DESIGN REPORT

Temporary Sedimentation Structure

N6-M

Black Mesa Mine

Navajo County, Arizona

for

PEABODY WESTERN COAL COMPANY
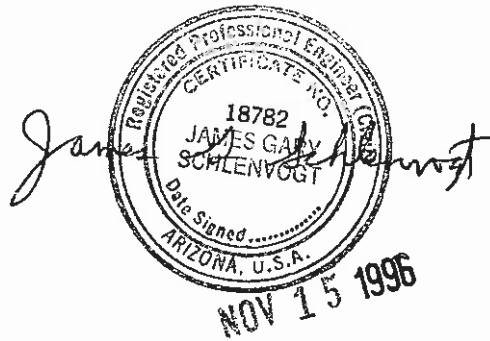
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JAMES GARY SCHLENVOGT

NOV 15 1996

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INTRODUCTION

Sedimentation structure N6-M will be an earthen embankment, designed and constructed by Peabody Western Coal Company as a temporary sedimentation structure to control runoff and sediment from portions of the N-6 disturbed surface mining area at the Black Mesa Mine. The location of structure N6-M and its watershed boundary is shown on Drawing No. 85400 (Sheets K-7 and L-7) 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 N6-M. 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 structure N6-M was inspected by a Registered Professional Engineer from Peabody Western Coal Company, to ensure that the site is suitable and no adverse conditions exist to prevent the successful construction of the 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 N6-M has a 77.4-acre tributary drainage area and is located on a tributary upstream of Coal Mine Wash at the Black Mesa Mine. The watershed is classified as 100% disturbed spoil as a conservative estimate of run-off and sediment loading and as the anticipated "worst case" watershed disturbance based on the current mine plan.

DESIGN ANALYSES

GENERAL

Structure N6-M 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. In anticipation of this area of the Black Mesa Mine becoming part of the permanent permit program, the permanent program regulations were utilized. 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

A homogeneous earthen embankment, compacted in lifts to design specifications, and approximately 15 feet wide on top will be constructed. An upstream slope of 3:1 (horizontal to vertical) and a downstream slope of 3:1 were assumed. Based on the total embankment height of 5 feet (10 feet incised), 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 15 foot wide riprap-lined trapezoidal channel.

HYDROLOGY

The hydrologic analysis was completed using the computer program SEDCAD+ (see Appendices A, B, and C). Structure N6-M 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 flood plain. The structure will impound less than 20 acre-feet and be less than 20 vertical feet in height from the upstream toe of embankment of the natural stream elevation to the emergency spillway elevation. The spillway for the N6-M pond was analyzed using the 25-year, 6-hour storm. The storage capacity of structure N6-M was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1.	Water Course length, L	0.631	mi
2.	Elevation Difference, H	191	ft
3.	Time of Concentration, T_c	0.202	hr
4.	SCS Curve Number	86	
5.	Rainfall Depth, 10-year, 24-hour storm	2.1	in
	25-year, 6-hour storm	1.9	in
6.	Drainage Area	77.4	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 Appendix A).

N6-M 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	66.57	78.92
Volume	ac-ft	5.97	
Storage			
Peak Stage	msl	N/A	6546.7
Emerg. Spillway Elev..	msl	6546.0	6546.0
Peak Storage	ac-ft	N/A	13.2
Storage Capacity	ac-ft	10.6	10.6
Outflow			
Peak Flow	cfs	N/A	15.2
Spillway Elevation	msl	6546.0	6546.0
Embankment Crest Elev.	msl	6549.0	6549.0
Peak Stage	msl	--	6546.7
Freeboard	ft	--	2.3
Emergency Spillway Channel			
Flow Depth	ft	--	0.7
Critical Velocity	fps	--	3.1
Mannings "n"	--	--	.037
Width	ft	--	15
Outflow Channel			
Slope	%	--	20
Normal Velocity	fps	--	4.5
Normal Depth	ft	--	0.2
Mannings "n"	--	--	0.051
Riprap D_{50}	in		3 in

