INSPECTION REPORT

Sedimentation Structure

WW-9C

Black Mesa Mine

Navajo County, Arizona

for

PEABODY COAL COMPANY


Dames & Moore
10139-011-22

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## INTRODUCTION

Sedimentation Structure WW-9C is an earthen embankment, designed and constructed in 1983 by Peabody Coal Company as a temporary sedimentation structure to control runoff and sediment from the disturbed mining areas of the Black Mesa Mine. The location of Structure WW-9C is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure WW-9C. 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-9C was inspected on August 30, 1985 by an inter-disciplinary 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 WW-9C 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 WW-9C has a 17.4-acre tributary drainage area and is located near the Yucca Flats Wash at the Black Mesa Mine. The watershed is classified as 92% Sagebrush/grass and 8% disturbed.

### EMBANKMENT

Structure WW-9C is a homogeneous earthen embankment classified as a in-wash embankment. Physical characteristics of the embankment are listed in the following table:

Structure WW-9C

| | |
|---|---|
| Embankment | Residual Shale Soils |
| Foundation | Alluvium |
| Right Abutment | Residual Shale Soils |
| Left Abutment | Residual Shale Soils |
| Height | 14.8 ft |
| Crest Width | 15 ft |
| Upstream Slope | 2 H : 1 V |
| Downstream Slope | 3.3 H : 1 V |

A cross-section of the embankment is shown on Plate 2, Existing Maximum Cross Section WW-9C, A-A'. Grass and rock provide erosion protection on the downstream slope of the embankment.

## ANALYSES

### STABILITY

Structure WW-9C is a category B-3 embankment. A standard category B-3 embankment has static and seismic factors of safety of 1.5 and 1.2, respectively, under the following conditions:

1. Maximum height = 20 ft
2. Maximum upstream slope = 2.0 H : 1 V
3. Maximum downstream slope = 2.5 H : 1 V
4. Normal pool with steady seepage saturation conditions

The WW-9C 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 WW-9C 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-9C was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

| | | | |
|---|---|---|---|
| 1. | Water Course length, L | 0.369 | mi |
| 2. | Elevation Difference, H | 106 | ft |
| 3. | Time of Concentration, $T_c$ | 0.136 | h |
| 4. | Lag time, $0.6T_c$ | 0.0817 | h |
| 5. | SCS Curve Number | 75 | |
| 6. | Rainfall Depth, 10-year, 24-hour storm | 2.1 | in. |
| | 25-year, 6-hour storm | 1.9 | in. |
| 7. | Drainage Area | 17.4 | 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 initial conditions and results of the analysis are summarized in the following table.

| | 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 | 13 | 15 | |
| Volume . . . . . | acre-ft | 0.75 | 0.62 | |
| Storage | | | | |
| Peak Stage . . . . . | ft | 6261.85 | -- | |
| Spillway Elevation . . | ft | 6273.80 | -- | |
| Peak Storage . . . . . | acre-ft | 0.75 | -- | |
| Storage Capacity . . . | acre-ft | 10.4 | -- | |
| Outflow | | | | |
| Peak Flow . . . . . | cfs | -- | 2 | |
| Embankment Crest Elevation . . . . . | ft | -- | 6275.20 | |
| Peak Stage . . . . . | ft | -- | 6274.12 | |
| Freeboard . . . . . | ft | -- | 1.08 | |
| Spillway Channel | | | | |
| Flow Depth . . . . . | ft | -- | 0.32 | |
| Critical Velocity. . . | fps | -- | 1.6 | |
| Manning's "n" . . . . | | -- | 0.035 | |
| Outflow Channel | | | Section I | Section II |
| Slope . . . . . | % | -- | 41 | 10 |
| Normal Velocity. . . . | fps | -- | 3.2 | 2.1 |
| Normal Depth . . . . . | ft | -- | 0.04 | 0.06 |
| Manning's "n" . . . . | | -- | 0.035 | 0.035 |

Spillway Channel

The existing spillway for WW-9C has a trapezoidal channel with the following dimensions:

| | |
|---|---|
| Channel depth | 2 ft |
| Channel width | 15 ft |
| Channel length | 21 ft |
| Side slopes (horizontal to vertical) | 2:1 |
| Average exit slope | 0 percent |

Rock provides 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, WW-9C.

