PHASE I INSPECTION REPORT

FOR

WHITE TANKS RETARDING DAM NO. 3

I.D. NO. AZ00108

MARICOPA COUNTY, ARIZONA

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PHASE I INSPECTION REPORT

FOR

WHITE TANKS RETARDING DAM NO. 3

I.D. NO. AZ00108

MARICOPA COUNTY, ARIZONA

NATIONAL PROGRAM

FOR INSPECTION OF DAMS

Prepared for

THE STATE OF ARIZONA
DEPARTMENT OF WATER RESOURCES

by

ERTEC WESTERN, INC.
Phoenix, Arizona

August 1981

DEPARTMENT OF THE ARMY
LOS ANGELES DISTRICT, CORPS OF ENGINEERS
P. O. BOX 2711
LOS ANGELES, CALIFORNIA 90053

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,

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. 3
I.D. NO. AZ00108
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. 3 is considered to be a high hazard, intermediate size structure. Results of the hydrologic and hydraulic analysis indicate the spillway is capable of passing approximately 60 percent of the probable maximum flood, and it is therefore considered to be inadequate. A flood equivalent to the probable maximum flood would overtop the entire dam crest up to a maximum of 1.12 feet for a period of 1.25 hours.

The surficial condition of the dam embankment appears to be good, and it appears to be performing its intended flood retention function. However, geotechnical studies performed in 1979 indicated that about forty 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. Results of previous cracking investigations (Fugro, 1979) indicate the embankment should be considered unsafe, non-emergency.

Based on results of the inspection, several recommendations regarding the operation and maintenance of the facility have been made. These include development of a warning system and evacuation plan, brush and sediment removal from outlet structures, fencing to prevent off-road vehicles from driving over the dam surfaces, controlling of burrowing animals by grading the slope surfaces or covering them with a rock or gravel blanket, and Phase II investigations to evaluate methods for modifying the spillway to accommodate the probable maximum flood, a geotechnical investigation to determine the cause of recent cracking, and an evaluation of any proposed remedial measures to mitigate cracking.

<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

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WHITE TANKS RETARDING DAM NO. 3

I.D. NO. AZ00108

MARICOPA COUNTY, ARIZONA

PERTINENT DATA

WATERSHED	
Stream:	Avondale Wash
Tributary To:	Gila River
County:	Maricopa
Damsite Location:	Sections 4,8,&9, T2N, R2W, G&SRB&M
Latitude:	33°32' N
Longitude:	112°28' W
Drainage Area:	23.69 square miles
Elevation of Watershed:	
Maximum:	4,083 feet
Minimum:	1,185 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:	1,216.0 feet
Streambed Elevation:	1,187.2 feet
Hydraulic Height:	28.8 feet
Crest Width:	10.0 feet
Crest Length:	7,667 feet
Roadway:	Local access
Embankment Slope	
Upstream:	2-1/2:1
Downstream:	2:1
Slope Protection:	Caliche and coarse gravel facing
Drains:	None

RESERVOIR	Elevation (Feet)	Area (Acres)	Capacity (Acre-Feet)
Principal Spillways: "K"	1,193.65		
"L"	1,191.68		
"M"	1,192.56		
Emergency Spillway Crest:	1,210.0	294	2,655
Dam Crest:	1,216.0	420	4,800

Hazard Class: High

Nearest Town: Buckeye

Distance: 12 miles southwest

PRINCIPAL SPILLWAYS

Type: Controlled - CMP

	"K"	"L"	"M"
Size (inches):	48	48	24
Length (feet):	109	117	116
Invert Elevation (feet):	1,190.20	1,188.24	1,190.30
Intake Elevation (feet):	1,193.65	1,191.68	1,192.56
Rating (cfs):	225	225	46

Stilling Basin: Trapezoidal shaped - gunite lined

EMERGENCY SPILLWAY

Type: Unlined curved open channel

Location: Right abutment

Crest Elevation: 1,210.0 feet at Station 0+00

Control Section Width: 1,100 feet

Channel Length: 700± feet

Slope: 0.0045, Station 0+00 to Station 7+00

Inlet Channel: Reservoir

Discharge Channel: Trapezoidal earth, slope = 0.0045

Material: Fine grained alluvial deposits

Rating: 48,000 cfs at WS Elevation 1,216.0 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

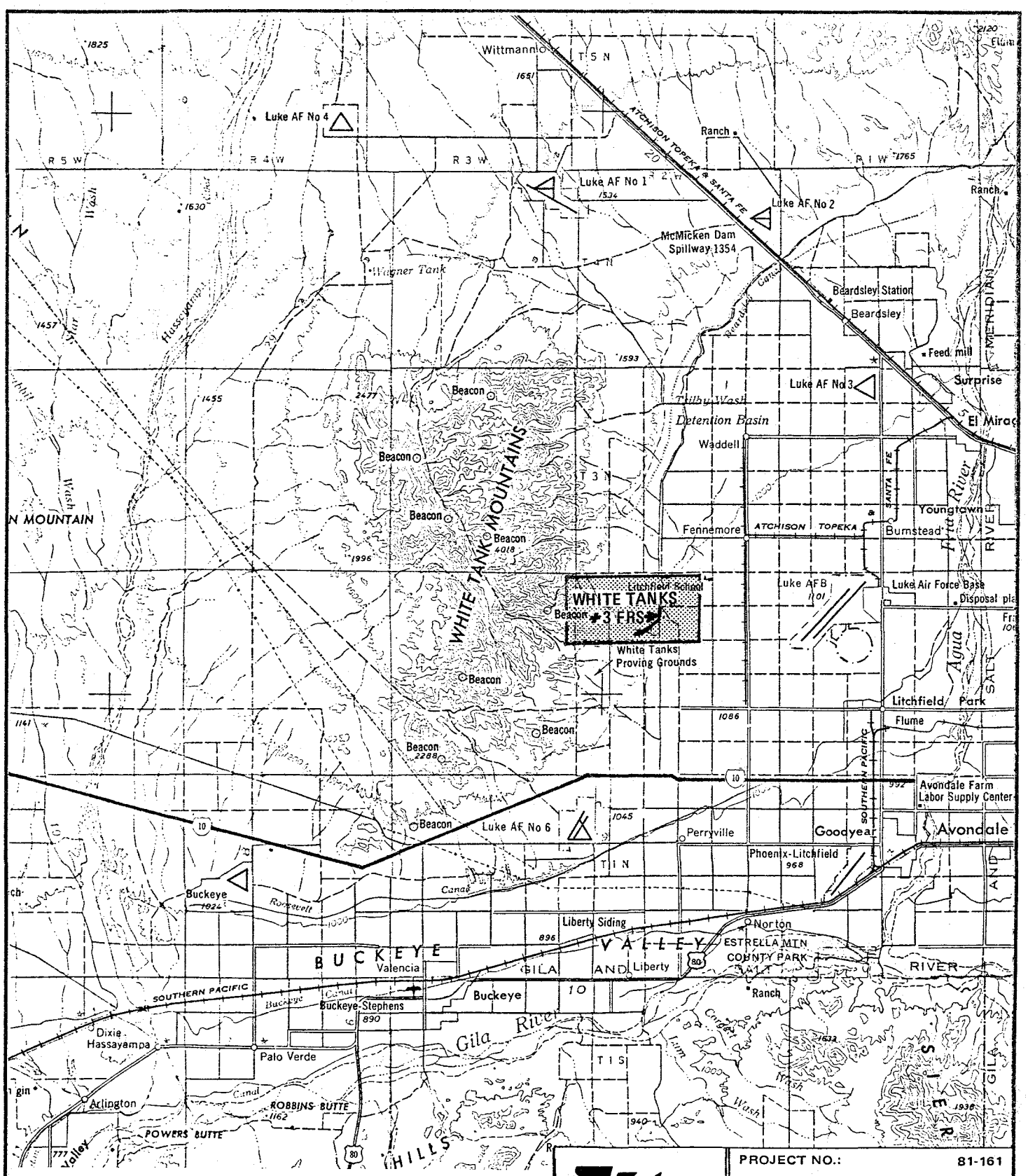
DESCRIPTION OF PROJECT

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 12 miles northeast of Buckeye in Maricopa County (USDA, 1954). Location of the dam is shown in Figure 1. It is in Sections 4, 8, and 9, Township 2 North, Range 2 West, G & SRB & M, at Latitude 33° 32' North and Longitude 112° 28' 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 dams, to low hills and steep mountains with slopes ranging from 10 to over 80 percent. Elevations range from 1,185 feet above sea level at the dam, to 4,083 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. 3 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

The White Tanks Retarding Dam No. 3 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 7,667 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 134 feet at the base. Maximum height above the streambed is about 29 feet. To provide for settlement, a one foot overfill was added to the top of the dam. Upstream sideslopes of the dam are 2-1/2:1, downstream side slopes of the dam are 2:1.

2.4 PRINCIPAL SPILLWAYS

The principal spillways (outlet works) consist of a 24-inch and a 48-inch corrugated metal pipe (CMP) located in the southwesterly segment of the dam, and a 48-inch CMP located in the northern segment. The 24-inch CMP is identified as Outlet "M", the 48-inch CMP in the southwesterly segment is identified as Outlet "L", and the 48-inch CMP in the northern segment is identified as Outlet "K". Locations and physical descriptions of the outlets are shown in Table 2.

Each outlet is 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-rising stem arrangement with the stem attached to anchor blocks on the upstream face. All three intakes were designed to be protected with trash racks, however, none were in place during the site inspection.

Each outlet discharges into a gunite lined, trapezoidal shaped energy dissipating structure with a flat bottom and 1:1 side slopes. Bottom width of the structure for Outlet "L" is 6 feet

TABLE 2

PRINCIPAL SPILLWAYS

ITEM	UNIT	OUTLET "K"	OUTLET "L"	OUTLET "M"
Location	Station	29+00	46+00	63+80
Diameter	Inches	48	48	24
Type		CMP	CMP	CMP
Min.Lip Elevation	Feet	1193.65	1191.68	1192.56
Slope		0.00184	0.0020	0.0024
Invert Elevation-Upstream	Feet	1190.2	1188.24	1190.3
Invert Elevation-Downstream	Feet	1190.0	1188.0	1190.0
Length	Feet	109	117	116

and it is 15 feet long. Downstream from the outlet structure the bottom width narrows to 2 feet in a distance of 5 feet, to conform with the bottom configuration of the outlet channel.

The outlet structure for Outlet "K" is 20 feet long and its bottom width is 5 feet which conforms with the bottom configuration of the outlet channel. Invert elevation of the structure is 1,188.17 feet; invert elevation of the 48-inch pipe at the downstream end is 1,190.0 feet.

Bottom width of the outlet structure for Outlet "M" is 3 feet and it is 8 feet long. The structure has a 12-inch high end sill with a top elevation of 1,190.0 feet which conforms with

the invert elevation of the 24-inch pipe at the downstream end. Invert elevation of the energy dissipating structure is 1,189.0 feet.

2.5 OUTLET CHANNELS

The outlet channels were designed to convey releases from the gated spillways to Beardsley Canal, located immediately east from the dam, following each storm event. All channels are trapezoidal shaped with 1:1 side slopes. The channel for Outlet "L" is unlined, its bottom width is 2 feet, and the bottom slope is 0.0025. The channel for Outlet "K" is gunite lined, its bottom width is 5 feet, and its bottom slope is 0.00163. Bottom width of the channel for Outlet "M" is 5 feet, and it is unlined with a bottom slope of 0.0024.

2.6 EMERGENCY SPILLWAY

The single emergency spillway for the dam is an 1,100-foot wide curved channel excavated through the right abutment ridge. The crest elevation is 1,210.0 feet and the control section is approximately 50 feet long. The approach channel is excavated from the reservoir and it has an adverse grade of 0.002; slope of the downstream spillway channel is 0.0045. Side slopes in the spillway exit channel are 1:1.

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 height of White Tanks Retarding Dam No. 3 from the streambed to the top of the dam is about 29 feet, and the maximum storage is 4,800 acre-feet, it is apparent from the table that the dam is small using the 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, Interstate 10, and State Route 80.

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 Beardsley Canal.

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 $229,500. No major modifications have been made since the dam was constructed. However, the Soil Conservation Service and Maricopa County Flood Control District filed applications with the Arizona Department of Water Resources on June 25, 1981 for removal and replacement of about 380 lineal feet of embankment between

Station 56 + 10 and 59 + 90. Additionally proposed, are three engineered interceptor drains 200 feet in length with depths ranging from 7.5 feet to 12 feet below the top of the dam. Drainfill outlets will be located at Station 18 + 00, 29 + 00 and 42 + 00 (Appendix A).

2.12 NORMAL OPERATIONAL PROCEDURES

The dam is designed to temporarily impound flood waters from the 23.69 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 Beardsley Canal. 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.

SECTION 3.0

DESIGN AND CONSTRUCTION DATA

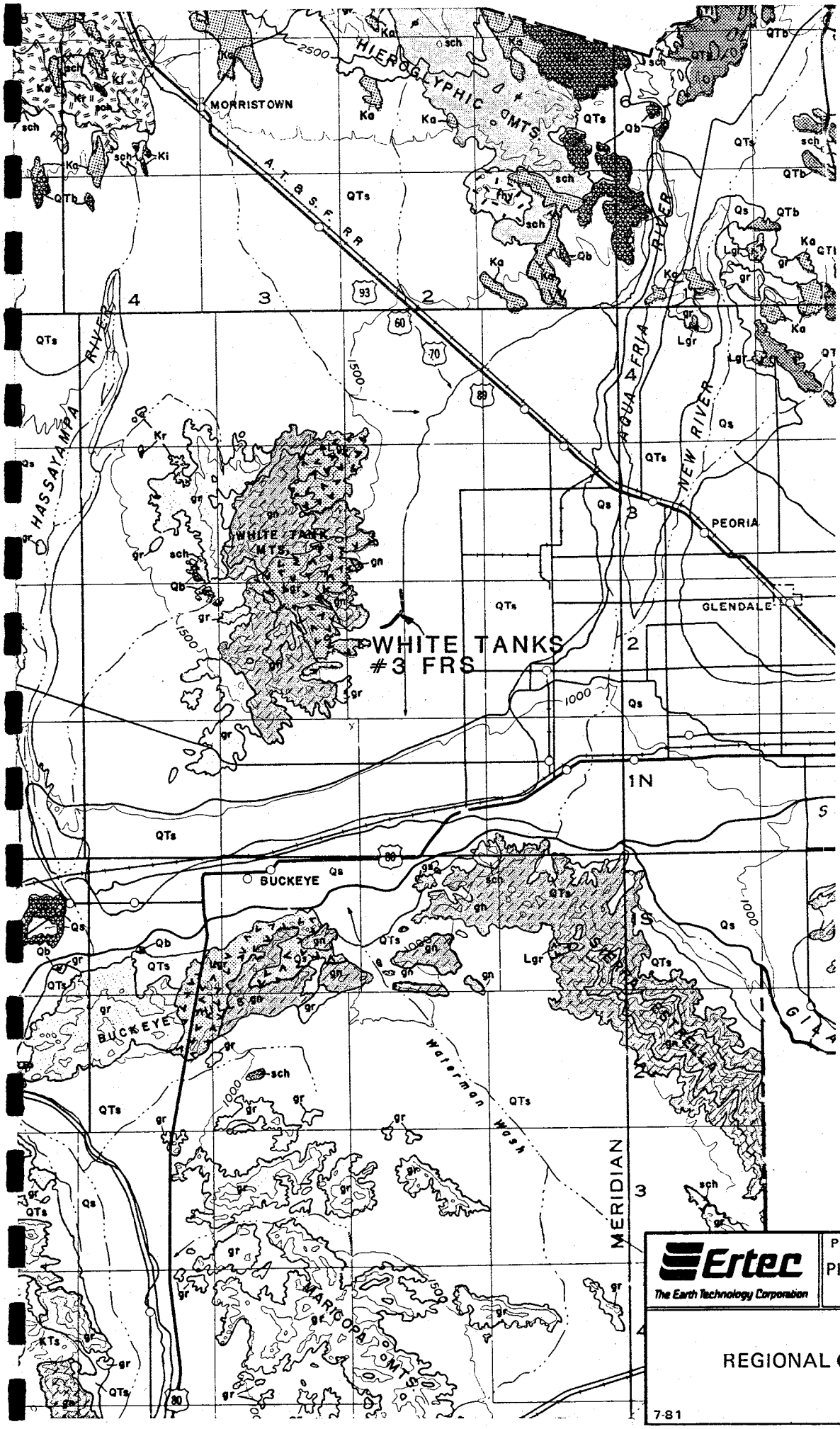
3.1 GEOLOGIC CONDITIONS

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



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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REGIONAL GEOLOGIC MAP

7-81

FIGURE 2

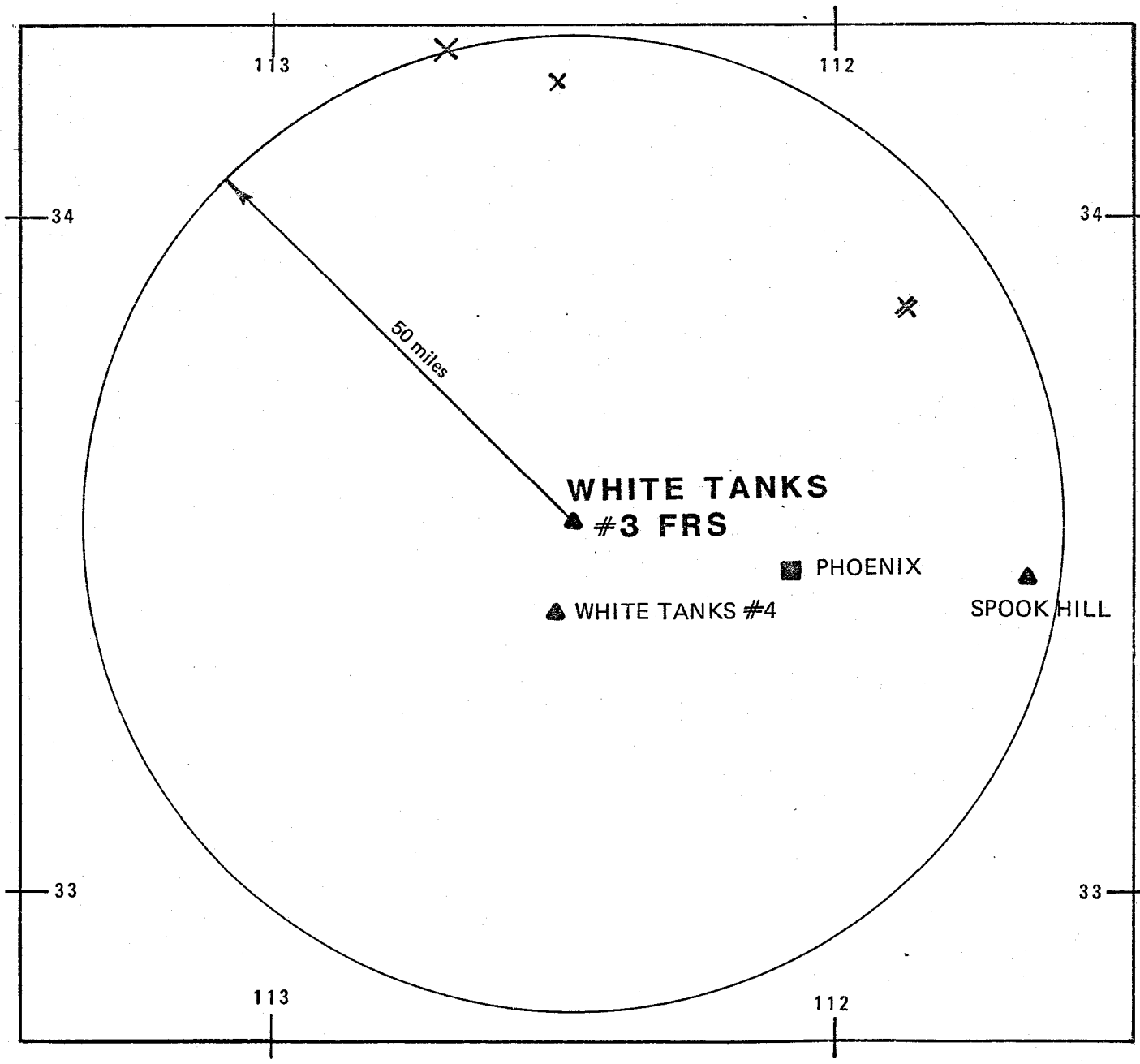
age for basin-fill deposits in southwestern Arizona (APS, 1980).

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 #3 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 115 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.



EXPLANATION

× M < 4

× 4 ≤ M < 5

FROM FUGRO 1980

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WHITE TANKS NO. 3 FRS

LOCATION OF EARTHQUAKE EPICENTERS

7-81

FIGURE 3

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 southeast of Gila Bend) to about 10 miles in length (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

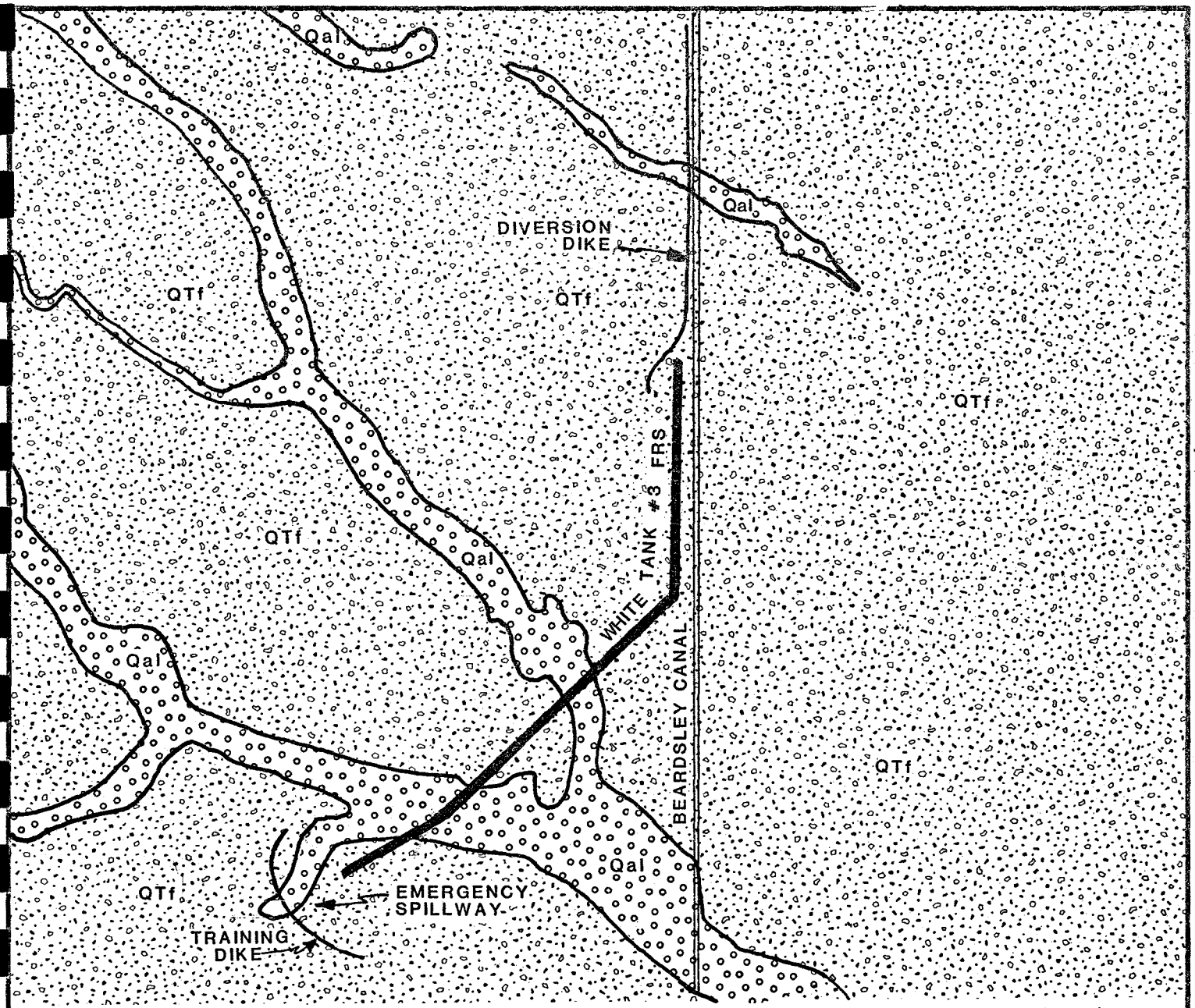
Based on our review of available records, apparently no geotechnical investigations were performed at White Tank #3 Floodwater Retarding Structure (FRS) to assess geologic and soils conditions of the dam site or borrow areas prior to construction. A geotechnical investigation was performed by Fugro (1979) 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.

The results of the crack investigation (Fugro, 1979) indicated the maximum depth of cracking below crest grade was 8 feet based on shallow trenching and flooding and to a depth of 22 feet based on backhoe pit explorations. The dominant mode of cracking was transverse, but one longitudinal crack was mapped between Station 25 + 36 and 26 + 18. Characteristics of the cracks exposed in the trench indicated filling of cracks with loose, fine to coarse sand had occurred. 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 60 percent of the structure had experienced no cracking as of the date of study, 30 percent had a low degree of cracking and 6 percent was moderately to severely cracked. Refer to Appendix E Maps, Trench Logs and Photographs from Crack Location Investigation, Fugro 1979.

A limited subsurface investigation was performed by the SCS in 1980 to characterize foundation soils between stations 53 + 00 and 59 + 00 to facilitate design of remedial repairs to the structure. The embankment soil types, included silty sand (SM), clayey sand (SC), and sandy silt (ML). Foundation soils between Station 53 and 59 include silty and clayey sand (SM-SC), silty and clayey gravels (GM-GC) and sandy silts (ML). A reconnaissance photo geologic map of the site area is shown in Figure 4.

The dam is founded on intermediate to lower slopes of Quaternary-Tertiary alluvial fans deposited on the eastern flanks of the White Tank Mountains. The predominantly younger alluvium consists of gravel, sand and silt derived from the granite and granite gneiss basement rock of the White Tank Mountains (USDA-SCS, 1977). According to an SCS soil survey of the area, the site is founded on soils of 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. 3 was about 450 feet or an elevation of 730 feet MSL.



EXPLANATION

QTf — ALLUVIAL FAN

Qal — RECENT ALLUVIUM

NORTH

NOTE:
Surficial geology interpreted from SCS Soil Survey Map from Soil Survey of Maricopa County, Arizona, Central part (1977), sheet #32, and from field reconnaissance.

0 1/4 1/2 3/4 1 Mile

0 1000 2000 3000 4000 5000 Feet

SCALE: 1:20000

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SITE SURFICIAL GEOLOGIC MAP

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FIGURE 4

Measurements by the Arizona Department of Water Resources show ground-water levels in 1980-81 as ranging from 390 feet to 420 feet below ground surface (ADWR personal communication, 1981). 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 250 feet has occurred in the site area between 1923 and 1977 (Ross, 1978).