EMERGENCY SPILLWAY AND OUTLET CHANNEL

The emergency spillway and outlet channel for N6-M will be a trapezoidal channel, the alignment and dimensions are shown on Exhibit 1 and includes the following dimensions:

Minimum Channel Depth	(Spillway)	1.7	ft
	(Outflow)	1.2	ft
Channel Width		15	ft
Channel Length	(Spillway)	40	ft
	(Outflow)	150	ft
Side Slopes (Horizontal to Vertical)		3:1	or flatter
Average Slope	(Spillway)	0	%
Maximum Slope	(Outflow)	. 20	%
Spillway Elevation		6546.0 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 N6-M is designed to contain approximately 10.59 acre-feet.

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

1.	Rainfall Factor, R	40
2.	Soil Erodibility Factor, K	0.25*
3.	Slope Factor, L	3.56
4.	Cover Factor	1.0
5.	Erosion Control Factor, P	1.0

* Soil erodibility factor taken as average spoil and reclaimed conditions to simulate staged

reclamation.

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 N6-M is shown on Exhibit 1, N6-M Stage Capacity Table, and the results of the sediment inflow analysis are summarized in the following table.

N6-M STORAGE

Total Storage Capacity	10.59	acre-ft
10-year, 24-hour Storm Inflow	5.97	acre-ft
Available Sediment Storage Capacity	4.62	acre-ft
Sediment Inflow Rate	1.2	acre-ft/yr
Sediment Storage Life	3.8	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 Temporary N6-M Sedimentation Pond Design

APPENDIX A

Hydrology, Hydraulic, and Sedimentation Calculations

PEABODY WESTERN COAL COMPANY
CALCULATED HYDROLOGIC DATA

PROJECT: N6-M Pond

TIME OF CONCENTRATION:

Start Elevation (ft) =	6732
End Elevation (ft) =	6541
Elevation Difference, E (ft) =	191
Watercourse Length (ft) =	3330
Watercourse Length, L (mi) =	0.631

$Tc = (11.9L^3/E)^{0.385} =$ __0.202__ hours

SCS CURVE NUMBER:

Cover Type	Soil Group	Curve Number	Area (acres)	CN*Area
Disturbed Spoil	B	86	77.4	6656.4
TOTAL:			77.4	6656.4

Weighted CN = Total CN*Area/ Total Area = __86__

DRAINAGE BASIN AREA:

77.4 Acres

PEABODY WESTERN COAL COMPANY
CALCULATED SEDIMENTOLOGY DATA

PROJECT: N6-M Pond

SOIL ERODIBILITY FACTOR:

Soil Type	Erodibility Factor, K	Area (acres)	K*Area
Spoil - Reclaimed	0.25	77.4	19.35
TOTAL:		77.4	19.35
Erodibility factor average of spoil to reclamed condition to simulate various stages of reclamation.			

Weighted K = Total K*Area/ Total Area =   0.25

SLOPE FACTOR:

Length (ft)	Elevation Change (ft)	Slope (%)	m	Slope Angle (deg)	LS Factor
430	40	9.3%	0.5	5.3	2.57
230	30	13.0%	0.6	7.4	3.34
450	30	6.7%	0.5	3.8	1.86
175	40	22.9%	0.6	12.9	5.50
250	70	28.0%	0.6	15.6	8.46
130	20	15.4%	0.6	8.7	2.91
410	40	9.8%	0.5	5.6	2.69
150	20	13.3%	0.6	7.6	2.66
380	30	7.9%	0.5	4.5	2.01

Average LS =   3.56

The LS Factor was calculated by:

LS = (Slope Length/72.6)^m*(10.8*sin(slope angle) + 0.03) for Slopes < 9%

LS = (Slope Length/72.6)^m*(16.8*sin(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*

