DESIGN REPORT

Temporary Sedimentation Structure

N9-H

Kayenta Mine

Navajo County, Arizona

For

PEABODY WESTERN COAL COMPANY

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INTRODUCTION

Sedimentation Structure N9-H will be an earthen embankment, designed and constructed by Peabody Western Coal Company (PWCC) as a temporary sedimentation structure to control runoff and sediment from portions of the N9 disturbed surface mining area at the Kayenta Mine. The location of Structure N9-H and its watershed boundary are shown on Drawing No. 85400, (Sheet K-6), 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 N9-H. 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 N9-H was inspected in October, 2004 by a Registered Professional Engineer from Woodson Engineering, 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

The N9-H Structure has a watershed of 88.64 acres and is located on a tributary upstream of Yazzie Wash at the Kayenta Mine. The 88.64-acre watershed, which contributes directly to structure N9-H, is classified as 23% undisturbed and 77% spoil.

DESIGN ANALYSES

GENERAL

Structure N9-H 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 1983 for Peabody Western Coal Company and was used in the analyses of the structure.

STABILITY

Structure N9-H is assumed to be a Category A-3 embankment. The structure will be a homogeneous earthen embankment, compacted in lifts to design specifications, and approximately 15 feet wide on top. A minimum upstream slope of 2H: 1V and minimum downstream slope of 4H: 1V were assumed. Based on the total embankment height of approximately 19.5 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 20-foot wide, riprap-lined, trapezoidal channel.

HYDROLOGY

The hydrologic analysis was completed using the computer program SEDCAD4 (see Appendices A, B, and C). Structure N9-H 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 structure has capacity less than 20 acre-feet; therefore, the spillway was analyzed using the 25-year, 6-hour storm event. The structure was conservatively assumed to be full to the emergency spillway at the time of 25-year storm event. The storage capacity of structure N9-H was analyzed using the 10-year, 24-hour storm event. The pond was verified to completely contain the 10-year, 24-hour storm event, and provide adequate sediment storage volume, without discharging into Yazzie Wash.

The following parameters were used in the hydrologic analysis:

1.	Water Course length, L	0.502 mi.
2.	Elevation Difference, H	155 ft
3.	Time of Concentration, T_c	0.168 hr
4.	NRCS Curve Number	81
5.	Rainfall Depth, 10-year, 24-hour storm 25-year, 6-hour storm	2.1 in 1.9 in
6.	Drainage Area	88.64 acres

Values reported represent the watershed, which drains directly to Pond N9-H.

HYDRAULICS

The SEDCAD4 and HYDROCALC 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).

N9-H 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	54.28	65.16
Volume	ac-ft	4.94	4.01
Storage			
Peak Stage	msl	N/A	6737.7
Emerg. Spillway Elev.	msl	6737.0	6737.0
Peak Storage	ac-ft	N/A	18.35
Storage Capacity	ac-ft	17.21	17.21
Outflow			
Peak Flow	cfs	N/A	30.62
Spillway Elevation	msl	6737.0	6737.0
Embankment Crest Elev.	msl	6739.9	6739.9
Peak Stage	msl	--	6737.7
Freeboard	ft	--	2.2
Emergency Spillway Channel			
Flow Depth	ft	--	0.7
Critical Velocity	fps	--	4.44
Mannings "n"	--	--	0.048
Width	ft	--	20
Outflow Channel			
Slope	%	--	25
Normal Velocity	fps	--	6.56
Normal Depth	ft	--	0.5
Mannings "n"	--	--	0.065
Riprap D_{50}	in	--	6

EMERGENCY SPILLWAY AND OUTLET CHANNEL

The emergency spillway and outlet channel for N9-H will be a trapezoidal channel with dimensions listed below. The alignment and dimensions are shown on Exhibit 1.

Minimum Channel Depth	(Spillway) (Outflow)	2.0 1.5	ft ft
Channel Width		20	ft
Channel Length	(Spillway) (Outflow)	33 195	ft ft
Sideslopes (Horizontal to Vertical)		3:1	or flatter
Average Slope	(Spillway)	0	%
Maximum Slope	(Outflow)	25	%
Spillway Elevation		6737.0	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 1983 aerial topographic mapping conducted for Peabody Western Coal Company. Structure N9-H is designed to contain approximately 17.21 acre-feet.

