7-29

PHASE I INSPECTION REPORT

FOR

WHITE TANKS RETARDING DAM NO. 4
I.D. NO. AZ00109
MARICOPA COUNTY, ARIZONA

Ertec

The Earth Technology Corporation

Ertec

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DEPARTMENT OF THE ARMY
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SPLED-DA

14 September 1981

Mr. Wesley E. Steiner
Director
Arizona Department of Water Resources
99 East Virginia Avenue
Phoenix, Arizona 85004

Dear Mr. Steiner:

We have reviewed and approved the Phase I Inspection Reports (dated August 1981) for White Tanks Retarding Dams Nos. 3 and 4.

We concur with the evaluation in the Phase I Reports that the dams are considered to be in an unsafe, non-emergency condition. The owner should be notified that further Phase II investigations of the deficiencies stated in the reports are required to determine the necessary action to make the dams safe. A copy of this letter and the Phase I Reports should be sent to the owner.

Sincerely,

for PAUL W. TAYLOR
Colonel, CE
Commanding

Copy Furnished:
Mr. Verne M. Bathurst
State Conservationist
U.S. Department of Agriculture
Soil Conservation Service
Federal Building, Room 3008
Phoenix, Arizona 85025
with copy of reports

SEP 1981
DEPARTMENT OF WATER RESOURCES

NATIONAL PROGRAM FOR INSPECTION OF DAMS

PHASE I INSPECTION REPORT
FOR
WHITE TANKS RETARDING DAM NO. 4
I.D. NO. AZ00109
MARICOPA COUNTY, ARIZONA

AUTHORIZATION: The National Dam Inspection Act, Public Law 92-367, dated August 8, 1972, provides for a national safety inspection program of non-federal dams by the U.S. Army Corps of Engineers. This report has been prepared in accordance with this authority by Ertec Western, Inc. through contract with the State of Arizona, Department of Water Resources.

BRIEF ASSESSMENT: Because of downstream development and the storage capacity of the facility, White Tanks Retarding Dam No. 4 is considered to be a high hazard, intermediate size structure. Results of previous cracking investigation (Fugro, 1979) and the hydrologic and hydraulic analysis indicate that the embankment and spillway may be seriously inadequate, and the dam should be considered to be unsafe, non-emergency until a Phase II study shows it to be otherwise. Without consideration for construction of Interstate 10, the dam is capable of passing approximately 30 percent of the probable maximum flood. A flood equivalent to the probable maximum flood would overtop the dam up to a maximum of 1.61 feet for a period of 2.5 hours.

The surficial condition of the dam embankment appears to be fair, and it appears to be performing its intended flood retention function. However, geotechnical studies performed in 1979 indicated that about ninety (90) percent (based on embankment length) of the structure is affected by varying degrees of cracking. Based on the crack investigation, the Soil Conservation Service is preparing to implement remedial repairs to the structure.

Based on results of the inspection, several recommendations regarding the need for additional studies, and operation and maintenance of the facility have been made. These include Phase II studies to determine the effect of Interstate 10 on inflow rates, to determine the cause of recent cracking, fencing to prevent off-road vehicles from driving over the dam surfaces, and controlling of burrowing animals by grading the surface or covering the slope surfaces with a rock or gravel blanket.

<u>RESPONSIBILITY</u>: This report creates no liability on the State of Arizona; Ertec Western, Inc.; nor the United States; their officers or employees. The owner and operator continues to be entirely responsible for all obligations and liabilities associated with the ownership and operation of the facility.

Prepared under the direction of,

Robert Y. Bush, P.E.
Ertec Western, Inc.
Arizona Registration No. 5487

Date: Aug 27, '81

Reviewed by,

Supervision of Dam Safety
Arizona Department of Water Resources
Arizona Registration No. 8162

Date: Sept. 8, 1981

TABLE OF CONTENTS

Section		Page
1.0	INTRODUCTION	1
	1.1 AUTHORITY	1
	1.2 PURPOSE AND SCOPE OF INVESTIGATION	1
	1.3 INSPECTION TEAM	1
2.0	DESCRIPTION OF PROJECT	3
	2.1 LOCATION AND PHYSICAL FEATURES	3
	2.2 CLIMATE	4
	2.3 DAM	5
	2.4 PRINCIPAL SPILLWAYS	7
	2.5 OUTLET CHANNELS	8
	2.6 EMERGENCY SPILLWAYS	9
	2.7 SIZE CLASSIFICATION	9
	2.8 HAZARD CLASSIFICATION	10
	2.9 OWNERSHIP	10
	2.10 PURPOSE	10
	2.11 DESIGN AND CONSTRUCTION HISTORY	11
	2.12 NORMAL OPERATIONAL PROCEDURES	11
	2.13 CONSTRUCTION OF INTERSTATE 10	12
3.0	DESIGN AND CONSTRUCTION DATA	14
	3.1 GEOLOGIC CONDITIONS	14
	3.1.1 Regional Geology	14
	3.1.2 Regional Seismicity and Faulting	15
	3.1.3 Site Geology and Ground Water	
	3.2 DESIGN	19
	3.3 CONSTRUCTION	21
	3.4 OPERATION AND MAINTENANCE	21

TABLE OF CONTENTS (Continued)

Section		Page
4.0	INSPECTION AND EVALUATION	22
	4.1 GENERAL	22
	4.2 DAM	22
	4.3 SPILLWAYS	24
	4.4 RESERVOIR AREA	25
	4.5 DOWNSTREAM CHANNELS	26
5.0	HYDROLOGIC AND HYDRAULIC ANALYSIS	27
	5.1 PREVIOUS HYDROLOGIC ANALYSES	27
	5.2 HYDROLOGIC AND HYDRAULIC EVALUATION OF DAM AND RESERVOIR	27
	5.3 RESULTS	34
	5.4 SEDIMENTATION	35
6.0	CONCLUSIONS AND RECOMMENDATIONS	37
LIST OF REFERENCES		40

LIST OF APPENDICES

Appendix No.	
A	DESIGN DRAWINGS
B	HYDROLOGIC AND HYDRAULIC COMPUTATIONS
C	STATE INSPECTION REPORTS
D	AN ECOLOGICAL ASSESSMENT OF BURROWING ACTIVITY AT WHITE TANKS #4 FLOOD RETARDING STRUCTURE
E	MAPS, TRENCH LOGS, AND PHOTOGRAPHS FROM THE WHITE TANKS NO. 4 CRACK LOCATION INVESTIGATION (FUGRO 1979).

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

Figure No.	
1	LOCATION MAP
2	REGIONAL GEOLOGIC MAP
3	LOCATION OF EARTHQUAKE EPICENTERS
4	SITE SURFICIAL GEOLOGIC MAP
5	STAGE-STORAGE, STAGE-DISCHARGE

LIST OF TABLES

Table No.	
1	AVERAGE MONTHLY AND ANNUAL PRECIPITATION AT BUCKEYE, ARIZONA
2	PRINCIPAL SPILLWAYS
3	SIZE CLASSIFICATION
4	HYDROLOGIC DATA SUMMARY

LIST OF PHOTOGRAPHS

Photo No.	
1A	VIEW TO EAST ALONG EMBANKMENT CREST, RESERVOIR TO LEFT
1B	VIEW TO EAST SHOWING UPSTREAM EMBANKMENT AND RESERVOIR
2A	TYPICAL INLET STRUCTURE SHOWING SLIDE GATE AND GATE STEM
2B	OUTLET STRUCTURE AND CHANNEL, NOTE VEHICLE TRACKS ON FACE OF DAM
3A	UPSTREAM FACE SHOWING CRACKS AND/OR EROSION GULLYING
3B	ANIMAL BURROW AT STATION 35+60
4A	TYPICAL OUTLET STRUCTURE
4B	RESIDENCE AND COUNTY ROAD LOCATED NEAR DOWNSTREAM TOE
5A	FOUR - 10′x8′ CBC′S UNDER INTERSTATE 10, LOOKING DOWNSTREAM
5B	FIVE - 10′x5′ CBC′S UNDER JACKRABBIT ROAD ON-RAMP, LOOKING UPSTREAM

WHITE TANKS RETARDING DAM NO. 4

I.D. NO. AZ00109

MARICOPA COUNTY, ARIZONA

PERTINENT DATA

WATERSHED

Stream:	Avondale Wash
Tributary to:	Gila River
County:	Maricopa
Damsite Location:	Sections 5&6, T1N, R2W, G&SRB&M
Latitude:	33°27′ N
Longitude:	112°29′ W
Drainage Area:	14.23 square miles
Elevation of Watershed:	
Maximum:	3,152 feet
Minimum:	1,036 feet
Cover Type:	Bursage, creosotebush, paloverde, ironwood, cactus, annual grass
Hydrologic Soil Group:	Complex of B, C, & D soils with rocky outcrops

DAM

Type:	Compacted earthfill with caliche and coarse gravel facing
Purpose:	Flood, erosion, and sediment control
Embankment Crest Elevation:	1,056.0 feet
Streambed Elevation:	1,036.0 feet
Hydraulic Height:	20.0 feet
Crest Width:	10.0 feet
Crest Length:	6,839 feet
Roadway:	Local access
Embankment Slope	
Upstream:	2:1
Downstream:	2:1
Slope Protection:	Caliche and coarse gravel facing
Drains:	None

RESERVOIR	Elevation (Feet)	Area (Acres)	Capacity (Acre-Feet)
Principal Spillways: "N"	1,039.18		
"O"	1,041.68		
Emergency Spillway Crest	1,050.0	155	1,036
Dam Crest	1,056.0	230	2,250

Hazard Class: High

Nearest Town: Buckeye

Distance: 7 miles southwest

PRINCIPAL SPILLWAYS

Type: Controlled - CMP

	"N"	"O"
Size (inches):	30	36
Length (feet):	76	64.5
Invert Elevation (feet):	1,036.90	1,039.13
Intake Elevation (feet):	1,039.18	1,041.68
Rating (cfs):	75	108

Stilling Basin: Trapezoidal shaped - gunite lined

EMERGENCY SPILLWAYS

Type: Unlined curved open channel

Location: Left and right abutment

Crest Elevation: 1,050.0 feet at Station 0+00 left abutment

1,050.0 feet at Station 0+00 right abutment

Control Section Width: 165 feet each

Channel Length: 296 feet left abutment

980 feet right abutment

Slope: 0.002, Station 0+00 to Station 2+96 left abutment

0.003, Station 0+00 to Station 9+80 right abutment

Inlet Channel: Reservoir

Discharge Channel: Trapezoidal earth

Material: Fine grained alluvial deposits

Rating: 13,100 cfs at WS Elevation 1,056.0 feet

SECTION 1.0

INTRODUCTION

1.1 AUTHORITY

The National Dam Inspection Act, Public Law 92-367, dated August 8, 1972, provides for a national safety inspection program of non-federal dams by the U.S. Army Corps of Engineers. This report has been prepared in accordance with this authority by Ertec Western, Inc. through contract with the State of Arizona, Department of Water Resources.

1.2 PURPOSE AND SCOPE OF INVESTIGATION

The purpose of this Phase I inspection was to evaluate the general structural integrity, hydraulic adequacy, and general safety of the dam. Included in the inspection project was a review of all available files, calculations, and plans for the dam, along with a visual inspection of the dam, reservoir area, inlet and outlet facilities, and outlet channel. Based upon findings of the review and visual inspection, an assessment was made of the structural integrity of the dam and the hydraulic capabilities of the reservoir and outlet facilities to safely pass expected hydrologic events.

1.3 INSPECTION TEAM

The visual inspection of the project and adjacent area was conducted on April 1, 1981. The following persons participated in the inspection:

Joseph Walters	-	Arizona Department of Water Resources
Stanley Smith	-	Maricopa County Flood Control District
William Payne	-	Soil Conservation Service
Ken Euge	-	Ertec Western, Inc.
Robert Bush	-	" " "
Douglas Schwantes	-	" " "
Gerald Bickel	-	" " "

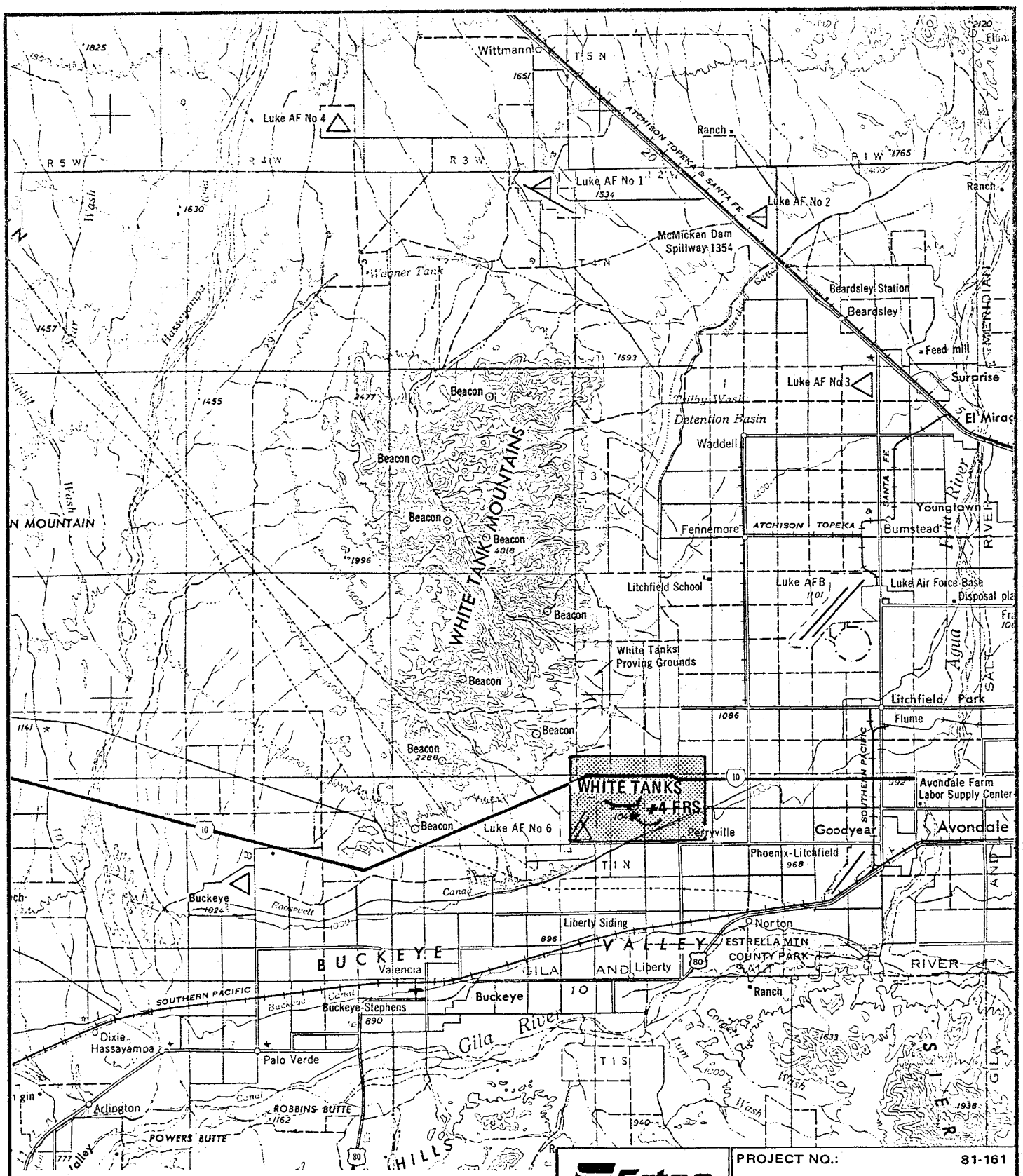
SECTION 2.0

DESCRIPTION OF PROJECT

2.1 LOCATION AND PHYSICAL FEATURES

The dam is located in the north central part of a watershed known locally as Avondale Wash, about 20 miles west from Phoenix, and 7 miles northeast of Buckeye in Maricopa County (USDA, 1954). Location of the dam is shown in Figure 1. It is in Sections 5 and 6, Township 1 North, Range 2 West, G & SRB & M, at Latitude 33° 27' North and Longitude 112° 29' West. Avondale Wash is a tributary to the Gila River and their confluence is located immediately west from the Aqua Fria/Gila River confluence.

The dam is situated on relatively flat slopes of the White Tank Mountains. Topographic features range from gently sloping to moderately sloping alluvial fans near the dam, to low hills and steep mountains with slopes ranging from 10 to over 80 percent. Elevations range from 1,036 feet above sea level at the dam, to 3,152 feet in the White Tank Mountains. Soils in the watershed are dominated by the Cherioni-Gachado-Rock Outcrop Association which is composed of shallow and very shallow gravelly and cobbly soils with exposures of bedrock.



SCALE: 1:250,000

0 5 10

miles

Reference: Base map obtained from USGS topographic sheet Phoenix, Arizona, 2 degree series.

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PHASE I SAFETY INSPECTION
WHITE TANKS NO. 4 FRS

LOCATION MAP

7-81

FIGURE 1

Vegetation consists of a sparse cover of bursage, creosotebush, paloverde and ironwood trees, cactus and annual grasses (USDA, 1977).

Avondale Wash and its tributaries are intermittent streams, and subject to flash floods during intense summer storms.

2.2 CLIMATE

The climate of the watershed is typical of semi-arid zones in general and of central Arizona in particular. Relative humidity and annual rainfall are generally low.

Daytime temperatures throughout the summer are normally high, but winters are usually mild. Nighttime temperatures frequently fall below freezing during the three coldest months, but afternoons are commonly sunny and mild. Based on observations at 11 AM and 5 PM at Phoenix, the average daytime relative humidity is about 30 percent (USDA, 1977).

There are two separate precipitation seasons. The first occurs from November to March, when the area is subjected to occasional storms from the Pacific Ocean. During this period cloudy skies and intermittent showers can prevail for several days. Snowfall is rare in the valleys in this part of Arizona. An occasional light fall occurs in the mountains above the 2,500-foot level.

The second rainfall season occurs in July, August, and September, when the area experiences widespread thunderstorm activity

associated with moist air moving into Arizona from the southern quadrant. These thunderstorms are extremely variable in intensity and location, and some of the most intense precipitation is observed in a short period during these months. About 40 percent of the annual precipitation occurs during July, August, and September. Flash floods are a common problem during this period. In some years, unusually intense precipitation can occur near the end of summer when a tropical disturbance moves northward from the Pacific Ocean. These storms affect the weather in the State about once in seven years, and during these occasions the area can receive a normal summer's rainfall in less than one day. The average monthly and annual precipitation at Buckeye is shown in Table 1.

2.3 DAM

White Tanks Retarding Dam No. 4 is a compacted earthfill structure with a caliche and coarse gravel facing on the upstream and downstream surfaces, and crest. The dam consists of two segments; the southwesterly segment extends across the wash approximately perpendicular to the valley axis; the northerly segment bends upstream parallel to the Beardsley Canal to merge with high ground on the gently sloping terrain adjacent to the wash. Total length of the dam is 6,839 feet.

TABLE 1

AVERAGE MONTHLY AND ANNUAL PRECIPITATION
AT BUCKEYE, ARIZONA (USDA, 1977)

Month	Precipitation[1/] Inches
January	0.7
February	0.7
March	0.7
April	0.3
May	0.1
June	0.1
July	0.8
August	1.3
September	0.7
October	0.4
November	0.5
December	0.8
Annual	7.1

[1/]Period of Record: 1941-1970

The width of the dam varies from 10 feet at the crest to a maximum of about 89 feet at the base. Maximum height above the streambed is about 20 feet. To provide for settlement, a one foot overfill was added to the top of the dam. Both the upstream and downstream side slopes are 2:1 (horizontal: vertical).

2.4 PRINCIPAL SPILLWAYS

The principal spillways (outlet works) consist of a 30-inch corrugated metal pipe (CMP) located in the the northern segment of the dam, and a 36-inch CMP located in the central segment. The 30-inch CMP is identified as Outlet "N"; the 36-inch CMP is Outlet "O". Locations and physical descriptions of the outlets are shown in Table 2.

Both outlets are gated with the intake cut flush with the upstream surface of the dam. Slide gates are activated from the top of the dam by a non-vising stem arrangement with the stem attached to anchor blocks on the upstream face. Both intakes were designed to be protected with trash racks, however, none were in place during the site inspection.

Outlet "N" discharges into a gunite lined, trapezoidal shaped energy dissipating structure with a flat bottom and 12-inch-high end sill. Bottom width of the structure is 6 feet; total length is 9' 6".

Outlet "O" discharges into a gunite lined, trapezoidal shaped energy dissipating structure. Bottom width of the structure is 12 inches for a distance of 2 feet; the bottom width then flares from a width of 12 inches to 2 feet 7-1/4 inches at the entrance to the outlet channel, and the invert rises from elevation 1,039.0 feet to 1,039.8 feet. Total length of the structure is 10 feet.

TABLE 2

PRINCIPAL SPILLWAYS

ITEM	UNIT	OUTLET "N"	OUTLET "O"
Location	Station	17 + 82	58 + 50
Diameter	Inches	30	36
Type		CMP	CMP
Min.Lip Elevation	Feet	1039.18	1041.68
Slope		0.002	0.002
Invert Elevation-Upstream	Feet	1036.90	1039.13
Invert Elevation-Downstream	Feet	1036.75	1039.00
Length	Feet	76	64.5

2.5 OUTLET CHANNELS

The outlet channels were designed to convey releases from the gated spillways to nearby irrigation ditches following each storm event. The channel for Outlet "N" is an unlined, trapezoidal shaped channel with an 8-foot bottom width and 1:1 side slopes. Slope of the channel is 0.010.

The channel for Outlet "O" is a gunite lined, trapezoidal shaped channel with a 2 foot 7 1/4 inch bottom width, and 1:1 side slopes. Slope of the channel invert is 0.0021.

2.6 EMERGENCY SPILLWAYS

The dam includes two emergency spillways, one through each abutment. Each spillway has a crest elevation of 1,050.0 feet, a bottom width of 165 feet, 1:1 side slopes, a flat crest for a distance of approximately 40 feet, an approach channel with an adverse grade of 0.002, and a downstream slope of 0.003.

2.7 SIZE CLASSIFICATION

Guidelines for the safety inspection of dams have been developed by the Corps of Engineers. Included in the guidelines are recommendations for establishing size and hazard classifications. Potential size classifications are small, intermediate, and large, based upon the storage capacity of the reservoir and height of dam as shown in Table 3.

Since the maximum height of White Tanks Retarding Dam No. 4 from the streambed to the top of the dam is 20 feet, and the maximum storage is 2,250 acre-feet, according to the table, the dam is unclassified using height criteria, and intermediate using storage criteria. The guidelines indicate that the larger size classification shall govern and therefore the dam is considered intermediate in size.

TABLE 3

SIZE CLASSIFICATION

Category	Impoundment	
	Storage acre-feet	Height Feet
Small	<1,000 and ≥50	<40 and ≥25
Intermediate	≥1,000 and <50,000	≥40 and <100
Large	≥50,000	≥100

2.8 HAZARD CLASSIFICATION

The dam has a high hazard classification because of the potential loss of lives and excessive property damage that could occur in the event of failure. Residences are located downstream from the dam, along with county and local roads, and the Southern Pacific Railroad.

2.9 OWNERSHIP

The dam is owned by the Flood Control District of Maricopa County, 3325 West Durango Street, Phoenix, Arizona 85009.

2.10 PURPOSE

Purpose of the dam is the temporary retention of flood waters to reduce the adverse effects of flooding, erosion, and sedimentation. The intakes are gated and water is impounded throughout each storm event. Following cessation of runoff the gates are manually opened and releases are made in conformance

with the capacity of the outlet channels and irrigation canals in the area.

2.11 DESIGN AND CONSTRUCTION HISTORY

The dam was designed by the Soil Conservation Service (SCS) and constructed in about 1954 under supervision of the SCS. Cost of the project was estimated to be approximately $124,150. No major modifications have been made since the dam was constructed. However, the Soil Conversation Service and Maricopa County Flood Control District filed applications with the Arizona Department of Water Resources on June 25, 1981 to install a continuous interceptor drain along the embankment centerline between Station 1 + 00 and 66 + 00 with six drain outlets.

2.12 NORMAL OPERATIONAL PROCEDURES

The dam is designed to temporarily impound flood waters from the 14.23 square mile tributary watershed. Gates to the outlet pipes are maintained in their closed position throughout each storm event. Following the cessation of runoff the gates are manually opened and releases are made in conformance with the hydraulic capacity of the outlet channels and irrigation canals in the area. The reservoir was designed to temporarily impound runoff from a storm that was estimated to substantially exceed the 100-year storm, without use of the emergency spillway. Storage capacity has been included in the reservoir for the estimated volume of silt accumulation for 50 years. The

reservoir has not filled to the emergency spillway level since the dam was completed in about 1954.

2.13 CONSTRUCTION OF INTERSTATE 10

In 1977, Interstate 10 was constructed across the watershed tributary to White Tanks Retarding Dam #4, about 1/2 mile upstream from the dam. Design drawings for the indicated portion are included in Appendix A. Interstate 10 is an elevated freeway at this location, and is a major east-west highway that connects Phoenix and cities to the east, with Southern California. Runoff from nearly the entire tributary watershed must cross under the freeway before entering the retention reservoir for White Tanks #4 retarding dam. Drainage crossings consist of four - 10' x 8' reinforced concrete box culverts (CBC's) near the westerly watershed boundary, five - 10' x 5' reinforced CBC's under the Jackrabbit Road On-Ramp (Jackrabbit Road is the eastern watershed boundary), and 19 corrugated metal pipes, ranging in diameter from 36" to 42", spaced at irregular intervals between the concrete culvert sets described above. Drainage crossings were designed for the 50-year recurrence interval storm.

A 12' x 12' reinforced concrete equipment crossing is located approximately 100 feet east from the 10' x 8' CBC's. Although it was constructed with an adverse grade, and its invert elevation is about 2.8' higher than the invert of the 10' x 8' CBC's, it would have the capability of conveying some runoff across the freeway and into the retention reservoir. However,

runoff from a major portion of the watershed is directed to the 10' x 8' CBC's by an earth levee, and very little natural runoff collects at the equipment crossing.

A north-south earth levee is located between the 10' x 8' CBC's and the equipment crossing. Its top elevation is about 11' above the invert elevation of the CBC's, about one foot above the design highwater elevation for the CBC's, and about 8.5' below the elevation of the freeway road surface at that location.

At Jackrabbit Road the freeway is 16' 4" above the road surface of that local access road. Between Jackrabbit Road and the western watershed boundary, the freeway dips to a minimum elevation of about four feet above natural ground. Natural ground contours indicate that any runoff from north of the freeway that is unable to cross via one of the culvert crossings will flow to the east parallel to the freeway. Runoff collecting at the freeway west of the low point elevation of the road surface will either sheet over the freeway or continue to the east where it will cross through the on-ramp culverts, or exit the watershed over Jackrabbit Road.

The implications of Interstate 10 on inflow to the retention reservoir will be discussed further in Section 5.0.

SECTION 3.0

DESIGN AND CONSTRUCTION DATA

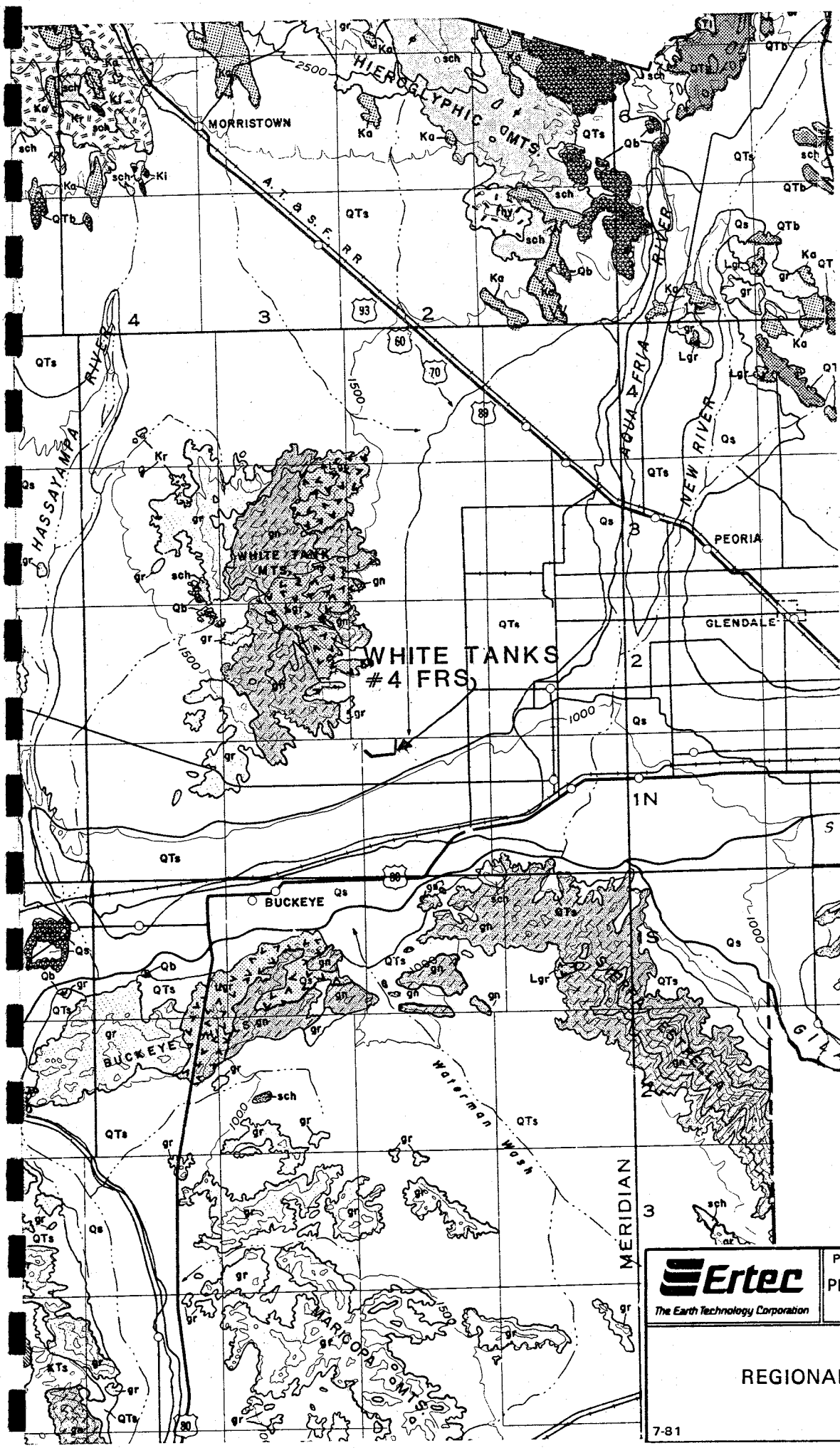
3.1 GEOLOGIC CONDITIONS

3.1.1 Regional Geology

The site is situated north of the westerly trending Gila River floodplain near the margin of the broad, relatively featureless Buckeye Valley and Phoenix Basins. The area is bounded on the west by the White Tank Mountains and on the south and southeast by the Buckeye Hills and Sierra Estrella Mountains (Figure 2). Maximum relief in the region is about 3,193 feet as defined by the valley floor (elevation 890 feet) and in the White Tank Mountains (elevation 4,083 feet).

The White Tank Mountains are composed of coarse grained granitic and metamorphic rocks of pre-Cambrian age including granite and granitic gneisses and Laramide age granite.

The Tertiary to Quaternary continental deposits are predominantly sedimentary units with some associated volcanic rocks which were deposited in structural basins characteristic of the present Basin and Range physiography. The Phoenix Basin contains alluvial detrital accumulations at least 2,000 feet thick. These basin-fill deposits consist of alluvial fan, fluvial floodplain, and lakebed deposits. The potassium-argon age dating of four basalt flows which overlie the continental deposits indicate a late Pliocene or early Pleistocene minimum age for basin-fill deposits in southwestern Arizona (APS, 1980).



EXPLANATION

Qs	SILT, SAND, AND GRAVEL	QUATERNARY
QTs	SAND, GRAVEL, CONGLOMERATE	QUATERNARY
Qb	BASALT	QUATERNARY
Ts	SAND, GRAVEL, CONGLOMERATE	TERTIARY
Tl	LAKE DEPOSITS	TERTIARY
Td	DACITE	TERTIARY
Lgr	GRANITE AND RELATED CRYSTALLINE ROCKS	LARAMIDE
Ki	DIKES AND PLUGS	LARAMIDE
KTs	SANDSTONE, SHALE	CRETACEOUS
Ka	ANDESITE	CRETACEOUS
Kr	RHYOLITE	CRETACEOUS
gr	GRANITE AND RELATED CRYSTALLINE ROCKS	OLDER PRECAMBRIAN
sch	SCHIST	OLDER PRECAMBRIAN
rhy	RED ROCK RHYOLITE	OLDER PRECAMBRIAN
gn	GRANITE GNEISS	OLDER PRECAMBRIAN

FAULT

STRIKE AND DIP

FROM WILSON, et al, 1957

SCALE 1:375,000

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WHITE TANKS NO. 4 FRS

REGIONAL GEOLOGIC MAP

7-81

FIGURE 2

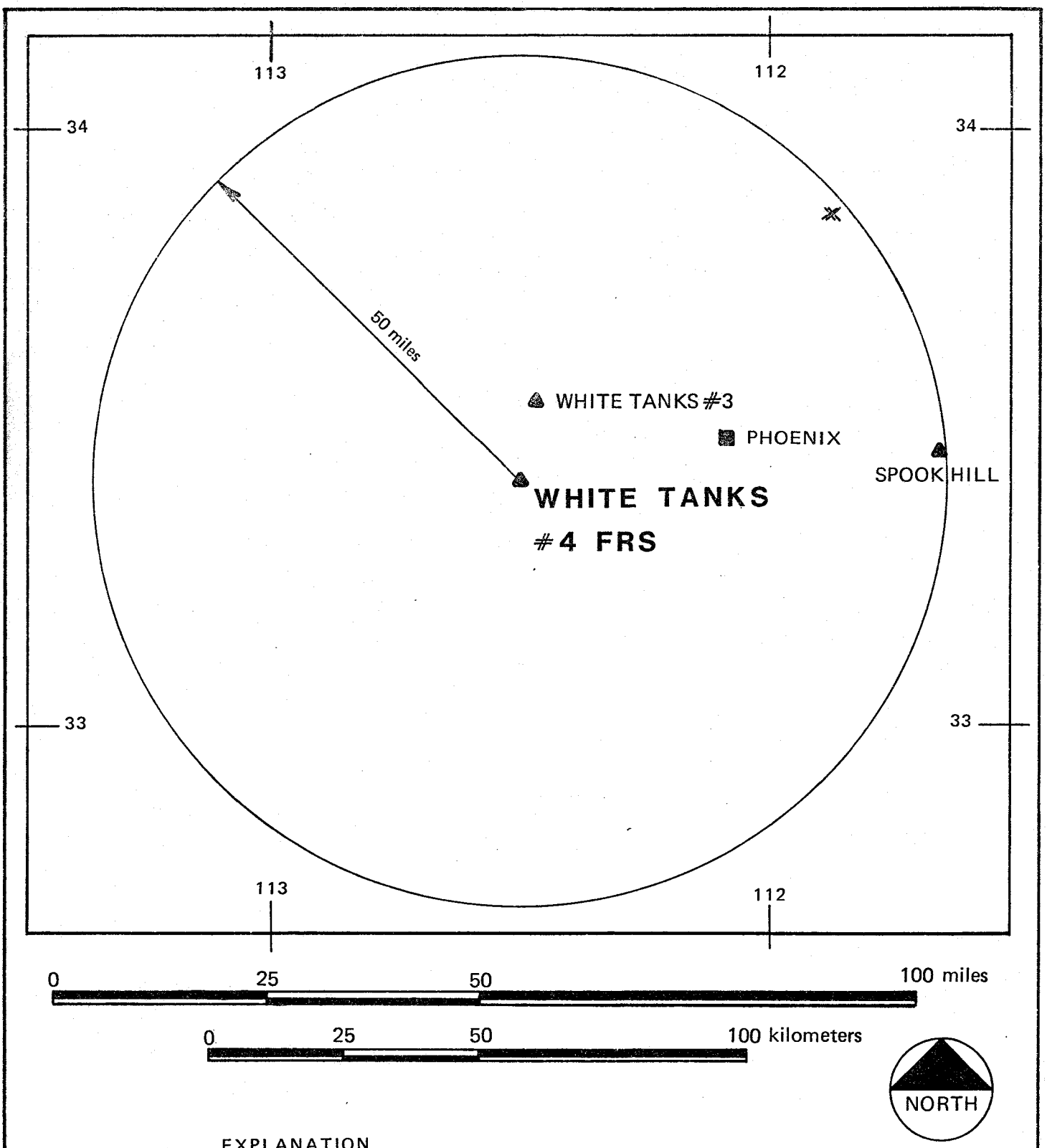
3.1.2 Regional Seismicity and Faulting

A regional review of historic seismic activity shows the study area to be one of seismic quiescence as compared to other parts of Arizona, such as the Yuma and Hoover Dam areas (Figure 3). Earthquakes are reported as occurring within a 50-mile radius of White Tanks #4 FRS ranging in Richter magnitude from 2.5 to 5.0. Smaller events may have occurred in the area, but they were not large enough to register at seismographs far removed from the epicenter.

Many of the earthquakes experienced in Arizona have been related to events originating outside the state, notably: the 1852 and 1853 Fort Yuma, California, the 1887 Sonora, Mexico, the 1934 Baja, California and the 1940, Imperial Valley Earthquakes.

The largest seismic events affecting Arizona are associated with the southeastward extension of the San Andreas Fault System. This zone lies approximately 110 miles west of the study area boundary. Earthquakes up to magnitude 7.1 have been generated within this zone. The records indicate that this area is capable of producing an earthquake of at least magnitude 6.0 to 6.5 and possibly magnitudes 7.0 every 6 to 10 years on the average.