PEABODY WESTERN COAL COMPANY
CALCULATED SEDIMENTOLOGY DATA

PROJECT: N6-M Pond

COVER AND PRACTICE FACTORS:

Cover Type	Cover (%)	Canopy (%)	Area (acres)	Cover Factor, C	C*Area	Practice Factor, P	P*Area
Disturbed Spoil	0%	0%	77.4	1.00	77.4	1.00	77.4
TOTAL:			77.4		77.4		77.4

Weighted C = Total C*Area/ Total Area = _____1.00_____

Weighted P = Total P*Area/ Total Area = _____1.00_____

RAINFALL FACTOR:

R = 40

PEABODY WESTERN COAL COMPANY
CALCULATED SEDIMENT YIELD

PROJECT: N6-M Pond

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	0.25	
Length Slope Factor	3.56	
Cover Factor	1.00	
Practice Factor	1.00	
Gross Annual Sediment Yield	35.57	tons/acre/year
Sediment Density	94.00	pcf
Gross Annual Sediment Yield	0.0174	acre-feet/acre/year
Sediment Delivery Ratio	90%	
Estimated Annual Sediment Yield	0.0156	acre-feet/acre/year
Watershed Area	77.4	acres
Watershed Annual Sediment Yield	1.2104	acre-feet/year
Approx. Number of Years of Storage	3.8	years
Available Pond Sediment Storage	4.62	acre-feet

SEDCAD+ RIPRAP CHANNEL DESIGN

N6-M Pond Outslope

INPUT VALUES:

Shape	TRAPEZOIDAL
Discharge	15.22 cfs
Slope	20.00 %
Sideslopes (L and R)	3.00:1 3.00:1
Bottom Width	15.00 feet
Freeboard	1 ft

RESULTS:

Steep Slope Design - PADER Method

Depth	0.21 ft
with Freeboard	1.21 ft
Top Width	16.29 ft
with Freeboard	22.29 ft
Velocity	4.54 fps
Cross Sectional Area	3.35 sq ft
Hydraulic Radius	0.20 ft
Manning's n	0.051
Froude Number	1.76
Dmax	0.313 ft (3.75 in)
D50	0.250 ft (3.00 in)
D10	0.083 ft (1.00 in)

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                    SEDCAD+ CHANNEL DESIGN
                    N6-M Pond Outslope
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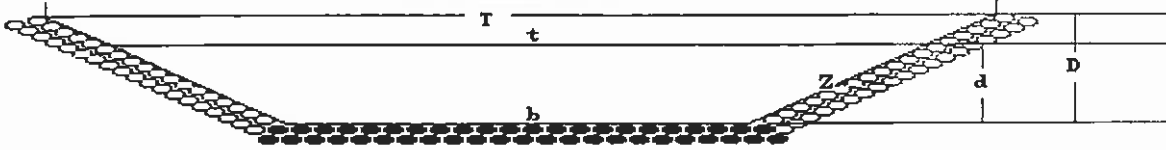


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          Riprap - Steep Slope Design - PADER Method

