INSPECTION REPORT

SEDIMENTATION STRUCTURE

WW-4

Black Mesa Mine

Navajo County, Arizona

by

PEABODY COAL COMPANY

INDEX

## Introduction

Sedimentation Structure WW-4 is an earthen embankment, designed and constructed in 1985 by Peabody Coal Company as a temporary sedimentation structure to control runoff and sediment from the disturbed areas of the Black Mesa Mine. The location of Structure WW-4 is shown on Plate 1 Site Plan.

This inspection report contains information specific to Structure WW-4. 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 WW-4 was inspected on October 31, 1985 by Compliance engineers from Peabody Coal Company. 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.

Peabody Coal Company's inspection was performed in accordance with applicable 30 CFR 780 and 816 regulations and included a review of the WW-4 project files and field inspection of the structure. The most current information contained in the Peabody Coal Company files includes the 1985 survey, design and construction quality assurance data. The survey data developed in 1985 was used in the analyses of the structure. Results of the field inspection are included in this report.

## Site Description

Land Use. Structure WW-4 has a 10.0-acre tributary drainage area and is located near Moenkopi Wash at the Black Mesa Mine. The watershed is classified as 28% disturbed and 72% undisturbed.

Embankment. Structure WW-4 is a homogeneous earthen embankment classified as an in-wash embankment. Physical characteristics of the embankment are listed in the following table:

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## Structure WW-4

| | |
|---|---|
| Embankment . . . . . . . . . . . . . . . . . . . . . . . . | Alluvium Soils |
| Foundation . . . . . . . . . . . . . . . . . . . . . . . | Alluvium Soils |
| Right Abutment . . . . . . . . . . . . . . . . . . . . . | Alluvium Soils |
| Left Abutment . . . . . . . . . . . . . . . . . . . . . . | Alluvium Soils |
| Height . . . . . . . . . . . . . . . . . . . . . . . . . | 12.0 ft |
| Crest Width . . . . . . . . . . . . . . . . . . . . . . | 15.0 ft |
| Upstream Slope . . . . . . . . . . . . . . . . . . . . . | 2.0 H : 1.0 V |
| Downstream Slope . . . . . . . . . . . . . . . . . . . . | 3.0 H : 1.0 V |

Grass will provide erosion protection for the upstream and downstream slopes, while riprap provides erosion protection for the downstream toe of the slope.


### Analyses

Stability. Structure WW-4 is a category C-1 embankment. A standard category C-1 embankment has static and seismic factors of safety of 1.5 and 1.2, respectively, under the following conditions:

1.  Maximum height = 12 ft
2.  Maximum upstream slope = 1.6 H : 1.0 V
3.  Maximum downstream slope = 2.8 H : 1.0 V
4.  Full pool condition with steady seepage

The WW-4 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 University of Kentucky's generalized computer program SEDIMOT II. Structure WW-4 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 WW-4 was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1.  Water Course Length, L . . . . . . . . . . . . . . . . . . . . 0.25 mi
2.  Elevation Difference, H . . . . . . . . . . . . . . . . . 150.0 ft
3.  Time of Concentration in hour, $T_c$ . . . . . . . . . . . . 0.076 h
4.  SCS. Curve Number . . . . . . . . . . . . . . . . . . . . . . 82.0

5.  Rainfall depth, 10-year, 24-hour storm . . . . . . . . . .  2.1 in

    "        "  , 25-year, 6-hour storm . . . . . . . . . .  1.9 in

6.  Drainage Area . . . . . . . . . . . . . . . . . . . . . . .  10.0 acres


Hydraulics.  SEDIMOT II program was utilized to evaluate inflow, reservoir response and outflow from the structure.  The initial conditions and results of the analysis are summarized in the Hydraulics table.