No faults are known to exist in the immediate vicinity of the dam. Regionally, a few faults ranging in length from about one mile (northwest end of Sand Tank Mountain) to about 10 miles



EXPLANATION

× M < 4

FROM FUGRO 1980

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WHITE TANKS NO. 4 FRS

LOCATION OF EARTHQUAKE EPICENTERS

7-81

FIGURE 3

(Verde River Valley) are reported as displacing Tertiary-Quaternary and Quaternary age rock and soil units. The recency of movement on these faults is not clearly defined, however, considering the age of displaced soil and rock units, the fault could conservatively be capable of producing earthquake epicentral magnitudes of 5.5 to 6.0.

Algermissen and Perkins (1976) determined the probabilistic estimates of ground acceleration generated by an earthquake based on the historical seismic records. Their studies indicate an event occurring in the White Tank Mountains region could generate 0.04g horizontal acceleration in rock with a 90 percent probability of not being exceeded in 50 years. The source zone is assigned a maximum earthquake magnitude of 4.9 with a maximum intensity of VI.

According to the Recommended Guidelines for Safety Inspection of Dams (U. S. Army, Corps of Engineers, 1979), the site is situated in Seismic Zone 2 which is assigned a seismic design coefficient of 0.05. Also, the guidelines state it may be assumed the structures located in Zone 2 present no hazard from earthquakes provided static stability conditions are satisfactory and conventional safety margins exist. However, based on our review of available data, no static stability analyses were performed to determine design safety margins.

3.1.3 Site Geology and Ground Water

Based on our review of available records, apparently no geotechnical investigations were performed at White Tank #4 Floodwater Retarding Structure (FRS), to assess geologic and soils conditions of the dam site or borrow areas prior to construction. A geotechnical investigation was performed by the SCS (1978) and Fugro (1979) to assess the degree of structural cracking affecting the dam. Several exploration pits were excavated in the embankment to assess crack characteristics and soil types. No pits were excavated into the foundation soils. The results of the crack investigation (Fugro, 1979) indicated the maximum depth of cracking below crest grade was 10 feet based on shallow trenching and flooding, and to a depth of about 9 feet based on backhoe pit explorations. The dominate mode of cracking was transverse, but incipriant longitudinal cracks up to 90 feet long were mapped locally. Characteristics of the cracks exposed in the trenches indicated the cracks were filled with loose, fine to coarse sand. Flooding of shallow trenches on the crest of the structure resulted in discharge of water through pipe-like conduits intersected by the flooded trench. Based on the crack investigation, it was estimated that only 10 percent of the structure had experienced no cracking as of the date of study, 62 percent had a low degree of cracking and 28 percent was moderately to severly cracked. Refer to Appendix E Maps, Trench Logs and Photographs from Crack Location Investigation, Fugro 1979. The embankment soil types, included silty sand (SM), clayey sand (SC),

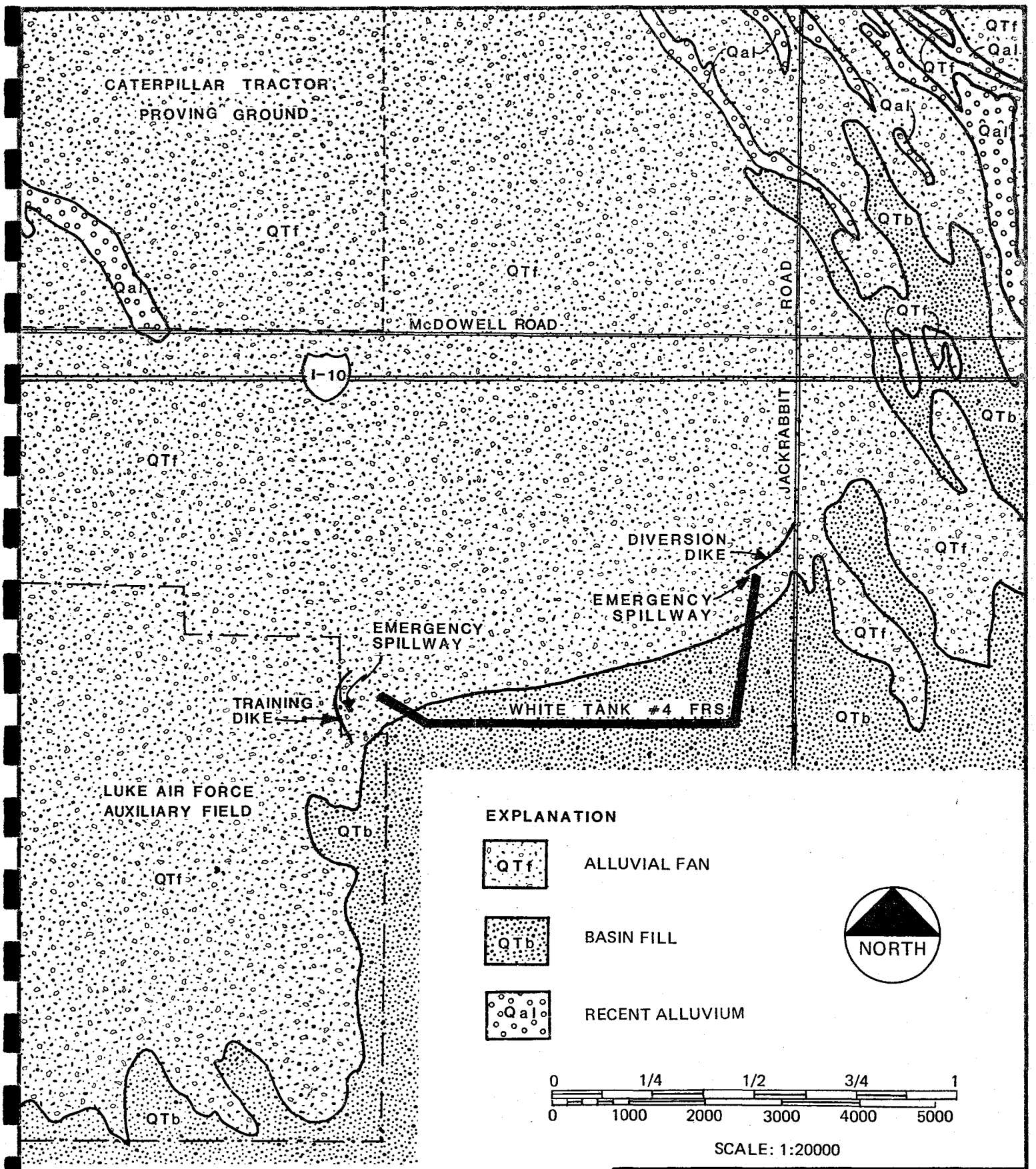
and sandy silt (ML). A reconnaissance photo geologic map of the site area is shown in Figure 4.

The White Tank #4 Dam is underlain by Tertiary age sedimentary units consisting of old alluvial deposits, alluvial fans and localized recent ephemeral stream channel deposits.

The dam site is situated near the distal end of alluvial fan deposits originating in the White Tank Mountain to the northwest. The main dam, abutment, diversion dike and emergency spillway are believed to be underlain by similar deposits. Several braided ephermal stream channels are interrupted by the structure and its diversion dikes which channelize flow into the detention basin.

According to an SCS soil survey of the area, the site is founded on clayey sand with low shrink-swell potential. However, the soils are reported to exhibit the potential to adversely affect embankment-type structures due to their susceptibility to piping. They have a medium to low compacted permeability and moderate to moderately rapid natural permeability.

Ground-water in the site area accumulates in the thick sedimentary basin fill deposited in the Salt River Valley. According to Ross (1978, depth to ground-water beneath White Tanks No. 4 was about 235 feet or an elevation of 800 feet MSL). Because of the great quantity of ground-water used for agricultural purposes in the Salt River Valley, a decline in regional water levels on the order of 150 feet has occured in



NOTE:
Surficial geology interpreted from SCS Soil Survey Map from Soil Survey of Maricopa County, Arizona, Central part (1977), sheet #45 and #62, and from field reconnaissance

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PROJECT NO.: 81-161

PHASE I SAFETY INSPECTION
WHITE TANKS NO. 4 FRS

SITE SURFICIAL GEOLOGIC MAP

7-81

FIGURE 4

The two principal spillways (outlet works) were designated as Outlet "N" and Outlet "O". Outlet "N" was designed as 30-inch diameter, gated, corrugated metal pipe with a trash rack on the inlet structures. Outlet "O" was designed as a 36-inch diameter, gated, corrugated metal pipe with a trash rack on the inlet structure. However, there are no trash racks on either of the inlet structures at this time.

Flow through both outlets is carried out of the embankment through reinforced concrete and gunite transition structures. For Outlet "N" the flow is carried away by an unlined ditch. For Outlet "O" flow is carried away by a concrete lined ditch. Outlet "N" is located approximately 1,850 feet from the east end of the dam and Outlet "O" is located approximately 950 feet from the west end of the dam. Additional details related to the principal spillways are contained in Section 2.4 of this report.

Two, 165-foot wide, emergency spillways were designed as open cut, trapezoidal channels; one through the east abutment and one through the west abutment. The spillway side slopes were designed as 1:1 cuts. The spillways were apparently designed on the basis of hydraulic requirements only. Additional descriptive data on the emergency spillways is contained in Section 2.6 of this report.

the site area between 1923 and 1977 (Ross, 1978).

As a result of the dewatering of the unconsolidated and semi-consolidated basin sediments, subsidence has been reported as occuring in the site area. Schumann (1974) reports a measured land subsidence of up to one foot in the dam area.

Continued agricultural activities in the site area will, in all likelihood, result in additional net declines in regional ground water. The potential for subsidence to continue will remain high. The effects of subsidence on embankment cracking are not clearly defined, however, it is believed to be a contributing factor.

3.2 DESIGN

Design of the White Tanks Dam No. 4 was completed by the SCS in the latter part of 1952. The geotechnical information, if any, used in the SCS's final design of the dam embankment and spillways was not available for review during the preparation of this report.

As previous described, the dam is a compacted earth dam with the slopes and crest faced with caliche and coarse gravel. Both the upstream and downstream faces have slopes of 2:1 (horizontal: vertical). The crest was designed to be rounded by an additional 12 inches of fill, apparently to compensate for settlement. The dam was designed to be founded on leveled original ground without a cutoff trench.

3.3 CONSTRUCTION

No records pertaining to the construction of White Tanks Dam No. 4 were available for review. Best estimates place construction sometime in 1954, or shortly thereafter.

3.4 OPERATION AND MAINTENANCE

Having gated inlets to the principal spillways, White Tanks Dam No. 4 requires operational personnel. It is designed to impound floodwater and provide a controlled release of the water through the two principal spillways. The period of impoundment would typically be only a few days. There is no known instrumentation.

Routine maintenance requirements involve: periodic visual inspection, upkeep maintenance of the principal spillway gates, clearing debris from the spillway inlets, and clearing brush from the dam and outlet channels. Maintaining the principal spillway inlet gates in proper working condition and keeping the principal spillways and outlet channels clear are probably the most severe maintenance problems.

As can be best determined, the dam and principal spillways have functioned as designed since put into operation. The reservoir level has apparently never risen sufficiently high to discharge over the emergency spillway.

SECTION 4.0

INSPECTION AND EVALUATION

4.1 GENERAL

A thorough on-site inspection and performance evaluation was performed at White Tanks Retarding Dam #4 on April 1, 1981. The inspection team consisted of Ertec, Arizona Department of Water Resources, Division of Dam Safety, Maricopa County Flood Control District and Soil Conservation Service representatives.

The field inspection of the dam and its appurtenances included the reservoir area, the upstream drainage basin, and the downstream area. Special attention was given to identify such items as cracking, leakage, erosion, piping, slope instability, settlement, and sinks, that might adversely affect the embankment, abutments or foundations.

At the time of the inspection, no water was stored in the reservoir area. In general, the dam and principal spillway appear to be in fair condition. The emergency spillway training dikes and inflow diversion dikes have been eroded over the years due to local runoff and vehicular traffic. The outlet channel is in fair condition having been subjected to erosional deposition and vehicular traffic.

4.2 DAM

A visual inspection of the dam was made by walking the crest and both the upstream and downstream toes of the structure.

The embankment appears to be in fair condition, although surficial grading and cleaning from an earlier investigation (Fugro, 1979) has obscured the crest preventing complete inspection of the internal embankment fill. According to Fugro (1979) about 90 percent of the structure (based on length) is effected by transverse and longitudinal embankment cracking. The internal structural integrity was characterized on the basis of the Fugro (1979) crack investigation. Cracks were easily identified by the alignment of pipe-shaped features aligned transversly and/or longitudinally to the dam centerline. The pipe ranged in size from one to twelve inches in diameter. Pipe-features were found on both the upstream and downstream slopes about 10 feet below crest grade. To evaluate the internal continuity of the pipe exposed at the crest and on the slope, selected areas of the structure were trenched and then flooded. Water from the trenches outlet at thirteen (13) downslope locations between Station 3 + 80 and 4 + 30, 21 + 70, to 22 + 70, 24 + 6 to 54 + 80, 60 + 00 to 60 + 60, and 63 + 00 to 63 + 40. Nine backhoe trenches were excavated to ascertain estimate of depth and characteristics of cracking. Crack depth ranged from about 4 feet to 9 feet with open crack width ranging from 3/4 to 1 1/2 inches as deep as 6 1/2 feet from the crest to hairline widths at depth (Refer to Appendix E). Soils exposed on the embankment are predominantly sandy silt and silty sand with occasional gravel-size clasts. The camber in the crest appears to have been removed over

the years through excessive vehicular traffic, and erosion across the crest. Vegetation on both the upstream and downstream slopes is sparse, consisting of grasses, weeds and occasional creosotebush. Burrowing animal activity at this structure is substantial. Burrows were identified on the upstream and downstream embankment slopes at Stations 68, 63, 56, 54, 45, 40, 36, 30, and 9. Vehicular activity on the structure is severe because of its proximity to residential development and a lack of restricted access to the structure. Four-wheel drive vehicle tracks have created depressions on the slope faces that are aggravated by gully erosion at least 2 feet deep. Vehicular activity is concentrated in the vicinity of Stations 64, 61, 49, 45, 40, 31, and 30 and through most of the diversion dikes.

Dumped, uncompacted fill has been placed on the upstream and downstream slope in the vicinity of Station 64 in an attempt to restrict vehicular traffic. Embankment cracking and piping is evidenced by the presence of circular or oblate vertical openings. Substantial embankment cracking was investigated by Fugro (1979).

4.3 SPILLWAYS

The principal spillways including the inlet structure, conduit and outlet structures appear to be in good working condition with the exception of small accumulations of brush and sediment in the outlet area. Two principal spillways are located at

Station 17 + 82 and 58 + 50. The inlets consist of steel circular gates set in a steel gate frame. The gate was closed during the inspection. The gate is operated by a stem arrangement with the stem attached to anchor blocks on the upstream face. Although shown on the design drawings, no trash racks were in-place at the time of the inspection. The spillway conduits consist of circular corrugated metal pipes coated with tar. Spillway conduit diameters are 30 inches and 36 inches at Station 17 + 82 and 58 + 50, respectively.

The emergency spillways appear to be in fair condition except that training dikes have been subjected to erosion and modifications due to local runoff and vehicular traffic.

4.4 RESERVOIR AREA

A large borrow pit is situated within the retention basin. The pit, excavated for road fill, increases the storage capacity of the structure by about 300 acre-feet, however, it would be dead storage as there are no means available to drain the pit rapidly. About 30 feet upstream of the upstream toe, the borrow channel (source of construction material for the embankment) parallels the dam's axis. The channel bottom is about 40 feet wide and roughly 5 feet deep.

Near the dam's east abutment, a training dike interrupts flow from the north along Jackrabbit Road and diverts it into the retention basin. The dike has been subjected to substantial

erosion and degradation due to weathering and vehicular traffic.

4.5 DOWNSTREAM CHANNEL

The outlet channels at White Tanks #4 are both lined and unlined, open channels from the outlet structure downstream to irrigated farmland where flow is interrupted by lined irrigation ditches and natural drainage courses. Soils exposed in the channel appear to be potentially erodible and could therefore, be subject to varying degrees of erosion and sedimentation depending on flow velocities.

SECTION 5.0

HYDROLOGIC AND HYDRAULIC ANALYSIS

5.1 PREVIOUS HYDROLOGIC ANALYSES

No calculations were available during this Phase I inspection concerning the hydrologic and hydraulic design of the structure. The Work Plan included a general discussion of the overall design considerations, and design drawings dated in 1952 included a graph of area-capacity relationships, and graphs of spillway discharge ratings.

According to the Work Plan, area-depth-duration relationships for storm rainfall were developed from a number of high intensity storms that were experienced in central and southern Arizona. For reservoir design, a storm with a total of four inches was used; for spillway design a six-inch storm was used. It was estimated that these storms greatly exceeded the rainfall associated with the 100-year recurrence interval storm for the area. Maximum evacuation time for the detention reservoir was estimated to be less than five days. Sediment capacity was provided for 50 years of estimated sediment accumulation.

5.2 HYDROLOGIC AND HYDRAULIC EVALUATION OF DAM AND RESERVOIR

The construction of Interstate 10 across the watershed and less than one mile north from White Tanks Retarding Dam #4, was discussed in Section 2.13 of this report. With the freeway in

place, flow conditions associated with an extreme flood event, such as the PMF, are extremely complex. Runoff in excess of the hydraulic capacity of the four - 10' x 8' CBC's will pond until it overtops the north-south levee, located about 50 feet east from the culverts, and flow toward the east parallel to the freeway. At the low point in the freeway a portion of the flow will overtop the freeway and continue south to the reservoir; the remainder will continue east to Jackrabbit Road. Runoff in excess of the culvert capacity beneath the on-ramp at Jackrabbit Road will overtop that road and exit the watershed to the east.

With an upstream water surface elevation at the top of the north-south levee, the hydraulic capacity of the four - 10' x 8' CBC's is about 4,000 cubic feet per second (cfs). A flow rate of 4,000 cfs at that location is expected to occur early in a PMF. Therefore, during a PMF a substantial quantity of runoff will flow east toward Jackrabbit Road, rather than directly south to the reservoir as occurred prior to freeway construction. Depending upon the water surface elevations associated with the discharge diverted along the north side of the freeway, a portion will overtop the freeway, as described above, and flow to the reservoir. Again, depending upon water surface elevations at Jackrabbit Road, runoff in excess of the culverts beneath the on-ramp will overtop Jackrabbit Road and continue east. The consideration of these flow diversions on

runoff timing, the effects of temporary storage north of the freeway, and determining the quantity of runoff that exits the watershed upstream from the reservoir, will require a detailed hydraulic and hydrologic evaluation. Since an evaluation of that detail is beyond the scope of a Phase I study, the remainder of this study will consider flow into the reservoir without consideration of the barrier effect of Interstate 10. Section 5.3 will include a brief qualitative discussion of the probable impact of the freeway on spillway adequacy.

Using the U. S. Army, Corps of Engineers HEC 1 Dam Safety computer program, inflow hydrographs were computed for the Probable Maximum Flood (PMF), and selected increments of the PMF (Corps, 1978). The program was used in conjunction with the SCS dimensionless unit hydrograph coefficients and the PMF was computed based on the Probable Maximum Precipitation (PMP) estimated for the basin. Results of the computation are shown in Table 4.

During the safety inspection of the dam and reservoir, both the upper and lower watershed area was inspected with Mr. Earl Hagen, Operations Manager, Caterpillar Tractor Company, and the drainage boundary was delineated on topographic maps in the field. During the inspection it was noted that there are no culverts crossing Jackrabbit Road north of Interstate 10 and the easterly watershed boundary was therefore defined by the road. However, during an extreme flood event it is possible that flow will overtop Jackrabbit Road at some point north of

TABLE 4

HYDROLOGIC DATA SUMMARY
WHITE TANKS DAM NO. 4

Item	Unit	PMF	1/2 PMF
Storm Duration	hours	6	6
Storm Precipitation	inches	13.5	
Peak Hour	inches	9.0	
Peak Inflow	cfs	56,781	28,391
Peak Inflow	csm	3,990	1,995
Peak Outflow	cfs	56,708	26,924
Peak Outflow	csm	3,985	1,892
Runoff Volume	AF	9,046	4,523
Runoff Volume	inches	11.93	5.96
Max. W.S. Elev.	feet	1,057.61	1,056.72
Top of Dam Elev.	feet	1,056.00	1,056.00
Residual Freeboard	feet	-1.61 (overtopped)	-0.72 (overtopped)
Dur. of Overtopping	hours	2.5	1.25
Time of Conc.	hours	1.52	1.52
Lag	hours	0.91	0.91
Curve Number		87.5	87.5

the interstate and bypass the reservoir. This possibility should be evaluated further during the Phase II study.

The drainage area tributary to the dam was then measured in the office and found to be 14.23 square miles. Using procedures outlined in Hydrometeorological Report No 49, PMP was estimated for both a general storm and a local storm. Since the peak six-hour duration rainfall for the general storm was 9.5 inches, and the six-hour rainfall for the local storm was 13.5 inches, the local storm was selected as the most critical for this evaluation. Hourly amounts and 15-minute amounts during the peak hour were computed and distributed in accordance with guidelines in Corps of Engineers EM 1110-2-1411. The peak 15-minute rainfall amount was 5.4 inches; incremental rainfall for each hour during the six-hour storm are shown in the table below, along with the storm total.

Storm Hour	PMP Inches
1	0.5
2	0.7
3	1.9
4	9.0
5	0.8
6	0.6
Total	13.5

Since snowfall in this area is rare, and major flooding generally occurs during summer thunderstorm activity, a rain-on-snow analysis was not included in this study.

For this evaluation the SCS dimensionless unit hydrograph methodology was selected to compute inflow hydrographs; SCS input coefficients include a watershed lag, and curve number for loss rate computations. The generalized equation for lag developed by SCS is as follows:

$$\text{Lag} = 0.6\ T_c$$

where T_c is the time of concentration. The time of concentration is defined as the time required for water to travel from the hydraulically most remote point in a watershed to its outlet. It is primarily a function of channel length, slope, and roughness characteristics of the channel. During this analysis, methods for computing T_c established by the SCS, Arizona Department of Highways, and local flood control districts were considered. The method recommended by the Arizona Department of Highways for drainage areas greater than 10 square miles was selected for final analysis. For that method T_c is a function of the length of the longest drainage course (L), and the change in elevation from the most remote point to the outlet (H), as follows:

$$T_c = L^{1.15}/7700\ H^{0.38}$$

In general, surface runoff from a watershed represents that portion of the precipitation that does not infiltrate the soil surface and replenish soil moisture storage. Hydrologic soil groups described by the SCS represent a measure of the infiltration

characteristics of the soil. Using the General Soil Map, Maricopa County Arizona published by the SCS in 1973, predominant soils in the study watershed were found to be the Cherioni-Gachado-Rock Association, the Ebon-Pinant-Tremant Association, and the Antho-Valencia Association. Soils of the Cherioni-Gachado-Rock Association are gently sloping to very steep gravelly loams with rock outcrops on mountains, buttes, and low hills. These are the dominant soils in the watershed, and their hydrologic soil group is D. The Ebon-Pinant-Tremant Association soils are level to gently sloping gravelly loams, very cobbly loams, and gravelly clay loams on old alluvial fans at the base of mountains. This association includes both B and C hydrologic soil groups. Soils of the Antho-Valencia Association are nearly level sandy loams on recent alluvial fans and valley plains. Their hydrologic soil group is B. Cover was estimated to be 10 percent and it includes bursage, creosote-bush, paloverde, ironwood, cactus, and annual grass. Based on the runoff curve number of each soil and percentage of occurrence in the study watershed, a weighted curve number of 87.5 was computed, and used in this analysis. Hydrologic calculations are shown in Appendix B. The curve number was selected from graphs prepared by the Arizona Highway Department for use in project design, and it is considered reasonably representative of runoff conditions for Phase I studies.

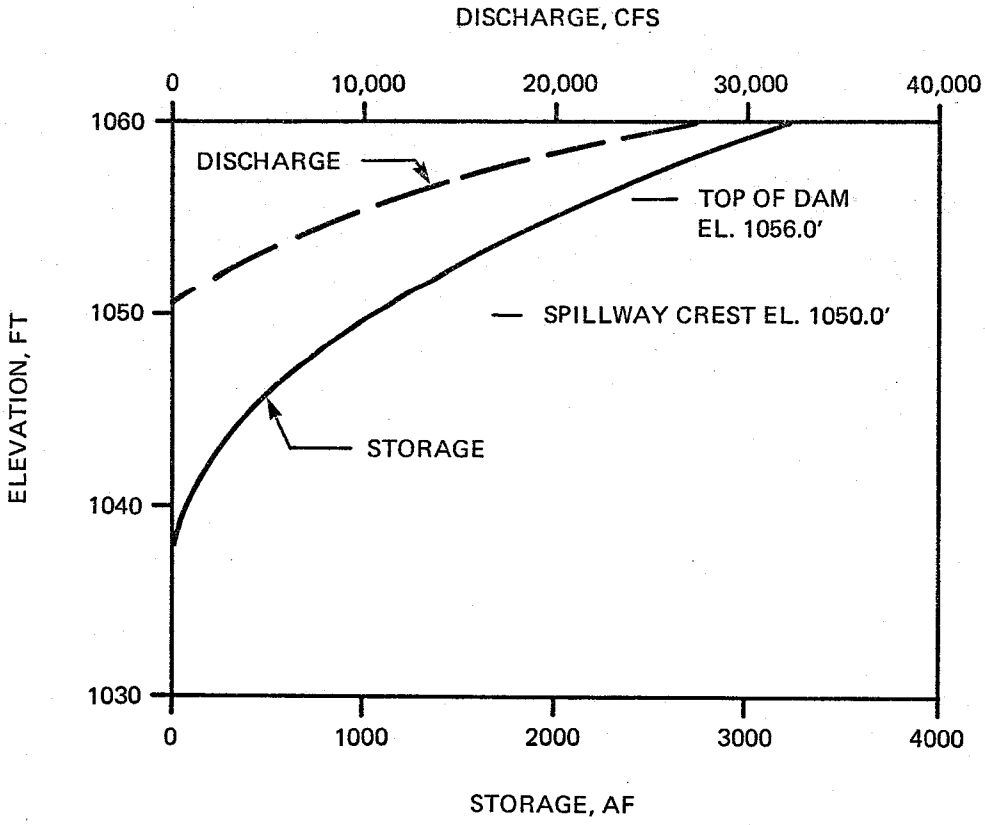
The HEC 1 reservoir routing subroutine requires estimates of the stage-storage and stage-discharge relationships for the dam

and reservoir. Stage-storage data were supplied with the as-built drawings, however, it was necessary to extend the data to elevations above the top of the dam. These calculations were completed using topographic data shown on USGS quadrangle maps of the reservoir area. Results of the stage-storage computations are shown in Figure 5.

Outlet facilities from the reservoir include two gated CMP's and two 165-foot wide open channel spillways excavated through each abutment. For the routing calculations it was assumed that the gated outlets were closed and the reservoir level was at the emergency spillway elevation at the beginning of the storm. Even if open, the minimal flow capacity of the principal spillways would have no bearing on the dam's capability to safely pass the PMF. The stage-discharge relationship for the emergency spillway as shown on the design drawings, was extended to elevations above the top of dam and used in the routing analysis.

5.3 RESULTS

Results of the routings are shown in Table 4 for a PMF and 0.5 PMF without consideration of the construction of Interstate 10. During a 100 percent PMF the dam would be overtopped by up to 1.61 feet for approximately 2.5 hours. The table also shows that a flood equivalent to 0.5 PMF would overtop the dam. Comparison of maximum discharges for various percentages of the PMF indicate that all floods greater than about 30 percent of the PMF would result in overtopping the dam.



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PHASE I SAFETY INSPECTION
WHITE TANKS DAM NO. 4

STAGE-STORAGE
STAGE-DISCHARGE

7-81

FIGURE 5

Compiled by ____ Drawn by ____ Checked by ____ Approved by ____

With consideration for the construction of Interstate 10, it is apparent that the capability of the emergency spillways to safely pass the PMF will depend upon the rate and volume of runoff that overtops the freeway between Jackrabbit Road and the western watershed boundary. The maximum discharge of the four 10' x 8' CBC's near the western watershed boundary is about 4,000 cfs. With a water surface elevation at the freeway on-ramp culverts equal to the crown elevation of Jackrabbit Road, the maximum flow through the culverts would be about 3,500 cfs. The combined flow through these culverts of 7,500 cfs is well below the reservoir spillway capacity of 13,500 cfs. However, a flow depth of four feet above the minimum freeway elevation at its low point would discharge over 24,000 cfs across the freeway and into the detention reservoir. This would be sufficient inflow to overtop the dam without consideration for discharge from the culvert crossings. This potential should be considered further in a Phase II study.

5.4 SEDIMENTATION

Design criteria for the dam indicate that it was sized to store expected sediment accumulation for 50 years, and provide flood retention storage to pass a storm greater than the 100-year flood event without use of the emergency spillway. According to the Work Plan, expected 50-year sediment deposition was estimated to be 193 acre-feet. During the field survey, the reservoir area was inspected and sediment deposition to date

was considered to be negligible; probably much less than the volume of the large borrow pit located in the reservoir area.

SECTION 6.0

CONCLUSIONS AND RECOMMENDATIONS

Corps of Engineers guidelines indicate that White Tanks Retarding Dam No. 4 is a high hazard dam because of downstream development; storage criteria indicate that it is intermediate in size. Because of the high hazard and intermediate size classification, the guidelines also indicate that the emergency spillway should have the capability to safely pass the PMF. However, in 1977 Interstate 10 was constructed across the White Tanks watershed less than one mile upstream from the dam. The freeway in this area is elevated, and for a major flood such as the PMF, inflow to the detention reservoir is extremely complex. Initial runoff will cross under the freeway in one of the culvert crossings up to the hydraulic capacity of the culvert; excess runoff will flow to the east parallel to the freeway with a portion overtopping the freeway and continuing to the reservoir. Preliminary hydraulic calculations indicate that a portion of the PMF will overtop the eastern watershed boundary and bypass the retention reservoir. However, it appears probable that during a PMF, sufficient runoff will cross the freeway to overtop the dam. A Phase II Study will be required to evaluate further the hydraulic effects of Interstate 10.

Assuming that all runoff from the tributary watershed enters the reservoir, the spillway can only accommodate 30 percent of the PMF, and the dam would experience an overtopping of

up to a maximum of 1.61 feet for approximately 2.5 hours. It is probable that the dam would fail in the event of such overtopping. Results of the existing data evaluation indicate the internal structural integrity is also questionable because of embankment cracking known to affect the structure.

Results of this Phase I inspection and technical evaluation indicate corrective actions must be implemented during regular maintenance of the structure and that Phase II studies must be implemented to evaluate and ultimately correct apparent hydrolic and structural deficiencies. Specific recommendations are as follows:

1. A Phase II study should be conducted to determine the hydrologic effect of construction of Interstate 10, at which time a warning system and evacuation plan can be developed if found to be necessary.

2. The dam and emergency spillways should be fenced to prevent trail bikes and off-road vehicles from using them as a playground.

3. Jackrabbit Road should be protected from the flow through the east emergency spillway.

4. Brush and sediment deposition should be cleaned from the outlet structures.

5. The dam embankment should be inspected at least annually to observe the occurrence of embankment cracking.

6. The population of burrowing animals on the embankment should be controlled by either periodically grading the surface to fill in burrows, or covering the surface with a rock or gravel blanket (see report in Appendix D).

7. A detailed Phase II geotechnical investigation should be made to evaluate the dam and its foundation to determine the cause of recent cracking.

8. Plans for any remedial construction should be reviewed with respect to the existing geotechnical conditions.

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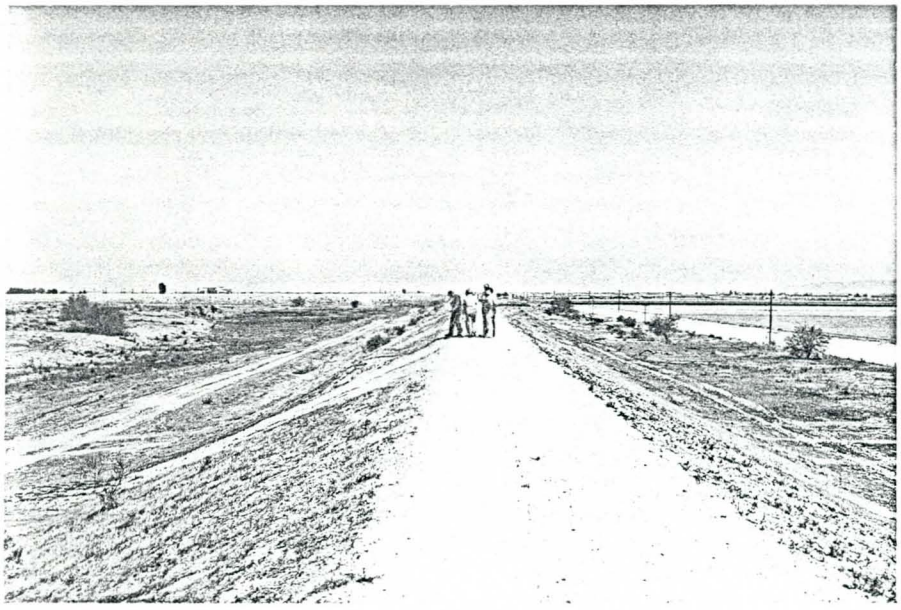
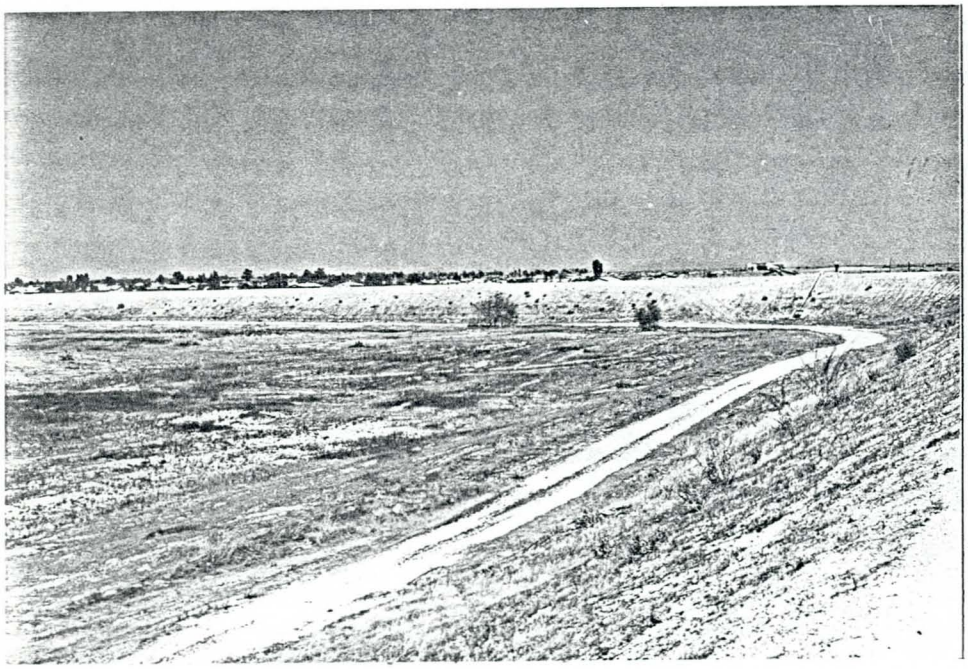
Wilson, E. D., et al., 1957, Geological Map of Maricopa County, Arizona, prepared by Arizona Bureau of Mines, University of Arizona, Tucson, Arizona.