                                                    w/ Freeboard:
Discharge        =   15.22 cfs      Depth (d)         =   0.21 (D =      1.21) ft
Bottom (b)       =   15.00 ft       Top width (t)     = 16.29 (T =     22.29) ft
Side slopes (Z)  = 3.0:1(L)  3.0:1(R)  Velocity       =    4.54 fps
Bed Slope        =   20.00 %        Hydraulic Radius  =    0.20 ft
Manning's n      =    0.051         Froude number     =    1.76
                          Dmax = 0.31 ft ( 3.75 in)
                          D50  = 0.25 ft ( 3.00 in)
                          D10  = 0.08 ft ( 1.00 in)
```

Project Description

Project File	c:\808\n6-m\n6-m.fm2
Worksheet	N6-M Spillway
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data

Mannings Coefficient	0.037	
Channel Slope	0.030255	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	15.00	ft
Discharge	15.22	cfs

Results

Depth	0.31	ft
Flow Area	4.95	ft²
Wetted Perimeter	16.97	ft
Top Width	16.86	ft
Critical Depth	0.31	ft
Critical Slope	0.030253	ft/ft
Velocity	3.07	ft/s
Velocity Head	0.15	ft
Specific Energy	0.46	ft
Froude Number	1.00	
Flow is supercritical.		

APPENDIX B

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

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

SEDIMENTATION POND N6-M

by

Name: K. Kammerzell

Company Name: ACZ, INC.
File Name: C:\808\N6-M\N6-M

Date: 11-13-1996

Company Name: ACZ, INC.
Filename: C:\808\N6-M\N6-M   User: K. Kammerzell
                Date: 11-13-1996 Time: 09:40:33
                Sedimentation Pond N6-M
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	77.40	86	F	0.202	0.000	0.000	0.0	5.97	66.57
			Type: Pond Label: N6-M						
111 Structure	77.40							5.97	
111 Total IN	77.40							5.97	66.57
111 Total OUT								5.97	14.12

Company Name: ACZ, INC.
Filename: C:\808\N6-M\N6-M   User: K. Kammerzell
Date: 11-13-1996 Time: 09:40:33
Sedimentation Pond N6-M
Storm: 2.10 inches, 10 year-24 hour, SCS Type II
Hydrograph Convolution Interval: 0.1 hr

============================
POND INPUT/OUTPUT TABLE
============================

J1, B1, S1
N6-M

Drainage Area from J1, B1, S1, SWS(s)1:   77.4 acres
Total Contributing Drainage Area: 77.4 acres

DISCHARGE OPTIONS:

	Emergency Spillway
==============================	====================
Riser Diameter (in)	----
Riser Height (ft)	----
Barrel Diameter (in)	----
ιrrel Length (ft)	----
rrel Slope (%)	----
ιng's n of Pipe	----
Spιιlway 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	6546.0
Crest Length (ft)	40.0
Z:1 (Left and Right)	3 3
Bottom Width (ft)	15.0

RESULTS:

| Permanent Pool (ac-ft) |
|========================|
| 10.6 |

	Runoff Volume (ac-ft)	Peak Discharge (cfs)
IN	5.97	66.57
OUT	5.97	14.12

Peak Elevation	Hydrograph Detention Time (hrs)
6546.6	0.00

****

Company Name: ACZ, INC.
Filename: C:\808\N6-M\N6-M   User: K. Kammerzell
Date: 11-13-1996 Time: 09:40:33
Sedimentation Pond N6-M
Storm: 2.10 inches, 10 year-24 hour, SCS Type II
Hydrograph Convolution Interval: 0.1 hr

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    ELEVATION-AREA-CAPACITY-DISCHARGE TABLE
============================================
```

J1, B1, S1
N6-M

Drainage Area from J1, B1, S1, SWS(s)1:   77.4 acres
Total Contributing Drainage Area: 77.4 acres

SW#1:   Emergency Spillway

Elev	Stage (ft)	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	
6540.00	0.00	0.25	0.00	0.00	
6541.00	1.00	0.58	0.40	0.00	
6542.00	2.00	1.02	1.19	0.00	
3.00	3.00	1.60	2.49	0.00	
.00	4.00	2.31	4.44	0.00	
.00	5.00	3.15	7.16	0.00	
6546.00	6.00	3.72	10.59	0.00	Stage of SW#1
6546.62	6.62	4.12	13.04	14.12	Peak Stage
6546.70	6.70	4.16	13.34	15.87	
6546.80	6.80	4.22	13.76	20.88	
6546.90	6.90	4.29	14.19	26.41	
6547.00	7.00	4.35	14.62	32.45	
6547.50	7.50	4.68	16.88	73.80	
6548.00	8.00	5.02	19.30	126.65	
6548.50	8.50	5.38	21.90	189.37	
6549.00	9.00	5.74	24.68	273.29	
6549.50	9.50	6.13	27.65	372.65	
6550.00	10.00	6.51	30.81	495.41	