As a result of the dewatering of the unconsolidated and semi-consolidated basin sediments and geometric relationships of buried bedrock surfaces, subsidence and earth fissuring has occurred in the site area.

Schumann (1974) reports a measured land subsidence of 1 to 3 feet in the dam area. Earth fissures are reported as being well developed about 3 miles east of the dam near Luke Air Force Base.

Continued agricultural activities in the site area will in all likelihood result in additional net declines in regional ground water. The potential for subsidence and earth fissuring to continue will remain higher. 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. 3 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 the preparation of this report.

As previously described, the dam is a compacted earth dam with the slopes and crest faced with caliche and coarse gravel. The upstream face has a slope of 2-1/2:1 (horizontal: vertical); the downstream face has a slope of 2:1. 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.

The three principal spillways (outlet works) were designated as Outlet "K", Outlet "L", and Outlet "M". Outlets "K" and "L" were designed as 48-inch diameter, gated, corrugated metal pipes with trash racks on the inlet structures. Outlet "M" was designed as a 24-inch diameter, gated, corrugated metal pipe with a trash rack on the inlet structure. However, there are no trash racks on the inlet structures at this time.

Flow through all three outlets is carried out of the dam embankment through reinforced concrete and gunite lined transition structures. For Outlet "K" the flow is carried away by a concrete lined ditch. For Outlets "L" and "M" flow is carried away by unlined ditches. Outlet "K" is located near the first quarter point south of the north end of the dam.

Outlet "L" is located near the center of the dam. Outlet "M" is located near the third quarter point south of the north end of the dam. Additional details related to the principal spillways are contained in Section 2.4 of this report.

The single emergency spillway was designed as an 1,100-foot wide, open-cut, trapezoidal channel through the west abutment. The spillway was apparently designed on the basis of hydraulic requirements only. Additional descriptive data on the emergency spillway is contained in Section 2.6 of this report.

3.3 CONSTRUCTION

No records pertaining to the construction of White Tanks Dam No. 3 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. 3 requires operational personnel. It is designed to impound floodwater and provide a controlled release of the water through the three 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 #3 on April 2, 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 subjected to some erosion over the years due to local surface runoff. The north inflow channel has been modified recently by the County. The outlet channels are in good condition having been subjected to some erosion and silt deposition. Evidence of vehicular traffic on the structure is limited in extent.

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 good 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 40 percent of the structure (based on length) is affected by transverse and longitudinal embankment cracking.

The internal structural integrity is characterized on the basis of the Fugro, 1979 crack investigation. Cracks were easily identified by the alignment of pipe-shaped features aligned transversely and/or longitudinally to the dam centerline. The pipe ranged in size from one to three inches in diameter. Pipe-features were found on both the upstream and downstream slopes, eight feet and six feet respectively below the crest. 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 discharged at four downslope locations between Station 18 + 00 and 19 + 00, 28 + 50, to 29 + 00, 42 + 00 to 42 + 50 and 57 + 90 to 58 + 40. Five backhow trenches were excavated to ascertain estimates of depth and characteristics of cracking. Crack depth ranged from 4 feet to 22 feet with crack width ranging from 1/4 to 1-1/2 inches near the top to hairline widths at depth (Refer to Appendix E).

Soils exposed on the embankment are predominantly clayey silt and clayey sand with gravel. 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 creosote-bush. Burrowing animal activity at this structure is localized. Burrows were identified on the upstream and downstream embankment slopes near the toe areas where the soils are less dense at Stations 7, 13, 16, 37, 40, 42. Burrows at the crest are concentrated near Stations 6 and 26. Vehicular activity on the structure is apparently due to the 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 which is locally severe and concentrated at Stations 6, 19, 20, 28, 34 to 36, 40, 41, and 49. Structural settlement may be affecting the embankment as indicated by an apparent sag or depression of the structures' crest at Station 9+00. The crest exhibited evidence of cracking, in the vicinity of Station 40+00, from parallel zones about 2.5 feet long through the crest at right angles to the axis. A depression is found in the crest at Station 58 which appears to be roughly coincident with a previously discovered crack reportedly affecting the structure to a depth of 21 feet (Fugro, 1979). The impact of settlement and apparent depressions in the dam crest on spillway freeboard, requires additional study with a level survey of the crest.

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 and a damaged turning gate wheel at Station 63+80. Principal spillways are located at Station 29+00, 46+00 and 63+80. The inlets consist of steel circular gates set in a steel gate frame. The gates were closed during the inspection. The gates are operated by a non-rising stem arrangement with the stem attached to anchor blocks on the upstream face. Although shown on design drawings, no trash racks were in-place at the time of the inspection. The conduit consists of circular corrugated metal pipes coated with tar. The spillway conduit is 48 inches in diameter at Station 29+00 and 46+00, and 24 inches at Station 63+80. The conduits outlet into a concrete lined channel at Station 29+00 and into unlined earthen channels at Stations 46+00 and 63+80. The conduit and channel at Station 29+00 has a minor accumulation of sand and gravel at the pipe outlet and brush where the channel lining ends. The outlet channels from Station 46+00 and 63+80 are heavily silted and brushed and the training dikes are moderately eroded due to weathering, and the dikes are cut by an access road which parallels the downstream toe of the embankment. The emergency spillway located at the dam's west abutment appears to be in good condition except that training dikes have been subjected to erosion and the spillway channel is moderately vegetated with desert growth.

4.4 RESERVOIR AREA

The storage area in the vicinity of the construction borrow excavation which parallel the embankment is relatively free from vegetation and it is regularly maintained by Maricopa County. Moderately thick growth of desert brush consisting of creosote, paloverde, and mesquite occupy the remainder of the retention basin.

Upstream from the retention basin the Case and Caterpillar Tractor Company have and continue to modify the watershed as a result of equipment testing. Modification consists of pits, trenches and berms scattered randomly throughout their property. The real extent of the excavation and their actual impact on reservoir storage were not determined during the Phase I inspection.

At the north end of the dam a diversion dike channelizes flow from the diversion and is interrupted by a recently excavated channel ditch which was constructed to direct flow away from the embankment toe. Training dikes extending to the north and southwest from the dam could possibly fail during an extreme flood event. This could alter inflow to the reservoir during these events by either increasing flow from adjacent watersheds, or runoff bypassing the reservoir.

4.5 DOWNSTREAM CHANNELS

The outlet channels at White Tanks #3 are unlined, open channels (with the exception of the channel at Station 29+00

from Outlet "K"). Easterly flow from the channel at Station 29+00 is interrupted by the Beardsley Canal. Flow from Station 46+00 and 63+80 are initially channelized to the southeast through natural drainages which are then interrupted by the Beardsley Canal.

The emergency spillway channel is trained to the southeast by a small berm. The channel is moderately vegetated. The channel soils are reported erodible. If emergency spillway discharge occurs it is conceivable the training dikes could be breached under a sustained flow. Sheet flow to the south would traverse open desert terrain until a sufficient number of natural drainages interrupted the flow, diverting it in an uncontrollable manner to the east where the Beardsley Canal might be overtopped.

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

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. Although the drainage boundary was found to be generally similar to the boundary shown in 1952 design drawings, some recent changes were noted along the southerly watershed divide caused by local access road and levee construction. The drainage area tributary to the dam was measured in the office and found to be 23.69 square miles; the area shown in the 1952 drawings was 24.1 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 9.2 inches, and the six-hour rainfall for the local storm was 12.7 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 4.7 inches; incremental rainfall for each hour during the six-hour storm are shown in the table below, along with the storm total.

TABLE 4

HYDROLOGIC DATA SUMMARY
WHITE TANKS DAM NO. 3

Item	Unit	PMF	1/2 PMF
Storm Duration	hours	6	6
Storm Precipitation	inches	12.7	
Peak Hour	inches	8.4	
Peak Inflow	cfs	89,543	44,771
Peak Inflow	csm	3,780	1,890
Peak Outflow	cfs	86,765	38,760
Peak Outflow	csm	3,663	1,636
Runoff Volume	AF	14,224	7,112
Runoff Volume	inches	11.26	5.63
Max. W.S. Elev.	feet	1,217.12	1,215.2
Top of Dam Elev.	feet	1,216.0	1,216.0
Residual Freeboard	feet	-1.12 (overtopped)	0.8
Dur. of Overtopping	hours	1.25	
Time of Conc.	hours	1.42	1.42
Lag	hours	0.85	0.85
Curve Number		88.5	88.5

Storm Hour	PMP Inches
1	0.5
2	0.7
3	1.7
4	8.4
5	0.9
6	0.5
Total	12.7

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:

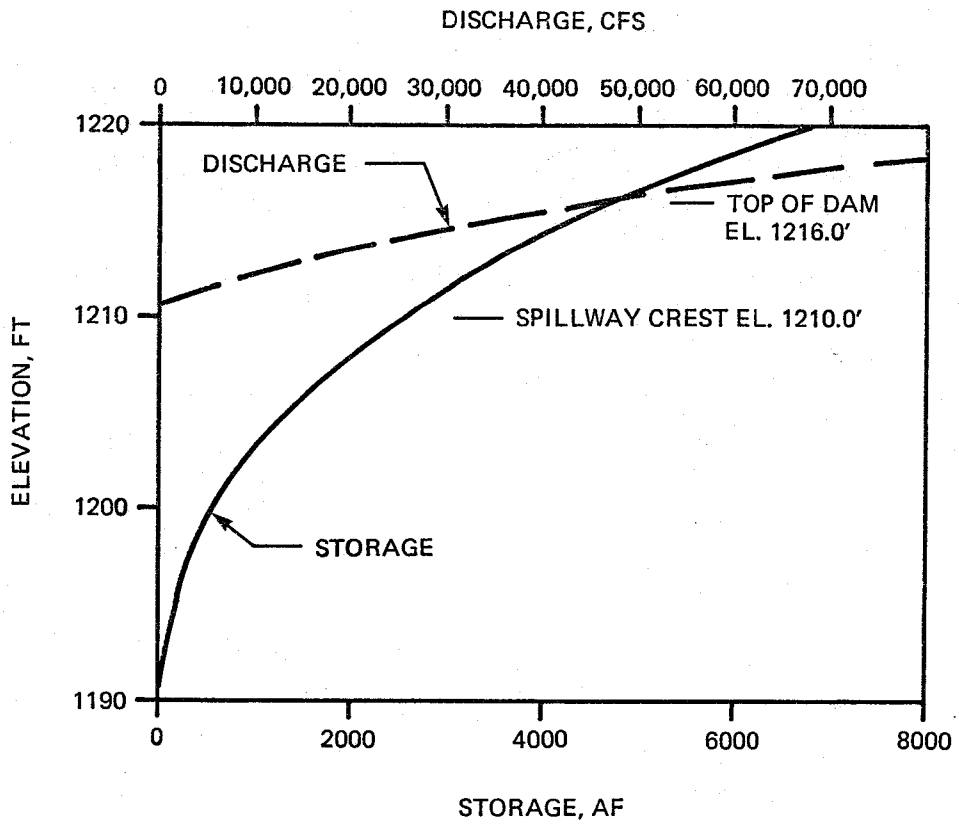
$$T_c = L^{1.15}/7700\ H^{0.38}$$

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, creosotebush, 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 88.5 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 relationship 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 three gated CMP's and an 1,100-foot wide open channel spillway excavated through the west 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.



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WHITE TANKS DAM NO. 3

STAGE-STORAGE
STAGE-DISCHARGE

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FIGURE 5

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

5.3 RESULTS

Results of the routings are shown in Table 4 for a PMF and 0.5 PMF. During a 100 percent PMF the entire dam crest would be overtopped by up to 1.12 feet for approximately 1.25 hours. The table also shows that a flood equivalent to 0.5 PMF would not overtop the dam. Comparison of maximum discharges for various percentages of the PMF indicate that all floods greater than about 60 percent of the PMF would result in overtopping the dam.

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.

SECTION 6.0

CONCLUSIONS AND RECOMMENDATIONS

Corps of Engineers guidelines indicate that White Tanks Retarding Dam No. 3 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. Results of this investigation indicate that the spillway can only accommodate 60 percent of the PMF, and the dam would experience a maximum overtopping across the entire dam crest of up to 1.12 feet for approximately 1.25 hours, during a PMF. 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 hydraulic and structural deficiencies. Specific recommendations are as follows:

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

2. Because of the known embankment cracking inadequate emergency spillway, a warning system and evacuation plan should be developed and implemented in the event of a possible dam failure.

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

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

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

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

7. The crest of the dam should be traversed by a level survey to determine the magnitude, if any, of any settlement since completion of construction. This should consist of determining ground surface elevations along the center of the crest at 20-foot intervals.

8. A Phase II investigation should be completed to further evaluate the embankment and foundation conditions and their stability, to characterize the cause(s) of recent cracking, and to provide a plan of action to correct the deficiencies in the embankment. Results of the level survey should be used to re-evaluate adequacy of the spillway, and means for modifying the spillway to accommodate the PMF should be investigated.

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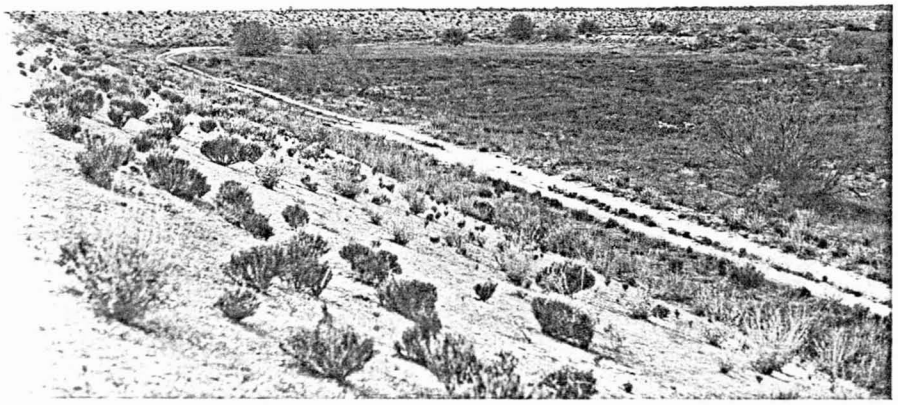
PHOTOGRAPHS

(A) VIEW OF DAM FROM NORTH ABUTMENT LOOKING SOUTH



(B) VIEW TO SOUTHWEST SHOWING UPSTREAM EMBANKMENT AND RESERVOIR

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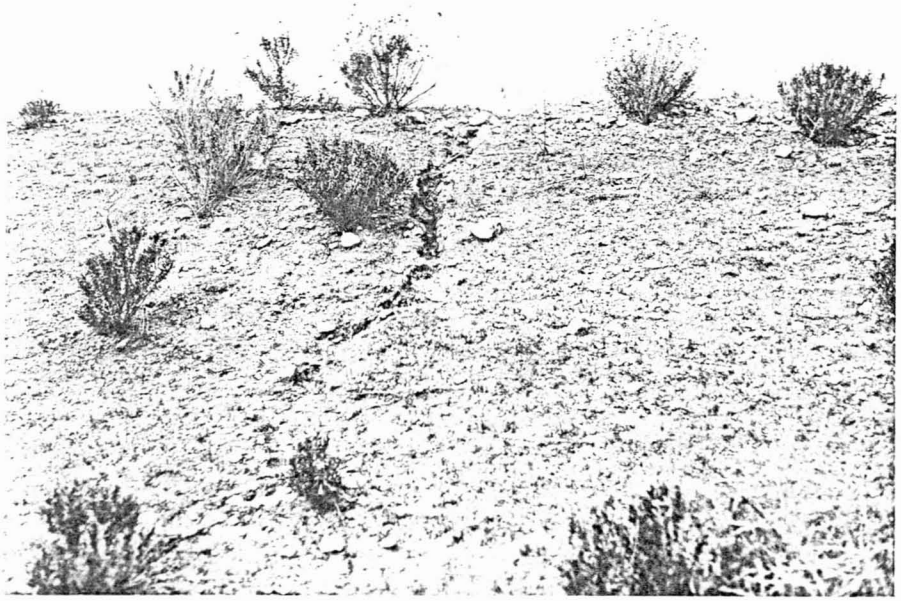
4/2/81 PHOTOGRAPH #1

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

(A) EROSION GULLEYS AT STATION 28+00 RESPONDING TO FOUR-WHEEL DRIVE VEHICLES



(B) EROSIONAL FEATURE ON DOWNSTREAM SLOPE AT STATION 9+00

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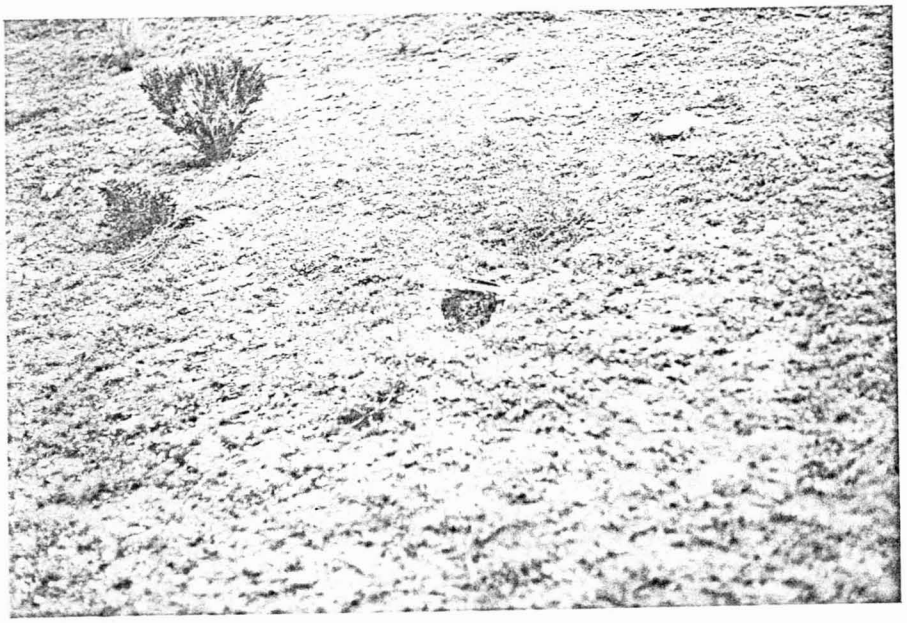
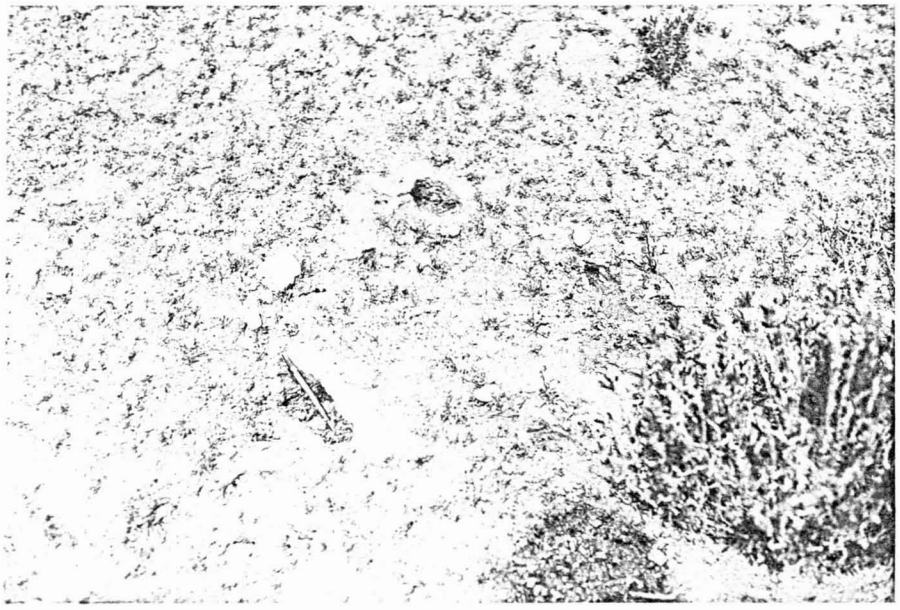
4/2/81 PHOTOGRAPH #2

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



(A) ANIMAL BURROW ON UPSTREAM FACE AT STATION 13+00



(B) CLUSTER OF ANIMAL BURROWS 1" TO 2" IN DIAMETER - STATION 7+00

Ertec
The Earth Technology Corporation

PROJECT NO. 81-161

WHITE TANKS DAM NO. 3

4/2/81

PHOTOGRAPH #3

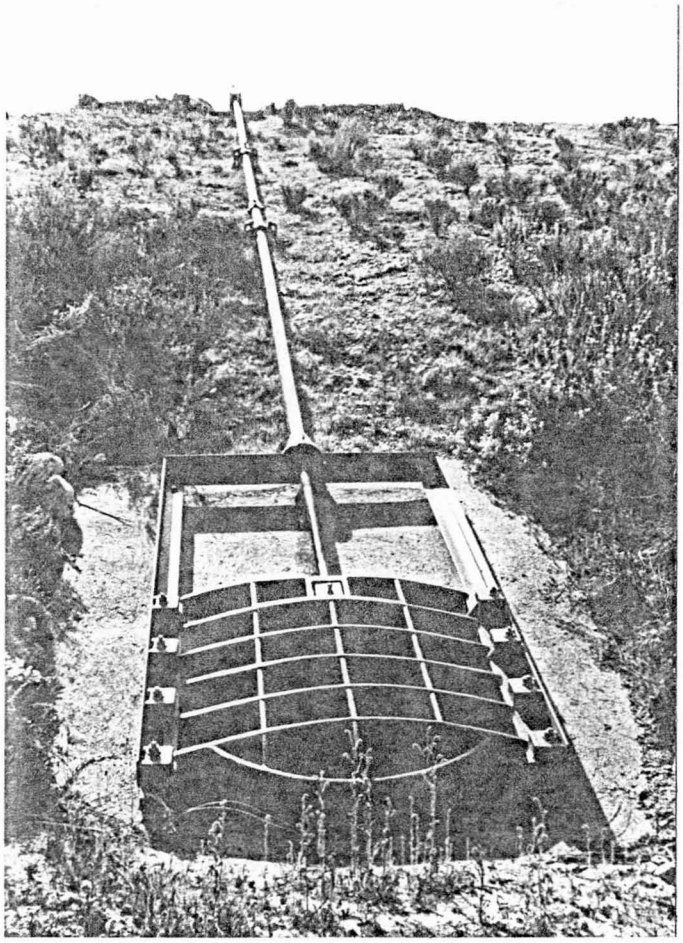
Compiled by ____ / ____ Drawn by ____ / ____ Checked by ____ / ____ Approved by ____ / ____

(A) TYPICAL OUTLET STRUCTURE SHOWING SEDIMENT DEPOSITION

(B) TYPICAL OUTLET CHANNEL TO BEARDSLEY CANAL

Ertec The Earth Technology Corporation	PROJECT NO. 81-161
WHITE TANKS DAM NO. 3	
4/2/81	PHOTOGRAPH #4

