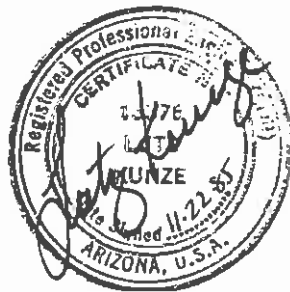


INSPECTION REPORT  
Sedimentation Structure  
WW-9B  
Kayenta Mine  
Navajo County, Arizona  
for  
PEABODY COAL COMPANY



Dames & Moore  
10139-011-22

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## INTRODUCTION

Sedimentation Structure WW-9B 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 Kayenta Mine. The location of Structure WW-9B is shown on Plate 1, Site Plan.

This inspection report contains information specific to Structure WW-9B. 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-9B was inspected on August 30, 1985 by an interdisciplinary 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-9B 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-9B has a 12.3-acre tributary drainage area and is located near Yucca Flats Wash at the Kayenta Mine. The watershed is classified as 91% Sagebrush/grass and 9% disturbed.

#### EMBANKMENT

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

#### Structure WW-9B

Embankment . . . . .	Residual Shale Soils
Foundation . . . . .	Sandstone
Right Abutment . . . . .	Residual Shale Soils
Left Abutment . . . . .	Residual Shale Soils
Height . . . . .	11.8 ft
Crest Width . . . . .	15 ft
Upstream Slope . . . . .	2.75 H : 1 V
Downstream Slope . . . . .	3.7 H : 1 V

A cross-section of the embankment is shown on Plate 2, Existing Maximum Cross Section WW-9B, A-A'. Grass provides erosion protection on the upstream slope of the embankment.

## ANALYSES

### STABILITY

Structure WW-9B is a category B-5 embankment. A standard category B-5 embankment has static and seismic factors of safety of 1.5 and 1.2, respectively, under the following conditions:

1. Maximum height = 15 ft
2. Maximum upstream slope = 1.75 H : 1 V
3. Maximum downstream slope = 2.5 H : 1 V
4. Normal pool with steady seepage saturation conditions

The WW-9B 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 WW9-B 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-9B was analyzed using the 10-year, 24-hour storm.

The following parameters were used in the hydrologic analysis:

1. Water Course length, L . . . . . 0.104 mi
2. Elevation Difference, H . . . . . 27 ft
3. Time of Concentration,  $T_c$  . . . . . 0.0534 h
4. Lag time,  $0.6T_c$  . . . . . 0.0321 h
5. SCS Curve Number . . . . . 81
6. Rainfall Depth, 10-year, 24-hour storm . 2.1 in.  
25-year, 6-hour storm. . 1.9 in.
7. Drainage Area . . . . . 12.3 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.

WW-9B HYDRAULICS

Units	10-year 24-hour Storm	25-year 6-hour Storm
<b>Initial Reservoir Volume</b>		
Condition	Empty	Full to the spillway elevation
<b>Inflow</b>		
Peak Flow . . . . . cfs	19	24
Volume . . . . . acre-ft	0.84	0.65
<b>Storage</b>		
Peak Stage . . . . . ft	6365.38	—
Spillway Elevation . . ft	6373.30	--
Peak Storage . . . . . acre-ft	0.84	--
Storage Capacity . . . acre-ft	5.38	--
<b>Outflow</b>		
Peak Flow . . . . . cfs	0	2
Embankment Crest		
Elevation . . . . . ft	—	6375.00
Peak Stage . . . . . ft	--	6373.68
Freeboard . . . . . ft	--	1.32
<b>Spillway Channel</b>		
Flow Depth . . . . . ft	--	0.38
Critical Velocity . . . fps	--	2.1
Manning's "n" . . . . .	—	0.035
<b>Outflow Channel</b>		
		<u>Section I</u> <u>Section II</u>
Slope . . . . . %	—	22      10
Normal Velocity . . . . fps	--	2.7      1.6
Normal Depth . . . . . ft	—	0.05      0.06
Manning's "n" . . . . .	--	0.035      0.035

Spillway Channel

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

Channel depth . . . . .	2	ft
Channel width . . . . .	14.5	ft
Channel length . . . . .	18	ft
Side slopes (horizontal to vertical). . .	2:1	
Average exit slope . . . . .	0	percent

There is presently 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-9B.