PHOTOGRAPHS



(A) VIEW TO EAST ALONG EMBANKMENT CREST, RESERVOIR TO LEFT



(B) VIEW TO EAST SHOWING UPSTREAM EMBANKMENT AND RESERVOIR

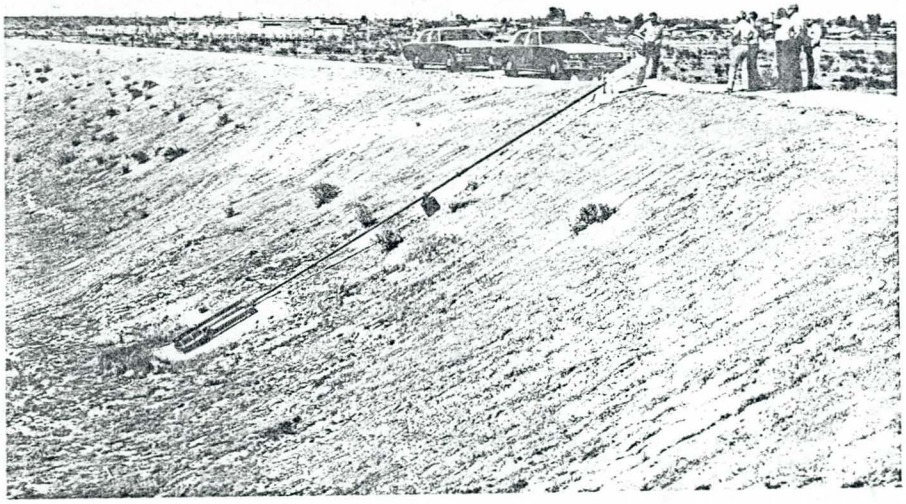
Ertec
The Earth Technology Corporation

PROJECT NO. 81-161

WHITE TANKS DAM NO. 4

4/1/81 PHOTOGRAPH #1

Compiled by ____ / ____ Drawn by ____ / ____ Checked by ____ / ____ Approved by ____ / ____



(A) TYPICAL INLET STRUCTURE SHOWING SLIDE GATE AND GATE STEM

(B) OUTLET STRUCTURE AND CHANNEL, NOTE VEHICLE TRACKS ON FACE OF DAM

Ertec The Earth Technology Corporation	PROJECT NO. 81-161
WHITE TANKS DAM NO. 4	
4/1/81	PHOTOGRAPH #2

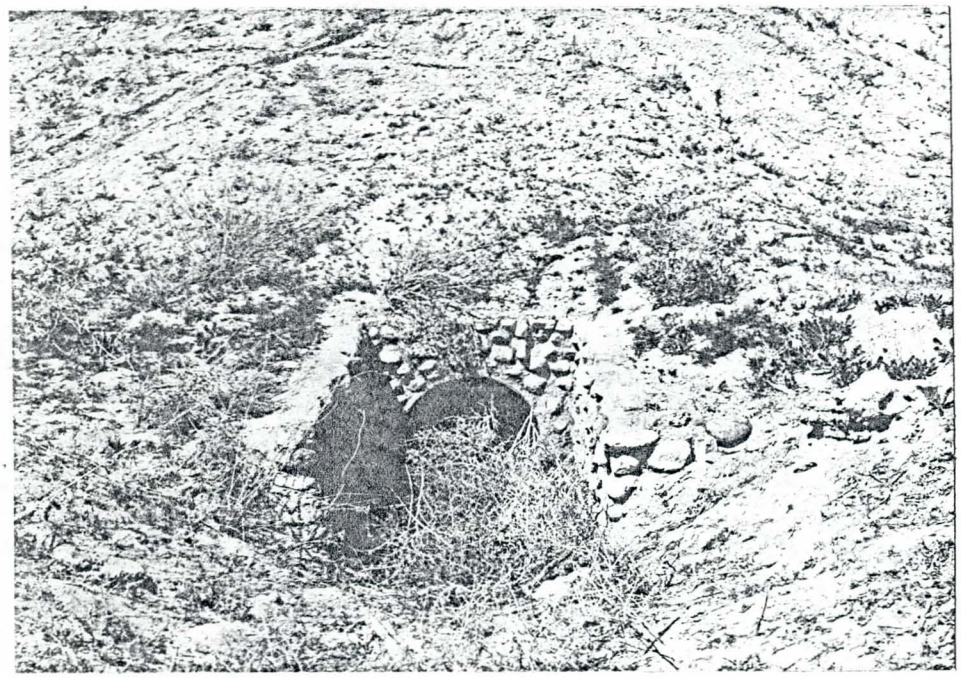
Compiled by ____ / ____ Drawn by ____ / ____ Checked by ____ / ____ Approved by ____ / ____

(A) UPSTREAM FACE SHOWING CRACKS AND/OR EROSION GULLYING

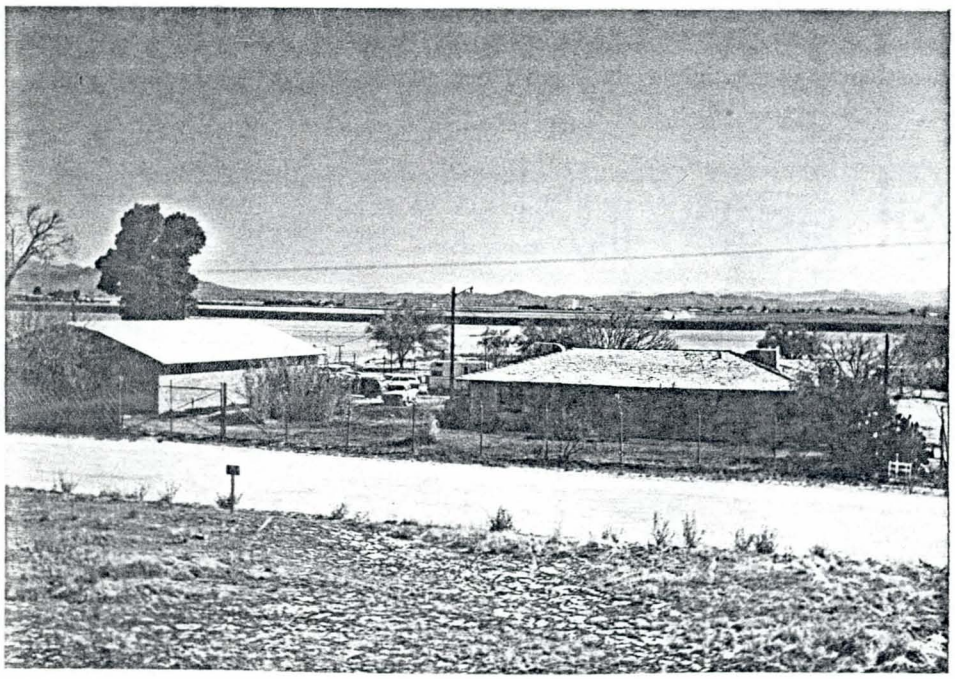
(B) ANIMAL BURROW AT STATION 35+60

Ertec The Earth Technology Corporation	PROJECT NO. 81-161
WHITE TANKS DAM NO. 4	
4/1/81	PHOTOGRAPH #3

Compiled by ____ / ____ Drawn by ____ / ____ Checked by ____ / ____ Approved by ____ / ____



(A) TYPICAL OUTLET STRUCTURE



(B) RESIDENCE AND COUNTY ROAD LOCATED NEAR DOWNSTREAM TOE

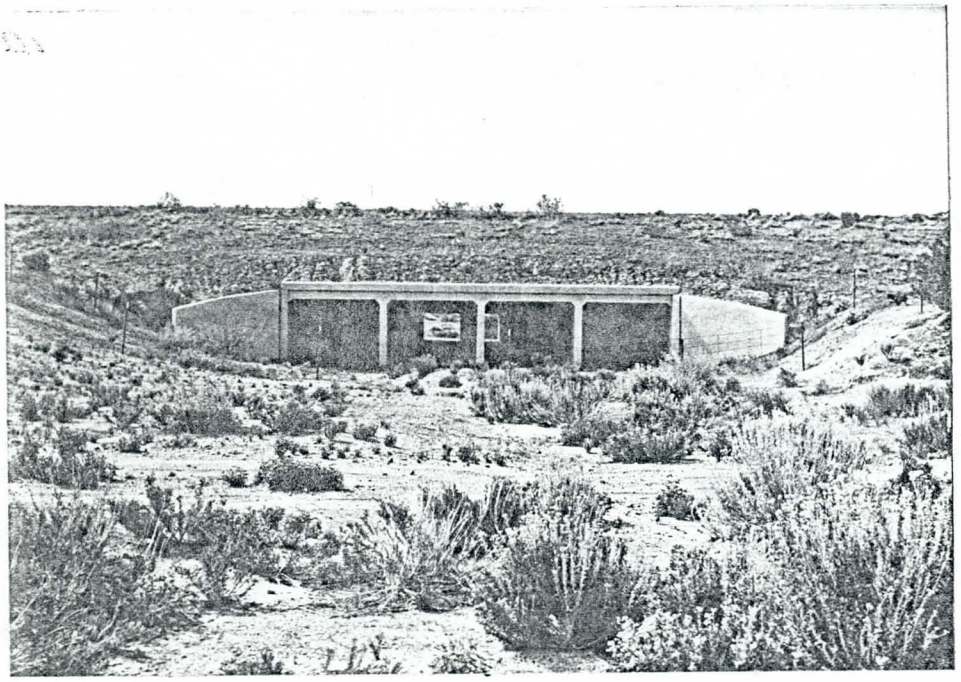
Ertec
The Earth Technology Corporation

PROJECT NO. 81-161

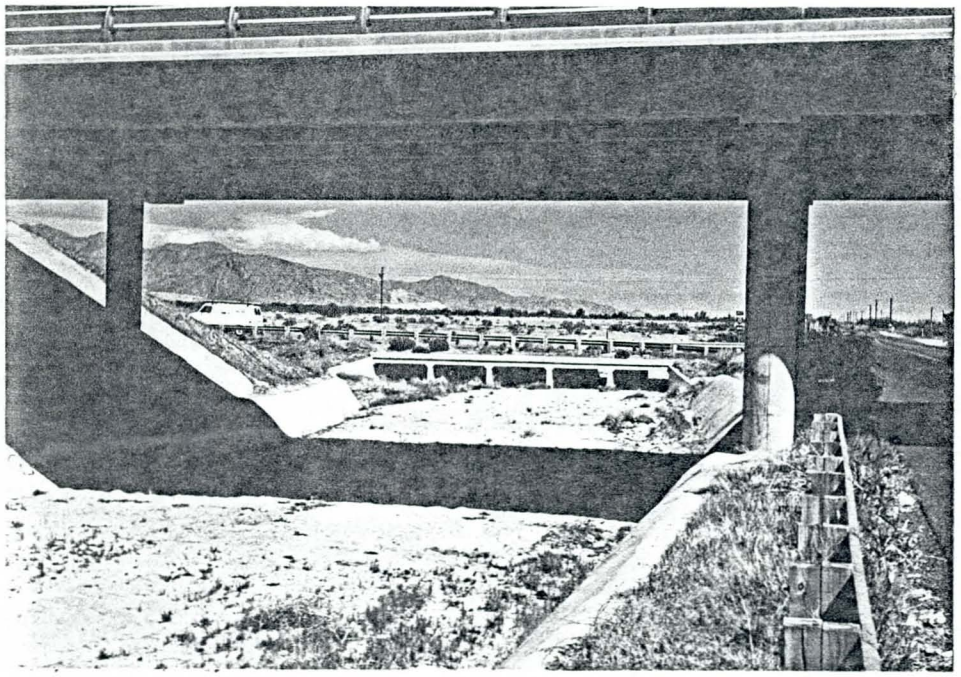
WHITE TANKS DAM NO. 4

4/1/81 PHOTOGRAPH #4

Compiled by ____ / ____ Drawn by ____ / ____ Checked by ____ / ____ Approved by ____ / ____



(A) FOUR - 10' X 8' CBC'S UNDER INTERSTATE 10, LOOKING DOWNSTREAM



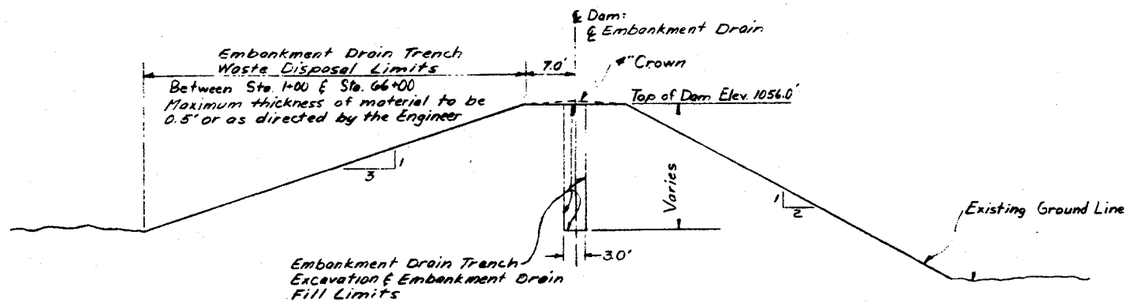
(B) FIVE - 10' X 5' CBC'S UNDER JACKRABBIT ROAD ON-RAMP, LOOKING UPSTREAM

Ertec The Earth Technology Corporation	PROJECT NO. 81-161
WHITE TANKS DAM NO. 4	
4/2/81	PHOTOGRAPH #5

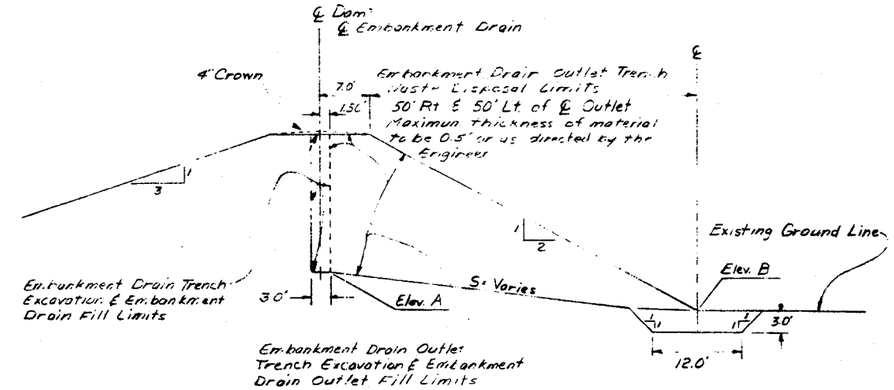
Compiled by ____ / ____ Drawn by ____ / ____ Checked by ____ / ____ Approved by ____ / ____

APPENDIX A

DESIGN DRAWINGS



TYPICAL CROSS SECTION
EMBANKMENT DRAIN

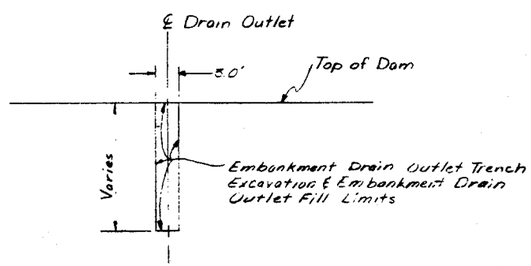


PROFILE ON ℄ OF EMBANKMENT
DRAIN OUTLET

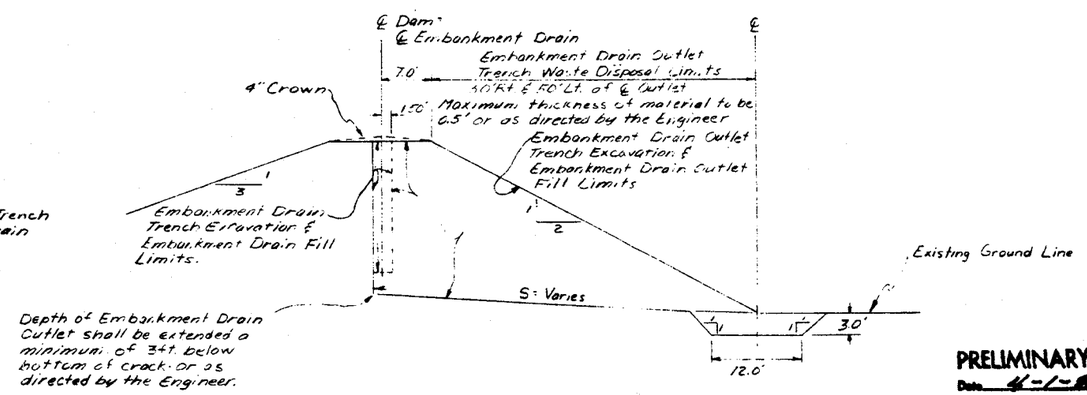
SCHEDULE OF EMBANKMENT
DRAIN OUTLETS

Station	Elevation A	Elevation B
11+00	1043.5±	1041.2±
21+00	1043.5±	1038.0±
31+00	1043.5±	1037.2±
41+00	1043.5±	1039.0±
51+00	1043.5±	1040.4±
61+00	1046.8±	1044.5±

Note: Auxiliary Embankment Drain Outlet Elevations shall be as directed by the Engineer.



TYPICAL CROSS SECTION
EMBANKMENT DRAIN OUTLET



PRELIMINARY
Date 4-1-81

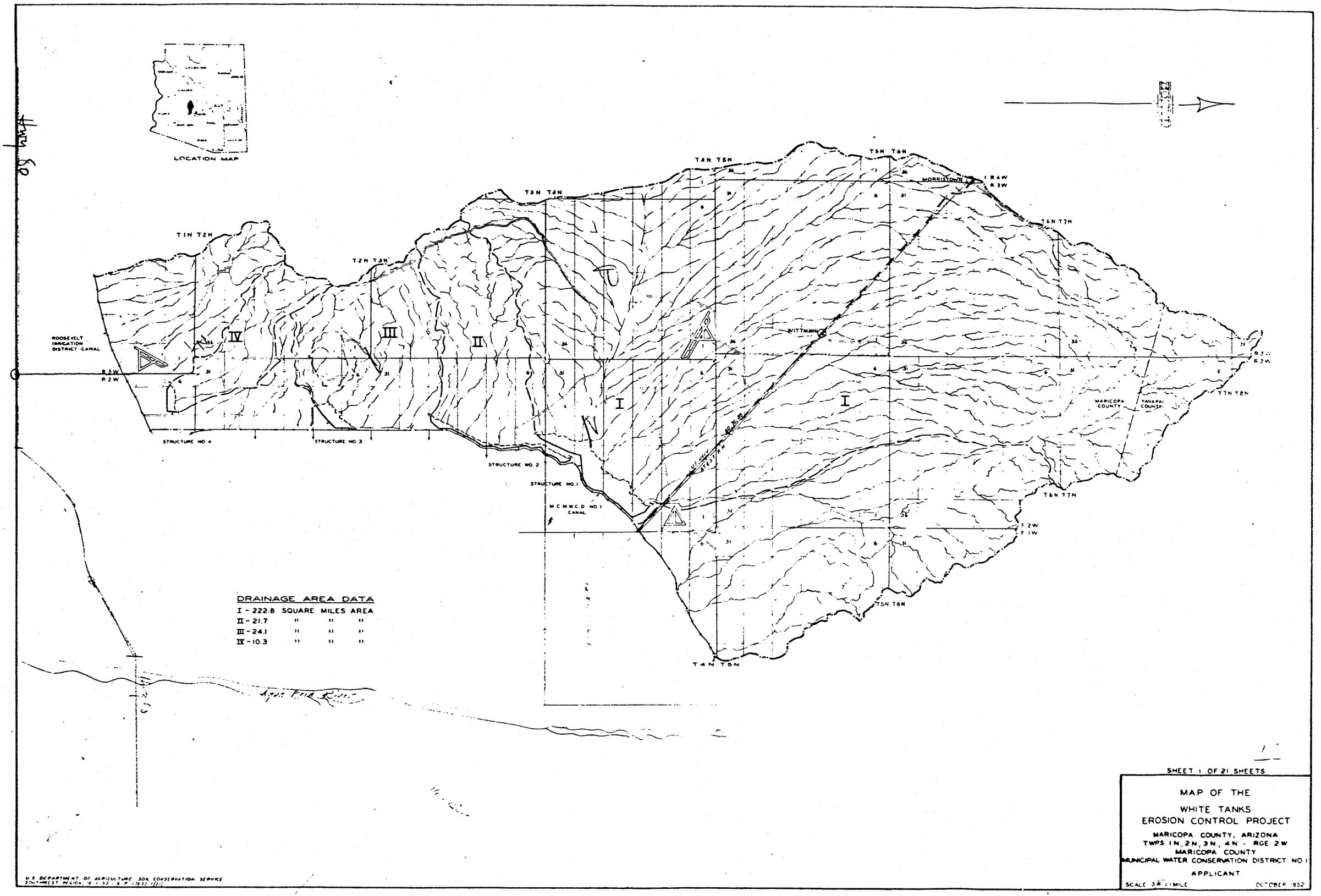
PROFILE ON ℄ OF AUXILIARY
EMBANKMENT DRAIN OUTLET

(Not to scale)

DETAILS OF DRAIN AND OUTLET
WHITE TANKS NO. 4 DRAIN
WHITE TANKS W.P.P.
MARICOPA COUNTY, ARIZONA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed WEP	Date 10-79	Approved by	
Drawn JAM	10-79	Title	
Traced		Title	
Checked		Sheet No. 3 of 3	Drawing No. 79022-AZ-Ph

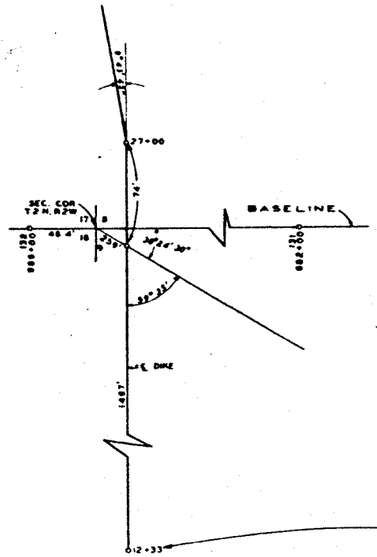


SHEET 1 OF 21 SHEETS

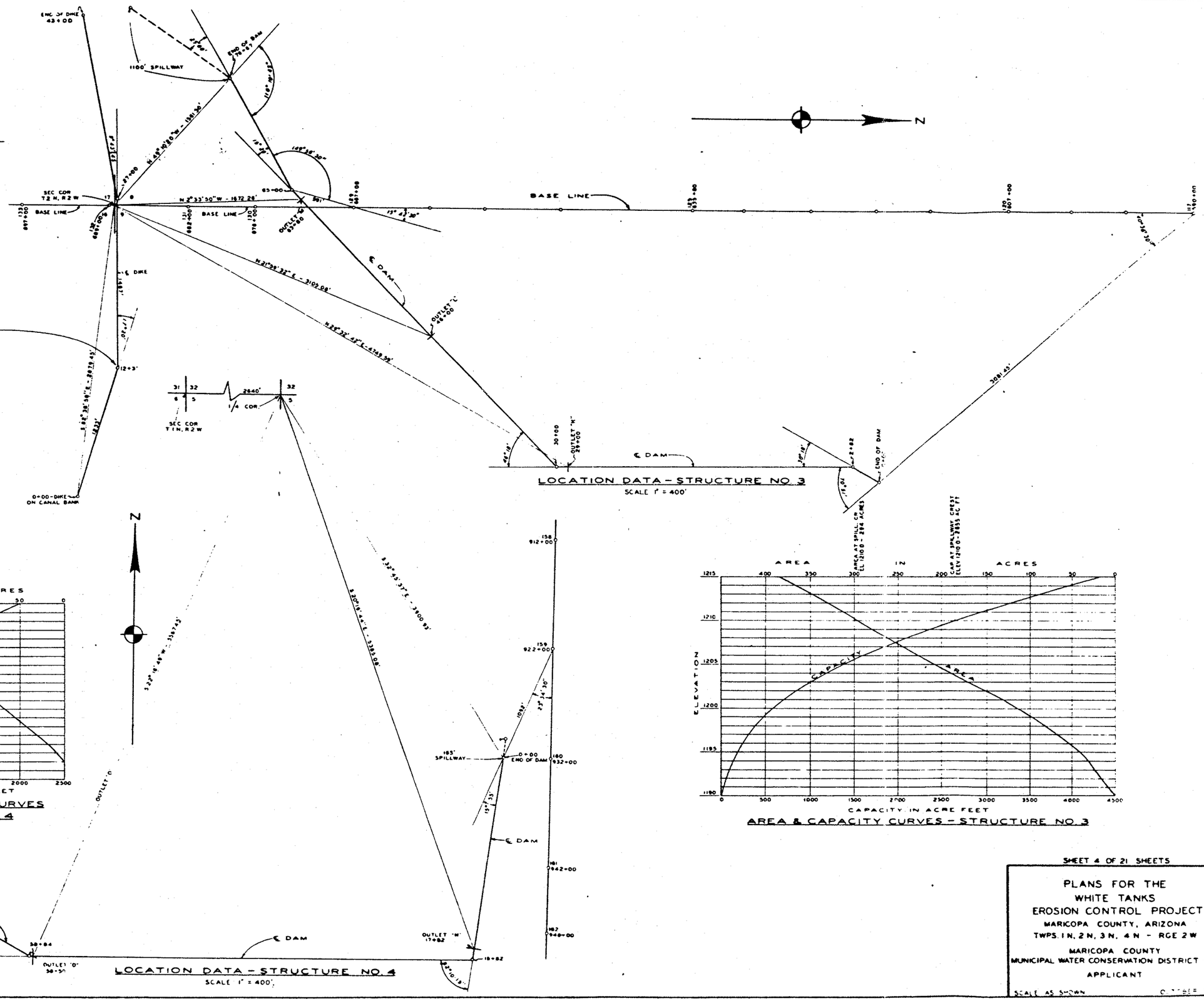
MAP OF THE
WHITE TANKS
EROSION CONTROL PROJECT

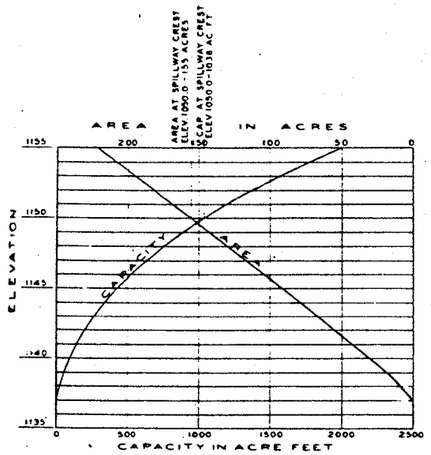
MARICOPA COUNTY, ARIZONA
TWPS 1N, 2N, 3N, 4N - RGE 2W
MARICOPA COUNTY
MUNICIPAL WATER CONSERVATION DISTRICT NO 1
APPLICANT

SCALE 3¼" = 1 MILE OCTOBER 1952



DETAIL OF DIKE & BASE LINE TIE
SCALE 1" = 50'





AREA & CAPACITY CURVES
STRUCTURE NO. 4

AREA & CAPACITY CURVES - STRUCTURE NO. 3

SHEET 4 OF 21 SHEETS

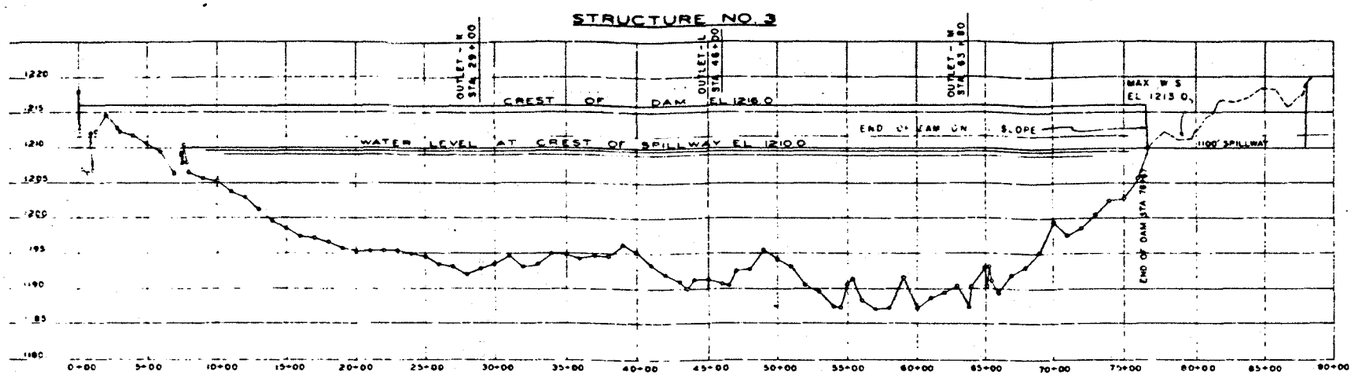
PLANS FOR THE
WHITE TANKS
EROSION CONTROL PROJECT
MARICOPA COUNTY, ARIZONA
TWPS. 1 N, 2 N, 3 N, 4 N - RGE 2 W

MARICOPA COUNTY
MUNICIPAL WATER CONSERVATION DISTRICT NO 1
APPLICANT

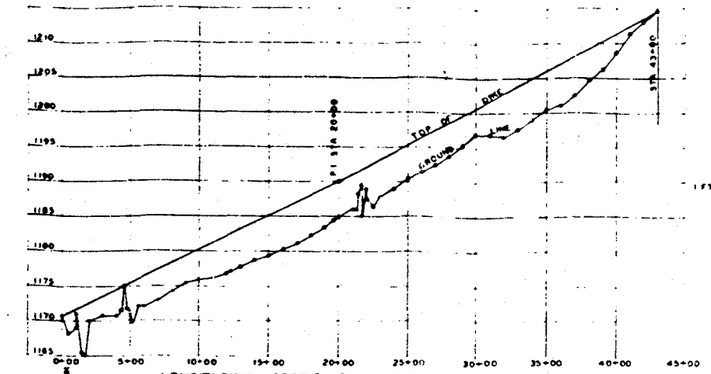
SCALE AS SHOWN

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE
SOUTHWEST REGION

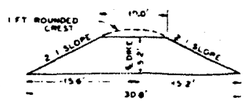
STRUCTURE NO. 3



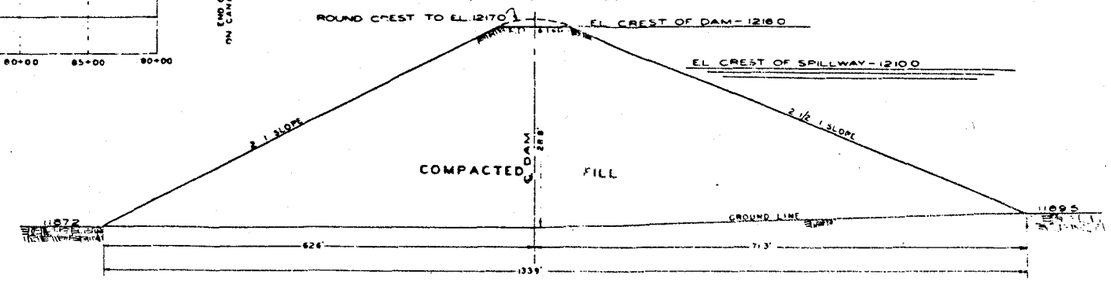
LONGITUDINAL SECTION ON ℄ OF DAM & SPILLWAY
SCALE - HOR 1" = 500', VERT. 1" = 10'
346,464 C Y EMBANKMENT



LONGITUDINAL SECTION ON ℄ OF DIKE AT LATERAL 12
SCALE - HOR 1" = 500', VERT 1" = 10'
6,645 C.Y. EMBANKMENT



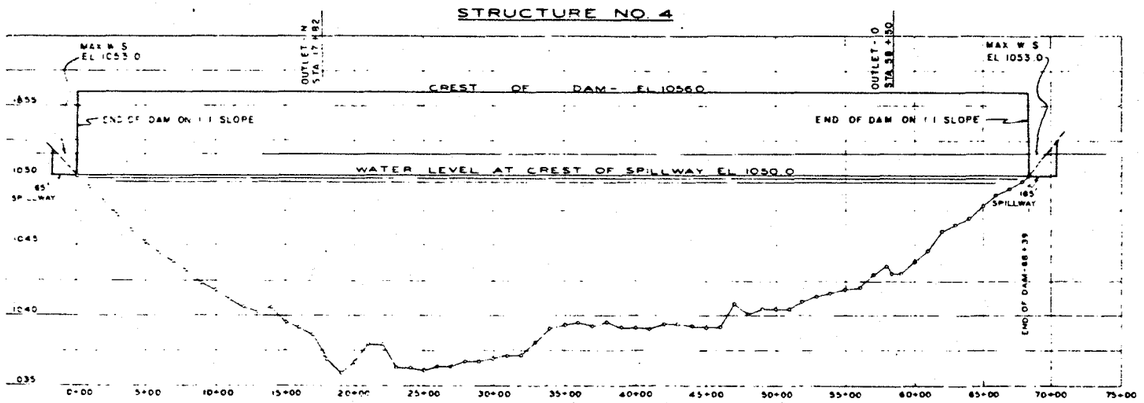
CROSS SECTION OF DIKE
AT STA. 20+00
SCALE 1" = 10'



MAXIMUM CROSS SECTION OF DAM AT STA. 57+00
SCALE 1" = 10'

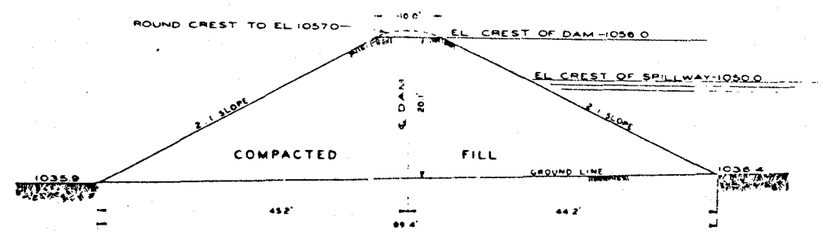
NOTE SLOPES & CRESTS OF DAMS TO BE FACED WITH CALICHE AND COARSE GRAVEL

STRUCTURE NO. 4

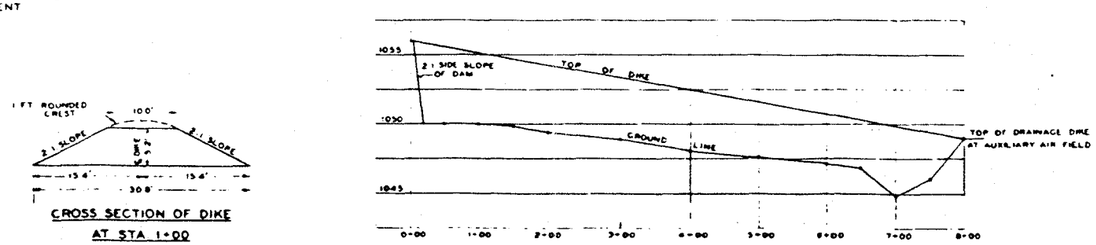


LONGITUDINAL SECTION ON ℄ OF DAM & SPILLWAYS
SCALE - HOR 1" = 500, VERT 1" = 5'
167,180 C Y EMBANKMENT

STRUCTURE NO. 4



MAXIMUM CROSS SECTION OF DAM AT STA. 19+00
SCALE 1" = 10'



LONGITUDINAL SECTION ON ℄ OF DIKE FROM WEST END OF STRUCTURE NO 4 TO AUXILIARY AIR FIELD DIKE
SCALE - HOR 1" = 100', VERT 1" = 5'
3110 C Y EMBANKMENT

CROSS SECTION OF DIKE
AT STA. 1+00
SCALE 1" = 10'

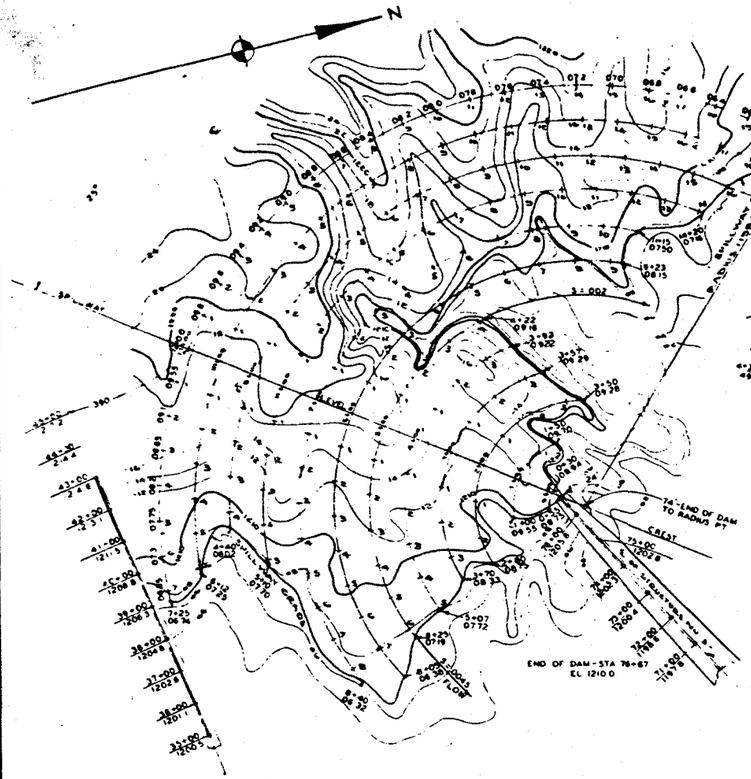
SHEET 16 OF 21 SHEETS

PLANS FOR THE
WHITE TANKS
EROSION CONTROL PROJECT
MARICOPA COUNTY, ARIZONA
TWPS. 1 N, 2 N - RGE 2 W

MARICOPA COUNTY
MUNICIPAL WATER CONSERVATION DISTRICT NO 1
APPLICANT

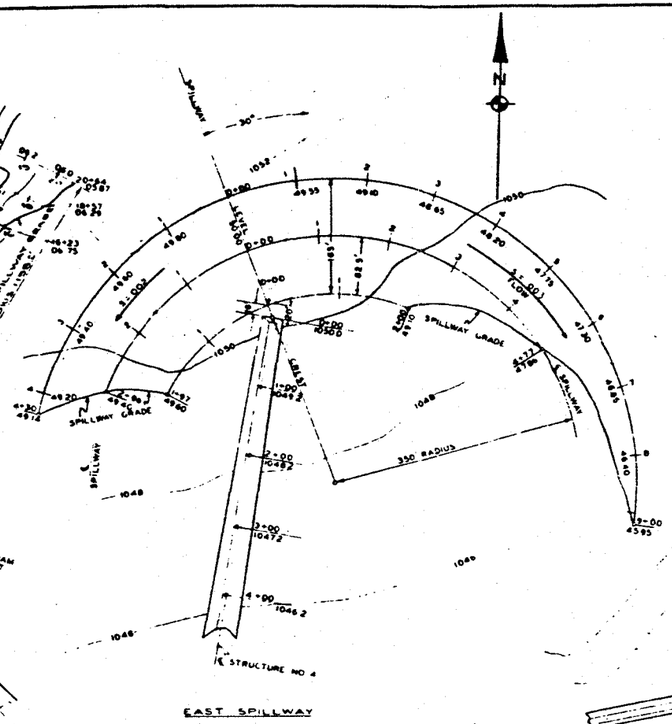
SCALE AS SHOWN — OCTOBER 1962

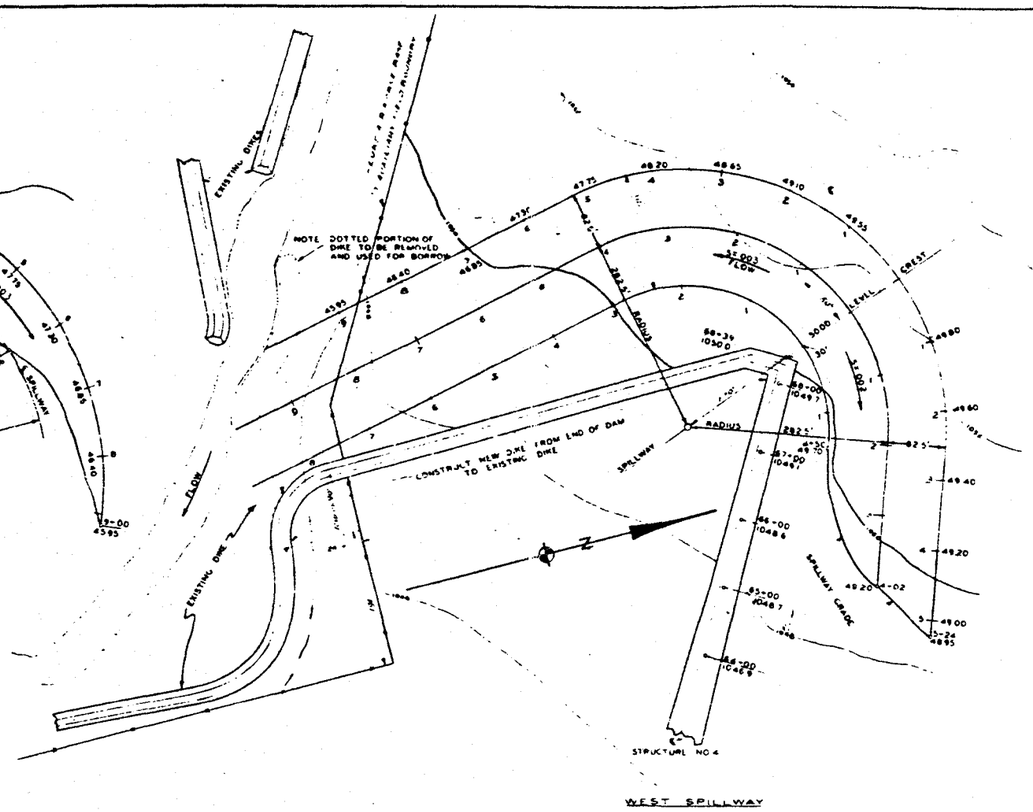
U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE
SOUTHWEST REGION (C-1-57-8-P-13833-16 (21))