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



TYPICAL INLET STRUCTURE SHOWING
SLIDE GATE AND GATE STEM ASSEMBLY

Ertec
The Earth Technology Corporation

PROJECT NO. 81-161

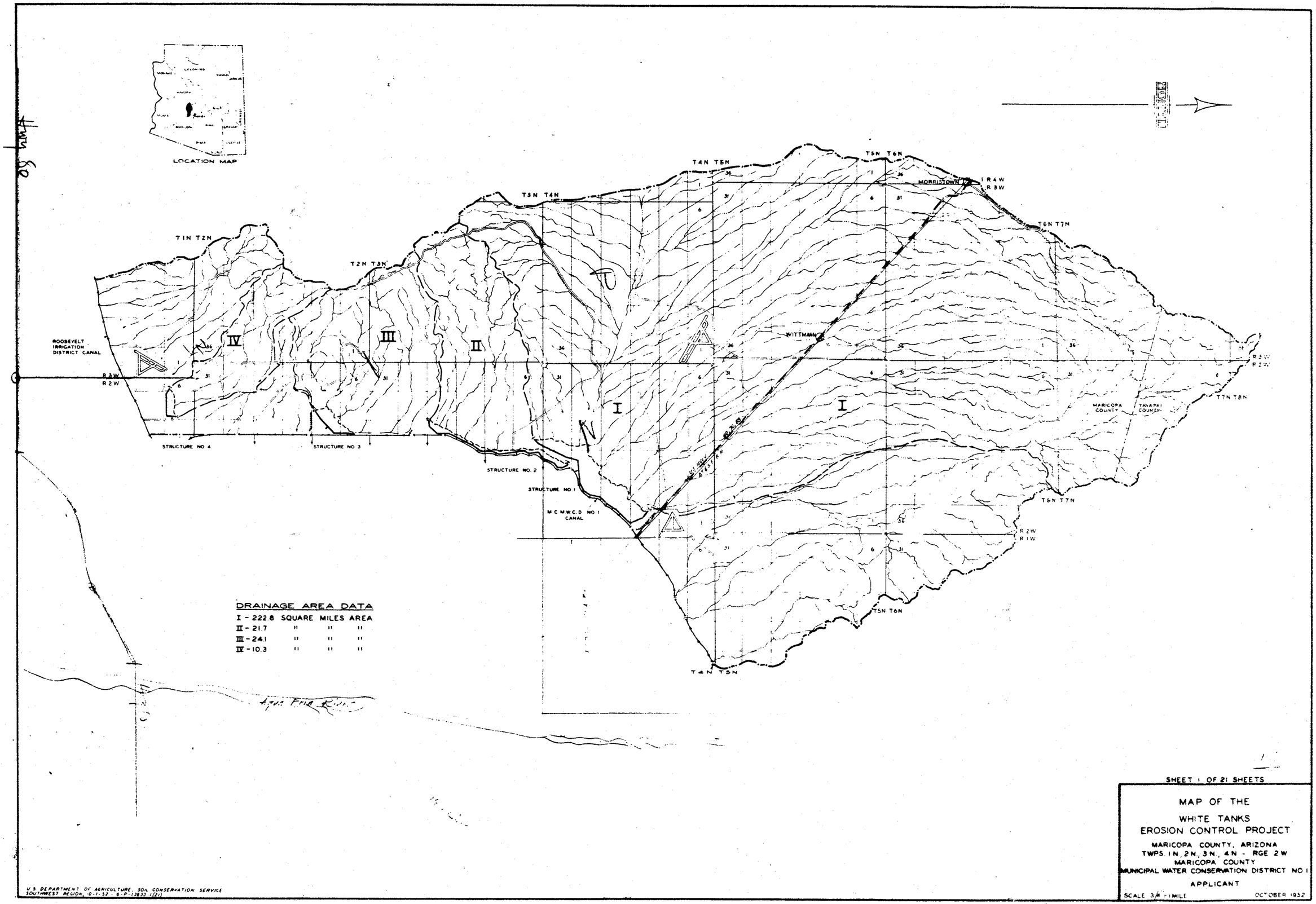
WHITE TANKS DAM NO. 3

4/2/81 PHOTOGRAPH #5

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

APPENDIX A

DESIGN DRAWINGS

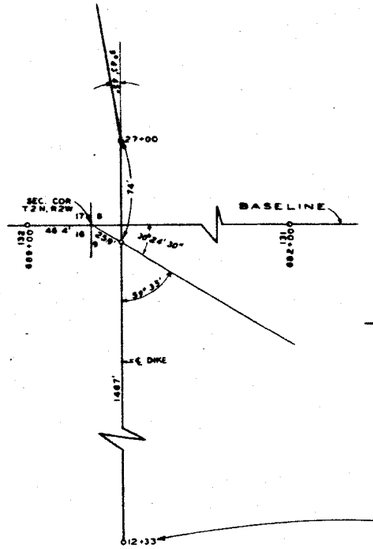


SHEET 1 OF 21 SHEETS

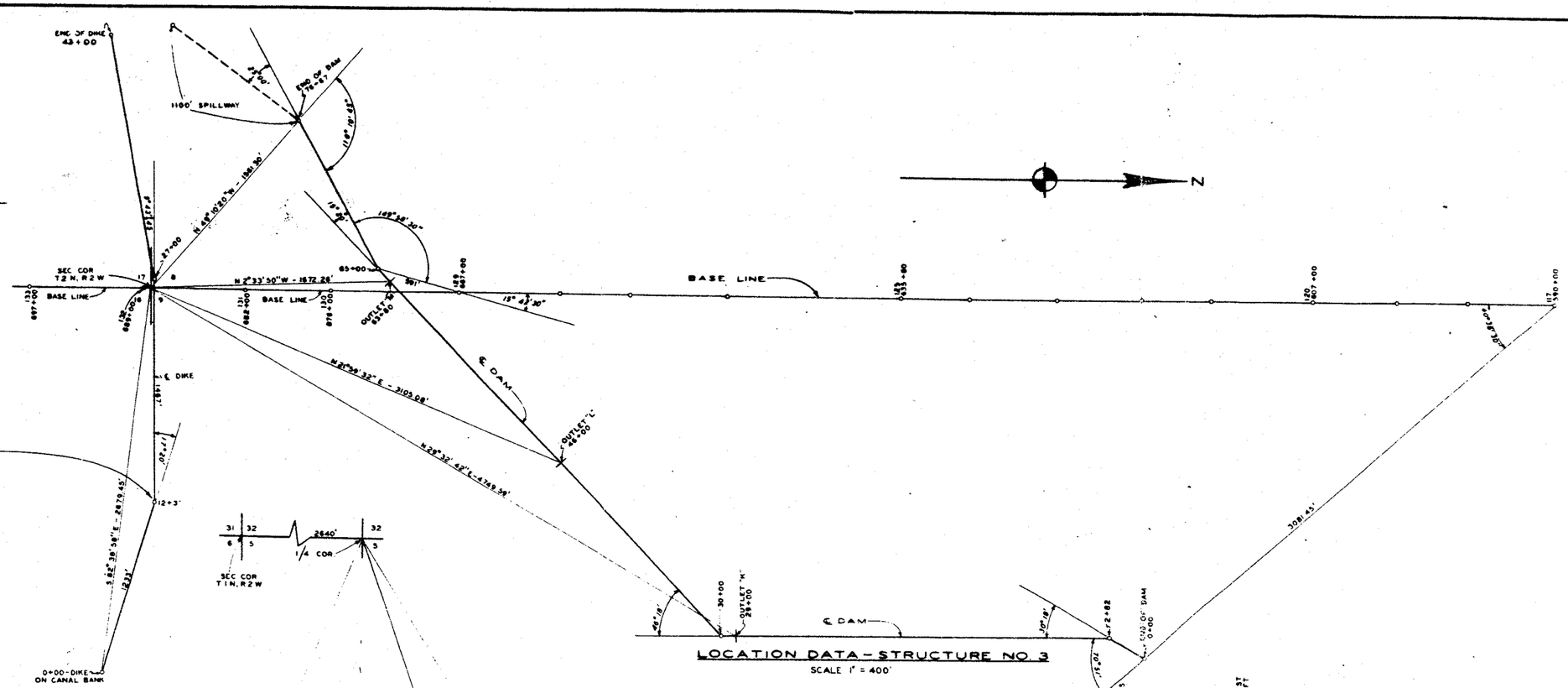
MAP OF THE
WHITE TANKS
EROSION CONTROL PROJECT
MARICOPA COUNTY, ARIZONA
TWPS. 1 N., 2 N., 3 N., 4 N. - RGE 2 W
MARICOPA COUNTY
MUNICIPAL WATER CONSERVATION DISTRICT NO 1
APPLICANT

SCALE 3/4" = 1 MILE
OCTOBER 1952

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE
SOUTHWEST REGION, 10-1-52 - 6-P-13833 1(21)

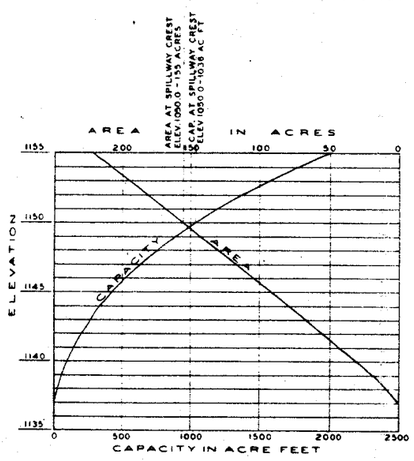


DETAIL OF DIKE & BASE LINE TIE
SCALE 1"= 50'

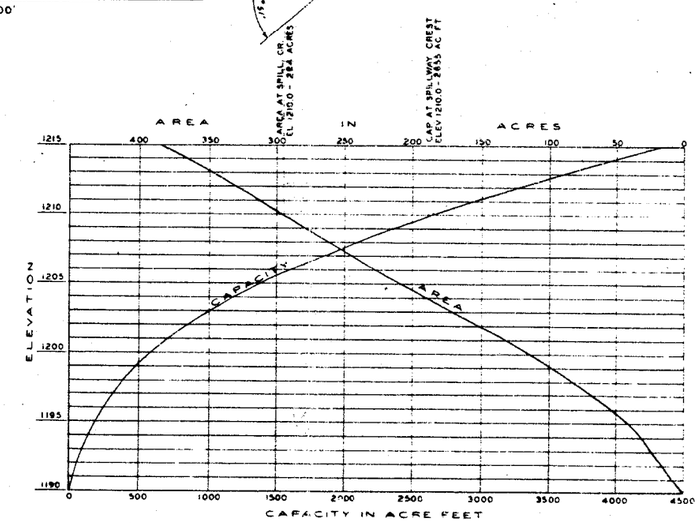


LOCATION DATA - STRUCTURE NO. 3
SCALE 1" = 400'

LOCATION DATA - STRUCTURE NO. 4
SCALE 1" = 400'



AREA & CAPACITY CURVES
STRUCTURE NO. 4



AREA & CAPACITY CURVES - STRUCTURE NO. 3

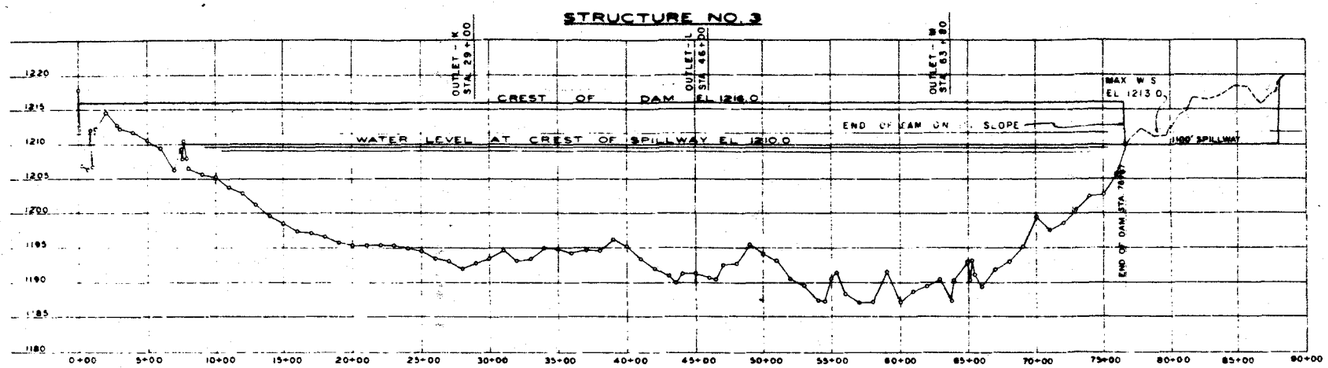
SHEET 4 OF 21 SHEETS

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

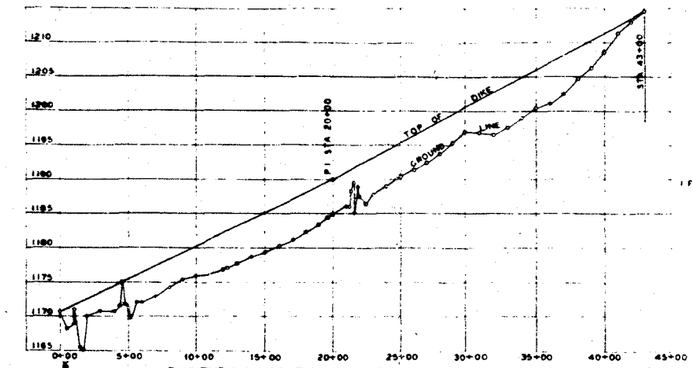
MARICOPA COUNTY
MUNICIPAL WATER CONSERVATION DISTRICT NO 1
APPLICANT

SCALE AS SHOWN

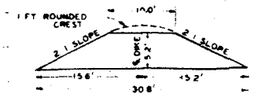
U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE
SOUTHWEST REGION



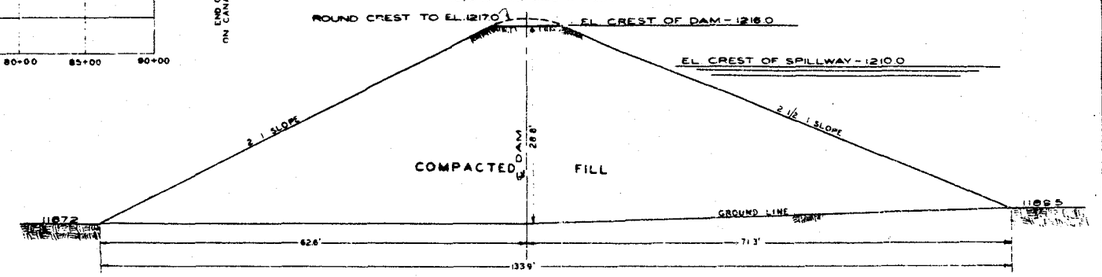
LONGITUDINAL SECTION ON ℄ OF DAM & SPILLWAY
SCALE - HOR 1" = 500', VERT. 1" = 10'
346,464 C.Y. EMBANKMENT



LONGITUDINAL SECTION ON ℄ OF DIKE AT LATERAL 12
SCALE - HOR. 1" = 500', VERT. 1" = 10'
16,645 C.Y. EMBANKMENT

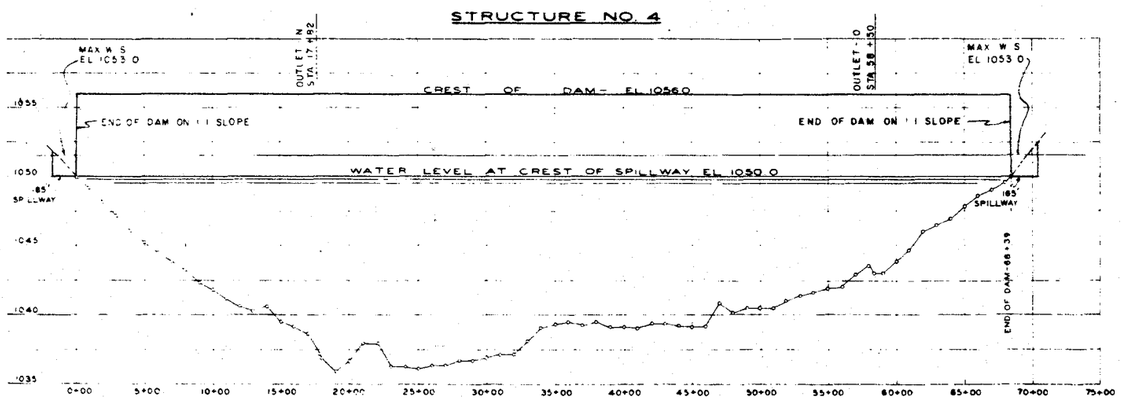


CROSS SECTION OF DIKE
AT STA. 20+00
SCALE 1" = 10'



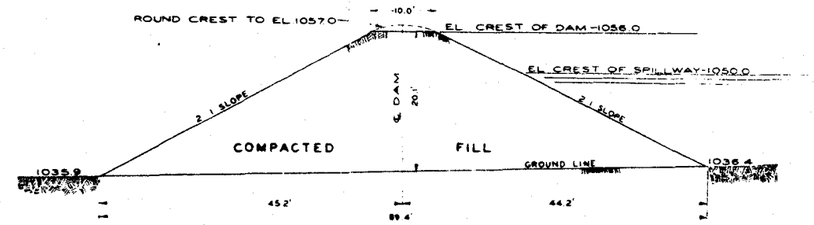
MAXIMUM CROSS SECTION OF DAM AT STA. 57+00
SCALE 1" = 10'

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

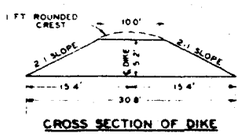


LONGITUDINAL SECTION ON ℄ OF DAM & SPILLWAYS
SCALE - HOR 1" = 500', VERT 1" = 5'
167,180 C.Y. EMBANKMENT

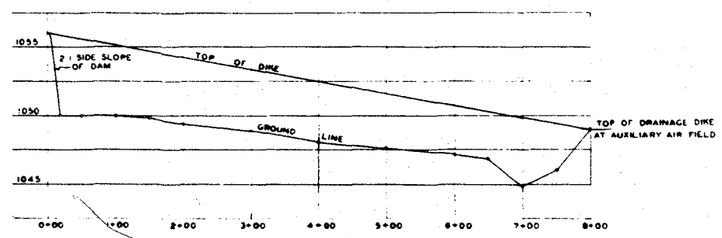
STRUCTURE NO. 4



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



CROSS SECTION OF DIKE
AT STA. 1+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

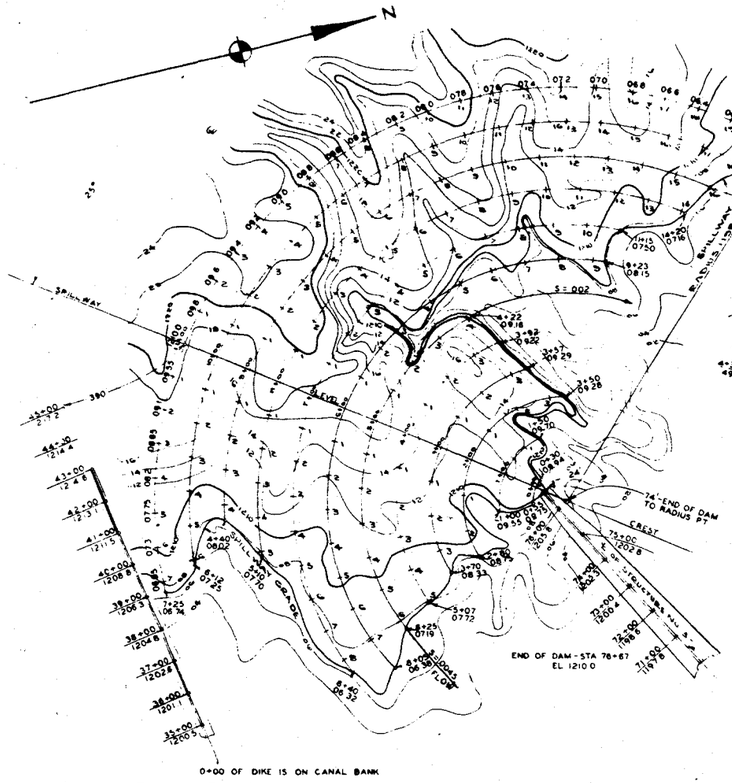
SHEET 16 OF 21 SHEETS

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

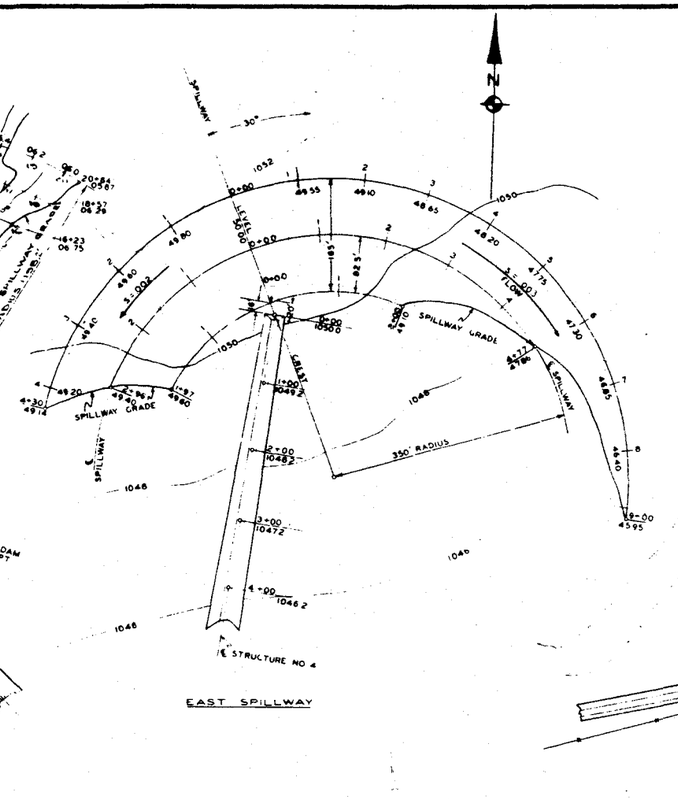
SCALE AS SHOWN OCTOBER 1952

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE
SOUTHWEST REGION (C-1-52-6-P-13833-16-21)

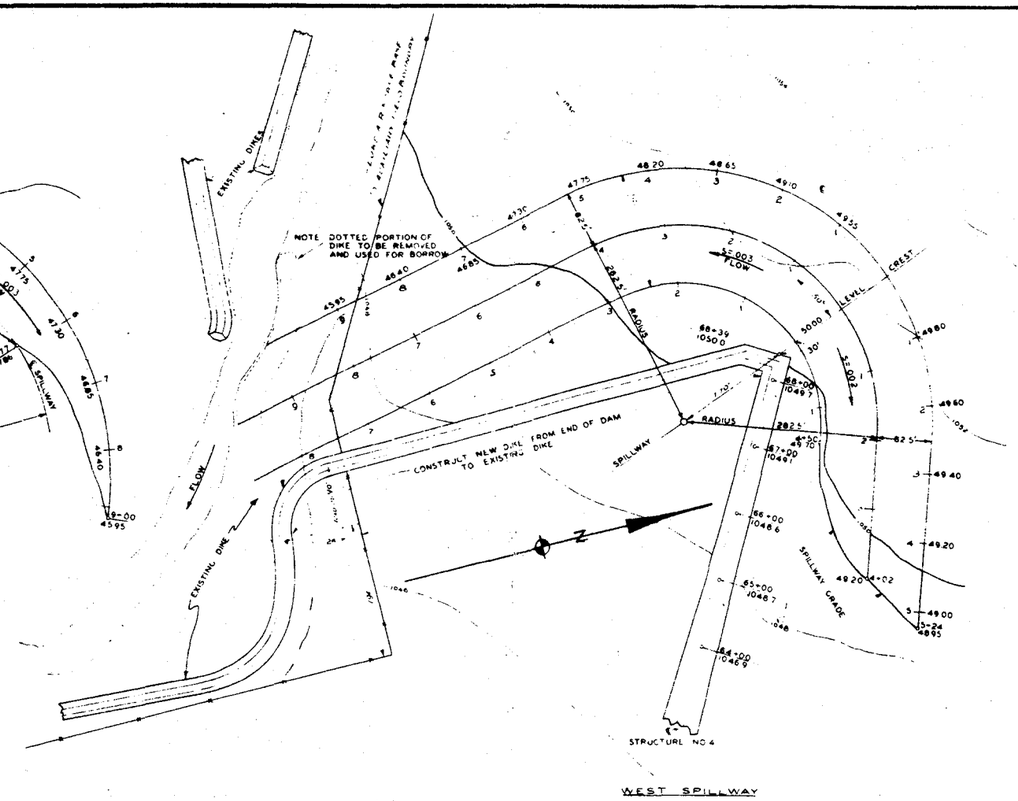


PLAN OF SPILLWAY - STRUCTURE NO. 3

SCALE 1" = 200'



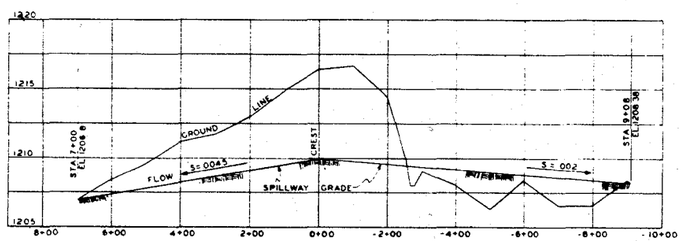
EAST SPILLWAY



WEST SPILLWAY

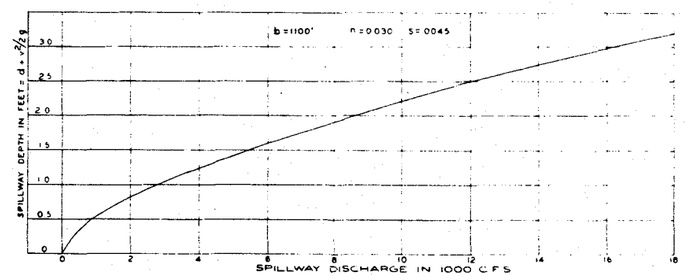
PLAN OF SPILLWAYS - STRUCTURE NO. 4

SCALE 1" = 100'

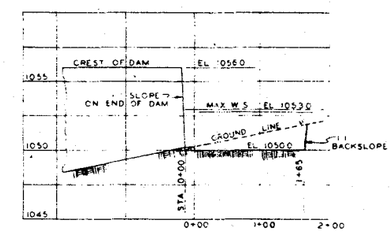


LONGITUDINAL SECTION ON ℄ OF SPILLWAY - STRUCTURE NO. 3

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



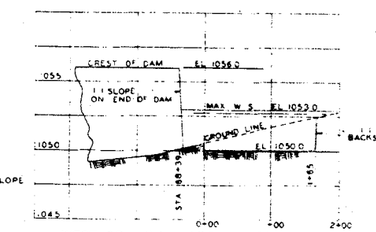
SPILLWAY DISCHARGE CURVE - STRUCTURE NO. 3



EAST SPILLWAY - STRUCTURE NO. 4

CROSS SECTION ON SPILLWAY CREST

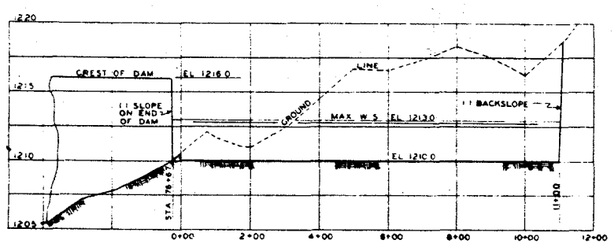
SCALE - HOR 1" = 100', VERT 1" = 5'



WEST SPILLWAY - STRUCTURE NO. 4

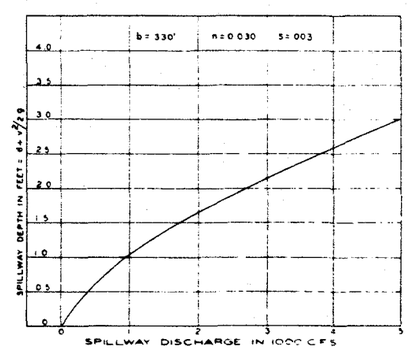
CROSS SECTION ON SPILLWAY CREST

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

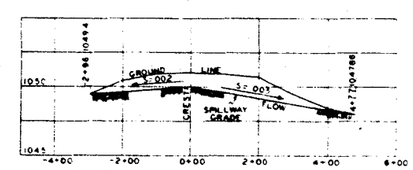


CROSS SECTION ON SPILLWAY CREST - STRUCTURE NO. 3

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



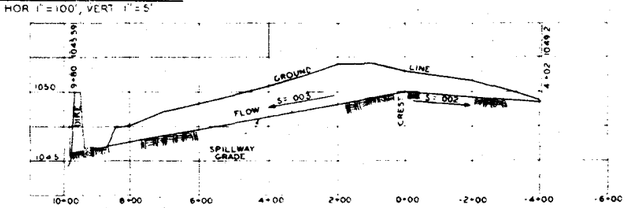
SPILLWAY DISCHARGE CURVE - STRUCTURE NO. 4



EAST SPILLWAY - STRUCTURE NO. 4

LONGITUDINAL SECTION ON ℄ OF SPILLWAY

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



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

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

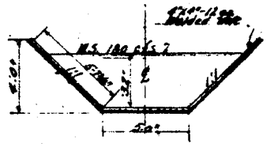
SHEET 17 OF 21 SHEETS

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

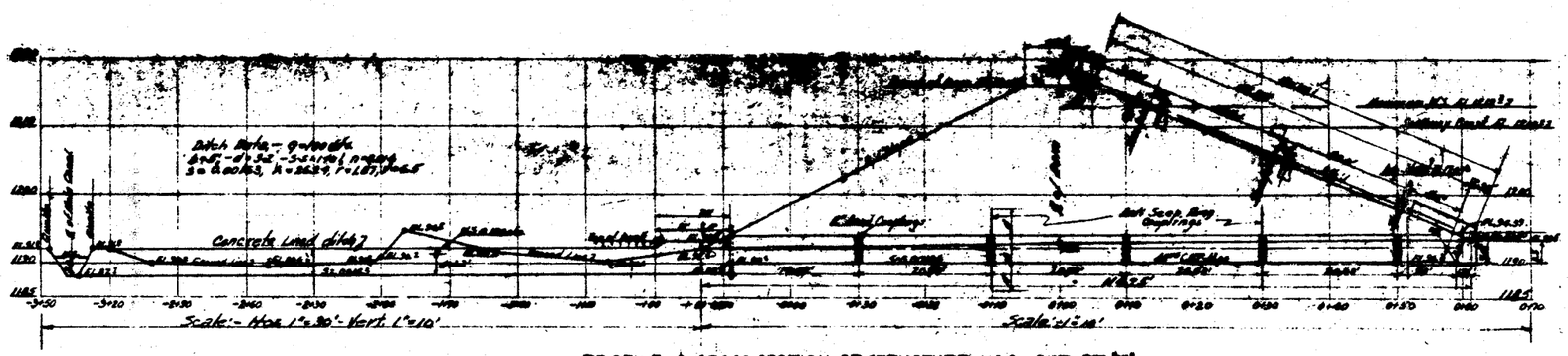
MARICOPA COUNTY
MUNICIPAL WATER CONSERVATION DISTRICT NO 1
APPLICANT

SCALE AS SHOWN — OCTOBER 1960

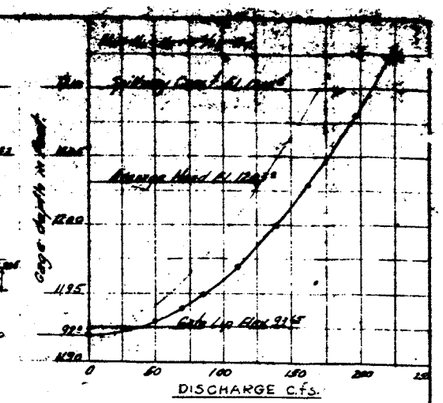
U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE
SOUTHWEST REGION