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

1. Rainfall Factor, R . . . . . 40
2. Soil Erodibility Factor, K . . . . . 0.195
3. Slope Factor, LS . . . . . 2.5
4. Cover Factor, C . . . . . 0.125
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-9B and the results of the sediment inflow analysis are summarized in the following table.

WW-9B STORAGE

Total Storage Capacity . . . . .	5.38	acre-ft
10-year, 24-hour Storm Inflow . . . . .	0.84	acre-ft
Available Sediment Storage Capacity . . . . .	4.54	acre-ft
Sediment Inflow Rate . . . . .	0.023	acre-ft/yr
Sediment Storage Life . . . . .	197	yrs

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

REMEDIAL COMPLIANCE PLAN

GEOTECHNICS

The inspection of Structure WW-9B indicated that the only geotechnical problems are rills on the upstream and downstream slopes and the right and left abutments. 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-9B are adequate; however, the spillway does not have an 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.

\* \* \*

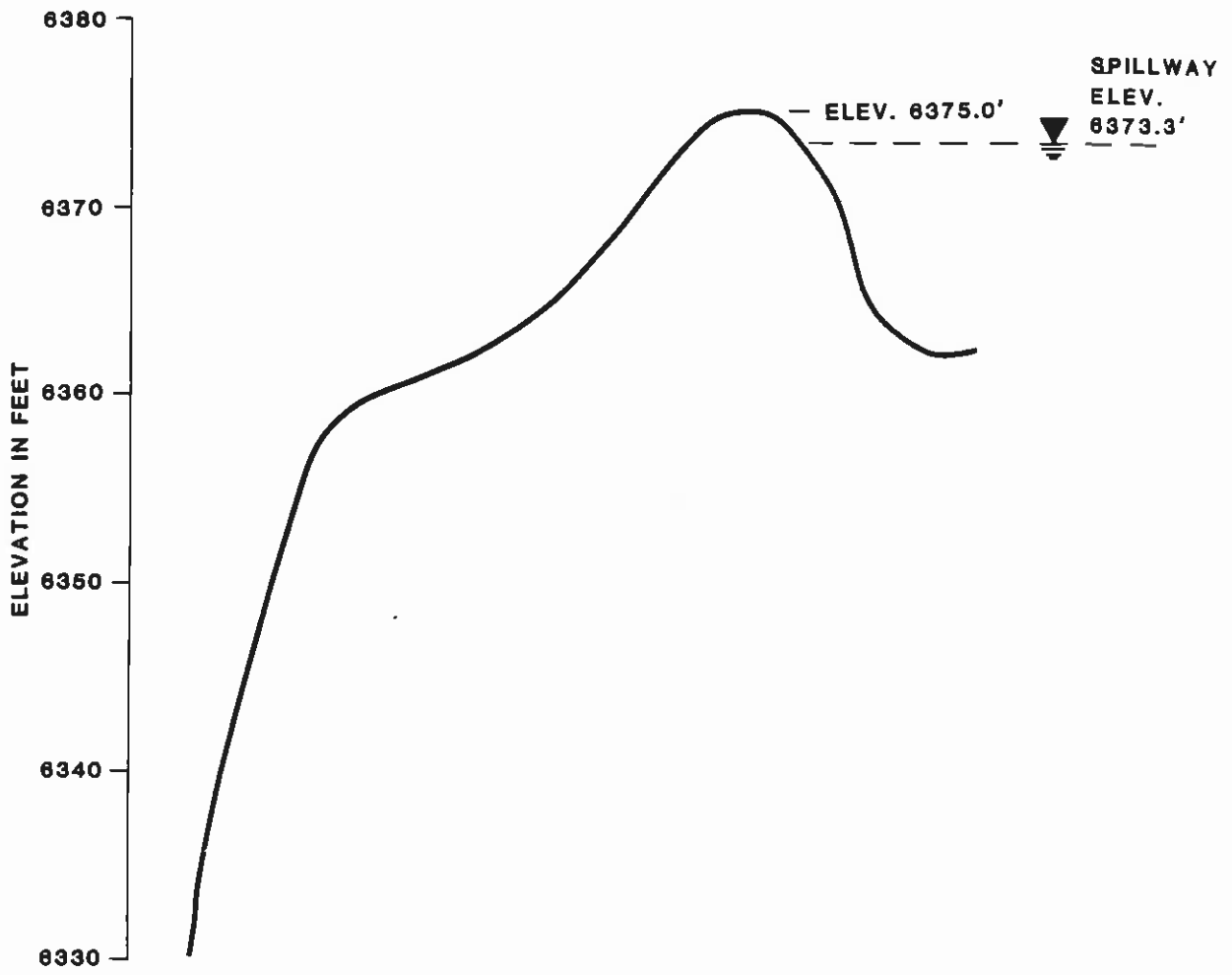
The following plates and appendix are attached and complete this inspection report.

