table, and the results of the sediment inflow analysis are summarized in the following table.

J7-U STORAGE

Total Storage Capacity	3.4	acre-ft
10-year, 24-hour Storm Inflow	1.7	acre-ft
Available Sediment Storage Capacity	1.7	acre-ft
Sediment Inflow Rate	0.22	acre-ft/yr.
Sediment Storage Life	7.7	years

* * *

The following appendices and drawing are attached and complete this design report.

- Appendix A - Hydrology, Hydraulic, and Sedimentation Calculations
- Appendix B - SEDCAD+ (Input and Output) 10-Year, 24-Hour Storm Event
- Appendix C - SEDCAD+ (Input and Output) 25-Year, 6-Hour Storm Event
- Exhibit # 1 - Proposed J7-U Sedimentation Pond Design

APPENDIX A

Hydrology, Hydraulic, and Sedimentation Calculations

**PEABODY WESTERN COAL COMPANY
CALCULATED HYDROLOGIC DATA**

PROJECT: J7-U

TIME OF CONCENTRATION (Haul Road):

Start Elevation (ft) = 6480
End Elevation (ft) = 6340
Elevation Difference, E (ft) = 140

Watercourse Length (ft) = 1500
Watercourse Length, L (mi) = 0.284

$T_c = (11.9L^{0.3}/E)^{0.385} =$ 0.090 hours

SCS CURVE NUMBER:

Cover Type	Soil Group	Curve Number	Area (acres)	CN*Area
Spoil	B	86	9.1	782.6
Disturbed	D	91	9.1	828.1
TOTAL:			18.2	1610.7

Weighted CN = Total CN*Area/ Total Area = 89

DRAINAGE BASIN AREA:

18.20 Acres

**PEABODY WESTERN COAL COMPANY
CALCULATED SEDIMENTOLOGY DATA**

PROJECT: J7-U

SOIL ERODIBILITY FACTOR:

Soil Type	Soil Group	Erodibility Factor, K	Area (acres)	K*Area
Spoil	B	0.12	9.1	1.092
Disturbed	D	0.22	9.1	2.002
TOTAL:			18.2	3.09
Erodibility factor average of spoil to reclaimed condition to simulate various stages of reclamation.				

$$\text{Weighted K} = \text{Total K*Area} / \text{Total Area} = \underline{\underline{0.170}}$$

SLOPE FACTOR:

Length (ft)	Elevation Change (ft)	Slope (%)	m	Slope Angle (deg)	LS Factor
500	30	6.0%	0.5	3.4	1.78
250	15	6.0%	0.5	3.4	1.28
200	50	25.0%	0.6	14.0	6.57
200	60	30.0%	0.6	16.7	7.95

$$\text{Average LS} = \underline{\underline{4.39}}$$

The LS Factor was calculated by:

$$LS = (\text{Slope Length}/72.6) * m * (10.8 * \sin(\text{slope angle}) + 0.03) \text{ for Slopes} < 9\%$$

$$LS = (\text{Slope Length}/72.6) * m * (16.8 * \sin(\text{slope angle}) - 0.5) \text{ for Slopes} > \text{ or } = 9\%$$

Where:

Slope < or = 3%	m = 0.3
Slope = 4%	m = 0.4
5% > Slope < 10%	m = 0.5
Slope > 10%	m = 0.6

COVER AND PRACTICE FACTORS:

Cover Type	Cover (%)	Canopy (%)	Area (acres)	Cover Factor, C	C*Area	Practice Factor, P	P*Area
Spoil	0%	0%	9.1	1	9.1	0.80	7.28
Disturbed	0%	0%	9.1	1.00	9.1	1.00	9.1
TOTAL:			18.2		18.2		16.38

$$\text{Weighted C} = \text{Total C*Area} / \text{Total Area} = \underline{\underline{1.00}}$$

$$\text{Weighted P} = \text{Total P*Area} / \text{Total Area} = \underline{\underline{0.90}}$$

RAINFALL FACTOR:

$$R = 40$$

PEABODY WESTERN COAL COMPANY
CALCULATED SEDIMENT YIELD

PROJECT: J7-U

The following spreadsheet calculates the predicted sediment yield for the project area. The gross sediment yield is determined according to the Revised Universal Soil Loss Equation.