PLAN OF SPILLWAY - STRUCTURE NO. 3

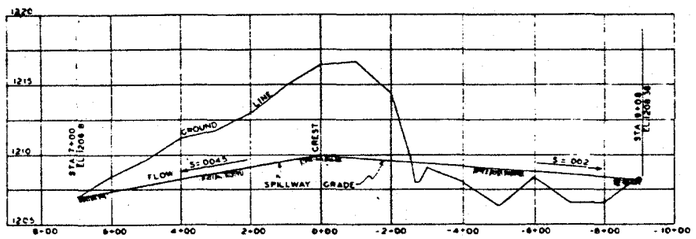
SCALE 1" = 200'





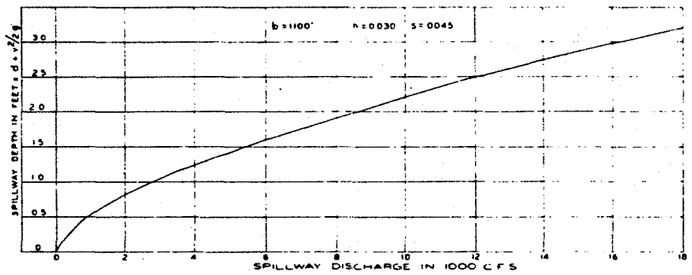
PLAN OF SPILLWAYS - STRUCTURE NO. 4

SCALE 1" = 100'

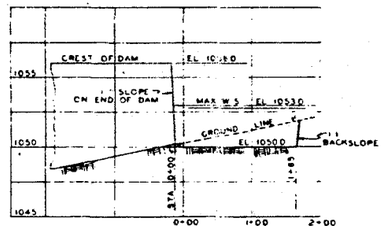


LONGITUDINAL SECTION ON ℄ OF SPILLWAY - STRUCTURE NO. 3

SCALE - HOR 1" = 200', VERT 1" = 5'



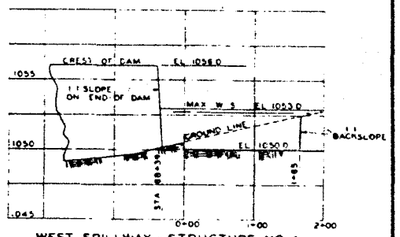
SPILLWAY DISCHARGE CURVE - STRUCTURE NO. 3



EAST SPILLWAY - STRUCTURE NO. 4

CROSS SECTION ON SPILLWAY CREST

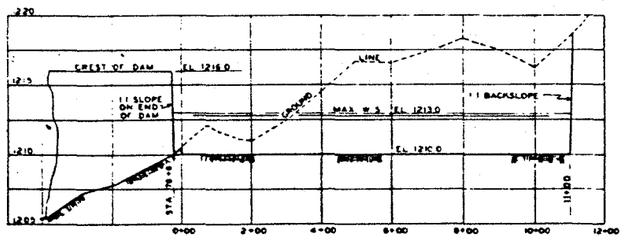
SCALE - HOR 1" = 100', VERT 1" = 5'



WEST SPILLWAY - STRUCTURE NO. 4

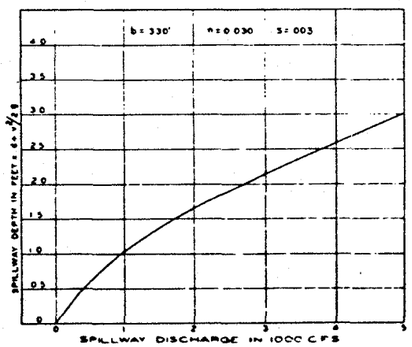
CROSS SECTION ON SPILLWAY CREST

SCALE - HOR 1" = 100', VERT 1" = 5'

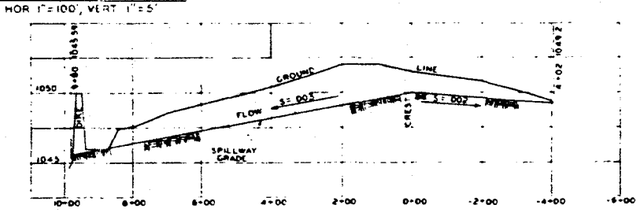


CROSS SECTION ON SPILLWAY CREST - STRUCTURE NO. 3

SCALE - HOR 1" = 200', VERT 1" = 5'

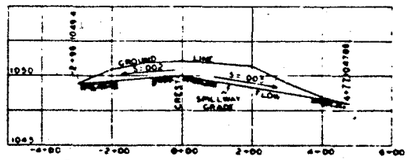


SPILLWAY DISCHARGE CURVE - STRUCTURE NO. 4



LONGITUDINAL SECTION ON ℄ OF WEST SPILLWAY - STRUCTURE NO. 4

SCALE HOR 1" = 200', VERT 1" = 5'



EAST SPILLWAY - STRUCTURE NO. 4

LONGITUDINAL SECTION ON ℄ OF SPILLWAY

SCALE - HOR 1" = 200', VERT 1" = 5'

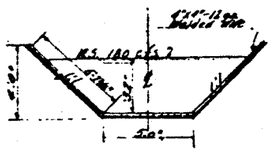
SHEET 17 OF 21 SHEETS

PLANS FOR THE
WHITE TANKS
EROSION CONTROL PROJECT
MARICOPA COUNTY, ARIZONA
TWPS 1 N, 2 N, 3 N, 4 N - RGE 2 W

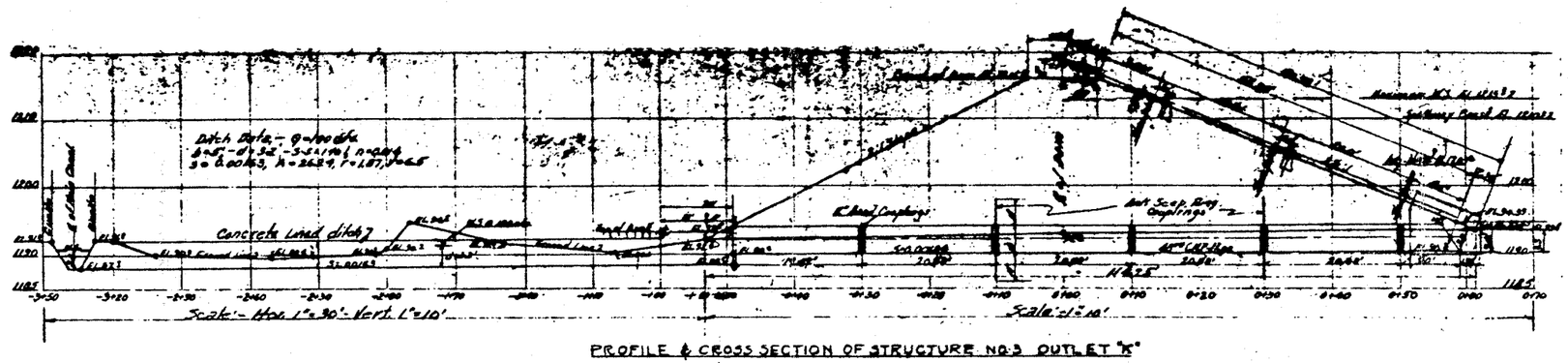
MARICOPA COUNTY
MUNICIPAL WATER CONSERVATION DISTRICT NO. 1
APPLICANT

SCALE AS SHOWN — OCTOBER 1952

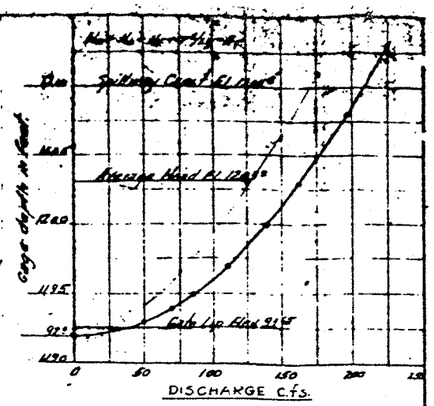
U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE
SOUTHWEST REGION - 10 1 32 - 8 P (2833) (7-52)

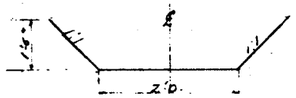


CROSS SECTION OF LINED DITCH
Scale: 3/8"=1'-0"

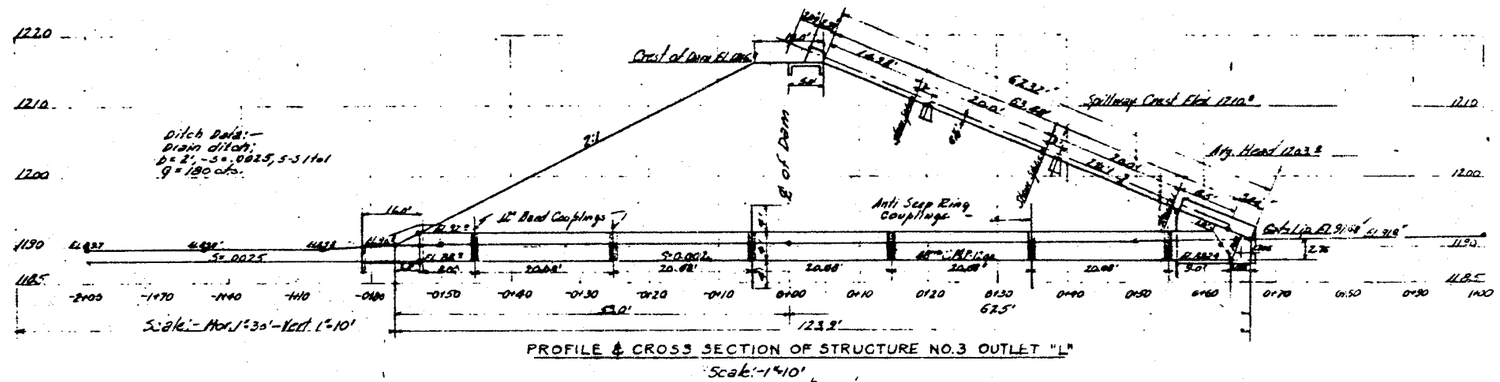


PROFILE & CROSS SECTION OF STRUCTURE NO.3 OUTLET "K"

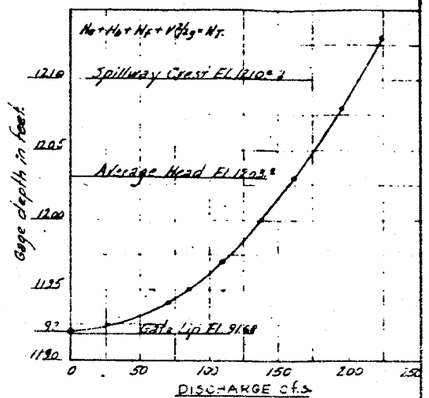


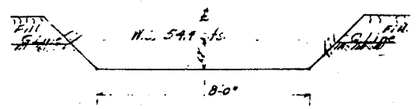


CROSS SECTION OF DRAIN DITCH
Scale:-1"=1'-0"

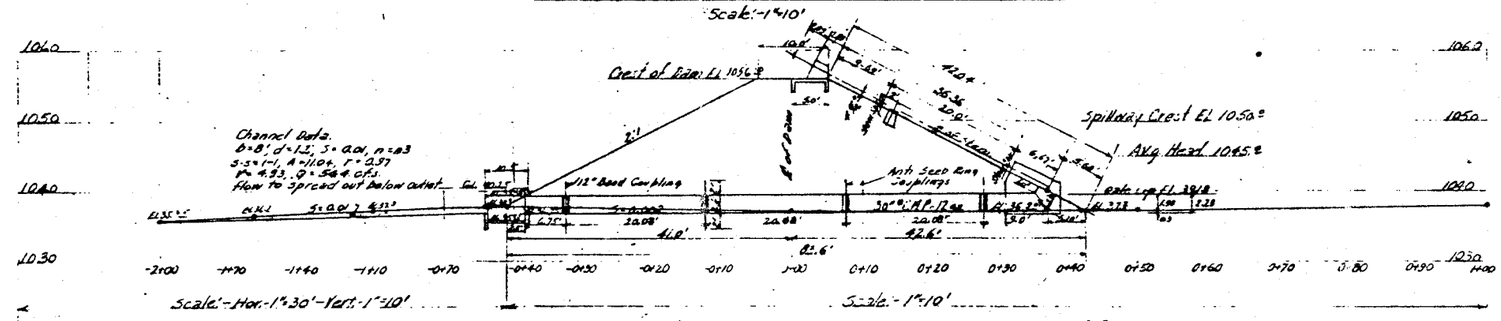


PROFILE & CROSS SECTION OF STRUCTURE NO.3 OUTLET "L"

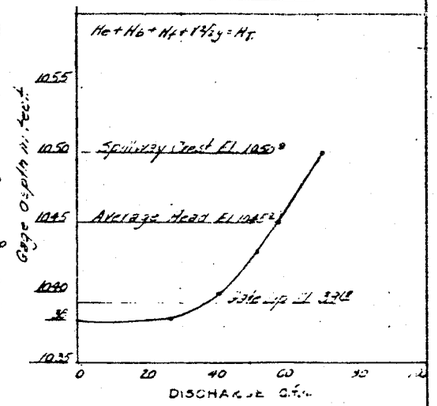




CROSS SECTION OF DITCH
Scale:-3/8"=1'-0"



PROFILE & CROSS SECTION OF STRUCTURE NO.4 OUTLET "N"



CAPACITY OF DISCHARGE PIPES

SHEET 18 OF 21 SHEETS

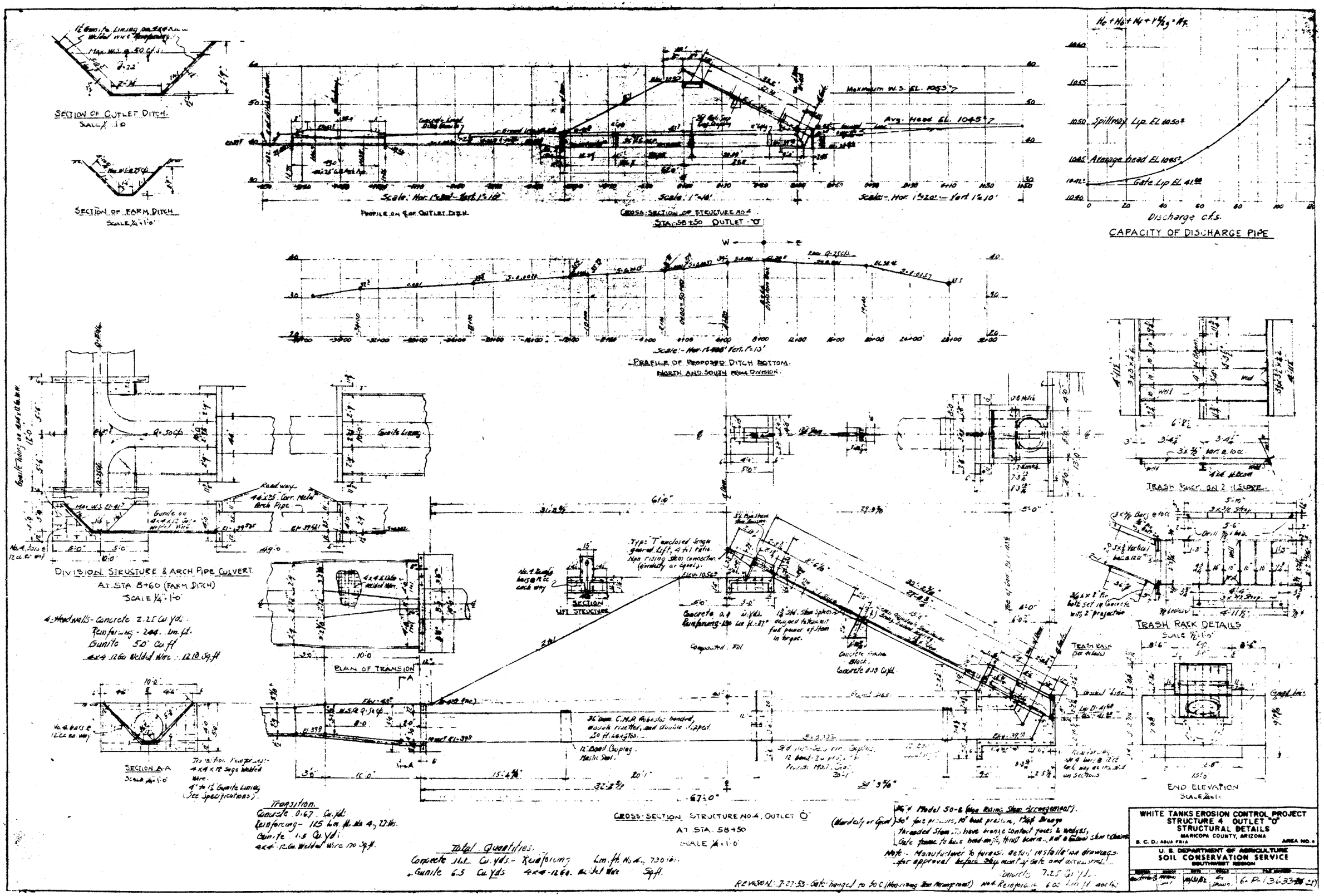
WHITE TANKS EROSION CONTROL PROJECT
STRUCTURES 3 & 4 OUTLETS K, L, N
SECTIONS AND PROFILES
MARICOPA COUNTY, ARIZONA

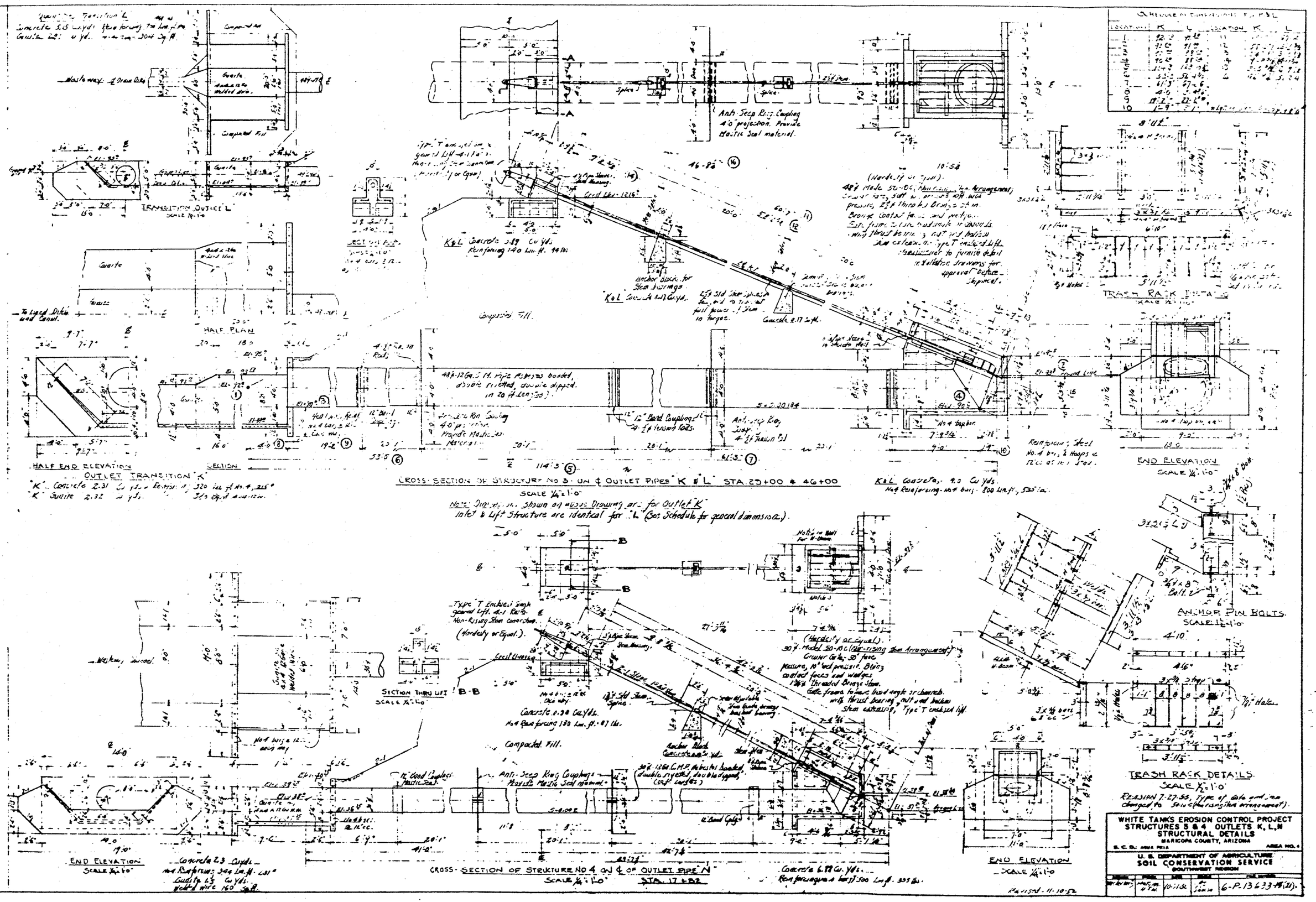
S. C. D.: ADMA F818 AREA NO. 4

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
SOUTHWEST REGION

6-P-13631-3( )

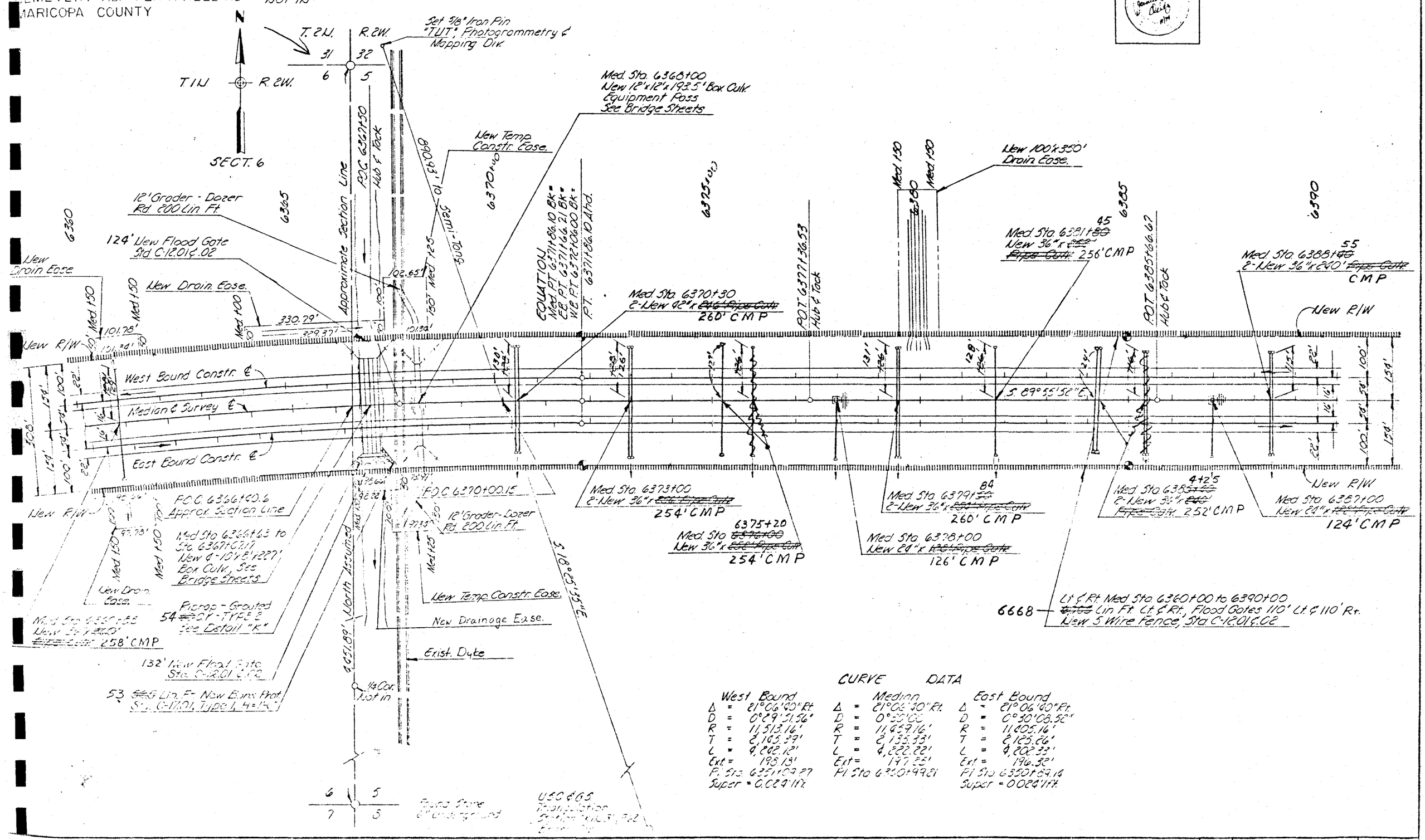
Revised 11-13-58


SECTION OF OUTLET DITCH
SCALE 1/4" = 1'0"
SECTION OF FARM DITCH
SCALE 1/4" = 1'0"
PROFILE ON ℄ OF OUTLET DITCH
Scale: Hor. 1" = 100' Vert. 1" = 10'
CROSS SECTION OF STRUCTURE NO 4
STA. 58+50 OUTLET "O"
Maximum W.S. EL. 1053.7
Avg. Head EL. 1045.7
Scale: 1" = 10'
Scale: Hor. 1" = 20' Vert. 1" = 10'
Spillway Lip EL 1050.2
Average head EL 1045.2
Gate Lip EL 41.50
Discharge c.f.s.
CAPACITY OF DISCHARGE PIPE
PROFILE OF PROPOSED DITCH BOTTOM
NORTH AND SOUTH FROM DIVISION
DIVISION STRUCTURE & ARCH PIPE CULVERT
AT STA 8+60 (FARM DITCH)
SCALE 1/4" = 1'0"
4-Headwalls - Concrete 2.25 Cu. yds.
Reinforcing - 244. Lin. ft.
Gunite 50 Cu. ft
4x4 12ga Welded Wire 1210 Sq. ft
PLAN OF TRANSITION
SECTION A-A
Transition.
Concrete 0.67 Cu. yds.
Reinforcing - 125 Lin. ft. No 4, 22 lbs.
Gunite 1.5 Cu. yds.
4x4 - 12 Ga. Welded Wire 170 Sq. ft.
Total Quantities.
Concrete 16.1 Cu. yds. - Reinforcing Lin. ft. No 4, 7301 lbs.
Gunite 6.5 Cu. yds 4x4 - 12 Ga. Welded Wire Sq. ft.
SECTION LIFT STRUCTURE
Type "T" enclosed single geared lift, 4 to 1 ratio. Non rising stem connection (Hardesty or Equal).
Concrete 0.4 Cu. yds.
Reinforcing - 130 Lin. ft. #4
Concrete Anchor Block.
Concrete 0.13 Cu. yds.
Compacted Fill
36" Diam. C.M.P. Asbestos bonded, double rivetted, and double lapped. 20 ft. lengths.
12" Band Coupling. Malle Steel.
CROSS SECTION STRUCTURE NO 4, OUTLET "O"
AT STA. 58+50
SCALE 1/4" = 1'0"
Model 50-B (Non Rising Stem Arrangement).
(Hardesty or Equal) 50# face pressure, 10# back pressure, 1 1/2# Drainage
Threaded Stem. To have bronze contact faces & wedges,
Gate frame to have head angle, thrust bearing, nut & guide stem extension
Note - Manufacturer to furnish detail installation drawings for approval before shipment of gate and accessories.
Concrete 7.25 Cu. yds.
Reinforcing 600 Lin. ft. #4 bars
REVISION: 7-27-53 - Gate changed to 50 C (Non-rising Stem Arrangement) No 4 Reinforcing
TRASH RACK ON 2:1 SLOPE
TRASH RACK DETAILS
SCALE 1/2" = 1'0"
END ELEVATION
SCALE 1/4" = 1'0"
WHITE TANKS EROSION CONTROL PROJECT
STRUCTURE 4 OUTLET "O"
STRUCTURAL DETAILS
MARICOPA COUNTY, ARIZONA
B. C. D.: AGUA FRIA
AREA NO. 4
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
SOUTHWEST REGION
6-P-13633


TRANSITION OUTLET "L"
HALF PLAN
HALF END ELEVATION
OUTLET TRANSITION "K"
SECTION
CROSS-SECTION OF STRUCTURE No 3 ON ℄ OUTLET PIPES "K" & "L" STA. 25+00 & 46+00
SCALE 1/4"=1'-0"
Anti-Seep Ring Coupling 4'-0" projection. Provide Mastic Seal material.
TRASH RACK DETAILS
SCALE 1/2"=1'-0"
END ELEVATION
SCALE 1/4"=1'-0"
ANCHOR PIN BOLTS
SCALE 1 1/2"=1'-0"
SECTION THRU LIFT B-B
SCALE 1/4"=1'-0"
END ELEVATION
SCALE 1/4"=1'-0"
CROSS-SECTION OF STRUCTURE No 4 ON ℄ OF OUTLET PIPE "N"
SCALE 1/4"=1'-0"
STA. 17+82
END ELEVATION
SCALE 1/4"=1'-0"
WHITE TANKS EROSION CONTROL PROJECT
STRUCTURES 3 & 4 OUTLETS K, L, M
STRUCTURAL DETAILS
MARICOPA COUNTY, ARIZONA
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
SOUTHWEST REGION
6-P-13633-A(21)

F.H.W.A. REGION	STATE	PROJECT NO	SHEET NO	TOTAL SHEETS	AS BUILT
9	ARIZ	I-10-E(31)	30	99	Hurlbert 10-18-77

EHRENBERG — PHOENIX HWY.
CEMETERY RD. — PERRYVILLE RD.
MARICOPA COUNTY



CURVE DATA

West Bound	Median	East Bound
Δ = 21°06'40" Rt.	Δ = 21°06'30" Rt.	Δ = 21°06'40" Rt.
D = 0°29'51.56"	D = 0°30'00"	D = 0°30'08.50"
R = 11,513.16'	R = 11,459.16'	R = 11,405.16'
T = 2,165.39'	T = 2,135.33'	T = 2,125.26'
L = 4,202.12'	L = 4,202.22'	L = 4,202.33'
Ext. = 198.13'	Ext. = 197.25'	Ext. = 196.32'
PI Sta. 6351+09.27	PI Sta. 6350+99.81	PI Sta. 6350+89.18
Super = 0.024'/ft.		Super = 0.024'/ft.

CEMETERY RD - PEARYVILLE RD.
MARICOPA COUNTY

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
9	ARIZ	I-	31	99	Hurtber 10-19-77

28' ROADWAY E.B. & W.B.

D.A. Lt 0.61 Sq. Mi.

D.A. Lt 13.51 Sq. Mi.

FUTURE W.B. Fin. E. Grade

-0.5556 %

W.B.

1000' V.C.
SDs 1532'

W.E. & Inv. Elev. 1063.22
S=-0.0190

Ground Line

1084.69
S= 0.005426
Qso=210 C.F.S.

1082.87 (W.B.E.)
S= 0.003141

1083.80 (W.B.E.)
S= 0.006268
Qso=326 C.F.S.

1082.70 (W.B.E.)
S= 0.01036

1082.63 (W.B.E.)
S= 0.01171

1081.82 (W.B.E.)
S= 0.006746

1080.74 (W.B.E.)
S= 0.007083

258' CMP

260' CMP

254' CMP

252' CMP

EQUATION
Long Sta. +19.90
Sta. 6372 to 6373 = 11290'

W.S. & F.L. Elev. 1020.50
Slope = 0.0111
Qcs=2333 C.F.S.
D.H.W. = 1020.40

72 72

EB

FUTURE EB Fin. E. Grade

-0.5650 %

EB.

1000' V.C.
SDs 1260'

Ground Line

FL. Elev. 1087.47 (EB.E.)
Slope = -0.019

FL. Elev. 1085.80 (EB.E.)
S= 0.00389

FL. Elev. 1081.50 (EB.E.)
S= 0.00430

EQUATION
Short Sta. -19.52'
Sta. 6371 = EB Sta. +80.11'

12.6' C.M.P.