- Plate 1 - Site Plan WW-9B
- Plate 2 - Existing Maximum Cross Section WW-9B, A-A'
- Plate 3 - Volume-Elevation Curve WW-9B
- Plate 4 - Channel Profile WW-9B, B-B'
- Plate 5 - Spillway and Outflow Channel Cross Section WW-9B
- Appendix A - Inspection Check List
- Appendix B - Hydrology and Hydraulic Calculations



**SITE PLAN  
WW-9B**



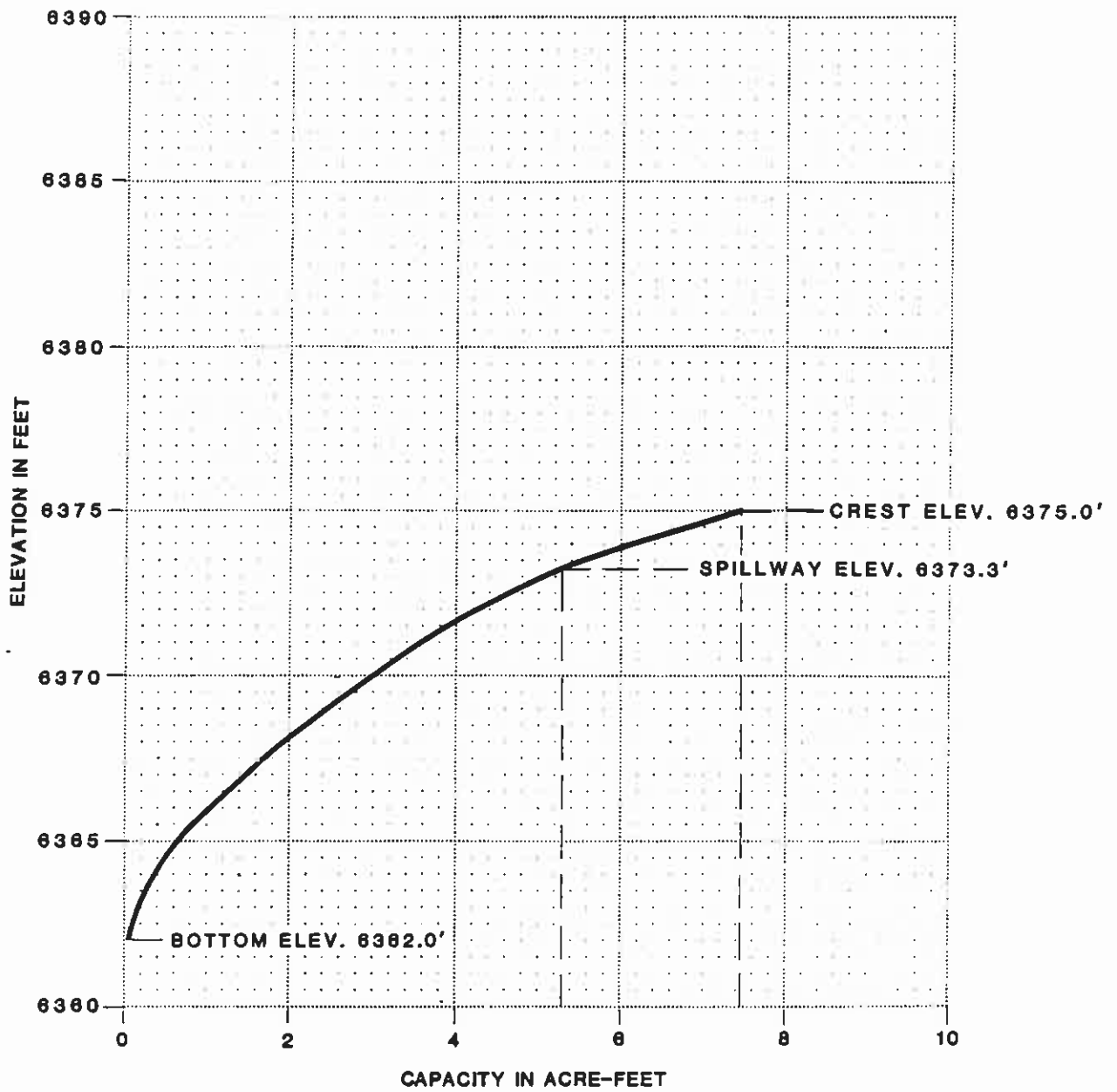


EXISTING  
MAXIMUM CROSS-SECTION  
A-A'  
WW-9B

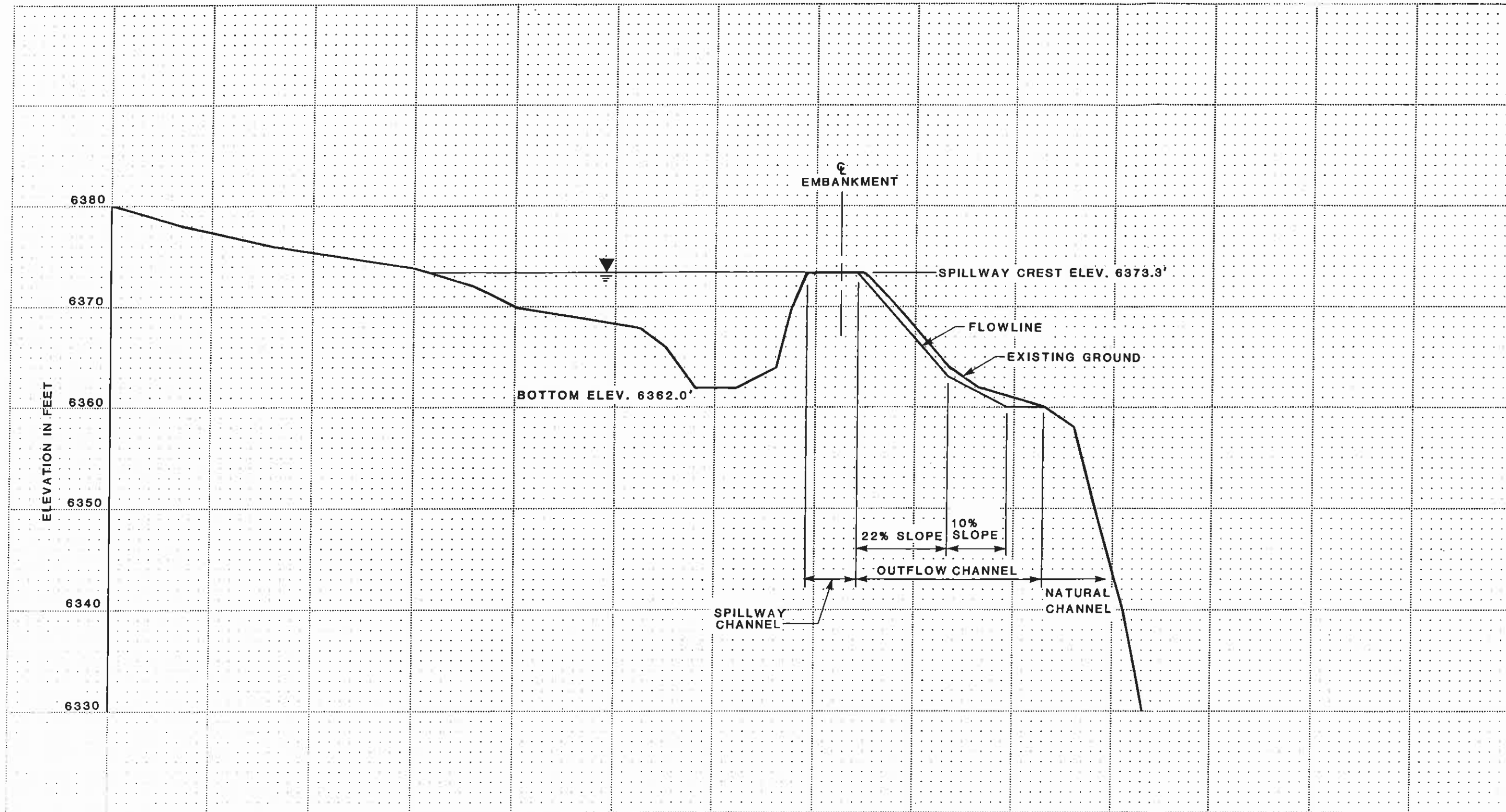
FOR LOCATION SEE PLATE 1

BY **Dames & Moore**