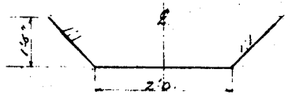


CROSS SECTION OF LINED DITCH
Scale: 1/8"=1'-0"

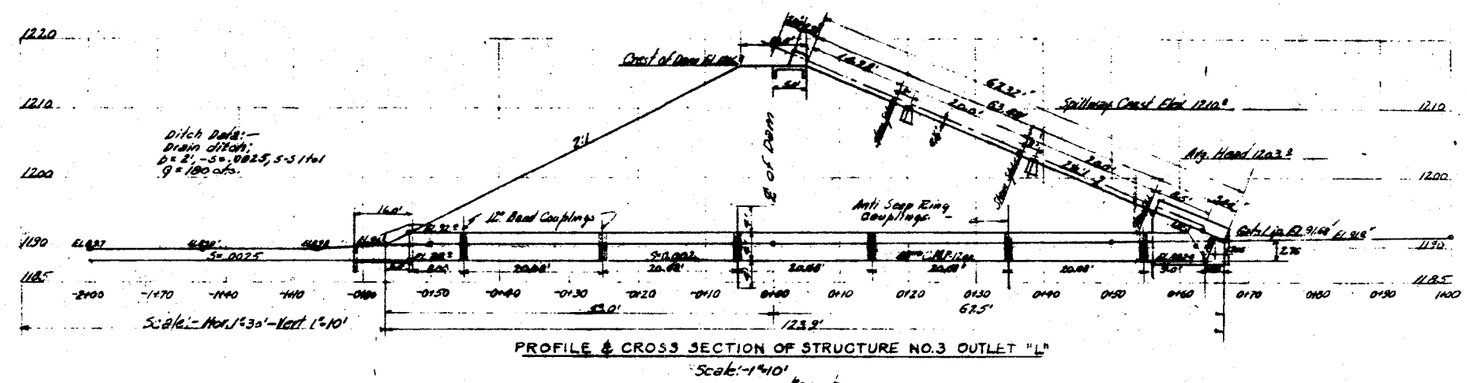


PROFILE & CROSS SECTION OF STRUCTURE NO.3 OUTLET "K"

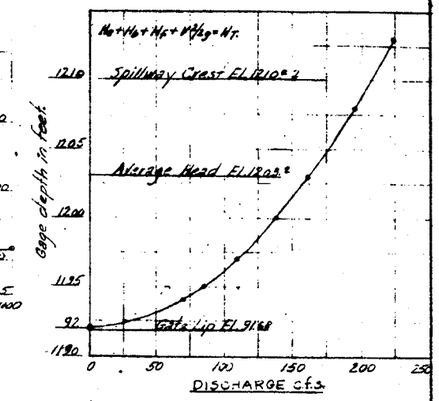


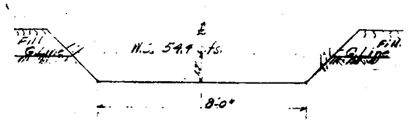


CROSS SECTION OF DRAIN DITCH
Scale:-1"=1'-0"

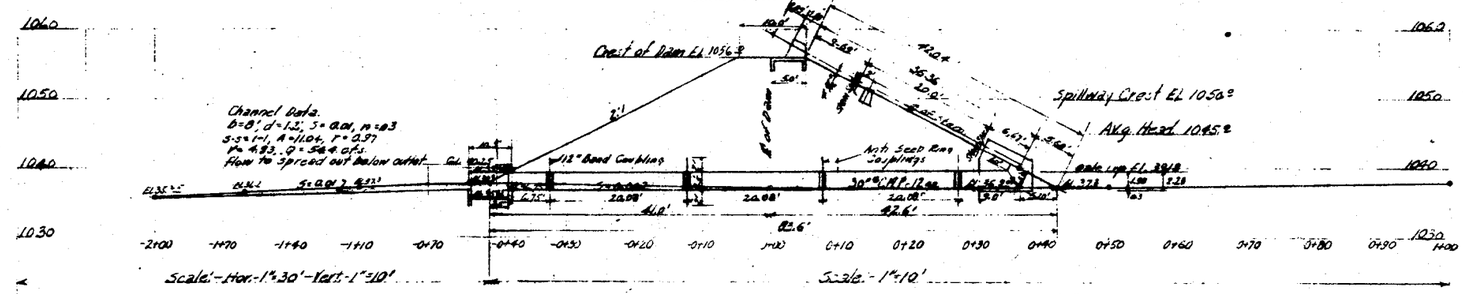


PROFILE & CROSS SECTION OF STRUCTURE NO.3 OUTLET "L"
Scale:-1"=10'

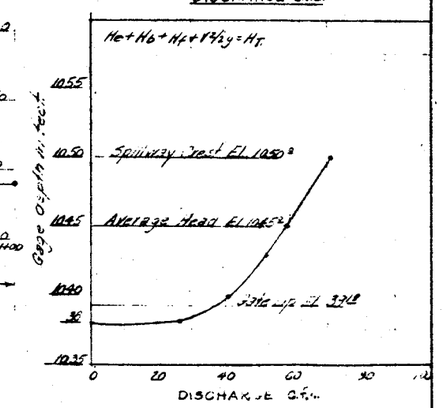




CROSS SECTION OF DITCH
Scale:-3/8"=1'-0"



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



CAPACITY OF DISCHARGE PIPES

Revised 11-10-52

SHEET 18 OF 21 SHEETS

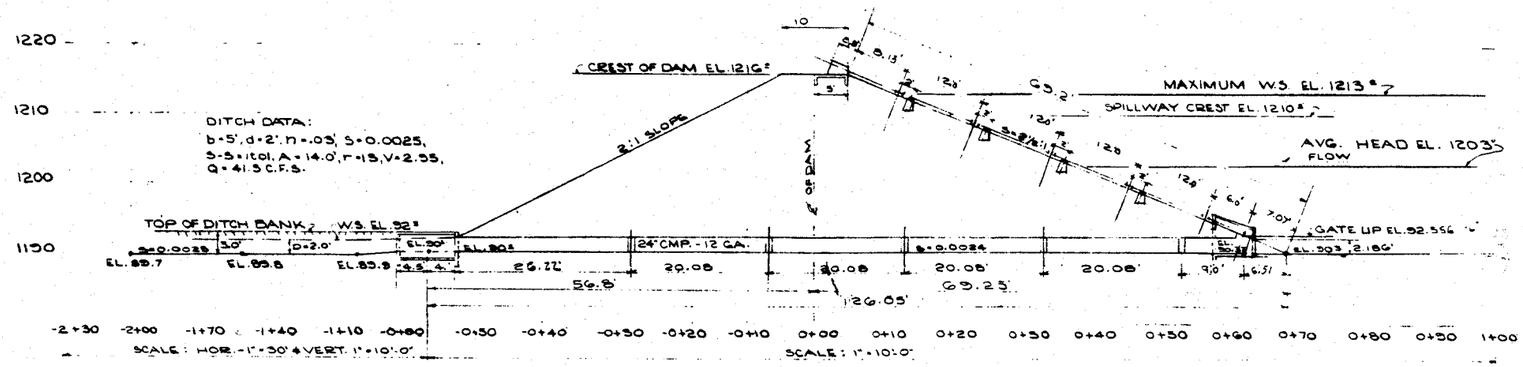
WHITE TANKS EROSION CONTROL PROJECT
STRUCTURES 3 & 4 OUTLETS K, L, N
SECTIONS AND PROFILES
MARICOPA COUNTY, ARIZONA

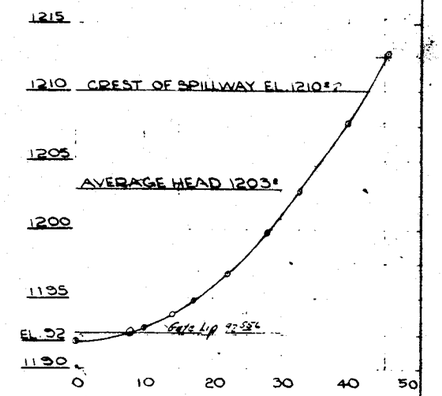
S. C. D.: AGUA FRIA — AREA NO. 4

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

6-P-13633-3(

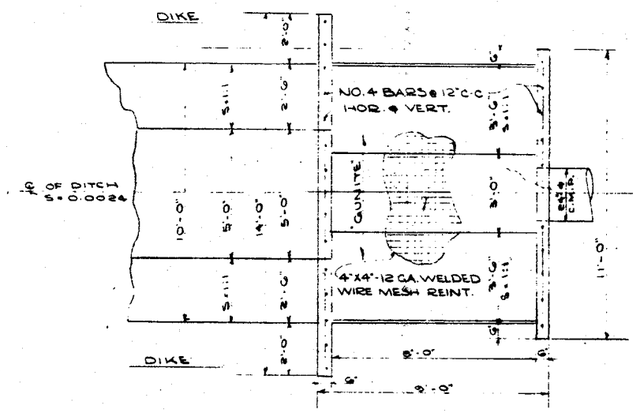
$H_e + H_D + H_f + V^2/2g = HT$



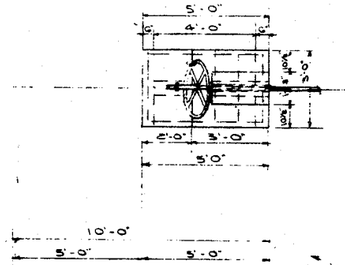


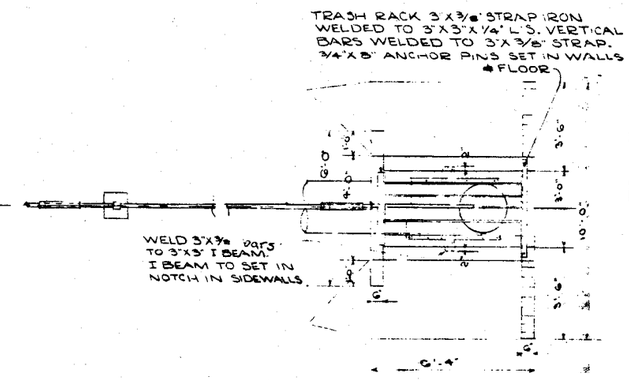
CAPACITY OF DISCHARGE PIPE

STRUCTURE NO. 3
OUTLET "M", STA. 63+80

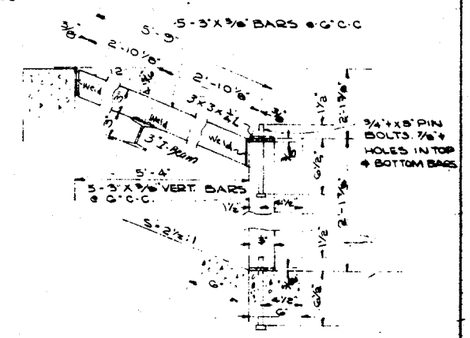


PLAN OF OUTLET
SCALE: 3/8"=1'-0"

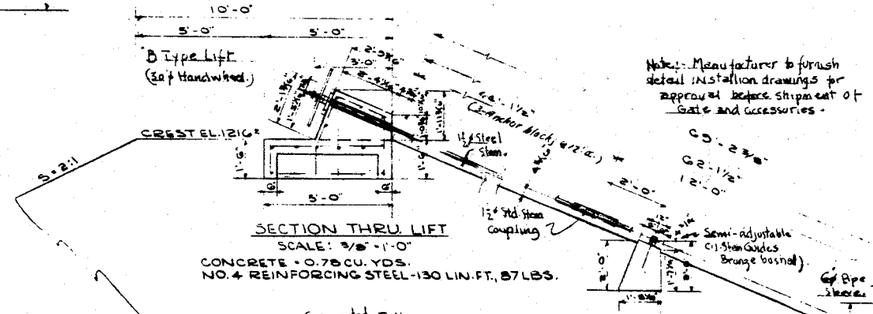




PLAN OF INLET
SCALE: 3/8"=1'-0"



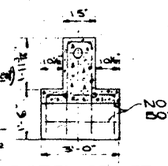
TRASH RACK DETAILS
SCALE: 1 1/2"=1'-0"



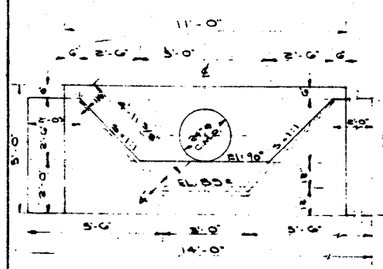
SECTION THRU. LIFT
SCALE: 3/8"=1'-0"
CONCRETE - 0.78 CU. YDS.
NO. 4 REINFORCING STEEL - 130 LIN. FT., 87 LBS.

Note:- Manufacturer to furnish detail installation drawings for approval before shipment of Gate and accessories.

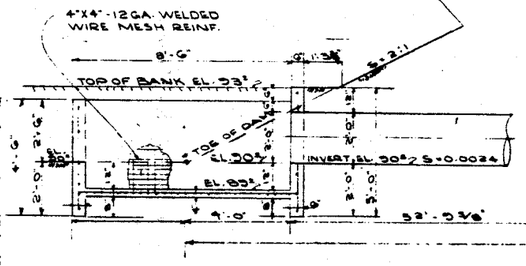
(Hardesty or Equal)
24" Mod(c) 50-10-C (Non rising Stem arrangement)
Circular Gate - 50' face pressure, 10' back pressure, 1 1/2" threaded bronze stem, bronze contact faces and wedges. Gate frame to have bead angles, thrust bearing, nut & hollow stem extension. Type "B" lift.



ELEVATION OF LIFT
SCALE: 3/8"=1'-0"

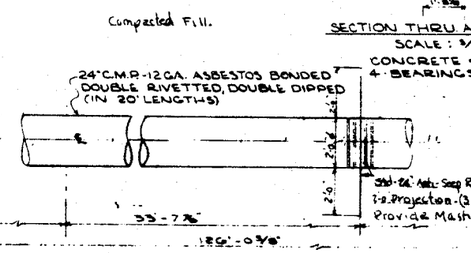


END ELEVATION

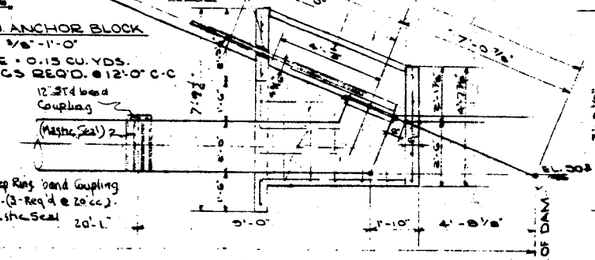


SECTION THRU OUTLET

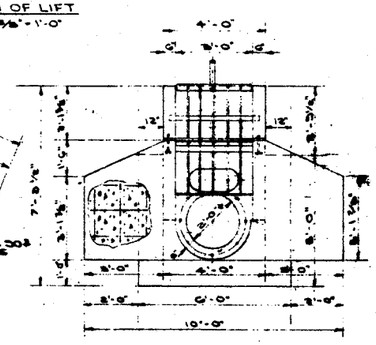
OUTLET TRANSITION:
SCALE: 3/8"=1'-0"
CONCRETE - 1.74 CU. YDS.
REINFORCING STEEL - 136 LIN. FT., NO. 4, 91 LBS.
GUNITE - 1.0 CU. YDS.
4x4 x 12 GA. WELDED WIRE, 135 SQ. FT.



SECTION ON ℄ OF OUTLET PIPE
SCALE: 3/8"=1'-0"



SECTION THRU. INLET
SCALE: 3/8"=1'-0"
CONCRETE - 3.21 CU. YDS.
REINFORCING STEEL 400 LIN. FT. NO. 4., 268 LBS.



Total Concrete 5.83 Cu. Yds.
No. 4 Reinforcing - 636 Lin. ft., 426 lbs.
Gunite 1.0 Cu. Yds.
4x4 x 12 Ga. Welded Wire 135 sq. yds.

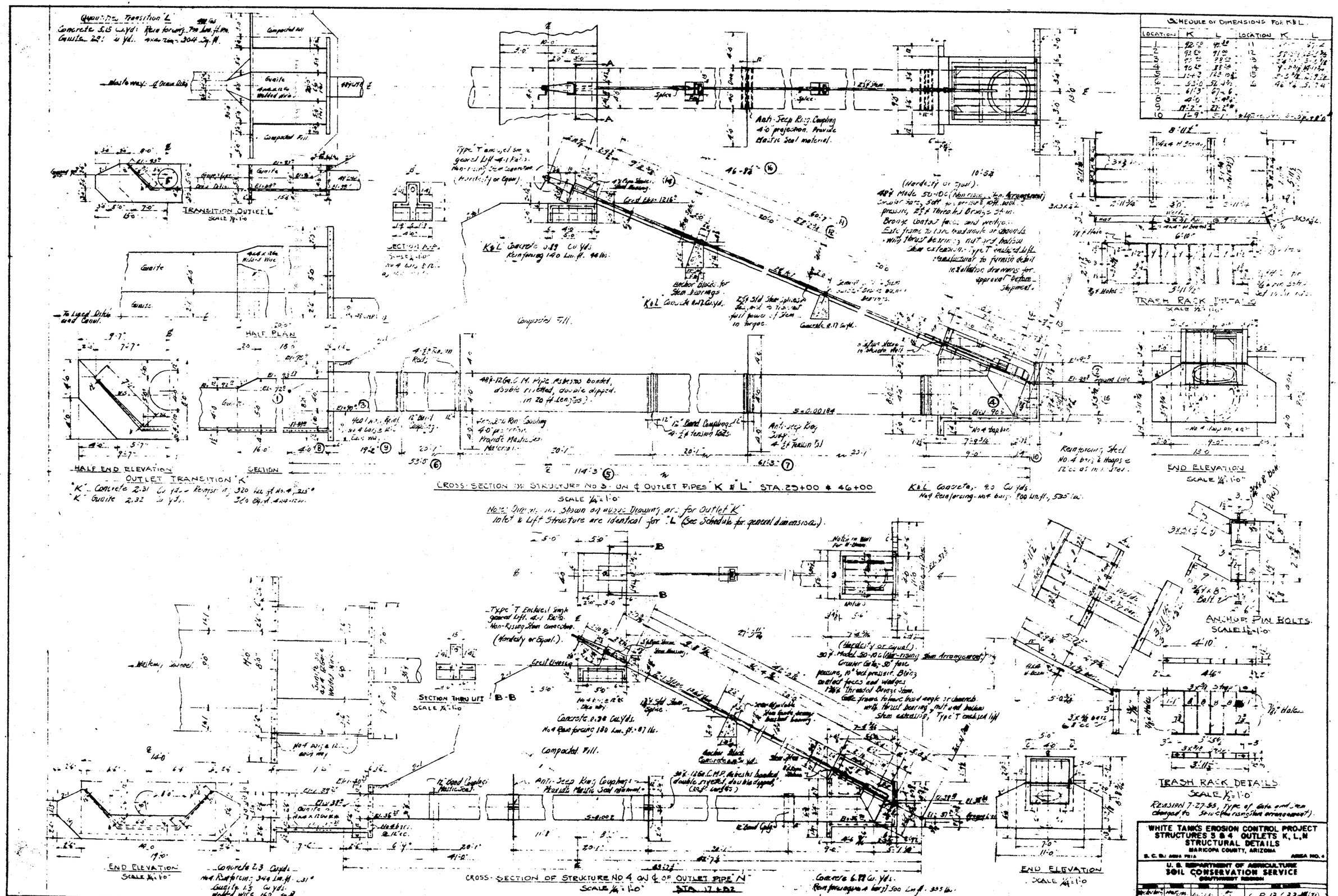
Revised 11-26-52
Supersedes 10-31-52

Revision 7-27-53: Type of Gate & Stem changed to 50-10-C (Non rising Stem arrangement)

WHITE TANKS EROSION CONTROL PROJECT
STRUCTURE 3 OUTLET "M"
STRUCTURAL DETAILS
MARICOPA COUNTY, ARIZONA
S.C.D. AGUA FRIA — AREA

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

DESIGN	DRAWN	DATE	SCALE	FILE NUMBER
[illegible]	Lund [illegible]	11/26/52	As Shown	6-P-13083-[illegible]



SCHEDULE OF DIMENSIONS FOR K & L

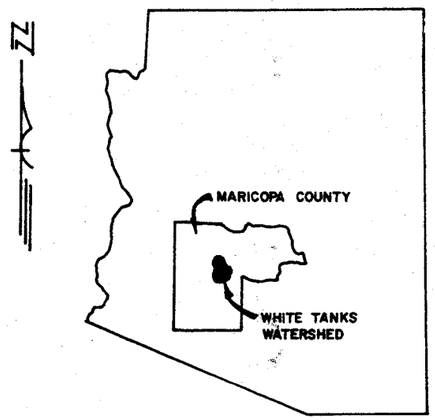
LOCATION	K	L	LOCATION	K	L
1	52.00	49.00	11	[illegible]	67.2
2	73.00	71.00	12	[illegible]	[illegible]
3	[illegible]	[illegible]	13	[illegible]	[illegible]
4	90.00	88.00	14	[illegible]	[illegible]
5	104.3	102.00	15	[illegible]	[illegible]
6	53.0	51.00	16	46.00	5.74
7	61.3	67.6			
8	4.0	5.49			
9	19.2	22.2			
10	12.9	[illegible]			

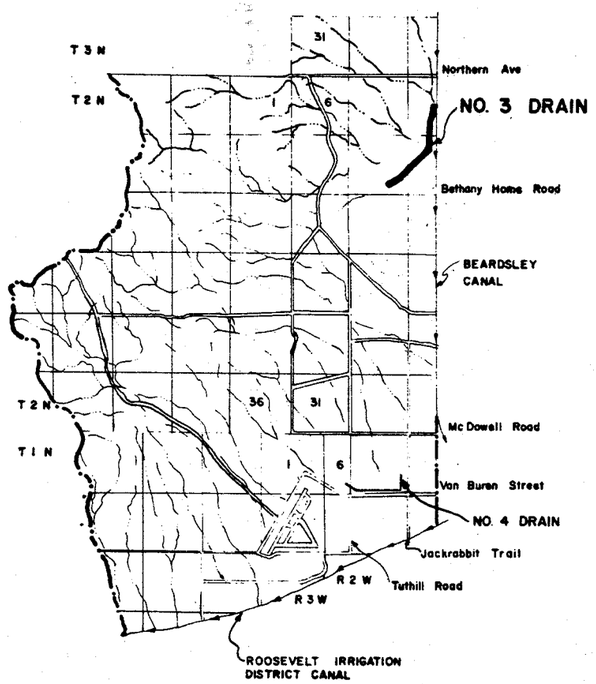
WHITE TANKS WATERSHED
PROTECTION AND FLOOD PREVENTION PROJECT
MARICOPA COUNTY, ARIZONA

PLANS FOR THE CONSTRUCTION OF

WHITE TANKS NO. 3 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
79021-AZ-Ph	1.	INDEX OF DRAWINGS
	2.	PLAN & PROFILE OF NO. 3 DRAIN
	3.	TYPICAL CROSS SECTIONS OF NO. 3 DRAIN

PRELIMINARY
Date 4-1-81

INDEX OF DRAWINGS
WHITE TANKS NO. 3 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. 1 of 3	Drawing No 79021-AZ-Ph

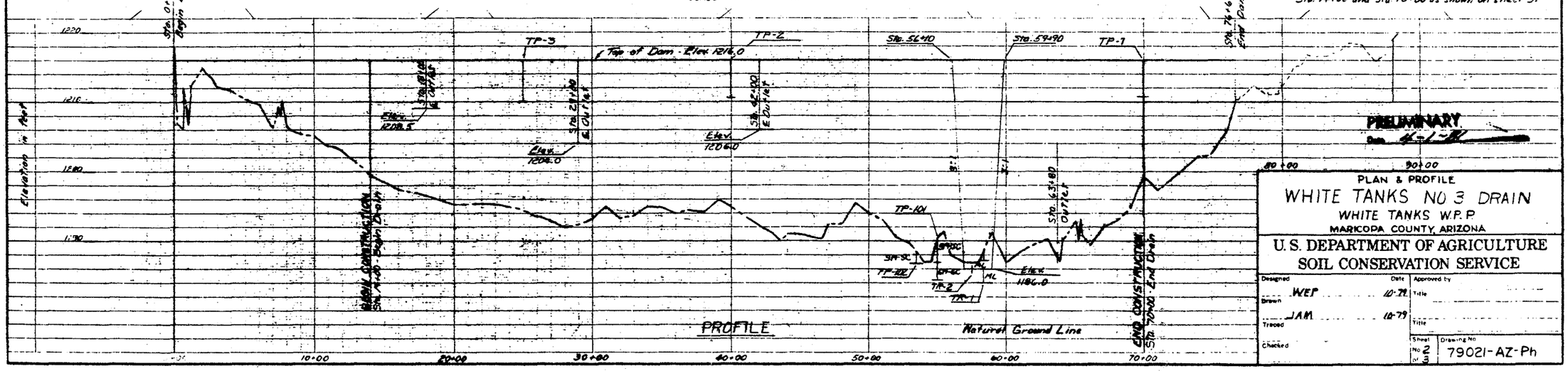
SCS-ENG-313C (REV. 6-75)

PLAN

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

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

3. Waste disposal area for the trench shall be on the upstream slope of the dam between Sta. 14+00 and Sta. 70+00 as shown on sheet 3.



PRELIMINARY

PLAN & PROFILE

WHITE TANKS NO. 3 DRAIN

WHITE TANKS W.P.P.