The calculations for the sediment load entering Structure WW-9C were made utilizing the Universal Soil Loss Equation with the following parameters:

1. Rainfall Factor, R . . . . . 40
2. Soil Erodibility Factor, K . . . . . 0.21
3. Slope Factor, LS . . . . . 1.50
4. Cover Factor, C . . . . . 0.163
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 WW-9C and the results of the sediment inflow analysis are summarized in the following table.

WW-9C STORAGE

| | | |
|---|---|---|
| Total Storage Capacity . . . . . | 10.4 | acre-ft |
| 10-year, 24-hour Storm Inflow . . . . . | 0.75 | acre-ft |
| Available Sediment Storage Capacity . . | 9.65 | acre-ft |
| Sediment Inflow Rate . . . . . | 0.02 | acre-ft/yr |
| Sediment Storage Life . . . . . | 482 | yrs |

Excess storage capacity in Structure WW-9C can be used for storing water produced during maintenance of the nearby water well.

## REMEDIAL COMPLIANCE PLAN

### GEOTECHNICS

The inspection of Structure WW-9C indicated that the only geotechnical problem is rill and gully erosion on the upstream and downstream slopes and on the left abutment. Correction of erosion is considered a periodic maintenance task and does not require remedial action.

HYDRAULICS

The storage capacity and spillway capacity of Structure WW-9C are adequate; however, the spillway does not have an adequate outflow channel or adequate erosion protection. A trapezoidal outflow channel should be constructed along the alignment B-B' shown in Plate 1. The channel profile is shown in Plate 4 and the required dimensions are shown in Plate 5. Both the spillway and outflow channel should be protected against erosion using geotextile and gravel as shown in Plate 5.

* * *

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

Plate 1 - Site Plan WW-9C

Plate 2 - Existing Maximum Cross Section WW-9C, A-A'