1000

1010

1020

1030

1040

1050

1060

1070

1080

1090

1100

1110

1120

1130

1140

1150

1160

1170

1180

1190

1200

1210

1220

1230

1240

1250

1260

1270

1280

1290

1300

1310

1320

1330

1340

1350

1360

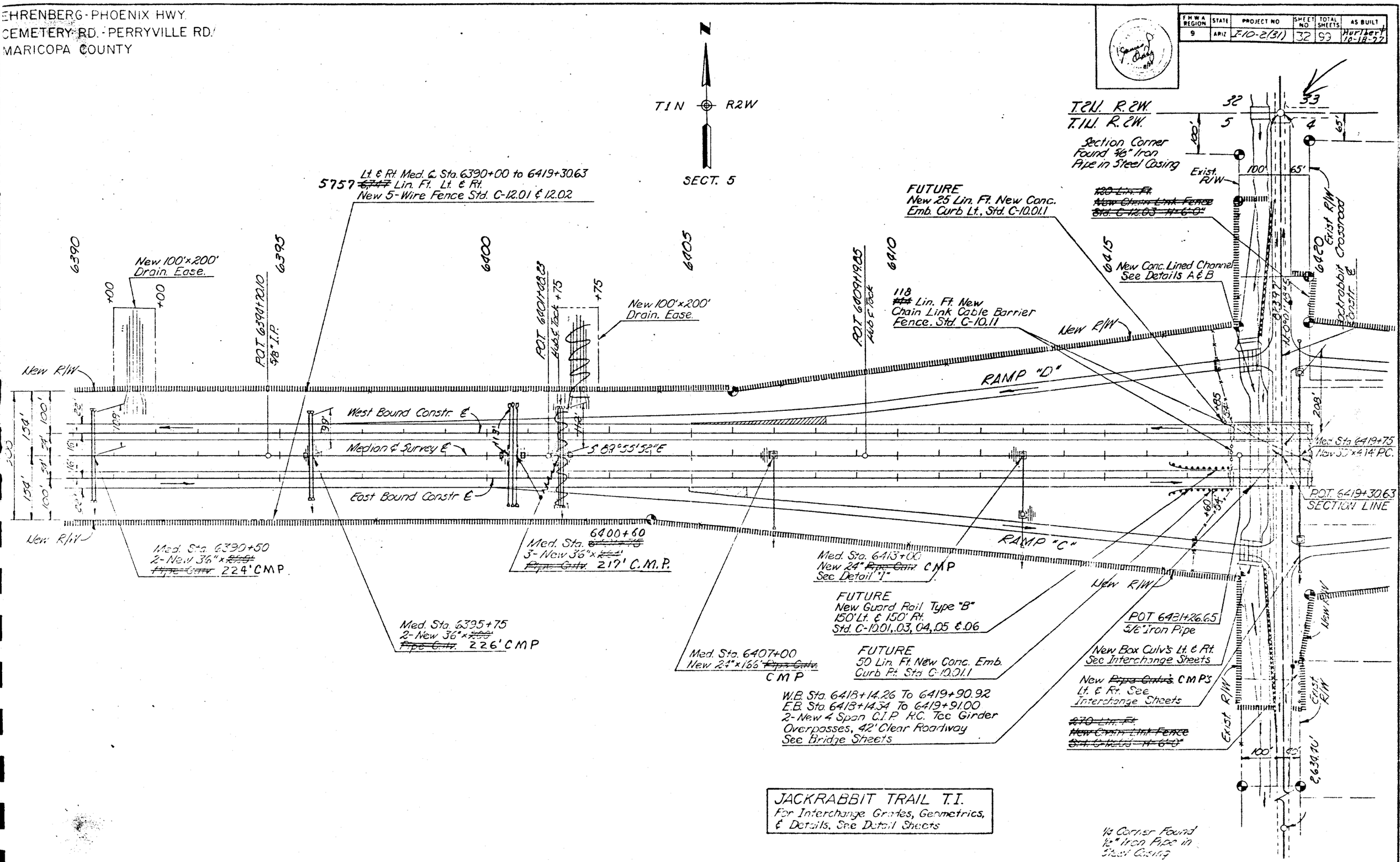
1370

1380

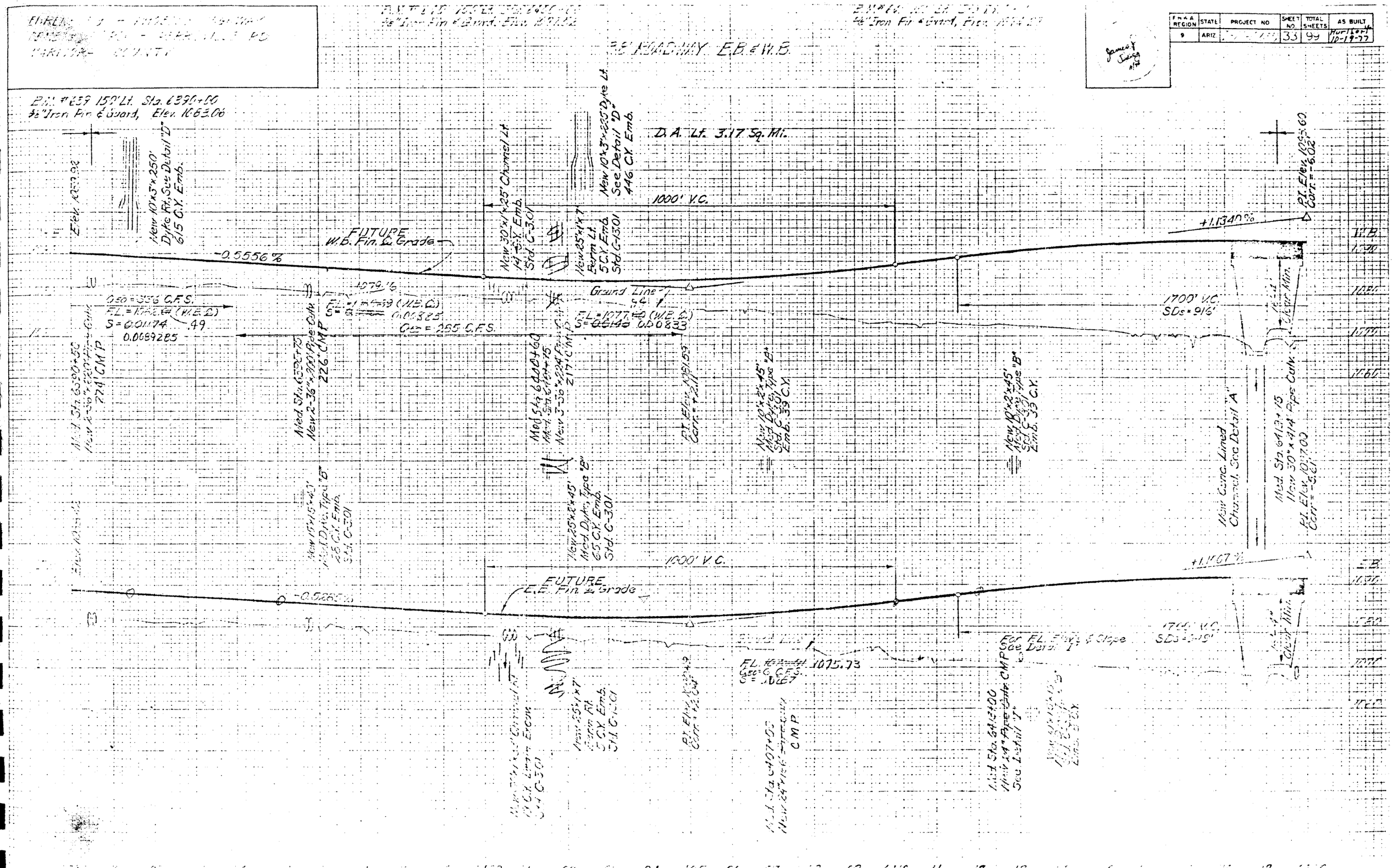
1390

EHRENBERG-PHOENIX HWY.
CEMETERY RD.-PERRYVILLE RD.
MARICOPA COUNTY

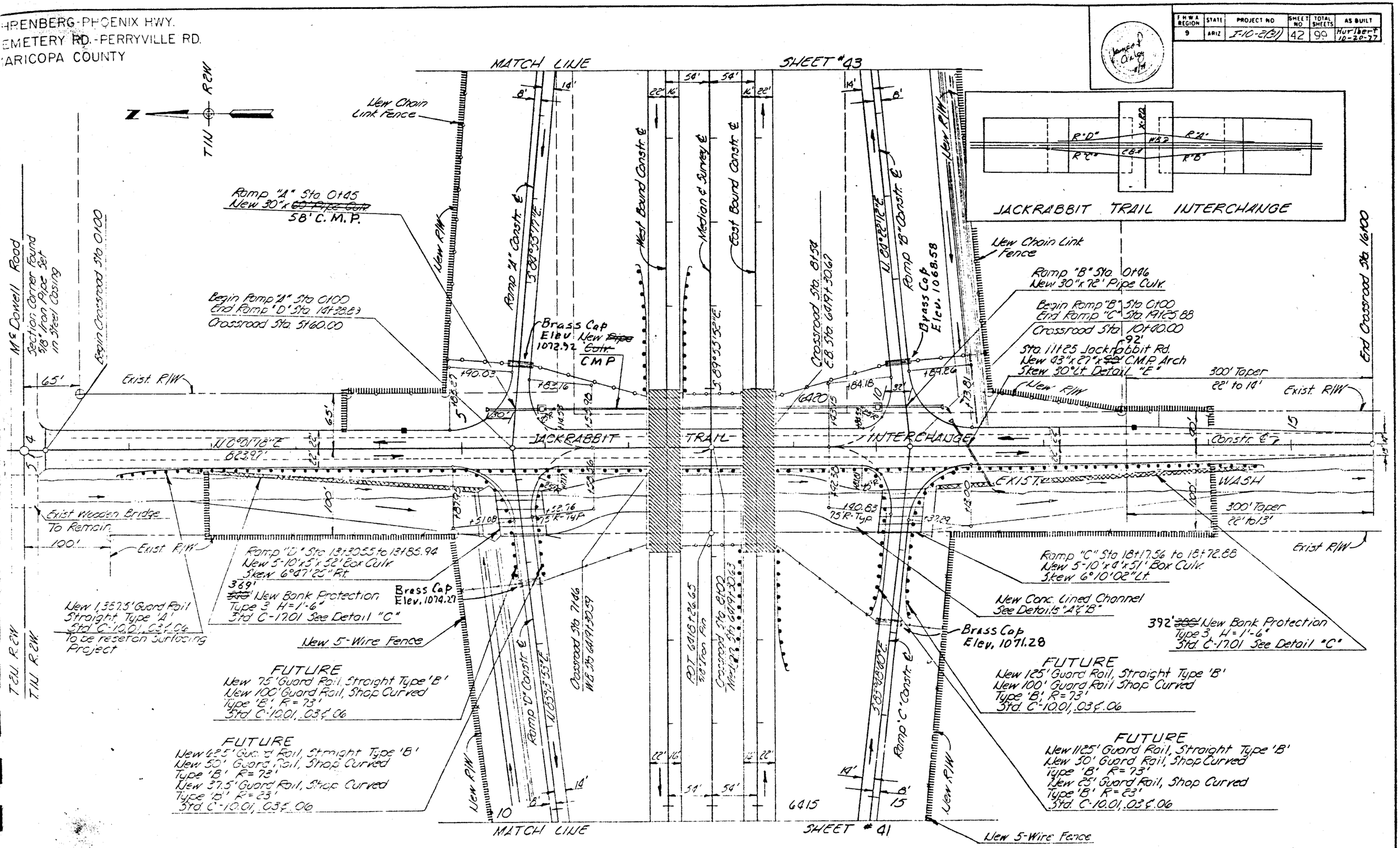
FHWA REGION	STATE	PROJECT NO	SHEET NO	TOTAL SHEETS	AS BUILT
9	ARIZ	I-10-2(31)	32	99	Hurlbert 10-18-72



FHWA REGION	STATE	PROJECT NO	SHEET NO.	TOTAL SHEETS	AS BUILT
9	ARIZ	[illegible]	33	99	Horizontal 10-19-77



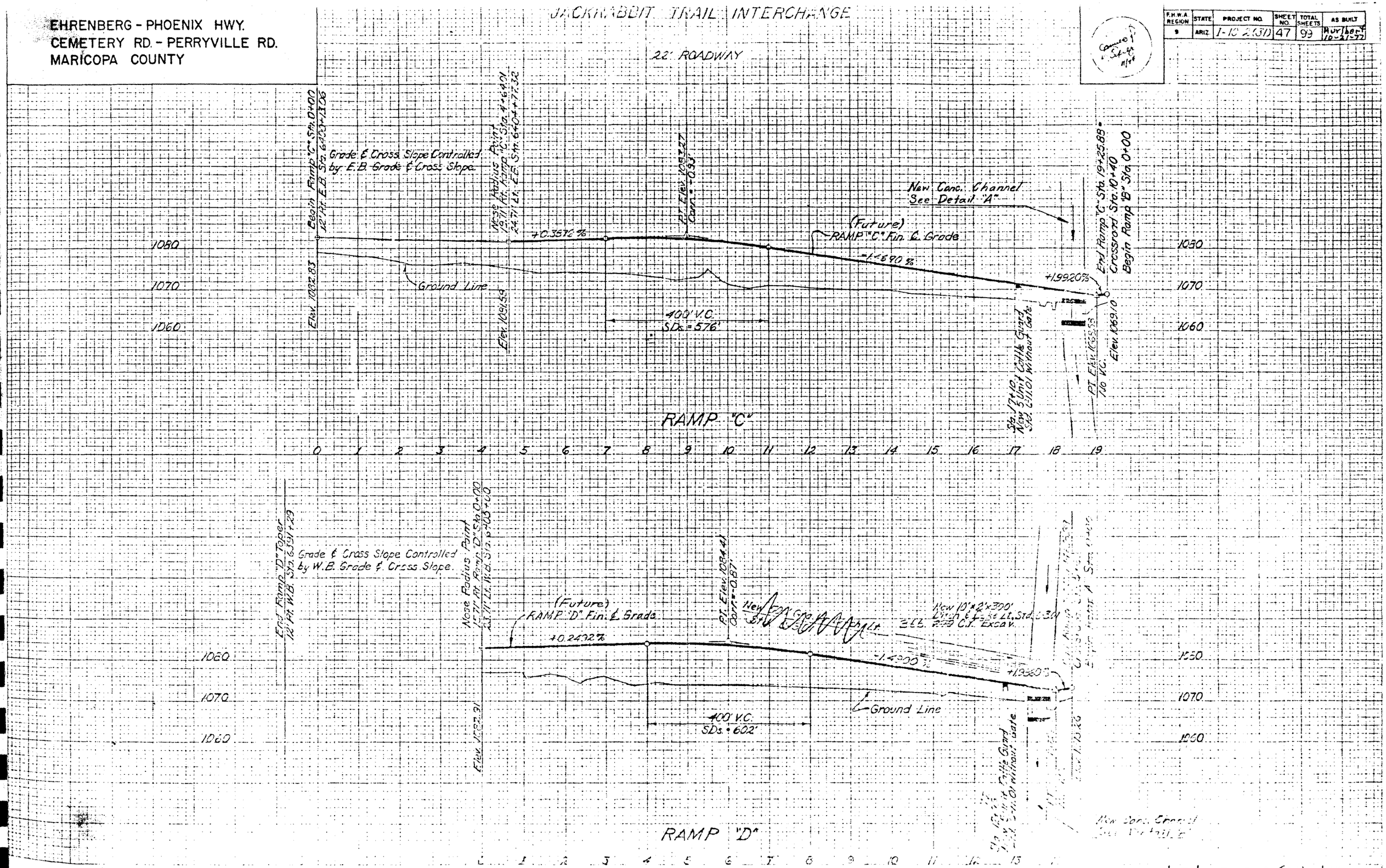
F.H.W.A. REGION	STATE	PROJECT NO	SHEET NO	TOTAL SHEETS	AS BUILT
9	ARIZ	I-10-2(31)	42	99	Hurlbert 10-20-77



EHRENBERG - PHOENIX HWY.
CEMETERY RD. - PERRYVILLE RD.
MARICOPA COUNTY

JACKRABBIT TRAIL INTERCHANGE

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
9	ARIZ.	I-10-2(31)	47	99	Rev. Sheet 10-21-77

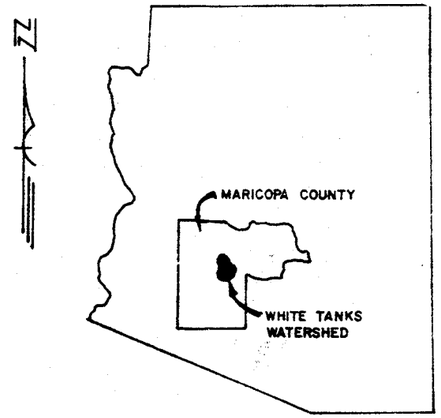


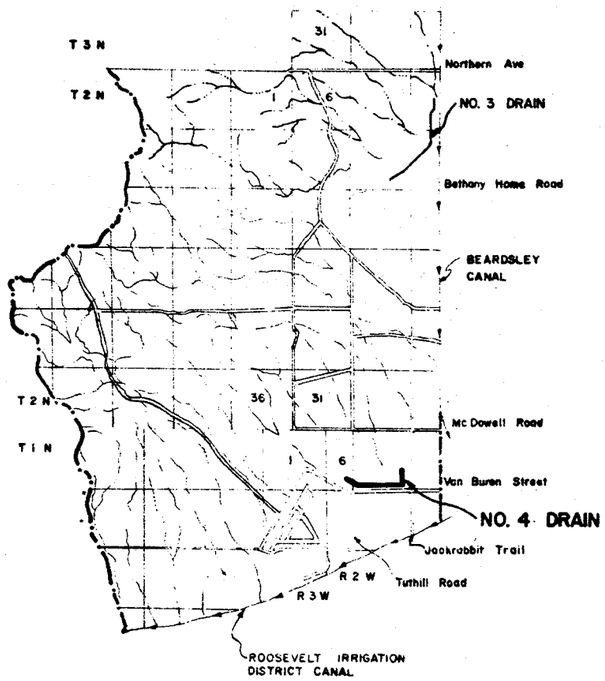
WHITE TANKS WATERSHED
PROTECTION AND FLOOD PREVENTION PROJECT
MARICOPA COUNTY, ARIZONA

PLANS FOR THE CONSTRUCTION OF

WHITE TANKS NO. 4 DRAIN

PREPARED FOR THE FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
BY
SOIL CONSERVATION SERVICE
U.S. DEPARTMENT OF AGRICULTURE





LOCATION MAP

1 0 2
Scale in miles

GENERAL NOTES

1. Elevations are in feet above mean sea level U.S.G.S datum
2. All stationing refers to centerline of construction and is the measured horizontal distance
3. All bearings are referenced to True North.

INDEX OF DRAWINGS

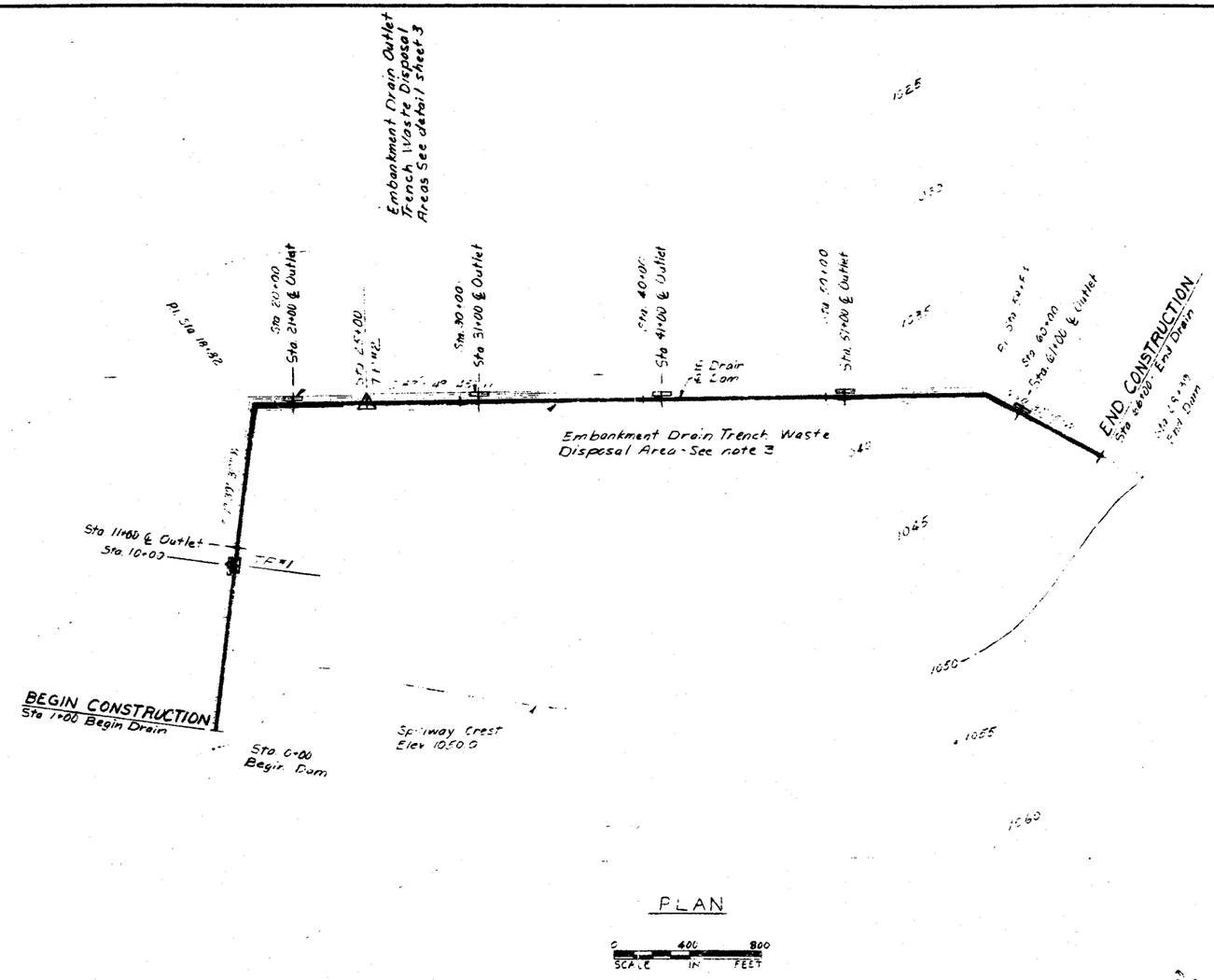
DRWG. NO.	SHT. NO.	TITLE
79022-AZ-Ph	1.	INDEX OF DRAWINGS
	2.	PLAN & PROFILE OF NO. 4 DRAIN
	3	TYPICAL CROSS SECTIONS OF NO. 4 DRAIN

PRELIMINARY
Date 4-1-81

INDEX OF DRAWINGS
WHITE TANKS NO. 4 DRAIN
WHITE TANKS W.P.P.
MARICOPA COUNTY, ARIZONA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed WEP	Date 10-79	Approved by	
Drawn JAM	10-79	Title	
Traced		Sheet No. 1 of 3	Drawing No. 79022-AZ-Ph
Checked			



PLAN

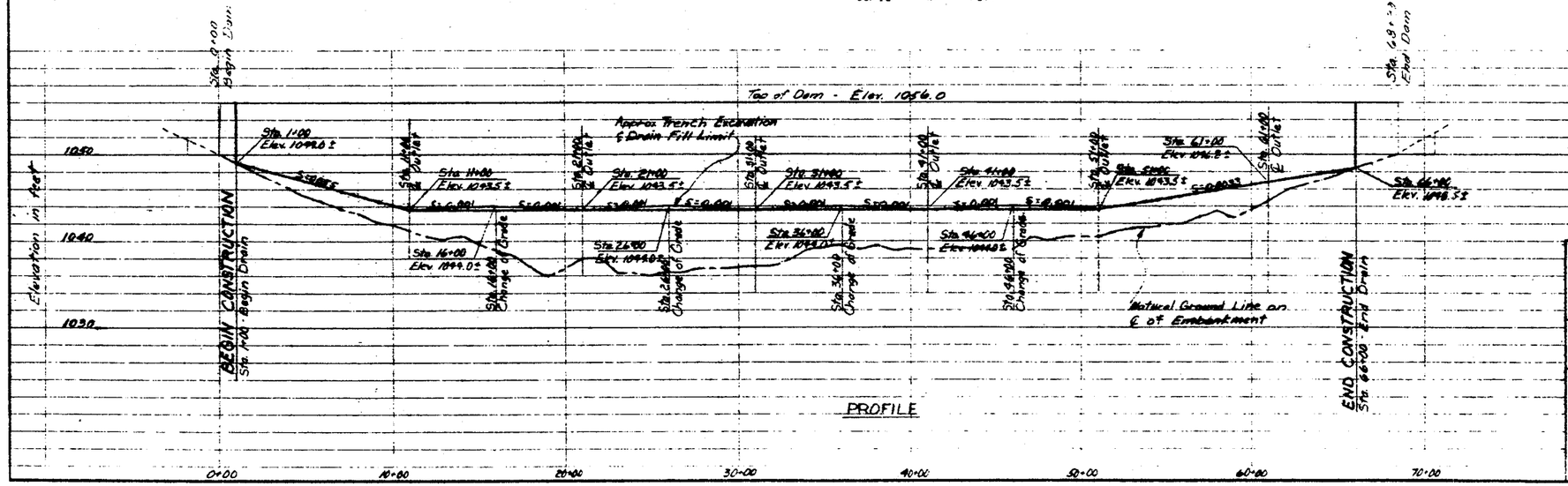
SCALE 0 400 800 IN FEET

Notes: 1. All cracks in the upstream face of the embankment drain trench that extend below the trench excavation limit shown on the drawings shall be intercepted by an auxiliary embankment drain outlet trench as shown on sheet 3 and as directed by the Engineer.

2. Details of the embankment drain and embankment drain outlet trenches are shown on sheet 3.

3. Waste disposal area for the embankment drain trench shall be on the upstream slope of the dam between Sta. 1+00 and Sta. 66+00 as shown on sheet 3.

4. TP#1 & TP#2 are locations of samples taken for drain filter design.



PROFILE

PRELIMINARY
Date 4-1-81

PLAN & PROFILE
WHITE TANKS NO 4. DRAIN
WHITE TANKS WFP
MARICOPA COUNTY, ARIZONA

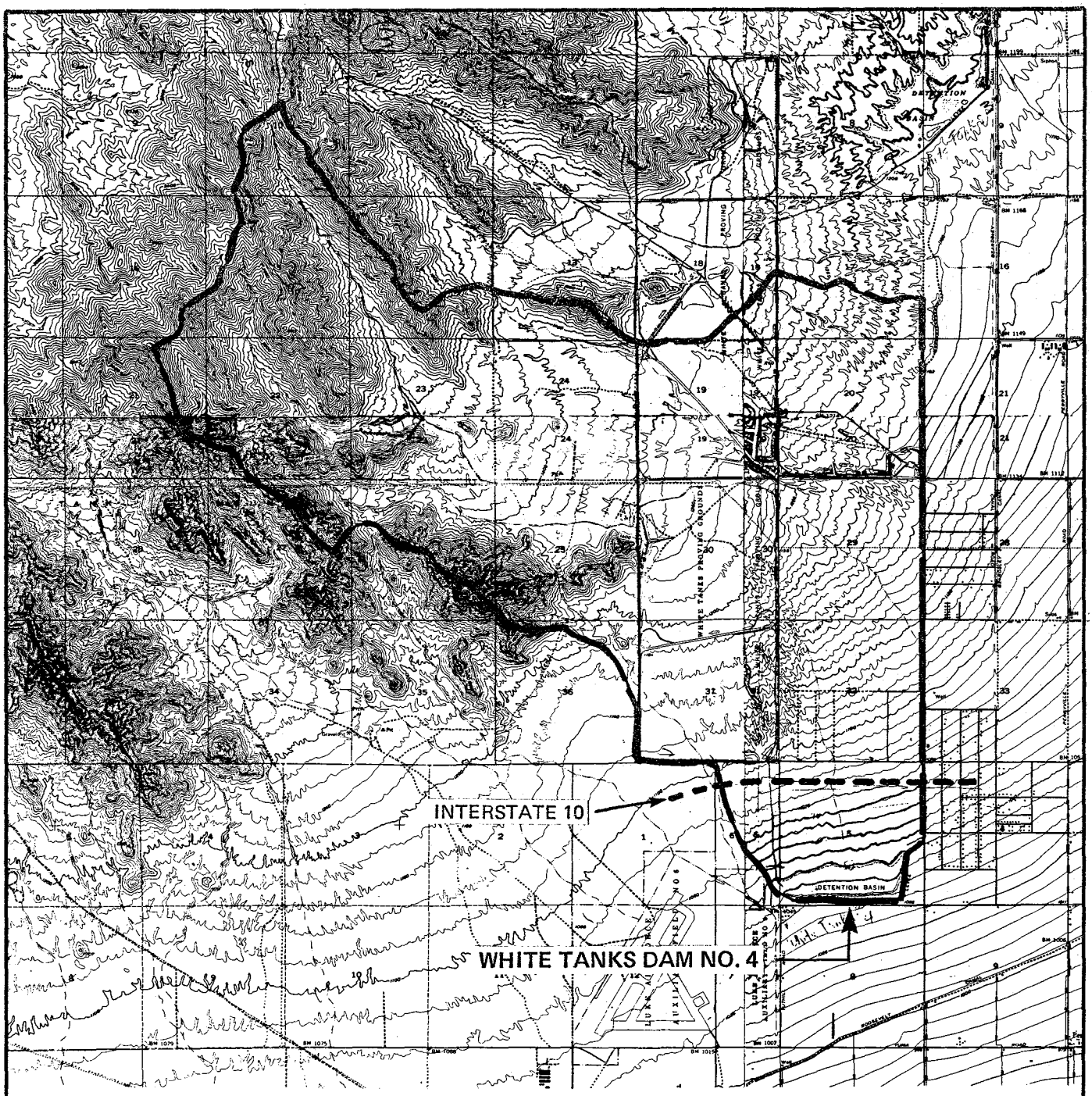
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	WEP	Date 10-79	Approved by
Drawn	JAM	10-79	
Traced			
Checked			

Sheet 2 of 3 — Drawing No. 79022-AZ-Ph

APPENDIX B

HYDROLOGIC AND HYDRAULIC COMPUTATIONS



NORTH

1 .5 0 1 MILES

1 .5 0 1 KILOMETERS

Ertec
The Earth Technology Corporation

PROJECT NO.: 81-161

PHASE I SAFETY INSPECTION
WHITE TANKS DAM NO. 4

WATERSHED MAP

7-81

Determine Inflow Hydrographs For PMF:

Use HEC 1 - Dam Safety Version

Data Required:

1. Probable Maximum Precipitation (PMP)
2. Drainage Area (D.A.)
3. Curve Number (CN)
4. Lag
5. Stage - Storage
6. Stage - Discharge

PMP

Ref: Hydrom. Report No. 49 - "PMP Estimates, Colorado River and Great Basin Drainages"

See calculations on page 2 & 3.

D.A.

Drainage area was delineated in the field with Mr. Earl Hagen, Operations Manager, Caterpillar Tractor Company.

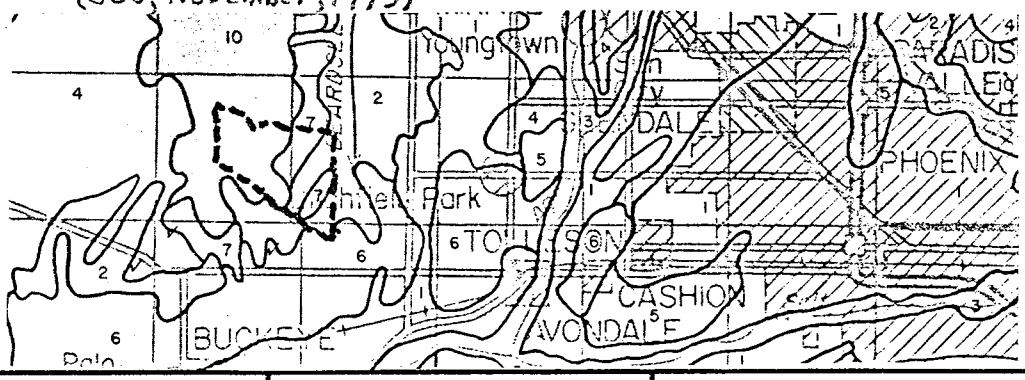
Planimeter D.A. from USGS topo maps in office.

D.A. = 14.23 sq. mi.

C.N.

Determine Soil types

Ref: General Soil Map, Maricopa County and Gila River Indian Reservation, Az. (SCS, November, 1973)



White Tanks Retarding Dam #4

BY GP DATE

CHECKED DATE

PAGE 1 OF

Ertec The Earth Technology Corporation LONG BEACH CALIFORNIA

PROJECT NO.: 81-161

Table 6.1.--General-storm PMP computations for the Colorado River and Great basin

Drainage White Tanks No. 4 Area 14.2 mi^2 (~~km^2~~)

Latitude 33° 29', Longitude 112° 31' of basin center

Month Aug.

Step	Duration (hrs) 6	12	18	24	48	72
A. Convergence PMP						
1. Drainage average value from one of figures 2.5 to 2.16	13.9 in. (~~mm~~)					
2. Reduction for barrier-elevation [fig. 2.18]	86 %					
3. Barrier-elevation reduced PMP [step 1 X step 2]	12.0 in. (mm)					
4. Durational variation [figs. 2.25 to 2.27 and table 2.7].	75	89	96	100	112	116 %
5. Convergence PMP for indicated durations [steps 3 X 4]	9.0	10.7	11.5	12.0	13.4	13.9 in. (~~mm~~)
6. Incremental 10 mi^2 (26 km^2) PMP [successive subtraction in step 5]	9.0	1.7	0.8	0.5	1.4	0.5 in. (~~mm~~)
7. Areal reduction [select from figs. 2.28 and 2.29]	98	99	100	100	100	100 %
8. Areally reduced PMP [step 6 X step 7]	8.8	1.7	0.8	0.5	1.4	0.5 in. (~~mm~~)
9. Drainage average PMP [accumulated values of step 8]	8.8	10.5	11.3	11.8	13.2	13.7 in. (mm)
B. Orographic PMP						
1. Drainage average orographic index from figure 3.11a to d.	2.0 in. (~~mm~~)					
2. Areal reduction [figure 3.20]	99 %					
3. Adjustment for month [one of figs. 3.12 to 3.17]	100 %					
4. Areally and seasonally adjusted PMP [steps 1 X 2 X 3]	2.0 in. (~~mm~~)					
5. Durational variation [table 3.6]	36	63	84	100	134	157 %
6. Orographic PMP for given durations [steps 4 X 5]	0.7	1.3	1.7	2.0	2.8	3.1 in. (~~mm~~)
C. Total PMP						
1. Add steps A9 and B6	9.5	11.8	13.0	13.8	16.0	16.9 in. (~~mm~~)

2. PMP for other durations from smooth curve fitted to plot of computed data.

3. Comparison with local-storm PMP (see sec. 6.3).

Table 6.3A.--Local-storm PMP computation, Colorado River, Great Basin and California drainages. For drainage average depth PMP. Go to table 6.3B if areal variation is required.

Drainage White Tanks No. 4 Area 14.2 mi^2 (~~km^2~~)
Latitude 33°29′ Longitude 112°31′ Minimum Elevation 1050 ft (~~m~~)

Steps correspond to those in sec. 6.3A.

1. Average 1-hr 1-mi^2 (2.6-km^2) PMP for drainage [fig. 4.5]. 11.6 in. (~~mm~~)

2. a. Reduction for elevation. [No adjustment for elevations up to 5,000 feet (1,524 m): 5% decrease per 1,000 feet (305 m) above 5,000 feet (1,524 m)]. 100 %

   b. Multiply step 1 by step 2a. 11.6 in. (~~mm~~)

3. Average 6/1-hr ratio for drainage [fig. 4.7]. 1.35

	Duration (hr)								
	1/4	1/2	3/4	1	2	3	4	5	6
4. Durational variation for 6/1-hr ratio of step 3 [table 4.4].	68	86	94	100	116	123	128	132	135 %
5. 1-mi^2 (2.6-km^2) PMP for indicated durations [step 2b X step 4].	7.9	10.0	10.9	11.6	13.5	14.3	14.8	15.3	15.7 in. (~~mm~~)
6. Areal reduction [fig. 4.9].	68	74	77	78	81	82	84	85	86 %
7. Areal reduced PMP [steps 5 X 6].	5.4	7.4	8.4	9.0	10.9	11.7	12.4	13.0	13.5 in. (mm)
8. Incremental PMP [successive subtraction in step 7].				2.0	1.9	0.8	0.7	0.6	0.5 in. (~~mm~~)
	5.4	2.0	1.0	0.6 } 15-min. increments					
9. Time sequence of incremental PMP according to:									
Hourly increments [table 4.7].				0.5	2.7	1.9	2.0	0.8	0.6 in. (~~mm~~)
Four largest 15-min. increments [table 4.8].				5.4	2.0	1.0	0.6		in. (~~mm~~)

Soil	% of Area	Soil Group	% Cover (Herb.)	CN	Weighted CN
Antho-Valencia Assoc.	25				
Antho	55	B	10	81	11.14
Valencia	25	B	10	81	5.06
Misc.	20	B	10	81	4.05
	100				
Ebon-Pinant-Tremant Assoc.	25				
Ebon	35	C	10	88	7.70
Pinant	25	B	10	81	5.06
Tremant	20	B	10	81	4.05
Misc.	20	C	10	88	4.40
	100				
Cherioni-Gachado-Rock Assoc.	50				
Cherioni	35	D	10	92	16.10
Gachado	15	D	10	92	6.90
Rock	35	D	10	92	16.10
Misc.	15	D	10	92	6.90
	100				
	100				87.46

USE 87.5

For Curve Numbers Ref: Arizona Highway Department, Hydrologic Design For Highway Drainage.

Lag: (L)

$$L = 0.6\ T_c$$

Compute T_c

Consider T_c methods used by SCS in NEH 4, Ventura & L.A. County Flood Control Districts, and Arizona Department of Highways.

Select Arizona Dept. of Highways as most appropriate.

$$T_c = L^{1.15} / 7700\ H^{0.38}$$

L = distance from ridge to reservoir along longest watercourse = 43,300 feet

H = elevation differential from ridge to spillway elevation = 3151 − 1056 = 2095 feet

$$T_c = 43{,}300^{1.15} / 7700 \times 2095^{0.38} = 1.52 \text{ hours}$$

$$\therefore \quad L = 0.6 \times 1.52 = 0.91 \text{ hours}$$

Stage - Storage

As-built drawings show data to top of dam, extend data above dam using contours shown on USGS topo map by planimetry.

Elev. feet	Storage "As-Built" AF	Area Planimetered Acres	Ave. Area Acres	Δ Volume AF	Storage AF
1037	0				
1040	100				
1045	400				
1050	1036				
1055	2000	208	242	1210	
1060		275	312	1560	3210
1065		349	385	1925	4770
1070		420			6695

Plot data and average values with smooth curve.

Stage - Discharge

Slope of emergency spillway = 0.0030

This is subcritical at all flow rates, ∴ flow does not pass through critical.

∴ $d_n + V^2/2g$ represents reasonable approximation

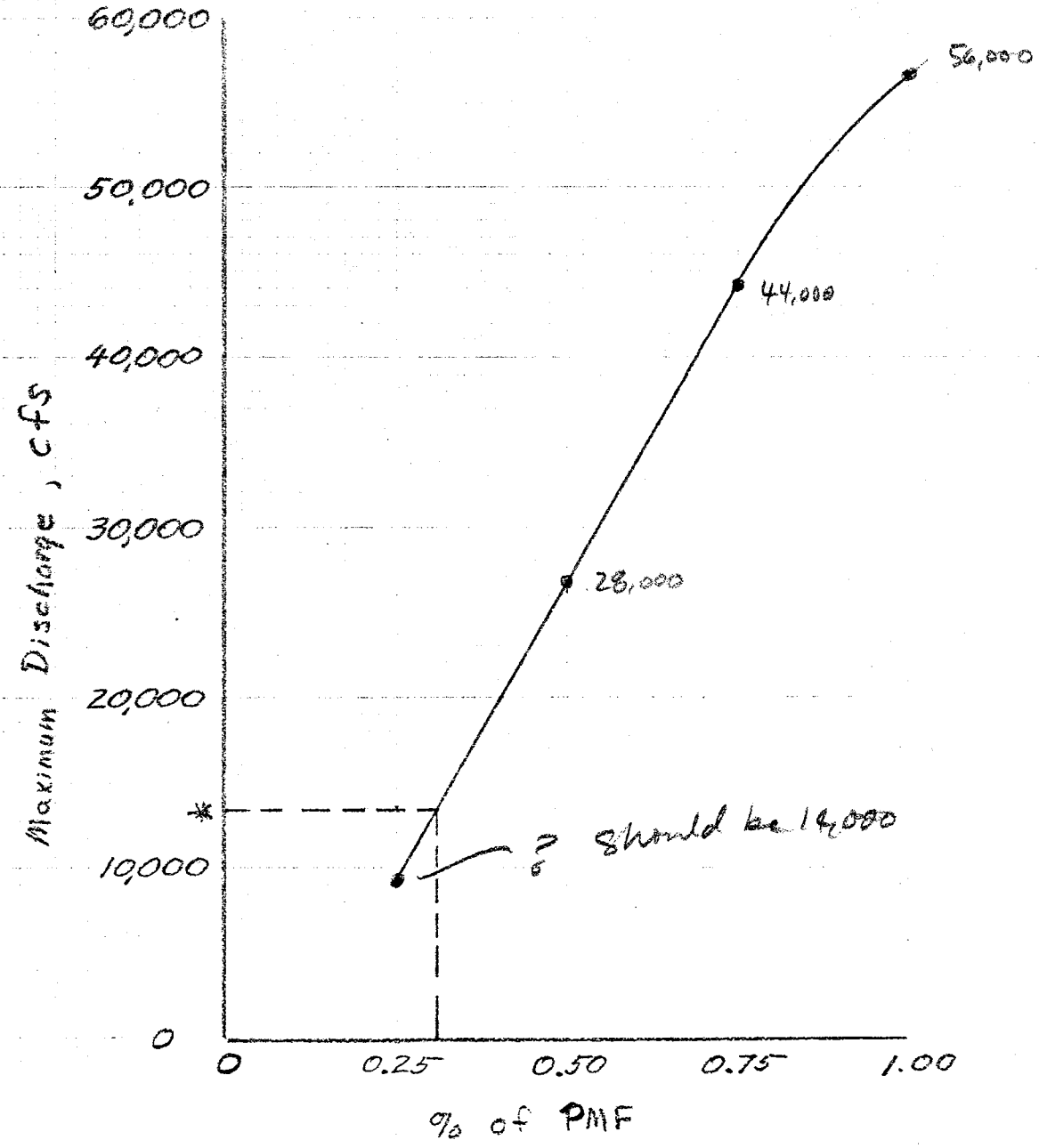
Compute curve using Manning's

$$Q = 1.486\, R^{2/3}\, S^{1/2}\, A/n$$

$S = 0.0030$
$n = 0.030$
$b = 330$ ft.

d_n ft.	Q cfs	V ft./sec.	$V^2/2g$ ft.	$d + V^2/2g$ ft.	W.S. Elev. ft.
0	0	0	0	0	1050
1	893	2.70	0.11	1.11	1051.1
2	2858	4.30	0.29	2.29	1052.3
4	9026	6.76	0.70	4.70	1054.7
6	17,740	8.80	1.20	7.20	1057.2
7	22,943	9.72	1.46	8.46	1058.5

Plot data and average values with smooth curve.



* Discharge with w.s. at top of dam

White Tanks Retarding Dam #4		Ertec The Earth Technology Corporation LONG BEACH CALIFORNIA
BY GB DATE	PAGE 7 OF	PROJECT NO.: 81-108
CHECKED DATE		

Freeway Culverts and Overflow:

Determine probable capacities of major freeway culverts and overflow. These will include:

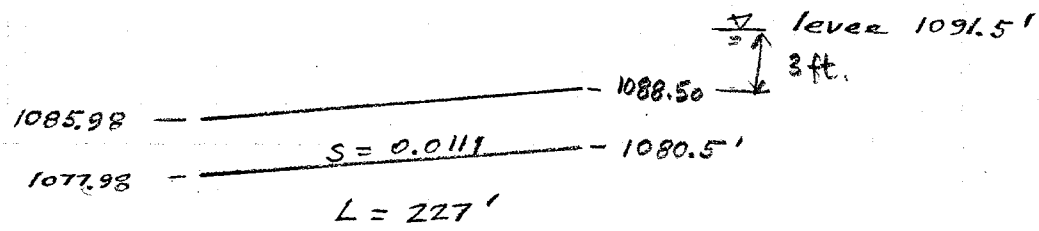
1). 4 – 10'x 8' culverts near western watershed boundary.

2). 5 – 10'x 5' culverts under On-Ramp near Jackrabbit Trail.

3). Freeway overflow at low point between culvert locations

Ref.: As-Built drawings on file with Arizona Department of Highways

4 - 10'x 8' Culverts



$$Q = A_c \sqrt{\frac{2gh}{1+\Sigma K}}$$

$A_c = 80 \ ft^2$

$h = 1091.5 - 1085.98 = 5.52'$

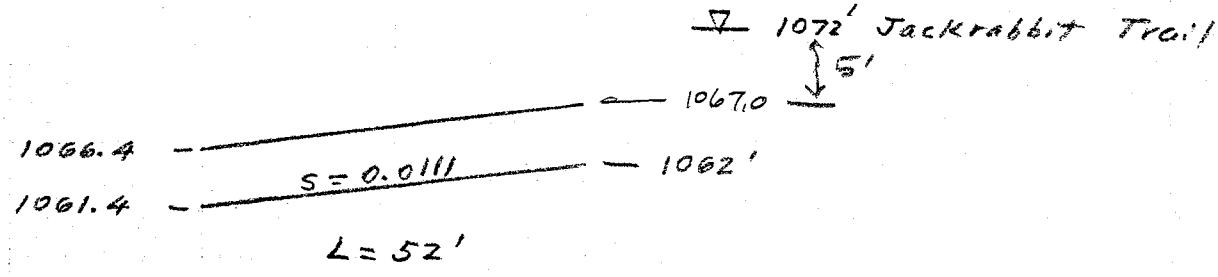
$K_o = 1.0$

$K_p L = 0.00142 \times 227 = 0.32$

$$Q_1 = 80 \sqrt{\frac{64.4 \times 5.52}{1 + 1.0 + 0.32}} = 990 \ cfs$$

$$Q_{1-4} = 990 \times 4 = 3{,}960 \ cfs.$$

5 - 10' x 5'



$L = 52'$

$A_L = 50 \ ft^2$

$h = 1072 - 1066.4 = 5.6'$

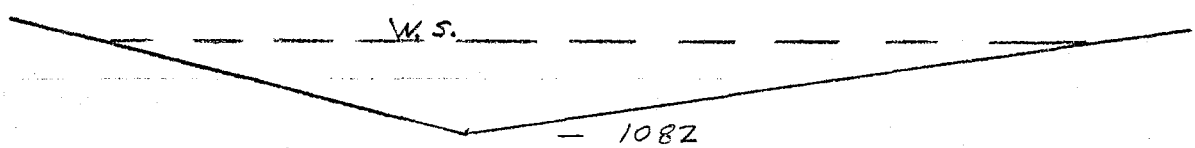
$K_o = 1$

$K_p L = 0.00199 \times 52 = 0.1$

$$Q_1 = 50\sqrt{\frac{64.4 \times 5.6}{1 + 1.0 + 0.1}} = 655 \ cfs$$

$$Q_{1-5} = 655 \times 5 = 3{,}276 \ cfs$$

Freeway Overflow



W.S. = 1086'

$D_m = a/T = 3000/1500 = 2$

$Q = a\sqrt{g D_m} = 3000\sqrt{32.2 \times 2} = 24{,}074 \ cfs$

W.S. = 1088'

$D_m = 3$

$Q = 6180\sqrt{32.2 \times 3} = 60{,}740 \ cfs$

```
1*********************************
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION      JULY 1978
   LAST MODIFICATION  01 APR 80
 *********************************
     1                 A1       ARIZONA DAM SAFETY-WHITE TANKS 4
     2                 A2       HYDRAULIC-HYDROLOGIC ANALYSES
     3                 A3       PROBABLE MAXIMUM FLOOD
     4                 B      75        0       15        0        0        0        0        2        0        0
     5                 B1      5
     6                 J       1        4        1
     7                 J1    .25      .50      .75      1.0
     8                 K       0        1                                          1
     9                 K1       RUNOFF FROM WHITE TANKS 3 BASIN
    10                 M       0        2    14.23            14.23
    11                 O      24     13.5
    12                 O1   .125     .125     .125     .125     .175     .175     .175     .175     .475     .475
    13                 O1   .475     .475      5.4      2.0      1.0      0.6     .200     .200     .200     .200
    14                 O1   .150     .150     .150     .150
    15                 T                                                          -1    -87.5
    16                 W2             .91
    17                 X       0        0        1
    18                 K       1        2                        2                1
    19                 K1       ROUTED FLOW THROUGH WHITE TANKS RESERVOIR BY MODIFIED PULS
    20                 Y                                 1        1
    21                 Y1      1                                             1036       -1
    22                 Y4   1050     1051   1052.3   1054.5   1057.7   1058.5
    23                 Y5      0     1000     3000     9000    17800    23000
    24                 $S      0      100      400     1036     2000     3210     4770     6440
    25                 $E   1037     1040     1045     1050     1055     1060     1065     1070
    26                 $$   1050
    27                 $D   1056      2.8      1.5     6839
    28                 K      99
1                            PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                                 RUNOFF HYDROGRAPH AT            1
                                 ROUTE HYDROGRAPH TO             2
                                 END OF NETWORK
```

ARIZONA DAM SAFETY-WHITE TANKS 4
HYDRAULIC-HYDROLOGIC ANALYSES
PROBABLE MAXIMUM FLOOD

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
75	0	15	0	0	0	0	2	0	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 4 LRTIO= 1
RTIOS= 0.25 0.50 0.75 1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

RUNOFF FROM WHITE TANKS 3 BASIN

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	2	14.23	0.00	14.23	0.00	0.000	0	0	0

PRECIP DATA

NP	STORM	DAJ	DAK
24	13.50	0.00	0.00

PRECIP PATTERN

0.12	0.12	0.12	0.12	0.17	0.17	0.17	0.17	0.47	0.47
0.47	0.47	5.40	2.00	1.00	0.60	0.20	0.20	0.20	0.20
0.15	0.15	0.15	0.15						

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-87.50	0.00	0.00

CURVE NO = -87.50 WETNESS = -1.00 EFFECT CN = 87.50

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= 0.91

RECESSION DATA
STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

UNIT HYDROGRAPH 20 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= 0.91 VOL= 1.00

914.	2947.	5636.	6631.	6151.	4862.	3121.	2088.	1441.	957.
655.	440.	296.	200.	135.	91.	65.	45.	27.	11.

END-OF-PERIOD FLOW

O MO. DA	HR. MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO. DA	HR. MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	0.15	1	0.13	0.00	0.13	0.	1.01	9.30	38	0.00	0.00	0.00	58.
1.01	0.30	2	0.13	0.00	0.13	0.	1.01	9.45	39	0.00	0.00	0.00	36.
1.01	0.45	3	0.13	0.01	0.12	5.	1.01	10.00	40	0.00	0.00	0.00	22.
1.01	1.00	4	0.13	0.02	0.10	36.	1.01	10.15	41	0.00	0.00	0.00	12.
1.01	1.15	5	0.18	0.06	0.12	147.	1.01	10.30	42	0.00	0.00	0.00	6.
1.01	1.30	6	0.18	0.08	0.10	396.	1.01	10.45	43	0.00	0.00	0.00	2.
1.01	1.45	7	0.18	0.09	0.08	805.	1.01	11.00	44	0.00	0.00	0.00	0.
1.01	2.00	8	0.18	0.10	0.07	1331.	1.01	11.15	45	0.00	0.00	0.00	0.
1.01	2.15	9	0.48	0.33	0.15	2103.	1.01	11.30	46	0.00	0.00	0.00	0.
1.01	2.30	10	0.48	0.37	0.10	3329.	1.01	11.45	47	0.00	0.00	0.00	0.
1.01	2.45	11	0.48	0.40	0.08	5166.	1.01	12.00	48	0.00	0.00	0.00	0.
1.01	3.00	12	0.48	0.41	0.06	7297.	1.01	12.15	49	0.00	0.00	0.00	0.
1.01	3.15	13	5.40	5.13	0.27	13685.	1.01	12.30	50	0.00	0.00	0.00	0.
1.01	3.30	14	2.00	1.96	0.04	26456.	1.01	12.45	51	0.00	0.00	0.00	0.
1.01	3.45	15	1.00	0.99	0.01	44091.	1.01	13.00	52	0.00	0.00	0.00	0.
1.01	4.00	16	0.60	0.59	0.01	55175.	1.01	13.15	53	0.00	0.00	0.00	0.
1.01	4.15	17	0.20	0.20	0.00	56781.	1.01	13.30	54	0.00	0.00	0.00	0.
1.01	4.30	18	0.20	0.20	0.00	50781.	1.01	13.45	55	0.00	0.00	0.00	0.
1.01	4.45	19	0.20	0.20	0.00	39540.	1.01	14.00	56	0.00	0.00	0.00	0.
1.01	5.00	20	0.20	0.20	0.00	29901.	1.01	14.15	57	0.00	0.00	0.00	0.
1.01	5.15	21	0.15	0.15	0.00	22774.	1.01	14.30	58	0.00	0.00	0.00	0.
1.01	5.30	22	0.15	0.15	0.00	17480.	1.01	14.45	59	0.00	0.00	0.00	0.
1.01	5.45	23	0.15	0.15	0.00	13855.	1.01	15.00	60	0.00	0.00	0.00	0.
1.01	6.00	24	0.15	0.15	0.00	11242.	1.01	15.15	61	0.00	0.00	0.00	0.
1.01	6.15	25	0.00	0.00	0.00	9246.	1.01	15.30	62	0.00	0.00	0.00	0.
1.01	6.30	26	0.00	0.00	0.00	7525.	1.01	15.45	63	0.00	0.00	0.00	0.
1.01	6.45	27	0.00	0.00	0.00	5829.	1.01	16.00	64	0.00	0.00	0.00	0.
1.01	7.00	28	0.00	0.00	0.00	4265.	1.01	16.15	65	0.00	0.00	0.00	0.
1.01	7.15	29	0.00	0.00	0.00	2971.	1.01	16.30	66	0.00	0.00	0.00	0.
1.01	7.30	30	0.00	0.00	0.00	1990.	1.01	16.45	67	0.00	0.00	0.00	0.
1.01	7.45	31	0.00	0.00	0.00	1327.	1.01	17.00	68	0.00	0.00	0.00	0.
1.01	8.00	32	0.00	0.00	0.00	856.	1.01	17.15	69	0.00	0.00	0.00	0.
1.01	8.15	33	0.00	0.00	0.00	522.	1.01	17.30	70	0.00	0.00	0.00	0.
1.01	8.30	34	0.00	0.00	0.00	330.	1.01	17.45	71	0.00	0.00	0.00	0.
1.01	8.45	35	0.00	0.00	0.00	211.	1.01	18.00	72	0.00	0.00	0.00	0.
1.01	9.00	36	0.00	0.00	0.00	137.	1.01	18.15	73	0.00	0.00	0.00	0.
1.01	9.15	37	0.00	0.00	0.00	89.	1.01	18.30	74	0.00	0.00	0.00	0.
							1.01	18.45	75	0.00	0.00	0.00	0.
									SUM	13.50	11.93	1.57	437810.
										(343.)	(303.)	(40.)	(12397.40)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	56781.	18079.	5837.	5837.	437810.
CMS	1608.	512.	165.	165.	12397.
INCHES		11.82	11.93	11.93	11.93
MM		300.19	302.90	302.90	302.90
AC-FT		8965.	9046.	9046.	9046.
THOUS CU M		11058.	11158.	11158.	11158.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 1

0.	0.	1.	9.	37.	99.	201.	333.	526.	832.
1291.	1824.	3421.	6614.	11023.	13794.	14195.	12695.	9885.	7475.
5693.	4370.	3464.	2811.	2312.	1881.	1457.	1066.	743.	498.
332.	214.	130.	83.	53.	34.	22.	14.	9.	6.
3.	1.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.					

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	14195.	4520.	1459.	1459.	109453.
CMS	402.	128.	41.	41.	3099.
INCHES		2.95	2.98	2.98	2.98
MM		75.05	75.72	75.72	75.72
AC-FT		2241.	2261.	2261.	2261.
THOUS CU M		2765.	2789.	2789.	2789.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 2

0.	0.	2.	18.	74.	198.	402.	666.	1052.	1665.
2583.	3649.	6842.	13228.	22045.	27588.	28391.	25390.	19770.	14951.
11387.	8740.	6928.	5621.	4623.	3763.	2915.	2132.	1485.	995.
664.	428.	261.	165.	105.	68.	45.	29.	18.	11.
6.	3.	1.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.					

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	28391.	9040.	2919.	2919.	218905.
CMS	804.	256.	83.	83.	6199.
INCHES		5.91	5.96	5.96	5.96
MM		150.10	151.45	151.45	151.45
AC-FT		4482.	4523.	4523.	4523.
THOUS CU M		5529.	5579.	5579.	5579.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 3

0.	0.	4.	27.	110.	297.	604.	998.	1577.	2497.
3874.	5473.	10264.	19842.	33068.	41381.	42586.	38086.	29655.	22426.
17080.	13110.	10392.	8432.	6935.	5644.	4372.	3198.	2228.	1493.
995.	642.	391.	248.	158.	102.	67.	43.	27.	17.
9.	4.	1.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.					

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	42586.	13559.	4378.	4378.	328358.
CMS	1206.	384.	124.	124.	9298.
INCHES		8.86	8.94	8.94	8.94
MM		225.15	227.17	227.17	227.17
AC-FT		6724.	6784.	6784.	6784.
THOUS CU M		8294.	8368.	8368.	8368.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 4

0.	0.	5.	36.	147.	396.	805.	1331.	2103.	3329.
5166.	7297.	13685.	26456.	44091.	55175.	56781.	50781.	39540.	29901.
22774.	17480.	13855.	11242.	9246.	7525.	5829.	4265.	2971.	1990.
1327.	856.	522.	330.	211.	137.	89.	58.	36.	22.
12.	6.	2.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.					

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	56781.	18079.	5837.	5837.	437810.
CMS	1608.	512.	165.	165.	12397.
INCHES		11.82	11.93	11.93	11.93
MM		300.19	302.90	302.90	302.90
AC-FT		8965.	9046.	9046.	9046.
THOUS CU M		11058.	11158.	11158.	11158.

HYDROGRAPH ROUTING

ROUTED FLOW THROUGH WHITE TANKS RESERVOIR BY MODIFIED PULS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	2	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	1036.	-1

STAGE	1050.00	1051.00	1052.30	1054.50	1057.70	1058.50
FLOW	0.00	1000.00	3000.00	9000.00	17800.00	23000.00

CAPACITY=	0.	100.	400.	1036.	2000.	3210.	4770.	6440.
ELEVATION=	1037.	1040.	1045.	1050.	1055.	1060.	1065.	1070.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1050.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1056.0	2.8	1.5	6839.

STATION 2, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	1.	3.	9.	24.	49.	87.	147.
240.	374.	603.	1078.	2257.	4345.	6805.	8499.	9212.	9075.
8440.	7571.	6639.	5746.	4934.	4210.	3562.	2986.	2669.	2357.
2061.	1788.	1542.	1324.	1132.	978.	881.	793.	714.	642.
577.	519.	466.	419.	376.	338.	303.	273.	245.	220.
198.	177.	159.	143.	129.	116.	104.	93.	84.	75.
68.	61.	55.	49.	44.	40.	36.	32.	29.	26.
23.	21.	19.	17.	15.					

STORAGE

1036.	1036.	1036.	1036.	1037.	1038.	1041.	1045.	1053.	1064.
1082.	1108.	1152.	1239.	1386.	1574.	1748.	1868.	1918.	1909.
1864.	1803.	1737.	1674.	1616.	1565.	1519.	1478.	1438.	1399.
1362.	1328.	1297.	1269.	1245.	1224.	1206.	1189.	1174.	1160.
1147.	1136.	1126.	1117.	1109.	1101.	1095.	1089.	1083.	1078.
1074.	1070.	1067.	1064.	1061.	1058.	1056.	1054.	1052.	1051.
1049.	1048.	1047.	1045.	1044.	1044.	1043.	1042.	1042.	1041.
1040.	1040.	1040.	1039.	1039.					

STAGE

1050.0	1050.0	1050.0	1050.0	1050.0	1050.0	1050.0	1050.0	1050.1	1050.1
1050.2	1050.4	1050.6	1051.1	1051.8	1052.8	1053.7	1054.3	1054.6	1054.5
1054.3	1054.0	1053.6	1053.3	1053.0	1052.7	1052.5	1052.3	1052.1	1051.9
1051.7	1051.5	1051.4	1051.2	1051.1	1051.0	1050.9	1050.8	1050.7	1050.6
1050.6	1050.5	1050.5	1050.4	1050.4	1050.3	1050.3	1050.3	1050.2	1050.2
1050.2	1050.2	1050.2	1050.1	1050.1	1050.1	1050.1	1050.1	1050.1	1050.1
1050.1	1050.1	1050.1	1050.0	1050.0	1050.0	1050.0	1050.0	1050.0	1050.0
1050.0	1050.0	1050.0	1050.0	1050.0					

PEAK OUTFLOW IS 9212. AT TIME 4.75 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	9212.	4165.	1458.	1458.	109314.
CMS	261.	118.	41.	41.	3095.
INCHES		2.72	2.98	2.98	2.98
MM		69.15	75.63	75.63	75.63
AC-FT		2065.	2259.	2259.	2259.
THOUS CU M		2547.	2786.	2786.	2786.

STATION 2, PLAN 1, RATIO 2

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	1.	6.	19.	48.	97.	174.	295.
481.	749.	1309.	2638.	6219.	10866.	17878.	26924.	22385.	17557.
14017.	12636.	11627.	10503.	9149.	7884.	6725.	5654.	4673.	3798.
3041.	2644.	2294.	1977.	1697.	1451.	1239.	1056.	932.	839.
755.	678.	610.	548.	492.	442.	397.	357.	320.	288.
258.	232.	209.	187.	168.	151.	136.	122.	110.	98.
88.	79.	71.	64.	58.	52.	46.	42.	37.	34.
30.	27.	24.	22.	20.					

STORAGE

1036.	1036.	1036.	1036.	1037.	1040.	1045.	1055.	1070.	1093.
1129.	1180.	1268.	1434.	1707.	2043.	2325.	2417.	2374.	2321.
2266.	2199.	2110.	2011.	1914.	1825.	1743.	1667.	1598.	1536.
1482.	1435.	1391.	1351.	1316.	1285.	1259.	1236.	1216.	1198.
1181.	1167.	1154.	1142.	1131.	1121.	1113.	1105.	1098.	1091.
1086.	1081.	1076.	1072.	1068.	1065.	1062.	1060.	1057.	1055.
1053.	1051.	1050.	1048.	1047.	1046.	1045.	1044.	1043.	1042.
1042.	1041.	1041.	1040.	1040.					

STAGE

1050.0	1050.0	1050.0	1050.0	1050.0	1050.0	1050.0	1050.1	1050.2	1050.3
1050.5	1050.7	1051.2	1052.1	1053.5	1055.2	1056.3	1056.7	1056.5	1056.3
1056.1	1055.8	1055.5	1055.0	1054.6	1054.1	1053.7	1053.3	1052.9	1052.6
1052.3	1052.1	1051.8	1051.6	1051.5	1051.3	1051.2	1051.0	1050.9	1050.8
1050.8	1050.7	1050.6	1050.5	1050.5	1050.4	1050.4	1050.4	1050.3	1050.3
1050.3	1050.2	1050.2	1050.2	1050.2	1050.2	1050.1	1050.1	1050.1	1050.1
1050.1	1050.1	1050.1	1050.1	1050.1	1050.1	1050.0	1050.0	1050.0	1050.0
1050.0	1050.0	1050.0	1050.0	1050.0					

PEAK OUTFLOW IS 26924. AT TIME 4.50 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	26924.	8563.	2916.	2916.	218723.
CMS	762.	242.	83.	83.	6194.
INCHES		5.60	5.96	5.96	5.96
MM		142.18	151.32	151.32	151.32
AC-FT		4246.	4519.	4519.	4519.
THOUS CU M		5237.	5574.	5574.	5574.

STATION 2, PLAN 1, RATIO 3

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	2.	9.	28.	71.	146.	262.	442.
721.	1185.	2203.	4942.	10427.	25402.	44280.	39591.	32986.	25373.
19689.	15582.	13101.	12325.	11350.	10267.	8917.	7608.	6360.	5213.
4201.	3338.	2772.	2399.	2064.	1770.	1513.	1291.	1100.	957.
861.	774.	696.	625.	561.	504.	453.	407.	366.	328.
295.	265.	238.	214.	192.	173.	155.	139.	125.	112.
101.	91.	81.	73.	66.	59.	53.	48.	43.	38.
35.	31.	28.	25.	22.					

STORAGE

1036.	1036.	1036.	1036.	1038.	1041.	1050.	1064.	1086.	1121.
1175.	1252.	1380.	1617.	2005.	2404.	2551.	2518.	2468.	2403.
2346.	2293.	2240.	2172.	2086.	1992.	1898.	1805.	1717.	1636.
1564.	1503.	1451.	1404.	1362.	1325.	1293.	1265.	1241.	1221.
1202.	1185.	1170.	1157.	1144.	1133.	1123.	1114.	1106.	1099.
1093.	1087.	1082.	1077.	1073.	1069.	1066.	1063.	1060.	1058.
1055.	1053.	1052.	1050.	1049.	1047.	1046.	1045.	1044.	1043.
1043.	1042.	1041.	1041.	1040.					

STAGE

1050.0	1050.0	1050.0	1050.0	1050.0	1050.0	1050.1	1050.1	1050.3	1050.4
1050.7	1051.1	1051.8	1053.0	1055.0	1056.7	1057.3	1057.1	1056.9	1056.7
1056.4	1056.2	1056.0	1055.7	1055.4	1055.0	1054.5	1054.0	1053.5	1053.1
1052.7	1052.4	1052.2	1051.9	1051.7	1051.5	1051.3	1051.2	1051.1	1051.0
1050.9	1050.8	1050.7	1050.6	1050.6	1050.5	1050.5	1050.4	1050.4	1050.3
1050.3	1050.3	1050.2	1050.2	1050.2	1050.2	1050.2	1050.1	1050.1	1050.1
1050.1	1050.1	1050.1	1050.1	1050.1	1050.1	1050.1	1050.0	1050.0	1050.0
1050.0	1050.0	1050.0	1050.0	1050.0					

PEAK OUTFLOW IS 44280. AT TIME 4.25 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	44280.	12994.	4375.	4375.	328150.
CMS	1254.	368.	124.	124.	9292.
INCHES		8.49	8.94	8.94	8.94
MM		215.76	227.03	227.03	227.03
AC-FT		6443.	6780.	6780.	6780.
THOUS CU M		7948.	8363.	8363.	8363.

STATION 2, PLAN 1, RATIO 4

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	2.	11.	38.	95.	194.	349.	590.
962.	1745.	3130.	7450.	15251.	53001.	56708.	53062.	43433.	33265.
25652.	20035.	16065.	13490.	12608.	11721.	10661.	9283.	7836.	6470.
5243.	4185.	3293.	2738.	2363.	2029.	1737.	1484.	1265.	1077.
944.	849.	763.	685.	615.	553.	497.	446.	401.	360.
323.	290.	261.	234.	211.	189.	170.	153.	137.	123.
111.	99.	89.	80.	72.	65.	58.	52.	47.	42.
38.	34.	31.	27.	25.					

STORAGE

1036.	1036.	1036.	1036.	1038.	1043.	1054.	1073.	1103.	1150.
1221.	1322.	1489.	1794.	2288.	2609.	2632.	2609.	2545.	2470.
2406.	2350.	2300.	2254.	2196.	2118.	2025.	1923.	1821.	1725.
1638.	1563.	1500.	1447.	1400.	1358.	1321.	1289.	1262.	1238.
1218.	1200.	1183.	1168.	1155.	1143.	1132.	1122.	1113.	1105.
1098.	1092.	1086.	1081.	1077.	1072.	1069.	1065.	1062.	1060.
1057.	1055.	1053.	1051.	1050.	1048.	1047.	1046.	1045.	1044.
1043.	1043.	1042.	1041.	1041.					

STAGE

1050.0	1050.0	1050.0	1050.0	1050.0	1050.0	1050.1	1050.2	1050.3	1050.6
1051.0	1051.5	1052.3	1053.9	1056.2	1057.5	1057.6	1057.5	1057.3	1056.9
1056.7	1056.4	1056.2	1056.1	1055.8	1055.5	1055.1	1054.6	1054.1	1053.6
1053.1	1052.7	1052.4	1052.1	1051.9	1051.7	1051.5	1051.3	1051.2	1051.0
1050.9	1050.8	1050.8	1050.7	1050.6	1050.6	1050.5	1050.4	1050.4	1050.4
1050.3	1050.3	1050.3	1050.2	1050.2	1050.2	1050.2	1050.2	1050.1	1050.1
1050.1	1050.1	1050.1	1050.1	1050.1	1050.1	1050.1	1050.1	1050.0	1050.0
1050.0	1050.0	1050.0	1050.0	1050.0					

PEAK OUTFLOW IS 56708. AT TIME 4.25 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	56708.	17451.	5834.	5834.	437583.
CMS	1606.	494.	165.	165.	12391.
INCHES		11.41	11.92	11.92	11.92
MM		289.77	302.74	302.74	302.74
AC-FT		8654.	9041.	9041.	9041.
THOUS CU M		10674.	11152.	11152.	11152.

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 0.25	RATIO 2 0.50	RATIO 3 0.75	RATIO 4 1.00
HYDROGRAPH AT	1	14.23	1	14195.	28391.	42586.	56781.
	(	36.86)	(	401.97)(	803.93)(	1205.90)(	1607.86)(
ROUTED TO	2	14.23	1	9212.	26924.	44280.	56708.
	(	36.86)	(	260.85)(	762.40)(	1253.86)(	1605.80)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1050.00	1050.00	1056.00
STORAGE	1036.	1036.	2242.
OUTFLOW	0.	0.	13125.

RATIO OF PMF	MAXIMUM RESERVOIR W.S. ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.25	1054.58	0.00	1918.	9212.	0.00	4.75	0.00
0.50	1056.72	0.72	2417.	26924.	1.25	4.50	0.00
0.75	1057.28	1.28	2551.	44280.	1.75	4.25	0.00
1.00	1057.61	1.61	2632.	56708.	2.50	4.25	0.00

APPENDIX C

STATE INSPECTION REPORTS

STATE OF ARIZONA
OFFICE OF STATE WATER ENGINEER
SUPERVISION OF DAMS
INSPECTION OF OPERATIONAL DAM

NAME OF DAM White Tanks Dam #4 DAM NO. 7-29

TYPE OF DAM Earth Embankment FREEBOARD - Ft.

STORAGE LEVEL Empty Ft. ( ) Above ( ) Below SPILLWAY CREST

CONTACTS Pete Pivonka & Bob Pendergast of Maricopa County Flood Control District

As a part of the other two major flood retarding structures White Tanks #3 and the McMicken Dam, the White Tanks Dam #4 is approximately 1 1/3-mile long earthern embankment having an average height of 20 feet.

The reservoir was totally empty at the time of inspection although a very small impoundment is reported during the recent floods of March 1978. The embankment appeared to be in a good condition. Some of the already logged shrinkage and transverse cracks were inspected and its is believed there hasn't been any significant increase in their severity or number since last inspection. Some minor erosion-gullies, probably created by the motorcycle tracks and deteriorated later, were observed on the downstream slope. The emergency spillway channel was also inspected and was found to be in a good condition and free of obstructions.

The principal spillway structure consists of a 24-in. diameter gated CMP with no trash guard at the inlet end of the pipe. The lifting mechanism of the gate was serviced about a month ago and appeared to be in an operable condition. The 24-inch diameter CMP forms the irrigation outlet and was found to be satisfactory. No major debris or silt deposits at the inlet and outlet ends of the pipes were observed during this inspection.

This structure was last inspected on January 20, 1978.

Inspection by: K.M. Hussain
Date of Inspection 6-6-78
Date of Report 6-16-78
Photos: YES ___ NO X

STATE OF ARIZONA
OFFICE OF STATE WATER ENGINEER
SUPERVISION OF DAMS
INSPECTION OF OPERATIONAL DAM

NAME OF DAM White Tanks #4 DAM NO. 7-29

TYPE OF DAM Earthfill FREEBOARD _____ Ft.

STORAGE LEVEL Dry Ft. ( ) Above ( ) Below SPILLWAY CREST

CONTACTS Jack Leavitt (Maricopa Flood Control Dist.) prior to inspection.

EMBANKMENT OR CONCRETE: (Erosion, vegetation, rodents, sloughing, cracks, seepage, movement, spalling)

Dan Lawrence and I visited the dam sites of the White Tanks #4 and the Buckeye #1. In order to locate the depth of cracks and cavities visible at the top of these dams, a ditch measuring about 8" wide x 12" deep is dug along the centerline of the White Tank Dam #4. We observed at least at 8 to 10 places holes measuring 1½" to 2" in diameter, and approximately 8" to 10" deep. Although at few places on the downstream side, flagging was done to indicate the end of the extended cracks or conduits, there were no definite sign of piping phenomenon anywhere along the embankment.

OUTLET WORKS:

SPILLWAY (Obstruction, scour):

REMARKS AND RECOMMENDATIONS:

Since it had been raining occasionally for the past few days, the pattern and direction of these cracks couldn't be established on the wet embankment.

Sufficient time will be required to investigate the actual causes of these sinkholes and find solution to the problem.

Inspection by: KMH/DRL
Date of Inspection 1-20-78
Date of Report 1-23-78
Photos: YES _____ NO X

STATE OF ARIZONA
OFFICE OF STATE WATER ENGINEER
SUPERVISION OF DAMS
INSPECTION OF OPERATIONAL DAM

NAME OF DAM White Tanks # 4 DAM NO. 7-29

TYPE OF DAM Earth FREEBOARD _____ Ft.

STORAGE LEVEL Dry Ft. ( ) Above ( ) Below SPILLWAY CREST

CONTACTS Messrs. W. Anderson and A. Gusak of the Maricopa County Flood Control & Water Cons. Dist.

EMBANKMENT OR CONCRETE: (Erosion, vegetation, rodents, sloughing, cracks, seepage, movement, spalling)

No cracks, erosion or settlement were observed.

The embankment is in good condition.

OUTLET WORKS:

Appeared to be in good condition. Gusak said they were operable.

SPILLWAY (Obstruction, scour):

Clear of obstructions. Bottom still exhibits the plowed condition as it did last year.

REMARKS AND RECOMMENDATIONS:

The dam and appurtenances are in good condition.

Inspection by: JDW/WCJ
Date of Inspection 3-29-77
Date of Report 4-4-77
Photos: YES _____ NO X

STATE OF ARIZONA
OFFICE OF STATE WATER ENGINEER
SUPERVISION OF DAMS
INSPECTION OF OPERATIONAL DAM

NAME OF DAM White Tank #4 DAM NO. 7-29

TYPE OF DAM Earth FREEBOARD _____ Ft.

STORAGE LEVEL Dry Ft. ( ) Above ( ) Below SPILLWAY CREST

CONTACTS R. Pendergast, Maricopa County Flood Control District

EMBANKMENT OR CONCRETE: (Erosion, vegetation, rodents, sloughing, cracks, seepage, movement, spalling)

The dam is relatively free of erosion, but has been abraided by motorcycle and dune buggy travel on the slopes.

OUTLET WORKS:

One of the outlets discharges into an outlet ditch feeding a near downstream irrigation ditch. At the time, this ditch was full of water which backs up into the outlet ditch. Perhaps this would not effect the outlet capacity, however.

SPILLWAY (Obstruction, scour):

Some erosion in both right and left spillway channels. Otherwise OK.

REMARKS AND RECOMMENDATIONS:

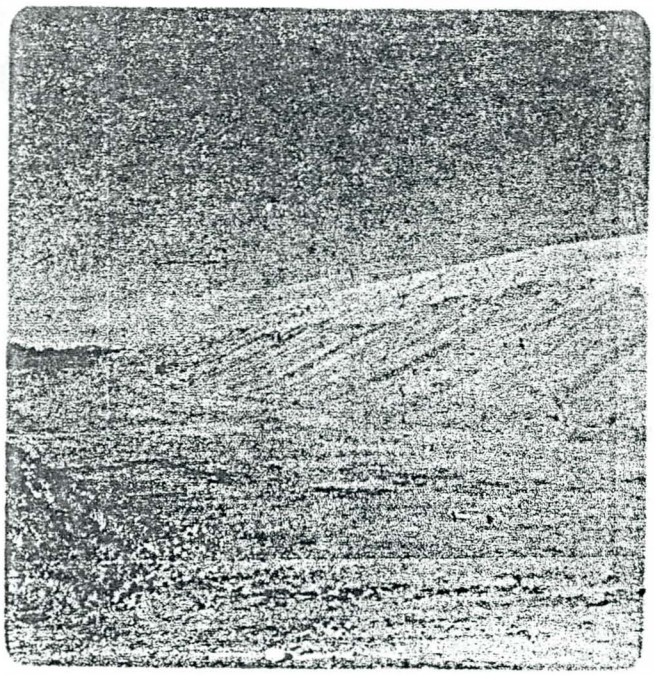
There doesn't appear to be any serious problems. Continued routine maintenance, primarily to correct minor damage due to vandals, is practiced by the District.

Inspection by: JDW/DRL JDW
Date of Inspection 2/17/76
Date of Report 2/27/76
Photos: YES X NO

WHITE TANKS #4 (7-29)

17 Feb 76

East Downstream Face
Note: Soil in pile waiting to be placed on downstream face.



Repairs made recently to South Downstream Face.

White Tanks #4 ( )

February 17, 1976

Upstream slope.

STATE OF ARIZONA
OFFICE OF STATE WATER ENGINEER
SUPERVISION OF DAMS
INSPECTION OF OPERATIONAL DAM

NAME OF DAM White Tanks #4 DAM NO. 7-29

TYPE OF DAM Earthfill FREEBOARD 5.85 Ft.