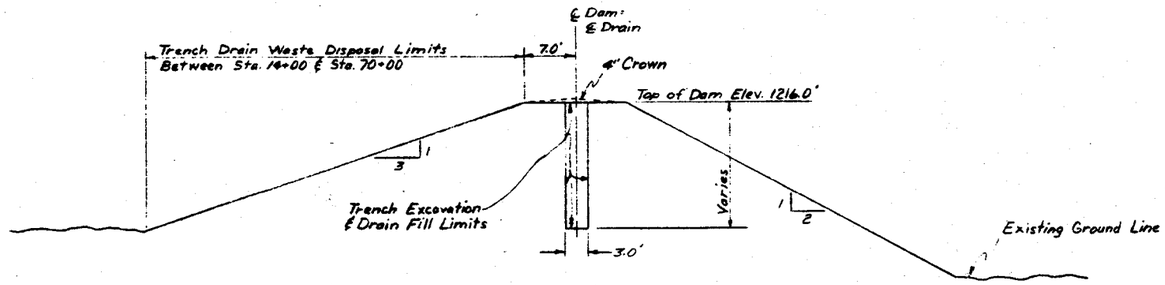
MARICOPA COUNTY, ARIZONA

U.S. DEPARTMENT OF AGRICULTURE

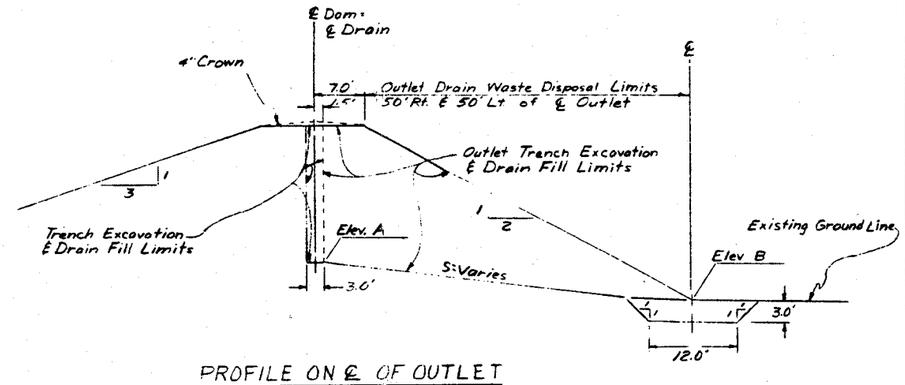
SOIL CONSERVATION SERVICE

Designed WEP	Date 10-79	Approved by	Title
Drawn JAM	10-79		Title
Traced			
Checked		Sheet No. 2 of 3	Drawing No. 79021-AZ-Ph

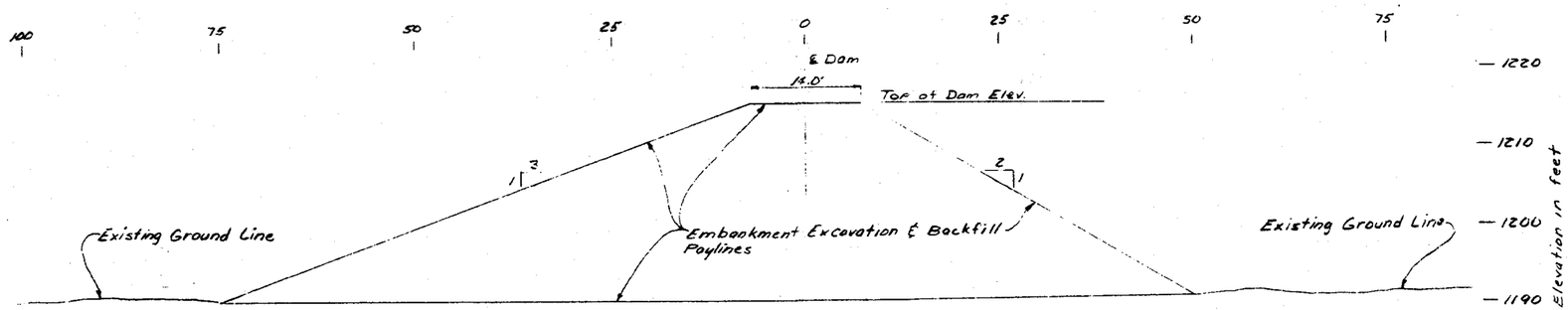
Form SCS-328 (November 1966)



TYPICAL CROSS SECTION DRAIN



PROFILE ON ℄ OF OUTLET

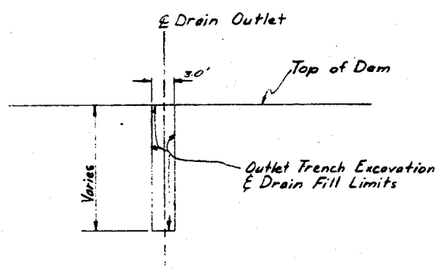


CROSS SECTION DAM REMOVAL AND
REPLACEMENT STA 58+00

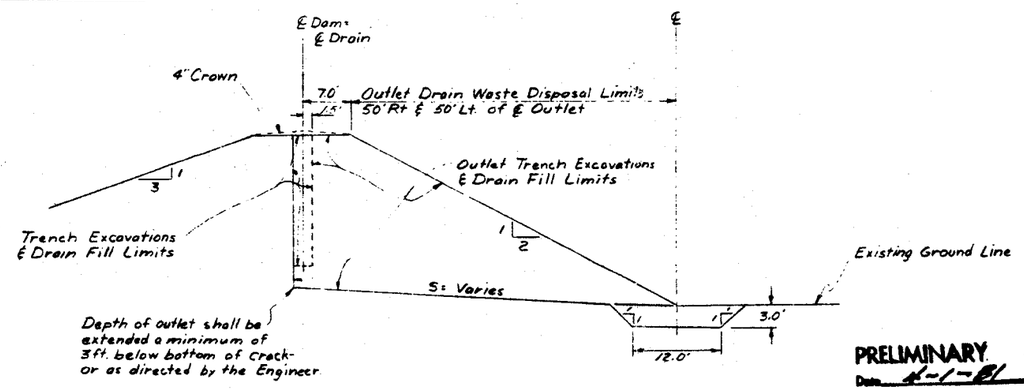
SCHEDULE OF OUTLETS

Station	Elevation A	Elevation B
18+00	1208.6 ±	1196.6 ±
29+00	1204.0 ±	1192.4 ±
42+00	1206.0 ±	1192.2 ±
55+00	1192.0 ±	1191.0 ±

Note: Auxiliary outlet elevations shall be as directed by the Engineer.



TYPICAL CROSS SECTION-OUTLET



PROFILE ON ℄ OF AUXILIARY OUTLET

PRELIMINARY
Date 4-1-81

DETAILS OF DRAIN AND OUTLET
WHITE TANKS NO. 3 REPAIR
WHITE TANKS W.P.P.
MARICOPA COUNTY, ARIZONA

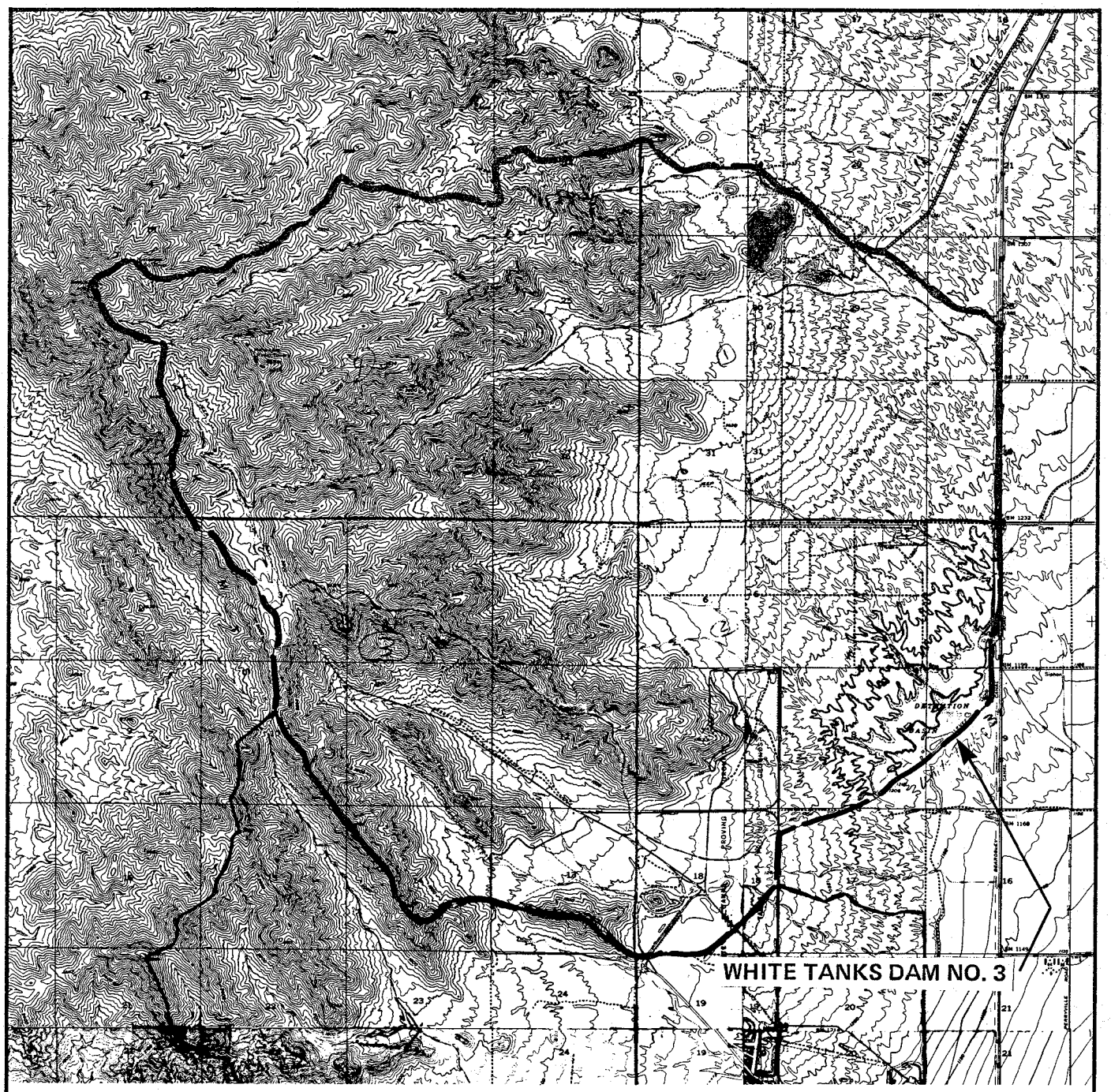
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date		
Designed	WEP	10-79	Approved by	
Drawn	JAM	10-79	Title	
Traced			Title	
Checked			Sheet No. 3 of 3	Drawing No 79021-AZ-Ph

SCS ENG-313C REV 6-76

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. 3

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 (C.N.)
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 Pages 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. = 23.69 sq. mi.

C.N.

Determine soil types:
General Soil Map, Maricopa County and Gila River Indian Reservation, AZ.
(SCS, November 1973)

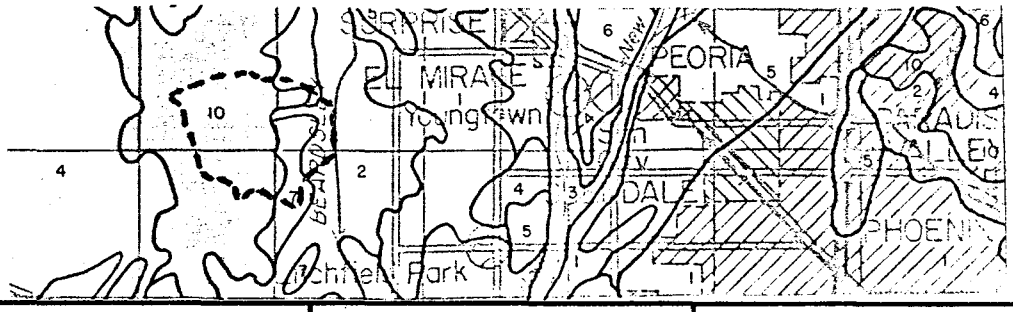


Table 6.1.--General-storm PMP computations for the Colorado River and Great basin

Drainage White Tanks No. 3 Area 23.7 mi^2 ~~(km^2)~~

Latitude 33°33.5', Longitude 112°30.5' 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 13.8 in. ~~(mm)~~						
2. Reduction for barrier-elevation [fig. 2.18] 86 %						
3. Barrier-elevation reduced PMP [step 1 X step 2] 11.9 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]	8.9	10.6	11.4	11.9	13.3	13.8 in. ~~(mm)~~
6. Incremental 10 mi^2 (26 km^2) PMP [successive subtraction in step 5]	8.9	1.7	0.8	0.5	1.4	0.5 in. ~~(mm)~~
7. Areal reduction [select from figs. 2.28 and 2.29]	96	99	100	100	100	100 %
8. Areally reduced PMP [step 6 X step 7]	8.5	1.7	0.8	0.5	1.4	0.5 in. ~~(mm)~~
9. Drainage average PMP [accumulated values of step 8]	8.5	10.2	11.0	11.5	12.9	13.4 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] 98 %						
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]	35	62	83	100	143	162 %
6. Orographic PMP for given durations [steps 4 X 5]	0.7	1.2	1.7	2.0	2.9	3.2 in. ~~(mm)~~
C. Total PMP						
1. Add steps A9 and B6	9.2	11.4	12.7	13.5	15.8	16.6 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. 3 Area 23.7 mi^2 (km^2)
Latitude 33°33.5' Longitude 112°30.5' Minimum Elevation 1200 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].	59	67	69	72	75	77	78	80	81 %
7. Areal reduced PMP [steps 5 X 6].	4.7	6.7	7.5	8.4	10.1	11.0	11.5	12.2	12.7 in. (mm)
8. Incremental PMP [successive subtraction in step 7].				8.4	1.7	0.9	0.5	0.7	0.5 in. (mm)
	4.7	2.0	0.8	0.9 } 15-min. increments					

9. Time sequence of incremental PMP according to:

   Hourly increments [table 4.7]. 0.5 0.7 1.7 8.4 0.9 0.5 in. (mm)

   Four largest 15-min. increments [table 4.8]. 4.7 2.0 0.8 0.9 in. (mm)

Soil	% of Area	Soil Group	% Cover (Herb.)	CN	Weighted CN
Antho - Valencia Assoc	17				
Antho	55	B	10	81	7.57
Valencia	25	B	10	81	3.44
Misc.	20	B	10	81	2.75
	100				
Ebon - Pinamt - Tremont Assoc	23				
Ebon	35	C	10	88	7.08
Pinamt	25	B	10	81	4.66
Tremant	20	B	10	81	3.73
Misc.	20	C	10	88	4.05
	100				
Cherioni - Gachado - Rock Assoc	60				
Cherioni	35	D	10	92	19.32
Gachado	15	D	10	92	8.28
Rock	35	D	10	92	19.32
Misc.	15	D	10	92	8.28
	100				
	100				88.48

Use 88.5

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.

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

White Tanks Retarding Dam #3

BY GR DATE

CHECKED DATE

PAGE 4 OF

Ertec The Earth Technology Corporation LONG BEACH CALIFORNIA

PROJECT NO.: 81-161

L = distance from ridge to reservoir along longest watercourse = 45,200 feet

H = elevation differential from ridge to spillway elevation = 4083 − 1210 = 2873 feet

$$T_c = 45{,}200^{1.15} / 7700 \times 2873^{0.38} = 1.42 \text{ hours}$$

$$\therefore \; L = 0.6 \times 1.42 = 0.85$$

Stage – Storage

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

Elev. feet	Storage "As-Builts" AF	Area Planimeter Acres	Avg. Area Acres	Δ Volume AF	Storage AF
1190	0				
1195	200				
1200	600				
1205	1,350				
1210	2,655	307			
1220		515	411	4,110	6,765
1230		772	643	6,430	13,195

Plot data and average values with smooth curve

Stage – Discharge

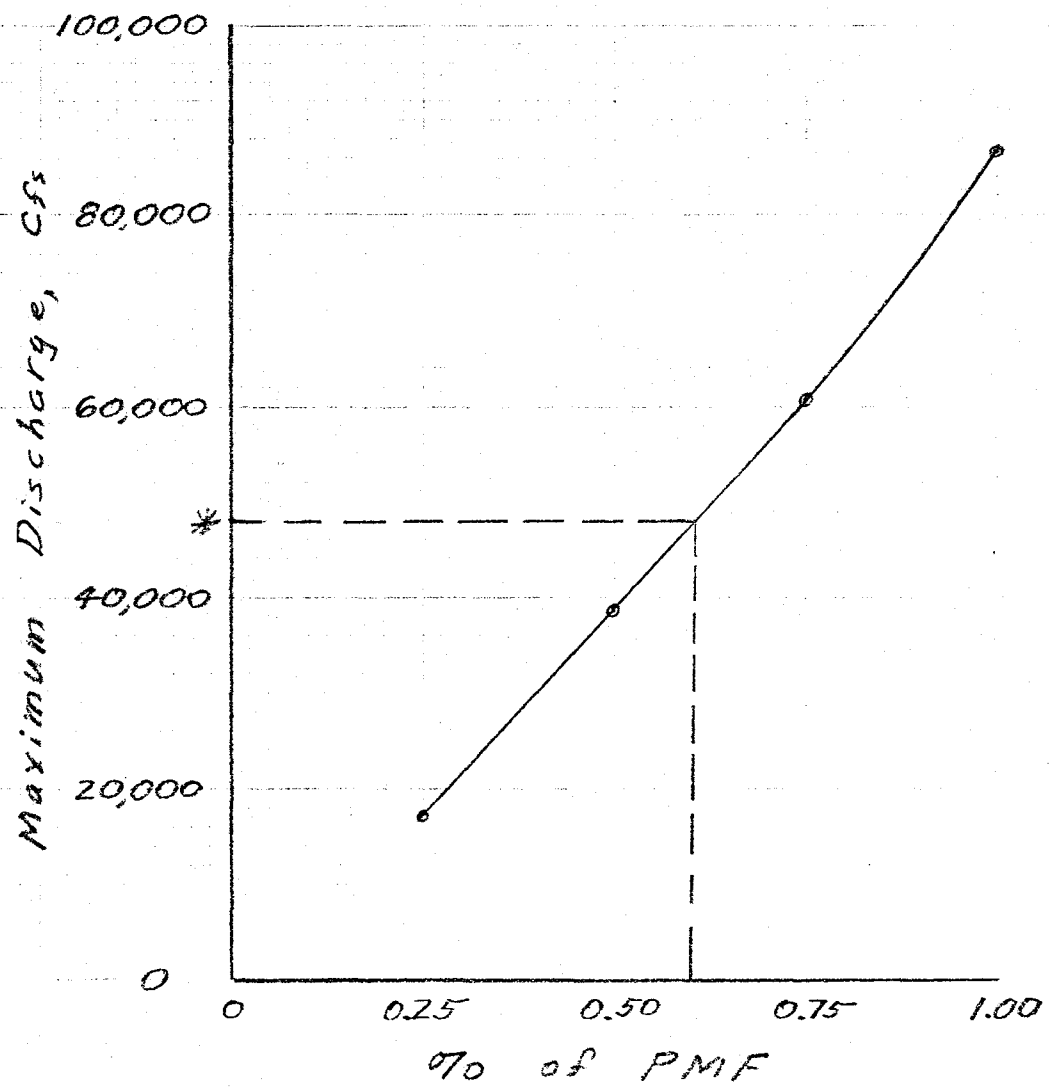
Slope of emergency spillway = 0.0045
This is subcritical at all flow rates,
∴ flow does not pass through critical.
∴ $d_n + V^2/2g$ represents reasonable approximation
Compute curve using Manning's

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

$S = 0.0045$
$n = 0.030$
$b = 1100$ 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	1,210
2	11,556	5.24	0.43	2.43	1,212.4
3	22,732	6.86	0.73	3.73	1,213.7
5	53,357	9.66	1.45	6.45	1,216.4
6	72,235	10.89	1.84	7.84	1,217.8

Plot data and average values with smooth curve.



* Discharge with W.S. at top of dam.