Spillway Channel.  The existing spillway for WW-4 has a trapezoidal channel with the following dimensions:

Channel depth . . . . . . . . . . . . . . . . . . . . . . . . . . . .  1.7 ft

Channel width . . . . . . . . . . . . . . . . . . . . . . . . . . . .  15.0 ft

Channel length  . . . . . . . . . . . . . . . . . . . . . . . . . . .  30.0 ft

Side Slope (horizonatal to vertical)  . . . . . . . . . . . . .  3 : 1

Average Exit Slope  . . . . . . . . . . . . . . . . . . . . . . . .  0 percent

The spillway channel is riprapped as per the approved design.


Outflow Channel.  The existing outflow channel for WW-4 is a trapezoidal channel of the following dimensions:

Channel depth . . . . . . . . . . . . . . . . . . . . . . . . . . . .  1.7 ft

Channel width . . . . . . . . . . . . . . . . . . . . . . . . . . . .  15.0 ft

Channel length  . . . . . . . . . . . . . . . . . . . . . . . . . .  150.0 ft

Side Slopes (horizontal to vertical)  . . . . . . . . . . . . .  3 : 1

Average Exit Slope  . . . . . . . . . . . . . . . . . . . . . . . .  12 percent

The spillway channel is riprapped as per the approved design.


Storage Capacity.  The impoundment Stage-Capacity Curve is based on site specific survey conducted for Peabody Coal Company's as-built inspection.  Additionally, the most recent topographic maps available were used in developing Plate 2, Stage-Capacity Curve, WW-4.


The calculations for the sediment load entering Structure WW-4 were made utilizing the Modified Universal Soil Loss Equation with the following parameters:

1.  Soil Erodibility Factor, K . . . . . . . . . . . . . . . . . .  0.32

2.  Average Slope  . . . . . . . . . . . . . . . . . . . . . . . . .  30%

3.  Average Length of Slopes . . . . . . . . . . . . . . . . . . . 300 ft

4.  Erosion Control Factor, P  . . . . . . . . . . . . . . . . . .  1.0


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The hydrologic analysis give the storage volume required to contain the 10-year, 24-hour storm, and the remaining storage volume available for storing sediment. The storage capacity of WW-4 is shown on Plate 2. Stage-Capacity Curve, WW-4, and the results of the analysis are summarized in the following table.

## WW-4 STORAGE

| | |
|---|---|
| Total Storage Capacity . . . . . . . . . . . . . . . . . . . . . . | 14.36 acre-ft |
| 10-year, 24-hour Storm Inflow . . . . . . . . . . . . . . . . . . | 0.60 acre-ft |
| Available Sediment Storage Capacity . . . . . . . . . . . . . . | 13.76 acre-ft |
| Sediment Inflow, 10-year, 24-hour Storm (MUSLE) . . . . . . . . | 0.73 acre-ft |
| Sediment Storage . . . . . . . . . . . . . . . . . . . . . . . . . | 18.37 10-year, 24 hour Storms |

## Remedial Compliance Plan

Geotechnics. The inspection of Structure WW-4 indicated that there are no geotechnical problems at this time.

Hydraulics. Peabody's evaluation indicates that the storage and spillway capacity of Structure WW-4 are adequate. No remedial work is required at this time.

4

| | 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 | 8 | 10 |
| Volume | acre-ft | 0.60 | 0.49 |
| Storage | | | |
| Peak Stage | ft | 6208.4 | 6228.5 |
| Spillway Elevation | ft | 6228.5 | -- |
| Peak Storage | acre-ft | 0.60 | -- |
| Storage Capacity | acre-ft | 14.36 | -- |
| Outflow | | | |
| Peak Flow | cfs | 0 | 5 |
| Embankment Crest Elevation | ft | -- | 6229.5 |
| Peak Storage | ft | -- | 6228.6 |
| Freeboard | ft | -- | 0.9 |
| Spillway Channel | | | |
| Flow Depth | ft | -- | 0.16 |
| Critical Velocity | fps | -- | 2.0 |
| Manning's "n" | | -- | 0.040 |
| Outflow Channel | | | |
| Slope | % | -- | 12.0 |
| Normal Velocity | fps | -- | 12.13 |
| Normal Depth | ft | -- | 0.03 |
| Manning's "n" | | -- | 0.040 |