Plate 2



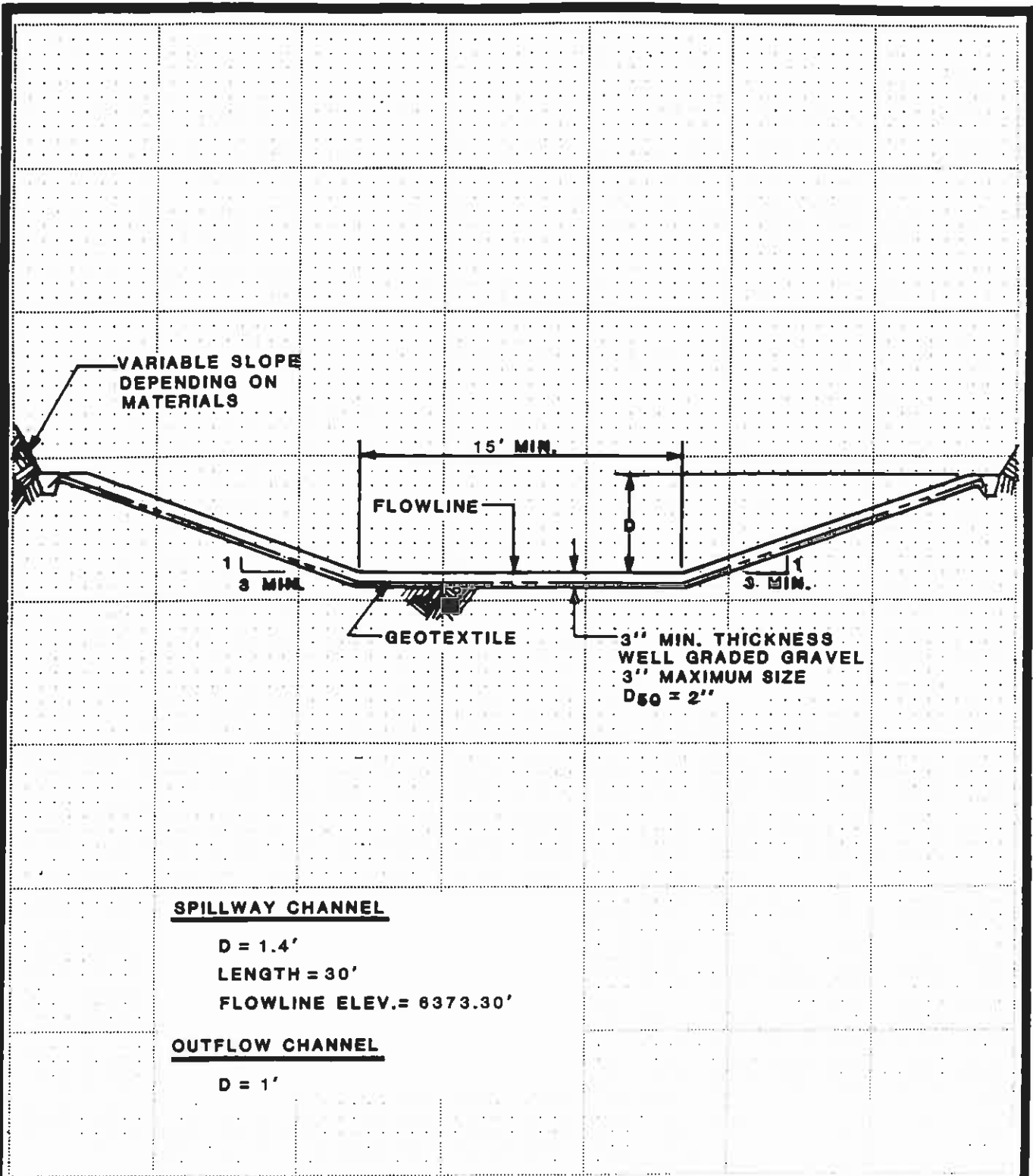
VOLUME-ELEVATION  
CURVE  
WW-9B



CHANNEL PROFILE B-B'  
WW-9B



FOR LOCATION SEE PLATE 1



**SPILLWAY AND  
OUTFLOW CHANNEL  
CROSS SECTION  
WW-9B**

APPENDIX A  
INSPECTION CHECK LIST



INSPECTION CHECK LIST

ITEM	YES	NO	REMARKS
1. CREST			IRREGULAR SURFACE Slopes 2% d.s.
a. Any visual settlements?		X	15' wide
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE			20°
a. Adequate grass cover?	X		20%
b. Any erosion?		X	
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			15° top portion flatter below
a. Adequate grass cover?		X	50% grass
b. Any erosion?	X		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?		X	
k. Is seepage present?		X	
l. Animal burrows?		X	
4. ABUTMENT CONTACT. RIGHT			
a. Any erosion?	X		Minor - Rill
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			brown SM
5. ABUTMENT CONTACT. LEFT			
a. Any erosion?	X		Minor - Rill
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	
e. Type of Material?			brown SM

ITEM	YES	NO	REMARKS
6. SPILLWAY/NORMAL			2' below crest
a. Location:			
Left abutment?			
Right abutment?			
Crest of Embankment?	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:			Open channel trap.
Are side slopes eroding?		X	
Are side slopes sloughing?		X	
Bottom of channel eroding?		X	
Obstructed?		X	
Erosion protection?		X	
d. Outflow Channel:		X	
Are side slopes eroding?			NA
Are side slopes sloughing?			NA
Bottom of channel eroding?	X		2' RW
Obstructed?			NA
Erosion protection?		X	
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?			