White Tanks Retarding Dam #3

BY GB DATE

CHECKED DATE

PAGE 7 OF

Ertec
The Earth Technology Corporation
LONG BEACH CALIFORNIA

PROJECT NO.: 81-161

```
1*********************************
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION      JULY 1978
   LAST MODIFICATION  01 APR 80
 *********************************
     1                 A1       ARIZONA DAM SAFETY-WHITE TANKS 3
     2                 A2       HYDRAULIC-HYDROLOGIC ANALYSES
     3                 A3       PROBABLE MAXIMUM FLOOD
     4                 B      75       0      15       0       0       0       0       0       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   23.69           23.69
    11                 O      24    12.7
    12                 O1   .125    .125    .125    .125    .175    .175    .175    .175    .425    .425
    13                 O1   .425    .425     4.7     2.0     0.9     0.8    .225    .225    .225    .225
    14                 O1   .125    .125    .125    .125
    15                 T                                                       -1   -88.5
    16                 W2             .85
    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                                           2655      -1
    22                 Y4   1210    1211    1212    1213    1214    1215    1216  1216.5    1218
    23                 Y5      0    2800    8600   16200   22500   36500   48000   53500   72500
    24                 $S      0     200     600    1350    2655    4300    6810   13240
    25                 $E   1190    1195    1200    1205    1210    1215    1220    1230
    26                 $$   1210
    27                 $D   1216     2.8     1.5    7667
    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 3
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	0	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	23.69	0.00	23.69	0.00	0.000	0	0	0

PRECIP DATA

NP	STORM	DAJ	DAK
24	12.70	0.00	0.00

PRECIP PATTERN

0.12	0.12	0.12	0.12	0.17	0.17	0.17	0.17	0.42	0.42
0.42	0.42	4.70	2.00	0.90	0.80	0.22	0.22	0.22	0.22
0.12	0.12	0.12	0.12						

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	-88.50	0.00	0.00

CURVE NO = -88.50 WETNESS = -1.00 EFFECT CN = 88.50

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= 0.85

RECESSION DATA
STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

UNIT HYDROGRAPH 19 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= 0.85 VOL= 1.00

1771.	5608.	10528.	11718.	10251.	7446.	4624.	3070.	2052.	1341.
879.	579.	384.	252.	165.	115.	79.	45.	15.	

O MO. DA	HR. MN	PERIOD	RAIN	EXCS	LOSS	END-OF-PERIOD FLOW COMP Q	MO. DA	HR. MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	0.15	1	0.13	0.00	0.12	0.	1.01	9.30	38	0.00	0.00	0.00	53.
1.01	0.30	2	0.13	0.00	0.12	0.	1.01	9.45	39	0.00	0.00	0.00	31.
1.01	0.45	3	0.13	0.01	0.12	17.	1.01	10.00	40	0.00	0.00	0.00	17.
1.01	1.00	4	0.13	0.03	0.10	104.	1.01	10.15	41	0.00	0.00	0.00	7.
1.01	1.15	5	0.17	0.06	0.11	373.	1.01	10.30	42	0.00	0.00	0.00	2.
1.01	1.30	6	0.17	0.08	0.09	920.	1.01	10.45	43	0.00	0.00	0.00	0.
1.01	1.45	7	0.17	0.10	0.08	1751.	1.01	11.00	44	0.00	0.00	0.00	0.
1.01	2.00	8	0.17	0.11	0.06	2752.	1.01	11.15	45	0.00	0.00	0.00	0.
1.01	2.15	9	0.43	0.30	0.12	4111.	1.01	11.30	46	0.00	0.00	0.00	0.
1.01	2.30	10	0.43	0.34	0.09	6188.	1.01	11.45	47	0.00	0.00	0.00	0.
1.01	2.45	11	0.43	0.36	0.07	9146.	1.01	12.00	48	0.00	0.00	0.00	0.
1.01	3.00	12	0.43	0.37	0.05	12402.	1.01	12.15	49	0.00	0.00	0.00	0.
1.01	3.15	13	4.70	4.47	0.23	22659.	1.01	12.30	50	0.00	0.00	0.00	0.
1.01	3.30	14	2.00	1.96	0.04	44391.	1.01	12.45	51	0.00	0.00	0.00	0.
1.01	3.45	15	0.90	0.89	0.01	72710.	1.01	13.00	52	0.00	0.00	0.00	0.
1.01	4.00	16	0.80	0.79	0.01	89046.	1.01	13.15	53	0.00	0.00	0.00	0.
1.01	4.15	17	0.23	0.22	0.00	89543.	1.01	13.30	54	0.00	0.00	0.00	0.
1.01	4.30	18	0.23	0.22	0.00	77936.	1.01	13.45	55	0.00	0.00	0.00	0.
1.01	4.45	19	0.23	0.22	0.00	60407.	1.01	14.00	56	0.00	0.00	0.00	0.
1.01	5.00	20	0.23	0.22	0.00	45954.	1.01	14.15	57	0.00	0.00	0.00	0.
1.01	5.15	21	0.13	0.12	0.00	35121.	1.01	14.30	58	0.00	0.00	0.00	0.
1.01	5.30	22	0.13	0.12	0.00	27015.	1.01	14.45	59	0.00	0.00	0.00	0.
1.01	5.45	23	0.13	0.12	0.00	21141.	1.01	15.00	60	0.00	0.00	0.00	0.
1.01	6.00	24	0.13	0.12	0.00	16807.	1.01	15.15	61	0.00	0.00	0.00	0.
1.01	6.15	25	0.00	0.00	0.00	13484.	1.01	15.30	62	0.00	0.00	0.00	0.
1.01	6.30	26	0.00	0.00	0.00	10645.	1.01	15.45	63	0.00	0.00	0.00	0.
1.01	6.45	27	0.00	0.00	0.00	7972.	1.01	16.00	64	0.00	0.00	0.00	0.
1.01	7.00	28	0.00	0.00	0.00	5639.	1.01	16.15	65	0.00	0.00	0.00	0.
1.01	7.15	29	0.00	0.00	0.00	3782.	1.01	16.30	66	0.00	0.00	0.00	0.
1.01	7.30	30	0.00	0.00	0.00	2433.	1.01	16.45	67	0.00	0.00	0.00	0.
1.01	7.45	31	0.00	0.00	0.00	1533.	1.01	17.00	68	0.00	0.00	0.00	0.
1.01	8.00	32	0.00	0.00	0.00	936.	1.01	17.15	69	0.00	0.00	0.00	0.
1.01	8.15	33	0.00	0.00	0.00	579.	1.01	17.30	70	0.00	0.00	0.00	0.
1.01	8.30	34	0.00	0.00	0.00	361.	1.01	17.45	71	0.00	0.00	0.00	0.
1.01	8.45	35	0.00	0.00	0.00	227.	1.01	18.00	72	0.00	0.00	0.00	0.
1.01	9.00	36	0.00	0.00	0.00	144.	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	12.70	11.26	1.44	688428.
										(323.)	(286.)	(36.)	(19494.11)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	89543.	28455.	9179.	9179.	688432.
CMS	2536.	806.	260.	260.	19494.
INCHES		11.17	11.26	11.26	11.26
MM		283.81	286.09	286.09	286.09
AC-FT		14110.	14224.	14224.	14224.
THOUS CU M		17405.	17545.	17545.	17545.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 1

0.	0.	4.	26.	93.	230.	438.	688.	1028.	1547.
2287.	3101.	5665.	11098.	18178.	22262.	22386.	19484.	15102.	11488.
8780.	6754.	5285.	4202.	3371.	2661.	1993.	1410.	946.	608.
383.	234.	145.	90.	57.	36.	22.	13.	8.	4.
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.	0.	0.					

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	22386.	7114.	2295.	2295.	172108.
CMS	634.	201.	65.	65.	4874.
INCHES		2.79	2.82	2.82	2.82
MM		70.95	71.52	71.52	71.52
AC-FT		3528.	3556.	3556.	3556.
THOUS CU M		4351.	4386.	4386.	4386.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 2

0.	0.	8.	52.	187.	460.	876.	1376.	2055.	3094.
4573.	6201.	11329.	22196.	36355.	44523.	44771.	38968.	30203.	22977.
17560.	13508.	10570.	8404.	6742.	5323.	3986.	2820.	1891.	1217.
766.	468.	290.	180.	114.	72.	45.	27.	16.	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.	0.					

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	44771.	14228.	4590.	4590.	344216.
CMS	1268.	403.	130.	130.	9747.
INCHES		5.59	5.63	5.63	5.63
MM		141.90	143.05	143.05	143.05
AC-FT		7055.	7112.	7112.	7112.
THOUS CU M		8702.	8772.	8772.	8772.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 3

0.	0.	12.	78.	280.	690.	1314.	2064.	3083.	4641.
6860.	9302.	16994.	33293.	54533.	66785.	67157.	58452.	45305.	34465.
26341.	20261.	15856.	12605.	10113.	7984.	5979.	4230.	2837.	1825.
1150.	702.	434.	271.	170.	108.	67.	40.	24.	13.
6.	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	67157.	21341.	6884.	6884.	516324.
CMS	1902.	604.	195.	195.	14621.
INCHES		8.38	8.45	8.45	8.45
MM		212.86	214.57	214.57	214.57
AC-FT		10583.	10668.	10668.	10668.
THOUS CU M		13053.	13159.	13159.	13159.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 4

0.	0.	17.	104.	373.	920.	1751.	2752.	4111.	6188.
9146.	12402.	22659.	44391.	72710.	89046.	89543.	77936.	60407.	45954.
35121.	27015.	21141.	16807.	13484.	10645.	7972.	5639.	3782.	2433.
1533.	936.	579.	361.	227.	144.	89.	53.	31.	17.
7.	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.	0.					

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	89543.	28455.	9179.	9179.	688432.
CMS	2536.	806.	260.	260.	19494.
INCHES		11.17	11.26	11.26	11.26
MM		283.81	286.09	286.09	286.09
AC-FT		14110.	14224.	14224.	14224.
THOUS CU M		17405.	17545.	17545.	17545.

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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	2655.	-1

STAGE	1210.00	1211.00	1212.00	1213.00	1214.00	1215.00	1216.00	1216.50
FLOW	0.00	2800.00	8600.00	16200.00	22500.00	36500.00	48000.00	53500.00
CAPACITY=	0.	200.	600.	1350.	2655.	4300.	6810.	13240.
ELEVATION=	1190.	1195.	1200.	1205.	1210.	1215.	1220.	1230.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1210.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1216.0	2.8	1.5	7667.

STATION 2, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	3.	12.	36.	84.	162.	274.	438.
677.	1003.	1549.	2653.	6213.	11012.	15371.	17327.	17316.	15952.
13711.	11421.	9339.	7775.	6546.	5459.	4494.	3633.	2877.	2501.
2177.	1875.	1602.	1362.	1154.	975.	822.	692.	582.	489.
410.	344.	289.	242.	203.	170.	143.	120.	100.	84.
70.	59.	50.	42.	35.	29.	24.	21.	17.	14.
12.	10.	8.	7.	6.	5.	4.	4.	3.	2.
2.	2.	1.	1.	1.					

STORAGE

2655.	2655.	2655.	2655.	2656.	2659.	2665.	2674.	2687.	2706.
2735.	2773.	2837.	2967.	3178.	3417.	3606.	3701.	3700.	3631.
3534.	3435.	3345.	3266.	3196.	3135.	3080.	3031.	2988.	2949.
2911.	2875.	2843.	2815.	2791.	2770.	2752.	2736.	2723.	2712.
2703.	2695.	2689.	2683.	2679.	2675.	2672.	2669.	2667.	2665.
2663.	2662.	2661.	2660.	2659.	2658.	2658.	2657.	2657.	2657.
2656.	2656.	2656.	2656.	2656.	2656.	2655.	2655.	2655.	2655.
2655.	2655.	2655.	2655.	2655.					

STAGE

1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.1	1210.1	1210.2
1210.2	1210.4	1210.6	1210.9	1211.6	1212.3	1212.9	1213.2	1213.2	1213.0
1212.7	1212.4	1212.1	1211.9	1211.6	1211.5	1211.3	1211.1	1211.0	1210.9
1210.8	1210.7	1210.6	1210.5	1210.4	1210.3	1210.3	1210.2	1210.2	1210.2
1210.1	1210.1	1210.1	1210.1	1210.1	1210.1	1210.1	1210.0	1210.0	1210.0
1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0
1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0
1210.0	1210.0	1210.0	1210.0	1210.0					

PEAK OUTFLOW IS 17327. AT TIME 4.50 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	17327.	6846.	2295.	2295.	172104.
CMS	491.	194.	65.	65.	4873.
INCHES		2.69	2.82	2.82	2.82
MM		68.28	71.52	71.52	71.52
AC-FT		3395.	3556.	3556.	3556.
THOUS CU M		4187.	4386.	4386.	4386.

STATION 2, PLAN 1, RATIO 2

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	1.	5.	24.	72.	169.	323.	548.	876.
1354.	2006.	3369.	7496.	15611.	25081.	36833.	38760.	37163.	31100.
24485.	20617.	17784.	14851.	12046.	9729.	7939.	6541.	5252.	4112.
3151.	2574.	2220.	1899.	1616.	1370.	1158.	976.	822.	691.
580.	487.	408.	342.	287.	241.	202.	169.	142.	119.
100.	84.	70.	59.	49.	41.	35.	29.	24.	20.
17.	14.	12.	10.	8.	7.	6.	5.	4.	3.
3.	2.	2.	2.	1.					

STORAGE

2655.	2655.	2655.	2656.	2658.	2663.	2675.	2693.	2719.	2758.
2814.	2891.	3016.	3250.	3617.	4032.	4315.	4399.	4329.	4173.
4018.	3873.	3725.	3584.	3462.	3362.	3276.	3196.	3123.	3058.
3004.	2958.	2916.	2878.	2845.	2816.	2791.	2770.	2752.	2736.
2723.	2712.	2703.	2695.	2689.	2683.	2679.	2675.	2672.	2669.
2667.	2665.	2663.	2662.	2661.	2660.	2659.	2658.	2658.	2657.
2657.	2657.	2656.	2656.	2656.	2656.	2656.	2656.	2655.	2655.
2655.	2655.	2655.	2655.	2655.					

STAGE

1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.1	1210.1	1210.2	1210.3
1210.5	1210.7	1211.1	1211.8	1212.9	1214.2	1215.0	1215.2	1215.1	1214.6
1214.1	1213.7	1213.3	1212.8	1212.5	1212.1	1211.9	1211.6	1211.4	1211.2
1211.1	1210.9	1210.8	1210.7	1210.6	1210.5	1210.4	1210.3	1210.3	1210.2
1210.2	1210.2	1210.1	1210.1	1210.1	1210.1	1210.1	1210.1	1210.1	1210.0
1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0
1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0
1210.0	1210.0	1210.0	1210.0	1210.0					

PEAK OUTFLOW IS 38760. AT TIME 4.50 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	38760.	13838.	4589.	4589.	344208.
CMS	1098.	392.	130.	130.	9747.
INCHES		5.43	5.63	5.63	5.63
MM		138.01	143.04	143.04	143.04
AC-FT		6862.	7112.	7112.	7112.
THOUS CU M		8464.	8772.	8772.	8772.

STATION 2, PLAN 1, RATIO 3

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	1.	8.	36.	108.	253.	485.	822.	1314.
2031.	3198.	6264.	12953.	24613.	42847.	54795.	61070.	53928.	46252.
40186.	32070.	23513.	19982.	17134.	14174.	11403.	8976.	7223.	5716.
4413.	3339.	2635.	2266.	1935.	1645.	1393.	1177.	992.	834.
701.	588.	493.	414.	347.	291.	244.	204.	171.	144.
120.	101.	85.	71.	59.	50.	42.	35.	29.	25.
21.	17.	15.	12.	10.	9.	7.	6.	5.	4.
4.	3.	2.	2.	2.					

STORAGE

2655.	2655.	2655.	2656.	2659.	2668.	2685.	2712.	2752.	2809.
2894.	3007.	3180.	3501.	4021.	4577.	4952.	5053.	4937.	4726.
4461.	4196.	3995.	3839.	3691.	3554.	3434.	3329.	3235.	3149.
3075.	3015.	2965.	2921.	2882.	2848.	2819.	2793.	2772.	2753.
2737.	2724.	2713.	2704.	2696.	2689.	2684.	2679.	2675.	2672.
2669.	2667.	2665.	2663.	2662.	2661.	2660.	2659.	2658.	2658.
2657.	2657.	2657.	2656.	2656.	2656.	2656.	2656.	2656.	2655.
2655.	2655.	2655.	2655.	2655.					

STAGE

1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.1	1210.2	1210.3	1210.5
1210.7	1211.1	1211.6	1212.6	1214.2	1215.6	1216.3	1216.5	1216.3	1215.8
1215.3	1214.7	1214.1	1213.6	1213.1	1212.7	1212.4	1212.0	1211.8	1211.5
1211.3	1211.1	1210.9	1210.8	1210.7	1210.6	1210.5	1210.4	1210.4	1210.3
1210.3	1210.2	1210.2	1210.1	1210.1	1210.1	1210.1	1210.1	1210.1	1210.1
1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0
1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0
1210.0	1210.0	1210.0	1210.0	1210.0					

PEAK OUTFLOW IS 61070. AT TIME 4.50 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	61070.	20872.	6884.	6884.	516314.
CMS	1729.	591.	195.	195.	14620.
INCHES		8.20	8.45	8.45	8.45
MM		208.17	214.57	214.57	214.57
AC-FT		10350.	10668.	10668.	10668.
THOUS CU M		12766.	13158.	13158.	13158.

STATION 2, PLAN 1, RATIO 4

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	1.	11.	48.	145.	337.	647.	1097.	1752.
2708.	5109.	9021.	18140.	38141.	59695.	86765.	83814.	70048.	55831.
46755.	40751.	33101.	24473.	20486.	17705.	14720.	11671.	8989.	7099.
5523.	4201.	3140.	2547.	2183.	1860.	1578.	1335.	1126.	948.
797.	669.	561.	470.	394.	330.	277.	232.	195.	163.
137.	115.	96.	81.	68.	57.	48.	40.	33.	28.
23.	20.	16.	14.	12.	10.	8.	7.	6.	5.
4.	3.	3.	2.	2.					

STORAGE

2655.	2655.	2655.	2656.	2661.	2672.	2695.	2731.	2784.	2861.
2973.	3115.	3331.	3743.	4372.	5032.	5364.	5332.	5172.	4970.
4748.	4486.	4220.	4017.	3866.	3721.	3578.	3446.	3330.	3228.
3138.	3063.	3003.	2954.	2911.	2874.	2840.	2812.	2787.	2766.
2749.	2734.	2721.	2710.	2701.	2694.	2688.	2682.	2678.	2674.
2671.	2668.	2666.	2664.	2663.	2662.	2661.	2660.	2659.	2658.
2658.	2657.	2657.	2657.	2656.	2656.	2656.	2656.	2656.	2656.
2655.	2655.	2655.	2655.	2655.					

STAGE

1210.0	1210.0	1210.0	1210.0	1210.0	1210.1	1210.1	1210.2	1210.4	1210.6
1211.0	1211.4	1212.1	1213.3	1215.1	1216.5	1217.1	1217.1	1216.7	1216.3
1215.9	1215.4	1214.8	1214.1	1213.7	1213.2	1212.8	1212.4	1212.1	1211.7
1211.5	1211.2	1211.1	1210.9	1210.8	1210.7	1210.6	1210.5	1210.4	1210.3
1210.3	1210.2	1210.2	1210.2	1210.1	1210.1	1210.1	1210.1	1210.1	1210.1
1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0
1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0	1210.0
1210.0	1210.0	1210.0	1210.0	1210.0					

PEAK OUTFLOW IS 86765. AT TIME 4.25 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	86765.	27924.	9179.	9179.	688420.
CMS	2457.	791.	260.	260.	19494.
INCHES		10.96	11.26	11.26	11.26
MM		278.51	286.09	286.09	286.09
AC-FT		13846.	14224.	14224.	14224.
THOUS CU M		17079.	17545.	17545.	17545.

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	23.69	1	22386.	44771.	67157.	89543.
	(	61.36)	(	633.89)(	1267.79)(	1901.68)(	2535.57)(
ROUTED TO	2	23.69	1	17327.	38760.	61070.	86765.
	(	61.36)	(	490.65)(	1097.57)(	1729.30)(	2456.91)(

1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1210.00	1210.00	1216.00
STORAGE	2655.	2655.	4802.
OUTFLOW	0.	0.	48000.

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	1213.18	0.00	3701.	17327.	0.00	4.50	0.00
0.50	1215.20	0.00	4399.	38760.	0.00	4.50	0.00
0.75	1216.50	0.50	5053.	61070.	0.75	4.50	0.00
1.00	1217.12	1.12	5364.	86765.	1.25	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 #3 DAM NO. 7-28

TYPE OF DAM Earth Embankment FREEBOARD _____ Ft.

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

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

The subject structure is approximately 1½-mile long earth embankment having a crest width of ___ feet and has an average height of 30 feet. It is in series with and forms a part of the other two major flood retarding structures, White Tanks Dam #4 and McMicken Dam. The embankment, in general, appeared to be in a fairly satisfactory condition with the exception of some already logged transverse cracks and rodent holes. The emergency spillway channel was also inspected and was found to be in a good condition and free of obstructions.

The reservoir was totally dry at the time of inspection although a very insignificant impoundment at the locations of the large sized outlets was recorded during the recent floods of March 1978. The two principal spillway structures consist of 48 inches diameter gated CMP with no trash guards at the inlet ends of the pipe. The 24 inches diameter gated CMP provides an irrigation outlet. All gates were serviced about a month ago and appeared to be in operable condition. 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 during March 1977.

Inspection by: K.M. Hussain
Date of Inspection 6-6-78
Date of Report 6-15-78
Photos: YES _____ NO X

BBS

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

NAME OF DAM White Tank #3 DAM NO. 7-28

TYPE OF DAM Earth FREEBOARD _____ Ft.

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

CONTACTS W. Anderson, A. Gusak of Maricopa Co. Flood Control and Water Conservation District

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

Embankment is in good condition. No cracks were observed. Very minor eroision.

OUTLET WORKS:

Flood Control Diversion Gate No. 2 is virtually inoperable, according to Gusak. He said they keep the operator and guides lubricated and had only recently attempted to free the gate leaf.

SPILLWAY (Obstruction, scour):

No problems.

REMARKS AND RECOMMENDATIONS:

Except for the small Diversion Gate No. 2, the dam and related works are entirely satisfactory.

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 #3 DAM NO. 7-28

TYPE OF DAM Earth FREEBOARD _____ Ft.

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

CONTACTS R. Pendergast of Maricopa Co. F.C.D.

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

Embankment is relatively free from erosion but minor damage has resulted from motorcycle and other vehicular traffic on the surfaces of the dam.

OUTLET WORKS:

No apparent problems.

SPILLWAY (Obstruction, scour):

No apparent problems. A nearby farm implement proving ground had used the spillway area to try out some new discing equipment.

REMARKS AND RECOMMENDATIONS:

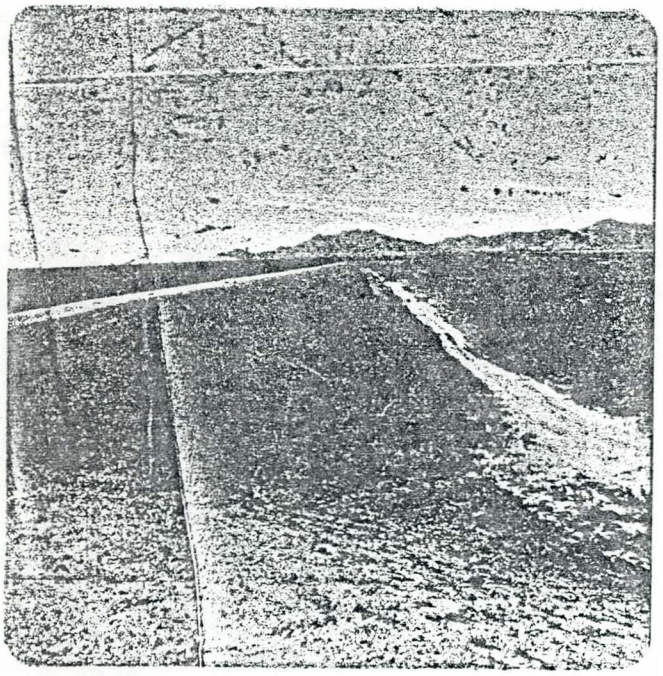
There are no problems that routine maintenance won't correct.

Inspection by: JDW/DRL JDW
Date of Inspection 2/17/76
Date of Report 3/1/76
Photos: YES X NO _____

RGS

WHITE TANKS #3

February 17, 1976



Upstream slope.

Control for outlet.

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

NAME OF DAM WHITE TANKS #3 DAM NO. 7-2[illegible]

TYPE OF DAM Earthfill FREEBOARD _____ Ft.

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

CONTACTS NONE

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

The embankment appeared to be in fair condition. Erosion along motorcycle and four-wheel vehicle paths on both faces of the dam was evident along the entire length of the dam. A problem with rodent activity was also evident on the embankment. A hole approximately 1-foot deep and 1-foot in diameter was discovered in the center of the roadway on the crest of the embankment. This was probably caused by rodent activity (see photo).

OUTLET WORKS:
(See Plans) The outlet basin for outlet works "M" was silted in with a large rock at the downstream end of the 24" CMP. The control gate on the upstream end of outlet works "M" appeared to be in operable condition.
The upstream end of the 48" CMP outlet structure "L" had a small amount of silt around the control gate, but did appear operable. The downstream end of this structure appeared in good condition. (Con't. Page Two)

SPILLWAY (Obstruction, scour):

The spillway located on the south end of the dam was relatively free from obstruction except for some small desert bushes and grass in its channel. The dike that forms the right side of the spillway was badly eroded in some places. The remainder of the spillway appeared to be free of major scouring.

REMARKS AND RECOMMENDATIONS:
The overall structural condition of the three outlet structures appeared to be satisfactory. The silt and rock at the downstream end of structure "M" should be removed.

Some "rainholes" were examined just to the south of outlet "L" near the upstream side of the dam, (see photo). One hole was very large (approximately 20'x20'x10'). This area could have been the location of an old streambed. No damage was evident to the embankment or structures nearby and no evidence of this appeared on the downstream side of the dam.

Continued on Page Two-

Inspection by: M. J. Adams MSA / J. R. Lawrence
Date of Inspection 12-12-[illegible]
Date of Report 12-12-[illegible]
Photos: YES X NO _____

HS

WHITE TANKS #1 (7-28) Continued-

OUTLET WORKS: - Continued

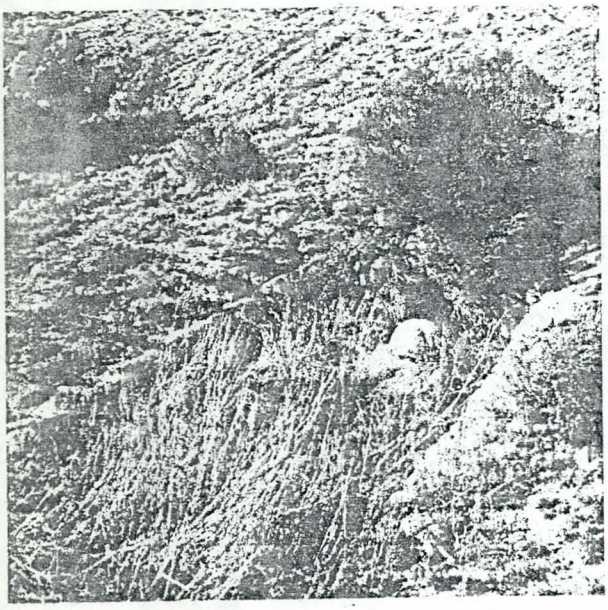
Outlet structure "K" appeared to be in operable condition with no silt around the control gate on the upstream end. The downstream end of the 48" CMP outlet appeared to be in good condition as did the concrete lined channel from the downstream end of the outlet to a main canal.

REMARKS AND RECOMMENDATIONS: - Continued

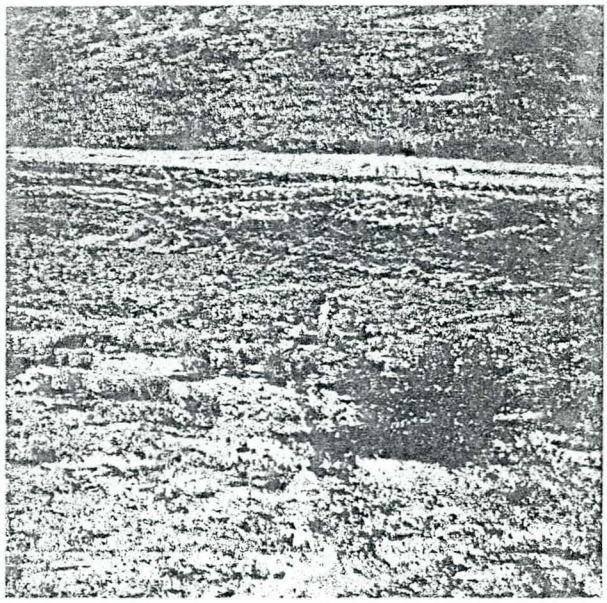
It is recommended that the damages to this dam and appurtenances, as mentioned above, be called to the owner's attention and that the problems be repaired.

WHITE TANKS DAM #3 (7-28)

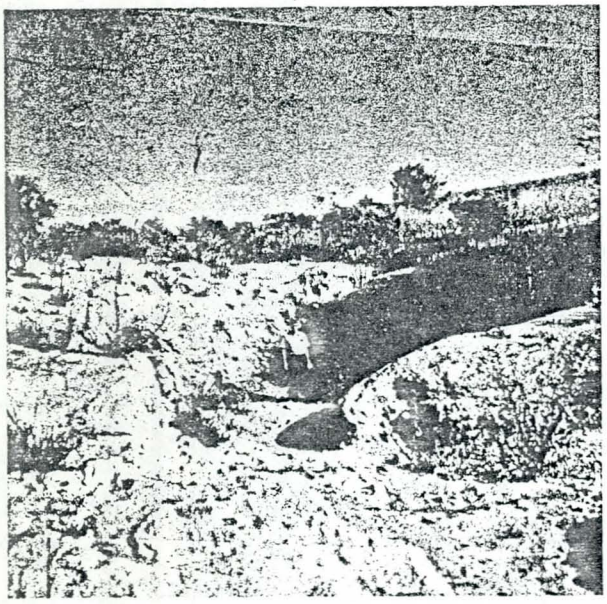
12-12-73



Outlet works "M" with large rock near outlet and basin silted in.



Erosion in vehicle tracks on upstream face of dam.

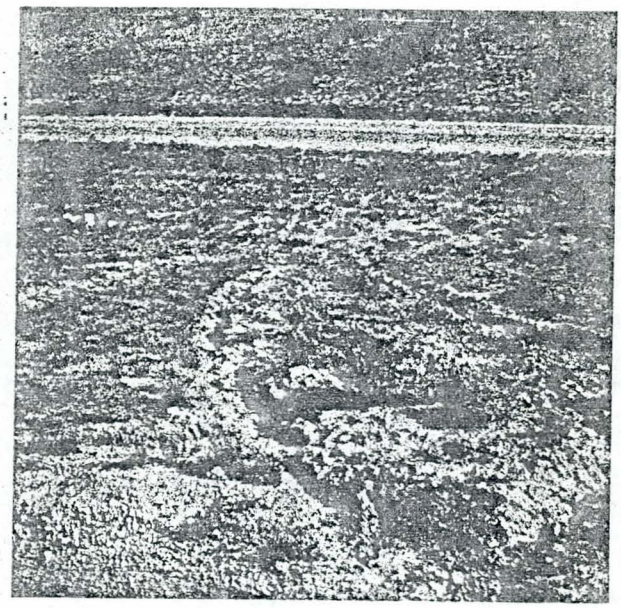


"Sinkhole" on upstream side of dam just south of outlet "L".

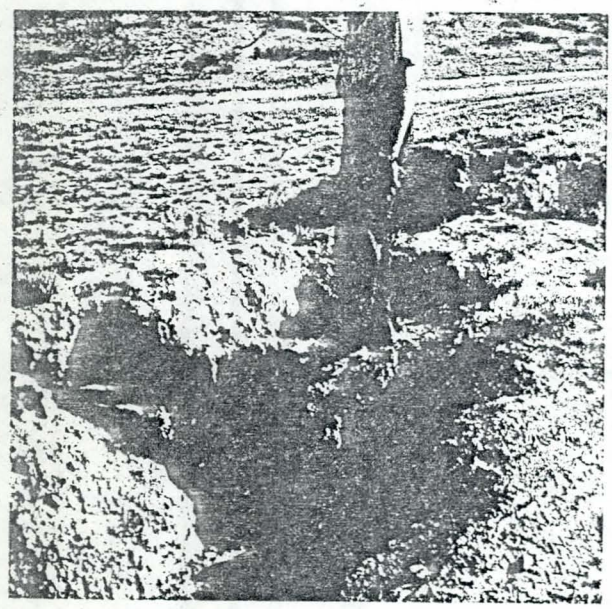
WHITE TANKS #3 (7-28) - WMSA

12-12-73

Hole in crest of dam caused by rodent activity.



Erosion along vehicle tire tracks on downstream slope of dam.



Erosion of dike on north end of dam.

Erosion on downstream face of dike on north end of dam.

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.

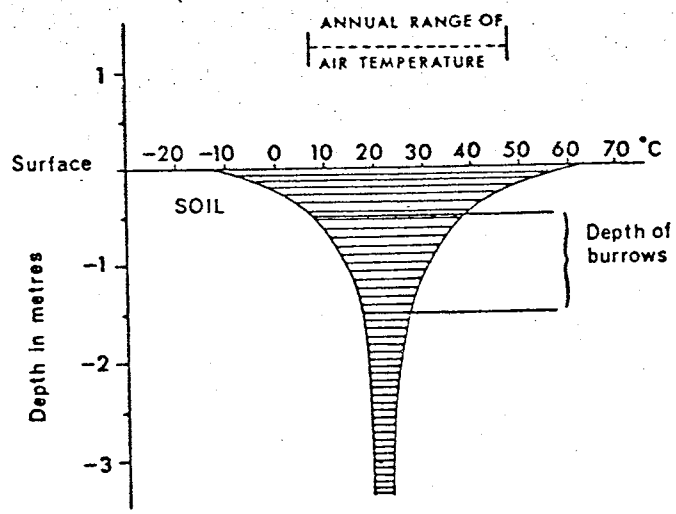


FIGURE 10.3. The relationship between the depth of kangaroo-rat burrows and the annual range of soil temperature in Arizona (after Schmidt-Nielsen, 1964, from Misonne, 1959).

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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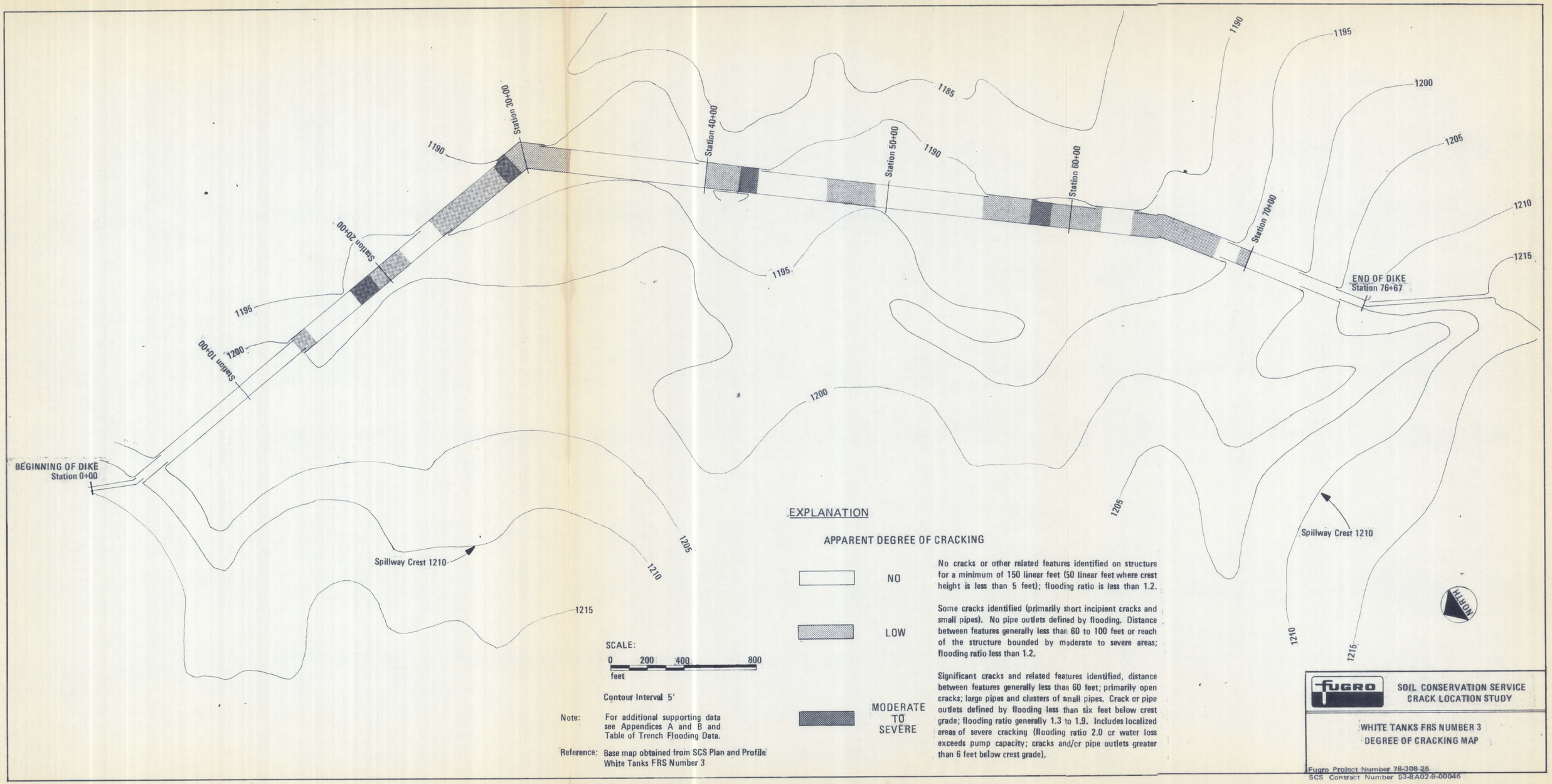
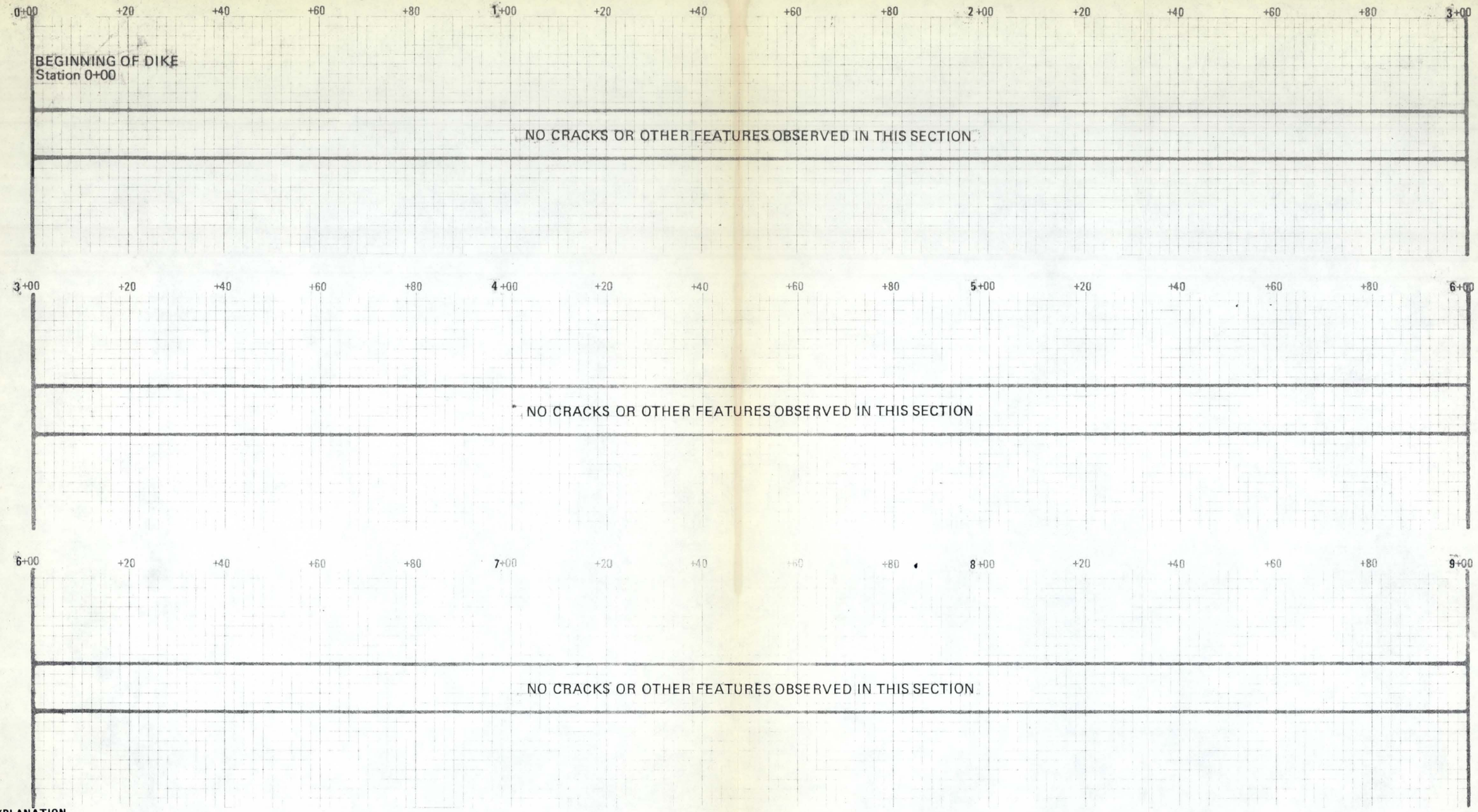
APPENDIX E

MAPS, TRENCH LOGS, AND PHOTOGRAPHS FROM THE WHITE TANKS #3 CRACK LOCATION INVESTIGATION (FUGRO, 1979)


BEGINNING OF DIKE
Station 0+00
Station 10+00
Station 20+00
Station 30+00
Station 40+00
Station 50+00
Station 60+00
Station 70+00
END OF DIKE
Station 76+67
1185
1190
1195
1200
1205
1210
1215
Spillway Crest 1210
Spillway Crest 1210
NORTH
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
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 Number 3
FUGRO
SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY
WHITE TANKS FRS NUMBER 3
DEGREE OF CRACKING MAP
Fugro Project Number 78-308-25
SCS Contract Number 53-8A02-9-00046



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'
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- c — > 2'

DT-4 — Ditch Witch Trench Area

BH-3 — Backhoe Exploratory Area

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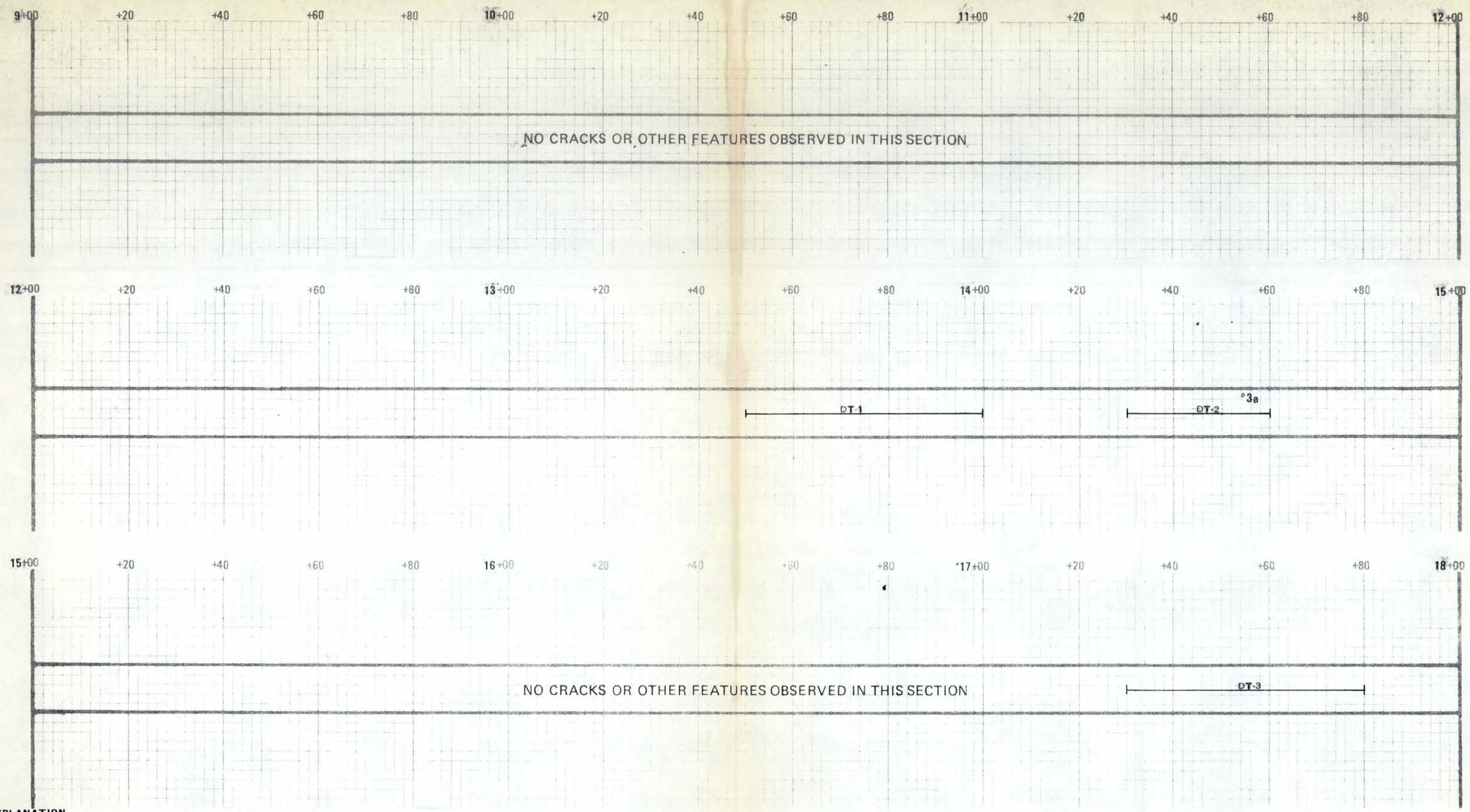
SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 3
FLOOD RETARDING STRUCTURE
CRACK LOCATION PLAN

Fugro Project Number 78-308-25 — Sheet 1 of 9

SCS Contract Number 53-8A02-9-00046



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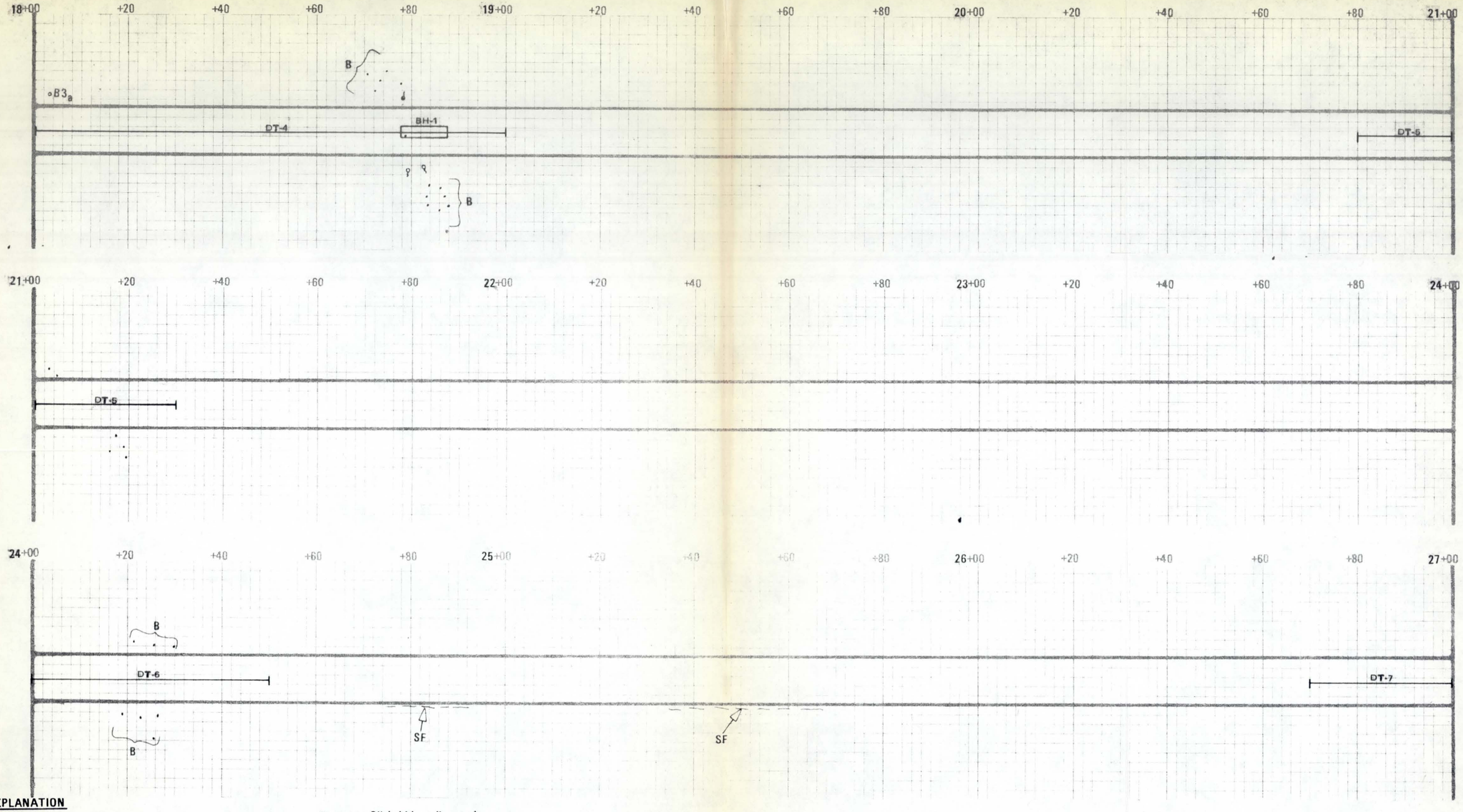
SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 3
FLOOD RETARDING STRUCTURE

CRACK LOCATION PLAN

Fugro Project Number 78-308-25 — Sheet 2 of 9

SCS Contract Number 53-8A02-9-00046



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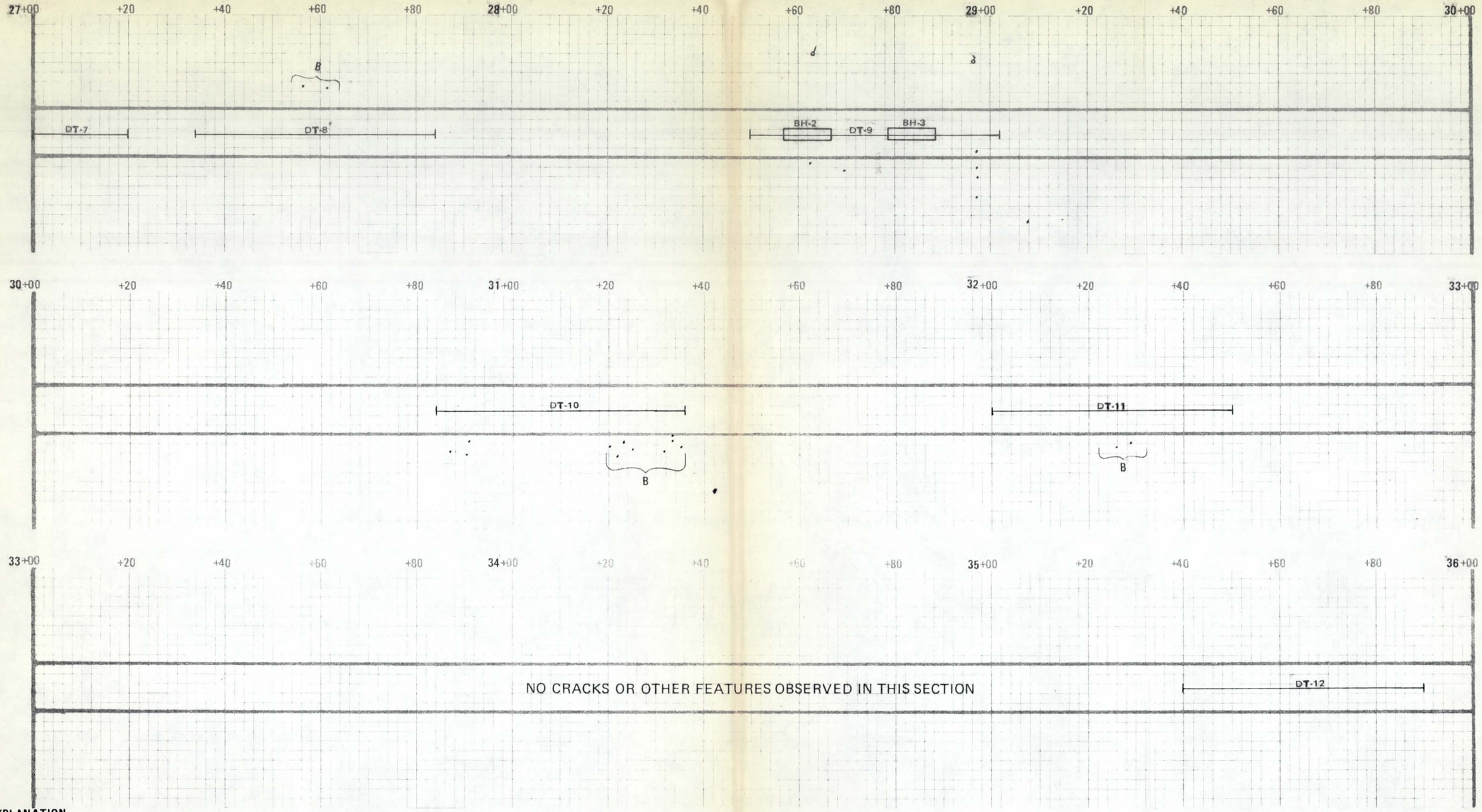
FUGRO

SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 3
FLOOD RETARDING STRUCTURE
CRACK LOCATION PLAN

Fugro Project Number 78-308-25 — Sheet 3 of 9

SCS Contract Number 53-8A02-9-00046



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FUGRO

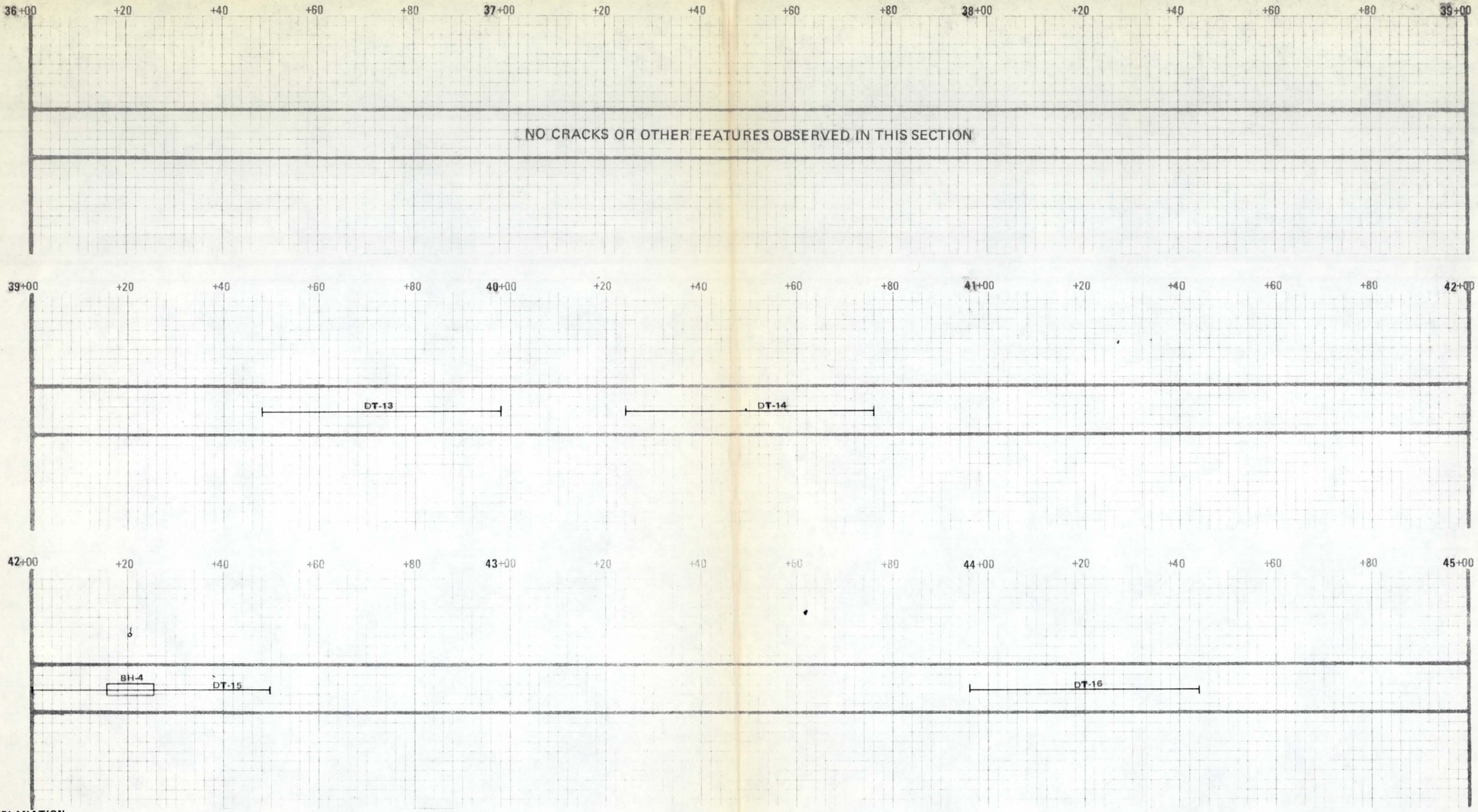
SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 3
FLOOD RETARDING STRUCTURE

CRACK LOCATION PLAN

Fugro Project Number 78-308-25 — Sheet 4 of 9

SCS Contract Number 53-8A02-9-00046



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FUGRO

SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

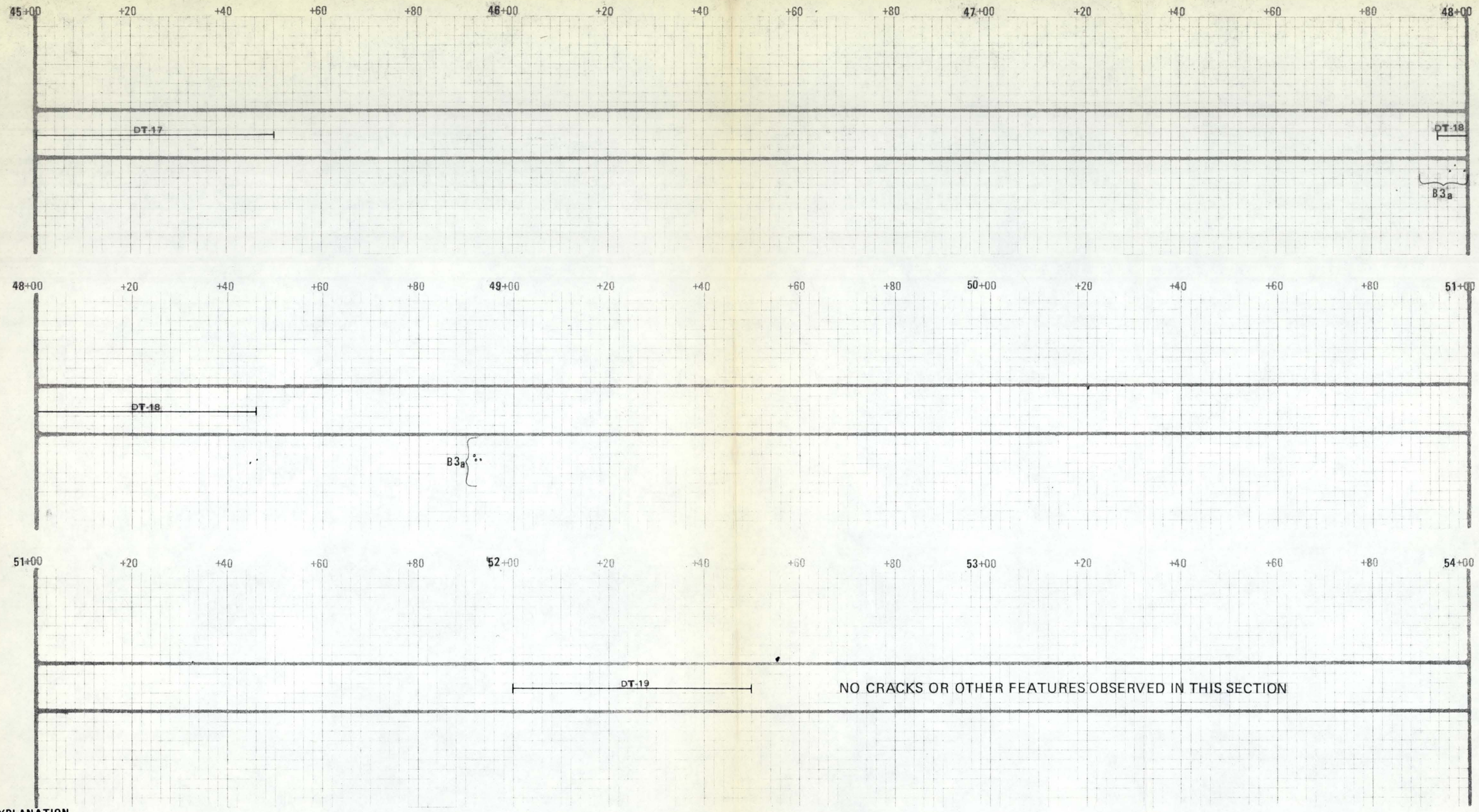
WHITE TANKS NUMBER 3
FLOOD RETARDING STRUCTURE

CRACK LOCATION PLAN

Fugro Project Number 78-308-25

Sheet 5 of 9

SCS Contract Number 53-8A02-9-00046



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FUGRO

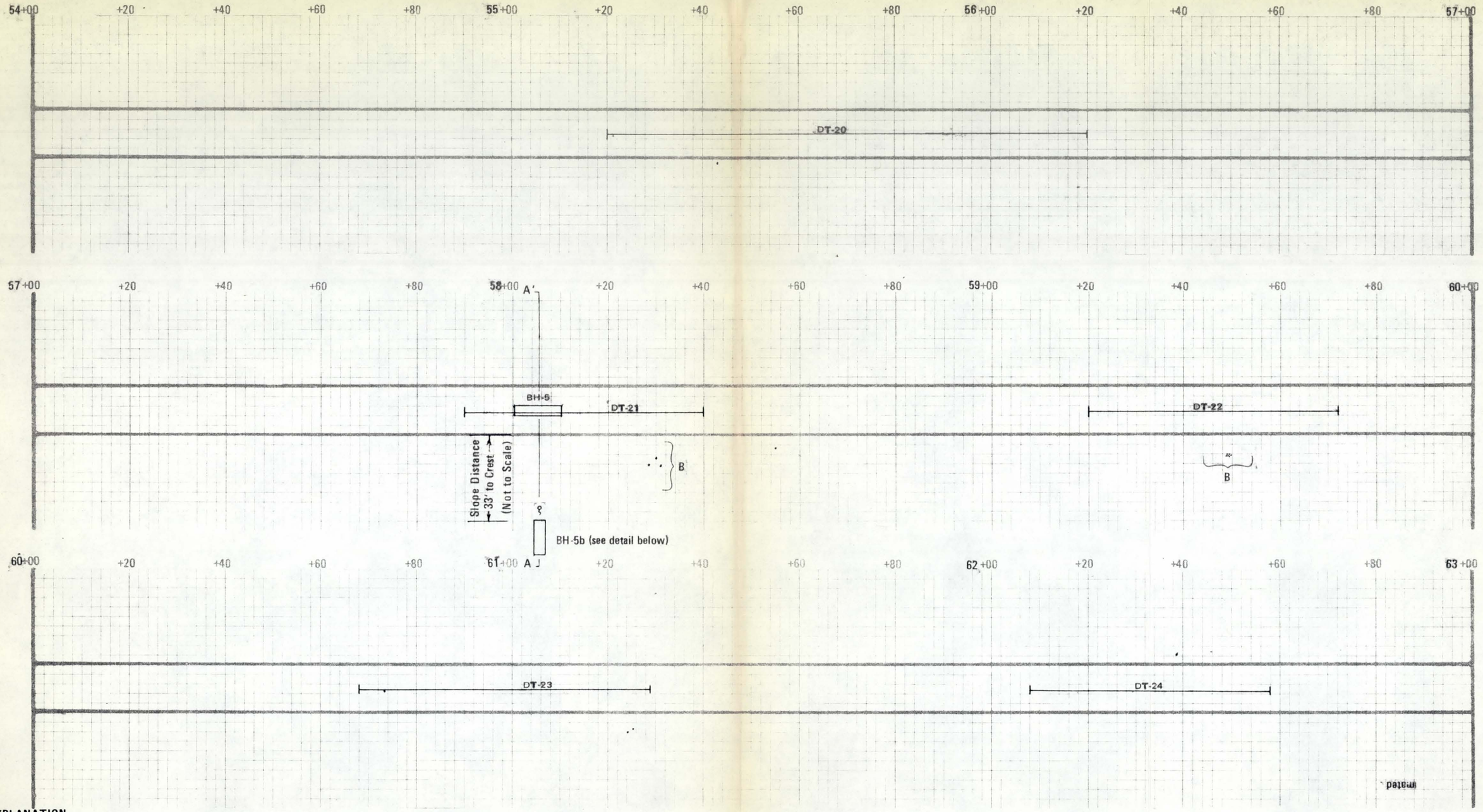
SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 3
FLOOD RETARDING STRUCTURE

CRACK LOCATION PLAN

Fugro Project Number 78-308-25 — Sheet 6 of 9

SCS Contract Number 53-8A02-9-00046



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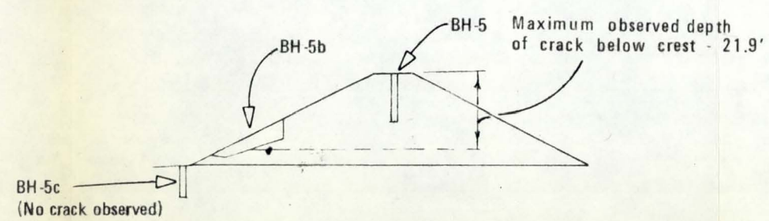


A-A' Detailed cross-section at BH-5 (58+06)
Scale: 1" = 50'

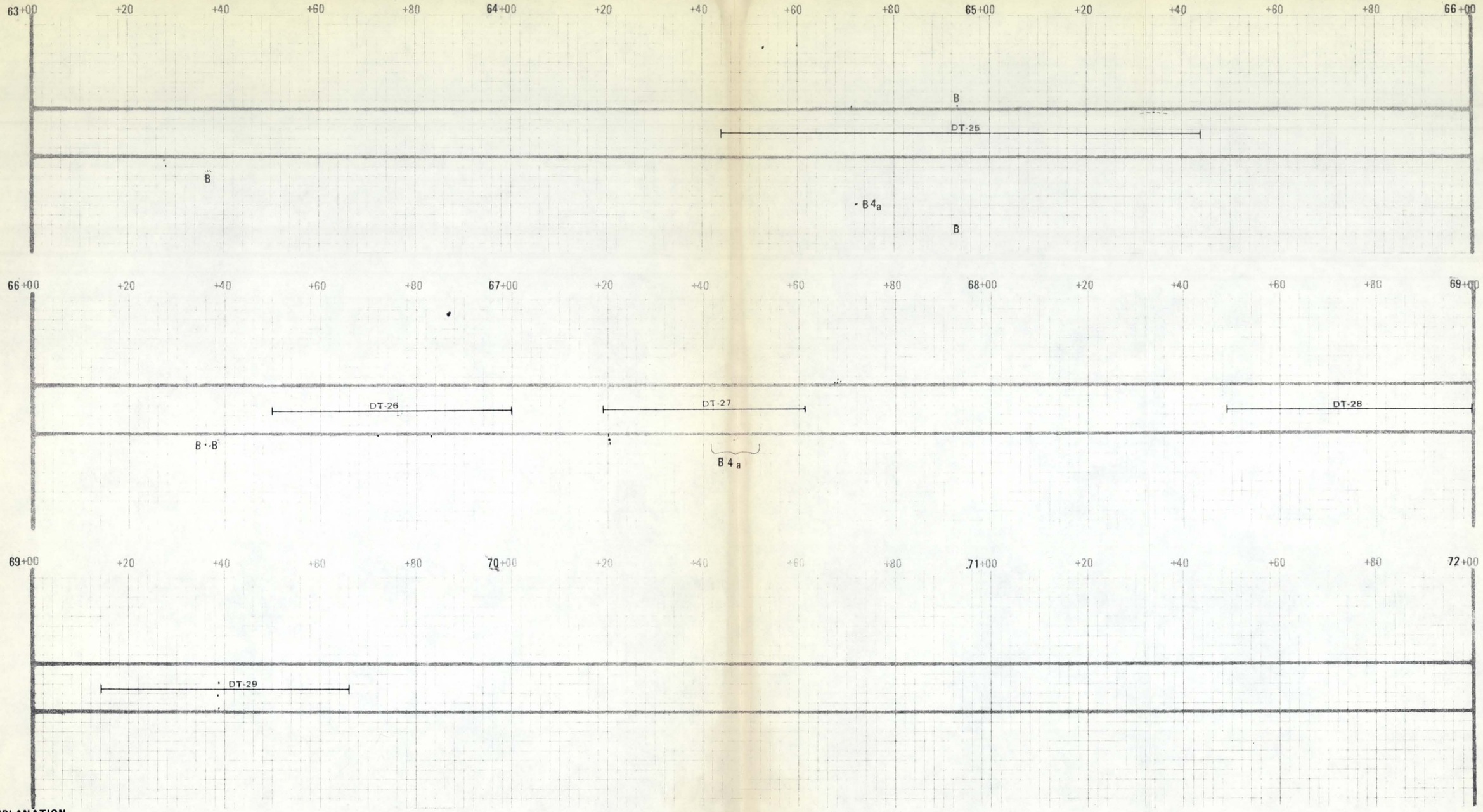
FUGRO

SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 3
FLOOD RETARDING STRUCTURE
CRACK LOCATION PLAN

Fugro Project Number 78-308-25 — Sheet 7 of 9

SCS Contract Number 53-8A02-9-00046



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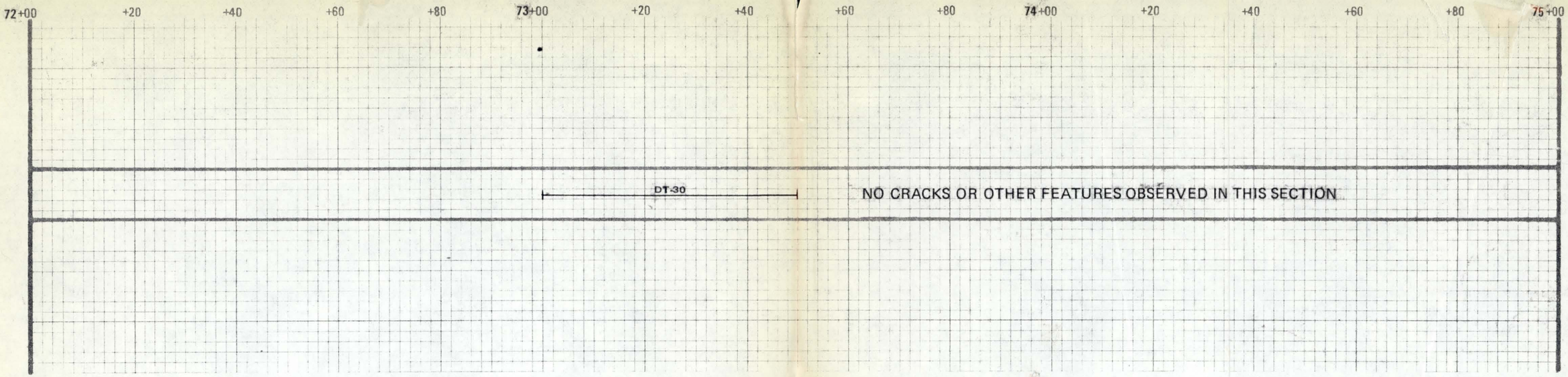
FUGRO

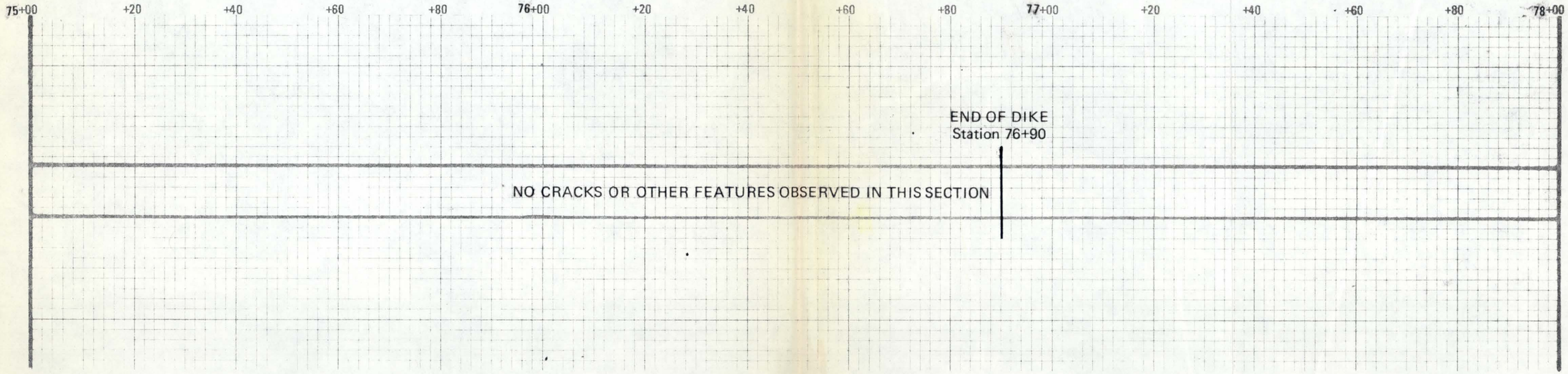
SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 3
FLOOD RETARDING STRUCTURE
CRACK LOCATION PLAN

Fugro Project Number 78-308-25 — Sheet 8 of 9

SCS Contract Number 53-8A02-9-00046





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FUGRO

SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 3
FLOOD RETARDING STRUCTURE
CRACK LOCATION PLAN

Fugro Project Number 78-308-25

Sheet 9 of 9

SCS Contract Number 53-8A02-9-00046

NOTES	Torvane kips/ft.^{2}	TRENCH PROFILE	Depth (feet)	SOIL DESCRIPTION
1" diameter pipe, probed 36".			0	
	1.3		1	
1/16" to 1/8" separation filled with sand				CLAYEY SAND (SC) dark yellow brown (10YR 4/4), medium dense, calcareous, moist.
			2	
Hairline crack			3	
			4	
	2.4			CLAYEY SAND (SC) yellow brown, (10YR 5/4), dense to very dense, calcareous, dry.
			5	
			6	Trench Depth 5.8'
			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 3
Log of WT-3 BH-1
Station 18+78

SCS Contract Number 53-8A02-9-00046

Fugro Project Number 78-308-25

NOTES	Torvane kips/ft.^{2}	TRENCH PROFILE	Depth (feet)	SOIL DESCRIPTION
2" to 3" wide zone of looser soil.			0	
	1.0		1	
3/4" to 1 1/2" wide open crack, probed 46".			2	CLAYEY SAND - CLAYEY SILT (SC-ML-CL), (10YR 4/4), dark yellow brown, medium dense, calcareous,moist.
			3	
1/2" to 3/4" crack filled with fine sand and silt.			4	
	2.6		5	
Hairline crack			6	CLAYEY SAND - CLAYEY SILT (SC-ML-CL) dark yellow brown (10YR 4/4), dense to very dense, calcareous, dry.
			7	
			8	
			9	
			10	Trench Depth 9.9'
			11	
			12	
			13	
			14	
			15	
	Width (feet)	0 1 2		

TRENCH PROFILE LOG

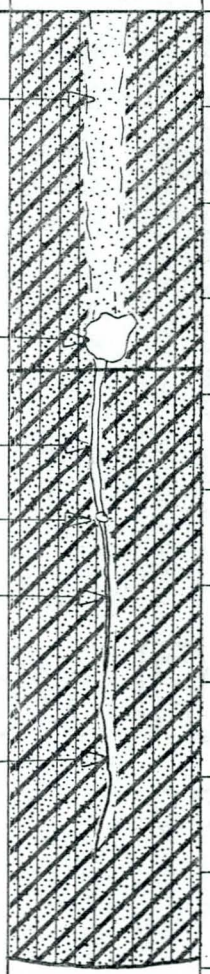
FUGRO

SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 3
Log of WT-3 BH-2
Station 28+62

SCS Contract Number 53-8A02-9-00046

Fugro Project Number 78-308-25

NOTES	Torvane kips/ft.^{2}	TRENCH PROFILE	Depth (feet)	SOIL DESCRIPTION
2" to 3" wide zone of looser soil.	.9		0	
			1	CLAYEY SAND - CLAYEY SILT (SC-ML-CL) (10YR 4/4), dark yellow brown, medium dense, calcareous, moist.
			2	
5" diameter pipe probed 28".			3	
			4	
3/4" to 1" crack filled with loose sand.				
			5	
1" diameter pipe probed 44".				
1/4" to 1/2" wide sand-filled crack.			6	CLAYEY SAND - CLAYEY SILT (SC-ML-CL) dark yellow brown (10YR 4/4), dense to very dense, calcareous, dry.
	2.6		7	
Hairline crack			8	
			9	
			10	Trench Depth 10'
			11	
			12	
			13	
			14	
			15	
	Width (feet)	0 1 2		

TRENCH PROFILE LOG

FUGRO

SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 3
Log of WT-3 BH-3
Station 28+87

SCS Contract Number 53-8A02-9-00046

Fugro Project Number 78-308-25

NOTES	Torvane kips/ft.^{2}	TRENCH PROFILE	Depth (feet)	SOIL DESCRIPTION
Hairline crack			0	
			1	
6" diameter pipe probed 31".	1.5			CLAYEY SAND - SANDY CLAY (SC-CL) yellow brown (10YR 5/4), medium dense, calcareous, moist.
1/2" to 3/4" sand-filled crack.			2	
			3	
			4	
Hairline crack			5	CLAYEY SAND - SANDY CLAY (SC-CL) yellow brown (10YR 5/4), dense to very dense, calcareous, dry.
	2.4		6	
			7	
			8	
				Trench Depth 8.7'
			9	
			10	
			11	
			12	
			13	
			14	
			15	
	Width (feet)	0 1 2		

TRENCH PROFILE LOG

SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 3
Log of WT-3 BH-4
Station 42+20

SCS Contract Number 53-8A02-9-00046

Fugro Project Number 78-308-25

NOTES	Torvane kips/ft.^{2}	TRENCH PROFILE	Depth (feet)	SOIL DESCRIPTION
			0	
	1.0		1	CLAYEY SAND (SC) dark yellow brown (10YR 4/4), medium dense, calcareous, moist.
1" to 2" wide crack, sediment filled.			2	
3" diameter pipe, probed 31".			3	lense of SAND (SP) very pale brown (10YR 7/3), calcareous, loose, slightly moist.
1 to 1 1/2" wide crack, discontinuously filled with soil.			4	
			5	CLAYEY SAND (SC) dark yellow brown (10 YR 4/4), dense calcareous, dry.
	1.9		6	
			7	
5" wide pipe probed 24".			8	
Open crack 1/2" to 1" wide.			9	
	2.4		10	CLAYEY SAND (SC) dark yellow brown (10 YR 4/4), dense to very dense, calcareous, dry.
			11	
			12	
1/4" to 1/2" wide crack, sand filled.			13	
			14	Original Trench Depth 14.2' 2/3/79
Crack probed 14" below bottom of trench.			15	
	Width (feet)	0 1 2		

TRENCH PROFILE LOG

FUGRO

SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 3
Log of WT-3 BH-5
Station 58+05

SCS Contract Number 53-8A02-9-00046

Fugro Project Number 78-308-25

Sheet 1 of 2

NOTES	Torvane kips/ft.^{2}	TRENCH PROFILE	Depth (feet)	SOIL DESCRIPTION
	2.4		15	CLAYEY SAND (SC) dark yellow brown (10YR 4/4), dense to very dense, calcareous, dry.
			16	Extended Trench Depth 15.5' 2/22/79
Probed 24" beyond extended depth.			17	
			18	
			19	
			20	
			21	
			22	
			23	
			24	
			25	
			26	
			27	
			28	
			29	
			30	
	Width (feet)	0 1 2		

TRENCH PROFILE LOG

FUGRO

SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 3
Log of WT-3 BH-5
Station 58+05

SCS Contract Number 53-8A02-9-00046

Fugro Project Number 78-308-25

Sheet 2 of 2

NOTES	Torvane kips/ft.^{2}	TRENCH PROFILE	Depth (feet)	SOIL DESCRIPTION
	.6		0	CLAYEY SAND (SC) dark yellow brown (10YR 4/4), medium dense, calcareous, moist.
1" wide pipe probed 36"				
1" to 1 1/2" wide crack probed 36"			1	
	1.6		2	CLAYEY SAND (SC) dark yellow brown (10YR 4/4), dense, calcareous, moist.
Hairline crack				
			3	
Open crack 1/2" 3/4" probed 36"			4	
	2.1			CLAYEY SAND (SC) dark yellow brown (10YR 4/4), dense to very dense, calcareous, dry.
1/8" to 1/4" wide crack filled with loose sand.			5	
TRENCH WALL				
TRENCH FLOOR			6	Trench Depth 6' (18.4' below crest of dike)
			7	
			8	
			9	Crack ends 21.9' below crest
			10	
			11	
			12	
			13	
			14	
			15	
	Width (feet)	0 1 2		

Note: Refer to Crack Location Plan (Station 58+05) for detailed cross section.

TRENCH PROFILE LOG

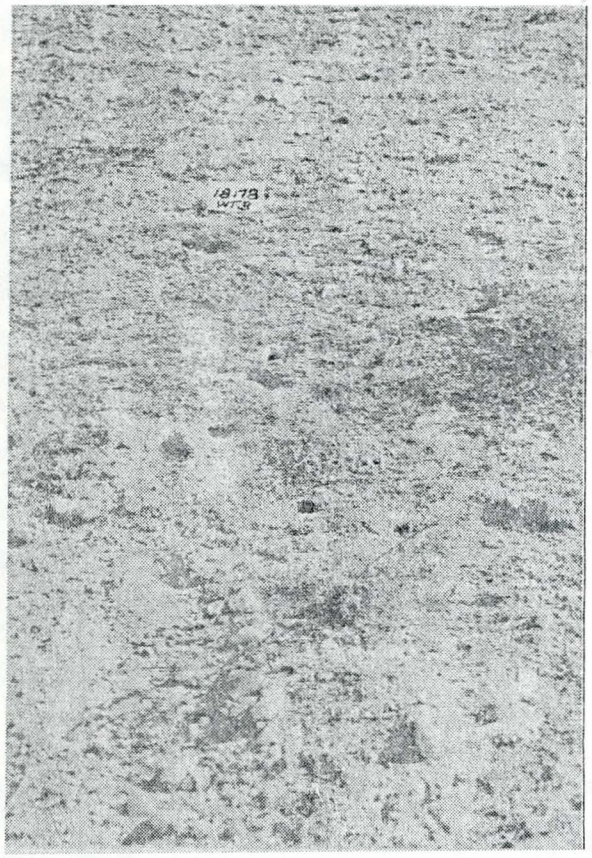
FUGRO

SOIL CONSERVATION SERVICE
CRACK LOCATION STUDY

WHITE TANKS NUMBER 3
Log of WT-3 BH-5b
Station 58+05

SCS Contract Number 53-8A02-9-00046

Fugro Project Number 78-308-25



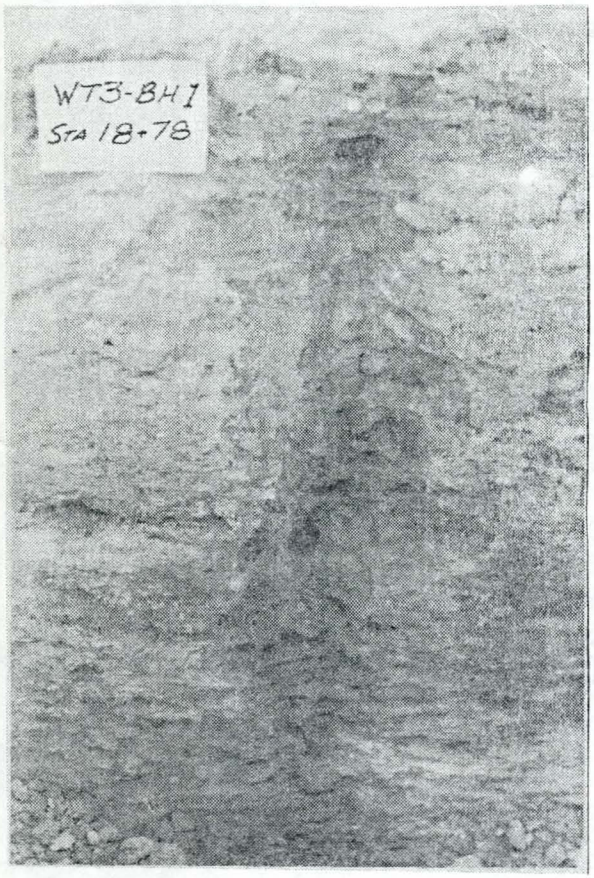
Pipes and suspected animal burrows on upstream slope at station 18+78.

SCALE:
0 1 2 3
feet

Flood induced piping at Ditch Witch trench, DT-4 (station 18+78).

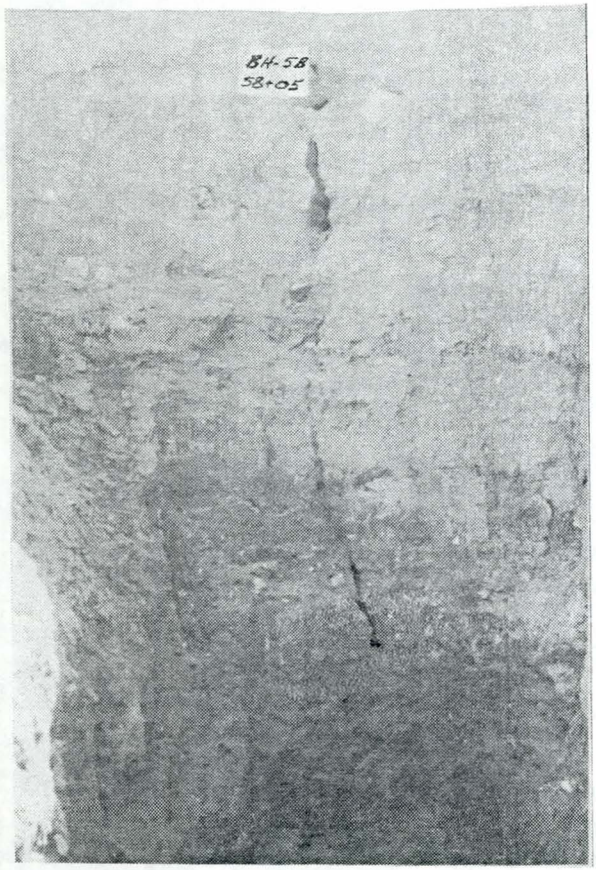
SCALE:
0 6 12
inches

Note: Scales vary with perspective away from station markers.



Transverse crack in backhoe trench BH-1 at station 18+78. Flood induced piping occurred along this crack from DT-4 (see trench profile log). Photograph shows enlarged crack following cleaning and detailed inspection.

SCALE:
0 6 12
inches



Transverse crack in backhoe trench BH-5b excavated on upstream slope adjacent to BH-5 at station 58+05 (see trench profile log).

SCALE:
0 1 2 3
feet

Note: Scales vary with perspective away from station markers.