APPENDIX A

PEABODY INSPECTION CHECK LIST

## INSPECTION CHECK LIST

| ITEM | YES | NO | REMARKS |
|---|---|---|---|
| **1. CREST** | | | |
| a. Any visual settlements? | | X | |
| b. Misalignment? | | X | |
| c. Cracking? | | X | |
| **2. UPSTREAM SLOPE  43%** | | | |
| a. Adequate grass cover? | | X | Not Established |
| b. Any erosion? | | X | |
| c. Are trees growing on slope? | | X | |
| d. Longitudinal cracks? | | X | |
| e. Transverse cracks? | | X | |
| f. Adequate riprap protection? | N.A. | | |
| g. Any stone deterioration? | N.A. | | |
| h. Visual depressions or bulges? | | X | |
| i. Visual settlements? | | X | |
| j. Animal burrows? | | X | |
| **3. DOWNSTREAM SLOPE  34%** | | | |
| a. Adequate grass cover? | | X | Not Established |
| b. Any erosion? | | X | |
| 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? | N.A. | | |
| i. Are the relief wells flowing? | N.A. | | |
| 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? | | | Sandy Silt (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? | | | Sandy Silt (SM) |

| ITEM | YES | NO | REMARKS |
|---|---|---|---|
| 6. SPILLWAY/NORMAL | | | |
| a. Location: | | | |
| Left abutment? | | | |
| Right abutment? | X | | |
| Crest of Embankments? | | | |
| b. Approach Channel: | N.A | | |
| Are side slopes eroding? | | | |
| Are side slopes sloughing? | | | |
| Bottom of channel eroding? | | | |
| Obstructed? | | | |
| Erosion protection? | | | |
| c. Spillway Channel: 0% | | | |
| Are side slopes eroding? | | X | |
| Are side slopes sloughing? | | X | |
| Bottom of channel eroding? | | X | |
| Obstructed? | | X | |
| Erosion protection? | X | | Riprap |
| d. Outflow Channel: 12% | | | |
| Are side slopes eroding? | | X | |
| Are side slopes sloughing? | | X | |
| Bottom of channel eroding? | | X | |
| Obstructed? | | X | |
| Erosion protection? | X | | Riprap |
| e. Weir: | N.A. | | |
| Condition? | | | |
| 7. SPILLWAY/EMERGENCY | | | |
| a. Location: | N.A. | | |
| 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? | | ✕ | (Elev.) | feet |
| b. Water present? | | ✕ | (Elev.) | feet |
| c. Siltation?      Drainage | | ✕ | | |
| d. Watershed matches ~~soil~~ map? | ✕ | | | |

**9. GENERAL COMMENTS**

Seeded in the fall but no significant vegetation on slopes yet. No apparent slope erosion.

APPENDIX B

HYDROLOGY AND HYDRAULIC CALCULATIONS

W-11-4

## TIME OF CONCENTRATION

ELEVATION DIFFERENCE = ___5363___ − ___5210___ = ___153___

WATER COURSE LENGTH = ___500___ / 5280 = ___.095___

$$T_c = \left(\frac{11.9 \left(\;.095\;\right)^3}{153}\right)^{0.385} = \;.076\; \text{hrs.}$$

## SCS CURVE NUMBER

| DRAINAGE AREA (ACRES) | COVER TYPE | HYDROLOGIC CONDITION | SOIL TYPE | WEIGHTED CURVE NO. |
|---|---|---|---|---|
| 2.14 | DISTURBED | | | |
| / | RECLAIMED | | | |
| 0 | P-J | | | |
| 1.42 | SAGE-GRASS | | | |
| 1.73 | SAGE-GRASS | POOR | B | |