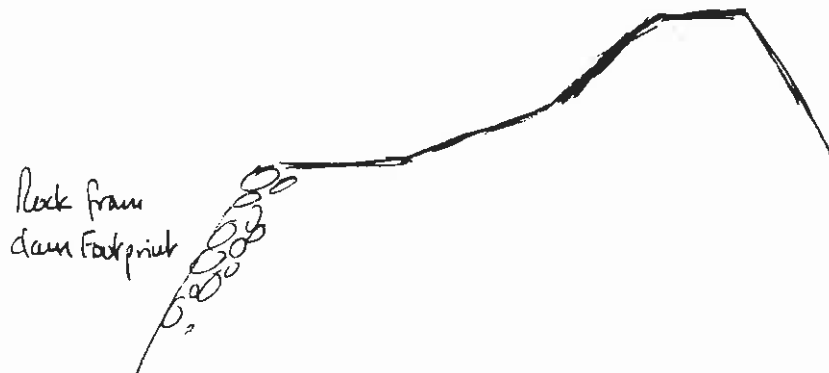
8. GENERAL COMMENTS

Embankment will erode if spillway activates  
spillway does not appear to have been activated

8. IMPOUNDMENT

Water in impoundment,  
Sagebrush/grass 85% gravel road 15%  
ground cover - Good  
Canopy cover - 20%

Sketch



APPENDIX B  
HYDROLOGY AND HYDRAULIC CALCULATIONS

TIME OF CONCENTRATION

ELEVATION DIFFERENCE = 6400 - 6373 = 27'

WATER COURSE LENGTH = 550' = 0.104 mi

$T_c = \left( \frac{11.9 (0.104)^3}{27} \right)^{0.385} = 0.0534 \text{ hr} = 3.2 \text{ min}$

LAG TIME = 0.6  $T_c$  = 0.0321 hr = 1.9 min

SCS CURVE NUMBER

	DRAINAGE AREA (ac)	COVER TYPE	HYDROLOGIC CONDITION	SOIL TYPE	WEIGHTED CURVE NUMBER
700' x 50'	0.3 (7%)	GRAV. RD	—	D	0.03(91) = 2.73
700' x 20'	0.3 (2%)	DIRT. RD	—	D	0.02(89) = 1.8
	11.2 (91%)	S-G	ave	D	0.91(79) = 71.9
					<u>81.0</u>

50% EH #23 - D  
 50% EH #52 - C  
 worst case D

Use 81

DRAINAGE BASIN AREA

12.3 AC.      0.020 SQ. MI.

REVISIONS  
 BY \_\_\_\_\_ DATE \_\_\_\_\_ TO EO \_\_\_\_\_  
 BY \_\_\_\_\_ DATE \_\_\_\_\_ TO EO \_\_\_\_\_

BY \_\_\_\_\_ DATE \_\_\_\_\_  
 CHECKED BY \_\_\_\_\_  
 COPY TO EO \_\_\_\_\_

UNIVERSAL SOIL LOSS EQUATION

RAINFALL FACTOR

$R = 40$

SOIL ERODIBILITY FACTOR

SOIL TYPE = 50% EH #23 0.5 (0.18)  
 50% EH #32 0.5 (0.21)  
~~TEXTURE~~ Use 0.195  
 K =

SLOPE FACTOR

LENGH (ft.)	Δ ELEV (ft.)	SLOPE (%)	LS
550	27	5	1.25
750	57	8	2.7
400	37	9	2.3
			Use 2.5

COVER FACTOR

AREA (ac.)	COVER TYPE	% COVER	CANOPY (%)	WEIGHTED C
9%	ROADS	-	-	0.09(1.0)
91%	S-G	40	25	0.91(0.13)
				C = .208

EROSION CONTROL FACTOR

$P = 1.0$

SEDIMENT INFLOW

$A = 40(0.195)(2.5)(.208)(1.0) = 4.056$  ton/acre/year

$A = 4.056(\frac{1}{2047})(12.3)(0.95) = .023$  acre-feet/year

REVISIONS  
 BY \_\_\_\_\_ DATE \_\_\_\_\_ TO EO \_\_\_\_\_  
 BY \_\_\_\_\_ DATE \_\_\_\_\_ TO EO \_\_\_\_\_

BY \_\_\_\_\_ DATE \_\_\_\_\_  
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