The calculations for the sediment load entering structure N9-H were made utilizing the Revised Universal Soil Loss Equation with the following parameters.

1.	Rainfall Factor, R	40
2.	Soil Erodibility Factor, K	0.13
3.	Slope Factor, LS	7.86
4.	Cover Factor, C	0.82
5.	Erosion Control Factor, P	0.85

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. Structure N9-H has sufficient storage capacity to contain the 10-year, 24-hour storm event. The storage capacity was determined for N9-H Structure and the results of the analysis are presented in the following table.

Storage for Structure N9-H

	N9-H
Total Storage Capacity (ac-ft)	17.21
10-Year, 24-Hour Storm Inflow (ac-ft)	4.94
Available Sediment Storage Capacity (ac-ft)	12.27
Sediment Inflow Rate/Year (ac-ft/yr)	1.09
Sediment Storage Life (yr)	11.3

* * *

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

Appendix A- Hydrology, Hydraulic, and Sedimentation Calculations

Appendix B- SEDCAD4 (Input and Output) 10-Year, 24-Hour Storm Event

Appendix C- SEDCAD4 (Input and Output) 25-Year, 6-Hour Storm Event

Exhibit #1- N9-H Proposed Sedimentation Pond

APPENDIX A

Hydrology, Hydraulic, and Sedimentation Calculations

PEABODY WESTERN COAL COMPANY
CALCULATED HYDROLOGIC DATA

PROJECT: N-9 MINING AREA

STRUCTURE: H

TIME OF CONCENTRATION:

Start Elevation (ft) =	6875	
End Elevation (ft) =	6720	
Elevation Difference, E (ft) =	155	
Watercourse Length (ft) =	2653	
Watercourse Length (mi) =	0.502	
Tc = (11.9L^3/E)^0.385 =	0.168	hours

ROUTING PARAMETERS:

Between structure routing parameters were calculated using the SCS Upland mathod in SEDCAD4. Input and output parameters are shown on the SEDCAD4 printouts in Appendices C.

SCS CURVE NUMBER:

Cover Type	Soil Group	Curve Number	Area (acres)	CN*Area
Pinyon Juniper	B	65	10.434	678.21
Pinyon Juniper	D	83	0.069	5.727
Sagebrush	B	60	9.517	571.02
Distrubed Land	B	86	68.62	5901.32
TOTAL:			88.64	7156.277

Weighted CN = Total CN * Area / Total Area = 81

Note: During Operations the open pit will collect most of the runoff from disturbed areas. The worst case is when the open pit is reclaimed and runoff from a larger area or regraded soil reports directly to the pond.

DRAINAGE BASIN AREA:

88.64 Acres

PEABODY WESTERN COAL COMPANY
CALCULATED SEDIMENTOLOGY DATA

STRUCTURE: H

SOIL ERODIBILITY FACTOR:

Soil Type	Erodibility Factor, K	Area	K*Area
13A	0.37	0.091	0.03
14AB	0.37	6.575	2.43
3DE	0.15	0.069	0.01
5	0.49	0.017	0.01
16CE	0.05	13.268	0.66
Disturbed	0.12	68.62	8.23
	TOTAL	88.64	11.38

Weighted K = Total K * Area / Total Area = 0.13

SLOPE FACTOR:

Length (ft)		Slope (%)	m	Slope Angle (deg)	LS Factor
614	80	13.03%	0.60	7.42	6.01
695	93	13.38%	0.60	7.62	6.70
904	158	17.48%	0.60	9.91	10.86

Average LS = 7.86

The LS Factor was calculated by:

LS=(Slope Length/72.6)^m*(10.8sin(slope angle)+.03) for slopes < 9%
LS=(Slope Length/72.6)^m*(16.8sin(slope angle)-0.5) for slopes > 9%

Where:

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

STRUCTURE: H

Cover and Practice Factors:

