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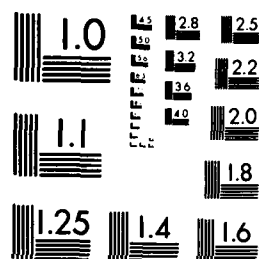
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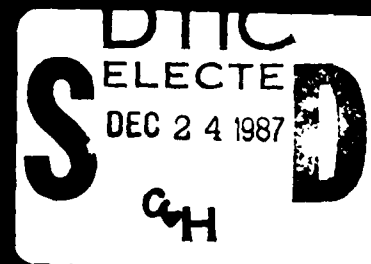
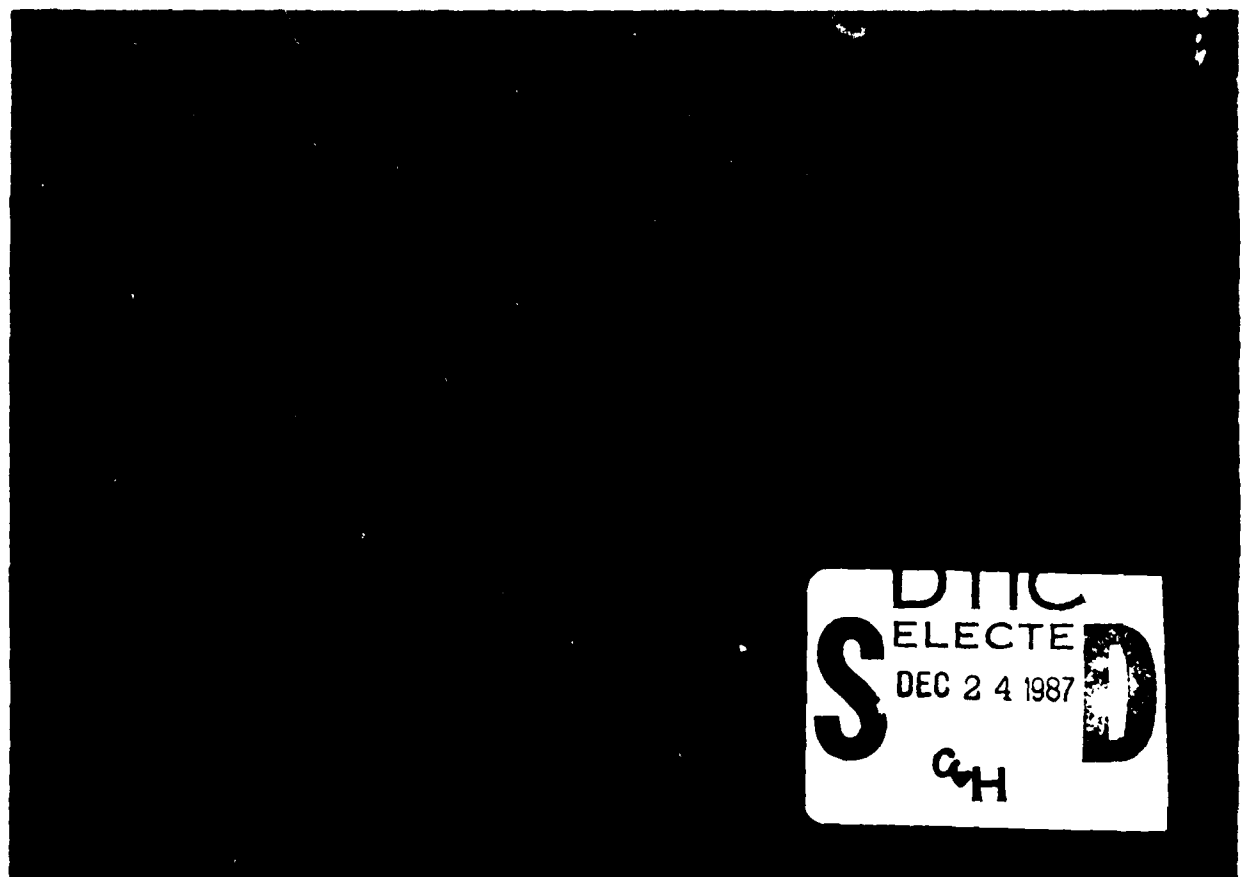
US Army Corps
of Engineers
Fort Worth District

O.C. FISHER LAKE

AD-A189 458

FINAL FOUNDATION REPORT

EMBANKMENT - OUTLET WORKS - SPILLWAY



AUGUST 1987

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CORPS OF ENGINEERS
FORT WORTH DISTRICT, TEXAS

FINAL FOUNDATION REPORT
O. C. FISHER LAKE
EMBANKMENT - SPILLWAY - OUTLET WORKS

- BY -

STEPHEN L. LACY

FORT WORTH, TEXAS
AUGUST 1987

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per Letter

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O. C. FISHER DAM AND LAKE

1. **Project Location and Description.** The O. C. Fisher Dam and Lake project is located near San Angelo, Texas in central Tom Green County (see Plates 1 and 2). The dam is built on the North Concho River, approximately 7 miles upstream from its confluence with the Concho River. The dam controls a drainage area of about 1,511 mi². The principal features of the O. C. Fisher project include:
 - a. A rolled earthfill embankment approximately 40,119 feet long including the emergency spillway dike and having a maximum height of 120 feet above streambed.
 - b. An ogee-type uncontrolled spillway 1,825 feet long with a discharge capacity of 483,200 second feet at the design water surface elevation 1,960.0.
 - c. Outlet works comprising a gated intake structure, two 18.5-foot diameter conduits having a discharge capacity of 26,500 second feet at conservation pool elevation 1,908.0 and a stilling basin.
2. **Construction Authority.** Congressional authority for construction of the San Angelo Reservoir and Floodway is contained in the Flood Control Act, approved 18 August 1941 (Public Law 228, 77th Congress, 1st Session), and Flood Control Act approved 22 December 1944 (Public Law 534, 78th Congress, 2d Session). San Angelo Reservoir was renamed O. C. Fisher Dam and Lake by Public Law 93-635 dated 3 January 1975.
3. **Purpose of Report.** This report has been prepared in accordance

with requirements as set forth by the Office, Chief of Engineers, and compiles data concerning the foundation characteristics, treatment, and preparation for the structures of the O. C. Fisher Dam project. A copy of this report should be included in the permanent records maintained at the project office.

4. Contract. Major contracts for construction of the project were as follows:

<u>Contract No.</u>	<u>Title</u>	<u>Contractor</u>	<u>Date of Contract</u>
W-41-243- ENG-1032	Portion of Embankment	Fuller Construction Company	7 May 1947
W-41-243- ENG-1062	Portion of Embankment	Hughes Construction Company	20 June 1947
W-41-243- ENG-1334	Construction of Outlet Works	Nolan Brothers, Incorporated	27 February 1948
W-41-243- ENG-1753	Completion of Embankment and Construction of Service Bridge and Spillway	Winston Brothers Company	22 March 1949

with requirements as set forth by the Office, Chief of Engineers. In 1983, the Corps of Engineers, Southwestern Division, requested that this report be prepared in order to compile data concerning the foundation characteristics, treatment and preparation for the various structures of the project. A copy of this report should be included in the permanent records maintained at the project office.

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Geology.

1. Regional Geology and Physiography. The O. C. Fisher Dam and Lake Project lies within the Central Texas section of the Great Plains physiographic province. It is encompassed on the south, west, and north by dissected remnants of the Edwards Plateau. The topography at the site is moderate to flat, formed by erosion of the nonresistant Permian strata and the reworking of the thick alluvial materials through which the North Concho River has cut its valley. The river floodplain is approximately 2,000 feet wide at the dam site. The left abutment rises very gradually away from the river. Two low terraces break the rise at 3,000 and 8,000 linear feet from the river edge. The right abutment rises abruptly from the floodplain and then grades into a gently rising slope. Vegetation on both abutments is moderate and consists of mesquite and oak.

2. Geology of the Dam Site.

a. Overburden. Alluvial materials overlying the primary material at the dam site vary in thickness between a few inches in the river bed to 82 feet on the left abutment. In the floodplain area, alluvial deposits range from 12 to 21 feet in thickness and consist chiefly of sandy or silty clay, caliche, sands, and gravels. The caliche deposits are intimately associated with the silt, clay, and gravel deposits by forming a weak cementing matrix between them.

The right abutment is covered by 10 to 20 feet of alternating soft and hard caliche which directly overlies Pleistocene conglomerate

deposits. A very thick soil mantle covers the left abutment. This 12- to 82-foot thick deposit consists of caliche, clay, sand, and gravel, and is locally cemented with a caliche or calcareous matrix, forming a soft conglomerate. The pervious strata in the alluvial deposits act as aquifers.

b. Primary. The primary formations at the dam site surface are of Permian age and were deposited near shore in a shallow fluctuating sea. As a result, these sedimentary beds often occur as tongues, lenses, or fans, and it is difficult to trace them over lateral distances. Strata of the San Angelo and Blaine Formations, Permian age, and the Trinity and Fredericksburg Group, Cretaceous age, outcrop in the O. C. Fisher reservoir area. The embankment is founded on the San Angelo Formation, whose beds dip beneath the Blaine strata 5 miles upstream from the dam site. Only the upper shale and sandstone beds of the San Angelo Formation are exposed in the 5-mile wide outcrop of the formation in the lower reservoir area. The Blaine Formation, consisting of alternating layers of shale, sandstone, limestone, and some gypsum seams unconformably overlie the San Angelo sediments. Underlying both of these units is the Chozo Formation consisting of 565 feet of red to green shale with some thin dolomitic limestone seams.

c. Structure. The Permian strata occurring in the project area have a general regional dip slightly north of west at a rate of 50 to 60 feet per mile. The beds strike northeast to southwest.

This normal westward dip of the Permian strata is broken only by minor structural features.

The oldest Permian strata outcrop is in eastern Tom Green County. Proceeding from southeast to northwest through the Concho and North Concho River watersheds, a successively younger series of Permian strata are revealed until they become buried under the Cretaceous overlap in northwestern Tom Green County. This feature is a result of the westward dip or tilting of the Permian beds and their consequent erosion. The Permian-Cretaceous contact is marked by a distinct erosional unconformity. No faulting is in evidence at the dam site. See Plate 3 for area geology map and sections.

d. Ground Water. In the river valley and right abutment, a perched semi-artesian aquifer is present in the Pleistocene basal conglomerates. Yields range from 3 to 4 gallons per minute to 400 gallons per minute indicating not only a wide range of transmissibility in various portions of the aquifer, but also that the main body of the aquifer is not continuous, but lenticular with interconnections of submerged lenses of sand and gravel.

e. Engineering Characteristics. Overburden materials consisting of sand, silt, clays, and some gravels are located along the axis of the embankment. They were found to have the average engineering characteristics:

Liquid Limit 36

Plasticity Index 20

Moisture Content 11

Natural Dry Density 80-97 pcf

Undisturbed samples of the foundation soils were secured from two core borings and three test pits. Direct shear tests were run on five samples from the two core borings. Values of ϕ averaged 23.3° and cohesion averages ran 0.2 tons per ft^2 . These tests are representative of the silty and clayey soils in the floodplain.

Bedrock strata of the San Angelo Formation which comprise the foundation medium for the embankment and appurtenant structures exhibit the following characteristics:

<u>Bedrock Type</u>	<u>Natural Dry Density</u>	<u>Natural Moisture Content</u>	<u>Unconfined Compressive Strengths</u>
Shale	111.4 to 136.0 pcf	2.9 to 15.0%	0.9 to 50.6 TSF
Sandstone	- -	- -	0.4 to 3.3 TSF

Explorations.

Geological investigations were initiated at the O. C. Fisher Dam site in 1938 with the drilling of four 2-inch core holes. During 1939, another 112 earth auger borings were completed in the general area of the dam site. An extensive investigation was started in 1943 and completed in 1945. This investigation included the drilling of 161 2-inch, and 13 6-inch borings to determine bedrock elevations, the nature of foundation rocks, and their stratigraphic and structural conditions. Water pressure tests were conducted in seven 2-inch core borings. One 30-inch boring was made on the right abutment for insitu visual inspection of the foundation rocks. Other soil investigations continued from 1943 to 1945 and included more than 400 auger borings in the proposed borrow areas. Additional borings were completed along the axis of the dam site. The types of borings made included fishtail borings, Denison samples, and test pits. See Plates 4-15 for boring location plans and logs of borings.

Character of Foundations.

1. Embankment. The embankment is situated in an area where resistant Pleistocene conglomerates form a high bluff along the right boundary of the river valley and where the thickest and most massive of the San Angelo Sandstones would form a foundation for the main embankment section.

Sandstone strata of the San Angelo Formation are overlain by 14 feet of sand, silt, and clay on the left bank of the river. At a point 2,000 feet north of the river (approximate embankment Station 249+00) these alluvial deposits have thickened to 25 feet where a shale member of the San Angelo Formation underlies the alluvial deposits. From this point to the north end of the dam axis, the alluvial deposits range from 25 to 82 feet in thickness and are underlain by relatively compact and impervious shale beds. A conglomeritic layer occurs on top of these shale beds and ranges from a few feet to 42 feet in thickness. Cementation in this bed is variable and irregular, portions of it occurring as sand and gravel whereas other portions are very firmly cemented.

Alluvial deposits are approximately 19 feet thick on the right side of the river and overlie sandstones of the San Angelo Formation to a point 1,200 feet south of the river (approximate embankment station 204+00) where shale strata underlie the alluvial deposits for a distance of approximately 450 feet. At this point, the shales are overlapped by conglomeritic beds. These beds underlie the 10-

to 20-foot alluvial blanket to the south end of the dam axis; are variably solutioned and irregularly cemented, and range from 15 to 30 feet in thickness. A grout curtain was constructed in this unit from Station 178+00 to Station 208+00 during the early 1960's.

The embankment foundation construction included an inspection trench excavated to or into the conglomerate from approximate Stations 175+50 to 208+00 on the south abutment. On the north abutment an inspection trench was excavated to a minimum of 10 feet and a maximum of 20 feet between approximate Stations 208+00 to 249+00. A toe drain and trench were constructed between Station 198+00 and 215+00 and between Stations 237+00 and 310+00. See Plates 16-21 for embankment plan and sections.

2. Outlet Works. Core borings drilled in the area underlying the outlet works indicated that the site contains a 25-foot stratum of massive, well-cemented sandstone of the San Angelo Formation. The sandstone is generally uniform in thickness and is mantled by a 15- to 20-foot alluvial deposit. The sandstone unit which forms the foundation of the outlet works was found to be structurally sound.

3. Spillway. The spillway is located approximately 4,000 feet west of the south end of the dam axis. Core borings indicate the foundation material to be shale beds of the San Angelo Formation. The shale is impervious and structurally sound, but will slake down and erode rapidly if subjected to stream scour in the approach and

discharge channels. Alluvial materials overlying the shale beds range from 6 to 15 feet in thickness and are pervious to water movement. See Plates 22-24 for the Embankment, Spillway, and Outlet Work structures plan and sections.

Foundation Treatment

1. Foundation Grouting. A grouting program was conducted intermittently from June 1960 to July 1963 placing a single line grout curtain within the conglomerate between embankment Stations 172+00 and 208+00 and 10 feet upstream of centerline. The initial spacing of the grout holes varied along the dam axis depending on the "tightness" of the conglomerate material and time restrictions. From Stations 172+00 to 183+00, an initial spacing of 40-foot centers was drilled. Between embankment Stations 183+20 to 186+00, a 20-foot initial spacing was used which varied from a 10- to 20-foot spacing from Station 186+00 to 195+80. In areas where large grout takes were found, secondary and tertiary holes were drilled on 10- and 5-foot centers. The main area of activity for the secondary and tertiary holes was from Stations 186+00 to 195+80. Beginning at Station 195+80 to Station 208+00, 200-foot centers were drilled. Secondary centers were drilled with a spacing of 20 feet although most of the holes were found to be tight.

a. Initial Foundation Grouting. The grout holes were drilled in one stage from the upstream edge of the roadway on top of the dam and projecting upstream at a 10° angle from the vertical. The bottom of the hole generally projected 3 to 5 feet into the underlying shale unit. Approximately 70 to 75 feet of each hole was cased through the embankment to prevent caving and to prohibit water and grout from acting on the embankment material. All foundation

materials were tight except for the solutioned zones within the conglomerate. Air expanded, single packers confined grout access to the zone of leakage and the top 3' to 5' of the underlying shale. Frequent difficulty was encountered during pressure testing and grouting due to packer failures while expanding into open joints. Grouting refusal pressures were established at 50 to 60 psi. Neat cement was used in w/c ratios from 4.0 to 0.8, with 1.0 being the most frequently used mix. Neat mixes without additives could not be pumped thicker than 0.8 w/c. Mixes were thickened as needed by using Sika Chemical Interplast "C" in the amount of 1 percent of the cement content.

The areas of highest grout take were located from Stations 181+00 to 192+50. Seepage through the conglomerate zone beneath the embankment appears to be critically related to the elevation of the reservoir. A reservoir elevation above 1900 to 1903 feet appears to be critical for seepage flows.

b. Continued Foundation Grouting. A second grouting program was conducted within the conglomerate zone in 1980 which extended the right abutment curtain from embankment Station 150+00 to 180+00. A total of 130 vertical holes were drilled with hole spacing of 10 to 40 feet along the upstream toe of the embankment. Hydraulic pressure tests confirmed that the conglomerate along this section was mostly tight. See Plates 25 through 34 for detailed plan and profile of the foundation grout curtain.

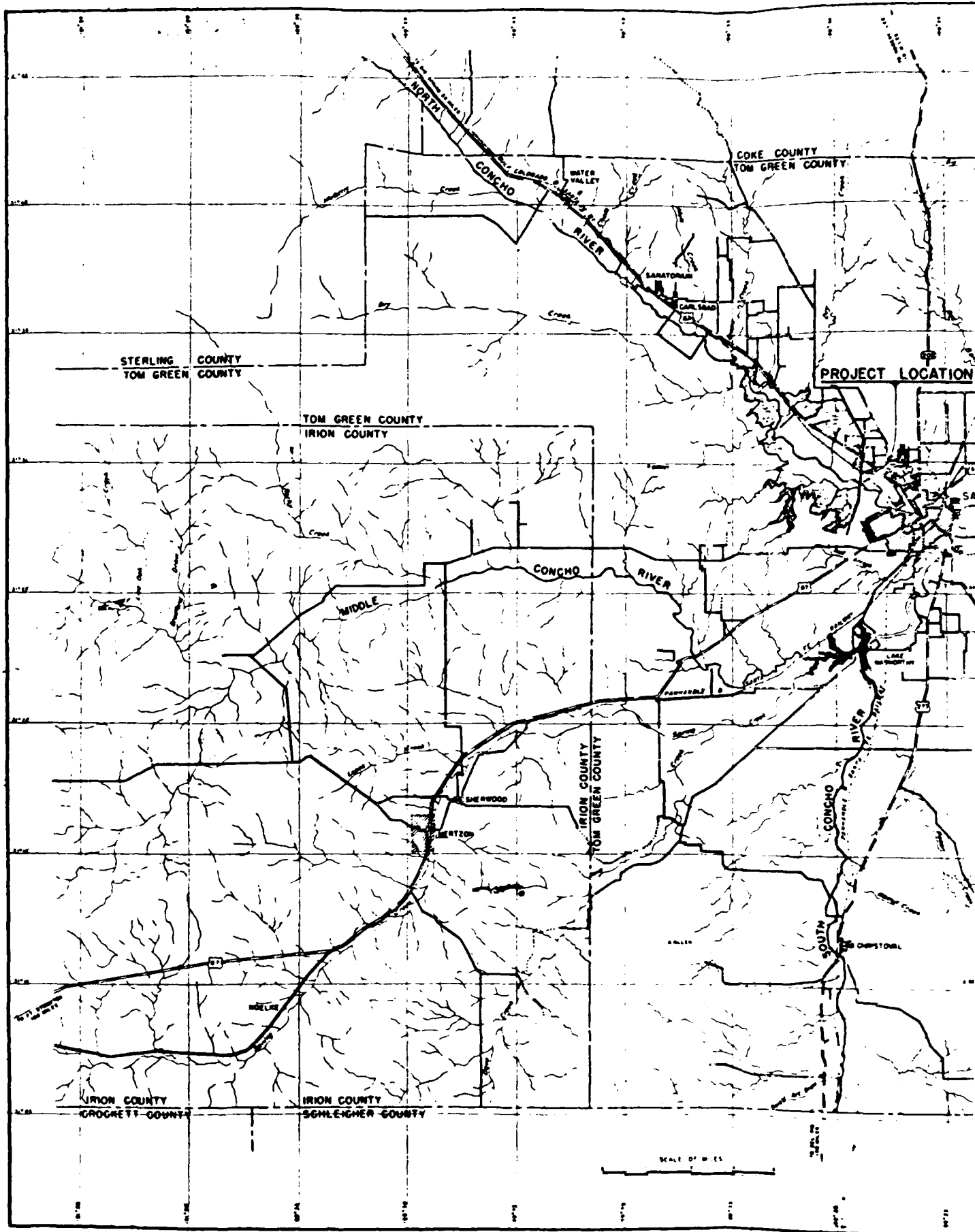
2. Drainage Provisions. A toe drain located in the foundation inside the downstream slope of the embankment consists of a 12-inch diameter perforated pipe embedded in gravel with intermittent manholes. The toe drain extends between Stations 198+00 and 215+00 and between Stations 227+00 and 310+00.

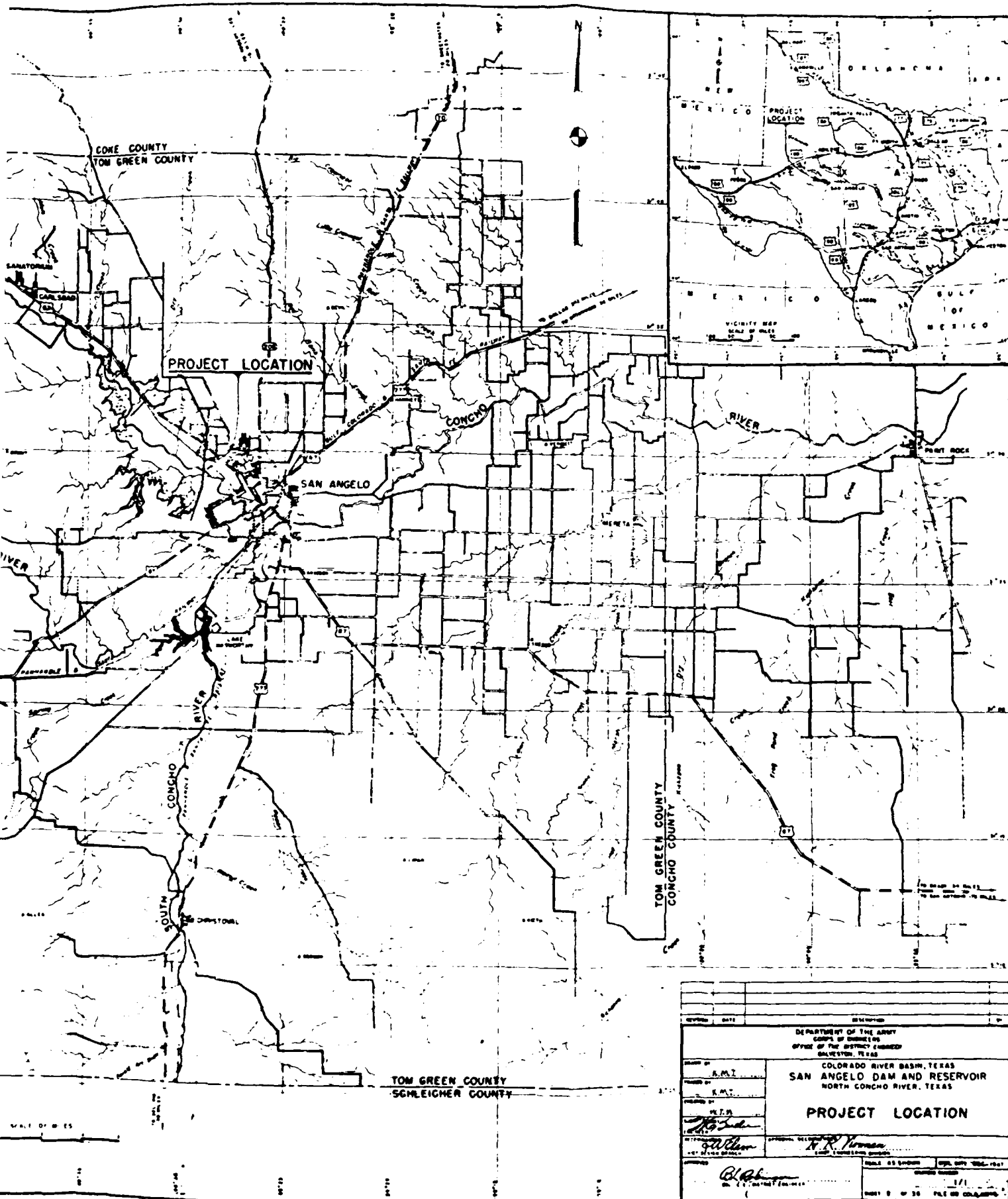
3. Relief Wells in Spillway. In the summer of 1977, 110 pressure relief wells were drilled at an angle of 30° from the vertical and with a total length of hole reaching 52 feet under the weir from Station 100+34 to a point intersecting a vertical plane through Station 100+20. The holes were centered at a distance of 10 feet apart across the full width of the weir monolith to provide the necessary drainage relief to the revised weir monolith stability design. See Plate 35 for a typical relief well diagram.

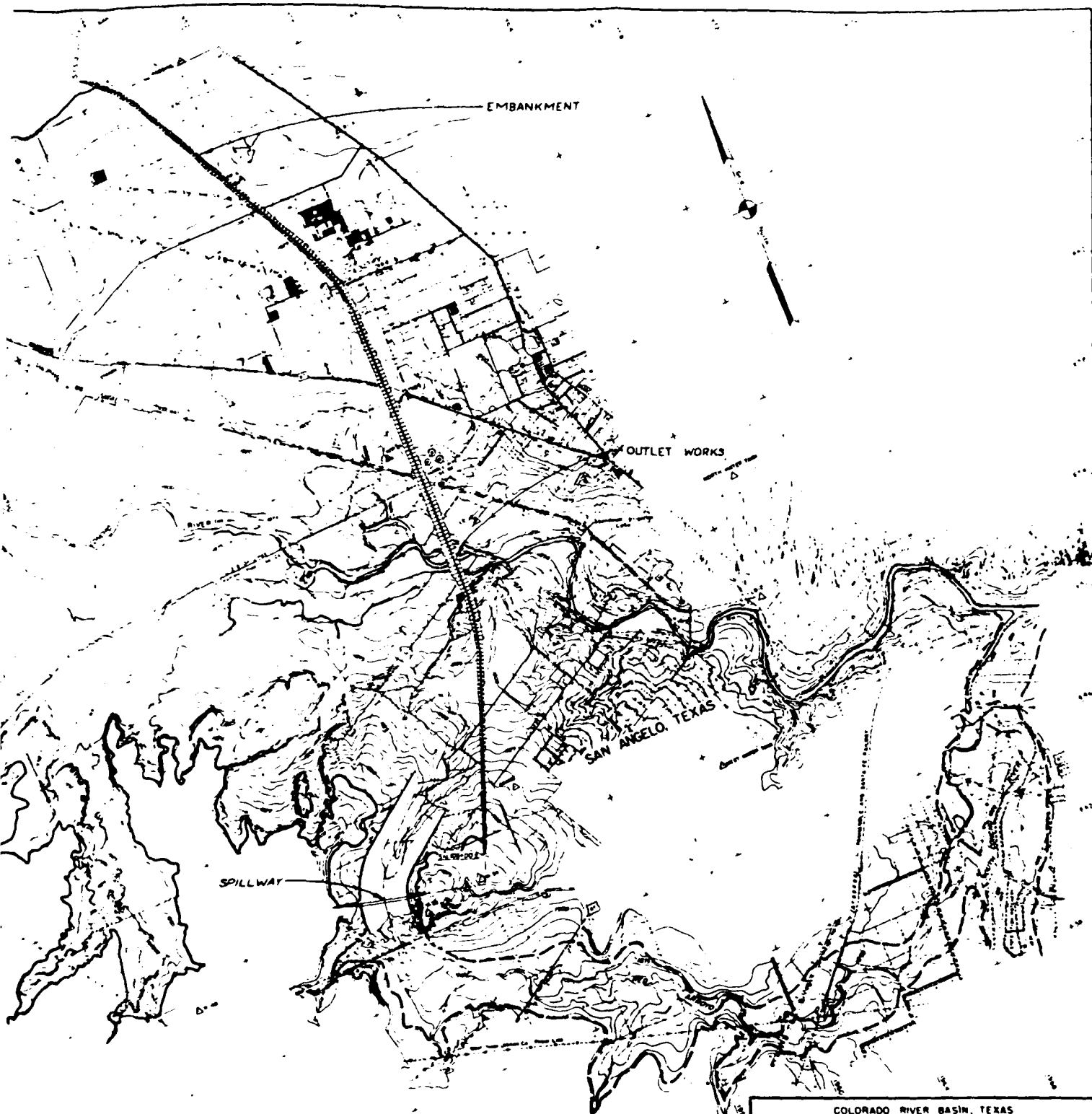
Foundation Instrumentation

Embankment and Embankment Foundation. No instrumentation was installed in the embankment or in the embankment foundation during construction of the dam. During the seepage investigation and grouting programs of 1958 and 1963, 51 ground-water observation wells were installed in the embankment foundation and downstream from the embankment.

During November 1974, six permanent additional ground-water observation wells were installed between the government property line and the North Concho River to better define any reservoir leakage. Fifteen wells are currently being monitored along the embankment. These wells are numbered 3, 7, 8, 10, 15, 25, 28-30, and 639-644. See Plates 36 and 37 for the boring layout of selected observation wells and water table elevations.







LEGEND

DESIGN WATER SURFACE EL. 1960.0

LIMITS OF FLOODING FOR 100,000 C.F.S. DISCHARGE

COLORADO RIVER BASIN, TEXAS

SAN ANGELO DAM AND RESERVOIR
NORTH CONCHO RIVER, TEXAS

RESERVOIR AREA

14 10 SHEETS

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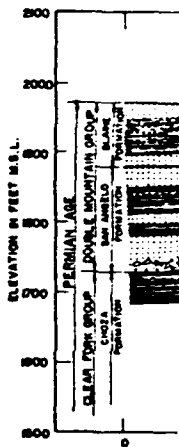
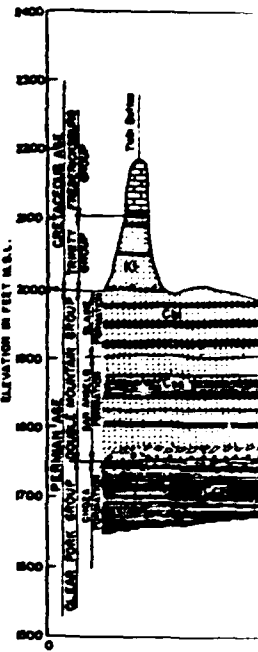
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U.S. ENGINEER OFFICE, GALVESTON, TEXAS MARCH 1947

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CHECKED BY <i>W. H. Shaw</i>	ENGINEERING DIVISION	SECTION
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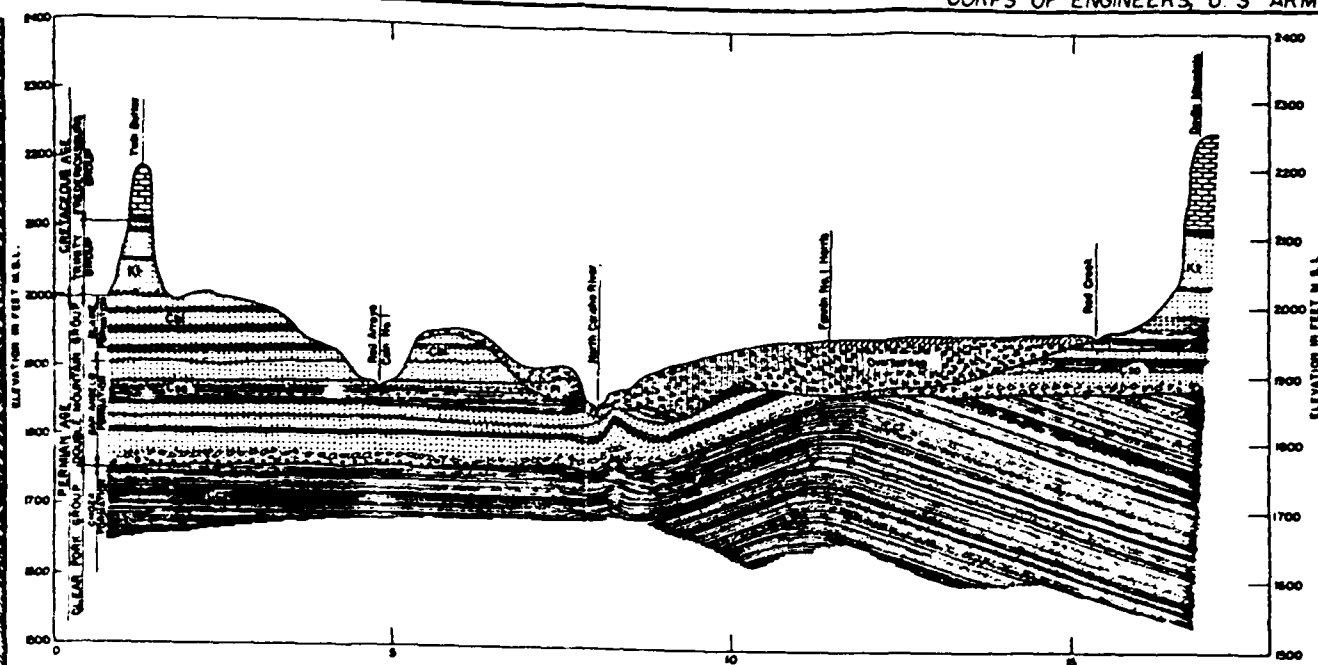
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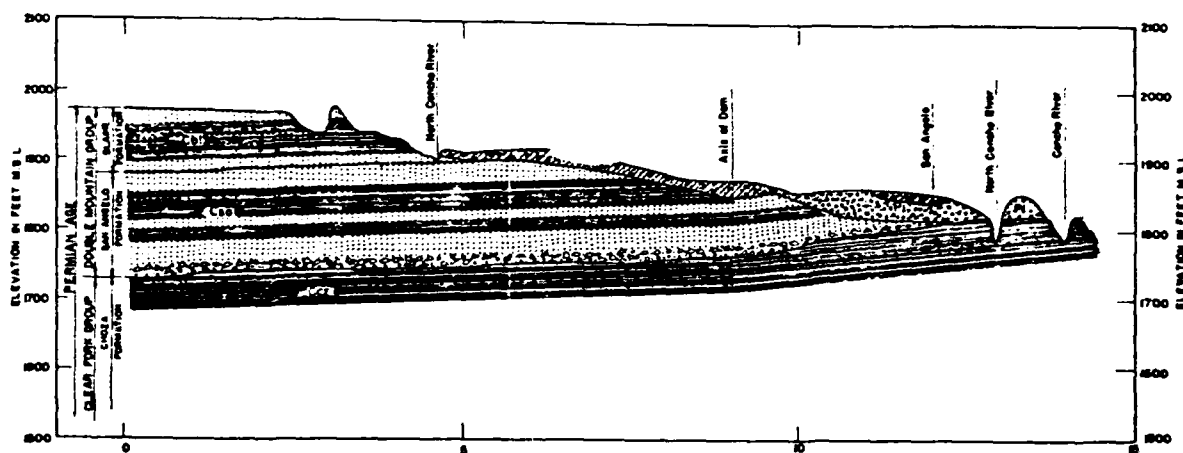
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AREAL GEOLOGY

Scale in miles



SECTION A-A



SECTION B-B

LEGEND

QUATERNARY

P1 PLEISTOCENE CONGLOMERATE

CRETACEOUS

FREDERICKSBURG GROUP

Fcd EDWARDS FORMATION

Fcp COMANCHE PEAK - WALNUT FORMATIONS

TRINITY GROUP

T1 (UNDIFFERENTIATED)