PARAMETER DESCRIPTION	VALUE
Annual Rainfall Factor	40.00
Soil Erodibility Factor	0.17
Length Slope Factor	4.39
Cover Factor	1.00
Practice Factor	0.90
Gross Annual Sediment Yield	26.85 tons/acre/year
Sediment Density	94.00 pcf
Gross Annual Sediment Yield	0.0131 acre-feet/acre/year
Sediment Delivery Ratio	90%
Estimated Annual Sediment Yield	0.0118 acre-feet/acre/year
Watershed Area	18.2 acres
Watershed Annual Sediment Yield	0.2148 acre-feet/year
Number of years	1 years
Required Pond Sediment Storage	0.215 acre-feet

SEDGAD+ RIPRAP CHANNEL DESIGN

J7-U

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	17.70 cfs	
Slope	31.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	10.00 feet	
Freeboard	.3 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	0.27 ft
with Freeboard	0.57 ft
Top Width	11.63 ft
with Freeboard	13.43 ft
Velocity	6.01 fps
Cross Sectional Area	2.95 sq ft
Hydraulic Radius	0.25 ft
Manning's n	0.055
Froude Number	2.10
Dmax	0.313 ft (3.75 in)
D50	0.250 ft (3.00 in)
D10	0.083 ft (1.00 in)

J7-U Spillway
Worksheet for Trapezoidal Channel

Project Description	
Project File	untitled.fm2
Worksheet	bb
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.031
Channel Slope	0.019396 ft/ft
Left Side Slope	3.000000 H : V
Right Side Slope	3.000000 H : V
Bottom Width	10.00 ft
Discharge	17.70 cfs

Results	
Depth	0.44 ft
Flow Area	4.97 ft ²
Wetted Perimeter	12.78 ft
Top Width	12.64 ft
Critical Depth	0.44 ft
Critical Slope	0.019397 ft/ft
Velocity	3.56 ft/s
Velocity Head	0.20 ft
Specific Energy	0.64 ft
Froude Number	1.00
Flow is subcritical.	

APPENDIX B

SEDCAD+ (Input and Output) 10-Year, 24-Hour Storm Event

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

PEABODY COAL COMPANY: POND J7-U (10-YR,24-HR)

by

Name: TEL

Company Name: ACZ, INC.

File Name: J:\861\0350\SEDCAD\J7-U

Date: 10-28-1997

Civil Software Design -- SEDCAD+ Version 3.1
 Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: ACZ, INC.
 Filename: J:\861\0350\SEDCAD\J7-U User: TEL
 Date: 10-28-1997 Time: 16:12:50
 PEABODY COAL COMPANY: POND J7-U (10-YR,24-HR)
 Storm: 2.10 inches, 10 year-24 hour, SCS Type II
 Hydrograph Convolution Interval: 0.1 hr

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SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

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-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base- Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	18.20	89	F	0.090	0.000	0.000	0.0	1.69	20.83
				Type: Null			Label: J7-U POND			
111	Structure	18.20							1.69	
111	Total IN/OUT	18.20							1.69	20.83

APPENDIX C

SEDCAD+ (Input and Output) 25-Year, 6-Hour Storm Event

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

PEABODY COAL COMPANY: POND J7-U (25-YR,6-HR)

by

Name: TEL

Company Name: ACZ, INC.