Cover Type	Cover (%)	Canopy (%)	Area (acres)	Cover Factor, C	C * Area	Practive Factor, P	P * Area
Pinyon Juniper	40%	25%	10.503	0.22	2.31	1.00	10.503
Sagebrush, Grass	40%	25%	9.517	0.2	1.90	1.00	9.517
Saltbrush	40%	25%	0	0.2	0.00	1.00	0
Disturbed	0%	0%	68.62	1	68.62	0.80	54.896
TOTAL:			88.64		72.83		74.92

Weighted C = Total C * Area / Total Area = 0.82

Weighted P = Total P * Area / Total Area = 0.85

RAINFALL FACTOR:

R= 40

PEABODY WESTERN COAL COMPANY
CALCULATED SEDIMENT YIELD

STRUCTURE: H

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 (R)	40.00	
Soil Erodibility Factor (K)	0.13	
Length Slope Factor (L)	7.86	
Cover Factor(C)	0.82	
Practice Factor (P)	0.85	
Gross Annual Sediment Yield	28.03	tons/acre/year
Sediment Density	94.00	pcf
Gross Annual Sediment Yield	0.0137	acre-feet/acre/year
Sediment Delivery Ratio	90%	
Estimated Annual Sediment Yield	0.0123	acre-feet/acre/year
Watershed Area	88.64	acres
Watershed Annual Sediment Yield	1.09	acre-feet/year
Number of Years	1.00	years
Calculated Sediment Volume	1.09	acre-feet

TRAPEZOIDAL CHANNEL ANALYSIS
CRITICAL DEPTH COMPUTATION
N9-H POND
November 8, 2004

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Flow Rate (cfs)	65.16
Channel Bottom Slope (ft/ft)	0.005
Manning's Roughness Coefficient (n-value)	0.048
Channel Left Side Slope (horizontal/vertical)	3.0
Channel Right Side Slope (horizontal/vertical)	3.0
Channel Bottom Width (ft)	20.0

COMPUTATION RESULTS

DESCRIPTION	VALUE
Critical Depth (ft)	0.67
Critical Slope (ft/ft)	0.04
Flow Velocity (fps)	4.44
Froude Number	1.0
Velocity Head (ft)	0.31
Energy Head (ft)	0.97
Cross-Sectional Area of Flow (sq ft)	14.69
Top Width of Flow (ft)	24.0

N9-H POND OUTFLOW CHANNEL

Material: Riprap

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
20.00	3.0:1	3.0:1	25.0	1.00		

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	65.16 cfs	
Depth:	0.46 ft	1.46 ft
Top Width:	22.79 ft	28.79 ft
Velocity:	6.56 fps	
X-Section Area:	9.93 sq ft	
Hydraulic Radius:	0.433	
Froude Number:	1.75	
Manning's n:	0.0650	
Dmin:	3.00 in	
D50:	6.00 in	
Dmax:	9.00 in	

APPENDIX B

SEDCAD4 (Input and Output) 10-Year, 24-Hour Storm Event

Peabody Western Coal
Kayenta Mine
N9-H POND DESIGN

Gary Altsisi

General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	10 yr - 24 hr
Rainfall Depth:	2.100 inches

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	88.640	88.640	54.28	4.94

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	88.640	0.168	0.000	0.000	81.000	F	54.28	4.941
	$\sum$	**88.640**						**54.28**	**4.941**

APPENDIX C

SEDCAD4 (Input and Output) 25-Year, 6-Hour Storm Event

Peabody Western Coal
Kayenta Mine
N9-H POND DESIGN
25YR 6HR STORM

Gary Altsisi

General Information

Storm Information:

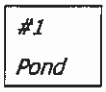
Storm Type:	NRCS Type II
Design Storm:	25 yr - 6 hr
Rainfall Depth:	1.900 inches

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	88.640	0.168	0.000	0.000	81.000	F	65.16	4.005
	Σ	**88.640**						**65.16**	**4.005**

Structure Networking:

Type	Stru #	(flows Into)	Stru #	Musk. K (hrs)	Musk. X	Description
Pond	#1	==>	End	0.000	0.000	N9-H



Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	In	88.640	88.640	65.16	4.00
	Out			30.62	4.01

Structure Detail:

Structure #1 (Pond)

N9-H

Pond Inputs:

Initial Pool Elev:	6,737.00
Initial Pool:	17.21 ac-ft

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
6,737.00	33.00	3.00:1	3.00:1	20.00

Pond Results:

Peak Elevation:	6,737.69
Dewater Time:	0.25 days

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
6,720.00	0.370	0.000	0.000	
6,720.50	0.414	0.196	0.000	
6,721.00	0.461	0.415	0.000	
6,721.50	0.511	0.658	0.000	
6,722.00	0.562	0.926	0.000	
6,722.50	0.617	1.220	0.000	
6,723.00	0.674	1.543	0.000	
6,723.50	0.733	1.894	0.000	
6,724.00	0.795	2.276	0.000	
6,724.50	0.859	2.690	0.000	
6,725.00	0.926	3.136	0.000	
6,725.50	0.924	3.598	0.000	
6,726.00	0.922	4.060	0.000	
6,726.50	0.919	4.520	0.000	
6,727.00	0.917	4.979	0.000	
6,727.50	0.915	5.437	0.000	
6,728.00	0.913	5.894	0.000	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
6,728.50	0.911	6.350	0.000		
6,729.00	0.908	6.805	0.000		
6,729.50	0.906	7.258	0.000		
6,730.00	0.904	7.711	0.000		
6,730.50	0.969	8.179	0.000		
6,731.00	1.036	8.680	0.000		
6,731.50	1.106	9.216	0.000		
6,732.00	1.177	9.786	0.000		
6,732.50	1.251	10.393	0.000		
6,733.00	1.328	11.038	0.000		
6,733.50	1.406	11.721	0.000		
6,734.00	1.487	12.445	0.000		
6,734.50	1.570	13.209	0.000		
6,735.00	1.655	14.015	0.000		
6,735.50	1.627	14.835	0.000		
6,736.00	1.599	15.642	0.000		
6,736.50	1.572	16.435	0.000		
6,737.00	1.545	17.214	0.000		Spillway #1
6,737.50	1.665	18.017	22.084	5.50	
6,737.69	1.715	18.350	30.617	0.45	Peak Stage
6,738.00	1.790	18.880	44.168		
6,738.50	1.920	19.808	98.327		
6,739.00	2.054	20.801	162.936		
6,739.50	2.192	21.862	244.347		
6,740.00	2.335	22.993	347.159		

Detailed Discharge Table

Elevation	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
6,720.00	0.000	0.000
6,720.50	0.000	0.000
6,721.00	0.000	0.000
6,721.50	0.000	0.000
6,722.00	0.000	0.000
6,722.50	0.000	0.000
6,723.00	0.000	0.000
6,723.50	0.000	0.000
6,724.00	0.000	0.000

Elevation	Emergency Spillway (cfs)	Combined Total Discharge (cfs)
6,724.50	0.000	0.000
6,725.00	0.000	0.000
6,725.50	0.000	0.000
6,726.00	0.000	0.000
6,726.50	0.000	0.000
6,727.00	0.000	0.000
6,727.50	0.000	0.000
6,728.00	0.000	0.000
6,728.50	0.000	0.000
6,729.00	0.000	0.000
6,729.50	0.000	0.000
6,730.00	0.000	0.000
6,730.50	0.000	0.000
6,731.00	0.000	0.000
6,731.50	0.000	0.000
6,732.00	0.000	0.000
6,732.50	0.000	0.000
6,733.00	0.000	0.000
6,733.50	0.000	0.000
6,734.00	0.000	0.000
6,734.50	0.000	0.000
6,735.00	0.000	0.000
6,735.50	0.000	0.000
6,736.00	0.000	0.000
6,736.50	0.000	0.000
6,737.00	0.000	0.000
6,737.50	22.084	22.084
6,738.00	44.168	44.168
6,738.50	98.327	98.327
6,739.00	162.936	162.936
6,739.50	244.347	244.347
6,740.00	347.159	347.159