APPENDIX C

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

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

SEDIMENTATION POND N6-M

by

Name: K. Kammerzell

Company Name: ACZ, INC.
File Name: C:\808\N6-M\N6-M

Date: 11-13-1996

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: ACZ, INC.
Filename: C:\808\N6-M\N6-M   User: K. Kammerzell
Date: 11-13-1996 Time: 09:40:34
Sedimentation Pond N6-M
Storm: 1.90 inches,   25 year- 6 hour, SCS Type II
Hydrograph Convolution Interval: 0.1 hr

===
SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE
===

-Hydrology-

JBS SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discharge (cfs)
111 1	77.40	86	F	0.202	0.000	0.000	0.0	4.99	78.92
			Type: Pond Label: N6-M						
111 Structure	77.40							4.99	
111 Total IN	77.40							4.99	78.92
111 Total OUT								4.99	15.22

Company Name: ACZ, INC.
Filename: C:\808\N6-M\N6-M   User: K. Kammerzell
Date: 11-13-1996 Time: 09:40:34
Sedimentation Pond N6-M
Storm: 1.90 inches, 25 year- 6 hour, SCS Type II
Hydrograph Convolution Interval: 0.1 hr

============================
POND INPUT/OUTPUT TABLE
============================

J1, B1, S1
N6-M

Drainage Area from J1, B1, S1, SWS(s)1:   77.4 acres
Total Contributing Drainage Area: 77.4 acres

DISCHARGE OPTIONS:

                                Emergency
                                Spillway
==
Riser Diameter (in)   ----
  Riser Height (ft)   ----
Barrel Diameter (in)   ----
  arrel Length (ft)   ----
   rrel Slope (%)   ----
    ng's n of Pipe   ----
Sp--lway 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   6546.0
Crest Length (ft)   40.0
Z:1 (Left and Right)   3   3
Bottom Width (ft)   15.0

` RESULTS:

                                Permanent
                                Pool
                                (ac-ft)
                                ========
                                10.6

```
              Runoff      Peak
              Volume   Discharge
              (ac-ft)    (cfs)
         =========================
    IN       4.99       78.92
    OUT      4.99       15.22

    Peak        Hydrograph
 Elevation   Detention Time
                 (hrs)
 ==========================
  6546.7          0.00
```

****

Civil Software Design -- SEDCAD+ Version 3.1
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Company Name: ACZ, INC.
Filename: C:\808\N6-M\N6-M   User: K. Kammerzell
Date: 11-13-1996 Time: 09:40:34
Sedimentation Pond N6-M
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
N6-M

Drainage Area from J1, B1, S1, SWS(s)1:   77.4 acres
Total Contributing Drainage Area: 77.4 acres

SW#1: Emergency Spillway

Elev	Stage (ft)	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	
6540.00	0.00	0.25	0.00	0.00	
6541.00	1.00	0.58	0.40	0.00	
6542.00	2.00	1.02	1.19	0.00	
ᶠ 3.00	3.00	1.60	2.49	0.00	
.00	4.00	2.31	4.44	0.00	
00	5.00	3.15	7.16	0.00	
6546.00	6.00	3.72	10.59	0.00	Stage of SW#1
6546.67	6.67	4.14	13.23	15.22	Peak Stage
6546.70	6.70	4.16	13.34	15.87	
6546.80	6.80	4.22	13.76	20.88	
6546.90	6.90	4.29	14.19	26.41	
6547.00	7.00	4.35	14.62	32.45	
6547.50	7.50	4.68	16.88	73.80	
6548.00	8.00	5.02	19.30	126.65	
6548.50	8.50	5.38	21.90	189.37	
6549.00	9.00	5.74	24.68	273.29	
6549.50	9.50	6.13	27.65	372.65	
6550.00	10.00	6.51	30.81	495.41	