## DRAINAGE BASIN AREA

_____ ACRES / 640 = ___0.005___ SQ. MILES

24,250 E

24,500 E

36,000 S

6250

6240

X 6232

X 6231.0

B

X 6231.5

●

X 6231.0

36,250 S

X 6229.5

X 6230.5

6230

Spillway

B'

6220

6210

X 6231.5

6229.6

6207.0

X 6229.5

A'

6230.5

6230

6220

X 6231.6

36,500 S

6230

6200

6210

N

X 6202.5

A

6210

6179

6220

36,750 S

## WW-4

### SITE PLAN

1"=100'
scale

100    0    100    200

feet

STAGE-CAPACITY CURVE WW-4
Black Mesa/Kayenta Mines

Spillway Inlet Elev. 6228.5

CAPACITY (ac-ft)

STAGE (ft.)
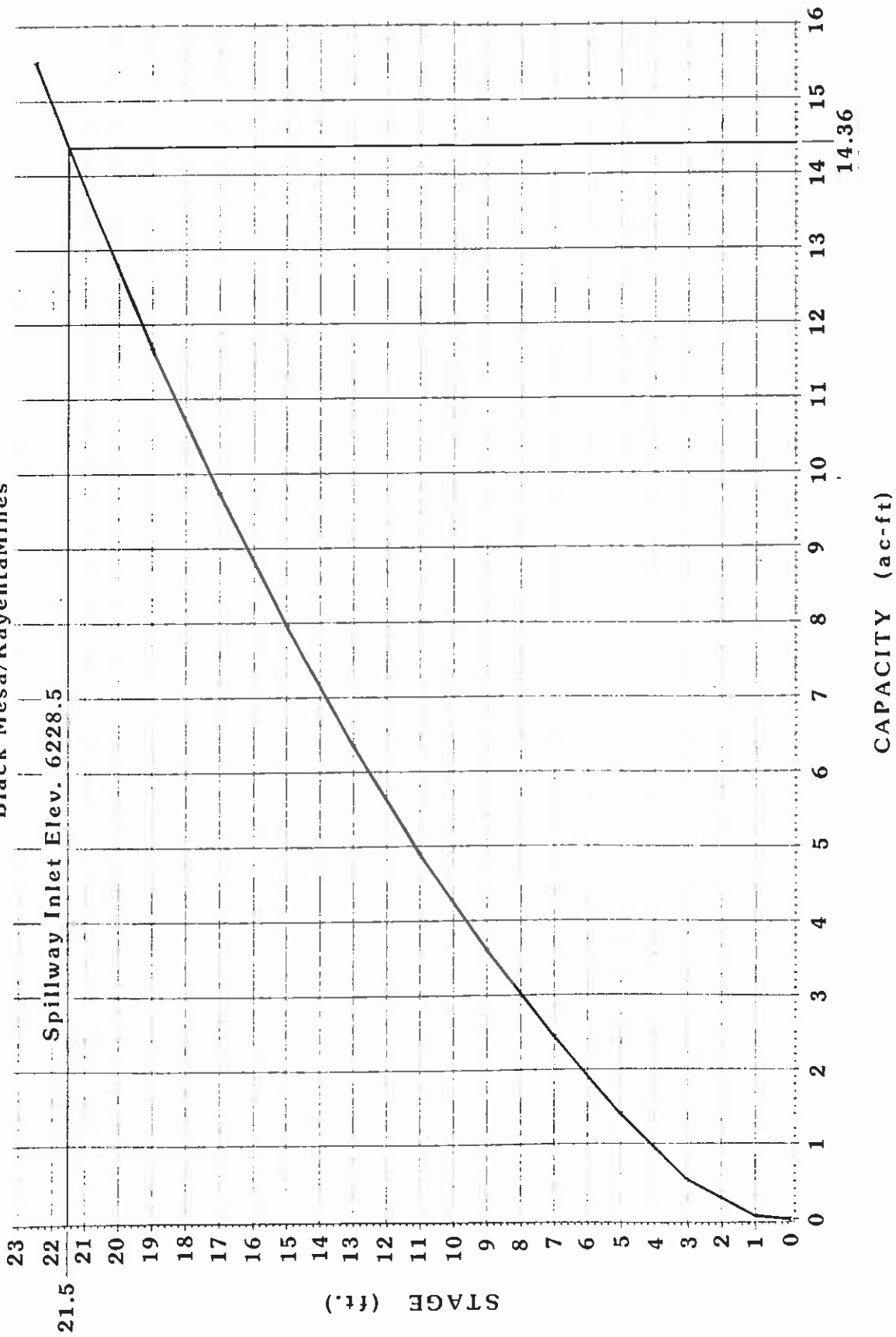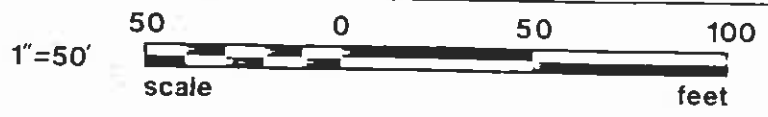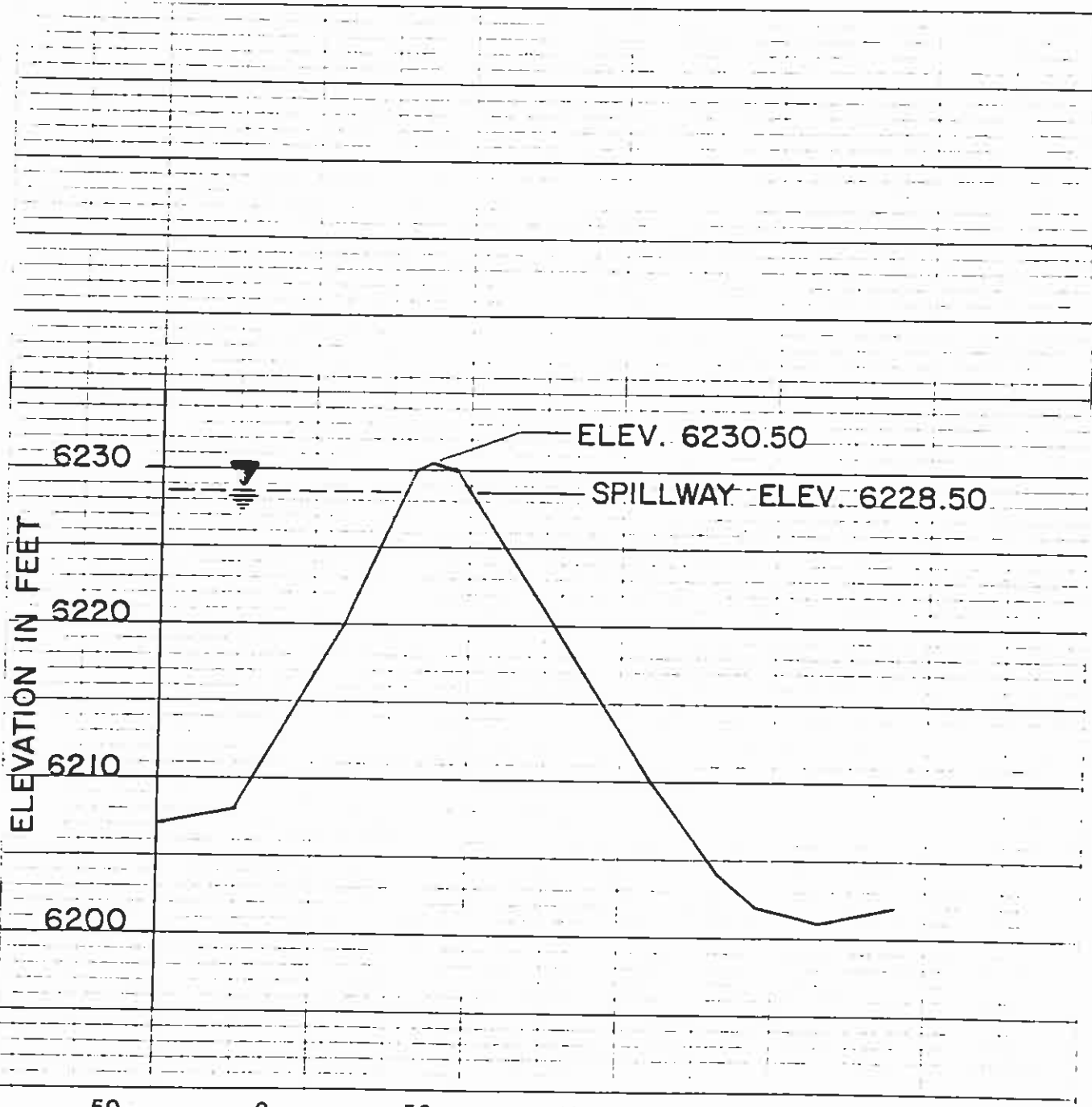
Plate 2