PERMIAN

DOUBLE MOUNTAIN GROUP

Cm BLAKE FORMATION

Cso SAN ANGELO FORMATION

Ccz CLEAR FORK GROUP

Ccz ONZA FORMATION

COLORADO RIVER BASIN, TEXAS

SAN ANGELO RESERVOIR

NORTH CONCHO RIVER, TEXAS

AREAL GEOLOGY AND
REGIONAL GEOLOGIC SECTIONS

IN 15 SHEETS

SCALES AS SHOWN

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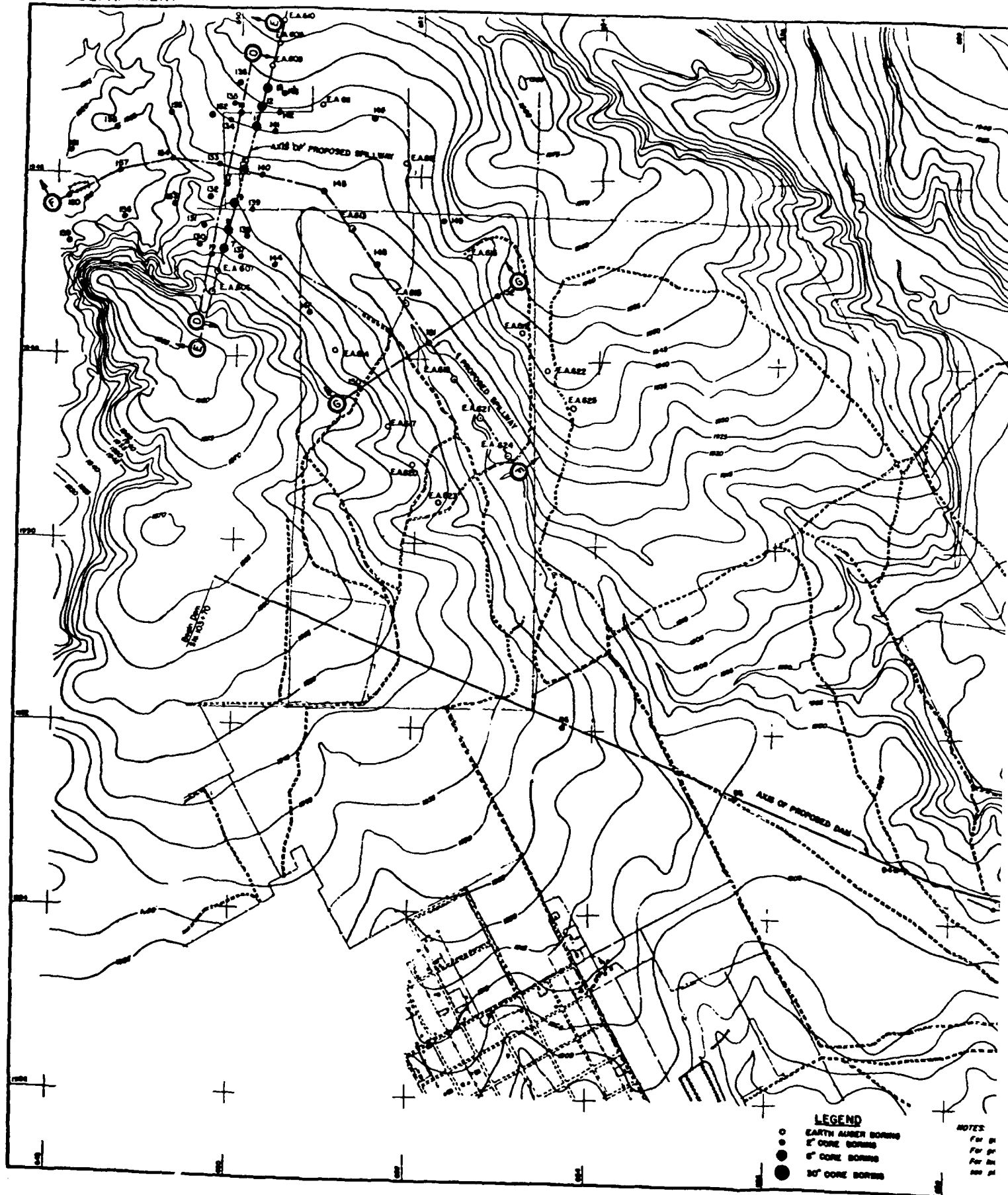
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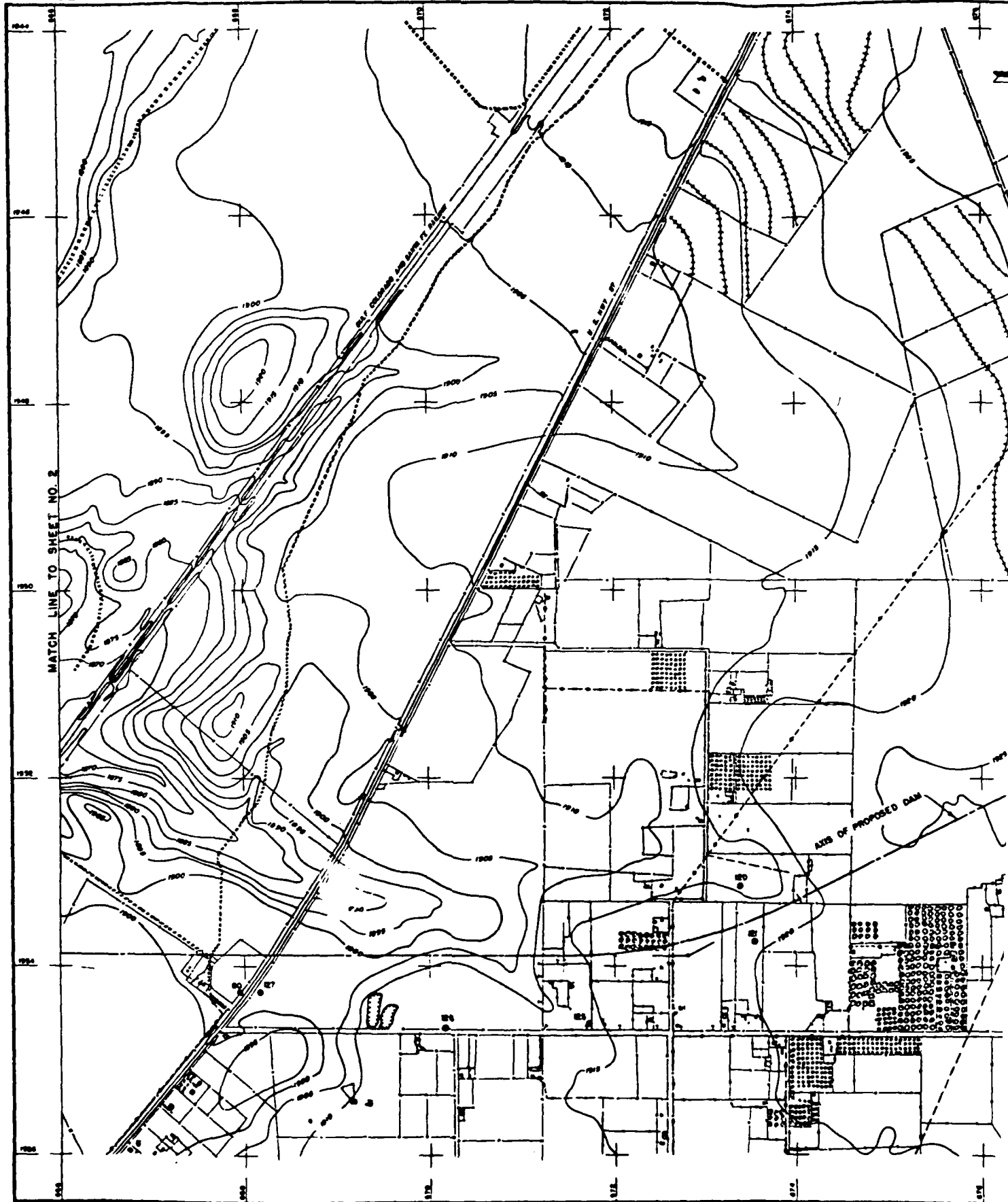
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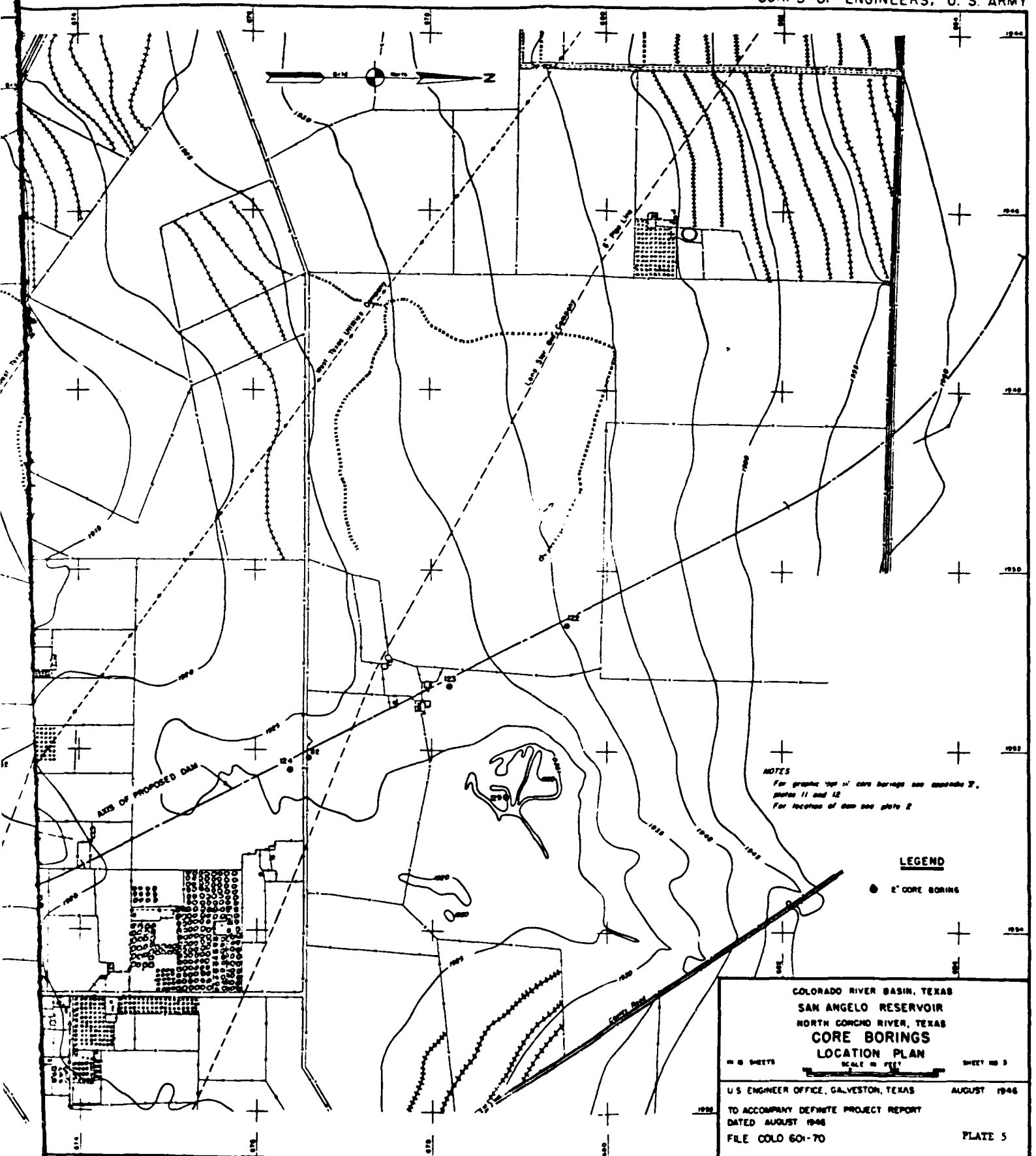
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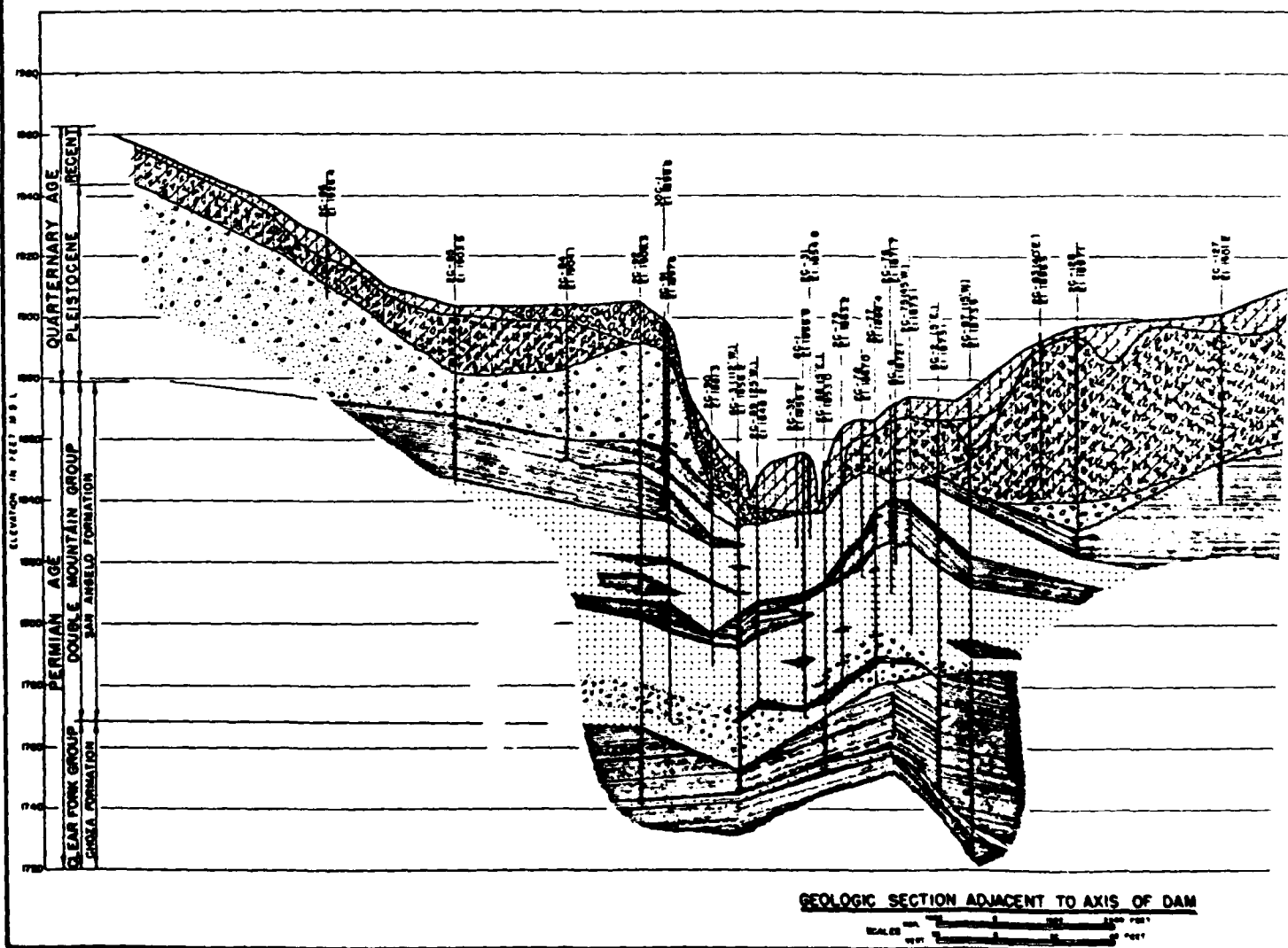
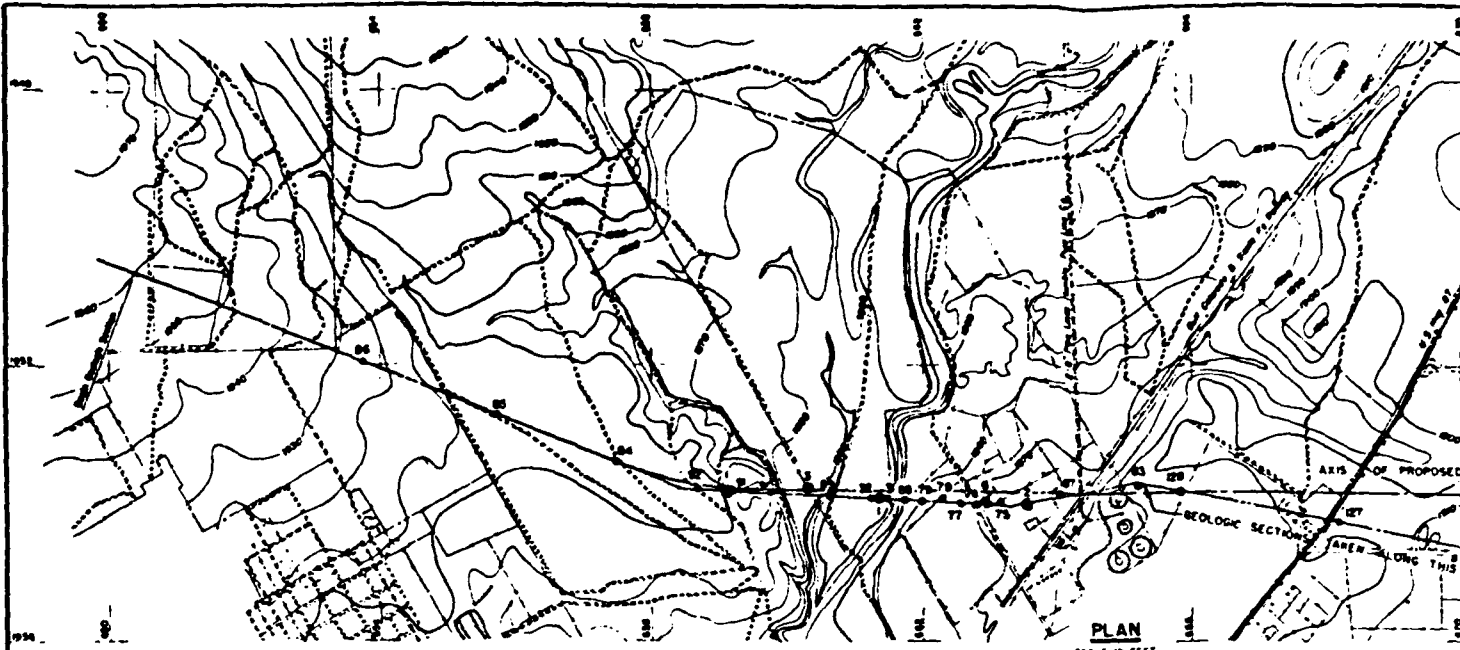
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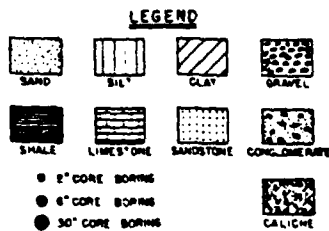
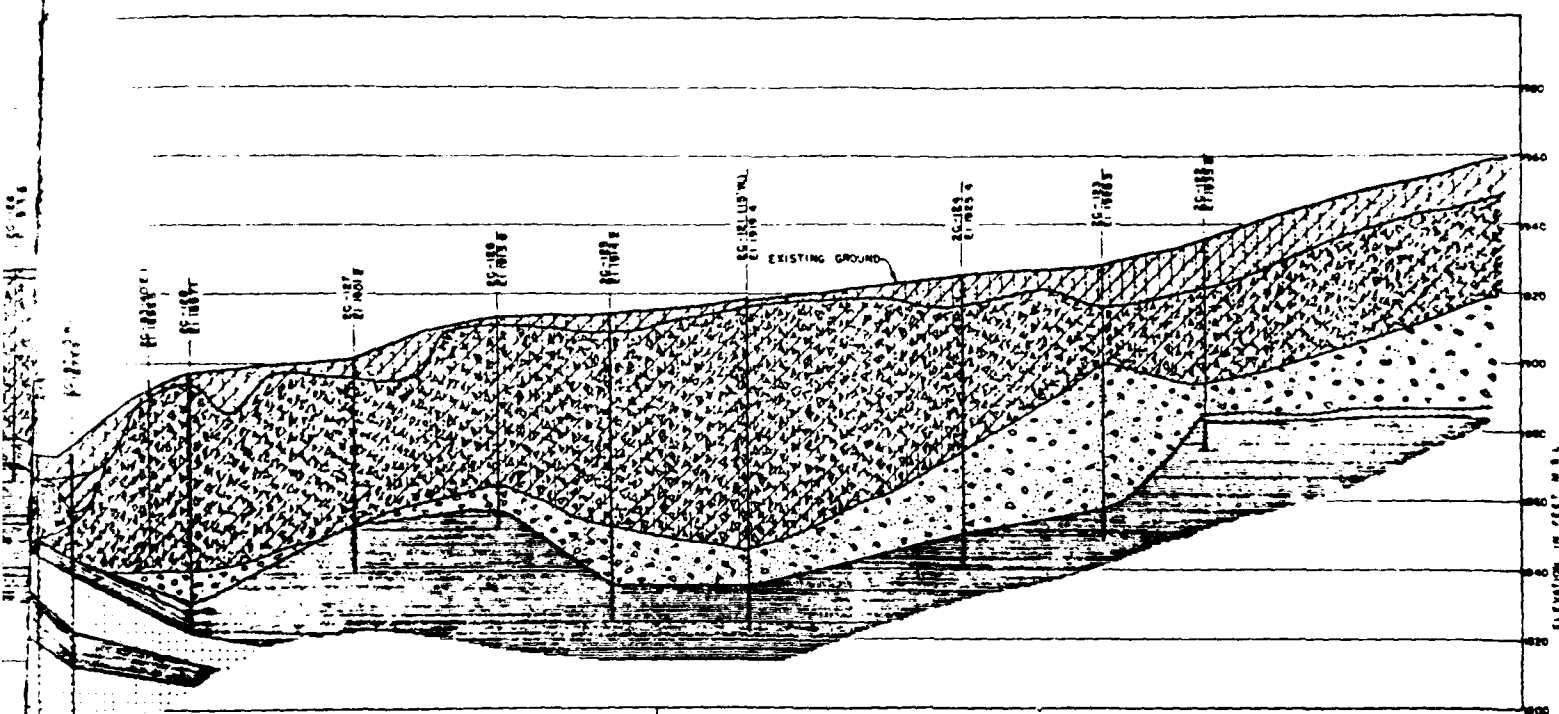
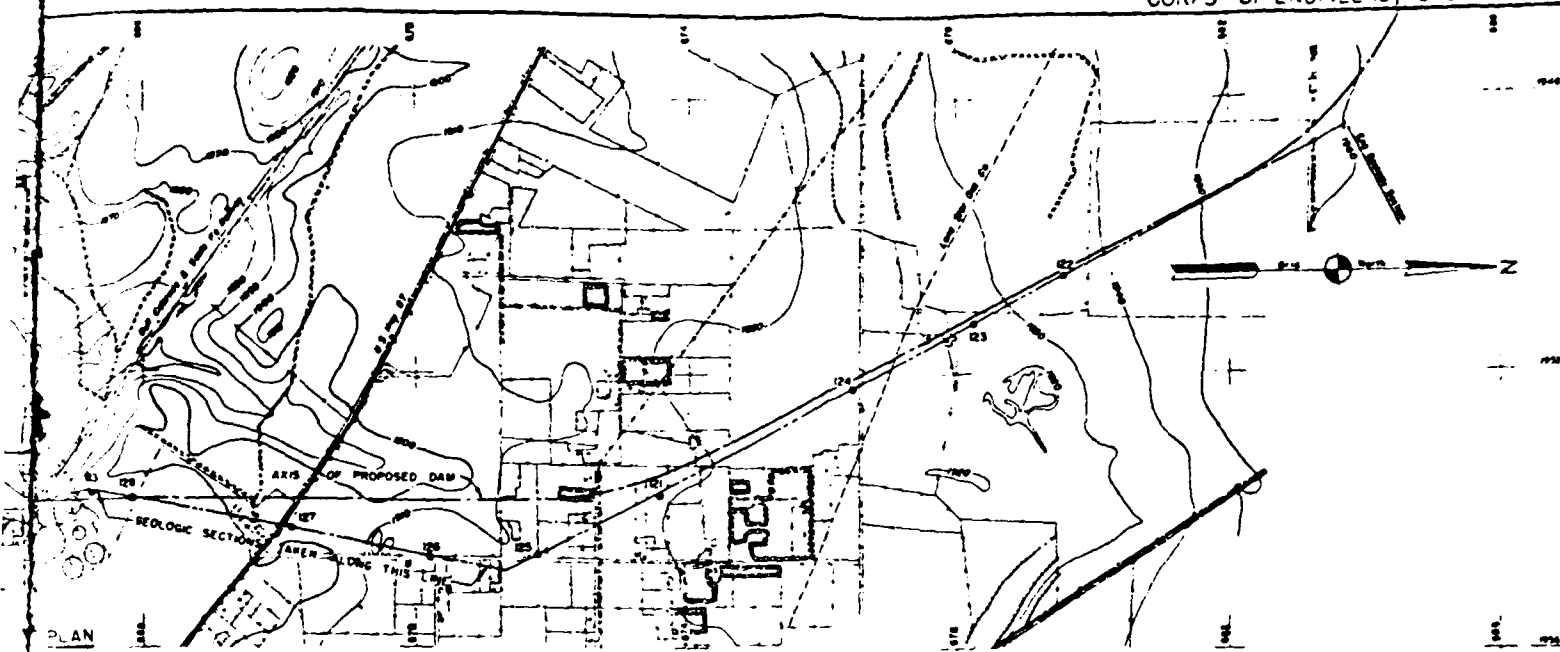
PLATE 3











NOTE
For graphic logs of core borings see appendix B,
pages 9 thru 13.

COLORADO RIVER BASIN, TEXAS
SAN ANGELO RESERVOIR
NORTH CONCHO RIVER, TEXAS
CORE BORINGS
PLAN AND GEOLOGIC SECTION

14 1/2 SHEETS

SHEET NO. 4

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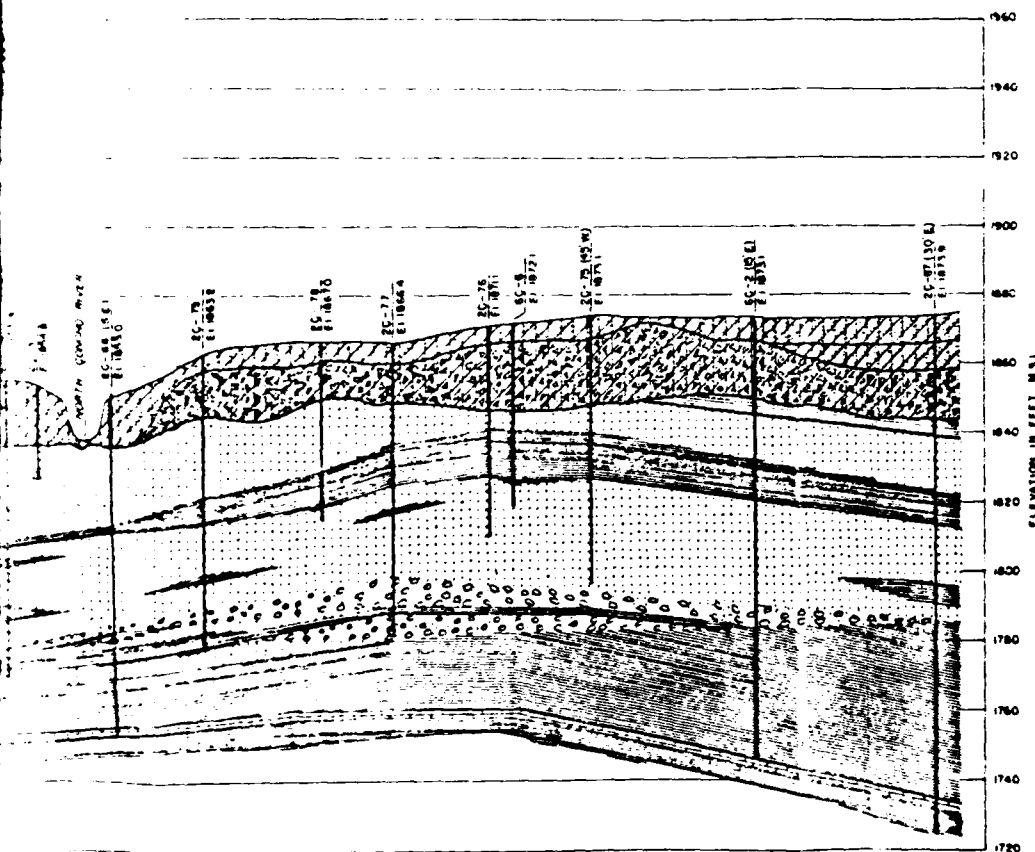
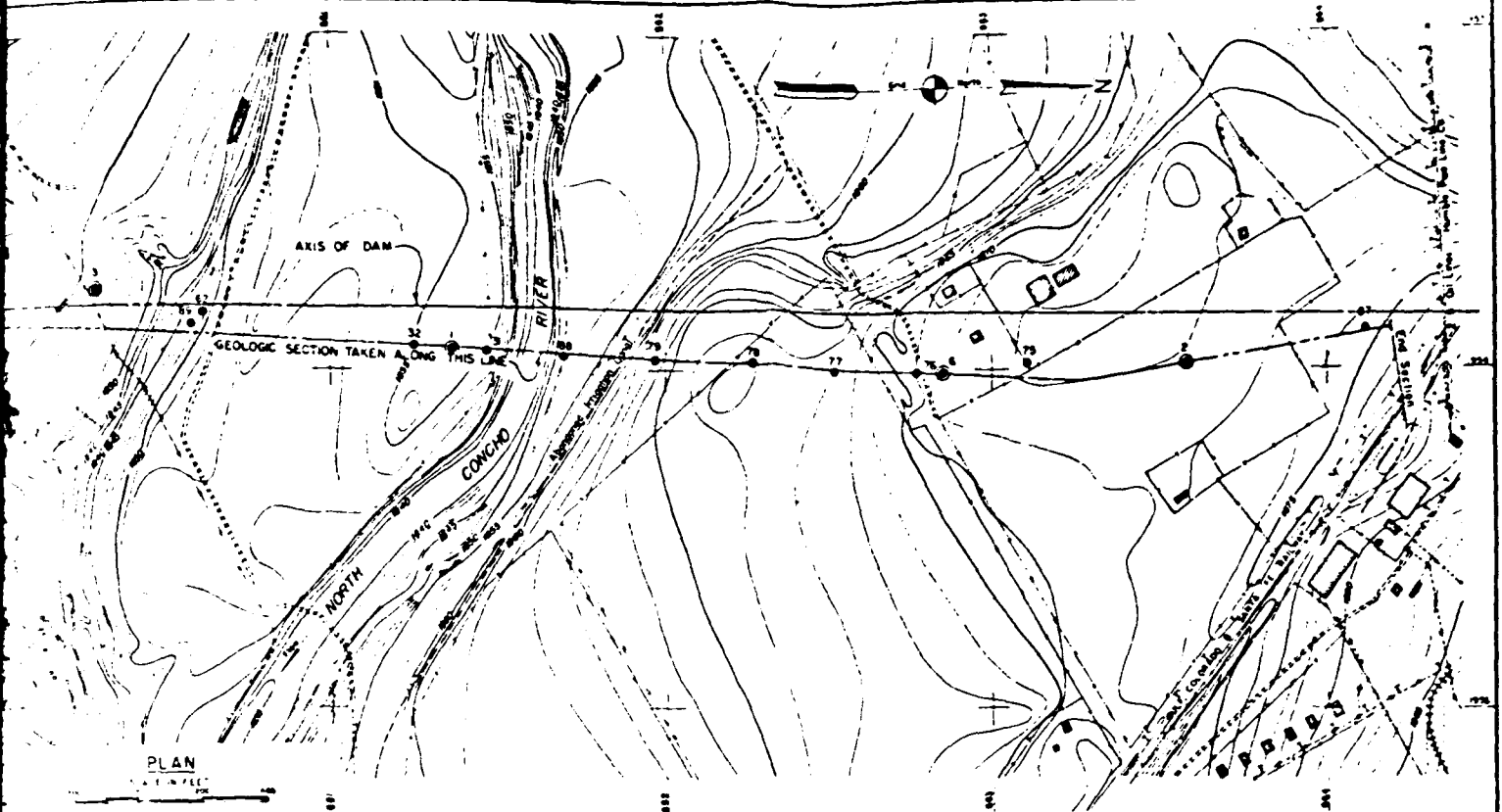
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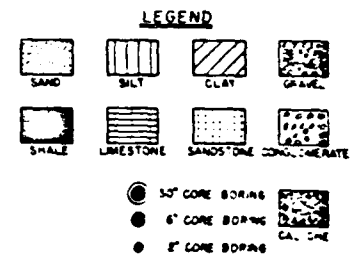
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DATED AUGUST 1946

FILE COLO 601-70

PLATE 6



NOTE:
For graphic logs of core borings
see Appendix II, plate 9 this set



COLORADO RIVER BASIN, TEXAS
SAN ANGELO RESERVOIR
NORTH CONCHO RIVER, TEXAS
CORE BORINGS
PLAN AND GEOLOGIC SECTION

10 IS SHEETS

SHEET NO. 8

SCALES AS SHOWN

U.S. ENGINEER OFFICE, GALVESTON, TEXAS

AUGUST 1946

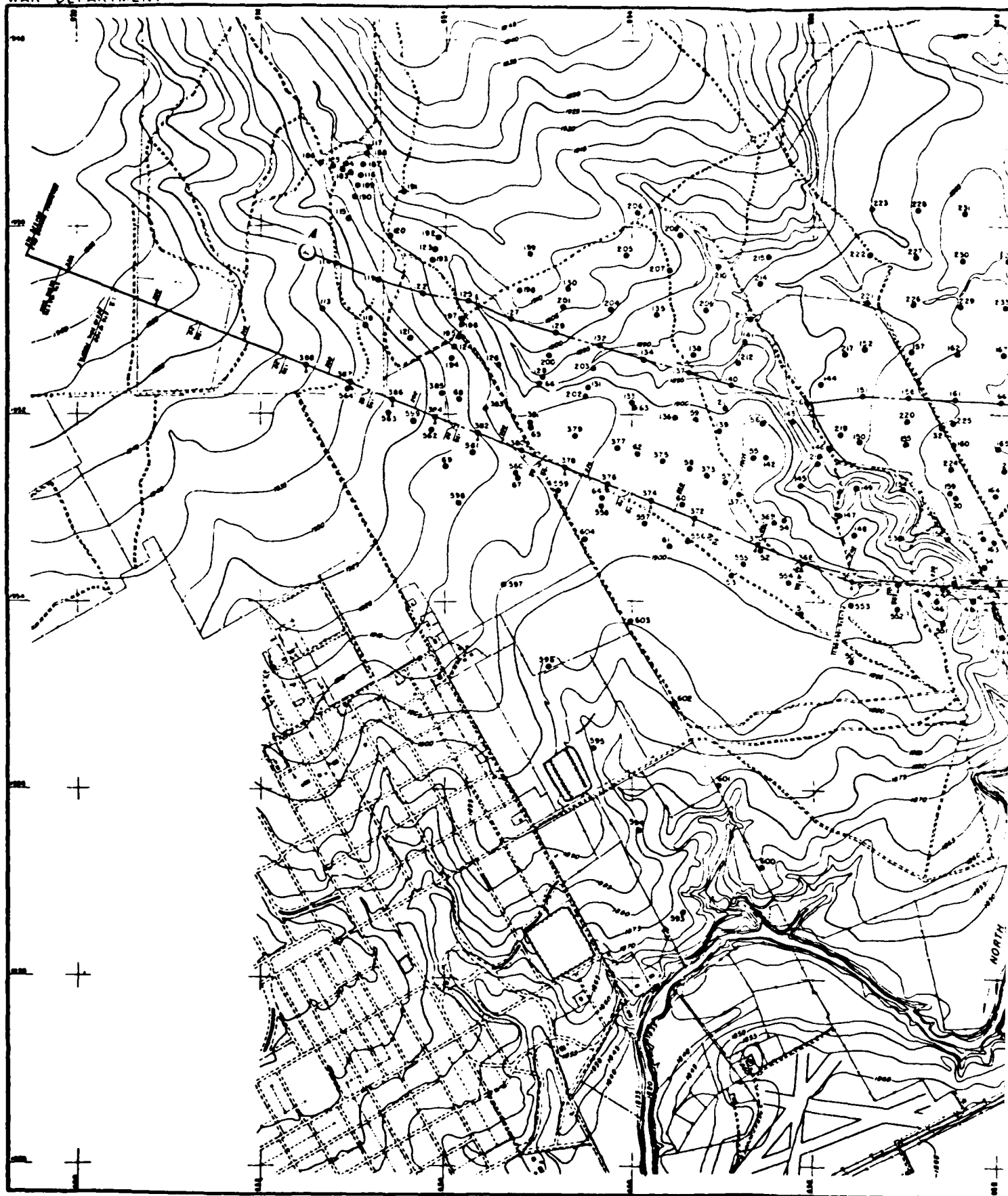
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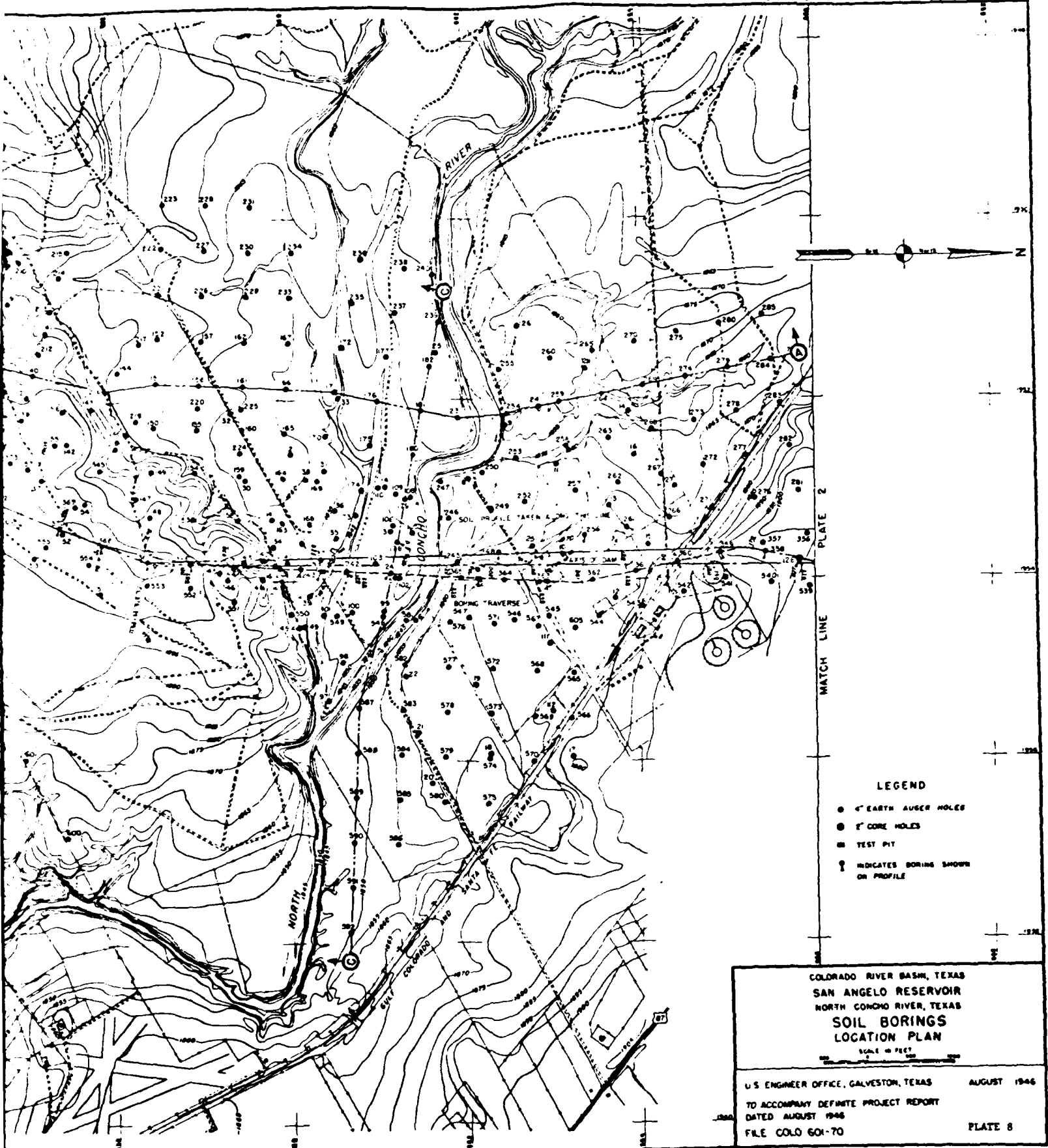
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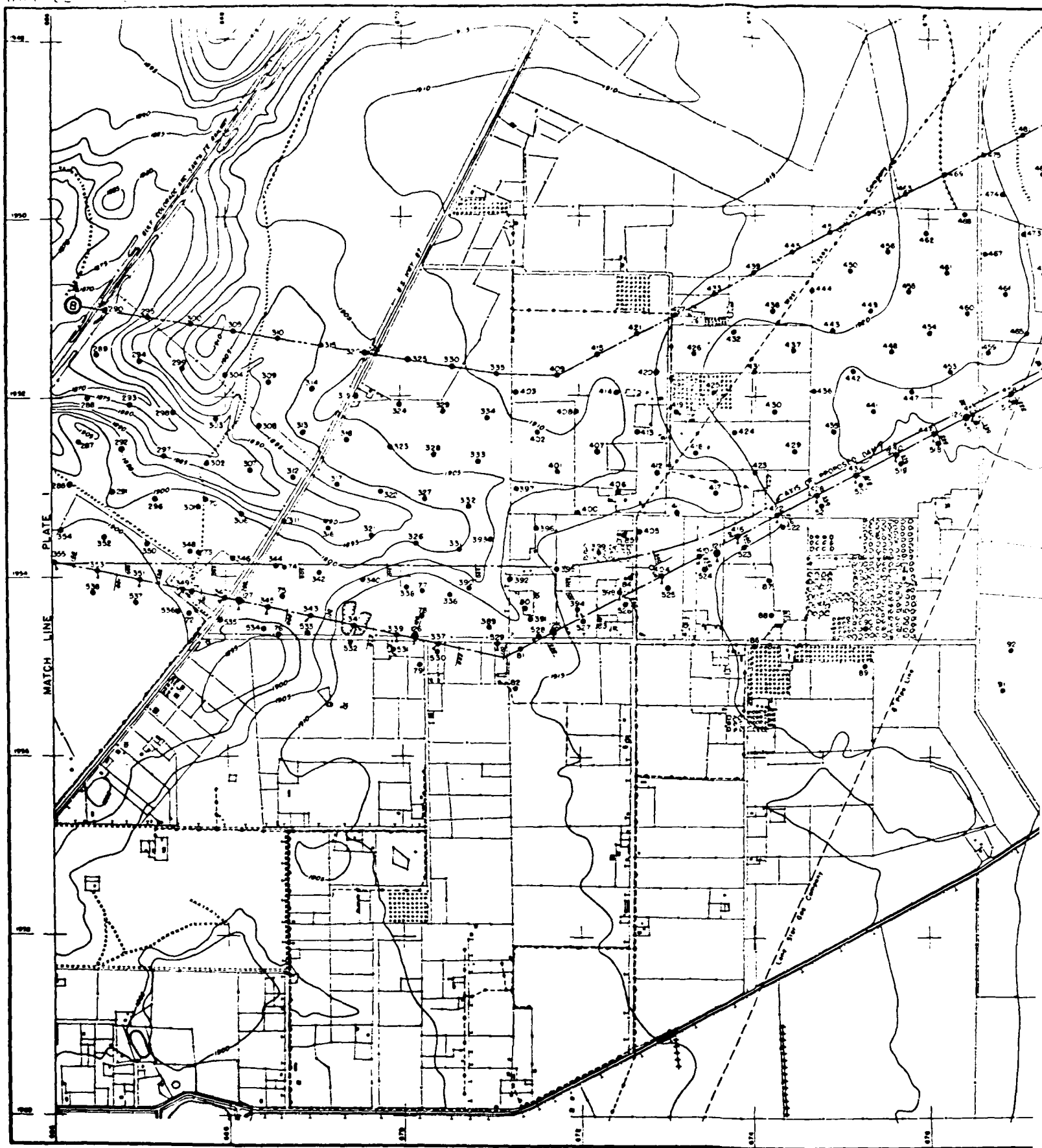
PLATE 7

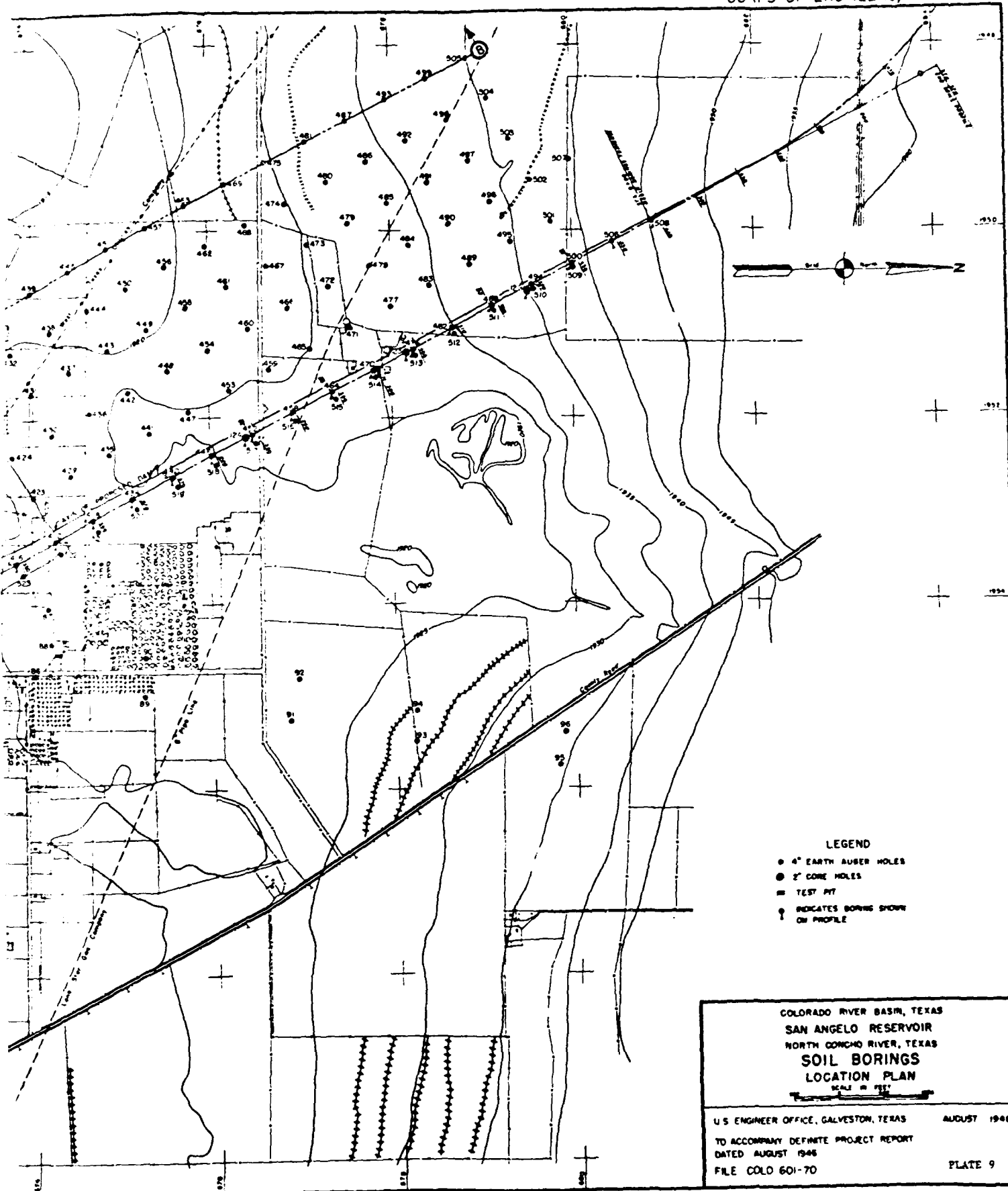
SECTION ADJACENT TO AXIS OF DAM

WAR DEPARTMENT







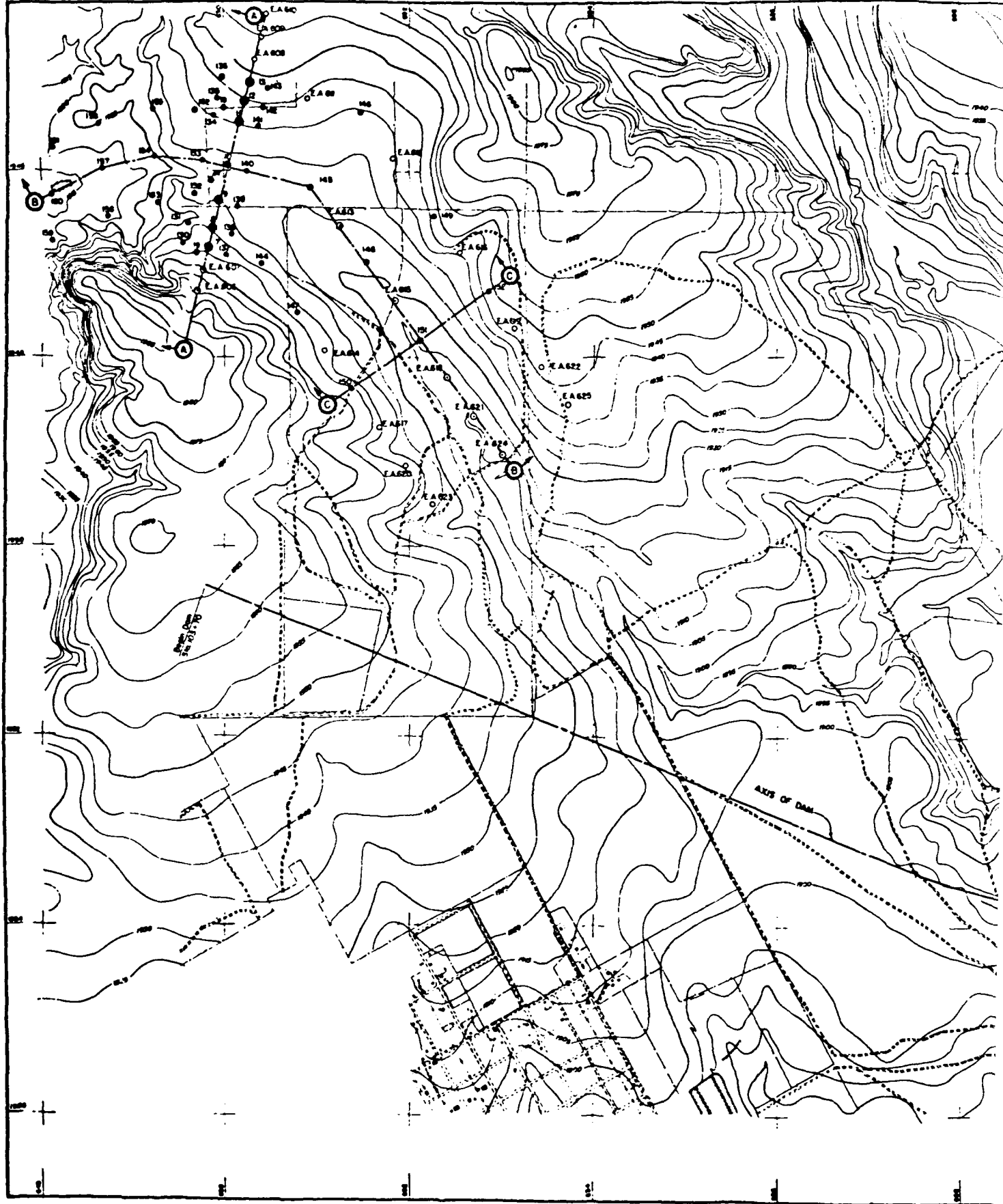


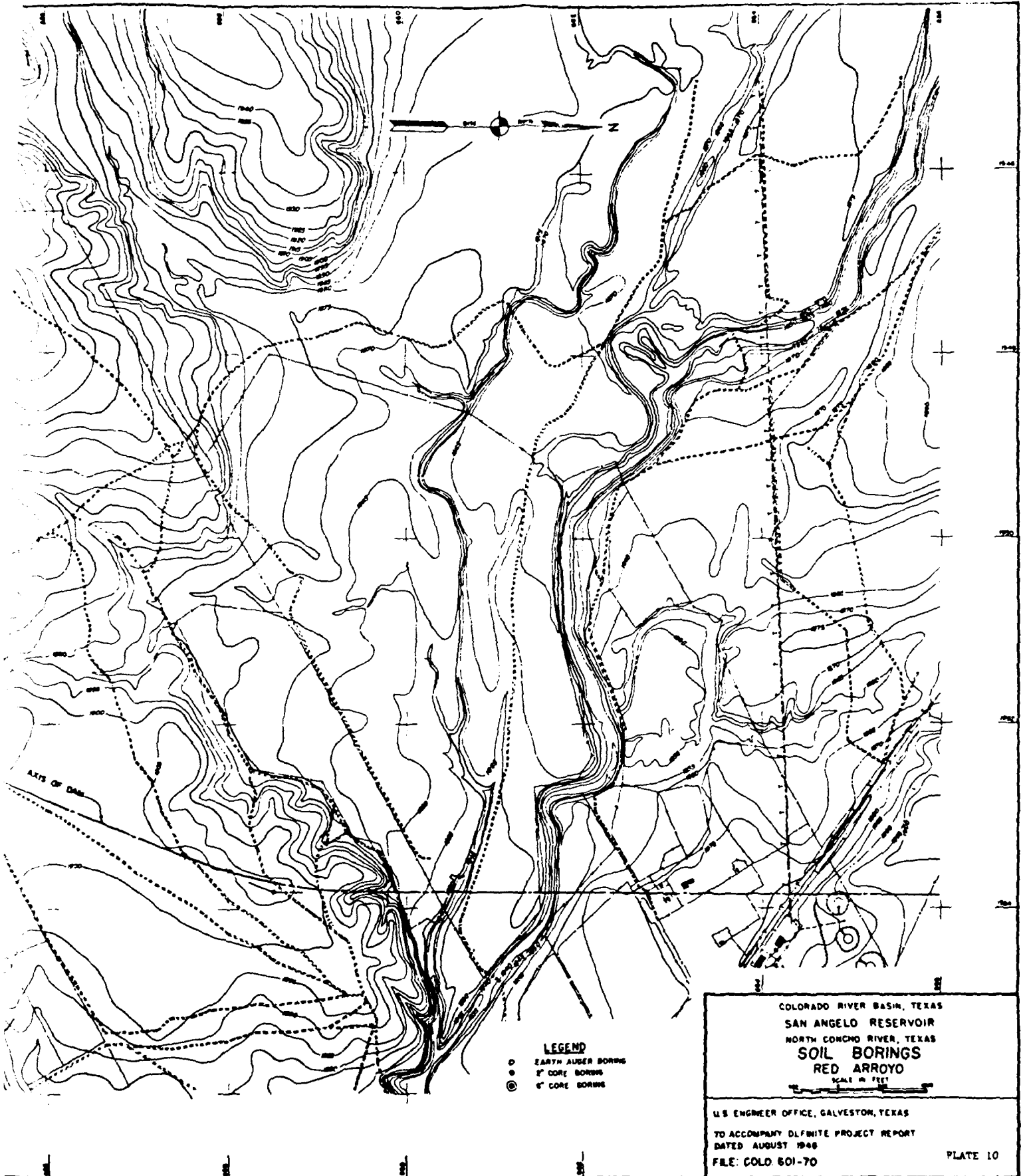
LEGEND
 ● 4" EARTH AUGER HOLES
 ● 2" CORE HOLES
 ■ TEST PIT
 —●— INDICATES BORING SHOWN ON PROFILE

COLORADO RIVER BASIN, TEXAS
 SAN ANGELO RESERVOIR
 NORTH CONCHO RIVER, TEXAS
 SOIL BORINGS
 LOCATION PLAN
 SCALE 1" = 100'

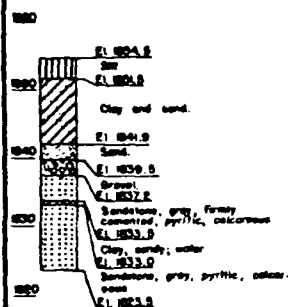
U. S. ENGINEER OFFICE, GALVESTON, TEXAS AUGUST 1946
 TO ACCOMPANY DEFINITE PROJECT REPORT
 DATED AUGUST 1946
 FILE COLO 601-70 PLATE 9

WAR DEPARTMENT

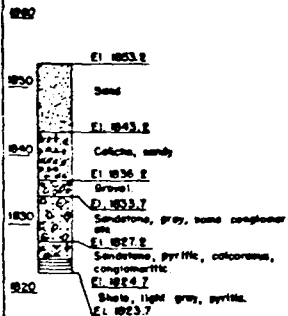




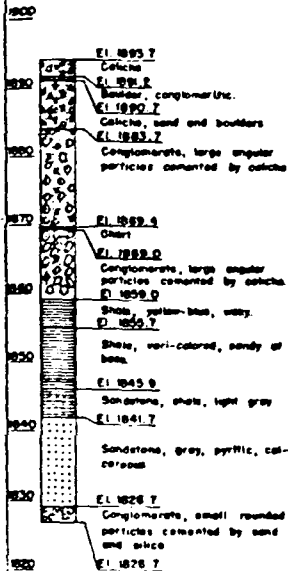
2C-12



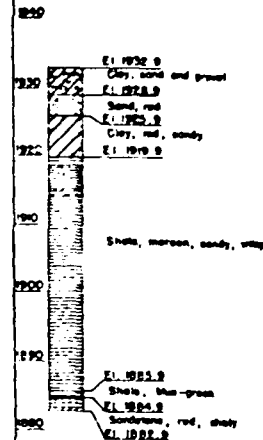
2C-13



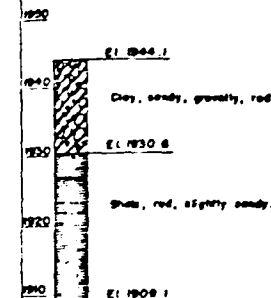
2C-14



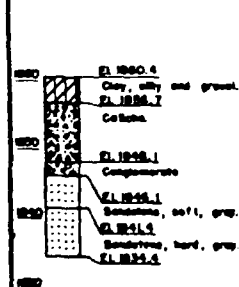
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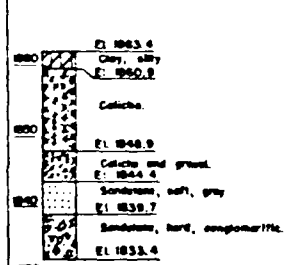
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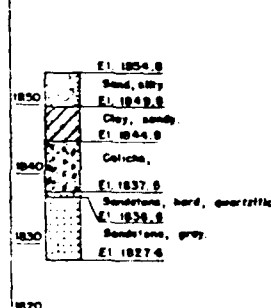
2C-27



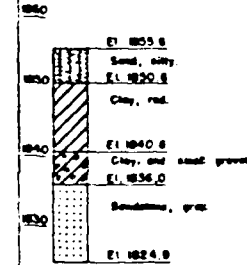
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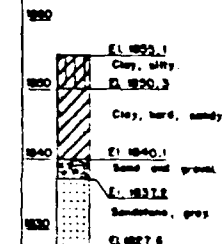
2C-31



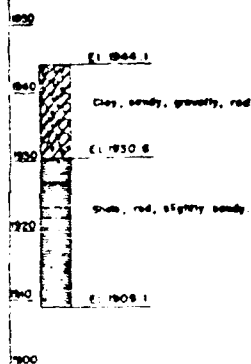
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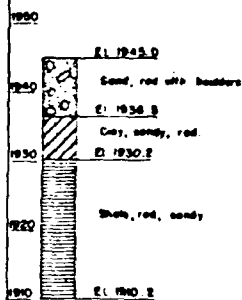
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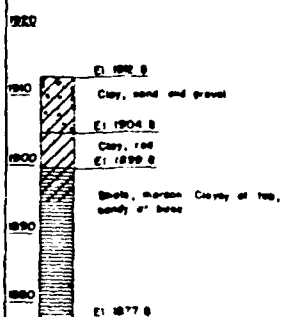
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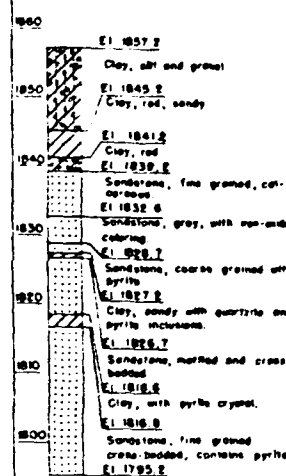
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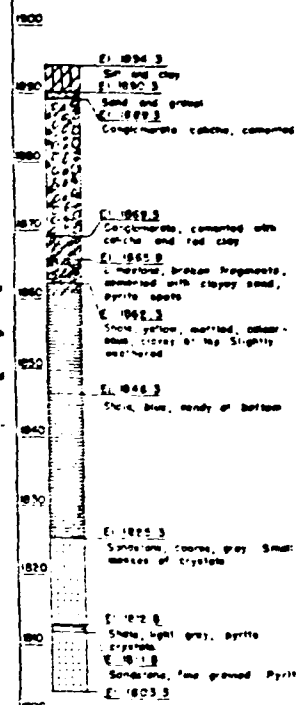
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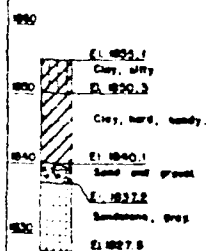
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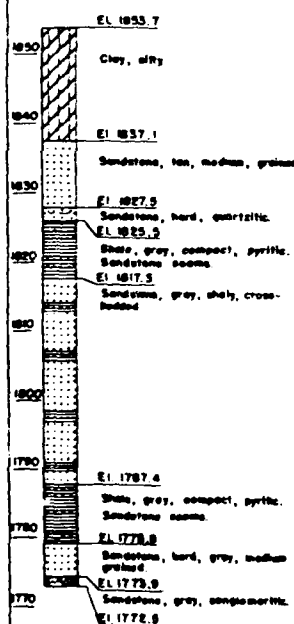
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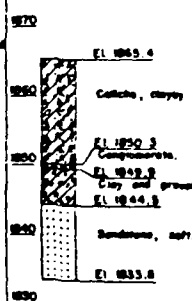
2C-33



2C-34



2C-35



NOTE
For location of core borings see appendix II, plate 2

COLORADO RIVER BASIN, TEXAS
SAN ANGELO RESERVOIR
NORTH CONCHO RIVER, TEXAS
CORE BORINGS
GRAPHIC LOGS

11 IS SHEETS

SCALE AS SHOWN

SHEET NO. 1

U.S. ENGINEER OFFICE, GALVESTON, TEXAS

AUGUST 1946

TO ACCOMPANY DEFINITE PROJECT REPORT

DATED AUGUST 1946

FILE COLO 601-70

PLATE 11

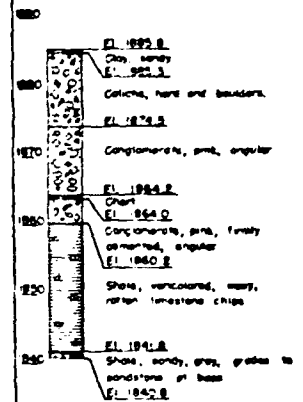
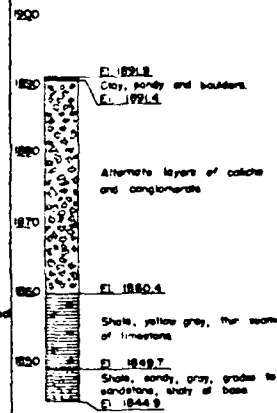
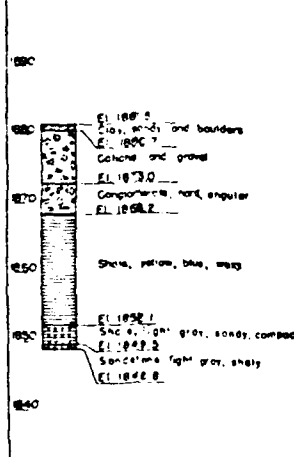
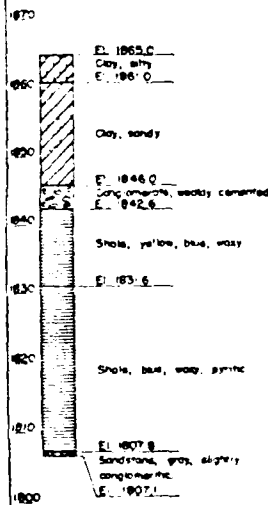
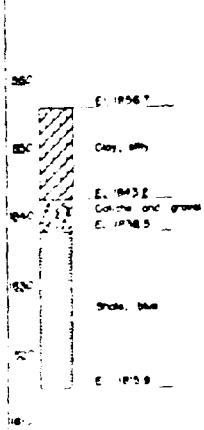
2C-65

2C-66

2C-68

2C-69

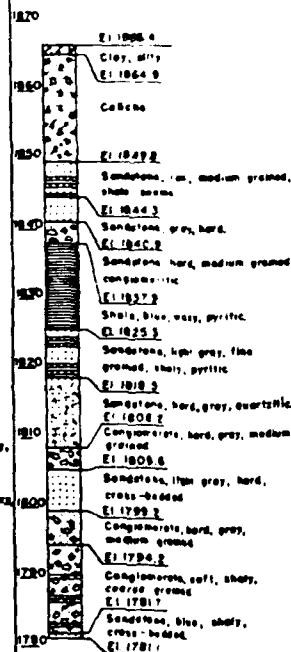
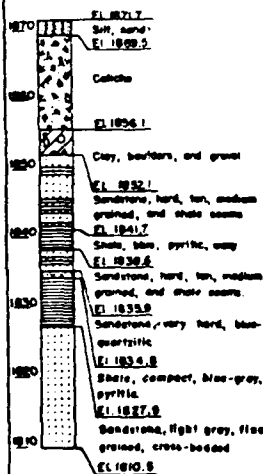
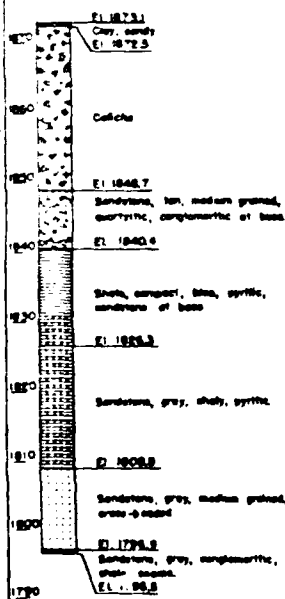
2C-70



2C-75

2C-76

2C-77



NOTE
For location of core borings see appendix I, plate 2

COLORADO RIVER BASIN, TEXAS
SAN ANGELO RESERVOIR
NORTH CONCHO RIVER, TEXAS
CORE BORINGS
GRAPHIC LOGS

11 SHEETS

SCALE AS SHOWN

SHEET NO. 10

U.S. ENGINEER OFFICE, GALVESTON, TEXAS

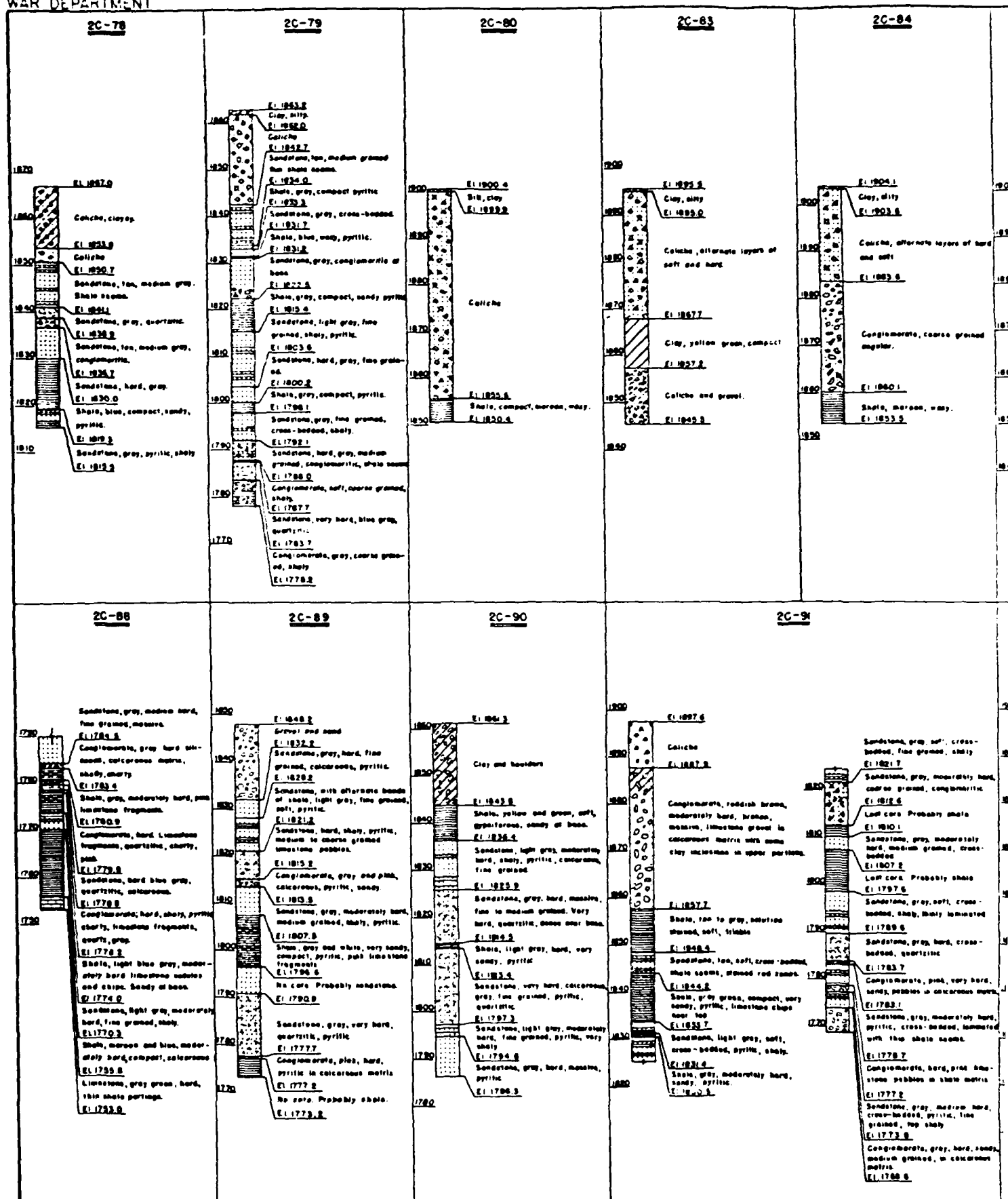
AUGUST 1946

TO ACCOMPANY DEFINITE PROJECT REPORT

DATED AUGUST 1946

FILE COLO 601-70

PLATE 12

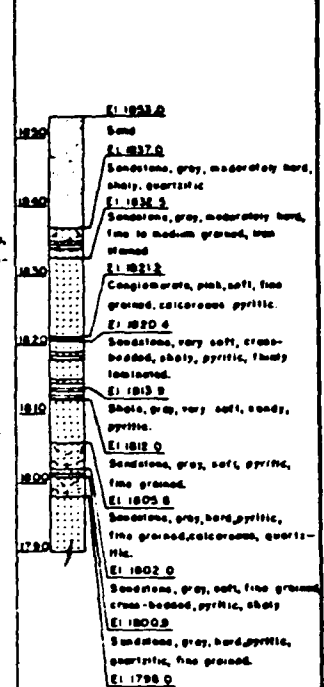
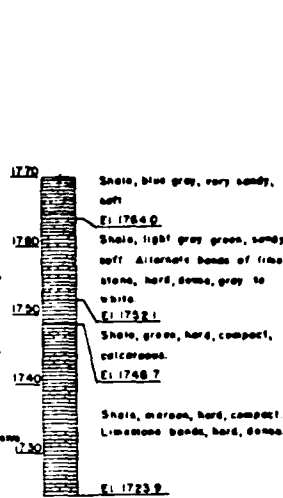
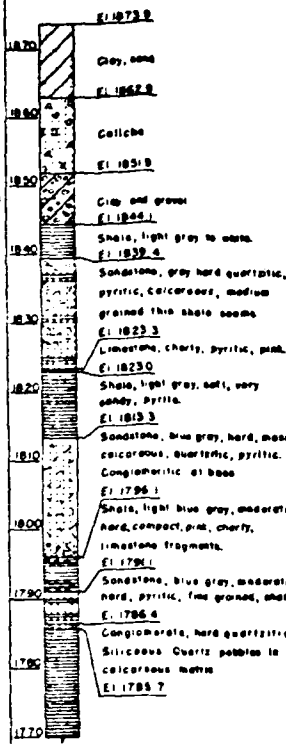
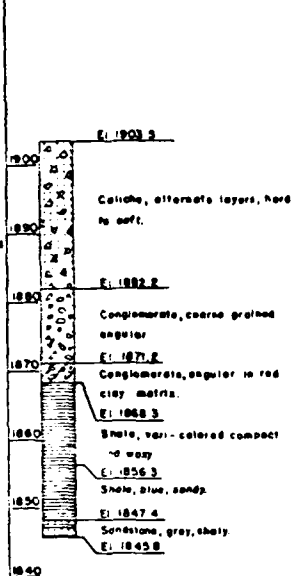
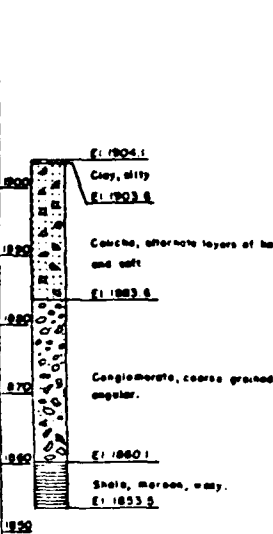


2C-84

2C-85

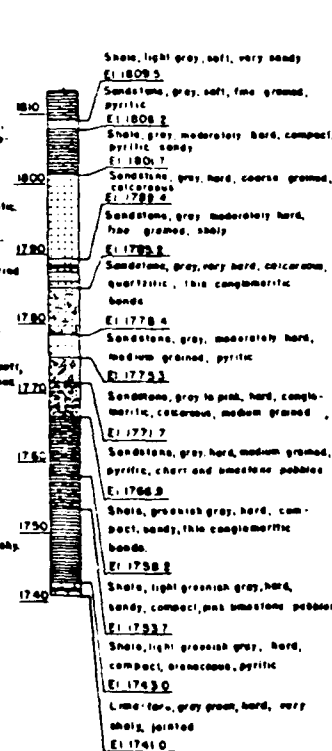
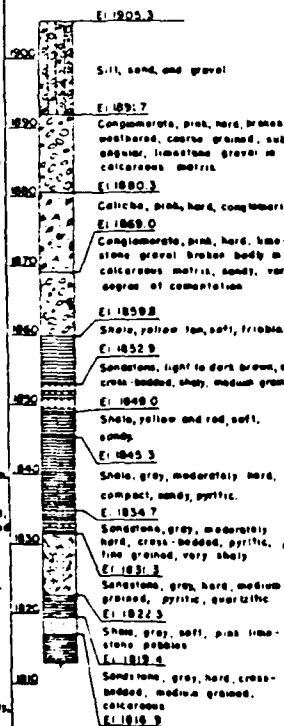
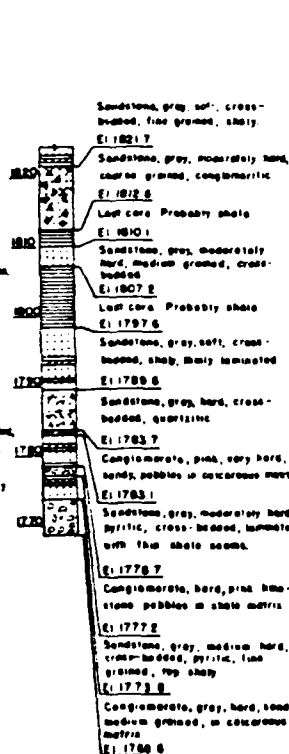
2C-87

2C-88



2C-91

2C-92



NOTE
For location of core borings see appendix I, pages 2 and 3

COLORADO RIVER BASIN, TEXAS
SAN ANGELO RESERVOIR
NORTH CONCHO RIVER, TEXAS
CORE BORINGS
GRAPHIC LOGS

11 IS SHEETS

SCALE AS SHOWN

SHEET NO. 11

U.S. ENGINEER OFFICE, GALVESTON, TEXAS

AUGUST 1946

TO ACCOMPANY DEFINITE PROJECT REPORT
DATED AUGUST 1946

FILE COLO 601-70

PLATE 13

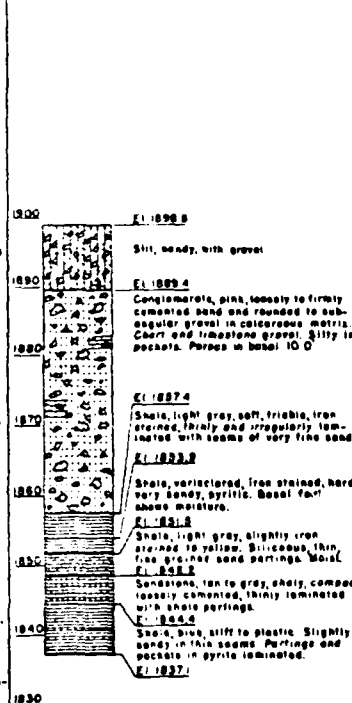
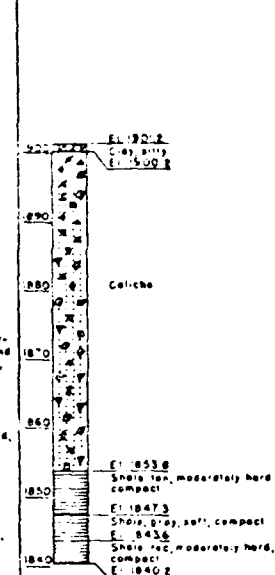
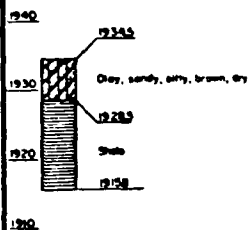
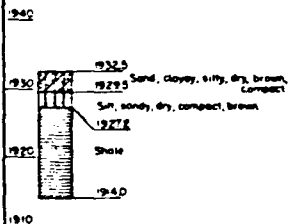


PLATE 14

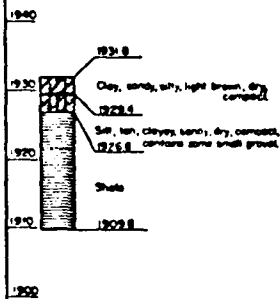
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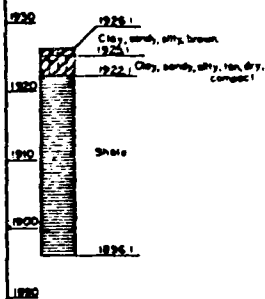
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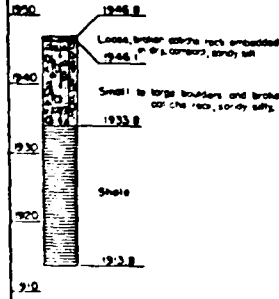
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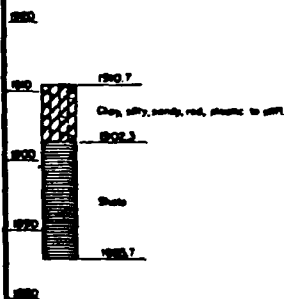
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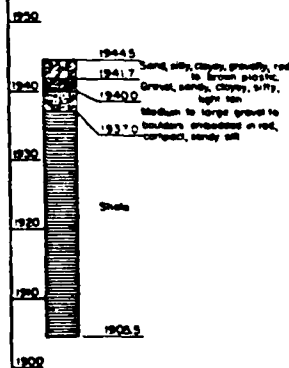
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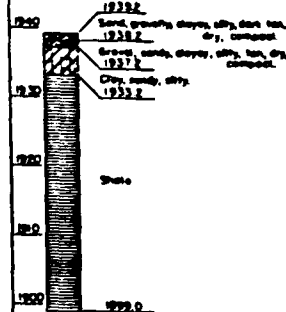
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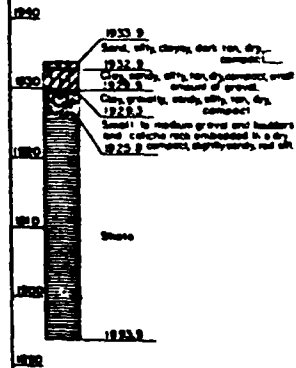
6C-7



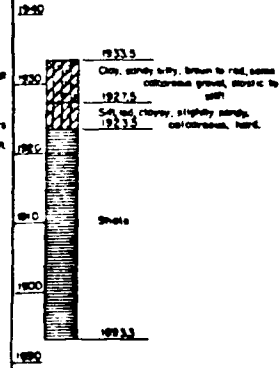
6C-8

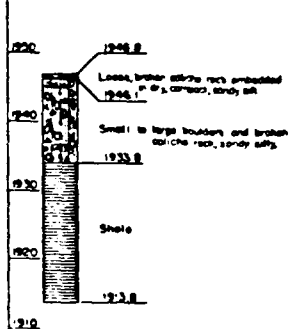
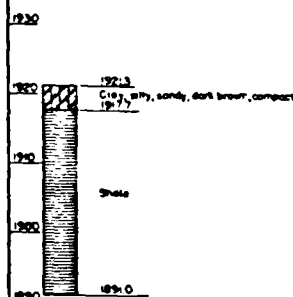
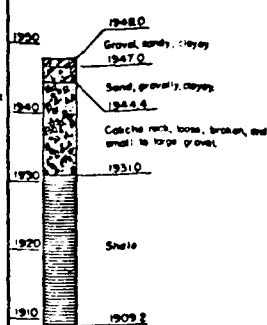
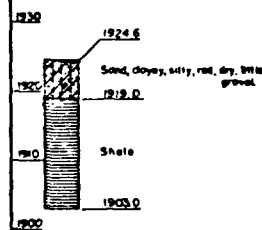
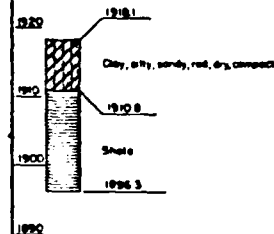
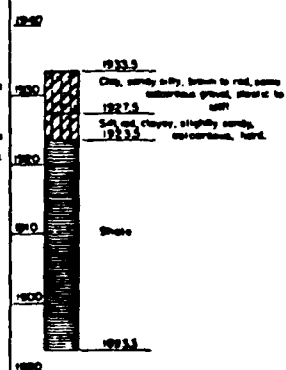
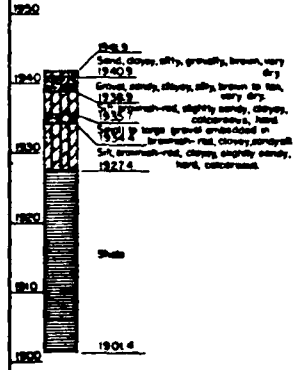
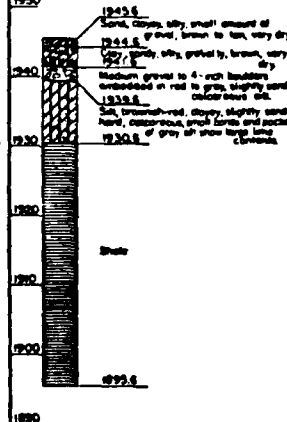
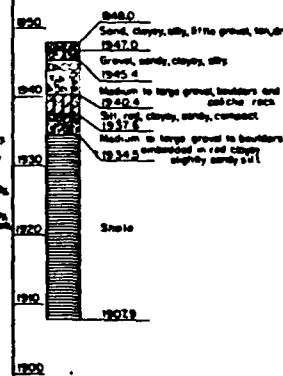


6C-9



6C-10



2C-1502C-1512C-1522C-1542C-1576C-106C-116C-126C-13

NOTE
For location of core borings see
Appendix I, page 2

COLORADO RIVER BASIN, TEXAS
SAN ANGELO RESERVOIR
NORTH CONCHO RIVER, TEXAS
CORE BORINGS
GRAPHIC LOGS

IN 15 SHEETS

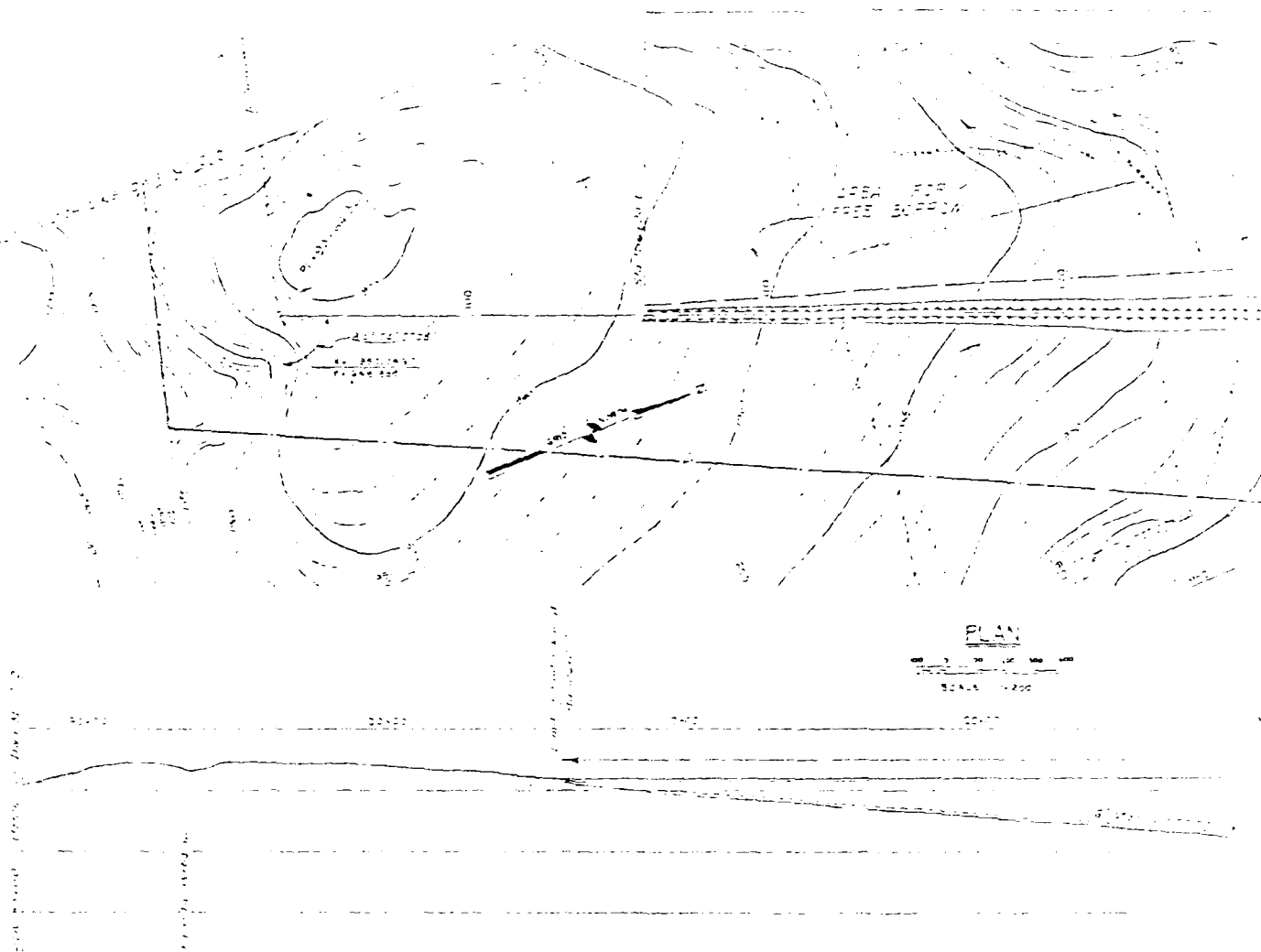
SCALE AS SHOWN

SHEET NO. 12

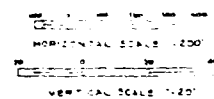
U.S. ENGINEER OFFICE, GALVESTON, TEXAS
TO ACCOMPANY DEFINITE PROJECT REPORT
DATED AUGUST 1946
FILE COLO 601-70

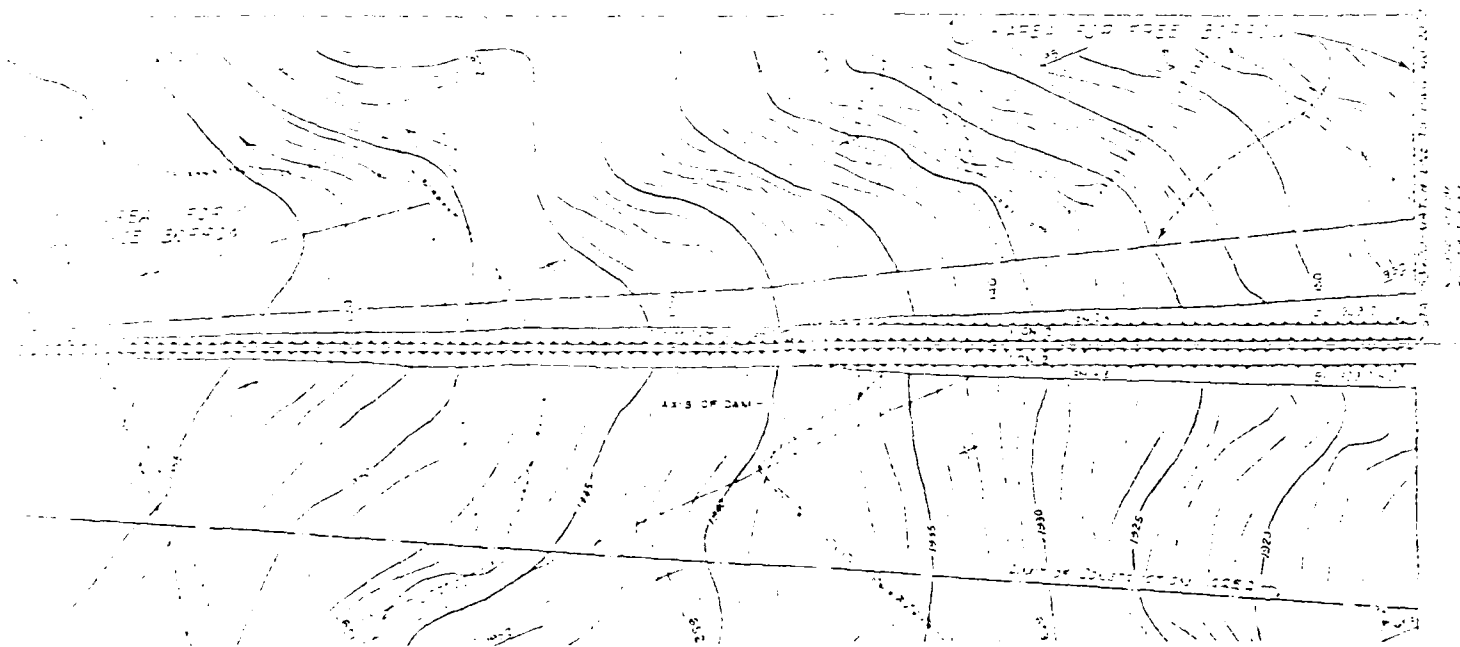
AUGUST 1946

PLATE 15



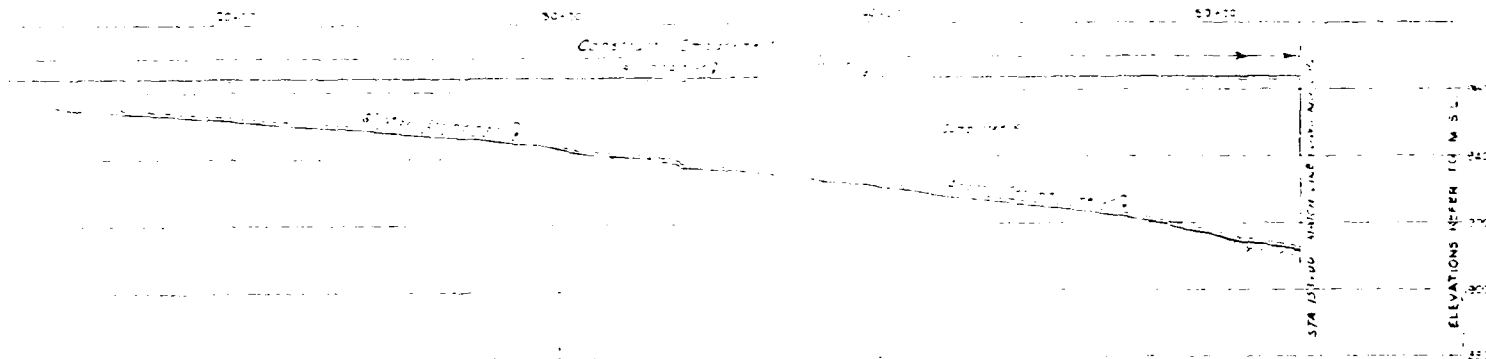
PROFILE ALONG AXIS





PLAN

SCALE 1"=200'



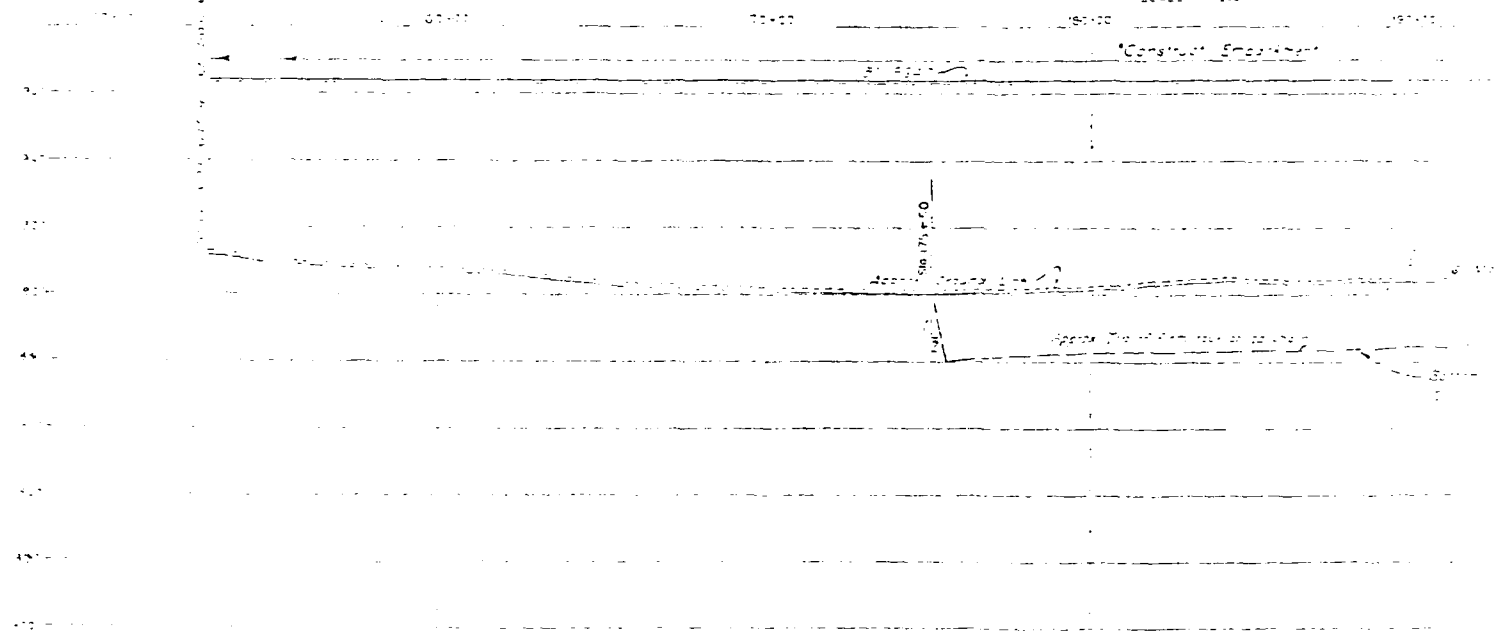
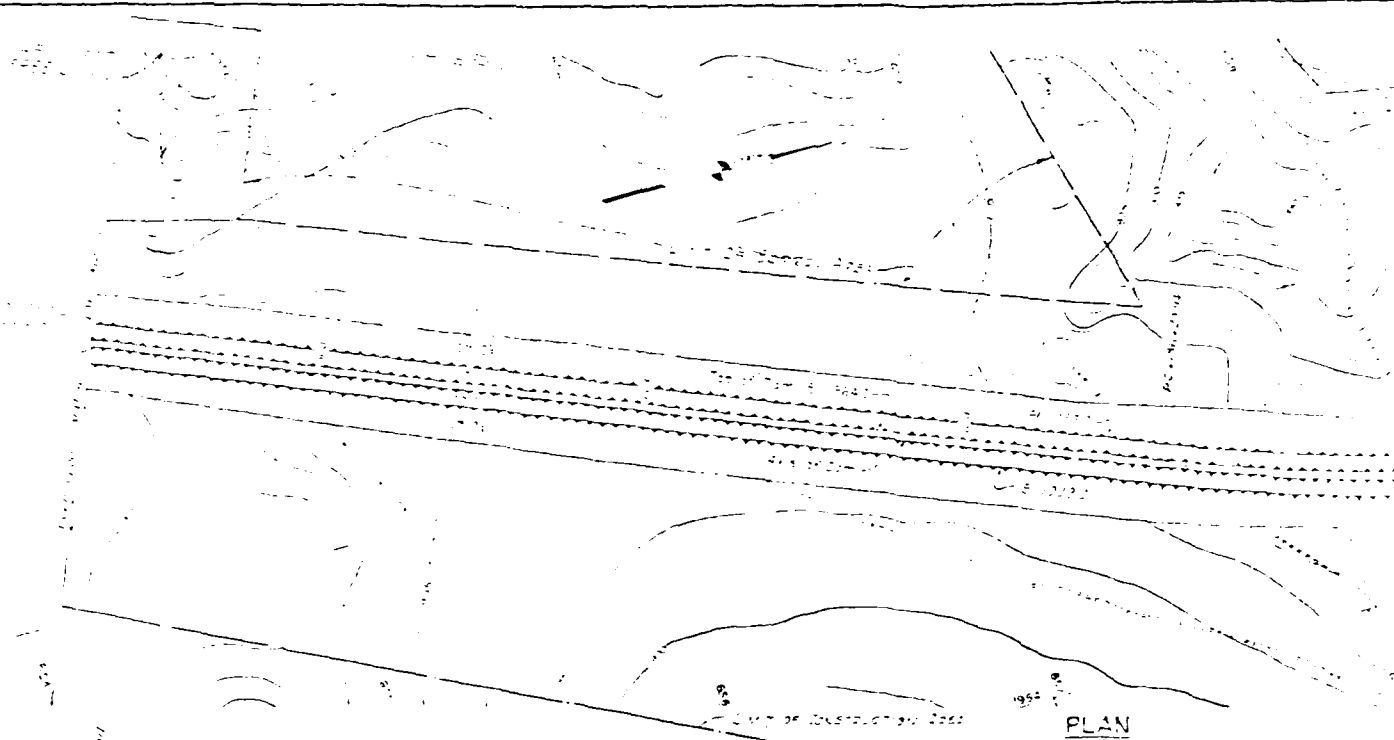
PROFILE ALONG AXIS

HORIZONTAL SCALE 1"=200'
VERTICAL SCALE 1"=20'

NOTES: FOR DETAILS AND SECTIONS OF EMBANKMENT, SEE DWG. NO. 17-5.
ELEVATIONS IN CIRCLES THUS () INDICATE ITEM NUMBER UNDER WHICH PAYMENTS WILL BE MADE.
FOR SOILS INFORMATION, SEE DWG. NO. 100-11-100-3.
MATERIAL FROM PROPOSED ELEVATION MAY BE USED IN EMBANKMENT FROM STA. 0+00 TO STA. 1+00.

RECEIVED
AS BUILT

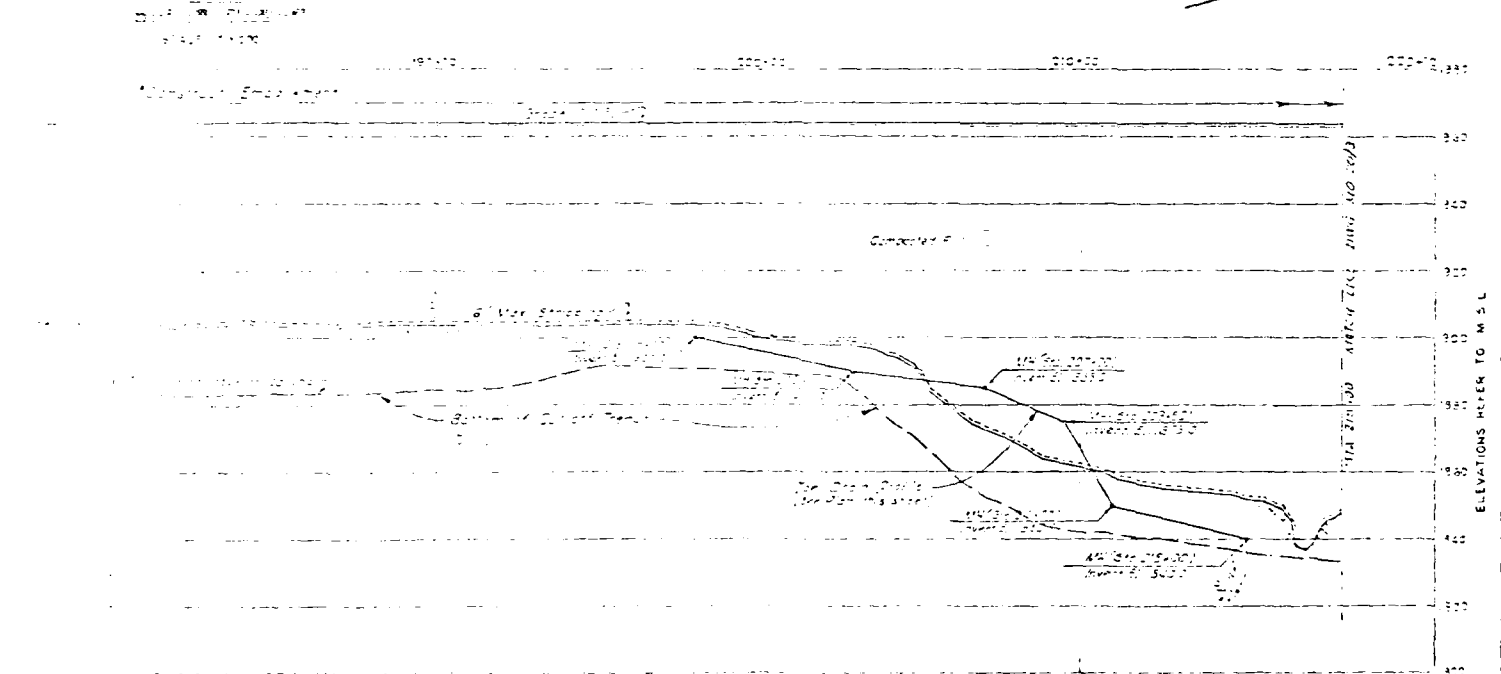
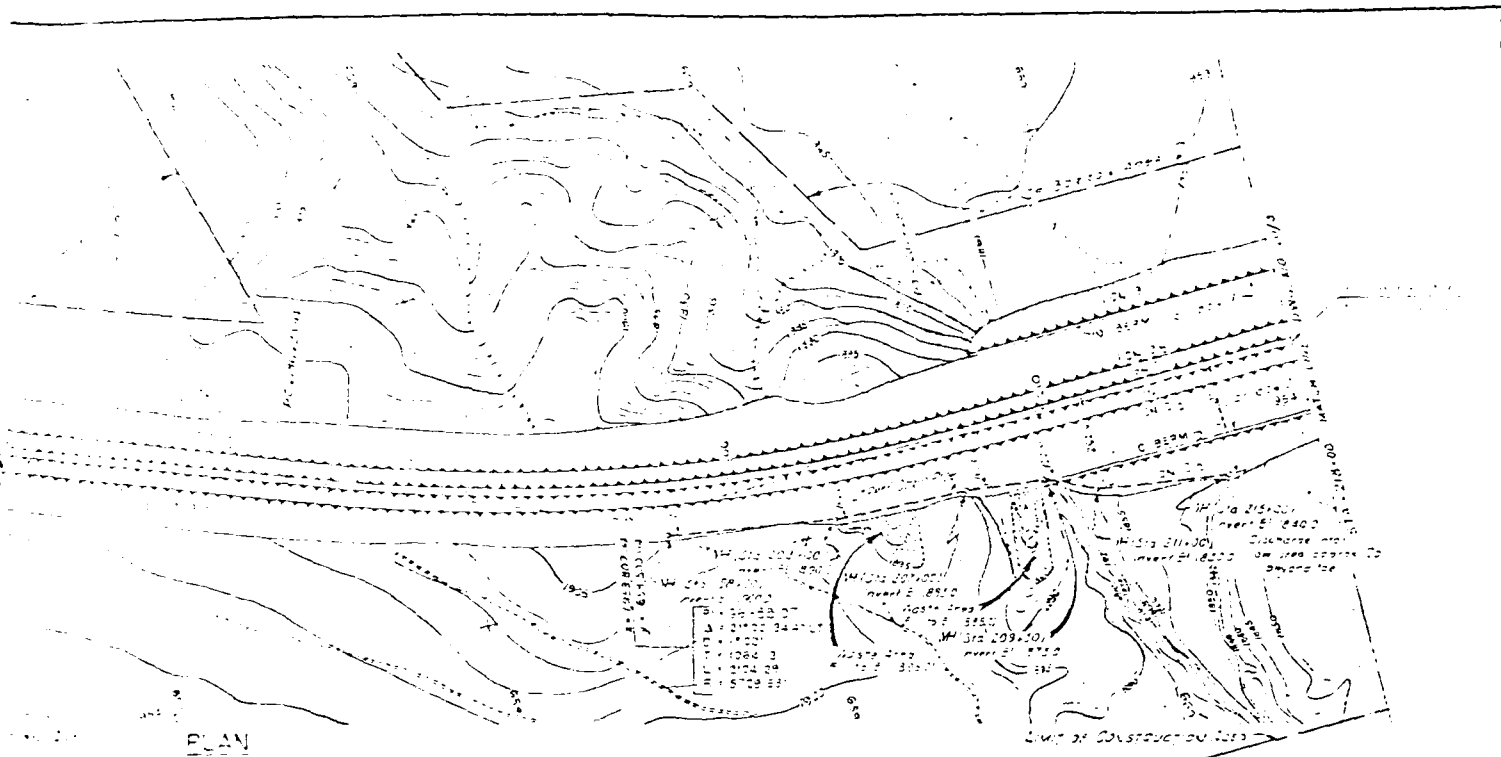
PROJECT NO. 17-5 COUNTY OF SAN DIEGO OFFICE OF THE ENGINEER SAN DIEGO, CALIF.	
DRAWN BY CHECKED BY APPROVED BY DATE	COLLEGE OF SAN DIEGO SAN ANDREAS DAM AND RESERVOIR NORTH SAN DIEGO, CALIF. EMBANKMENT PLAN AND PROFILE PLATE 16 2011



Profile along 1955

Horizontal Scale 1" = 200'

Vertical Scale 1" = 20'

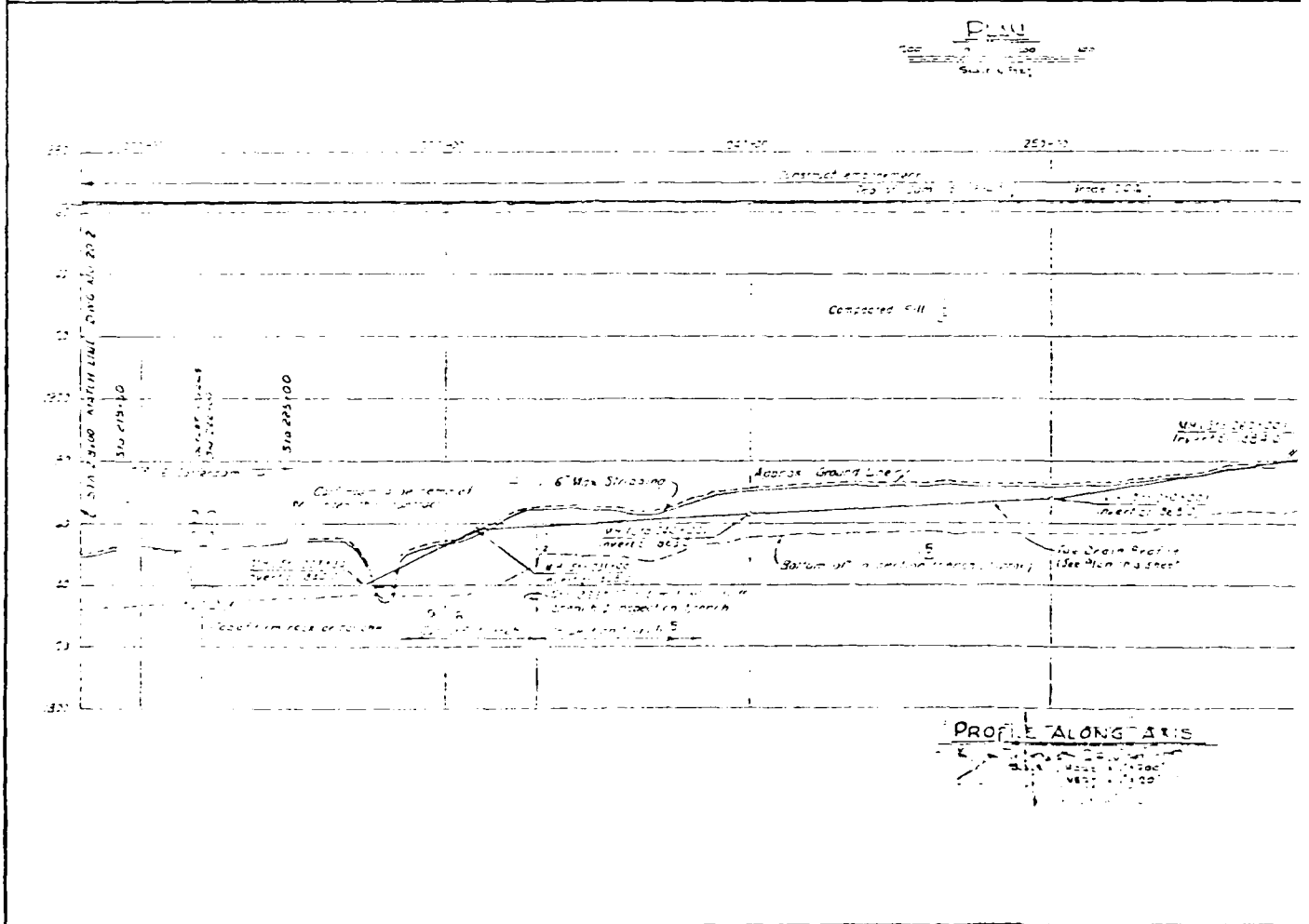
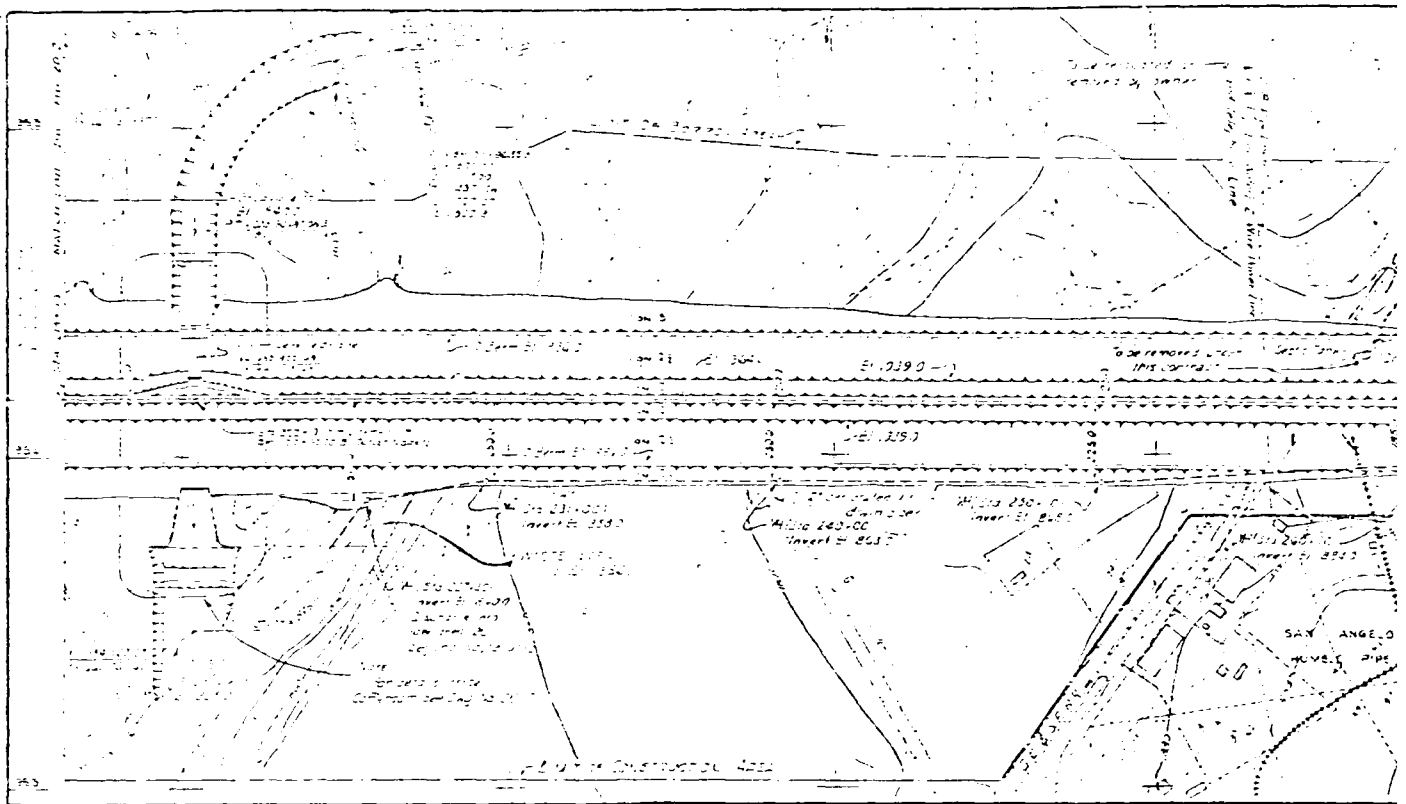


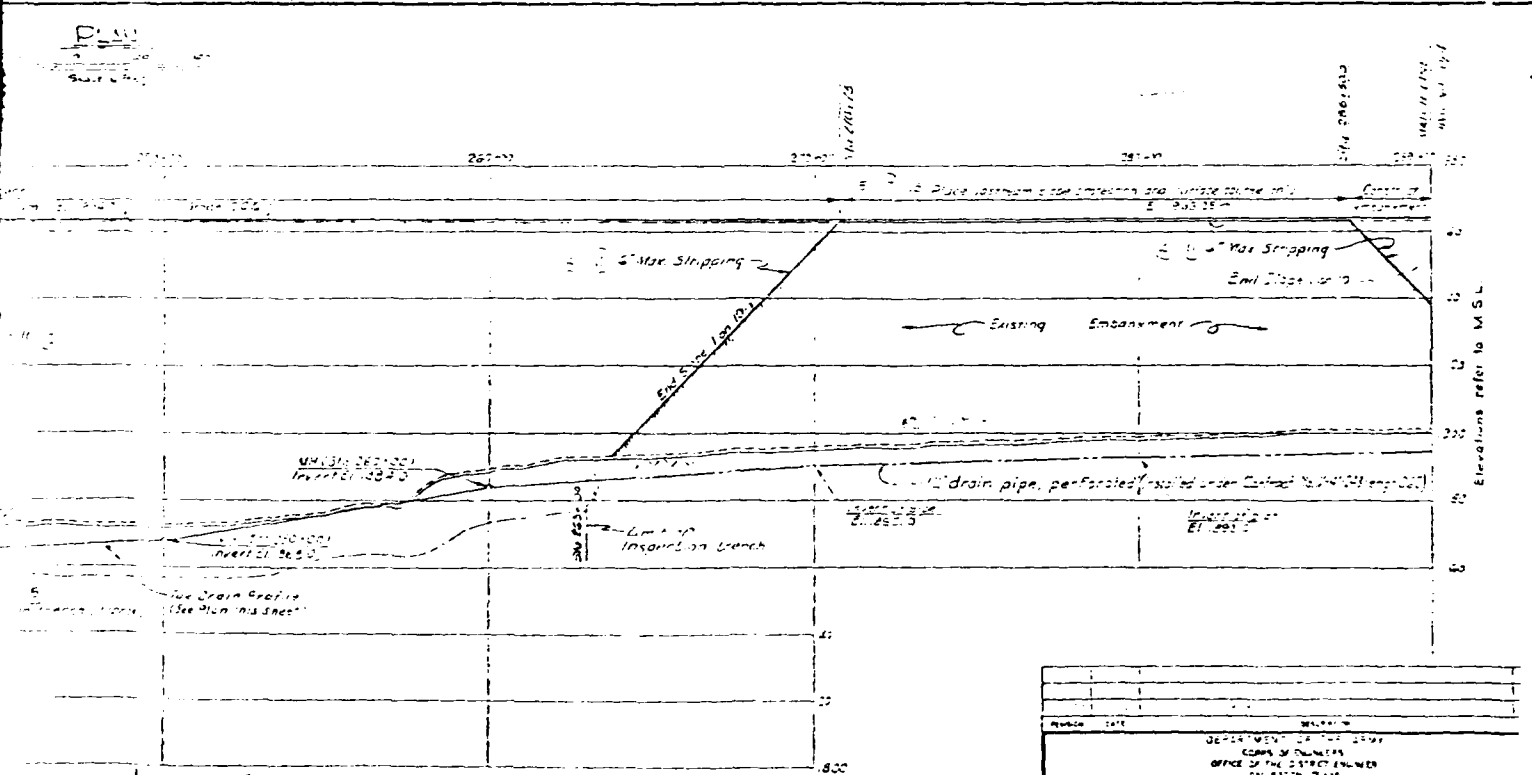
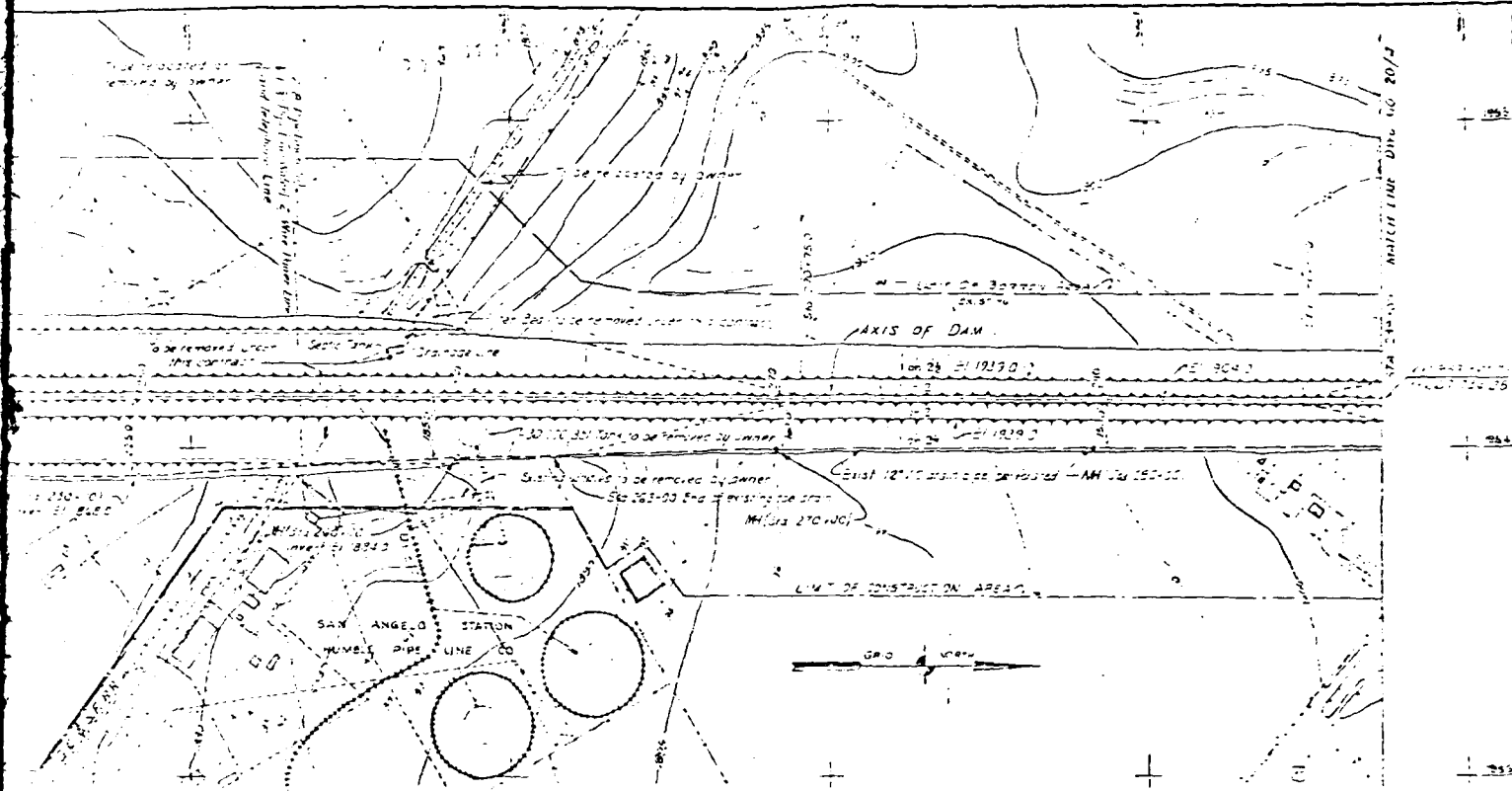
Profile Along Axis
Elevations in feet to M.S.L.

NOTES
For Section and Data, refer to the San Angelo Dam and Reservoir project.
The profile shown is for the proposed embankment.
The profile is for the proposed embankment.
The profile is for the proposed embankment.

AS BUILT

PROJECT NO. 100-100 DRAWN BY: [Signature] CHECKED BY: [Signature] DATE: [Date]		COLORADO RIVER BASIN, TEXAS SAN ANGELO DAM AND RESERVOIR NORTH CONCHO RIVER, TEXAS EMBANKMENT PLAN AND PROFILE PLATE 17 20-2
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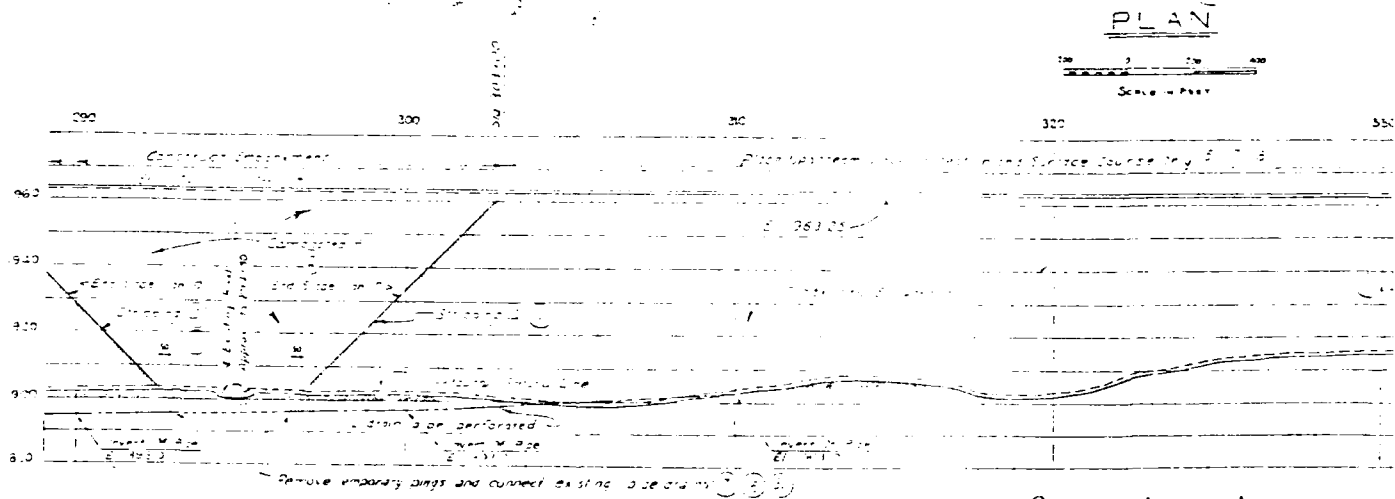
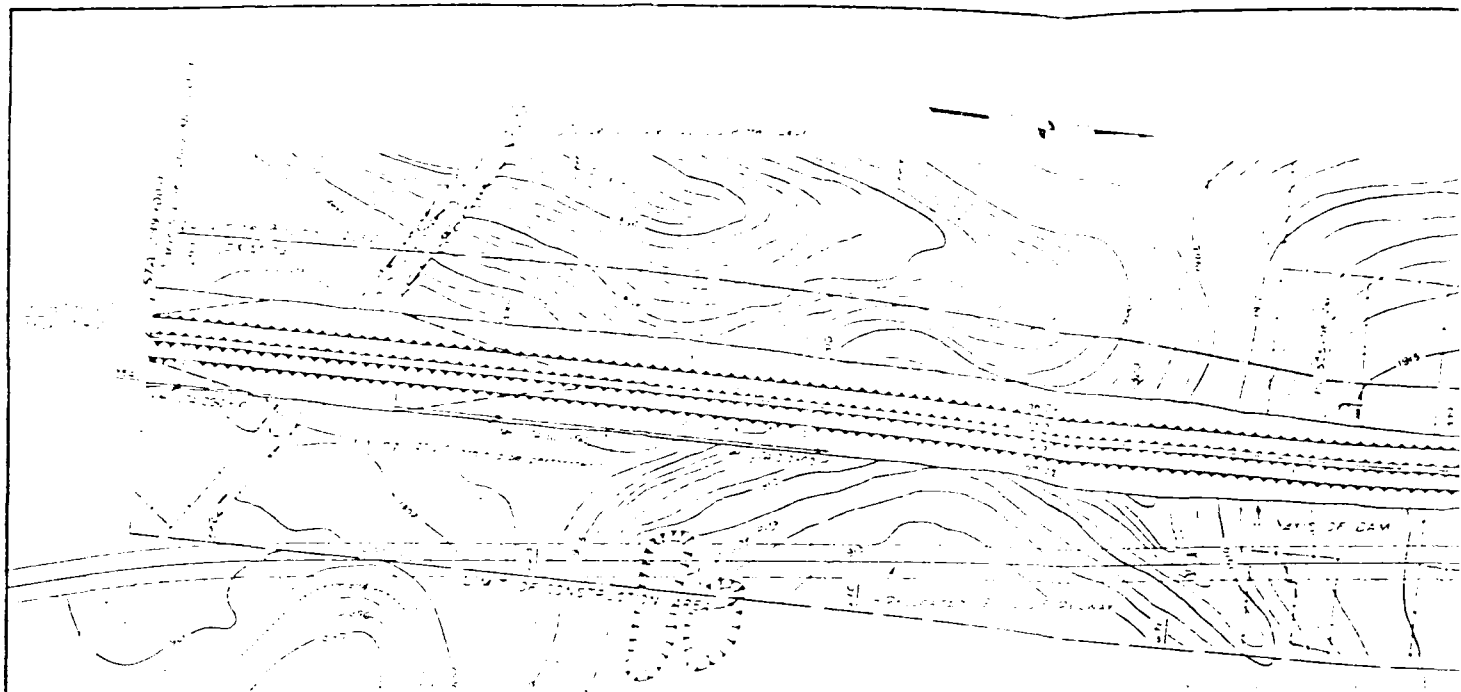


PROFILE ALONG AXIS

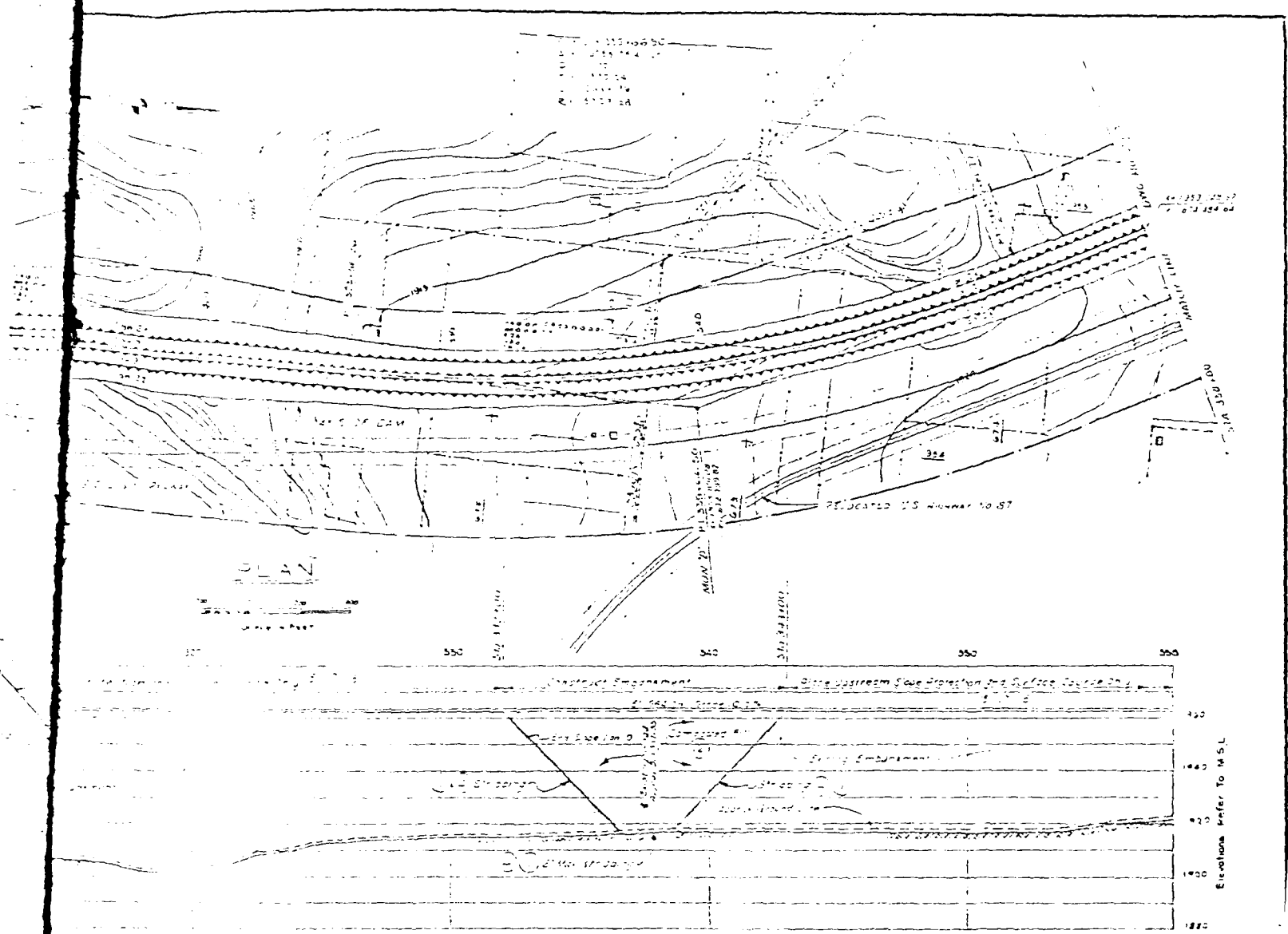
Notes
 Figures in circles are spot elevations from topography
 under which they are shown
 For embankment sections and data see Dwg No 20/1
 For soil information see Dwg No 20/2
 For details of service bridge see Dwg No 20/3
 For details of dam drain & foundation see Dwg No 20/4
 For details of dam foundation and dam see Dwg No 20/5
 Dwg No 20/6

RECORD DRAWING
 NO. 107

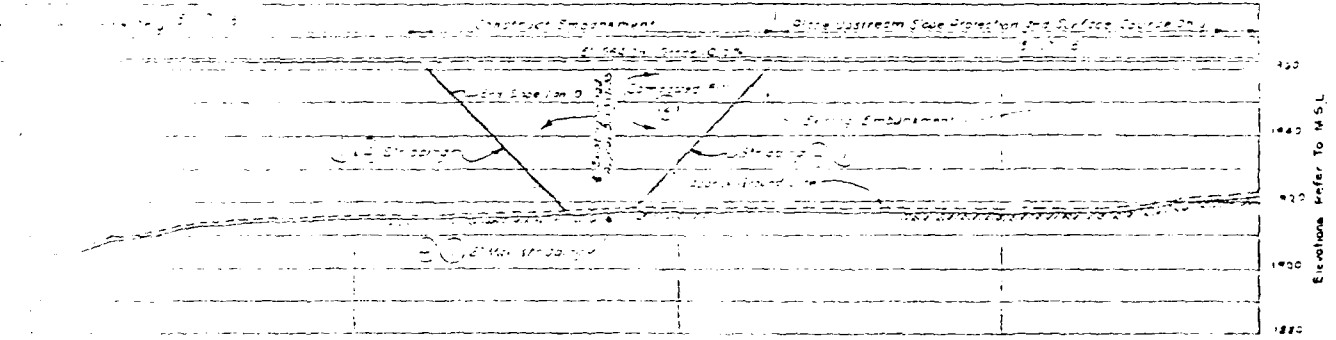
REVISION		DATE	BY
DEPARTMENT OF PUBLIC WORKS COUNTY OF DALLAS OFFICE OF THE DISTRICT ENGINEER DALLAS, TEXAS			
PROJECT NO.		SAN ANGELO DAM AND RESERVOIR	
TRACT NO.		NORTH CONCHO RIVER, TEXAS	
SHEET NO.		EMBANKMENT	
DRAWN BY		PLAN AND PROFILE - III	
CHECKED BY		F. J. [Signature]	
APPROVED BY		[Signature]	
SCALE		AS SHOWN	
DATE		20/1	



PROFILE ALONG AXIS
 SCALE HOR 1"=20'
 VERT 1"=20'



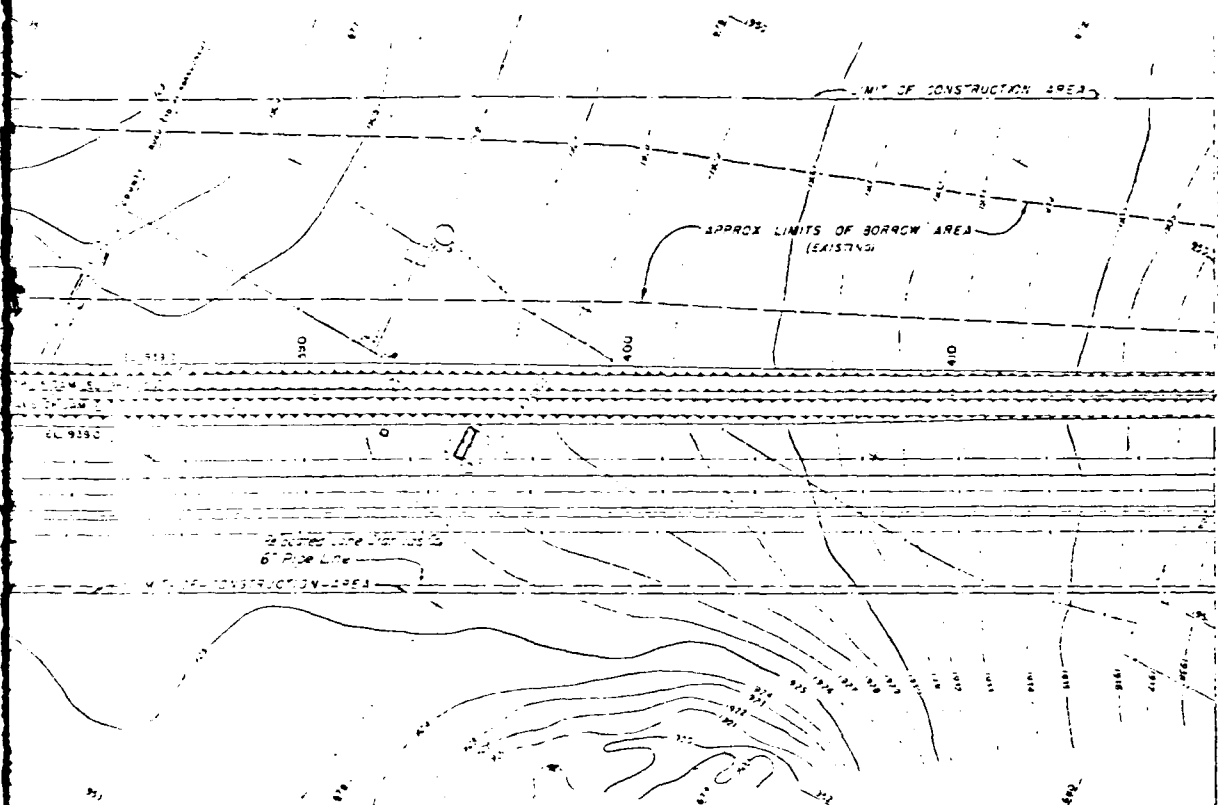
PROFILE ALONG AXIS
 HOR. 1"=20'
 VERT. 1"=20'



NOTES:
 See Div. No. 1014 for sections and details of embankment structure and materials.
 Figures in circles thus (12) indicate item number under which payment is to be made.
 For section information, see Div. No. 1014 through 1003.
 For retaining wall construction and details, see Div. No. 2010.

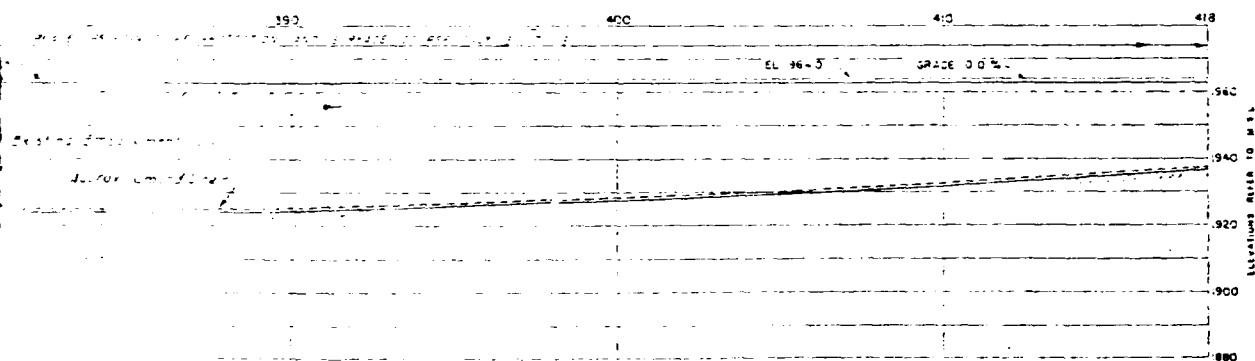
RECORD DRAWING
 AS BUILT

DEPARTMENT OF PUBLIC WORKS OFFICE OF THE DISTRICT ENGINEER COLUMBIA, TEXAS	
COLORADO RIVER BASIN, TEXAS SAN ANGELO DAM AND RESERVOIR NORTH CONCHO RIVER, TEXAS	
EMBANKMENT PLAN AND PROFILE--	
DRAWN BY: CHECKED BY: APPROVED BY:	PLATE 19 SCALE: AS SHOWN DATE: 1924 FILE NO. 1014



PLAN

SCALE 1" = 100'



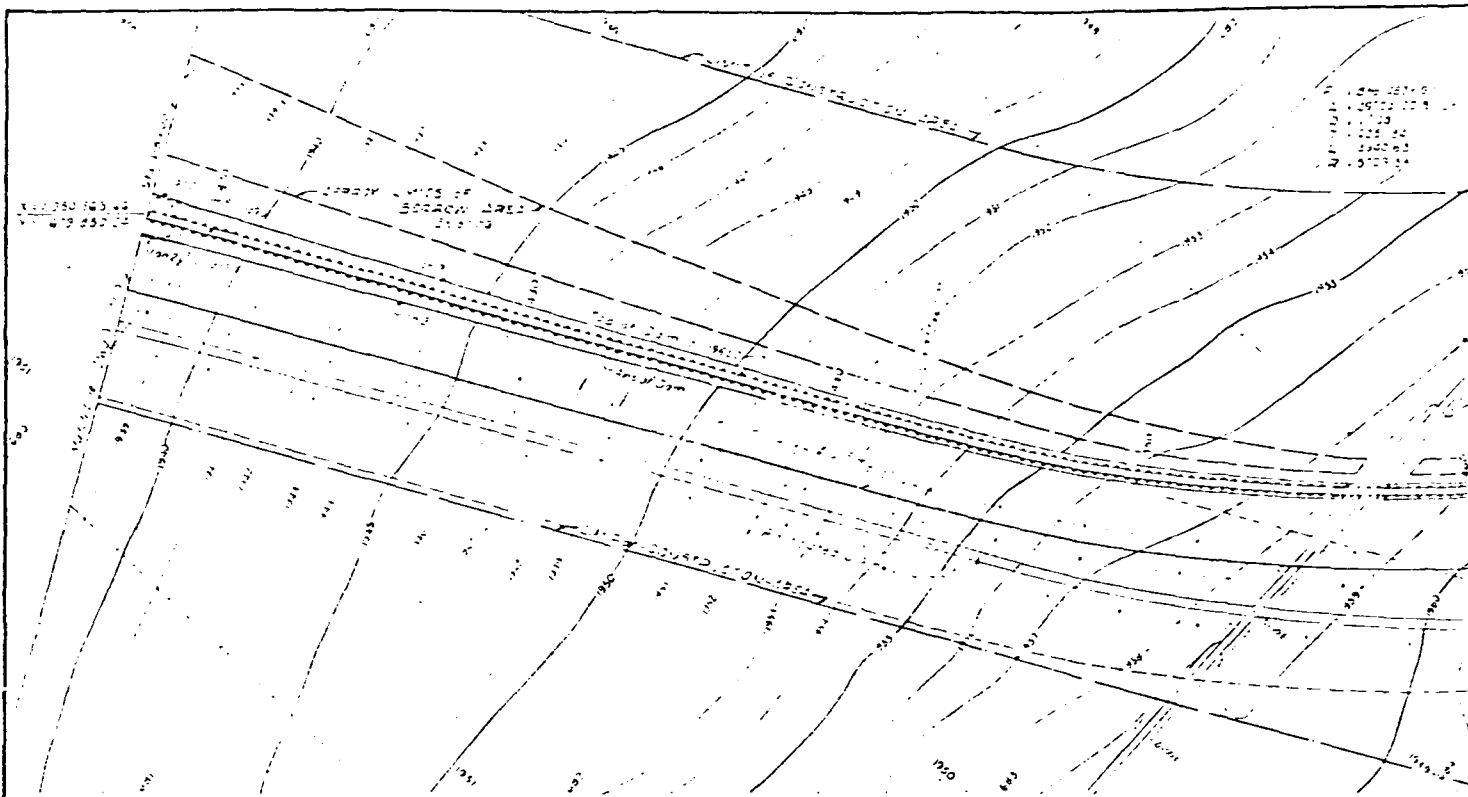
PROFILE ALONG AXIS

SCALE 1" = 100'

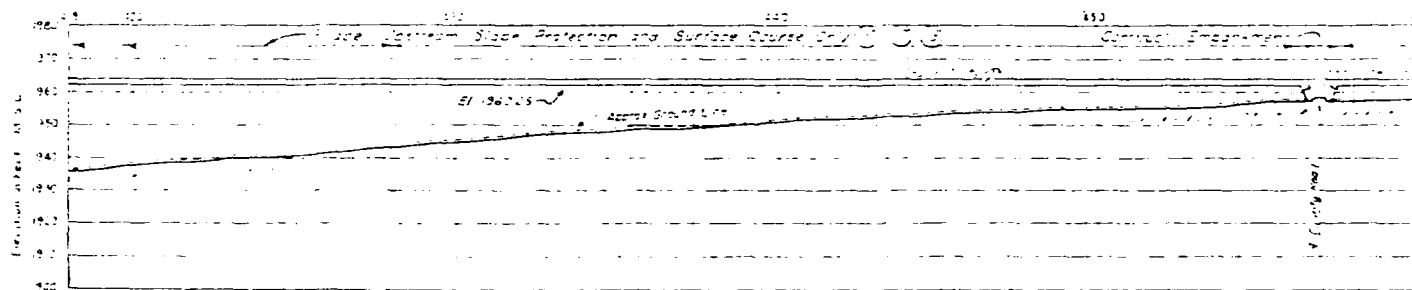
Note
Figures in circles, thus (3), indicates item number under which payment will be made for Sections and Details of Embankment see Drawing No. 20/5
For full information see Drawing No. 20/5
For relation to other drawings see Drawing No. 20/5

RECORD DRAWING
AS BUILT

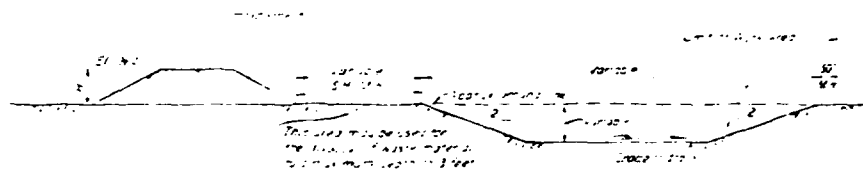
DEPARTMENT OF THE ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER DALLAS, TEXAS	
COLORADO RIVER BASIN, TEXAS SAN ANGELO DAM AND RESERVOIR NORTH CONCHO RIVER, TEXAS	
EMBANKMENT PLAN AND PROFILE - II	
PLATE 20	
DATE: 10/1/54	SCALE: AS SHOWN
BY: [Signature]	CHECKED: [Signature]
APPROVED: [Signature]	DATE: 10/1/54



PLAN



PROFILE ALONG AXIS



TYPICAL SECTION THRU BORROW AREA

PLAN

PROFILE ALONG AXIS

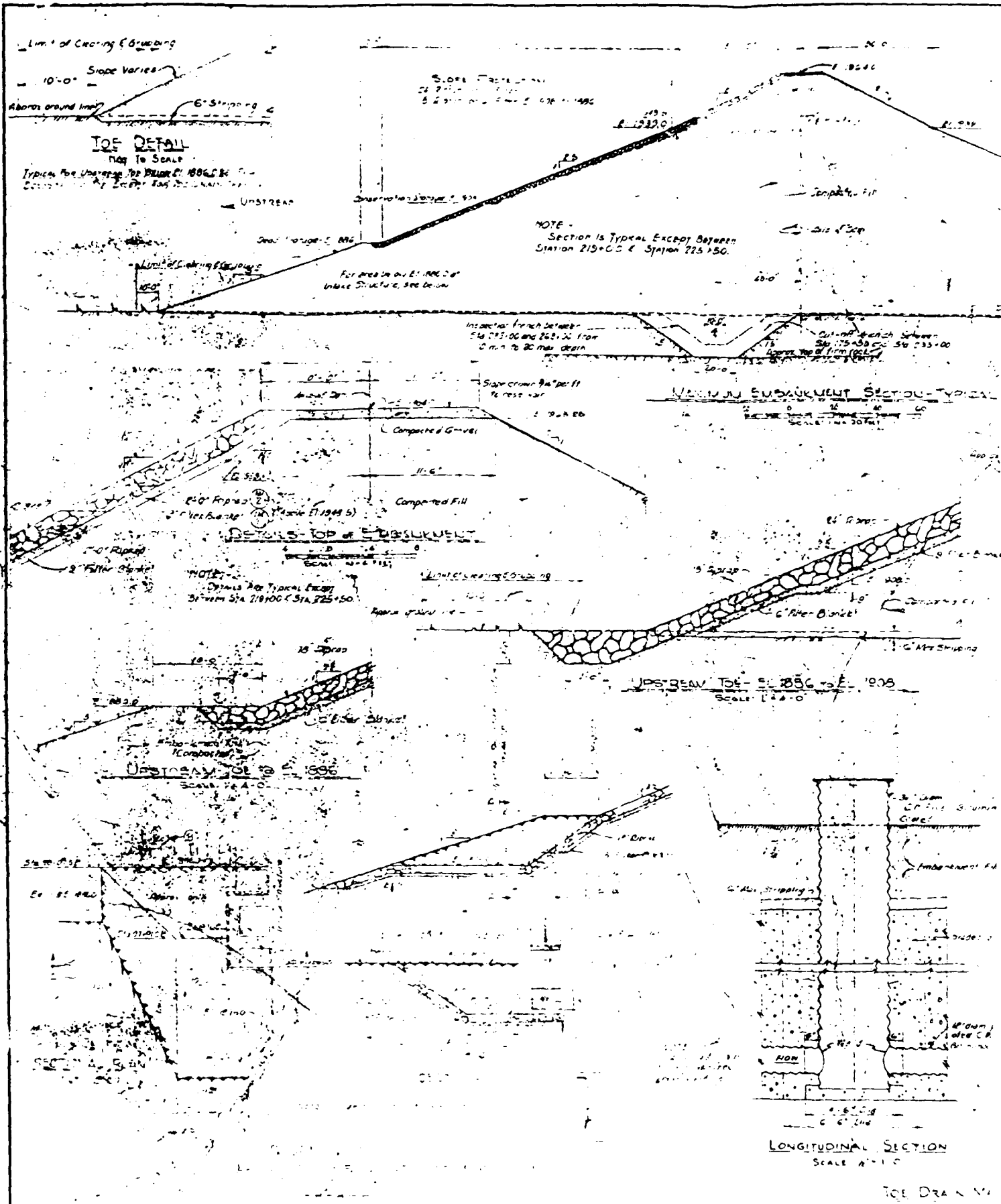
Horizontal Scale: 1" = 100' (1" = 100')

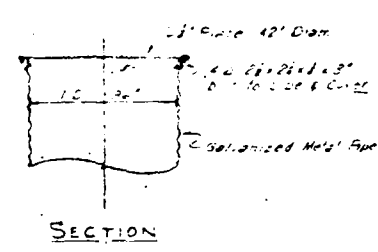
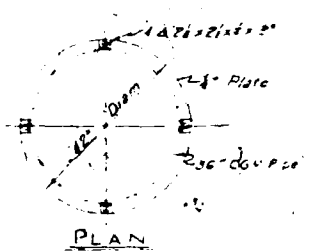
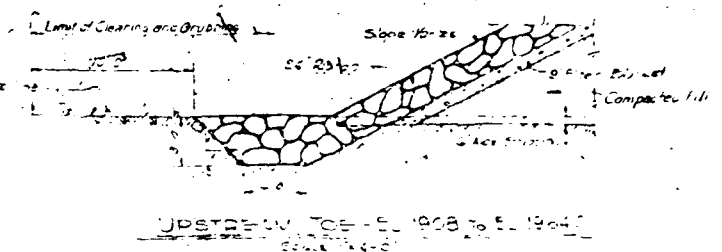
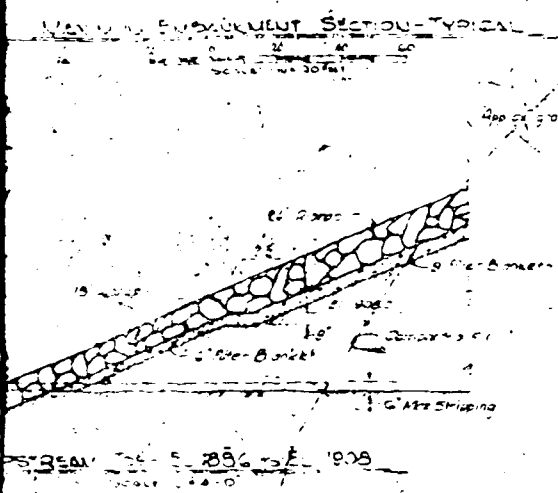
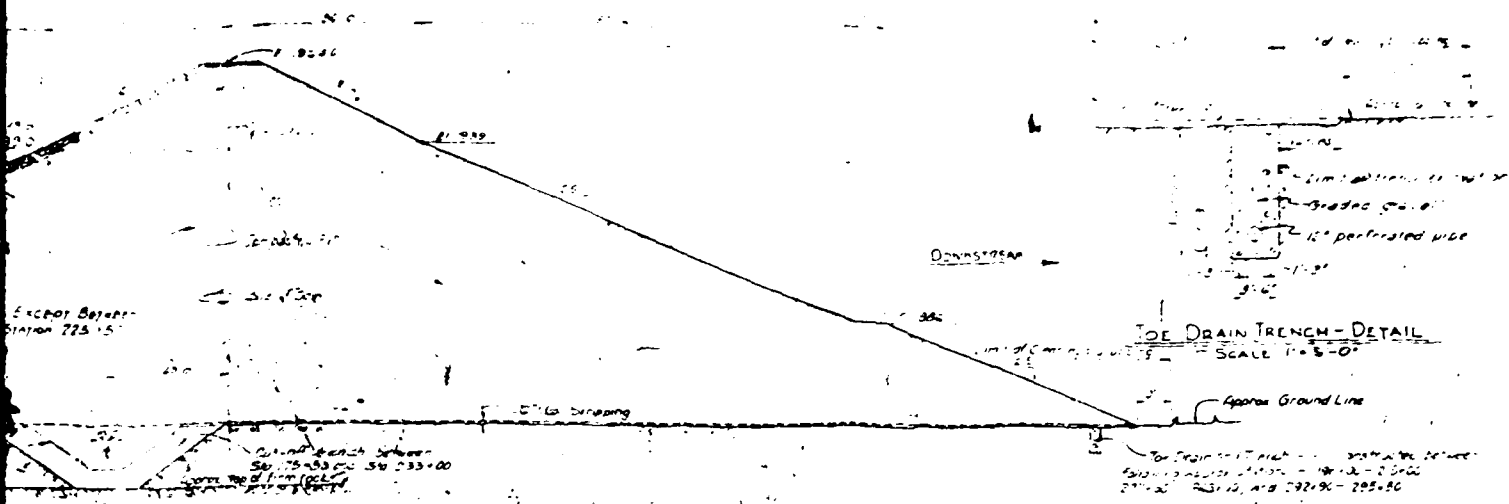
Note: Figures in circles are station numbers under which is given the station number for sections and details of embankment. For sections and details of embankment see Data No. 1.

RECORD DRAWING
AS BUILT

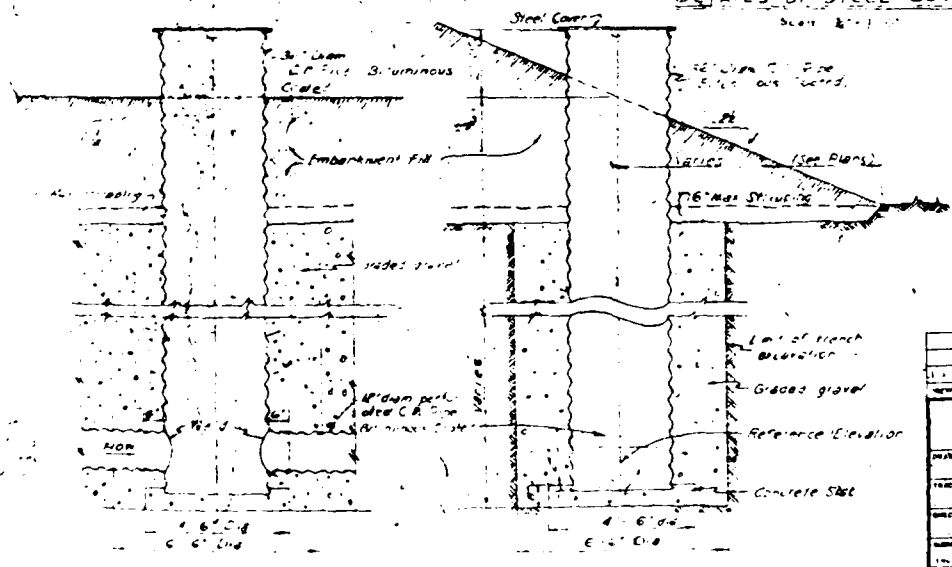
DEPARTMENT OF AGRICULTURE OFFICE OF THE DISTRICT ENGINEER SAN ANTONIO, TEXAS	
COLORADO RIVER BASIN, TEXAS SAN ANGELO DAM AND RESERVOIR NORTH CONCHO RIVER, TEXAS	
EMBANKMENT PLAN AND PROFILE - III	
DRAWN BY: <i>[Signature]</i> CHECKED BY: <i>[Signature]</i> DATE: <i>[Date]</i>	PLATE 21 SCALE: 1" = 100' (1" = 100') DATE: 20/6/

THIS DRAWING SUPERSEDES ONE DATED 20/6/



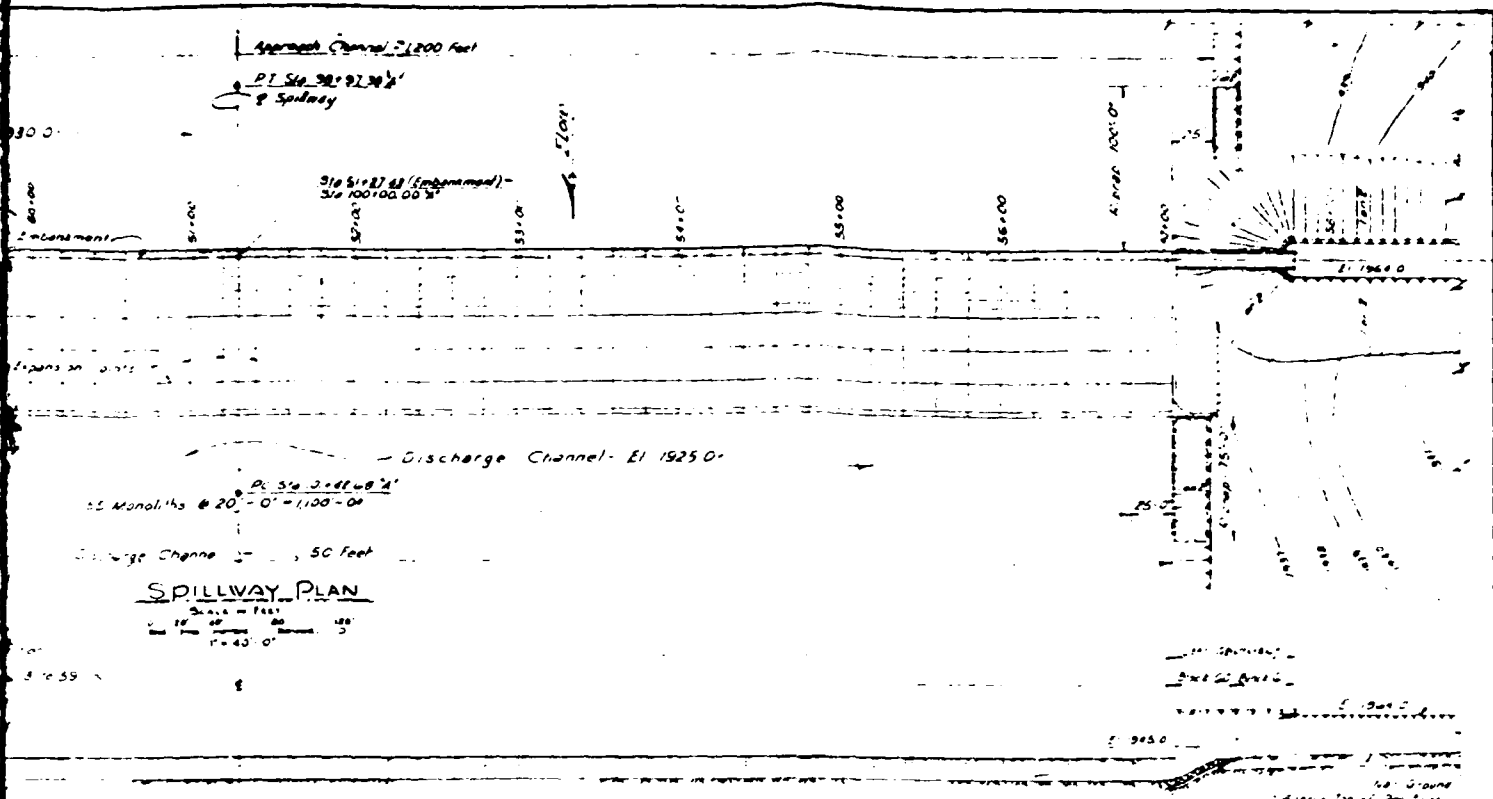


DETAILS OF STEEL COVER
Scale 1"=1'-0"



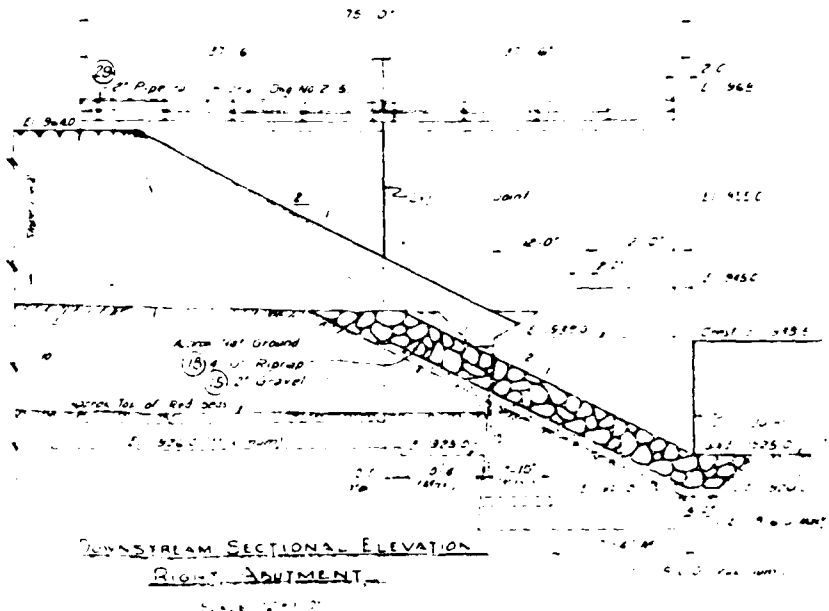
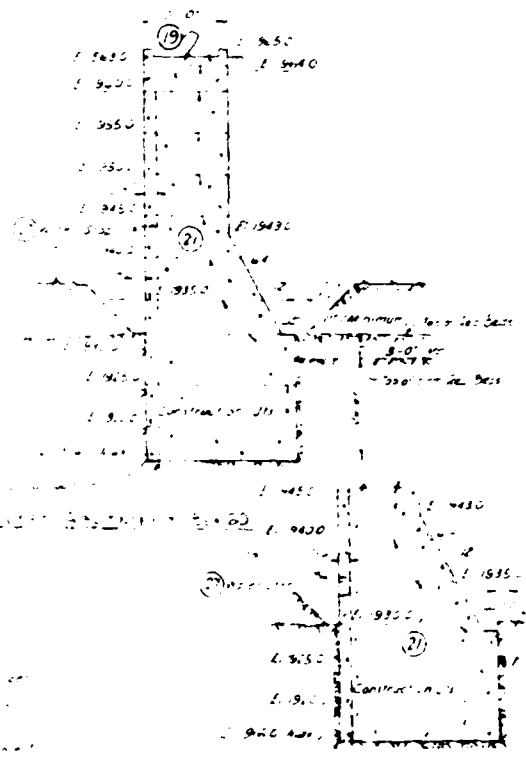
TOE DRAIN MANHOLE - DETAILS

DEPARTMENT OF THE ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER DAVENPORT, TEXAS	
COLORADO RIVER BASIN, TEXAS SAN ANGELO DAM AND RESERVOIR NORTH CONCHO RIVER, TEXAS	
EMBANKMENT SECTIONS AND DETAILS	
PROJECT NO. DRAWN BY CHECKED BY APPROVED BY	DATE SCALE SHEET NO. 22 OF 22 PREPARED BY DATE SCALE SHEET NO. 22 OF 22



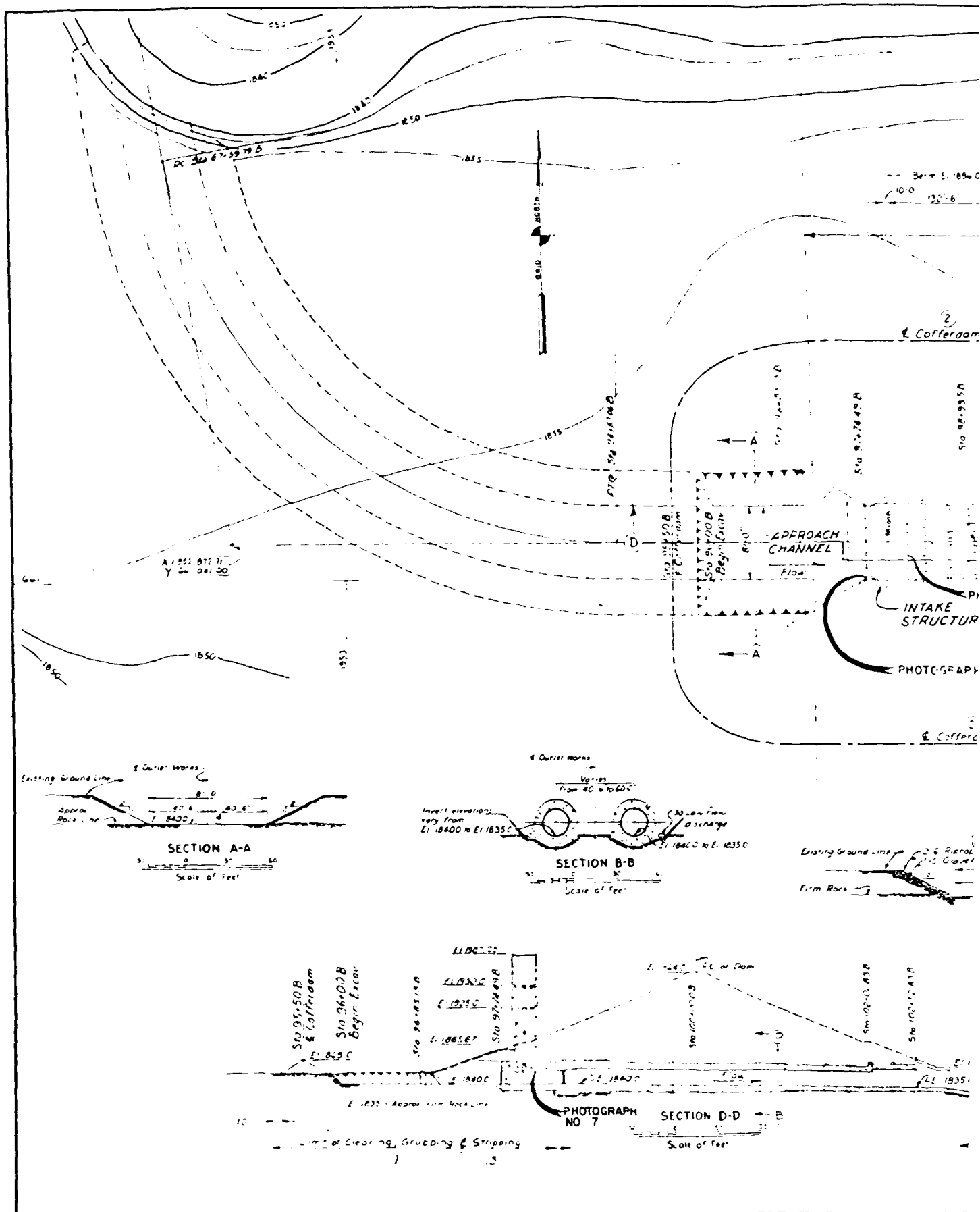
DOWNSTREAM SECTIONAL ELEVATION

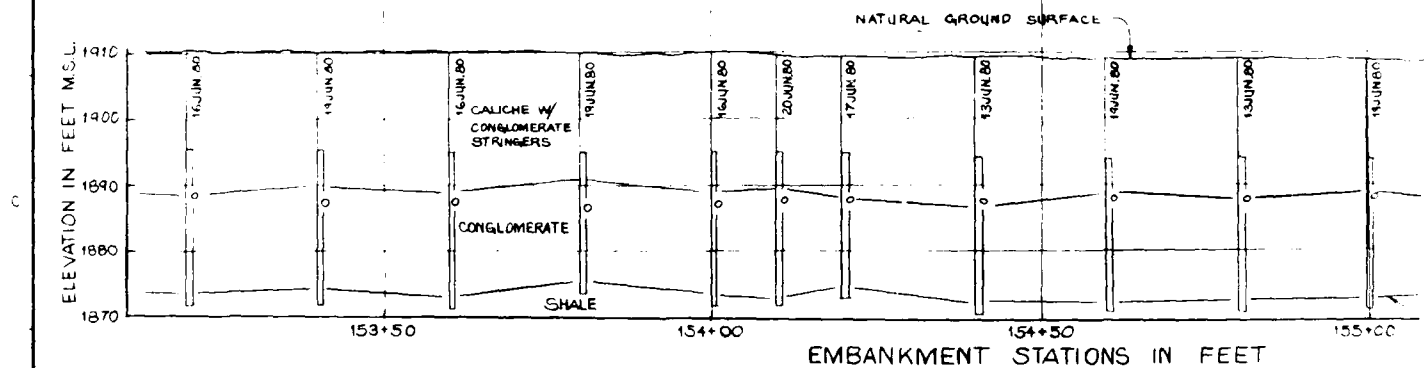
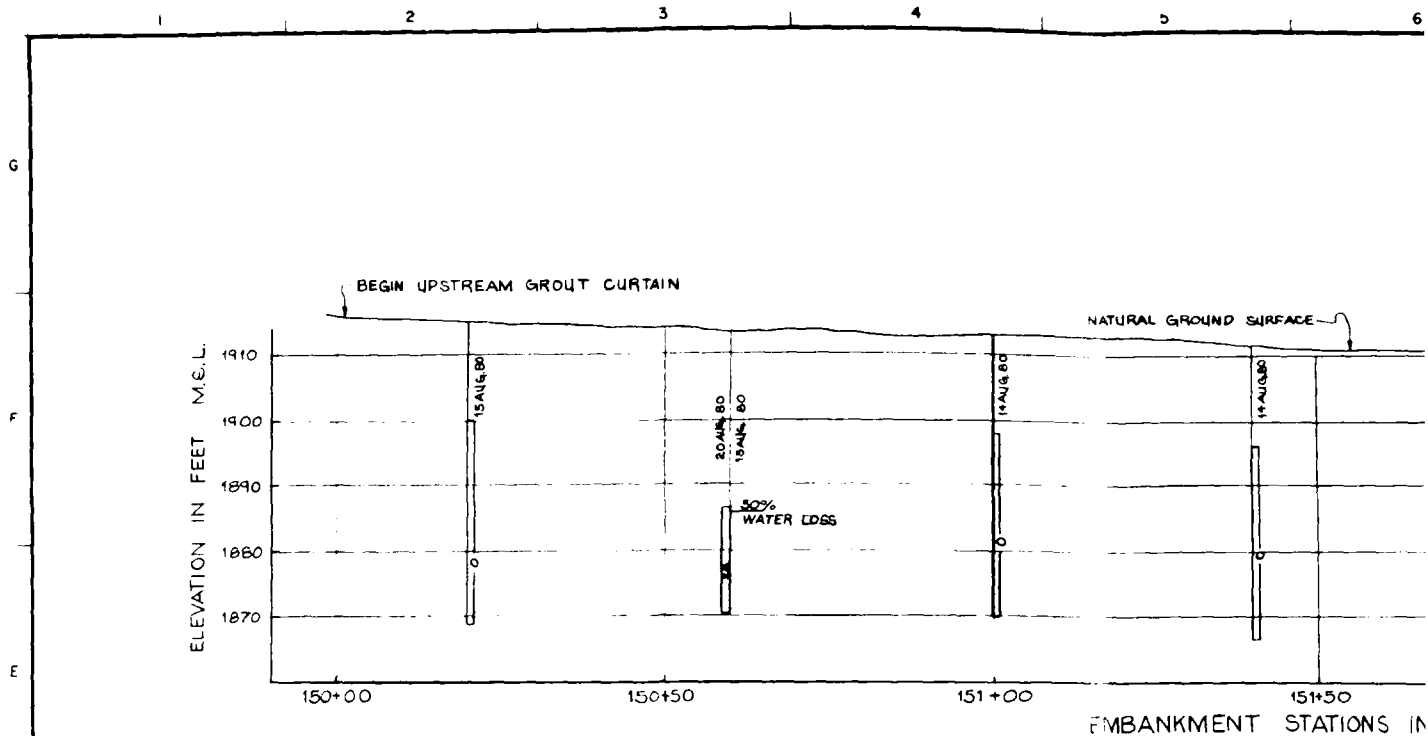
See sheet 23 for transfer into the main plan and

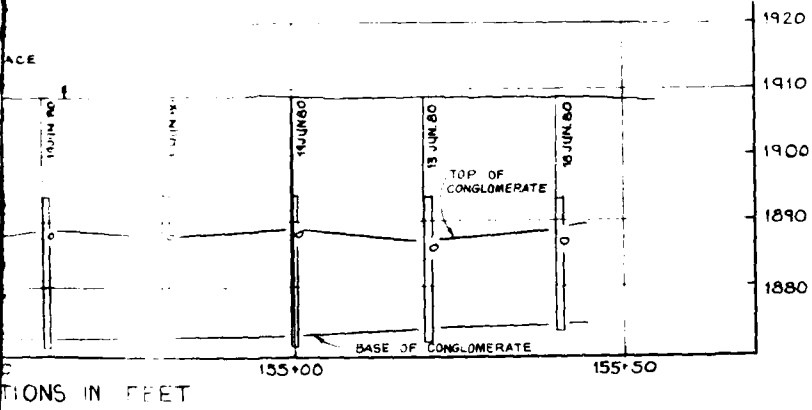
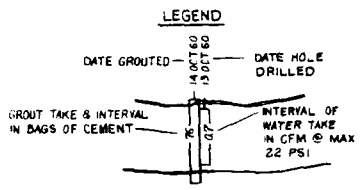
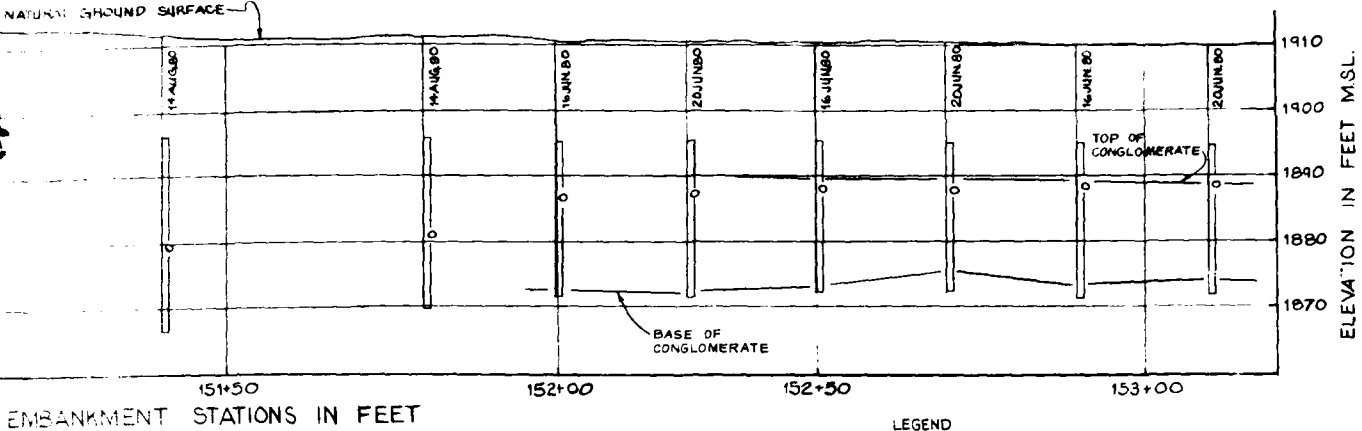
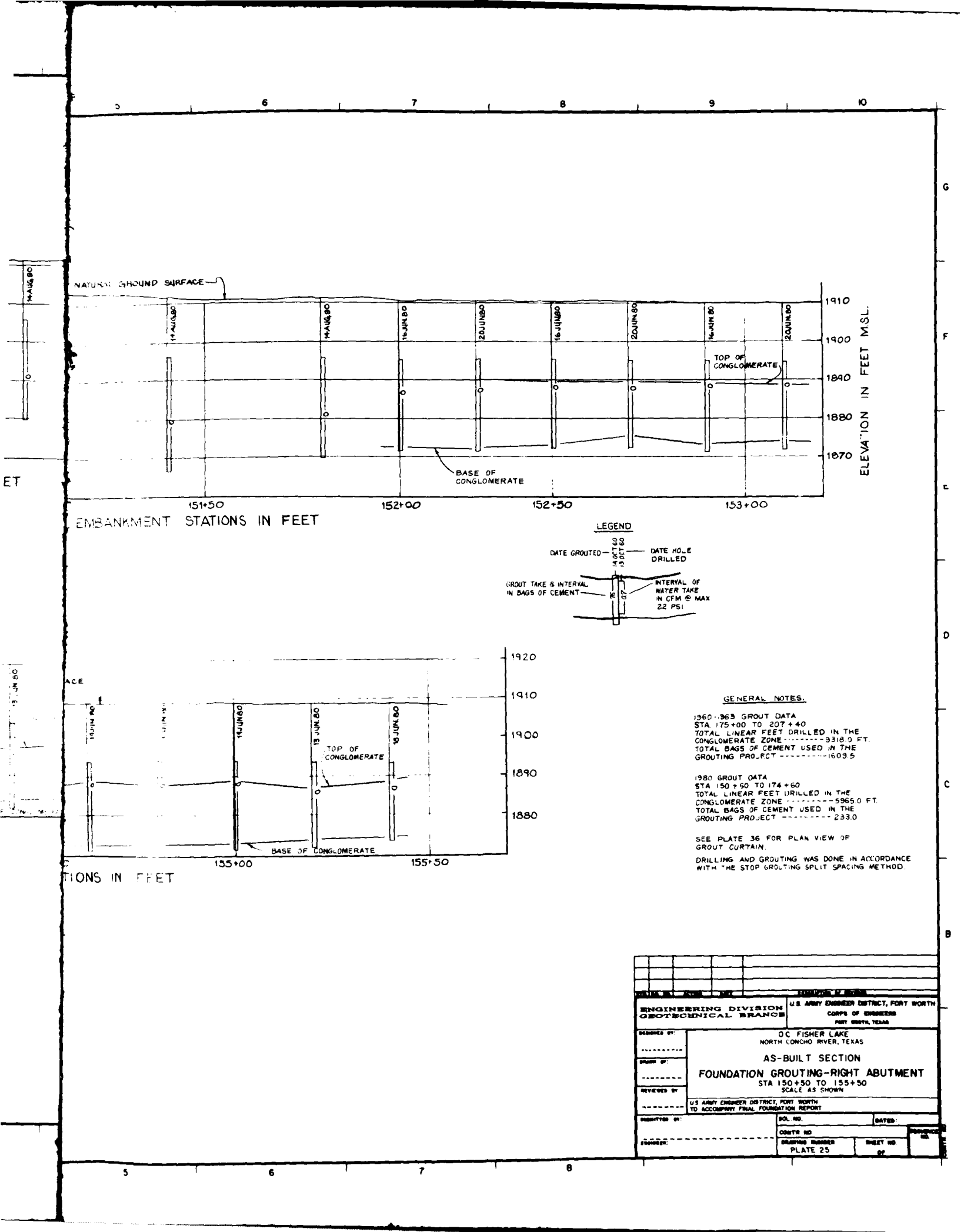


RIGHT ABUTMENT (B-2)
MAXIMUM NON-OVERFLOW SECTIONS
Scale 1" = 40'-0"

DEPARTMENT OF THE ARMY OFFICE OF THE DISTRICT ENGINEER SAN ANGELO DAM AND RESERVOIR NORTH CONCHO RIVER, TEXAS	
DRAWN BY: [Signature] CHECKED BY: [Signature] APPROVED BY: [Signature]	SPILLWAY PLAN AND ELEVATIONS
SCALE AS SHOWN 1" = 40'-0" SHEET NO. 23 OF 23	







GENERAL NOTES.

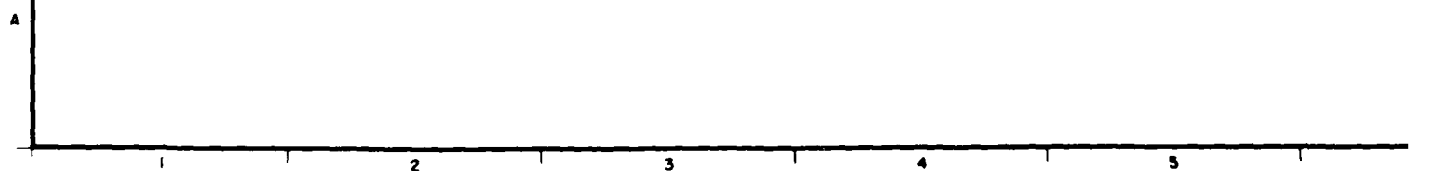
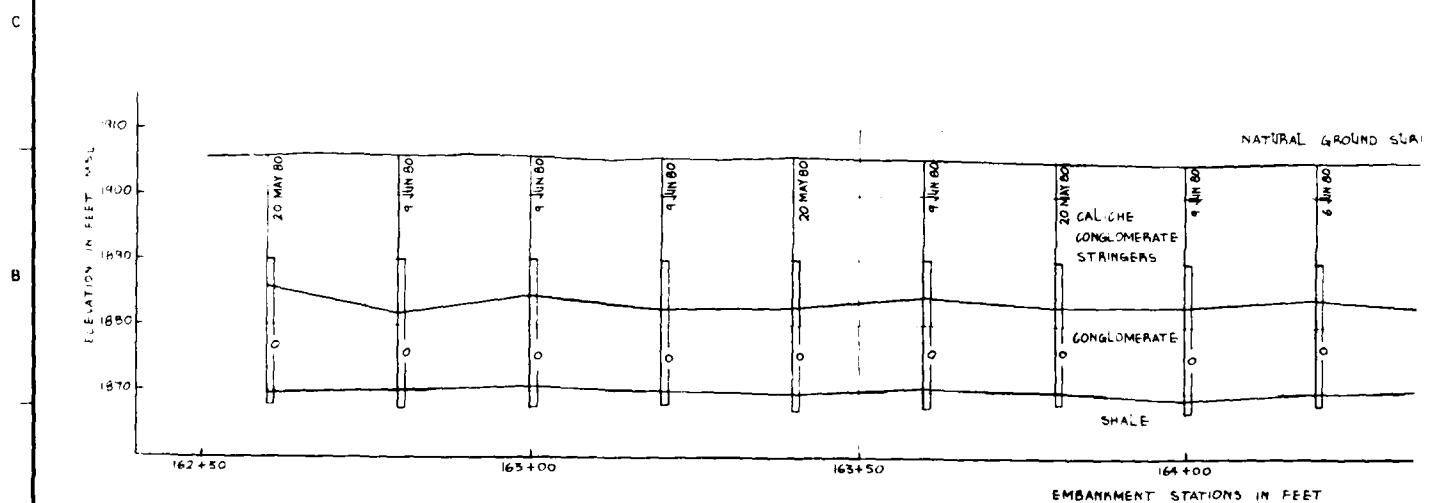
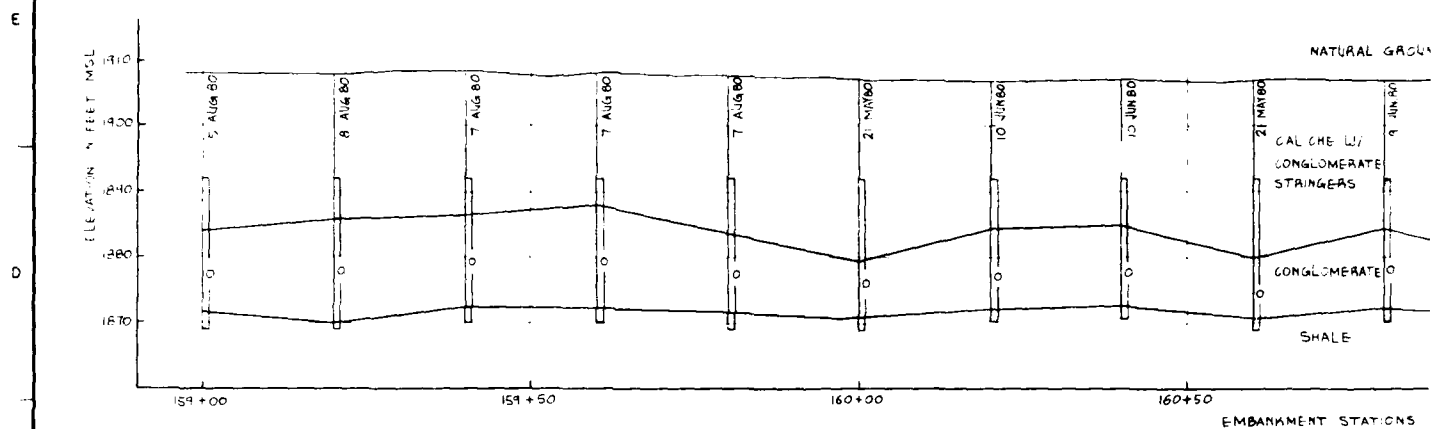
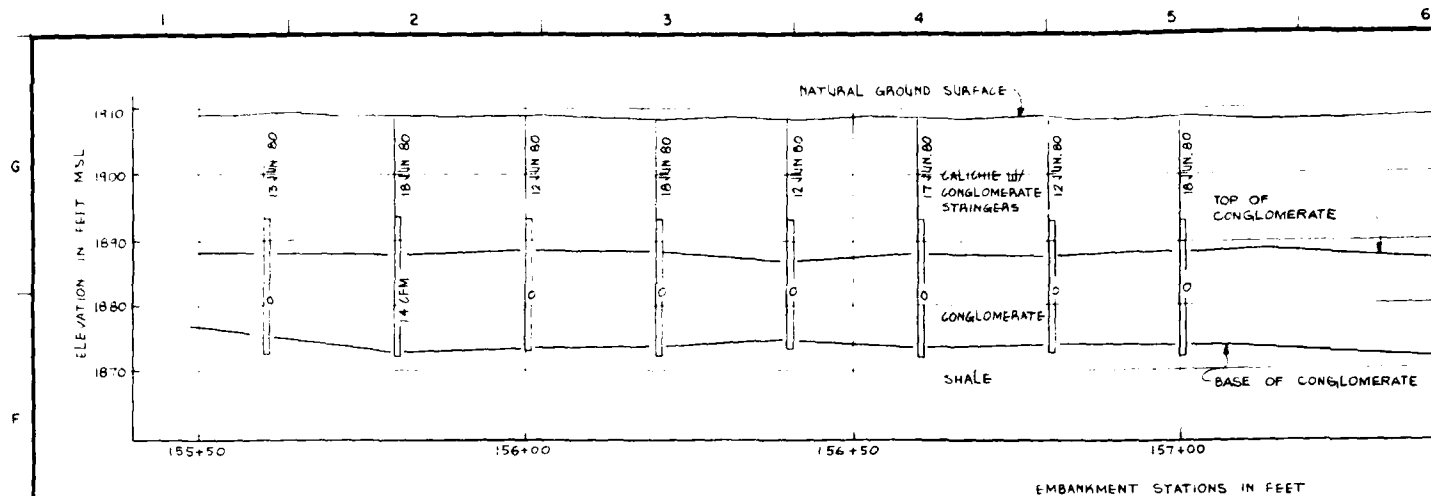
1960-1963 GROUT DATA
STA 175+00 TO 207+40
TOTAL LINEAR FEET DRILLED IN THE CONGLOMERATE ZONE -----9318.0 FT.
TOTAL BAGS OF CEMENT USED IN THE GROUTING PROJECT -----1603.5

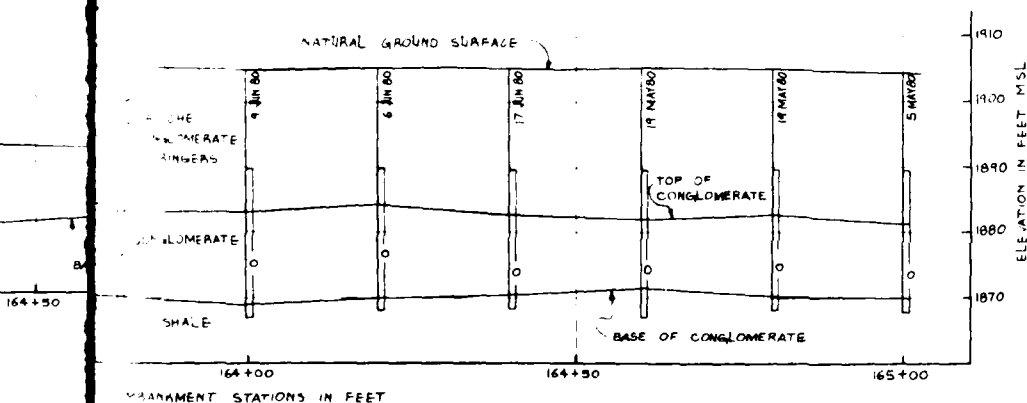
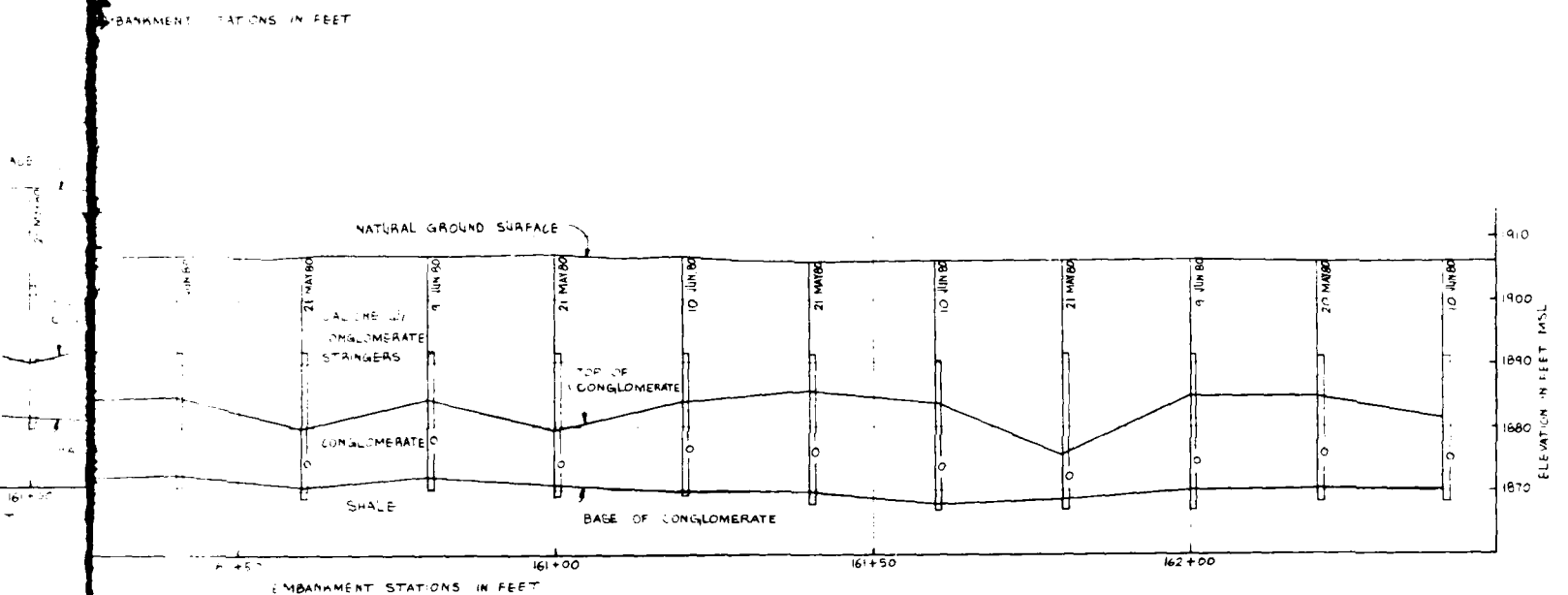
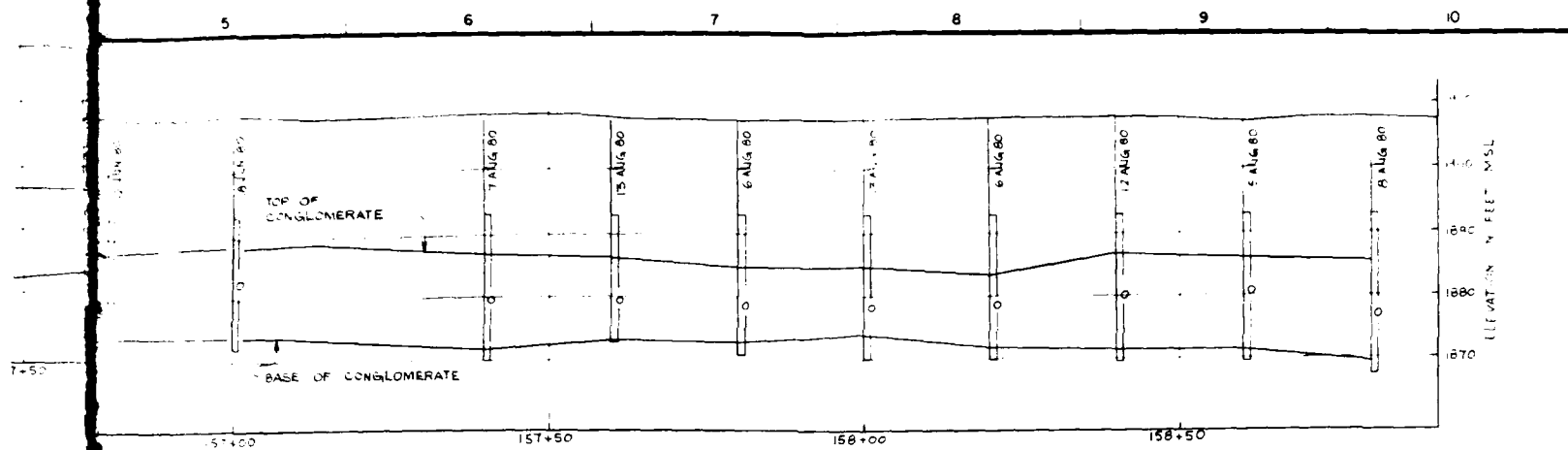
1980 GROUT DATA
STA 150+50 TO 174+60
TOTAL LINEAR FEET DRILLED IN THE CONGLOMERATE ZONE -----5965.0 FT.
TOTAL BAGS OF CEMENT USED IN THE GROUTING PROJECT -----233.0

SEE PLATE 36 FOR PLAN VIEW OF GROUT CURTAIN.

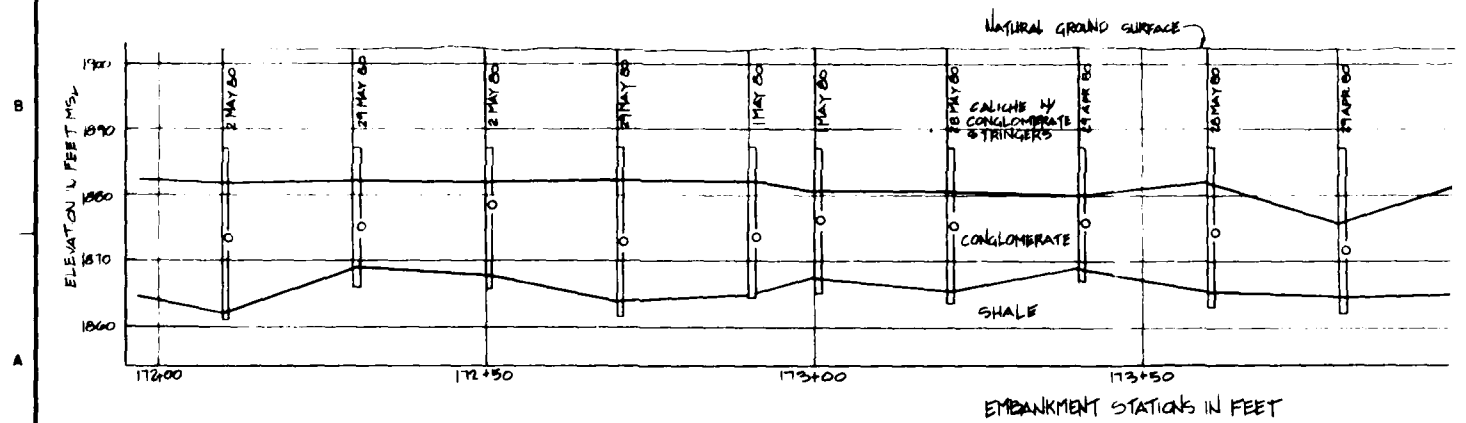
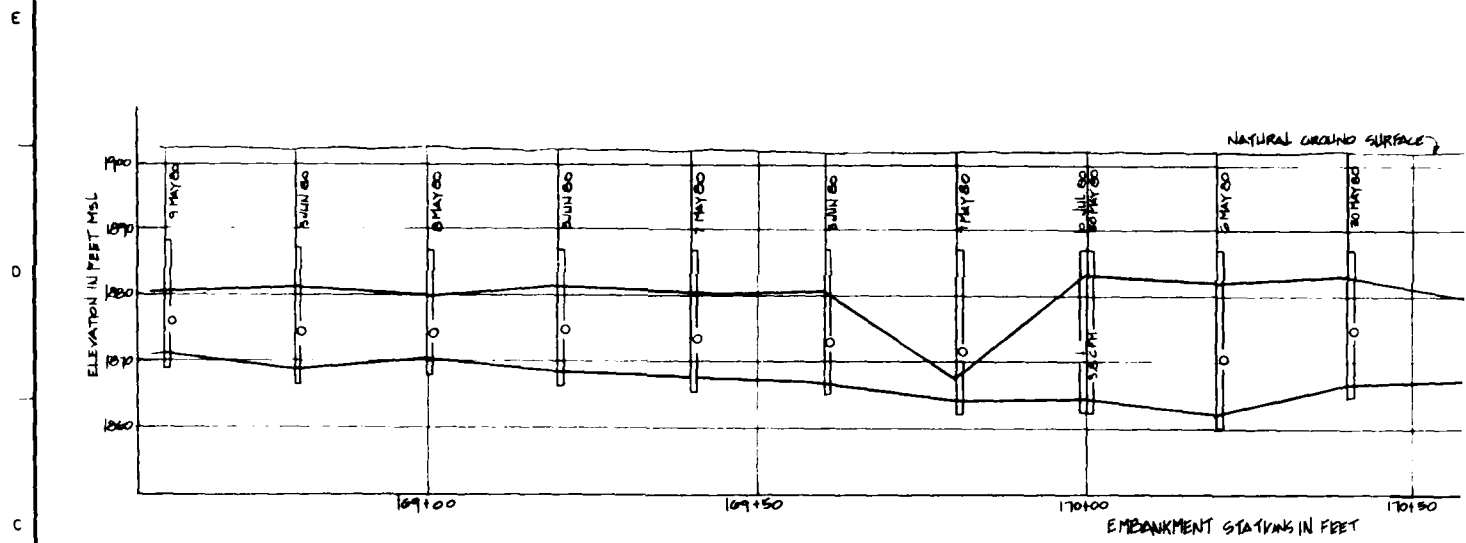
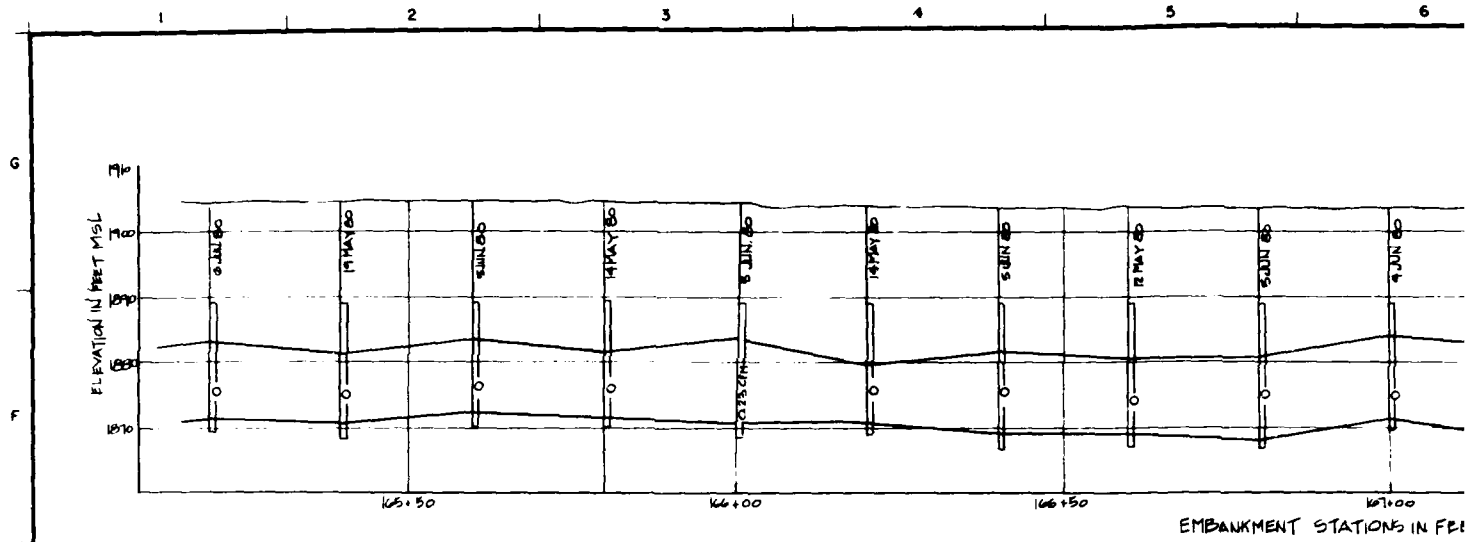
DRILLING AND GROUTING WAS DONE IN ACCORDANCE WITH THE STOP GROUTING SPLIT SPACING METHOD.

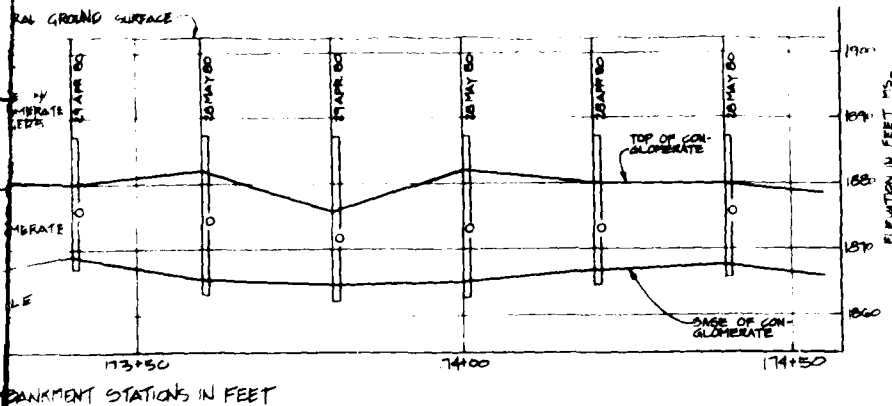
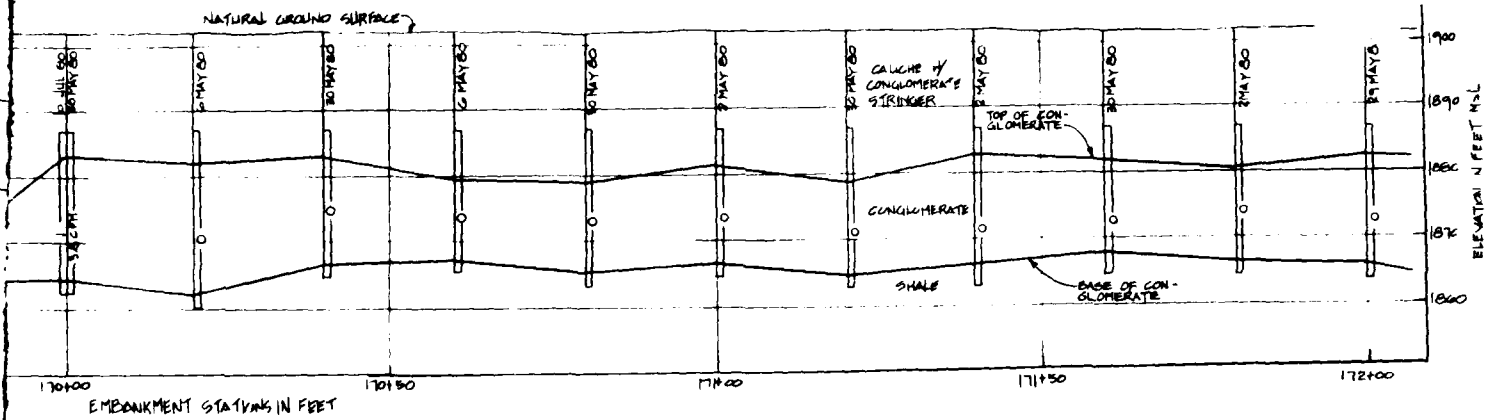
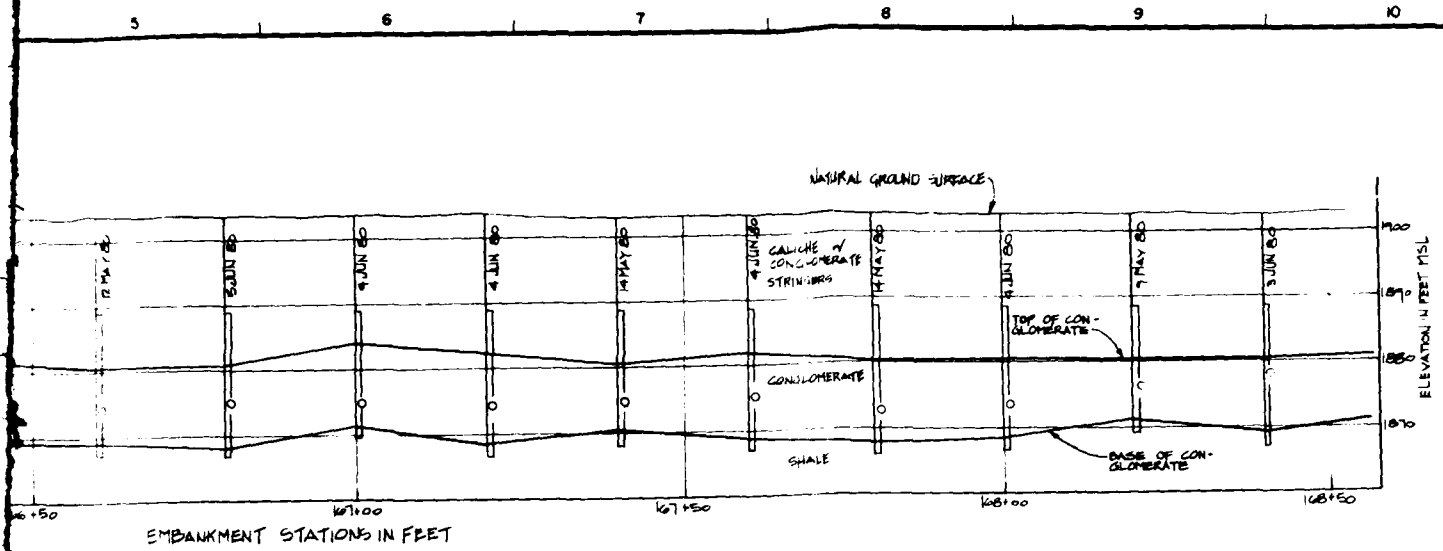
ENGINEERING DIVISION GEOTECHNICAL BRANCH		U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
DESIGNED BY: O.C. FISHER LAKE NORTH CONCHO RIVER, TEXAS		DRAWN BY: AS-BUILT SECTION	
CHECKED BY: FOUNDATION GROUTING-RIGHT ABUTMENT		REVIEWED BY: STA 150+50 TO 155+50	
SCALE AS SHOWN		U.S. ARMY ENGINEER DISTRICT, FORT WORTH TO ACCOMPANY FINAL FOUNDATION REPORT	
PRINTED BY:	SOL. NO.	DATED:	
CONTR. NO.	DESIGN NUMBER	SHEET NO.	BY
PLATE 25			



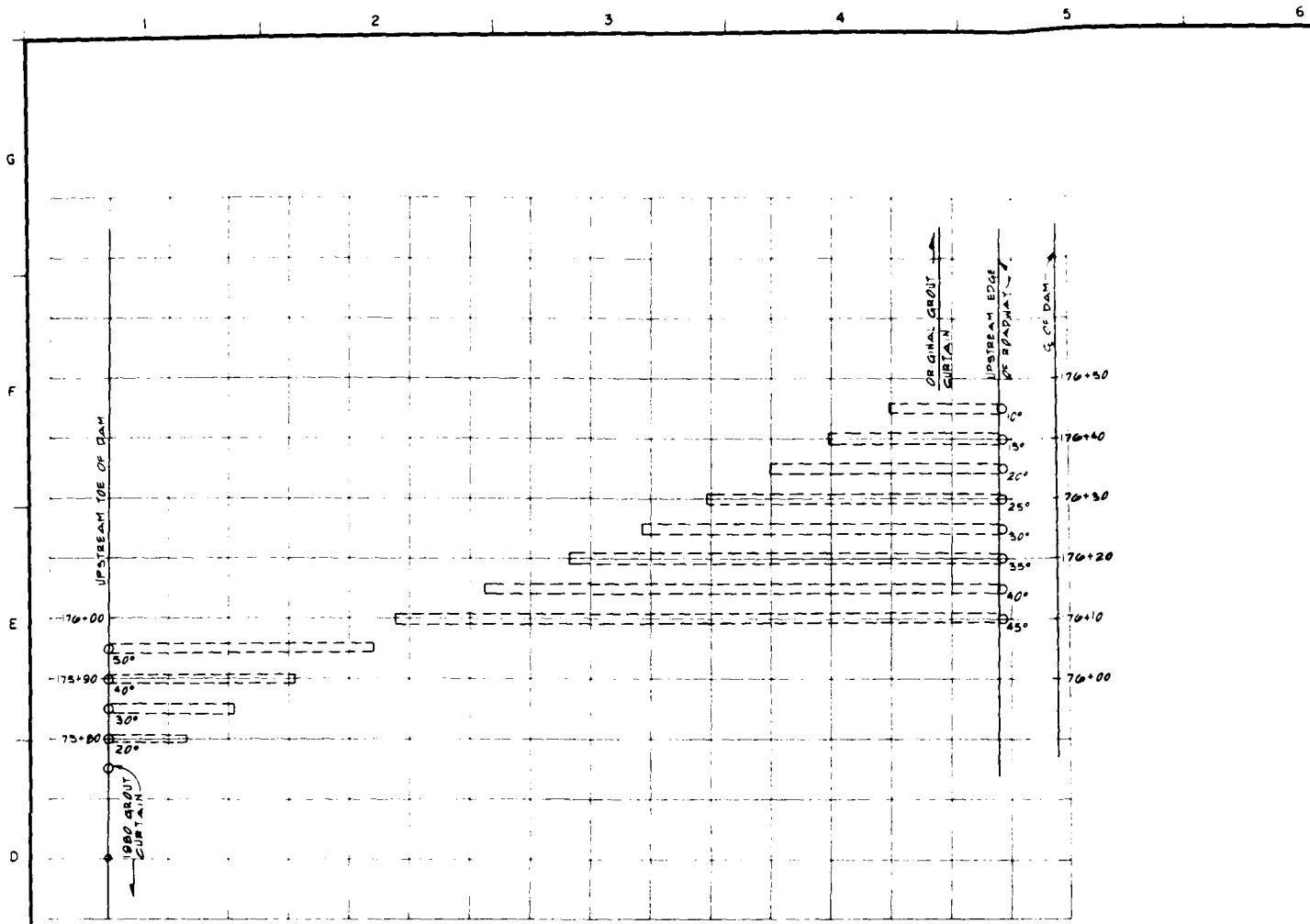


ENGINEERING DIVISION GEOTECHNICAL BRANCH		U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
DESIGNED BY	O.C. FISHER LAFAYETTE NORTH CONCHO RIVER, TEXAS		
DRAWN BY	AS-BUILT SECTION		
REVIEWED BY	FOUNDATION GROUTING - RIGHT ABUTMENT		
STA. 155+50 TO 165+50 SCALE AS SHOWN			
U.S. ARMY ENGINEER DISTRICT, FORT WORTH TO ACCOMPANY FINAL FOUNDATION REPORT			
SUBMITTED BY	COL. NO.	DATED:	
CONTR. NO.	DRAWING NUMBER		SHEET NO.
PLATE 26		BY	

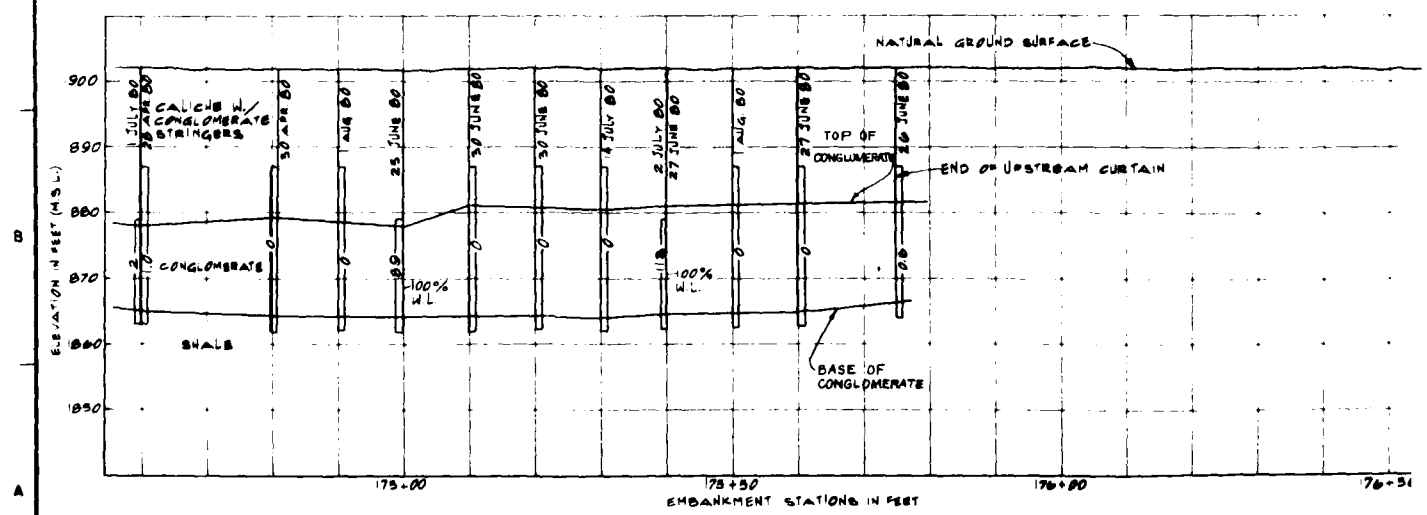


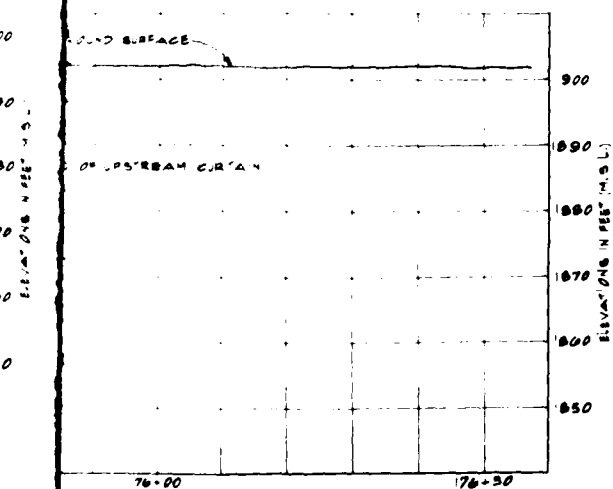


ENGINEERING DIVISION GEOTECHNICAL BRANCH		U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
DESIGNED BY:	O.C. FISHER LAKE NORTH CONCHO RIVER, TEXAS		
DRAWN BY:	AS-BUILT SECTION		
REVIEWED BY:	FOUNDATION GROUTING-RIGHT ABUTMENT		
U.S. ARMY ENGINEER DISTRICT, FORT WORTH TO ACCOMPANY FINAL FOUNDATION REPORT		STA 165+50 TO 174+50	SCALE AS SHOWN
SUBMITTED BY:	BOL. NO.	DATED:	
CONTR. NO.	DRAWING NUMBER	SHEET NO.	
PLATE 27		82	



PLAN VIEW





<table border="1"> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> </table>																																																																																																						REVISIONS BY: <u> </u> NO. <u> </u> DATE <u> </u>	
ENGINEERING DIVISION GEOTECHNICAL BRANCH		U.S. ARMY ENGINEER DISTRICT, FORT CORPS OF ENGINEERS POST OFFICE, TEXAS																																																																																																					
DESIGNED BY: <u> </u> CHECKED BY: <u> </u> REVIEWED BY: <u> </u>	O. C. FISHER LAKE NORTH CONCHO RIVER, TEXAS AS-BUILT SECTION FOUNDATION GROUTING—RIGHT ABUTMENT STA. 174+50 TO 176+50 SCALE AS SHOWN																																																																																																						
U.S. ARMY ENGINEER DISTRICT, FORT WORTH TO ACCOMPANY FINAL FOUNDATION REPORT																																																																																																							
SUBMITTER OF: <u> </u> COMMENTS: <u> </u>	SOL. NO. <u> </u> CONSTR. NO. <u> </u> DRAWING NUMBER PAGE 28		DATED: <u> </u> SHEET NO. OF <u> </u>																																																																																																				

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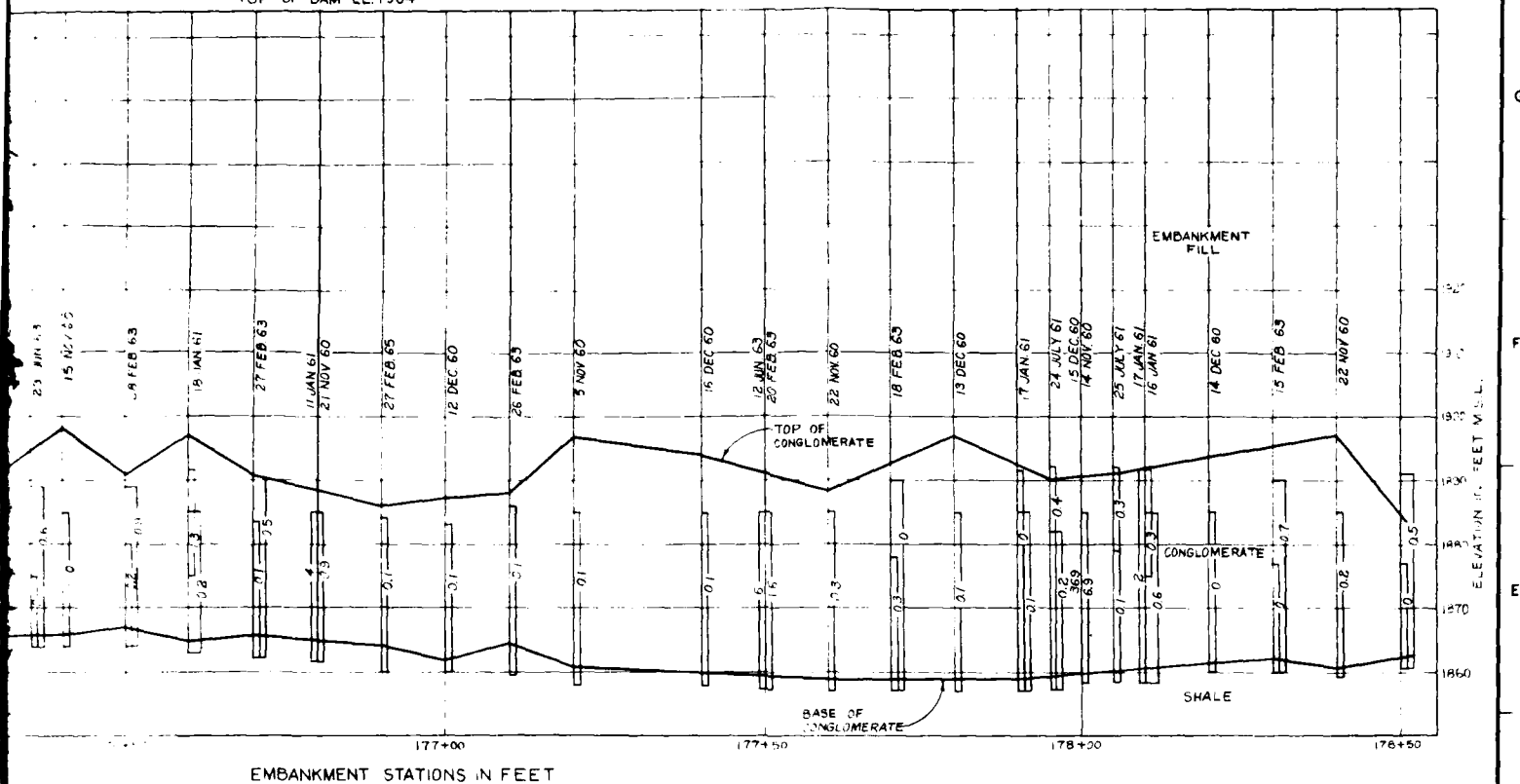
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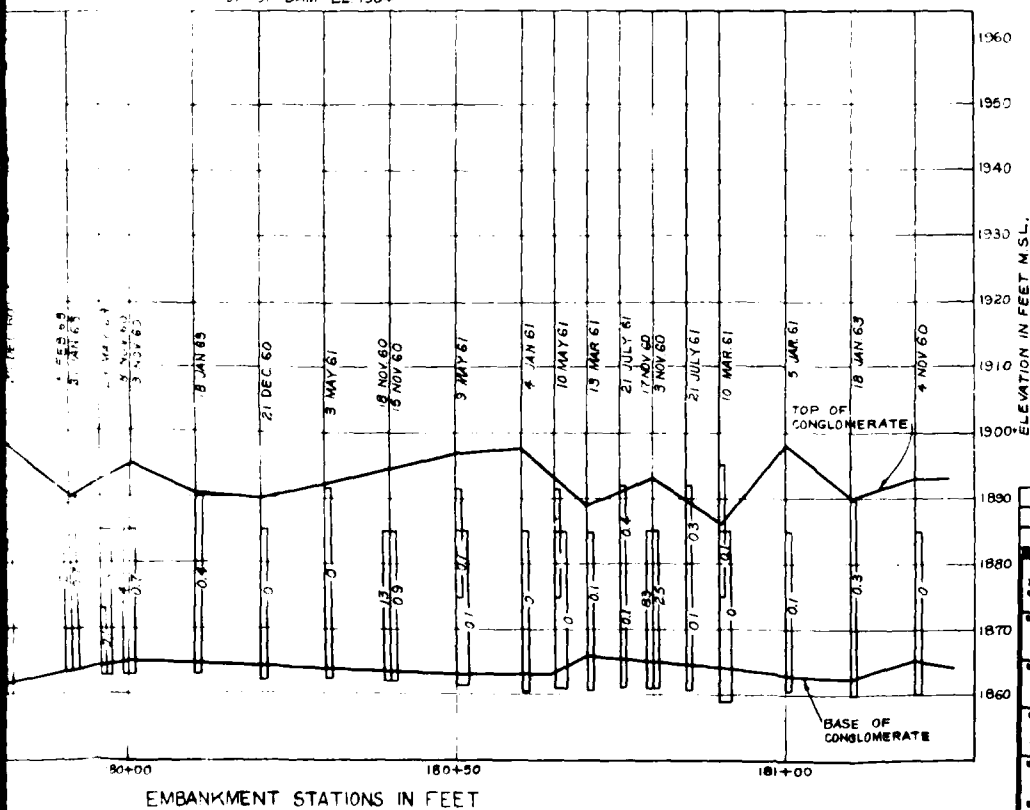
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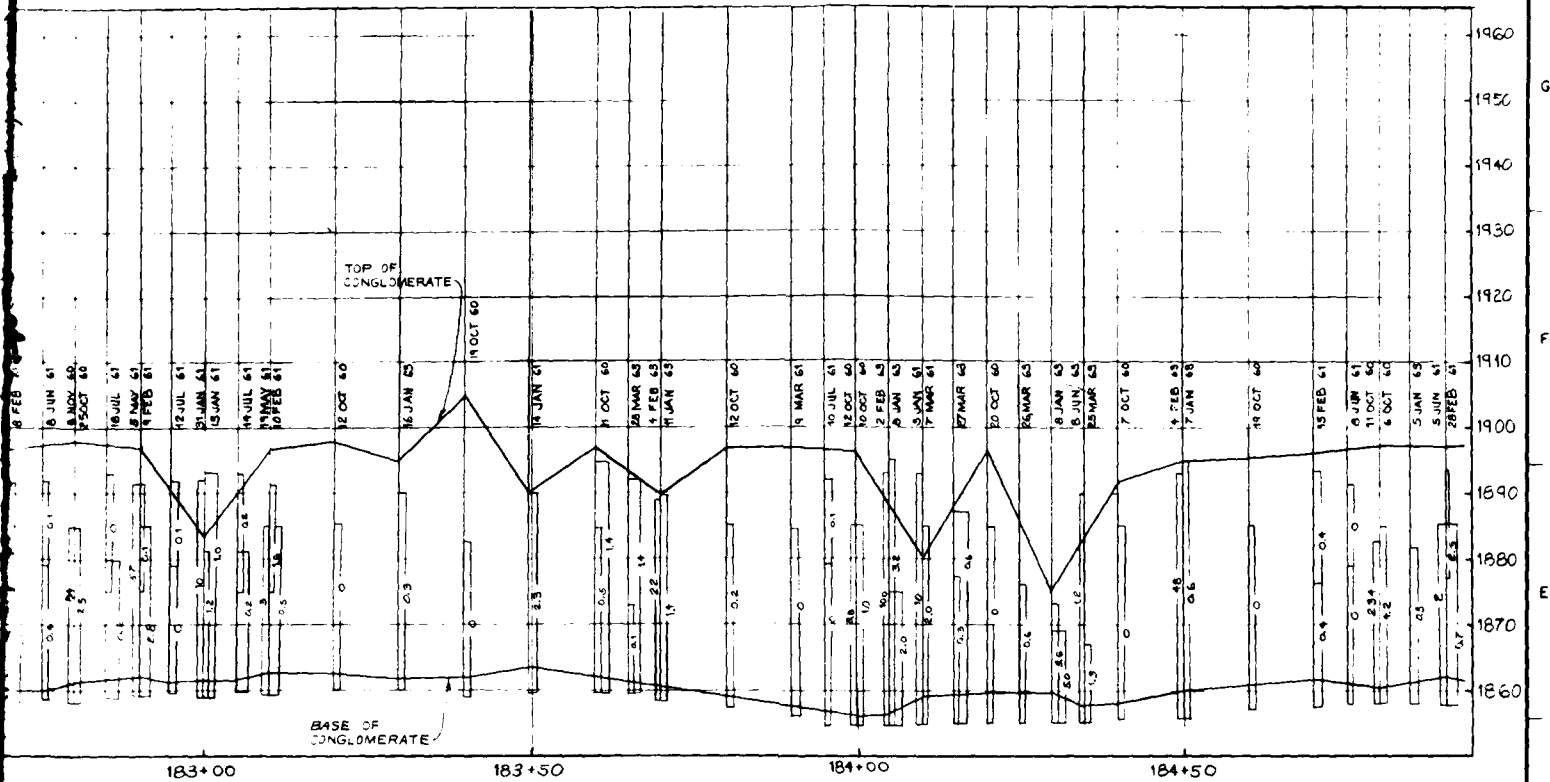
TOP OF DAM-EL. 1964



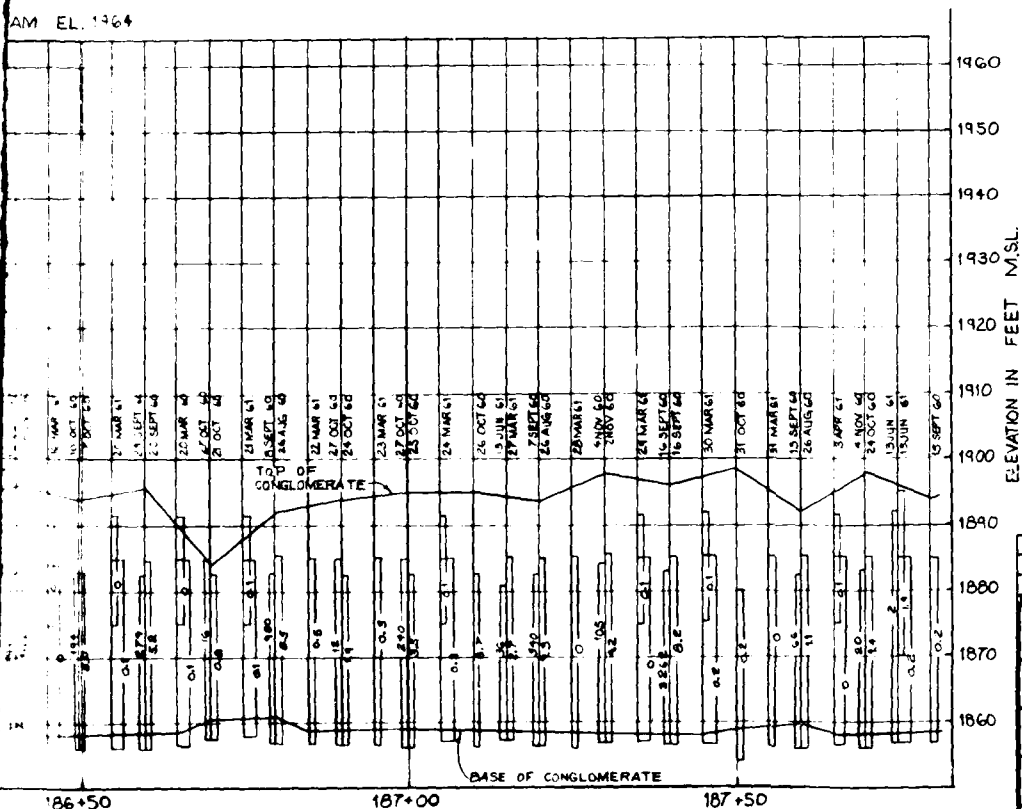
TOP OF DAM-EL. 1964



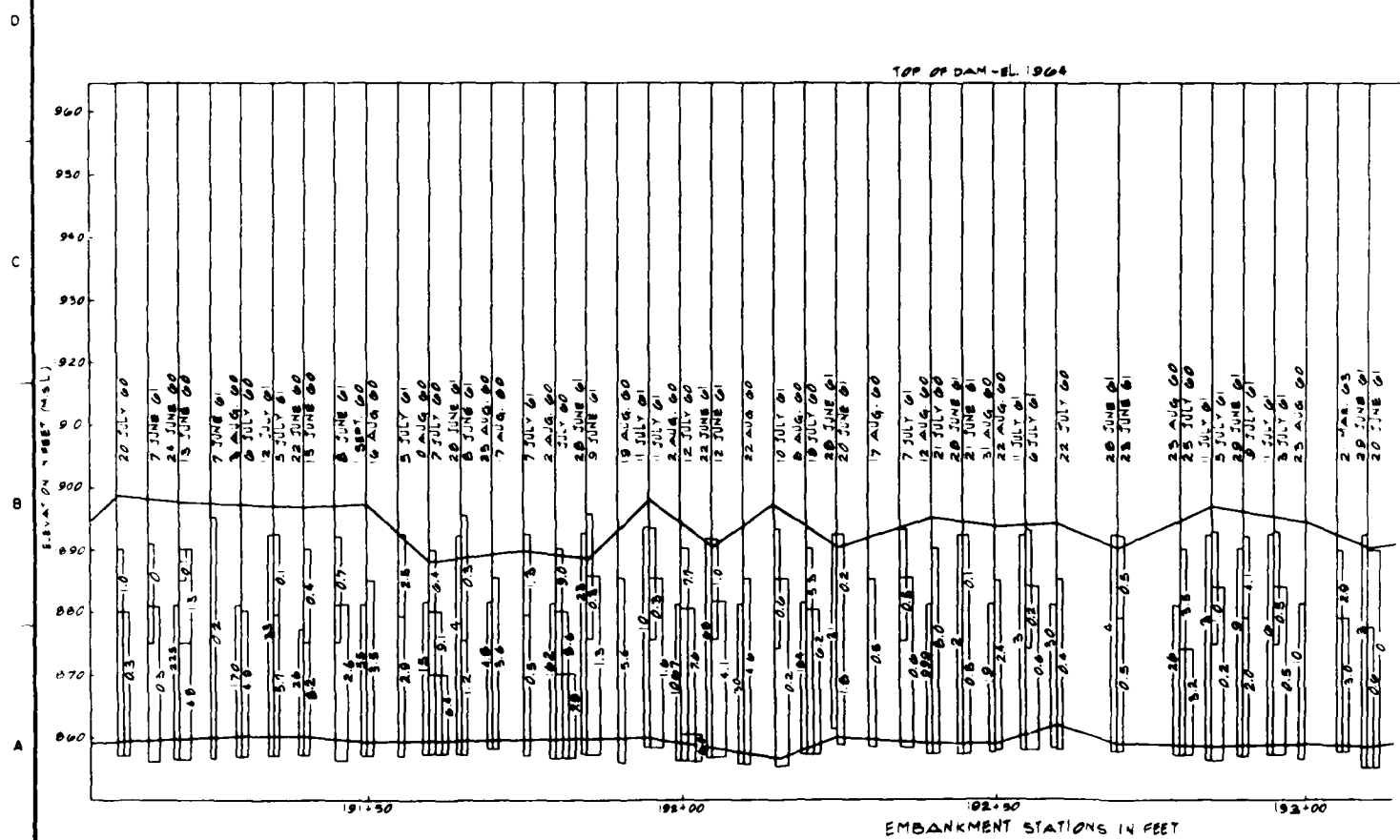
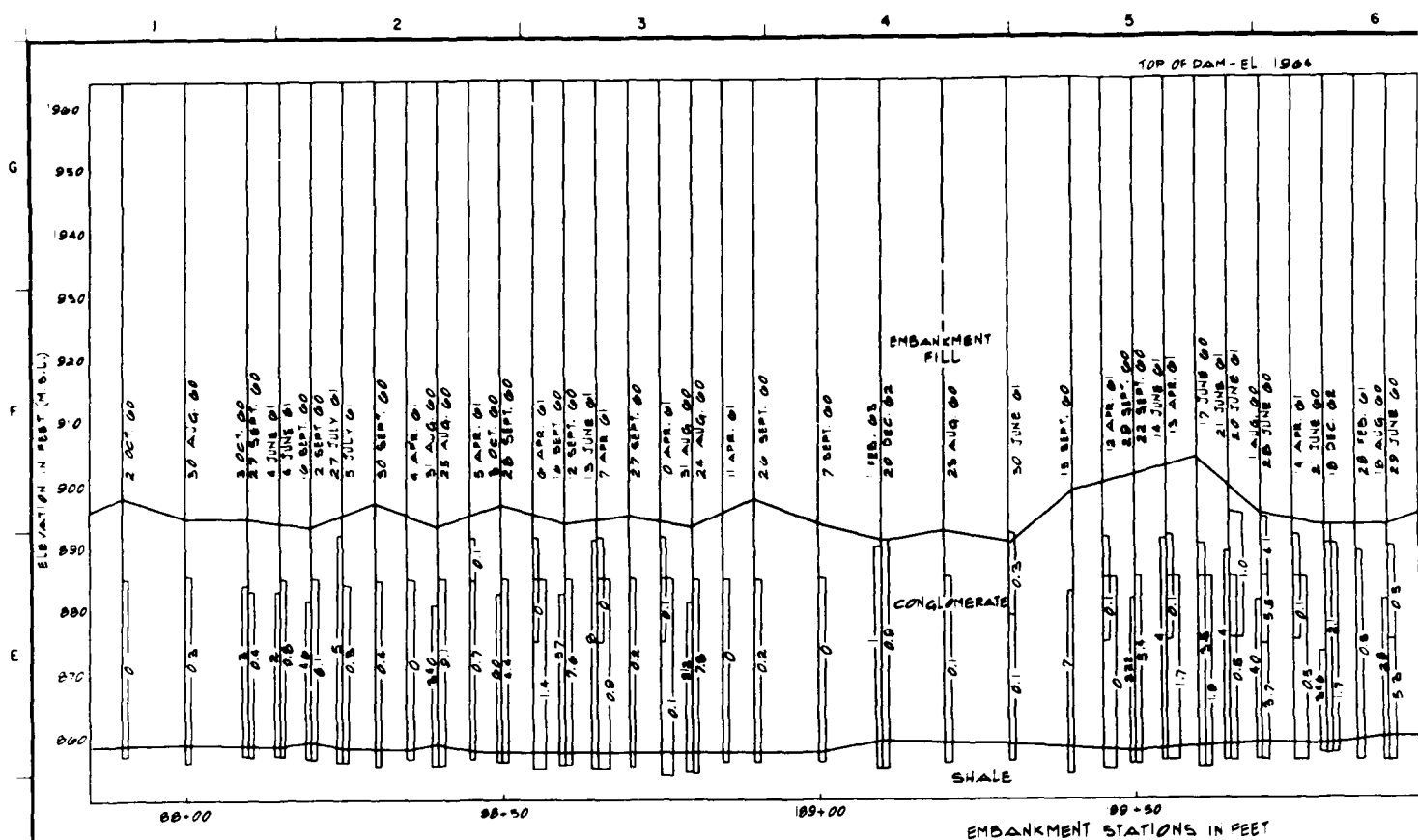
ENGINEERING DIVISION GEOTECHNICAL BRANCH		U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
DESIGNED BY:		O.C. FISHER LAKE	
DRAWN BY:		NORTH CONCHO RIVER, TEXAS	
CHECKED BY:		AS-BUILT SECTION	
REVIEWED BY:		FOUNDATION GROUTING-RIGHT ABUTMENT	
APPROVED BY:		STA 176+50 TO 181+50	
U.S. ARMY ENGINEER DISTRICT, FORT WORTH TO ACCOMPANY FINAL FOUNDATION REPORT		SCALE AS SHOWN	
DATE:	SOL. NO.	DATE:	SOL. NO.
DATE:	CONTR. NO.	DATE:	CONTR. NO.
DATE:	PLATE 29	DATE:	PLATE 29

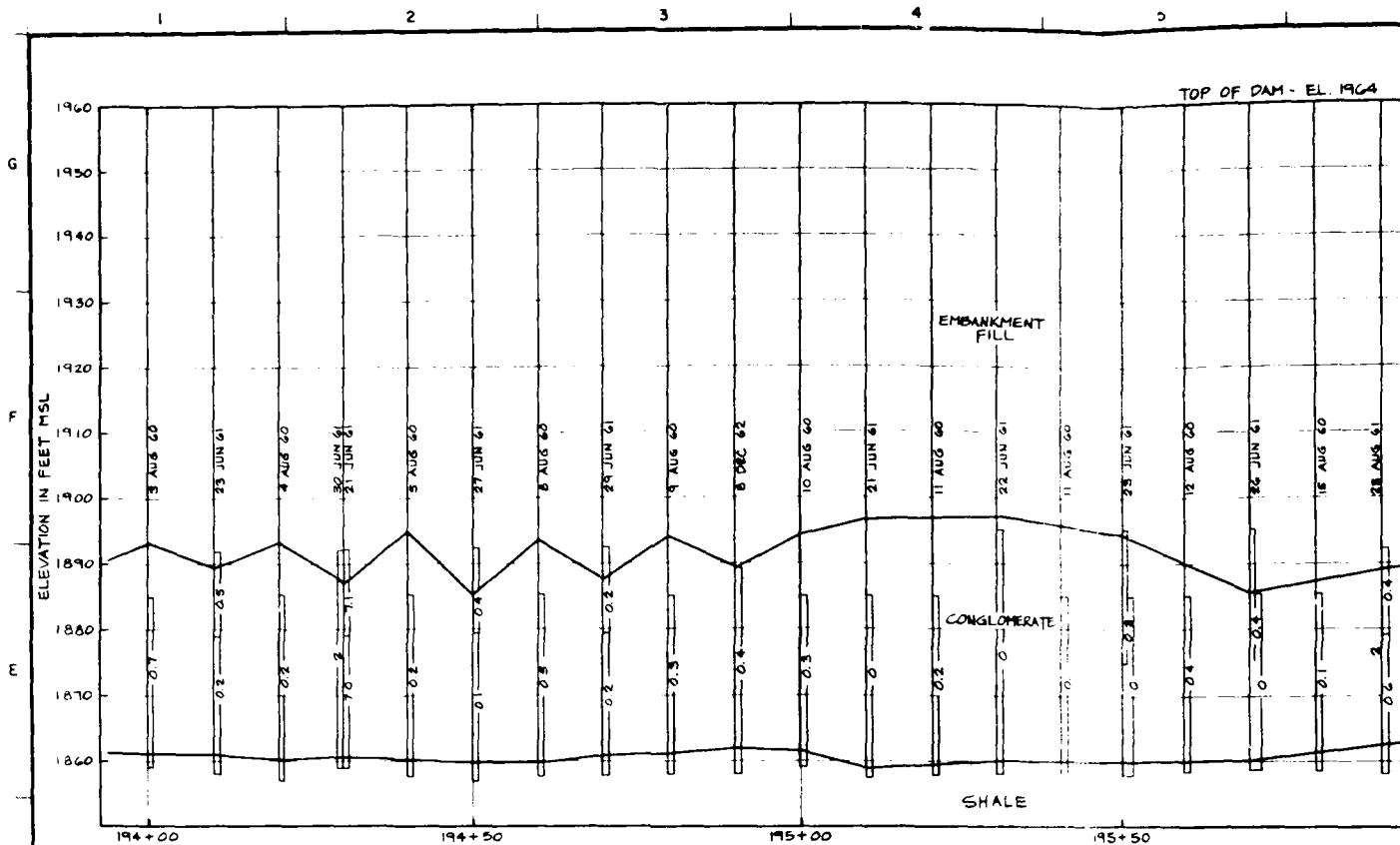


AM EL. 1964

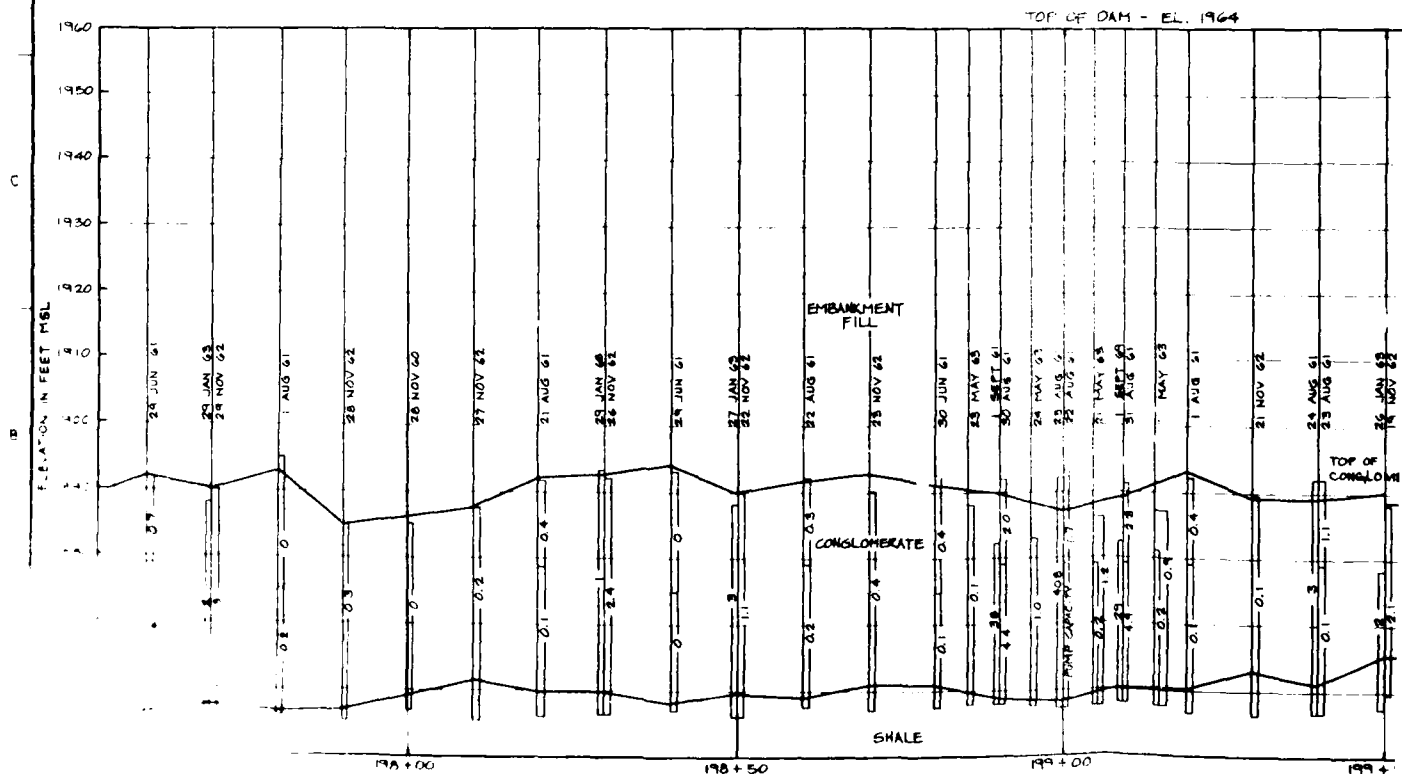


ENGINEERING DIVISION GEOTECHNICAL BRANCH		U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
DESIGNED BY: ----- DRAWN BY: ----- REVIEWED BY: -----	DC FISHER LAKE NORTH CONCHO RIVER, TEXAS AS-BUILT SECTION FOUNDATION GROUTING-RIGHT ABUTMENT STA 181+50 TO 187+50 SCALE AS SHOWN		
U.S. ARMY ENGINEER DISTRICT, FORT WORTH TO ACCOMPANY FINAL FOUNDATION REPORT			
SUBMITTED BY: ----- ENGINEER:	SOL. NO. CONTN. NO. DRAWING NUMBER PLATE 30	DATED: SHEET NO. OF	NO.

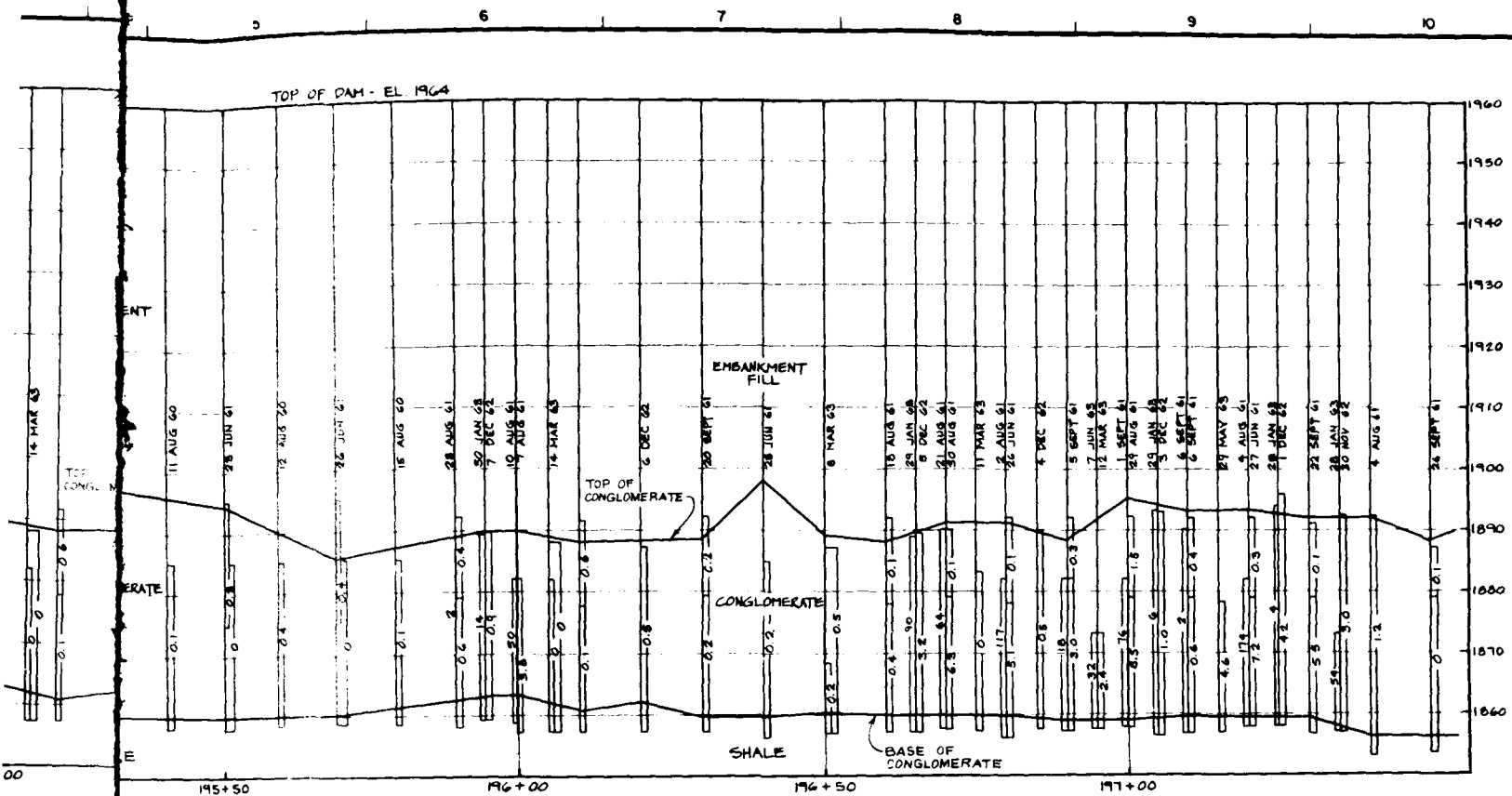




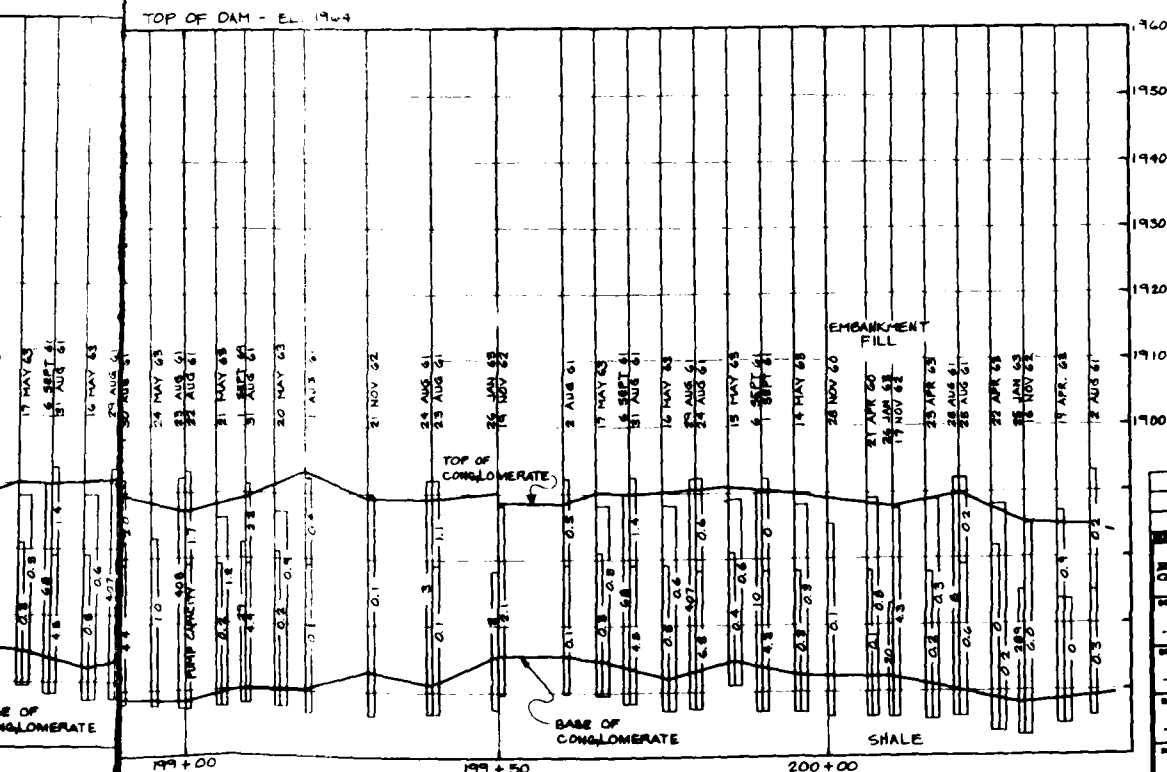
EMBANKMENT STATION IN



EMBANKMENT STATIONS IN FEET



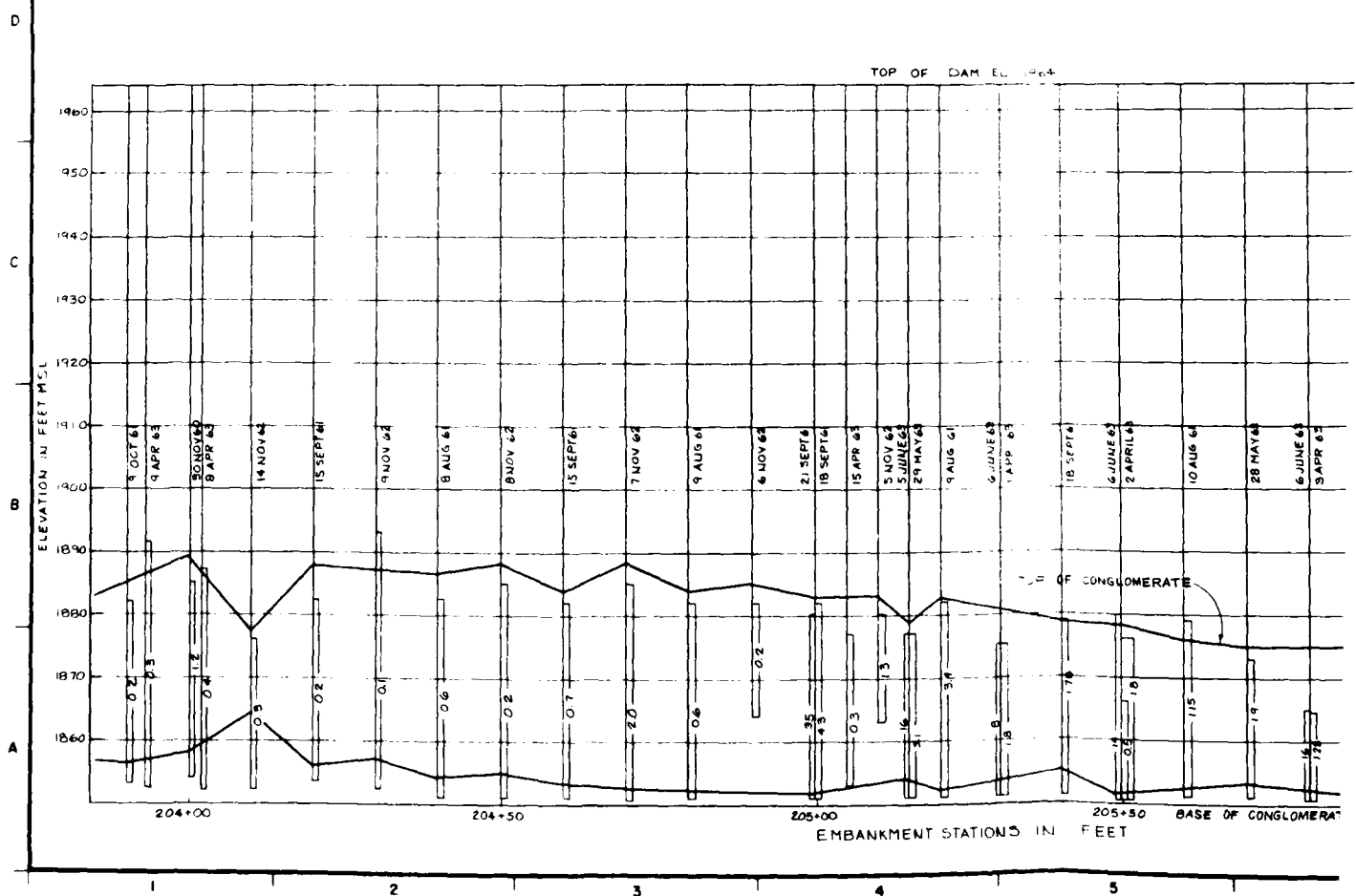
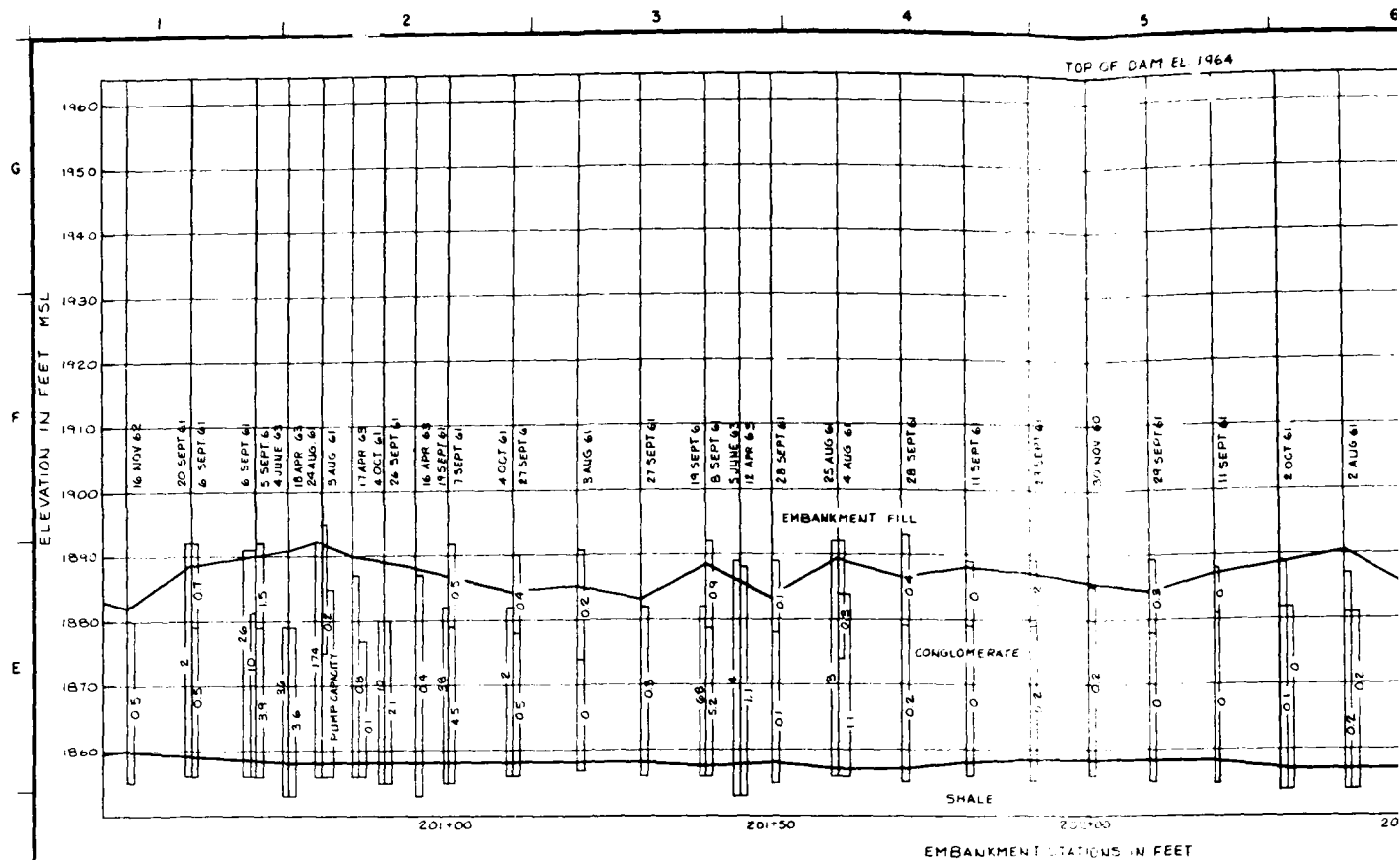
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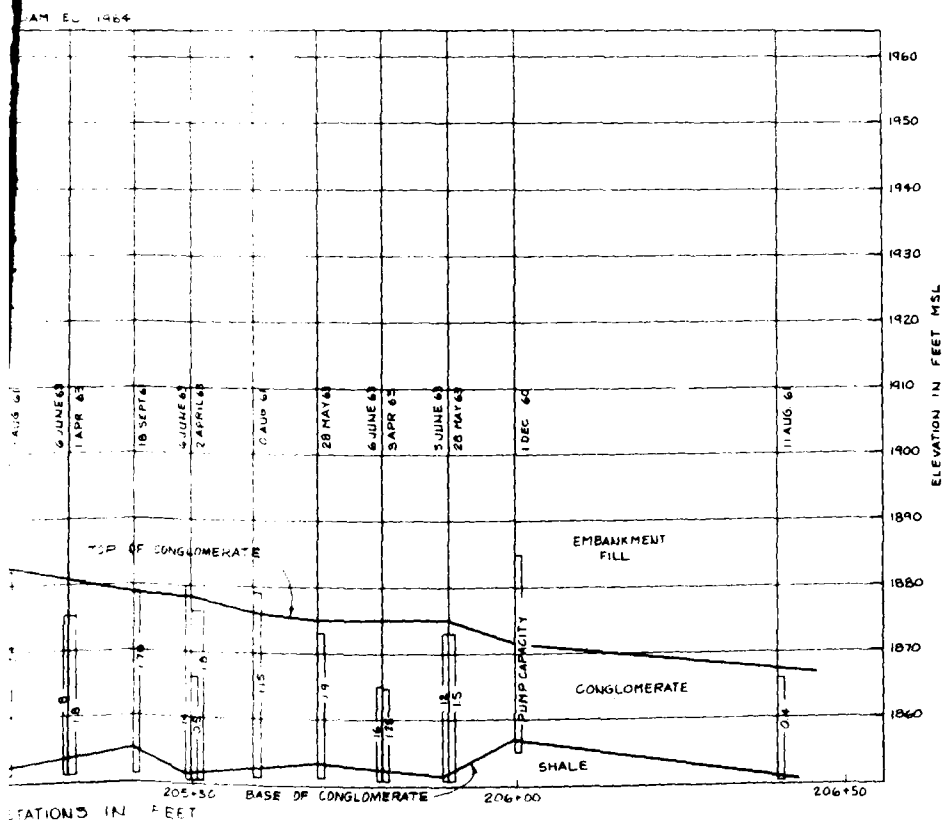
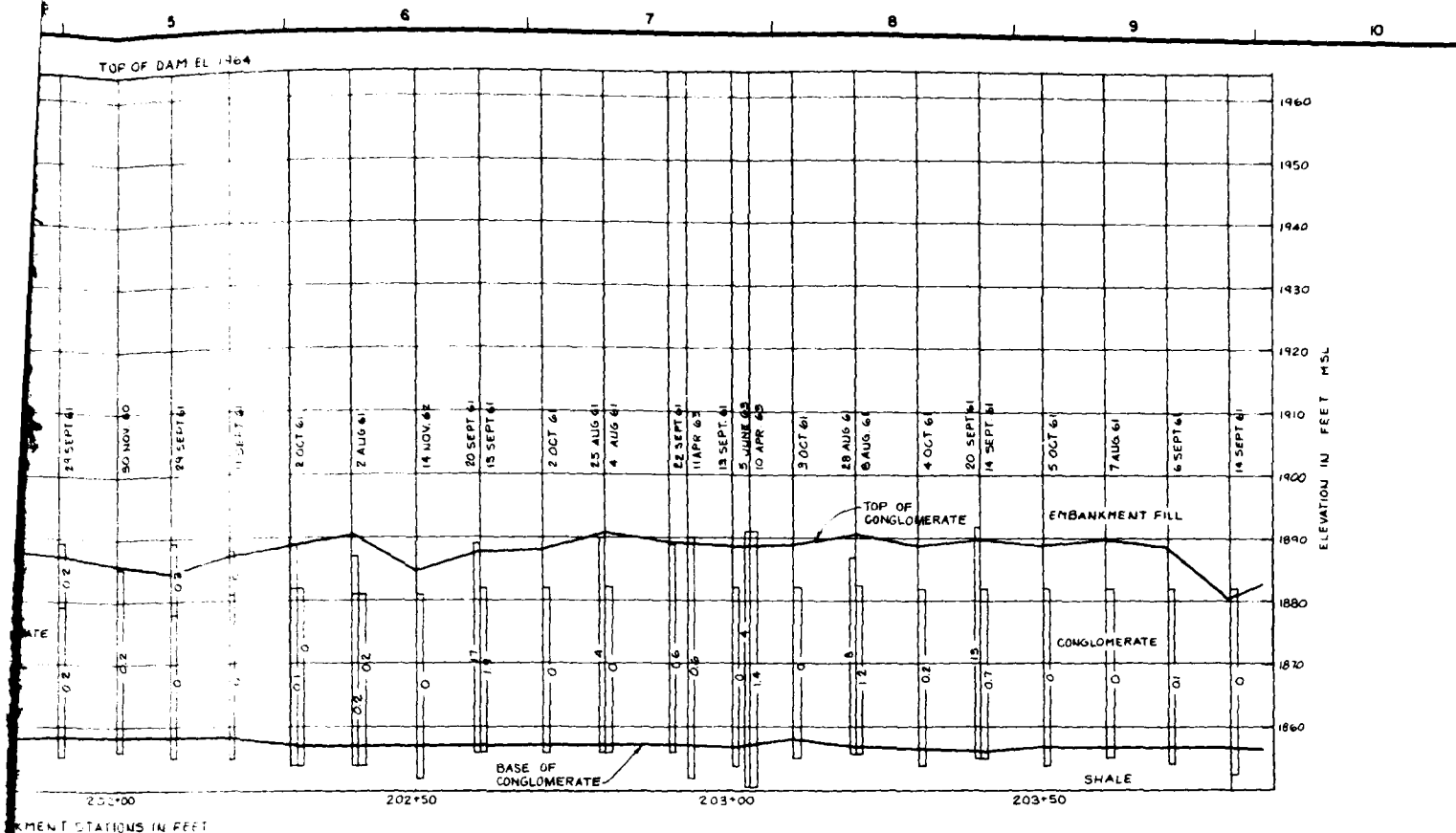


ELEVATION IN FEET MSL

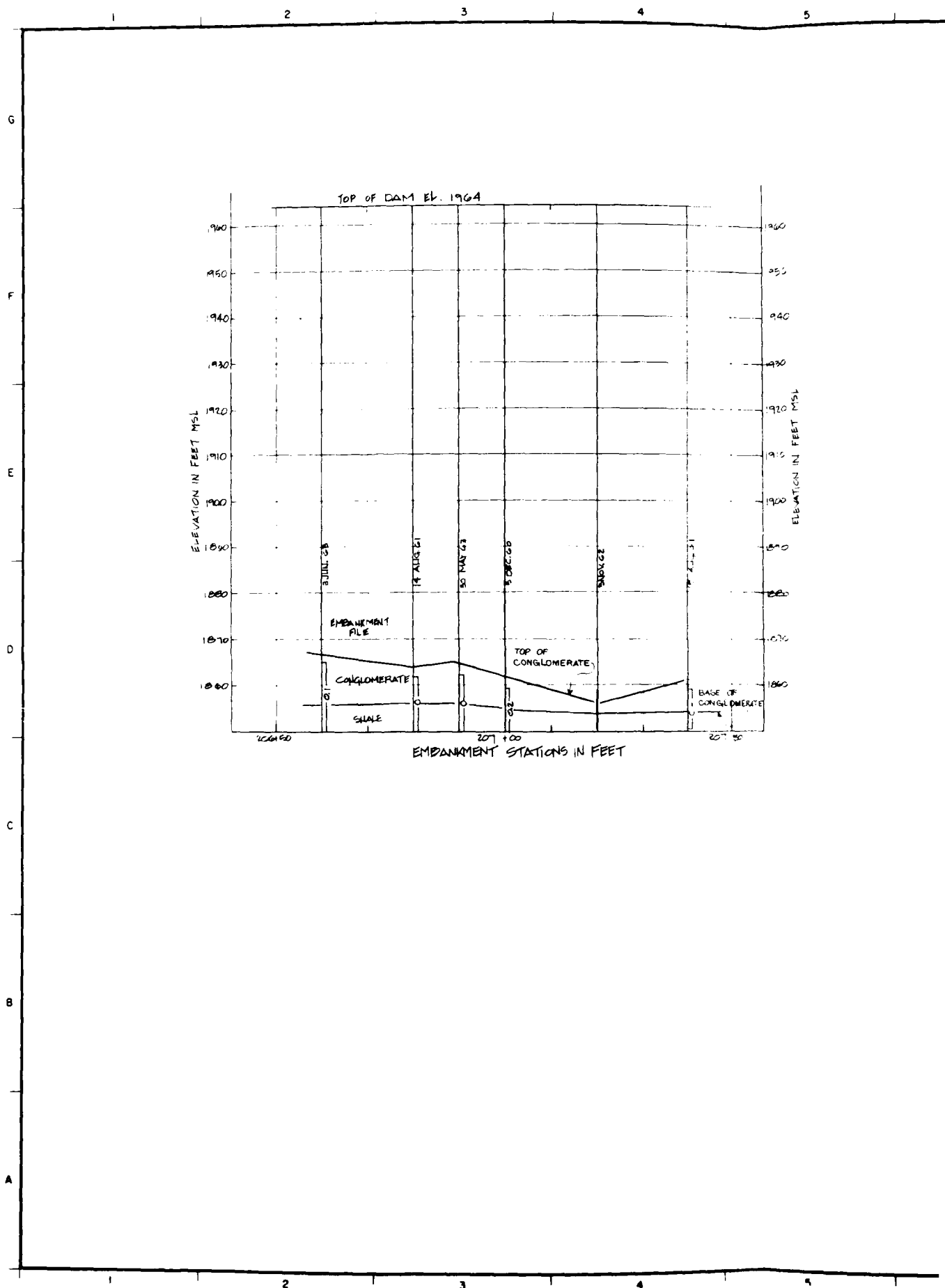
STATIONS IN FEET

ENGINEERING DIVISION GEOTECHNICAL BRANCH		U.S. ARMY ENGINEER DISTRICT, FORT CORPS OF ENGINEERS FORT WORTH, TEXAS	
DESIGNED BY:		O.C. FISHER LAKE	
DRAWN BY:		NORTH CONCHO RIVER, TEXAS	
REVIEWED BY:		AS-BUILT SECTION	
APPROVED BY:		FOUNDATION GROUTING-RIGHT ABUTMENT	
U.S. ARMY ENGINEER DISTRICT, FORT WORTH TO ACCOMPANY FINAL FOUNDATION REPORT		STA 194+00 TO 200+50 SCALE AS SHOWN	
PROJECT NO.:	DATE:	CONTR. NO.	SHEET NO.
PLATE 32			





ENGINEERING DIVISION GEOTECHNICAL BRANCH		U.S. ARMY ENGINEER DISTRICT, FORT CORPS OF ENGINEERS FORT WORTH, TEXAS	
DESIGNED BY:		O.C. FISHER LAKE NORTH CONCHO RIVER, TEXAS	
DRAWN BY:		AS-BUILT SECTION	
REVIEWED BY:		FOUNDATION GROUTING-RIGHT ABUTM STA 200+50 TO 206+50 SCALE AS SHOWN	
SUBMITTED BY:		U.S. ARMY ENGINEER DISTRICT, FORT WORTH TO ACCOMPANY FINAL FOUNDATION REPORT	
APPROVED:		SOL. NO.	DATED:
		CONTR. NO.	
		GRADING NUMBER PLATE 33	SHEET NO. 33



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+ 300

+ 250

+ 240

+ 230

+ 220

+ 210

+ 200

+ 190

+ 180

+ 170

+ 160

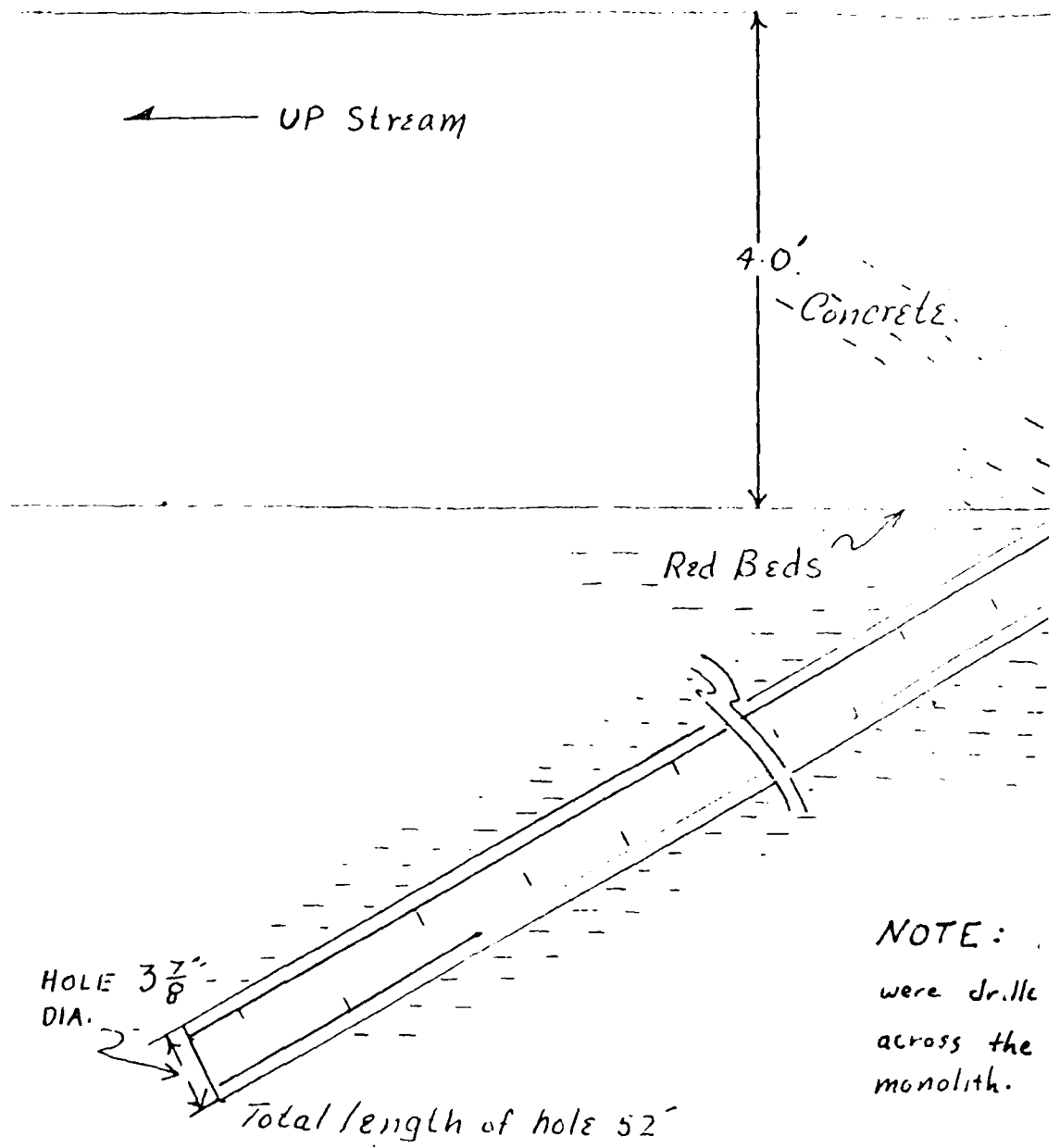
ELEVATION IN FEET MSL

F
OMERATE

ENGINEERING DIVISION GEOTECHNICAL BRANCH		U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
DESIGNED BY: O.C. FISHER LAKE NORTH CONCHO RIVER, TEXAS		DATE:	
DRAWN BY:		CONTR. NO.	
CHECKED BY:		SHEET NO.	
SUBMITTED BY:		DATE:	
U.S. ARMY ENGINEER DISTRICT, FORT WORTH TO ACCOMPANY FINAL FOUNDATION REPORT		DRAWING NUMBER PLATE 34	
SHEET NO.		OF	

O.C. F1

Typic.

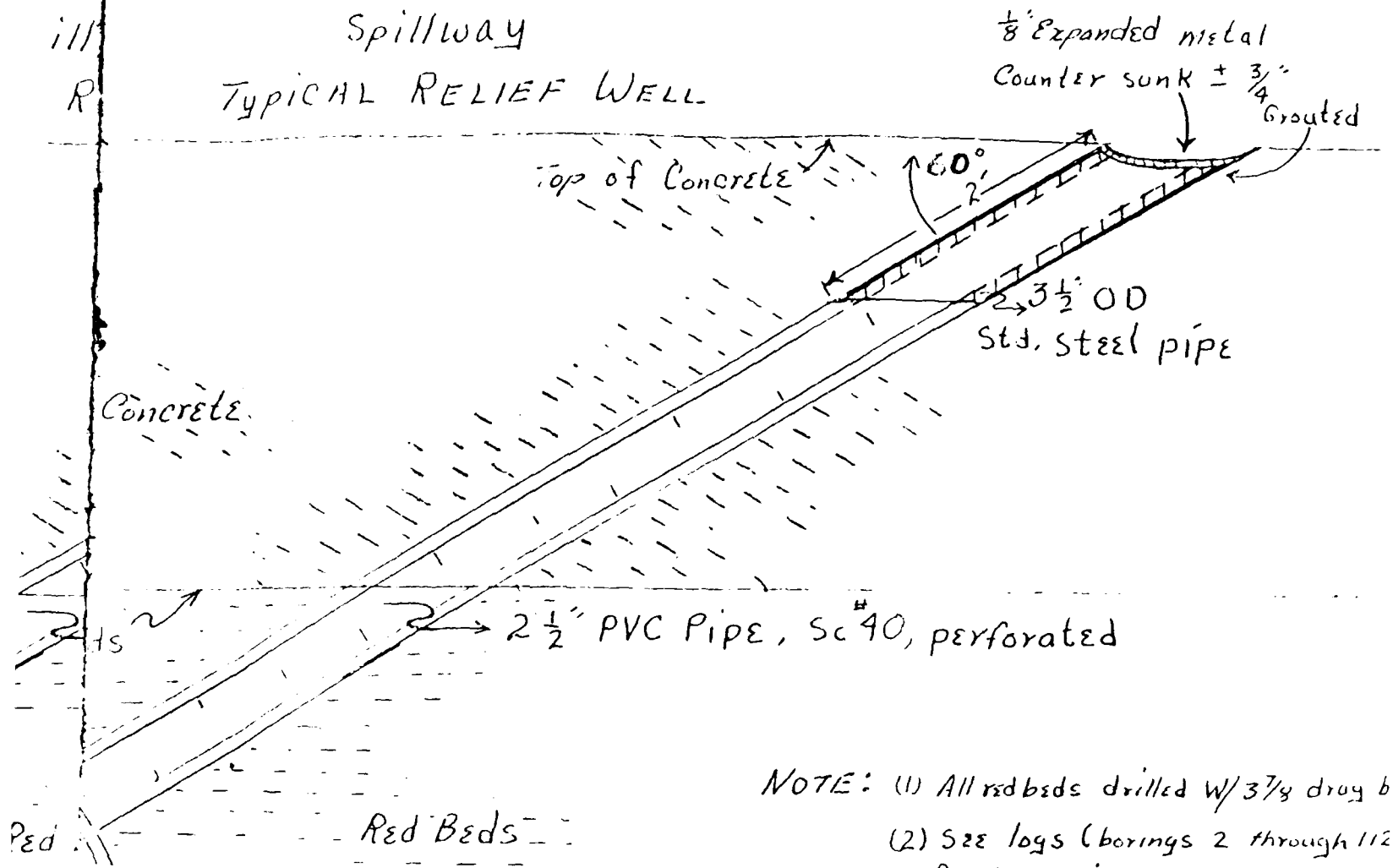


ER
III
R

O.C. FISHER DAM & LAKE

Spillway

TYPICAL RELIEF WELL

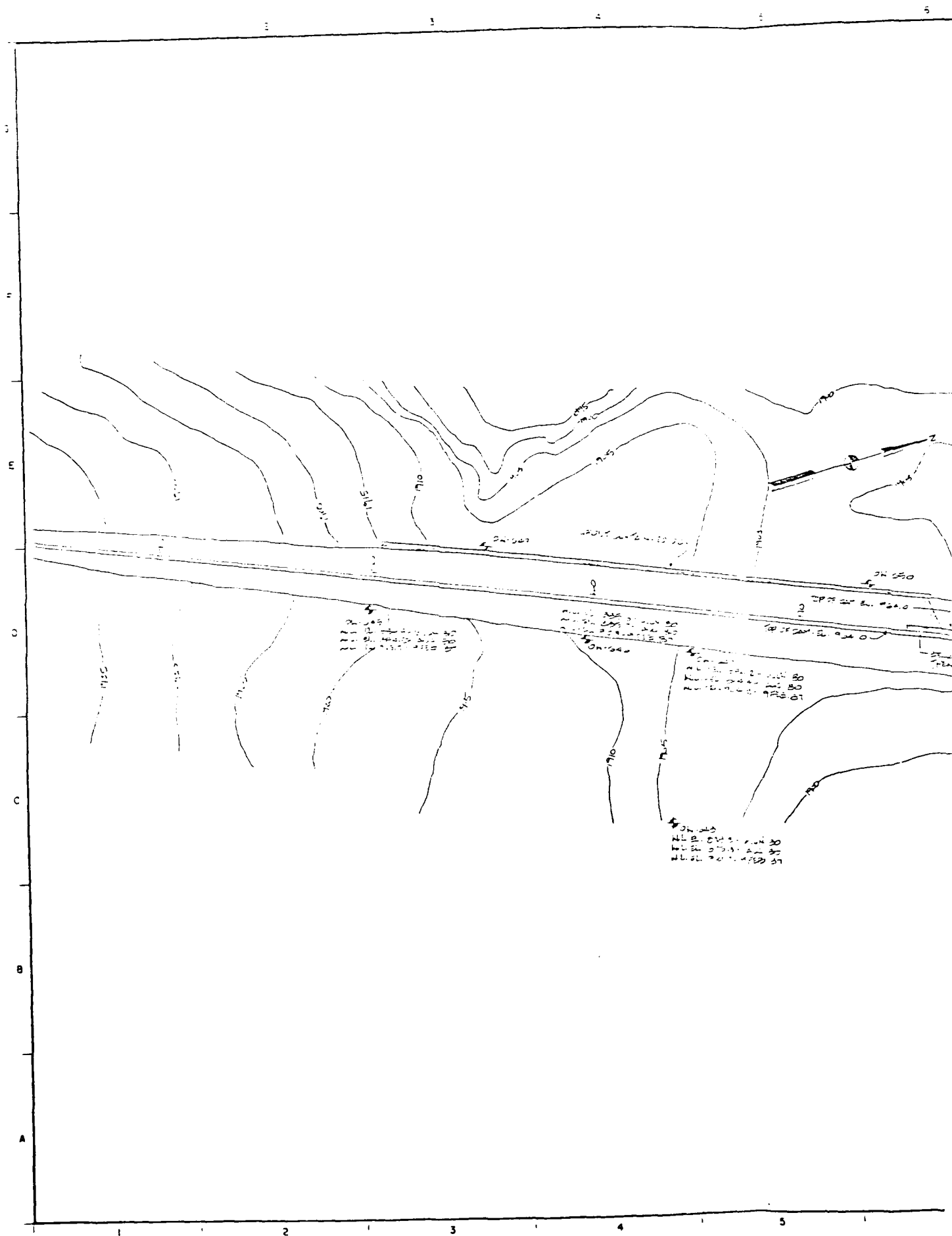


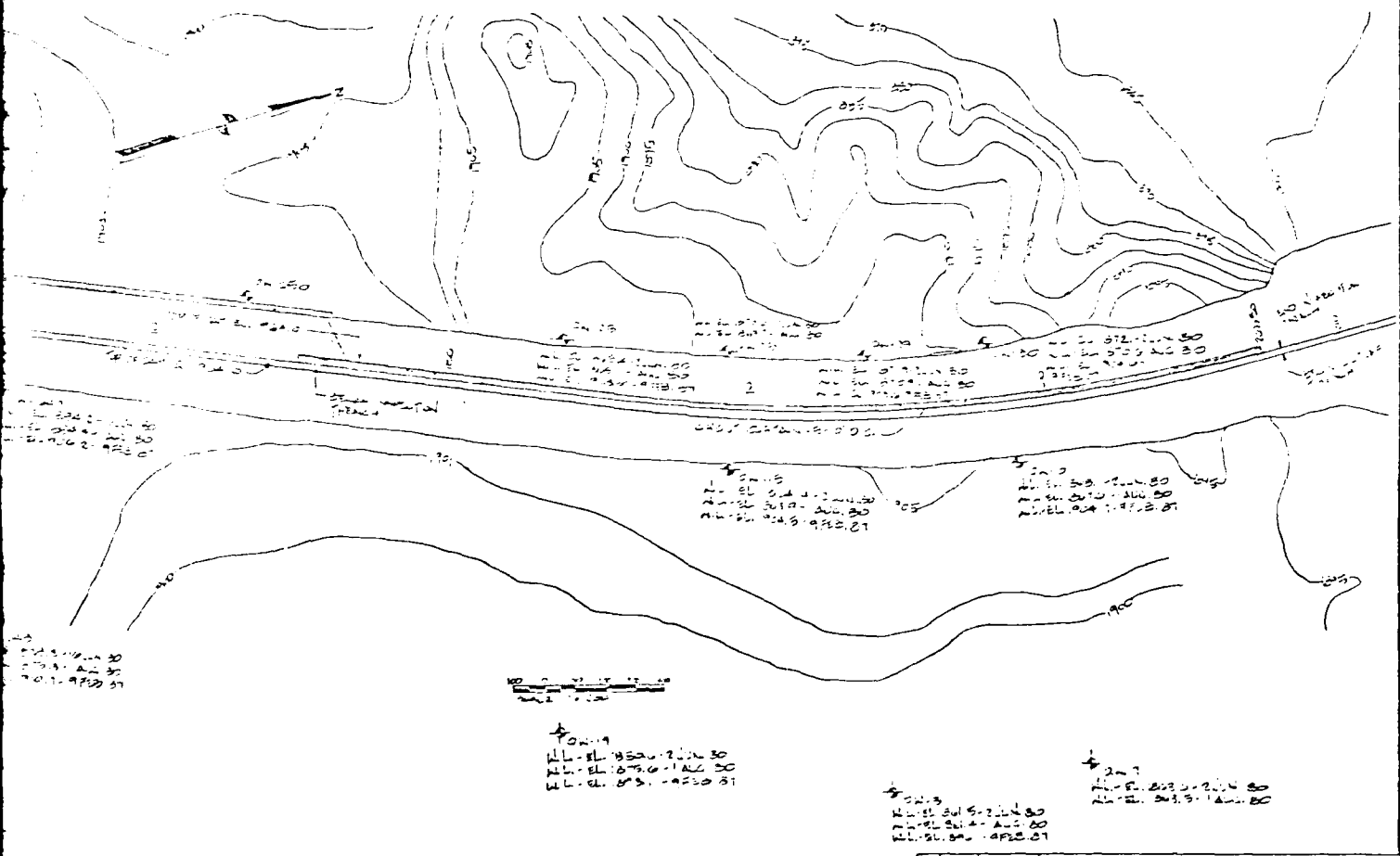
NOTE: (1) All red beds drilled w/ 3 7/8 drag b
(2) See logs (borings 2 through 112
for hole dia. through concrete

NOTE: 110 Pressure Relief Wells
were drilled centered 10 feet apart
across the full width of the wier
monolith.

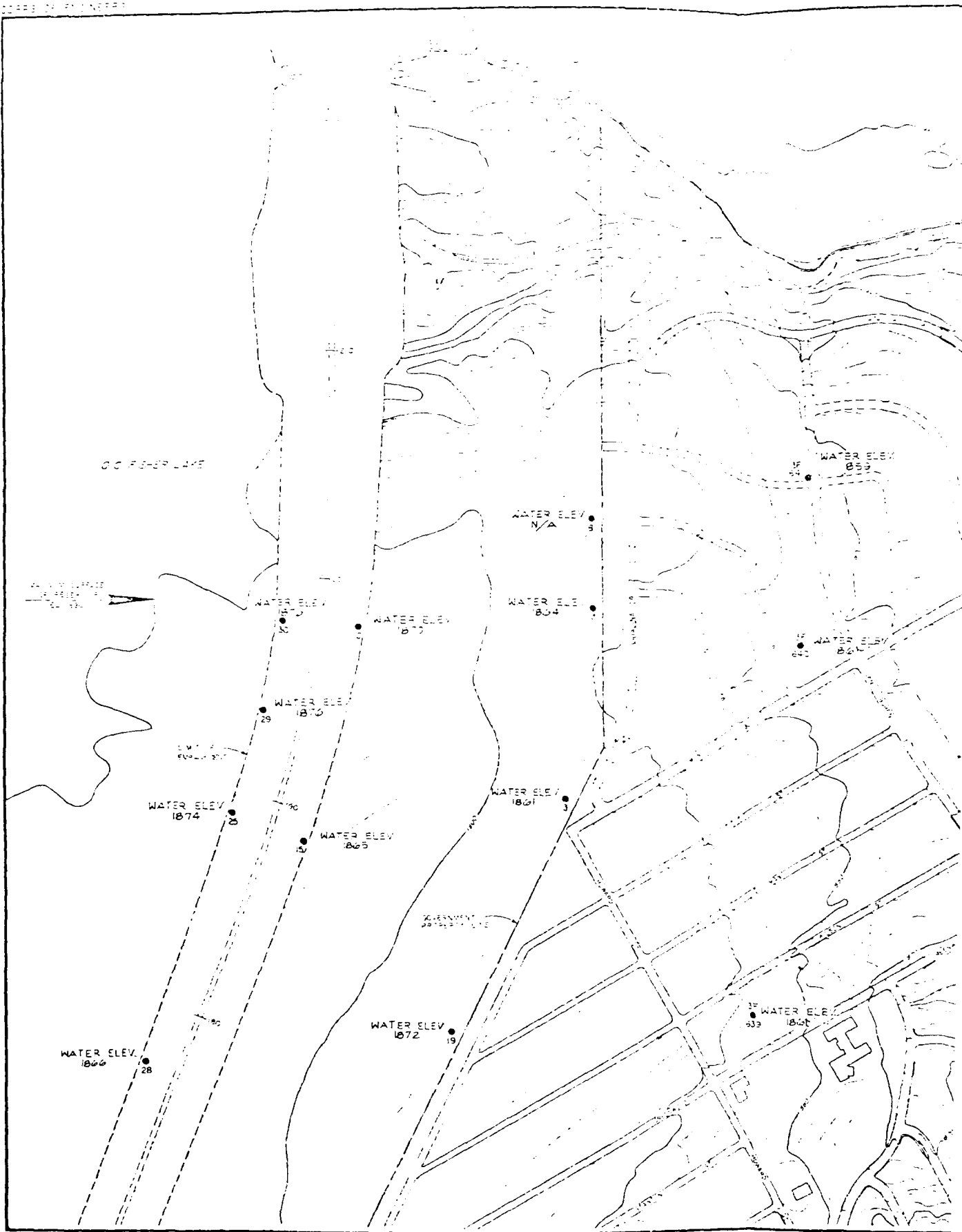
LEGEND
NOT to SCALE

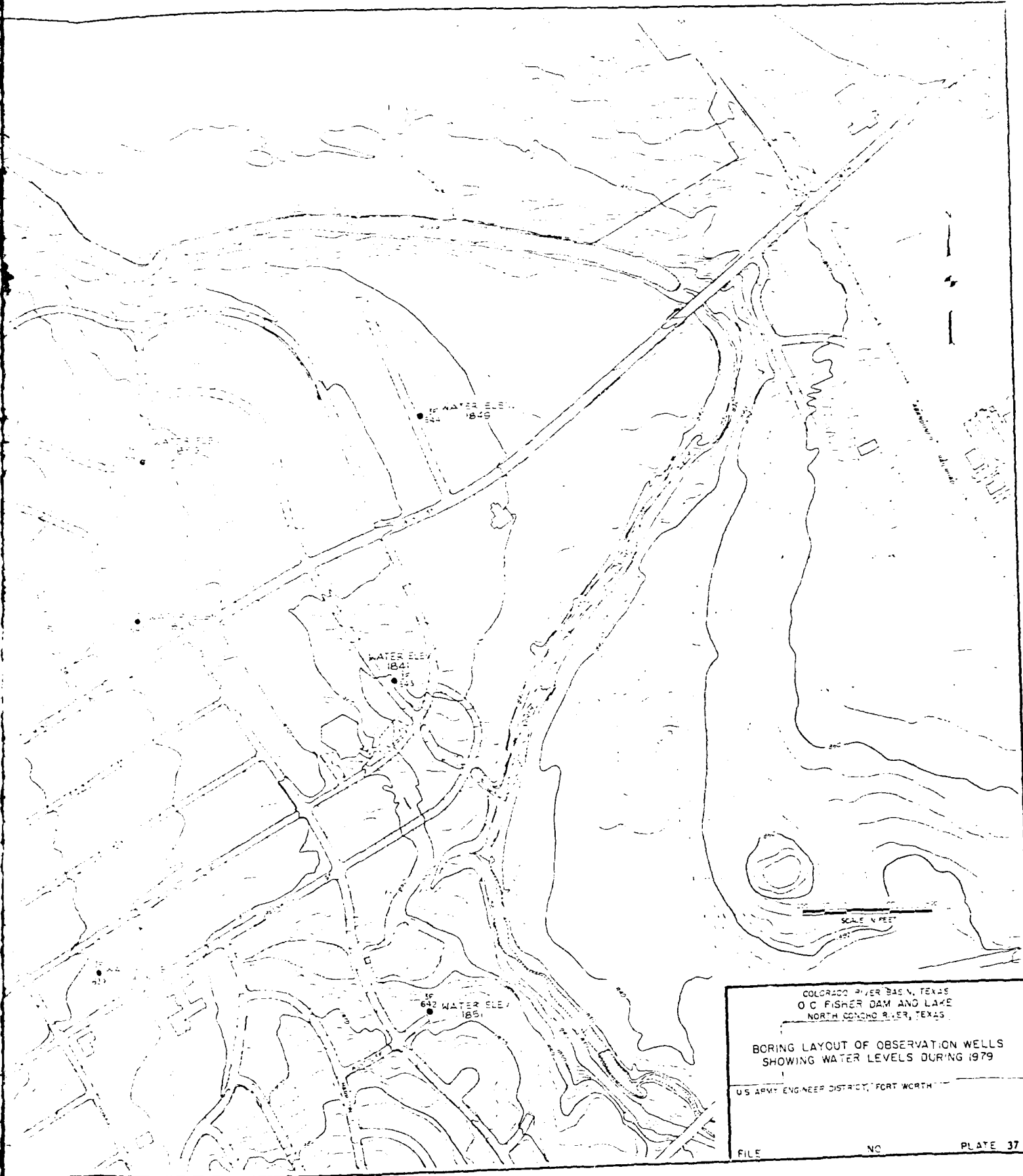
SEP. 1979
L. COLE





U.S. ARMY ENGINEER DISTRICT, PORT WORTH	
CORPS OF ENGINEERS	
PORT WORTH, TEXAS	
DESIGNED BY	COLORADO RIVER BASIN, TEXAS
DRAWN BY	O C FISHER DAM
REVIEWED BY	NORTH CONCHO RIVER, TEXAS
FOUNDATION GROUTING AND OBSERVATION WELL WATER LEVELS ALONG THE RIGHT ABUTMENT	
ENGINEER	DATE
DRAWING NUMBER	SHEET NO
REVISION NO	NO





COLORADO RIVER BASIN, TEXAS
O C FISHER DAM AND LAKE
NORTH CONCHO RIVER, TEXAS

BORING LAYOUT OF OBSERVATION WELLS
SHOWING WATER LEVELS DURING 1979

U.S. ARMY ENGINEER DISTRICT, FORT WORTH

DATE
FILMED
3 8