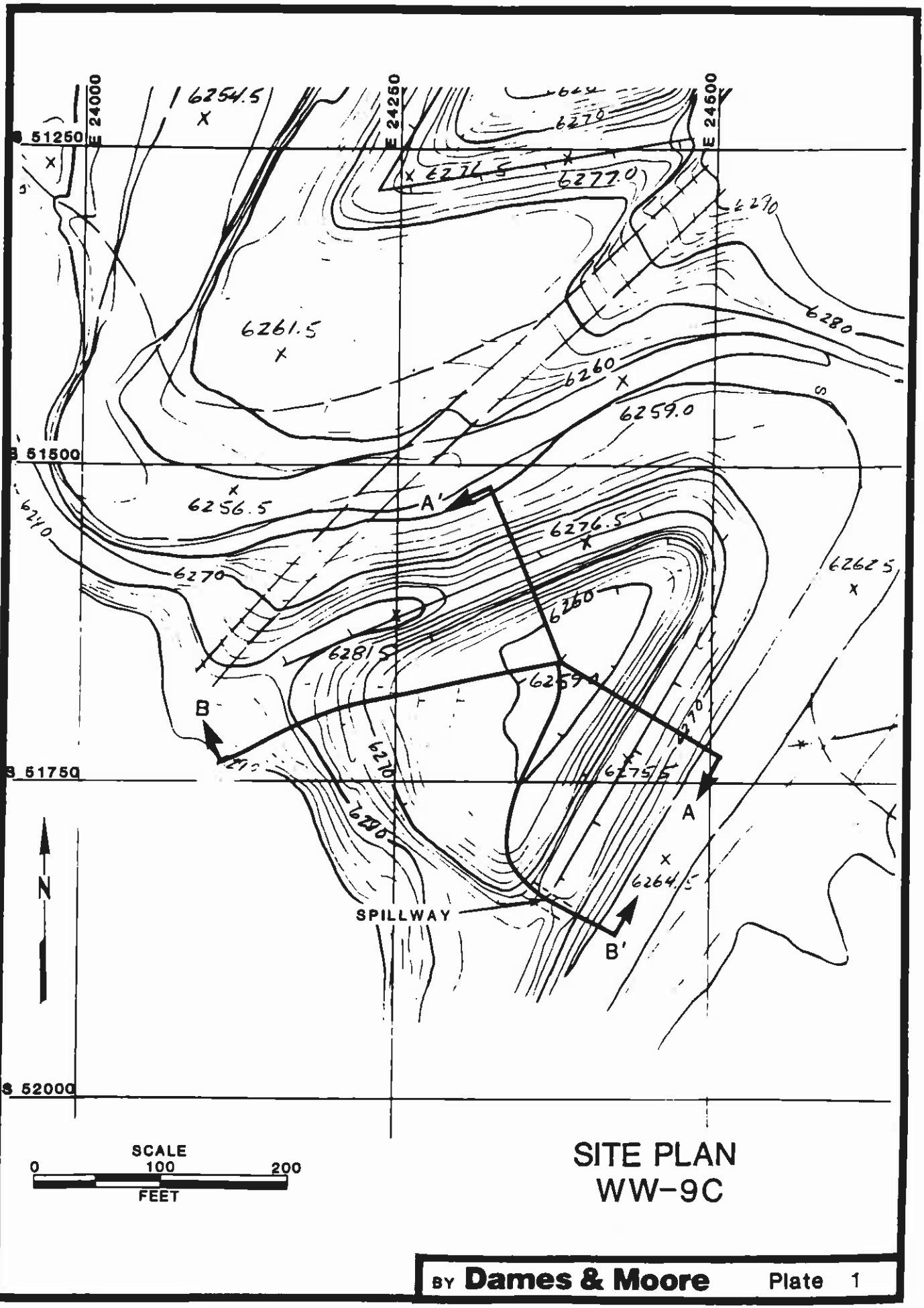
Plate 3 - Volume-Elevation Curve WW-9C

Plate 4 - Channel Profile WW-9C, B-B'