MAXIMUM CROSS-SECTION
A-A'
WW-4

BY Peabody Coal Company

Plate 3
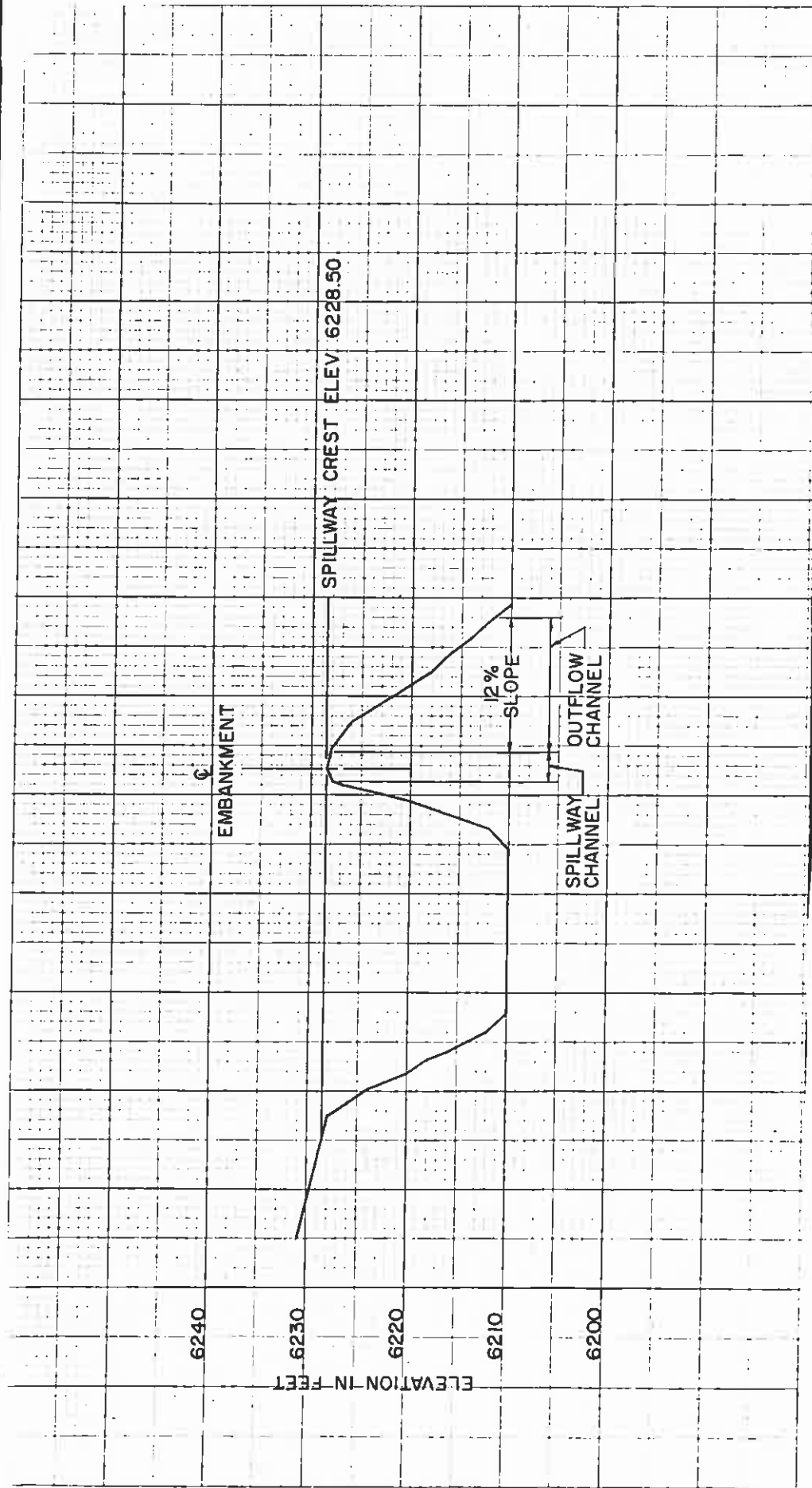
CHANNEL PROFILE B-B'
WW-4
Plate 4