File Name: J:\861\0350\SEDCAD\J7-U25

Date: 10-28-1997

Civil Software Design -- SEDCAD+ Version 3.1
 Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: ACZ, INC.
 Filename: J:\861\0350\SEDCAD\J7-U25 User: TEL
 Date: 10-28-1997 Time: 16:48:17
 PEABODY COAL COMPANY: POND J7-U (25-YR,6-HR)
 Storm: 1.90 inches, 25 year- 6 hour, SCS Type II
 Hydrograph Convolution Interval: 0.1 hr

=====

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

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-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base- Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111	1	18.20	89	F	0.090	0.000	0.000	0.0	1.43	26.38
					Type: Pond	Label: J7-U POND				
111	Structure	18.20							1.43	

111	Total IN	18.20							1.43	26.38
111	Total OUT								1.43	17.73

=====

Company Name: ACZ, INC.
Filename: J:\861\0350\SEDCAD\J7-U25 User: TEL
Date: 10-28-1997 Time: 16:48:17
PEABODY COAL COMPANY: POND J7-U (25-YR,6-HR)
Storm: 1.90 inches, 25 year- 6 hour, SCS Type II
Hydrograph Convolution Interval: 0.1 hr

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POND INPUT/OUTPUT TABLE
=====

J1, B1, S1
J7-U POND

Drainage Area from J1, B1, S1, SWS(s)1: 18.2 acres
Total Contributing Drainage Area: 18.2 acres

DISCHARGE OPTIONS:

	Emergency Spillway
Riser Diameter (in)	----
Riser Height (ft)	----
Barrel Diameter (in)	----
Barrel Length (ft)	----
Barrel Slope (%)	----
Manning's n of Pipe	----
Spillway Elevation	----
Lowest Elevation of Holes	----
# of Holes/Elevation	----
Entrance Loss Coefficient	----
Tailwater Depth (ft)	----
Notch Angle (degrees)	----
Weir Width (ft)	----
Siphon Crest Elevation	----
Siphon Tube Diameter (in)	----
Siphon Tube Length (ft)	----
Manning's n of Siphon	----
Siphon Inlet Elevation	----
Siphon Outlet Elevation	----
Emergency Spillway Elevation	6350.0
Crest Length (ft)	20.0
Z:1 (Left and Right)	3 3
Bottom Width (ft)	10.0

RESULTS:

Permanent
Pool
(ac-ft)

=====
3.4

	Runoff Volume (ac-ft)	Peak Discharge (cfs)
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IN	1.43	26.38
OUT	1.43	17.73

Peak Elevation	Hydrograph Detention Time (hrs)
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6350.8	0.00
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Company Name: ACZ, INC.

Filename: J:\861\0350\SEDCAD\J7-U25 User: TEL

Date: 10-28-1997 Time: 16:48:17

PEABODY COAL COMPANY: POND J7-U (25-YR,6-HR)

Storm: 1.90 inches, 25 year- 6 hour, SCS Type II

Hydrograph Convolution Interval: 0.1 hr

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ELEVATION-AREA-CAPACITY-DISCHARGE TABLE

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J1, B1, S1

J7-U POND

Drainage Area from J1, B1, S1, SWS(s)1: 18.2 acres

Total Contributing Drainage Area: 18.2 acres

SW#1: Emergency Spillway

Elev	Stage (ft)	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	
6340.00	0.00	0.18	0.00	0.00	
6341.00	1.00	0.21	0.20	0.00	
6342.00	2.00	0.24	0.42	0.00	
6343.00	3.00	0.27	0.68	0.00	
6344.00	4.00	0.30	0.96	0.00	
6345.00	5.00	0.34	1.28	0.00	
6346.00	6.00	0.37	1.64	0.00	
6347.00	7.00	0.41	2.03	0.00	
6348.00	8.00	0.44	2.45	0.00	
6349.00	9.00	0.48	2.92	0.00	
6350.00	10.00	0.52	3.42	0.00	Stage of SW#1
6350.60	10.60	0.55	3.74	10.17	
6350.70	10.70	0.55	3.79	13.20	
6350.80	10.80	0.55	3.85	17.43	
6350.81	10.81	0.55	3.85	17.73	Peak Stage
6350.90	10.90	0.56	3.91	21.64	
6351.00	11.00	0.56	3.96	26.78	
6351.50	11.50	0.58	4.25	58.07	
6352.00	12.00	0.60	4.54	102.53	