Plate 5 - Spillway and Outflow Channel Cross Section WW-9C

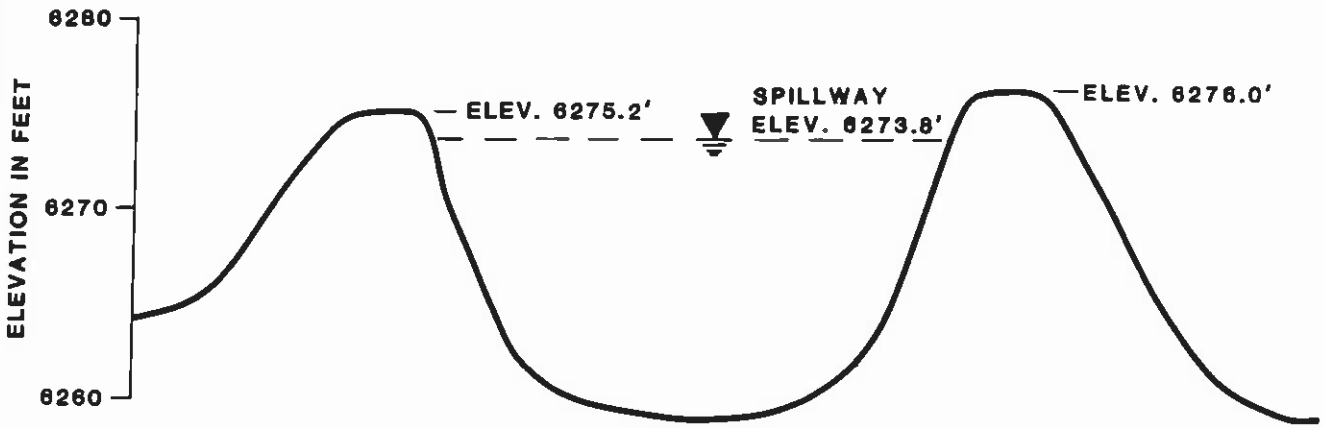
Appendix A - Inspection Check List

Appendix B - Hydrology and Hydraulic Calculations




# SITE PLAN
# WW-9C

BY **Dames & Moore** Plate 1

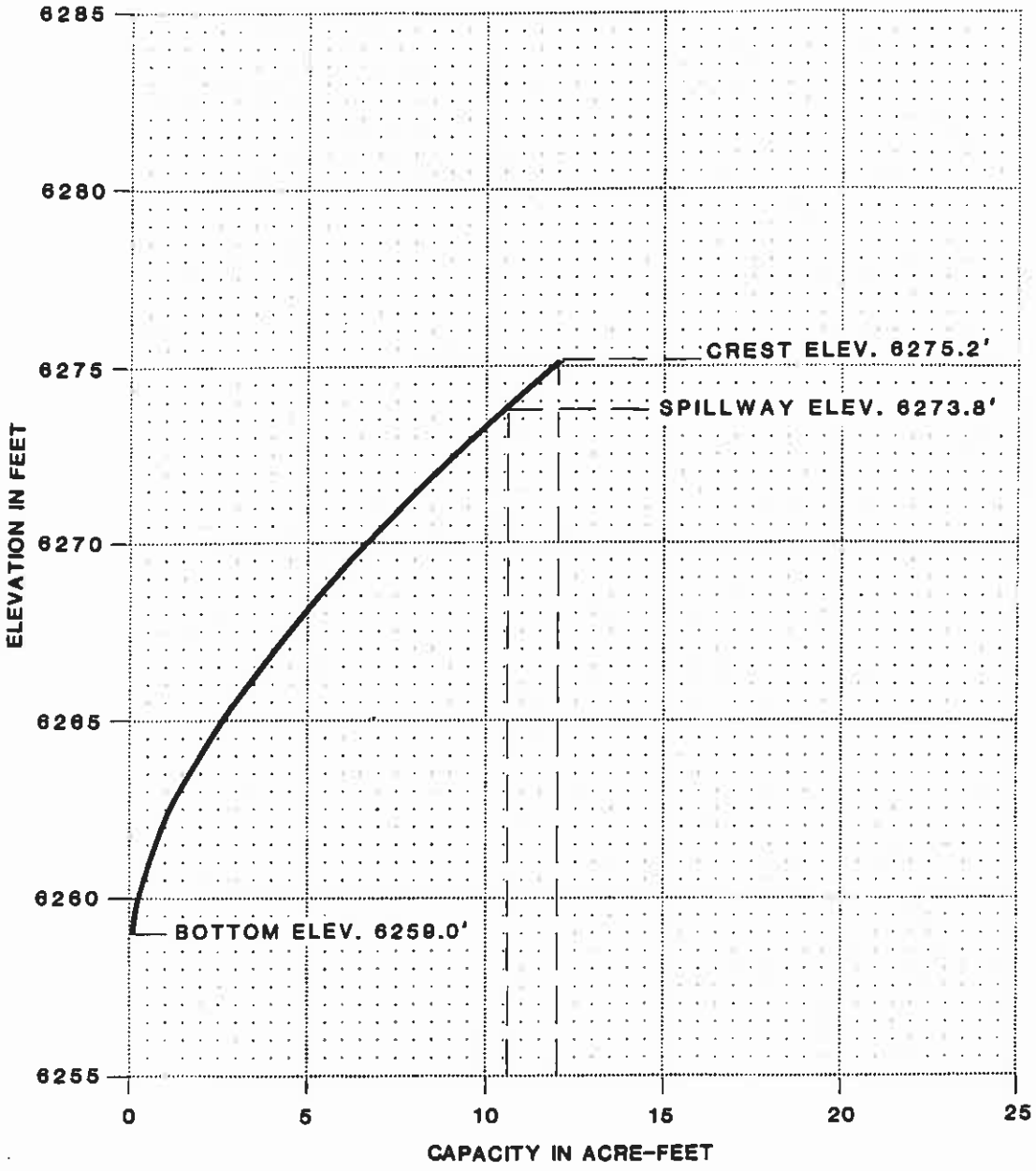



SCALE
0 50 100
FEET

# EXISTING MAXIMUM CROSS-SECTION A-A' WW-9C

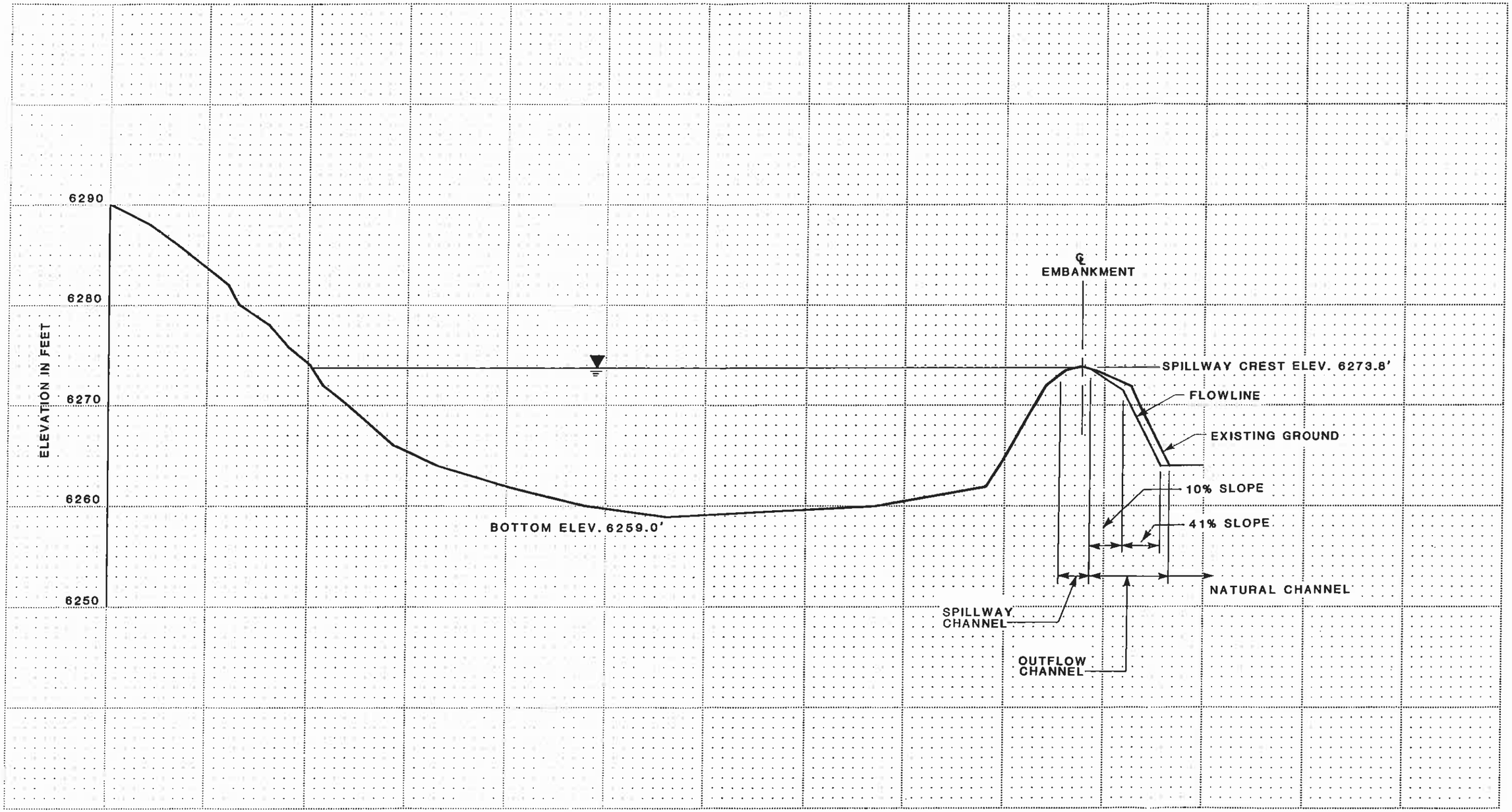
FOR LOCATION SEE PLATE 1

BY **Dames & Moore** Plate 2




# VOLUME-ELEVATION CURVE WW-9C

BY **Dames & Moore** Plate 3

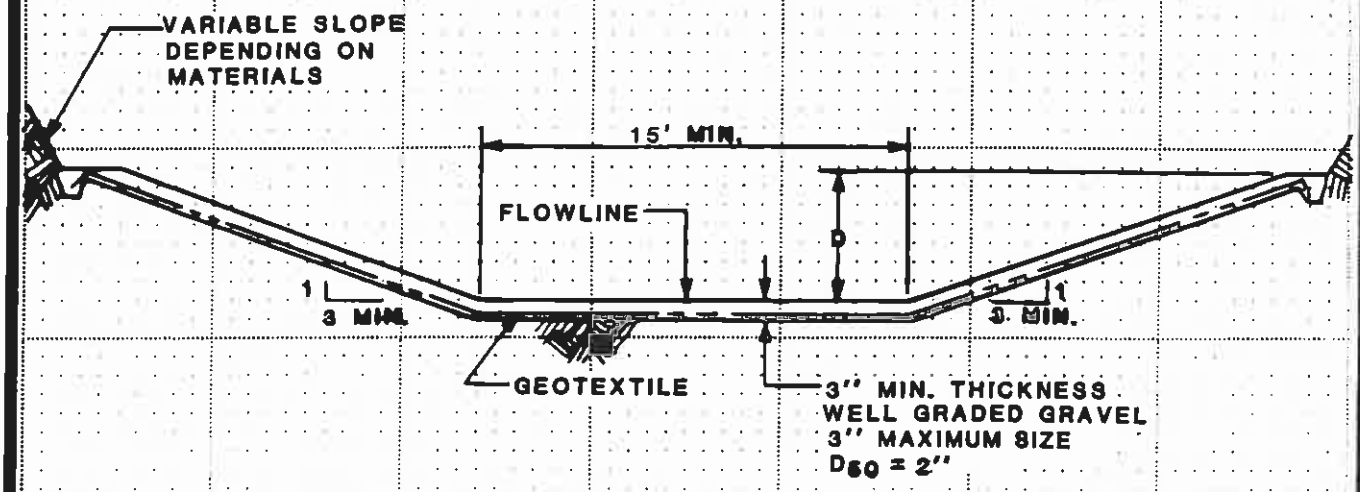



SCALE
0 50 100
FEET

# CHANNEL PROFILE B-B'
# WW-9C

FOR LOCATION SEE PLATE 1

BY **Dames & Moore** Plate 4




**SPILLWAY CHANNEL**

D = 1.4'

LENGTH = 30'

FLOWLINE ELEV.= 6273.80'

**OUTFLOW CHANNEL**

D = 1'

# SPILLWAY AND OUTFLOW CHANNEL CROSS SECTION

WW-9C

BY **Dames & Moore** Plate 5

# APPENDIX A

# INSPECTION CHECK LIST

## INSPECTION CHECK LIST

| ITEM | YES | NO | REMARKS |
|---|---|---|---|
| 1. CREST | | | TRIANGULAR EMBANKMENT with short side at South end |
| a. Any visual settlements? | | X | |
| b. Misalignment? | | X | |
| c. Cracking? | | X | |
| 2. UPSTREAM SLOPE | | | 27° |
| a. Adequate grass cover? | X | | 25% |
| b. Any erosion? | X | | Rills |
| 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 17° | | | Rock Rip Rap (see comments) |
| a. Adequate grass cover? | X | | 60% Grass where Rock is not |
| b. Any erosion? | X | | Minor - Rills |
| 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? | | | NA |
| 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? | | | SM / Rock shallow |
| 5. ABUTMENT CONTACT. LEFT | | | |
| a. Any erosion? | X | | Gulley / inlet channel from culvert |
| b. Visual differential movement? | | X | |
| c. Any cracks noted? | | X | |
| d. Is seepage present? | | X | |
| e. Type of Material? | | | gray SM |

| ITEM | YES | NO | REMARKS |
|---|---|---|---|
| 6. SPILLWAY/NORMAL | | | |
| a. Location: | | | |
| Left abutment? | | | |
| Right abutment? | | | |
| Crest of Embankments? | X | | Near Right Abutment |
| b. Approach Channel: | | X | |
| Are side slopes eroding? | | | NA |
| Are side slopes sloughing? | | | NA |
| Bottom of channel eroding? | | | NA |
| Obstructed? | | | NA |
| Erosion protection? | | | NA |
| c. Spillway Channel: | | | |
| Are side slopes eroding? | | X | |
| Are side slopes sloughing? | | X | |
| Bottom of channel eroding? | | X | |
| Obstructed? | | X | |
| Erosion protection? | X | | some (50%) rock D50/6" |
| d. Outflow Channel: | | X | |
| Are side slopes eroding? | | | NA |
| Are side slopes sloughing? | | | NA |
| Bottom of channel eroding? | | | NA |
| Obstructed? | | | NA |
| Erosion protection? | X | | Rock on slope D50/18" |
| e. Weir: | | X | |
| Condition? | | | |
| 7. SPILLWAY/EMERGENCY | | | NA |
| 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? | | | |

Sediment Impoundment Name: WW9-C
Page: 6

**8. GENERAL COMMENTS**

LARGE ROCK UP TO 10' SLABS OF SAND STONE ON D.S. SLOPE some stone deterioration D50 / 24"