STORAGE LEVEL _____ Ft. ( ) Above ( ) Below SPILLWAY CREST

CONTACTS None

EMBANKMENT OR CONCRETE: (Erosion, vegetation, rodents, sloughing, cracks, seepage, movement, spalling)

The crest of the embankment was approximately 9 feet wide and fairly level. Some shrinkage cracks approximately 3 to 4 feet deep were evident along the crest of the dike. Some rodent activity was also evident along with minor places of erosion on the downstream face of the dike. A motorcycle trail near the north end of the dike was beginning to erode.

OUTLET WORKS:

The gate on the west outlet structure was closed and blocked by silt. The gate on the east outlet structure appeared to be in good condition. The bottom of the gate was above ground level with some silt around it.

SPILLWAY (Obstruction, scour):

The spillway measured approximately 170 feet wide with a freeboard of 5.85 feet. Within the spillway on the left side was a bench that ranged from 30 to 70 feet wide with an average freeboard of 5 feet. The west dike forming the west side of the spillway was 0.8 to 1 foot lower than main dam.

REMARKS AND RECOMMENDATIONS:

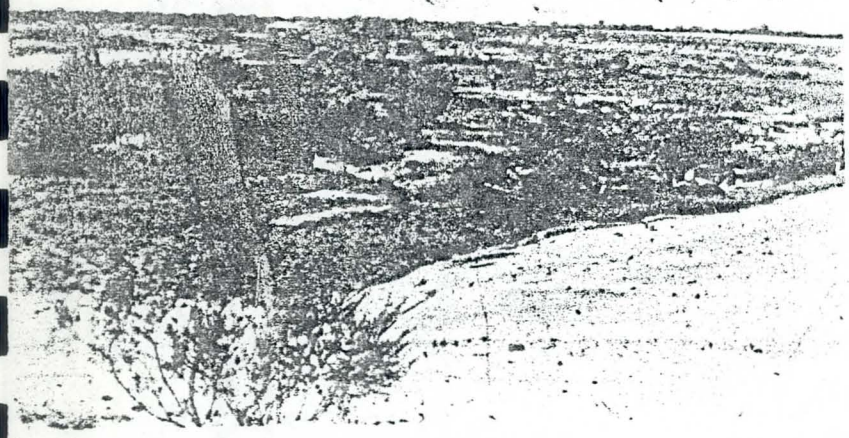
The silt around the gates on the outlet structures should be cleaned out.

MSA

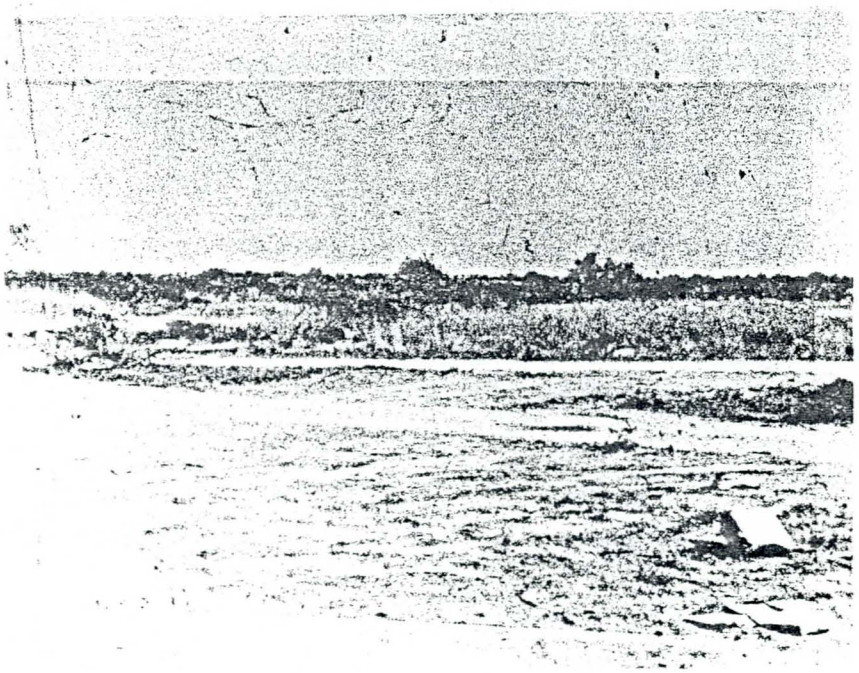
Inspection by: MSA, BGS
Date of Inspection 10-18-73
Date of Report 10-29-73
Photos: YES X NO

WHITE BANKS #[illegible] (7-25)

10-18-[illegible]



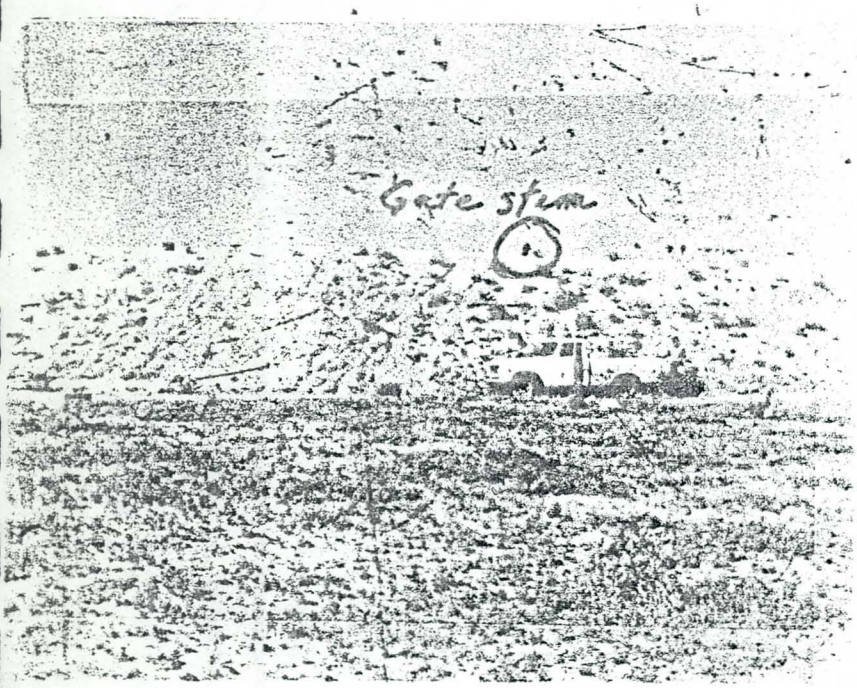
Looking downstream from right entrance to spillway



Spillway-looking downstream from left entrance

WHITE RANCH

10-18-



Downstream face of embankment at outlet near bend in alinement.

Outlet gate on west embankment -- partially covered with silt.

APPENDIX D

AN ECOLOGICAL ASSESSMENT OF BURROWING ACTIVITY AT WHITE TANKS #4 FLOOD RETARDING STRUCTURE

AN ECOLOGICAL ASSESSMENT OF BURROWING ACTIVITY

AT

WHITE TANKS #4 FLOOD RETARDING STRUCTURE

MARICOPA COUNTY, ARIZONA

prepared by

Harry L. Norman

for

E. Linwood Smith and Associates

Ecological Consultants

An Ecological Assessment of Burrowing Activity at White Tanks #4 Flood Retarding Structure, Maricopa County, Arizona

I. Introduction

The White Tank #4 Flood Retarding Structure is located west of Phoenix near Perryville, one mile south of the I-10 Interstate Highway, approximately one quarter of a mile west of Jackrabbit Trail. The embankment forming the structure varies in height from six to 20 feet and is constructed of sandy loam. Sandy loam is an ideal substrate for fossorial activity. Certain small burrowing mammals are closely associated with this soil type. The suitability of sandy loam for fossorial behavior is evidenced by observation of the lower portions of the embankment, which are riddled with burrow openings.

II. Methodology

An on-site inspection of White Tank #4 Flood Retarding Structure was conducted in early May 1981. During this study, the entire embankment was surveyed for evidence of burrowing activity in an effort to identify those species most likely to be present. Assessment of nocturnal species included use of 200 small animal traps. The traps were divided into three groups; 60 traps were placed in the vicinity of the north-south spurs, 80 traps were set near the middle of the southern boundary. Diurnal activity was observed by walking the perimeter of the embankment examining

burrowing openings and looking for other indications of animal activity.

III. Results

Five species of small mammals were observed during this assessment. Two species representing the Order Logomorpha: Lepus californicus, the Black-tailed Jackrabbit; and Sylvilagus audubonii, the Desert Cottontail. Three species of burrowing rodents were observed: Spermophilus tereticaudus, the Round-tailed Ground Squirrel; Dipodomys merriami, Merriam's Kangaroo Rat; and Perognathus amplus, the Arizona Pocket Mouse. The presence of other mammalian species was indicated by carnivore tracks. The tracks appeared to be from a coyote and a smaller carnivore, probably a skunk. Other species of burrowing rodents, which may inhabit the region of White Tank #4 are: Perognathus longimembrus, the Little Pocket Mouse; and Onychomys torridus, the Southern Grasshopper Mouse. In the nearby agricultural area, Peromyscus maniculatus, the Deer Mouse, and Mus musculus, the House Mouse, are also likely to be present(Cockrum, 1960).

Although there was an abundance of burrow openings in the lower half of the embankment and on the adjacent level regions, most did not appear to be presently occupied. The greatest density of currently active burrows were located near the ends of the embankment associated with the north-south spurs. The vast majority of

burrows appeared to be the work of two rodent species; the Round-tailed Ground Squirrel and Merriam's Kangaroo Rat. The sandy loam soil used to form the embankment is an ideal substrate for the burrowing habits of these species. Both of these rodents inhabit regions of sandy soil and sparse vegetation, and both may develop extensive burrow systems with openings about the size of those occurring in the embankment.

IV. Discussion

The distribution of Spermophilus tereticaudus is generally restricted to sandy soils(Neal, 1964). The Round-tailed Ground Squirrel usually avoids rocky hills preferring level land, especially places where wind drifted sand has accumulated into small mounds about the base of small bushes(Grinnell and Dixon, 1918). Spermophilus tereticaudus typically burrows in locations which are relatively level. The burrow systems are likely to be complex with a vertical depth of at least three feet(Vorhies, 1945). Although a related Russian species, Citellus pygmaeus, has been reported to have constructed burrows up to 180 centimeters in depth(Golly et.al., 1975), there are no comparable reports of Round-tailed Squirrel escavations. Spermophilus tereticaudus occurs in small scattered colonies, each colony marked by 12 to 15 open holes(Neal, 1964). The mean home range for adults is .74 acre(Drabek, 1973). Drabek also found a 68.5% fidelity to

the home range over a one-year period with the remainder staying within 150 feet of the original home range. The young usually established residence 75 to 100 feet from the original burrow. Females usually have one litter per year with two to twelve young. The average litter size is approximately 6.2(Grinnell and Dixon, 1918). Round-tailed Ground Squirrels typically remain underground in the burrow system during the winter months.

Dipodomys merriami also is most often found inhabiting regions characterized by loose soil and sparse vegetation. Carpenter(1966) reports that the burrow systems of this species are generally simple and about 25 to 30 centimeters deep. During the day, the openings to the burrows are usually plugged with soil. A related species of Kangaroo Rat, Dipodomys spectabilis, has been reported to prepare labyrinthine underground dens with a nesting chamber at a depth of nearly two feet(Vorheis, 1945). An extreme report on the depth of the Kangaroo Rat burrows is found in Ecology of Soil Animals by Wallwork (1970). He writes that Kangaroo Rats construct, "...elaborate burrow systems with several entrance and exit holes leading to a central chamber at a depth of 30 centimeters to two meters below the soil surface." There was no reference or documentation for this description and nothing comparable has been located in recent literature. The average home range for male Merriam's Kangaroo Rat is .324 acre and for female Merriam's Kangaroo

Rat is .215 acre(Vaughan, 1976). There may be some overlap in the home range for males but almost none for females. Vaughan found a peak density of 15.0 individuals per hectare with an average of 8.7 and 10.5 at two different study sites. Dipodomys merriami was found to be active above ground year-round. Reproductive activity has also been reported to be year-round with the peak activity between May and September.

While assessing the burrowing activity at White Tank #4, it is instructive to consider the records of fossorial behavior in Pocket Gophers. Their burrow systems have been extensively studied and provide some indication of characteristics which might be expected of other small burrowing mammals. M. A. Miller(1957) traced a burrow system, which had 107 feet of tunnels with nearly 80% of the total footage within 12 inches of ground surface. Richard S. Miller(1964) reported that although the Pocket Gopher made a superficial network of feeding tunnels, the nesting chamber was up to 19 inches below ground. Grinnell(1923) measured a nesting chamber 20 inches below ground. The extreme record for burrowing activity by a Pocket Gopher was reported by Kevan(1962). He reports that a single female has been known to dig a burrow 542 feet in length, with a depth from four inches to three feet-four inches and nine separate mounds.

A major advantage of burrow construction for desert animals is

thermo-regulation. In a study conducted at the Santa Rita Agricultural Experiment Stations south of Tucson, the temperature in a burrow four feet deep never exceeded 29 degrees Centigrade even when the soil surface temperature reached 75 degrees Centigrade(Vorhies, 1945). In sand, the annual variation at one meter is 11 degrees - 12 degrees Centigrade, and the highest temperature seldom exceeds 30 degrees(see figure 10.3). Dipodomys merriami are able to maintain body temperatures within reasonable limits at air temperatures up to 37 degrees Centigrade(Schmidt-Nielson, 1964). For thermo-regulation, optimal depth for a burrow appears to be between one-half to one and one-half meters.

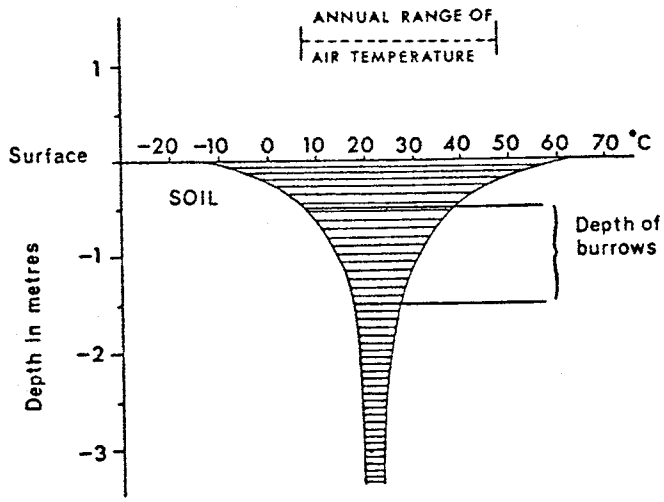


FIGURE 10.3. The relationship between the depth of kangaroo-rat burrows and the annual range of soil temperature in Arizona (after Schmidt-Nielsen, 1964, from Misonne, 1959).

The depth of burrow systems effects the concentration of respiratory gases. In the relatively shallow burrows of Pocket Gophers, Darden(1972) measured oxygen concentrations as low as 15.5% and carbon dioxide concentrations as high as 3.8%. Schmidt-Nielson(1979) reported that carbon dioxide levels may increase to above 5% in some Pocket Gopher burrows. Respiratory gas concentrations at these levels have considerable physiological effects, including reduced metabolic rates.

It is characteristic of most rodent populations to vary in density over a period of years. Although the population density in early May, 1981, was not high, it is possible that there were periods of much higher density in the past and maybe again in the future. Periods of flooding are one means of population control, as the majority of animals living along the inner perimeter would be drowned. Population control might be facilitated by other means. Periodic grading of the surface of the embankment would bury many individuals, especially if done during the winter hibernation of the Round-tailed Ground Squirrel. The grading would also reduce the number of individuals which could be supported. Burrow construction by the Round-tailed Ground Squirrel and Merriam's Kangaroo Rat is less frequent in rocky habitats as both species prefer sandy substrates. Covering the surface of the embankment with rocks would also be likely to

reduce the densities of both species. Grading the surface to fill in burrows or covering the surface of the embankment with rocks would aid in population control. From an ecological point of view, these procedures would seem to be preferable to the use of poisoned baits. Poisoned baits using the anticoagulant Warfarin or Zinc phosphide have an impact on nontarget species; e.g., other gramivores such as quail, and preditory species including foxes, coyotes, and raptors.

V. Conclusions

The earth embankment forming White Tank #4 was constructed circa 1952 from sandy loam obtained from an adjacent shallow borrow area. Since its construction, there is evidence of extensive burrowing activity by small animals. Two rodent species are most likely to have been responsible. Most of the burrows are probably the work of the Round-tailed Ground Squirrel, Spermophilus tereticaudus. Merriam's Kangaroo Rat; Dipodomys merriami, is the other burrowing species, which was found to be quite active during this assessment. Both species prefer sandy habitats with sparse vegetation and burrow systems constructed on relatively flat land. This preference for flatter terrain explains the higher incidence of burrow openings nearer the bottom of the embankment. Both species may have several openings for each burrow, meaning that each opening does not represent an individual animal. The young of each species will leave the original burrow system and dig their own system rather than

inhabit the "home burrow". This behavior will increase the number of burrows in a given region so that over a period of years, the area may become riddled with openings. Large "burrows" dug into the wall are most likely the result of coyotes and badgers attempting to dig out their prey.

The optimal depth for burrow systems in terms of thermoregulation would appear to be between .5 and 1.5 meters. Below 1.5 meters there is little reduction in the temperature range; therefore, little advantage to be gained in body temperature maintenance during the summer heat. Deep burrow systems have the disadvantage of leading to changes in the respiratory gas concentration which in turn lead to physiological changes including a reduction in metabolic rate. Taking these factors into consideration, it is likely that most of the burrows in the embankment forming White Tank #4 penetrate less than 1.5 meters. These burrows are primarily located in the lower, thicker portion of the structure. These factors should be taken into consideration in evaluating the affect of burrowing animals in the structure's integrity.

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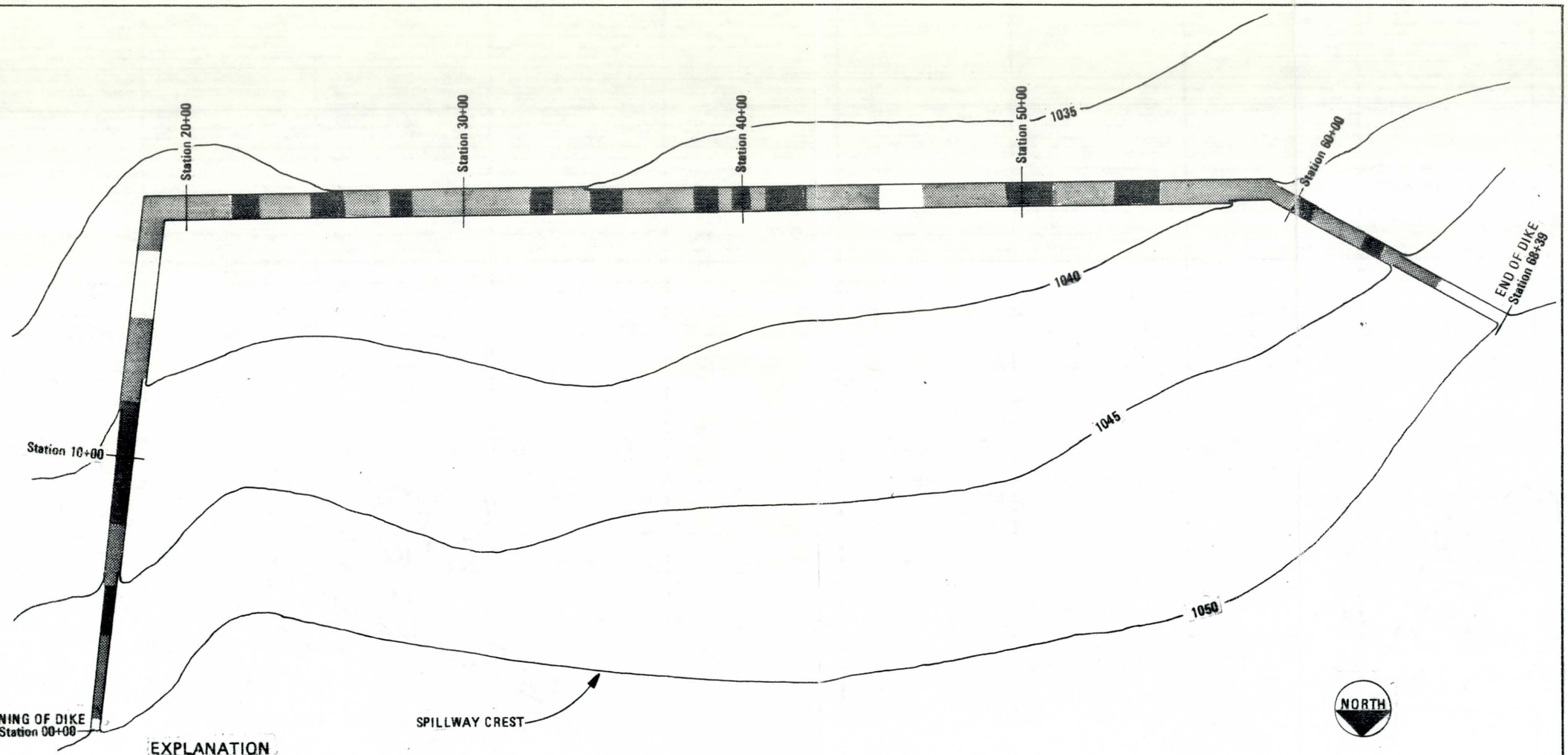
APPENDIX E

MAPS, TRENCH LOGS, AND PHOTOGRAPHS FROM THE WHITE TANKS NO. 4 CRACK LOCATION INVESTIGATION (FUGRO 1979)



EXPLANATION

APPARENT DEGREE OF CRACKING

	NO	No cracks or other related features identified on structure for a minimum of 150 linear feet (50 linear feet where crest height is less than 5 feet); flooding ratio is less than 1.2.
	LOW	Some cracks identified (primarily short incipient cracks and small pipes). No pipe outlets defined by flooding. Distance between features generally less than 60 to 100 feet or reach of the structure bounded by moderate to severe areas; flooding ratio less than 1.2.
	MODERATE TO SEVERE	Significant cracks and related features identified, distance between features generally less than 60 feet; primarily open cracks; large pipes and clusters of small pipes. Crack or pipe outlets defined by flooding less than six feet below crest grade; flooding ratio generally 1.3 to 1.9. Includes localized areas of severe cracking (flooding ratio 2.0 or water loss exceeds pump capacity; cracks and/or pipe outlets greater than 6 feet below crest grade).

SCALE

0 200 400 800
feet

Crest of Dike 1056' MSL

Contour Interval 5'

Note: For additional supporting data see Appendices A and B and Table of Trench Flooding Data.

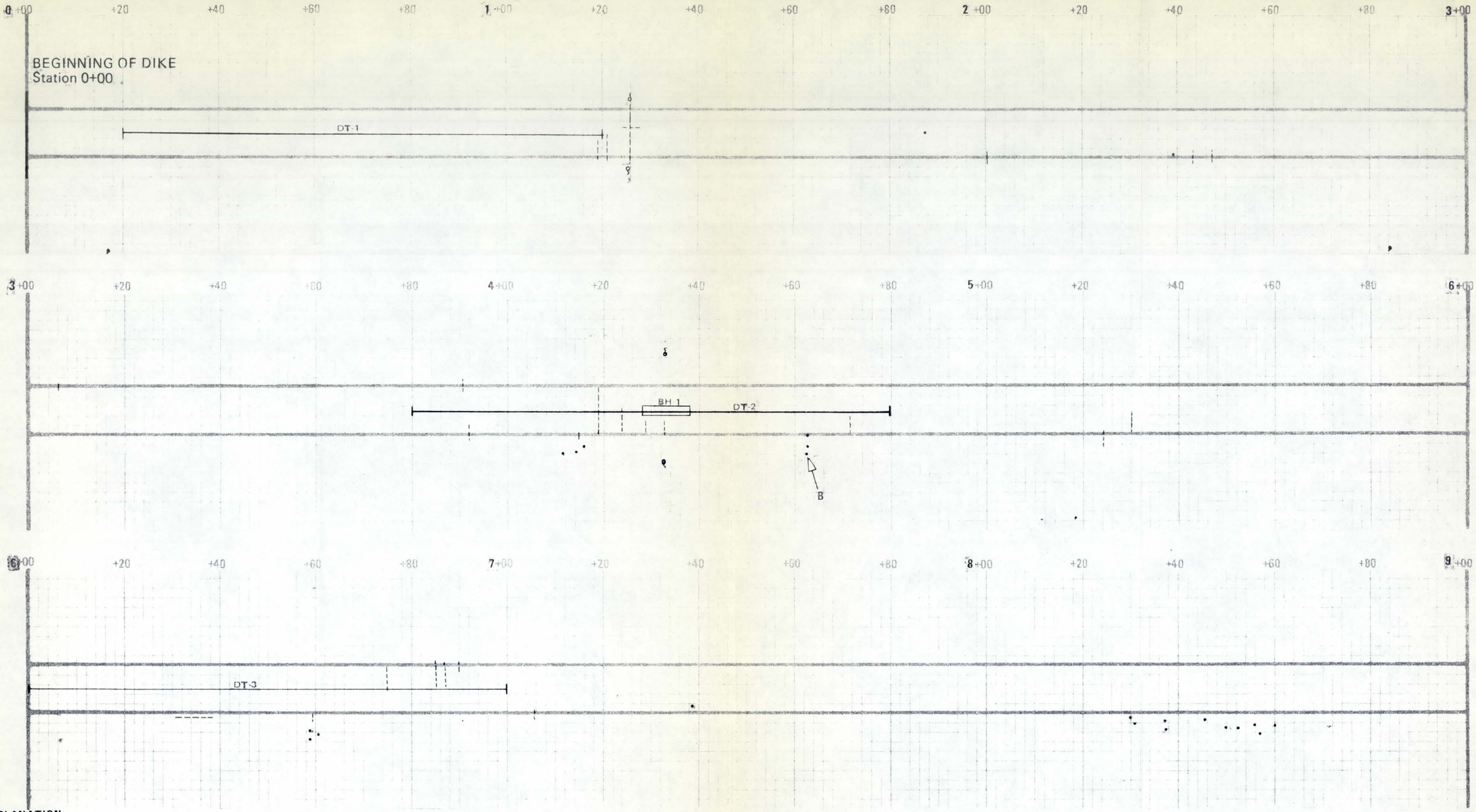
Reference: Base map obtained from SCS Plan and Profile White Tanks FRS Structure Number 4

fugro

SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 4
DEGREE OF CRACKING MAP

Fugro Project Number 78-308-26
SCS Contract Number, 53-9A02-9-00046



EXPLANATION

- o — pipe > 2" in diameter
- · — pipe ≤ 2" in diameter
- ——— — crack, dashed where < 1/16" separation
- D — depression, pipe or crack collapse suspected
- SF — sediment filled pipe or crack
- ? — flooding induced pipe or crack outlet
- B — suspected animal burrow

Feature > 2" (width or diameter)

Example: 6 b — Number indicates width or diameter (inches) of feature. Letter (a,b, or c) indicates range of depth (x) probed

- a — 2" < x < 1'
- b — 1' ≤ x ≤ 2'
- c — > 2'

DT-4 — Ditch Witch Trench Area

BH-3 — Backhoe Exploratory Area

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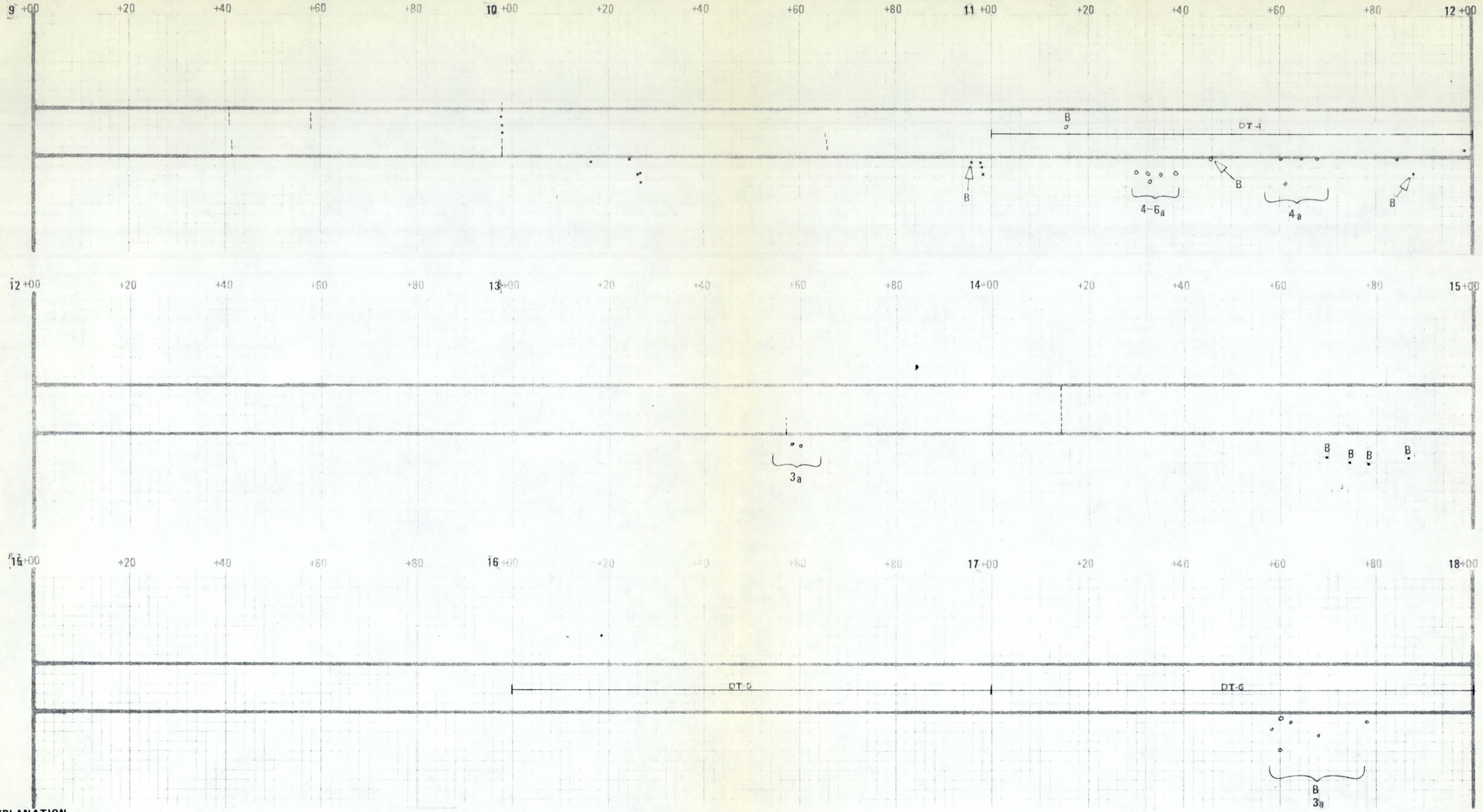
SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 4
FLOOD RETARDING STRUCTURE

CRACK LOCATION PLAN

Fugro Project Number 78-308-26 — Sheet 1 of 8

SCS Contract Number 53-8A02-9-00046



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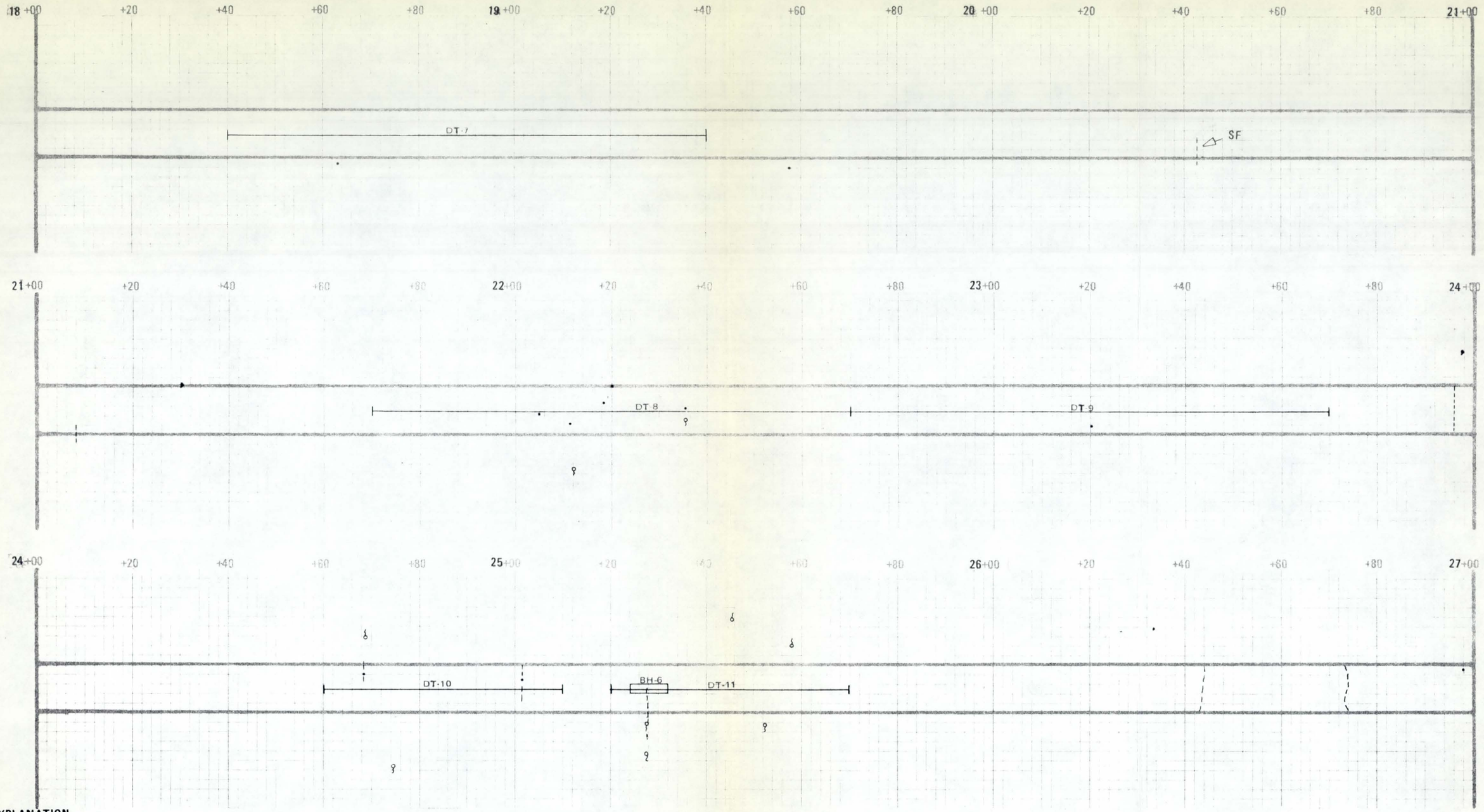
SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 4
FLOOD RETARDING STRUCTURE
CRACK LOCATION PLAN

Fugro Project Number 78-308-26 — Sheet 2 of 8

SCS Contract Number 53-8A02-9-00046



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DT-4 — Ditch Witch Trench Area

BH-3 — Backhoe Exploratory Area

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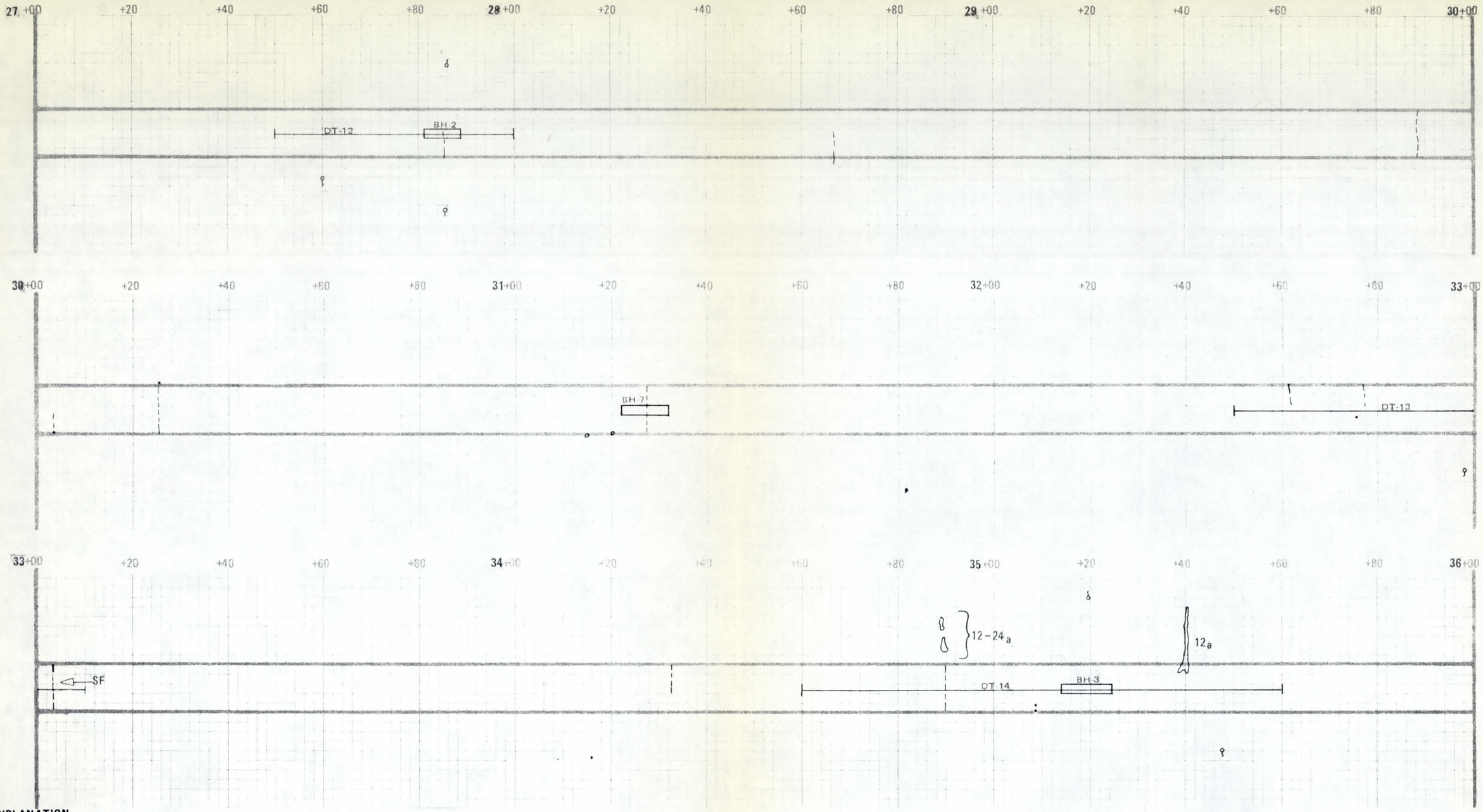
SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 4
FLOOD RETARDING STRUCTURE
CRACK LOCATION PLAN

Fugro Project Number 78-308-26 — Sheet 3 of 8

SCS Contract Number 53-8A02-9-00046



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- c — > 2'

DT-4 — Ditch Witch Trench Area

BH-3 — Backhoe Exploratory Area

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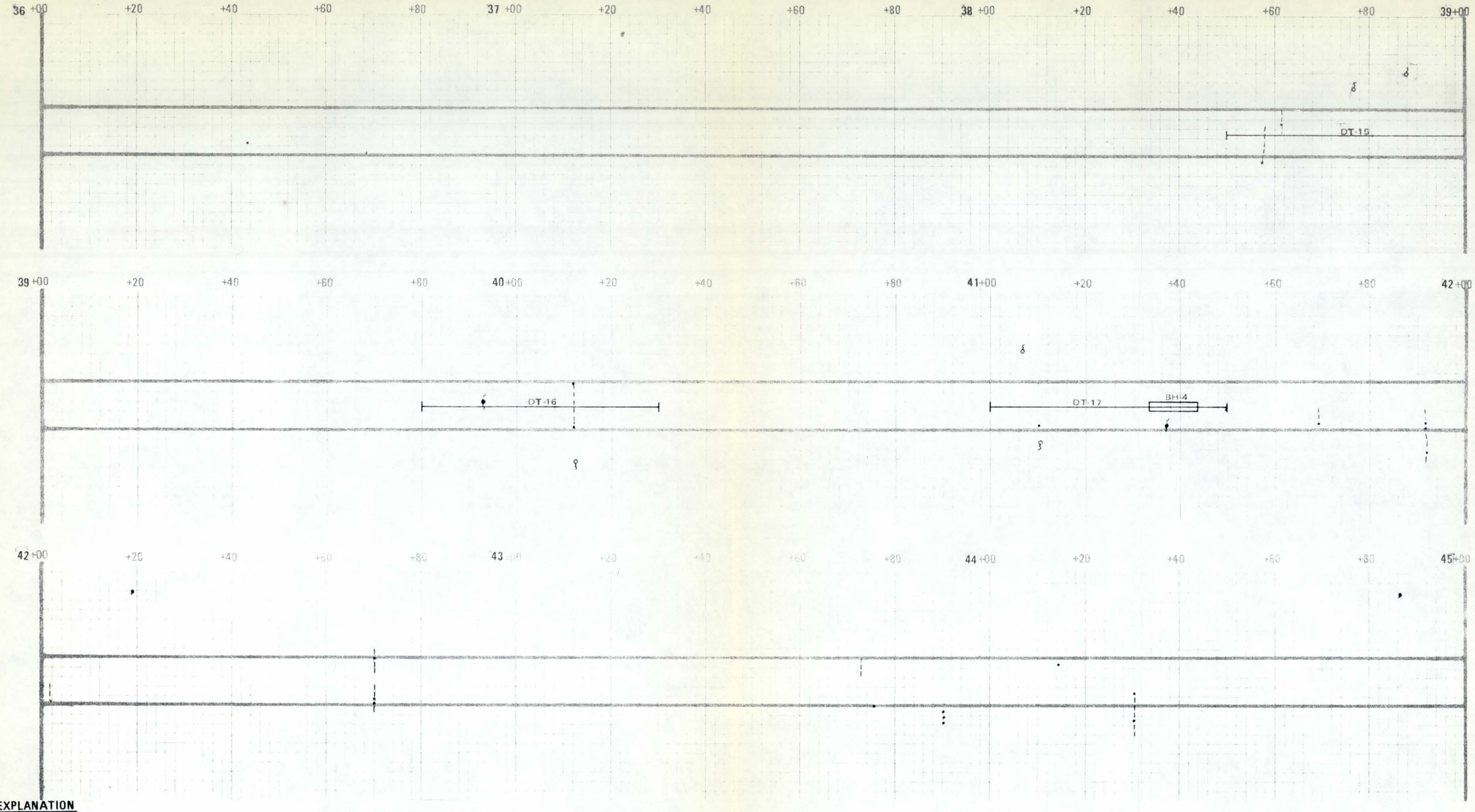
SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 4
FLOOD RETARDING STRUCTURE
CRACK LOCATION PLAN

Fugro Project Number 78-308-26 — Sheet 4 of 8

SCS Contract Number 53-8A02-9-00046



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- b 1' ≤ x ≤ 2'
- c > 2'

DT-4 — Ditch Witch Trench Area

BH-3 — Backhoe Exploratory Area

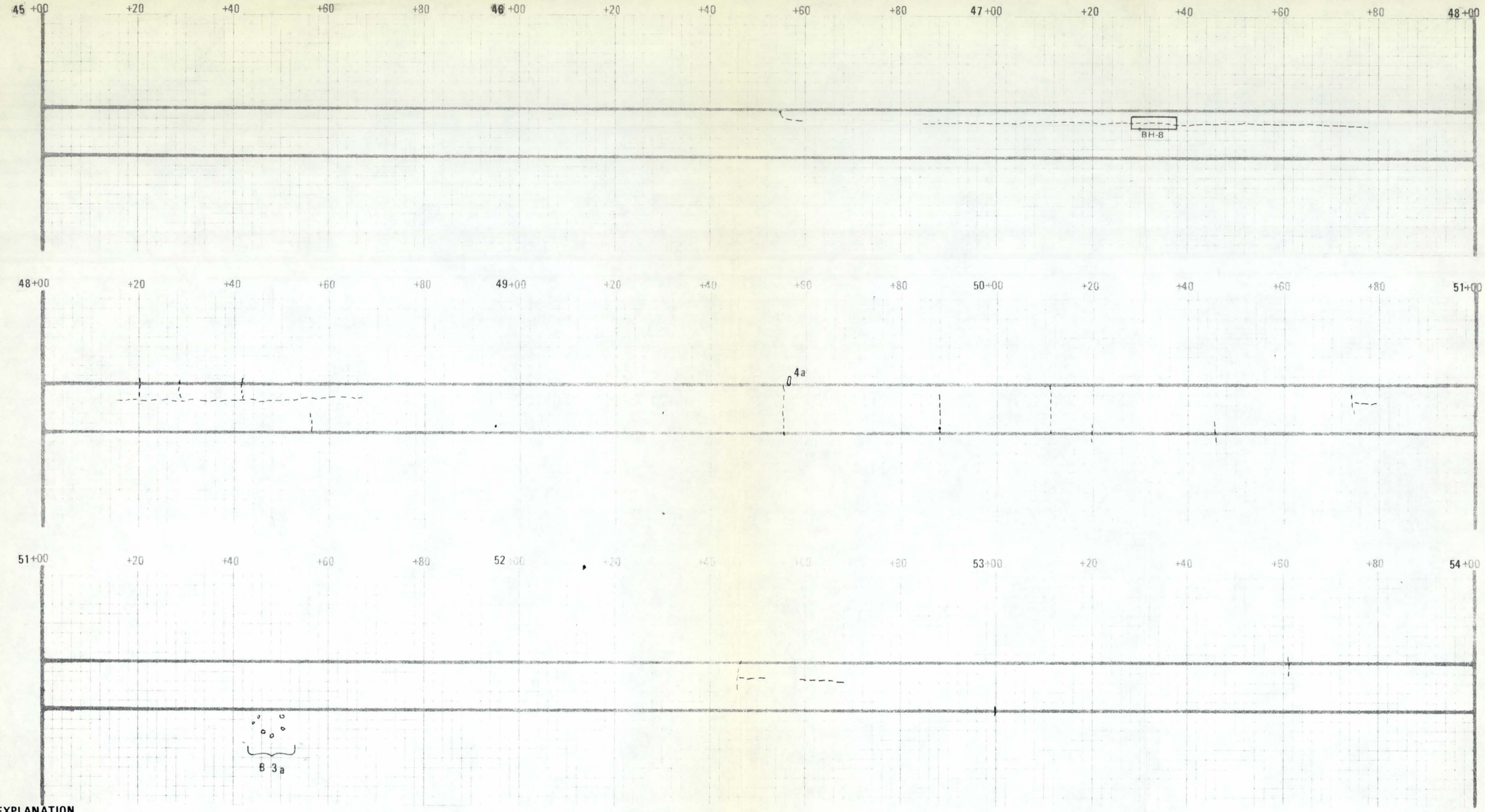
FUGRO

SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 4
FLOOD RETARDING STRUCTURE

CRACK LOCATION PLAN

Fugro Project Number 78-308-26 — Sheet 5 of 8
SCS Contract Number 53-8A02-9-00046



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Example: 6 b — Number indicates width or diameter (inches) of feature. Letter (a,b, or c) indicates range of depth (x) probed

- a 2" < x < 1'
- b 1' ≤ x ≤ 2'
- c > 2'

DT-4 — Ditch Witch Trench Area

BH-3 — Backhoe Exploratory Area

FUGRO

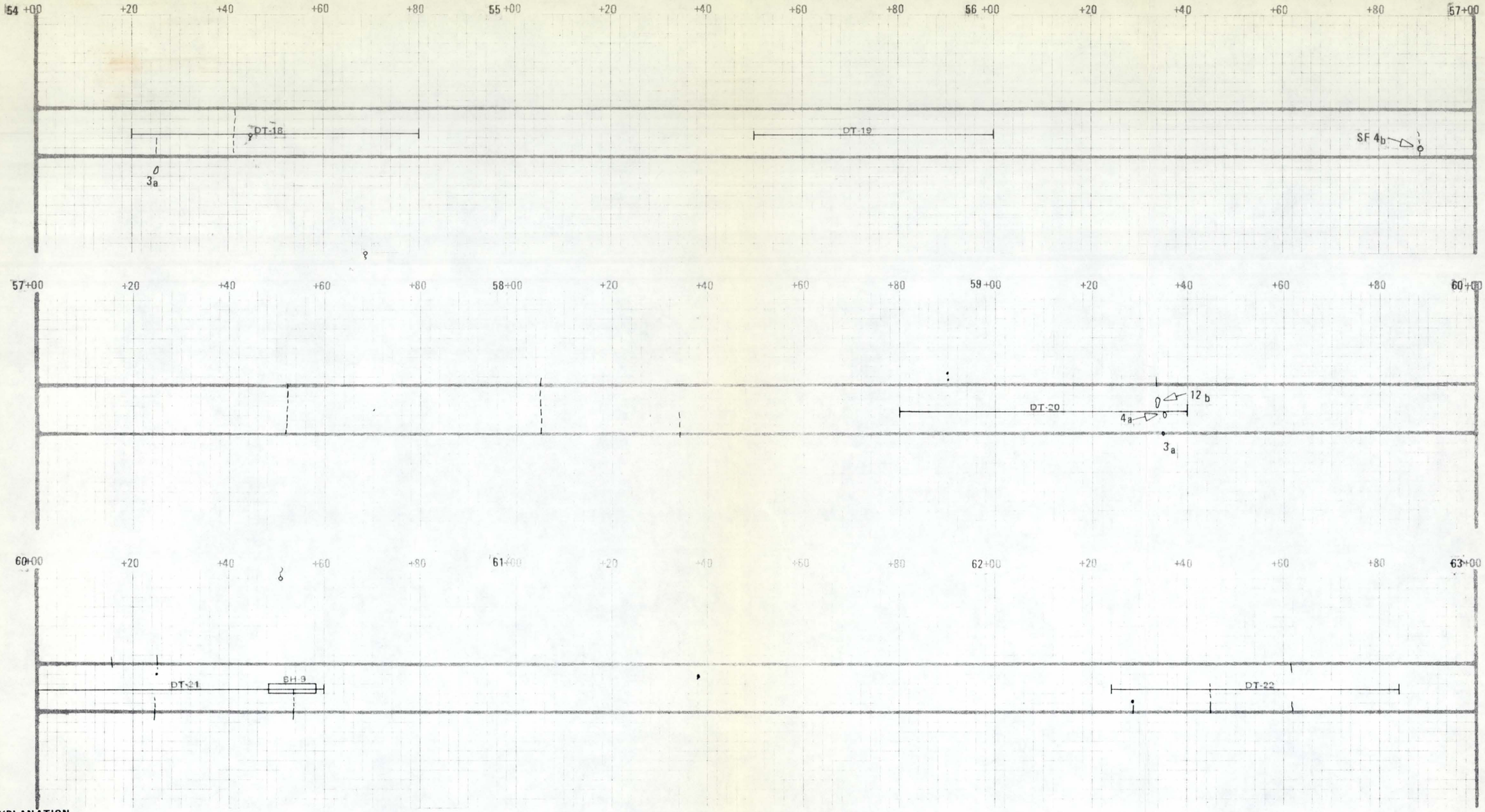
SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 4
FLOOD RETARDING STRUCTURE

CRACK LOCATION PLAN

Fugro Project Number 78-308-26 — Sheet 6 of 8

SCS Contract Number 53-8A02-9-00046



EXPLANATION

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- ? flooding induced pipe or crack outlet
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Feature > 2" (width or diameter)

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- b 1' ≤ x ≤ 2'
- c > 2'

DT-4 — Ditch Witch Trench Area

BH-3 — Backhoe Exploratory Area

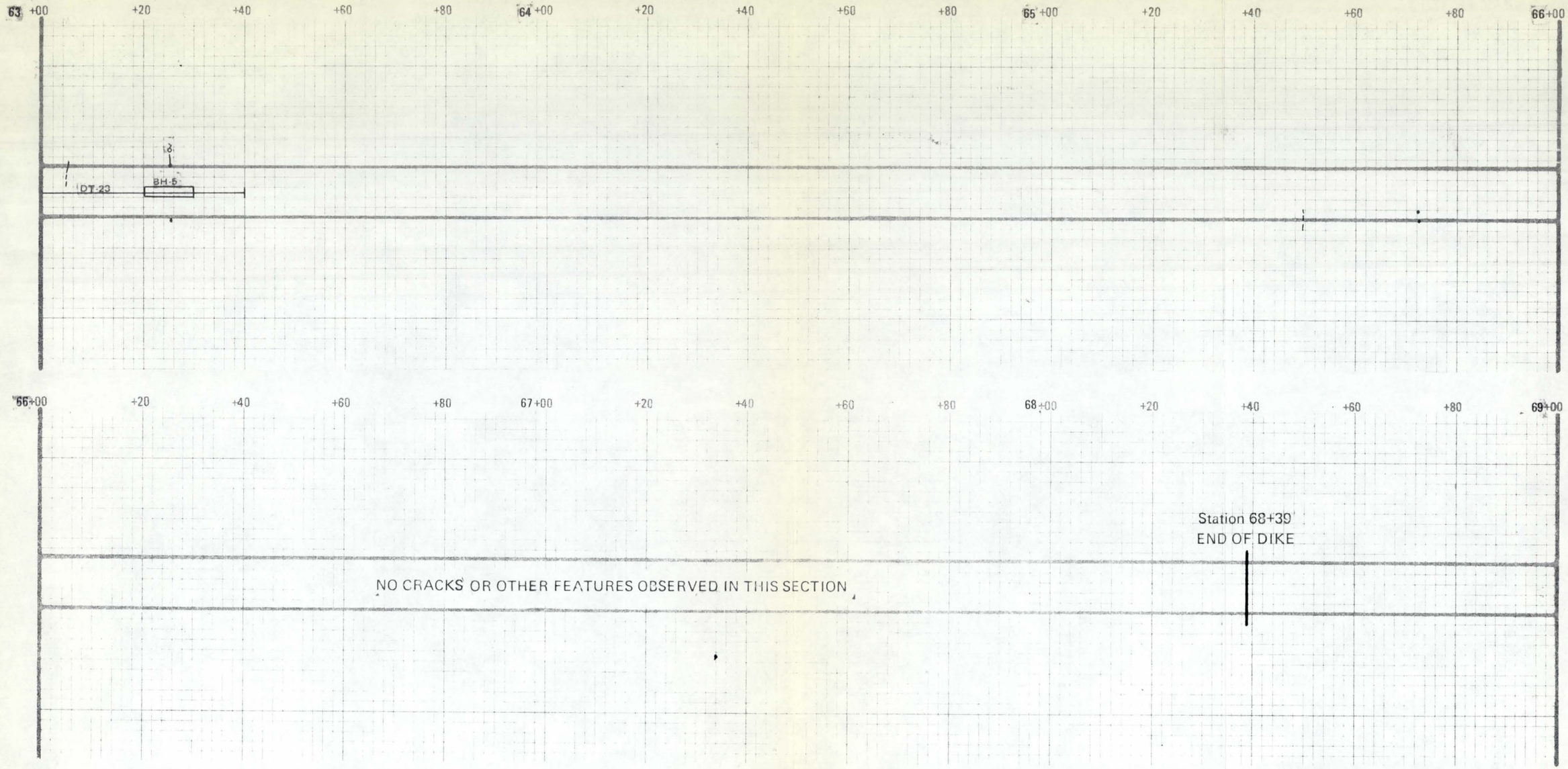
FUGRO

SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 4
FLOOD RETARDING STRUCTURE
CRACK LOCATION PLAN

Fugro Project Number 78-308-26 — Sheet 7 of 8

SCS Contract Number 53-8A02-9-00046



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- flooding induced pipe or crack outlet
- B — suspected Animal burrow

Feature > 2" (width or diameter)

Example:

6b — Number indicates width or diameter (inches) of feature. Letter (a,b, or c) indicates range of depth (x) probed

- a — 2" < x < 1'
- b — 1' ≤ x ≤ 2'
- c — > 2'

DT-4 — Ditch Witch Trench Area

BH-3 — Backhoe Exploratory Area

FUGRO

SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 4
FLOOD RETARDING STRUCTURE
CRACK LOCATION PLAN

Sheet 8 of 8

Fugro Project Number 78-308-26
SCS Contract Number 53-8A02-9-00046

NOTES	Torvane kips/ft.^{2}	TRENCH PROFILE	Depth (feet)	SOIL DESCRIPTION
	0.6		0	SILTY SAND (SM) brown (7.5YR 5/4) medium dense, calcareous, moist.
No visible crack above pipe			1	
pipe 4" to 6" in diameter - 36" deep				
	0.7		2	CLAYEY SAND (SC) strong brown (7.5YR 5/6) medium dense, calcareous, slightly moist.
Crack discontinuously filled with fine to coarse sand 3/4" wide 24 to 30" deep, non-calcareous.			3	
	0.8		4	SILTY SAND - SANDY SILT (SM - ML) dark yellowish brown (10YR 4/6) medium dense, calcareous, dry.
			5	Trench Depth 4.9'
			6	
			7	
			8	
			9	
			10	
			11	
			12	
			13	
			14	
			15	
	Width (feet)	0 1 2		

TRENCH PROFILE LOG

FUGRO

SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

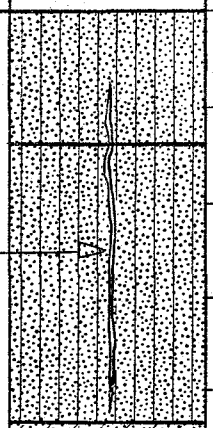
WHITE TANKS NUMBER 4

LOG OF WT4-BH1

Station 4+33

SCS Contract Number 53-8A02-9-00046

Fugro Project Number 78-308-26

NOTES	Torvane kips/ft.^{2}	TRENCH PROFILE	Depth (feet)	SOIL DESCRIPTION
	0.9		0	SILTY SAND (SM), strong brown (7.5YR 5/6), medium dense, calcareous, moist.
Crack 3/4 to 1" wide - 18" deep.	1.2		1	SILTY SAND (SM), brown (7.5YR 5/4), dense, calcareous, slightly moist.
			2	
			3	
			4	
			5	CLAYEY SAND (SC) with fine gravel, light brown (7.5YR 6/4), very dense, contains residual CaCO3 nodules, dry.
			6	
			7	
	1.4		8	
			9	
			10	
			11	Trench Depth 11.0'
			12	
			13	
			14	
			15	
	Width (feet)	0 1 2		

TRENCH PROFILE , LOG

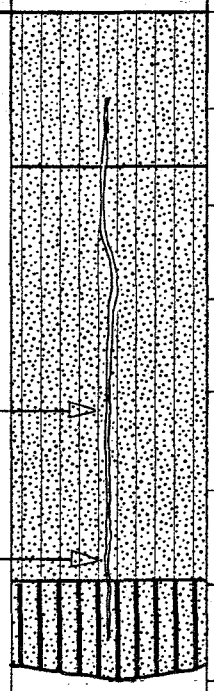
FUGRO

SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 4
LOG OF WT4-BH2
Station 27+85

SCS Contract Number 53-8A02-9-00046

Fugro Project Number 78-308-26

NOTES	Torvane kips/ft.^{2}	TRENCH PROFILE	Depth (feet)	SOIL DESCRIPTION
	0.6		0	SILTY SAND (SM), strong brown (7.5 YR 5/6), medium dense, calcareous, moist.
	0.9		1	
			2	
			3	
Crack 3/4" to 1" wide - 40" deep.			4	SILTY SAND (SM), with fine gravel, strong brown (7.5YR 5/6) dense, calcareous, slightly moist.
	1.0		5	
lower 14" filled with sand & some gravel (loose - torvane 0.5)			6	SILTY SAND - SANDY SILT (SM - ML), with fine gravel dark yellowish brown (10YR 4/6), dense to very dense, contains residual CaCo3, dry.
	1.2		7	Trench Depth 7.0'
			8	
			9	
			10	
			11	
			12	
			13	
			14	
			15	
	Width (feet)	0 1 2		

TRENCH PROFILE LOG

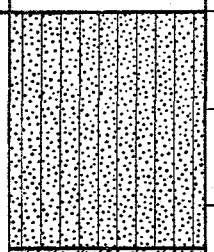
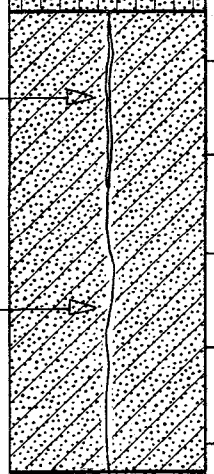
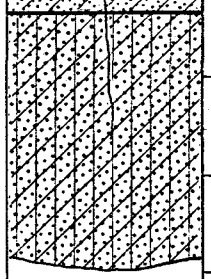
FUGRO

SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 4
LOG OF WT4-BH3
Station 35+20

SCS Contract Number 53-8A02-9-00046

Fugro Project Number 78-308-26

NOTES	Torvane kips/ft.^{2}	TRENCH PROFILE	Depth (feet)	SOIL DESCRIPTION
	0.8		0 1 2	SILTY SAND (SM), strong brown (7.5 YR 5/6), medium dense, calcareous, moist.
Crack 1/2" wide 12" deep.			3 4	
	1.2		5	CLAYEY SAND (SC) with fine gravel, light brown (7.5 YR 6/4) dense, calcareous, dry.
Hairline crack			6 7	
			8	SILTY SAND - CLAYEY SAND (SM-SC) strong brown (7.5YR 5/6), dense to very dense, calcareous, dry.
				Trench Depth 8.6'
			9 10 11 12 13 14 15	
	Width (feet)	0 1 2		

TRENCH PROFILE LOG

FUGRO

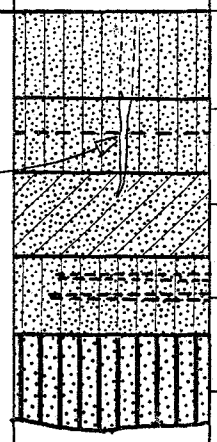
SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 4
LOG OF WT4-BH4

Station 41+38

SCS Contract Number 53-8A02-9-00046

Fugro Project Number 78-308-26

NOTES	Torvane kips/ft.^{2}	TRENCH PROFILE	Depth (feet)	SOIL DESCRIPTION
	0.6		0	SILTY SAND (SM), brown (7.5YR 5/4) medium dense, calcareous, moist.
SAND (SP), yellowish brown (10 YR 5/6), loose crack 3/4" to 1 1/2" wide - sand filled.	0.8		1	SILTY SAND (SM), strong brown (7.5YR 5/6), change to light brown (7.5 YR 6/4) at 1.3', medium dense, calcareous, slightly moist.
	1.1			
	1.2		2	CLAYEY SAND (SC), dark yellowish brown (10YR4/6), medium dense, calcareous, slightly moist.
	1.2		3	SILTY SAND (SM) with gravel lenses, strong brown (7.5 YR 5/6) medium dense, calcareous, slightly moist.
	1.3		4	SANDY SILT (ML), brownish yellow (10YR 6/6), dense contains residual $CaCO_3$, dry.
			5	Trench Depth 4.4'
			6	
			7	
			8	
			9	
			10	
			11	
			12	
			13	
			14	
			15	
	Width (feet)	0 1 2		

TRENCH PROFILE LOG

FUGRO

SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 4
LOG OF WT4-BH5
Station 63+25

SCS Contract Number 53-8A02-9-00046

Fugro Project Number 78-308-26

NOTES	Torvane kips/ft.^{2}	TRENCH PROFILE	Depth (feet)	SOIL DESCRIPTION
	0.6		0	
layer of coarser material, higher percentage of coarse sand and fine gravel.	0.7		1	SILTY SAND (SM), strong brown (7.5 YR 5/6), medium dense, calcareous, moist.
	0.6			
4" Diameter - possilbe burrow - probed 87" horizontally.			2	
	1.3		3	SILTY SAND - SANDY SILT (SM-ML), light brown (7.5 YR 6/4) medium dense, calcareous, moist.
			4	Tench Depth 4.2'
			5	
			6	
			7	
			8	
			9	
			10	
			11	
			12	
			13	
			14	
			15	
	Width (feet)	0 1 2		

TRENCH PROFILE LOG

FUGRO

SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 4
LOG OF WT4-BH6
Station 25+28

SCS Contract Number 53-8A02-9-00046

Fugro Project Number 78-308-26

NOTES	Torvane kips/ft.^{2}	TRENCH PROFILE	Depth (feet)	SOIL DESCRIPTION
	0.8		0	
3" pipe - probed 15" horizontally.	1.1		1	SILTY SAND (SM), strong brown (7.5 YR 5/6) medium dense, calcareous, moist.
Crack filled with fine to coarse sand and fine gravel 1/2" to 1 1/2" wide.	1.2		2	SILTY SAND (SM), light brown (7.5 YR 6/4) dense, calcareous, slightly moist.
			3	
	1.3		4	
3" wide zone of hairline cracks less than 1/8" separation.			5	CLAYEY SAND (SC), light yellowish brown (10 YR 6/4) dense to very dense, calcareous, dry.
			6	
			7	
	1.4		8	Trench Depth 8.3'
			9	
			10	
			11	
			12	
			13	
			14	
			15	
	Width (feet)	0 1 2		

TRENCH PROFILE LOG

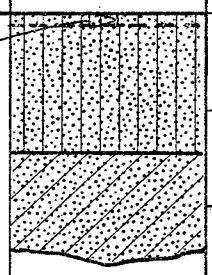
FUGRO

SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 4
LOG OF WT4-BH7
Station 31+27

SCS Contract Number 53-8A02-9-00046

Fugro Project Number 78-308-26

NOTES	Torvane kips/ft.^{2}	TRENCH PROFILE	Depth (feet)	SOIL DESCRIPTION
LONGITUDINAL CRACK Hairline crack in crusted upper layer only less than 1/16" wide - less than one inch deep.	1.1		0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	SILTY SAND (SM), strong brown (7.5 YR 5/6) medium dense, calcareous, moist. CLAYEY SAND (SC), strong brown (7.5 YR 5/6) medium dense, calcareous, slightly moist. Trench Depth 2.6'
		Width (feet) 0 1 2		

TRENCH PROFILE LOG

FUGRO

SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 4
LOG OF WT4-BH8
Station 47+35

SCS Contract Number 53-8A02-9-00046

Fugro Project Number 78-308-26

NOTES	Torvane kips/ft.^{2}	TRENCH PROFILE	Depth (feet)	SOIL DESCRIPTION
			0	
	0.8		1	SILTY SAND (SM), strong brown (7.5YR 5/6), medium dense, calcareous, moist.
upper 10" filled with SILTY SAND (SM) (same as upper unit)				
crack 1/2" to 3/4" wide - probed 47".	1.0		2	CLAYEY SAND - SILTY SAND (SC - SM), light brown (7.5 YR 6/4) medium dense to dense, calcareous, slightly moist.
lense of coarser material - higher percentage of coarser sand and fine gravel.	1.1		3	
	1.2		4	
	1.3		5	SILTY SAND - SANDY SILT (SM - ML) brown (7.5 YR 5/4), dense to very dense contains residual CaCO3 nodules, dry.
lower 22" of crack filled with fine to coarse sand.				
	1.5		6	
				Trench Depth 6.6'
			7	
			8	
			9	
			10	
			11	
			12	
			13	
			14	
			15	
	Width (feet)	0 1 2		

TRENCH PROFILE LOG

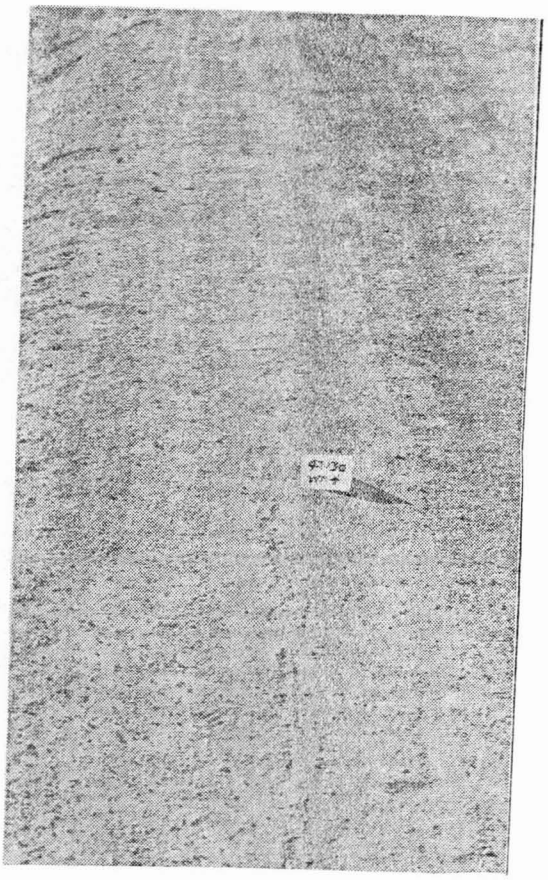
FUGRO

SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 4
LOG OF WT4-BH9
Station 60+53

SCS Contract Number 53-8A02-9-00046

Fugro Project Number 78-308-26



Incipient longitudinal crack extends from station 46+84 to 47+78. The photograph was taken prior to the December, 1978 storm.

SCALE:

0 1 2 3

feet

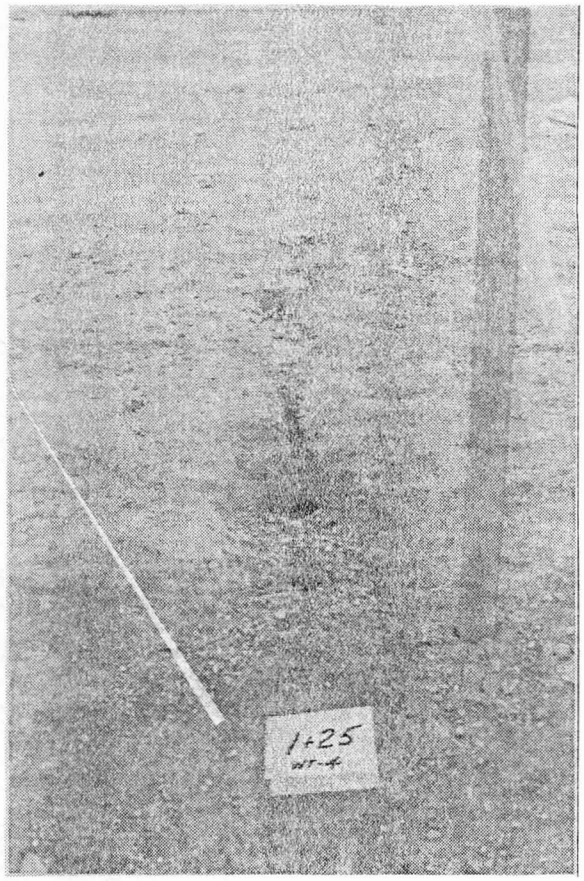
Same area as shown above in January 1979, note filling or "healing" of crack. Backhoe trench BH-8 was excavated along crack at station 47+35. The crack was present only in the crusted upper silty sand layer, extending less than one inch deep.

SCALE:

0 3 6

inches

Note: Scales vary with perspective away from station markers.



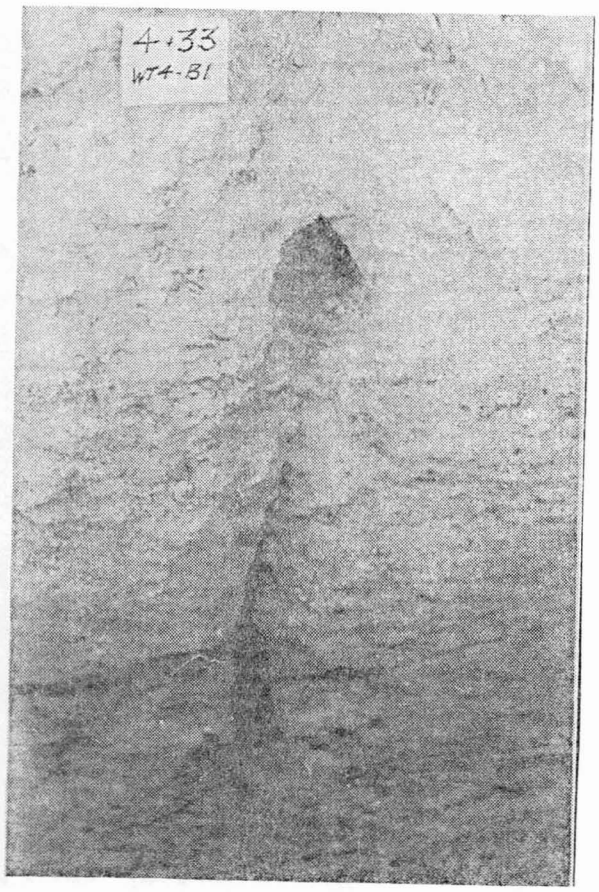
One inch wide crack and associated pipes at station 1+25. Flood induced piping from trench DT-1 occurred at this location.

SCALE:
0 6 12
inches

Flood induced piping occurred at station 4+33 from trench DT-2. Backhoe trench BH-1 was excavated at this location.

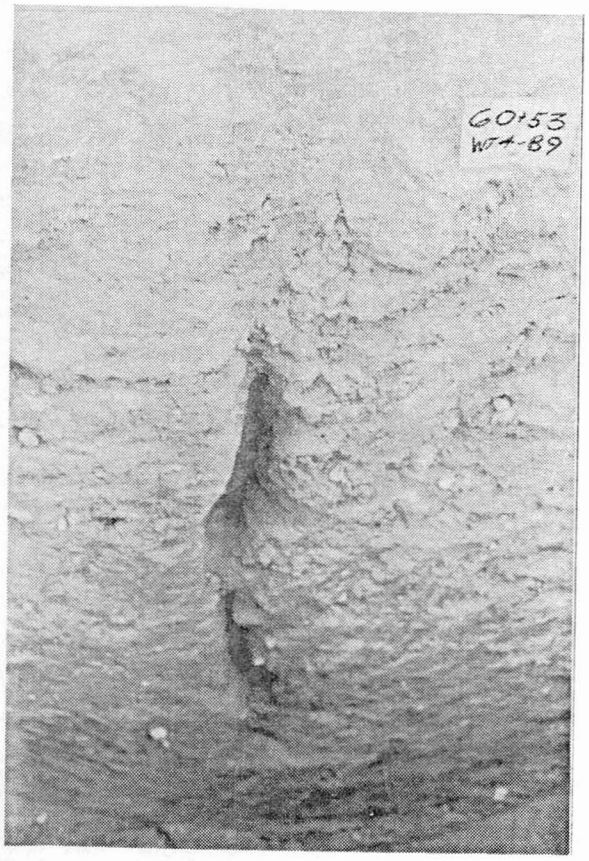
SCALE:
0 1 2
feet

Note: Scales vary with perspective away from station markers.



Six inch diameter pipe, probed horizontally 36 inches, exposed in BH-1 (station 4+33). Below this pipe, 0.75 inch wide crack extended to 3.8 feet below the crest grade. DT-2 induced piping at this location.

SCALE:
0 6 12
inches



In backhoe trench BH-9 one-half inch wide crack extends from 1.1 to 6.2 feet at station 60+53 (refer to trench profile log). Flood induced piping occurred at this location from trench DT-21.

SCALE:
0 6 12
inches

Note: Scales vary with perspective away from station markers.