BY Peabody Coal Company

FOR LOCATION SEE PLATE 1

VARIABLE SLOPE
DEPENDING ON
MATERIALS

15' MIN.

FLOWLINE

RIPRAP
$D_{50} = 12"$

D

$\dfrac{L}{3}$

$\dfrac{I}{3}$

1.5' MIN.

GEOTEXTILE

4" MIN. BEDDING
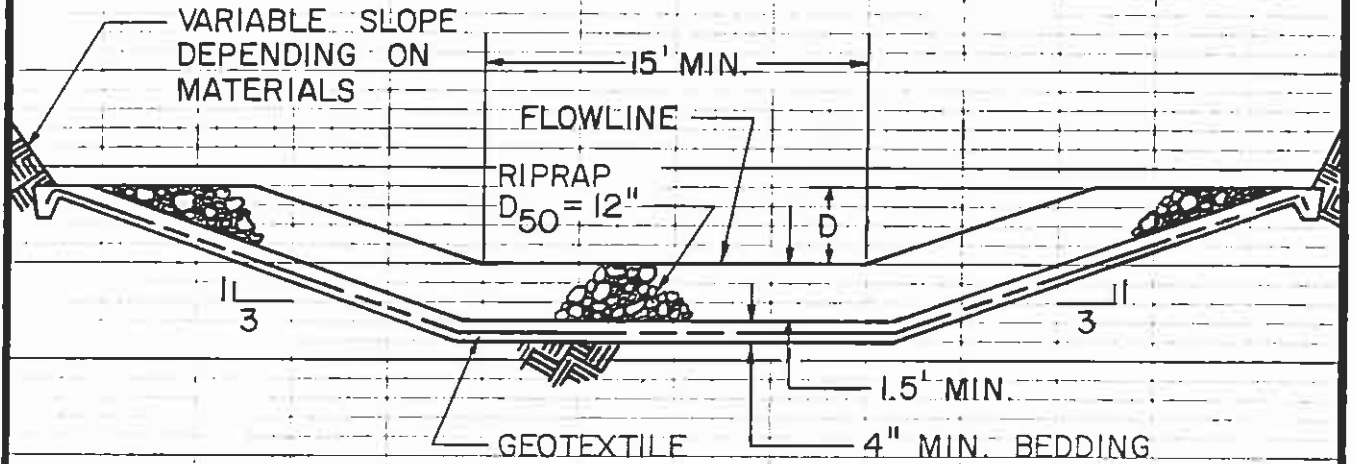
SPILLWAY CHANNEL

D = 1.7'

LENGTH = 30.0'

FLOWLINE ELEV. = 6228.5

OUTFLOW CHANNEL

D = 1.7'

WW-4
SPILLWAY AND
OUTFLOW CHANNEL
CROSS SECTION

BY Peabody Coal Company

Plate 5