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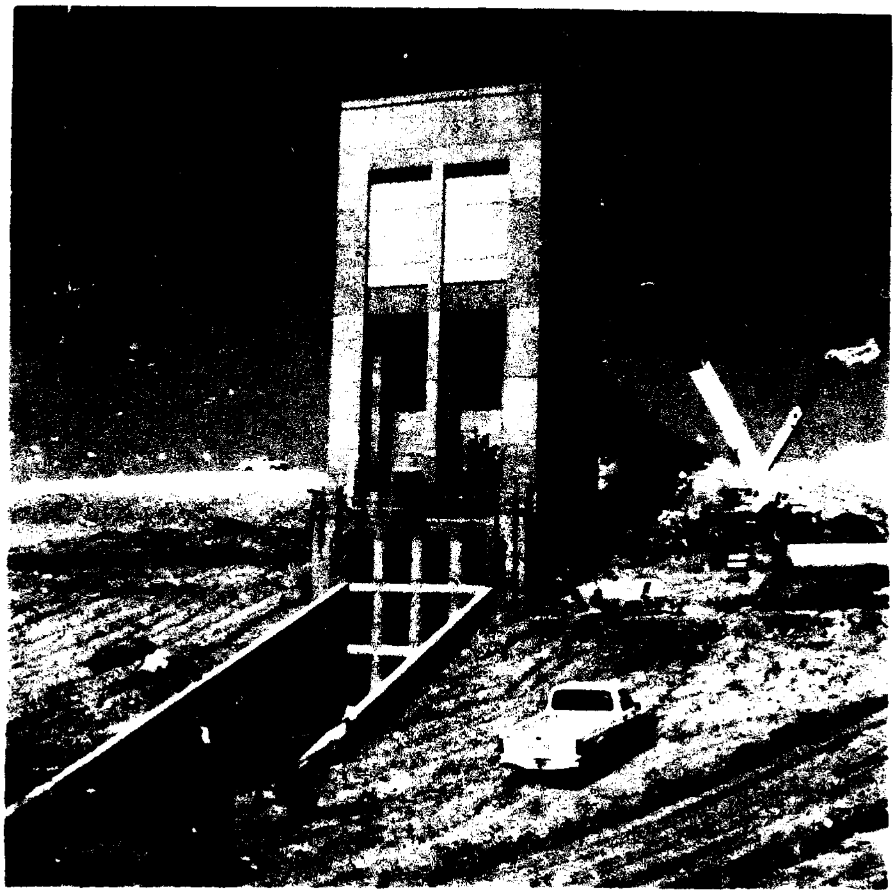
US Army Corps of Engineers
Fort Worth District

FINAL FOUNDATION REPORT

(5)

COMPLETION OF EMBANKMENT OUTLET WORKS AND SPILLWAY

COOPER LAKE
SULPHUR RIVER, TEXAS



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A-1

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PREFACE

This report was prepared in the Geotechnical Branch, Engineering Division, Fort Worth District. The report was authored by Project Geologist, George Ruede, under the supervision of the Chief, Engineering Geology Section, Robert C. Behm, and Chief of the Geotechnical Branch, Melvin G. Green

District Engineers for the Fort Worth District during construction of Cooper Lake were Colonel John E. Schaufelberger, Colonel William D. Brown, and Colonel John A. Mills. Mr. Terry Coomes was Chief, Engineering Division. Area Engineer for construction was Mr. James D. Lesley and later Mr. Jobie R. Smith. Project Engineer was Mr. Kenneth S. Bain who was succeeded by Mr. Donald R. Clements.

COOPER FOUNDATION REPORT

I INTRODUCTION

A. Project Location and Description of Features. Cooper Dam is located in northeast Texas on the South Sulphur River at river mile 23.2 upstream of Wright Patman Dam and Lake. It is situated in Delta and Hopkins Counties, about 4 miles southeast of the town of Cooper, and 13 miles north of the town of Sulphur Springs. See Plate 1 for the lake and vicinity map.

1. Embankment. The earthfill embankment, which is approximately 28,911 feet long, has a maximum height of 68 feet above the floodplain, a top of dam elevation of 464.5 feet (after overbuild), and a crown width of 30 feet. The embankment is constructed of three different materials which are placed in zones paralleling the centerline of the dam. The outermost zones upstream and downstream from the centerline are comprised of semicompacted fill. Immediately interior from each of the semicompacted zones is a random fill zone, both upstream and downstream. The central or core zone consists of compacted impervious clay fill. See Plates 3 and 4 for plan and sections of the embankment.

2. Outlet Works. The cut-and-cover outlet works consists of an approach U-wall structure, a gate control tower, a conduit, a discharge chute, and a stilling basin. See Plates 5, 6, 7, and 8 for plans and sections of these structures. The approach, tower, and conduit are constructed on an unreinforced concrete slab 3-1/2 inches thick which extends outward beyond the structures a distance of 3 feet. The slab in turn protects the excavated surface of the foundation. The chute and stilling basin structures are constructed on an unreinforced protective concrete slab 3-1/2 inches thick, which in turn is founded on a 12-inch thickness of filter sand placed on the surface of the foundation from station 80+73.5 at the headwall downstream to approximately station 81+97.5. Sand-filled drains approximately 4.0 feet in width are located alongside the chute and stilling basin between these same stations. From outlet station 81+97.5 to the cutoff key at station 82+06.5, the structure is constructed on an unreinforced, 3-1/2 inch thick protective concrete slab which in turn covers the excavated foundation surface.

3. Spillway. The spillway walls are 505.0 feet long, extending from spillway station 5+21.0 upstream to station 10+26.0 downstream. Downstream from the weir, the interior slab flooring the spillway is comprised of six lanes crossing the spillway chute from wall footing to wall footing. Each slab lane crossing the spillway is supported by a 1.0-foot thick blanket of filter sand with a covering of 3-1/2 inches of protective concrete immediately upstream from each concrete key which is embedded in the foundation or a cross drain as at station 9+63 in the stilling basin. However, the filter blanket which is designed to drain the foundation between keys and adjacent to the cross drain in the stilling basin, is present downstream only as far as station 9+87.

Downstream from this location the slab is supported directly by the foundation to the cutoff key at the downstream end of the stilling basin. There are a total of 870 anchors constructed in the chute and stilling basin to protect the interior slab from the effects of uplift should the filter blanket beneath the slab become ineffective. The anchors are embedded 14 feet into the foundation and grouted in place. Each anchor is oriented at 90° to the foundation surface. The top of each anchor is bent 90° to parallel the concrete slab and to increase embedment in the slab concrete. See Plates 9, 10, and 11 for spillway plan and sections.

B. <u>Construction Authority</u>. Congressional authorization for construction of the Cooper Lake and Channels is contained in Public Law 218 (Chapter 501), 84th Congress, approved August 3, 1955.

C. <u>Purposes of the Report</u>. This report has been prepared pursuant to Regulation No.1110-1-1801 to record foundation conditions before and during construction. The report is also intended to record unanticipated foundation conditions encountered during construction, and methods used to overcome them.

D. <u>Location of Structures</u>.

1. <u>Embankment</u>. The earthfill embankment commences effectively at the P.T. station of the south access road on the right abutment which is station 14+60.30, or approximately embankment station -15+43.30. The embankment then extends to the spillway, across the backfilled outlet works, accross the valley of the South Sulphur River to the left abutment, then along the gently rising land surface of the left abutment to embankment station 281+50.95 where it ends. Total length of the embankment is approximately 28,911.25 feet, neglecting the interior width of the spillway.

2. <u>Spillway</u>. The spillway is located on the right abutment, the centerline of which is at embankment station 30+84.4. This point is also spillway station 6+40 and lies between the approach walls, upstream from the weir. An inspection trench into foundation material, which elsewhere follows the centerline of the embankment, is offset 80 feet upstream from the embankment alignment, crossing the spillway beneath both approach wall monolith 1 and monolith 2.

3. <u>Outlet Works</u>. The outlet works is also located on the right abutment, 440 feet toward the valley from the left spillway wall. The centerline of the outlet works is at station 38+74.34 of the embankment. This is station 70+00.00 of the outlet works conduit. See Plate 2 for the project layout.

E. <u>Contractors and Contract Supervision</u>. Cooper Dam was constructed under two contracts. The initial contract was not completed due to default of the contractor. Uncompleted work was added to the second and final contract.

1. <u>Initial Embankment Contract</u>.

Contract Number: DACW63-87-C-0019
Contractor: Caliber Construction, Inc., Conroe, Texas
Scope of Work: Construction of embankment from station 217+05 to the end of the embankment at station 281+50.95
Contract Award Price: $666,778.20
Date of Notice to Proceed: January 7, 1987
Date of Acknowledgemnt of Notice to Proceed: January 15, 1987
Work Commenced: January 15, 1987
Work Ceased: October 22, 1987 due to default of Caliber Construction Company
Total Payment: $242,034.48

2. <u>Completion of Embankment, Spillway, and Outlet Works</u>.

Contract Number: DACW63-87-C-0085
Contractor: Luhr Brothers, Inc. of Columbia, Illinois.
Contract Award Price: $41,364,970.35
Date of Notice to Proceed: August 7, 1987
Date of Acknowlegement of Notice to Proceed: August 13, 1987
Work Commenced: August 14, 1987
Payments to October 15, 1990: $36,156,109.50 (includes 34 modifications to the contract, one of which was to remedy default of Caliber contract: $396,801.37). Net without modificaions: $35,759,308.13.
Subcontractor to Luhr Brothers: Martin K. Eby Company, Inc. of Wichita, Kansas, for fine-grading structure foundations, construction of concrete structures and slabs, and mechanical and electrical work for the outlet works.
Subcontractor to Martin K. Eby Company (operation of a concrete batch plant): Lattimore Materials Company of Mckinney, Texas.
Subcontractor to Martin K. Eby Company (subsequent to completion of outlet works, spillway, and service bridges): Westbrook Ready-Mix Company of Sulphur Springs, Texas.
Subcontractor to Luhr Brothers, Inc: (for installation of foundation instrumentation, e.g. settlement plates, inclinometers, and piezometers) Woodward-Clyde Consultants of Denver, Colorado.

3. <u>Contract Supervision</u>. Both the initial and completion contracts listed above were administered by the North Texas Area Office of the Fort Worth District, first under Mr. James D. Lesley, Area Engineer until his retirement, then by Mr. Jobie R. Smith, Area Engineer. The on-site Cooper constiuction office was administered by Mr. Kenneth S. Bain, Project Engineer until his death on 11 October 1989. Mr. Donald R. Clements was appointed Project Engineer to complete construction of Cooper Dam and Lake.

II FOUNDATION EXPLORATIONS

A. **Investigations Prior to Construction**. An extensive investigation of the Cooper site was conducted by the New Orleans District between 1957 and 1974. During this investigation approximately 249 borings were drilled at the dam site and in the borrow areas. Work on Cooper Project was not prosecuted during the period between 1974 and 1984 while environmental effects of the project were litigated. During this period the Cooper project was transferred to the Fort Worth District. Approximately 74 additional borings of all types were drilled by the Fort Worth District between 1984 and 1986. The reader is referred to the publication Design Memorandum No. 3 (Revised), Cooper Lake and Channels, Embankment, Spillway, and Outlet Works, Volumes 1 and 2, January 1986 by the Fort Worth District for further details of these investigations. Boring plan and boring logs are shown on Plates 35 through 54.

B. **Investigations During Construction**. The possibility of underseepage through the sand stratum and through fractures in the overlying limestone stratum in the higher elevations of the right abutment, particularly in the vicinity of the spillway and outlet works, was considered during construction. The sand stratum, approximately 10 feet in thckness in this area, is partially cut off in the spillway proper by clay backfill in the deep inspection trench and the weir. The upper, most permeable part of the sand, and the overlying fractured limestone bed, are cut off by a wedge-shaped strip of select impervious clay embedded in the sand stratum across the entire chute slope of the spillway. The concern was that lake water entering the outcrop of the sand stratum, or possibly the fractured limestone in the upstream slopes of the abutment ridge, or water standing in the spillway, might communicate downstream to seep or flow from the surface of the embankment slope. Another concern was that due to these factors, and particularly the presence of the strip of select impervious across the chute slope, the foundation in the downstream slope of the right abutment ridge might not be in a sufficiently drained condition during normal or flood pool conditions. The area of possible downward percolation of lake water in the spillway is approximately 52,800 square feet and lies between the spillway approach apron and the backfilled deep inspection trench upstream. There will be 6 feet of water ponded here during conservation conditions. The principal remedy employed to reduce lake water entry into the sand and fractured limestone beds in the foundation upstream was to plate any outcrops with clay. This investigation was designed to locate the outcrop of the sand stratum and the limestone, if present, in the abutment slopes upstream. Three very shallow trenches, dug with a tractor-mounted backhoe, were excavated in the upstream slopes of the abutment ridge a few hundred feet upstream from the spillway. The trenches were only deep enough to penetrate all disturbed material and expose the natural in-situ materials beneath. The first trench, located about 350 feet west (left) and 450 feet upstream from the spillway, found the sand stratum at an elevation very close to that at which it was anticipated. The next two trenches nearer the spillway were commenced at elevations at least 5 feet above the anticipated elevation of the top of sand as a precautionary measure. The second trench was located so as to align with the inside face of the left spillway wall. The bottom of this trench dropped 18 feet in elevation along its path down the abutment slope, finding the top of a sand stratum at the base of the abutment ridge slope at an elevation approximately 10 feet lower than the sand stratum in the first trench. The third trench, located between the first two trenches, found only clay and did not find the lower sand because it did not terminate at quite as low an elevation at the base of the ridge slope. Results obtained in the three trench excavations seemed to indicate that a fault exists a short distance upstream from the spillway. With the sand stratum upstream offset 10 feet lower in elevation, and the sand and its immediately overlying impervious clay appearing to be the same materials as those present in the spillway (but without the limestone bed between them), it is believed that the sand stratum in the spillway proper is effectively cut off from direct recharge from the lake in this area. As will be seen subsequently under the title Structure, this natural cut off of the sand probably persists eastwardly up the abutment toward station 0+00. The practical consequence of the fault cutoff of the sand stratum in this area was that only a small area of sand outcrop need to be plated with impervious clay to reduce infiltration of lake water between the spillway and the fault. This area lies west of the spillway between the spillway and the outlet works approach channel where the land surface is a slope. Later, after the outlet approach channel had been excavated, the down-faulted portion of the sand stratum was found in the channel slopes where it ended abruptly at the anticipated location of the fault. Locations of the exploratory trenches, the fault, the spillway, and the outlet works approach channel are shown on Plate 3.

III GEOLOGY

A. Regional Geology. Cooper dam is situated in the northwestern quadrant of a regional structural feature called the East Texas Basin. The same feature is sometimes referred to as the East Texas Syncline. It is a large basin occupying nearly all of East Texas, but open on the south to merge with structure of the Gulf Coast. Peripheral to the basin on the west and north sides is a system of predominantly down-to-the-coast (down to the south), normal (gravity) faulting which extends well beyond the East Texas Basin eastward into Louisiana and Mississippi and beyond, and southward and south westward for a considerable distance beyond the basin. As expected, all of the formations other than those of surficial material (overburden/alluvium), dip into the basin more steeply than the inclination of the ground surface giving rise to the youngest bedrock units being at the ground surface in the central part of the basin. Bedrock formations in and about the area of Cooper Dam and Lake dip south and slightly to the east by reason of their being situated in the northwest quadrant of the basin. Stratigraphically, the bedrock formations croping out in the East Texas Basin range in age from Upper Cretaceous to late Tertiary See Plates 12 through 16 for regional geology map and geologic sections. Additional description of the regional geologic setting can be found in the previously referred to document entitled Design Memorandum No. 3 (Revised), Cooper Lake and Channels.

Embankment, Spillway, and Outlet Works, Volumes 1 and 2, January 1986 by the Fort Worth District, Corps of Engineers.

B. **Site Geology and Character of Foundations**.

1. **Physiography**. Physiographically the uplands of the right abutment form a gently rolling, relatively level land surface of erosional topography. A moderately steep slope divides the right abutment from the floodplain of the South Sulphur River valley in the vicinity of embankment station 43+50, a short distance west of the outlet works. This slope persists upstream as a landform for several miles. The bottom of the South Sulphur River valley is comprised of approximately two levels of very gently sloping land surface which is depositional topography. The left abutment of the dam consists of a gently rising land surface. This slope also extends upstream for several miles bordering the lake though the slope there is dissected by a few prominent tributary stream channels. As in the instance of the right abutment, this abutment is comprised of erosional topography, but differs from the right abutment by being topography developed on the dip slope of the bedrock formations.

2. **Overburden**. So far as can be discerned, there is little alluvium on either abutment. Nearly all of the overburden on both abutments is residual soil because it is the product of extreme weathering of the bedrock in-place. Alluvial and residual soils are shown on accompanying plates portraying geology of the inspection trench. Residual soils in the abutments of the dam almost universally consist of clay. Soils which were present in the inspection trench in the bottom of the Sulphur River valley are all alluvial clay, though there is some sand and silt deeper in the valley alluvium. Discriminating between alluvial soils and residual soils is done here for two reasons, because residual soils are more closely related to the bedrock beneath them than to the alluvium and because residual soils have a history of overconsolidation.

3. **Bedrock Classification and Stratigraphy**. Bedrock is classified into three principal types of material for purposes of this report: shale (the dominant bedrock lithology), limestone (a minor constituent of the bedrock sequence), and sandstone of which there is very little in the sequence. Though it is a soil, sand occurs in the bedrock sequence in the uppermost slopes of the right abutment, particularly under the spillway and again immediately beneath the embankment at the top of the abutment left (west) of the outlet works excavation. It should be noted that both the limestone bed and the sandy clay overlying it were removed from the right abutment west of the outlet works, leaving the sand stratum in-place, prior to placing embankment fill.

Stratigaphically, five rock units are involved in the foundation of the dam and its structures. They are, from oldest and deepest to youngest and nearest the surface: the Marlbrook Formation, the Neylandville Formation, the Navarro Group (undivided), and the Midway Group which in this area consists of the Kincaid Formation overlain by the Wills Point Formation. The last two, the Kincaid and the Wills Point are shown on

Plate 12, but are undivided in mapping by the State of Texas (Texarkana Sheet of the <u>**Geologic Atlas of Texas**</u>, published by the Bureau of Economic Geology). The first three of these rock units are Cretaceous in geologic age and the Midway Group is of Tertiary geologic age. All of these units are comprised predominantly of shale. Since so little thickness of these units is involved in the foundations of the spillway and the outlet works excavations, and since there are not sufficiently different physical characteristics between the Kincaid and the Wills Point to accurately distinguish them, no further use of formational names will be made, other than to say that both the Kincaid and the Wills Point may be present in the spillway/outlet works area, but that from lithology encountered in excavations, it is doubted that the Wills Point is present. Locally, just outside the spillway and outlet works area, the limestone bed at the top of the right abutment is missing from the geologic section. In the deep inspection trench immediately east of the spillway in the vicinity of embankment station 24+50, the 2 to 3 feet thick limestone bed thins eastward then disappears, being replaced by boulders, cobbles, and gravel (all of limestone), which are overlain by the sandy clay bed that overlies the limestone elsewhere. In an area where the limestone and its detrital remnants are both absent, the sandy clay lies directly on the sand bed. This relationship is that of a typical erosional unconformity of at least local extent. The limestone bed is also missing from the geologic section in the area explored with backhoe trenches upstream from the spillway. The limestone bed was also missing from the section in the approach channel of the outlet works. Relationships in this area will be described again under <u>Bedrock Structure</u>.

The principal variations within the shales exposed in excavations for the spillway and the outlet works are relatively thin layers defined by differences in sand and/or lime content of the shale matrix. The general relationship is very low sand content in the lowest elevations of the spillway and the chute and stilling basin of the outlet works, the sand content increasing upward to the sand bed near the top of the abutment. An insignificant oddity in the section is the presence of near-round concretionary masses of limestone the size of large cannon balls which occur in a few of the zones of very limy shale. The presence of the limestone masses may explain why core descriptions from borings indicated the presence of a number of thin limestone beds which on excavation were seen to be isolated bodies of limestone rather than beds. A number of limestone beds described in boring logs did not seem to correlate or produced erratic structure when correlated. Only one limestone bed of significant extent was found in excavations for the spillway and the outlet works.

4. <u>Bedrock Weathering</u>. Bedrock is weathered to a greater depth beneath the land surface in both abutments than it is elsewhere. This condition is normal and typical because the abutments have been subject to weathering for a much longer time than has bedrock beneath the flood-plain, which is the most recently eroded bedrock and is covered by alluvium. The depth to which bedrock is weathered was best exhibited in the spillway and outlet works excavations and in the deep portion of the

inspection trench on the right abutment. This can be seen in sectional views of the as-built deep inspection trench on Plates 20, 21, and 22. The depth to which weathering extends elsewhere in the right abutment and in the left abutment as well, can be seen to only a very limited extent because of the shallow depth of the trench at those sites. In the spillway portion of the deep inspection trench, weathering extends from the surface downward nearly to the base of the sand/sandstone interval. From the outlet works excavation west to the end of the right abutment (toward the South Sulphur River) the base of bedrock weathering did not appear in the inspection trench. Here all of the sand/sandstone bed is weathered and the trench is based in residual clay soil. See Plate 23 for a sectional view of the area west of the outlet works.

5. Bedrock Structure. The principal geologic structure present at the dam and lake is regional dip. In the vicinity of the South Sulphur River between the Highway 19 crossing, a short distance downstream from the dam, and the city of Commerce, a few miles upstream from the dam, regional dip is directed approximately south 20° east. No reliable data for determining regional dip of the bedrock strata are available, mainly due to faulting. The site of the dam and lake is on or very near the northern margin of the Talco-Luling-Mexia fault system, because several faults of this collective system have been mapped in the bedrock in the river bottom and the right abutment. The principal engineering effect of the faults is vertical offset of the bedrock strata. Considering the nature of the bedrock materials, no significant leakage of lake water is expected to occur along fault planes. See Plate 12 for the location of faults mapped near the dam site. A fault probably crosses the inspection trench between embankment station 15+67 and embankment station 22+67 because the limestone bed near the top of the right abutment is approximately 16 feet lower in elevation here than at station 24+55 in the deep inspection trench. The difference in elevation of the limestone bed at the two places cannot be explained by dip. The most likely location of the fault seems to be near station 16+00. See Plates 18, 19, and 20 for these relationships. This fault, being down-thrown on the side away from the South Sulphur River valley, indicates that the middle fault shown at the same location on Plate 12 is not shown correctly with its down-thrown block on the river valley side of the fault. Existence of two other faults, one on each side of this the middle fault, could not be confirmed or denied because of excessive weathering of bedrock or the bedrock being buried too deeply by alluvium to be encountered in the inspection trench.

Evidence of a probable fault was found in the right slope of the outlet works approach channel. A thin bed of sand, approximately 7 feet thick, which had lost some of its thickness through erosion, was found in the right slope at outlet station 71+00. The bed extends north toward the outlet works as far as station 72+27 where the bed abruptly terminates. No fault plane could be identified at the bed termination, because the materials there are all weathered to residual soils, but it is believed that the sand bed is terminated by the offset of a fault. The sand bed was excavated along the the side of the approach channel with a notch-shaped cut and the material removed was replaced by clay. The ground surface away from the cut and cover was also plated with clay (3- to 4 feet thickness) as additional protection against infiltration of lake water in case the sand bed was not totally offset by faulting in this immediate area. The sand bed is not terminated in the left slope of the approach channel opposite station 72+27, but there the bed rises in elevation toward the outlet works (downstream) forming a gentle flexure. From this it is inferred that the fault ended in material removed in excavating the approach channel and its displacement is made up by the flexure in the left side of the approach channel. It was not firmly established that a fault exists upstream from the spillway and outlet works as suggested here, but a line drawn to connect the most likely fault location in the inspection trench (station 16+00) with the termination of the sand bed in the right slope of the approach channel renders conditions found in the backhoe trenches easy to explain: The two trenches which found only clay at the elevation of the target sand bed of the spillway proper are upstream from the fault line as drawn and appear to be on the down-thrown side of the fault because a sand bed was found there at a lower elevation. The trench which found sand at the approximate elevation of the target sand in the deep inspection trench is downstream (toward the spillway) from the fault line as drawn and presumably is on the upthrown side of the fault. Elevation of the top of the sand bed is 422.3 feet and elevation of the bottom of the sand bed is 419.3 feet, both elevations comparing closely with those of the sandbed in the upstream slope of the deep inspection trench (see Plate 13). It should be noted that the limestone bed normally overlying the sand bed is missing here as it is east of the spillway in the deep inspection trench. In any event the effect of these relationships saved much construction effort plating the target sand outcrops upstream with 3 to 5 feet of impervious clay. The fact that sandy clay overlying the sand bed here is down-faulted supports the contention that it is a residual material derived from bedrock rather than alluvium. This is predicated on the generally accepted interpretation that faulting here is not of recent geologic age.

Both the spillway and the outlet works appear to be on the same fault block. Stratigraphic and structural relationships of the bedrock could best be seen when the rough cut excavations were first completed. Bedrock strata in the rough-cut spillway slopes revealed themselves by their differential resistance to erosion. One could follow several individual beds entirely across the spillway excavation. There were no fault offsets apparent. Approximate correlation could be made between the spillway and the outlet works. No fault offsets were apparent in the outlet works excavation either. It was visually apparent that bedrock strata dip across the spillway from the right side to the left side, but it was not so apparent whether the bed rock strata dipped upstream or downstream. Perspective within the spillway and along the downstream fall of the outlet works conduit complicated judgement visually. Sectional views of bedrock and residual soils in the deep inspection trench show clearly that these strata are not structurally planar. Rather, these views indicate a number of minor local warps. The simplest portrayal of structural dip of the bedrock in the spillway and outlet works is to treat the bedrock as being part of a single fault block. The average component of dip of the base of the limestone bed, measured in the upstream slope of the deep inspection trench between local station 1+99.5 and local station 8+99.5 is to the west (toward the valley) at the rate of 1.55 feet vertically per 100 feet horizontally. The average component of dip along the centerline of the spillway between the weir and the deep inspection trench is upstream at 0.9 feet vertically per 100 feet horizontally. Similarly, though at a much lower elevation, the component of structural dip along the conduit foundation between station 76+40.5 and station 78+43.5 is upstream at the rate of 0.13 feet vertically per 100 feet horizontally on the right side of the conduit and 0.24 feet vertically per 100 feet horizontally upstream on the left side of the conduit. But the centerline of the spillway and the centerline of the outlet works are not parallel and can be seen to converge downstream at an angle of 10.8 degrees (see Plate 3). Taken together, these data suggest that the direction of average local dip of the bedrock and residual soils in this fault block is westward and slightly upstream along the embankment alignment as it crosses the spillway. Very few fractures were mapped in the foundation of the chute and stilling basin of the outlet works. None were mapped in the approach, gate tower, or conduit structure foundations. See Plates 30, 31, and 32 for the outlet works foundation. Quite a few fractures were mapped in the foundation of the spillway. The preponderance of them were located in the stilling basin and in the lower slopes of the chute where the shale has the lowest sand content of any excavated, unweathered material. Shale in this portion of the spillway appeared to have had some low-grade cleavage developed within it. While quite a number of the fractures mapped obviously existed prior to excavation, quite a number also appeared to have developed from using a scraping tool (a backhoe) for fine grading the foundation surface of the cleavable shale. These fractures did not extend to any significant depth into the shale. See Plate 33 for the foundation of the spillway. The most significant fracturing from an engineering standpoint seemed to be those fractures encountered during initial excavation of the right end of the cutoff key at the downstream end of the spillway slab. At this location several slices of foundation shale failed into the key excavation very shortly after it was excavated with a toothed ditching machine (Vermeer T-650). In all instances the shale failed on what appeared to be slickensided cleavage surfaces dipping downstream more gently than the steep upstream 4V on 1H slope of the key. Even though the fractures were not apparent when the key was first excavated, it seems likely that they existed prior to that time because of the slickensiding on the failure surfaces (pre-failed shale). One failure occurred immediately following excavation. A second failure consisting of several thin slices of shale occurred after the earlier thicker failure slices blocking the excavation had been cleared and preparations were being made to place structural concrete. The failure section was between offset 270 right and offset 344 right of the spillway centerline. The downstream vertical surface of the cutoff key is at spillway station 10+10. The contractor (Martin K. Eby Co.) repaired the excavation and placed structural concrete as indicated in his sketch (Figure 1).

6. Ground Water. A minimum of ground water data are available from which to develop more than general conclusions. The expected

condition of the ground water table being a much subdued reflection of surface topography seems born out at the site of Cooper Dam. The only issuance of ground water from the foundation during construction was from an exploratory core hole low in the parabolic chute slope of the outlet works. Similarly in the spillway, ground water seeped from a few fractures low in the chute slope. In both instances the top of the ground water seepages was very little above the elevation of the South Sulphur River. Though fractures in the bedrock shale appear to drain well, it seems unlikely that any individual fractures extend entirely through the core of the right abutment. Even if a system of interconnected fractures extends through the core of the abutment, it seems unlikely such a system would allow significant seepage through the abutment because of the length and tortuosity of the flow paths.

7. **Leaching and/or Solution Activity**. The only condition noticed which may indicate leaching of the foundation involves the sand bed at the top of the right abutment as seen in the spillway, deep inspection trench, and the top of the abutment immediately west of the outlet works excavation. This bed is almost clayless and free draining at its top just below the limestone bed, and is progressively more clayey downward through the bed. In its basal portion it is a very poorly cemented, weathered, argillaceous sandstone locally. Whether this material was deposited as described or was changed due to downward leaching of clay is not important as properties of the material rather than its history are of primary interest here.

8. **Engineering Characteristics of the Foundation Materials.** Based on field investigations, laboratory testing, and engineering judgement, the parameters adopted for embankment design are as follows. The parameters selected are the same as those determined by NOD except for the shear strengths of the floodplain alluvium. Examination of shear strength data by SWF indicated that a non-zero angle of internal friction (phi) could be used for Q-strengths of the upper and lower alluvium. A very small but needed value (1.7°) was assigned.

Embankment Foundation Design Parameters.

(1) Upper Alluvial:

Moist unit weight 125 pcf
Saturated unit weight 130 psf

Type Strength	Cohesion, tsf	Angle of internal friction, degrees
Q	0.85	1.7
R	0.4	12.0
S	0.0	20.0

(2) **Lower Alluvial:**

Moist unit weight 125 pcf
Saturated unit weight 130 pcf

Type Strength	Cohesion, tsf	Angle of internal friction, degrees
Q	0.4	1.7
R	0.4	12.0
S	0.0	30.0

(3) **Kincaid Formation:**

Moist unit weight 120 pcf
Saturated unit weight 125 pcf

Type Strength	Cohesion, tsf	Angle of internal friction, degrees
Q	4.0	0.0
R	3.0	19.0
S	0.0	30.0

IV EXCAVATION PROCEDURES

A. Excavation Grades. Specifications for excavating foundations in the spillway and the outlet works required that a minimum of 2 feet of undisturbed material above all final grades be left in-place until final finished grades were to be excavated, except in the case of hard rock layers. The final 2 feet of material was to be excavated in a continuous operation within a period of 4 hours. If an unfavorable local weather forecast existed, the final 2 feet of excavation was to be postponed. These provisions were intended primarily to protect the rough-cut excavated surfaces from either drying or slaking when exposed to weather for a protracted period of time. Secondarily they were to protect the finished surfaces from erosion. They were first applied in grading foundations of the outlet works and were found to significantly inhibit the contractor's normal work cycle. After being excavated to finish grade, the freshly exposed surfaces were also required to be protected (to be described subsequently) then covered with protective concrete, filter material, or compacted fill within 4 hours. These specifications reduced the amount of foundation area which could be completed in a daily work cycle of 8 to 10 hours. The specification which required excavation of the final 2 feet of material within 4 hours was modified to provide that the first 1.5 feet of the final 2.0 feet to be excavated could be removed 1 day and the final 0.5 feet of material removed the following morning, immediately followed by sealing the foundation and placement of concrete, filter material, or compacted fill on the foundation. This change occurred while excavating conduit monoliths in the outlet works. The modification resulted in an increase in production without inducing any visible deterioration of the foundation. Very few areas in either the outlet works or the spillway were significantly overexcavated, none of which were by direction. The first of these areas was the site of the collar foundation at the downstream end of the transition section from the gate tower to the conduit. The contractor extended flat-bottom grading downstream beyond the transition, through the site of the collar, into the upstream end of the first conduit monolith, thereby removing foundation shale needed to form a V-bottom for the collar and conduit monolith. The overexcavated shale was replaced by backfill concrete, formed to support the structural concrete of the collar and the conduit monolith. Shale comprising the foundation of spillway wall footing L-14 was overexcavated as much as 2 feet. This apparently occurred because the area was one in which excavating equipment turned sharply while rough-cutting the stilling basin. The overexcavated shale was replaced by over-thickening the slab of protective concrete covering the shale. Similarly, the few other locations where the structure foundations were overexcavated were corrected by thickening the filter sand or protective concrete, whichever directly covered the foundation.

B. Unanticipated Foundation Conditions Encountered During Construction. The cutoff key beneath the end sill at the downstream end of the spillway slab was first excavated from offset 344 feet right to offset 294 feet right (50 feet) on 25 October 1988. The upstream slope of the key was cut first using a self-propelled Vermeer T-650 ditching machine (effectively a saw). The upstream slope of the key is inclined downstream at the rate of 4 feet vertical on 1 foot horizontal. This cut was approximately 5.5 feet deep and its width was approximately that of the cutter head. Large splinter-shaped pieces of shale slid out of the upstream slope into and across the cut before the intended full length of the first cut was completed. The vertical downstream face of the key was then cut and the slide blocks were removed from the key excavation. The upstream slope of the key was then laid back to a slope of 1 foot vertical on 1 foot horizontal, which was the approximate dip of the planes on which the blocks of shale had slid downstream. The shale was then sprayed with Aerospray 70 to protect it from drying. Very shortly after this a number of large but thin (3 inches thick?) sheets or slices of shale slid out of the upstream slope of the key, crossing the key excavation. The key excavation was then refilled with a temporary backfill of shale rubble because of imminent rain showers. The slide planes on which the shale moved were poorly slickensided fractures dipping downstream at an inclination of roughly 45°. The foundation shale in this portion of the spillway appeared to have a poorly developed cleavage dipping in the same direction and to the same degree as the slide planes. The key foundation was not reopened and repaired until 1 December 1988. Figure 1 shows the method of repair utilized by the contractor. No further slides or problems of this sort were experienced in the remaining excavation of the key or other foundation excavations.

C. Unwatering Provisions. No problems caused by flows of ground water requiring special control measures were experienced during construction of the outlet works, spillway, or inspection trench. There were, however, isolated instances of ground water seepage from fractures in the shale foundations of the outlet works chute and the spillway chute. Pre-construction water level data from borings on the outlet works alignment have indicated the water table to be at approximately elevation 390 in the uppermost part of the chute slope. Pre-construction water level data from borings in the spillway indicated that the water table likely was between elevation 394 and elevation 401, just below the middle of the slope of the spillway chute. Excavation of the chute and stilling basin of both the outlet works and the spillway apparently lowered the water table in both instances as expected, but there was no opportunity to measure the altered water table. The only flow of ground water of any significance experienced during excavation of the outlet works chute was from a boring which had been made into an observation well (pre-construction) located about one-third of the way up the chute slope from the bottom of the stilling basin. This boring was plugged in the process of preparing the foundation. There was very little seepage of ground water from fractures in the foundation of the outlet works chute and stilling basin, none of which was difficult to route or control. Similarly, there were only a very few, isolated, local seeps of ground water which emanated from fractures in the lowermost slopes of the chute or the bottom of the stilling basin of the spillway. The general absence of foundation materials capable of either storing or transmitting significant quantities of ground water below the pre-construction water table made unwatering largely unnecessary during construction of the embankment, outlet works, and spillway. Unwatering in the form of routing of runoff was employed during construction of the outlet works and spillway. No such provision was necessary in the inspection trench as all but the deep portion of the inspection trench was open for extremely limited periods of time. A few storms caused significant amounts of runoff to flow through the inspection trench however, from the east end of the deep portion of the trench (abutment end) westward to the outlet works excavation where the flow emptied down the right sideslope of the excavation into the outlet works drainage system at the toe of the sideslope. These flows exceeded the capacity of the outlet works drainage system on at least one occasion. Runoff protection in the outlet works excavation consisted of two ditches, one at the toe of each of the sideslopes of the excavation. The ditches commenced in the vicinity of the upstream end of the gate control tower and extended downstream. The ditches ended initially in sumps immediately downstream from the future site of the conduit headwall. The ditches were subsequently extended farther downstream as the chute and stilling basin were excavated, ending in a large sump just beyond the left downstream corner of stilling basin. A large diesel-powered pump was maintained at the sump. The upstream end of the outlet works excavation was protected by a dike. Runoff routing in the spillway was essentially limited to a collector ditch located just downstream from and parallel to the cutoff key beneath the endsill of the stilling basin. A large sump with a diesel-powered pump was maintained at the east end of the collector ditch immediately downstream from the end of the right wall footing. No peripheral ditches were employed outside either the right or left wall footings. The stilling basins of both the outlet works and the spillway were protected downstream by a broad, unexcavated area on which a downstream-curving dike was constructed with a top elevation of 407 feet to prevent any inundation by flooding of the South Sulphur River. The spillway and outlet works discharge channels were excavated downstream from this dike early in the construction of both these structures.

D. <u>**Overburden Excavation.**</u> Excavation for foundations comprised of soil was done entirely by conventional means. The inspection and deep inspection trenches were excavated utilizing scrapers with push cats (dozers) and blades (road maintainers). Backhoes were used only infrequently. Most of the scrapers used on the job required use of at least one push cat (usually a D-9 Caterpillar dozer), but there were also two paddle-wheel (self-loading) scrapers in use on the job.

E. <u>**Rock Excavation.**</u> With the exception of limetone at the top of the right abutment, all structure foundation materials classified as rock were excavated by the same means that were used to excavate overburden materials, namely scrapers, maintainers, and backhoes. As described above under **Excavation Grades**, materials in the spillway and outlet works classified as rock (excepting limestone) were excavated so as to leave a minimum thickness of 2 feet above finished grade. This excavation was done with scrapers. Excavation of the final 2 feet of rock to reach finished grade for structure foundations was done with a backhoe. The initial 1.5 feet of this excavation was done with the backhoe bucket teeth exposed for efficient excavation. The final 0.5 feet of this excavation was with a smooth, sharpened, steel bar mounted on the backhoe bucket in a manner to cover the bucket teeth and scrape a smooth surface on the foundation.

1. <u>**Blasting**</u>. Blasting was done at the site of the spillway to excavate a ±3-foot limestone bed to final grade in the chute slope, also at the location of both the right and left wall footings, and in slopes to be backfilled against outside both walls. Limestone in the spillway dips to the west (to the left). Consequently, it was encountered at progressively lower elevations to the west across the chute slope and in slopes exterior to the wall footings. Limestone in the uppermost slopes of the outlet works excavation was excavated by blasting. Blasting was required to remove limestone from the deep inspection trench between embankment station 24+50 amd embankment station 43+10 near the west end of the right abutment. Except for two blasting caps used for each end of the initiating row of each shot, no electric blasting caps were used. The following two types of blasting were done to remove the average thickness of 3 feet of limestone in excavations for the spillway, outlet works, and deep inspection trench.

a. **Presplitting.** Pre-splitting shot holes were drilled inclined at 1 foot vertical on 1 foot horizontal (steeper than 1 on 1.5 slideslopes of the deep inspection trench and the 1 V on 3.5 H sideslopes of the outlet works excavation and the chute and sides of the spillway excavation).

(1) **Spillway.** Presplitting across both the chute slope and the sideslopes of the spillway was done at finished grade at the elevation of the top of the limestone. Presplitting was also done in an extensive area upstream from the top of the chute slope. This area lies between the outside of the right wall footings and a line a short distance inside the right wall footings where the limestone was above slab grade, and in the same area between the approach apron upstream from the weir and the deep inspection trench.

(2) **Outlet Works.** The outlet works excavation was outlined by presplitting at finished grade at the elevation of the top of the limestone. (Note: The outlet works excavation was open at both ends.)

(3) **Deep Inspection Trench.** The deep inspection trench was outlined at finished grade applicable to the elevation of the top of the limestone upstream from the spillway and in that portion of the trench located west (riverward) from the outlet works to the end of the right abutment. (Note: Both trench segments are open-ended.)

(4) **Presplitting Details.**

Hole size: 2-1/2 inches
Hole spacing: 3 feet, center to center.
Depth of holes: 3 feet (to bottom of limestone bed).
Explosive charge per hole: 1 inch x 4 inches, 75 percent Extra Gel located in bottom 1- to 1-1/2 feet of hole, hole stemmed to ground surface.
Trunk line from explosive charge to row line: 50 gr. E-Cord (trade name).
Row line connecting trunk lines: 75 gr. H.D. Permaline.
Row line shot with one zero-delay electric blasting cap at each end of line (only electric caps used). All shot holes drilled during each day were loaded with an explosive charge and shot the same day.

b. **Production Blasting.**

(1) **Spillway and Outlet Works.** Production blasting within pre-split outlines listed above. This included removing all limestone between the spillway chute and the right abutment hillside downstream, and in part of the area from the weir upstream sufficient to permit reaching grade from outside the right wall and its footings westward until the limestone was below grade.

(2) **Right Abutment.** Production blasting necessary to remove all limestone from the top of the right abutment west (riverward) of the outlet works excavation. This was a change of design and followed

excavation of the deep inspection trench in the same part of the right abutment.

(3) Production Blasting Details.

Hole size: 2-1/2 inches.
Depth of holes: 3 feet (to bottom of limestone bed).
Explosive charge per hole: Primer: 1 inch x 4 inch Extra Gel; Filled bottom 1 foot to 1-1/2 feet of hole with S.E.I. from Strawn Explosives, Inc. (this explosive is anfo).
Stemmed portion of hole: Top 1 to 1-1/2 feet of hole. Trunk line from explosives to row line: 50 gr. E-Cord (trade name).
Row line connecting trunk lines: 75 gr. H. D. Permaline.
Connectors joining row lines and providing successive shot delays: 50 millisecond (ms) delay connectors.
Initiating row line shot withe electric blasting cap at each end of row.
First shot pattern used: 4 feet x 5 feet, produced rock of too small size.
Second shot pattern used: 7 feet x 9 feet, produced adequate-sized rock.
Quantities of materials used for all blasting (approximate, includes presplitting): 44,000 feet of 75 gr. H.D Permaline (row-shooting primacord), 22,000 feet of 50 gr.
E-Cord (dowm-hole and trunk-shooting primacord), 250 connectors of 50 millisecond delay, 23,600 lb. of S. E. I. (anfo blasting mixture).
Blasting ratio: 23,600 lb. explosive/38,000 cu. yd. of in-place rock = 0.62 lb. per cu. yd.

F. Foundation Preparation. Aside from fine-grading foundations using a back hoe with a smooth blade covering the bucket teeth, foundation preparation consisted almost exclusively of spraying shale foundations with a commercial product known as Aerospray 70 Binder, sold by the American Cyanamid Company of Wayne, New Jersey. Aerospray 70 Binder is a polyvinyl acetate emulsion resin, containing approximately 60° total solids. The purpose of treating shale foundations with this product was to vastly reduce the drying rate of shale exposed in finished excavations, allowing more foundation to be prepared at a time increasing construction efficiency. Aerospray 70 was applied as a mixture of bulk liquid and water in a ratio of 1 to 1. This fluid mixture was applied using portable spraying equipment, the nozzle of which produced a relatively coarse spray to reduce air-borne drying of the spray and to produce better wetting of the shale surfaces involved. Thinner mixtures were tried but gave too little protection. In a few instances such as during hot weather, a 1/2 to 1 ratio of Aerospray 70 to water was used. It was necessary to respray a foundation infrequently. The product Aerospray 70 was a successor to the product Aerospray 52, formerly sold by American Cyanamid Company. Aerospray 70 appeared to be somewhat less effective in preventing drying of shale foundations than was Aerospray 52, and consequently was applied as a slightly heavier coating. Aerospray 52 had been used in construction of Granger and Aquilla dams in the Fort Worth District and on several construction projects in the Huntington and Baltimore districts.

V FOUNDATION ANCHORS

A. Spillway. A total of 870 anchors was installed in the spillway, connecting the structural concrete slab to the foundation. They were installed from the top of the chute slope at the downstream edge of the weir at approximately spillway station 7+29.8 to station 9+67.0 in the stilling basin and from the right wall footings to the left wall footings. All anchors were oriented normal to (at 90° to) the surface of the structural concrete slab. Prior to construction of the permanent anchors, two test anchors were constructed, one at station 7+80 near the top of the chute slope 4 feet left of the centerline and the other at station 9+42 in the stilling basin, 4 feet right of the centerline. Both test anchors were constructed in 6-inch diameter drilled holes to the required minimum depth of 14 feet into the foundation. Each anchor was subjected to a pull-out test and each anchor demonstrated required resistance to pull-out. A generalized description of the anchors and their construction follows: Installation of an anchor commenced with placing a sleeve of tubular material larger than 6 inches in diameter through the filter sand blanket and cementing it into the top of the shale. Next, a slab of protective concrete 3-1/2 inches thick was placed on top of the filter sand blanket with the sleeve extending slightly above the surface of the protective concrete. The sleeve can be made of any of a variety of materials such as sheet metal ducting, but 8 inch diameter corrugated plastic pipe was used here. It was to serve as a conductor pipe through the protective concrete, the filter sand blanket, and the top of the foundation shale to seal off the filter sand to prevent sand from the filter blanket from being entrained in the return air flow when drilling the anchor hole. Without sand entrainment no void will develop in the filter sand blanket beneath the protective concrete slab. Following drilling and cleaning of the anchor hole, the assembled anchor is placed in the hole and the hole filled to the top of the protective slab with grout. The anchors themselves consist of #9 rebar stock, bent 90° at the top for embedment in concrete of the structural slab. A 1/2-inch diameter grout pipe, long enough to protrude above the protective concrete and to reach downward to within the bottom 1 foot of the anchor, is wired to each anchor along with two "spacers," which should have been identified on the plans by their functional name, centralizers. The centralizers are wired to each anchor 1 foot and 13 feet above the bottom of the anchor. The centralizers used in the Cooper spillway were prefabricated units. Each centralizer was made of relatively thin but stiff round rod stock as five pieces welded together. The top and bottom pieces were open rings, with a gap sufficient to allow them to be slipped on the anchor rebar. Three short lengths of the same sized rod stock, were bent in the shape of a hump in a way that the ends of each piece align with each other. The three hump-shaped pieces of rod stock connect the two rings of each centralizer and are welded to the rings in such a way that the hump-shaped pieces are spaced around the rings 120° apart with the hump portions outermost. When the finished centralizers are oriented with the hump-shaped pieces parallel to the anchor rebar, the gap in the two rings is aligned with each other and the centralizers can be slipped on the anchor and wired to it. The anchor will slide in or out of the hole easily with the hump-shaped pieces acting like sled runners. In the past, centralizers have been fabricated with horizontally oriented centralizing rings, the rings looking very much like rings on a ski pole when the anchor is vertical. Centralizers of this design tend to hang on defects in the wall of the hole and are awkward to use.

B. Outlet Works. The use of anchors was not specified for structures comprising the outlet works.

VI FUTURE CONSIDERATIONS

A. Reservoir Seepage Through Embankment. It is now believed that a small potential for seepage of lake water from the downstream slope of the embankment between the spillway and the outlet works exists when the lake is at conservation pool or higher levels. The estimated risk of seepage of lake water through the shallow sand bed in the foundation was significantly reduced by the discovery of the fault-offsetting of the sand bed between upstream slope of the abutment ridge and the spillway, and by plating the sand bed with an impervious clay fill in the limited area where it cropped out in the abutment slopes upstream. Though the risk of lake water seepage from the embankment downstream appears to be much less than originally thought, the possibility of seepage is not considered to have been eliminated. If seepage does develop, the sand bed between the weir and the wedge-shaped strip of select fill may develop a low head of water due to the inability of the filter blanket to completely drain the sand.

Entrance of lake water into the sand bed upstream and its transmission to the downstream embankment slope of the right abutment left (west) of the outlet works appears to be unlikely because all but a thin sliver of the sand is cut off by the backfill of the deep inspection trench and because this portion of the right abutment ridge is completely encased in compacted embankment fill.

Recommended Observations. It is recommended that periodic observations of water levels in piezometers P-1 through P-5 be made, with emphasis on piezometers P-1 and P-5 (in the sand bed). These piezometers are located in a row oriented upstream/ downstream, in the area of concern between the spillway and the outlet works. The piezometers should predict the likelihood of underflow to the downstream slope of the embankment. It is also recommended that the downstream embankment slopes in the vicinity of station 16+00, and also to the immediate left of the outlet works, be observed for the possible commencement of seepage, particularly when the lake level rises above conservation pool.

B. Spillway Anchor Foundations. "Wall packing," while drilling 6 inch anchor holes in the chute and stilling basin of the spillway, indicated the possibility of unseen foundation damage. Other evidence indicated possible displacement of filter sand of the drainage blanket in the stilling basin shortly after drilling commenced. "Wall packing" means the collectng and packing of drill cuttings between the drill rod, on which the bit is mounted, and the wall of the hole. "Wall packing" stops or greatly reduces the return flow of air which normally blows drill cuttings from the hole. Obstruction of the return air flow causes a build up of air pressure in the hole below the "wall pack". "Wall packing" became so severe during the early stages of anchor drilling that additional cutters were welded to the top of the drill bit so that the bit could be drilled out of the hole through the "wall pack". The need for drilling out of the hole diminished somewhat through time. The rented drill appeared to be one intended primarily for drilling hard rock with a bit less than 6 inches in diameter. It operated by both hammer action and rotation, hammer action on a rotary drill bit not being efficient. Diameter of the drill rod appeared to be slightly over 1 inch. The air course down the center of the drill rod was so small that one could not quite insert the end of his little finger in it, which was responsible for the small return air flow and an unknown pressure drop in the system. Though air pressure at the bottom of holes during drilling could not be measured, nor reliably calculated, concern for foundation damage from drilling was generated by the fact that air pressure at the discharge of the nearby air compressor suppying the drill was seven times that which would be necessary to lift foundation shale, filter sand, and the protective concrete slab commencing at a depth of 15 feet, if a horizontal fracture was present at that depth which drilling air could enter. Direct evidence of excessive air pressure affecting the foundation and/or the filter blanket consisted of bubbling water emerging along the downstream edge of key concrete located at the base of the chute slope while drilling the first anchor holes in the stilling basin near the right wall. In addition, a small amount of filter sand had been distributed on top of the protective concrete slab and key concrete along the junction between the two at the same location. These conditions suggested that the foundation shale penetrated by the anchor holes might have been pneumatically fractured during the process of drilling anchor holes and that any fractures produced probably would not be filled with grout used to backfill the holes after the anchors were installed. Foundation designers were consulted with a view to requiring the contractor to substitute a different drill which would not risk foundation damage. It was agreed that there was some risk of creating new fratures in the foundation shale, also possible risk of minor displacement of filter sand. While it would have been preferable to have a different drill used, one which would not result in "wall packing" of drill cuttings, it was believed that the risk of unacceptable foundation damage was not sufficiently great to justify paying the contractor significantly more money to substitute a different type of drill for the one he was using.

Recommended Observations. All observations to detect foundation damage from anchor drilling are of necessity indirect since the foundation is covered with concrete. Once Cooper Lake becomes operational, the spillway stilling basin will be filled with water except for rare instances when pumping and cleaning is required, during which time any deformation of the concrete can be observed. The slab on the chute slope above the water surface in the stilling basin can be observed at all times when no flood water is passing over the weir. It is recommended that concrete of the spillway chute be observed for cracking and deformation immediately following cessation of any flood flows over the weir, but otherwise only during normal routine maintenance inspection. The stilling basin should be similarly inspected during periods when it is dewatered and cleaned of sediment. It appears likely that the time of greatest likelihood of problems stemming from foundation damage or filter blanket damage would be when passing a flood, during which vibration from rapidly moving water may occur. If sand composing the filter blanket should settle the slightest amount at this time, some contact between the slab concrete and the filter sand will be lost, the sand may shift down slope in the chute, and the slab will be supported only by the anchors in any areas where contact between the sand and the slab is lost.

EBY — MARTIN K. EBY CONSTRUCTION CO., INC.

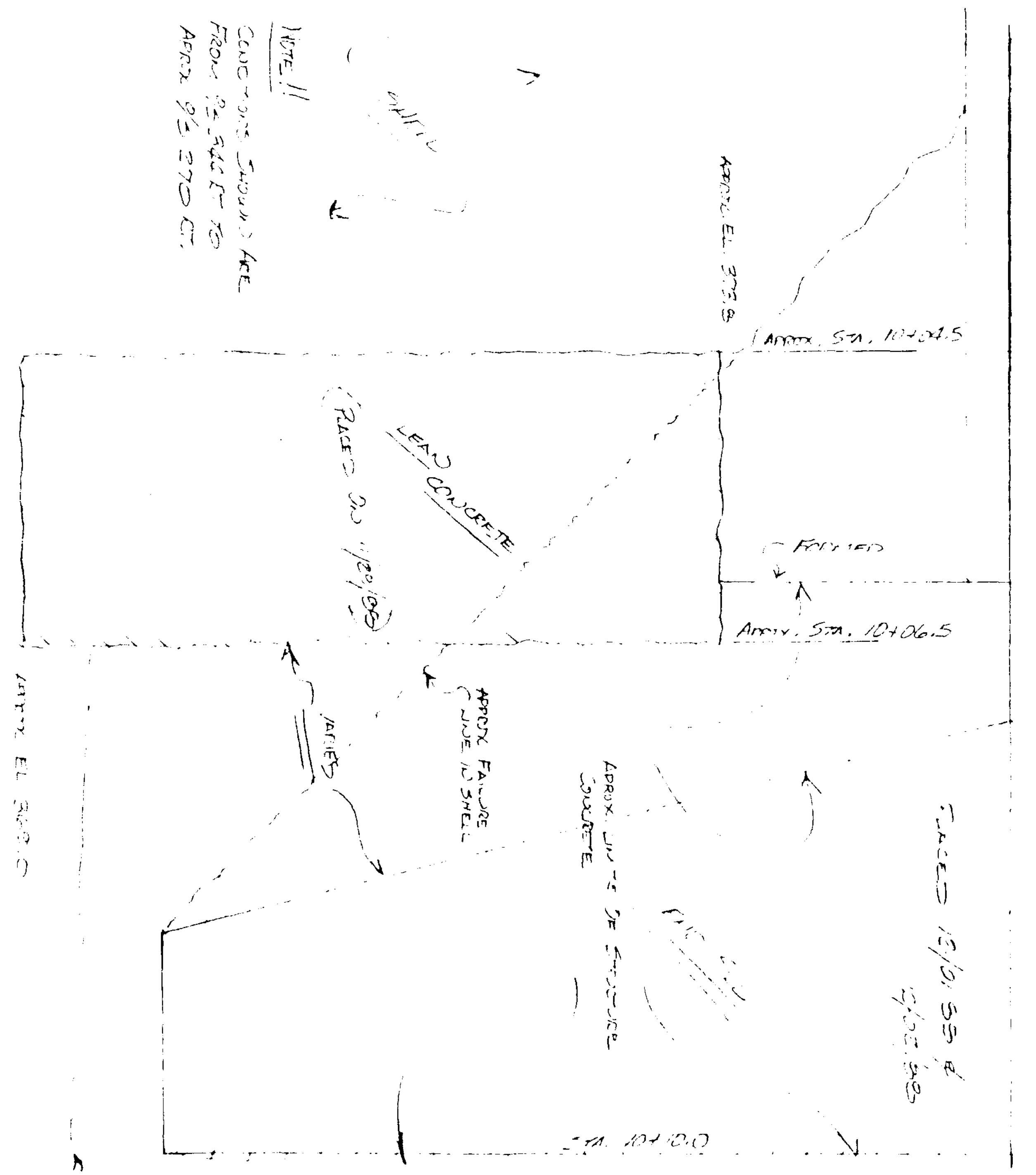
PROJECT: ______

LOCATION: ______

JOB NO. ______

BY ______ CKD ______

DATE ______ SHEET NO. ____ OF ____



AS-BUILT REPAIR IN SPILLWAY KEY EXCAVATION (SEE IV B OF TEXT)

J-5(11/86)

FIGURE 2. Approach cut off key of outlet works. Upstream is to left. Note film of Aerospray 70 coating shale foundation.

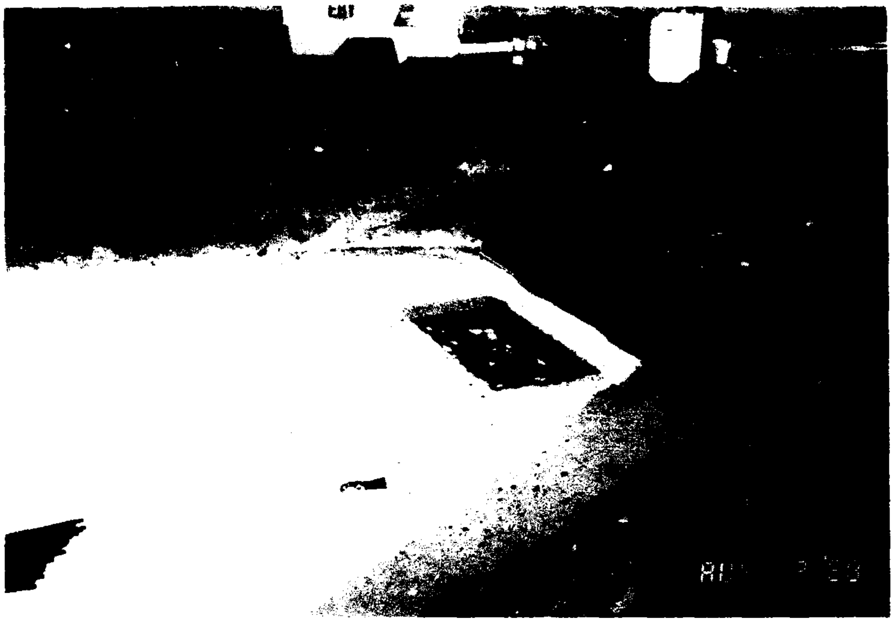


FIGURE 3. Downstream end of tower transition to conduit. Collar (open area) overexcavated requiring concrete build up to replace shale foundation. Downstream is to right.

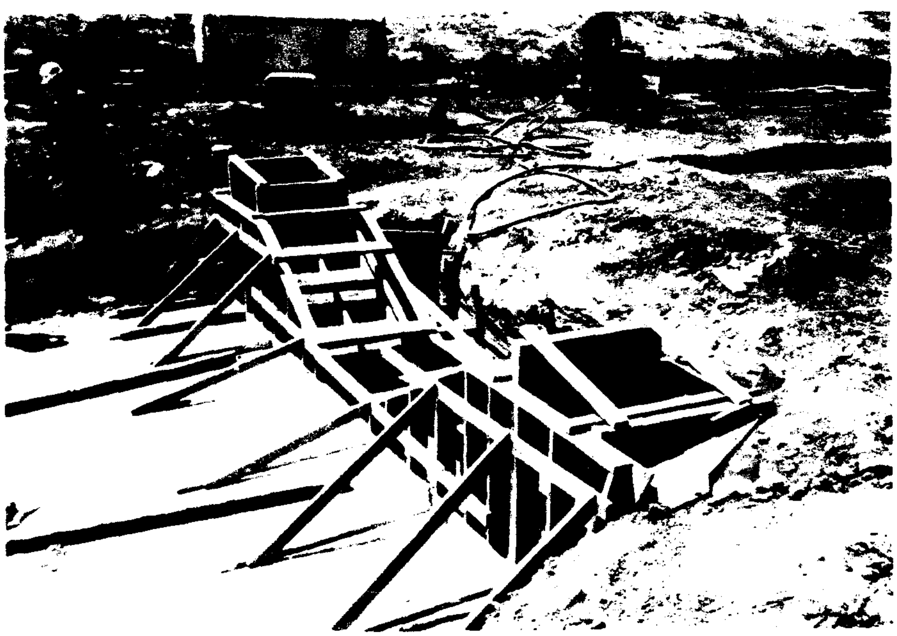


FIGURE 4. Forming for collar structural concrete after build up of backfill concrete beneath collar forming. Downstream is to right.

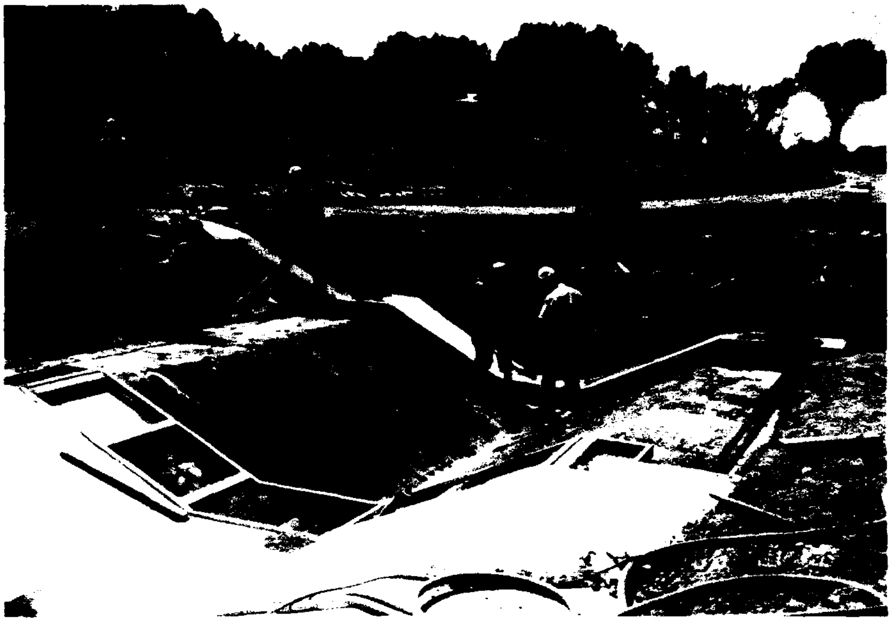


FIGURE 5. Monolith 1 of outlet conduit, looking upstream past collar at end transition into construction of gate tower base. Note block out for downstream collar.

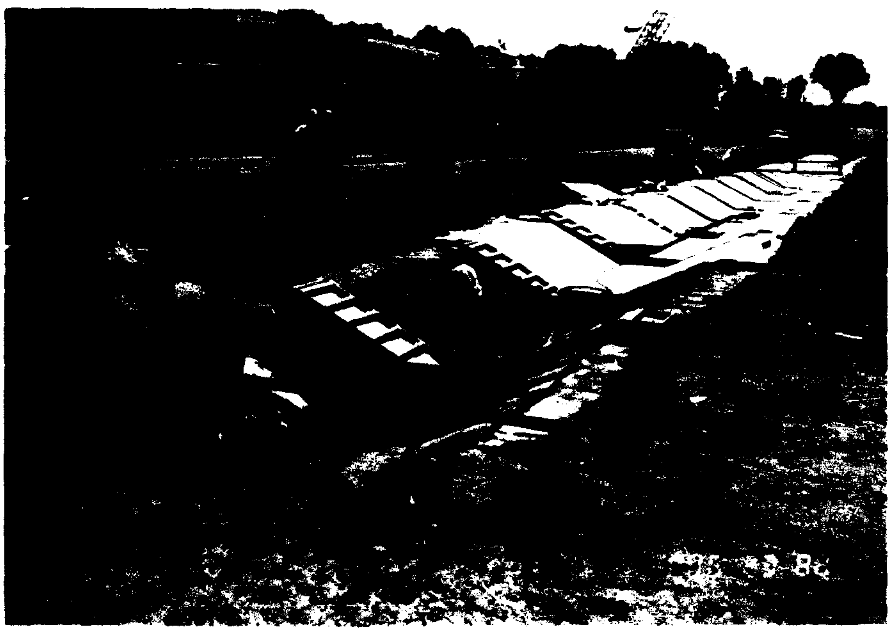


FIGURE 6. Looking upstream through conduit protective slabs and collar block outs toward outlet gate control tower construction.

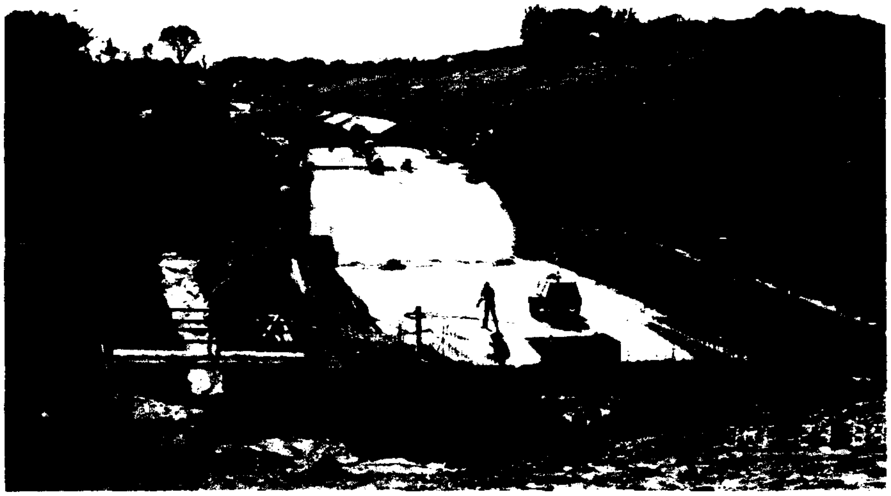


FIGURE 7. Looking upstream in outlet excavation. Note: Protective concrete of chute and stilling basin. Rain runoff control ditches can be seen on each side of the excavation.

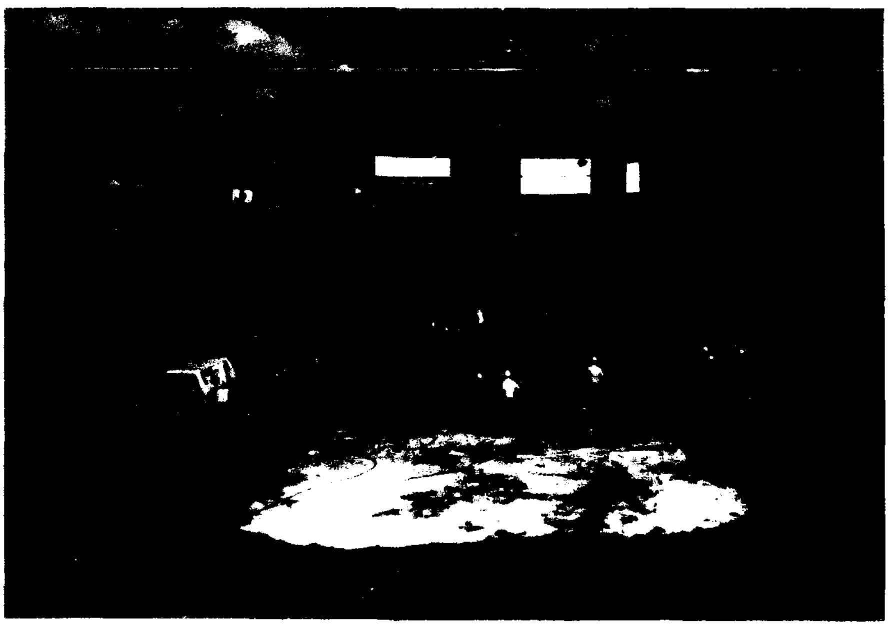


FIGURE 8. Looking downstream into stilling basin. Note elevated pump and pipe reaching down into sump for runoff at left, far corner of stilling basin (beyond far left corner of filter sand area).

FIGURE 9. General view of spillway during final excavation and placement of filter sand and protective concrete. Anchor hole drilling can be seen on the protective concrete in the higher elevations of the chute.

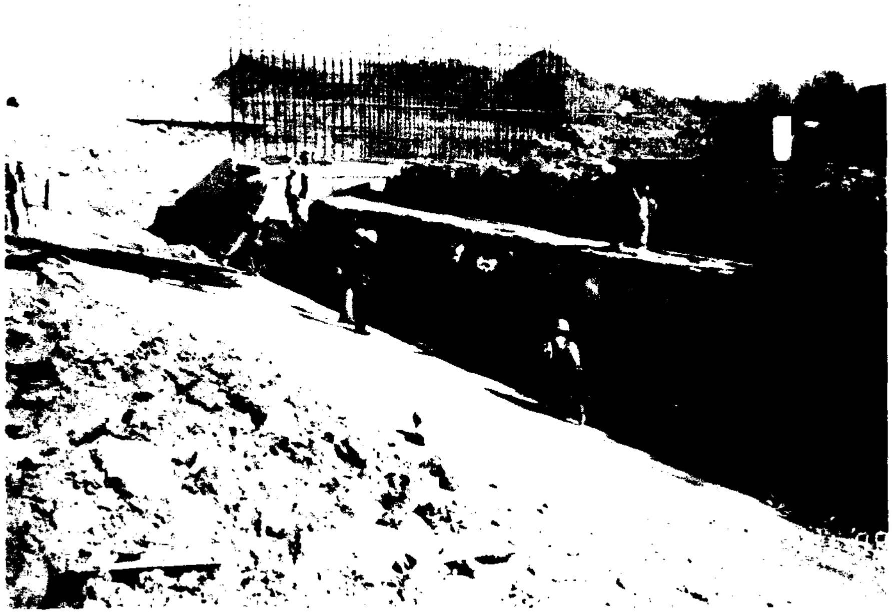


FIGURE 10. Looking right and upstream. Spillway weir foundation with right wall footing (R-6) in background. Note limestone in backslope (upstream) overlain by recompacted clay and underlain by undisturbed fine sand.

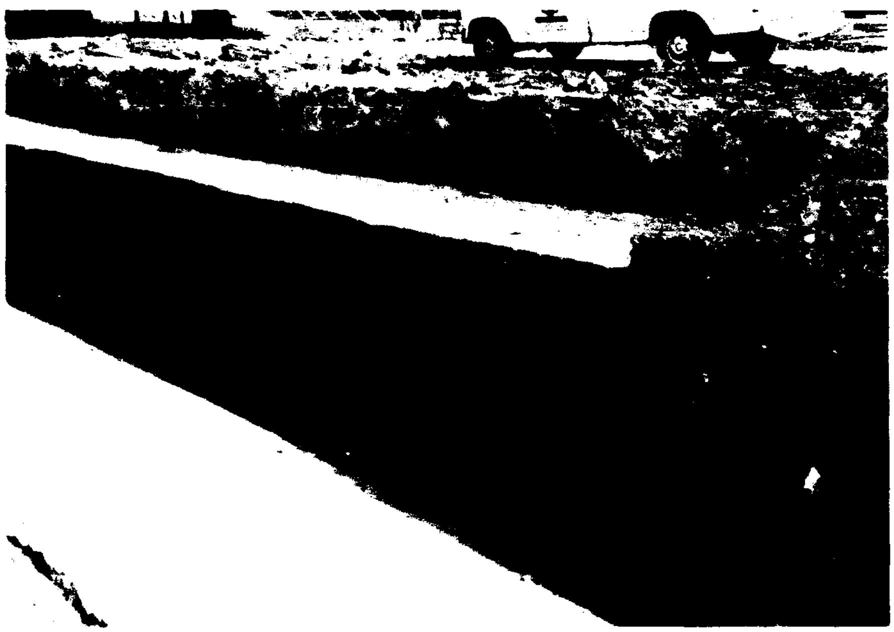


FIGURE 11. Spillway weir backslope showing limestone surrounded by recompacted fine sand which is overlain by compacted clay.

FIGURE 12. Spillway weir showing limestone in backslope, sand in bottom, limestone at near break in slope, which is overlain by undisturbed sandy clay (beneath two near figures). Sample sandy clay above limestone in backslope.

FIGURE 13. Ditching machine used to excavate key foundations in the spillway.

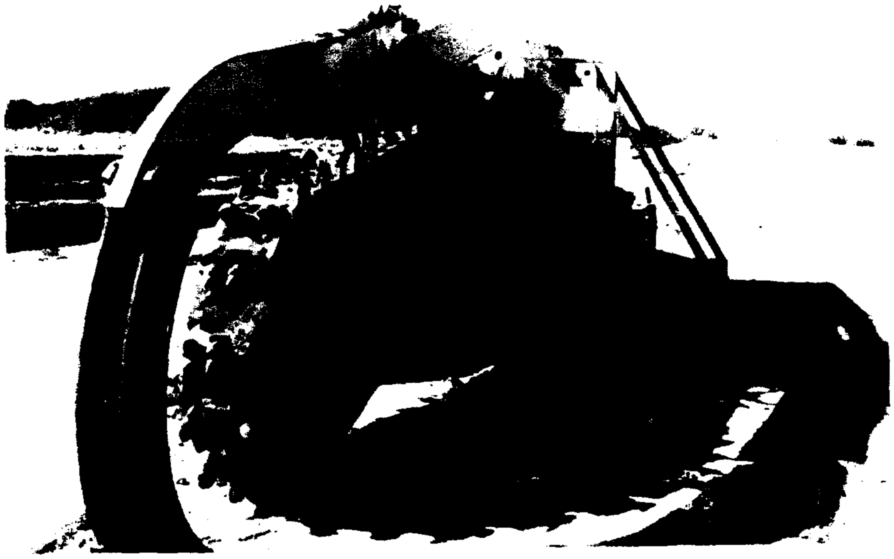


FIGURE 14. View of cutters of Vermeer T-650 used to excavate key foundations in the spillway.

FIGURE 15. Initial excavation of cutoff key at downstream right end of spillway slab (end sill key). This view is at the time of first movement of slide blocks. Movement of thin slices of shale into the excavation occurred later after the key had been cleared of slide blocks and the upstream slope re-excavated to a 1V on 1H slope.

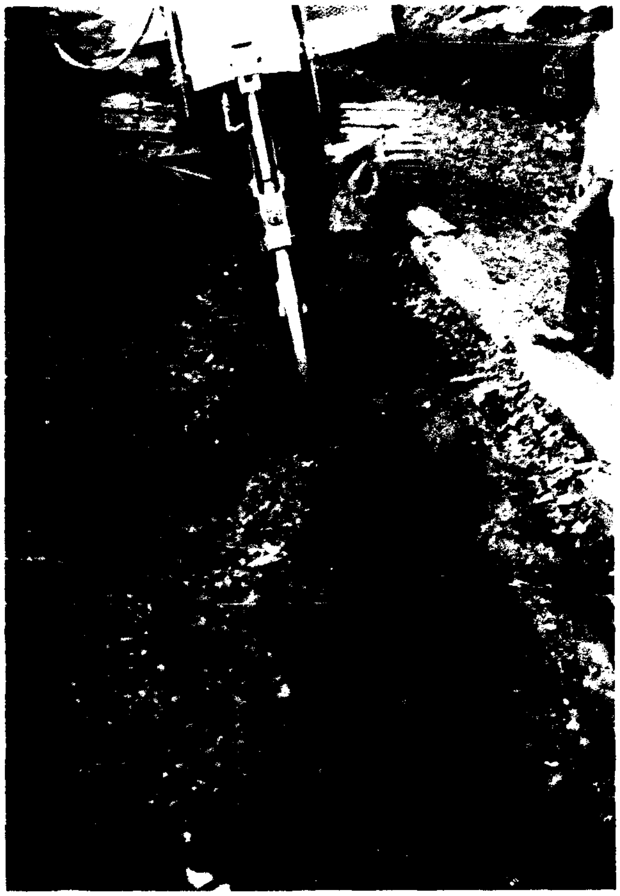


FIGURE 16. Excavation of cut off key at downstream right end of spillway at the commencement of slide block movement into excavation.

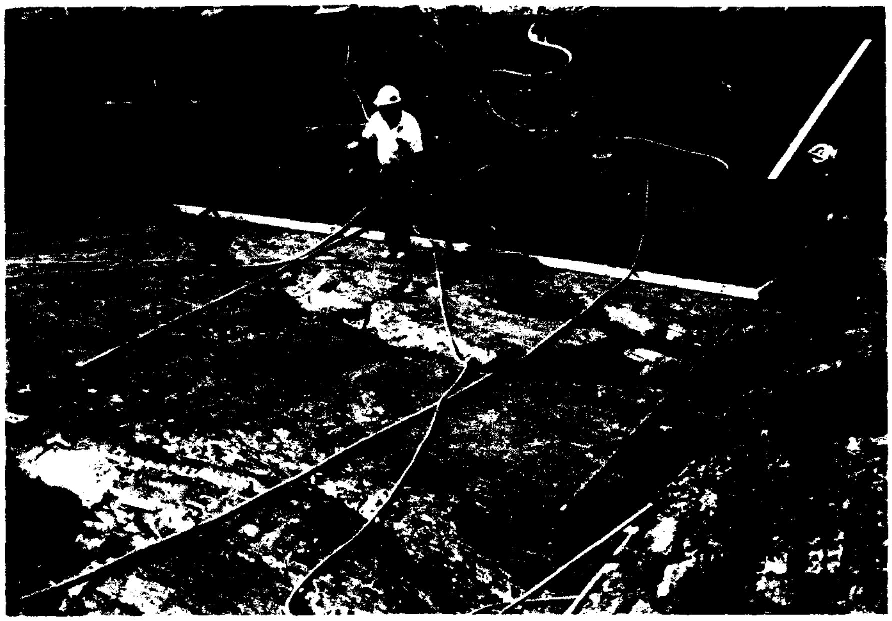


FIGURE 17. Downstream portion of spillway wall footing R-15 (end wall footing of right wall). Form boards in upper center of photo (along downstream edge of R-15) outline commencement of the cut off key where it wraps around the downstream end of the key. Note fracture-generated pullouts of foundation shale.

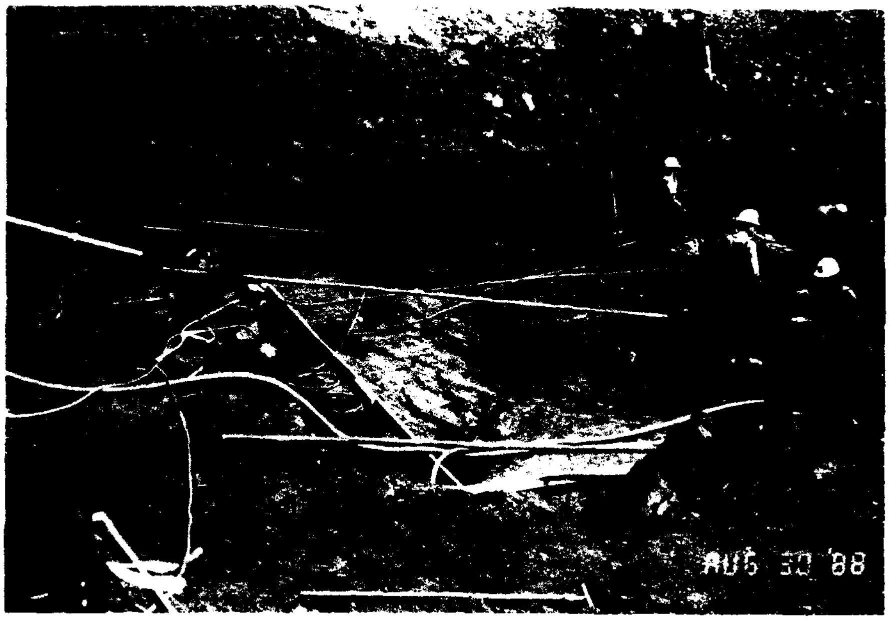


FIGURE 18. Downstream portion of spillway wall footing R-15 (end wall footing). Form boards shown along the left side of the cleaned foundation outline the cutoff key along the downstream end of wall footing R-15. Note fracture patterns and pullouts crossing foundation of downstream half of R-15. (Cutoff key starts in upper left corner of foundation, as seen here, extends toward viewer to near corner, then extends to right in near ground to out of sight behind unexcavated shale. This is side of R-15 nearest spillway centerline.

FIGURE 19. Upstream portion of spillway wall footing R-15 (end wall footing). Form boards seen here are along the side of R-15 nearest the spillway centerline. Note the angling of the form boards in the upper right. This is the location where the cut off key turns 90° from the edge of R-15 toward the spillway centerline as the cut off key (also known as the end sill key). Fractures and pullouts seen here are also to be seen in Figures 17 and 18.

FIGURE 20. Upstream portion of spillway wall footing R-15 (end wall footing). This is a close view of fractures shown in figure 19. Fractures are in sets, dipping in opposite directions.

FIGURE 21. Upstream portion of spillway wall footing R-15. View looking down dip slope of fractures dipping upstream.

FIGURE 22. Upstream portion of spillway wall footing R-15. