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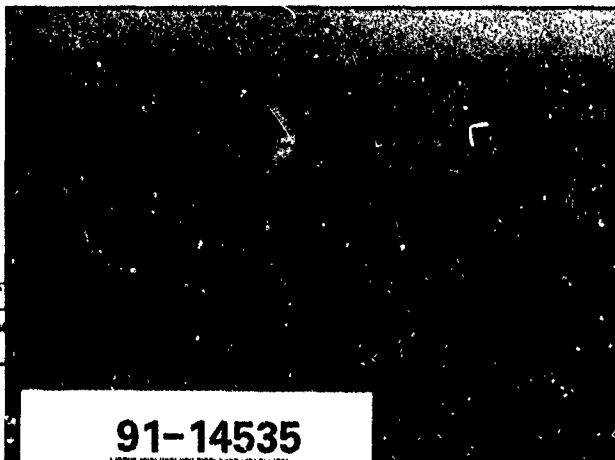
US Army Corps
of Engineers
Fort Worth District

Embankment Criteria and Performance Report

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JOE POOL LAKE MOUNTAIN CREEK, TEXAS TRINITY RIVER BASIN



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9 October 1991

SUBJECT: Joe Pool Lake, Texas, Embankment Criteria and Performance Report

FOR THE COMMANDER:

FOR *W. H. J. Brown*
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Chief, Engineering Division

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JOE POOL LAKE
MOUNTAIN CREEK, TEXAS
TRINITY RIVER BASIN

EMBANKMENT CRITERIA
AND
PERFORMANCE REPORT

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
FORT WORTH, TEXAS

MAY 1991

JOE POOL LAKE
MOUNTAIN CREEK, TEXAS
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

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JOE POOL LAKE
MOUNTAIN CREEK, TEXAS
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

SECTION I - INTRODUCTION

1-01. Authority. - Authority for preparing Embankment Criteria and Performance Reports is contained in ER 1110-2-1901; Subject: Embankment Criteria and Performance Report, dated 31 December 1981.

1-02. Purpose. - The purpose of the report is to provide the information needed to (1) familiarize engineers with the project, (2) re-evaluate the earthen embankment and appurtenant structural features in the event of unsatisfactory performance, and (3) provide guidance for designing comparable future projects.

1-03 Authorization and Purpose of the Project. - Joe Pool Lake (formerly Lakeview Lake) was authorized by the River and Harbor Act of 1965, approved 27 October 1965 (Public Law 89-298) in accordance with the plan of improvement as outlined in House Document 276 (89th Congress, 1st Session) The purpose of the project is flood control, water supply, general recreation, and fish and wildlife enhancement

1-04. Project Maintenance. - The project is operated and maintained by the U S. Army Corps of Engineers, Fort Worth District (CESWF). Joe Pool Dam is inspected annually by the Operations Division and inspected periodically by the Engineering Division in accordance with the Corps of Engineers program of "Periodic Inspection and Continuing Evaluation of Completed Civil Works Structures", ER 1110-2-100, dated 8 April 1988

1-05. History of Project Design - The overall design of the Joe Pool Lake was presented in Design Memorandum No 4, General, dated December 1969. The

design of the outlet works was presented in Design Memorandum No. 24, Outlet Works, dated November 1978. The feature design for the Joe Pool Lake embankment and spillway was presented in Design Memorandum No. 9, Embankment and Spillway, dated April 1980. All of these Design Memoranda were reviewed and approved by the Southwestern Division and the Office, Chief of Engineers.

SECTION II - PROJECT DESCRIPTION

2-01. General. - Joe Pool Lake is located on Mountain Creek, a tributary to the West Fork of the Trinity River, Texas, in southwest Dallas County near Grand Prairie and extends into Tarrant and Ellis Counties. The watershed is southwest of Dallas with a length of approximately 37 miles and lies within parts of Dallas, Tarrant, Ellis, and Johnson Counties. The dam site is located in Dallas and Tarrant Counties at river mile 11.2, on Mountain Creek, about 7.1 miles upstream from Mountain Creek Dam. The location of the project is shown on plate 1. A general plan of the embankment and dike is shown on plate 2, and typical embankment sections are shown on plates 3 and 4. Major structures at the project include an earthfill embankment, an outlet works (plates 5 through 10), a spillway (plates 11 through 16), and a dike. The embankment and dike are rolled earthfills totaling approximately 24,340 feet in length. The limited service spillway consists of an uncontrolled rectangular broadcrested weir with a crest length of 50 feet. The outlet works consists of excavated approach and discharge channels, intake structure and service bridge, a 660-foot long by 10.5-foot diameter cut-and-cover conduit, and a stilling basin.

2-02. Pertinent Data.

a. Embankment and Dike.

- (1) Type - Earthfill
- (2) Embankment length - 22,180 feet
- (3) Dike length - 2,160 feet
- (4) Maximum height - 108.5 feet above streambed
- (5) Embankment crest width - 30 feet
- (6) Top elevation - 564.5 feet (NGVD)
- (7) Total Volume of Fill - 12.7 million cubic yards (approximate)

b. Spillway.

- (1) Type - Uncontrolled rectangular broadcrested weir, limited service
- (2) Length of Crest - 50 feet
- (3) Crest Elevation - 541.0 feet (NGVD)
- (4) Capacity (@559.4 feet NGVD) - 11,900 cfs

c. Outlet Works.

- (1) Type - Gated conduit
- (2) Conduit Diameter - 10.5 feet
- (3) Conduit Length - 660 feet
- (4) Control - Two 4' 7.5 x 10' 5" foot gates
- (5) Capacity (@559.4 feet NGVD) - 4,500 cfs

d. Drainage Area - 232 square miles

e. Reservoir Data.

Feature	Elevation (feet NGVD)	Area (Acres)	Acre-Feet	Equivalent Runoff (Inches)
Top of Dam	564.5	--	--	--
Maximum Water Design Surface	559.4	18,600	642,400	51.92
Spillway Crest	541.0	12,470	361,000	29.31
Top of Flood Control Pool	536.0	10,940	304,000	24.57
Top of Conservation Pool	522.0	7,470	176,900	14.30
Maximum Tailwater (at dam site)	471.6	--	--	--
Streambed	456.0	--	--	--

SECTION III - GEOLOGY

3-01. General Physiography - The Joe Pool Dam is located in the Eagle Ford Prairie subdivision on the West Gulf Coastal Plain section of the Coastal Plain physiographic province. The major topographic feature in the area is the White Rock escarpment which is located approximately one-half mile east of the dam's right abutment. This escarpment has a vertical relief of about 200 feet, trends north-northeast, and marks the western extent of the Austin Chalk Formation. Immediately west of the escarpment are numerous remnants of a small cuesta. The cuesta was formed by a resistant limestone bed of the Eagle Ford Formation which was subsequently eroded into series of sub-rounded hills rising some 30 to 60 feet above the present Mountain Creek floodplain. Topographically, the Joe Pool Dam is characterized by a moderately steep right (east) abutment formed by one of the above mentioned "Eagle Ford" hills, a relatively flat 5,000-foot wide floodplain and a gently rising left (west)

abutment.

3-02. General Geology. - Bedrock strata underlying the embankment and reservoir area consists of Upper Cretaceous sediments belonging to the Eagle Ford Formation. Lithologically, the Eagle Ford strata include a variety of rock types, but consists predominantly of soft to moderately hard clay shale. The formation outcrops in a 15-mile wide belt striking approximately north-south through northeast Texas. The regional structure of the strata is monoclinical with a gentle dip to the southeast. The Eagle Ford Formation has a thickness of 600 feet near Sherman, Texas. However, the formation thins considerably to the south and has a maximum thickness of 225 feet at Joe Pool Dam. An areal geology map is presented on plate 24.

3-03. Geology of the Dam Site. - A detailed description of the geology, as determined through foundation mapping of excavations during construction, are presented in the Final Foundation Reports for the Outlet Works, and the Embankment and Spillway. The following are excerpts therefrom.

a. Description of the Overburden. - Overburden consisting of Quaternary age alluvial and terrace deposits cover all bedrock at the dam site with the exception of some isolated areas on the right abutment where weathered bedrock has been exposed by hillside erosion. The deposits consist predominantly of clay, with heterogeneous assortments of silt, sand, and gravel either mixed in or occurring separately. Overburden materials encountered during preconstruction investigations and observed during construction in the shallow inspection trench were predominantly clays, sandy clays, and gravelly clays. Impure sand and gravel deposits are generally found near the base of the overburden unit. Along the embankment centerline, the thickness of the overburden ranged from 3 feet at station 69+50 to a maximum of 55 feet in a

suspected buried stream channel at station 15+00. A geologic profile along the embankment centerline is presented on plates 25 through 29.

In the valley section of the embankment, between stations 17+00 and 65+00, the overburden consists of Recent floodplain deposits having an average thickness of 45 feet. In general, these deposits consist of 35 to 40 feet of medium to high plasticity clay underlain by 5 to 10 feet of semi-impervious clayey sand and gravel immediately overlying bedrock. Excavations within this unit in the vicinity of the old Mountain Creek channel (station 53+00 to 56+00) encountered pockets of organic materials and some water-bearing sand and gravel zone.

Quaternary terrace deposits mantle the bedrock from about station 65+00 to the west end of the dam. These deposits consist of sandy clay and clayey sand. Fairly clean sand with some gravel was noted from station 72+00 to 75+00. This area was formerly the site of an old abandoned gravel pit. Average thickness of the terrace deposits is about 30 feet.

b Bedrock Stratigraphy. - Primary strata beneath the dam site belong to the Britton member of the Eagle Ford Formation, Upper Cretaceous in age. Thickness of the Eagle Ford ranges from about 80 feet at the west end of the dam to approximately 250 feet at the right abutment. Immediately underlying the Eagle Ford are the interbedded sand and clay shale strata of the Woodbine Formation.

The Britton member, which is the lowest (oldest) member of the Eagle Ford Formation, is divided into three units based on lithology. In ascending order they are: (1) the Lower Britton, Unit I; (2) the Lower Britton, Unit II, and (3) the Upper Britton. During construction of the dam, strata belonging to the Upper Britton Unit were exposed in excavations for the

spillway, the diversion channel and drop structure, the outlet works, and in the deep inspection trench at the right abutment. The Lower Britton, Unit II, was exposed during excavation for the outlet works stilling basin. None of the construction excavations penetrated the Lower Britton, Unit I.

Along the embankment alignment, beds of the Upper Britton Unit lie directly beneath the overburden between stations 0+00 and 45+00, and from station 63+00 to 113+00. Overburden is supported by strata of the Lower Britton, Unit II, from station 45+00 to 63+00, and between stations 113+00 and 168+00. From station 168+00 to the west end of the embankment, overburden is underlain by beds belonging to the Lower Britton, Unit I. The bedrock units dip southeastward resulting in the older strata occurring nearer the surface progressively westward, and the contacts between the units occurring at greater depths as they progress eastward. A geologic profile along the embankment centerline showing the bedrock stratigraphy is presented on plates 25 through 29.

c. Bedrock Structure. - The regional structure of the Eagle Ford Formation is monoclinial with dip of the strata to the east-southeast at approximately 50 feet per mile. In the area of Joe Pool Lake and eastward toward Dallas, strata of the Eagle Ford Formation and the overlying Austin Chalk Formation are extensively faulted. The majority of the faults are normal faults, occurring as a result of consolidation and differential settlement of individual beds. Typical displacement across a fault line is normally less than 15 feet. Several small displacement faults were noted in the area of Joe Pool Lake, either by direct observation within excavation areas, or as inferred from preconstruction electric log interpretations and 6-inch core sample inspection. A discussion of bedrock faulting examined in

the major excavation area follows:

(1) Right Abutment Deep Inspection Trench. - Subsurface investigations during design along the dam site centerline at the right abutment revealed that the top of bedrock dropped abruptly into the floodplain due to the erosion and curving action of an ancient buried stream channel located at the base of the abutment. The buried channel contained a maximum of 55 feet of alluvium and colluvium consisting of clay with variable amounts of sand, gravel, shale, and limestone fragments. The right abutment was also investigated as a potential site for the outlet works and spillway structures. However, these investigations revealed the presence of a large bedrock slump block, consisting of highly jointed, fractured brecciated shale. The slump block is located downstream of the embankment centerline in the area where the outlet works stilling basin would be located. Rather than requiring deep excavations through unstable bedrock for the outlet works and spillway stilling basins, both structures were resited to their present locations

As a result of these discoveries during early investigations, the decision was made to deepen the inspection trench at the right abutment so that any unstable bedrock or highly permeable channel deposits encountered could be treated and/or removed. The deep inspection trench, located between embankment stations 8+50 and 19+00, was designed to penetrate to bedrock and disclose any pervious materials in the buried stream channel. The design slopes of the trench were 1V on 3H, resulting in a maximum trench width of 420 feet, exposing a large surface area of bedrock for inspection. A geologic map and profile of the deep inspection trench is shown on plate 30.

The deep inspection trench was closely inspected by geotechnical personnel from CESWF and CESWD after the bottom of the trench had reached

elevation ± 458 , approximately 19 feet above the design excavation grade. Materials observed in the bottom of the trench consisted of unweathered clay shale of the Upper Britton member of the Eagle Ford Formation, an area of stiff, moist, brown alluvial clay, and a small pocket (less than 10 feet across) of very gravelly clay (described as colluvial material on preconstruction boring logs). The contact between the clay shale and the alluvial clay was very distinct and vertically oriented, reflecting a buried vertical face in the bedrock which occurs at embankment centerline station 14+30. During the inspection, the decision was made to immediately terminate excavations in the deep inspection trench and start backfilling. The decision was based on the conclusion that the primary materials exposed in the floor of the trench were competent and the colluvial materials comprising the buried stream channel were sufficiently impervious so that stability and leakage through the embankment foundation would not be a problem. The materials in the buried stream channel were predominantly clay and gravelly clay which will preclude detrimental seepage. Although some minor faulting was present in the exposed clay shale, the bedrock generally appeared competent and in much better condition than the bedrock encountered by borings in the slump block area downstream of the embankment.

(2) Outlet Works and Spillway. - Geologic profiles of the outlet works and spillway are presented on plates 31 and 32, respectively. Detailed bedrock descriptions are presented in the above referenced foundation reports

SECTION IV - FOUNDATION CONDITIONS

4-01. General. - The embankment is founded on a clay overburden which overlies shale of the Eagle Ford Group. The overburden is composed primarily of CH and CL clays with interbedded strata of clayey sands, clayey gravels and

silty sands. The shale is generally soft (rock classification) increasing to moderately hard with depth, jointed, fractured, calcareous and contains numerous bentonite seams and lenses. Engineering parameters for the embankment, outlet works and spillway foundations are included in the profiles and sections shown on plates 37 through 47.

4-02. Floodplain Embankment Foundation. -

a. The floodplain embankment foundation from station 2+60 to station 9+00 consists of up to 10 feet of CH and CL clay overburden overlying weathered shale. The weathered shale ranges from 10 to 20 feet thick, is calcareous, very soft to soft, and exhibits lower shear strength characteristics than do the overburden materials. The weathered shale overlies soft to moderately hard unweathered shale that contains bentonite seams and numerous low to high angle joints and fractures

b. The floodplain embankment foundation from station 9+00 to about station 20+00 includes CH and CL clay overburden materials generally ranging in thickness from about 5 feet to about 40 feet. One boring in this area indicated that overburden extended to the top of unweathered shale which was at a depth of approximately 57 feet. This boring also revealed a possible buried stream channel filled with deposits of sandy, gravelly clay. However, construction of a deep inspection trench in this area revealed only insignificant amounts of clay-choked gravel.

c. The embankment foundation in the floodplain from about stations 20+00 to 60+00 consists of 25 to 45 feet of overburden lying directly on unweathered Eagle Ford shale. The overburden is predominantly CH clay with lesser amounts of CL clay, clayey sands and clayey gravel. The unweathered shale is calcareous, soft to hard, fractured and contains bentonite seams up

to 1 foot thick. From about station 60+00 to station 68+00 the topography rises, and the thickness of the overburden decreases to about 15 feet, but still overlies unweathered primary. The overburden in this reach is predominantly CH and CL clays transitioning to predominantly clayey and silty sands toward station 74+00.

d. Overburden clays in the floodplain between about station 25+00 and 64+00 exhibit a weaker lower section; i.e., weaker than the overlying clays. The weaker clay stratum is saturated, and overlies sandy and gravelly clays.

4-03. Outlet Works Foundation. - The overburden along the embankment centerline varies from about 15 feet of primarily clayey and silty sands at station 73+20 to about 25 feet of CH and CL clays at station 81+00. The primary materials along this reach are weathered shale overlying unweathered shale. The shale is soft to moderately hard, jointed, calcareous, and contains bentonite seams.

4-04. Left Embankment Foundation. - The left embankment foundation from station 82+00 to station 224+40 is predominantly a CH and CL clay overburden ranging in thickness from about 10 feet to about 50 feet. In general, the clay overburden is calcareous, sandy, and contains discontinuous strata of sands and gravels. The overburden is supported by weathered shale that transitions into unweathered shale.

4-05. Dike Foundation. - The dike foundation from station 228+00 to station 249+60 is similar to the left embankment foundation described above, except overburden thickness averages about 20 to 25 feet.

4-06. Spillway Foundation. - The spillway was constructed on compacted fill, overburden soils, and primary materials. The overflow structure is founded on compacted embankment fill, while the chute is founded on either compacted

fill, overburden, or primary materials, depending upon location. The spillway stilling basin was constructed entirely on primary materials. Compacted fill under the spillway consisted of CL clay materials having a liquid limit range of 30 to 45 with a maximum thickness of approximately 14 feet. Overburden materials in this area consisted of approximately 15 feet of stiff to hard CL and CH clays. The primary materials are composed of up to 25 feet of weathered shale overlying unweathered shale containing numerous high-angle fractures and bentonite seams.

SECTION V - EMBANKMENT DESCRIPTION

5-01. General. - Joe Pool Dam consists of a rolled earthfill embankment and dike with typical sections and general plan as shown on plates 2 and 3. The embankment and dike consist mainly of clays and were constructed under three contracts as described in Section: Construction. Clay shale and other primary materials from required excavations were allowed in the semi-compacted zones; however, clay shales comprised only a small percentage of the total volume. The embankment and dikes have lengths of 22,180 and 2,160 feet, respectively, and a maximum height above streambed of 108.5 feet. The crest width is 30 feet for the embankment (which supports a public roadway) and 10 feet for the dike (which supports a service road).

5-02. Embankment Zoning.

a. Impervious Fill. - Materials in the central impervious fill zone consist of clay material excavated from borrow areas. Clays for the impervious fill were limited to CH and CL materials with liquid limits equal to or greater than 40, having not less than 60 percent by weight passing the No. 200 sieve, and containing no rock or stone particles greater than 3 inches in any dimension. The materials were placed in 8-inch maximum loose lifts at

moisture contents after compaction between optimum and 3 percent above optimum. The impervious zone of the embankment consists of a total of approximately 2.8 million cubic yards, or about 22 percent of the entire dam.

b. Random Fill. - The random fill zones of the embankment are symmetrically located adjacent to the impervious zone, and are composed of materials excavated from the designated borrow areas. Random fill was limited to materials classified as overburden materials (e.g., CL, CH, and SC) containing no rock or stone particles greater than 6 inches in any dimension. The fill was specified to be placed in 8-inch maximum loose lifts at moisture contents after compaction between 2 percent below optimum and 3 percent above optimum. The random fill zones of the embankment consist of a total of approximately 4.8 million cubic yards, or about 38 percent of the entire dam.

c. Semi-Compacted Fill. - The semi-compacted fill zones are symmetrically located adjacent to the random zone, and are composed of materials obtained from required excavations and borrow areas. The materials for the semi-compacted fill included both overburden and primary materials containing no rock or stone greater than 10 inches in any dimension. The fill was specified to have 10-inch (initial contract) or 12-inch (completion contract) maximum loose lifts for compaction with rubber-tired rollers. During construction, the contractors were optionally allowed to use 8-inch maximum lifts for compaction with tamping rollers. The required moisture content after compaction was between 2 percent below optimum and 3 percent above optimum in the initial contract, and 5 percent below optimum and 4 percent above optimum in the completion contract. The semi-compacted zones of the embankment consist of a total of approximately 4.3 million cubic yards, or about 34 percent of the entire dam.

d. Select Impervious Fill. - Materials in the select impervious fill zone consist of clay materials excavated from borrow areas. Select impervious fill was limited to materials having liquid limits of 30 to 45 (inclusive) under the spillway for the initial contract. Elsewhere a 30 to 60 (inclusive) range was used in both the initial and completion contracts. Select impervious fill was also limited to materials containing no rock or stone particles greater than 3 inches in any dimension and a moisture content after compaction of optimum to 3 percent above optimum. The select impervious fill zones of the embankment consist of a total of approximately 0.7 million cubic yards, or about 6 percent of the entire dam.

5-03. Dike. - The dike is composed of materials excavated from the designated borrow areas of the road relocation contract. Fill was limited to overburden materials having no rock or stone greater than 3 inches in any dimension. The dike was specified to have a moisture content within 2 percent below optimum to 3 percent above optimum. The contractor was allowed to use 8-inch maximum loose lifts for tamping-type rollers or 10-inch maximum loose lifts for pneumatic type rollers. The dike volume is comparatively very small and will not be quoted here.

5-04. Borrow. - Borrow areas were located upstream of the embankment and below the proposed conservation pool elevation (plate 19). During the initial contract, borrow areas B-1, C-1, E-2, and E-4 were made available for usage. During the completion contract, all borrow areas were available, but only areas A, B-1, C-1, D-1, D-2, E-1, and E-3 were actually utilized. Most of these areas were only partially exhausted of usable materials. Borrow Area A was the most extensively used area by the completion contractor and his excavations were not only deeper than anticipated, they were extended

riverward at his request outside the defined limits. Approximately 1.8 million cubic yards or about 18 percent of the entire fill quantity that was required for the contract was obtained outside the designated borrow areas. Because of a claim during construction partly involving availability of materials, the borrow areas were surveyed to record excavation extent. The resulting topographic information is presented on plates 20 and 21. Similar information concerning extent of excavation is presented in profile format on plate 22. The excavation depth exceeded 40 feet in some areas.

5-05. Slope Protection.

a. Riprap and stone protection for the upstream slopes are as follows:

(1) Twelve inches of stone protection was placed on the 1 vertical on 2.8 horizontal upstream slope above elevation 543.0.

(2) Twenty-four inches of riprap on 9 inches of bedding was placed on the 1 vertical on 5 horizontal slope of the outlet works embankment from elevation 512 to elevation 543 and from station 72+00 to station 82+00

(3) Twenty-four inches of riprap on 9 inches of bedding was placed from station 99+13 to station 100+87 (adjacent to the spillway) and from natural ground to elevation 564.5

b. Riprap for the outlet works is as follows:

(1) Thirty-six inches of riprap on 6 inches of bedding over filter cloth was placed from outlet works station 27+40 to outlet works station 28+85 from the training walls up to elevation 474.

(2) Thirty-six inches of riprap on an 18-inch two-stage transitional filter bedding (12 inches on 6 inches) was placed from outlet works station 28+85 to outlet works station 29+60, in the channel bottom to and up the slopes to elevation 474

(3) Twenty-four inches of riprap on 9 inches of bedding was placed in the outlet works discharge channel from outlet works station 29+60 to outlet works station 31+35, in the channel bottom and up the slopes to elevation 474.

c. Riprap for the spillway is as follows:

(1) Thirty-nine inches of riprap on 6 inches of bedding on filter cloth was placed along the spillway from the walls up to elevation 509.0 and from spillway station 12+45 to spillway station 14+10.

(2) Thirty-nine inches of riprap on an 18-inch two stage transitional filter bedding (12 inches on 6 inches) was placed along the discharge channel from spillway station 14+10 to spillway station 14+45, in the channel bottom and up the slopes to elevation 509.0

(3) Twenty-four inches of riprap on 9 inches of bedding was placed along the spillway discharge channel from spillway station 14+45 to spillway station 16+70, in the channel bottom and up the slopes to elevation 509.0.

5-06. Closure Plan. - Embankment closure was made between approximate stations 39+50 and 62+50. The closure plan included the diversion channel, the channel plugs and the cofferdams as shown in plan and profile on plate 48.

a. Diversion Channel. - The diversion channel and closure section provided passage for flows of Mountain Creek during construction prior to the embankment closure. The following elements were included in the plan.

(1) The diversion channel had a bottom width of 40 feet at approximate elevation 458 and 1 vertical on 4 horizontal side slopes.

(2) Excavation for the diversion channel was entirely in overburden materials.

(3) During embankment closure, the diversion channel was excavated

1 throughout to sound material (plate 49) and backfilled according to embankment zoning.

b. Channel Plugs - Three plugs were constructed in the closure area (plate 48) Details are given below.

(1) Each plug was built outside the embankment limits to an elevation equivalent to the adjacent natural ground.

(2) The plugs had approximately 12-foot crown widths, symmetrical 1 vertical on 4 horizontal slopes, and were constructed using random-type fill materials.

(3) The plugs located upstream of the embankment in Mountain Creek diverted flows through the diversion channel during construction of the main embankment and during river cleanout (plate 49).

(4) The plug located in the diversion channel upstream of the embankment diverted flows through the outlet works and provided some flood protection for the upstream cofferdam construction.

(5) A diversion channel plug downstream of the embankment provided protection for the closure area after the cofferdam was constructed upstream.

c. Cofferdam - A cofferdam consisting of random-type fill material was constructed in the diversion channel at the upstream limit of the embankment (plate 48).

(1) The cofferdam had approximately a 12-foot wide crown and formed a permanent portion of the main embankment.

(2) The upstream cofferdam had approximate slopes of 1 vertical on 8 horizontal from elevation 499.5 down to elevation 488.0, 1 vertical on 3 horizontal down to elevation 468.0 and 1 vertical on 4 horizontal down to the bottom of the diversion channel.

(3) The upstream cofferdam provided protection for construction of the embankment in the closure area against a flood with an average recurrence interval of 10 years with 5.0 feet of freeboard (or 25 years with no freeboard). No overtopping occurred.

SECTION VI - EMBANKMENT DESIGN

6-01. General. - The design analyses of the embankment was divided into typical sections including the floodplain, outlet works, spillway, and left abutment. The following paragraphs provide a brief review of the field investigations, including sampling, laboratory testing, design data, and the stability analyses. The typical embankment sections are shown on plates 3 and 4

6-02. Field Investigations. - The dam foundation was investigated using auger, shelby, Denison and core barrel samplers. Calyx holes were also utilized in the vicinity of the right abutment. Borrow areas were investigated using auger borings. From these borings, both disturbed and relatively undisturbed samples were obtained for conducting laboratory tests. The plans of borings for the embankment, dike, outlet works, and spillway are shown on plates 33 through 36.

6-03. Laboratory Testing. - Selected samples from the field investigations were tested in the laboratory to evaluate the engineering properties of the foundation and the fill. The tests included index tests, classification, unconfined compression, direct shear, residual (or steady state) and pre-split residual direct shear, triaxial Q , R , and S tests, and consolidation-expansion tests. Remolded samples from the borrow areas were subjected to the aforementioned tests in order to simulate fill conditions, while undisturbed samples were used from the dam foundation areas. Engineering parameters, as

depicted in profiles and sections through the embankment and related structures, are shown in plates 37 through 47.

6-04. Embankment Design Data. - Based on field investigations, laboratory testing and engineering judgment, the parameters adopted for embankment design and analyses are as tabulated below. Assumed parameters for the overburden and primary are listed in the order found relative to natural grou.

a. Overburden.

Moist unit weight 129 pcf
Saturated unit weight 130 pcf

<u>Type Strength</u>	<u>Cohesion, tsf</u>	<u>Angle of internal Friction, ϕ, degrees</u>
Q	1.0	1.0
R	0.3	13.0
S	0.0	20.0

b. Weak Overburden

Moist unit weight 124 pcf
Saturated unit weight 125 pcf

<u>Type Strength</u>	<u>Cohesion, tsf</u>	<u>Angle of internal Friction, ϕ, degrees</u>
Q	0.6	0.0
R	0.3	13.0
S	0.0	20.0

c. Sand and Gravel Stratum

Moist unit weight 132 pcf
Saturated unit weight 132 pcf

<u>Type Strength</u>	<u>Cohesion, tsf</u>	<u>Angle of internal Friction, ϕ, degrees</u>
S	0.0	30.0

d. Primary

Moist unit weight 125 pcf
Saturated unit weight 130 pcf

	<u>Type Strength</u>	<u>Cohesion, tsf</u>	<u>Angle of internal Friction, ϕ, degrees</u>
(shale)	S	0.5	18.0
(bentonite)	S	0.0	18.0

e. Borrow. - Design unit weights and shear strengths listed below were selected based on placement of compacted clay borrow materials at 95% Standard density and a moisture content of optimum plus 3 percent. For the purpose of stability analyses, no distinction was made between the shear strengths of the various zones of the embankment.

Moist unit weight 125 pcf
Saturated unit weight 129 pcf

	<u>Type Strength</u>	<u>Cohesion, tsf</u>	<u>Angle of internal Friction, ϕ, degrees</u>
	Q	0.7	1.5
	R	0.1 - 0.2	12.0
	S	0.0	20.0

6-05. Seepage Analyses

a. General. - The Joe Pool embankment was constructed of medium, but mostly high plasticity, erosion and piping resistant, impervious materials. The embankment was designed and constructed to preclude any detrimental through or under seepage. Seepage analyses, as described in the following paragraphs, revealed that no underseepage control methods were necessary. A deep inspection trench was included at the right abutment to evaluate the condition and secondary permeability of the colluvium and clay shales. No problems were discovered and, in fact, the trench was terminated at a higher level than anticipated due to the competency and impervious nature of the materials being encountered.

b. Embankment, Station 2+60 to Station 80+00. - The embankment from the right abutment to about station 80+00 will be the only reach which will be

1 subject to a constant head of water since natural ground elevation for the remainder of the embankment is above conservation pool. Due to the impervious nature of the embankment, coupled with the long seepage paths, it is expected that the embankment would not be saturated and that no detrimental underseepage would develop. A deep inspection trench was excavated on the right abutment to allow evaluation of the secondary permeability of the weathered shale on the abutment and of the colluvial material in the supposed buried channel at the abutment base. A description of the excavation is presented in Section III - Geology.

c. Embankment, Station 80+00 to Station 224+40. - The embankment west of about station 80+00 will be subject to very infrequent reservoir pools. Natural ground along this reach is above conservation pool elevation. Due to the transient, short duration inundation of the impervious embankment, little saturation of the embankment will occur.

d. Foundation. - Potential underseepage was analyzed during design using three flownets. A number of conservative and simplifying assumptions were made to facilitate easier flownet construction. The various assumptions are listed on the referenced plates.

(1) Buried Channel. - The supposed buried channel located at the base of the right abutment near station 14+50 was believed to be partially filled with colluvium. Since the permeability of the colluvium would be greater than the overlying clays, it was conservatively assumed that the colluvium existed from natural ground to the channel bottom. Actually, the colluvium was believed to fill only a small part of the channel and was covered by a 20-foot blanket of impervious clay. Horizontal and vertical permeabilities for the colluvium were conveniently assumed to be equal. A k-

value of 1×10^{-4} cm/sec was assumed. Based on this conservative assumption, the analysis presented on plate 50, the seepage quantity for conservation pool elevation is estimated to be less than 3 gal/day per linear foot of dam. The computed exit gradients are 0.06 with the reservoir at conservation pool and 0.15 at the maximum design water surface. Both exit gradients are low and fall well below the maximum desired range of 0.3 to 0.4. Thus, a deep trench was not needed except for inspection and evaluation of secondary permeability. As discussed earlier, actual construction revealed that no problem exists.

(2) Right Abutment. - Underseepage potential through the right abutment was analyzed as shown on plate 51. The primary and overburden were assumed to be clay. The overburden and the weathered primary material were assumed to be the only potential seepage paths; i.e., the unweathered primary and the compacted embankment fill were assumed to be impervious. The ratio of k-horizontal to k-vertical was assumed equal to 25 with k-horizontal being equal to 1×10^{-8} cm/sec. Computed underseepage rates based on these assumptions are 6×10^{-4} gal/day per linear foot of embankment for conservation pool conditions. Seepage exit gradients were computed to be 0.11 for conservation pool, and 0.34 for maximum design water surface. Thus, underseepage design measures were not necessary.

(3) Floodplain. - Underseepage potential in the floodplain was estimated using a section at the deepest portion of the valley as shown on plate 51. The analysis assumed overburden was entirely clay and that it and the weathered primary are the only materials through which seepage can occur, i.e., unweathered clay shale and compacted fill were assumed to be impermeable. The horizontal permeability was assumed to be 25 times larger than the vertical permeability with k_v equal to 10^{-8} cm/sec. With the

1 reservoir at conservation pool, the computed seepage quantity is 1.6×10^{-3} gal/day per linear foot of embankment. The maximum computed exit gradient for conservation pool is 0.16. The computed exit gradient at maximum design water surface is 0.27. Thus, underseepage control measures were not needed.

(4) Conclusions. - Underseepage and through seepage quantities are estimated to be negligible. Exit gradients calculated are all well below accepted maximum values and calculated underseepage quantities are very small. Since the flownets were drawn using conservative assumptions with regard to foundation material isotropy, permeability and stratigraphy, the seepage control afforded by the design is adequate.

e. Spillway. - Seepage design considerations for the spillway are discussed in paragraph 6-07. Additionally, finite element analyses were conducted at the Waterways Experiment Station to evaluate steady state (plate 52) and transient (plates 54 and 55) lines of seepage at this embankment section.

(1) Steady state seepage at or below the conservation pool elevation 522.0 is the most realistic line of seepage, if any, that can occur (plate 52). Since conservation pool will be below the embankment base, no through seepage will develop. Seepage exit gradients were computed to be 0.22 or less along the spillway underdrain system. Seepage quantities were computed to be 0.0003 gallon per day per linear foot of embankment.

(2) Transient lines of seepage through the embankment were estimated assuming the longest duration of reservoir pool at higher elevations based on the pool duration curves shown on plate 53. The results of these finite element analyses are shown on plate 54 and verify judgment that the pool durations above conservation pool are too short to cause saturation of

the impervious embankment. Thus, embankment through seepage conditions do not apply.

(3) Steady state lines of seepage at pools higher than conservation pool are not considered likely. However, they were estimated and are presented on plate 55.

6-06. Stability Analyses. - The stability of the various embankment sections was evaluated using circular arc and wedge methods. The embankment was conveniently divided into sections for engineering purposes with stability analyses conducted for the floodplain, outlet works, and left embankments (plates 3 and 4). The analyses included both computer and manual methods in accordance with criteria in EM 1110-2-1902, Stability of Earth and Rock Fill Dams, dated 1 April 1970. A large portion of the stability analyses during design were performed using a crest elevation of 563.0; however, the crest elevation was later raised to 564.5. The increase of 1.5 feet in the top of dam resulted in minimal changes in the computed safety factors; therefore, not all analyses were rerun. The following tables show the results of the stability analyses conducted during design for the conditions of: (1) end of construction (with and without 50 percent excess pore pressure), (2) steady seepage, and (3) partial pool.

FLOODPLAIN EMBANKMENT
TABLE 6-1

Condition	Shear Strength	Type of Analysis	Elevation of Failure Plane ft. NGVD	Safety Factor Computer:Manual	Footnotes
<u>Floodplain embankment, station 2+60 to 70+00</u>					
<u>(1 vertical on 8 horizontal slopes, crest elevation 564.5)</u>					
End of Construction	Q	Wedge	436	1.23: -	4
End of Construction	Q,S	Wedge	435	1.52: -	1,3
End of Construction	Q,S	Wedge	430	1.41: 1.40	1,6
<u>(1 vertical on 10 horizontal slopes, crest elevation 563.0)</u>					
Steady seepage	S,R+S 2	Wedge	436	2.13: -	4,7
Steady seepage	S,R+S 2	Wedge	468	2.20: -	2,7
Partial pool	S,R+S 2	Wedge	468	2.01: -	2

FOOTNOTES

- | | |
|--|---|
| 1 50% excess pore water pressure in foundation
2 Failure plane through base of embankment
3. Failure plane through overburden
4 Failure plane through weak overburden | 5. Failure plane through shale
6. Failure plane through bentonite ~~mm~~
7 Conservation pool elevation 522 0
8. Surcharge pool elevation 557.5
9. Through spillway |
|--|---|

OUTLET WORKS EMBANKMENT
TABLE 6-2

Condition	Shear Strength	Type of Analysis	Elevation of Failure Plane ft. NGVD	Safety Factor Computer:Manual	Footnotes
<u>Outlet works embankment, station 73+20 to 81+00</u> <u>(crest elevation 563.0)</u>					
End of construction	Q	Circular Arc	496	2.93 ÷ 2.93	3
End of construction	Q,S	Wedge	495	1.96 ÷ -	1,5
End of construction	Q,S	Wedge	494.5	1.34 ÷ 1.36	1,6
End of construction	Q,S	Wedge	496	1.40 -	1,3
Steady seepage	$\frac{S,R+S}{2}$	Circular Arc	496	1.50 ÷ -	7
Steady seepage w/surcharge pool	$\frac{S,R+S}{2}$	Circular Arc	496	1.50 ÷ 1.50	8
Partial pool	$\frac{S,R+S}{2}$	Circular Arc	515	1.42 -	7

FOOTNOTES

- | | |
|---|--|
| 1. 50% excess pore water pressure in foundation | 5. Failure plane through shale |
| 2. Failure plane through base of embankment | 6. Failure plane through bentonite ~~am~~ |
| 3. Failure plane through overburden | 7. Conservation pool elevation 522.0 |
| 4. Failure plane through weak overburden | 8. Surcharge pool elevation 557.5 |
| | 9. Through spillway |

LEFT EMBANKMENT
TABLE 6-3

Condition	Shear Strength	Type of Analysis	Elevation of Failure Plane ft. NGVD	Safety Factor Computer:Manual	Footnotes
<u>Left embankment, station 82+00 to 224+40</u> <u>(crest elevation 563.0)</u>					
End of construction	Q	Circular Arc	505	3.40 * -	3
End of construction	Q,S	Wedge	505	1.45 * 1.43	1,3
End of construction	Q,S	Wedge	504	1.97 * -	1,5
End of construction	Q,S	Wedge	503.5	1.35 * 1.37	1,6
Steady seepage	$\frac{S,R+S}{2}$	Circular arc	525	1.47 * 1.47	2,7
Steady seepage	$\frac{S,R+S}{2}$	Circular arc	505	1.50 * -	3,7
Steady seepage w/surcharge pool	$\frac{S,R+S}{2}$	Circular arc	525	1.47 * -	2,8
End of construction	Q	Circular Arc	460	2.92 * -	5,9
End of construction	Q,S	Wedge	459	1.54 * 1.55	1,6,9

FOOTNOTES

- | | |
|---|--|
| 1. 50% excess pore water pressure in foundation | 5. Failure plane through shale |
| 2. Failure plane through base of embankment | 6. Failure plane through bentonite ~~mm~~ |
| 3. Failure plane through overburden | 7. Conservation pool elevation 522.0 |
| 4. Failure plane through weak overburden | 8. Surcharge pool elevation 557.5 |
| | 9. Through spillway |

a. Sudden Drawdown. - Pool elevation probability and duration curves for Joe Pool Lake (plate 53) indicate that the reservoir will stay at or below conservation pool elevation 522 approximately 90 percent of the time, and at or below elevation 530 approximately 99 percent of the time. Further, average pool recurrence interval curves indicate that elevation 530 has a 15.5-year recurrence interval, and elevation 538.5 has a 100-year interval. The sudden drawdown condition is therefore not considered applicable as it is unrealistic that pool durations at the higher elevations would cause saturation of the highly impervious embankment materials. Thus, analyses assuming sudden drawdown conditions were not performed.

b. Stability of the Floodplain Embankment.

(1) End of Construction. - The wedge method was used to analyze the floodplain embankment assuming end-of-construction conditions; i.e., water table located at natural ground and using Q-strength in the embankment and foundation. The minimum calculated factor of safety was 1.23 (by computer) for the embankment section having 1 vertical on 8 horizontal slopes and a crest elevation of 564.5. A factor of safety less than the 1.3 was deemed satisfactory by CESWD in an Endorsement to the General Design Memorandum.

(2) End-Of-Construction With Excess Pore Pressure. - The floodplain embankment was analyzed using the wedge method assuming end of construction conditions with 50 percent excess pore pressure in the foundation; i.e., groundwater at natural ground, Q-strength in the embankment, S-strength in the foundation overburden and primary, and a positive excess pore water pressure head in the foundation equal to the height of the embankment. For embankment slopes of 1 vertical on 8 horizontal, a crest elevation of 564.5, and assuming failure planes through the weak overburden

and bentonite seams, the computer factors of safety were 1.52 and 1.41, respectively. A manual check of the last safety factor gave a value of 1.40 for the failure plane passing through the bentonite seam (plate 56).

(3) Steady Seepage. - The following analyses were performed assuming embankment crest elevation 563.0 and 1 vertical on 10 horizontal slopes.

(a) The floodplain embankment was analyzed assuming steady seepage conditions developed at conservation pool elevation 522 (plate 57). The wedge method was used and a minimum factor of safety of 2.13 was calculated for a failure surface along the base of the weak overburden clays. Failure surfaces along the base of the embankment at natural ground were also investigated, and a local minimum factor of safety of 2.20 was calculated.

(b) The floodplain embankment was not analyzed assuming steady seepage conditions with a surcharge pool. The analyses discussed in paragraph (a) above has a sufficiently high computed factor of safety to eliminate performing this analysis; i e., experience indicates that analyses assuming short duration surcharge pools do not produce critical calculated factors of safety for embankment geometries like Joe Pool.

(4) Partial Pool. - The floodplain embankment was analyzed using the wedge method assuming crest elevation 563.0, 1 vertical on 10 horizontal slopes, and partial pool conditions (plate 57). A minimum factor of safety of 2.01 was calculated for a failure plane along the base of the embankment crest with the critical pool elevation being 520. Manual calculations were not performed for this analysis.

c Stability of the Outlet Works Embankment. - The following analyses were performed assuming embankment crest elevation 563.0.

(1) End of Construction. - The outlet works embankment section with crest elevation 563.0 was analyzed using the circular arc method assuming end-of-construction conditions; i.e., water table at natural ground and Q-strength in the embankment and foundation. A minimum computed factor of safety for a circular arc failure tangent to the base of overburden was 2.93 (plate 58). Investigation of other tangent elevations revealed very similar calculated factors of safety. For example, a local minimum factor of safety of 2.94 was calculated for circles passing tangent to the base of the embankment.

(2) End of Construction With Excess Pore Pressure. - The outlet works embankment section with crest elevation 563.0 was analyzed using the wedge method assuming end of construction conditions with 50 percent excess pore pressure in the foundation; i.e., groundwater at natural ground, Q-strength in the embankment and S-strength in the foundation overburden and primary, and an induced excess pore water pressure head in the foundation equal to the height of the embankment. A local minimum factor of safety of 1.96 was calculated for wedge failures through the shale (plate 33). The minimum factor of safety calculated was 1.34 for a wedge through a bentonite seam using $\phi = 18$ degrees for the bentonite. Manual calculations for the failure plane passing through the bentonite seam gave a calculated factor of safety of 1.36 (plate 59).

(3) Steady Seepage. - The steady seepage condition controls the design of the downstream slope of the outlet works embankment section.

(a) The outlet works embankment section with crest elevation 563.0 was analyzed using the circular arc method assuming steady seepage conditions developed at conservation pool elevation 522, and the lower cohesion value for

R-strength. The phreatic surface was conservatively simulated as a straight line from its entry point to the downstream toe. The minimum factor of safety calculated by the computer and manual methods was 1.50 for a circle passing tangent to the base of the foundation overburden (plate 60). A local minimum factor of safety of 1.53 was also calculated for a circle passing tangent to the base of the embankment.

(b) The outlet works embankment crest elevation 563.0 was further analyzed using the circular arc method assuming steady seepage conditions developed at conservation pool elevation 522, but with a surcharge pool at elevation 557.5. This analysis did not produce a lower calculated factor of safety than described above.

(4) Partial Pool. - The outlet works embankment section with a crest elevation of 563 was analyzed assuming partial pool conditions using circular arc failure surfaces. Failure tangent to the base of the embankment produced lower calculated factors of safety than did failure through the overburden. Therefore, failure tangent to the base of the embankment will be discussed in detail.

(a) A computer analysis was performed assuming failure surfaces tangent to the base of the embankment using 0.1 tsf as the cohesive portion of the R-strength. The search process showed the most critical circle to be centered at x and y coordinates 140 and 740, respectively, a critical pool at elevation 534, and a calculated factor of safety of 1.26. Since this critical pool is 12 feet above conservation pool elevation 522, the pool duration would be short. Thus, the horizontal line of seepage at this high an elevation assumed in the computer analysis is unrealistically conservative. A manual analysis was performed on the above described critical circle, but assuming

the cohesive portion of the R-strength as 0.2 tsf and a line of seepage more appropriate for a short duration pool at elevation 534. Using these assumptions, the calculated factor of safety is 1.42 (see figure 1, plate 61).

(b) The computer analysis was then rerun using 0.2 tsf as the assumed cohesive portion of the R-strength. The results showed that the critical circle location shifts to x and y coordinates 120 and 680, respectively, and the critical pool shifts to spillway crest elevation 536 (see plate 61, figure 2). As shown in figure 2, the two critical circles of discussion are very similar. Further, they have calculated factors of safety differing by only 0.02. Therefore, a manual analysis was not performed.

(c) The computer analysis was again rerun assuming a constant pool elevation 522 and the higher value of cohesion for R-strength. The grid of computed factors of safety showed the critical circle to shift to x and y coordinates 160 and 800, respectively, with the minimum value being 1.47. Even though this analysis assumed a horizontal line of seepage, it is considered to be a realistic analysis. Figure 3 on plate 61 presents the results of this computer analysis, and, figure 2 presents all three critical circles so that a visual comparison can be made.

(d) Summarizing, the outlet works embankment section was analyzed assuming partial pool conditions. Several analyses were performed using various assumptions. The most realistic assumptions yielded a calculated factor of safety of 1.42 or higher for failure surfaces tangent to the base of the embankment with pool elevations 522 or higher.

d. Stability of the Left Embankment. - The following analyses were performed assuming embankment crest elevation 563 0.

(1) End-of-Construction. - The circular arc method was used to

analyze the left embankment assuming end-of-construction conditions; i.e., water table at natural ground and Q-strength in embankment and foundation. The minimum calculated factor of safety was 3.40 for a failure plane passing tangent to the base of embankment. Manual analyses were not performed for these assumptions.

(2) End of Construction With Excess Pore Pressure. - The left embankment was analyzed using the wedge method assuming end of construction conditions with 50 percent excess pore pressure in the foundation; i.e., groundwater at natural ground, Q-strength in the embankment and S-strength in the foundation overburden and primary, and a positive excess pore water pressure head in the foundation equal to the height of the embankment. Failure planes were assumed to pass through the overburden, shale, and bentonite seam ($\phi = 18$ degrees) in the shale. The computer factors of safety were 1.45, 1.97, and 1.35, respectively. A manual check was made for the first and third cases. These factors of safety were 1.43 (plate 62) and 1.37 (plate 63), respectively.

(3) Steady Seepage.

(a) The left embankment was analyzed by the circular arc method assuming steady seepage conditions developed at conservation pool elevation 522. A minimum factor of safety of 1.47 was calculated for a failure surface through the base of the embankment (plate 64). A local minimum factor of safety of 1.50 was calculated for a failure surface through the overburden.

(b) The left embankment was further analyzed assuming steady seepage conditions developed at conservation pool elevation 522, and a surcharge pool at elevation 557.5. These conditions resulted in a computed factor of safety of 1.47 for a circular failure plane passing through the base

of the embankment (plate 64). Subsequent to these analyses, the maximum design water surface elevation was changed to elevation 559.4. Analyses were not rerun.

e. Stability of the Spillway at the Left Embankment No. 2.

(1) General. - Stability analyses for a section through the spillway at embankment station 100+00 were conducted for end of construction conditions as described below.

(2) End of Construction. - The circular arc method was used to analyze failure through the spillway channel assuming end of construction conditions; i.e., water table at natural ground and ϕ -strength in the embankment and foundation. The minimum calculated factor of safety was 2.92 for a failure plane passing through the shale. Manual calculations were not performed for these assumptions.

(3) End of Construction With Excess Pore Pressure. - The spillway was analyzed using the wedge method assuming end of construction conditions with 50 percent excess pore water pressure in the foundation. The analyses assumed excess pore water pressures in the foundation and a failure plane through a bentonite seam in the shale. The minimum calculated factors of safety were 1.54 by computer and 1.55 by manual methods (plate 65)

6-07. Spillway Foundation Design. - The spillway foundation is unique in that the spillway was designed to be founded on compacted medium plasticity ($30 \leq LL \leq 45$) clays rather than directly on undisturbed foundation materials. Through-seepage will be controlled due to the features discussed below that have been incorporated into the design and construction of the spillway foundation

a. Differential settlement can create cracking in compacted fill

materials and it can destroy a desired water-tight concrete-fill interface. In either case, a path for movement of water can be created. Features incorporated into the spillway design to reduce or contend with differential settlement are:

(1) The left embankment No. 2 (spillway foundation) was constructed using medium plasticity clay materials. This type of fill material is not only impervious, but it should exhibit a higher degree of volumetric stability.

(2) The first contract provided for the construction of the left embankment No. 2 to full height. This allowed for foundation settlement to occur at a non-critical time; thus, differential and total settlement after construction of the spillway under the completion contract was reduced because the foundation was preloaded by the embankment built under the first contract. This preloading was very successful in accomplishing the settlement ahead of spillway construction as shown on plates 91 and 92.

(3) A positive contract pressure between the embankment fill and the concrete U-frame walls of the overflow structure was desirable. To encourage this continuous contract, the walls were designed with a positive batter so that the fill can wedge against the wall and tend to cause the walls and fill to move together as a unit.

b. An embankment filter drainage system was included as an extra measure to intercept, collect and discharge any embankment through seepage. The chimney portion of the drain extends to elevation 560 and provides protection slightly higher than the maximum design water surface elevation 6-08. Spillway Foundation Design Data. - Based on field investigations, laboratory testing, and engineering judgment, the parameters adopted for use

in the foundation design of the structural concrete portion of the spillway were as follows:

Embankment fill and overburden

Unit weight = 125 pcf
c = 400 psf ϕ = 23 degrees
Allowable bearing capacity = 3.0 KSF

Non-expansive backfill

Unit weight = 130 pcf
c = 0 ϕ = 30 degrees

Shale

Unit weight = 130 pcf
c = 400 psf ϕ = 12 degrees
Anchor pullout resistance: 2.0 KSF for the case of assuming full tailwater with impervious blanket failed. 0.8 KSF for the case of assuming full tailwater with impervious blanket intact.
Allowable bearing capacity = 5.0 KSF

Backfill

Unit weight = 125 pcf (except nonexpansive)
Earth pressure coefficients (k):
Within embankment: K-effective = 0.75 (horizontal backfill)
Outside embankment: K-effective = 0.50 (horizontal backfill)
Throughout: K-effective = 1.0 (sloping backfill)

The pullout resistance parameters for anchor design were adopted to compensate for the severe uplift conditions assumed; i.e., to achieve a realistic anchoring scheme. Anchor pull-out tests were performed during construction to confirm the assumed capacity.

VII - CONSTRUCTION

7-01. General. - The embankment, outlet works, spillway and associated structures were constructed under two main contracts. The dike was constructed as part of a relocation of roads contract.

7-02. Overview of Contracts. - The pertinent details for the construction contracts are listed below:

a. Outlet Works and Initial Embankments - The initial contract included an initial floodplain embankment to elevation 514.0 from station

27+00 to station 49+00; a pre-load embankment to elevation 564.5 from station 95+00 to station 105+00 (spillway location); the outlet works tower and associated structures, except for the service bridge, and portions of the outlet works approach and discharge channels. A plan showing the areas of work in the initial contract is presented on plate 2.

b. Completion of Embankment, Spillway and Outlet Works. - During the completion contract, the major work performed included completion of the earthfill embankment, except for the dike which had already been built under a contract for Relocations of Roads, construction of the outlet works service bridge, construction of the spillway, and construction of the roadway on top of the embankment. Other work that was performed during the completion contract included construction of a drop structure near the spillway and completion of the outlet works approach and discharge channels.

c. Relocation of City Streets and County Roads, Road Relocation No. 1, Part I. - During this road relocation contract, the major work performed was the construction of a road that crosses the dike. Also included in this contract was the construction of a small portion of the embankment, station 217+75 to station 223+65, and the dike on the west end of the embankment, station 228+67 to station 249+60.

7-03. Contract Data

a. Outlet Works and Initial Embankments

- (1) Contract No - DACW63-80-C-0009
- (2) Contractor - The Lane Construction Corp., Meriden, CT
- (3) Contractor's Bid - \$11,200,632.50
- (4) Notice to Proceed - 6 Dec 79 (acknowledged)
- (5) Actual Completion Date - 4 Jun 82

b. Completion of Embankment, Spillway, and Outlet Works.

- (1) Contract No. - DACW63-81-C-0191
- (2) Contractor - Servidone Construction Corp, Castleton, NY
- (3) Bid Price - \$25,781,338.18
- (4) Notice to Proceed - 18 May 82 (acknowledged)
- (5) Actual Embankment Completion Date - Sep 85±

c. Relocation of City Streets and County Roads. Road Relocation No. 1 -

Part I.

- (1) Contract No. - DACW63-82-C-0092
- (2) Contractor - H.B. Zachary Co., Grand Prairie, Texas
- (3) Bid Price - N/A
- (4) Notice to Proceed - 28 Jun 82 (acknowledged)
- (5) Actual Completion Date - 7 Feb 84

7-04. Contract Fill Estimates (Approximate). -

a. Outlet Works and Initial Embankments

- | | |
|-----------------------|--------------------------|
| (1) Impervious | 0.75 million cubic yards |
| (2) Select Impervious | 0.16 million cubic yards |
| (3) Random | 0.91 million cubic yards |
| (4) Semi-Compacted | 1.33 million cubic yards |
| Total | 3.15 million cubic yards |

b. Completion of Embankment, Spillway and Outlet Works

- | | |
|-----------------------|--------------------------|
| (1) Impervious | 2.05 million cubic yards |
| (2) Select Impervious | 0.54 million cubic yards |
| (3) Random | 3.94 million cubic yards |
| (4) Semi-Compacted | 2.98 million cubic yards |
| Total | 9.51 million cubic yards |

c. Relocation of City Streets and County Roads No. 1, Part I. - The

di-ke portion of the embankment was constructed as an unzoned, uniform fill. Fill quantity was small and is, therefore, not summarized herein.

7-05. Embankment Construction Equipment. - The equipment used for the construction of the embankment was similar for both of the main contracts. The specification governing compaction equipment was based on the Civil Works Construction Guide Specification CW-02212. The following subparagraphs provide general information on the embankment construction equipment.

a. Excavating and Hauling Equipment. - During both contracts, the primary methods of excavating borrow materials was with Holland loaders and scrapers. The Holland loaders were used to fill scrapers and belly dumps. In addition, during the completion contract, end dumps were used to haul fill.

b. Processing and Compacting Equipment. - Fill materials were processed on the fill using a fleet of equipment including 36-inch diameter discs, graders, water wagons and dozers. The materials were always processed by discing to either achieve uniform moisture or to achieve breaking up and blending. If discing was performed to achieve uniform moisture, none was required for breaking up and blending. Compaction during both contracts was primarily accomplished using sheepsfoot rollers

7-06. Foundation Protection. - The clay shales encountered at this site deteriorates and degrades to clay if allowed to undergo cycles of wetting and drying. To contend with this, the contracts required timely excavation and protection by covering final surfaces within specified times. Each contract included an excavation staging/phasing for the purpose of protection of final clay shale surfaces as shown on plate 18 for the outlet works and plate 17 for the spillway. These controls were adequate and enforceable.

7-07. Construction Problems.

a. General. - The inherent properties that make CL and CH clays desirable for use in an embankment also produce characteristics that make them tough and hard to manage. Every phase of the production process, from excavation to placement, processing, compaction and preserving the in-place moisture content can be a frustrating, but normal experience. The materials used on this project are some of the toughest that can be found for the liquid limit ranges involved in that they plot near to and paralleling the U-line on a plasticity chart. At low moisture contents, they can be hard and dusty, and upon wetting become sticky, slick, stiff to soft and muddy. At all moisture levels encountered in the construction process, these fat clays form chunks or clods of sizes dependent somewhat on the excavation method. While clod size was not a problem with respect to acceptability, a layer of fill left "open" on the fill usually created severe moisture control problems. During both contracts, moisture control was considered by the contractors to be their major problem. This is understandable because in-place moisture was the main acceptance criteria. Both contractors routinely chose to perform moisture adjustment on the fill rather than at the borrow. However, when used, moisture adjustment at the borrow worked very well, especially when done in conjunction with scraper excavation operation. The lack of selectivity in the borrow including mass vertical face excavation using Holland loaders nearly always created layers of fill having wet and dry areas. Thus, watering the layer on the embankment put water on the materials not needing water, and the opposite problem occurred when discing for the purpose of assisting the drying process was performed. When a layer of material is left open after either having been discd or freshly dumped, individual chunks of material upon

drying form crusts. Water sprayed onto the fill at any rate faster than a fine mist quickly flows off the chunks and accumulates at the bottom of the loose layer. Thus, trying to solve the problem of dry, crusted materials in one area can create an entire under-laying of materials that are too wet. Though this is not an uncommon situation on any high plasticity embankment job, it seemed that on this one, especially the completion contract, that the lesson had to be learned over and over again. Additional problems for each contract are discussed below.

b. Initial Contract.

(1) During the initial contract, it became apparent that the availability of select impervious fill materials having a 30 to 45 liquid limit range without an unreasonable amount of selective borrowing was a problem. Designers from CESWF and CESWD jointly agreed that the problem should be solved by expanding the definition of select impervious fill so as to allow materials with liquid limit ranges from 30 to 60 for all locations except for the spillway foundation. The contract was modified accordingly.

(2) Shortage of water for spraying onto the fill, combined with record high temperatures, became a problem during the summer of 1980. The contractor resorted to pumping water from the Mountain Creek Lake which is located downstream of this project.

(3) Completion Contract. - The major problems associated with this contract from the contractor's point of view was moisture control. This is understandable since moisture was the main acceptance criterion. From the Government's point of view, one of the main problems was lack of contract compliance, especially with respect to safety and lack of CQC enforcing contract requirements. For example, the following summary shows the magnitude

of some of the problem areas as documented on the construction daily logs:

<u>Subject</u>	<u>No. of Different Days on Which the Incidence Was Documented</u>
1. Improper or no scarification of previous lift	101
2. Government temporarily stopped/halted some of contractor's equipment (while active) due to safety violation	60
3. Roller passes shorted or otherwise deficiently performed	54
4. Fill lift too thick	127
5. Roots/organics in fill	39
6. Safety: Construction equipment operated too close to pedestrians	11
7. Safety: Dusty haul roads	203
8. Safety: Haul road too narrow	66
9. Safety: Flagperson needed	32
10. Safety: Back-up alarm violation	175
11. Safety: Operator on large equipment more than 10 hours	21
12. Safety: Inadequate brakes on large equipment	42
13. Safety: Large equipment being driven too fast	77
14. Safety: Unattended large equipment with engines running	77
15. Accident: Large equipment crash/overturned	21
16. Safety: Seat belt violation	41
17. Safety: Hard hat violation (not worn)	130
18. Safety: Improper or inadequate clothes	35

In addition to the above type problems, throughout the job there was great reluctance on the contractor's part concerning his reworking areas

4-20-4
failing to meet contract requirements. The contractor's point of view was that a passing test represented a large volume of fill and that a failing test required him to only rework an area the width of a dozer blade by about 30 feet in length. To contend with this, the Government chose retest locations that may or may not have been located where the original test failure occurred. The actual volume of rework performed on the job is estimated at less than one percent of the total volume.

7-08. Construction Modifications.

a. Initial Contract. - During the initial contract, the following modifications were implemented.

<u>Mod No.</u>	<u>Description</u>	<u>Approximate Amount (\$)</u>
P00001	Relocate fence at archaeological site west of outlet works	180
P00002	Delete note on Sequence No. 4 for optional use of house and buildings by contractor, provide barbed wire fence around old house and building	22,000
P00003	Allow topsoil stockpiling upstream of the left embankment (credit)	-3,650
P00004	Revise low flow intake and other miscellaneous items in the Outlet Works-Intake Structure, and delete the stilling basin stop logs and lifting beams (credit)	-24,827
P00005	Construct Government office complex using an existing trailer and a new contractor furnished trailer	22,927
P00006	Expand the liquid limit (LL) range of compacted impervious backfill used for the outlet works to be equal to or greater than 40 and less than or equal to 70	0
P00007	Revision of specifications for select impervious fill to having: $30 \leq LL \leq 45$ within 75 feet of the spillway centerline, and $30 \leq LL \leq 60$ for all other areas	0

<u>Mod No.</u>	<u>Description</u>	<u>Approximate Amount (\$)</u>
P00008	Provide aerospray 52 and 1-1/2-inch thick protective concrete in lieu of pneumatic concrete in the excavation for conduit joint footings (credit)	-3,517
P00009	Revise arrangement of low flow gate hoists and shear connectors to roof double tees	635
P00010	Install embedded material for stop log slot in stilling basin monolith No. 6 of the outlet works intake structure. Also, revision of a portion of P00004.	14,672
P00011	Revise concrete finish in a portion of the Outlet Works-Intake Structure	810
P00012	Revise Special Provision 23 by deleting "DD Form 1140-1" and substituting "Standard Form 295"	0
P00013	Provided 9 additional days due to weather	0
P00014	Provided 26 additional days due to weather	0
P00015	Provided 7 additional days due to weather	0
P00016	Provided 15 additional days due to weather	0
P00017	Delete installation of letters on Outlet Works Tower (credit)	-750
P00018	Provided 12 additional days due to weather	0
P00019	Procurement of additional supplies for QA testing	9,967
P00020	Repair of floodplain slope erosion	8,500
P00021	Provided 1 additional day due to weather	0
P00022	Payment of interest on monies due the contractor concerning clearing and grubbing	1,429
P00023	Repairs associated with service gates and an increase of 18 days in the contract	60,278
P00024	Stripping and exploration of a borrow source for materials to construct the spillway embankment	35,000
P00025	Non-shrink grout for anchor bars, and extended contract by 52 days	13,365

b. Completion Contract. - During the completion contract, the following modifications were implemented.

<u>Mod No.</u>	<u>Description</u>	<u>Approximate Amount (\$)</u>
P00001	Time of performance extended 215 days for delay in issuing notice to proceed from 15 Oct 81 through 18 May 82	0
P00002	Furnish 2 trailers for Government offices	99,595
P00003	Revision of centerline profile of the deep inspection trench approximately between stations 10+50 and 8+10	27,074
P00004	Provide electrical services	83,500
P00005	Revision of finish grade of spillway slabs monoliths No. 4 through No. 13	2,104
P00006	Compensation for delay in issuing notice to proceed	449,995
P00007	Traffic control and barricades to close Belt Line Road	6,481
P00008	Interest on Modification P00006	40,711
P00009	Additional excavation of unsuitable material	220,000
P00010	Revision of spillway expansion joint (credit)	-350
P00011	Provision for grouted riprap in the areas of the outlet works access to fishing platform	2,320
P00012	Provision and installation of project name on the Outlet Works Tower	12,000
P00013	Provided 72 additional days due to weather	0
P00014	Administrative change (increase in funds available)	N/A
P00015	Revision of spillway finish from Class B to Class D and furnish water well (credit)	-10,000

7-09. Construction Photographs. - Selected photographs taken during and subsequent to the main contracts are presented on exhibits 1 through 11

SECTION VIII - EMBANKMENT FILL QUALITY ASSURANCE

8-01. General. - Embankment fill construction was controlled and monitored through a Contractor Quality Control (CQC) system and a Government Quality Assurance (GQA) system, respectively. Only the latter will be discussed herein. The GQA system included an acceptance sampling and testing program and visual observations by inspectors. Sampling and testing were accomplished using frequencies deemed necessary by the Contracting Officer. Quality assurance samples were selected from lifts-below-compacted lifts; i.e., samples were not taken until the materials were covered by a minimum of one lift of compacted fill. The specifications indicated that the GQA Program could consist of each sample being tested for classification, moisture content, liquid limit and bar linear shrinkage. In addition to the above, approximately every fifth sample could have included in-place density and plastic limit tests. On approximately every tenth sample, a Standard compaction test could be run in addition to the tests outlined for every fifth sample. During construction, unacceptable material or unacceptable in-place moisture contents resulted in either reworking, removal, or retesting of the material in question. Since in-place density was not specified for the rolled fill, materials were never rejected because of density. Experience on this and previous projects in similar materials has proved that at least a 95 percent Standard density is obtained provided the lift thickness, moisture content, and compactive effort are in accordance with the specifications. These provisions, when combined with the controls afforded by the Liquid Limit Correlation Method, form a superior fill placement quality assurance program in these type materials.

8-02. Fill Properties - On a monthly basis, data from the GQA laboratory

tests on the impervious, select impervious, random and semi-compacted zones were summarized on ENG Form 4080. A plasticity chart for materials from the borrow areas is shown on plate 68. The following tabulations provide summaries of some of the pertinent engineering data.

a. Initial Contract (All Values Are Approximate)

<u>Fill Zone</u>	<u>Average LL</u>	<u>Average PI</u>	<u>Average W</u>	<u>Average W-W_o</u>	<u>Average % Compaction</u>
Impervious (Outlet Works)	60	38	23.2	+2.0	100
Impervious (Embankment)	72	49	25.9	+1.9	102
Select Impervious (Under Spillway)	43	28	18.7	+1.5	106
Select Impervious (Embankment)	52	34	20.7	+1.4	105
Random	71	50	25.5	+1.7	103
Semi-Compacted	66	43	24.1	+1.0	104

LL - Liquid Limit
 PI - Plasticity Index
 W - Field Water Content
 W_o - Optimum Water Content

b. Completion Contract (All Values Are Approximate)

<u>Fill Zone</u>	<u>Average LL</u>	<u>Average PI</u>	<u>Average W</u>	<u>Average W-W_o</u>	<u>Average % Compaction</u>
Impervious	67	46	25.6	+1 6	104
Select Impervious	52	36	21.4	+1.5	105
Random	67	46	25.3	+1 1	105
Semi-Compacted	69	47	25.2	+0 6	106

8-03. Liquid Limit Correlation Method. - Acceptance of fill moisture was accomplished using the Liquid Limit Correlation Method. This method has been

utilized successfully on numerous embankments within CESWF. Embankment and borrow samples are used to establish correlation curves that represent the relationships between liquid limit and optimum moisture, and liquid limit and maximum dry density. Thus, a liquid limit value obtained from an embankment sample during construction is used in conjunction with the correlation curves to determine the maximum dry density and the optimum moisture content for that sample. These values are then compared with the in-place moisture and/or density to determine compliance with specified moisture requirements and to verify desired compaction.

a. Establishment of Correlation Curves. - Tests were initially performed on materials representing the range of materials expected from the borrow areas and from required excavations using materials obtained from borings. These data were used to establish the so-called "starting" curves for the initial contract. The data obtained during the initial contract were used to establish the "starting" curves for the completion contract

b. Updated Correlation Curves. - During the construction, the Government continued to conduct compaction and other tests to evaluate the current curves and to make appropriate update changes or extensions to them. The correlation curves utilized on both construction contracts are presented on plates 66 and 67.

c. Use of Correlation Curves. - The relationship of field moisture content to specified values was determined in the Government's on-site laboratory for each embankment sample. Sand cone densities and Standard compaction tests were performed less frequently. A complete summary for the completion contract (Government Quality Assurance Tests) is as follows:

GQA Test Types	Test Frequency (Test/Cubic Yards) (Completion Contract)					
	Req'd By Contract	COE Manual*	Imp. Fill	Random Fill	Semi- Compacted Fill	Combined All
Moisture Content & Liquid Limit (MC & LL)	As Deemed Necessary By Gov't	Not Stated	1/470	1/1080	1/3480	1/940
Field Density (in addition to MC & LL)	Approx 1/5 the freq. of MC & ML	1/1000 to 1/3000	1/2600	1/6040	1/29,050	1/5280
Standard Compac- tion (in addition to field density, MC & LL)	Approx 1/10 the freq. of MC & LL	Not Stated	1/7400	1/18,740	1/58,680	1/15,420

*EM1110-2-1911

As indicated in the tabulation, the frequency of testing was greater in the more important central zone and lesser toward the outer zones. The methodology was such that the laboratory personnel would run liquid limit and moisture content tests on control samples and then compare the optimum moisture obtained from the correlation curve to the sample moisture content. The specifications allowed the following range of in-place moisture contents:

<u>Fill Zone</u>	<u>Allowed Moisture Content Range From Optimum, %</u>
Impervious	0 to +3
Select Impervious	0 to +3
Random	-2 to +3
Semi-Compacted	-2 to +3 (initial contract) -5 to +4 (completion contract)

The contractors were always allowed a deviation of at least 0.4% outside the

specified ranges. Field density, obtained by sand cone, was compared with the maximum laboratory density obtained from the correlation curve of liquid limit versus 100 percent of maximum Standard compaction density. The target or desired minimum density was equal to or greater than 95 percent of maximum laboratory density, although no minimum was specified. The usual range of achieved values was from 95 to 120 percent compaction. This range for percent compaction is also typical for other CESWF embankments involving CL and CH materials.

d. Accuracy of the Method. - The liquid limit correlation method is well suited for use on CL and CH clays. This fact makes it ideal for use in most areas of CESWF. Due to the contractor's contention in a claim that the method was inaccurate, an extensive study was undertaken to show otherwise. Since nearly 600 Standard compaction tests had been performed during the completion contract in conjunction with the liquid limit test, a "what if" type comparison was easy to perform concerning acceptance of in-place moisture content. The following is a summary of the comparison expressed as percentages of the total tests in each zone on which the compaction test was performed.

<u>Fill Zone</u>	<u>Based on LL</u>		<u>If Standard Compaction Test Had Been Used</u>			
	<u>% Pass</u>	<u>% Fail</u>	<u>% Pass</u>	<u>% Fail</u>	<u>% Pass But Failed by LL</u>	<u>% Fail But Passed by LL</u>
Impervious	80-83	17-20	60-62	38-40	3-4.5	23-25
Random	88-89	11-12	73-76	24-27	1-3	13-19
Semi-Compacted	95-97	3-5	93-97	3-7	2.5-3	3-5
Select Impervious	81-82	18-19	64-73	27-36	5-5.5	13-22

Stated differently, the results of the "what if" comparison as to acceptable in-place moisture content shows the following.

Both methods agree (Both pass or both fail)	75% - 80% of cases
Compaction test would have given a failure when LL method did not	17% - 21% of cases
LL method gave a failure when compaction test would not	3% - 4% of cases

Based on this comparison, the liquid limit correlation method did not adversely affect the contractors; and in fact, according to these data, it appears to have been "easier" on them than waiting and using the Standard compaction tests results in that moisture content failure rates would have been higher. The U.S. Claims Court agreed with the above.

8-04. Moisture Content Failure Rate. - Final acceptance or rejection of in-place fill based on its moisture content was accomplished using the liquid limit correlation method as described above. Government Quality Assurance testing was performed at locations previously selected by designers and at locations selected by the construction personnel based on their judgment. Based on the results of this testing on initial tests (i.e., not considering retesting of failed areas), the percent of tests failing to meet specified moisture content ranges understandably varied as a function of the magnitude of allowed moisture range or "window". This variation can be seen numerically for the completion contract in the tabulations in paragraph 8-03, and graphically for both contracts on Plate 69. By comparison to other dams in CESWF which involved high plasticity clays, it can be seen that the test failure rate on the Joe Pool project was not unusual. This comparison is presented on Plate 70. Failing tests were reported to the contractors for them to rework each area

8-05. Construction Inspection By Geotechnical Personnel. - Foundation

preparation and fill construction were inspected and evaluated by geotechnical engineers throughout both the initial and completion contracts. All foundation approval was performed by a geotechnical engineer, and all excavations and inspection trenches were mapped and approved by a project geologist.

SECTION IX - RECORD SAMPLES

9-01. General. - A total of 42 record samples were obtained during both of the construction contracts. The purpose of these record samples was to obtain data to compare to the assumed design parameters and to provide documentation of as-built conditions. These samples were taken from the impervious, select impervious, and random zones of the embankment. Record samples were not taken from the semi-compacted fill zones. Record samples were obtained at depths of greater than 2.5 feet below the then current fill elevation to ensure that they would represent materials to be left in-place.

9-02. Sampling and Testing. - At each record sample location, both undisturbed and disturbed samples were obtained. The undisturbed sampling consisted of pushing a 7.5-inch diameter by 10-inch high steel sampler into the compacted fill by jacking against a dozer blade, trimming around it, followed by removal and sealing the ends. The disturbed (bag) samples consisted of about 150 pounds of fill and were obtained from the material surrounding the undisturbed samples. The samples were transported to the CESWD Laboratory in Dallas, Texas, for testing. The record sample testing was not always very timely; i.e., up to a year passed before testing some samples actually occurred as shown on plate 79. The effect of this long sample storage time on strength is not known. The record samples were subjected to the following laboratory tests: visual classification, grain size analysis

(mechanical and hydrometer), Atterberg limits, bar linear shrinkage, specific gravity, expansion consolidation, Standard compaction, direct shear (S), unconsolidated undrained (Q), and consolidated undrained (R) tests.

9-03. Laboratory Test Results and Evaluation. - The record sample test summary shown on plate 79 indicates the zone, location, and some of the engineering parameters other than shear strengths determined from record samples. The table also indicates that of the 42 record samples, 22 tests were in the impervious zone, 5 tests were in the select impervious zone, and 15 tests were in the random zone. For comparison to design values, the shear strengths from record samples as determined by Q, R, and direct shear (S) tests have been plotted for each contract as shown on plates 71 through 78. These plots show that the as-built Q and R strengths are at or above design assumptions and that the S strengths are at or slightly below. These slight variations from design assumptions can be attributed to the fact that the average liquid limits of the materials actually utilized by the contractors was higher than assumed during design. The use of these higher plasticity materials will result in higher shrink-swell capacity and the potential for shallow surface sloughs and/or down-slope creep. This is a common maintenance problem for embankments in this area of the country. These problems are usually first evident as cracking at the crest edges. Slides are usually initiated as water enters cracks and lubricates these shallow failure planes. On Joe Pool, an experimental downstream concrete edge cover was constructed along a major length of the embankment to serve as a surface water shed. This is the second embankment in SWF where this technique is being studied.

SECTION X - EMBANKMENT AND FOUNDATION INSTRUMENTATION

10-01. General - For purposes of performance evaluation and construction

monitoring, the following instruments were installed: piezometers, settlement plates, embankment station monuments, outlet works reference pins, spillway reference marks, deep bench marks and heave points. Plans of instrumentation locations are presented on plates 98 through 100. These devices were installed and monitored by the contractors and the Government in accordance with the schedules as outlined on plates 80 through 81. In addition, these plates provide information on location and design of the various types of instruments.

10-02. Piezometers.

a. General. - There were a total of 18 porous plastic tip piezometers installed by Government forces during construction of this project. Plates 80, 81 and 98 through 100 provide information on the location, filter elevation, and design of the piezometers. This type of piezometer has been used on numerous projects throughout CESWF and has proven to function well in a variety of materials including clay shales, granular and high plasticity clay materials. The piezometers were installed to monitor any excess pore pressures developed in response to fill placement, and any seepage pressures after impoundment. Excess pore pressure in this report is defined as the ratio of increased piezometric pressure above natural ground to the increased foundation pressure due to fill at that location, expressed as a percentage. Piezometers were installed along four sections in the floodplain and at the spillway. Readings of these instruments were taken by the contractors on a weekly basis, while the Government verified the readings at random. Since completion, the piezometers have been read on a quarterly basis. All other instrumentation is being read annually. Pool elevation vs time is presented on plate 82. Analyses of the piezometer readings are presented in the

following paragraphs.

b. Station 16+00± - The initial plans for this station called for the installation of three piezometers in a supposed pervious buried stream channel. Investigations during the construction of the embankment and the installation of P-10 and P-12 failed to show any indications of a pervious channel. Therefore, P-11 was not installed. Plots of piezometric elevation, fill placement and lake elevation versus time are shown for P-10 and P-12 on plate 86. Piezometer P-10 is located in a sandy clay layer of the overburden and showed no readings until a few months after completion of fill placement. P-10 readings remained at approximately 1 foot above the tip until 1988. Since then it has been dry. Piezometer P-12, which is located in weathered clay shale, responded immediately to fill placement with a maximum excess pore pressure response of less than 10 percent. Its readings steadily declined until a slight increase in 1989 to slightly above the level recorded in 1983.

c. Station 38+50± - At this section, five piezometers were installed, two in unweathered clay shale and three in overburden materials. Piezometers P-1 and P-3 were placed in the unweathered clay shale and have shown the responses as shown on plate 83. P-1 reacted immediately to fill placement and reached a maximum excess pore pressure of less than 60 percent. Since the completion of fill placement, P-1 has shown a steady decrease in pressure and without any response to pool. Piezometer P-3 has shown a slow, but steady increase in pore pressure, but of insignificant magnitude. Piezometers P-2, P-4A, and P-13 were installed in the overburden clays and provided the data as shown on plate 87. P-2 showed an excess pore pressure response of less than about 10 percent which has since been decreasing. A falling head test and subsequent readings have shown that P-2 is obstructed at El. 463± and may

no longer be functioning properly. Piezometer P-4A was installed to replace P-4 which was damaged during construction. P-4A has shown no response to either fill placement or pool. Piezometer P-13 reacted several months after completion of fill placement and showed an increasing level until its submergence. However, using the definition herein, it did not exhibit any excess pore pressure.

d. Station 50+00+ - Three piezometers (P-14, P-15 and P-16) were installed in a gravelly-sandy clay at this section of the embankment. Readings are shown on plate 88. Piezometer P-14, which is located downstream, has shown essentially no change in readings. P-15 is located near the embankment centerline and responded rapidly to fill placement with an excess pore pressure of less than 25 percent. Pore pressure then dissipated until impoundment. Since then, P-15 readings have reflected changing pool levels. P-16 was abandoned due to submergence. It showed no excess pore pressure response during fill placement.

e. Station 63+00+ - Piezometers P-17, P-18, and P-19 were installed in overburden clays at this section of the embankment. Readings are shown on plate 89. Piezometer P-17 has remained dry, while P-18 and P-19 responded minimally to fill placement. None have shown any response to pool changes. Piezometer P-19 has been submerged.

f. Spillway - Station 100+00+ - Five piezometers were installed in the vicinity of the spillway with readings as shown on plates 84 and 85. Piezometers P-6, P-8, and P-9 are located in weathered clay shale, and P-5 and P-7 are located in clay overburden. All five of these piezometers have remained relatively dry or have shown very slight response to pool changes.

g. Analysis of Piezometric Data - With the exception of piezometer P-

15, all of the piezometers have shown no substantial response to pool changes. All the floodplain piezometers within the limits of the embankment displayed an increased piezometric surface due to fill placement. Several of the floodplain piezometers have shown what appears to be either a very minimal horizontal translation of pore pressure related to the construction of the embankment or a response to pool. In the area of the spillway, there has been essentially no increases in piezometric elevations due to the reservoir pool elevation nor due to the fill load. The maximum excess foundation pore pressure profile actually experienced during construction was less severe than assumed during design.

10-03. Settlement Plates.

a. General. - During the initial contract, there were a total of six settlement plates installed - two in the floodplain and four at the spillway. The three settlement plates located at the embankment-foundation contact were installed by the Contractor. The remaining three required drilling and were installed by the Government. These deeper plates are designated with "D" prefixes for "deep". All settlement plates were maintained and read by the Contractors on approximately a weekly basis. Plate 81 shows the details for both types of instruments, while plates 98 and 99 show their locations. Since completion of this project, the Government has been conducting annual surveys

b. Floodplain - Station 38+50± - There were two settlement plates installed at this location of which DSP-1 was placed on top of the weak overburden clay layer at El. 444±, while SP-1 was placed at the embankment-foundation contact. Plate 90 indicates there has been slightly over 20 feet of total settlement occurring in the foundation materials as recorded by SP-1. Based on DSP-1, the upper 29± feet of overburden has accounted for about 10

foot of this total and an equal amount has occurred in the remaining overburden (12± feet) and primary materials. Rate of settlement has been decreasing and is approaching 0.05 foot per year. Most of this remaining settlement is occurring in the primary materials.

c. Spillway - Station 100+00± - Four settlement plates were installed to monitor the spillway foundation. One shallow and one deep settlement plate was placed on each side of the spillway. For purposes of discussion, the spillway can be divided into left side settlement plates (station 100+50±) and right side settlement plates (station 99+50±) as shown on details No. 1 and 2 on plates 91 and 92. These instruments were installed to evaluate the success of preloading the foundation by monitoring settlement and/or heave prior to and after the construction of the spillway. The right side instruments consist of SP-2 and DSP-2 which were placed at the embankment-foundation contact and on top of weathered clay shale, respectively. Plots of the settlement plate movements for SP-2 and DSP-2 are shown on plate 91. The left side consists of SP-3 located at the embankment-foundation contact and DSP-3 located on top of unweathered clay shale. A plot of the movements associated with SP-3 and DSP-3 is presented on plate 92. During the preloading stage, the right side (east) underwent a total settlement of about 0.4 foot, while the left side showed about 0.3 foot. Both sides showed about a 0.1-foot rebound or heave at the foundation contact in response to excavation for constructing the spillway. Subsequent to spillway construction and fill placement, both sides of the spillway have approached the same total settlement value of 0.3 foot. About one half of this total occurred in the overburden materials and one half in the primary materials. The rates of settlement have now essentially approached zero.

d. Analysis of Settlement Data. - The settlement plate surveys indicate settlement magnitudes that are within expected ranges. The preloading of the spillway foundation can be considered a success in that differential settlements were essentially avoided, and total settlement occurring after the reloading has been about 0.1 foot.

10-04. Embankment Station Monuments.

a. General. - Embankment station monuments were installed at every whole numbered station from station 3+00 to station 219+00. Plate 81 shows the typical detail for these monuments that were placed on the downstream portion of the crest along the guard rail. Surveys have been conducted to coincide with periodic inspections.

b. Analysis of Crest Movements. - Plate 93 shows the comparison of the initial survey to the latest survey. This amount of settlement reflected corresponds to the amount also recorded by the settlement plates. Thus, the consolidation reflected by the crest surveys is accountable for as foundation settlement rather than within the embankment itself. The greatest amount of settlement recorded has understandably been recorded in the closure section (station 41 to 63).

10-05. Outlet Works Reference Pins.

a. General. - Reference pins were installed during the initial contract along the invert of the outlet works intake tower and conduit, along the discharge chute, and on the stilling basin walls. A typical detail of these pins is shown on plate 81. These pins have been read a total of four times since July 1985, not including the initial survey which was conducted in September 1984. This initial survey was used as a base line with all movements being referenced to this line.

b. Analysis of Outlet Works Reference Pin Data. - Plate 94 shows a plot of the surveys along the invert of the tower and conduit. These surveys indicate essentially no changes in any of the referenced locations. Most of these apparent differential movements (less than 0.1 foot) can be assumed to be related to survey inaccuracy rather than conduit settlement. To date no surveys have been conducted on the pins in the discharge chute; however, steps are being taken to verify that they do exist and to begin taking readings. Plates 96 and 97 provide a tabulation of the horizontal and vertical measurements on the outlet works stilling basin wall pins. These data indicate that the stilling basin has undergone practically no movement.

10-06. Spillway Reference Marks.

a. General. - During the completion contract, 18 reference marks were installed in the walls and slab of the spillway. The contract required 20 reference pins as shown on plate 81. The Contractor did not etch reference point numbers 4A and 6A on the metal expansion joint until several months after the completion of the roadway. These points were first surveyed in 1985. The detail for these marks is similar to the outlet works reference pins

b. Analysis of Reference Mark Data. - A table of the survey data for the spillway reference marks is presented on plate 96. The data indicate no substantial movements to date. This, combined with the settlement plate data discussed earlier, indicates that the foundation preloading during the first contract was successful.

10-07. Deep Bench Marks. - A total of six deep bench marks were installed. These bench marks, which are identical in design to the deep settlement plates as shown on plate 81, were installed to provide a stable reference datum for

elevation surveys during and after construction of the dam. All of these bench marks are founded in clay shale at the locations and depths as tabulated on plate 33.

10-08. Heave Points. - Prior to spillway excavation, 12 heave points were installed in drilled holes in the area of the spillway discharge chute and stilling basin. Plate 98 presents a tabulation of the locations of these points with reference to the spillway centerline. The data from these points were either inconclusive/inaccurate or indicated there were insignificant movements; therefore, the data are not presented. This type of instrument is not recommended for future application due to the problems associated with installing them in small diameter holes and accurately taking initial readings.

SECTION XI - DOWNSTREAM EMBANKMENT SLIDE

11-01. General. - In late 1988, cracking was observed from station 89 to 93 along the downstream edge of the embankment crest. Progressive movement was observed for about 5 months until a relatively large downstream slope failure occurred on 1 January 1989. Movement continued and by 22 March 1989, the slide extended about 600 feet along the crest (sta. 88+50 to 94+50) and, for a shorter reach, had retrograded to the upstream edge of the crest. A near vertical scarp about 18 feet high had developed and the failure involved about 50,000 cubic yards of material.

11 02. Subsurface Investigations - Borings and backhoe trenches were dug through the embankment materials to investigate the nature of the slide. A soft, very wet, continuous layer of embankment materials (3 to 4 inches thick) was discovered at or about elevation 528.5, or approximately 3 feet above natural ground. Laboratory testing showed the materials to be 7 to 10 percent

above optimum moisture content. No evidence of similar wet material was observed in fill above or below this layer, nor outside the slide limits or within the foundation.

11-03. Cause of Slide. - The cause of the slide was a soft, very wet layer of fill surmised to be the result of a construction deficiency. The layer, which was located about 3 feet above natural ground, was probably a rain-soaked layer that was bridged-over rather than being reworked to proper moisture content. This deficiency is also evident by reviewing construction records in that a 1-inch crack along the crest from station 87+00 to 90+00 was observed by an inspector at the time when the embankment was being topped-out. Documenting the crack and then allowing the crack to be plowed and filled over, effectively temporarily masking the movement evidence, was unfortunately the only action taken. It is believed that the crack was the first sign of the beginning of a progressive failure through the wet layer, ending as the materials approached steady-state strength conditions.

11-04. Repair. - A construction contract was developed to repair the slide area using accelerated contracting procedures. The repair consisted of removal and replacement of most of the slide materials from station 89+00 to 94+00 and then flattening the downstream slope to 1V on 4.5H from station 84+00 to 99+00 (plates 101 through 104). The overall cost for design and construction for the contract was approximately \$1,070,000.

SECTION XII - INSERVICE EVALUATION

12-01. General. - The inservice performance of the Joe Pool embankment and appurtenant structures foundation has shown to be good. Deliberate impoundment began on 7 Jan 86. Conservation pool elevation 522 was first attained in May 1989. The embankment and appurtenant structures has already

been subjected to five periodic inspections as part of the program for Continued Evaluation of Completed Civil Works Projects. Instrumentation is being read and evaluated on a scheduled basis. In addition to the periodic inspection program, surveillance inspections have been conducted subsequent to deliberate impoundment in accordance with the "Reservoir Filling Plan," DM No. 29. All data and observations indicate the embankment is and will continue to function as a safe structure.

SECTION XIII - CLAIM AND LITIGATION

13-01. General. - The following summary was written by William Brown (CESWF-OC). Additional information concerning the litigation and lessons learned can be obtained by calling him at 817-334-3561.

13-02. During the completion contract, the contractor presented a claim to the Government for \$13,146,740, alleging several causes of action. The primary basis for the claim was an alleged differing site condition involving the fill materials to be used in the embankment. The contractor alleged both type I and type II differing site conditions. It alleged that the contract documents materially misrepresented the nature of the fill materials to be used in the embankment, a type I condition. It also alleged that the fill materials were unusual and differed materially from those generally used in construction projects of this type, a type II condition.

a The contractor also alleged that the specifications were defective, primarily that the liquid limit correlation curve was a defective method of determining acceptability of the compacted fill materials. The contractor also alleged that its costs were increased by the Government's over-testing of the embankment materials; by selective testing of non-representative materials, that is, small areas of materials that were either too wet or too

dry and which did not accurately represent the area from which the sample was taken; and that the Government improperly interfered with its operations with over-zealous inspections an general harassment and uncooperativeness on the part of the Government field personnel.

b. The claim was appealed to the U.S. Claims Court, and at the time of the trial in March 1988, the amount of the claim had been revised to \$41,877,029. An extensive hearing was held during which 6 weeks of testimony was presented by the contractor and the Government

13-03. The Claims Court issued its decision in February 1989. Most portions of the contractor's claim were denied, including the type I differing site condition and the allegations of over-testing, defective test methods, non-representative testing, and harassment and interference on the part of the Government personnel. Of particular note was the fact that the court found that the data in the contract documents concerning the fill material were accurate and did not misrepresent the nature of the fill material to be used in the embankment. However, the court did find that the contractor had encountered a type II differing site condition in that the fill materials, in their extreme toughness and difficulty to work, were unusual in nature and differed materially from those normally encountered in construction work of this nature. From a design standpoint, the court's decision did not fault the project's designers; it said essentially that no amount of information in the contract documents could have adequately warned a prospective contractor of the extreme toughness of the material, which it found to be some of the toughest material in the world. While a geotechnical engineer could possibly have predicted the relative toughness of the fill materials by analysis of the index properties of the materials utilizing a plasticity chart, the court

found that a prospective construction contractor could not have predicted the difficulty of working these materials from the information presented in the contract or, in fact, any other objective data.

13-04. The court awarded damages in the amount of \$14,703,211.43, plus interest pursuant to the Contract Disputes Act of 1978. The damages were awarded on a total cost basis; i.e., the difference between the contractor's bid price and the total costs the contractor incurred on the project. The court, however, modified the recovery based on the fact that it found that the contractor's bid was unreasonably low, partially the result of a poor pre-bid site investigation. To account for this fact, the court substituted the bid of a different bidder on the project for the amount the contractor should have bid. That bid was found to have been reasonable based on testimony concerning the bidder's experience in working with soils in Texas and in the vicinity of the project. That bid, then, formed the baseline for the determination of the contractor's increased costs, which the court attributed in full to the type II differing site condition. The contractor presented convincing evidence through its auditor that it had incurred substantially increased costs on the project, and the court relied entirely on the contractor's cost data. The Government was unable to disprove the contractor's data, and the court found that the Government's DCAA audit of the claim and the auditor's testimony at the hearing were unpersuasive and lacked coherence.

13-05. Since the decision indicated that the contract documents could not have been improved to indicate the nature of the fill materials, the primary lessons to be learned from the claim and litigation are in the area of damages. Because the contractor's recovery was based on the total cost method, the Government needed to show that the contractor's increased costs

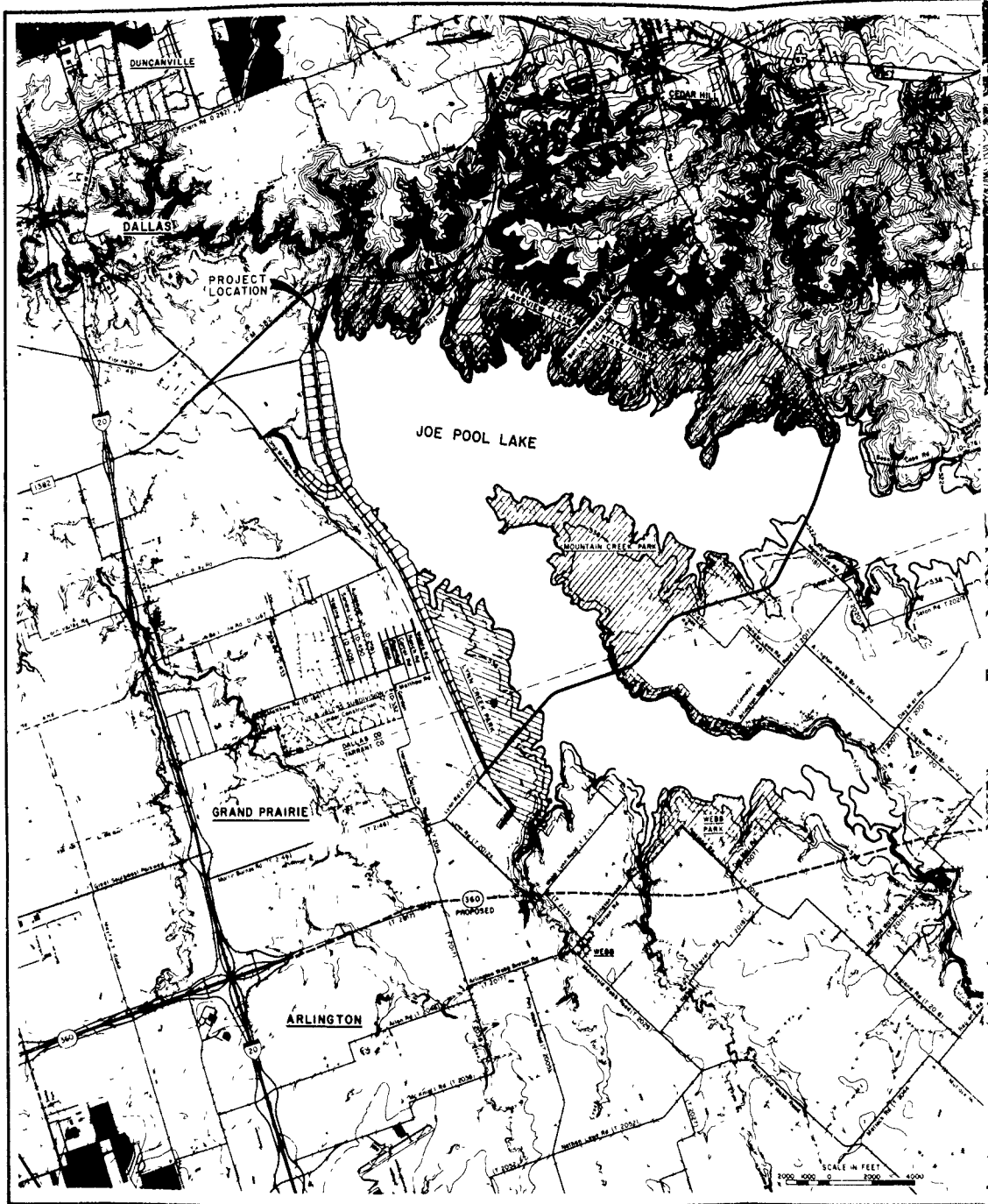
were not totally related to the differing site condition and that all, or at least most, of the increased costs resulted from the contractor's inefficient construction methods and its inexperience in dealing with material of this type. Two major lessons can be learned from the Government's experience in this litigation.

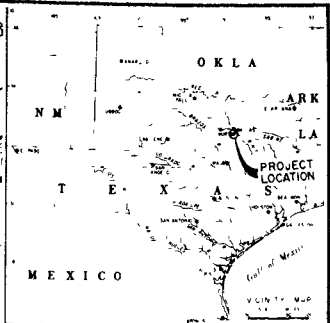
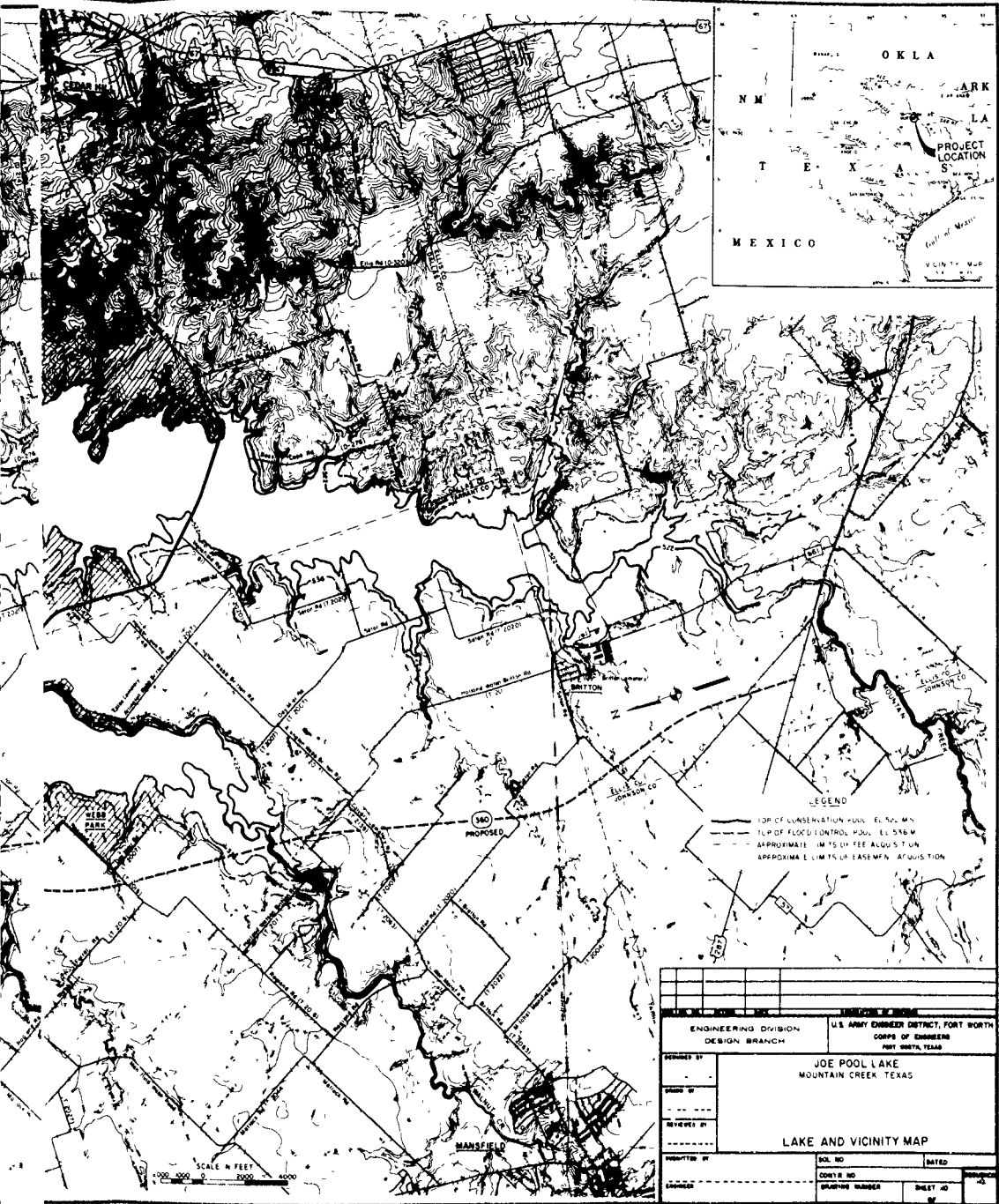
a. First, it is absolutely essential that the Government accurately and completely document any difficulties a contractor may be having during construction, especially if they are related to a possible claim dealing with differing site conditions. The Government, in this litigation, was unable to convincingly prove to the Claims Court that the contractor increased its own construction costs because of its inefficiency, poor construction methods, and lack of effective quality control. It is essential that detailed documentary evidence of such failures on the part of the contractor be kept throughout the project in order to support testimony at a hearing. Especially helpful in the case of this litigation would have been videotape of the contractor's construction methods and illustrations of how its lack of quality control contributed to the increase in its costs

b. Second, the Government needs to get any necessary expert witnesses involved as early in the process as possible. Even though the contractor's claim on this project was filed in February 1984, the Government did not hire the expert witness it used at the trial until approximately June 1986. By that time, construction of the embankment had been completed, and the expert witness was not able to observe the contractor's operations on the embankment. While a test pit in one of the borrow areas was dug to allow the expert to observe the materials, this did not effectively substitute for observation of the contractor's actual construction methods and any difficulties the

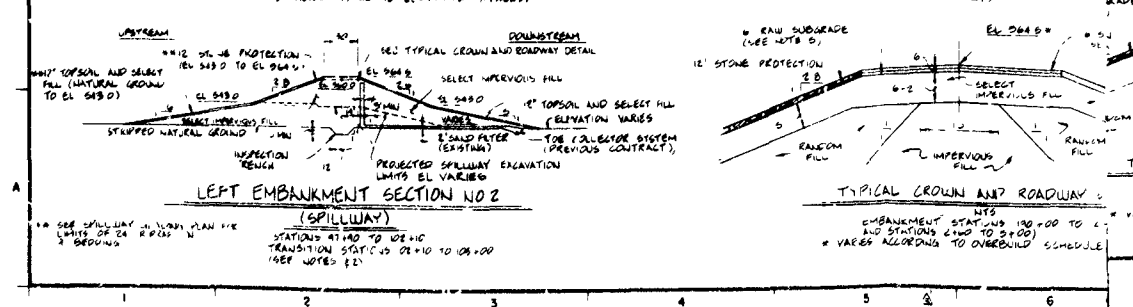
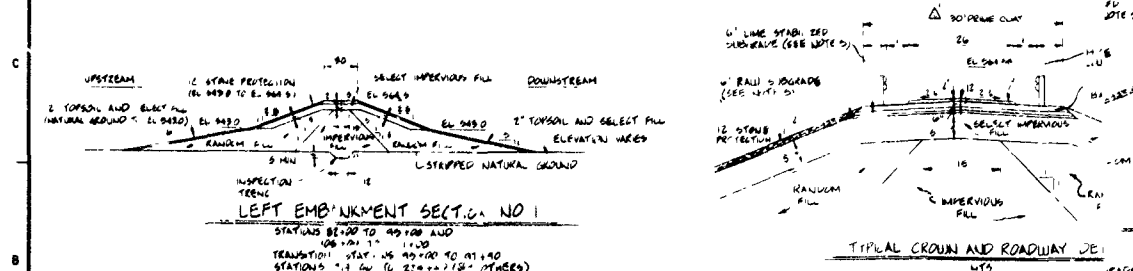
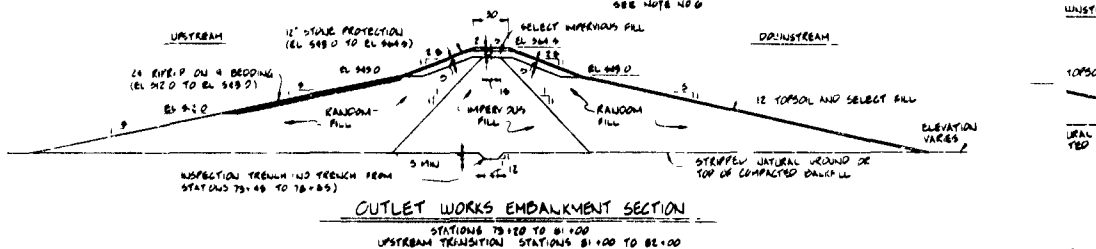
contractor had with the fill material. As such, the Government was at a disadvantage with the contractor, whose expert had observed the embankment work in progress in 1985.

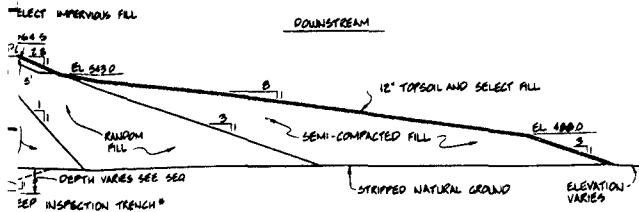
13-06. This case was somewhat unusual in that the claim was filed when the project was still underway; in fact, over one-half of the embankment volume remained to be placed at the time the claim was filed. Thus, the Government had ample opportunity to hire an expert and have that expert observe the actual embankment construction. To ensure that an expert witness has the opportunity to observe the actual conditions, it is recommended that on future large projects, consideration be given to hiring an expert even before a claim is filed. This should be done if there is sufficient indication through the contractor's correspondence or verbal communication that a claim may be filed. By so doing, the Government will ensure that its expert is sufficiently prepared to testify even if the contractor waits until the job is completed or nearly completed to actually file claims. If claims are not filed, the expense would still be justified when compared to the Government's potential risk of damages.





ENGINEERING DIVISION DESIGN BRANCH		U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
DESIGNED BY	JOE POOL LAKE MOUNTAIN CREEK TEXAS		
DRAWN BY			
REVIEWED BY			
APPROVED BY			
DATE	SHEET NO.	OF	



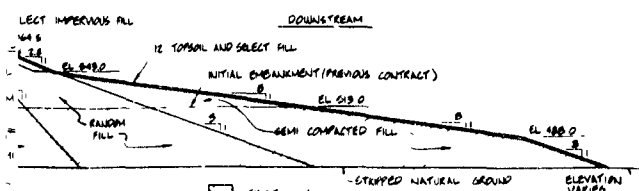


SECTION NO 1

STATION 100+00 TO 100+100

STATION 100+100 TO 100+200

STATION 100+200 TO 100+300

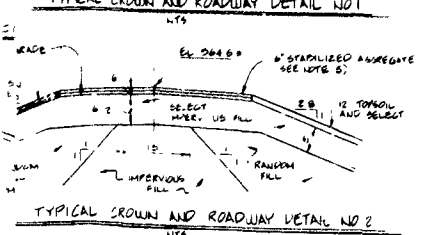
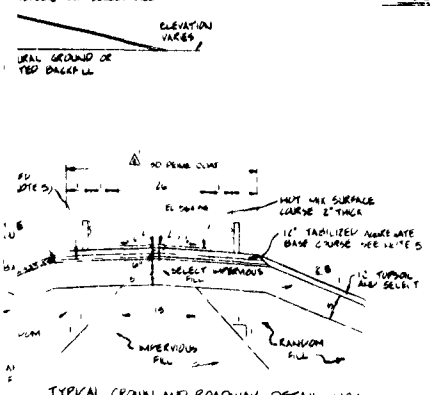
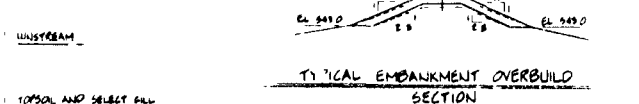


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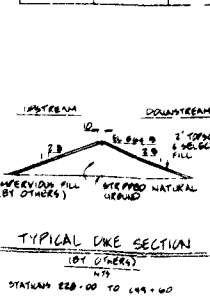
STATION 100+00 TO 100+100

STATION 100+100 TO 100+200

STATION 100+200 TO 100+300



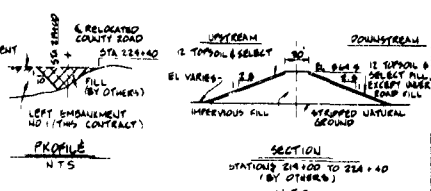
MATERIALS SOURCE AND PLACEMENT SUMMARY				
ZONE	CONSTRUCTION & PLACEMENT	PLACEMENT	REQUIRED	MATERIALS
IMPERVIOUS FILL	CH & CL LL & 40	OPTIMUM TO 10% ABOVE OPTIMUM	WHENVER OF SHEEP FOOT ROLES & MAX UNCOMPACTED 10%	BORROW AREAS
RANDOM FILL	OUTSIDE IMPERVIOUS TOPSOIL AND SELECT FILL WILL SEE	10% BELOW OPTIMUM TO 10% ABOVE OPTIMUM	10% BELOW OPTIMUM TO 10% ABOVE OPTIMUM	REQUIRED STEPPED & BORROW AREAS
SEMI-COMPACTED FILL	OUTSIDE IMPERVIOUS TOPSOIL AND SELECT FILL WILL SEE	10% BELOW OPTIMUM TO 10% ABOVE OPTIMUM	10% BELOW OPTIMUM TO 10% ABOVE OPTIMUM	REQUIRED RELOCATION & BORROW AREAS
FILTER MATERIAL	SPECIFIED EL 549.0	SATURATED BY SPREADING OVER A COMPACTION	10% BELOW OPTIMUM TO 10% ABOVE OPTIMUM	COMMERCIAL SOURCES
SELECT IMPERVIOUS FILL	CH & CL LL & 40	OPTIMUM TO 10% ABOVE OPTIMUM	WHENVER OF SHEEP FOOT ROLES & MAX UNCOMPACTED 10%	BORROW AREAS
RANDOM FILL	SEE SPECIFICATION	SEE SPECIFICATION	SEE SPECIFICATION	COMMERCIAL SOURCES
STRUCTURAL BACKFILL	SEE SPECIFICATION	SATURATED BY SPREADING OVER A COMPACTION	10% BELOW OPTIMUM TO 10% ABOVE OPTIMUM	COMMERCIAL SOURCES
IMPERVIOUS FILL	CH & CL LL & 40	OPTIMUM TO 10% ABOVE OPTIMUM	WHENVER OF SHEEP FOOT ROLES & MAX UNCOMPACTED 10%	BORROW AREAS



- NOTES
- SEE SEC 100 FOR ADDITIONAL LEFT EMBANKMENT NO 2 ZONING REQUIREMENTS, EXTENT OF EXISTING LEFT EMBANKMENT NO 2 AND APPROXIMATE LIMITS OF EXISTING EMBANKMENTS, UNDER CONTRACT NO 100. THE INITIAL EMBANKMENT, UNDER CONTRACT NO 100, WAS THE PREVIOUS CONTRACT FROM STATION 2+00 TO STATION 4+00 TO ELEVATION 549.0 AND FROM STATION 4+00 TO STATION 100+00 TO ELEVATION 549.0.
 - ELEVATIONS ON TYPICAL EMBANKMENT SECTIONS ARE THE ESTIMATE ELEVATIONS. OVERBUILD SHALL BE APPLIED TO THE CROWN AND UPPER 14 ON 8 BY EMBANKMENT SLOPES IN ACCORDANCE WITH THE FOLLOWING SCHEDULE:

STATION	OVERBUILD, FT
2+00	0
100+00	1.5
60+00	1.5
70+00	0.75
80+00	0.75
90+00	0
110+00	0

- OVERBUILD AT ANY POINT BETWEEN THE ABOVE LISTED STATIONS SHALL BE DETERMINED BY LINEAR INTERPOLATION
- THE STONE PROTECTION, EXPOSED BEDDING, AND TOPSOIL AND SELECT FILL SHALL BE MEASURED PERPENDICULAR TO THE SLOPE DURING PROTECTION.
 - SPECIFICATIONS FOR DENSITY OF ROADWAY MATERIALS.
 - ZONING FOR THE UPSTREAM COFFERDAM IS SHOWN ON



JOE POOL LAKE

ENRANKMENT, SPILLWAY, AND OUTLET WORKS

TYPICAL ENRANKMENT SECTIONS I

DESIGNED BY: T. SCHEIDT

CHECKED BY: R. REED

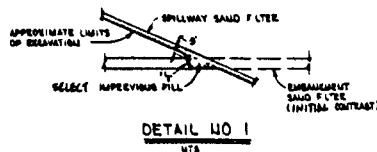
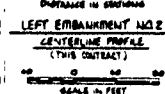
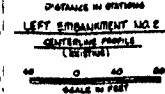
REVIEWED BY: J. L. JONES

DRAWN BY: J. L. JONES

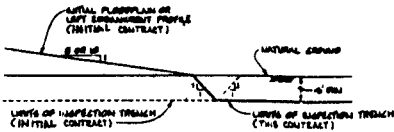
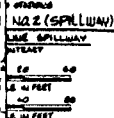
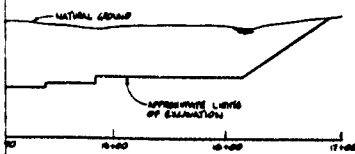
DATE: JULY 1961

SHEET NO: 10

PLATE 3

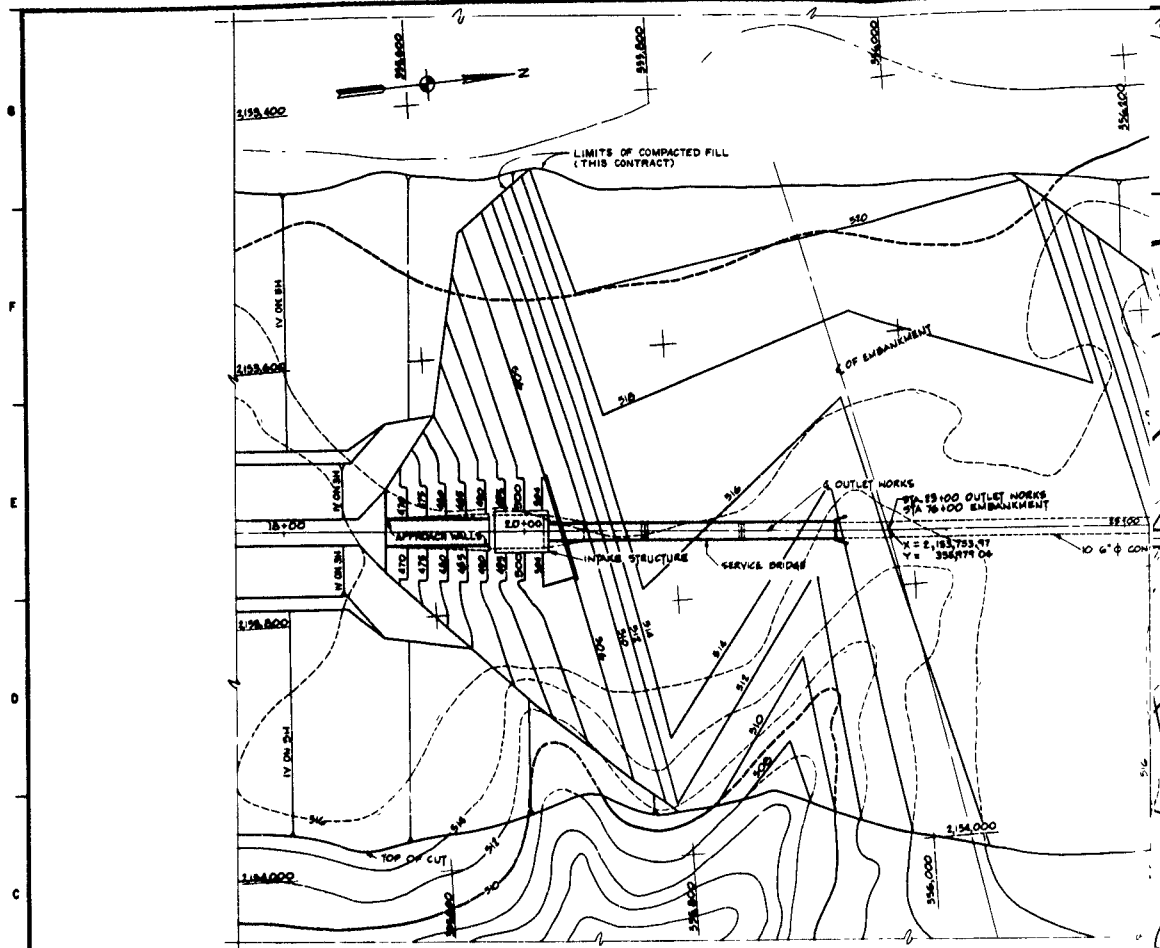


- NOTES:
1. SEE SEQ. 10 FOR TYPICAL EMMENTMENT SECTIONS.
 2. SEE SEQ. 10 FOR NOTES
 3. ONE CIVIL AND STRUCTURAL DRAWINGS FOR SAND FILTER CONSTRUCTION DETAILS. THE EMMENTMENT FILTER DESIGN SHALL BE MADE INDEPENDENT OF BOTH THE SULLY AND UNDERDRAIN AND THE WITH RESPECTIVE SANDFILL BEHIND THE DISCHARGE DUCTS.
 4. SEE CIVIL DRAWINGS FOR EXCAVATION LIMITS.
 5. SEE SECTION TRENCH LIMITS ARE SHOWN ON P. 92.

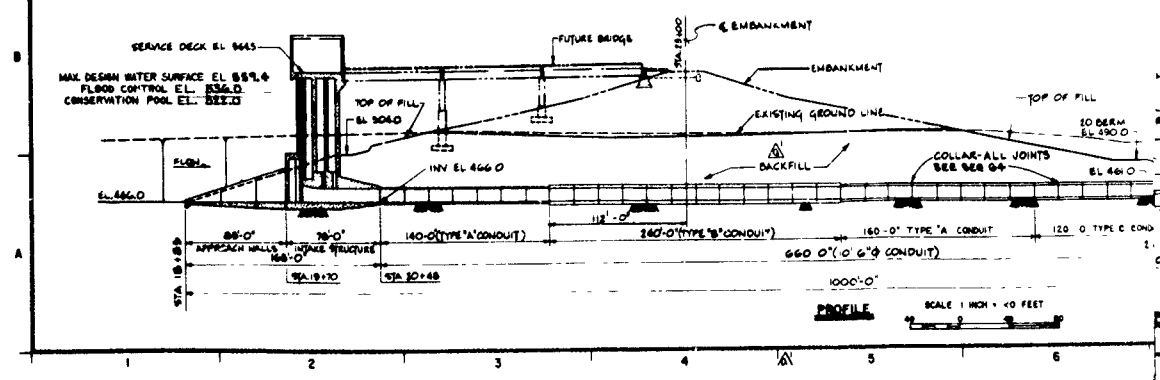


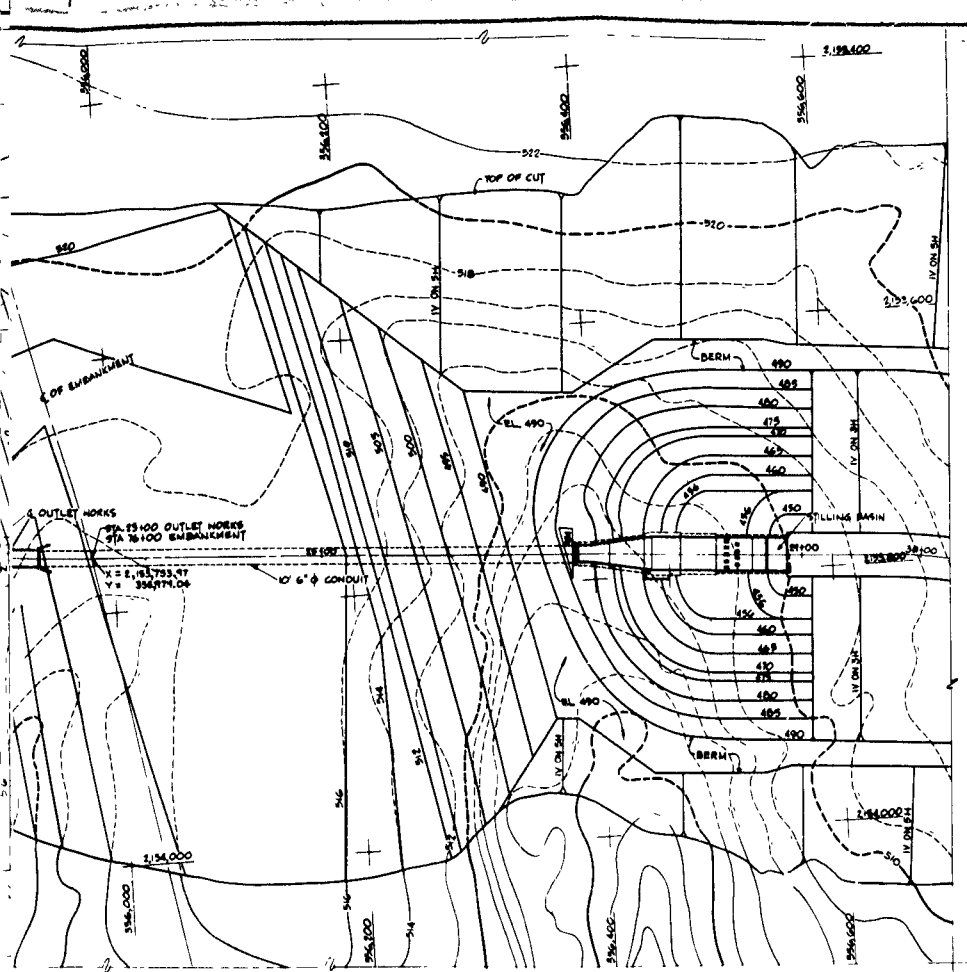
SAND FILTER MATERIAL SHALL BE WITHIN THE FOLLOWING GRADATION LIMITS	
SIEVE SIZE (GIVEN IN MM)	PERCENT PASSING (BY WEIGHT)
750 MM	100
Nº 4	75-100
Nº 10	70-90
Nº 16	65-80
Nº 30	50-60
Nº 100	0-5

[illegible]



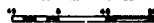
PLAN
SCALE 1 INCH = 40 FEET





PLAN

SCALE 1 INCH = 40 FEET



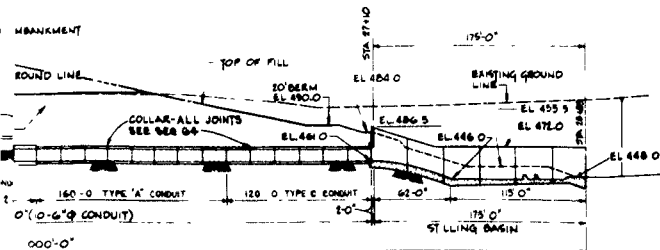
LEGEND

- 450 — FINISHED GRADE CONTOUR
- - 310 - - EXISTING CONTOUR

NOTES

- 1 SEE REQ 19 FOR APPROACH WALLS, REQ 22 FOR INTAKE STRUCTURE, REQ 23 FOR CONDUIT AND REQ 24 FOR STILLING BASIN
- 2 SEE REQ 16 FOR EXCAVATION PLAN
- 3 SEE REQ 15 & 16 FOR SECTIONS AND PROFILES OF FILL

RECORD DRAWING-WORK AS BUILT



PROFILE

SCALE 1 INCH = 40 FEET

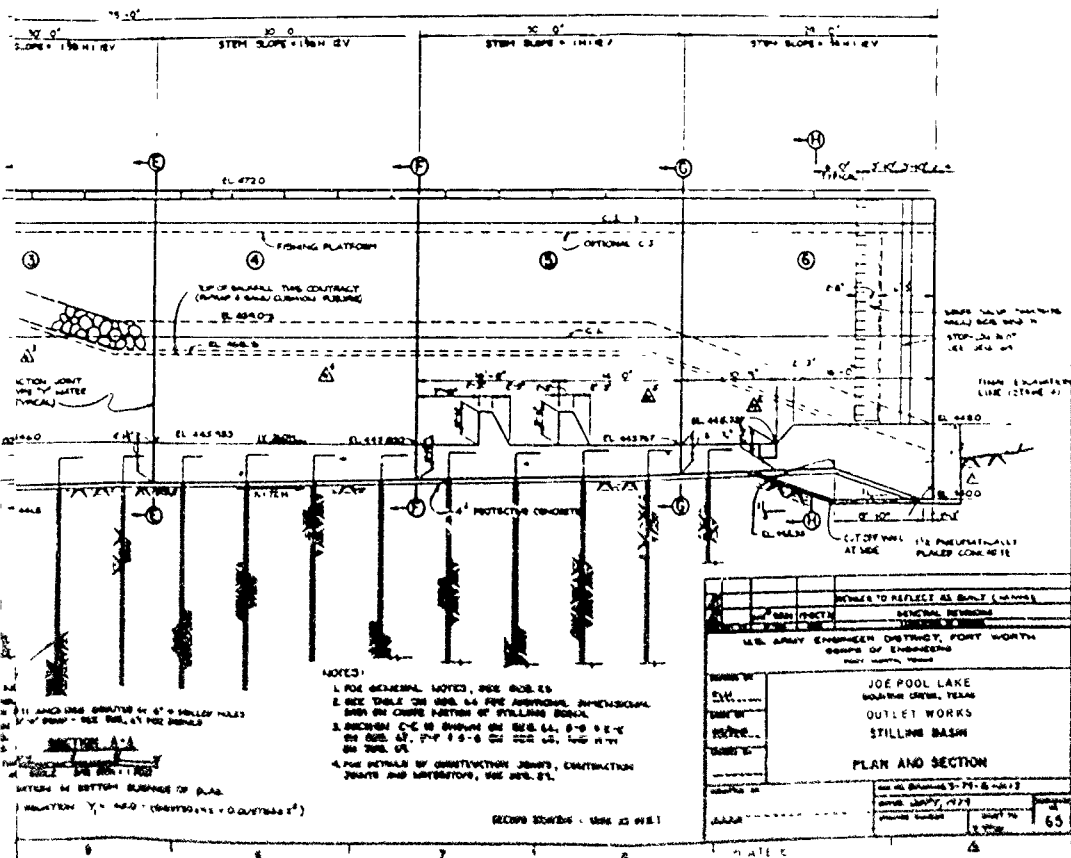


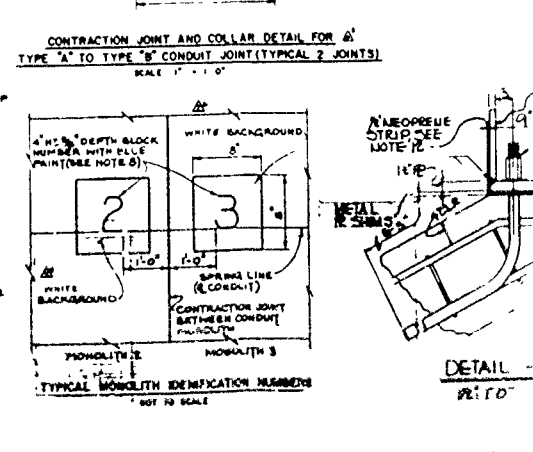
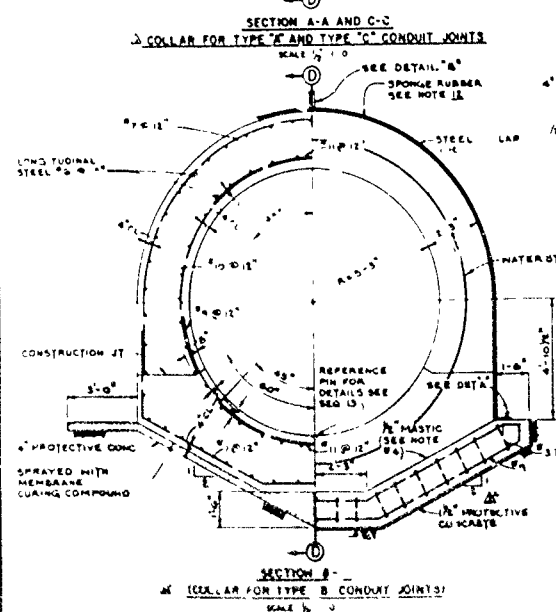
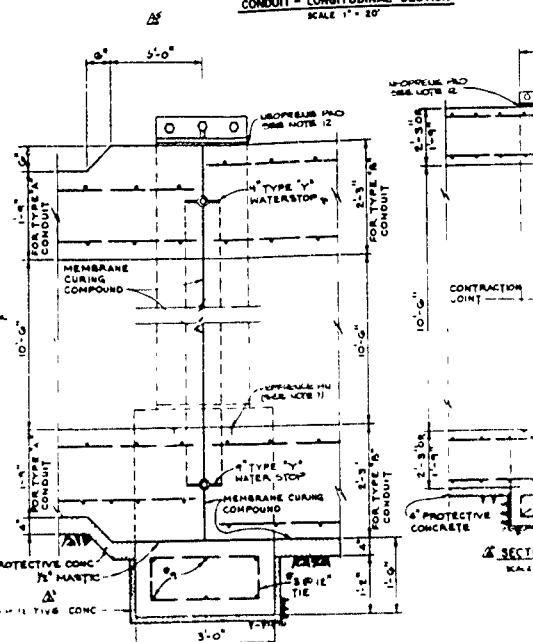
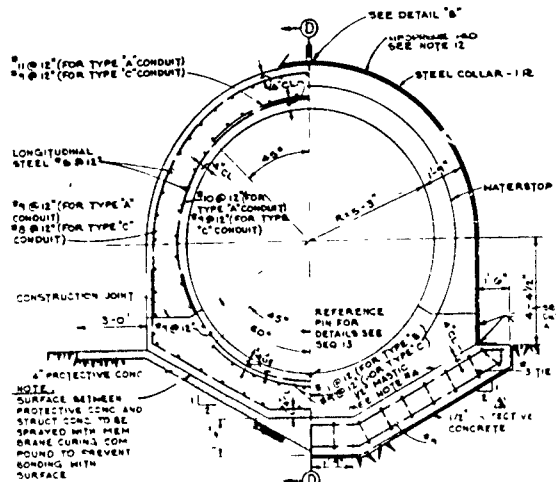
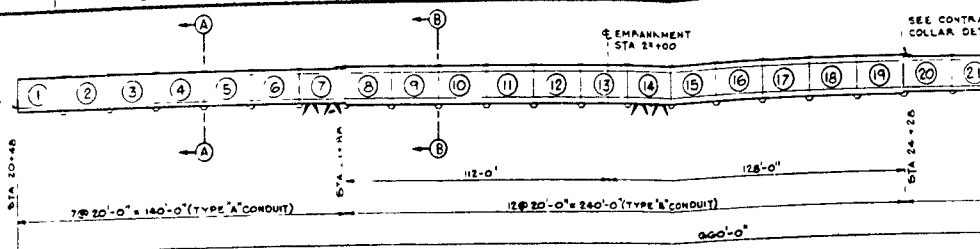
AM 0001 100771		REVISED TO REFLECT IN J. CHANGES	
U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS			
DESIGNED BY R.H. R.S.A.	JOE POOL LAKE MOUNTAIN CREEK, TEXAS		
DRAWN BY C.M.B.	OUTLET WORKS		
CHECKED BY J.N.H.	PLAN AND PROFILE		
APPROVED BY	1111 NO DACHING-74-B-0113		
DATE	DATED SEP 1979		
CONTRACT	DRAWING NUMBER	SHEET NO	18

LINEAR REGRESSION IN BOTTOM NUMBER OF GLASS
 104/75 GLASS REGRESSION: $Y_1 = 24.8 - (0.00076524X + 0.0007664X^2)$

PLAN

SCALE 3/16" = 1' - 0"





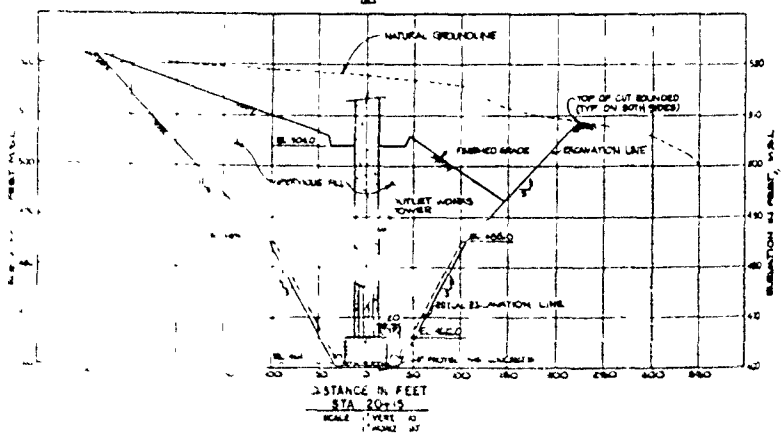
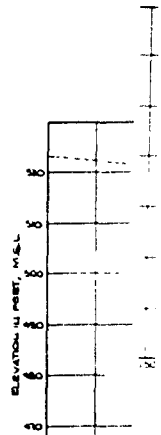
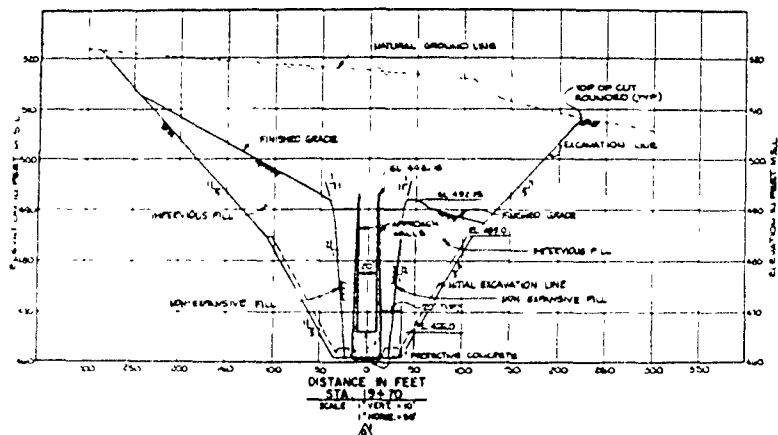
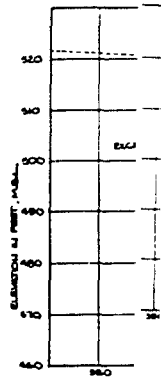
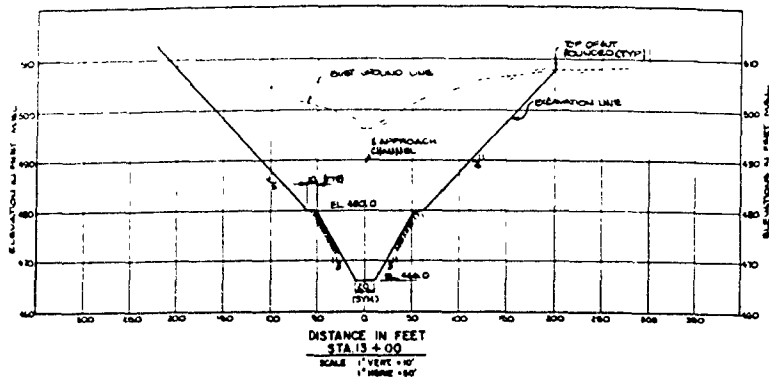


1910

Journal of the

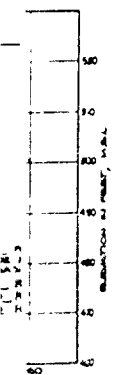
RECORD DRAWING WORK AS BUILT

[illegible]

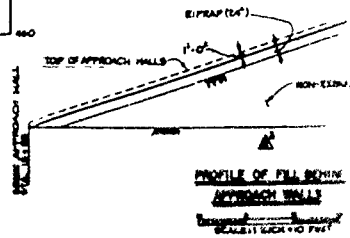
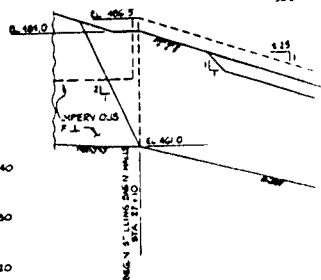
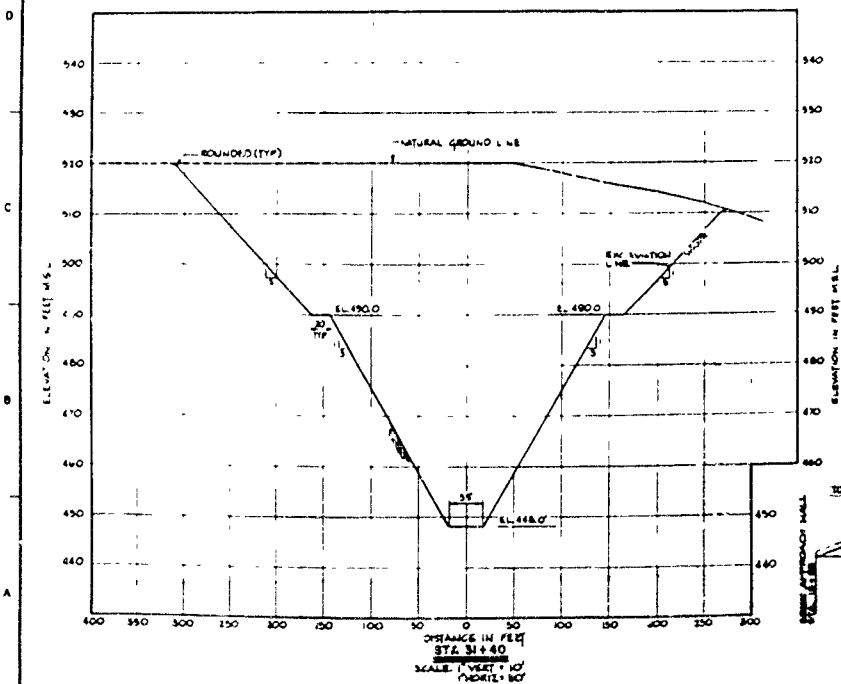
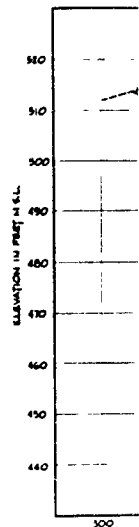


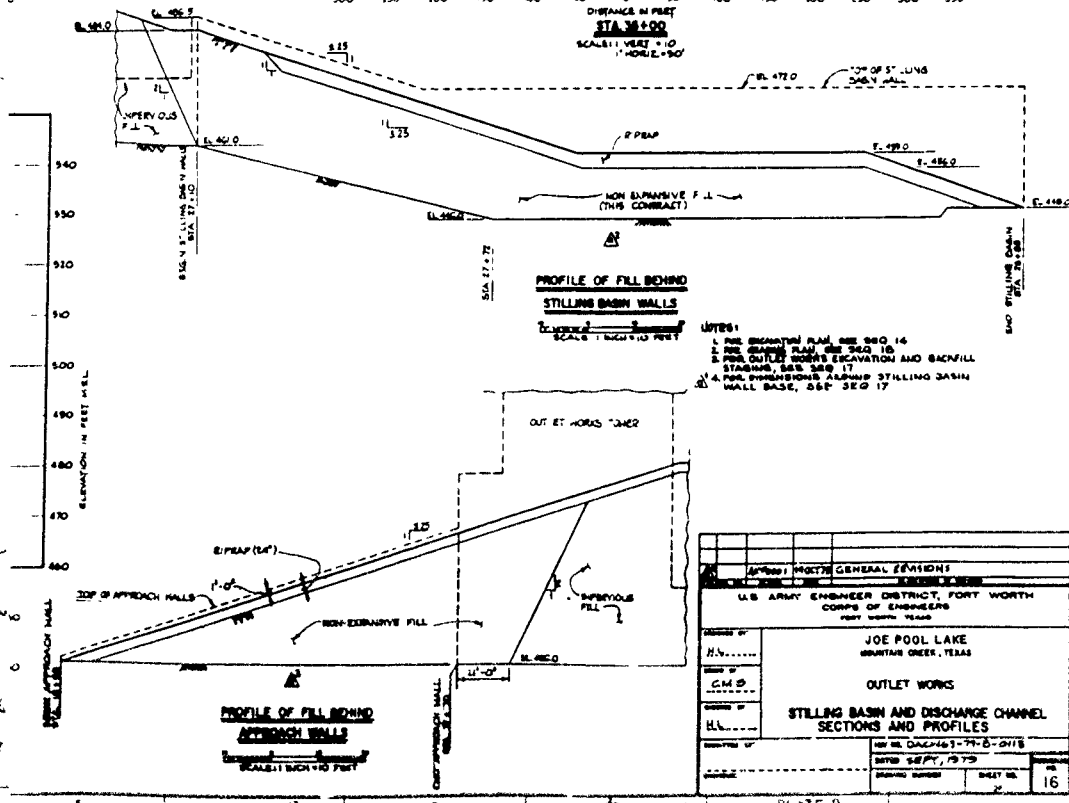
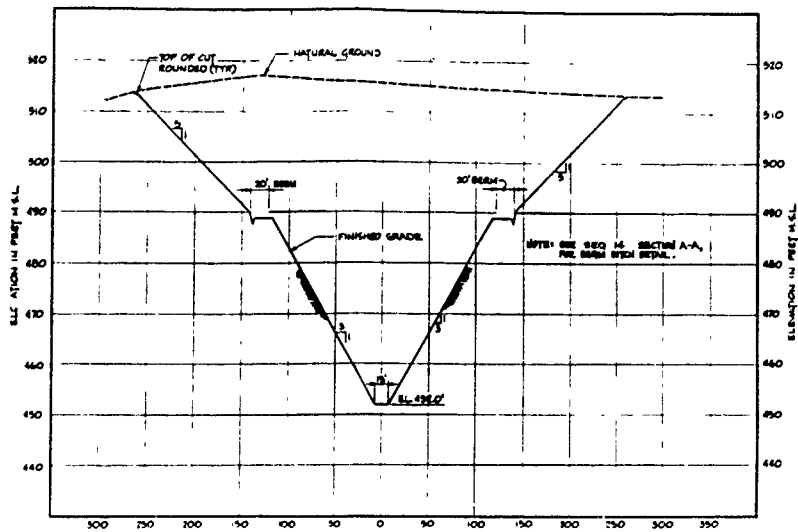
NOTES

1. SEE GRID 11. A
STAGING FOR 1
STILLING BASIN
2. SEE GRID 12. A
STAGING FOR 1
STILLING BASIN
3. SEE GRID 13. A
STAGING FOR 1
STILLING BASIN
4. SEE GRID 14. A
STAGING FOR 1
STILLING BASIN

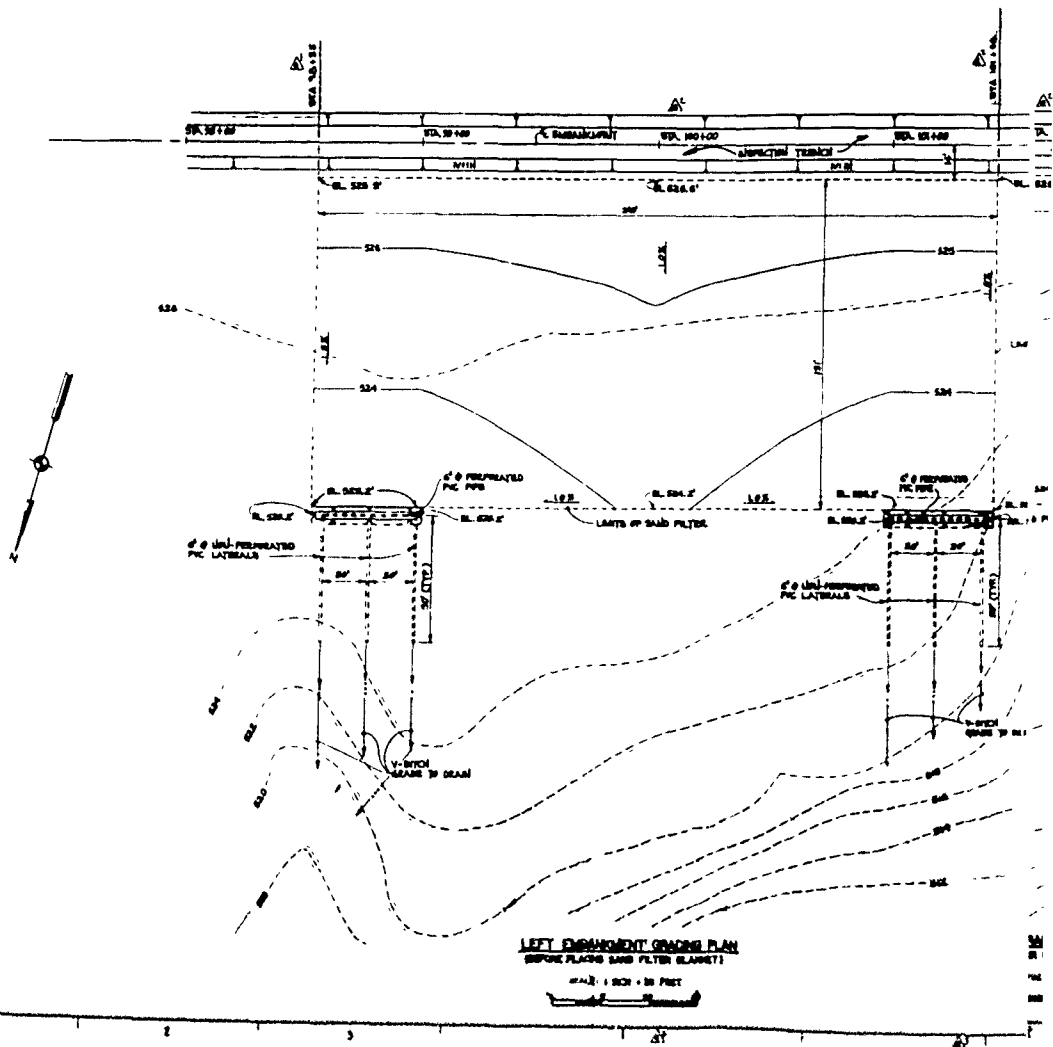


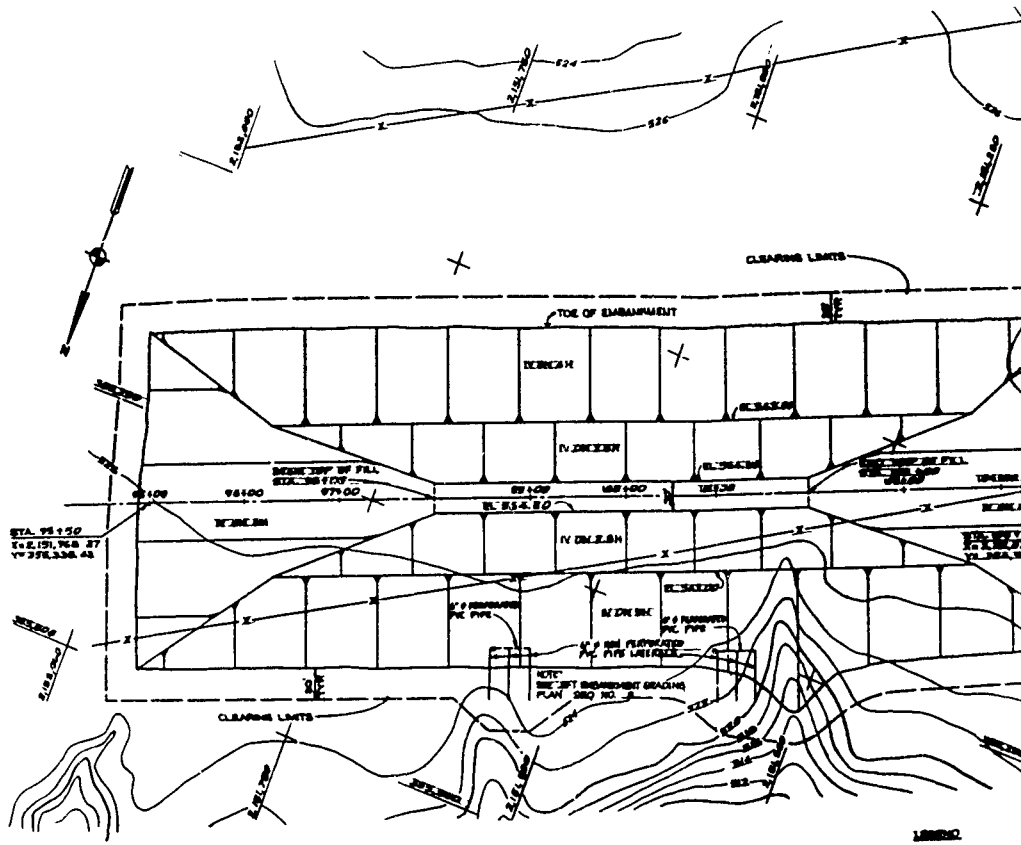
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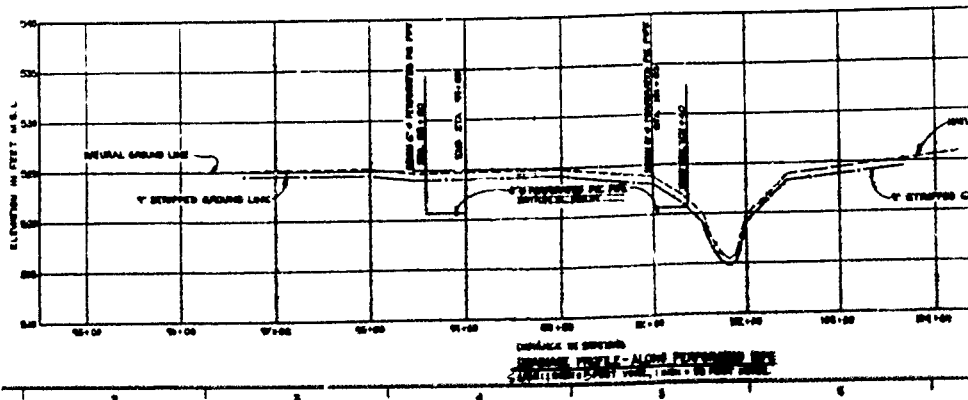


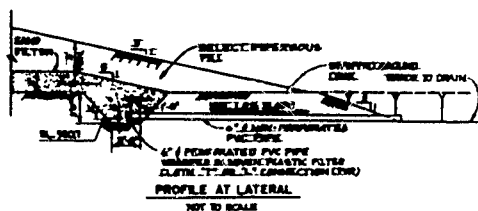
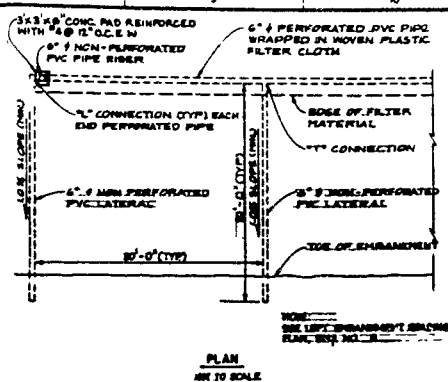
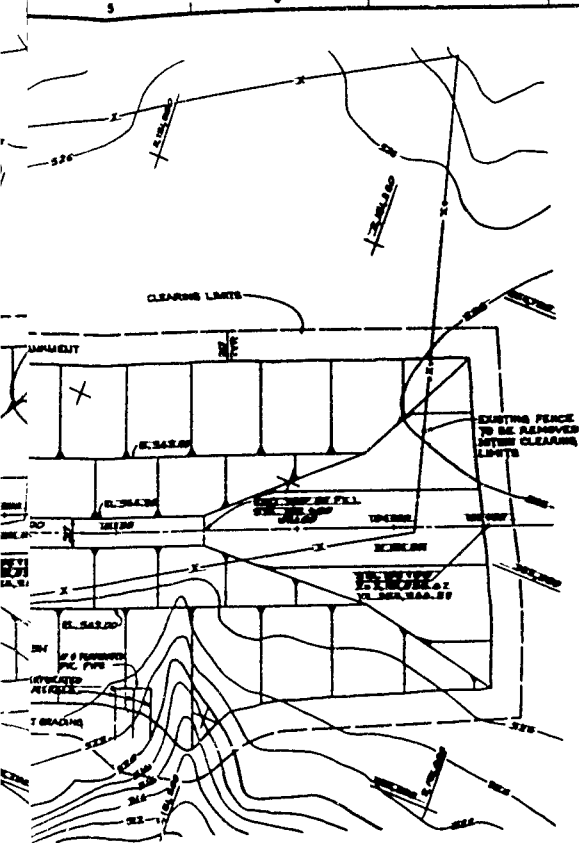
PROJECT: GENERAL EMISSIONS	
U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
DESIGNED BY H.N.	JOE POOL LAKE MOUNTAIN CREEK, TEXAS
DRAWN BY C.M.D.	OUTLET WORKS
CHECKED BY H.L.	STILLING BASIN AND DISCHARGE CHANNEL SECTIONS AND PROFILES
DATE SEPT. 1975	NO. 16
DRAWING NUMBER	SHEET NO.





PLAN
SCALE: 1" = 50' HORIZONTAL
1" = 10' VERTICAL





Drainage Collection System Details

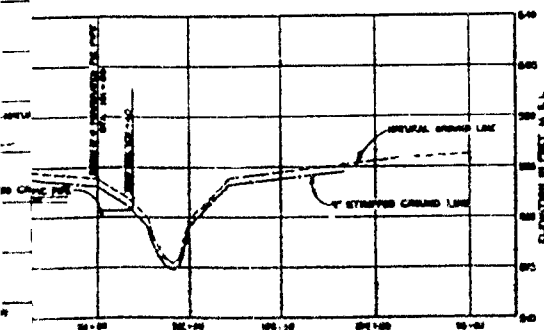
SCALE: 1" = 5' HORIZ.
1" = 5' VERT.

NOTES:

1. SEE SHEET 12 FOR CENTERLINE PROFILE AND SECTION.
2. CLEARING LIMITS SHALL NOT EXTEND MORE THAN 20' FROM THE LINE OF EMBANKMENT.
3. CONTRACTOR SHALL SURVEY SPACIALLY LOCATIONS OF THE ENDS OF THE PERFORATED PVC PIPE AND HAVE COORDINATES AND ELEVATIONS TO THE CONTRACTING OFFICE BEFORE COVERING THE ENDS.
4. BACKFILL AROUND THE NON-PERFORATED PIPES SHALL BE SELECT SUPERVISORY FILL MATERIALS COMPACTED AS SPECIFIED.

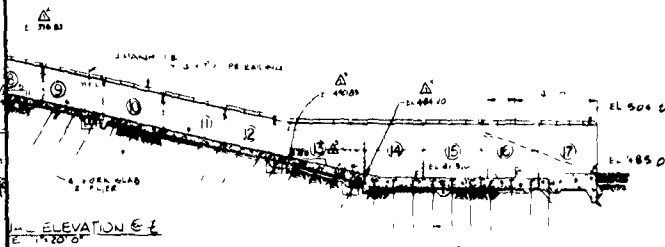
1. 6" NON-PERFORATED PVC PIPE RISER

50 FEET



1. 6" NON-PERFORATED PVC PIPE RISER

JOE POOL LAKE BOYD COUNTY, TEXAS LEFT EMBANKMENT	
PLAN AND DRAINAGE DETAILS	
DATE: 12-15-77	BY: J. W. H. / J. W. H.
SCALE: 1" = 5' HORIZ. 1" = 5' VERT.	12



DO NOT EXTEND THROUGH COUPLER JOINTS
FILL GAP WITH AIR DRY G.
ON THE FILLWAY AND E6 WILL BE A 1/2" AIR DRY G.
IF THE GAP IS 1/2" OR MORE, THEN THE GAP SHOULD BE 1/2" OR MORE.

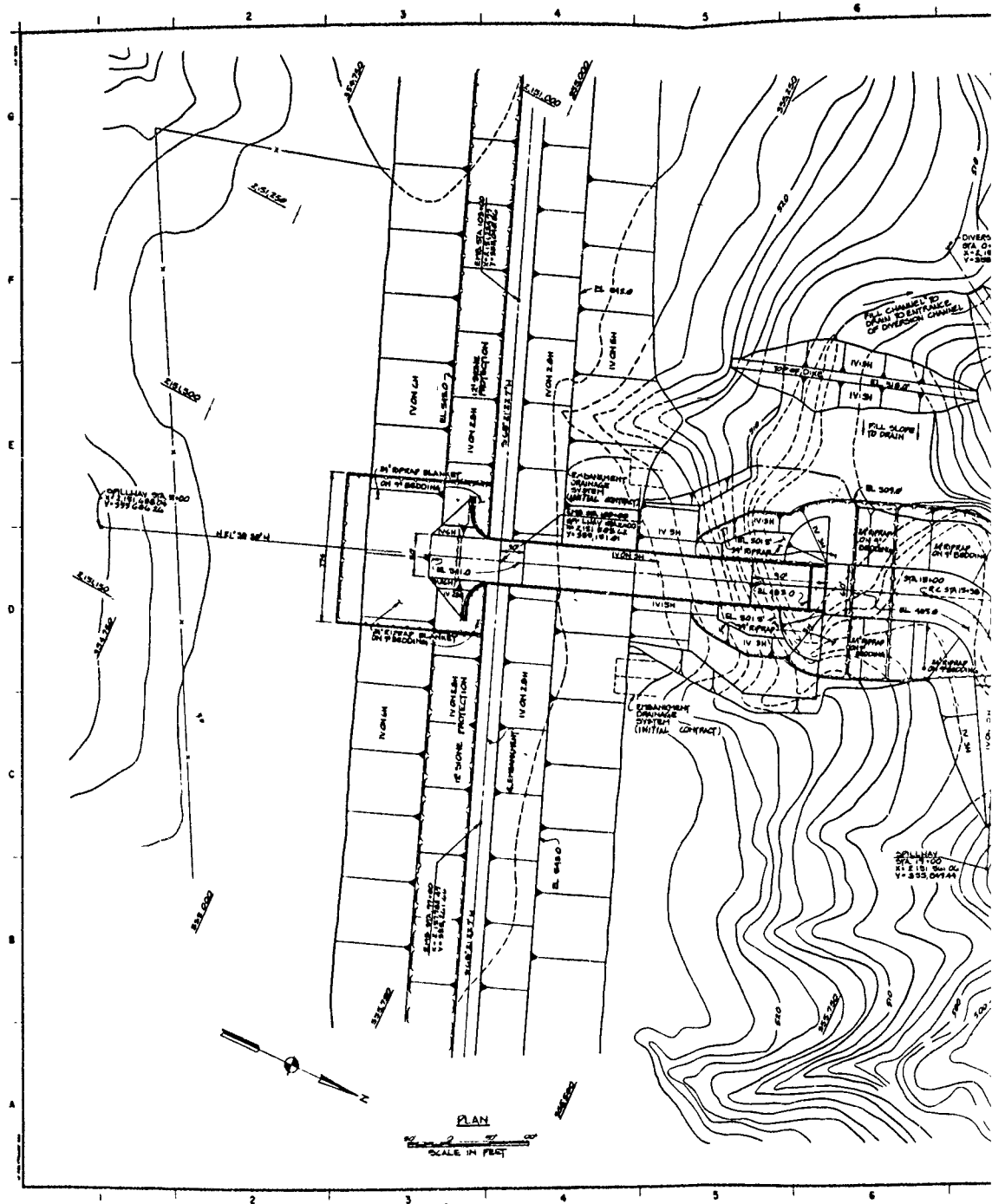
ALL CRITICAL OR NEAR VERTICAL SURFACES IN SHALL BE PERFORMED
VERMONT - EVERETT DIVISION SHALL BE SCHEDULED
AS NOTED ON THE PLAN AND AT E

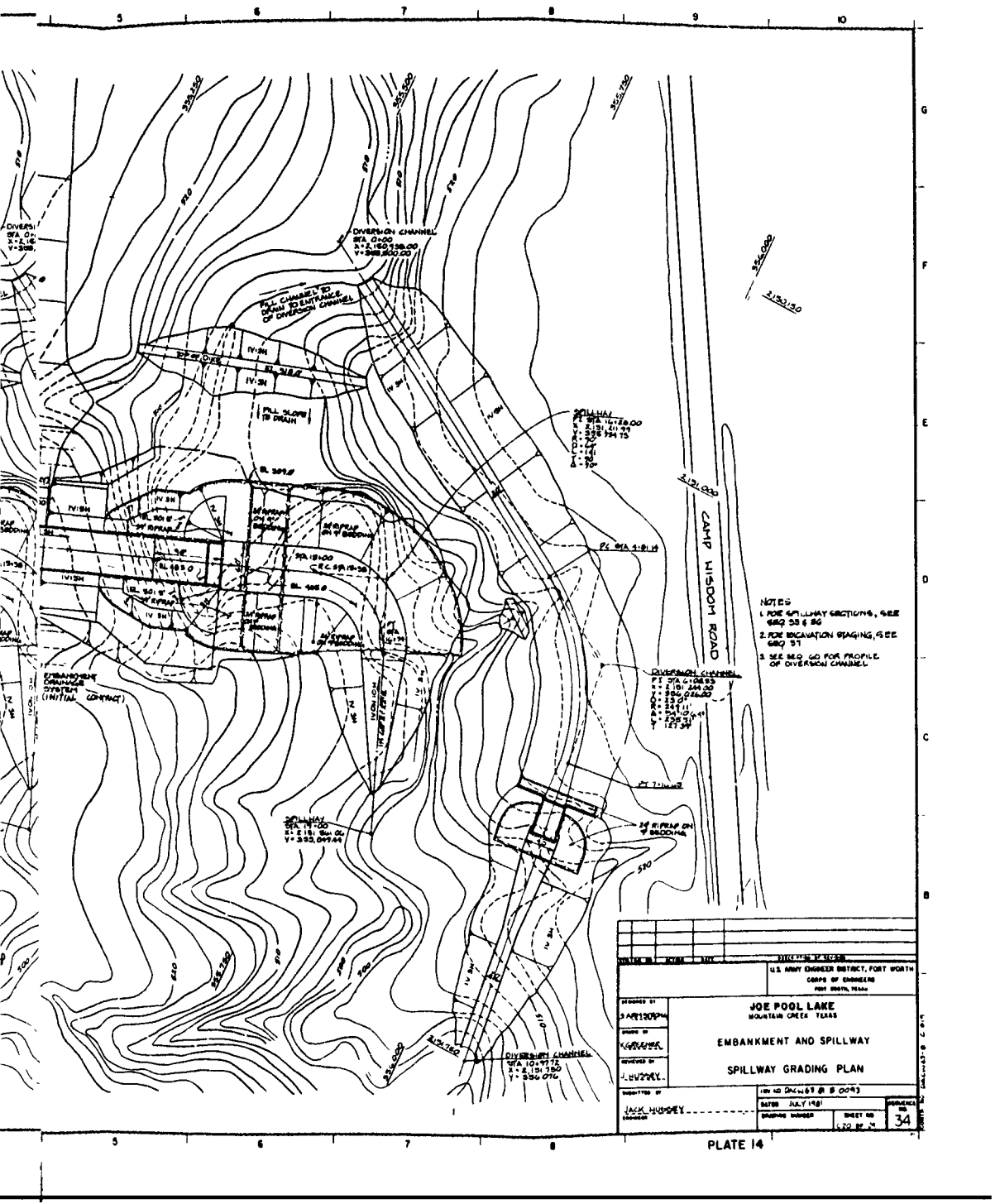
1-2-4-5-6-7-8
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CLASS 2 TENSION LAP BAR AND EMBANKMENT						
6	1)	BAR	LAP (SHORT)	(INCH)	EMBANKMENT	(LENGTH)
		OTHER BAR	TOP BAR	TOP BAR	OTHER BAR	TOP BAR
3000 P.D.	15,000 P.D.	4	1	8	12	5
		5	1	8	15	14
		5	1	24	12	7
		7	2	27	21	22
		7	2	26	21	20
		8	2	26	18	1
		8	2	26	36	45
		10	2	26	45	83
		11	2	131	56	27
		12	2	131	56	27

NO 651 FOR CLARIFICATION OF ENGAGEMENT AND LAP LENGTH SEE 202 54

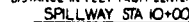
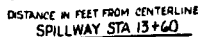
DATE	PM	LARGE REVISION SLAB "HICKORY"
NO.		REVISED
J.E. ARMY ENGINEER DISTRICT FORT WORTH CORPS OF ENGINEERS FORT WORTH TEXAS		
JEE POOL LAKE MOUNTAIN CREEK TEXAS		
EMBANKMENT, SPILLWAY, AND OUTLET WORKS		
SPILLWAY PLAN & PROFILE		
NO.	JULY 1961	P. 2013
DATE	JULY 1961	
DRAWING NUMBER	SHEET NO.	38

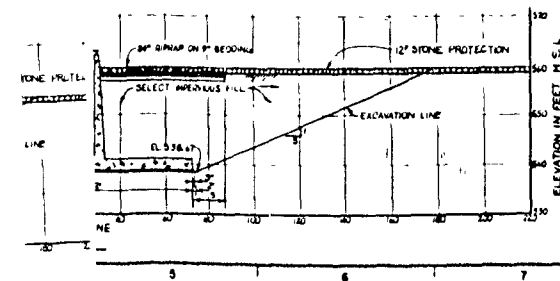




- NOTES
1. FOR SPILLWAY SECTIONS, SEE SHEET 33 & 34
 2. FOR EMBANKMENT GRADING, SEE SHEET 31
 3. SEE SHEET 30 FOR PROFILE OF OVERFLOW CHANNEL

TITLE: JOE POOL LAKE		
U.S. ARMY CORP. DISTRICT, FORT WORTH		
CAMP OF ENGINEERS		
FORT WORTH, TEXAS		
DESIGNED BY J. H. HUBBARD	JOE POOL LAKE MOUNTAIN CREEK TEXAS	
DRAWN BY J. H. HUBBARD		
REVIEWED BY J. H. HUBBARD		
APPROVED BY J. H. HUBBARD		
SUBMITTED BY JACK HUBBARD		(REV NO. 001) OF 0003
DATE JULY 1961		SHEET NO. 34
DRAWING NUMBER		34

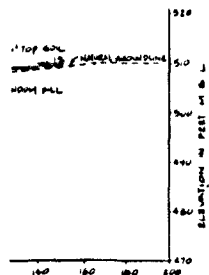
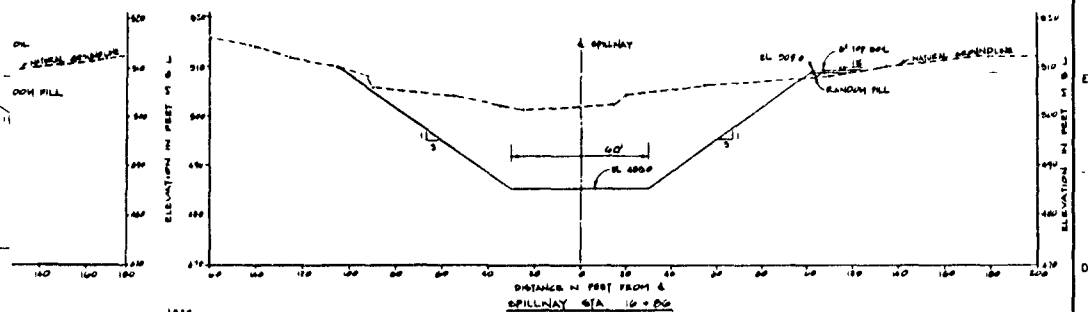
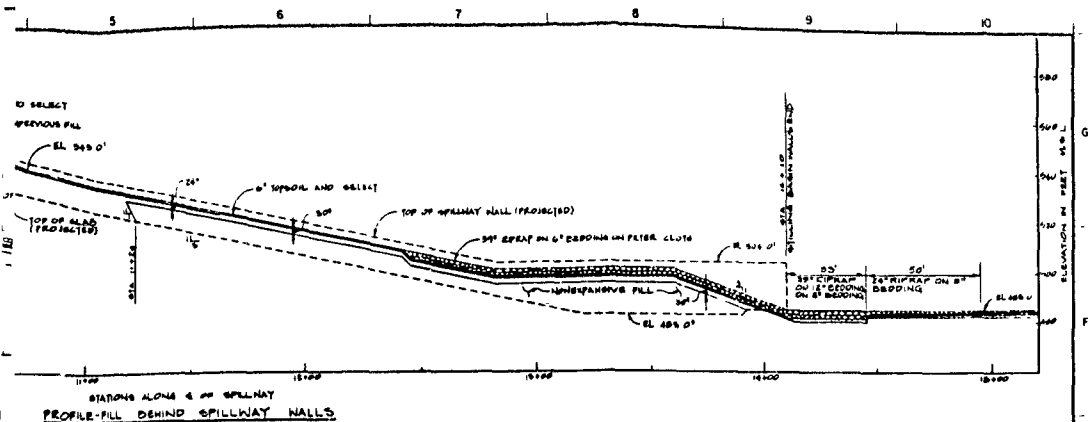




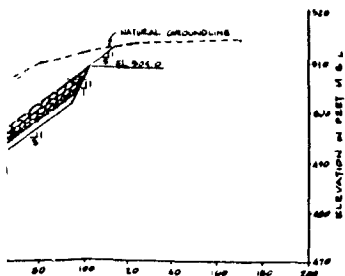
NOTES

- 1 SEE SEQ 34 FOR PLAN VIEW
- 2 STRUCTURAL DRAWINGS ARE SHOWN ON SEQ 35 THEN 36
- 3 PEOPLE OF BACAFILL JUST BEHIND THE HALLS IS SHOWN ON SEQ 36
4. FOR TYPICAL SECTIONS, SEE SEQ 32
5. STORMY EXCAVATION PLAN IS SHOWN ON SEQ 37

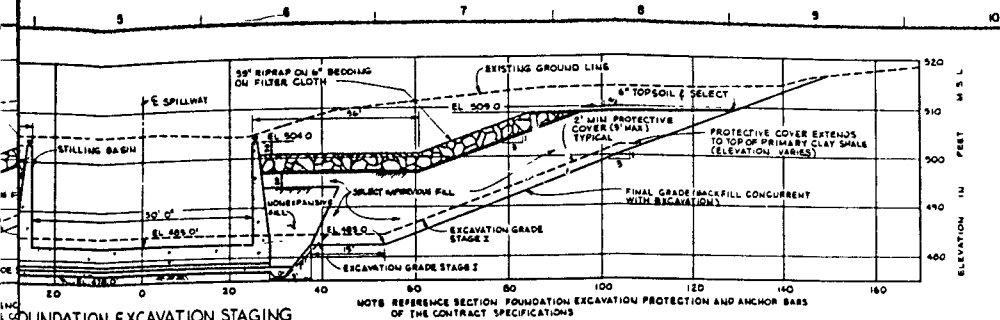
[illegible]



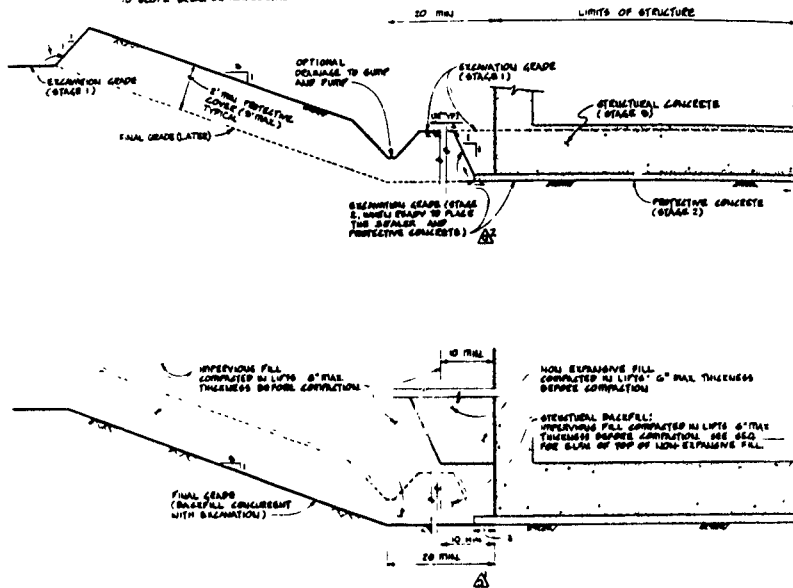
NOTE:
1. IF MOORING SHALL BE 12' BEYOND FILLED OVER 2' BEYOND



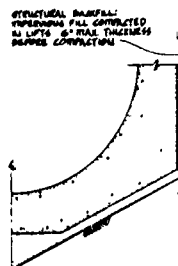
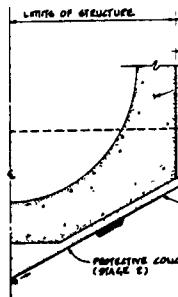
UNITED STATES OF AMERICA		ENGINEERING DISTRICT	
U.S. ARMY ENGINEER DISTRICT FORT WORTH		FORT WORTH, TEXAS	
DESIGNED BY		JOE POOL LAKE	
CHECKED BY		MOUNTAIN CREEK, TEXAS	
APPROVED BY		EMBANKMENT AND SPILLWAY	
REVISIONS		SPILLWAY SECTIONS-III	
DATE		STA 14+20 TO STA 16+00	
DRAWN BY		100 NO. 1000000 R. B. COOK	
DATE		JULY 1968	
DRAWING NUMBER		36	



NOTE: PROTECTIVE COVER SHALL EXTEND TO GLOBE BREAK OR HORIZONTAL DEENT



STAGES 1, 2 & 3



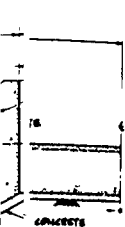
4TH STAGE

EXCAVATION AT APPROACH STRUCTURE

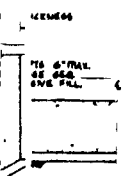
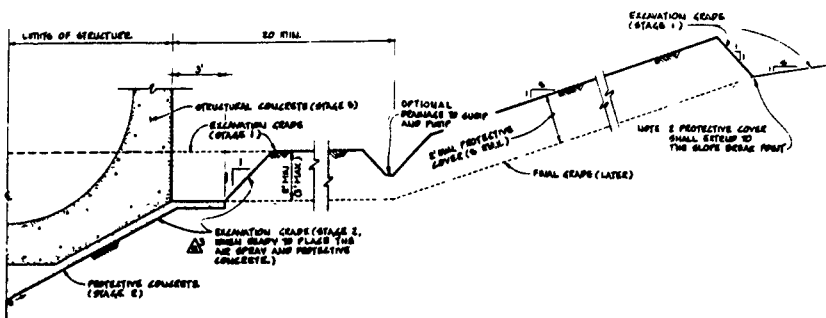
(STRAIGHT BACKSILLAGE)
NOT TO SCALE

NOTES

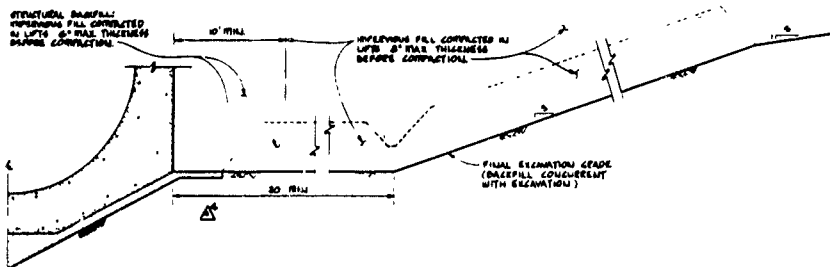
1. ALL SECTIONS SHOWN ARE REPRESENTATIVE ABOUT CENTERLINE
2. APPROACH BACKFILL STAGING REQUIREMENTS ARE PROVIDED IN PARAGRAPH 20-15 OF THE CONTRACT SPECIFICATIONS
3. ADDITIONAL EXCAVATION REQUIREMENTS FOR PROTECTION OF THE SHALE AND CLAY SHALES ARE PROVIDED IN SECTION 28 OF THE CONTRACT SPECIFICATIONS
4. STRUCTURAL BACKFILL INCLUDES AS A MINIMUM ALL NON-EXPANSIVE FILL AND/OR INTERVENING FILL LOCATED WITHIN 10 FEET OF A CONCRETE STRUCTURE, MEASURED IN ANY DIRECTION INCLUDING VERTICALLY ABOVE A STRUCTURE.
5. USE THIS SEE 13 ONLY FOR SCOPE OF EXCAVATION, PROTECTIVE CONCRETE AND BACKFILLING
6. THE SYMBOL "S" INDICATES THE LIMITS BETWEEN WHICH THE EXCAVATED SURFACES SHALL BE GRADED WITH A GRADE DETERMINED IN THE SPECIFICATIONS. THE LIMITS SHALL BE CORRELATED WITH
7. IT IS RECOMMENDED THAT BACKFILL, INTERVENING (INCL. NON-EXPANSIVE FILL) FOR COMPACTED AREAS, SUCH AS THE LOWER PORTION OF THE OUTLET WORKS, BE PRE-MITTED OR OMO-BACK TO A MOISTURE CONTENT NECESSARY TO ACHIEVE THE PRESCRIBED IN-PLACE MOISTURE CONTENT. THIS WILL BOTH ENHANCE FOUNDATION PROTECTION AND ELIMINATE SOME PROBLEMS THAT PROCESSING THE MATERIALS IN COMPACTED AREAS CAN CREATE.
8. SEE SEE 25.4.15 FOR EXTENT OF BACKFILL BEHIND VAN LS



STAGES 1, 2 & 3



4TH STAGE

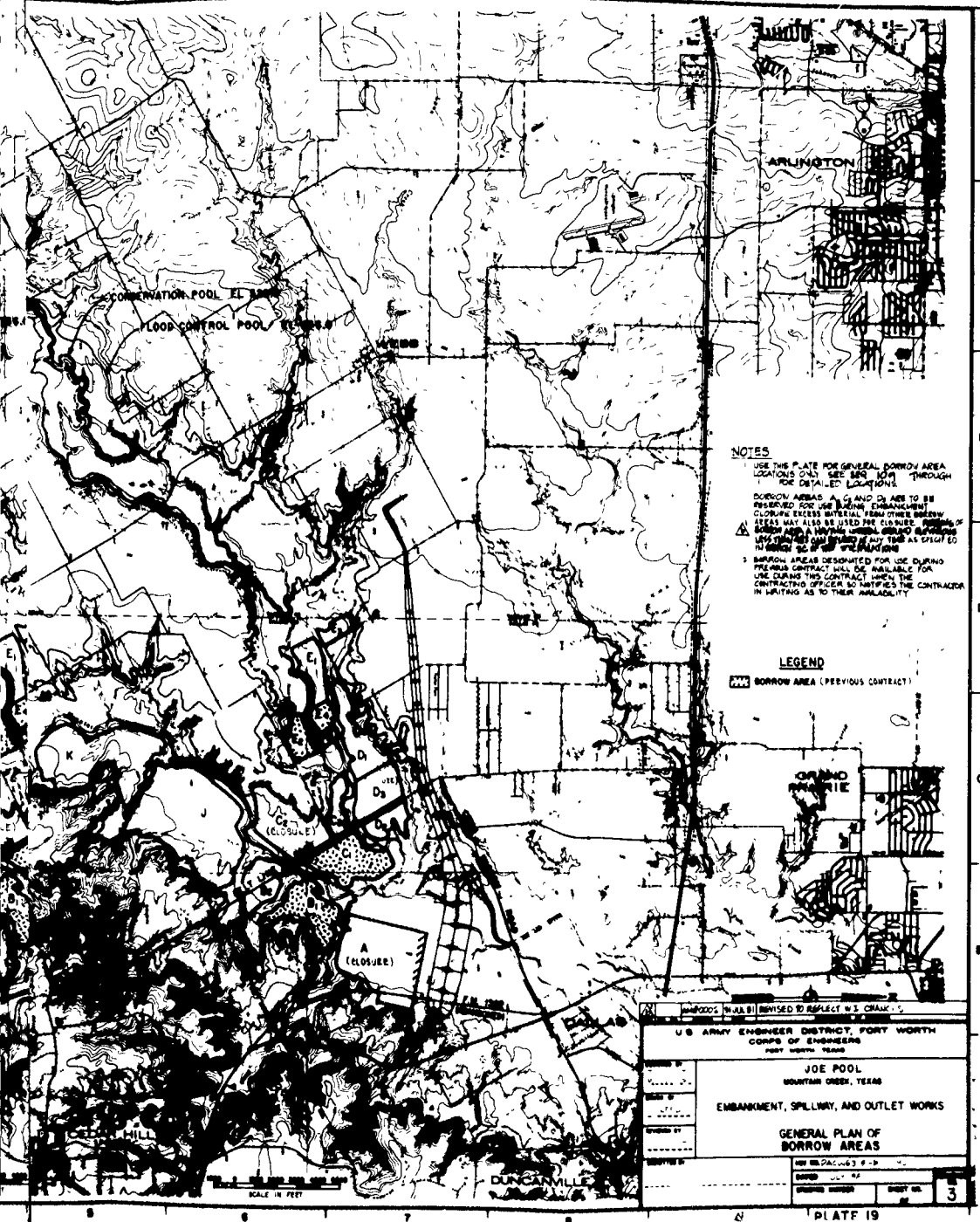


EXCAVATION AT CONDUIT

NOT TO SCALE

APPROVED FOR THE GENERAL SUPERVISOR	
U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
DESIGNED BY TWO / WSM	JOE POOL LAKE MOUNTAIN CREEK TEXAS
CHECKED BY S.E. BULL	OUTLET WORKS
DESIGNED BY TWO / WSM	EXCAVATION STAGING
HW 46-6246-3-79-5-0113 DATED 5-SEP-79 SHEET NO. 17	





NOTES

1. USE THIS PLATE FOR GENERAL BORROW AREA
LOCATIONS ONLY. SEE SEQ 1019 THROUGH
1024 FOR DETAILED LOCATIONS.

BORROW AREAS A, C, AND D₂ ARE TO BE
 RESERVED FOR USE DURING EMBANKMENT
 CLOSURE EXCESS MATERIAL FROM OTHER BORROW
 AREAS MAY ALSO BE USED FOR CLOSURE. ~~REMARKS OF~~
 BORROW AREA A MAY BE USED FOR CLOSURE. ~~REMARKS OF~~
 USES THAT ARE NOT PERMITTED AT ANY TIME AS SPECIFIED
 IN SECTION 2C OF THE SPECIFICATIONS

2. BORROW AREAS DESIGNATED FOR USE DURING PREVIOUS CONTRACT WILL BE AVAILABLE FOR USE DURING THIS CONTRACT WHEN THE CONTRACTING OFFICER SO NOTIFIES THE CONTRACTOR IN WRITING AS TO THEIR AVAILABILITY.

LEGEND

BORROW AREA (PREVIOUS CONTRACT)

1000000	24 JUL 81	REVISED TO REFLECT W3 CHANG.
---------	-----------	------------------------------

U S ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH TEXAS

JOE POOL
MOUNTAIN CREEK, TEXAS

EMBANKMENT, SPILLWAY, AND OUTLET WORKS

GENERAL PLAN OF BORROW AREAS

24/06/2018

DATE _____

000000	000000
--------	--------

PLATE 19

G

APPROXIMATE 2. EMBANKMENT

APPROXIMATE 10E OF EMBANKMENT

F

F

E

D

B

A





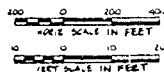
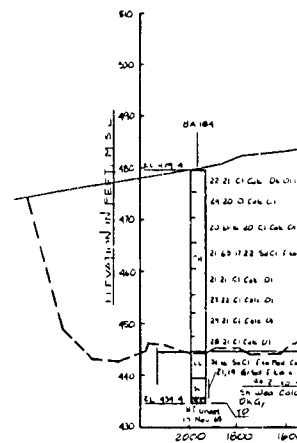
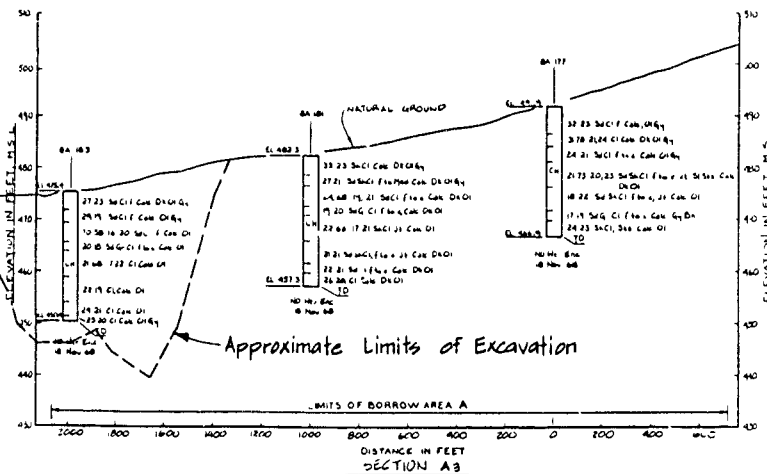
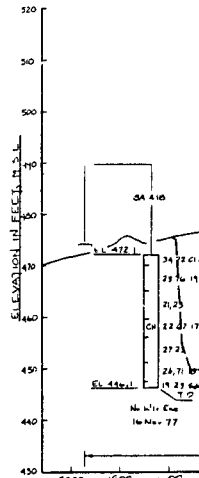
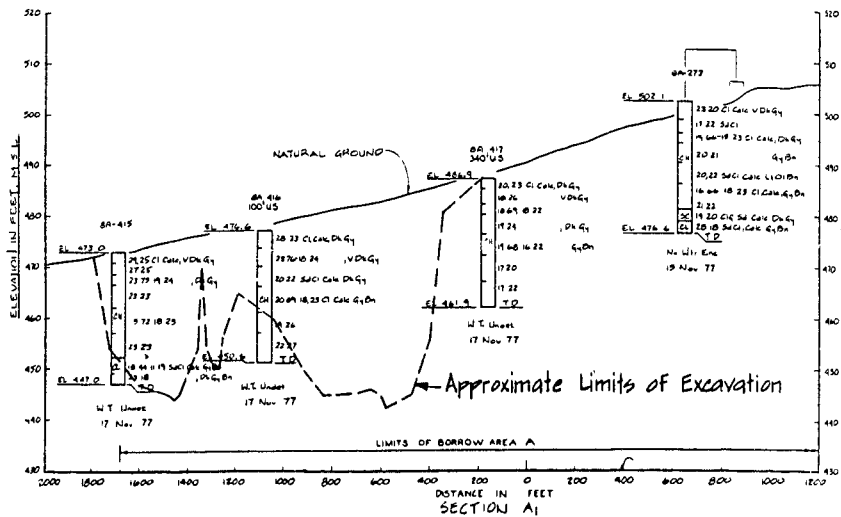
G
F
E
D
C
B
A

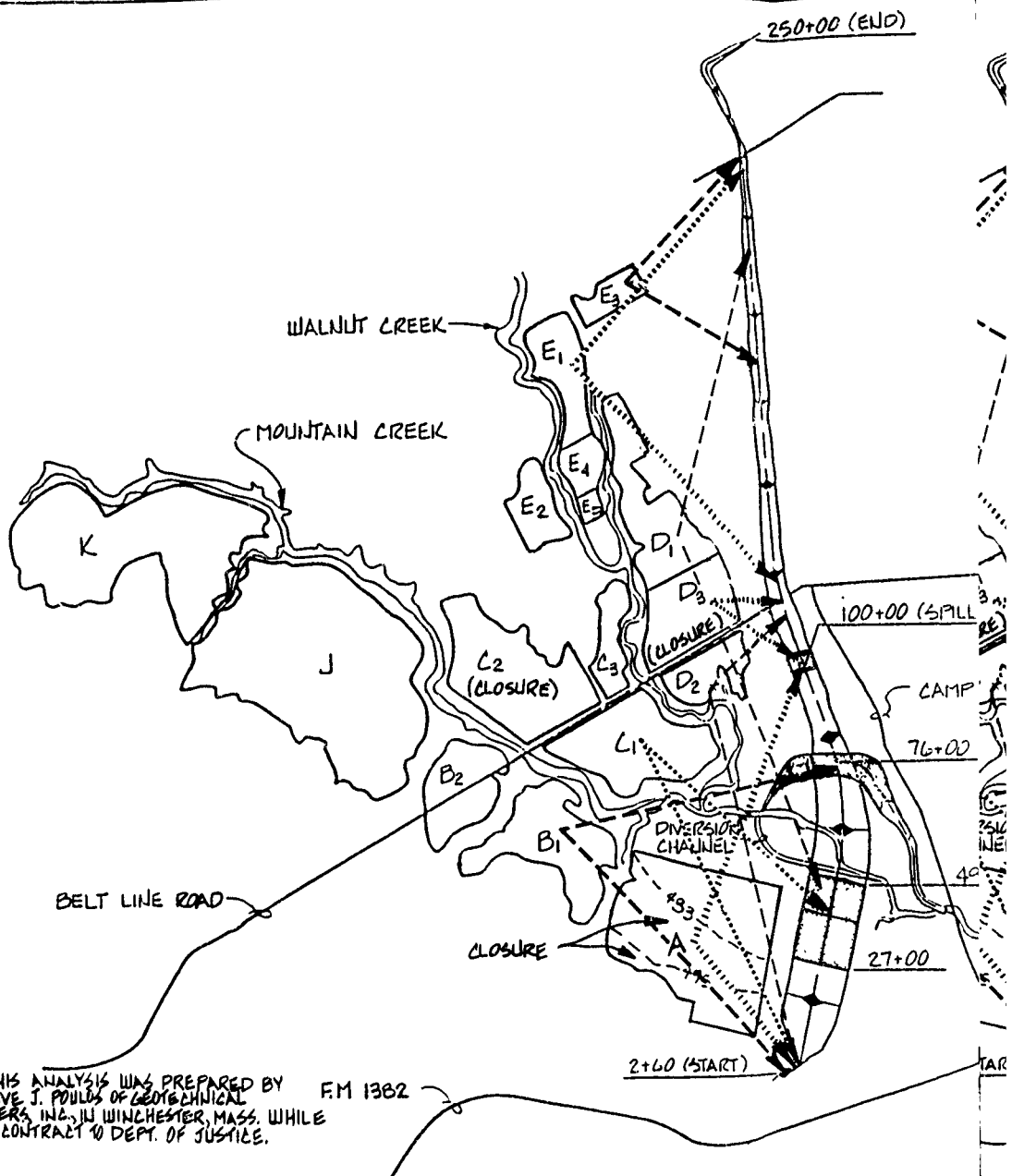


1 2 3 4 5 6



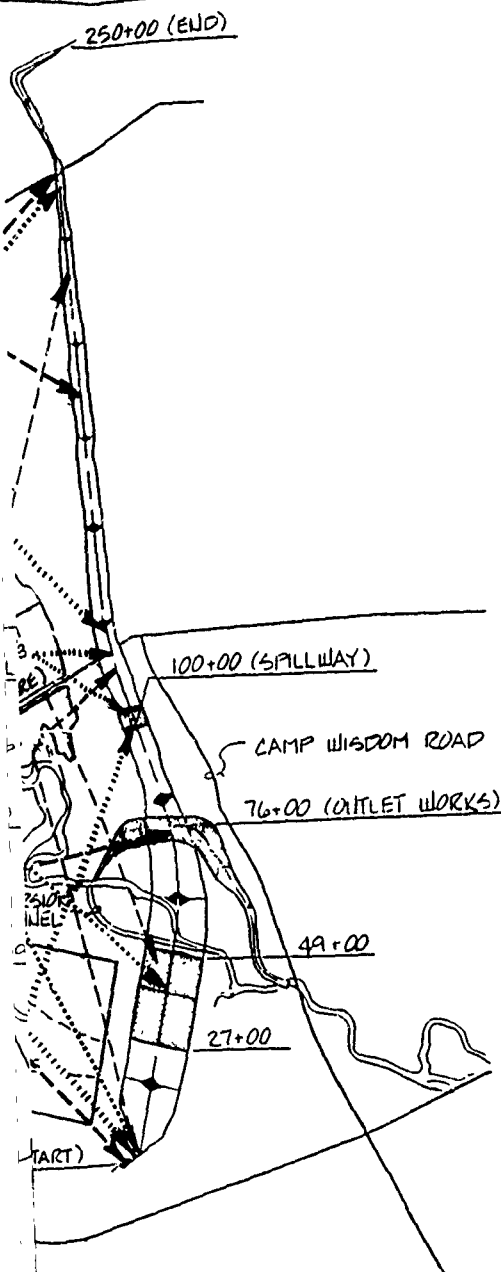
UNITED STATES OF AMERICA	
U.S. ARMY ENGINEER DISTRICT FORT WORTH	
CORPS OF ENGINEERS	
FORT WORTH, TEXAS	
DESIGNED BY	JOE POOL
DRAWN BY	W. H. F. 124
CHECKED BY	
APPROVED BY	
EMBANKMENT SPILLWAY, AND OUTLET WORKS	
EXTENT OF BORROW AREA EXCAVATION	
BORROW AREAS-II	
E1, E2, E3, E4 AND E5	
SCALE 1" = 100' HORIZONTAL	
DATE	
DRAWING NUMBER	SHEET NO.
	110





NOTE: THIS ANALYSIS WAS PREPARED BY
DR STEVE J. POULOS OF GEOTECHNICAL
ENGINEERS, INC., IN WINCHESTER, MASS. WHILE
UNDER CONTRACT TO DEPT. OF JUSTICE.

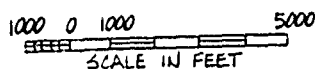
F.M 1382



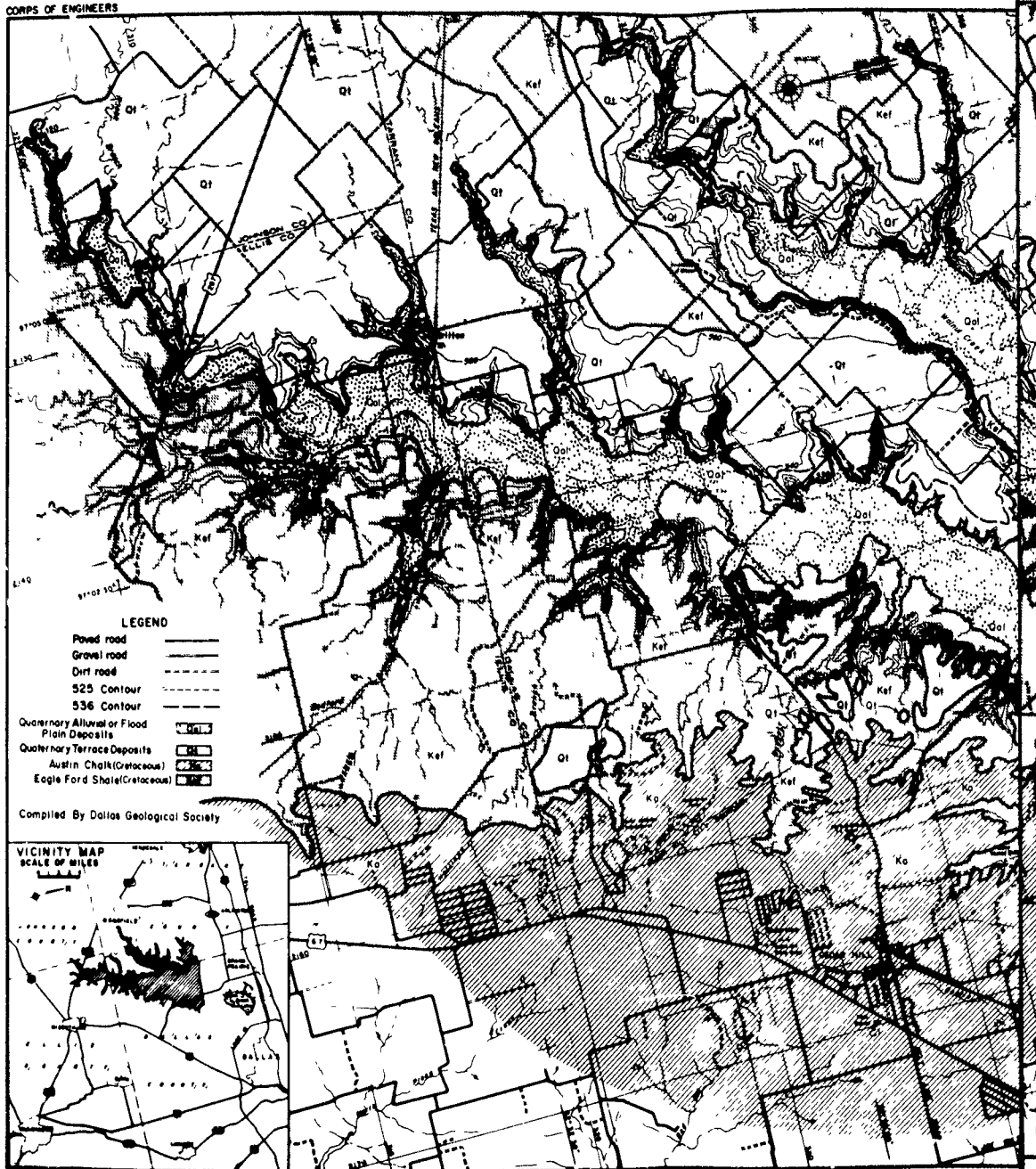
LEGEND:

 1st CONTRACT

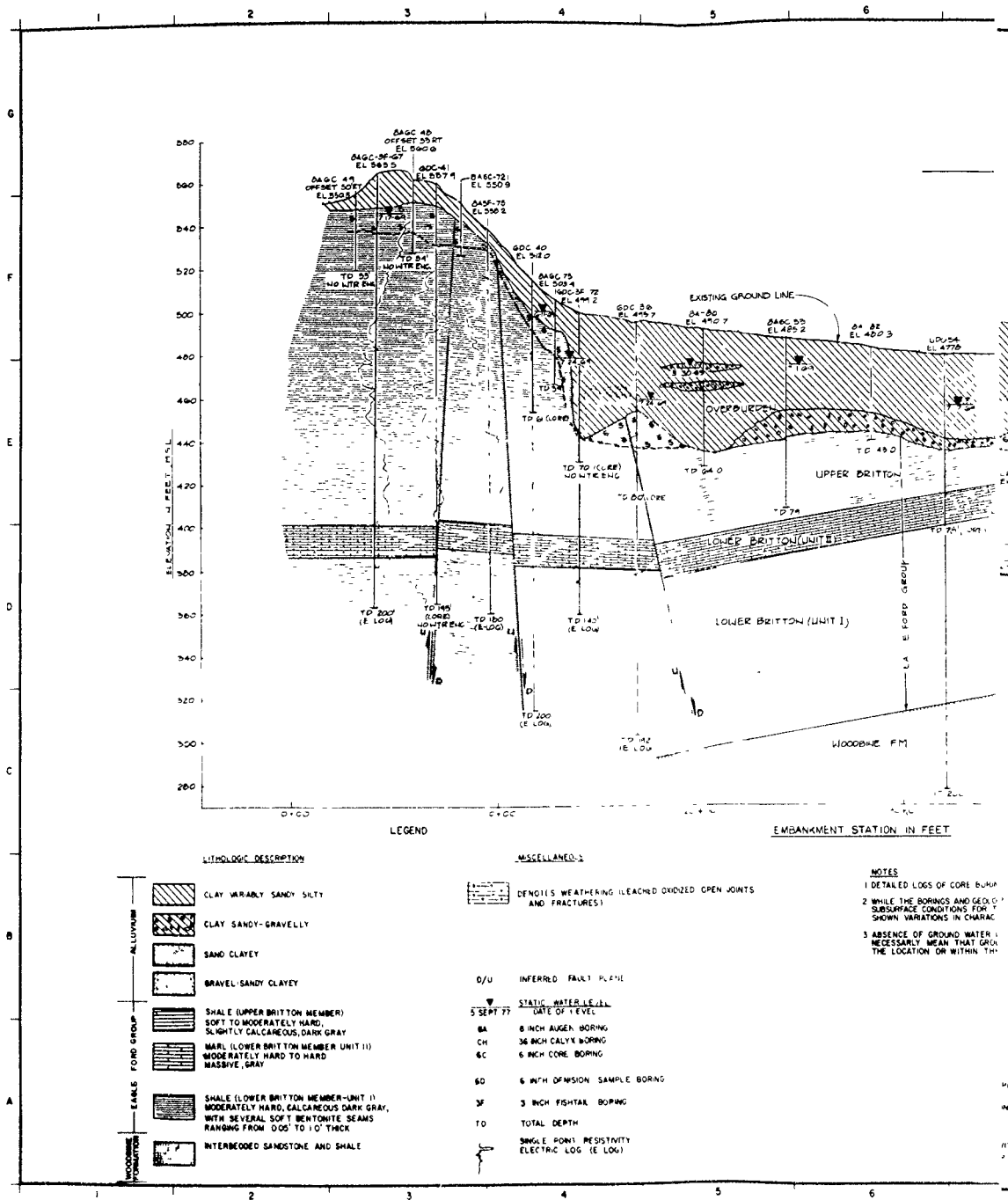
ARROWS INDICATE WHERE MATERIALS FROM THE BORROW AREAS WERE PLACED IN THE DAM

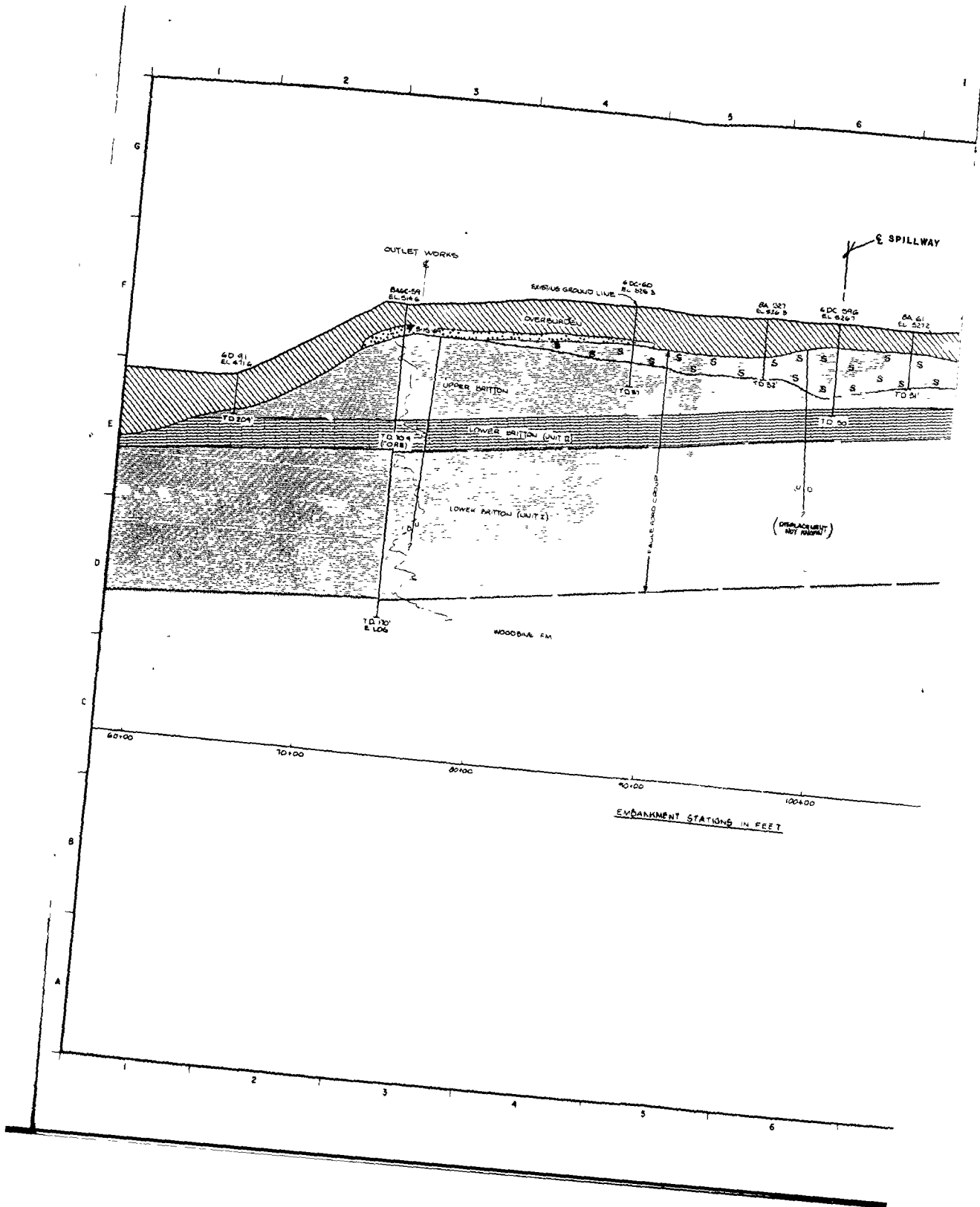


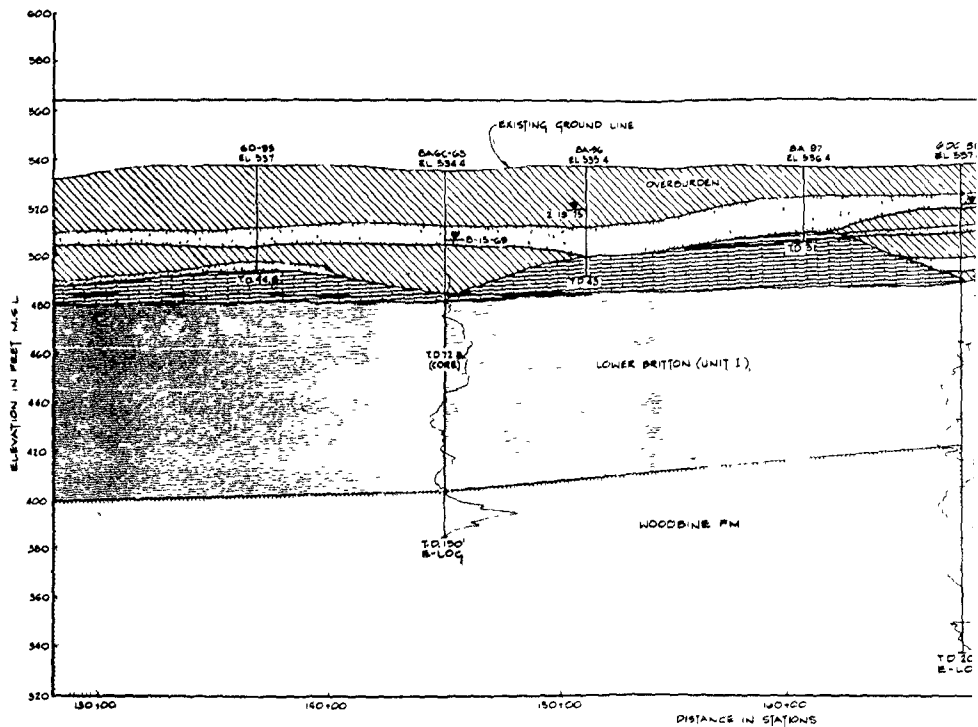
U.S. ARMY ENGINEER DISTRICT FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS			
SITE NO. 18 POULAS		JOE POOL LAKE MOUNTAIN CREEK, TEXAS	
PAGE NO.		EMBANKMENT, SPILLWAY, AND OUTLET WORKS	
DESIGNED BY T. SCHEIDT		MATERIALS SOURCE AND PLACEMENT LOCATIONS COMPLETION CONTRACT	
DRAWN BY		SHEET NO.	
DATE		SHEET NO. 33 OF 43	
PROJECT NO.		PROJECT NO.	



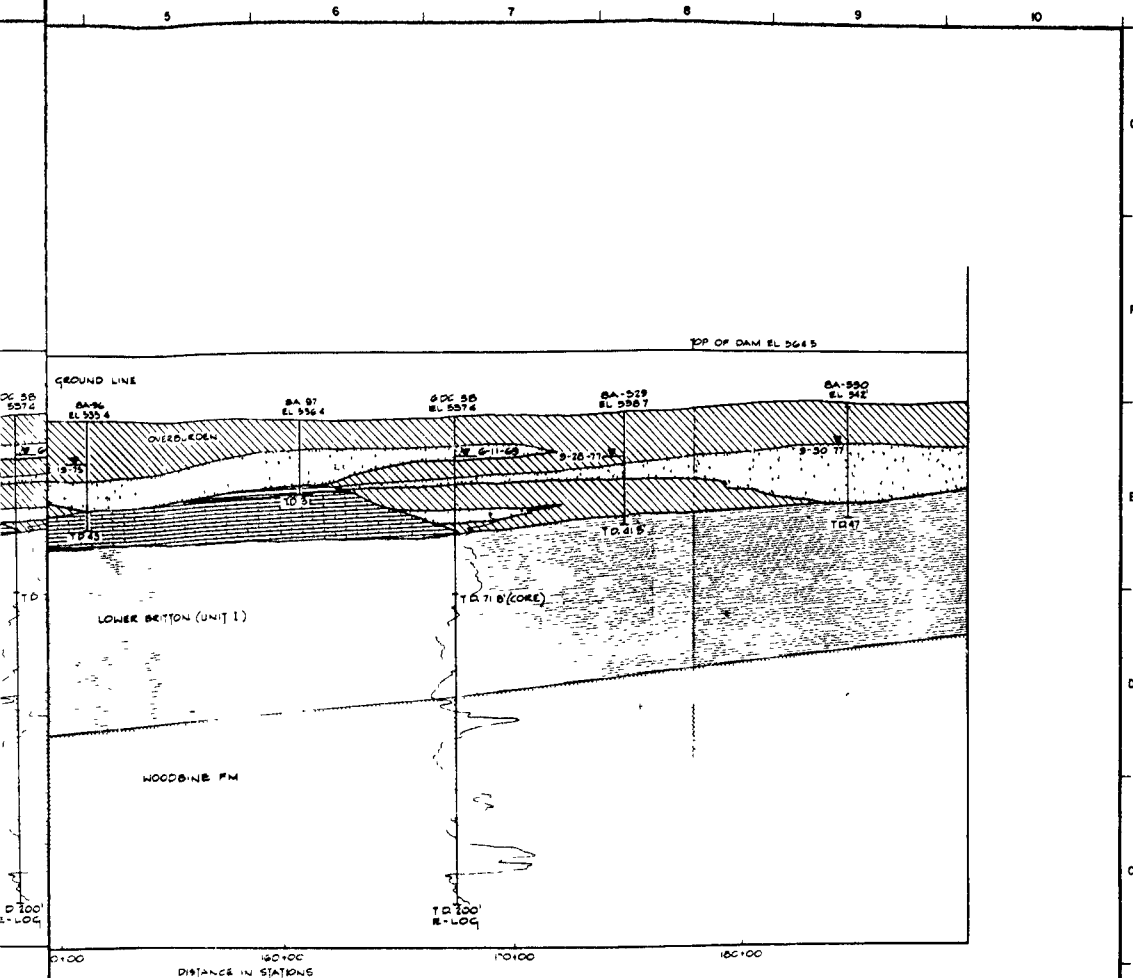








PROFILE



PROFILE

FOR LEGEND AND GENERAL NOTES SEE 882

UNITED STATES OF AMERICA	
U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
DESIGNED BY	JOE POOL LAKE MOUNTAIN CREEK, TEXAS
DRAWN BY	MARR
CHECKED BY	
IDENTIFIED BY	
EMBANKMENT, SPILLWAY, AND OUTLET WORKS GEOLOGIC PROFILE EMBANKMENT CENTERLINE (STA 128+00 TO STA 180+00)	
NO. 882-63-81-S-CORE	
DATED JULY 1961	
DRAWING NUMBER	SHEET NO. 10

ELEVATION IN FEET M.S.L.

360
340
320
300
280
260
240
220

190+00

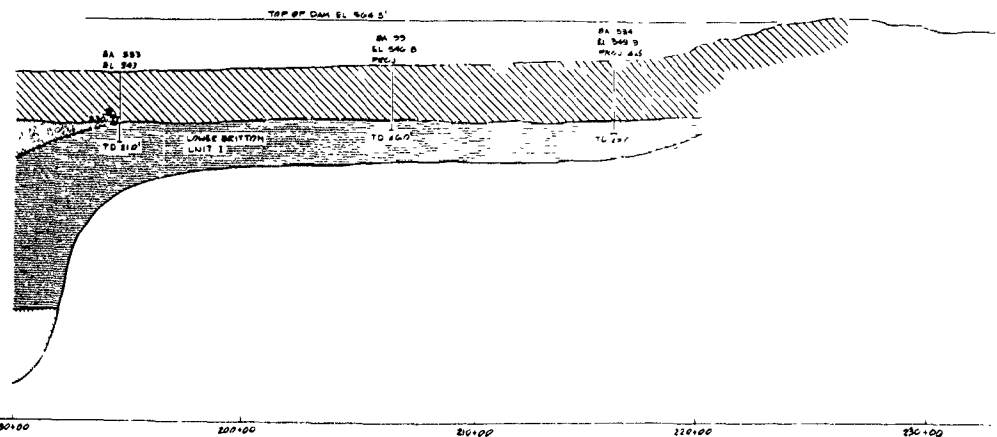
200+00

210+00

220+00

230+00

EMBANKMENT STATIONS IN FEET



5

6

7

8

9

10

G

F

E

D

C

B

PA 554
E. 544.9
PROJ. 415

TO 244'

110+00

130+00

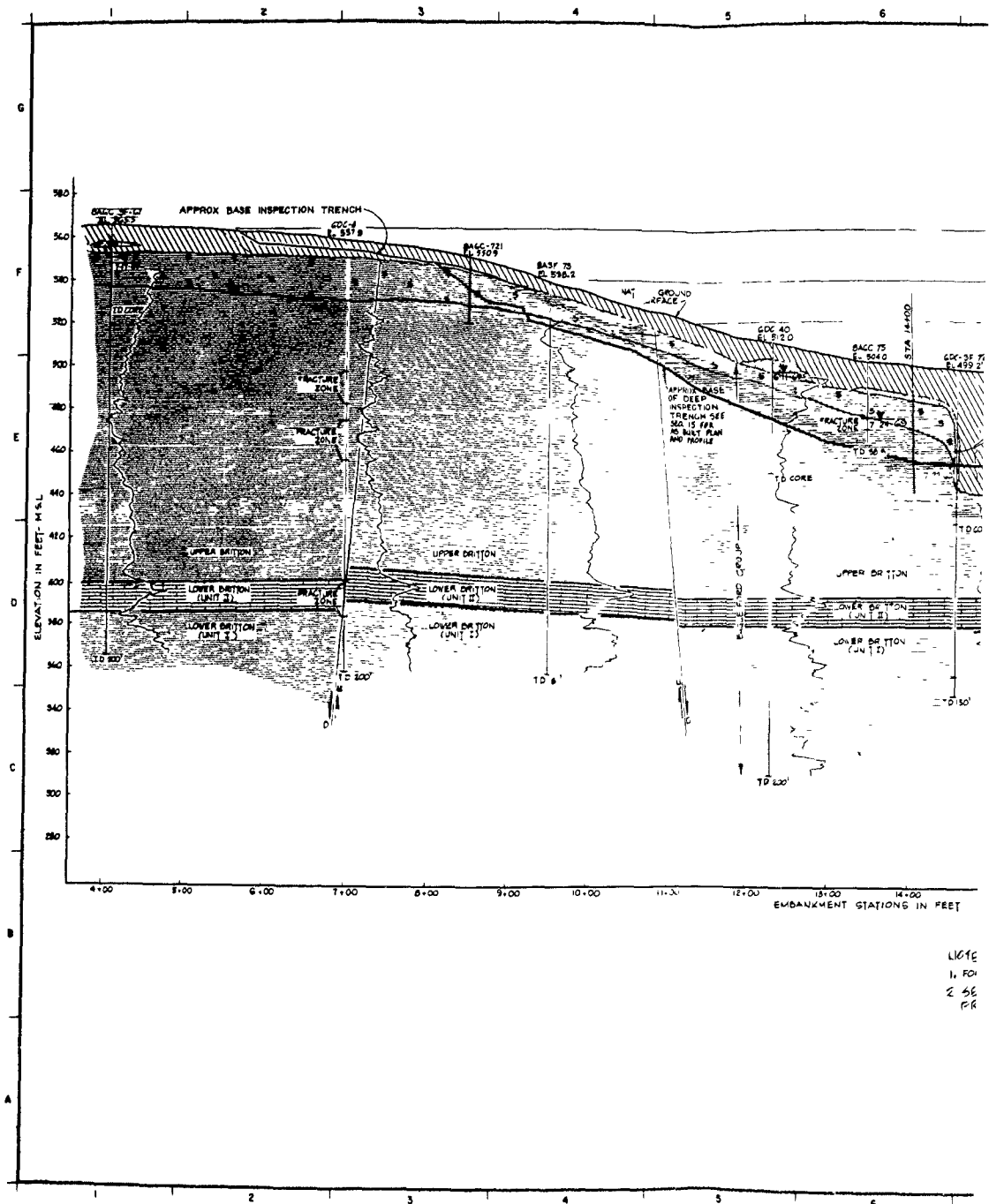
240+11.0

ENT STATIONS IN FEET

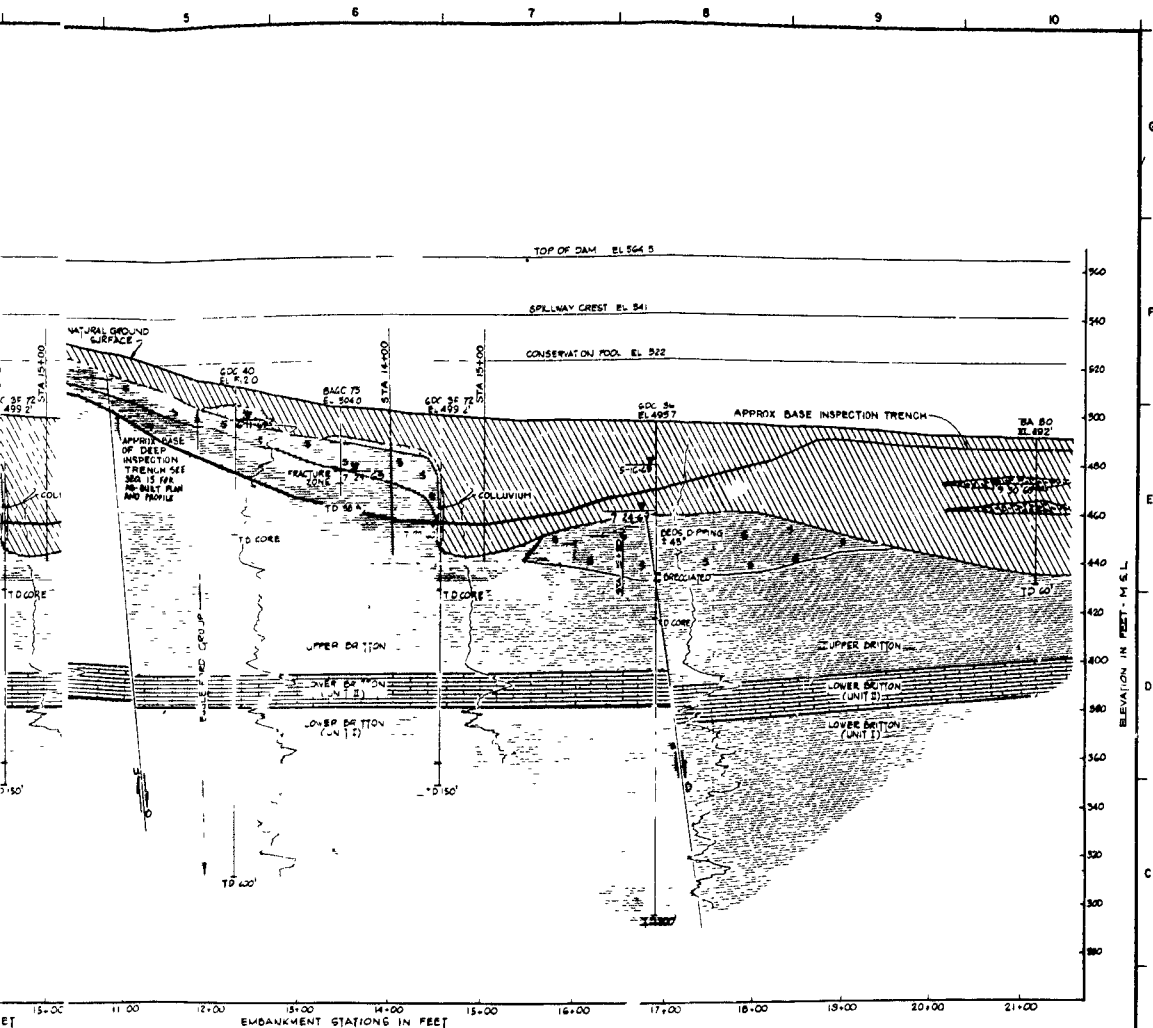
FOR LEGEND AND GENERAL NOTES SEE SEQ

U.S. ARMY ENGINEER DISTRICT FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
DESIGNED BY	JOE POOL LAKE MOUNTAIN CREEK, TEXAS
DRAWN BY	MARR
ENGINEER BY	EMBANKMENT, SPILLWAY, AND OUTLET WORKS GEOLOGIC PROFILE EMBANKMENT CENTERLINE (STATION 150+00 TO 225+00)
REVIEWED BY	NOV 10 1961 DATE SHEET NO 11

PLATE 28



NOTE
1. FOR
2. SEE
PR



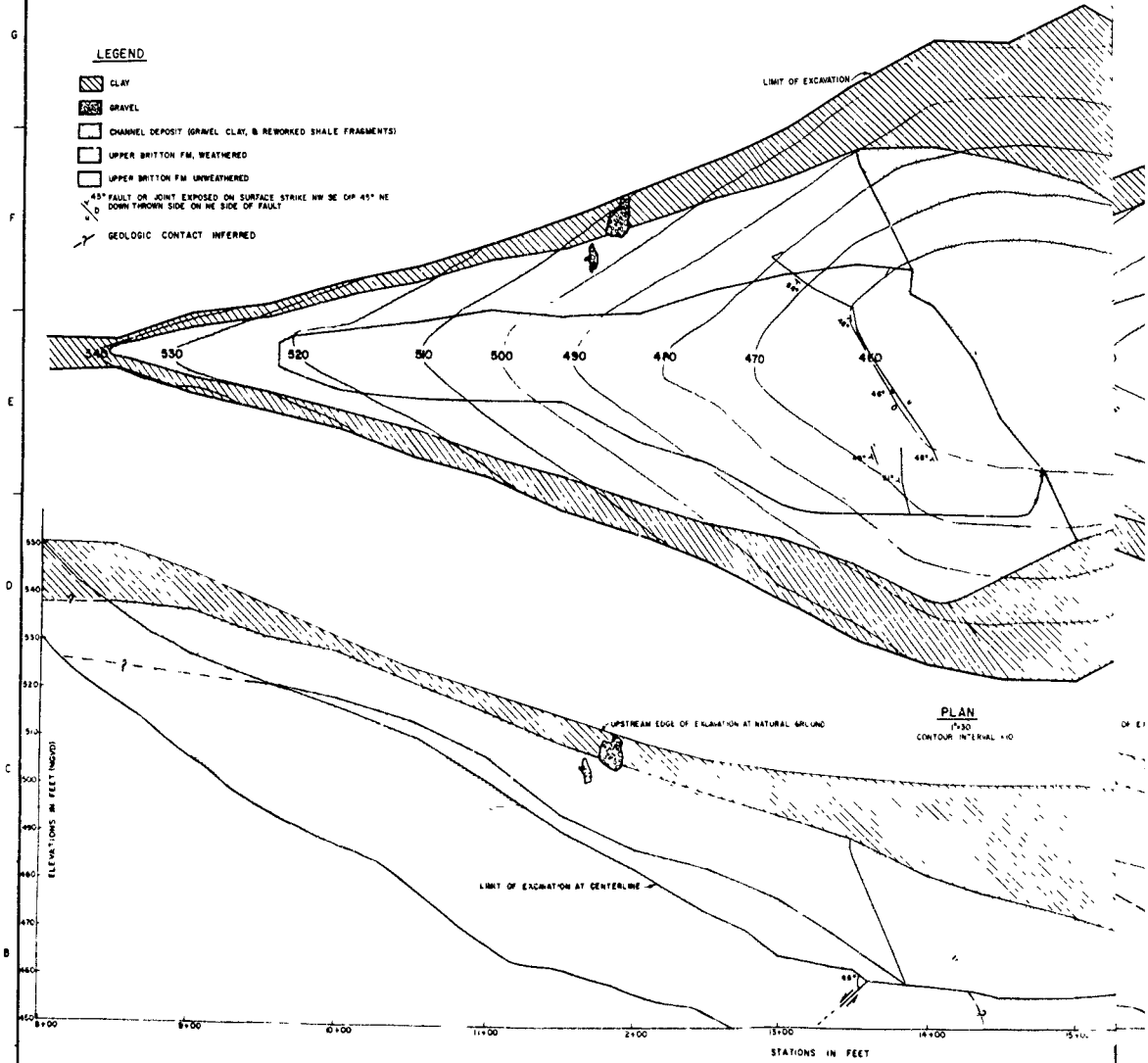
1. FOR LEG
2 SEE F
PR 1

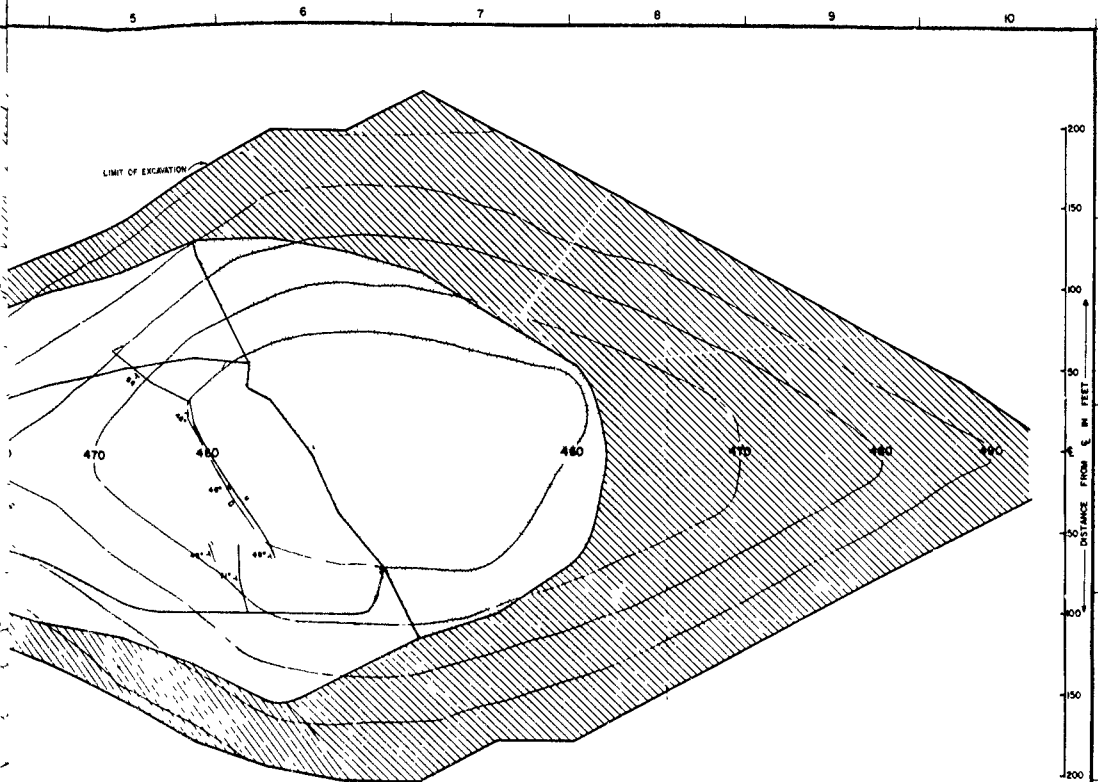
1. FOR LEGEND AND GENERAL NOTES SEE SEE
2 SEE PLATE 30 FOR AS-BUILT PLAN AND
PROFILE OF DEEP INSPECTION TRENCH

U.S. ARMY ENGINEER DISTRICT FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
PROJECT NO.	JOE POOL LAKE MOUNTAIN CREEK TEXAS
DESIGNED BY	EMBANKMENT, SPILLWAY, AND OUTLET WORKS
APPROVED BY	GEOLOGIC PROFILE
REVIEWED BY	EMBANKMENT CENTERLINE
QUANTITY BY	EMBANKMENT CENTERLINE RIGHT ABUTMENT
DRAW NO. DASH 65-01-8-0003 DATE: JULY 1961 DRAWING NUMBER SHEET NO. 13	

LEGEND

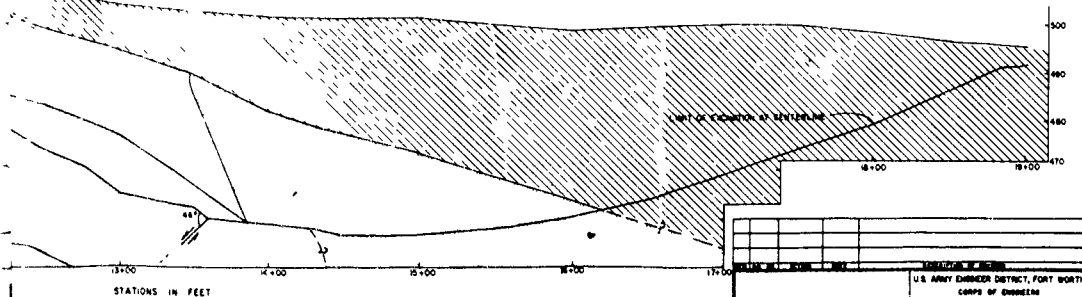
-  CLAY
-  GRAVEL
-  CHANNEL DEPOSIT (GRAVEL, CLAY, & REWORKED SHALE FRAGMENTS)
-  UPPER BRITTON FM. WEATHERED
-  UPPER BRITTON FM. UNWEATHERED
-  45° FAULT OR JOINT EXPOSED ON SURFACE STRIKE NW 30° SE DIP 45° NE DOWN THROWN SIDE ON NE SIDE OF FAULT
-  GEOLOGIC CONTACT INFERRED





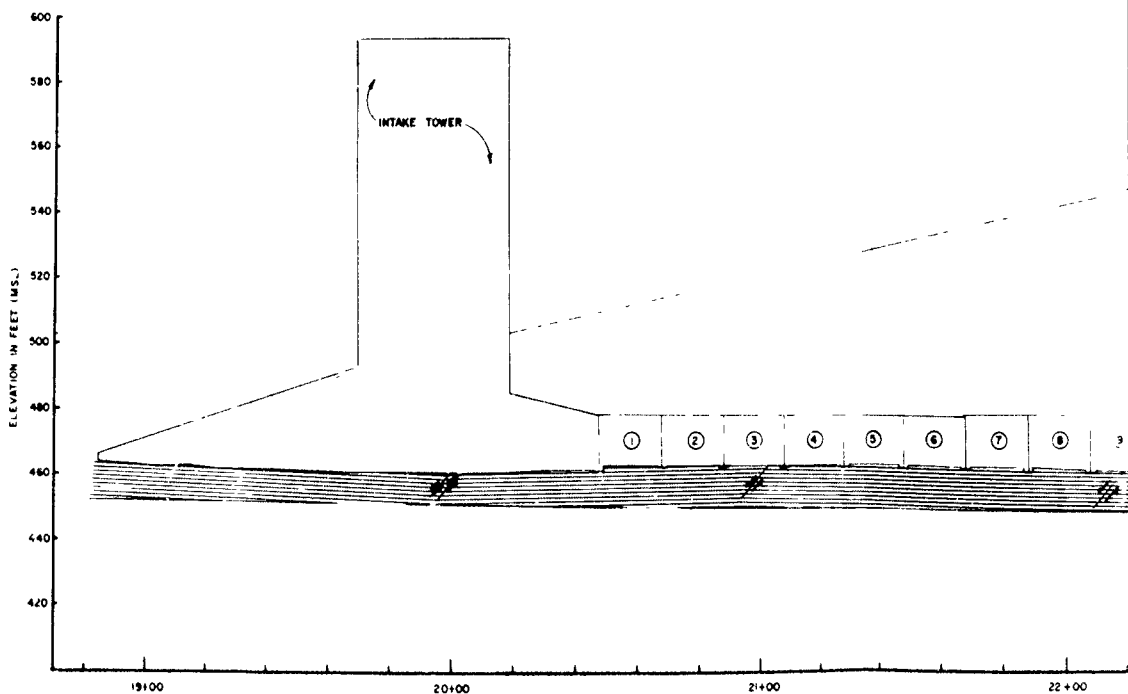
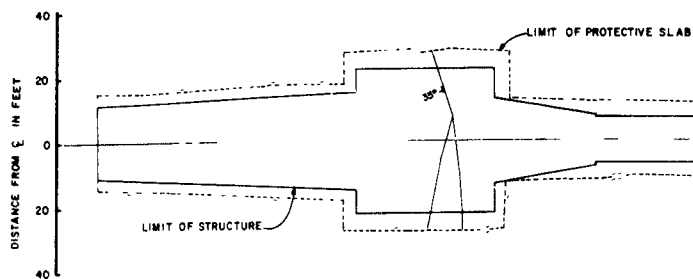
PLAN
1" = 30'
CONTOUR INTERVAL = 10'

OF EXCAVATION AT NATURAL GROUND

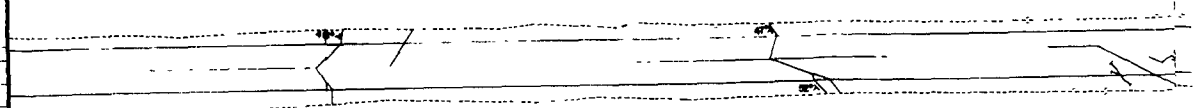


PROFILE AND MAP OF UPSTREAM EXCAVATION SLOPE
1" = 30' HORIZ. 1" = 10' VERT.

DRAWN BY A. MARR		CHECKED BY A. MARR	
DESIGNED BY A. MARR		REVIEWED BY A. MARR	
SUBMITTED BY A. MARR		DATED 1947	
ENGINEER A. MARR		CORPS NO. 10074	
SHEET NO. 10		SHEET NO. 10	



PLAN VIEW



EMBANKMENT CENTERLINE



CENTERLINE PROFILE

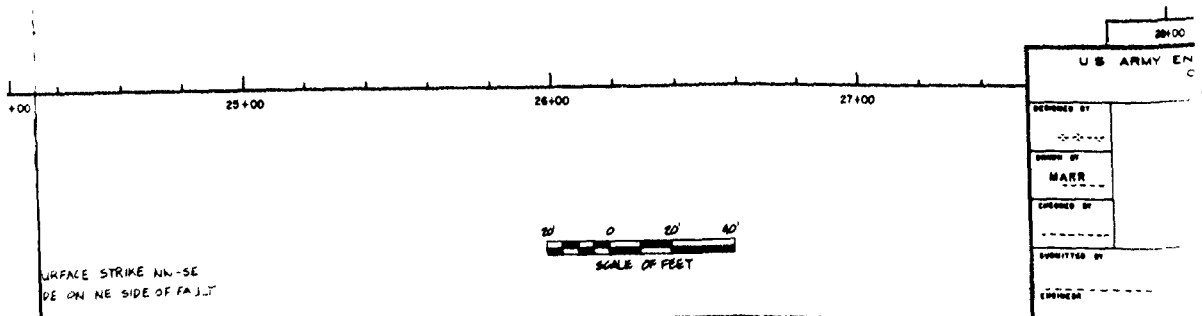
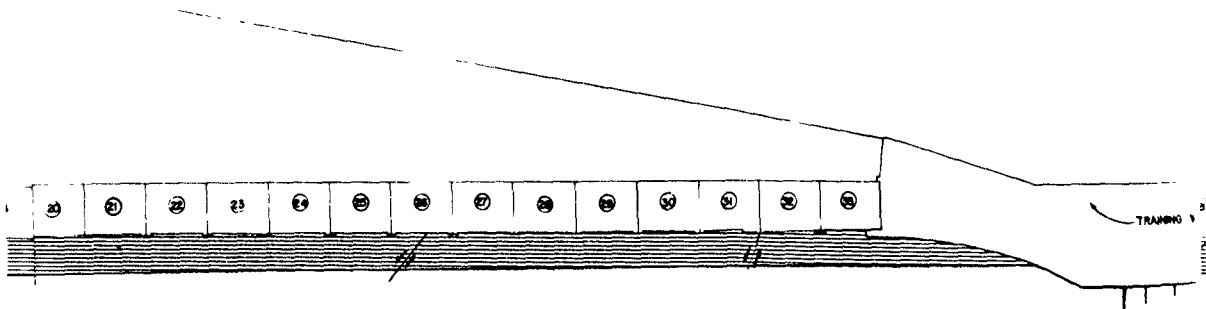
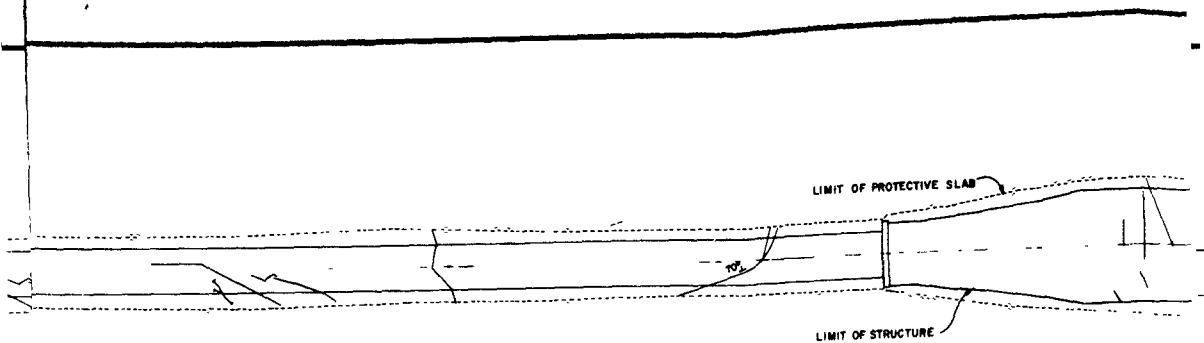
22+00 23+00 24+00 25+00
STATIONS IN FEET

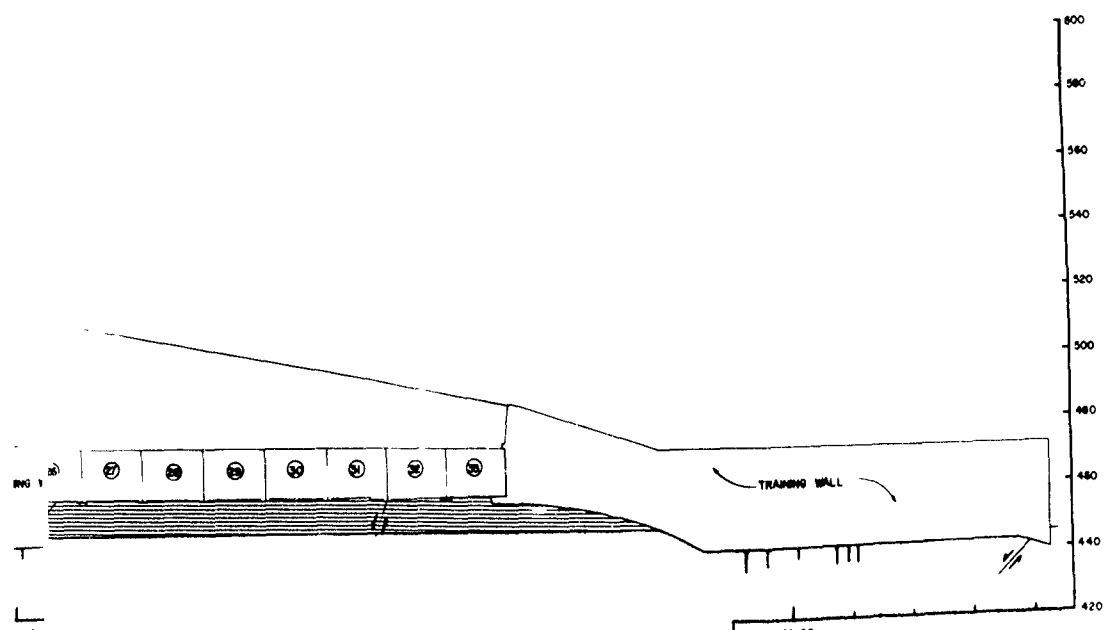
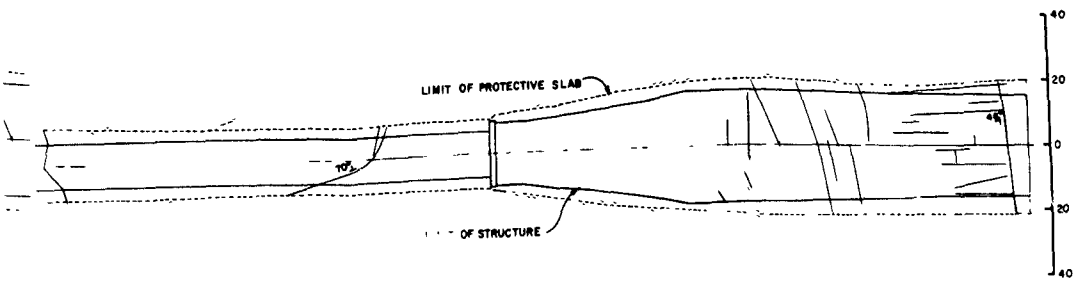
LEGEND

 UPPER BRITTON FM

 LOWER BRITTON FM

 FAULT OR JOINT EXPOSED ON SURFACE STRIKE NN-SE
DIP 45° NE DOWNTHROWN SIDE ON NE SIDE OF FAULT

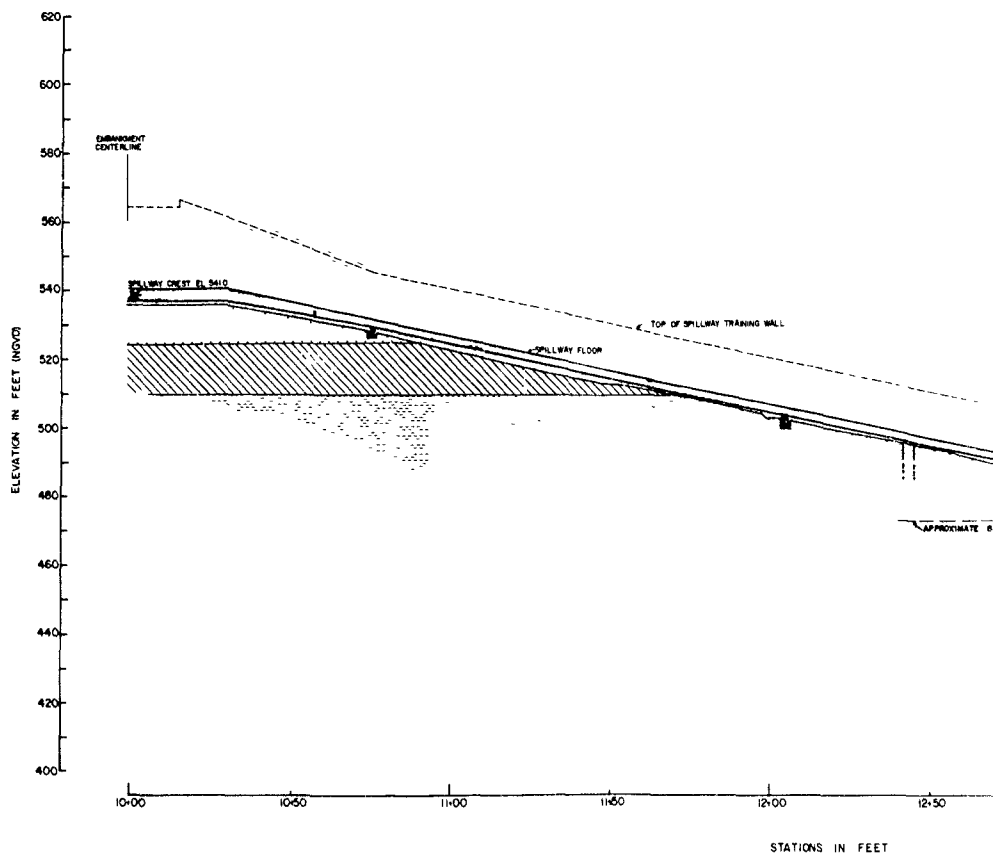




U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY	JOE POOL LAKE MOUNTAIN CREEK, TEXAS		
DESIGN BY	MARR		
CHECKED BY			
SUBMITTED BY			
DATE			
CONTR NO	DRAWING NUMBER		SHEET NO
			37
PLATE			

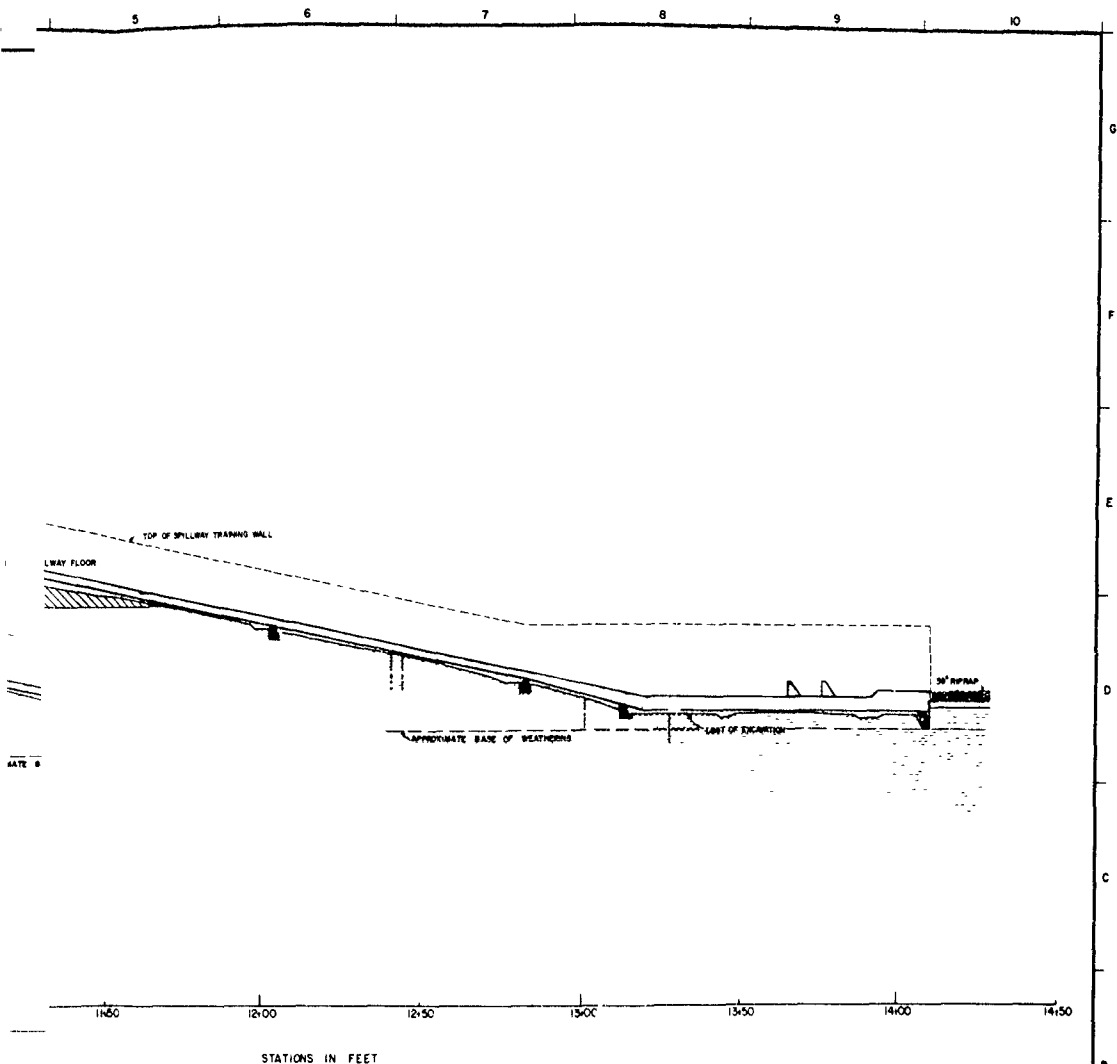
PLATF 31



LEGEND

-  STRUCTURAL CONCRETE
-  FILTER SAND
-  FILL (INITIAL CONTRACT)
-  OVERBURDEN (CLAY, SANDY)
-  UPPER BRITTON FM
-  VERTICAL JOINT INTERSECTS EXCAVATION SURFACE

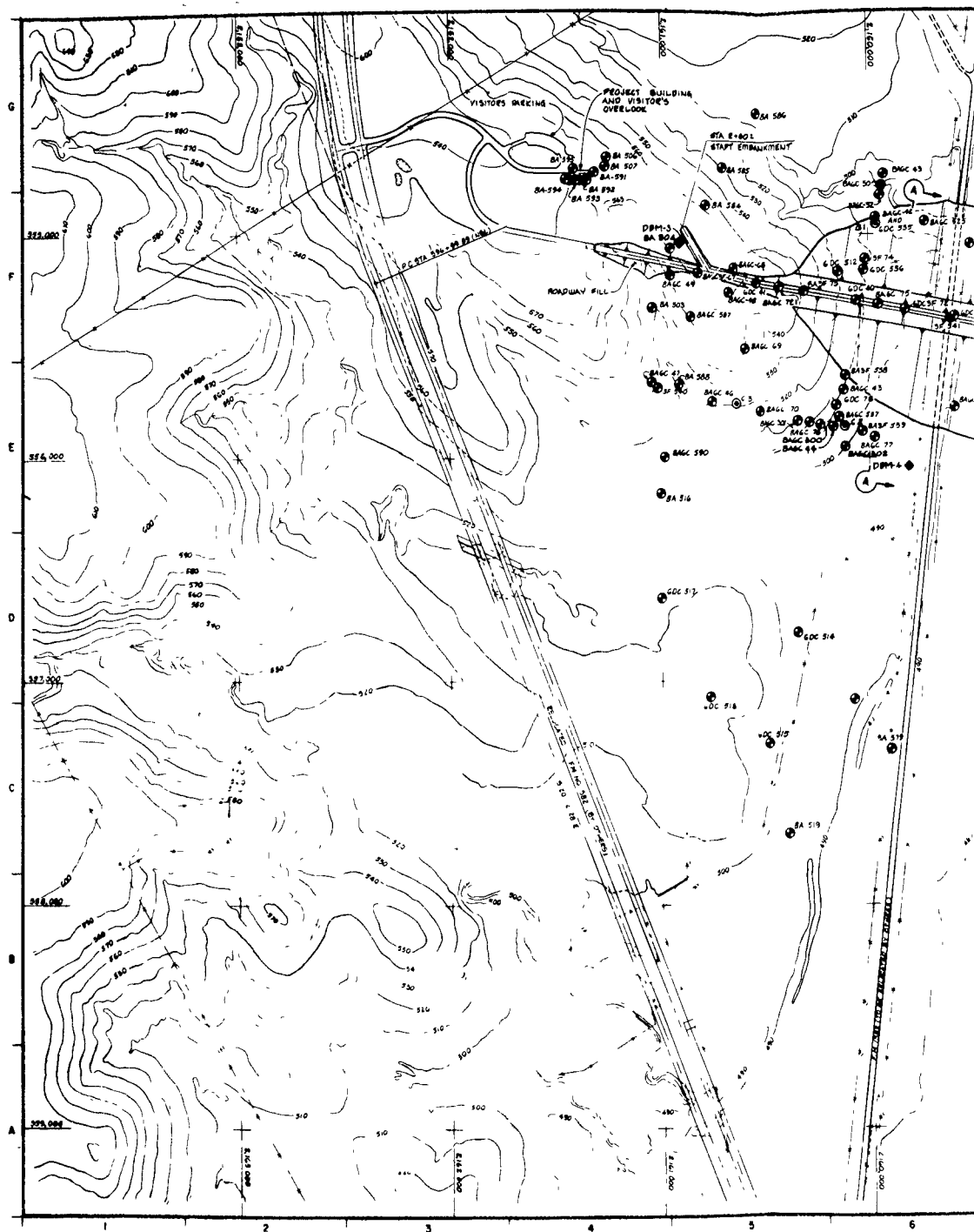
SPILLWAY PROFILE

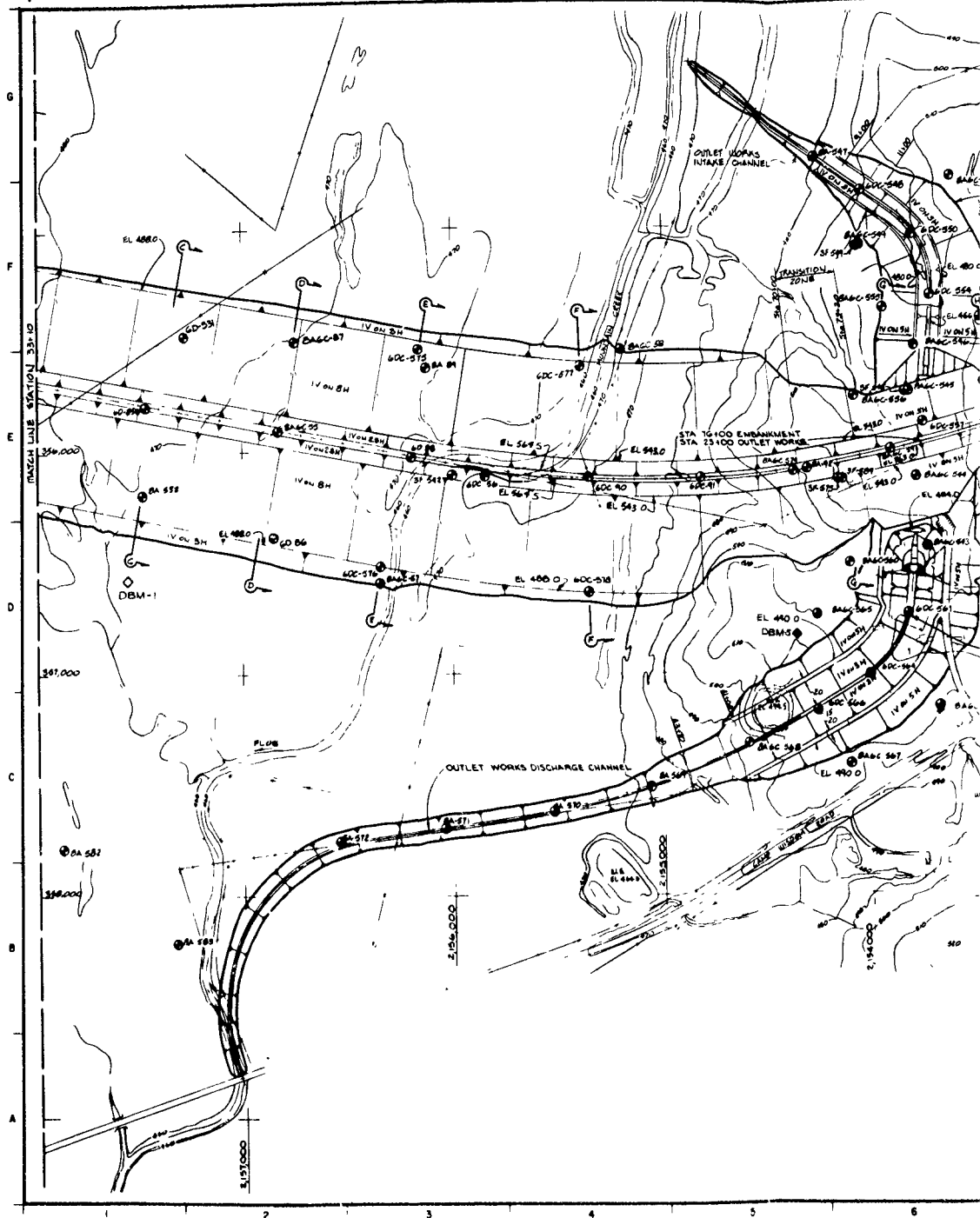


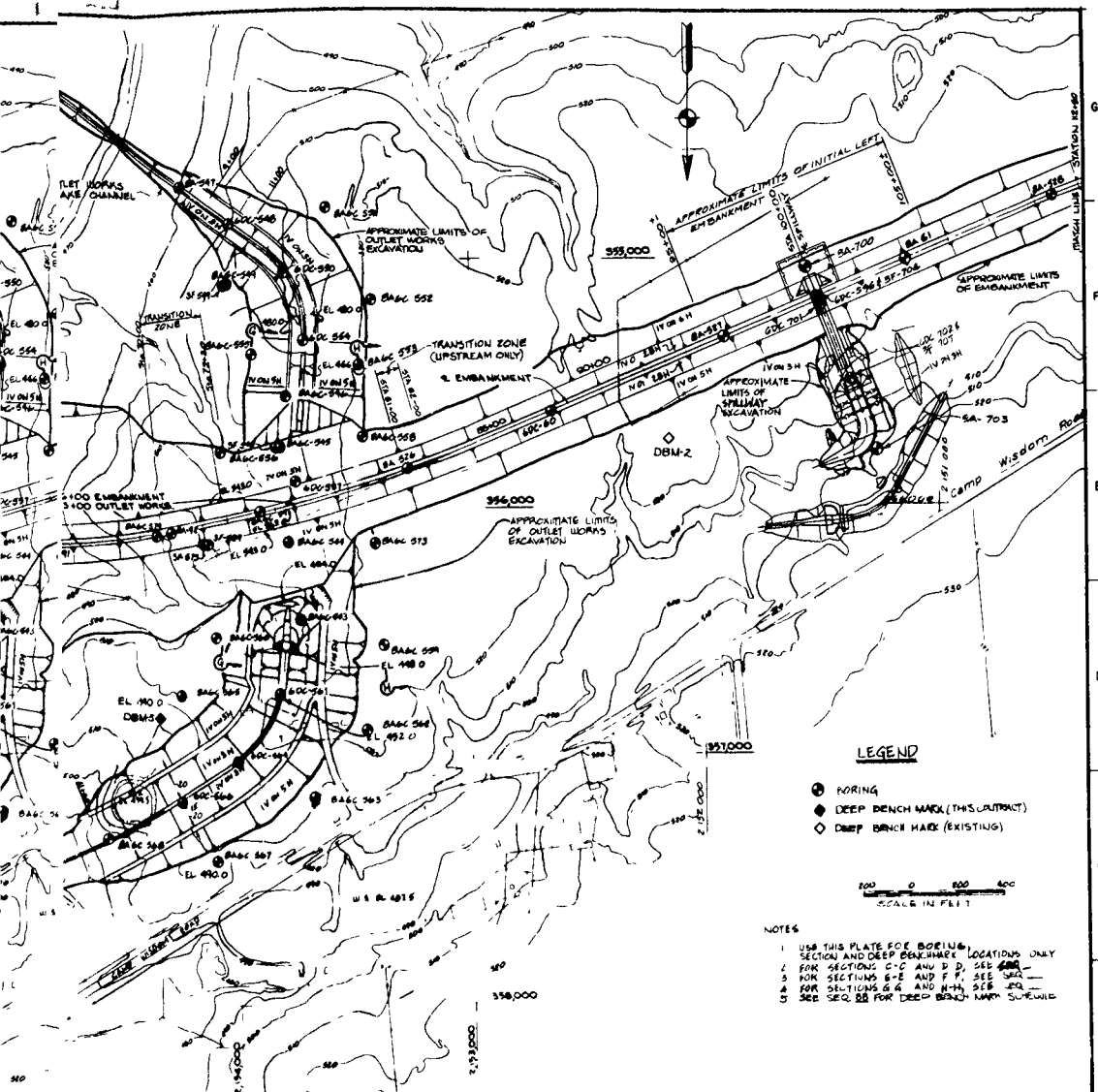
SPILLWAY PROFILE

DESIGNED BY		JOE POOL LAKE MOUNTAIN CREEK, TEXAS	
DRAWN BY		GEOLOGIC PROFILE	
REVIEWED BY		SPILLWAY CENTERLINE (AS-BUILT)	
SUBMITTED BY		COL NO.	DATED
CHECKED BY		CONST. NO.	QUEST. NO.
APPROVED BY		SHOWN NUMBER	QUEST. NO.

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS







LEGEND

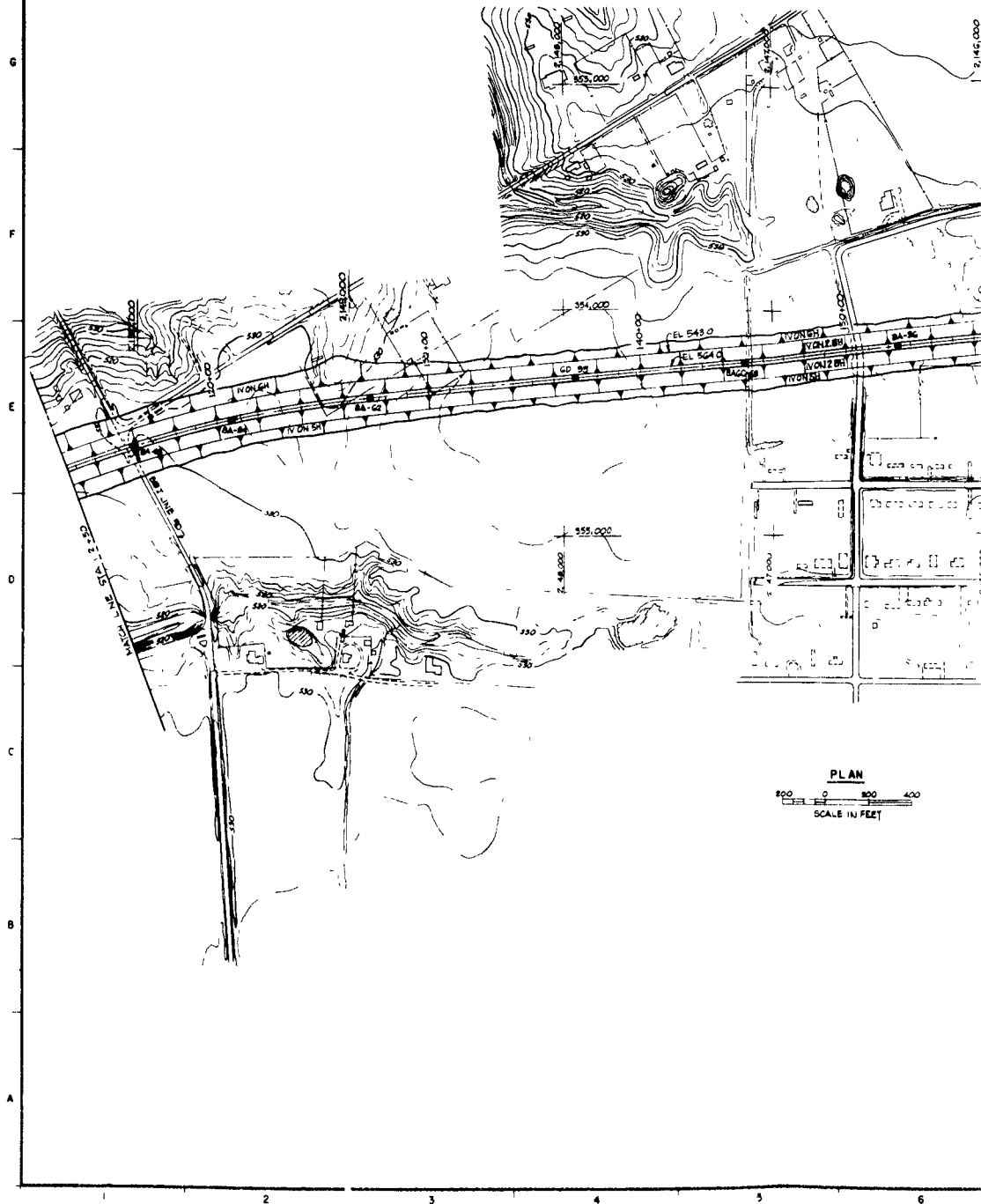
- BORING
- ◆ DEEP BENCH MARK (THIS PLANT)
- ◇ DEEP BENCH MARK (EXISTING)

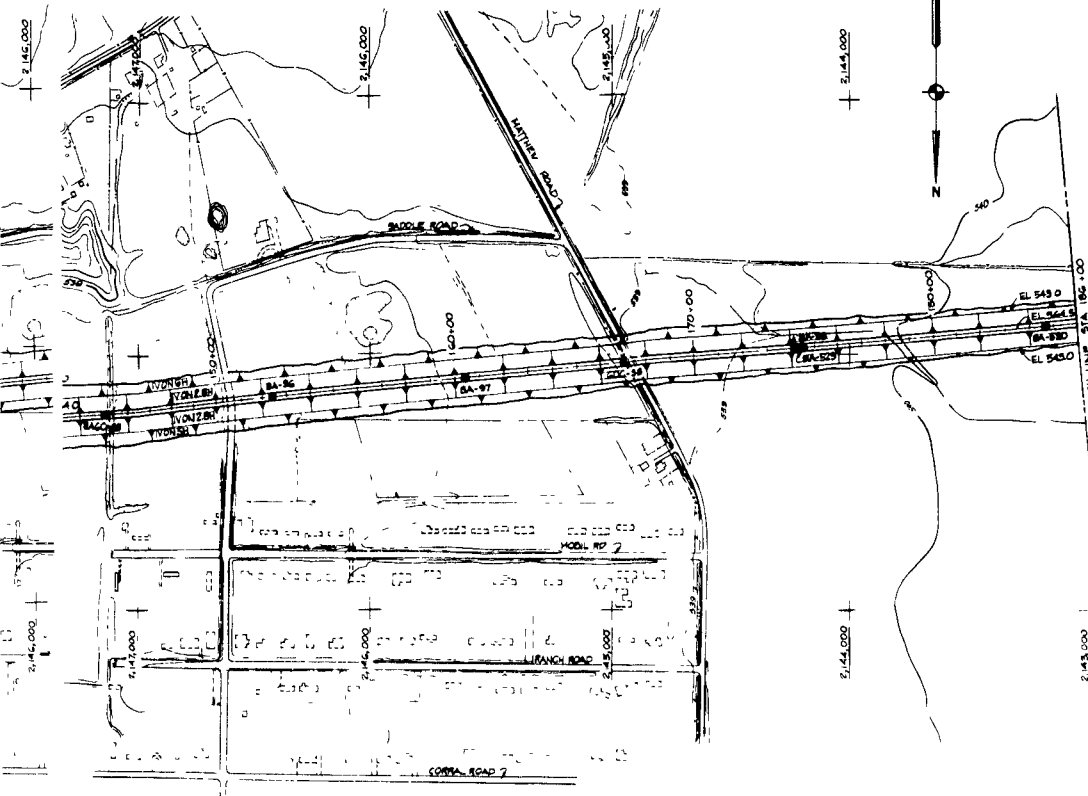
0 200 400
SCALE IN FEET

NOTES

1. USE THIS PLATE FOR BORING SECTION AND DEEP BENCH MARK LOCATIONS ONLY
2. FOR SECTIONS C-C AND D-D, SEE SHEET 88
3. FOR SECTIONS E-E AND F-F, SEE SHEET 89
4. FOR SECTIONS G-G AND H-H, SEE SHEET 90
5. SEE SHEET 88 FOR DEEP BENCH MARK SCHEDULE

U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
DESIGNED BY T. SCHMIDT DRAWN BY R. BROWN CHECKED BY T. SCHMIDT SUBMITTED BY	JOE POOL LAKE MOUNTAIN CREEK, TEXAS EMBANKMENT, SPILLWAY, AND OUTLET WORKS PLAN OF BORINGS II STATION 33+10 TO STATION 112+50 DRAWN BY DATED JULY 1958 SHEET NO. 4 OF 43



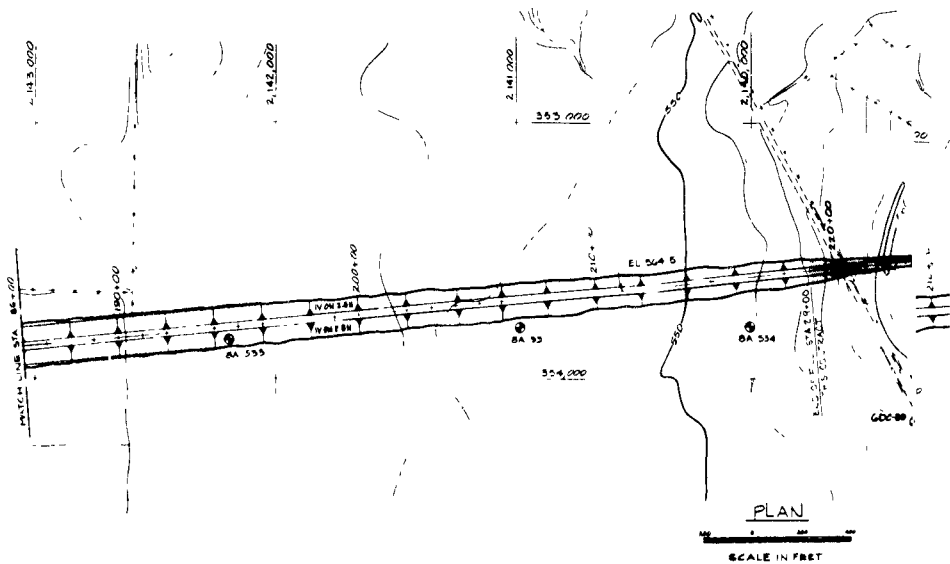


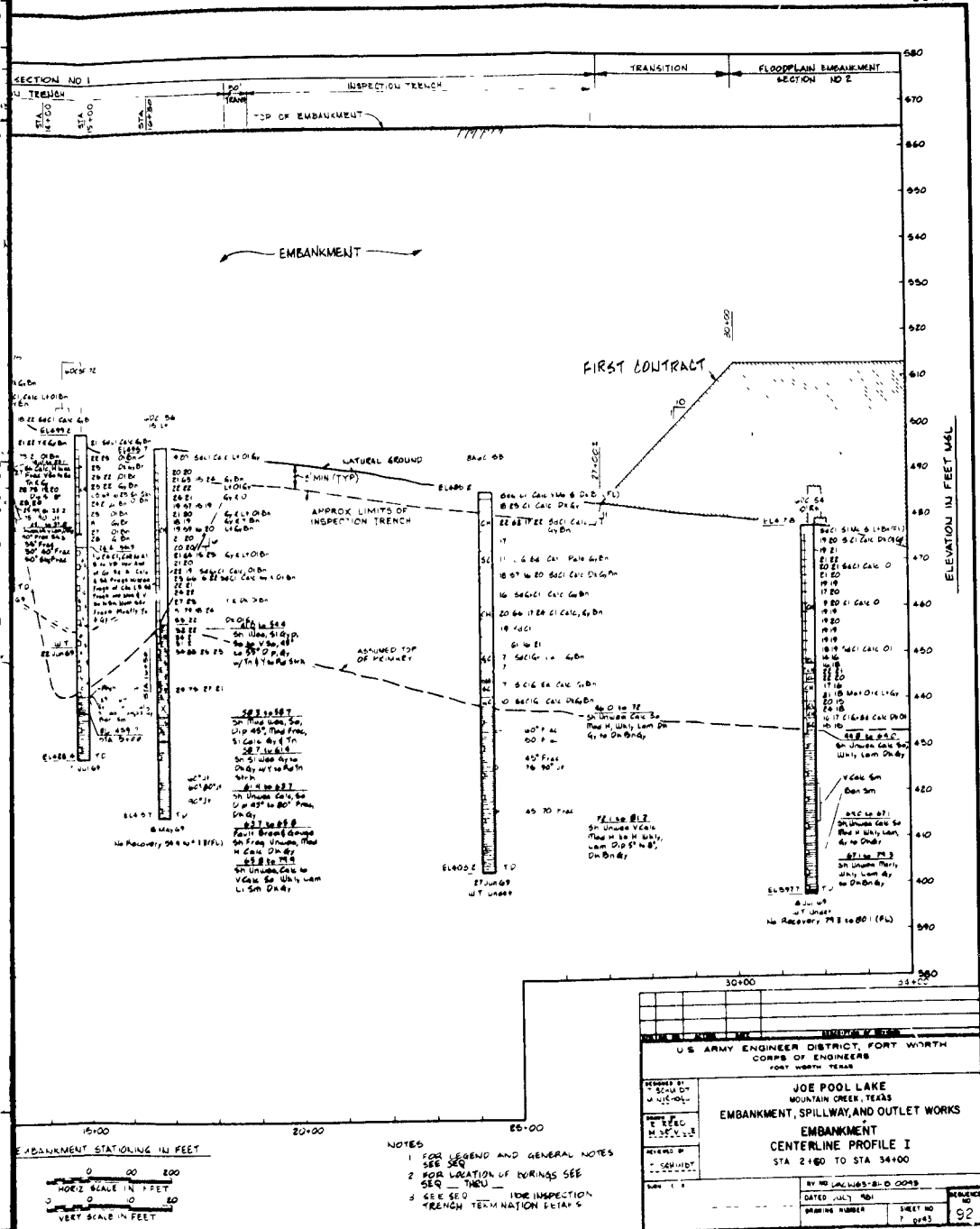
PLAN
800 400
SCALE IN FEET

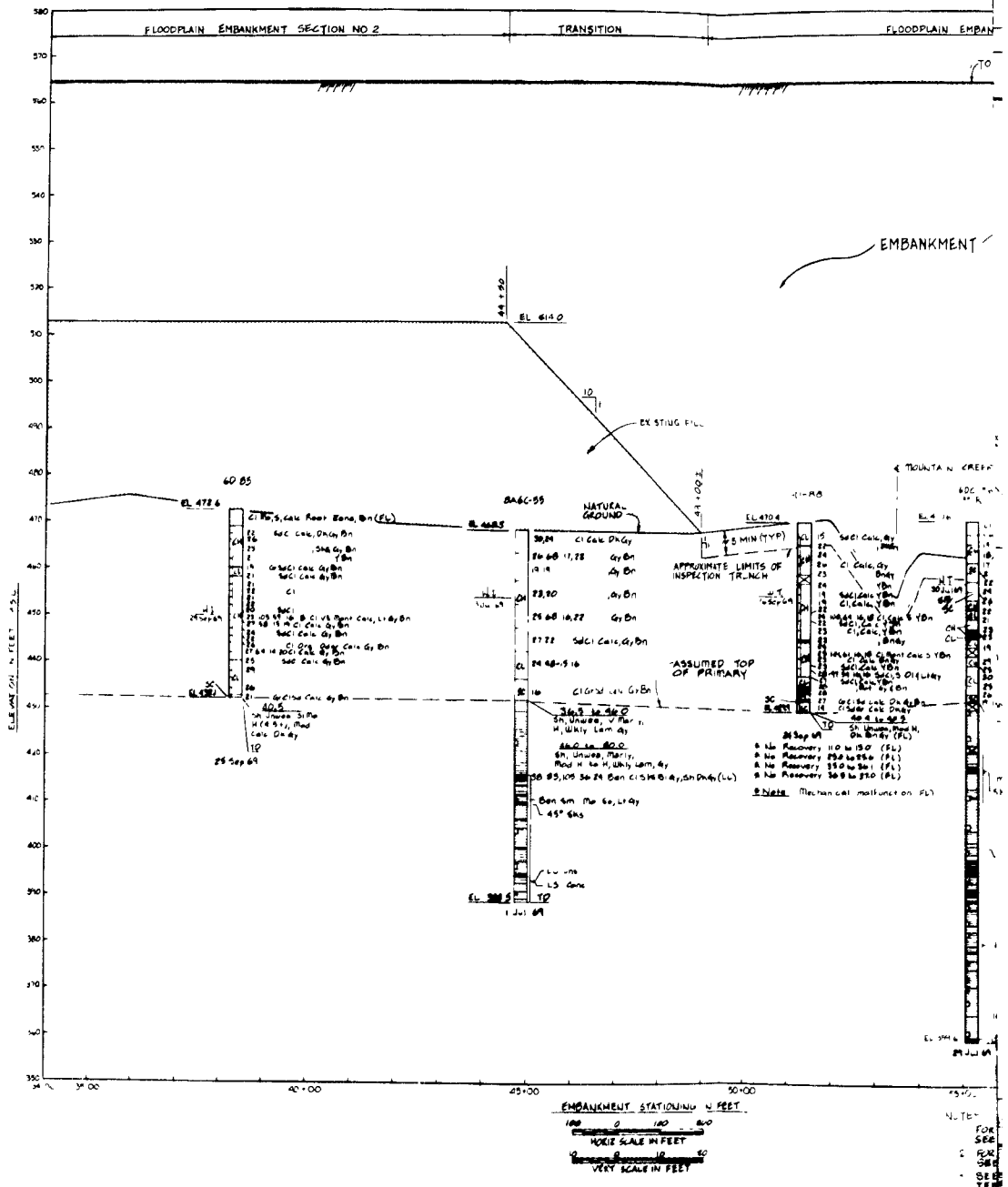
LEGEND
● BORING

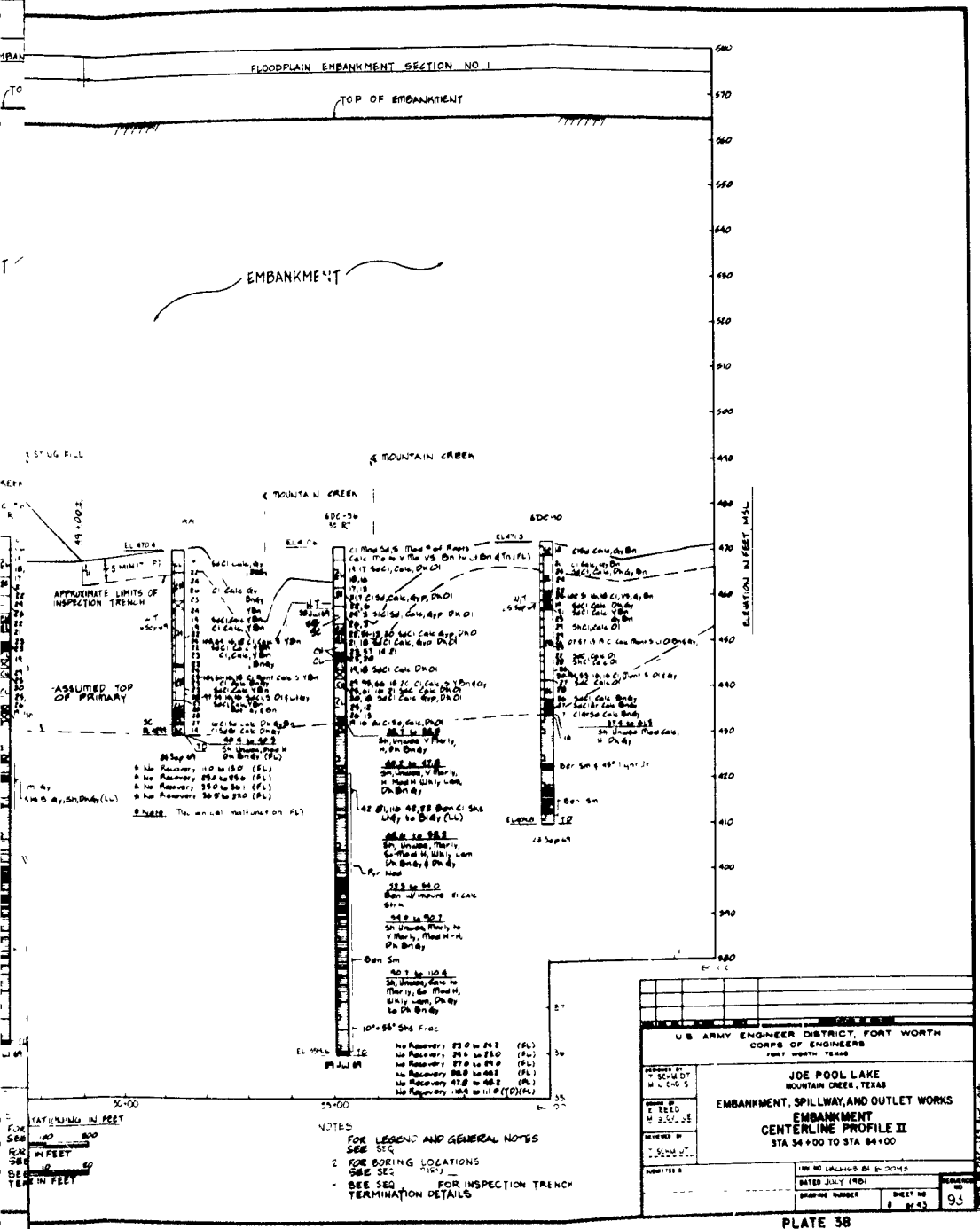
NOTES
1. USE THIS SEQUENCE FOR BORING LOCATIONS ONLY

U.S. ARMY ENGINEER DISTRICT FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS		JOE POOL LAKE MOUNTAIN CREEK, TEXAS	
DESIGNED BY T. SCHMIDT W. H. HENRY		EMBANKMENT, SPILLWAY, AND OUTLET WORKS	
CHECKED BY W. H. HENRY		PLAN OF BORINGS III STA 112+50 TO 186+00	
REVIEWED BY T. SCHMIDT		DRAWN BY J. H. HENRY	
SUBMITTED BY		DATE JULY 1961	
		SHEET NO. 3 OF 43	
		90	









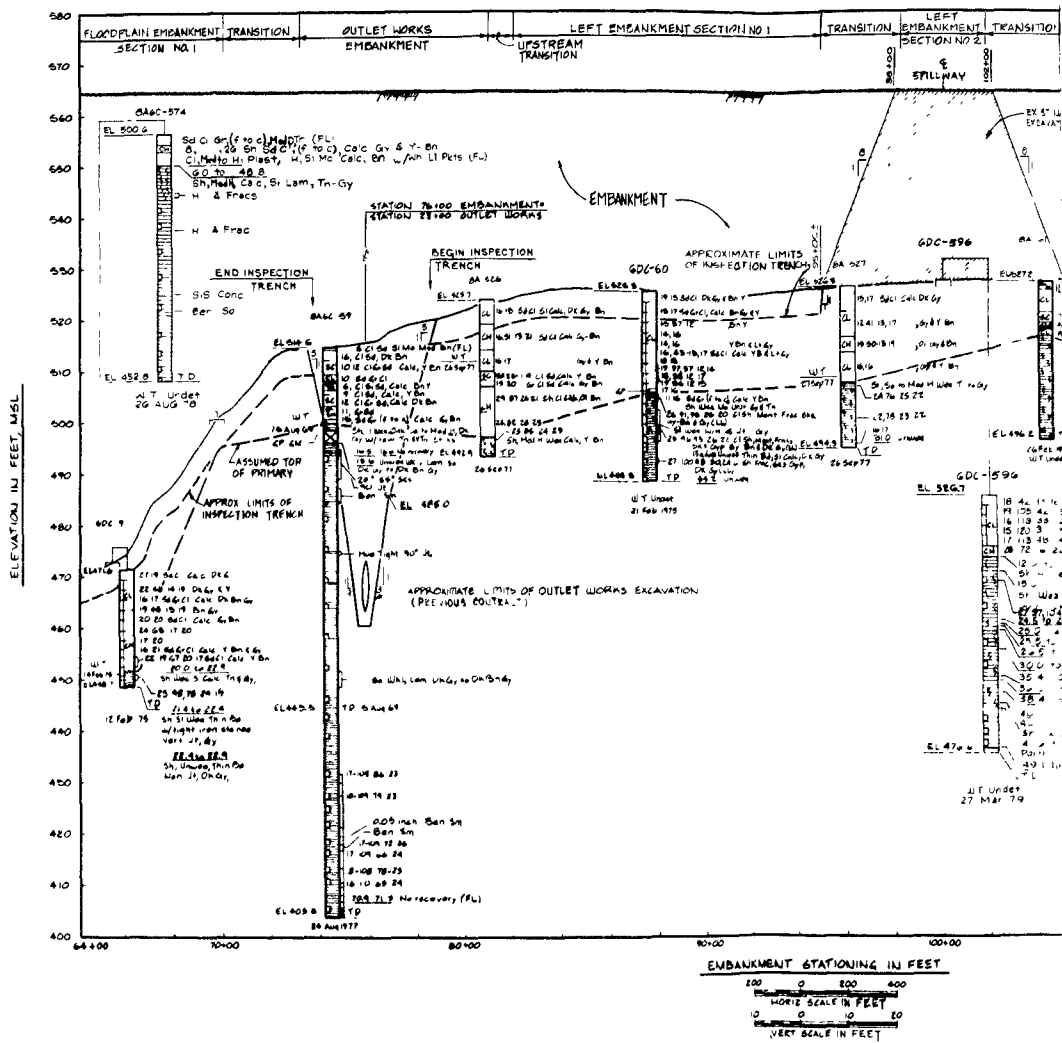
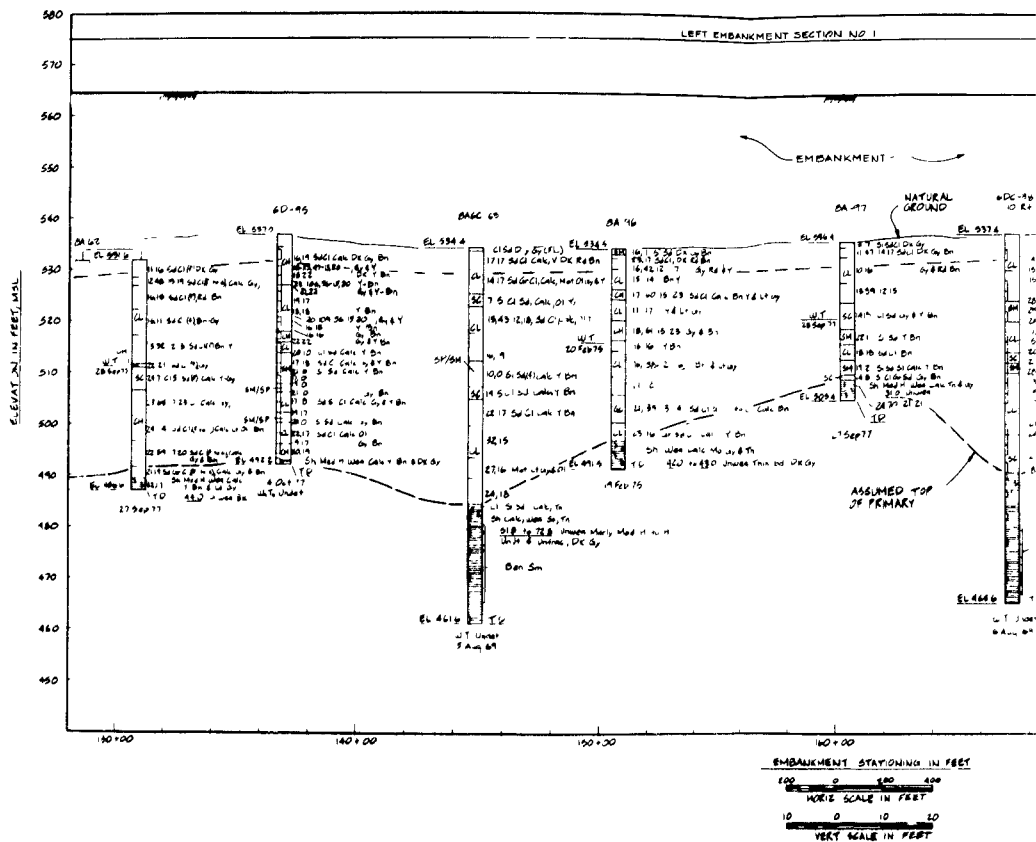
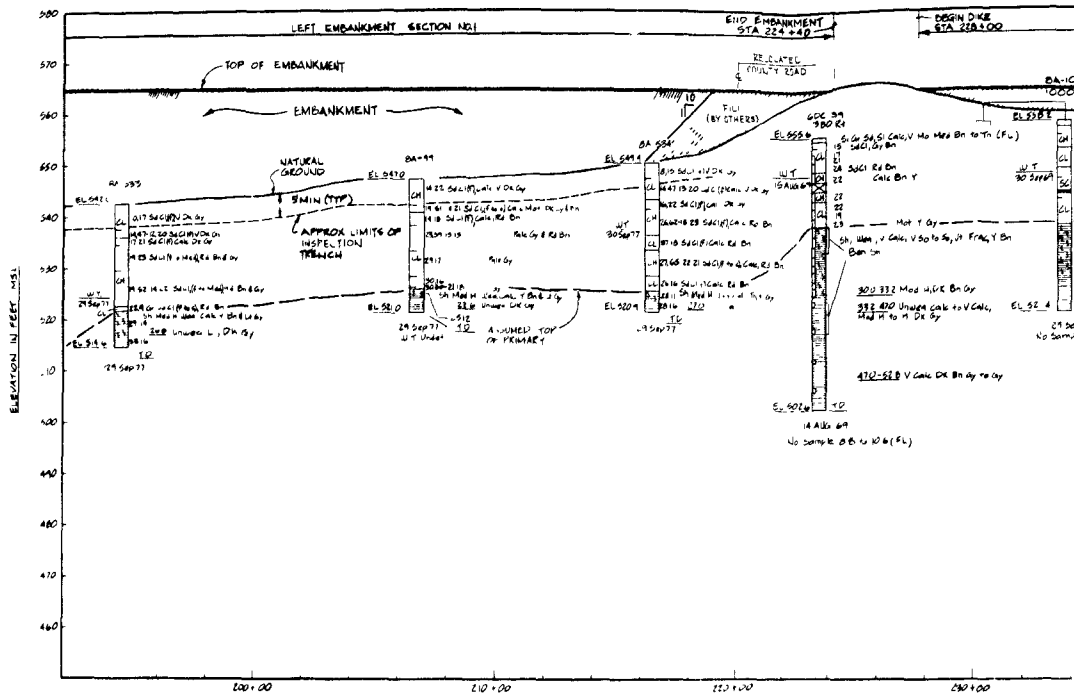


PLATE 39





EMBANKMENT STATIONING IN FEET

200	0	200	400
-----	---	-----	-----

1089 (1996) 1057

WORK SCALE IN FIVE:

10 0 10

LEGEND

1. SUAL CLASSIFICATION

all
Callan or
Mar
Vern
Sally or Sandy
Clay or Clayer,
D. still in Sils
D. still in Sils
D. still in Sils
Vern or Vane,
Comptroller
Lester
Dean or Hains
Lester
Brecciated
Dypping
Joint or fragmented
Joint or jointed
Slickensided
Callin or Callin
Splay out
Dip or slight,
Dip
Concrete
Vary
Vary or -ms,
Agn or agnly
Lefthal
P.E. log
P.E. log
P.E.
-ss
Breccia
Breccia
Pyrite
Mylonite zone
A liron
Bentonite
Jnt
Jnt
Chert
Mass c
Poorly

[illegible]

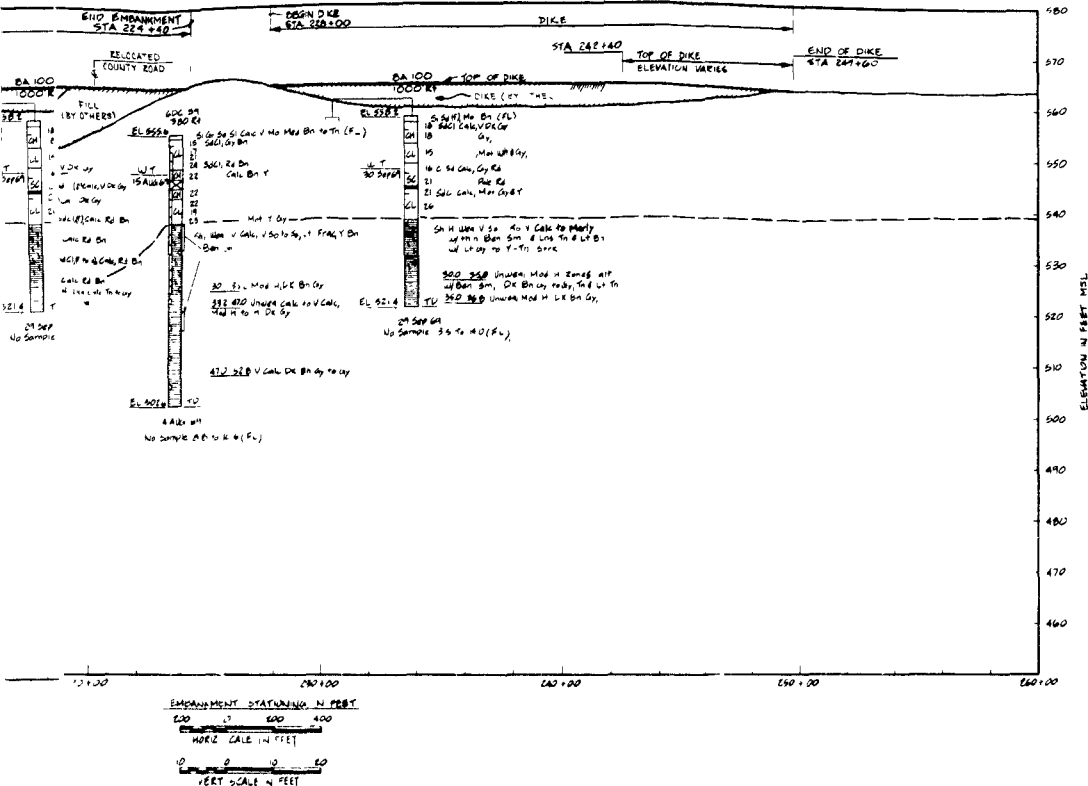
1:	area:
Mr	Mr 16 + Mr 11C
nt	interacting
nt	Alternating
Plant	Punctuality
Freedom	Freedom naturally
Part	Partials or Partials
Quants	Quasidimensional
Unit	unimodal
Unfram	unfractured
vs	vs of it
Sci	Science
Sci	Science
Org	Organic
Bl	Blat
D	Denial

LABORATORY CLASSIFICATION

2.	Clayey gravers gravel sand mixtures
3M	Silty sands sand silt mixtures
5u	Gravelly sands sand clay mixtures
6	Intergrading clays of low plasticity to gravelly clays sandy clays
7M	Intergrading clays of high plasticity fat clays
8P	Poorly graded gravels gravel sand mixtures, little or no fines
9M	Silty gravelly gravel sand-silt mixtures
10P	Poorly graded sands gravelly sands, little or no fines

STATIGRAPHIC CLASSIFICATION

 - MALE Wei
 - FEMALE, Unmarried
 1. 2. 3. 4. 5. 6.



GENERAL NOTES

- | | |
|-----|---|
| 12C | Clay, graining gravel and clay mixtures |
| 3M | Silty sands and s. mixtures |
| 3C | Clayey sands and clay mixtures |
| 1C | Impure clays of low plasticity |
| | clays sandy clays |
| 1H | Impure clays of high plasticity |
| 4P | Poorly graded gravels |
| | blitters, lime or no fines |
| 1M | Silty weathered gravel and s. mixtures |
| 4P | Poorly graded sands |
| | little or no fines |

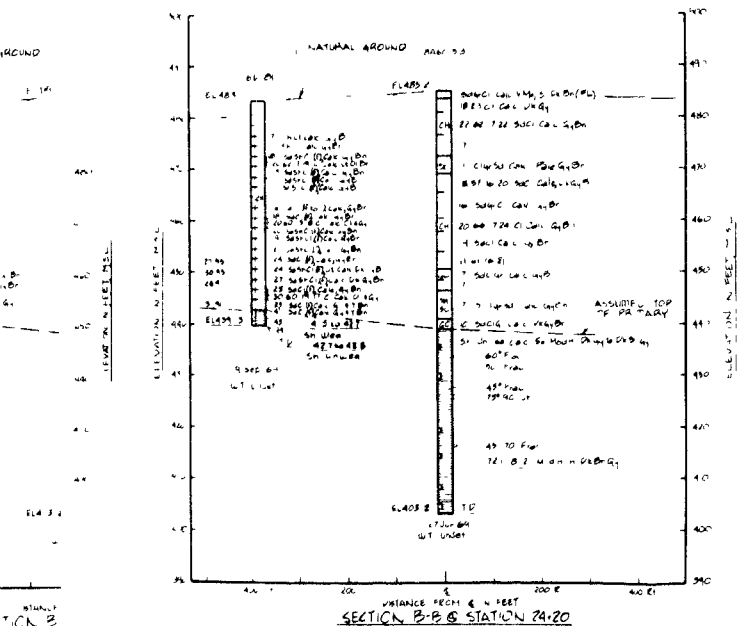
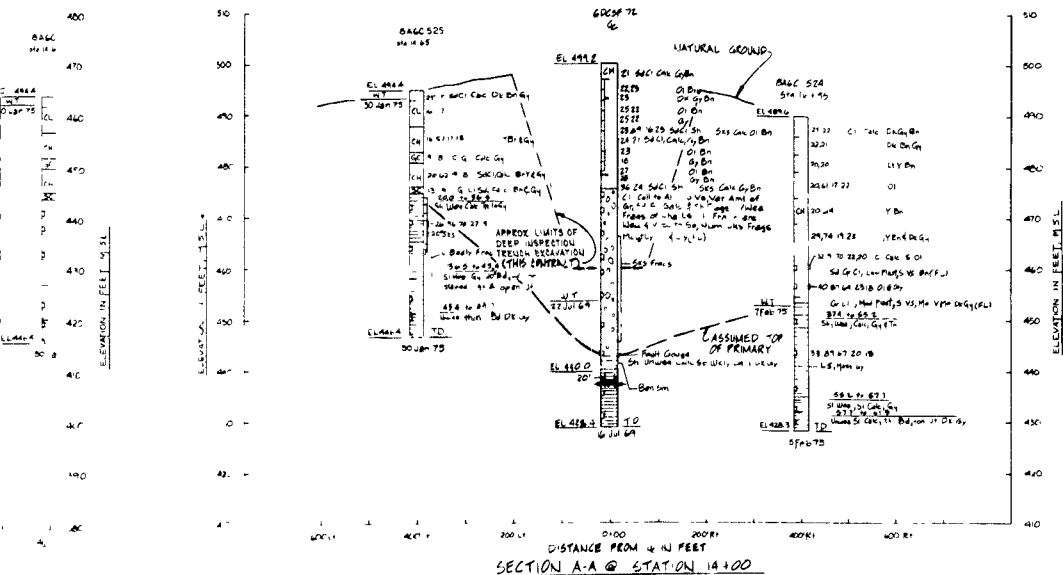
- 1 Absence of ground water levels appears being
age does not necessarily mean that ground water will
be absent. It may be the location or when the vertical
reaches of the borehole.
- 2 The water table will be the water contents
of the soil. It will be the water table. It will be the water table. It will be the water table.
- 3 The water table will be the water contents
of the soil. It will be the water table. It will be the water table. It will be the water table.
- 4 Overburden descriptions are in accordance with laboratory
test results. Low liquid values obtained. Plastic
descriptions are in accordance with field logs which
are also obtained.
- 5 The soil water moisture (SW) test used a nuclear
method that correlates approximately with the
liquid test.
- 6 Up to 100 feet. The correlations shown do not reflect
the actual ground profiles shown and
interpolations and extrapolations of available
elevation data. Minor differences may exist
between elevations shown and actual ground
elevations.
- 7 NO GRAVEL, SAND, OR SILT MENTIONED IN THE
OVERBURDEN DESCRIPTIONS. THE "F"
REMARKS INDICATE THE "F" IS NOT
OBTAINED. 3%, 8%, AND 8% RESPECTIVELY.
- 8 FOR BORING LOCATIONS SEE "BORING" SECTION.

STRATIGRAPHIC CLASSIFICATION

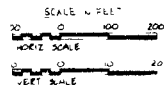
-  - MALE used
 - FEMALE used


[illegible]

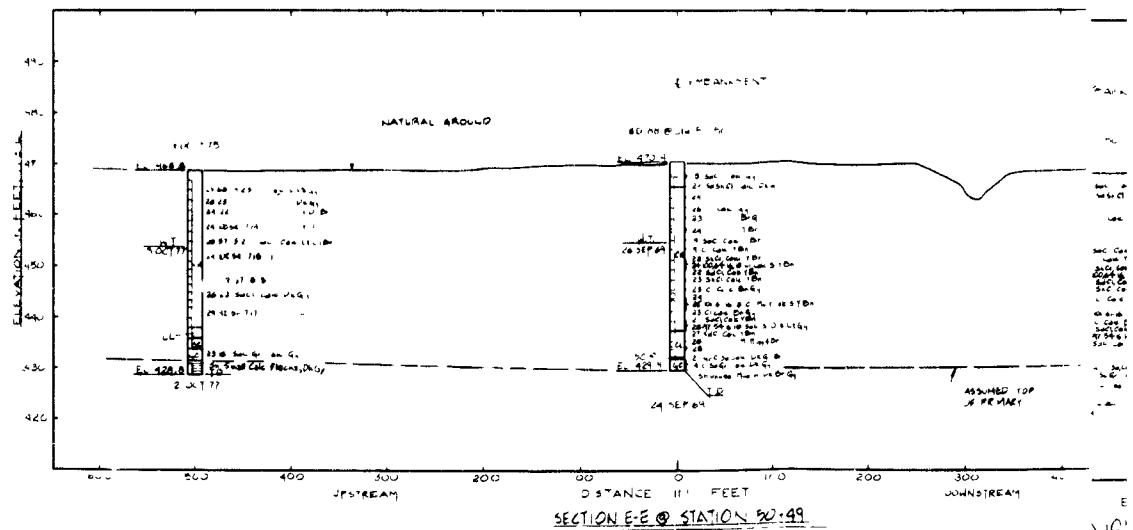
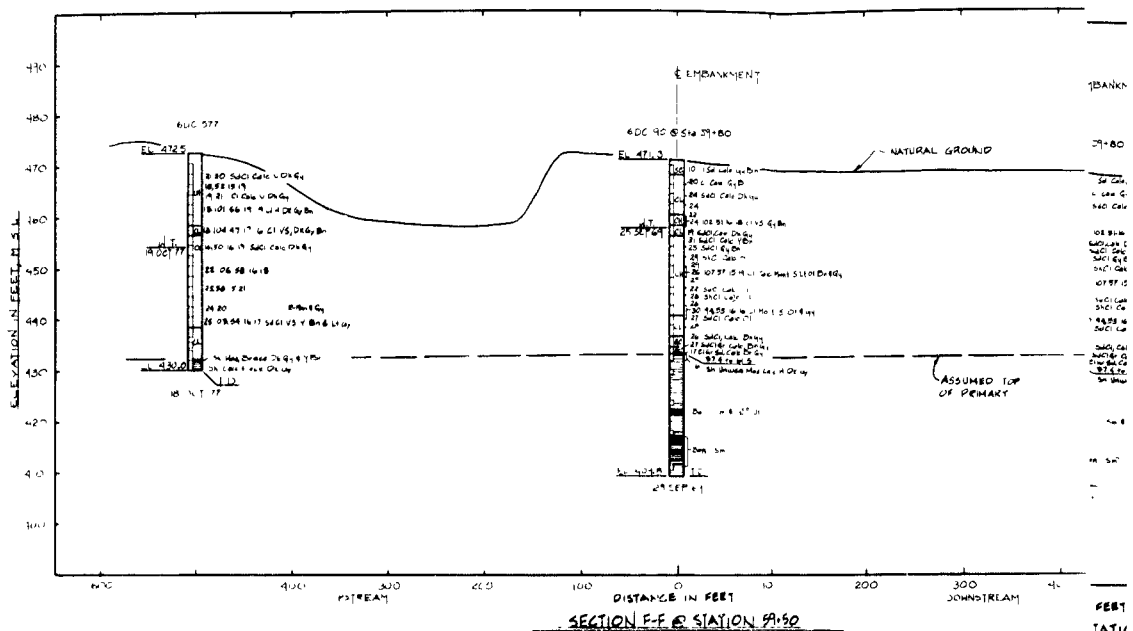


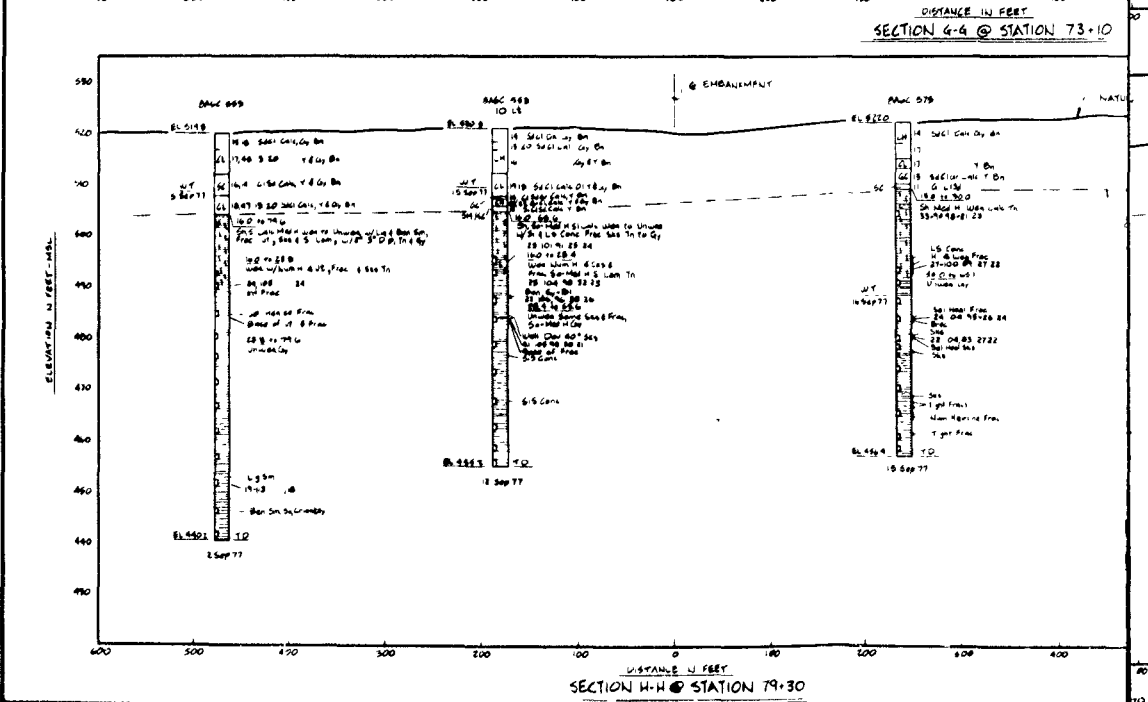
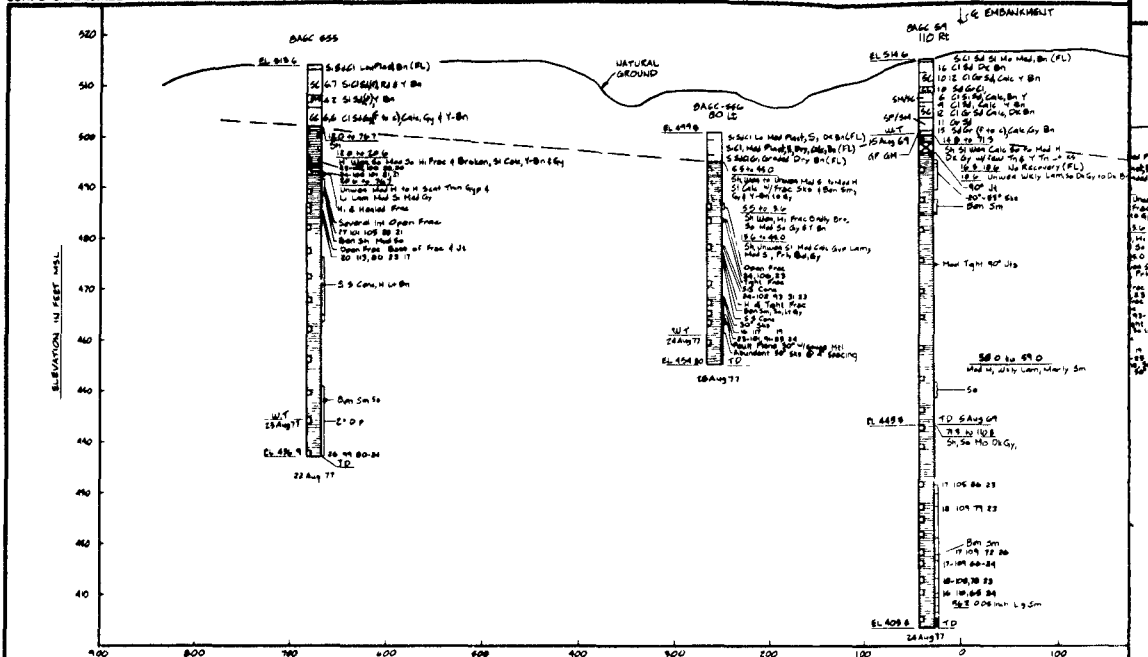


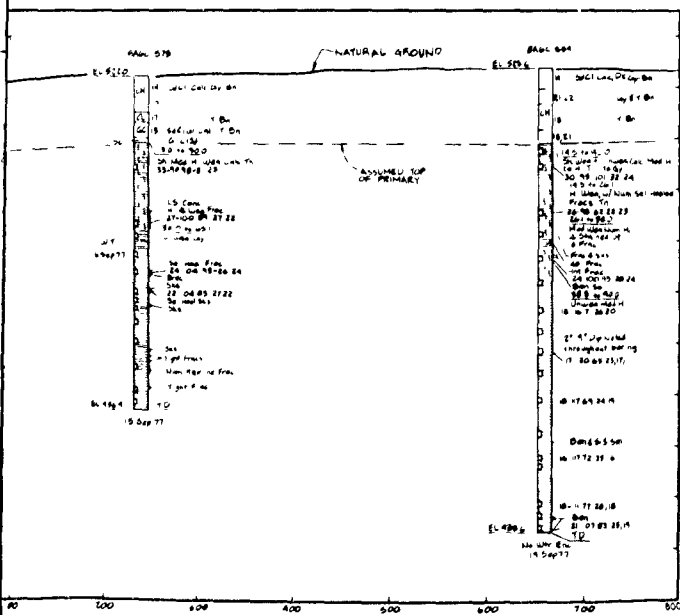
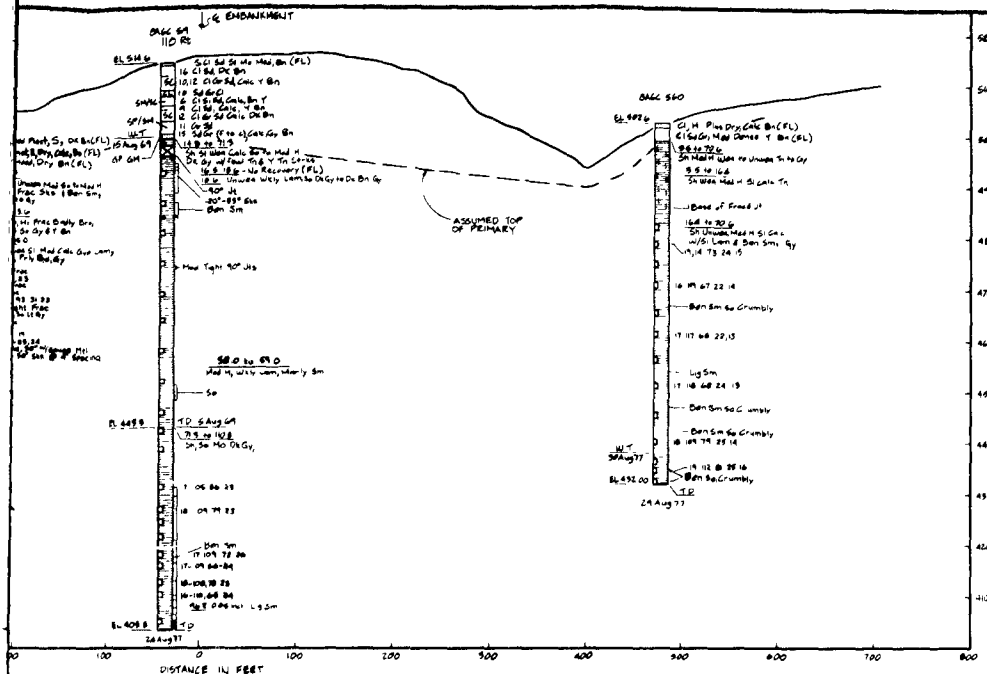
- NOTES
1. FOR GENERAL NOTES AND LEGEND SEE V.L.
 2. FOR LOCATION OF SECTIONS SEE SEQ. AND
 3. INSPECTION TRENCH SHOWN ON SECTION A-A ONLY



U.S. ARMY ENGINEER DISTRICT FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
DESIGNED BY M. J. P.	JOE POOL LAKE MOUNTAIN CREEK, TEXAS
CHECKED BY U. S. J. E.	EMBANKMENT, SPILLWAY, AND OUTLET WORKS
APPROVED BY	EMBANKMENT SECTIONS A-A, B-B, C-C AND D-D
DATE JULY 1961	PROJECT NO. B-00098
SHEET NO. 12 OF 43	SHEET NO. 97







NOTES

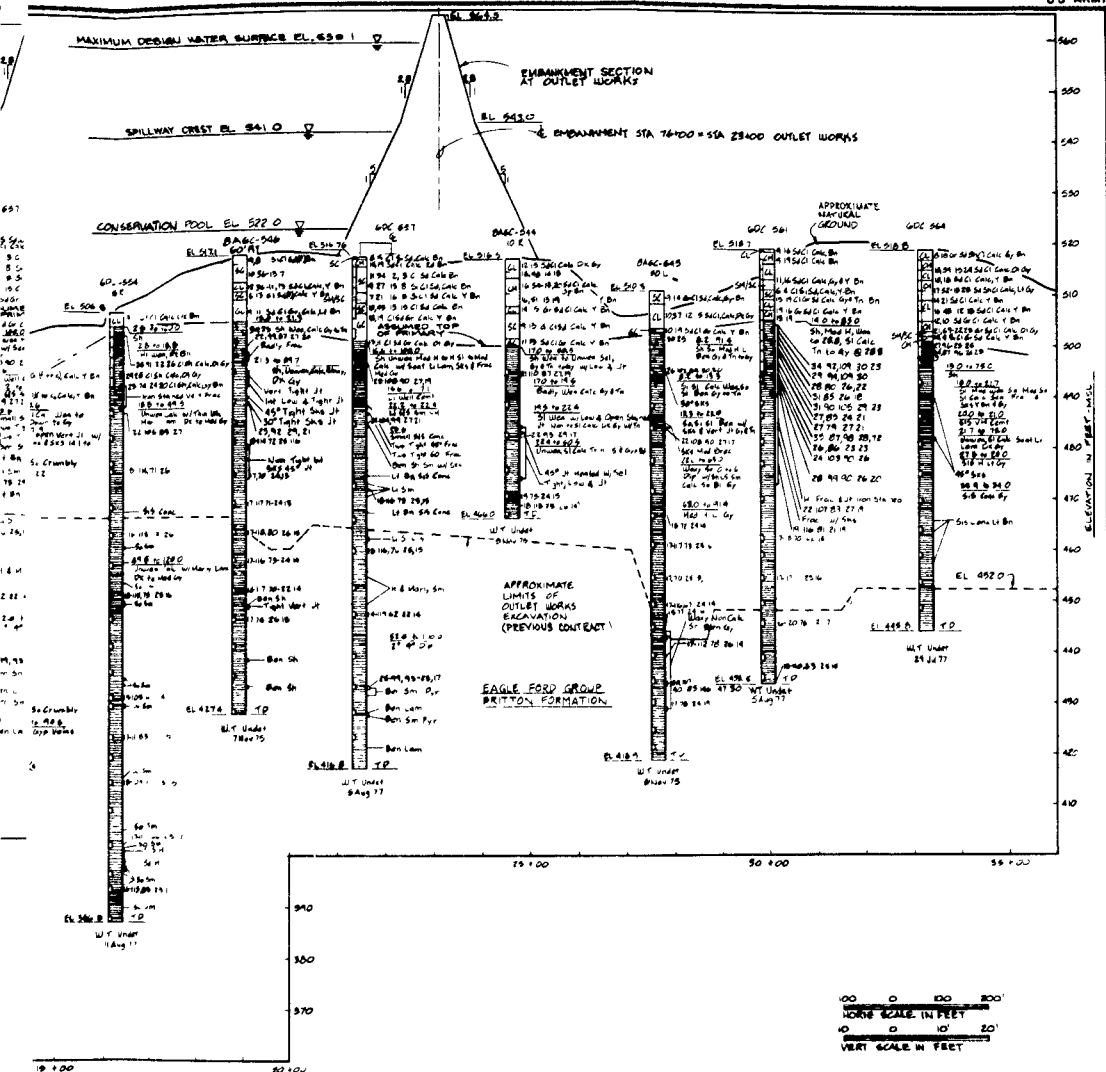
1. SEE SEQ. FOR LEGEND AND GENERAL NOTES
2. SEE SEQ. FOR LOCATION OF SECTIONS
3. INSPECTION TRENCH NOT SHOWN

50 0 50 100
HORIZ SCALE IN FEET
VERT SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
PROJECT NO. T. 5000 H. 1000	JOE POOL LAKE MOUNTAIN CREEK TEXAS
DESIGNED BY T. 5000 H. 1000	EMBANKMENT, SPILLWAY, AND OUTLET WORKS
REVIEWED BY T. 5000 H. 1000	EMBANKMENT SECTIONS G-G AND H-H
DRAWN BY T. 5000 H. 1000	
CHECKED BY T. 5000 H. 1000	
DATE JULY 1961	
SHEET NO. 14 OF 43	
REVISION NO. 99	



NOTES
1 SEE SEQ
2 SEE SEQ
3 SEE SEQ



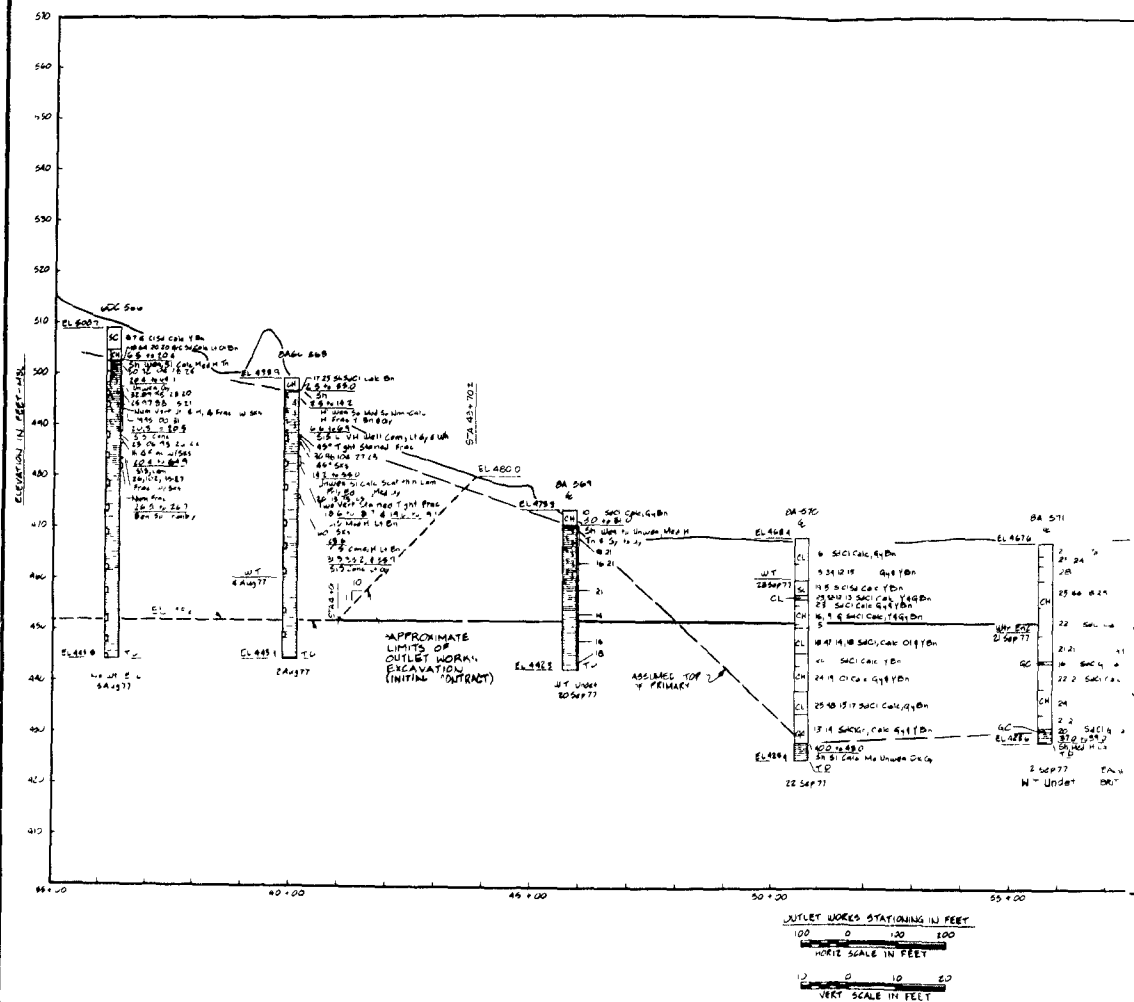
STATIONING IN FEET ALONG & OUTLET WORKS

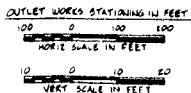
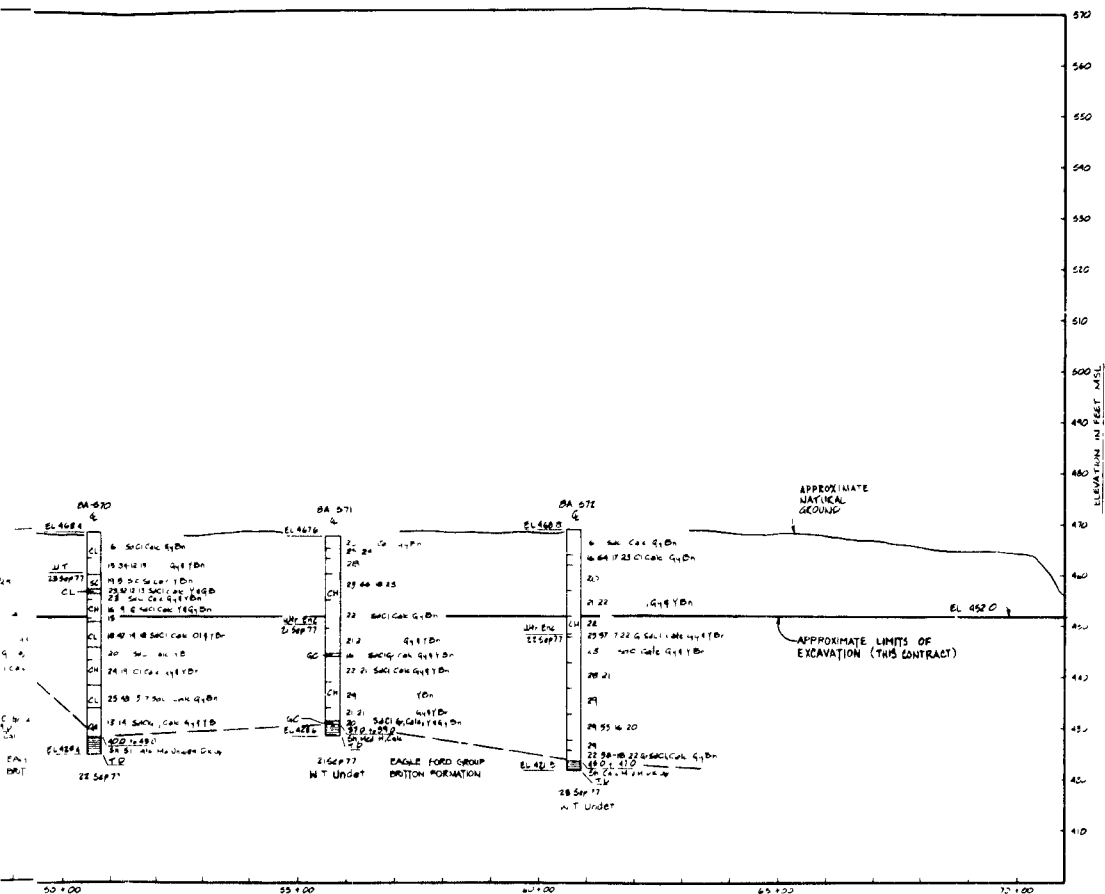
NOTES

- 1 SEE SEQ FOR LEGEND AND GENERAL NOTES
- 2 SEE SEQ FOR BORING LOCATIONS
- 3 SEE SEQ FOR EXCAVATION LIMITS

100 0 100 200
HORIZONTAL SCALE IN FEET
1" = 100'
VERTICAL SCALE IN FEET
1" = 20'

U.S. ARMY ENGINEER DISTRICT FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
PROJECT: JOE POOL LAKE MOUNTAIN CREEK, TEXAS EMBANKMENT, SPILLWAY, AND OUTLET WORKS OUTLET WORKS CENTERLINE PROFILE I STATION 0+00 TO 36+00	
DESIGNED BY: T. SCHMIDT CHECKED BY: M. J. LEE APPROVED BY: J. L. BROWN	BY: W. J. BROWN & S. BROWN DATED: JULY 1961 DRAWING NUMBER: 16-21-43
SHEET NO. 101	

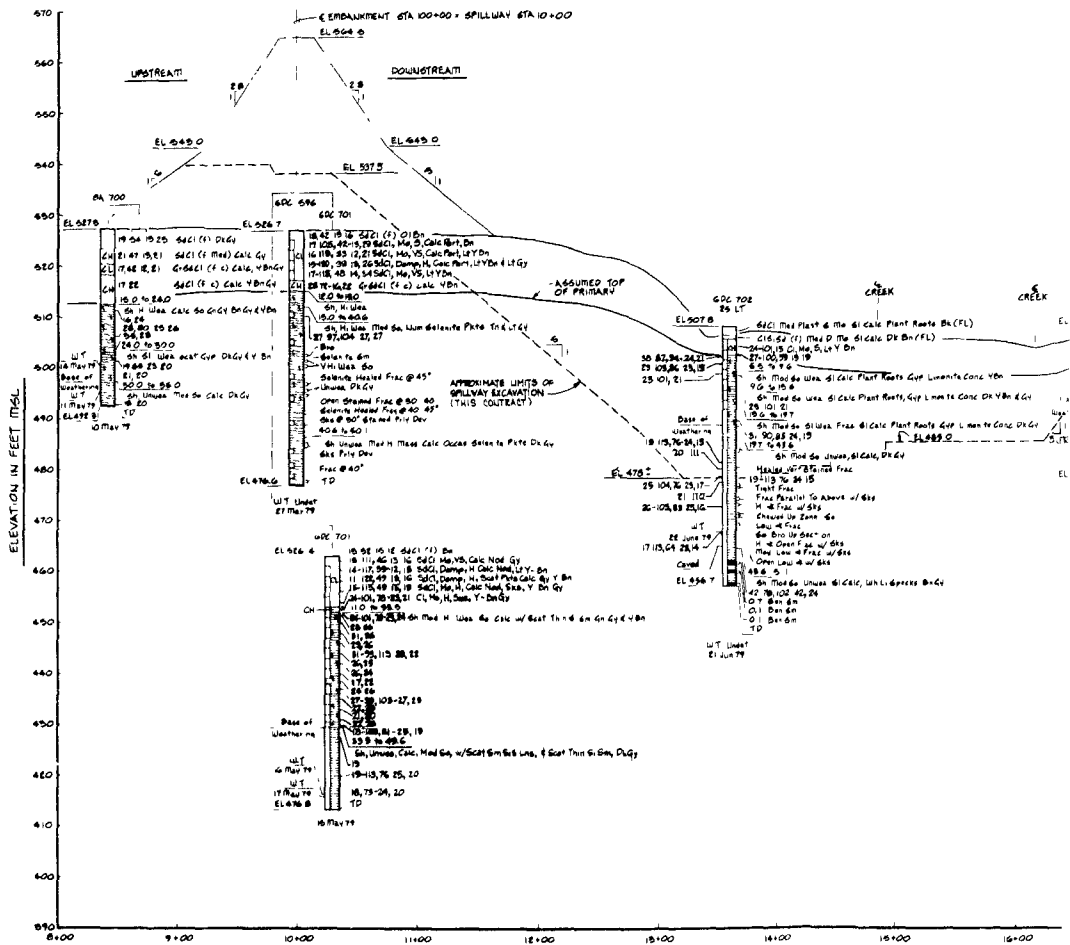




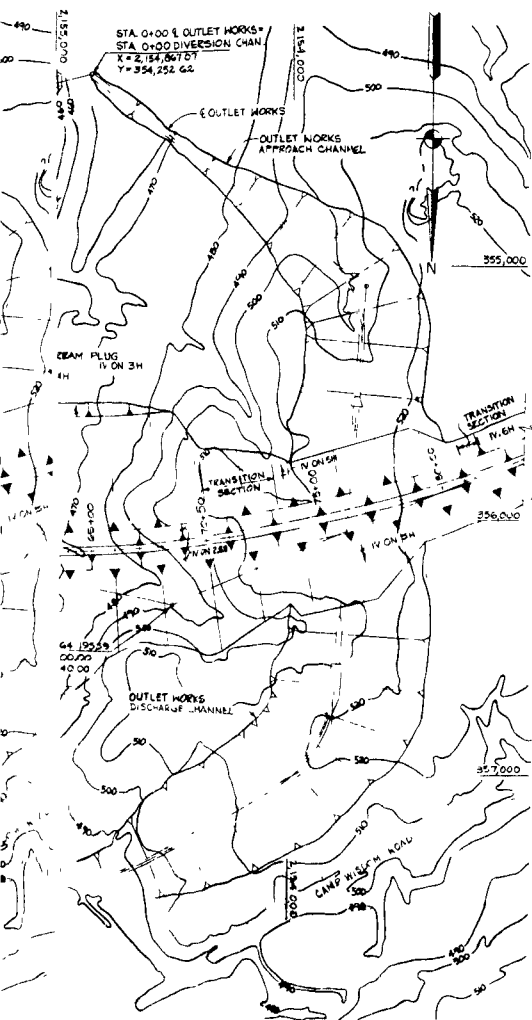
NOTES

1. SEE SEQ -- FOR LEGEND AND GENERAL NOTES
2. SEE SEQ -- FOR LOCATION OF BORINGS
3. SEE SEQ -- FOR EXCAVATION LIMITS

U.S. ARMY ENGINEER DISTRICT FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
DESIGNED BY M. J. BARNETT M. J. BARNETT	JOE POOL LAKE MOUNTAIN CREEK, TEXAS
CHECKED BY T. J. BARNETT T. J. BARNETT	EMBANKMENT, SPILLWAY, AND OUTLET WORKS
OUTLET WORKS CENTERLINE PROFILE II STATION 35+00 TO STATION 71+00	
DATE JULY 1961	BY NO. 100-100-100-100
DRAWING NUMBER 7-43	SHEET NO. 102

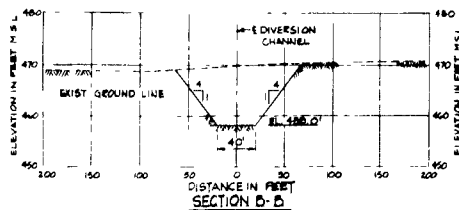
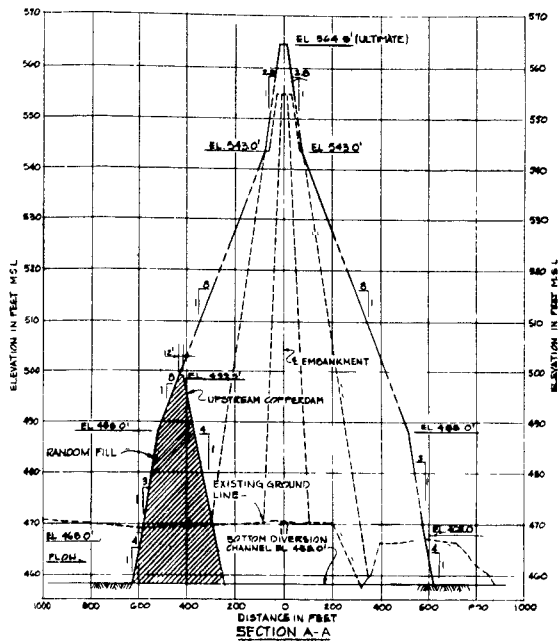


SPILLWAY CENTERLINE PROFILE
DISTANCE IN FEET

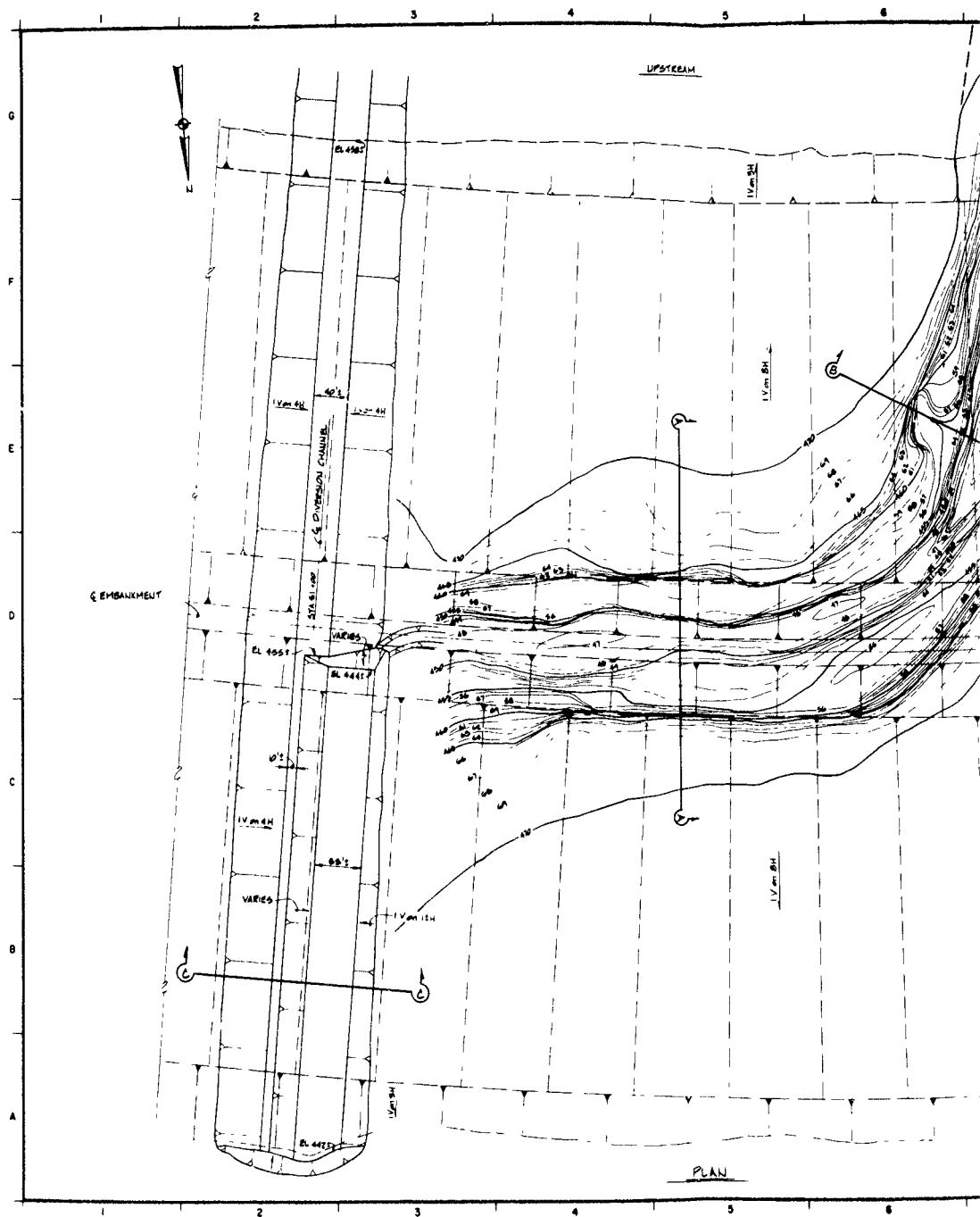


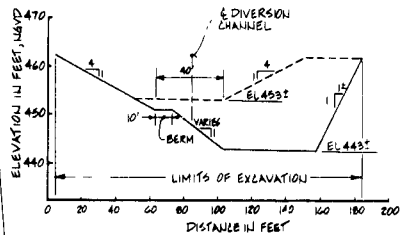
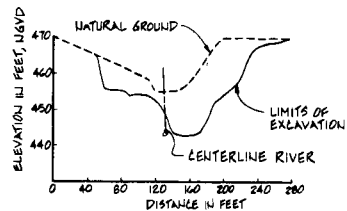
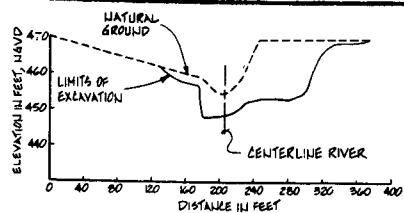
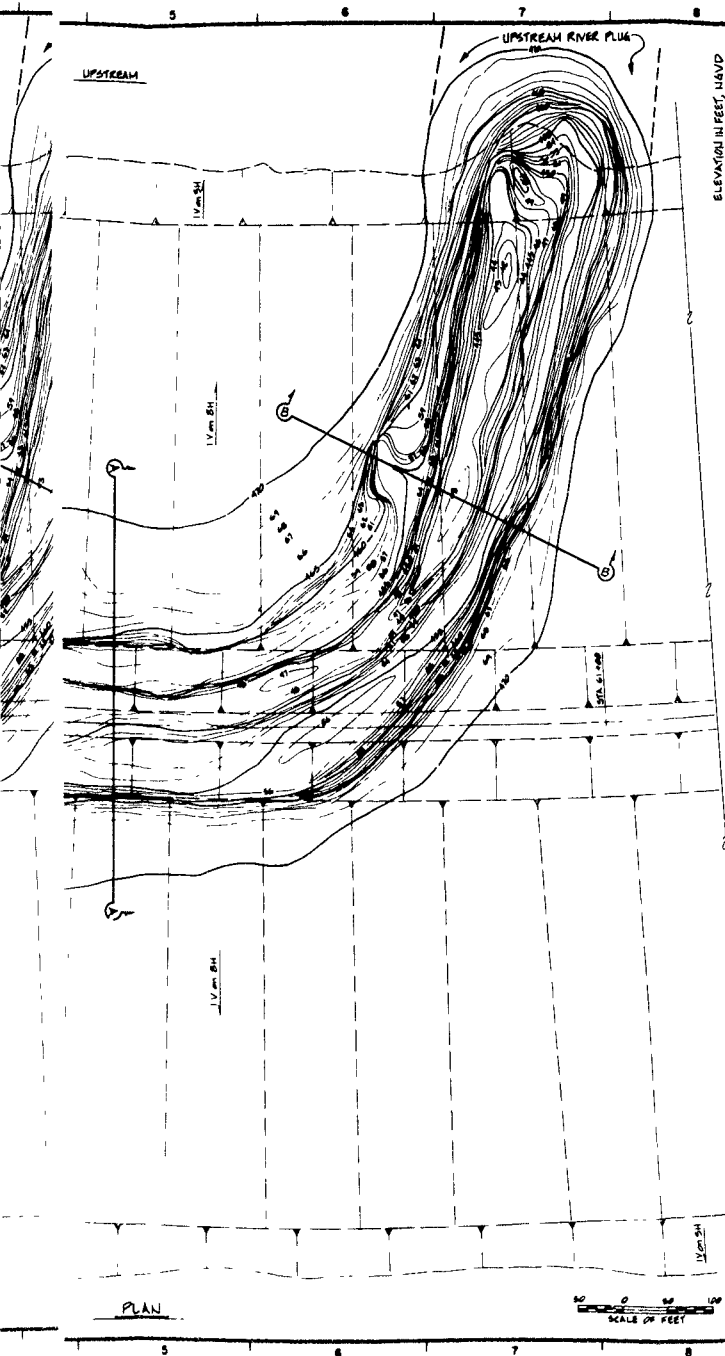
NOTES:

1. SEE SEQ. FOR CONSTRUCTION STAGING
2. TYPICAL EMBANKMENT SECTIONS ARE SHOWN ON SECS.
3. THE UPSTREAM PLUGS AND THE DOWNSTREAM PLUGS SHALL BE CONSTRUCTED USING CH CLAY MATERIAL.

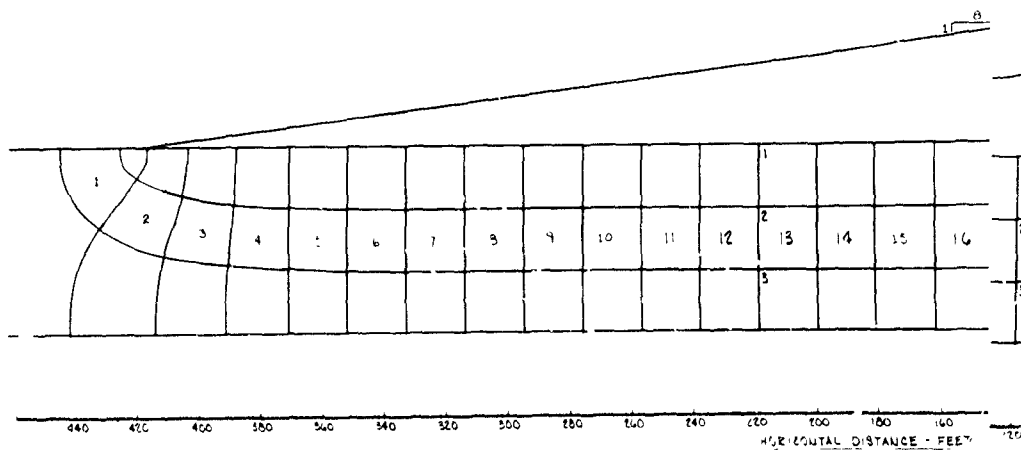


U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
DESIGNED BY ARMSTRONG	JOE POOL LAKE MOUNTAIN CREEK, TEXAS
DRAWN BY ARMSTRONG	EMBANKMENT
CHECKED BY ARMSTRONG	EMBANKMENT CLOSURE
DATE JULY 1961	BY JULY 1961
DRAWING NUMBER C 15 24	SHEET NO. 31





U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
JOE POOL LAKE MOUNTAIN CREEK, TEXAS RIVER CLEANOUT PLAN AND SECTIONS	
DESIGNED BY T. SCHMIDT	CHECKED BY W. DELANEY
APPROVED BY T. SCHMIDT	DATE 10/1/54
PROJECT NO. 1-54-100	SHEET NO. 10



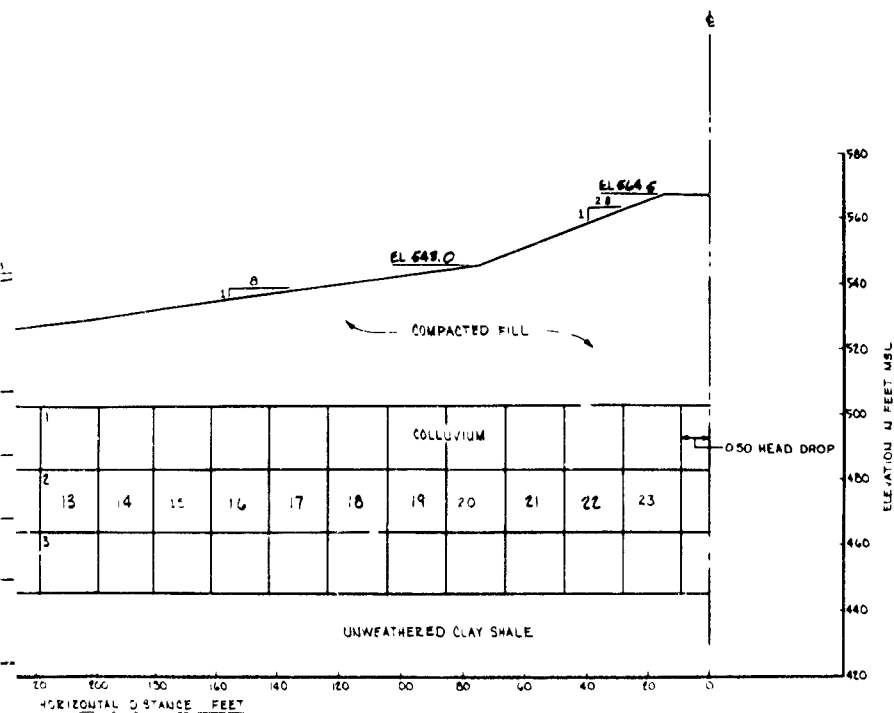
NOTES

1. FLOWNET IS SYMMETRICAL ABOUT THE CENTERLINE

NUMBER OF FLOW CHANNELS - 3
 NUMBER OF HEAD BOUNDS - 47
 SEEPAGE QUANTITY - 196 GAL/DAY
 EXT GRADIENT WITH RESERVOIR A
 EXT GRADIENT WITH RESERVOIR B

ASSUMPTIONS

1. $K_x = K_y = 1.4 \text{ CM/SEC}$
 2. UNWEATHERED CLAY SHALE AND
 3. SEEPAGE OCCURS THROUGH THE
 4. COLLECTUM IS CONTINUOUS UNDE
 TO THE GROUND SURFACE

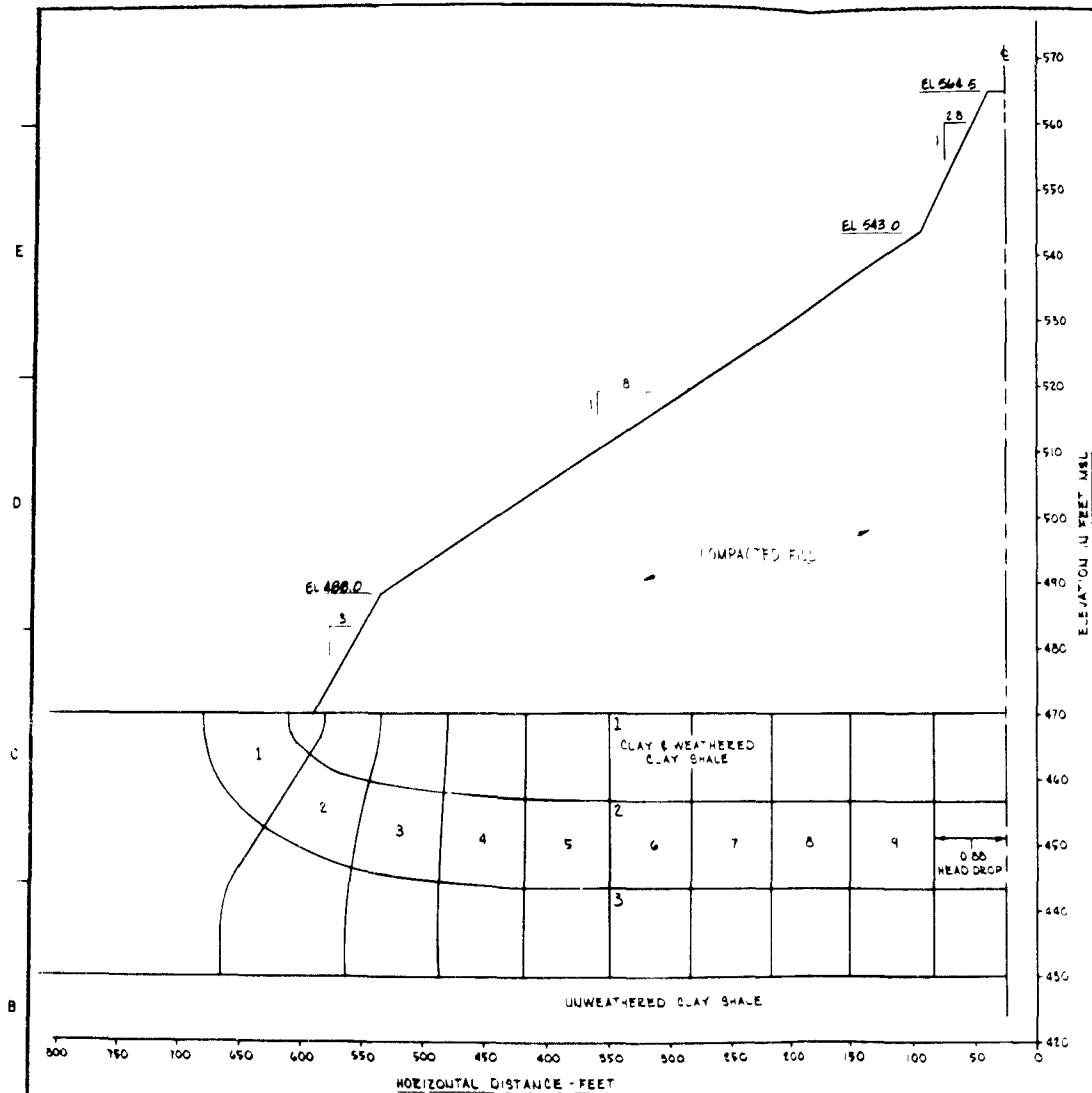


NUMBER OF FLOW CHANNELS - 3
 NUMBER OF HEAD DROPS - 47
 SEEPAGE QUANTITY - 295 GAL/DAY PER FOOT OF DAM (AT CONSERVATION POOL)
 EXIT GRADIENT WITH RESERVOIR AT CONSERVATION POOL = 0.06
 EXIT GRADIENT WITH RESERVOIR AT MAXIMUM DESIGN WATER SURFACE = 0.15

ASSUMPTIONS

1. $K_h = K_v = 0.4 \text{ CM/SEC}$
2. UNWEATHERED CLAY SHALE AND COMPACTED FILL ARE IMPERMEABLE
3. SEEPAGE OCCURS THROUGH THE COLLUVIUM ONLY
4. COLLUVIUM IS CONTINUOUS UNDERNEATH THE DAM AND EXTENDS TO THE GROUND SURFACE

U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
DESIGNED BY YES	JOE POOL LAKE MOUNTAIN CREEK, TEXAS
DRAWN BY YES	
CHECKED BY YES/YES	
FLOWNET FOR ASSUMED BURIED CHANNEL AT RIGHT ABUTMENT	
REV NO.	SHEET NO.
DATED	BY
DESIGNING NUMBER	125



FLOODPLAIN - APPROXIMATE STATION 46+00

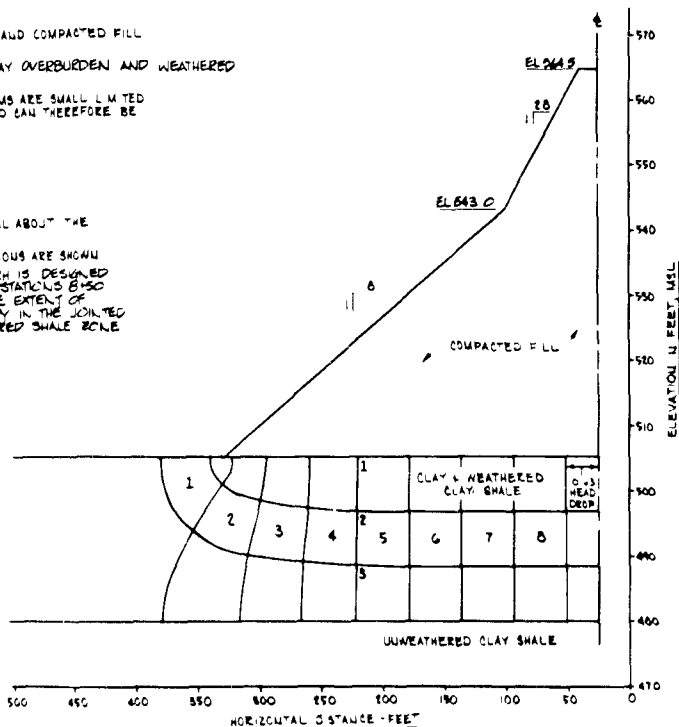
NUMBER OF FLOW CHANNELS = 3
 NUMBER OF HEAD DROPS = 19.8
 SEEPAGE QUANTITY = 1.6×10^{-3} GAL/DAY PER FOOT OF DAM AT RESERVOIR POOL
 EXT. GRADE ENT. WITH RESERVOIR AT LOWER ELEVATION POOL = 0.4
 EXT. GRADE ENT. WITH RESERVOIR AT MAXIMUM DESIGN WATER SURFACE = 0.27

ASSUMPTIONS

- 1 $K_v = 25 K_h = 10^{-8}$ CM/SEC
- 2 UNWEATHERED CLAY SHALE AND COMPACTED FILL ARE IMPERMEABLE
- 3 SEEPAGE OCCURS IN THE CLAY OVERBURDEN AND WEATHERED CLAY SHALE ONLY
- 4 ANY SAND AND GRAVEL STRIPS ARE SMALL LIMITED IN EXTENT, VERY CLAYEY AND CAN THEREFORE BE IGNORED

NOTES

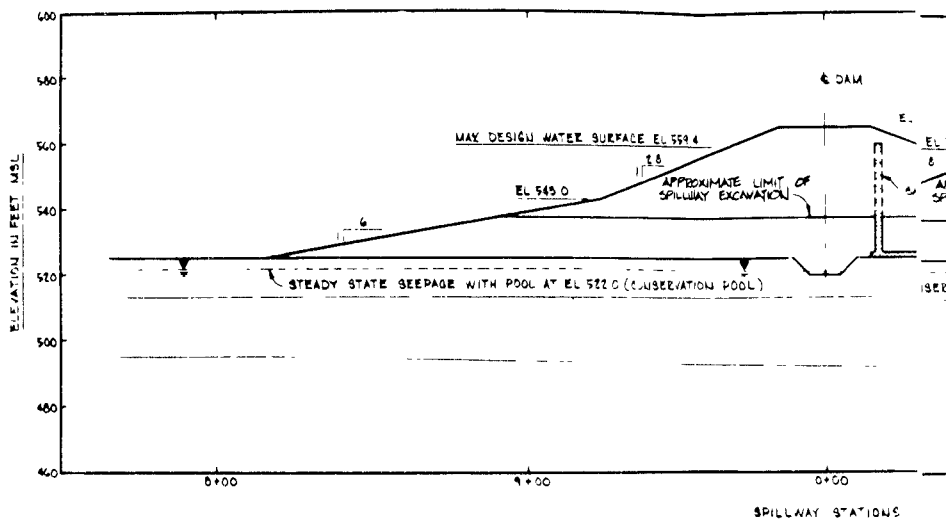
- 1 FLOWNETS ARE SYMMETRICAL ABOUT THE CENTERLINE
- 2 TRANSFORMED CROSS SECTIONS ARE SHOWN
- 3 A DEEP INSPECTION TRENCH IS DESIGNED BETWEEN APPROXIMATE STATIONS 6+50 AND 17+00 TO DETERMINE EXTENT OF SECONDARY PERMEABILITY IN THE JOINTED AND FRACTURED WEATHERED SHALE ZONE



RIGHT ABUTMENT - APPROXIMATE STATION 12+60

NUMBER OF FLOW CHANNELS - 3
 NUMBER OF HEAD DROPS - 73
 SEEPAGE QUANTITY - 0.27 X 0.4 GAL/DAY
 PER FOOT OF DAM AT CONSERVATION
 EXT. GRADIENT WITH RESERVOIR AT
 CONSERVATION POOL - 0.1
 EXT. GRADIENT WITH RESERVOIR AT
 MAXIMUM DESIGN WATER
 SURFACE - 0.54

DESIGNED BY YES		CHECKED BY YES		APPROVED BY MED/TWO	
US ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH TEXAS					
JOB POOL LAKE MOUNTAIN CREEK TEXAS					
FOUNDATION FLOWNETS AT THE RIGHT ABUTMENT AND FLOODPLAIN					
REV NO		DATED		SEQUENCE NO	
DRAWING NUMBER		SHEET NO		BY	

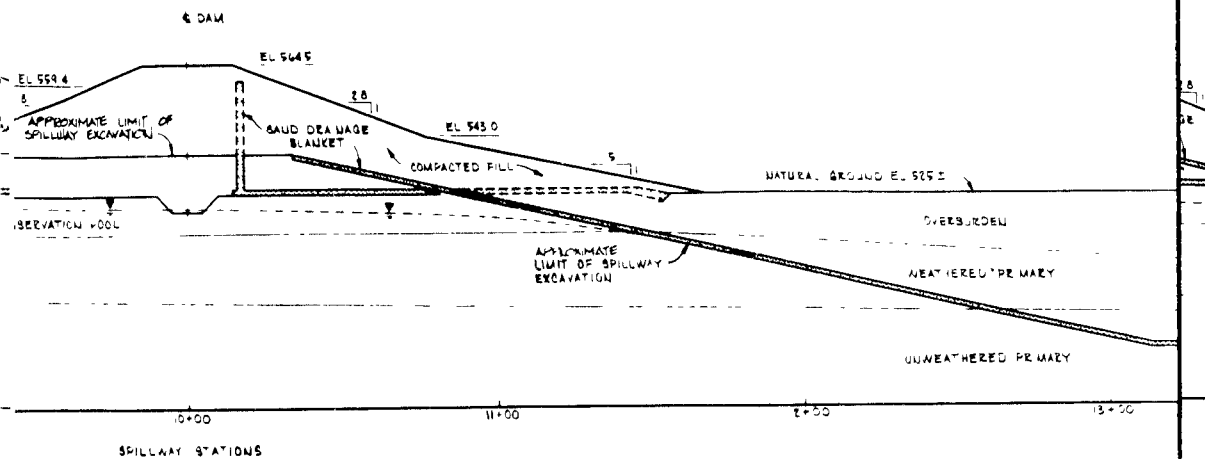


ASSUMED DESIGN PARAMETERS

MATERIAL	K_H (CM/SEC)	K_V (CM/SEC)
COMPACTED FILL	5×10^{-8}	1×10^{-8}
OVERBURDEN	5×10^{-9}	1×10^{-9}
WEATHERED PRIMARY	1×10^{-8}	1×10^{-9}
UNWEATHERED PRIMARY	1×10^{-9}	1×10^{-10}

K_H = HORIZONTAL PERMEABILITY

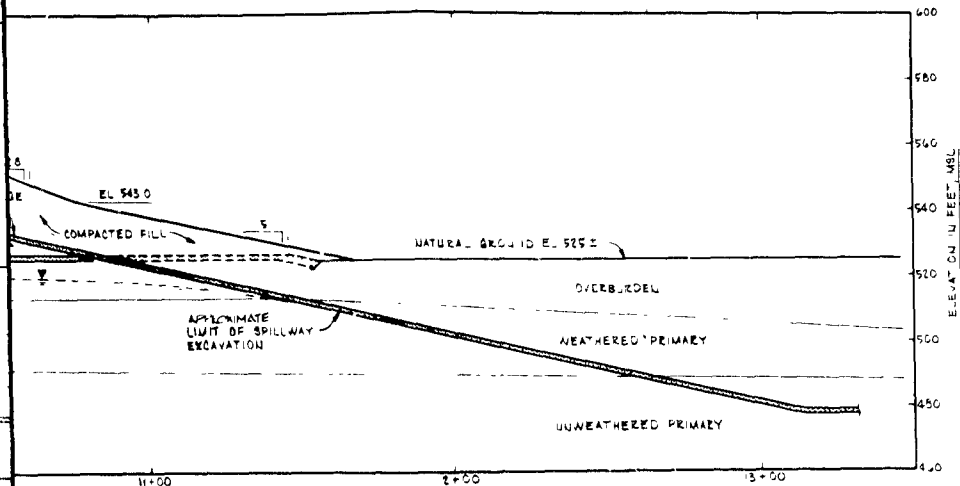
K_V = VERTICAL PERMEABILITY



NOTES

1. LOCATION OF SEEPAGE LINE WAS ESTIMATED USING FINITE ELEMENT COMPUTER ANALYSIS CONDUCTED AT WES
2. NATURAL GROUND ELEVATION AT THE LEFT EMBANKMENT WDS APPROXIMATELY E 516.5 ABOVE CONSERVATION POOL E. 522.6

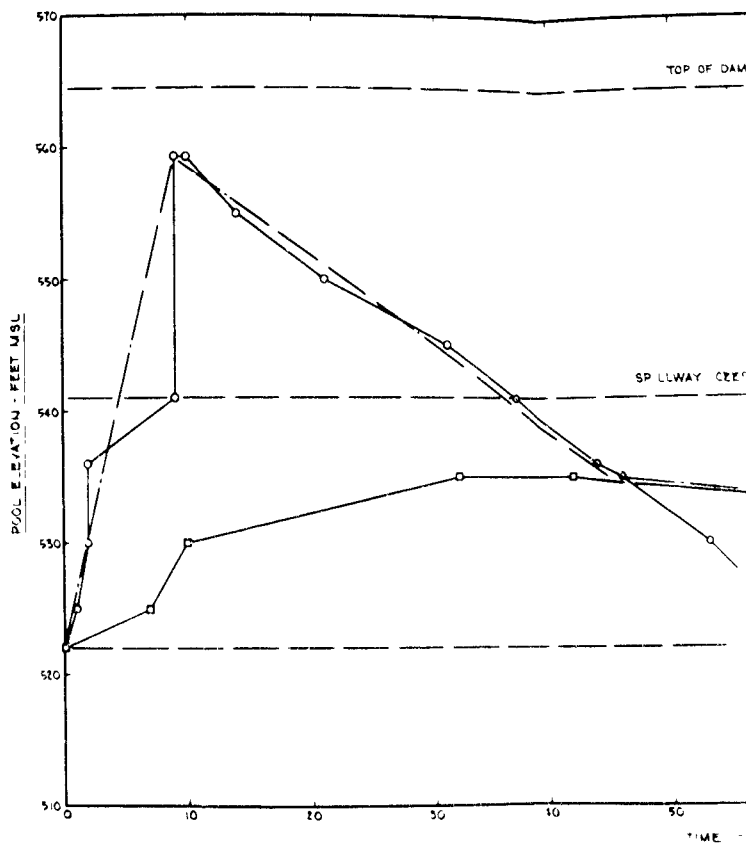
U.S. ARMY	
DESIGNED BY	MEP/7.25
DRAWN BY	MEP
CHECKED BY	MEP/7.25



NOTES

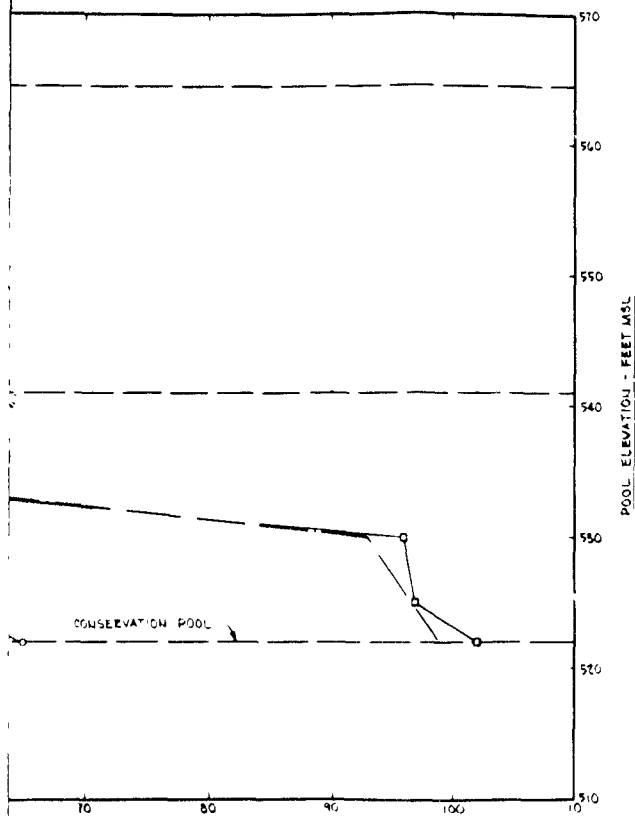
1. LOCATION OF SEEPAGE LINE WAS ESTIMATED USING FINITE ELEMENT COMPUTER ANALYSIS CONDUCTED AT WES
2. NATURAL GROUND ELEVATION AT THE LEFT EMBANKMENT NO 2 APPROXIMATELY E 525.5 ABOVE CONSERVATION POOL EL 522.0

U.S. ARMY ENGINEER DISTRICT FORT WORTH CORPS OF ENGINEERS FORT WORTH TEXAS			
DESIGNED BY MES/TUS	JOE POOL LAKE MOUNTAIN CREEK TEXAS		
DRAWN BY MSP.	LEFT EMBANKMENT NO 2 (SPILLWAY, STEADY STATE SEEPAGE AT CONSERVATION POOL (EL 522.0))		
CHECKED BY MES/TUS	INVESTIGATION NO.	SPECIFICATIONS DATED	REFERENCE NO.
	QUANTITY NUMBER	SHEET NO.	OF

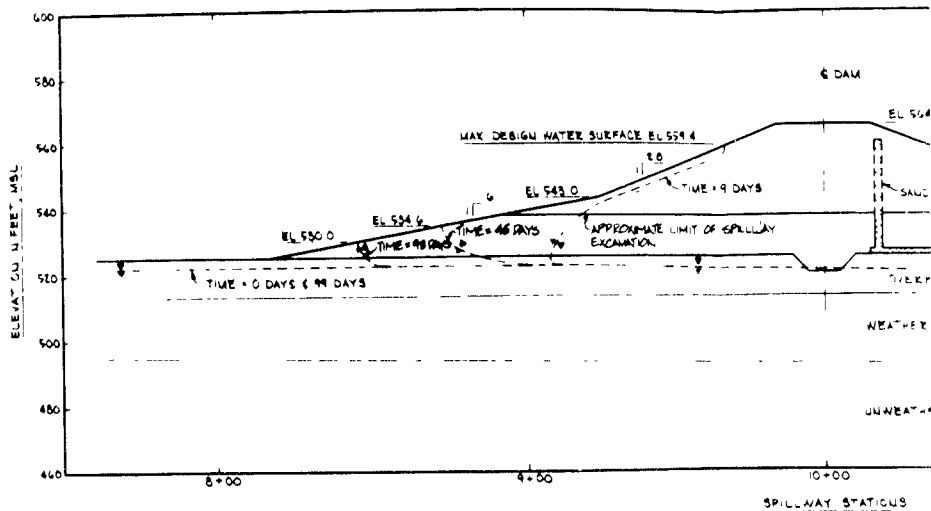


- PROBABLE MAXIMUM FLOOD
- FLOOD OF RECORD (WITH LAKEVIEW DAM)
- FLOOD USED FOR TRANSIENT SEEPAGE ANALYSIS

[illegible]



U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
DESIGNED BY JWS	JOE MILLER A. E. E. E. C. E. A. S.
DRAWN BY TEP	POOL ELEVATION SURVEY
CHECKED BY ME	DATE 1948
REVISIONS NO. 1 DESCRIPTION POOL ELEVATION SURVEY	



5 DAM

EL 564.5

2.0

EL 563.0

COMPACTED FILL

NATURAL GROUND EL 525.2

WEATHERED PRIMARY

APPROXIMATE LIMIT OF SPILLWAY ELEVATION

UNWEATHERED PRIMARY

0+00

+50

1+50

3+20

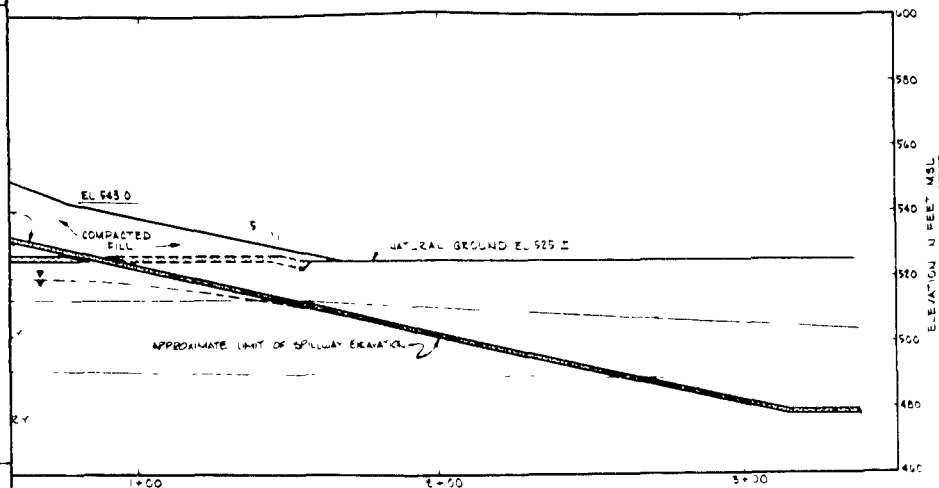
SPILLWAY STATUS

NOTES

1. SEEPAGE TEST RESULTS WERE DETERMINED USING WHITE ELEMENT COMPUTER ANALYSIS CONDUCTED AT LES
2. WATER SURFACE ELEVATIONS AND DURATIONS ARE SHOWN ON PLATE
3. SEE PLATE FOR A TABULATION OF ASSUMED PERMEABILITIES
4. THE STEADY STATE SEEPAGE CONDITION AT OBSERVATION POINT PLATE WAS ASSUMED AS INITIAL AND TUS FOR THESE ANALYSES

U.S. ARMY

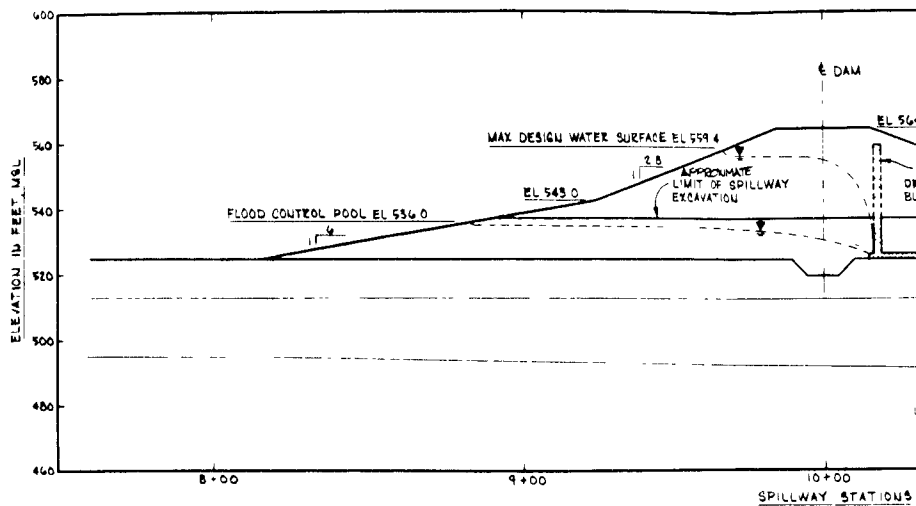
REVIEWED BY
M. J. L. S.
DATE
M. J. L. S.
DATE
M. J. L. S.

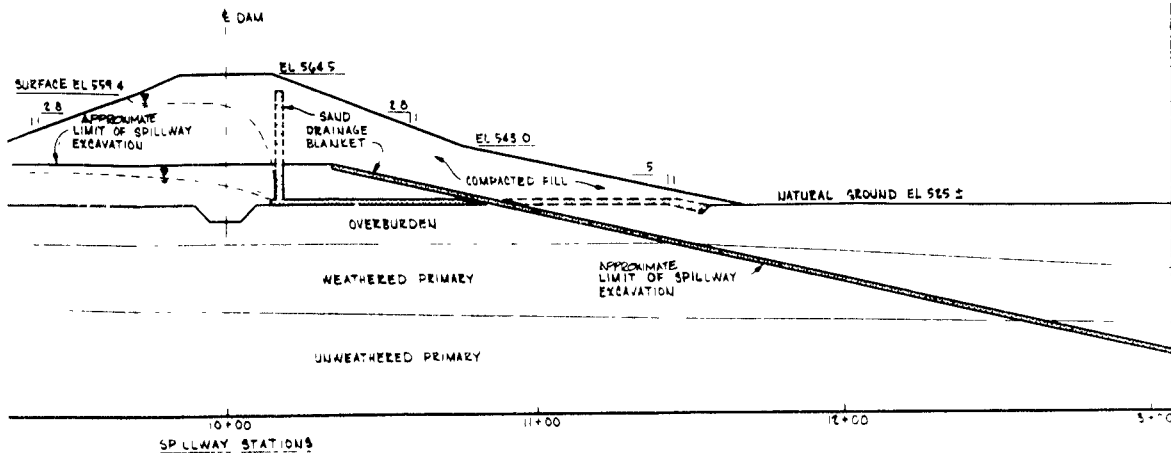


NOTES

1. SEEPAGE WAS CALC. BASED UPON THE ASSUMED SOIL PROFILE ELEMENT COMPLETELY UNSATURATED, CONDUCTED AT UES
2. WATER SURFACE ELEVATIONS AND SECTIONS ARE SHOWN ON PLATE
3. SEE PLATE FOR A TABULATION OF ASSUMED PERMEABILITIES
4. THE STEADY STATE SEEPAGE CONDITION AT ROUSSEAU ON P.O.O. PLATE WAS ASSUMED AS A TOTAL "SEEPAGE" FOR THESE ANALYSES

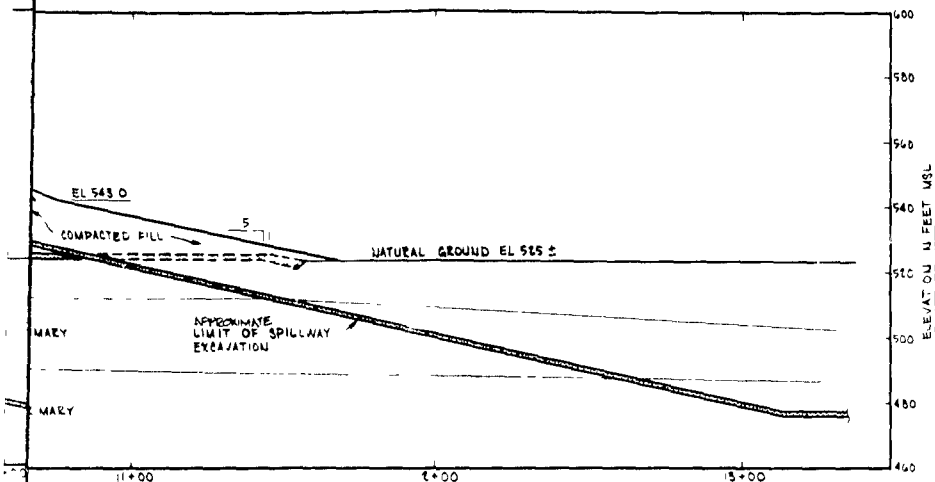
U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS			
DESIGNED BY MESTUS	JOE POOL LAKE MOUNTAIN VIEW, TEXAS		
DESIGNED BY MOP	LEFT EMBANKMENT NO. 2 (SPILLWAY) TRANSIENT SEEPAGE LINES		
DESIGNED BY MESTUS	INVITATION NO. SPECIFICATIONS DATED DRAWING NUMBER SHEET NO. OF		





NOTES

- 1 LOCATION OF SEEPAGE LINES DETERMINED USING FINITE ELEMENT ANALYSES CONDUCTED AT WES
- 2 SEE PLATE FOR A TABULATION OF ASSUMED PERMEABILITIES
- 3 DEVELOPMENT OF THE SEEPAGE LINES SHOWN IS HIGHLY UNLIKELY DUE TO THE SHORT DURATION OF THE POOLS THE IMPERVIOUS NATURE OF THE EMBANKMENT MATERIALS AND THE RELATIVELY LONG SEEPAGE PATHS & THE CONDITIONS SHOWN ON PLATES AND ARE MORE APPROPRIATE FOR DESIGN

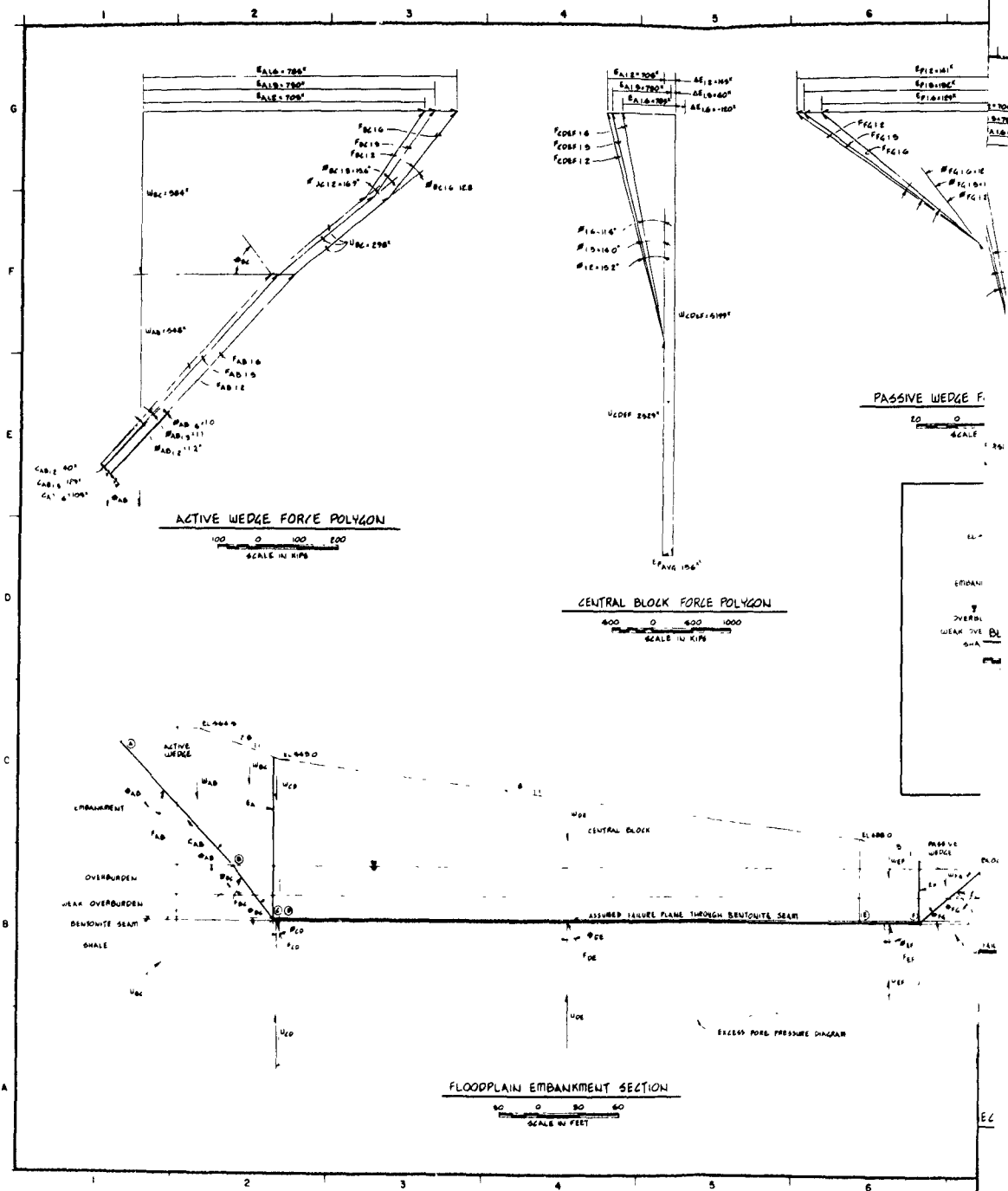


NOTES

- 1 LOCATION OF SEEPAGE LINES DETERMINED BY USUG FINE ELEMENT ANALYSES CONDUCTED AT WES
- 2 SEE PLATE FOR A TABULATION OF ASSUMED PERMEABILITIES
- 3 DEVELOPMENT OF THE SEEPAGE LINES SHOWN IS HIGHLY UNLIKELY DUE TO THE SHORT DURATION OF THE POOLS, THE IMPERVIOUS NATURE OF THE EMBANKMENT MATERIALS AND THE RELATIVELY LONG SEEPAGE PATHS. THE CONDITIONS SHOWN ON PLATES AND ARE MORE APPROPRIATE FOR DESIGN

U.S. ARMY ENGINEER DISTRICT, FORT WORTH			
CORPS OF ENGINEERS			
FORT WORTH, TEXAS			
DESIGNED BY WES/RS		JOB POOL LAKE	
DRAWN BY MBP		MOUNTAIN CREEK, TEXAS	
CHECKED BY MORTON		LEFT EMBANKMENT NO. 2 (SPILLWAY) STEADY STATE SEEPAGE AT FLOOD CONTROL POOL (EL 556.0) AND AT MAXIMUM DESIGN WATER SURFACE (EL 559.4)	
INVESTIGATOR NO.		SPECIFICATIONS DATED	
DRAWING NUMBER		SHEET NO.	
		OF	
		REVISION NO.	

PLATE 55



$\angle = 70.5^\circ$
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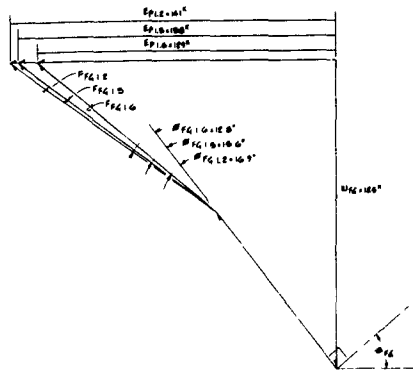
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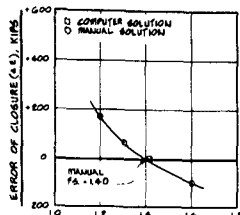
$\angle = 70.5^\circ$
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$\angle = 70.5^\circ$
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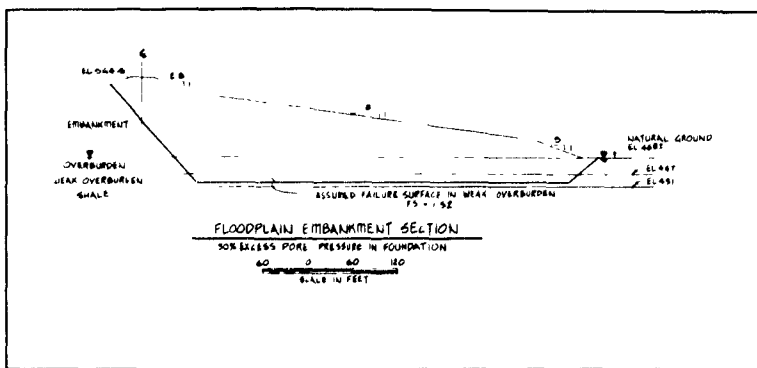
PASSIVE WEDGE FORCE POLYGON

SCALE IN KIPS



TRIAL FACTOR OF SAFETY

THE MINIMUM FACTOR OF SAFETY CALCULATED USING COMPUTER METHODS IS 1.81. MANUAL CALCULATIONS FOR VERIFYING COMPUTER ACCURACY ARE PRESENTED ON THIS PLATE.



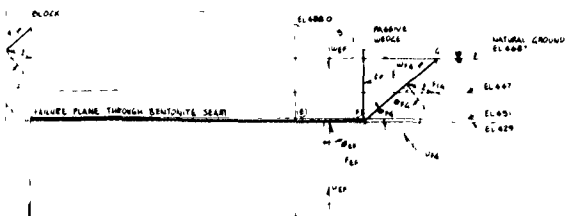
FLOODPLAIN EMBANKMENT SECTION

50% EXCESS PORE PRESSURE IN FOUNDATION

SCALE IN FEET

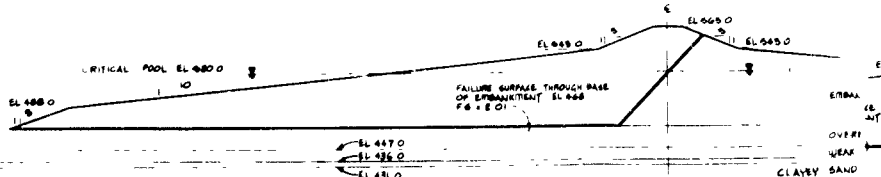
NOTES

- SEE PLATE FOR ADOPTED SHEAR STRENGTHS AND UNIT WEIGHTS
- FOR SIMPLICITY THE ANALYSIS SHOWN ON THIS PLATE ASSUMED THE SAND AND GRAVEL STRATA VERTICALLY ASSURED PRESENT AT THE TOP OF PRIMARY SHALE IN THE FLOODPLAIN
- THE ANALYSES WERE CONDUCTED ASSUMING 50% EXCESS PORE PRESSURE IN THE FOUNDATION, 5% STRENGTH IN THE FOUNDATION AND 0% STRENGTH IN THE EMBANKMENT



EXCESS PORE PRESSURE DIAGRAM

U.S. ARMY ENGINEER DISTRICT FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
DESIGNED BY	JOE POOL LAKE MOUNTAIN CREEK TEXAS
CHECKED BY	EMBANKMENT AND SPILLWAY FLOODPLAIN EMBANKMENT SECTION STABILITY ANALYSES WEDGE METHOD
ENGINEER BY	END OF CONSTRUCTION CONDITIONS WITH 50% EXCESS PORE PRESSURE IN FOUNDATION
REV NO.	DATE
CONTR NO.	
DRAWING NUMBER	SHEET NO.
	OF



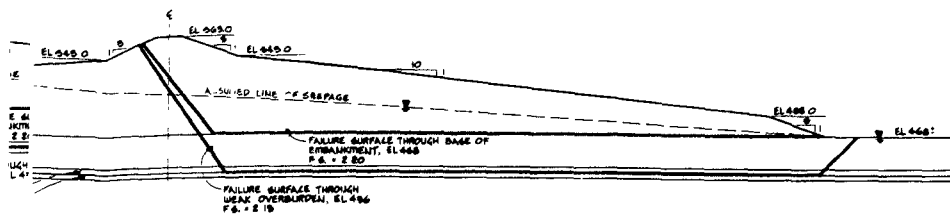
CASE 2 PARTIAL POOL

1 THE LINES OF SEEPAGE SHOWN ON THIS PLATE ARE CONSERVATIVELY HIGH SINCE THE RESULTING COMPUTED FACTORS OF SAFETY DO NOT CONTROL THE EMBANKMENT SECTION. MORE REALISTIC ASSUMPTIONS ARE NOT WARRANTED.

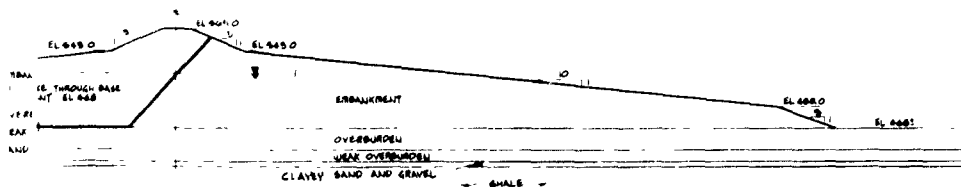
- 8 THE ELEVATION OF THE EMBANKMENT CREST HAS BEEN CHANGED FROM 50.0 TO 50.5 AND THE SLOPES OF THE UPPER SLOPE OF THE EMBANKMENT HAVE BEEN CHANGED FROM 1 ON 3 TO 1 ON 2.5 SINCE THESE ANALYSES WERE COMPLETED THE VERTICAL AND HORIZONTAL SLOPES HAVE BEEN CHANGED TO 1 VERTICAL ON 0 HORIZONTAL
- 9) MANUAL CALCULATIONS WERE NOT PERFORMED FOR THESE CONDITIONS

- ⁵ MANUAL CALCULATIONS WERE NOT PERFORMED FOR THESE CONDITIONS

ADOPTED DESIGN PARAMETERS



CASE 1: STEADY SEEPAGE



CASE 2: PARTIAL POOL

PLATE ARE CONSERVATIVELY HIGH
FACTORS OF SAFETY DO NOT CONTROL
REALISTIC ASSUMPTIONS ARE

REST HAS BEEN CHANGED FROM 500.0
UPPER BOUNDARY OF THE EMBANKMENT
- TO 10' ON 20' RAMP THESE ANALYSES
- HORIZONTAL SLOPES HAVE BEEN CHANGED

PERFORMED FOR THESE CONDITIONS

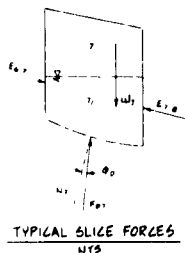
0 20 40 60
SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
DESIGNED BY -----	LAKVIEW LAKE BOWTOWN CREEK, TEXAS EMBANKMENT AND SPILLWAY FLOODPLAIN EMBANKMENT SECTION STABILITY ANALYSES STEADY SEEPAGE AND PARTIAL POOL CONDITIONS
DRAWN BY KLHLL	
CHECKED BY -----	
TO ACCOMPANY DIVISION MEMORANDUM NO. 5 EMBANKMENT AND SPILLWAY	100' 100' DATED DRAWING NUMBER SHEET NO. 57

SLICE NO.	AREA SQ FT	WEIGHT, KIPS		SLICE LENGTH, FEET	COHESION C, KIPS / SQ FT	ϕ
		MOIST	BLUHM			
1	207	10.0	—	50.0	0.8	0.01
2	68.0	10.0	—	30.0	20	11.9
3	504	25.0	—	85.0	16	7.6
4	646	30.8	—	80.8	10	4.8
5	16	—	1.1	1.1	10	6.8
6	646	30.8	—	—	—	—
7	10.0	—	19.0	89.8	21	14.0
8	436	68.9	—	—	—	—
9	228	—	15.4	84.5	20	15.6
10	480	60.0	—	—	—	—
11	500	—	21.6	81.6	21	14.3
12	200	50.0	—	—	—	—
13	560	—	24.5	74.5	21	14.3
14	520	40.0	—	—	—	—
15	340	—	28.0	65.0	21	14.3
16	240	50.0	—	—	—	—
17	500	—	20.2	60.2	21	14.3
18	150	19.0	—	—	—	—
19	130	—	12.8	51.8	20	16.4
20	72	11.6	—	—	—	—
21	80	—	9.4	16.9	22	14.8

* BASED ON $\phi = 2.93$

SLICE PARAMETERS



ELEVATION IN FEET, MSL.

600
580
560
540
520
500
480
460
440
420

EL 549.0

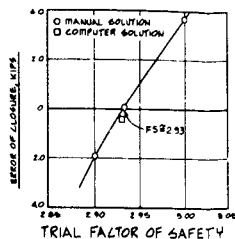
EL 558.0

EMBANKMENT

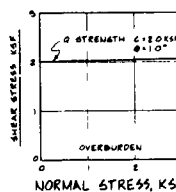
OVERBURDEN

SHALE

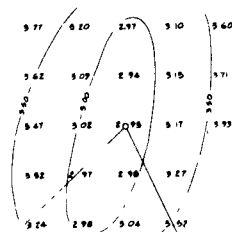
OUTLET WORKS EMBANKMENT SECTION

0 20 40
SCALE IN FEET

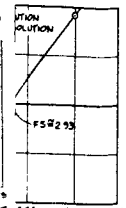
THE MINIMUM FACTOR OF SAFETY
CALCULATED BY COMPUTER METHOD IS
2.93. MANUAL CALCULATIONS FOR
VERIFYING COMPUTER ACCURACY ARE
PRESENTED ON THIS PLATE.



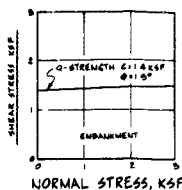
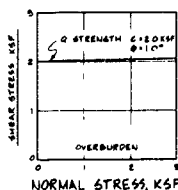
ADOPTED



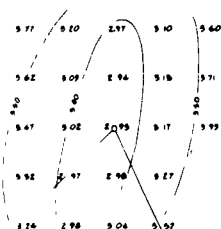
COMPUTER GRID OF FACTORS
OF SAFETY FOR TANGENT EL 549.0



ATION SOLUTION
R OF SAFETY
OR OF SAFETY
D COMPUTER METHOD IS
LICATIONS FOR
TER ACCURACY ARE
NS PLATE.



ADOPTED DESIGN PARAMETERS



LOWEST AND OF TALLOE
OF SAFETY FOR TANGENT EL. 490

SECTION 54
CENTER AT EL. 490

ASSUMED DIRECTION OF EARTH FORCES

BEED OF CLOSURE 0.6°

COMPOSITE FORCE POLYGON FOR FS = 2.95

SCALE IN KIPS

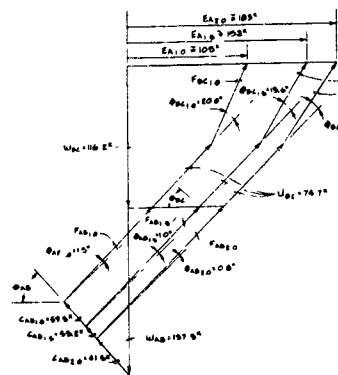
WORKS EMBANKMENT SECTION

SCALE 1/4" = 1' 0"

NOTE

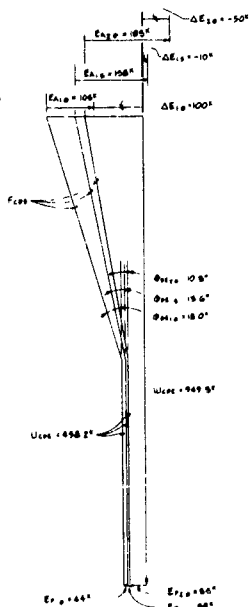
1. THE BENTON OF THE EMBANKMENT CREST HAS BEEN CHANGED FROM 465.0 TO 564.5, AND THE SLOPES OF THE UPPER 21.5 FEET OF THE EMBANKMENT HAVE BEEN CHANGED FROM 1 VERTICAL ON 3 HORIZONTAL TO 1 VERTICAL ON 2 HORIZONTAL SINCE THESE ANALYSES WERE COMPLETED THESE CHANGES ARE CONSIDERED TOO SLIGHT TO RE-ANALYZE THE SECTION

U.S. ARMY ENGINEER DISTRICT FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
JOE POOL LAKE WORTHAM CREEK, TEXAS	
EMBANKMENT AND SPILLWAY OUTLET WORKS EMBANKMENT SECTION STABILITY ANALYSES	
CIRCULAR ARC METHOD END OF CONSTRUCTION CONDITIONS	
DESIGNED BY	DATE
CHECKED BY	DATE
DRAWN BY	DATE
SCALE	DATE



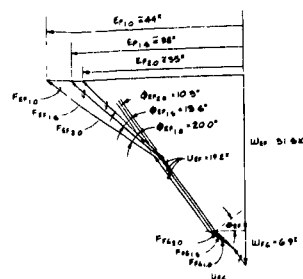
ACTIVE WEDGE FORCE POLYGON

SCALE IN KIIPS



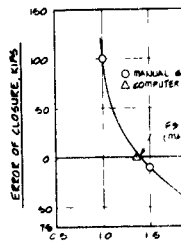
CENTRAL BLOCK FORCE POLYGON

SCALE IN KIIPS

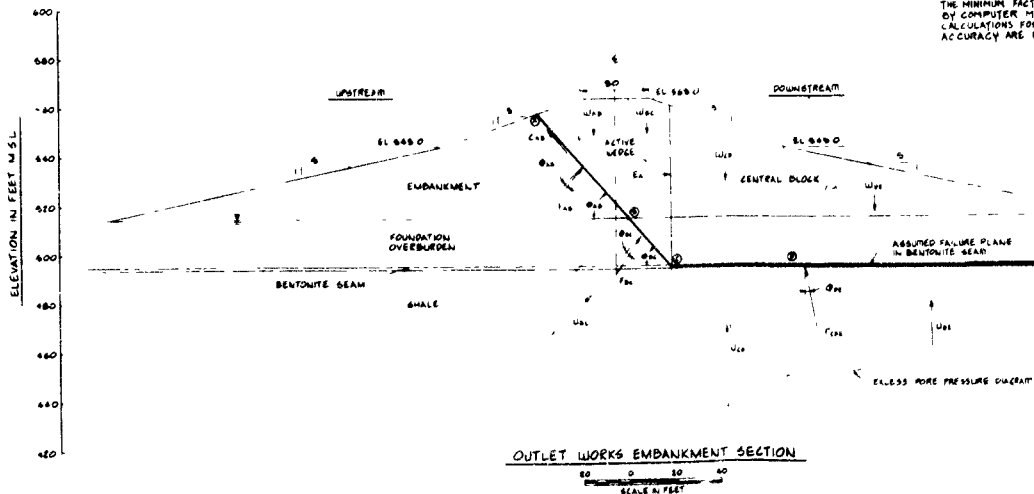


PASSIVE WEDGE FORCE POLYGON

SCALE IN KIIPS

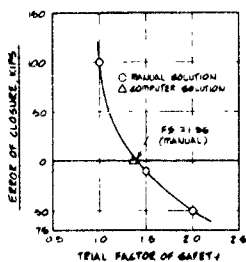
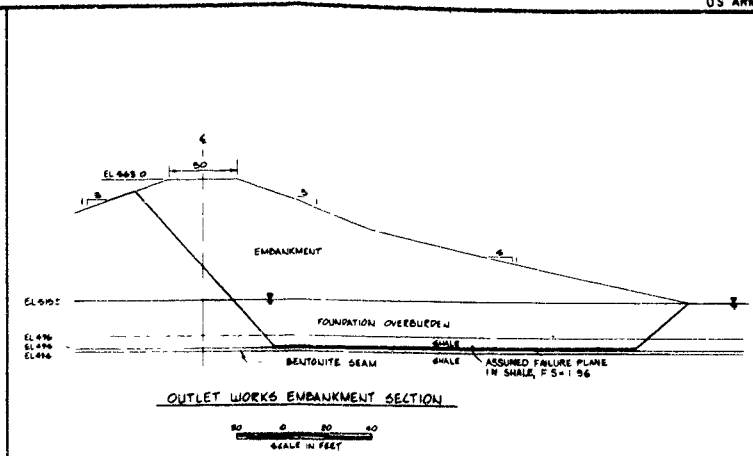
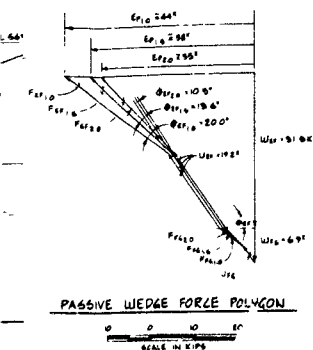


THE MINIMUM FACTOR OF 5 BY COMPUTER METHODS CALCULATIONS FOR VERIFY ACCURACY ARE PRESENT



OUTLET WORKS EMBANKMENT SECTION

SCALE IN FEET



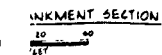
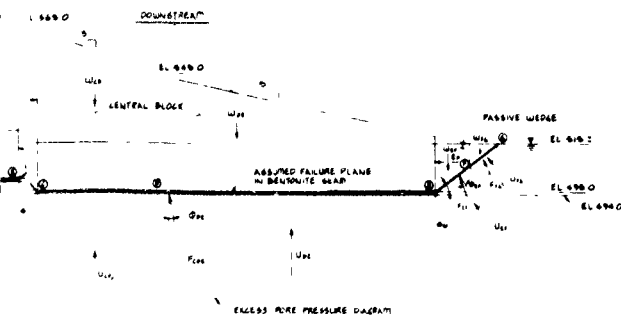
THE MINIMUM FACTOR OF SAFETY CALCULATED
BY COMPUTER METHODS IS 134 MANUAL
CALCULATIONS FOR VERIFYING COMPUTER
ACCURACY ARE PRESENTED ON THIS PLATE

ADOPTED DESIGN PARAMETERS

WATER REPORT	WATER TYPE	ANALYSIS			
		EMBALLMENT	FOUNDATION OVERLAY	SEALANT	SEALANT
UNSAT		125.0	125.0	125.0	
SATURATED		119.0	119.0	119.0	
UNSATURATED		66.5	67.5	67.5	
C 101	NA	0.0	0.0	0.0	
C 102	NA	0.0	0.0	0.0	
C 103	1.5	NA	NA	NA	
C 104	1.5	NA	NA	NA	

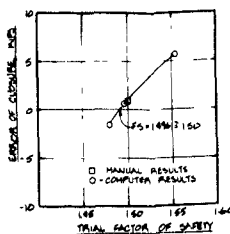
NOTES

- 1 THE ANALYSES WERE CONDUCTED ASSUMING 50% EXCESS PORE PRESSURE IN THE FOUNDATION, STRENGTH IN THE FOUNDATION AND Q-VALUE IN THE EMBANKMENT
- 2 THE OBSERVATION OF THE EMBANKMENT CREST HAD BEEN CHANGED TO EL 564.5, AND THE UPPER IV ON 3H SLOPES HAVE BEEN CHANGED TO IV ON 2.8H SINCE THESE ANALYSES WERE PERFORMED THESE CHANGES ARE CONSIDERED TOO SUIT TO RE-ANALYZE THE SECTION

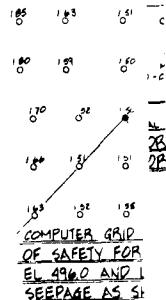


1	2	3	4	5	6	7	8	9	10	11	12
13	14	15	16	17	18	19	20	21	22	23	24
U S ARMY ENGINEER DISTRICT FORT WORTH CORPS OF ENGINEERS FORT WORTH TEXAS											
JOE POOL LAKE MOUNTAIN CREEK TEXAS EMBANKMENT AND SPILLWAY OUTLET WORKS EMBANKMENT SECTION STABILITY ANALYSES HEIDE METHOD END OF CONSTRUCTION CONDITIONS WITH 30% EXCESS PORE PRESSURE IN FOUNDATION											
BY NO DATED CHECKED NO DRAWING NUMBER SHEET NO DESIGNED NO											

SLICE NO.	AREA	HEIGHT	WEIGHT	WATER	WATER	TOTAL	AL. BASE	WATER	($W+U$)
1	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
2	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
3	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
4	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
5	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
6	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
7	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
8	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
9	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
10	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
11	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
12	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
13	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
14	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
15	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
16	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
17	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
18	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
19	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
20	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
21	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
22	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
23	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
24	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
25	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
26	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
27	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
28	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
29	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0
30	100.0	10.0	1000	0.0	1000	1000	10.0	0.0	0.0



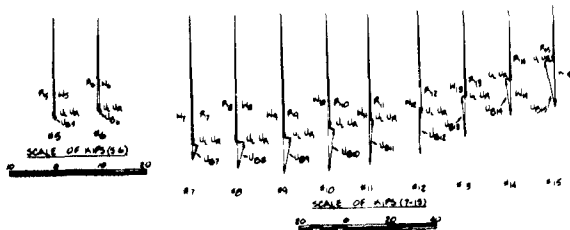
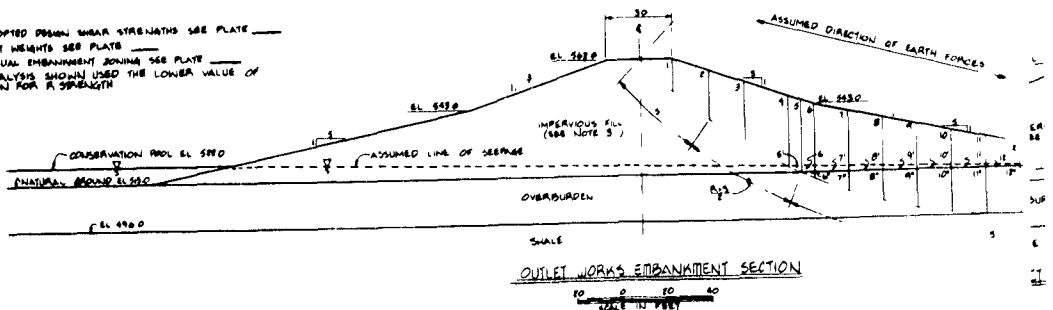
TRIAL FACTOR OF SAFETY VERSUS
ERROR OF CLOSURE



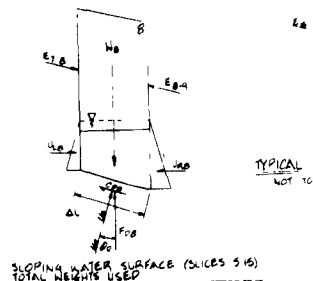
COMPUTER GRID
OF SAFETY FOR
EL 496.0 AND
SEEPAGE AS S

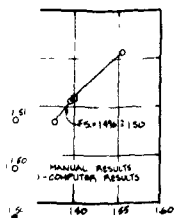
NOTES:

- FOR ADOPED DESIGN SHEAR STRENGTHS SEE PLATE
- FOR UNIT WEIGHTS SEE PLATE
- FOR ACTUAL TREMBLEMENT ZONING SEE PLATE
- THE ANALYSIS SHOWN USED THE LOWER VALUE OF COHESION FOR A STRENGTH



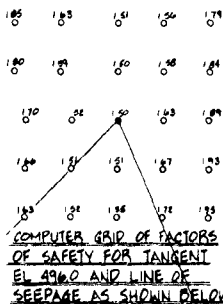
RESULTS OF WEIGHT AND
WATER FORCES ON SLICE





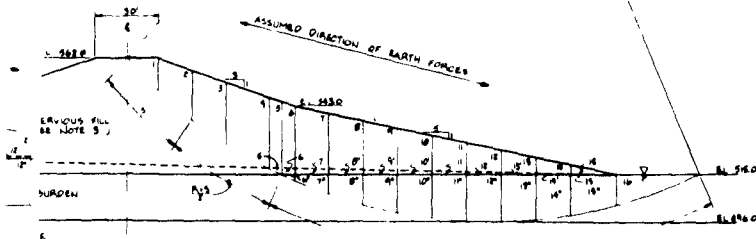
MANUAL RESULTS
1 - COMPUTER RESULTS

FS OF SAFETY
VS. OF CLOSURE



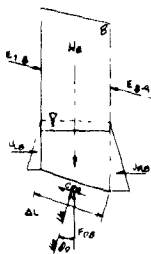
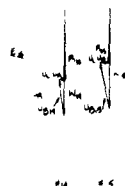
COMPUTER GRID OF FACTORS
OF SAFETY FOR TANGENT
EL 494.0 AND LINE OF
SEEPAGE AS SHOWN BELOW

EL 494
(CENTER OF MOUNT 700)



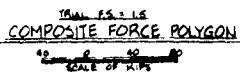
T WORKS EMBANKMENT SECTION

10 0 10 20 30 40
SCALE IN FEET



TYPICAL SLICES
NOT TO SCALE

SLOPING WATER SURFACE (SLICES 5-10)
TOTAL WEIGHTS USED

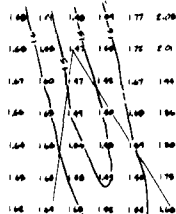


COMPOSITE FORCE POLYGON
SCALE OF 1000

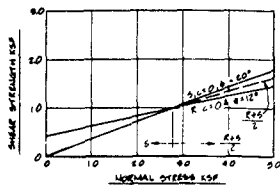
JOE POOL LNKE
MOUNTAIN CREEK TEXAS
OUTLET WORKS EMBANKMENT SECTION
STABILITY ANALYSIS
STEADY SEEPAGE CONDITION
SCALE AS SHOWN

U.S. ARMY ENGINEER DISTRICT FORT WORTH

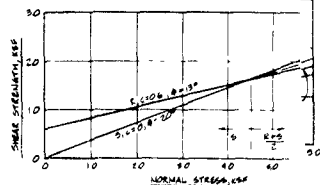
FILE NO. PLATE



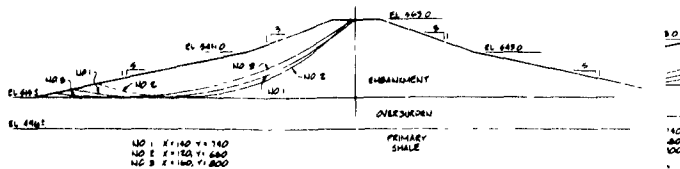
COMPUTER GEP OF FACTORS
OF SAFETY FOR PUL
ELEVATION SEE TALLEST
ELEVATION 600, AND 10400
FOR R-STRENGTH



ENHANCEMENT
COMPOSITE STRENGTH ENVELOPE

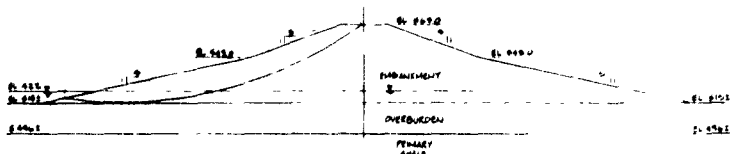
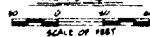


OVERBURDEN
COMPOSITE STRENGTH ENVELOPE



OUTLET WORKS EMBANKMENT SECTION

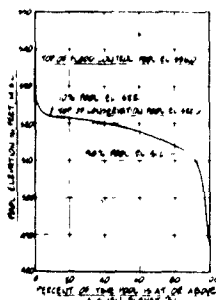
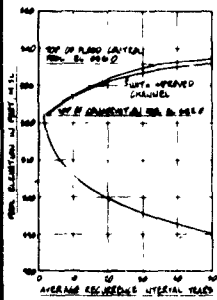
FIGURE NO 2



OUTLET WORKS EMBANKMENT SECTION

FIGURE NO 2

CAT 30



#	SHEET NO.	AREA		UNSATURATED		ADJUST TOTAL	% BASE	WATER	W. LOSS
		AREA	WATERLOADED	SATURATED			RESULT	%W	%W
1	1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3	3	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4	4	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5	5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6	6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7	7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9	9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
11	11	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12	12	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
13	13	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14	14	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
15	15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
16	16	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
17	17	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
18	18	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
19	19	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
20	20	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
21	21	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
22	22	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
23	23	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
24	24	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
25	25	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
26	26	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
27	27	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
28	28	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
29	29	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
30	30	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
31	31	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
32	32	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
33	33	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
34	34	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
35	35	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
36	36	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
37	37	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
38	38	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
39	39	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
40	40	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
41	41	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
42	42	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
43	43	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
44	44	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
45	45	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
46	46	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
47	47	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
48	48	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
49	49	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
50	50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
51	51	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
52	52	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
53	53	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
54	54	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
55	55	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
56	56	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
57	57	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
58	58	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
59	59	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
60	60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
61	61	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
62	62	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
63	63	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
64	64	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
65	65	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
66	66	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
67	67	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
68	68	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
69	69	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
70	70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
71	71	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
72	72	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
73	73	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
74	74	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
75	75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
76	76	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
77	77	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
78	78	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
79	79	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
80	80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
81	81	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
82	82	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
83	83	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
84	84	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
85	85	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
86	86	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
87	87	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
88	88	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
89	89	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
90	90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
91	91	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
92	92	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
93	93	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
94	94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
95	95	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
96	96	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
97	97	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
98	98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
99	99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
100	100	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

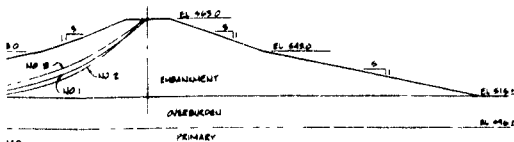
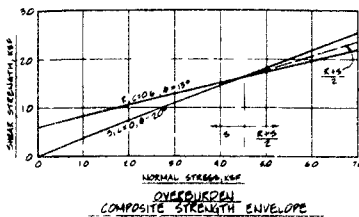
10260

FOR INT. ELEMENTS SEE PAGE
12 SEE THAT THE SCORING OF DATA IS
SHOWN IN THIS RATE

NOTES

- 1 CURVES BASED UPON PERIOD OF RECORD JANUARY 1924 TO 30 SEPTEMBER 1940
- 2 CURVES BASED UPON HYPOTHETICAL AGE REGULATION AFTER 10 YEARS OF SEDIMENTATION
- 3 2, 300 G WAS A RECOMMENDED INTERVAL OF 40 YEARS

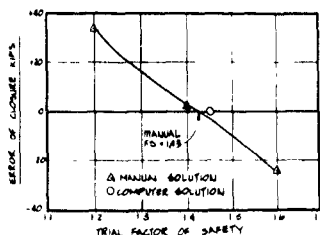
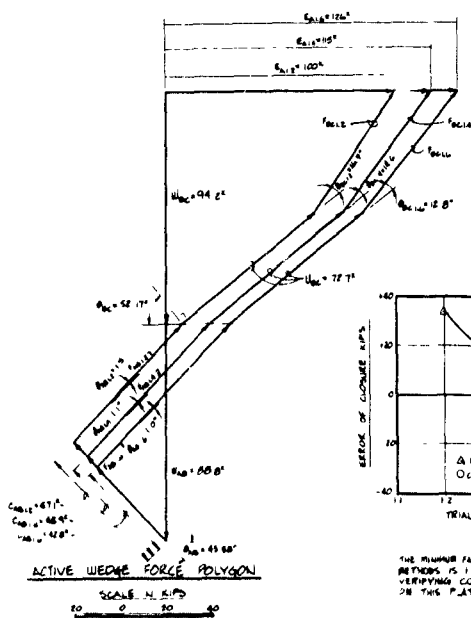
POOL ELEVATION PROBABILITY AND DURATION CURVES



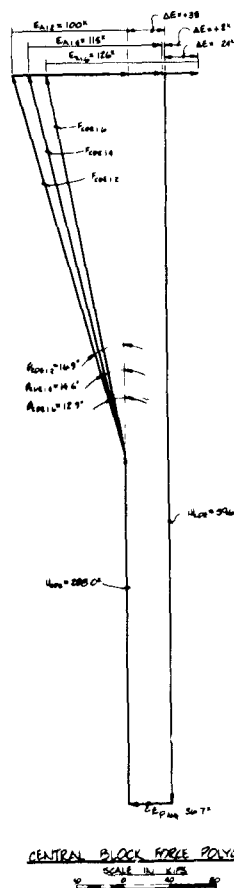
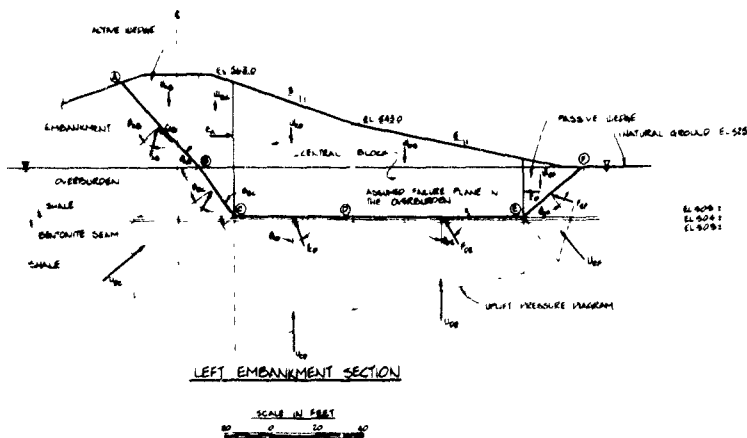
SCALE OF FEET

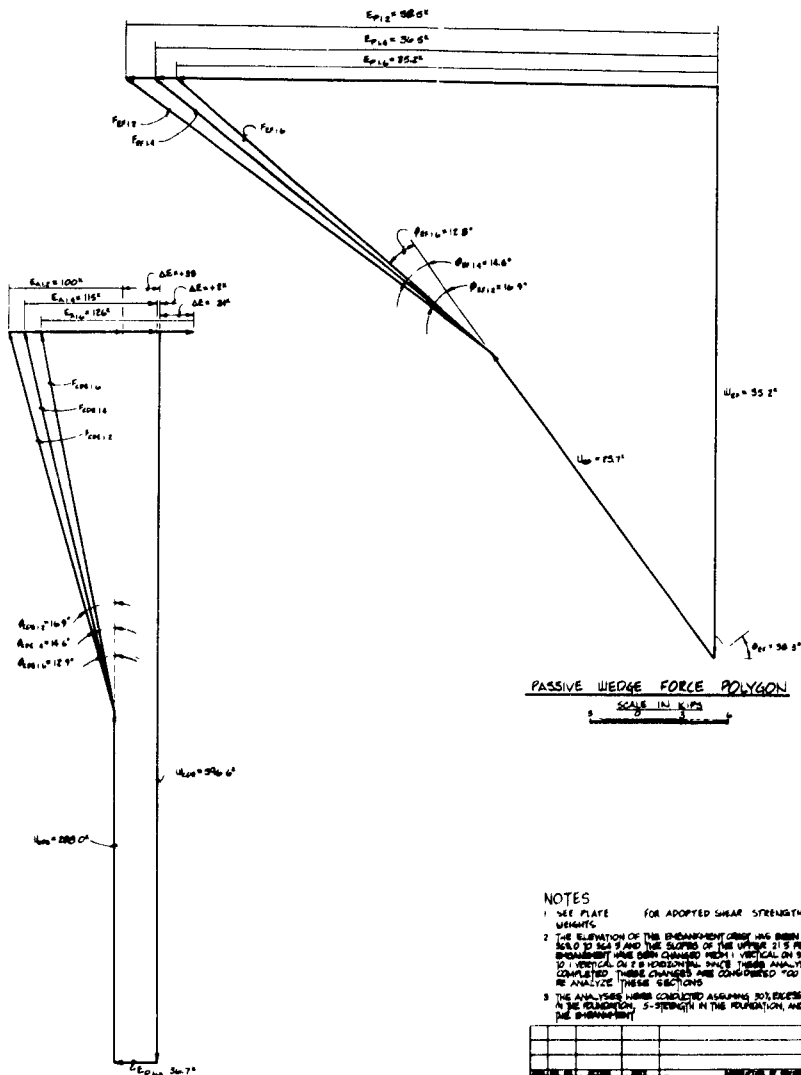
EL 215.0
EL 249.0

WATER ELEV.	WATER DEPTH	WATER TOTAL	WATER SURFACE	WATER BOTTOM	WATER CENTER	WATER SURFACE	WATER BOTTOM	WATER CENTER
258.0	1.00	259.0	258.0	257.0	258.5	258.0	257.0	258.5
259.0	1.00	260.0	259.0	258.0	259.5	259.0	258.0	259.5
260.0	1.00	261.0	260.0	259.0	260.5	260.0	259.0	260.5
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262.0	1.00	263.0	262.0	261.0	262.5	262.0	261.0	262.5
263.0	1.00	264.0	263.0	262.0	263.5	263.0	262.0	263.5
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294.0	1.00	295.0	294.0	293.0	294.5	294.0	293.0	294.5
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296.0	1.00	297.0	296.0	295.0	296.5	296.0	295.0	296.5
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298.0	1.00	299.0	298.0	297.0	298.5	298.0	297.0	298.5
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335.0	1.00	336.0	335.0	334.0	335.5	335.0	334.0	335.5
336.0	1.00	337.0	336.0	335.0	336.5	336.0	335.0	336.5
337.0	1.00	338.0	337.0	336.0	337.5	337.0	336.0	337.5
338.0	1.00	339.0	338.0	337.0	338.5	338.0	337.0	338.5
339.0	1.00	340.0	339.0	338.0	339.5	339.0	338.0	339.5
340.0	1.00	341.0	340.0	339.0	340.5	340.0	339.0	340.5
341.0	1.00	342.0	341.0	340.0	341.5	341.0	340.0	341.5
342.0	1.00	343.0	342.0	341.0	342.5	342.0	341.0	342.5
343.0	1.00	344.0	343.0	342.0	343.5	343.0	342.0	343.5
344.0	1.00	345.0	344.0	343.0	344.5	344.0	343.0	344.5
345.0	1.00	346.0	345.0	344.0	345.5	345.0	344.0	345.5
346.0	1.00	347.0	346.0	345.0	346.5	346.0	345.0	346.5
347.0	1.00	348.0	347.0	346.0	347.5	347.0	346.0	347.5
348.0	1.00	349.0	348.0	347.0	348.5	348.0	347.0	348.5
349.0	1.00	350.0	349.0	348.0	349.5	349.0	348.0	349.5
350.0	1.00	351.0	350.0	349.0	350.5	350.0	349.0	350.5
351.0	1.00	352.0	351.0	350.0	351.5	351.0	350.0	351.5
352.0	1.00	353.0	352.0	351.0	352.5	352.0	351.0	352.5
353.0	1.00	354.0	353.0	352.0	353.5	353.0	352.0	353.5
354.0	1.00	355.0	354.0	353.0	354.5	354.0	353.0	354.5
355.0	1.00	356.0	355.0	354.0	355.5	355.0	354.0	355.5
356.0	1.00	357.0	356.0	355.0	356.5	356.0	355.0	356.5
357.0	1.00	358.0	357.0	356.0	357.5	357.0	356.0	357.5
358.0	1.00	359.0	358.0	357.0	358.5	358.0	357.0	358.5
359.0	1.00	360.0	359.0	358.0	359.5	359.0	358.0	359.5
360.0	1.00	361.0	360.0	359.0	360.5	360.0	359.0	360.5
361.0	1.00	362.0	361.0	360.0	361.5	361.0	360.0	361.5
362.0	1.00	363.0	362.0	361.0	362.5	362.0	361.0	362.5
363.0	1.00	364.0	363.0	362.0	363.5	363.0	362.0	363.5
364.0	1.00	365.0	364.0	363.0	364.5	364.0	363.0	364.5
365.0	1.00	366.0	365.0	364.0	365.5	365.0	364.0	365.5
366.0	1.00	367.0	366.0	365.0	366.5	366.0	365.0	366.5
367.0	1.00	368.0	367.0	366.0	367.5	367.0	366.0	367.5
368.0	1.00	369.0	368.0	367.0	368.5	368.0	367.0	368.5
369.0	1.00	370.0	369.0	368.0	369.5	369.0	368.0	369.5
370.0	1.00	371.0	370.0	369.0	370.5	370.0	369.0	370.5



THE MINIMUM FACTOR OF SAFETY CALCULATED BY COMPUTER METHODS IS 1.40. MANUAL CALCULATIONS FOR VERIFYING COMPUTER ACCURACY ARE PRESENTED IN THIS PLATE.





ALCULATED BY COMPUTER
ALCULATIONS FOR
ARE PRESENTED

REDAID E-525

EL 600.2
EL 600.2
EL 600.2

CENTRAL BLOCK FORCE POLYGON

SCALE IN KIPS

PASSIVE WEDGE FORCE POLYGON

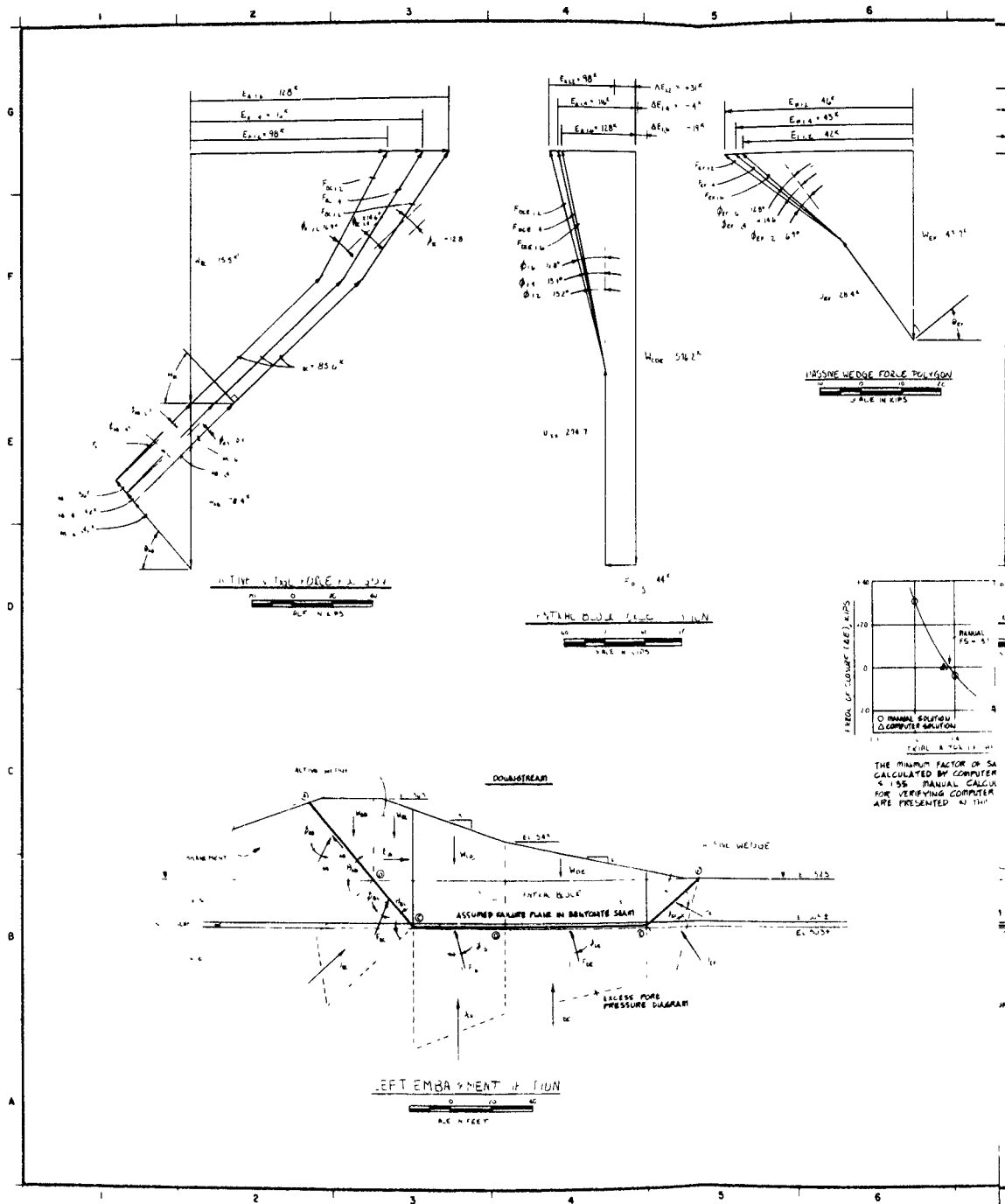
SCALE IN KIPS

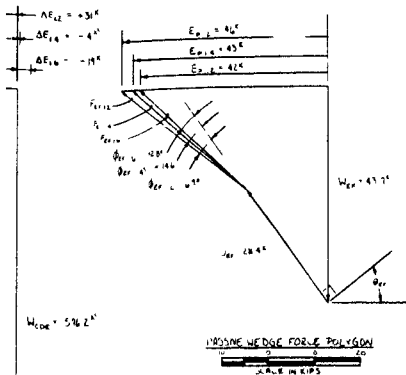
NOTES

1. SEE PLATE FOR ADOPTED SHEAR STRENGTHS AND UNIT WEIGHTS.
2. THE ELEVATION OF THE DRAINAGE GROUT WAS CHANGED FROM 210 TO 215 AND THE SLOPE OF THE UPPER 215 FEET OF THE DRAINAGE WAS CHANGED FROM 1:1 VERTICAL ON 3 HORIZONTAL TO 1:1 VERTICAL ON 2 HORIZONTAL. SINCE THESE ANALYSES WERE COMPLETED THESE CHANGES WERE CONSIDERED "ON SLIGHT" TO BE ANALYSED THESE SECTIONS.
3. THE ANALYSES WERE CONDUCTED ASSUMING 20% EXCESS PORE PRESSURE IN THE FOUNDATION, 5% EXCESS IN THE FOUNDATION AND 0% EXCESS IN THE DRAINAGE.

U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
DESIGNED BY:	JOB POOL LAKE MOUNTAIN CREEK, TEXAS
DRAWN BY:	ERIKHMENT AND SPILLWAY LEFT EMBANKMENT SECTION
CHECKED BY:	STABILITY ANALYSES
APPROVED BY:	WEAPONS METHOD END OF CONSTRUCTION CONDITIONS WITH SOIL EXCESS PORE PRESSURE IN FOUNDATION
DATE:	1974
DRAWING NUMBER:	SHEET NO. 12

PLATE 62

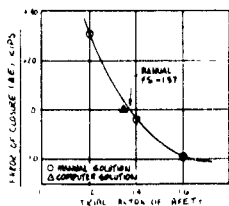




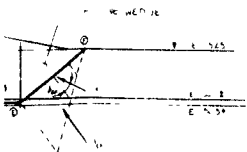
PROPERTY	ADOPTED DESIGN PARAMETERS	
	EMBANKMENT	FOUNDATION
UNIT	25.0	14.0
WATER	12.0	12.0
WATER	12.0	12.0
WATER	12.0	12.0
WATER	12.0	12.0
WATER	12.0	12.0
WATER	12.0	12.0
WATER	12.0	12.0
WATER	12.0	12.0
WATER	12.0	12.0

NOTES

- THE ANALYSIS WERE CONDUCTED ASSUMING 50% EXCESS PORE PRESSURE IN THE FOUNDATION, 5% STRENGTH IN THE FOUNDATION, AND 5% STRENGTH IN THE EMBANKMENT.
- THE ELEVATION OF THE EMBANKMENT CREST HAS BEEN CHANGED FROM 563.0 TO 548.5, AND THE UPPER 1 VERTICAL TO 3 HORIZONTAL SLOPES HAVE BEEN CHANGED TO 1 VERTICAL TO 2.8 HORIZONTAL SINCE THESE ANALYSES WERE PERFORMED. THESE CHANGES ARE CONSIDERED TOO SLIGHT TO REANALYZE THESE SECTIONS.



THE MINIMUM FACTOR OF SAFETY CALCULATED BY COMPUTER METHODS IS 1.55. MANUAL CALCULATIONS FOR VERIFICATION COMPUTER ACCURACY ARE PRESENTED IN THIS PLATE.



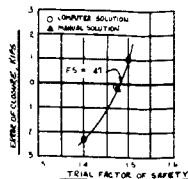
FORCE
AND
DIAGRAM

U.S. ARMY ENGINEER DISTRICT FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
PROJECT NO. _____	
DRAWING NO. _____	
SHEET NO. _____	
DATE _____	
BY _____	
CHECKED BY _____	
APPROVED BY _____	
TITLE JOE POOL LAKE EMBANKMENT AND SPILLWAY LEFT EMBANKMENT SECTION STABILITY ANALYSES WEDGE METHOD END OF CONSTRUCTION CONDITIONS WITH 50% EXCESS PORE PRESSURE IN FOUNDATION	

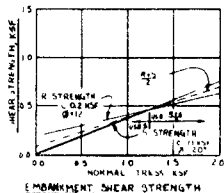
FIGURE 3
SLICE PARAMETERS*

SLICE NO.	SURF. NO.	SLICE WIDTH, FT.	HORIZ. WIDTH, FT.	AREA, SQ. FT.	UNIT WEIGHT, LB./CU. YD.	SLICE WEIGHT, LB.	BASE LENGTH, FT.	C_u , LB./SQ. FT.	ϕ_u , DEG.	$F.S. = 1.47$
1	1	8	7	36	0.125	4.5	12	0	15.9°	
2	2	11	20	220	0.125	27.5	25	2.5	12°	
3	3	11	70	320	0.125	40.0	24	2.4	12.2°	
4	4	11	10	300	0.125	40.0	20	2.0	12°	
5	5	11	15	270	0.125	33.8	10	1.0	11.2°	
6	6	11	12	204	0.125	25.5	19	1.9	11.2°	
7	7	11	4	21	0.125	4.0	29	0	13.9°	

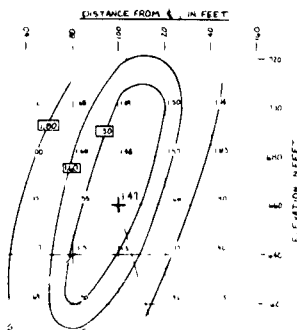
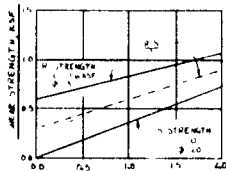
* FOR FAILURE SURFACE SHOWN IN FIGURE 1



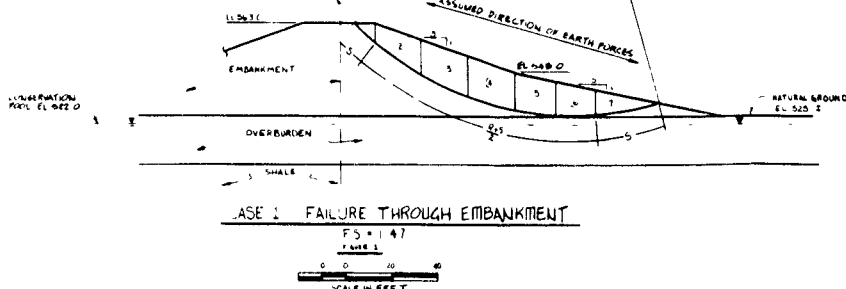
THE MINIMUM FACTOR OF SAFETY CALCULATED BY COMPUTER METHODS IS 1.47. MANUAL CALCULATIONS FOR VERIFYING COMPUTER ACCURACY ARE PRESENTED ON THIS PLATE.



OVERBURDEN SHEAR STRENGTH
ADOPTED STRENGTH PARAMETERS
FIGURE 2

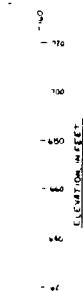
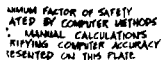


COMPUTER GRID OF FACTORS OF SAFETY FOR TANGENT ELEVATION 565

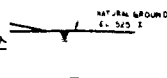


COMPOSITE FORCE POLYGON FOR F.S. = 1.47

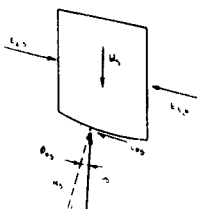
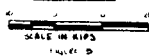
SCALE IN KIPS
1 INCH = 5 KIPS



FROM CES



COMPOSITE FORCE POLYGON
FOR FB = 1.47



TYPICAL SLICE FORWES
FIGURE 4 AT5

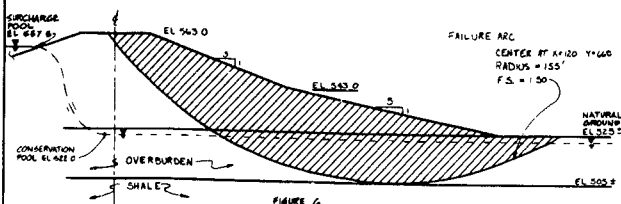


FIGURE 6
STEADY SEEPAGE CONDITIONS WITH
FAILURE ASSUMED THROUGH FOUNDATION
FS = 150 BY COMPUTER METHODS
MANUAL CALCULATIONS WERE NOT
PERFORMED

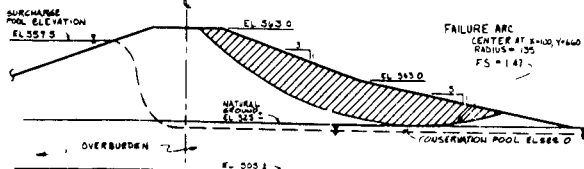


FIGURE 7
STEADY SEEPAGE CONDITIONS WITH
FAILURE ASSURED THROUGH PUMPAGE
AT NATURAL GROUND P.S. = 1.47 BY
COMPUTER METHODS SEE FIGURES 1 AND 3 FOR DETAILS

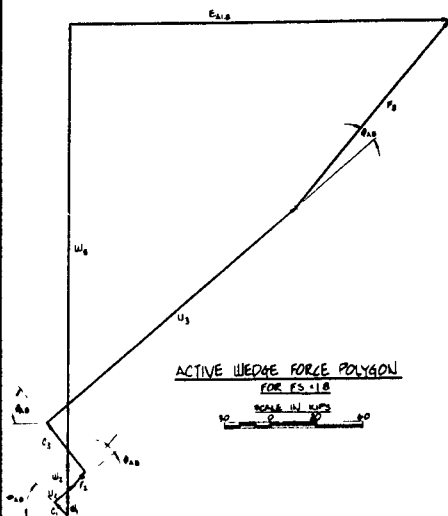


NOTES

THE ELEVATION OF THE EMBANKMENT NEXT HAS BEEN CHANGED FROM 803.0 TO 506.5, AND THE SLOPES OF THE UPPER 21.9 FEET OF THE EMBANKMENT HAVE BEEN CHANGED FROM 1 VERTICAL ON 3 HORIZONTAL TO 1 VERTICAL ON 2.0 HORIZONTAL SINCE THESE ANALYSES WERE COMPLETED. THESE CHANGES ARE CONSIDERED TOO SLIGHT TO REANALYZE THESE SECTIONS.

AS INDICATED IN FIGURES 6 AND 7, THE SURCHARGE POOL DOES NOT CHANGE THE LOCATION OF THE CRITICAL CIRCULAR FAILURE SURFACES.

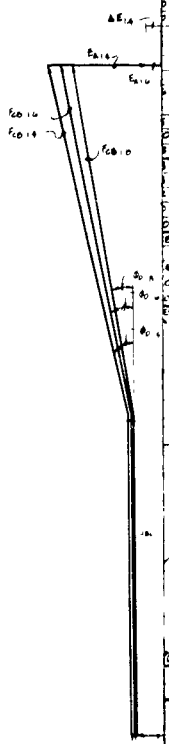
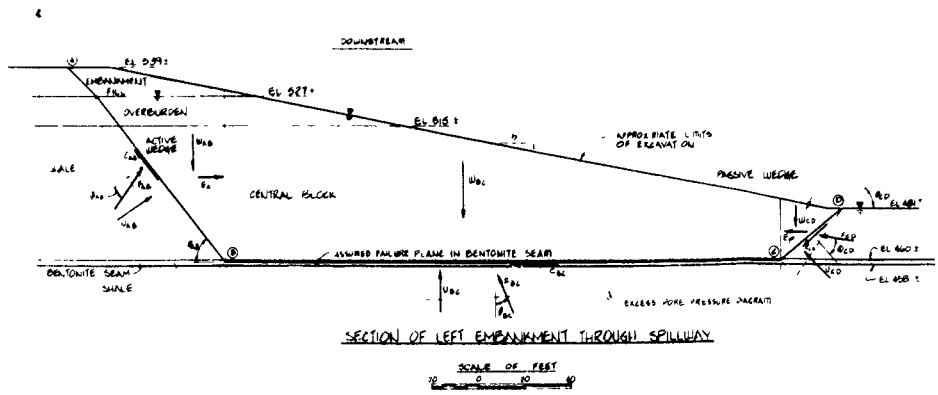
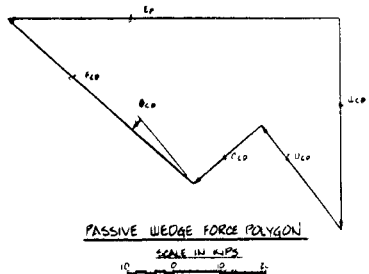
UNITED STATES OF AMERICA U S ARMY ENGINEER DISTRICT FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS		RECEIVED BY DISTRICT	
SUBMITTED BY NAME OF MRS. ... COLLECTED BY DATE	JOE POOL LAKE MOUNTAIN CREEK TOXAS EMBANKMENT AND SPILLWAY LEFT EMBANKMENT SECTION STABILITY ANALYSES CIRCULAR ARC METHOD STEADY SEEPAGE CONDITIONS		
DRAW NO DATED		SHEET NO OF	
DRAWING NUMBER		DRAWING NO	



MAGNITUDES OF FORCE VECTORS

VECTOR	FS	1.4	1.6	1.8
U1	9.0	9.0	9.0	9.0
U2	28.1	28.1	28.1	28.1
U3	272.0	272.0	272.0	272.0
U4	17.0	14.9	18.2	18.2
U5	0	0	0	0
U6	51.3	44.9	39.9	39.9
U7	0	0	0	0
U8	17.2	17.2	17.2	17.2
U9	208.4	208.4	208.4	208.4
U10	0	0	0	0
U11	10.6	10.6	10.6	10.6
U12	128.0	128.0	128.0	128.0
U13	218.3	218.3	218.3	218.3
U14	43.8	43.8	43.8	43.8
U15	24.8	24.8	24.8	24.8
U16	28.2	28.2	28.2	28.2
U17	61.0	54.0	52.0	52.0
U18	86.0	77.2	71.7	71.7
U19	1367.8	1367.8	1367.8	1367.8
U20	0	0	0	0
U21	658.4	658.4	658.4	658.4
U22	932.0	724.0	714.0	714.0
U23	491.0	11.0	46.0	46.0

NOTE: ALL VALUES IN KIPS

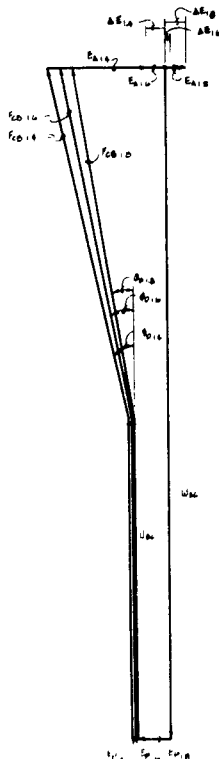


TOTAL
EMBEDMENT
TENSILE
SHALE
BELOW
SPILLWAY
ADOPTED

FORCE VECTORS

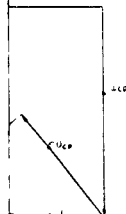
	16	18
1	9.0	9.0
2	28.1	28.1
3	270.0	270.0
4	14.9	18.2
5	0	0
6	44.9	54.9
7	0	0
8	17.8	17.8
9	208.6	208.6
10	0	0
11	15.8	10.0
12	150.8	250.9
13	230.0	287.3
14	43.8	43.8
15	21.8	14.3
16	28.2	28.2
17	54.0	52.0
18	77.2	71.7
19	1867.8	1567.8
20	0	0
21	638.4	638.4
22	724.0	714.0
23	111.0	48.0

25.41 x 10³



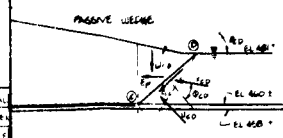
CENTRAL BLOCK FORCE POLYGON

SCALE IN KIPS
100 200 300



POLYGON

DATE LOTS
ANALYSIS

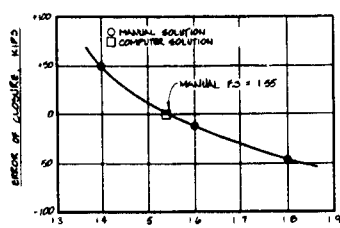


WALL PRESSURE FACTOR

FILLWAY

MATERIAL	3 (PCS)	C (NSP)	θ
EMBANKMENT	175	4	15°
OVERBURDEN	150	0	20°
SHALE	150	10	18°
BEHIND FILLWAY	113	0	18°

ADOPTED DESIGN PARAMETERS

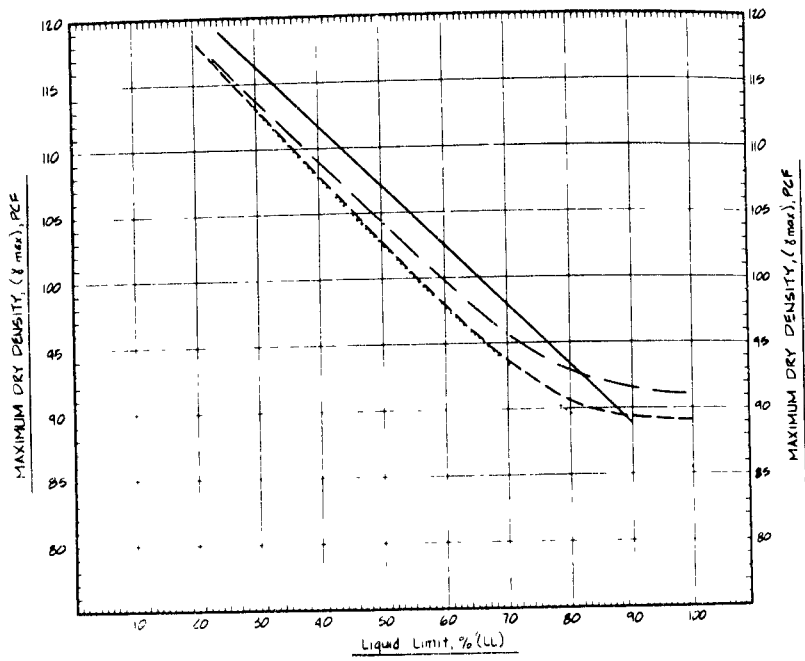


TRIAL FACTOR OF SAFETY
THE MINIMUM FACTOR OF SAFETY
CALCULATED BY COMPUTER METHODS
IS 1.56. MANUAL CALCULATIONS
FOR VERIFYING COMPUTER ACCURACY
ARE PRESENTED ON THIS PLATE.

NOTE

1. THE ANALYSES WERE CONDUCTED ASSUMING 50% EXCESS PORE
PRESSURE IN THE FOUNDATION, Q STRENGTH IN THE EMBANKMENT AND
S STRENGTH IN THE FOUNDATION.

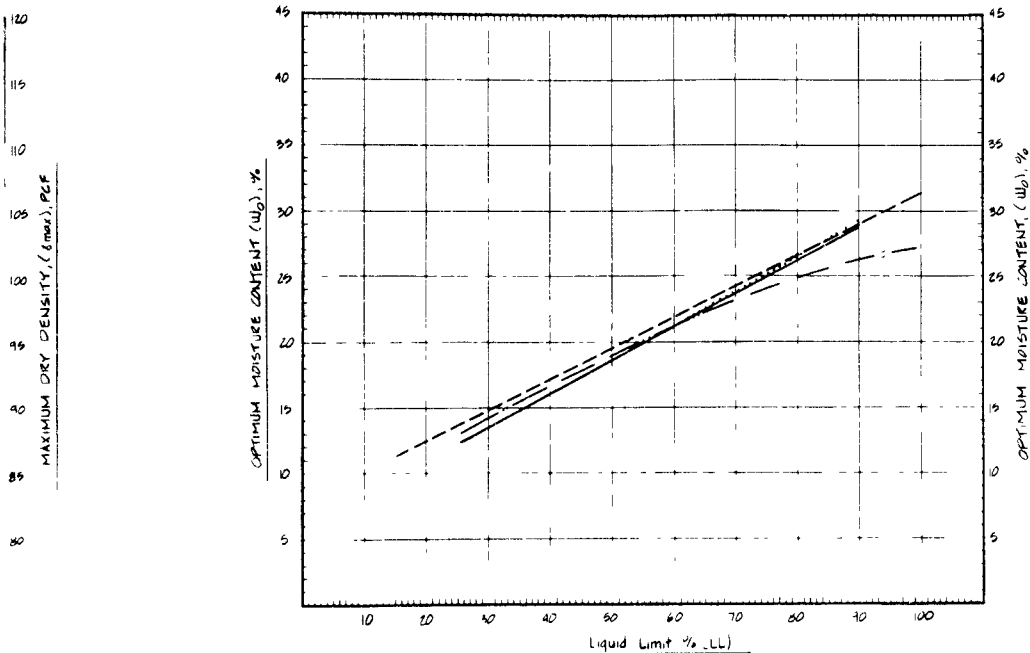
U.S. ARMY ENGINEER DISTRICT FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
DESIGNED BY DRAWN BY CHECKED BY DATE	JOB: POOL LAKE MOUNTAIN CREEK, TEXAS EMBANKMENT AND SPILLWAY LEFT EMBANKMENT SECTION FOR AT SPILLWAY STABILITY ANALYSES WEDGE METHOD END OF CONSTRUCTION CONDITIONS WITH 50% EXCESS PORE PRESSURE IN FOUNDATION
SHEET NUMBER SHEET NO.	SHEET NO.



LIQUID LIMIT vs MAXIMUM DRY DENSITY

LEGEND

- C
- - - H
- . - E

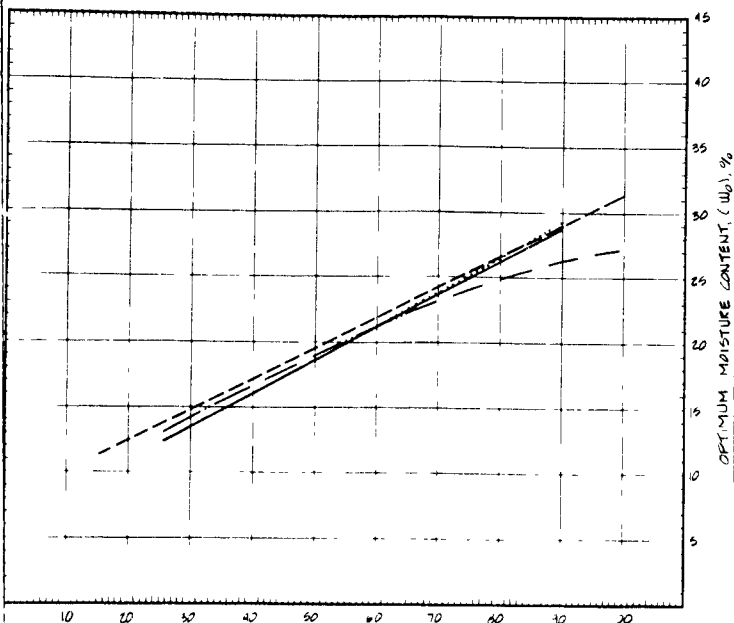


LIQUID LIMIT vs OPTIMUM MOISTURE CONTENT

LEGEND

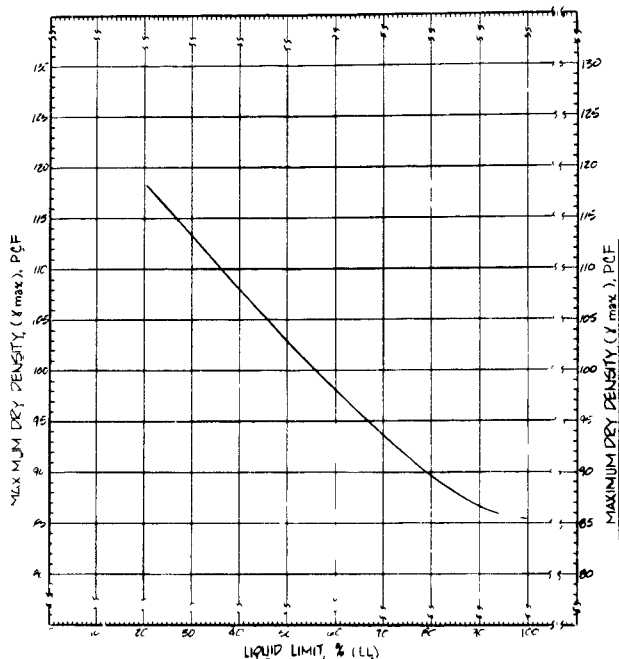
—— ORIGINAL
 ——— 19 MAY 80
 6 OCT 80
 -.-.- 15 JAN 81

REVISION NO.	ACTION	DATE
DESIGNED BY	JUB	
DRAWN BY	LIQUID LIMIT	
REVIEWED BY	INIT	
SUBMITTED BY	NY 1A	
ENGINEER	CONTR	
	DRAW	



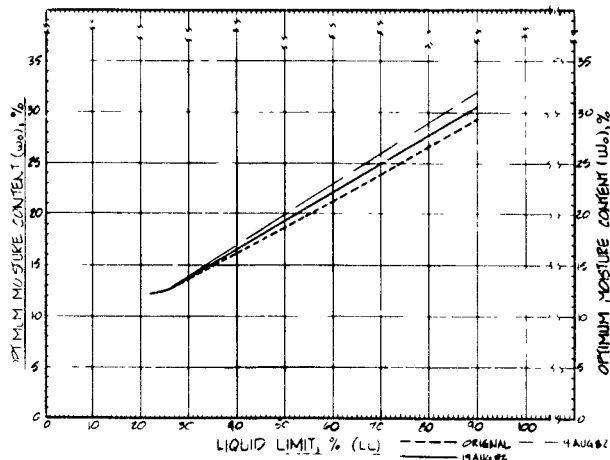
Liquid Limit (% LL)
LIQUID LIMIT vs OPTIMUM MOISTURE CONTENT

SERIAL NO.		ACTION		DATE		DESCRIPTION OF REGION			
						U.S. ARMY ENGINEER DISTRICT FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS			
DESIGNED BY		JOE POOL LAKE LIQUID LIMIT CORRELATION CURVES INITIAL CONTRACT							
DRAWN BY									
CHECKED BY									
REVIEWED BY									
SUBMITTED BY		INVESTIGATION NO.		DATE					
ENGINEER		CONTRACT NO. DRAWING 66-80-6-0009				SHEET NO. _____ OF _____			
		DRAWING NUMBER				REQUIREMENT NO.			



LIQUID LIMIT vs MAXIMUM DRY DENSITY

NOTE: MAXIMUM DRY DENSITY IN POUNDS/CUBIC FOOT (PCF) IS DETERMINED BY A STANDARD COMPACTION TEST



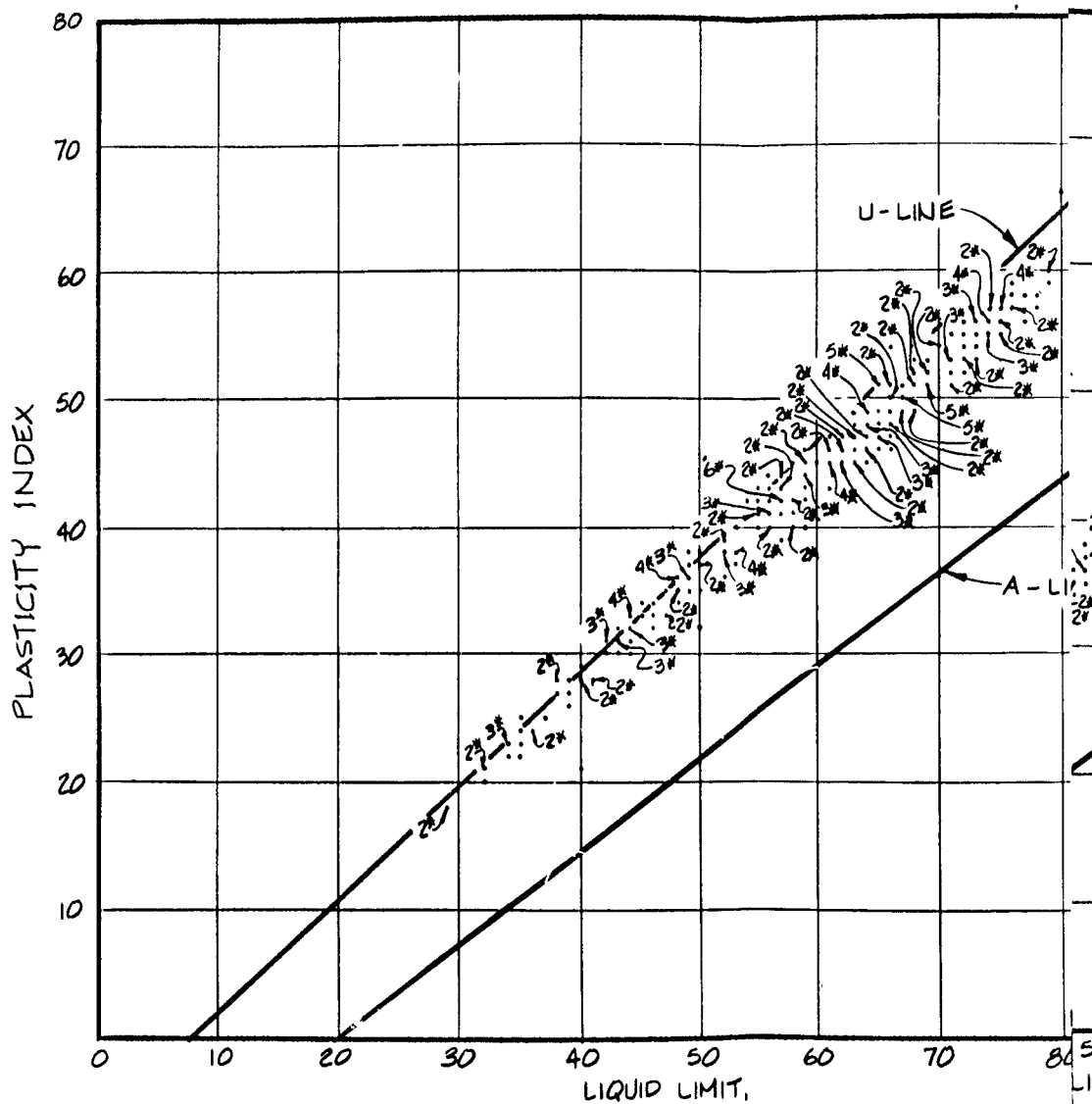
LIQUID LIMIT vs OPTIMUM MOISTURE CONTENT

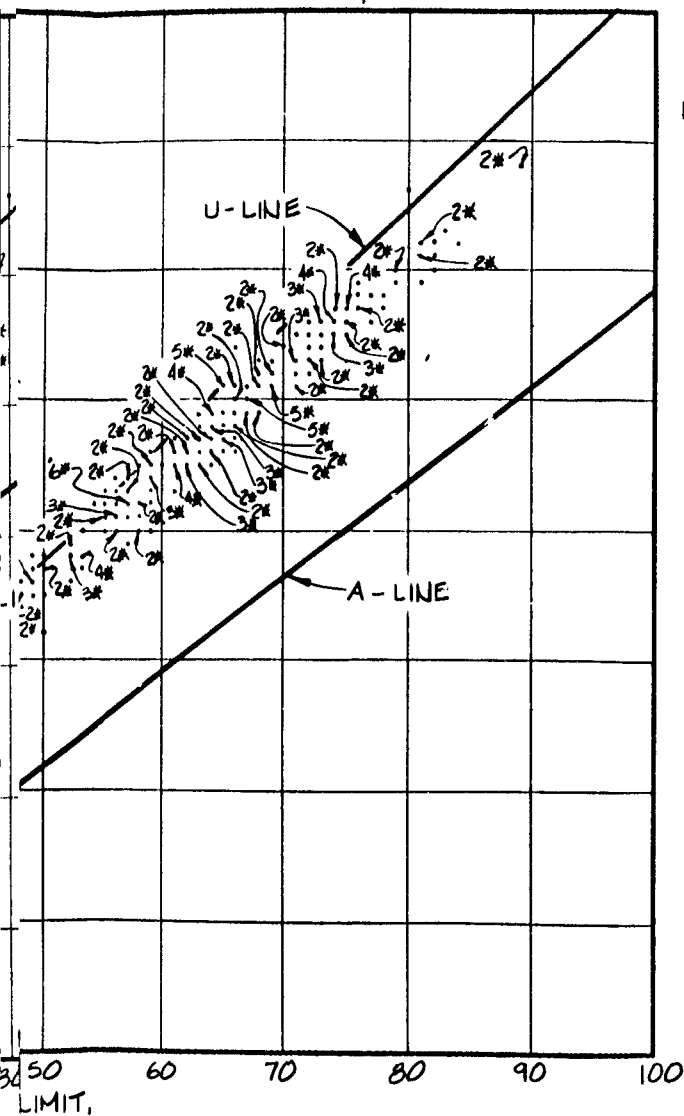
NOTE

1. THE ORIGINAL CURVE WAS BASED ON DATA OBTAINED DURING THE FIRST CONTRACT.

U.S. ARMY ENGINEER DISTRICT PLANT WORTH			
PLANT WORTH, TEXAS			
JOE POOL LAKE			
MOUNTAIN CREEK, TEXAS			
EMBANKMENT AND SPILLWAY			
LIQUID LIMIT CORRELATION CURVES			
COMPLETION CONTRACT			
DESIGNED BY	BY	DATE	REFERENCE NO.
DRAWN BY	BY	DATE	
CHECKED BY	BY	DATE	
APPROVED BY	BY	DATE	
ENGINEER	BY	DATE	
DRAWING NUMBER	SHEET NO.	OF	

PLATE 67





NOTE

1. THIS PLATE PRESENTS A SUMMARY FOR ALL BORROW AREAS.

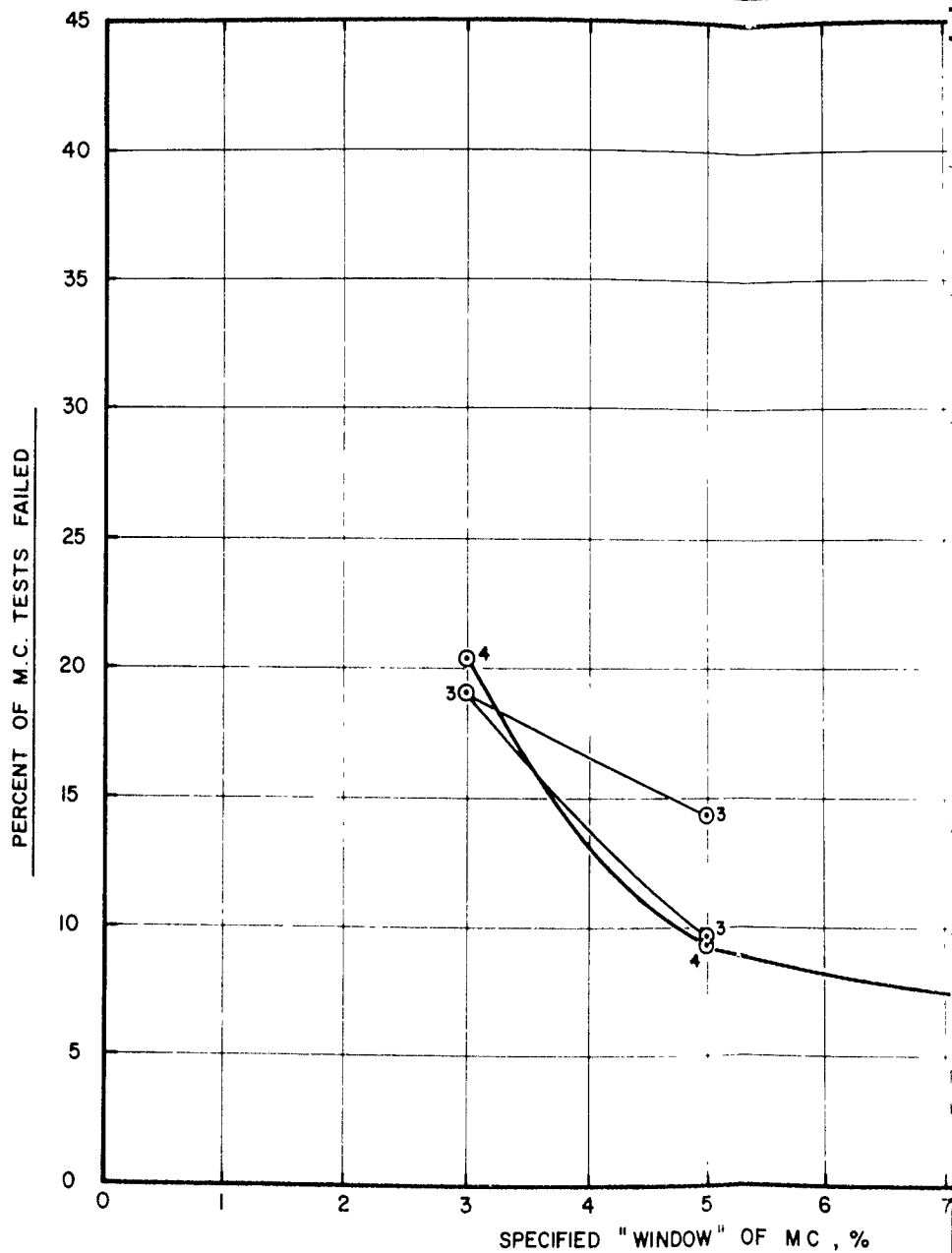
* INDICATES NUMBER OF
SAMPLES WITH SAME
INDICES.

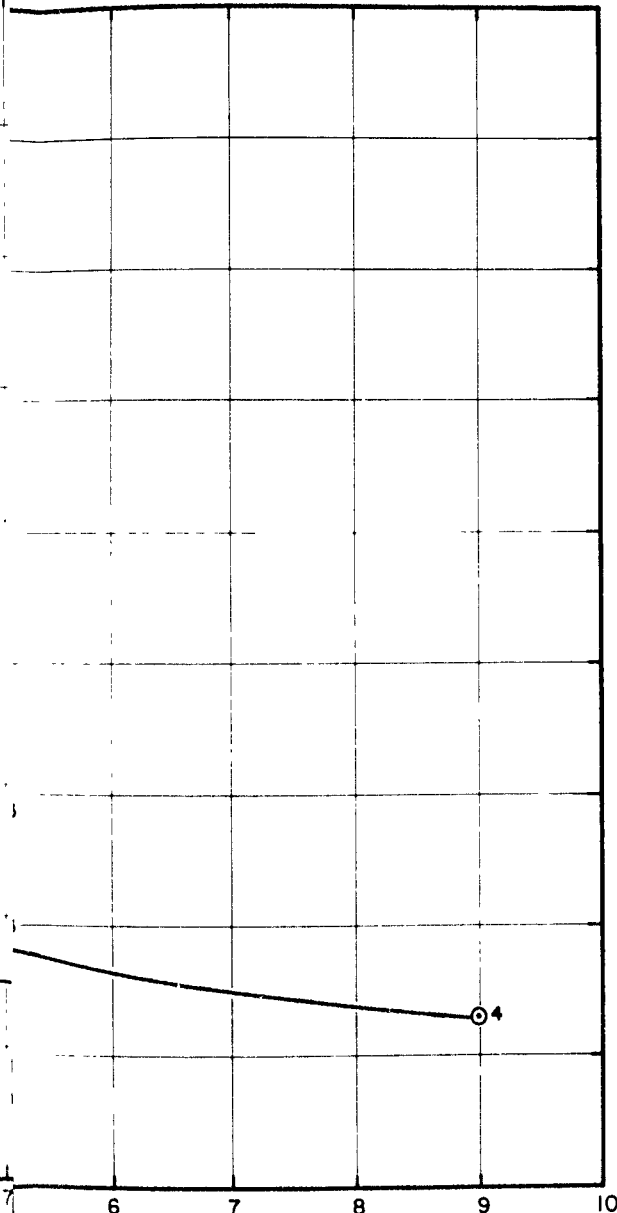
JOE POOL LAKE

MOUNTAIN CREEK, TEXAS

PLASTICITY CHART BORROW AREAS

U S ARMY ENGINEER DISTRICT, FT WORTH





OF M.C , %

LEGEND

<u>PROJECT</u>	<u>CONTRACTOR</u>
3 JOE POOL	LANE
4 JOE POOL	SERVIDONE

NOTE THE "WINDOW" OF MOISTURE CONTENT IS THE TOTAL RANGE IN PERCENT ALLOWED FOR A ZONE OR TYPE OF FILL. FOR EXAMPLE, AN ALLOWABLE RANGE OF MINUS TWO TO PLUS THREE FROM OPTIMUM IS A FIVE PERCENT WINDOW

JOE POOL LA
PERCENT OF

SPECIFIC
JC

US ARMY ENGINE

LEGEND

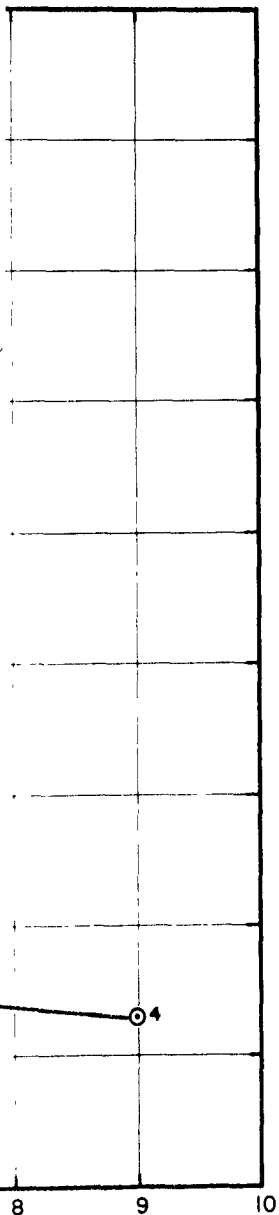
<u>PROJECT</u>	<u>CONTRACTOR</u>	<u>CONTRACT</u>
3 JOE POOL	LANE	1ST. CONTRACT
4 JOE POOL	SERVIDONE	COMPLETION CONTRACT

NOTE THE "WINDOW" OF MOISTURE CONTENT IS THE TOTAL RANGE IN PERCENT ALLOWED FOR A ZONE OR TYPE OF FILL. FOR EXAMPLE, AN ALLOWABLE RANGE OF MINUS TWO TO PLUS THREE FROM OPTIMUM IS A FIVE PERCENT WINDOW.

DT/
YF
OF
A

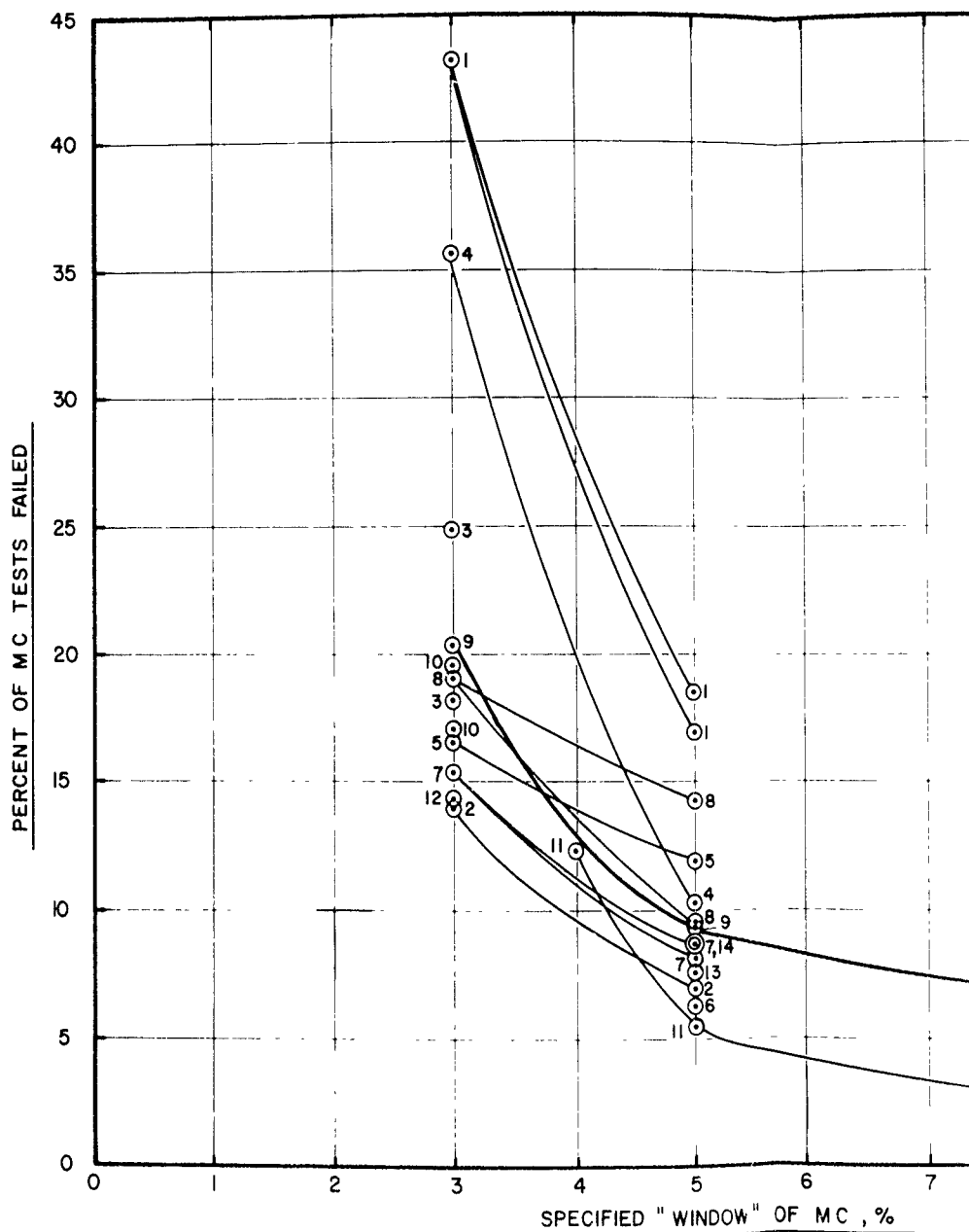
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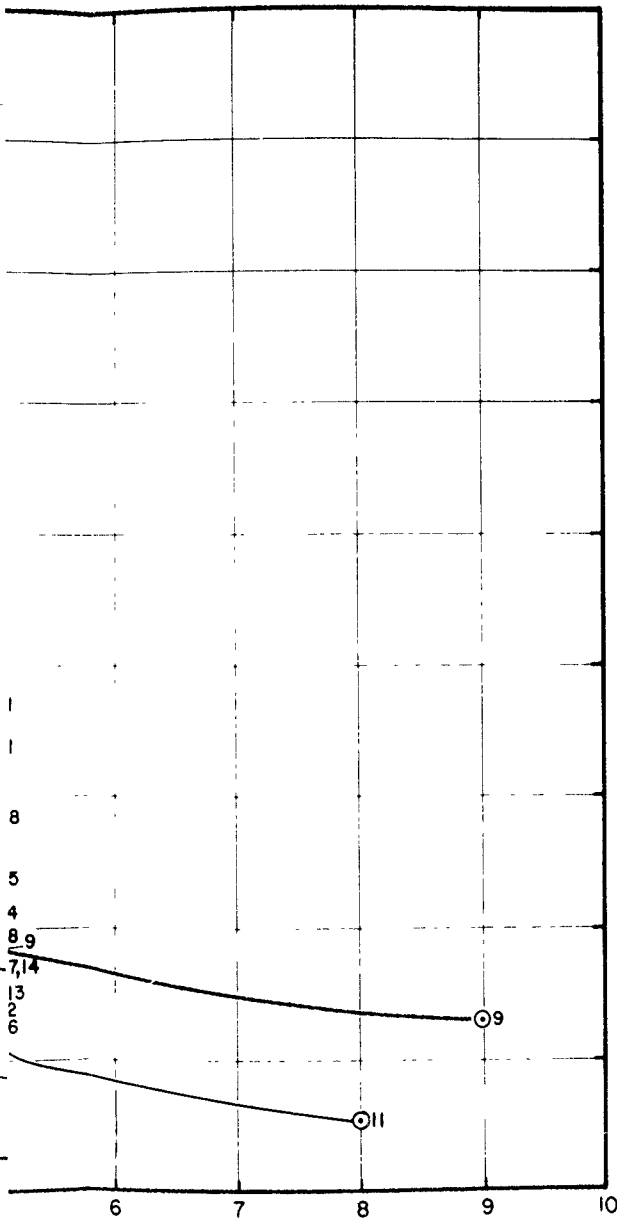
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JOE POOL LAKE, MOUNTAIN CREEK
PERCENT OF M.C. TESTS FAILED
VS
SPECIFIED "WINDOW" OF M.C.
JOE POOL LAKE

US ARMY ENGINEER DISTRICT, FT WORTH





PROJECT	LEGEND	CONTRACT
1 AQUILLA		CLEARWATER
2 AQUILLA		HOLLOWAY
3 BARDWELL		MOORMAN & S
4 GEORGETOWN		DAHLSTROM
5 GRANGER		DAHLSTROM
6 GRANGER		HENSEL PHELF
7 GRANGER		ABRAMS
8 JOE POOL		LANE
9 JOE POOL		SERVIDONE
10 PROCTOR		ADAM
11 RAY ROBERTS		PHILLIPS & JO
12 STILLHOUSE HOLLOW		TECON
13 WACO		MOOPMAN & S
14 WACO		CLEMENT BRO

NOTE:

1 ONLY FILLS IN FORT WORTH DISTRICT THAT INC ARE INCLUDED IN THIS DATA

2 THE METHOD USED TO SELECT THE OPTIMUM MC WAS THE LIQUID LIMIT CORRELATION, EXCEPT AND BARDWELL WHERE VISUAL COMPARISON W GRANGER (5) AND STILLHOUSE HOLLOW WHE PARTIALLY PERFORMED USING THE RAPID COMP

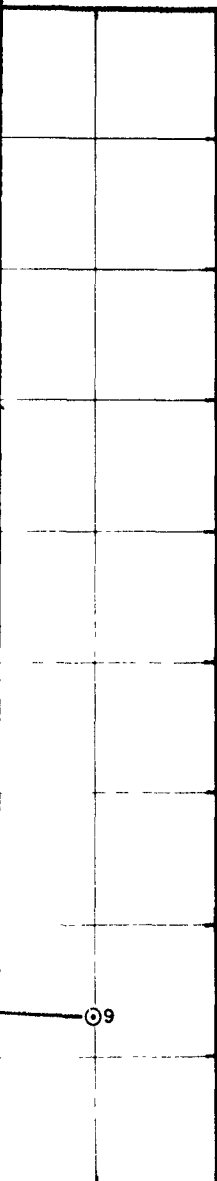
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U.S. ARMY

DOW" OF MC. , %

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LEGEND

	<u>PROJECT</u>	<u>CONTRACTOR</u>
1	AQUILLA	CLEARWATER
2	AQUILLA	HOLLOWAY
3	BARDWELL	MOORMAN & SINGLETON
4	GEORGETOWN	DAHLSTROM
5	GRANGER	DAHLSTROM
6	GRANGER	HENSEL PHELPS
7	GRANGER	ABRAMS
8	JOE POOL	LANE
9	JOE POOL	SERVIDONE
10	PROCTOR	ADAM
11	RAY ROBERTS	PHILLIPS & JORDAN
12	STILLHOUSE HOLLOW	TECON
13	WACO	MOORMAN & SINGLETON
14	WACO	CLEMENT BROTHERS

NOTE:

1 ONLY FILLS IN FORT WORTH DISTRICT THAT INCLUDE CH CLAYS ARE INCLUDED IN THIS DATA

2 THE METHOD USED TO SELECT THE OPTIMUM MOISTURE CONTENT WAS THE LIQUID LIMIT CORRELATION, EXCEPT ON WACO AND BARDWELL WHERE VISUAL COMPARISON WAS USED, AND GRANGER (5) AND STILLHOUSE HOLLOW WHERE CONTROL WAS PARTIALLY PERFORMED USING THE RAPID COMPACTION METHOD

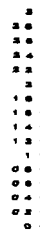
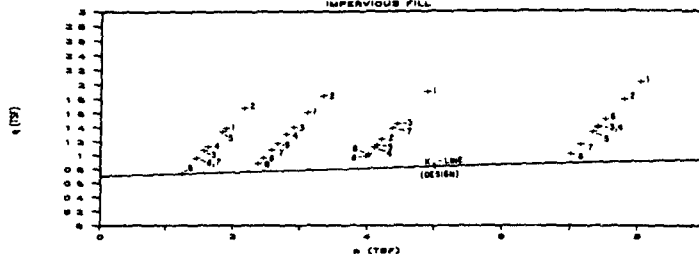
JOE POOL LAKE, MOUNTAIN CREEK
PERCENT OF M.C TESTS FAILED
VS
SPECIFIED "WINDOW" OF M.C
DAMS IN CESWF

U.S. ARMY ENGINEER DISTRICT, FT. WORTH

CORPS OF ENGINEERS

Q TEST—INITIAL CONTRACT

IMPERVIOUS FILL

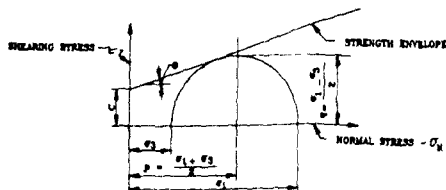


Sample No	Class	LL (%)	PI (%)	Mc (%)	Y _D (pcf)	S ₀ (%)	e ₀	σ ₃ (TSF)	σ ₁ (TSF)	p (TSF)	q (TSF)	PLOT SYMBOL
1-1	CH	60	46	29.1	82	94	.849	0.5	3.27	1.88	1.39	1
				27.7	94	92	.822	1.5	4.72	3.11	1.61	1
				27.6	94	92	.821	3.0	6.79	4.90	1.90	1
				29.0	93	95	.837	6.0	10.07	8.04	2.04	1
1-2	CH	66	48	23.6	102	97	.661	0.5	3.84	2.17	1.67	2
				24.6	100	96	.693	1.5	5.18	3.34	1.84	2
				25.9	98	97	.722	3.0	5.46	4.23	1.23	2
				24.7	100	97	.693	6.0	9.60	7.80	1.80	2
1-3	CH	64	45	25.6	98	95	.736	0.5	2.64	1.57	1.07	3
				25.1	98	94	.727	1.5	4.29	2.90	1.40	3
				24.4	100	95	.697	3.0	5.39	4.45	1.45	3
				25.1	99	96	.710	6.0	8.82	7.41	1.41	3
1-4	CH	65	45	26.3	96	94	.758	0.5	2.76	1.63	1.13	4
				25.4	97	93	.741	1.5	4.09	2.80	1.30	4
				26.9	96	95	.767	3.0	5.22	4.11	1.11	4
				25.2	98	93	.736	6.0	8.80	7.40	1.40	4
1-5	CH	63	44	24.5	99	93	.720	0.5	3.17	1.84	1.34	5
				26.1	98	96	.741	1.5	3.84	2.67	1.17	5
				26.7	97	96	.756	3.0	5.30	4.15	1.15	5
				26.2	98	96	.743	6.0	8.68	7.34	1.34	5
1-6	CH	63	46	26.7	96	96	.764	0.5	2.41	1.46	0.96	6
				26.5	97	96	.754	1.5	3.42	2.44	0.96	6
				26.3	98	96	.743	3.0	4.98	3.99	0.99	6
				24.7	99	95	.711	6.0	9.03	7.52	1.52	6
1-250	CH	61	44	23.8	101	97	.661	0.5	2.41	1.46	0.96	7
				23.9	101	97	.661	1.5	3.65	2.58	1.08	7
				23.9	101	97	.666	3.0	5.77	4.39	1.39	7
				23.7	101	97	.661	6.0	8.31	7.16	1.16	7
1U-240	CH	55	40	24.8	97	93	.709	0.5	1.98	1.24	0.74	8
				24.7	98	95	.693	1.5	3.28	2.29	0.89	8
				21.6	101	90	.640	3.0	5.03	4.02	1.02	8
				24.0	99	94	.678	6.0	8.03	7.02	1.02	8

Sample No	Class	LL (%)
R-1	CH	71
R-2	CH	65
R-3	CH	66
R-4	CH	74
R-5	CH	65
R-6	CH	64
R-7	CH	64
R-8	CH	72

LEGEND

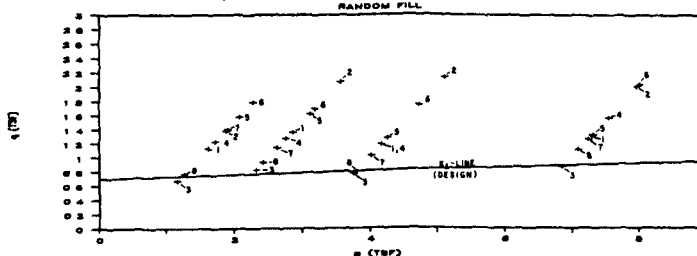
Class	Sample Classification According to the Unified Soil Classification System
LL	Liquid Limit
PI	Plasticity Index
Mc	Water Content
Y _D	Unit Dry Weight
S ₀	Saturation Before Shear
e ₀	Void Ratio Before Shear
σ ₃	Minor Principal Stress
σ ₁	Major Principal Stress



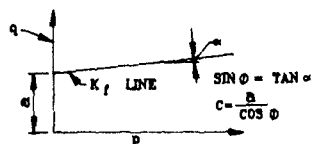
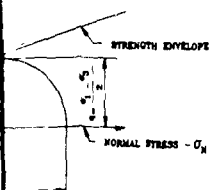
DETERMINATION OF "p" AND "q" FROM TRIAXIAL TEST USING MOHR'S DIAGRAM

RELATIONSHIP
LIN. P

Q TEST-INITIAL CONTRACT



Sample No	Class	LL (S)	PI (S)	H _c (S)	Y _D (PCF)	S _o (S)	H _g	σ _v (TSF)	σ _h (TSF)	P (TSF)	q (TSF)	PLOT SYMBOL
R-1	CH	71	51	29.5	94	97	.838	0.5	2.75	1.63	1.13	1
				29.0	94	97	.826	1.5	4.21	2.86	1.36	1
				29.5	94	98	.827	3.0	5.36	4.18	1.18	1
				28.2	95	97	.803	6.0	8.81	7.31	1.31	1
R-2	CH	65	45	23.0	98	86	.715	0.5	3.25	1.88	1.38	2
				23.2	97	85	.734	1.5	5.64	3.57	2.07	2
				23.4	97	86	.730	3.0	7.26	5.13	2.13	2
				23.5	97	87	.721	6.0	9.99	8.00	2.00	2
R-3	CH	66	47	27.9	94	97	.770	0.5	1.84	1.17	0.67	3
				28.1	94	97	.773	1.5	3.15	2.33	0.83	3
				28.7	94	98	.786	3.0	4.54	3.77	0.77	3
				27.6	95	98	.753	6.0	7.73	6.87	0.87	3
R-4	CH	74	53	28.3	94	97	.794	0.5	2.95	1.73	1.23	4
				28.4	94	96	.801	1.5	4.03	2.77	1.27	4
				28.8	95	99	.785	3.0	5.35	4.18	1.18	4
				28.5	95	100	.771	6.0	9.11	7.56	1.56	4
R-5	CH	65	41	25.9	97	95	.742	0.5	3.65	2.08	1.58	5
				25.6	98	97	.720	1.5	4.74	3.12	1.62	5
				26.7	97	96	.753	3.0	5.53	4.27	1.27	5
				26.6	96	95	.761	6.0	8.66	7.33	1.33	5
R-6	CH	65	45	23.7	99	89	.727	0.5	4.07	2.29	1.79	6
				24.7	99	91	.723	1.5	4.88	3.19	1.69	6
				23.5	100	91	.709	3.0	6.48	4.74	1.74	6
				24.2	100	95	.699	6.0	10.06	8.03	2.03	6
R-7	CH	64	45	25.4	98	94	.736	0.5	3.30	1.90	1.40	7
				25.3	98	95	.730	1.5	3.77	2.64	1.14	7
				26.2	98	96	.741	3.0	5.04	4.02	1.02	7
				24.7	99	95	.713	6.0	8.51	7.26	1.26	7
R-8	CH	74	52	28.9	93	96	.824	0.5	2.03	1.27	0.77	8
				29.1	94	98	.810	1.5	3.36	2.43	0.93	8
				29.4	93	98	.822	3.0	4.58	3.80	0.80	8
				28.6	95	99	.789	6.0	8.22	7.11	1.11	8

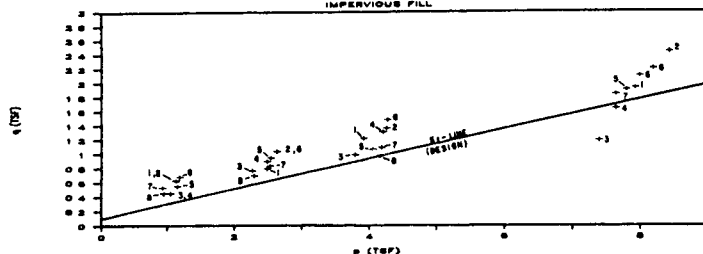


RELATIONSHIP OF "c" AND "φ" TO K_f
LINE ON p-q DIAGRAM

"p" AND "q" FROM
MOHR'S DIAGRAM

JOE POOL LAKE
MOUNTAIN CREEK, TEXAS
RECORD SAMPLE TEST RESULTS
"Q" TRIAXIAL SHEAR TESTS
IMPERVIOUS AND RANDOM FILL
INITIAL CONTRACT

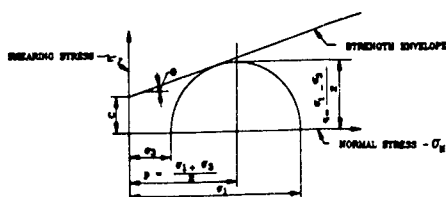
U.S. ARMY ENGINEER DISTRICT, FT. WORTH

R TEST—INITIAL CONTRACT
IMPERVIOUS FILL

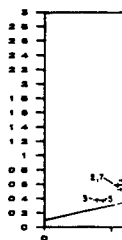
Sample No	Class	LL (%)	PI (%)	Wc (%)	Yd (pcf)	q ₀	σ'_3 (TSF)	σ'_1 (TSF)	P (TSF)	q (TSF)	PLOT SYMBOL
1-1	CH	68	46	32.0	91	.879	0.5	1.75	1.13	0.63	1
				29.2	95	.801	1.7	3.30	2.50	0.80	1
				25.8	100	.709	2.7	5.14	3.92	1.22	1
				22.9	106	.628	6.0	9.85	7.93	1.93	1
1-2	CH	66	48	27.6	97	.751	0.5	1.75	1.13	0.63	2
				25.8	100	.701	1.6	3.68	2.64	1.04	2
				25.6	100	.695	2.9	5.61	4.26	1.36	2
				23.3	104	.634	6.0	10.87	8.44	2.44	2
1-3	CH	64	45	30.8	93	.842	0.6	1.49	1.05	0.45	3
				30.0	94	.819	1.5	3.03	2.27	0.77	3
				28.9	95	.789	2.8	4.77	3.79	0.99	3
				28.0	97	.764	6.2	8.58	7.39	1.19	3
1-4	CH	65	45	29.8	94	.814	0.6	1.50	1.05	0.45	4
				27.7	97	.754	1.6	3.39	2.50	0.90	4
				26.5	99	.724	2.9	5.51	4.21	1.31	4
				24.9	101	.680	6.0	9.27	7.64	1.64	4
1-5	CH	63	44	28.6	96	.782	0.6	1.70	1.15	0.55	5
				27.0	98	.741	1.6	3.49	2.55	0.95	5
				27.2	98	.745	3.0	5.11	4.06	1.06	5
				25.5	101	.699	5.9	9.69	7.80	1.90	5
1-6	CH	63	46	28.0	97	.766	0.5	1.86	1.18	0.68	6
				26.9	98	.737	1.6	3.67	2.64	1.04	6
				25.3	101	.692	2.8	5.75	4.28	1.48	6
				23.6	104	.645	5.9	10.09	8.00	2.10	6
1-250	CH	61	44	26.5	98	.714	0.4	1.45	0.93	0.53	7
				26.0	99	.702	1.7	3.38	2.54	0.84	7
				24.7	101	.664	3.1	5.28	4.19	1.09	7
				23.3	103	.630	5.8	9.47	7.64	1.84	7
1U-240	CH	55	40	25.8	99	.688	0.5	1.40	0.95	0.45	8
				23.0	103	.614	1.6	2.99	2.30	0.70	8
				22.9	104	.610	3.2	5.13	4.17	0.97	8
				19.6	109	.523	6.0	10.39	8.20	2.20	8

LEGEND

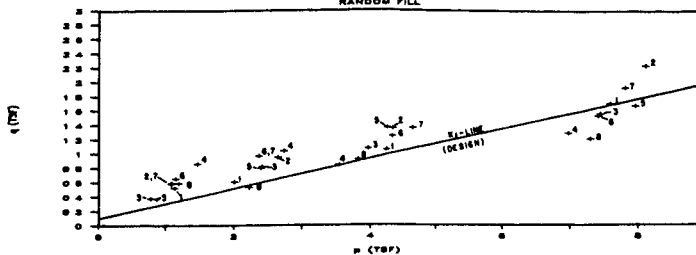
Class	Sample Classification According to the Unified Soil Classification System
LL	Liquid Limit
PI	Plasticity Index
Wc	Water Content
Y _d	Unit Dry Weight
S ₀	Saturation Before Shear
e ₀	Void Ratio Before Shear
σ'_3	Minor Principal Stress
σ'_1	Major Principal Stress



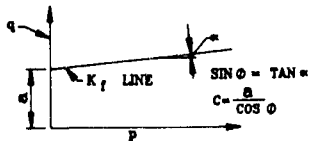
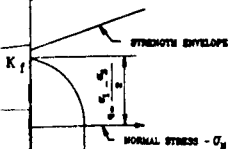
DETERMINATION OF "p" AND "q" FROM TRIAXIAL TEST USING MOHR'S DIAGRAM



Sample No	Class
R-1	CH
R-2	CH
R-3	CH
R-4	CH
R-5	CH
R-6	CH
R-7	CH
R-8	CH

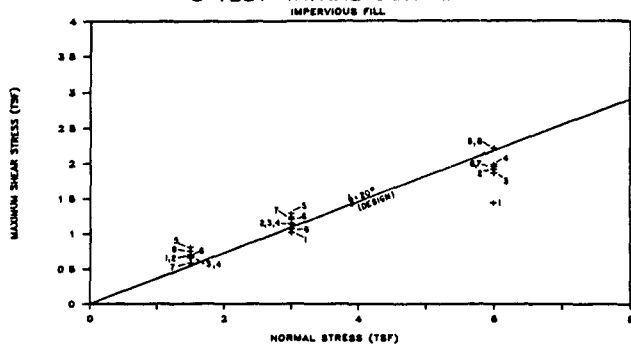
R TEST—INITIAL CONTRACT
RANDOM FILL

Sample No	Class	LL (%)	PI (%)	W_c (%)	U_B (pcf)	e_0	σ'_v (TSF)	σ'_1 (TSF)	p (TSF)	q (TSF)	PLOT SYMBOL
R-1	CH	71	51	30.8	93	.852	0.6	1.66	1.13	0.53	1
				29.6	95	.819	1.4	2.42	2.01	0.61	1
				28.8	96	.796	3.2	5.29	4.25	1.05	1
				25.7	101	.711	5.9	9.29	7.60	1.70	1
R-2	CH	65	45	29.7	94	.802	0.5	1.68	1.09	0.59	2
				28.0	96	.756	1.7	3.60	2.85	0.95	2
				26.5	98	.716	3.0	6.70	4.35	1.35	2
				24.7	101	.667	5.9	10.35	8.13	2.23	2
R-3	CH	66	47	30.8	92	.828	0.4	1.16	0.78	0.38	3
				29.9	93	.804	1.6	3.23	2.42	0.82	3
				28.2	96	.757	2.9	5.04	3.97	1.07	3
				26.6	98	.715	5.9	9.02	7.46	1.56	3
R-4	CH	74	53	30.3	93	.823	0.6	2.31	1.46	0.86	4
				29.4	94	.799	1.7	3.77	2.74	1.04	4
				27.9	97	.759	2.7	4.38	3.54	0.84	4
				27.3	97	.743	5.7	8.27	6.99	1.29	4
R-5	CH	65	46	27.5	97	.750	0.5	1.23	0.87	0.37	5
				26.5	96	.779	1.6	3.20	2.40	0.80	5
				25.7	100	.702	2.9	5.61	4.26	1.36	5
				25.3	101	.691	6.3	9.64	7.97	1.67	5
R-6	CH	65	45	28.5	96	.783	0.5	1.79	1.15	0.65	6
				27.1	98	.746	1.4	3.33	2.37	0.97	6
				25.5	101	.702	3.1	5.57	4.34	1.24	6
				25.6	101	.704	5.9	8.96	7.43	1.53	6
R-7	CH	64	45	28.8	96	.788	0.5	1.66	1.08	0.58	7
				27.7	97	.758	1.4	3.34	2.37	0.97	7
				26.5	99	.729	3.3	6.01	4.66	1.36	7
				25.2	101	.689	5.9	9.73	7.82	1.92	7
R-8	CH	74	52	31.1	91	.869	0.6	1.77	1.19	0.59	8
				30.8	93	.843	1.7	2.75	2.23	0.53	8
				29.0	95	.794	2.9	4.74	3.82	0.92	8
				26.7	99	.730	6.1	8.51	7.31	1.21	8

RELATIONSHIP OF "c" AND "phi" TO K_f
LINE ON p-q DIAGRAMJOE POOL LAKE
MOUNTAIN CREEK, TEXAS
RECORD SAMPLE TEST RESULTS
"R" TRIAXIAL SHEAR TESTS
IMPERVIOUS AND RANDOM FILL
INITIAL CONTRACT

U.S. ARMY ENGINEER DISTRICT, FT WORTH

S TEST—INITIAL CONTRACT

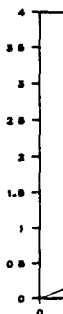


Sample No	Class	LL (%)	PI (%)	W_c (%)	Y_D (%)	e_0	Normal Stress (TSF)	Max. Shear Stress (TSF)	PLOT SYMBOL
1-1	CH	68	46	25.7	100	.713	1.5	0.69	1
				28.0	100	.711	3.0	1.02	1
				25.9	100	.715	6.0	1.44	1
1-2	CH	66	48	24.6	101	.668	1.5	0.69	2
				24.3	102	.663	3.0	1.14	2
				24.8	101	.674	6.0	1.82	2
1-3	CH	64	45	25.2	101	.682	1.5	0.66	3
				25.3	100	.687	3.0	1.15	3
				24.8	101	.673	6.0	1.87	3
1-4	CH	65	45	23.6	99	.721	1.5	0.66	4
				23.3	100	.739	3.0	1.14	4
				23.4	100	.706	6.0	1.99	4
1-5	CH	63	44	24.0	100	.702	1.5	0.81	5
				23.3	100	.704	3.0	1.29	5
				23.5	101	.692	6.0	2.27	5
1-6	CH	63	46	24.0	102	.673	1.5	0.70	6
				24.0	101	.663	3.0	1.21	6
				23.9	102	.671	6.0	1.96	6
1-250	CH	61	44	25.8	99	.686	1.5	0.58	7
				25.6	99	.691	3.0	1.24	7
				25.4	100	.679	6.0	1.96	7
1U-240	CH	55	40	23.5	101	.643	1.5	0.75	8
				24.0	99	.678	3.0	1.07	8
				23.7	101	.642	6.0	2.27	8

LEGEND

Class Sample Classification According to the Unified Soil Classification System

LL Liquid Limit
 PI Plasticity Index
 W_c Water Content
 Y_D Unit Dry Weight
 e_0 Void Ratio before Shear



Sample No

R-1

R-2

R-3

R-4

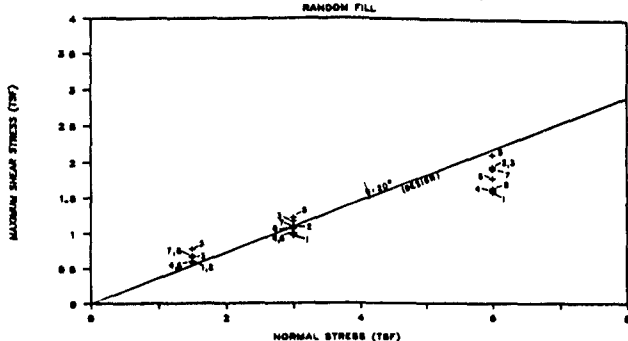
R-5

R-6

R-7

R-8

S TEST-INITIAL CONTRACT



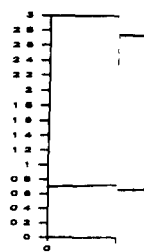
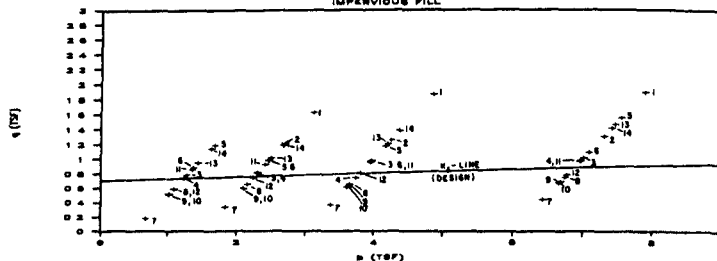
Sample No.	Class	LL (%)	PI (%)	W _c (%)	Y _B (%)	q ₀	Normal Stress (TSF)	Max. Shear Stress (TSF)	PLAT SYMBOL
R-1	CH	71	51	26.1	101	.767	1.5	0.60	1
				26.0	102	.783	3.0	0.98	1
				26.6	101	.777	6.0	1.60	1
R-2	CH	65	45	25.4	101	.663	1.5	0.60	2
				25.9	100	.677	3.0	1.00	2
				25.4	101	.663	6.0	1.62	2
R-3	CH	64	47	26.6	98	.704	1.5	0.64	3
				26.4	97	.716	3.0	1.17	3
				26.1	98	.683	6.0	1.96	3
R-4	CH	74	53	27.8	96	.759	1.5	0.59	4
				28.2	97	.744	3.0	1.00	4
				27.3	97	.743	6.0	1.63	4
R-5	CH	65	46	24.8	95	.791	1.5	0.78	5
				25.7	97	.754	3.0	1.22	5
				26.8	94	.796	6.0	2.12	5
R-6	CH	65	45	23.4	103	.651	1.5	0.59	6
				24.0	102	.674	3.0	1.00	6
				22.7	104	.646	6.0	1.79	6
R-7	CH	64	45	25.7	99	.713	1.5	0.68	7
				26.5	98	.734	3.0	1.10	7
				26.0	98	.714	6.0	1.92	7
R-8	CH	74	52	27.9	95	.790	1.5	0.68	8
				28.6	94	.806	3.0	1.07	8
				27.6	95	.782	6.0	1.66	8

JOE POOL LAKE
MOUNTAIN CREEK, TEXAS
RECORD SAMPLE TEST RESULTS
"S" DIRECT SHEAR TESTS
IMPERVIOUS AND RANDOM FILL
INITIAL CONTRACT

U.S. ARMY ENGINEER DISTRICT, FT. WORTH

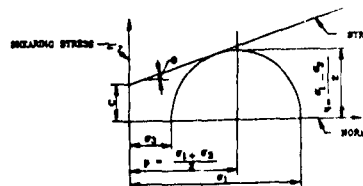
Q TEST-COMPLETION CONTRACT

IMPERVIOUS FILL

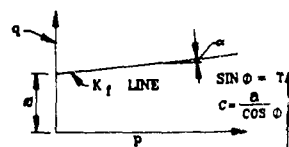


Sample No.	Class	LL (%)	PI (%)	W _c (%)	Y _d (%)	S _d (%)	R _d (%)	σ ₁ (TSF)	σ ₃ (TSF)	P (TSF)	q (TSF)	PLOT SYMBOL
PR-1	CH	74	54	25.2	100	95	.74	1.5	4.75	3.13	1.63	1
				25.8	97	98	.8	3.0	6.74	4.87	1.87	1
				27.	99	98	.77	6.0	9.79	7.90	1.90	1
PR-3	CH	69	50	25	100	94	.75	1.5	3.91	2.71	1.21	2
				25.1	102	97	.72	3.0	5.52	4.26	1.26	2
				25.6	102	99	.73	6.0	8.62	7.31	1.31	2
PR-6	CH	60	49	29.4	92	95	.849	0.5	2.05	1.28	0.78	3
				29.7	93	94	.836	1.5	3.14	2.32	0.82	3
				29.6	92	95	.841	3.0	4.94	3.87	0.87	3
				28.8	93	94	.832	6.0	8.03	7.02	1.02	3
PR-7	CH	65	46	27.4	95	95	.784	0.5	1.98	1.24	0.74	4
				28.4	93	95	.810	1.5	3.11	2.31	0.81	4
				27.7	95	96	.779	3.0	4.47	3.74	0.74	4
				27.7	95	96	.782	6.0	7.95	6.90	0.90	4
PR-8	CH	70	50	26.4	95	93	.770	0.5	2.87	1.89	1.19	5
				28.9	93	96	.817	1.5	3.45	2.48	0.90	5
				28.0	94	96	.787	3.0	5.36	4.18	1.18	5
				26.5	95	93	.769	6.0	9.11	7.56	1.56	5
PR-10	CH	56	38	25.3	98	93	.749	0.5	2.26	1.38	0.88	6
				24.7	98	92	.741	1.5	3.48	2.49	0.99	6
				25.1	99	93	.739	3.0	4.96	3.96	0.96	6
				25.0	98	92	.749	6.0	8.17	7.09	1.09	6
PR-12	CL	49	34	33.4	85	93	.961	0.5	0.85	0.68	0.18	7
				29.3	91	93	.843	1.5	2.17	1.84	0.34	7
				28.8	92	94	.823	3.0	3.74	3.27	0.37	7
				26.1	93	89	.789	6.0	6.87	6.44	0.44	7
PR-13	CH	68	47	27.9	94	95	.787	0.5	1.68	1.09	0.59	8
				26.9	95	94	.780	1.5	2.82	2.16	0.66	8
				27.5	94	93	.802	3.0	4.30	3.65	0.65	8
				26.4	95	92	.773	6.0	7.50	6.75	0.75	8
PR-14	CH	62	43	28.0	94	94	.805	0.5	1.52	1.01	0.51	9
				26.3	93	95	.807	1.5	2.70	2.10	0.60	9
				24.7	99	94	.683	1.5	4.91	3.61	0.61	10
				27.3	94	94	.793	3.0	4.26	3.63	0.63	9
				27.9	94	95	.787	6.0	7.37	6.69	0.69	9
PR-16	CH	54	40	24.9	98	94	.714	0.5	1.53	1.02	0.52	10
				24.7	99	94	.683	1.5	3.35	2.43	0.93	11
				22.9	101	93	.663	3.0	4.21	3.61	0.61	10
				22.2	101	92	.652	6.0	7.34	6.67	0.67	10
PR-17	CH	63	47	24.3	101	97	.682	0.5	2.21	1.36	0.86	11
				23.7	101	96	.672	1.5	3.35	2.43	0.93	11
				23.9	101	96	.673	3.0	4.91	3.61	0.61	11
				24.2	101	97	.680	6.0	7.93	6.97	0.97	11
PR-18	CH	39	26	21.9	103	95	.618	0.5	1.67	1.09	0.59	12
				21.4	106	100	.574	1.5	2.99	2.25	0.75	12
				21.2	105	96	.591	3.0	4.61	3.81	0.81	12
				22.1	104	98	.600	6.0	7.56	6.78	0.78	12
PR-23	CH	57	39	24.7	100	98	.682	0.5	2.39	1.45	0.95	13
				23.5	102	98	.651	1.5	3.54	2.52	1.02	13
				24.8	101	99	.678	3.0	5.41	4.21	1.21	13
				23.7	102	99	.650	6.0	8.93	7.47	1.47	13
PR-24	CH	66	45	25.2	99	98	.683	0.5	2.77	1.64	1.14	14
				25.3	98	98	.692	1.5	3.87	2.69	1.19	14
				24.7	100	98	.671	3.0	5.77	4.39	1.39	14
				25.0	100	100	.671	6.0	8.84	7.42	1.42	14

Sample No.	Class	Symbol
PR-2	CH	1
PR-4	CH	2
PR-5	CH	3
PR-9	CH	4
PR-11	CH	5
PR-15	CH	6
PR-22	CH	7

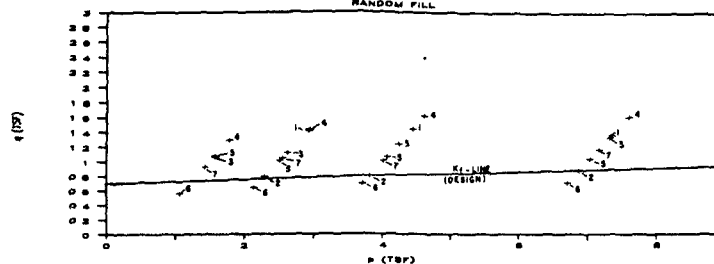


DETERMINATION OF "p" AND "q" FROM TRIAXIAL TEST USING MOHR'S DIAGRAM

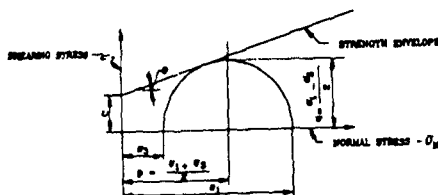


RELATIONSHIP OF "c" AND "φ" TO K₁ LINE ON p-q DIAGRAM

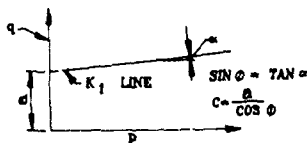
Q TEST-COMPLETION CONTRACT



Sample No	Class	LL (%)	PI (%)	Wc (%)	Y _D (%)	S ₀ (%)	e ₀	σ ₃ (TSF)	σ ₁ (TSF)	p (TSF)	q (TSF)	PLOT SYMBOL
PR-2	CH	72	52	24.8	100	95	.73	1.5	4.33	2.92	1.42	1
				24.6	101	95	.73	3.0	5.88	4.44	1.44	1
				24.7	102	96	.71	6.0	8.72	7.36	1.36	1
PR-4	CH	68	50	27.8	97	99	.78	1.5	3.07	2.29	0.79	2
				27	99	100	.75	3.0	4.59	3.80	0.80	2
				26.1	102	100	.69	6.0	7.76	6.80	0.80	2
PR-5	CH	66	42	28.9	92	94	.835	0.5	2.64	1.57	1.07	3
				29.2	92	94	.838	1.5	3.74	2.62	1.12	3
				29.2	92	94	.838	3.0	5.47	4.24	1.24	3
				29.4	92	95	.837	6.0	8.65	7.33	1.33	3
PR-9	CH	55	36	23.1	98	87	.728	0.5	3.08	1.79	1.29	4
				22.9	100	87	.708	1.5	4.38	2.94	1.44	4
				23.5	99	89	.718	3.0	6.23	4.62	1.62	4
				23.3	99	89	.711	6.0	9.21	7.61	1.61	4
PR-11	CH	61	41	23.6	98	89	.713	0.5	2.65	1.58	1.08	5
				25.7	97	95	.732	1.5	3.82	2.51	1.01	5
				25.0	98	95	.711	3.0	5.12	4.06	1.06	5
				25.2	98	96	.710	6.0	8.07	7.04	1.04	5
PR-15	CH	50	36	23.2	99	91	.686	0.5	1.63	1.07	0.57	6
				23.4	99	92	.689	1.5	2.77	2.14	0.64	6
				22.4	101	91	.663	3.0	4.37	3.69	0.69	6
				22.8	101	92	.667	6.0	7.42	6.71	0.71	6
PR-22	CH	61	45	22.2	103	97	.615	0.5	2.35	1.43	0.93	7
				21.6	105	96	.590	1.5	3.60	2.55	1.05	7
				21.7	105	97	.598	3.0	5.01	4.01	1.01	7
				21.3	104	95	.599	6.0	8.33	7.17	1.17	7



DETERMINATION OF "p" AND "q" FROM TRIAXIAL TEST USING MOHR'S DIAGRAM



RELATIONSHIP OF "c" AND "φ" TO K_f LINE ON p-q DIAGRAM

LEGEND

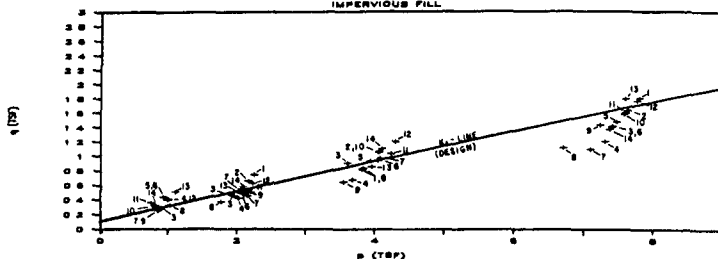
Class	Sample Classification According to the Unified Soil Classification System
LL	Liquid Limit
PI	Plasticity Index
Wc	Water Content
Y _D	Unit Dry Weight
S ₀	Saturation Before Shear
e ₀	Void Ratio Before Shear
σ ₃	Minor Principal Stress
σ ₁	Major Principal Stress

JOE POOL LAKE
MOUNTAIN CREEK, TEXAS
RECORD SAMPLE TEST RESULTS
"Q" TRIAXIAL SHEAR TESTS
IMPERVIOUS AND RANDOM FILL
COMPLETION CONTRACT

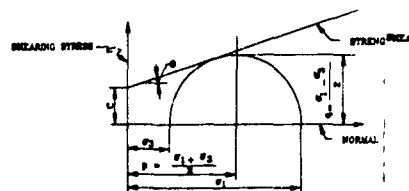
US ARMY ENGINEER DISTRICT, FT WORTH

CORPS OF ENGINEERS

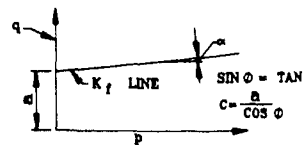
R TEST—COMPLETION CONTRACT IMPERVIOUS FILL



Sample No	Class	LL (%)	PI (%)	Mc (%)	Y _D (pcf)	e ₀	σ ₃ (TSF)	σ ₁ (TSF)	P (TSF)	q (TSF)	PLOT SYMBOL
PR-1	CH	74	54	28.2	99	.76	1.5	2.99	2.25	0.75	1
				28.8	97	.8	3.0	4.68	3.84	0.84	1
				26.4	104	.68	6.0	9.61	7.81	1.81	1
PR-3	CH	69	50	27.7	101	.73	1.5	2.81	2.16	0.66	2
				25.3	106	.66	3.0	5.14	4.07	1.07	2
				24.8	106	.65	6.0	9.27	7.64	1.64	2
PR-6	CH	68	49	32.7	90	.895	0.6	1.20	0.90	0.30	3
				27.1	98	.742	1.5	2.41	1.96	0.46	3
				24.1	103	.659	3.1	4.82	3.96	0.86	3
PR-7	CH	65	46	25.8	100	.708	6.0	8.81	7.41	1.41	3
				29.9	94	.813	0.6	1.40	1.00	0.40	4
				29.0	95	.789	1.6	2.46	2.03	0.43	4
PR-8	CH	70	50	27.2	98	.738	3.0	4.35	3.68	0.68	4
				26.6	99	.723	6.1	8.51	7.31	1.21	4
				30.8	92	.833	0.5	1.38	0.94	0.44	5
PR-10	CH	56	38	30.1	93	.826	1.4	2.37	1.89	0.49	5
				29.5	94	.798	3.0	4.87	3.94	0.94	5
				27.5	97	.744	6.0	8.95	7.48	1.48	5
PR-12	CL	49	34	27.7	98	.764	0.5	1.37	0.94	0.44	6
				26.7	99	.736	1.5	2.62	2.06	0.56	6
				26.0	100	.718	3.1	4.99	4.05	0.95	6
PR-13	CH	68	47	23.1	105	.636	6.0	8.84	7.42	1.42	6
				26.5	98	.713	0.6	1.14	0.87	0.27	7
				24.7	101	.665	1.6	2.58	2.09	0.49	7
PR-14	CH	62	43	23.5	103	.632	3.1	5.06	4.08	0.98	7
				22.9	104	.616	6.0	8.19	7.10	1.10	7
				29.6	94	.804	0.7	1.36	1.03	0.33	8
PR-16	CH	54	40	29.5	94	.803	1.4	2.16	1.78	0.38	8
				26.6	99	.723	3.0	4.64	3.82	0.82	8
				24.8	101	.674	5.6	7.84	6.72	1.12	8
PR-17	CH	63	47	29.9	94	.813	0.6	1.12	0.86	0.26	9
				28.6	95	.778	1.7	2.61	2.16	0.46	9
				28.2	96	.767	2.9	4.19	3.55	0.65	9
PR-18	CL	39	26	25.2	101	.684	5.8	8.68	7.24	1.44	9
				24.6	101	.663	0.5	1.11	0.81	0.31	10
				22.8	104	.614	1.7	2.72	2.21	0.51	10
PR-23	CH	57	39	20.0	109	.540	3.0	5.11	4.06	1.06	10
				19.2	111	.518	6.0	9.18	7.59	1.59	10
				26.6	99	.725	0.4	1.12	0.76	0.36	11
PR-24	CH	66	45	25.2	101	.687	1.6	2.68	2.14	0.54	11
				23.9	103	.651	3.2	5.28	4.24	1.04	11
				21.7	107	.591	6.0	9.21	7.61	1.61	11
PR-25	CH	57	39	22.0	105	.590	0.6	1.41	1.01	0.41	12
				21.1	107	.564	1.6	2.85	2.23	0.63	12
				19.8	109	.530	3.1	5.52	4.31	1.21	12
PR-26	CH	66	45	19.2	110	.515	6.0	9.53	7.77	1.77	12
				26.5	99	.721	0.6	1.62	1.11	0.51	13
				25.3	101	.688	1.5	2.53	2.02	0.52	13
PR-27	CH	66	45	25.0	101	.681	2.7	4.51	3.61	0.91	13
				23.4	104	.635	5.8	9.39	7.60	1.80	13
				30.7	92	.822	0.5	1.16	0.83	0.33	14
PR-28	CH	66	45	29.1	94	.780	1.5	2.68	2.09	0.59	14
				25.7	99	.688	3.0	5.22	4.11	1.11	14
				31.7	90	.850	6.0	8.76	7.38	1.38	14



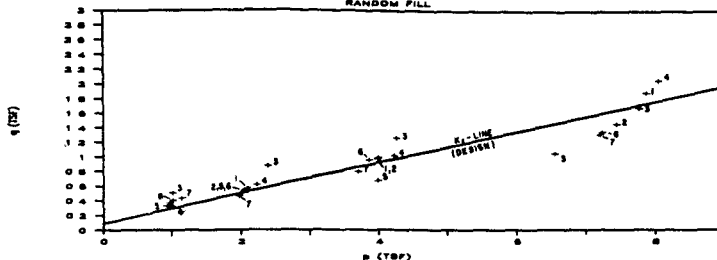
DETERMINATION OF "p" AND "q" FROM TRIAXIAL TEST USING MOHR'S DIAGRAM



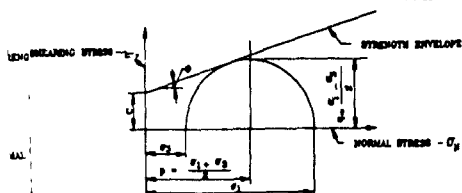
RELATIONSHIP OF "c" AND "phi" TO K_f LINE ON p-q DIAGRAM

R TEST-COMPLETION CONTRACT

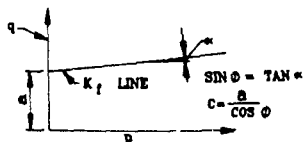
RANDOM FILL



Sample No	Class	LL (%)	PI (%)	Wc (%)	Yd (%)	So	σ ₃ (TSF)	σ ₁ (TSF)	P (TSF)	q (TSF)	PLOT SYMBOL
PR-2	CH	72	52	26.2	103	.69	1.5	2.66	2.08	0.58	1
				25.2	107	.64	3.0	4.97	3.99	0.99	1
				23.8	109	.6	6.0	9.75	7.88	1.88	1
PR-4	CH	68	50	29.3	100	.74	1.5	2.60	2.05	0.55	2
				29.1	103	.69	3.0	4.95	3.98	0.98	2
				27.2	105	.64	6.0	8.89	7.45	1.45	2
PR-5	CH	66	42	31.9	91	.868	0.5	1.51	1.01	0.51	3
				30.3	93	.825	1.5	3.25	2.38	0.88	3
				28.9	95	.786	3.0	5.51	4.26	1.26	3
				28.5	96	.775	6.1	9.43	7.77	1.67	3
PR-9	CH	55	36	27.5	98	.752	0.6	1.34	0.97	0.37	4
				25.7	100	.704	1.6	2.84	2.22	0.62	4
				25.4	101	.696	3.2	5.23	4.22	1.02	4
				22.9	105	.626	6.0	10.10	8.05	2.05	4
PR-11	CH	61	41	26.7	98	.722	0.6	1.25	0.93	0.33	5
				25.6	100	.692	1.5	2.58	2.04	0.54	5
				25.5	100	.691	3.3	4.85	3.98	0.88	5
				24.7	101	.670	5.5	7.60	6.55	1.05	5
PR-15	CH	50	36	24.7	101	.665	0.6	1.42	1.01	0.41	6
				23.4	103	.632	1.5	2.58	2.04	0.54	6
				22.0	106	.592	2.9	4.82	3.86	0.96	6
				21.1	107	.569	5.9	8.57	7.24	1.34	6
PR-22	CH	61	45	24.4	101	.656	0.7	1.57	1.14	0.44	7
				24.1	102	.649	1.5	2.44	1.97	0.47	7
				23.4	103	.629	2.9	4.49	3.70	0.80	7
				22.9	104	.615	5.9	8.52	7.21	1.31	7



DETERMINATION OF "p" AND "q" FROM TRIAXIAL TEST USING MOHR'S DIAGRAM



RELATIONSHIP OF "c" AND "φ" TO K_f LINE ON p-q DIAGRAM

LEGEND

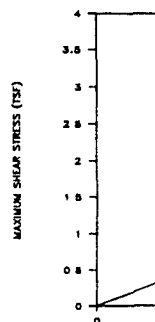
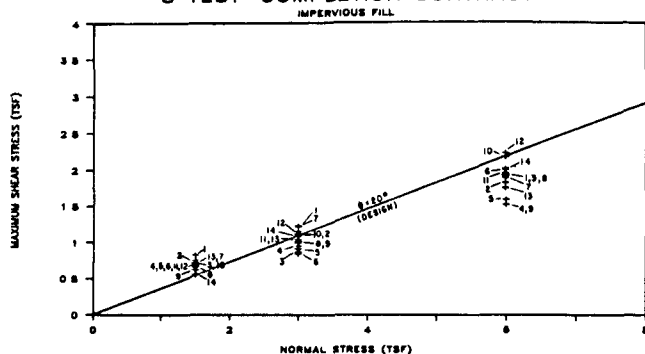
Class	Sample Classification According to the Unified Soil Classification System
LL	Liquid Limit
PI	Plasticity Index
Wc	Water Content
Yd	Unit Dry Weight
So	Saturation Before Shear
So	Yield Ratio Before Shear
σ ₁	Minor Principal Stress
σ ₃	Major Principal Stress

JOE POOL LAKE
MOUNTAIN CREEK, TEXAS
RECORD SAMPLE TEST RESULTS
"R" TRIAXIAL SHEAR TESTS
IMPERVIOUS AND RANDOM FILL
COMPLETION CONTRACT

U.S. ARMY ENGINEER DISTRICT, FT WORTH

CORPS OF ENGINEERS

S TEST-COMPLETION CONTRACT



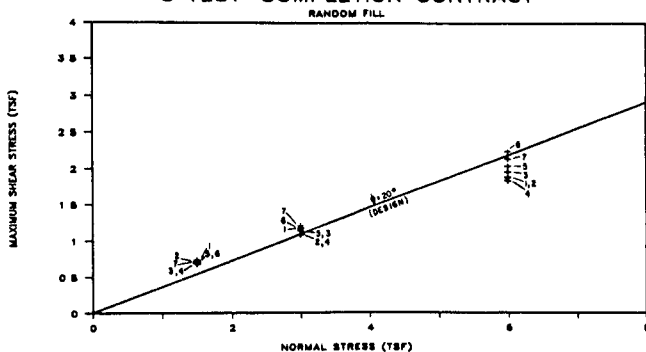
Sample No	Class	LL (%)	PI (%)	Mc (%)	γ_D (pcf)	e_0	Normal Stress (TSF)	Max Shear Stress (TSF)	PLOT SYMBOL
PR-1	CH	74	54	26.2 25.2 26.1	98 99 98	.75 .73 .72	1.5 3.0 6.0	0.83 1.23 1.94	1 1 1
PR-3	CH	69	50	25.7 25.7 25.4	102 100 101	.72 .72 .66	1.5 3.0 6.0	0.75 1.12 1.82	2 2 2
PR-6	CH	60	49	27.5 26.0 25.1	97 100 99	.761 .706 .717	1.5 3.0 6.0	0.71 0.87 1.93	3 3 3
PR-7	CH	65	46	27.5 27.9 28.4	97 96 95	.747 .758 .772	1.5 3.0 6.0	0.68 0.95 1.52	4 4 4
PR-8	CH	70	50	27.1 26.7 26.9	97 98 97	.728 .722 .729	1.5 3.0 6.0	0.68 0.91 1.59	5 5 5
PR-10	CH	56	38	24.6 25.1 25.0	102 102 102	.688 .679 .686	1.5 3.0 6.0	0.68 0.85 2.00	6 6 6
PR-12	CL	49	34	26.0 25.8 24.0	98 99 100	.705 .689 .674	1.5 3.0 6.0	0.72 1.22 1.89	7 7 7
PR-13	CH	68	47	27.5 27.9 27.4	97 96 97	.743 .753 .738	1.5 3.0 6.0	0.66 1.01 1.92	8 8 8
PR-14	CH	62	43	27.5 27.3 27.0	97 97 98	.741 .737 .732	1.5 3.0 6.0	0.62 1.00 1.52	9 9 9
PR-16	CH	54	40	22.1 23.6 21.4	105 100 107	.603 .670 .574	1.5 3.0 6.0	0.70 1.11 2.16	10 10 10
PR-17	CH	63	47	23.2 24.4 24.0	103 100 103	.646 .688 .652	1.5 3.0 6.0	0.68 1.04 1.96	11 11 11
PR-18	CL	39	26	22.7 22.4 20.6	103 103 106	.623 .609 .568	1.5 3.0 6.0	0.68 1.15 2.23	12 12 12
PR-23	CH	56	39	24.8 25.5 25.5	100 99 100	.688 .699 .697	1.5 3.0 6.0	0.72 1.04 1.75	13 13 13
PR-24	CH	66	45	25.4 24.2 24.1	98 99 99	.703 .683 .683	1.5 3.0 6.0	0.56 1.09 2.02	14 14 14

LEGEND

Class	Sample Classification According to Soil Classification System
LL	Liquid Limit
PI	Plasticity Index
Mc	Water Content
γ_D	Unit Dry Weight
e_0	Void Ratio before Shear

Sample No	Class
PR-2	CH
PR-4	CH
PR-5	CH
PR-9	CH
PR-11	CH
PR-15	CH
PR-22	CH

S TEST-COMPLETION CONTRACT



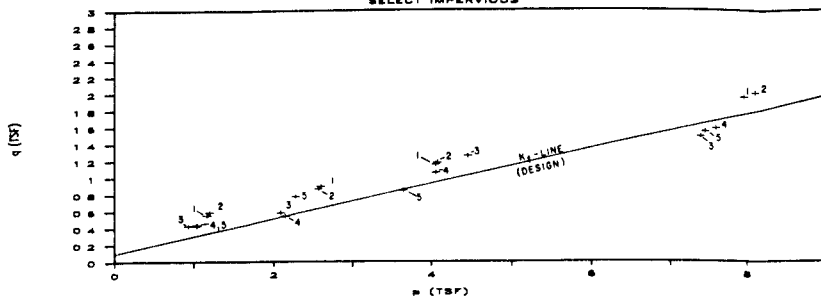
Sample No	Class	LL (%)	PI (%)	W_c (%)	V_D (pcf)	e_0	Normal Stress (TSF)	Max. Shear Stress (TSF)	PLOT SYMBOL
PR-2	CH	72	52	22.2	105	.66	1.5	0.75	1
				22.4	105	.67	3.0	1.17	1
				23.0	105	.66	6.0	1.88	1
PR-4	CH	68	50	27.1	100	.73	1.5	0.72	2
				27.2	101	.71	3.0	1.09	2
				28.0	96	.8	6.0	1.89	2
PR-5	CH	66	42	30.3	93	.824	1.5	0.69	3
				30.3	93	.824	3.0	1.14	3
				29.0	94	.789	6.0	1.96	3
PR-9	CH	55	36	24.0	101	.680	1.5	0.69	4
				24.1	101	.692	3.0	1.09	4
				23.6	102	.661	6.0	1.84	4
PR-11	CH	61	41	22.3	105	.608	1.5	0.74	5
				23.0	102	.644	3.0	1.14	5
				22.0	105	.599	6.0	2.04	5
PK-15	CH	50	36	21.4	107	.574	1.5	0.73	6
				21.2	107	.567	3.0	1.18	6
				20.3	108	.550	6.0	2.24	6
PR-22	CH	61	45	22.2	104	.608	1.5	0.70	7
				21.2	105	.588	3.0	1.21	7
				21.5	105	.586	6.0	2.14	7

LEGEND

Class	Sample Classification According to the Unified Soil Classification System
LL	Liquid Limit
PI	Plasticity Index
W_c	Water Content
V_D	Unit Dry Weight
e_0	Void Ratio before Shear

JOE POOL LAKE
MOUNTAIN CREEK, TEXAS
RECORD SAMPLE TEST RESULTS
"S" DIRECT SHEAR TESTS
IMPERVIOUS AND RANDOM FILL
COMPLETION CONTRACT

U.S. ARMY ENGINEER DISTRICT, FT. WORTH

R TEST-INITIAL & COMPLETION CONTRACT
SELECT IMPERVIOUS

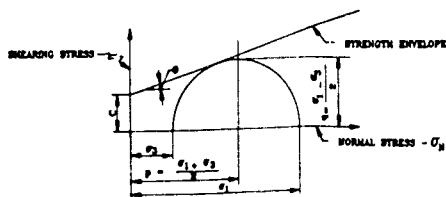
Sample No	Class	LL (%)	PI (%)	W _c (%)	Y _D (pcf)	e ₀	σ ₃ (TSF)	σ ₁ (TSF)	P (TSF)	q (TSF)	PLOT SYMBOL
SI-1	CH	57	41	24.9	101	.678	0.6	1.72	1.16	0.56	1
				23.4	104	.635	1.7	3.49	2.60	0.90	1
				22.2	106	.603	2.9	5.22	4.06	1.16	1
				20.3	109	.551	6.0	9.91	7.96	1.96	1
SI-2	CL	40	27	19.7	110	.532	0.6	1.77	1.19	0.59	2
				18.2	113	.491	1.7	3.43	2.57	0.87	2
				17.2	115	.464	2.9	5.26	4.06	1.18	2
				15.9	118	.430	6.1	10.11	8.11	2.01	2
PR-19	CH	62	48	25.4	101	.694	0.5	1.35	0.93	0.43	3
				24.7	102	.675	1.5	2.67	2.09	0.59	3
				23.1	104	.631	3.2	5.71	4.46	1.26	3
				22.1	106	.602	5.9	8.88	7.39	1.49	3
PR-20	CH	70	50	23.8	102	.636	0.6	1.45	1.03	0.43	4
				23.1	103	.615	1.6	2.69	2.15	0.55	4
				23.5	102	.626	3.0	5.12	4.06	1.06	4
				20.5	108	.546	6.0	9.18	7.59	1.59	4
PR-21	CH	51	37	26.0	100	.709	0.6	1.46	1.04	0.44	5
				24.9	101	.680	1.5	3.05	2.28	0.76	5
				24.6	102	.676	2.8	4.49	3.65	0.85	5
				20.5	109	.560	5.9	6.99	7.45	1.55	5

LEGEND

Class Sample Classification According to the Unified Soil Classification System

LL Liquid Limit

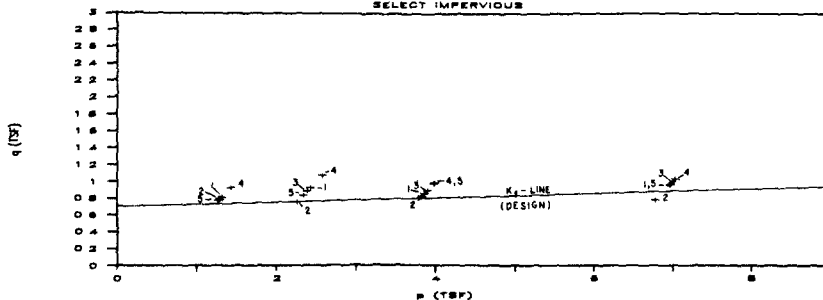
PI Plasticity Index

W_c Water ContentY_D Unit Dry Weighte₀ Saturation Before Shearσ₃ Minor Principal Stressσ₁ Major Principal Stress

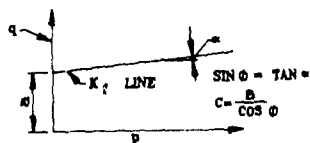
TRACT

Q TEST-INITIAL & COMPLETION CONTRACT

SELECT IMPERVIOUS



Sample No	Class	LL (%)	PI (%)	W _c (%)	V _D (pcf)	S _o (%)	W _o	C _u (TSF)	C _v (TSF)	P (TSF)	q (TSF)	PLOT SYMBOL
S1-1	CH	57	41	22.8	101	93	.665	0.5	2.13	1.32	0.82	1
1				21.9	103	93	.640	1.5	3.36	2.43	0.93	1
1				22.8	102	95	.652	3.0	4.72	3.86	0.86	1
1				22.5	103	94	.646	6.0	7.92	6.96	0.96	1
S1-2	CL	40	27	17.8	109	90	.534	0.5	2.07	1.29	0.79	2
2				18.0	109	89	.542	1.5	3.02	2.26	0.76	2
2				18.4	108	90	.550	3.0	4.85	3.83	0.83	2
2				18.0	109	90	.538	6.0	7.55	6.78	0.78	2
PR-19	CH	62	48	23.9	103	100	.650	1.5	3.27	2.39	0.89	3
3				22.8	104	98	.631	3.0	4.80	3.90	0.90	3
3				23.1	104	99	.633	6.0	8.00	7.00	1.00	3
PR-20	CH	70	55	23.9	101	100	.637	0.5	2.35	1.43	0.93	4
4				22.9	102	98	.624	1.5	3.85	2.56	1.06	4
4				23.4	102	99	.626	3.0	4.96	3.98	0.98	4
4				23.0	103	99	.616	6.0	8.06	7.03	1.03	4
PR-21	CH	51	37	24.1	100	95	.687	0.5	2.04	1.27	0.77	5
5				23.7	101	95	.679	1.5	3.17	2.34	0.84	5
5				22.6	102	93	.641	3.0	4.96	3.99	0.99	5
5				23.1	102	94	.669	6.0	7.93	6.97	0.97	5

RELATIONSHIP OF "c" AND "phi" TO K_f LINE ON p-q DIAGRAM

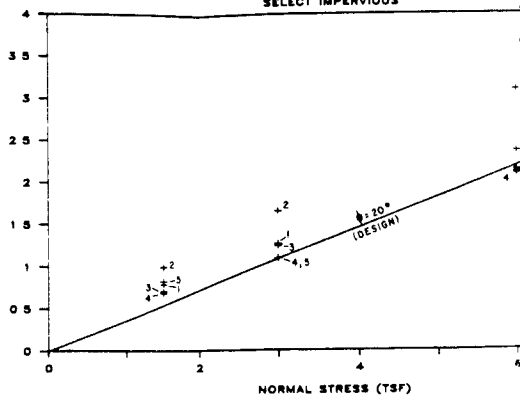
JOE POOL LAKE
MOUNTAIN CREEK, TEXAS
RECORD SAMPLE TEST RESULTS
"Q" AND "R" TRIAXIAL SHEAR TESTS
SELECT IMPERVIOUS FILL
INITIAL AND COMPLETION CONTRACTS
U.S. ARMY ENGINEER DISTRICT, FT. WORTH

CORPS OF ENGINEERS

S TEST-INITIAL & COMPLETION CO

SELECT IMPERVIOUS

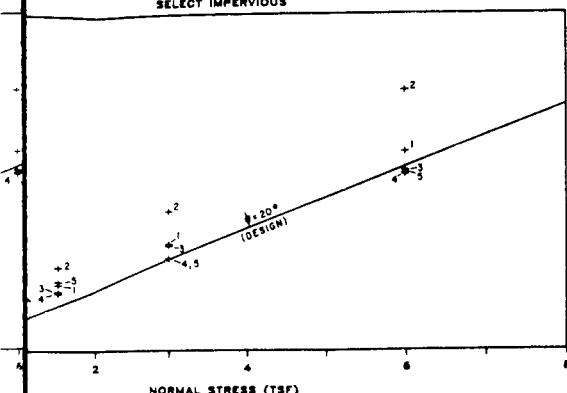
MAXIMUM SHEAR STRESS (TSF)



NORMAL STRESS (TSF)

Sample No	Class	LL (%)	PI (%)	W _c (%)	Y _D (pcf)	e ₀	Normal Stress (TSF)
SI-1	CH	57	41	21.5	106	.587	1.5
				21.6	106	.593	3.0
				22.0	106	.588	6.0
SI-2	CL	40	27	17.0	112	.498	1.5
				15.6	116	.452	3.0
				17.3	112	.500	6.0
PR-19	CH	62	48	22.6	105	.621	1.5
				21.2	107	.585	3.0
				22.2	105	.610	6.0
PR-20	CH	70	55	22.6	104	.601	1.5
				22.7	102	.625	3.0
				22.6	104	.599	6.0
PR-21	CH	51	37	22.4	106	.606	1.5
				23.0	103	.651	3.0
				22.0	106	.599	6.0

INITIAL & COMPLETION CONTRACT SELECT IMPERVIOUS



LL (%)	PI (%)	Mc (%)	Y _D (pcf)	e ₀	Normal Stress (TSF)	Max. Shear Stress (TSF)	PLOT SYMBOL
57	41	21.5	106	.587	1.5	0.80	1
		21.6	106	.592	3.0	1.27	1
		22.0	106	.588	6.0	2.36	1
40	27	17.0	112	.498	1.5	1.00	2
		15.6	116	.452	3.0	1.66	2
		17.3	112	.500	6.0	3.09	2
62	48	22.6	105	.621	1.5	0.71	3
		21.2	107	.585	3.0	1.25	3
		22.2	105	.610	6.0	2.14	3
70	55	22.6	104	.601	1.5	0.69	4
		22.7	102	.625	3.0	1.10	4
		22.6	104	.599	6.0	2.09	4
51	37	22.4	106	.606	1.5	0.83	5
		23.0	103	.651	3.0	1.10	5
		22.0	106	.599	6.0	2.11	5

LEGEND

Class Sample Classification According to the unified Soil Classification System

LL Liquid Limit

PI Plasticity Index

Mc Water Content

Y_D Unit Dry Weight

e₀ Void Ratio before Shear

JOE POOL LAKE
MOUNTAIN CREEK, TEXAS
RECORD SAMPLE TEST RESULTS
"S" DIRECT SHEAR TESTS
SELECT IMPERVIOUS FILL
INITIAL AND COMPLETION CONTRACTS
U.S. ARMY ENGINEER DISTRICT, FT WORTH

CORPS OF ENGINEERS

JOE POOL - COMPLETION CONTRACT - LABORATORY DATA FROM RECORD SAMPLE

Sample No	Zone	Sample Date	Test Date	Hub Station	Offset Hub CL (ft)	Flow (cfs)	Class	LL (ft)	PL (ft)	MS (ft)	W _c (ft)	Y _D (PCF)	Hub Station
PR-1*	Impervious	8/82	3/83	22+00	50 D/S	494	CH	74	20	--	26	97	22+00
PR-2*	Random	12/82	1/83	43+00	150 D/S	514	CH	72	20	--	24	102	43+00
PR-3*	Impervious	12/82	3/83	15+00	50 D/S	505	CH	69	19	--	25	99	15+00
PR-4*	Random	1/83	3/83	38+00	150 D/S	517	CH	68	18	--	28	97	38+00
PR-5	Random	3/83	8/83	23+00	50 D/S	520	CH	66	24	20	29	96	23+00
PR-6	Impervious	3/83	8/83	59+00	50 D/S	674	CH	68	19	19	30	96	59+00
PR-7	Impervious	6/83	11/83	35+00	0	531	CH	65	19	22	28	96	35+00
PR-8	Impervious	7/83	11/83	13+00	0	538	CH	70	20	23	28	97	13+00
PR-9	Random	7/83	11/83	69+00	200 D/S	491	CH	55	19	20	24	101	69+00
PR-10	Impervious	7/83	12/83	67+00	50 D/S	497	CH	56	18	20	25	101	67+00
PR-11	Random	10/83	4/84	58+00	170 D/S	509	CH	61	20	24	24	100	58+00
PR-12	Impervious	12/83	4/84	175+00	0	548	CL	49	15	18	26	97	175+00
PR-13	Impervious	1/84	8/84	69+00	0	531	CH	68	21	20	27	96	69+00
PR-14	Impervious	1/84	10/84	75+00	0	532	CH	62	19	19	28	96	75+00
PR-15	Random	2/84	10/84	146+00	50 U/S	542	CH	50	14	17	22	105	146+00
PR-16	Impervious	2/84	11/84	150+00	0	543	CH	54	14	14	23	104	150+00
PR-17	Impervious	5/84	3/85	94+00	0	546	CH	63	16	19	24	101	94+00
PR-18	Impervious	5/84	1/85	125+00	0	548	CL	39	13	13	21	106	125+00
PR-19	Set Imp	5/84	3/85	94+00	50 U/S	547	CH	62	14	19	23	102	94+00
PR-20	Set Imp	8/84	3/85	99+00	0	549	CH	70	15	19	23	103	99+00
PR-21	Set Imp	8/84	6/85	100+00	0	549	CH	51	14	15	23	102	100+00
PR-22	Random	9/84	1/86	113+00	100 D/S	535	CH	61	14	21	27	104	113+00
PR-23	Impervious	3/85	3/86	50+00	50 U/S	494	CH	57	18	14	25	100	50+00
PR-24	Impervious	8/85	3/86	48+00	0	545	CH	66	21	17	25	99	48+00

* MMD Lab

** Compaction Test Result Redrawn Based on Engineering Judgment

JOE POOL - INITIAL CONTRACT - LABORATORY DATA FROM RECORD SAMPLE

Sample No	Zone	Sample Date	Test Date	Emp Station	Offset Emp CL (ft)	Flow (cfs)	Class	LL (ft)	PL (ft)	MS (ft)	W _c (ft)	Y _D (PCF)	G _s	Emp Station
I-1	Impervious	11/80	8/81	35+00	50 U/S	510	CH	68	22	22	26	98	2.75	35+00
I-2	Impervious	10/80	7/81	36+00	0	498	CH	66	18	19	25	101	2.72	36+00
I-3	Impervious	8/80	12/80	43+00	50 D/S	488	CH	64	19	19	28	97	2.73	43+00
I-4	Impervious	8/80	11/80	37+00	0	483	CH	65	20	20	26	97	2.73	37+00
I-5	Impervious	8/80	11/80	45+00	50 U/S	481	CH	63	19	18	25	100	2.74	45+00
I-6	Impervious	7/80	10/80	39+00	50 D/S	475	CH	63	17	18	25	101	2.74	39+00
I-250	Impervious	10/81	7/82	23+00*	50 LT*	483	CH	61	17	20	25	101	2.70	23+00
IU-240	Impervious	9/81	5/82	25+00*	50 RT*	471	CH	55	15	19	23	99	2.87	25+00
R-1	Random	10/80	7/81	36+00	150 U/S	498	CH	71	20	20	29	96	2.77	36+00
R-2	Random	7/80	10/80	42+00	200 U/S	478	CH	65	20	23	25	96	2.76	42+00
R-3	Random	7/80	10/80	44+00	100 U/S	476	CH	66	19	22	27	97	2.69	44+00
R-4	Random	10/80	7/81	33+00	100 D/S	506	CH	74	21	20	28	96	2.77	33+00
R-5	Random	8/80	12/80	32+00	200 D/S	488	CH	65	19	20	26	97	2.73	32+00
R-6	Random	8/80	11/80	39+00	100 D/S	481	CH	65	20	18	24	100	2.75	39+00
R-7	Random	8/80	11/80	42+00	200 D/S	478	CH	64	19	19	26	100	2.74	42+00
R-8	Random	11/80	7/81	40+00	100 U/S	508	CH	74	22	20	29	95	2.74	40+00
SI-1	Set Imp	4/81	8/81	97+00	0	545	CH	57	16	18	22	104	2.77	97+00
SI-2	Set Imp	2/81	8/81	100+00	50 D/S	534	CL	40	13	16	17	112	2.76	100+00

* STATION AND OFFSET ARE WITH RESPECT TO THE OUTLET WORKS CHANNEL

JOE POOL - COMPLETION CONTRACT - LABORATORY DATA FROM RECORD SAMPLES

Station	Offset Sub. CL (ft)	Elev (ft)	Class	LL (ft)	PL (ft)	ML (ft)	HL (ft)	W (PCF)	G _s	% Gravel	% Sand	% Fines
22+00	50 U/S	494	CH	74	20	--	26	97	2.79	0	5	95
43+00	150 D/S	514	CH	72	20	--	24	102	2.81	3	7	90
15+00	50 D/S	505	CH	69	19	--	25	99	2.81	0	10	90
38+00	150 U/S	517	CH	68	18	--	28	97	2.77	2	6	92
23+00	50 D/S	520	CH	66	24	20	29	96	2.72	4	9	87
59+00	50 D/S	474	CH	68	19	19	30	96	2.74	4	5	91
35+00	0	531	CH	65	19	22	28	96	2.72	0	3	97
13+00	0	538	CH	70	20	23	28	97	2.71	0	2	98
69+00	200 D/S	491	CH	55	19	20	24	101	2.74	1	9	90
67+00	50 U/S	497	CH	54	18	20	25	101	2.76	5	8	87
58+00	170 D/S	509	CH	61	20	24	28	100	2.71	1	4	95
75+00	0	548	CL	49	15	18	26	97	2.69	0	14	86
64+00	0	531	CH	68	21	20	27	96	2.72	0	5	95
75+00	0	532	CH	62	19	19	28	96	2.72	0	8	92
146+00	50 U/S	542	CH	50	14	17	22	105	2.70	0	21	79
150+00	0	543	CH	54	14	16	23	104	2.70	2	18	80
84+00	0	546	CH	63	16	19	24	101	2.73	4	17	79
125+00	0	548	CL	39	13	13	21	106	2.68	3	30	67
94+00	50 U/S	547	CH	62	14	19	23	102	2.73	1	34	65
99+50	0	549	CH	70	15	19	23	103	2.67	6	21	73
100+50	0	549	CH	51	14	15	23	102	2.73	4	17	79
113+00	100 D/S	535	CH	61	16	21	23	104	2.69	0	11	89
50+00	50 U/S	494	CH	57	18	14	25	100	2.72	0	11	89
48+00	0	545	CH	66	21	17	25	99	2.68	0	4	96

Engineering Judgment

JOE POOL - INITIAL CONTRACT - LABORATORY DATA FROM RECORD SAMPLES

Station	Offset Sub. CL (ft)	Elev (ft)	Class	LL (ft)	PL (ft)	ML (ft)	HL (ft)	W (PCF)	G _s	% Gravel	% Sand	% Fines
35+00	50 U/S	510	CH	68	22	22	26	98	2.75	1	6	93
36+00	0	498	CH	66	18	19	25	101	2.72	0	5	95
41+00	50 D/S	488	CH	64	19	19	28	97	2.73	0	5	95
37+00	0	483	CH	65	20	20	26	97	2.73	0	4	96
45+00	50 U/S	481	CH	63	19	18	25	100	2.74	0	5	95
39+00	50 D/S	475	CH	63	17	18	25	101	2.74	0	5	95
23+00*	50 LT*	487	CH	61	17	20	25	101	2.70	0	7	93
25+00*	50 RT*	471	CH	55	15	19	23	99	2.67	0	10	90
36+00	150 U/S	498	CH	71	20	20	29	96	2.77	0	8	92
42+00	200 U/S	478	CH	65	20	23	25	98	2.70	0	4	96
44+00	170 U/S	476	CH	66	19	22	27	97	2.69	0	5	95
33+00	100 D/S	506	CH	74	21	20	28	96	2.72	6	7	87
31+00	200 D/S	488	CH	65	19	20	26	97	2.73	0	4	96
39+00	100 D/S	481	CH	65	20	18	24	100	2.75	0	4	96
42+00	200 D/S	478	CH	64	19	19	26	100	2.74	0	3	97
40+00	100 U/S	508	CH	74	22	20	29	95	2.74	3	7	90
31+00*	0	545	CH	57	16	18	22	105	2.72	10	27	63
00+00	50 D/S	534	CL	40	13	16	17	112	2.70	3	37	60

TO THE OUTLET WORKS CHANNEL

JOE POOL LAKE
MOUNTAIN CREEK, TEXAS

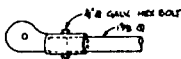
RECORD SAMPLE TEST SUMMARY

INITIAL AND COMPLETION CONTRACTS

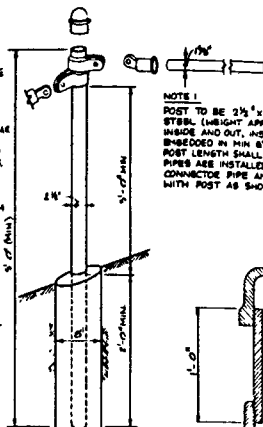
U.S. ARMY ENGINEER DISTRICT, FT WORTH

INSTALLATION DETAIL

NOTE: 3-3/8" x 6" FENCE POSTS LOCATED BY 1947 TOW RAILS TO BE INSTALLED AROUND EACH ITEM LISTED IN THE SCHEDULE ON THIS SHEET. POSTS WILL BE LOCATED IN SUCH A MANNER AS TO BE NEARLY AT THE LINE OF SIGHT BOTH PERPENDICULAR AND PARALLEL TO THE CENTERLINE OF THE DAM. FENCES ARE TO BE INSTALLED AFTER EACH INSTALLATION. AFTER EACH INSTALLATION, THE POSTS ARE TO BE PAINTED WITH TWO COATS OF ALUMINUM PAINT. ALL FENCES WILL BE FURNISHED WITH TAGS WHICH WILL BEOM BOTH THE UPPER AND LOWER CORNERS OF EACH POST. THE INSTRUMENTATION WITHIN THIS FENCE LETTERS SHALL BE 3-INCH BLACK LETTERS SHOWING BOTH THE POST NUMBER AND THE NUMBER OF THE INSTRUMENT.

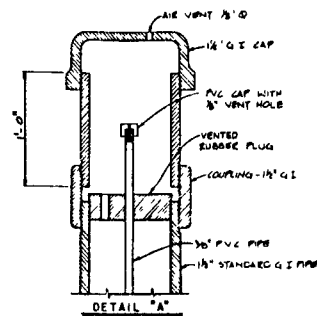


CONNECTOR PIPE AND FITTING DETAIL

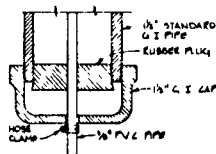


POST DETAIL

NOTE 1
POST TO BE $2\frac{1}{2}" \times 3'-0"$ (MIN) HEAVY DUTY
STEEL (WEIGHT APPROX 12 LB PER LF) GALV
INSIDE AND OUT, INSTALLED IN A PLUMB POSITION
EMBEDDED IN MIN 8" CONCRETE 2'-0" DEEP
POST LENGTH SHALL VARY SUCH THAT CONNECTOR
PIPS ARE INSTALLED IN A LEVEL POSITION
CONNECTOR PIPE AND FITTINGS TO BE COMPATIBLE
WITH POST AS SHOWN



DETAIL 'A'



DETAIL 'B

EMBANKMENT
POROUS PLASTIC TIP

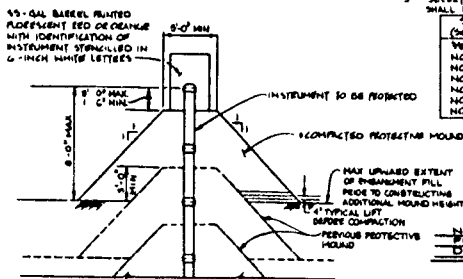
NOV 19

NOTES ON INSTALLATION OF PIZOMETERS

1. ELEVATIONS OF PREMEASURER TIES ARE APPROXIMATE.
2. ALL ELEVATIONS WILL BE DETERMINED AT THE TIME OF INSTALLATION.
3. THE CONTRACTOR SHALL PROVIDE ALL MATERIALS FOR PREMEASURERS AND EXTEND ALL PIPES IN A FLUSH POSITION.
4. THE CONTRACTOR SHALL PROVIDE ALL MATERIALS FOR PREMEASURERS AND EXTEND ALL PIPES IN A FLUSH POSITION.
5. THE CONTRACTOR SHALL STATE THE PREMEASURER NUMBER, PREFIXED BY THE LETTER "P" ON THE TOP OF EACH PREMEASURER CAP AND NEAR THE TOP OF THE EXPOSED BENEATH THE PREMEASURER.
6. THE JOINT - BENTONITE GASKET DOWEL PINS SHALL BE MIXED IN THE PROPORTIONS BY VOLUME AND WEIGHT SEVEN AND ONE HALF GALLONS OF WATER, FIVE POUNDS OF CEMENT AND ONE GALLON OF BENTONITE. IT MUST BE CONSISTENTLY BE THOROUGHLY MIXED TO A UNIFORM CONSISTENCY BEFORE BACKFILLING.
7. SELECT SAND FILTERS FOR THE PREMEASURER SENSING LINES SHALL BE WITHIN THE FOLLOWING GRAIN LIMITS:

SEVEN FEET (SQUARE MEAN)	PERCENT PAYMENT (BY NIGHT)
78 INCH	100
NO 4	91-100
NO 8	79 90
NO 16	60-75
NO 30	34-47
NO 50	10 10
NO 100	0-4

NOTE, ALL THREADED CONNECTIONS TO BE MADE UP WITH TEFLON TAPE



TEMPORARY INSTRUMENTATION PROTECTION
NOT TO SCALE

6. SEE NOTES ON TEMPORARY PHYSICAL MEASUREMENT DEVICE PROTECTION, THIS SHEET, AND THE CONTRACT SPECIFICATIONS.

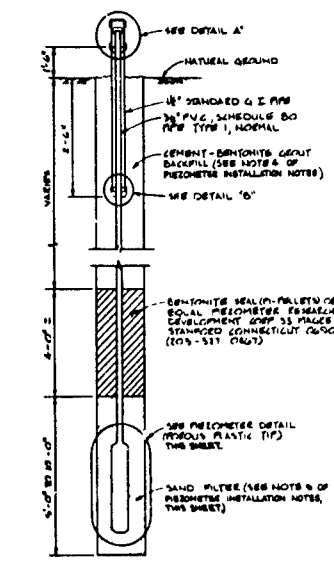
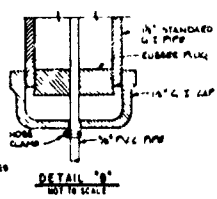
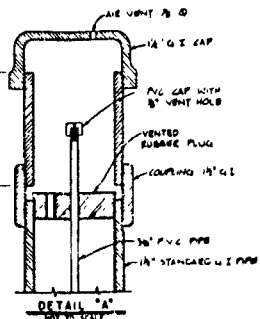
~~NOTES ON TEMPORARY
PHYSICAL MEASUREMENT
DEVICE PROTECTION~~

2. SLOPES SHOWN ARE THE STEEPEST SLOPES PERMITTED
3. COMPACTED FILL (THE SAME TYPE AS SUBORDINATE FILL) WITHIN THE LIMITS SHOWN SHALL BE PLACED IN 4-INCH LAYERS, COMPACTED BY POWER TAMPERS TO DENSITY AND MOISTURE CONTENT SPECIFIED FOR THE SUBORDINATE FILL AND KEPT IN THE SAME CONDITION AS SPECIFIED FOR ADJACENT COMPACTED FILL.
4. THE COMPACTED PROTECTIVE FILL AROUND PHYSICAL MEASUREMENT DEVICES SHALL BE PLACED WITHIN SIX HOURS AFTER EXTENSIONS ARE ADDED.
5. THE TEMPORARY PROTECTION SHOWN SHALL BE A MINIMUM CONTRACTOR EFFORT. ADDITIONAL PROTECTION AS REQUIRED IS ALSO A CONTRACT REQUIREMENT AS SPECIFIED IN THE SPECIFICATIONS.

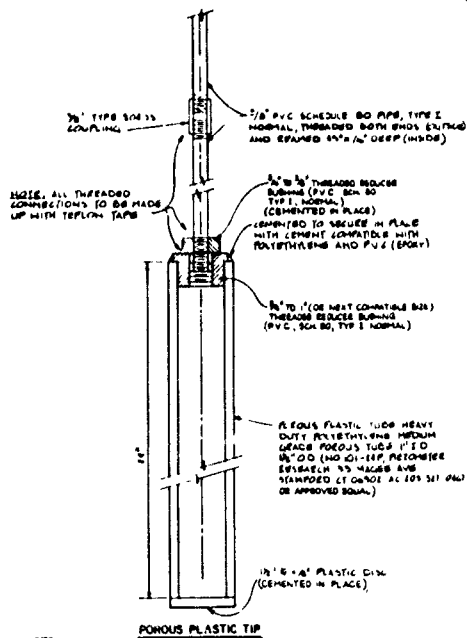
NOTE: SIMILAR POROUS PLASTIC TYPES ALSO
OFFER RESEARCH AND DEVELOPMENT
CONNECTICUT 06901, PHONE NO
IS UNASSEMBLED, THE CONTRACTOR
LABOR TO COMPLETELY ASSEMBLE
CONTRACTING OFFICE AT NO ADDITIONAL

POROUS POLYMER

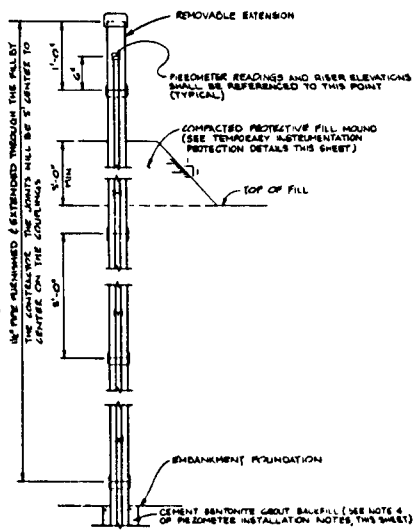
2 1/2" x 5'-0" (MIN) HEAVY DUTY
WAT APPLIED 12 LB. PER 1.5' DIA
OUT, INSTALLED IN A PLUMB POSITION.
1 MIN 8" B CONCRETE 3'-0" DEEP
1 SHALL VARY SUCH THAT CONNECTOR
INSTALLED IN A LEVEL POSITION
PIPE AND FITTINGS TO BE COMPATIBLE
AS SHOWN



POROUS PLASTIC TIP PIEZOMETER DETAIL
NOT TO SCALE



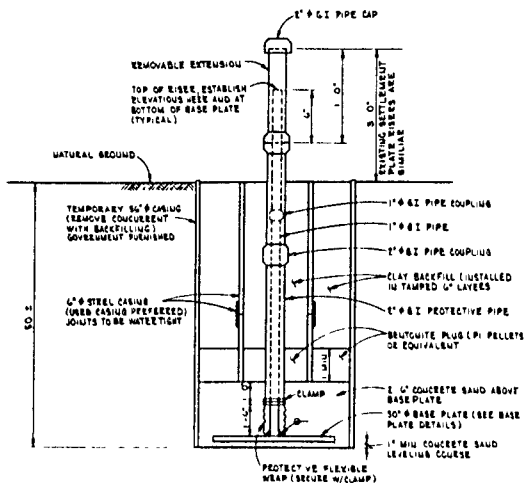
NOTE
NOT TO SCALE
SIMILAR POROUS PLASTIC TIP ALREADY ASSEMBLED MAY BE AVAILABLE FROM THE PER-
METER RESEARCH AND DEVELOPMENT CORP. 33 HAGES AVE. STAMFORD
CONNECTICUT 06407. PHONE NO. 203-327-0467. IF CONTRACTOR PURCHASED EQUIPMENT
OR ASSEMBLED, THE CONTRACTOR SHALL FURNISH SUFFICIENT TOLERANCE QUALIFIED
LABOR TO COMPLETELY ASSEMBLE PIEZOMETER TIPS UNDER SUPERVISION OF THE
CONTRACTING OFFICER AT NO ADDITIONAL COST TO THE GOVERNMENT.



**EMANKMENT FOUNDATION
POROUS PLASTIC TIP PIEZOMETER
EXTENSION DETAIL 'A'
INSTALLATION WITHIN LIMITS
OF EMANKMENT**
NOT TO SCALE

* SIMILAR FOR EXTENSION OF
SETTLEMENT PLATES AND DEEP
SETTLEMENT PLATES

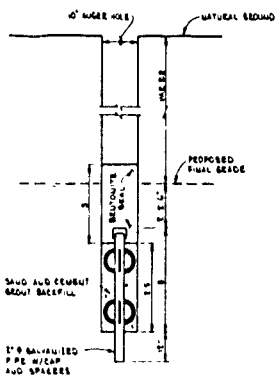
DESIGNED BY T. SCHMIDT		JOE POOL LAKE MOUNTAIN CREEK TEXAS	
CHECKED BY T. SCHMIDT		EMANKMENT, SPILLWAY, AND OUTLET WORKS	
APPROVED BY H. R. STROMAN		PHYSICAL MEASUREMENT DEVICES-I	
DATE JULY 1961		SHEET NO. 19 OF 43	
DRAWING NUMBER		23	



**DEEP BENCH MARK DETAIL
AND
DEEP SETTLEMENT PLATE DETAIL**
UTS

NOTES ON INSTALLATION OF DEEP BENCH MARK PLATES

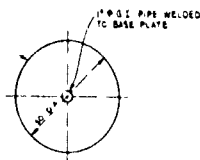
- 1 THE BASE PLATE AND ANY OTHER NON GALVANIZED SURFACES SHALL BE COATED WITH PROTECTIVE PAINT (RED LEAD BASE COAT AND ALUMINUM OUTER COAT)
- 2 THE CONTRACTOR SHALL STAMP THE BENCH MARK NUMBER PREFIXED BY THE LETTERS "DM" ON THE TOP OF SAND BENCH MARK CAP AND WEAR THE TOP OF THE PROTECTIVE P.P.E
- 3 THE CONTRACTOR SHALL PROVIDE ALL MATERIALS EXCEPT TEMPORARY SAND CASING
- 4 DEEP BENCH MARKS SHALL BE INSTALLED BY GOVERNMENT PERSONNEL



HEAVE POINT DETAIL
UTS

NOTES

- 1 IF ROCK LIES OR SQUEEZES TEMPORARY CASING SHOULD BE SET
- 2 PRIOR TO BACKFILLING THE BENCH MARK OF THE TOP OF P.P.E CAP SHOULD BE ESTABLISHED
- 3 AFTER SURVEY IS COMPLETE THE CASING SHOULD BE PULLED AND THE HOLE BACKFILLED



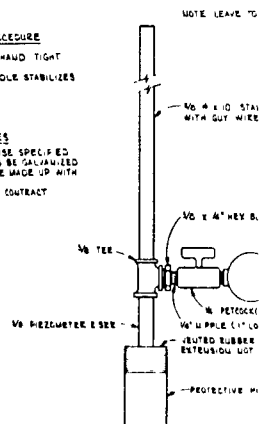
30\"/>

READING PROCEDURE

- 1 INSTALL GAGE HAND TIGHT
- 2 OPEN PRYCOCK
- 3 WHEN GAGE NEEDLE STABILIZES MAKE READING
- 4 CLOSE PRYCOCK
- 5 REMOVE GAGE

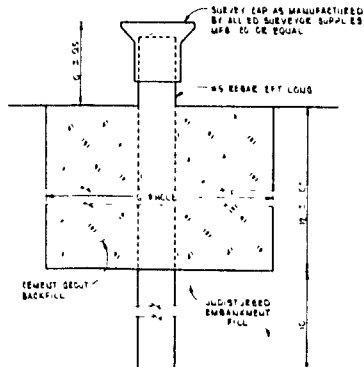
NOTES

- 1 UNLESS OTHERWISE SPECIFIED ALL FITTINGS TO BE GALVANIZED
- 2 ALL JOINTS TO BE MADE UP WITH TEFLOON TAPE
- 3 REFERENCE THE CONTRACT SPECIFICATIONS



PROCEDURE FOR FLOWING PIEZOMETER
UTS

TOP OF CAP DETAIL



EMBANKMENT STATION MONUMENT DETAIL
UTS

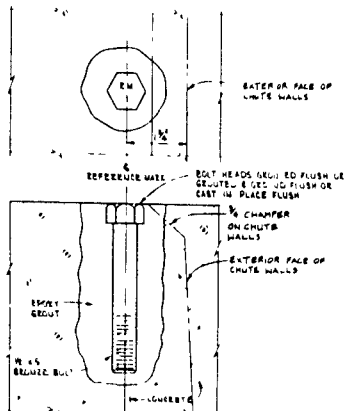
EMBANKMENT STATION MONUMENTS INSTALLATION NOTES

- 1 THE MONUMENTS SHALL BE INSTALLED AT EVERY WHOLE NUMBERED STATION ON THE DOWNSTREAM SIDE OF THE DAM CREST FROM STATION 50+00 TO STATION 81+00
- 2 THE MONUMENTS SHALL BE CONTRACTOR PROVIDED AND INSTALLED
- 3 THE MONUMENTS SHALL BE INSTALLED CONCURRENT WITH THE DAM CONSTRUCTION THE MONUMENTS WILL BE INSTALLED ALONG THE CENTERLINE OF THE DAM. 4 POSTS AND THE QUADRANT POSTS SHALL NOT BE INSTALLED WITHIN 1 FOOT OF THE MONUMENT
- 4 THE STATION NUMBER SHALL BE STAMPED ON TOP OF THE MONUMENTS AS SHOWN

1 UNLESS OTHERWISE SPEC F E W
2 ALL FIT UGS TO BE GALVAN ZED
3 ALL JOINTS TO BE MADE UP WITH
4 TEFLOW TAPE
5 REFERENCE THE CONTRACT
6 SPECIFICATIONS

Diagram illustrating the installation of a water meter, showing the connection between the protective pipe, the meter, and the main line. The diagram includes the following components and labels:

- NO. 2 x 1/2 STAINLESS (SUPPORT WITH GUY WIRES AS NECESSARY)
- 1/2 x 1/4 HEX BUSHING
- MARSH GAGE OR APPROVED EQUIVALENT (TO BE INSTALLED FOR BATH READINGS AND THEN REMOVED) BACK TO ZERO IN FEET OF WATER, 1/2 PETCOCK (BRASS)
- 1/2 W/ PLUG (1" LONG)
- HEATED RUBBER PLUG AND REMOVABLE EXTENSION NOT SHOWN
- PROTECTIVE PIPE



STATION
75+00

12'-0"

10'-0"

24'-0"

CONCRETE BACKFILL

JULY 1970 ROAD CONSTRUCTION

புறக்கணக்கில் 9 டி 30 அம்சங்கள் மீதான மீதான மீதான

- 1 THE MONUMENTS SHALL BE INSTALLED AT EVERY MILE.
- 2 NUMBERED STATO CH IN DOWNSTREAM SIDE OF THE DAM.
- 3 THE MONUMENTS SHALL BE SUBTRACTED FROM THE DAM.
- 4 THE MONUMENTS SHALL BE INSTALLED SUBTRACTED WITH THE GUARDIAN OF THE STATE.
- 5 THE MONUMENTS SHALL BE INSTALLED SUBTRACTED WITH THE GUARDIAN OF THE STATE.
- 6 THE MONUMENTS SHALL BE INSTALLED SUBTRACTED WITH THE GUARDIAN OF THE STATE.
- 7 THE MONUMENTS SHALL BE INSTALLED SUBTRACTED WITH THE GUARDIAN OF THE STATE.
- 8 THE MONUMENTS SHALL BE INSTALLED SUBTRACTED WITH THE GUARDIAN OF THE STATE.
- 9 THE MONUMENTS SHALL BE INSTALLED SUBTRACTED WITH THE GUARDIAN OF THE STATE.
- 10 THE MONUMENTS SHALL BE INSTALLED SUBTRACTED WITH THE GUARDIAN OF THE STATE.

NOTES ON REFERENCE MATR.

UTS
* OUTLET WORKS
REFERENCE PINS
ARE SIMILAR

1 REFERENCE MARKS TO BE INSTALLED AS SHOWN
ON REQ 22 ON THE ST LUNG BAY FLOOR
AND WALLS
2 AT THE INTERIORS OF EACH OF THE REFERENCE
MARKS MAY BE CAST IN PLACE WITH
STRUCTURAL CONCRETE
3 BE SURE TO CONFORM TO REQ SPECS
CG 8 150 AND AM 2

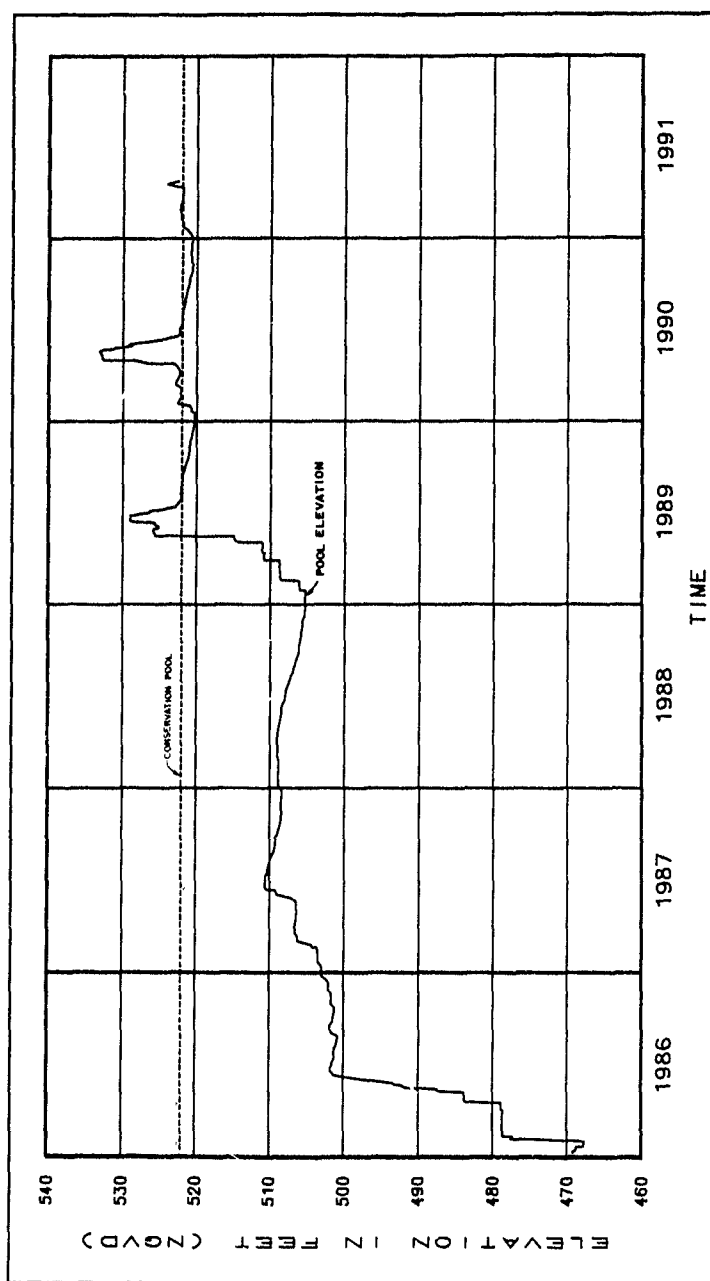
[illegible]

- THE CONTRACTOR OFFICER WILL MAKE ADDITIONAL READINGS ON ANY SCHEDULE OR REQUIRED NECESSARY IN ADDITION TO THOSE MADE BY THE CONTRACTOR
- THE CONTRACTOR SHALL REMOVE ALL DEWET EXPOSED TO 5 FEET AND LENS LONG EXIST WITH THE AIRWAY ELEVATION AND REASSEMBLE EXISTING AS BACKFILL IS PLACED

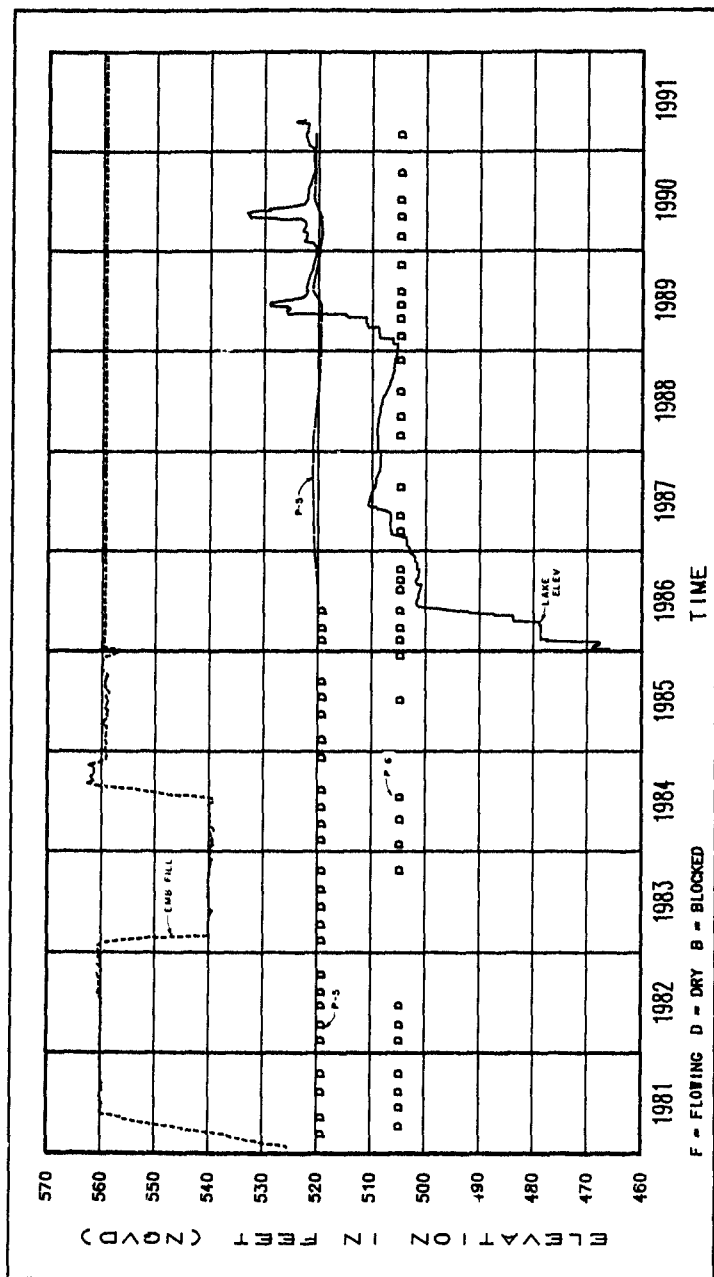
GENERAL NOTES

- 1 SEE SEQ 23 FOR TEMPORARY AND PERMANENT
PROTECT AND DETAILS FOR PHYSICAL MEASUREMENT
CRICES
2 SEE SEQ 200 THRU 211 FOR DETAIL OF

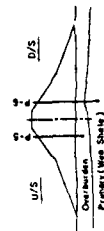
SPECS		U S FEET		HRS		SUND REENT WITH THE NO. 10047	
MORNING		MID		AFTER		EVENING	
10:00 AM		11:00 AM		12:00 PM		1:00 PM	
U S ARMY ENGINEER DISTRICT FORT WORTH CORPS OF ENGINEERS FORT WORTH TEXAS							
ENGINEER IN CHARGE M. J. LAMON		JOE POOL LAKE MOUNTAIN, POOL TEXAS					
PROJECT BY M. J. LAMON		EMBANKMENT, SPILLWAY, AND OUTLET WORKS					
REVIEWED BY M. J. LAMON		PHYSICAL MEASUREMENT DEVICES-II					
LIMITED TO		BY NO. 10047 P. 10047					
DATE		DATE		DATE		DATE	
10/1/54		10/1/54		10/1/54		10/1/54	
BY		BY		BY		BY	
M. J. LAMON		M. J. LAMON		M. J. LAMON		M. J. LAMON	



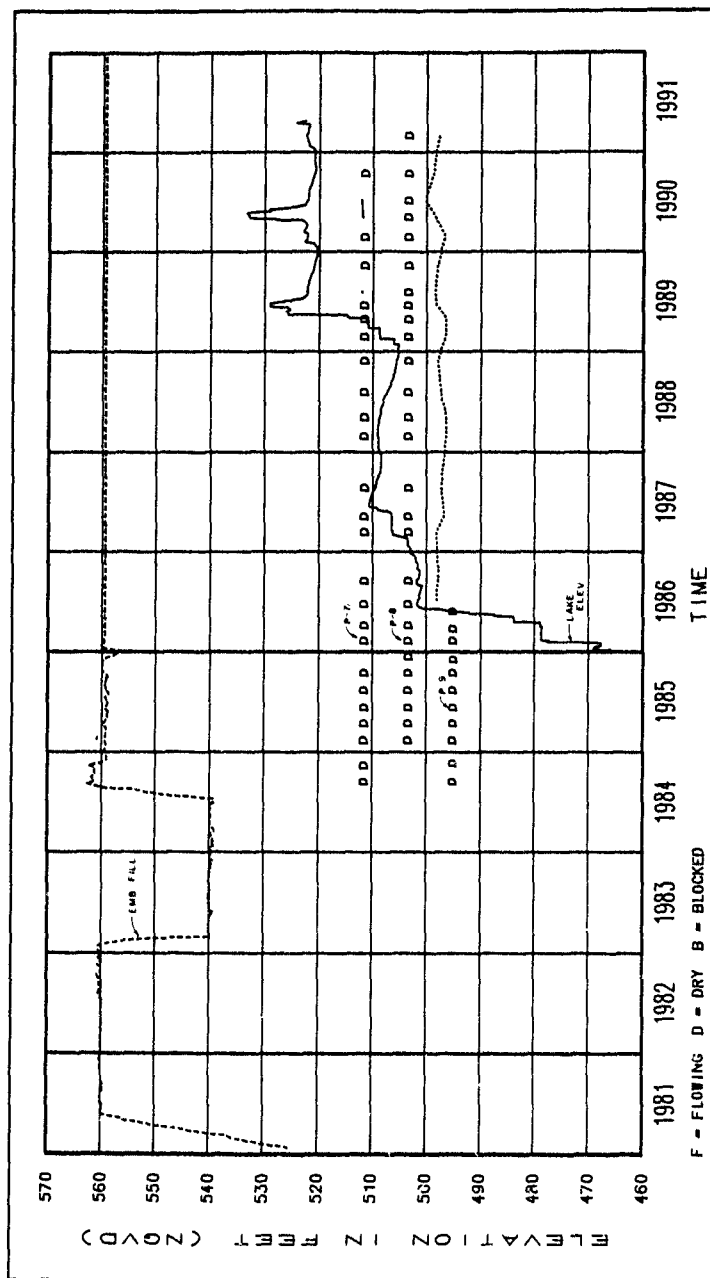
JOE POOL LAKE
FORT WORTH DISTRICT
LAKE ELEV. VS. TIME
EXHIBIT



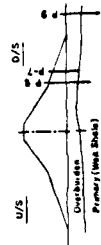
PIEZ. NO.	STATION	OFFSET	TIP ELEV.	FORMATION	LEGEND
LAKE ELEV					---
FILL	99+50		TOP OF	EMB FILL	---
P-5	99+50	35	U/S	OVERBURDEN	---
P-6	99+30	30	D/S	CLAY SHALE (WEA)	---

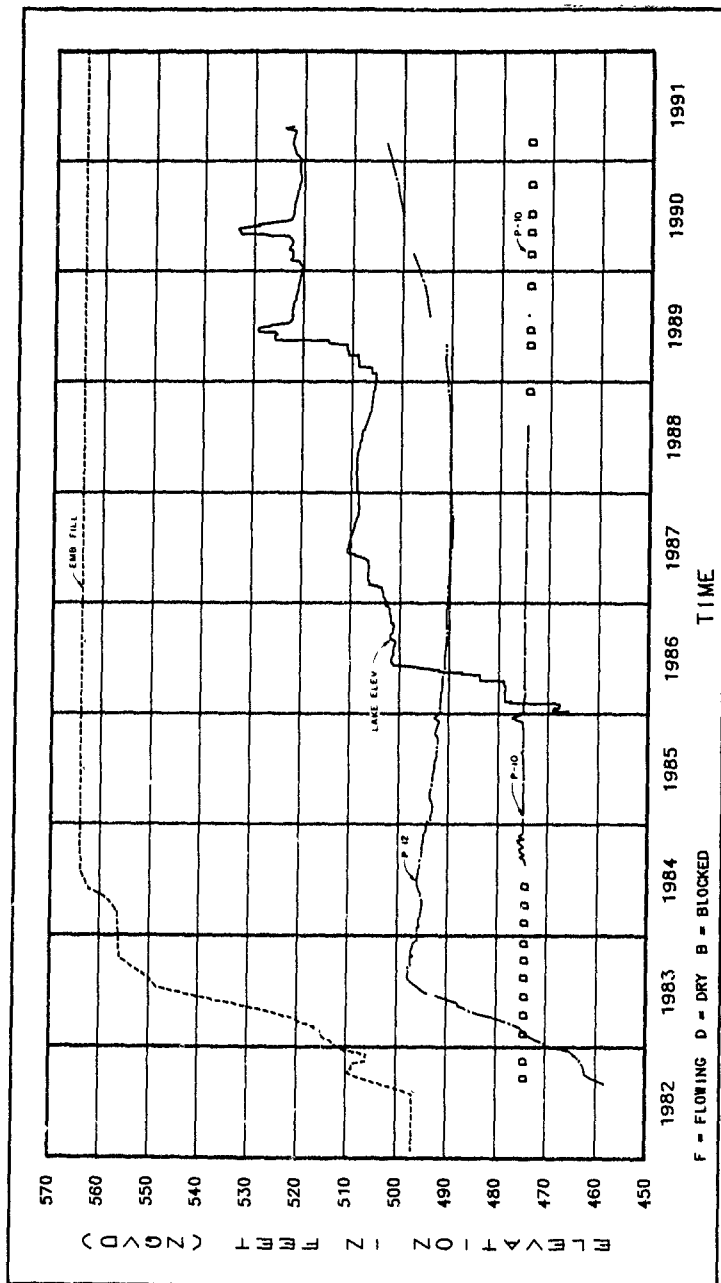


JOE POOL LAKE
FORT WORTH DISTRICT
PIEZOMETERS
FILL-H, P-5, P-6
PIEZOMETRIC ELEV. vs. TIME
EXHIBIT

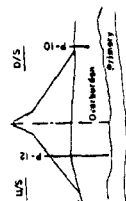


JOE POOL LAKE
FORT WORTH DISTRICT
PIEZOMETERS
FILL-H, P-7, P-8, P-9
PIEZOMETRIC ELEV. vs. TIME
EXHIBIT

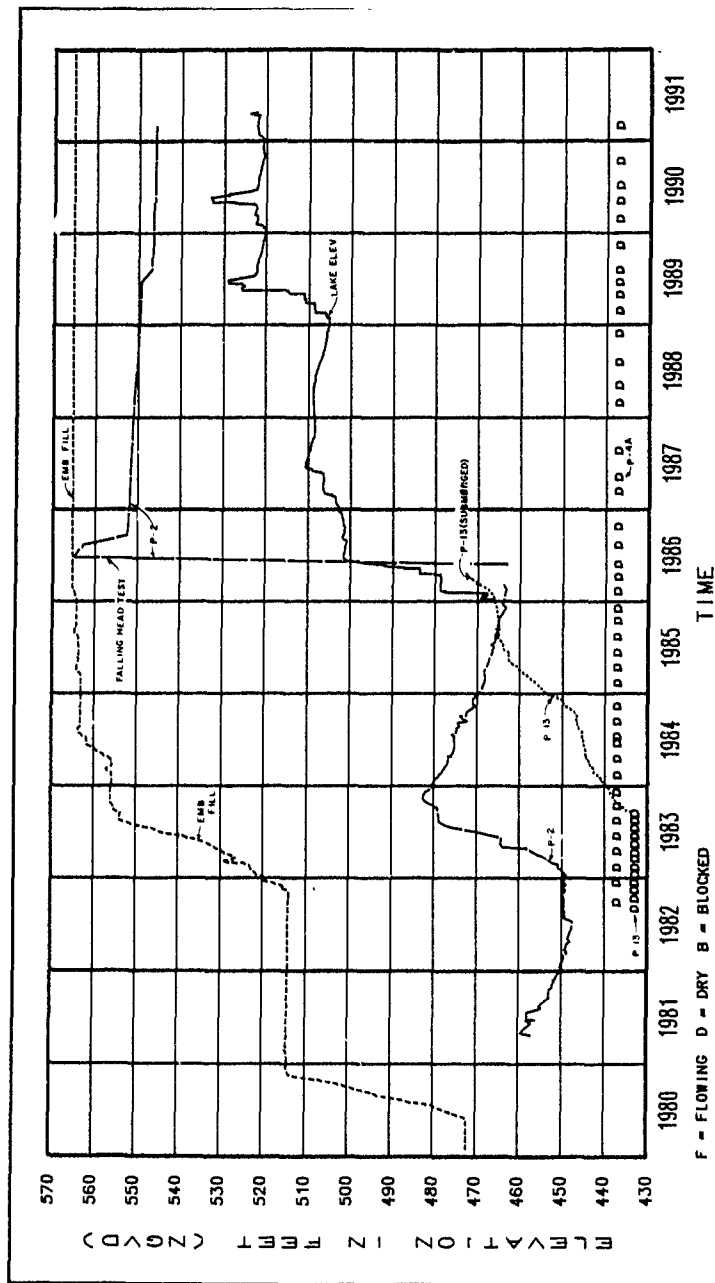




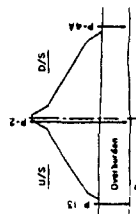
PIEZ. NO.	STATION	OFFSET	TIP ELEV.	FORMATION	LEGEND
LAKE ELEV					
FILL	16+00		TOP OF	EMB FILL	
P-10	15+70	508 D/S	474.15	OVERBURDEN	
P-12	16+10	220 U/S	454.66	CLAY SHALE	



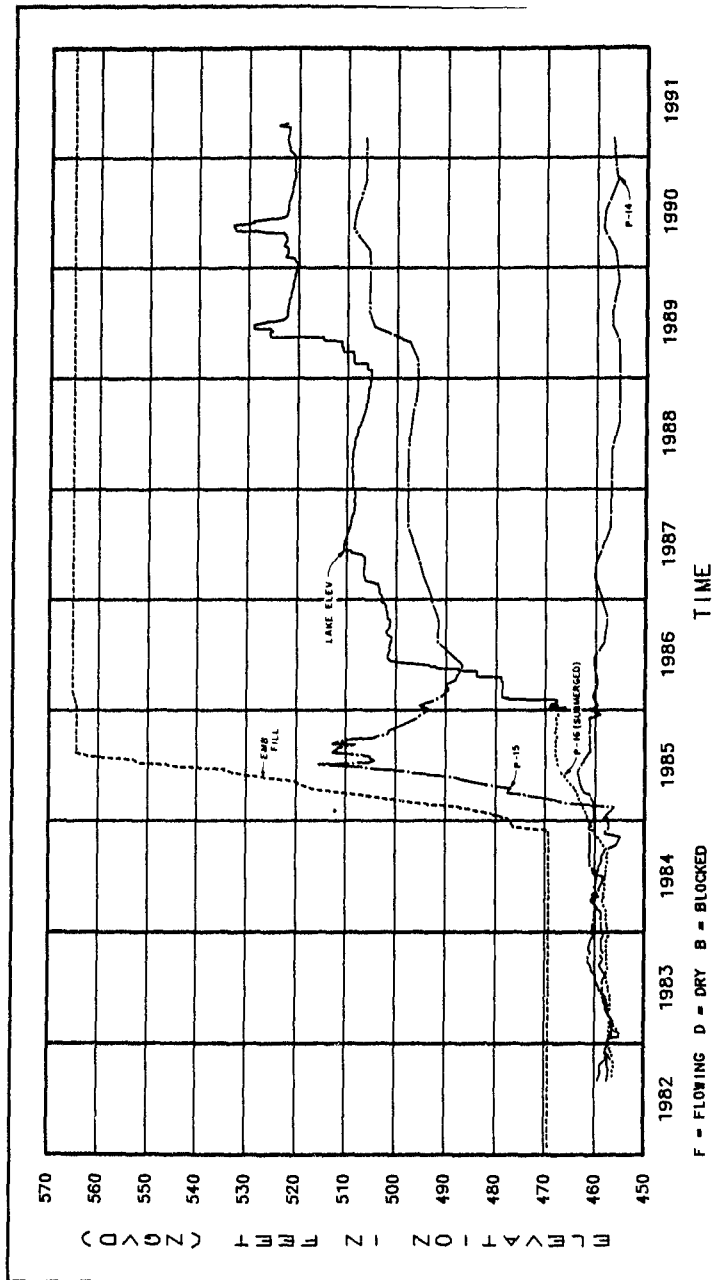
JOE POOL LAKE
FORT NORTH DISTRICT
PIEZOMETERS
FILL-D, P-10, P-12
PIEZOMETRIC ELEV. vs. TIME
EXHIBIT



PIEZ. NO.	STATION	OFFSET	TIP ELEV.	FORMATION	LEGEND
LAKE ELEV					
FILL	384+30		TOP OF	EMB FILL	—
P-2	384+59	15 U/S	440.52	OVERBURDEN	---
P-4A	384+66	600 D/S	437.17	OVERBURDEN	----
P-13	384+50	560 U/S	432.96	OVERBURDEN	

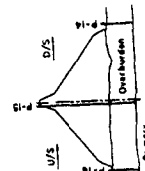


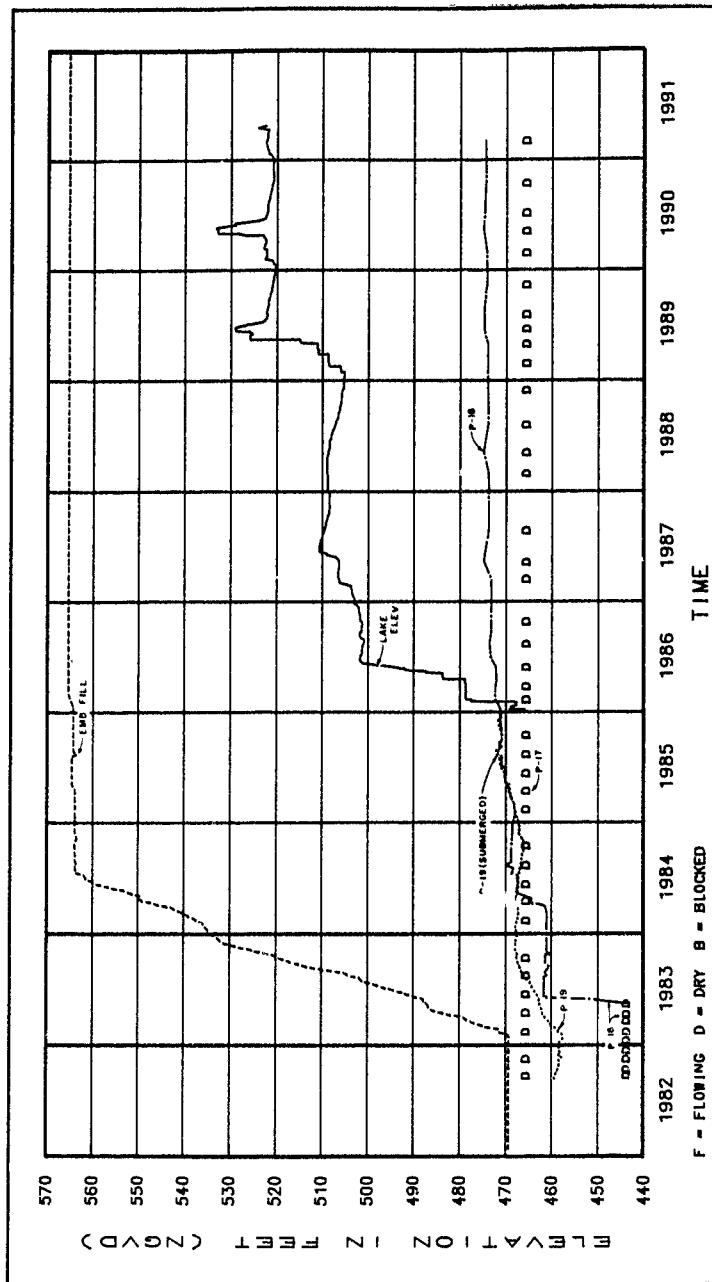
JOE POOL LAKE
 FORT WORTH DISTRICT
 PIEZOMETERS
 FILL-E-P-2, P-4A, P-13
 PIEZOMETRIC ELEV. vs. TIME
 EXHIBIT



PIEZ. NO.	STATION	OFFSET	TIP ELEV.	FORMATION	LEGEND
LAKE ELEV					
FILL	50+00		TOP OF	EMB FILL	
P-14	50+00	610 D/S	434.52	OVERBURDEN	
P-15	49+95	15 U/S	433.94	OVERBURDEN	
P-16	50+00	600 U/S	435.24	OVERBURDEN	

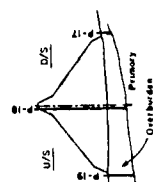
JOE POOL LAKE
FORT NORTH DISTRICT
PIEZOMETERS
FILL-F, P-14, P-15, P-16
PIEZOMETRIC ELEV. vs. TIME
EXHIBIT

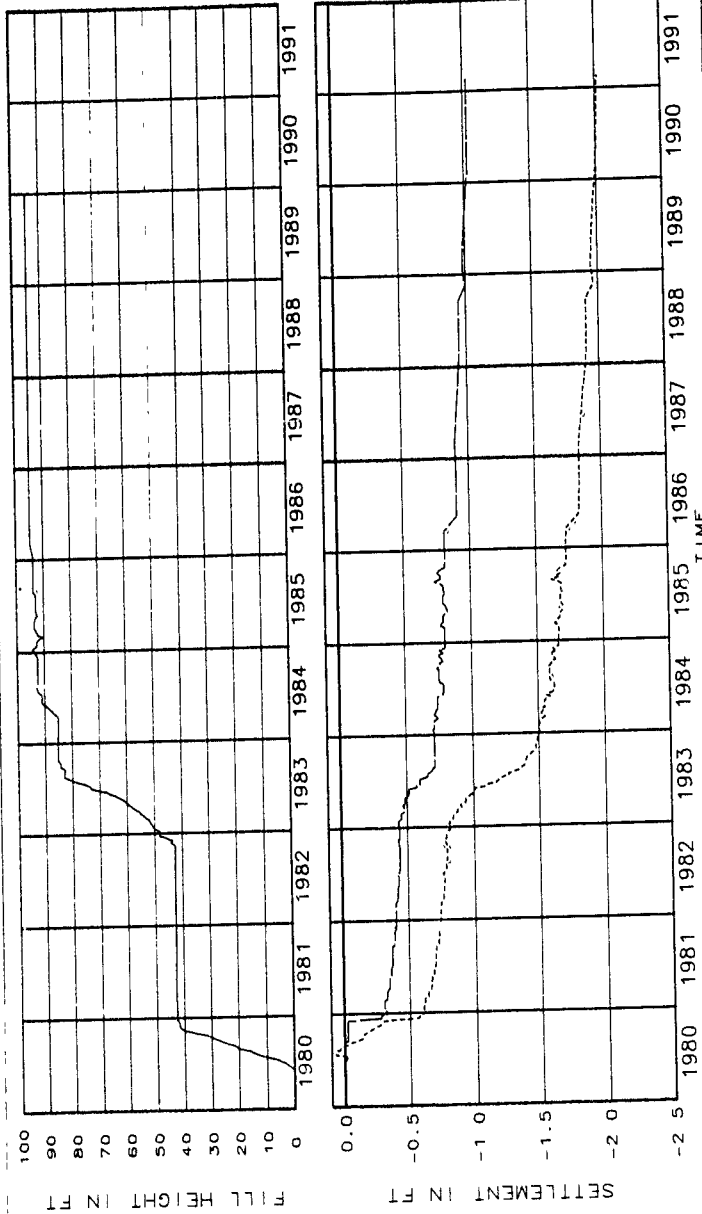




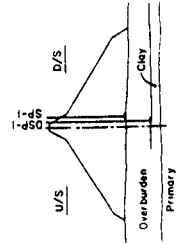
PIEZ. NO.	STATION	OFFSET	TIP ELEV.	FORMATION	LEGEND
LAKE ELEV					
FILL	63+00		TOP OF	EMB FILL	---
P-17	63+00	577 D/S	465.65	OVERBURDEN	---
P-18	63+00	15 U/S	443.73	OVERBURDEN	---
P-19	63+00	616 U/S	437.67	OVERBURDEN	---

JOE POOL LAKE
FORT WORTH DISTRICT
PIEZOMETERS
FILL-G, P-17, P-18, P-19
PIEZOMETRIC ELEV. vs. TIME
EXHIBIT

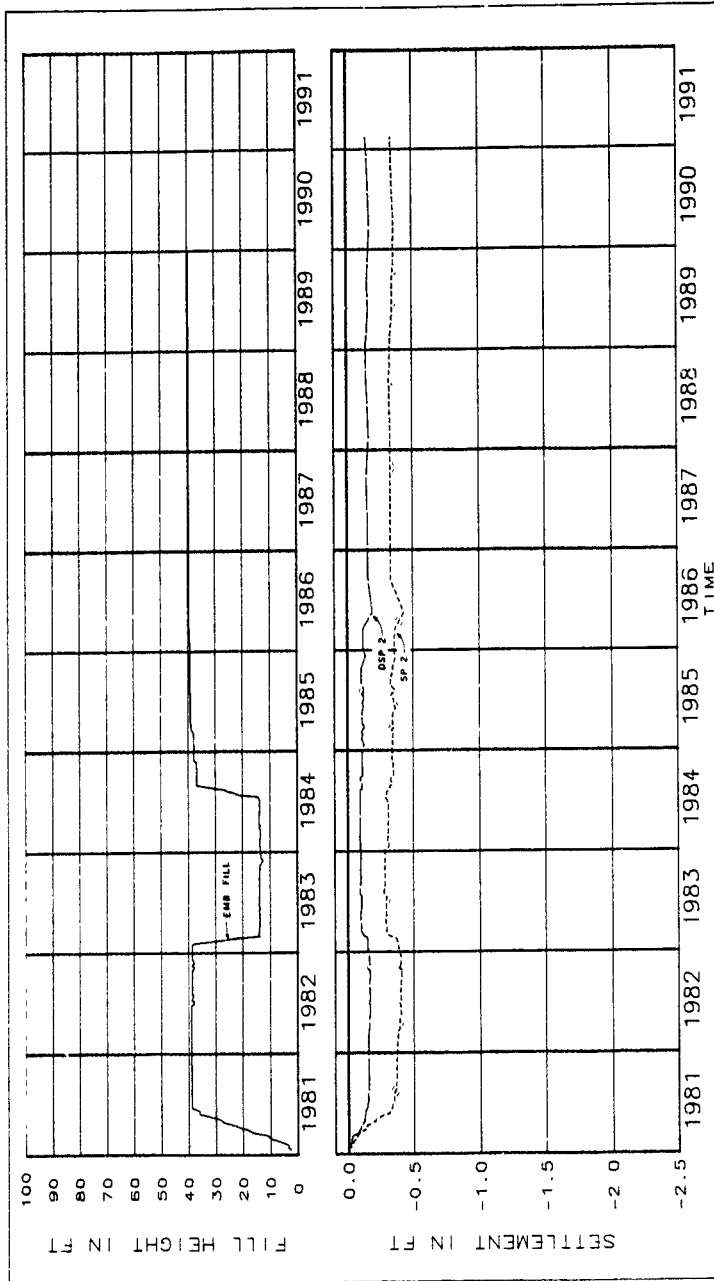




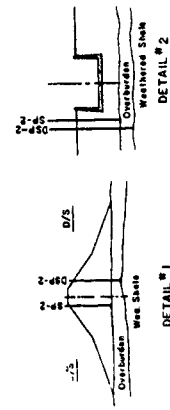
JOE POOL LAKE
FORT WORTH DISTRICT
FILL/SETTLEMENT PLATES
SP-1, DSP-1
SETTLEMENT vs. TIME
EXHIBIT



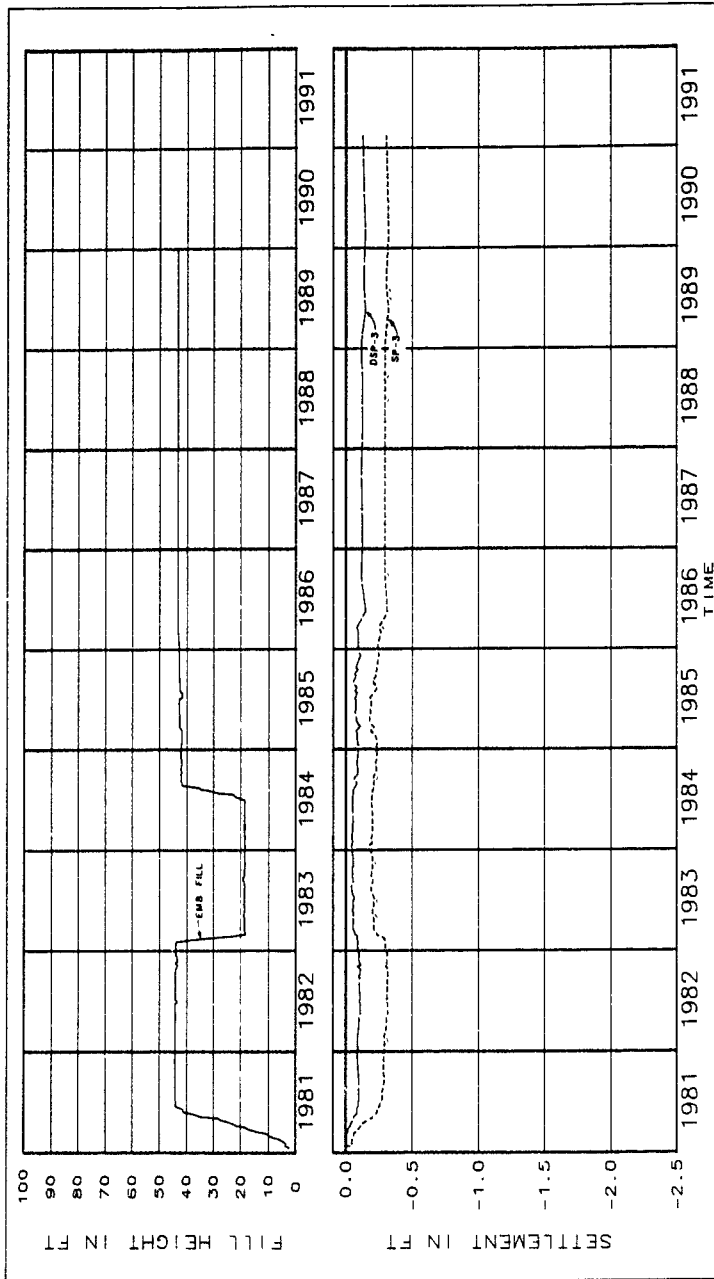
SP NO	STATION	OFFSET	PLATE EL	FORMATION	LEGEND
FILL	38+70			EMB FILL	
SP-1	38+70	17 D/S	472.271	CLAY OVB(NG)	---
DSP-1	38+50	17 D/S	443.800	CLAY LAYER	---



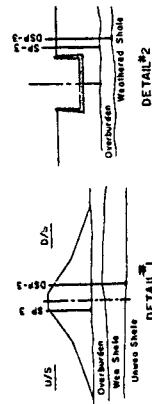
JOE POOL LAKE
FORT NORTH DISTRICT
FILL/SETTLEMENT PLATES
SP-2, DSP-2
SETTLEMENT vs. TIME
EXHIBIT



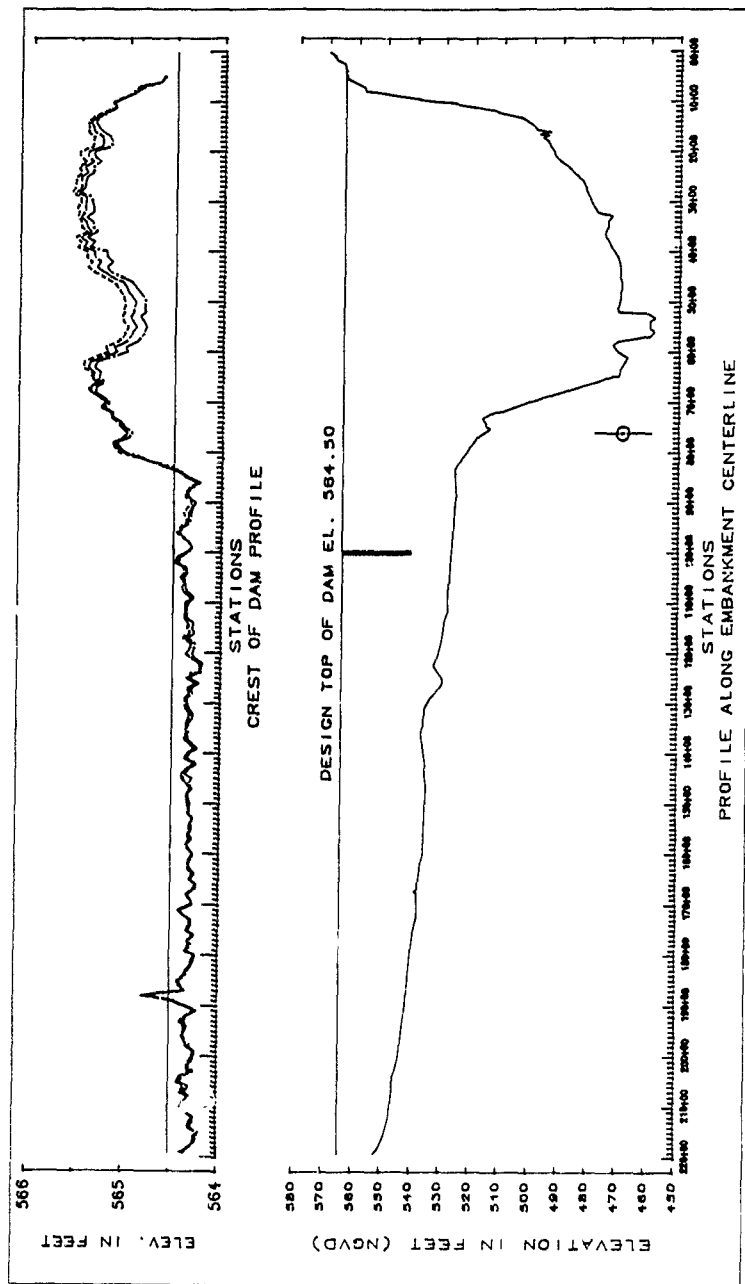
SP NO	STATION	OFFSET	PLATE EL	FORMATION	LEGEND
FILL	99+50			EMB FILL	---
SP-2	99+50	15 U/S	526 250	CLAY OVB (NC)	---
DSP-2	99+50	31 D/S	517 300	CLAY SHALE (WEA)	---



JOE POOL LAKE
FORT NORTH DISTRICT
FILL/SETTLEMENT PLATES
SP-3, DSP-3
SETTLEMENT vs. TIME
EXHIBIT



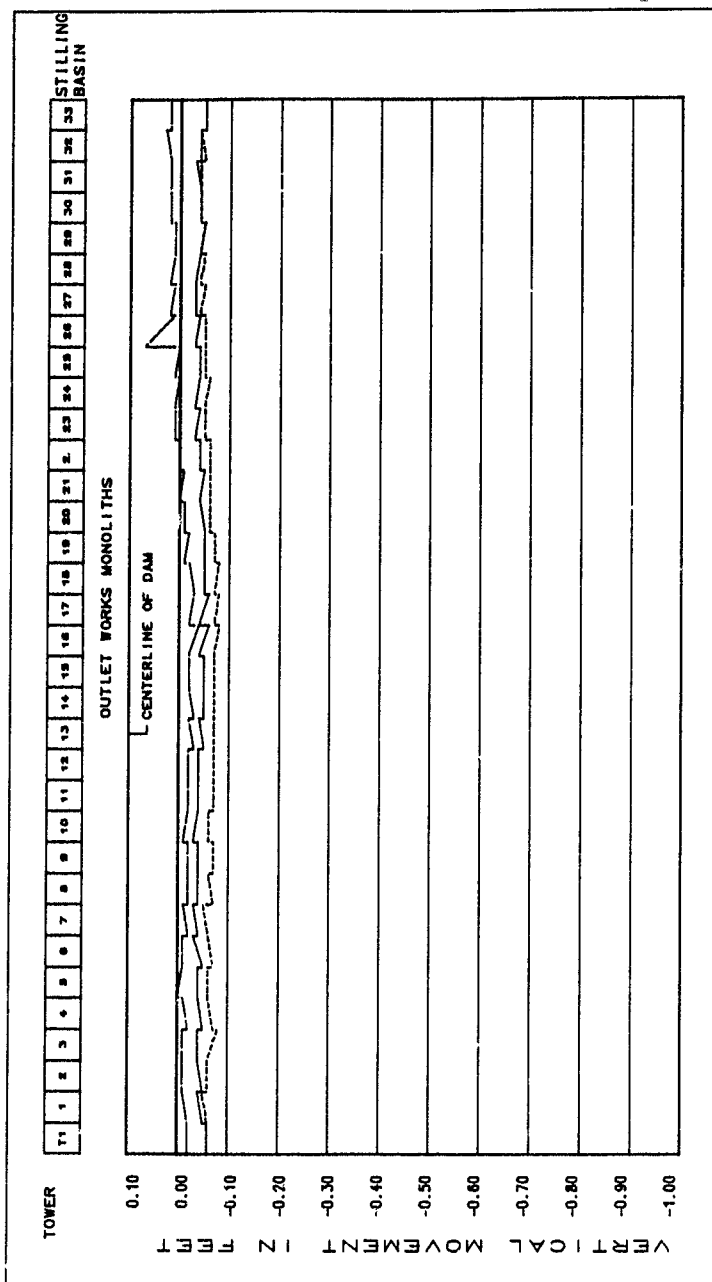
SP NO	STATION	OFFSET	PLATE EL	FORMATION	LEGEND
FILL	100+50			EMB FILL	—
SP-3	100+50	17 U/S	526.037	CLAY OVR(NC)	---
DSP-3	100+50	29 D/S	493.700	CLAY SHALE	---



NOTE: Survey rods for crest of dam are located approximately 15' downstream of the embankment centerline.

DATE OF SURVEY	LEGEND
15FEB87 CENTERLINE	-----
15DEC87 CENTERLINE	-----
15JAN89 CENTERLINE	-----

JOE POOL LAKE
FORT NORTH DISTRICT
CREST OF DAM PROFILE
EXHIBIT



DATE OF SURVEY	LEGEND
01JUL85	—————
15FEB88	—————
15FEB91	—————

NOTES:

INITIAL SURVEY TAKEN 15SEP84

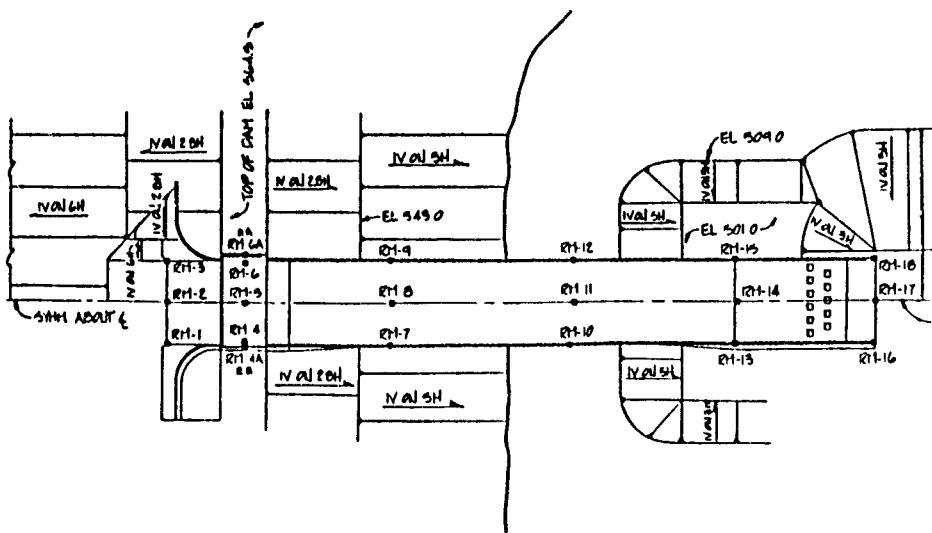
INITIAL SURVEY SET AS "0" BASELINE. ALL SUBSEQUENT
MOVEMENT PLOTTED RELATIVE TO INITIAL READING.

JOE POOL LAKE
FORT WORTH DISTRICT
OUTLET WORKS
REFERENCE MARKS
VERTICAL MOVEMENT vs. TIME
EXHIBIT

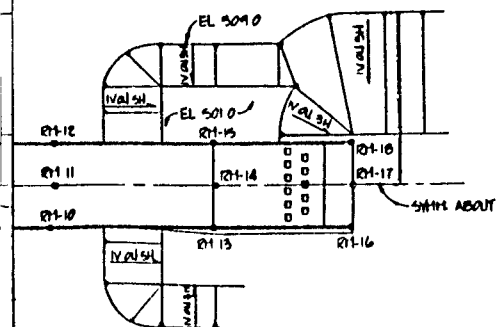
CORPS OF ENGINEERS

Change From Original Elevation: (+) Heave (-) Settlement

Original Elev.	540.92 6/28/85	540.97 6/28/85	540.95 6/28/85	540.88 6/28/85	540.83 6/28/85	540.91 6/28/85	541.52 6/28/85	528.20 6/28/85	541.53 6/28/85	517.63 6/28/85	504.31 6/28/85	517.53 6/28/85	503.99 6/28/85	20
Date	RM-1	RM-2	RM-3	RM-4	RM-5	RM-6	RM-7	RM-8	RM-9	RM-10	RM-11	RM-12	RM-13	8
Feb 86	+ .02	+ .02	+ .02	+ .02	- .02	+ .02	.00	+ .06	+ .02	+ .03	+ .04	+ .08	+ .06	06
Sep 86	.00	+ .01	+ .02	+ .01	+ .01	+ .01	+ .02	+ .06	+ .02	+ .04	+ .09	+ .06	+ .04	06
Feb 87	+ .01	+ .02	+ .01	+ .01	+ .02	+ .01	+ .04	+ .07	+ .05	+ .05	+ .10	+ .07	+ .07	07
Sep 87	.00	+ .02	.00	+ .01	+ .01	+ .01	+ .04	+ .07	+ .04	+ .06	+ .10	+ .07	+ .07	07
Feb 88	- .01	.00	- .02	- .01	- .01	.00	+ .04	+ .05	+ .04	+ .03	+ .05	+ .05	+ .03	05
Aug 89	0	+ 01	- 01	+ 01	+ 01	+ 01	+ 07	+ 10	+ 05	- 09	+ 11	+ 10	*	10
Feb 90	- 01	0	- 02	0	0	0	+ 06	+ 11	+ 05	+ 07	+ 12	+ 09	*	11
Feb 91	0	+ 01	- 01	+ 01	+ 02	0	+ 08	+ 11	+ 06	+ 06	+ 11	+ 10	+ 04	11



58/85	541.53 6/28/85	517.63 6/28/85	504.31 6/28/85	517.53 6/28/85	503.99 6/28/85	Underwater 6/28/85	504.01 6/28/85	503.98 6/28/85	Underwater 6/28/85	504.02 6/28/85
-8	RM-9	RM-10	RM-11	RM-12	RM-13	RM-14	RM-15	RM-16	RM-17	RM-18
06	+02	+03	+04	+08	+06	Underwater	+07	+07	Underwater	+06
06	+02	+04	+09	+06	+04	Underwater	+06	+05	Underwater	+06
07	+05	+05	+10	+07	+07	Underwater	+07	+07	Underwater	+07
07	+04	+06	+10	+07	+07	Underwater	+07	+07	Underwater	+07
05	+04	+03	+05	+05	+03	Underwater	+06	+03	Underwater	+06
10	+05	+09	+11	+10	*	Underwater	*	*	Underwater	*
11	+05	+07	+12	+09	*	Underwater	*	*	Underwater	*
11	+06	+06	+11	+10	+04	Underwater	+08	*	Underwater	*



Original Elev	564 48 Feb 88	564 46 Feb 88
Date	RM-4A	RM-5A
Feb 88	0	0
Sep 88	0	0
Jan 89	0	+01
Aug 89	-01	0
Feb 90	-03	02
Feb 91	0	0

JOE POOL LAKE
MOUNTAIN CREEK LAKE

SPILLWAY
REFERENCE MARKS

U S ARMY ENGINEER DISTRICT, FT WORTH

PLATE

CORPS OF ENGINEERS

VERTICAL MOVEMENT IN FEET LEFT WALL

DATE	DS-1L	US-2L	DS-2L	US-3L	DS-3L	US-4L
ORIGINAL ELEV.	478.79	478.48	472.15	472.16	472.14	472.15
April 86						
Sep 86	.00	.00	-.01	-.01	-.02	-.01
Feb 87	-.01	-.02	-.01	-.01	-.02	-.01
Sep 87	-.01	-.02	.00	.00	-.01	-.01
Feb 88	-.05	-.04	-.04	-.04	-.06	-.05
Jan 89	-.03	-.03	-.03	-.03	-.04	-.03
Aug 89	+ .01	.00	+ .02	+ .01	+ .01	+ .01
Feb 90	.00	+ .01	-.01	-.01	-.03	-.02
Feb 91	.00	.00	+ .01	.00	.00	+ .01

DATE	DS-4L	US-5L	DS-5L	US-6L	DS-6L
ORIGINAL ELEV.	472.16	472.15	472.16	472.15	472.17
April 86					
Sep 86	-.01	-.01	-.01	-.02	-.02
Feb 87	.00	-.01	-.01	-.01	-.01
Sep 87	.00	.00	.00	-.01	-.02
Feb 88	-.04	-.05	-.05	-.05	-.05
Jan 89	-.02	-.03	-.02	-.03	-.02
Aug 89	+ .03	+ .02	+ .02	+ .01	+ .02
Feb 90	.00	-.01	.00	-.01	-.01
Feb 91	+ .02	+ .01	+ .02	+ .01	+ .01

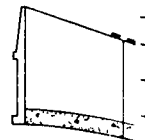
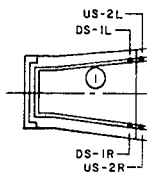
VERTICAL MOVEMENT IN FEET RIGHT WALL

DATE	DS-1R	US-2R	DS-2R	US-3R	DS-3R	US-4R
ORIGINAL ELEV.	478.75	478.47	472.15	472.15	472.15	472.16
April 86						
Sep 86	.00	+ .01	-.02	-.02	-.01	.02
Feb 87	.00	-.01	-.01	-.01	.00	-.01
Sep 87	.01	-.02	.01	-.01	.01	-.01
Feb 88	-.04	-.04	-.05	-.05	-.04	-.05
Jan 89	-.02	-.02	-.03	-.03	-.02	-.03
Aug 89	+ .02	+ .01	+ .01	.00	+ .01	.00
Feb 90	+ .01	+ .02	.00	-.01	+ .01	.00
Feb 91	+ .01	+ .01	.00	.00	+ .01	.00

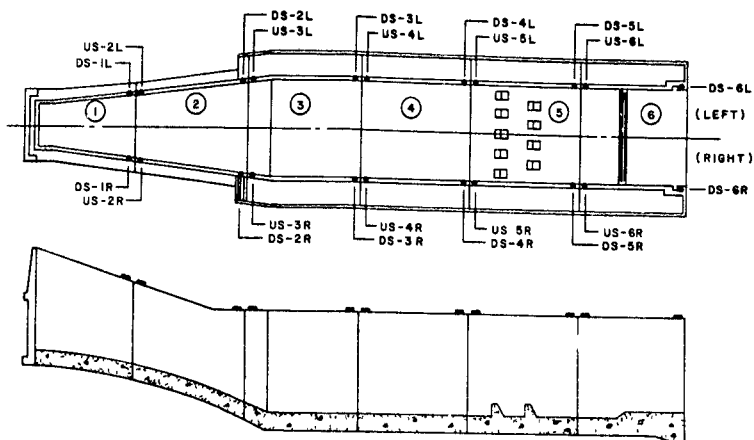
DATE	DS-4R	US-5R	DS-5R	US-6R	DS-6R
ORIGINAL ELEV.	472.15	472.15	472.14	472.14	472.16
April 86					
Sep 86	-.02	-.02	-.01	-.02	-.02
Feb 87	-.01	-.02	-.01	-.02	-.01
Sep 87	.01	-.01	.00	-.01	-.01
Feb 88	-.05	-.06	.04	.05	-.05
Jan 89	-.03	-.03	-.02	-.03	.03
Aug 89	+ .01	.00	+ .01	.00	.00
Feb 90	+ .01	.00	+ .01	.00	.00
Feb 91	+ .01	.00	+ .01	+ .01	.01

(+) = heave

(-) = settlement



US-4L
472.15
-01
-01
-01
-05
-03
+01
-02
+01



US-4R
472.16
-02
-01
-01
-05
-03
00
00
00

JOE POOL LAKE
STILLING BASIN REFERENCE MARKS
Outlet Works

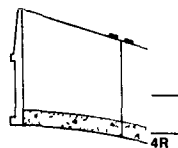
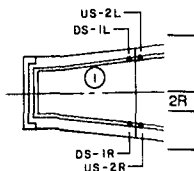
US ARMY ENGINEER DISTRICT, FT WORTH

PLATE

CORPS OF ENGINEERS

HORIZONTAL MOVEMENT (Distance Between Points)

DATE	DS-1L TO DS-1R	US-2L TO US-2R	DS-2L TO DS-2R
ORIGINAL DIST.			
April 86	16 25'	16 47'	23 67'
Sep 86	16 24'	16 46'	23 67'
Feb 87	16 24'	16 47'	23 67'
Sep 87	16 24'	16 47'	23 67'
Feb 88	16 24'	16 46'	23 67'
Jan 89	16 23'	16 45'	23 66'
Aug 89	16 25'	16 47'	23 68'
Feb 90	16 24'	16 46'	23 66'
Feb 91	16 24'	16 46'	23 66'

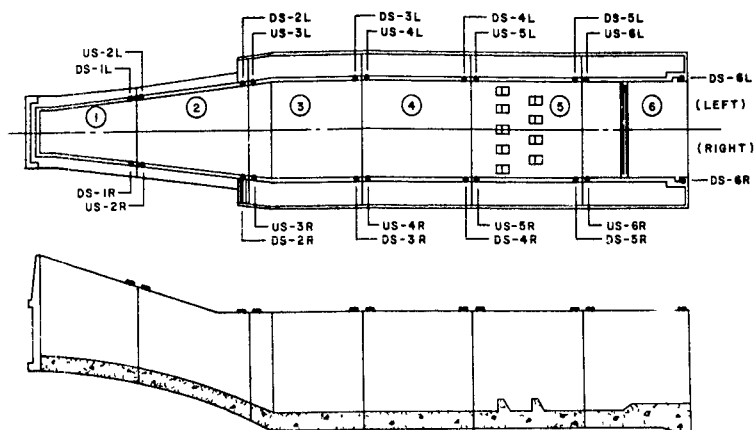


DATE	US-3L TO US-3R	DS-3L TO DS-3R	US-4L TO US-4R
ORIGINAL DIST.			
April 86	23 93'	25 23'	25 26'
Sep 86	23 93'	25 23'	25 25'
Feb 87	23 93'	25 23'	25 26'
Sep 87	23 94'	25 23'	25 26'
Feb 88	23 92'	25 22'	25 25'
Jan 89	23 92'	25 22'	25 25'
Aug 89	23 94'	25 24'	25 27'
Feb 90	23 93'	25 22'	25 25'
Feb 91	23 92'	25 22'	25 25'

DATE	DS-4L TO DS-4R	US-5L TO US-5R	DS-5L TO DS-5R
ORIGINAL DIST.			
April 86	25 36'	25 37'	25 39'
Sep 86	25 36'	25 37'	25 39'
Feb 87	25 37'	25 38'	25 40'
Sep 87	25 36'	25 37'	25 39'
Feb 88	25 36'	25 37'	25 39'
Jan 89	25 36'	25 38'	25 39'
Aug 89	25 37'	25 38'	25 39'
Feb 90	25 36'	25 37'	25 39'
Feb 91	25 36'	25 36'	25 29'

DATE	US-6L TO US-6R	DS-6L TO DS-6R
ORIGINAL DIST.		
April 86	25 40'	25 29'
Sep 86	25 40'	25 30'
Feb 87	25 40'	25 29'
Sep 87	25 40'	25 29'
Feb 88	25 40'	25 28'
Jan 89	25 40'	25 29'
Aug 89	25 40'	25 29'
Feb 90	25 40'	25 29'
Feb 91	25 40'	25 29'

5R

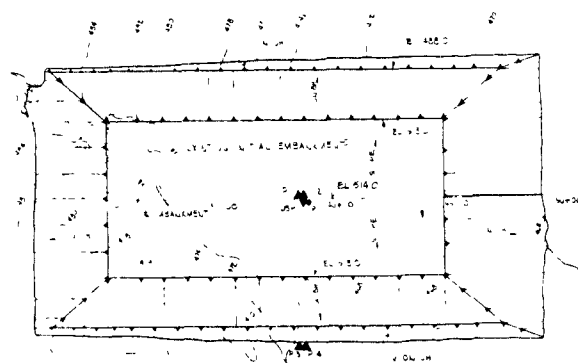
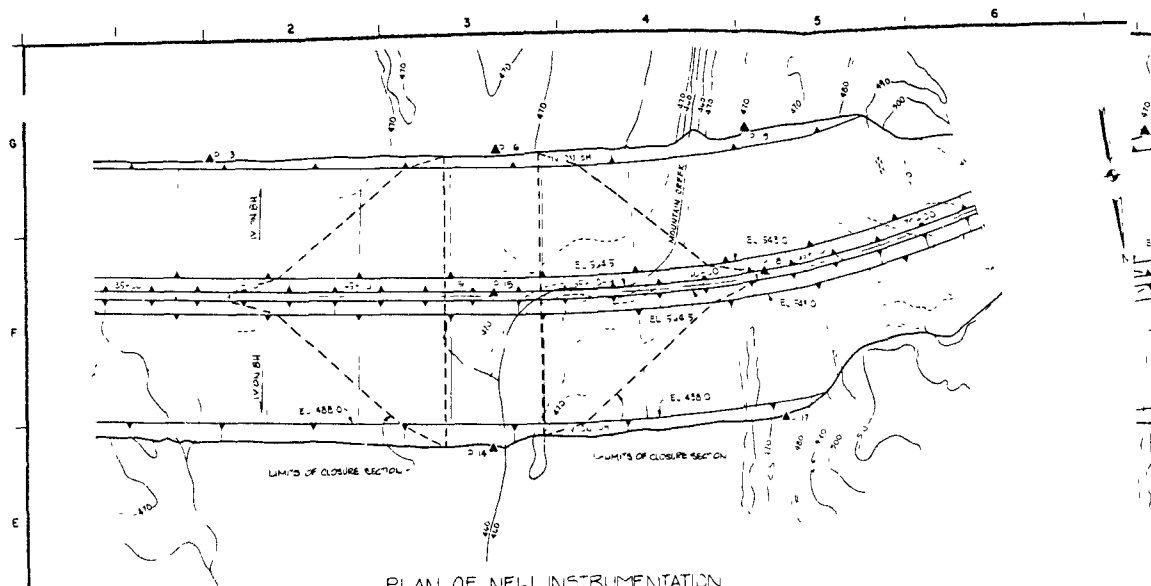


JOE POOL LAKE
STILLING BASIN WALL REFERENCE MARKS
Outlet Works

U.S. ARMY ENGINEER DISTRICT, FT. WORTH



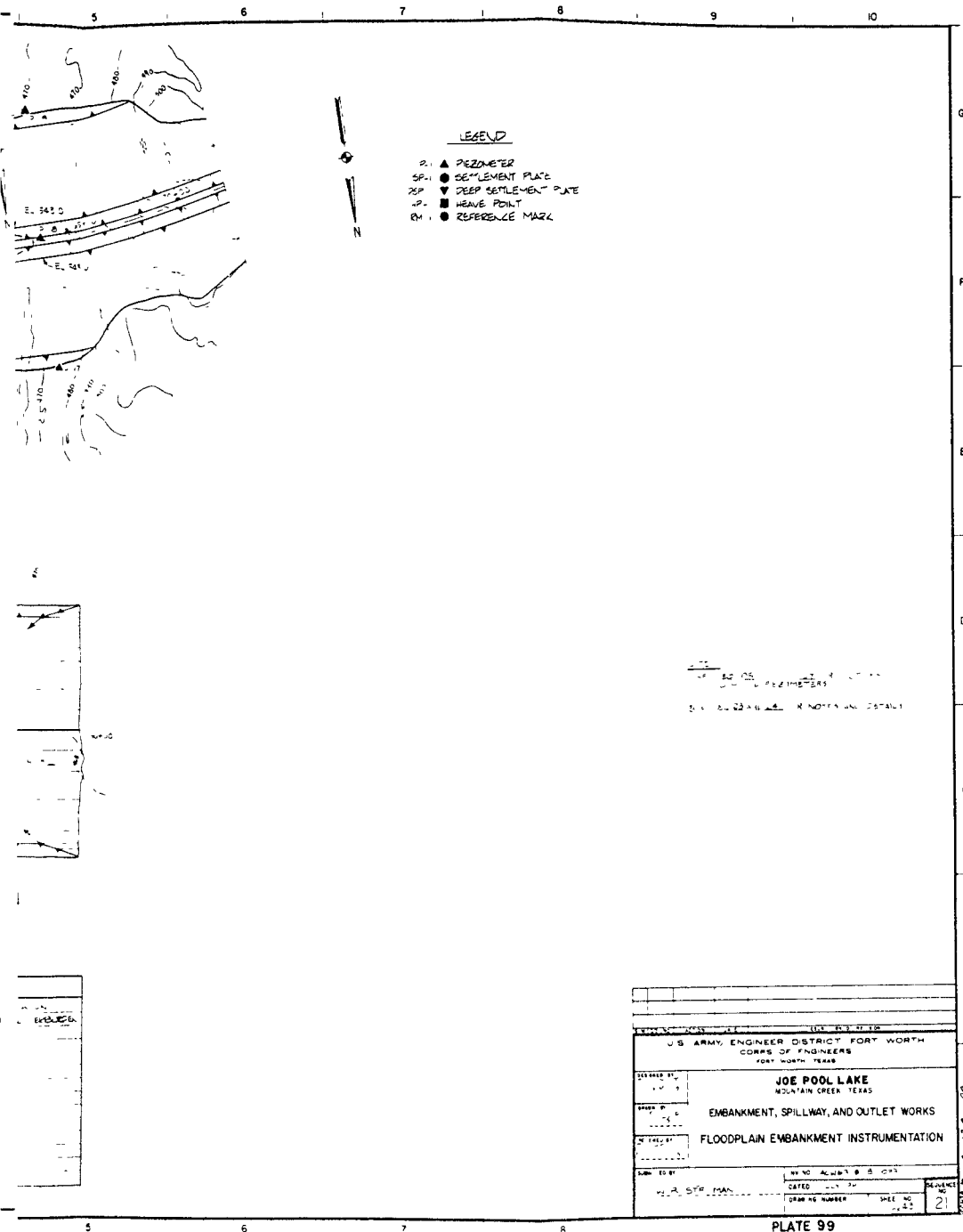
PLATE 98

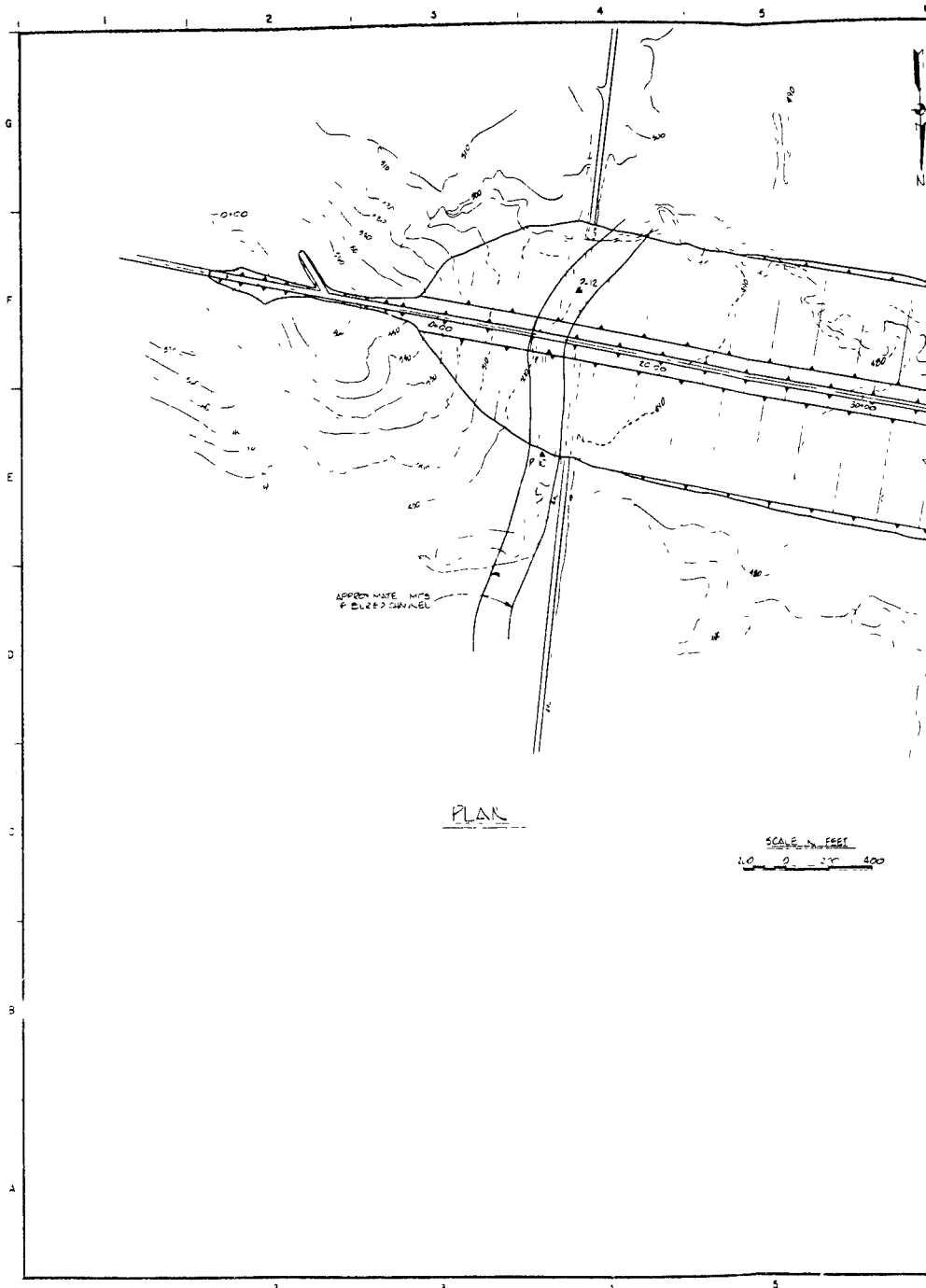


PLAN OF EXISTING INSTRUMENTATION

[illegible]

* L I E PERIMETER T I E E V A T I O N H W W A Z E A P P R O X I M A T E
A I T A L I E A T I O N S H O U L D B E D E T E R M I N E D A T T H E C O U N T Y A T





S-27	
10-27	
11-27	
12-27	
13-27	
14-27	
15-27	
16-27	
17-27	
18-27	
19-27	
20-27	
21-27	
22-27	
23-27	
24-27	
25-27	
26-27	
27-27	

NOTE

PLAN

SCALE IN FEET
10 0 100 200

SHEET 3 OF INSTRUMENTATION				
NO	STATION	OFFSET	FEET ELEVATION	REMARKS
P-10	5+70	5000	440 - 444	} LOCATED N. BURIED CHANNEL
P-11	15+25	7000	440 - 444	
P-12	16+10	2200	440 - 444	

* NOTE: ELEVATION SHOWN WERE APPROXIMATE ACTUAL ELEVATIONS WILL BE DETERMINED AT THE TIME OF INSTRUMENTATION.

SCALE 1" = 50 FT
200 400 600

NOTES

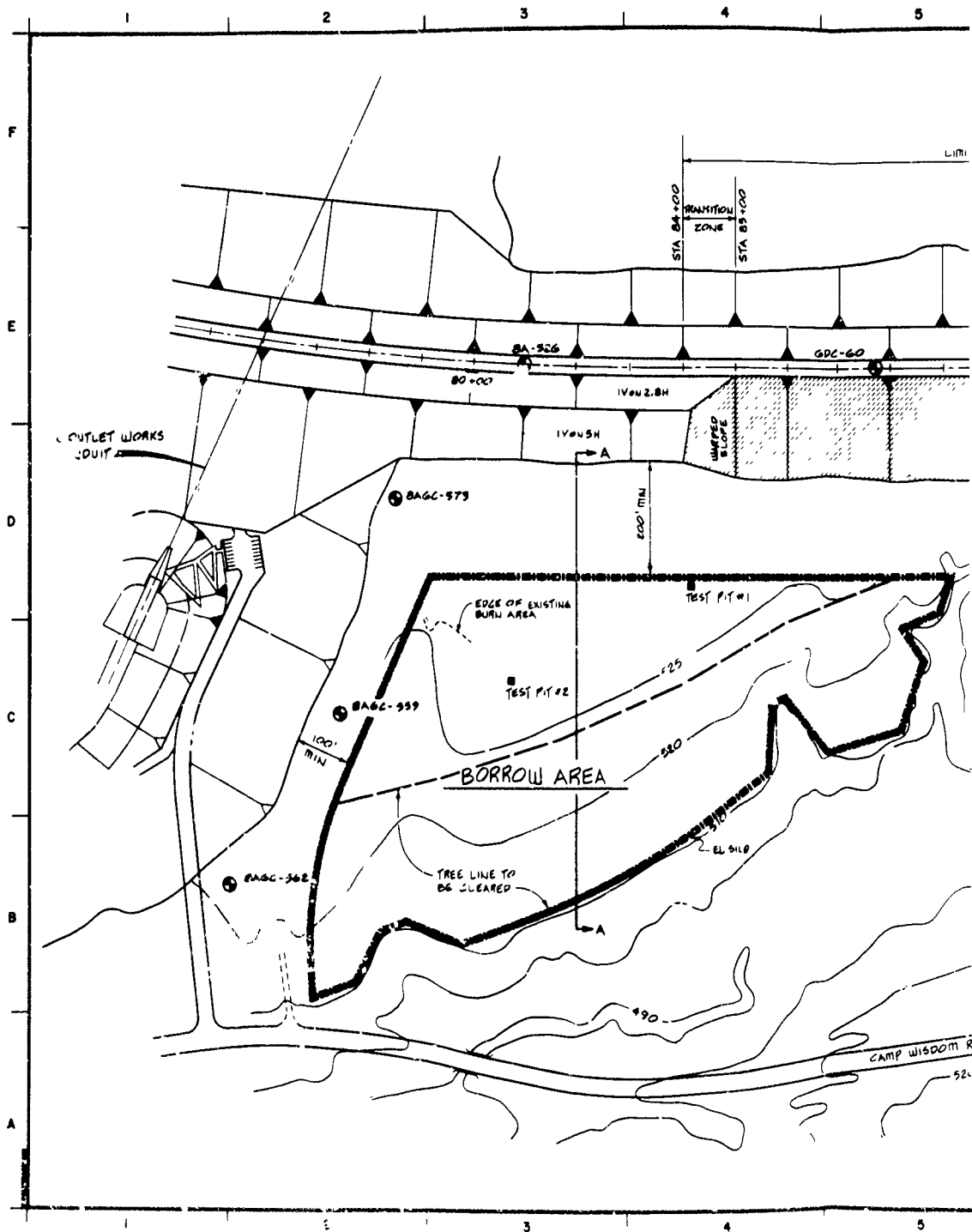
1 SEE SHEET 104 FOR SECTION THROUGH
MEASUREMENTS

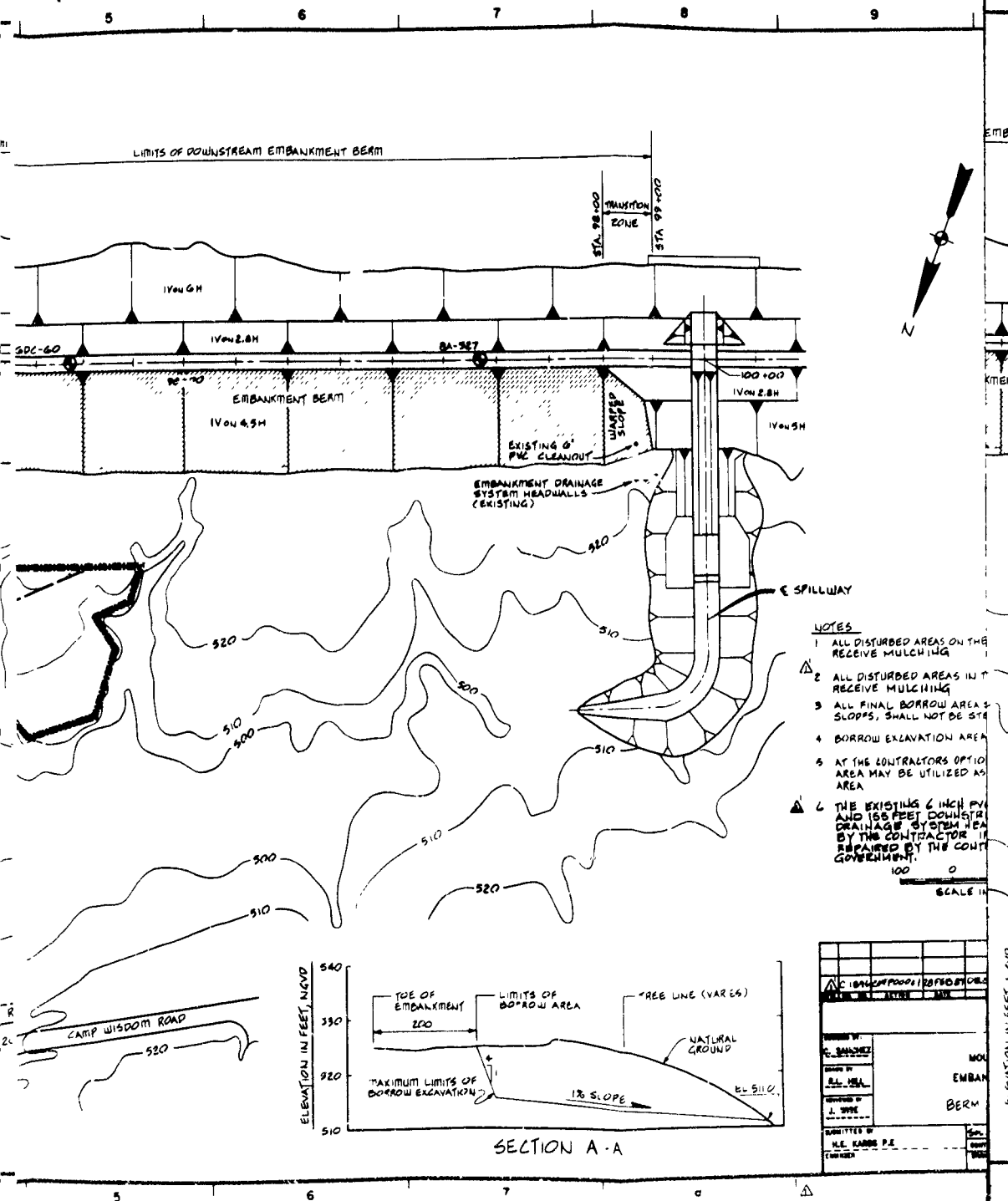
2 SEE SHEET 104 FOR LAYOUT

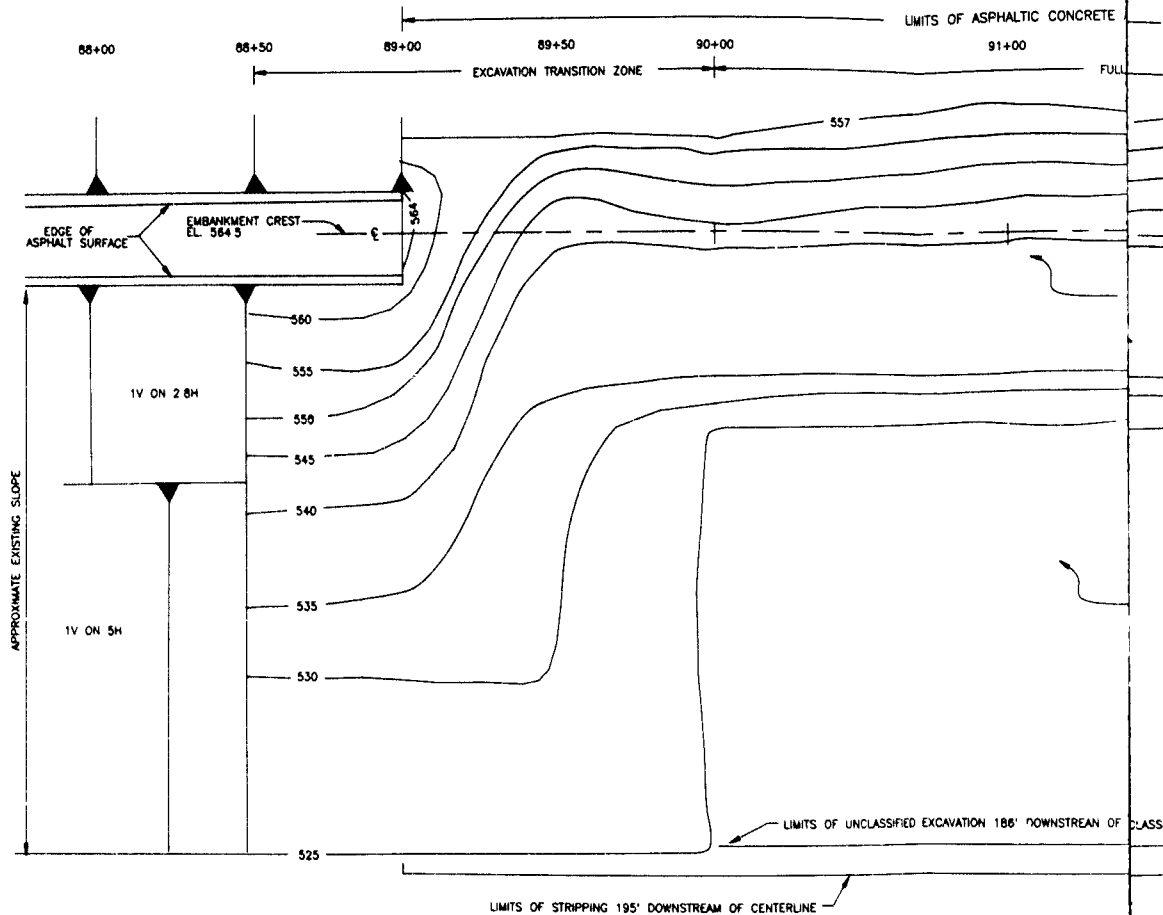
3 SEE SHEET 104 AND 105 FOR NOTES AND DETAILS

U.S. ARMY ENGINEER DISTRICT FORT WORTH CORPS OF ENGINEERS FORT WORTH TEXAS									
JOE POOL LAKE MOUNTAIN CREEK TEXAS									
EMBANKMENT, SPILLWAY, AND OUTLET WORKS									
PLAN OF INSTRUMENTATION BURIED CHANNEL AT RIGHT ABUTMENT									
DESIGNED BY R. STEPHAN	<table border="1"> <tr> <td>DATE</td> <td>NOV 1954</td> </tr> <tr> <td>DRAWN BY</td> <td>NOV 1954</td> </tr> <tr> <td>CHECKED BY</td> <td>NOV 1954</td> </tr> <tr> <td>APPROVED BY</td> <td>NOV 1954</td> </tr> </table>	DATE	NOV 1954	DRAWN BY	NOV 1954	CHECKED BY	NOV 1954	APPROVED BY	NOV 1954
DATE	NOV 1954								
DRAWN BY	NOV 1954								
CHECKED BY	NOV 1954								
APPROVED BY	NOV 1954								
SEQUENCE NO. 20									

PLATE 100







LIMITS OF ASPHALTIC CONCRETE AND STABILIZED AGGREGATE BASE COURSE EXCAVATION

91+00

92+00

93+00

94+00

FULL EXCAVATION ZONE

EXCAVATION TRANSITION ZONE

D AC

INE

557

555

550

545

540

EL 540

535

530

525

EL 525

51

52

53

540

535

530

525

CLASSIFIED EXCAVATION 186 DOWNSTREAM OF CENTERLINE



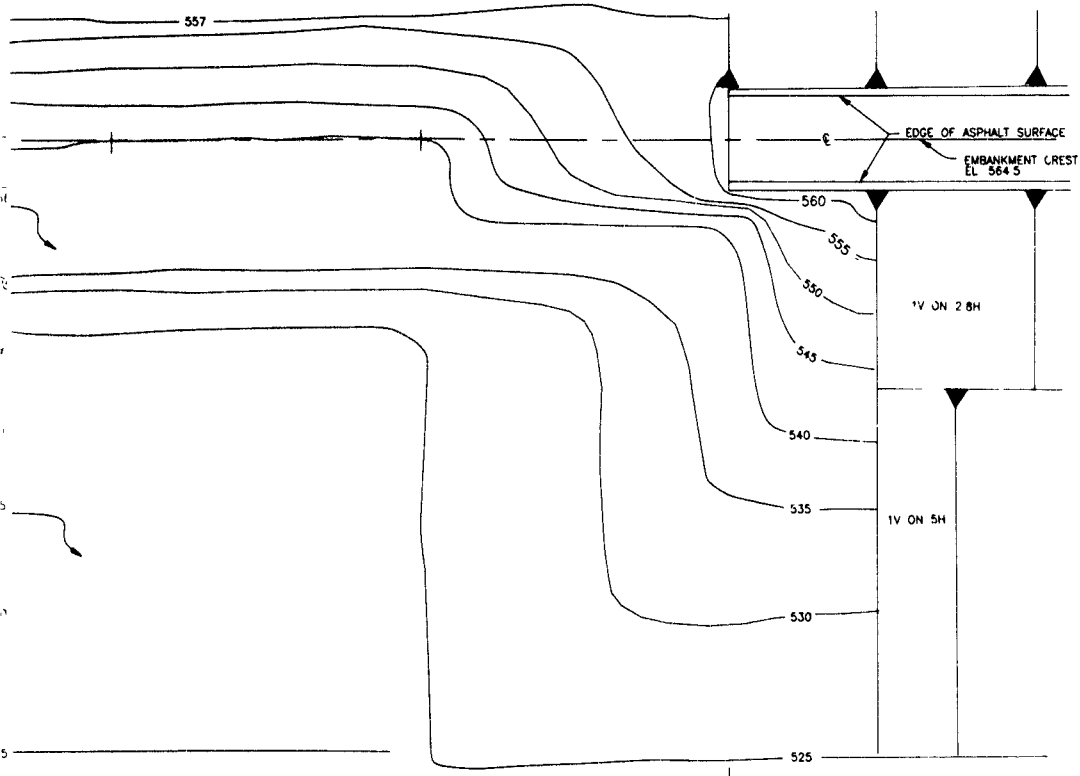
SCALE IN FEET

		15 APR 2001	
SYMBOL NO.		2001	
ENGINEERING DIVISION GEOTECHNICAL BRANCH			
DESIGNED BY	EMBA E		
DRAWN BY			
CHECKED BY			
APPROVED BY			
H. KARRS			

D AGGREGATE BASE COURSE EXCAVATION

92+00 93+00 94+00 94+50 95+00

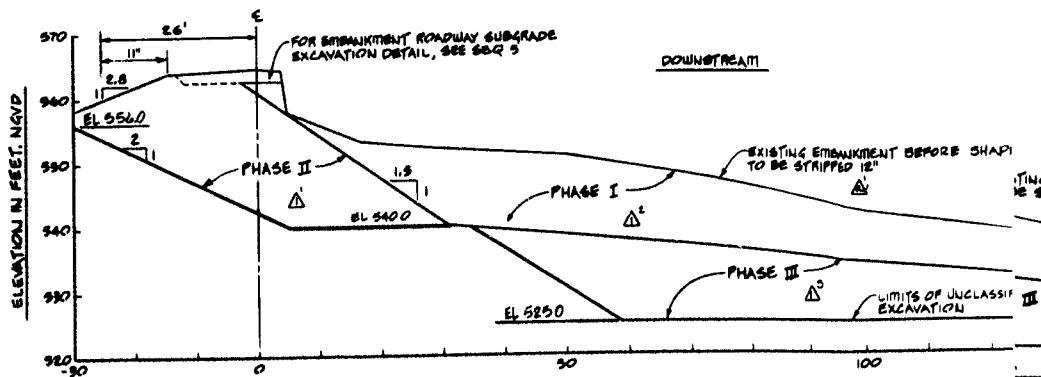
EXCAVATION TRANSITION ZONE



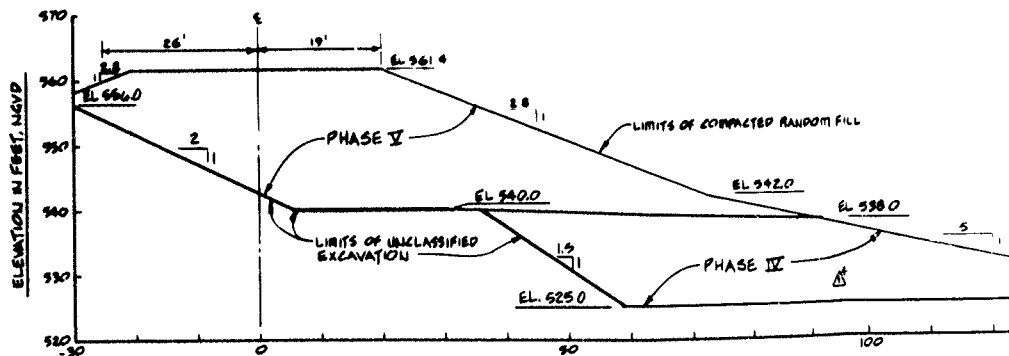
SCALE IN FEET

15 APR 1981		ASBUILT	
ENGINEERING DIVISION GEOTECHNICAL BRANCH		U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
DESIGNED BY S. J. JAMES		JOE POOL LAKE MOUNTAIN CREEK LAKE EMBANKMENT SLIDE REPAIR EXCAVATION PLAN	
CHECKED BY L. J. JAMES			
REVIEWED BY J. J. JAMES			
DRAWN BY H. KARBS		REVISION NO.	DATE
ENGINEER		CONTRACT NO.	SHEET NO. OF
		DRAWING NUMBER	SEQUENCE NO.

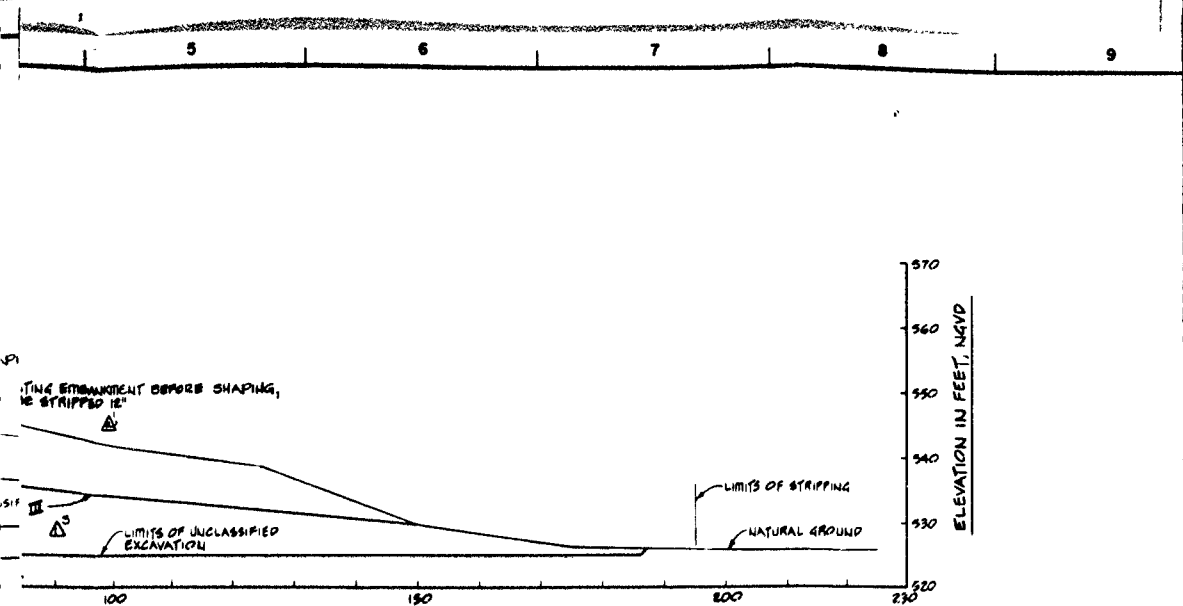
PLATE 102



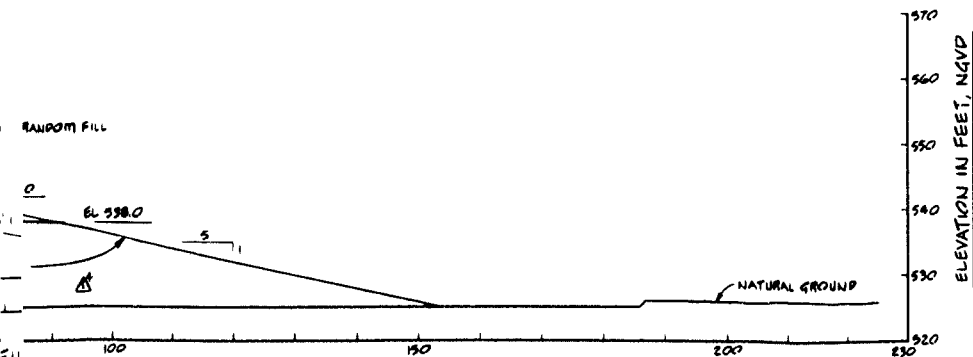
TYPICAL EXCAVATION SECTION



TYPICAL COMPACTED RANDOM FILL



NATURAL EXCAVATION SECTION



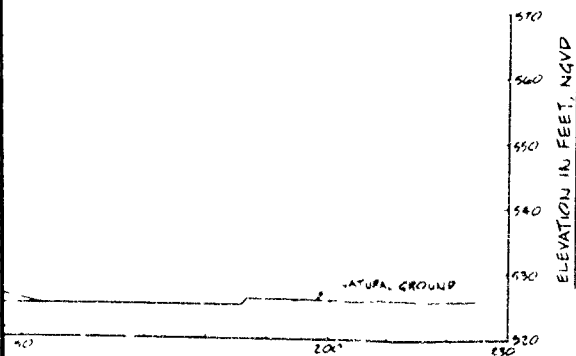
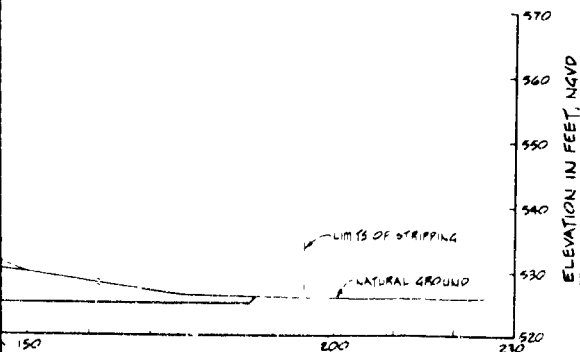
IMPACTED RANDOM FILL SECTION

NOTES

1. PHASE I EXCAVATION SHALL BE COMPLETED PRIOR TO START OF PHASE II EXCAVATION.
2. TOTAL WORK REQUIRED FOR PHASE II EXCAVATION SHALL BE COMPLETED PRIOR TO START OF PHASE III EXCAVATION.
3. PHASE IV COMPACTED FILL SHALL BE PLACED AFTER PHASE III EXCAVATION IS COMPLETED.
4. LIMITS OF UNCLASSIFIED EXCAVATION WILL VARY.
5. ACTUAL LIMITS WILL VARY.

10 0 10 20 30
SCALE IN FEET: 1"=10'-0"

PROJECT NO.	204100-0000	74P
DATE	AMR00011F00	
DESIGNED BY	RL HILL	
CHECKED BY	J. WISE	
SUBMITTED BY	H. KARBS	
DATE		



10 0 10 20 30
SCALE - FEET 0 5

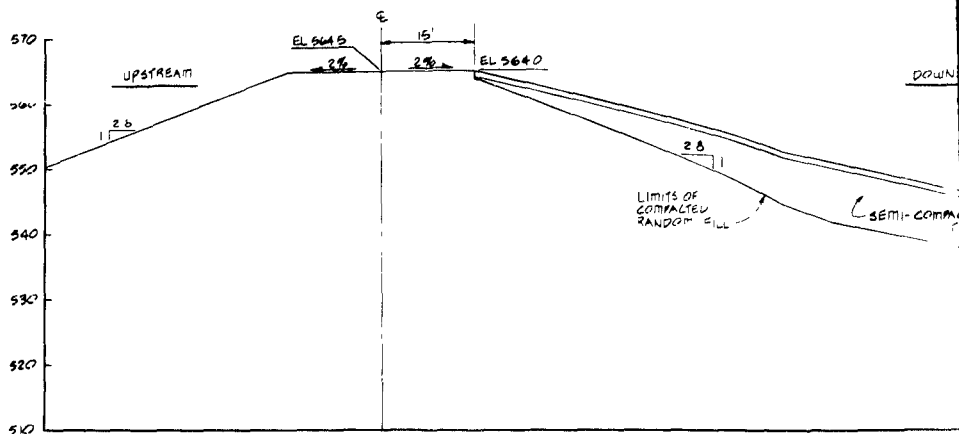
NOTES

- 1 PHASE I EXCAVATION SHALL BE COMPLETED PRIOR TO STARTING PHASE II EXCAVATION, AND PHASE II EXCAVATION SHALL BE COMPLETED PRIOR TO STARTING PHASE III EXCAVATION
- 2 TOTAL WORK REQUIRED TO EXCAVATE AND PLACE COMPACTED FILL BACK TO EL 561.4 SHALL NOT EXCEED 30 CALENDAR DAYS
- 3 PHASE IV COMPACTED FILL SHALL BE COMPLETED WITHIN 7 CALENDAR DAYS AFTER COMPLETION OF PHASE III EXCAVATION
- 4 LIMITS OF UNCLASSIFIED EXCAVATION AND COMPACTED RANDOM FILL PLACEMENT WILL VARY IN TRANSITION AREAS
5. ACTUAL LIMITS WILL VARY BASED ON FIELD CONDITIONS

PROJECT NO. 204100-0000		TAPER		GENERAL REVISIONS	
A - AMP 0001		FEB 01		REVISED TO REFLECT W.I. CHANGES	
DESIGNED BY		CHECKED BY		REVISIONS	
E. SANKAR		J. KAROS		1	
SUBMITTED BY		J. KAROS		2	
DATE		10/10/00		3	
SUBMITTED BY		J. KAROS		4	
DATE		10/10/00		5	
SUBMITTED BY		J. KAROS		6	
DATE		10/10/00		7	
SUBMITTED BY		J. KAROS		8	
DATE		10/10/00		9	
SUBMITTED BY		J. KAROS		10	
DATE		10/10/00		11	
SUBMITTED BY		J. KAROS		12	
DATE		10/10/00		13	
SUBMITTED BY		J. KAROS		14	
DATE		10/10/00		15	
SUBMITTED BY		J. KAROS		16	
DATE		10/10/00		17	
SUBMITTED BY		J. KAROS		18	
DATE		10/10/00		19	
SUBMITTED BY		J. KAROS		20	
DATE		10/10/00		21	
SUBMITTED BY		J. KAROS		22	
DATE		10/10/00		23	
SUBMITTED BY		J. KAROS		24	
DATE		10/10/00		25	
SUBMITTED BY		J. KAROS		26	
DATE		10/10/00		27	
SUBMITTED BY		J. KAROS		28	
DATE		10/10/00		29	
SUBMITTED BY		J. KAROS		30	
DATE		10/10/00		31	
SUBMITTED BY		J. KAROS		32	
DATE		10/10/00		33	
SUBMITTED BY		J. KAROS		34	
DATE		10/10/00		35	
SUBMITTED BY		J. KAROS		36	
DATE		10/10/00		37	
SUBMITTED BY		J. KAROS		38	
DATE		10/10/00		39	
SUBMITTED BY		J. KAROS		40	
DATE		10/10/00		41	
SUBMITTED BY		J. KAROS		42	
DATE		10/10/00		43	
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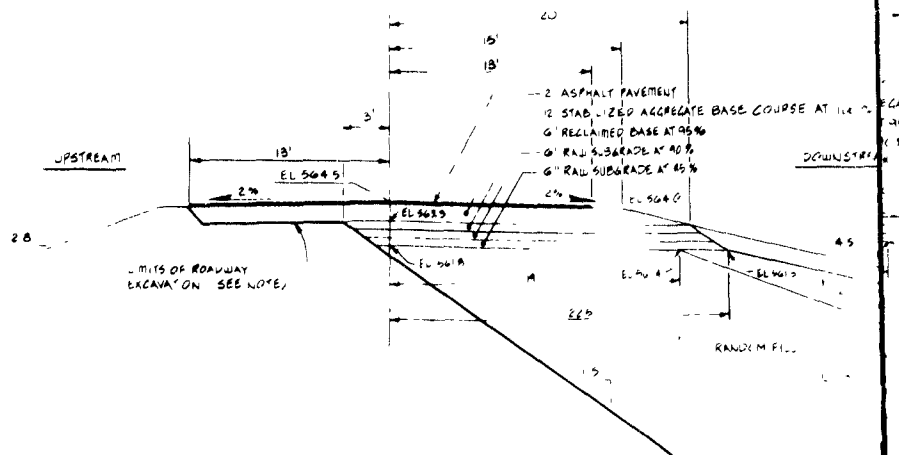
JOE POOL LAKE
MOUNTAIN CREEK, TEXAS
EMBANKMENT SLIDE REPAIR
TYPICAL REPAIRS SECTIONS

ELEVATION IN FEET, NAVD



TYPICAL SEMI-COMPACTED

STA 85+00 TO STA 99+00



TYPICAL CROWN AND EMBANKMENT ROAD

STA 90+00 TO STA 99+00

NTS

UP TO UP RUN
AT STA 99+00
ENT

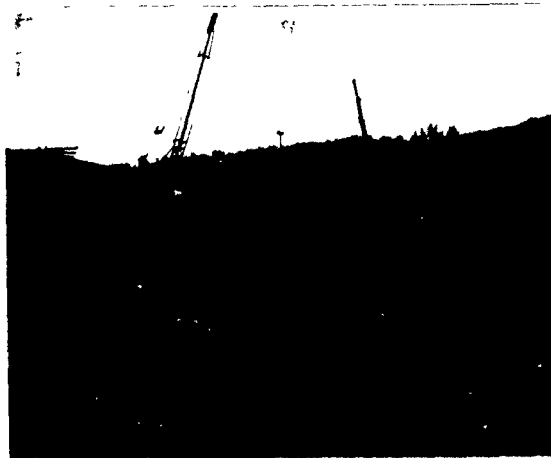


Photo No.1 Initial Contract 20 Mar 81
View along outlet works conduit showing protective concrete
and steel placement. Note block-outs for conduit bottom
collars and mobile excavation templates.

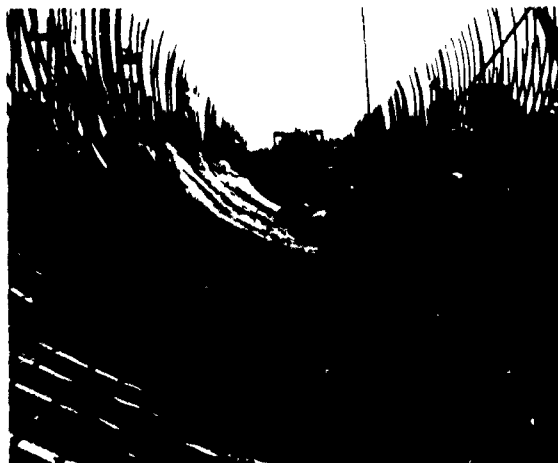


Photo No. 2 Initial Contract 20 Mar 81
View of outlet works steel for conduit invert.



Photo No. 3 Initial Contract 5 Aug 81
View of outlet works conduit and backfill. Note also the thin coal tar epoxy coated steel alignment conduit collars. Steel collars were 1" thick by 2'-0" wide. All joints were water-stopped. A 1/2" by 2'-0" neoprene backing was used for the steel collars.



Photo No. 4 Initial Contract 16 Dec 80
View of Holland loader used for borrow excavation.



Photo No. 5 Completion Contract 15 Sep 82
View from right abutment along embankment centerline. Note
deep inspection trench in foreground.



Photo No. 6 Completion Contract 15 Sep 82
View of Holland loader excavation operation in borrow area.

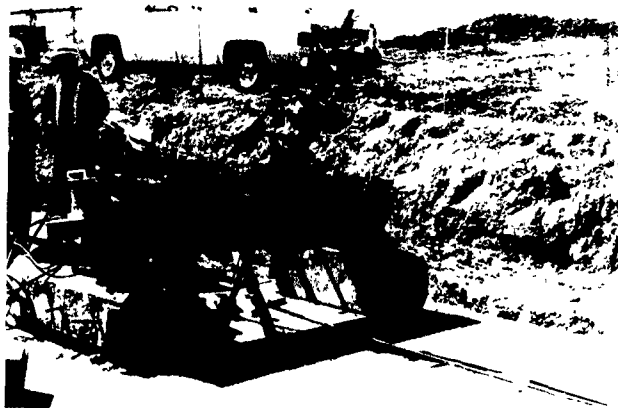


Photo No. 7 Completion Contract 15 Apr 83
Anchor pull-out test on spillway chute. Anchor is No. 11 rebar
(60 ksi) grouted in 6-inch diameter hole. Anchor lengths were
21 feet in the outlet works and 15 feet in the spillway.

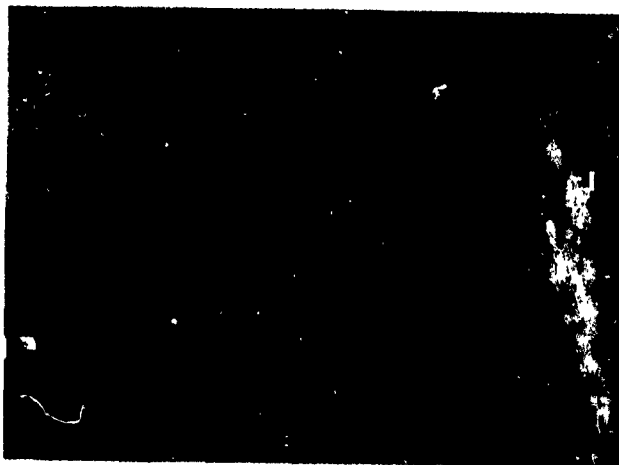


Photo No. 8 Completion Contract 26 Jan 84
View east from sta. 96+. Note disc plows being pulled by
rubber-tired tractor and by dozers, and the use of end dumps
and belly dumps for hauling.



Photo No. 9 Completion Contract 9 Mar 84
Typical embankment surface drainage system pipe and impact
basin (sta. 59+)



Photo No. 10 Completion Contract 9 Apr 84
View looking easterly at typical compaction operation
using towed tamping rollers.

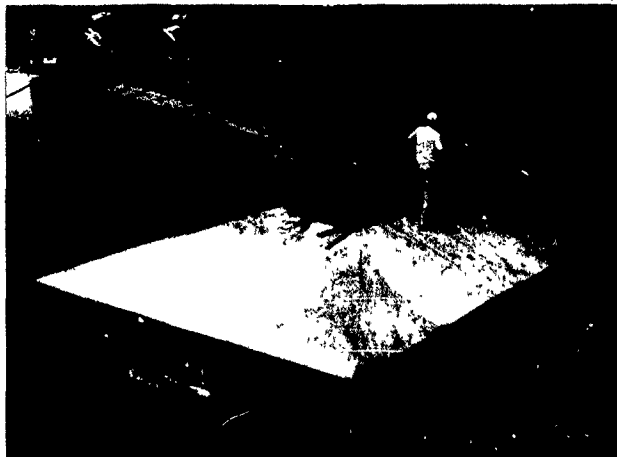


Photo No. 11 Completion Contract 25 Jul 84
View of outlet works tower bridge pier footing.



Photo No. 12 25 Jul 84
Completion Contract

View of outlet works tower. Note
concrete placement for service
bridge piers.



Photo No. 13 Completion Contract 25 Jul 84
View looking easterly at broadcrested spillway and chimney
drain construction. Outlet works is visible in background.



Photo No. 14 Completion Contract 22 Sep 84
Muck removal in D/S portion of diversion channel in the
closure section. Downstream plug is visible at far left
background.



Photo No. 15 Completion Contract 22 Sep 84
View of borrow area scraper operation. Note water wagon being
used to pre-wet materials. Pre-wetting was not a typical prac-
tice, but when used, it greatly reduced the required amount of
moisture adjustment necessary at the embankment.



Photo No. 16 Completion Contract 7 Nov 84
View looking westerly at U/S cofferdam construction.



Photo No. 17 Completion Contract 13 Feb 85
View easterly at fill placement operations during embankment closure. Note well organized placement, discing, and compaction occurring concurrently at different locations.



Photo No. 18 Completion Contract 1 Apr 85
View looking easterly at embankment closure operations. Note larger body of water upstream is a portion of Borrow Area "A" that was excavated too deep to drain.



Photo No. 19 Completion Contract 1 Apr 85
View looking easterly showing spillway, outlet works,
closure section, and ponded water in some upstream borrow
areas.

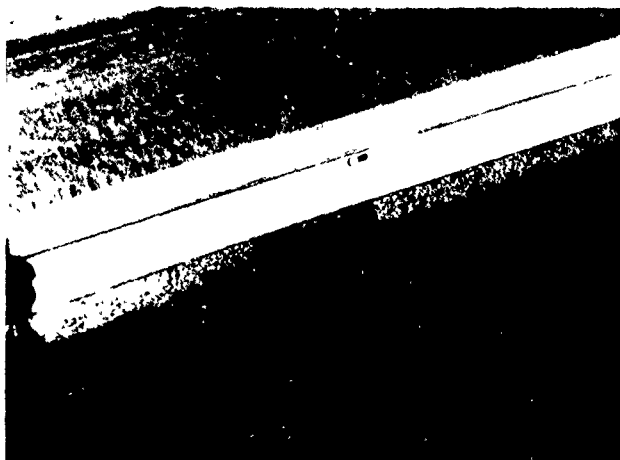


Photo No.20 12 Feb 87
Improper backfilling around guard rail post on crest of dam.
This was typical. If uncorrected, it would provide a means for
surface water to enter the fill.



Photo No. 21

12 Feb 87

View looking up spillway chute. Weir length at crest
is 50 feet.

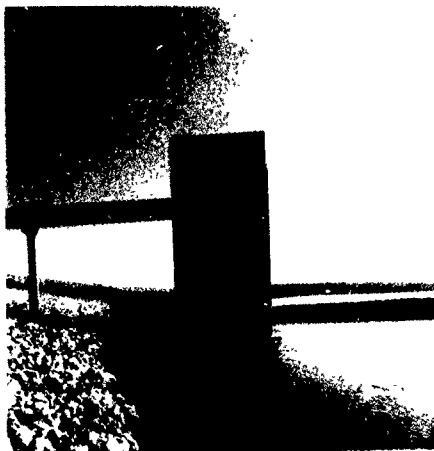


Photo No. 22

12 Feb 87

View of outlet works tower with water impoundment at
Elev. 503.6 or 18.4 feet below conservation pool.