Inlet channel to impoundment unlined & deepening x 24" effluent at road

does not endanger embankment yet recommend riprap upper end

8. IMPOUNDMENT

No water

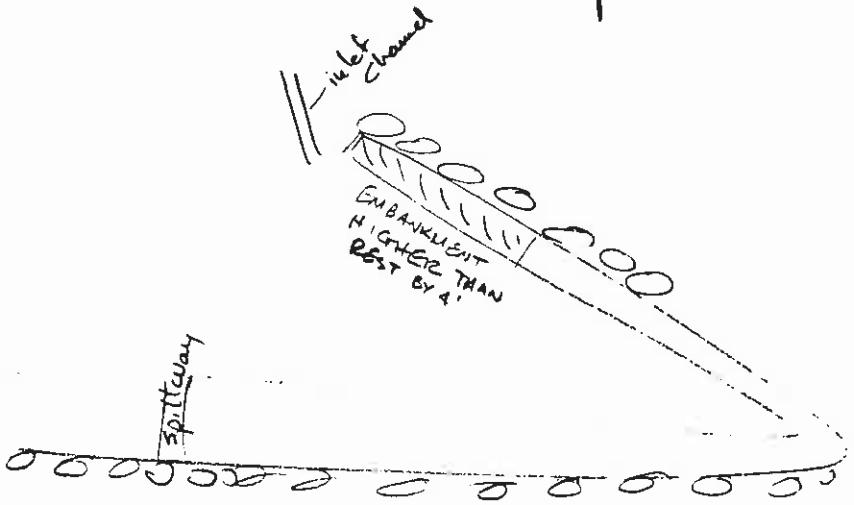
Watershed same as design

Canopy 25 %

Ground cover 50%

Sagebrush / grass

Not much sediment in pond



# APPENDIX B

## HYDROLOGY AND HYDRAULIC CALCULATIONS

FILE PEABODY COAL CO 10139-011-22
SUBJECT SEDIMENT POND HYDROLOGY
WW9-C SHEET ___ OF ___

REVISIONS
BY ___ DATE ___ TO EO ___
BY ___ DATE ___ TO EO ___

## TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 6380 - 6274 = 106'

WATER COURSE LENGTH = 1950' = 0.369 mi

$$T_c = \left(\frac{11.9\,(0.369)^3}{106}\right)^{0.385} = 0.136 \text{ hr}$$

LAG TIME = $0.6\,T_c$ = 0.0817 hr

## SCS CURVE NUMBER

| | DRAINAGE AREA (ac) | | COVER TYPE | HYDROLOGIC CONDITION | SOIL TYPE | WEIGHTED CURVE NUMBER | |
|---|---|---|---|---|---|---|---|
| 1250'x50' | 1.4 | (8%) | GRAV. RD. | — | C | 0.08(89) = | 7.1 |
| | 160 | (92%) | S-G | ave. | C | 0.92(73) = | 67.2 |
| | | | | | EH 32- | | 74.3 |

Use 75

## DRAINAGE BASIN AREA

17.4 AC. 0.027 SQ. MI.

BY GDeardorff DATE 1/6/85
CHECKED BY ___
COPY TO EO ___

FILE KEABOY COAL CO 1039-011-22
SUBJECT SEDIMENT INFLOW
WW9-2 SHEET ___ OF ___

REVISIONS BY ___ DATE ___ TO EO ___ BY ___ DATE ___ TO EO ___

# UNIVERSAL SOIL LOSS EQUATION

## RAINFALL FACTOR

R = 40

## SOIL ERODIBILITY FACTOR

SOIL TYPE = EH #32

~~PERTAINED~~

K = 0.21

## SLOPE FACTOR

| LENGTH (ft.) | Δ ELEV (ft.) | SLOPE (%) | LS | |
|---|---|---|---|---|
| 1450 | 40 | 3 | 0.65 | 75% area |
| 550 | 67 | 12 | 4.2 | 25% area |

USE 1.5 WEIGHTED

## COVER FACTOR

| AREA (ac.) | COVER TYPE | % COVER | CANOPY (%) | WEIGHTED C |
|---|---|---|---|---|
| 8% | ROAD | — | — | 0.08 (1.0) |
| 92% | S-G | 40 | 25 | 092 (.13) |

USE .200

## EROSION CONTROL FACTOR

P = 1.0

## SEDIMENT INFLOW

BY ___ DATE ___ CHECKED BY ___ COPY TO EO ___

$A = 40(0.21)(1.5)(.200)(1.0) = 2.52$ ton/acre/year

$A = 2.52\left(\frac{1}{2047}\right)(17.4)(0.95) = .020$ acre-feet/year

**Dames & Moore**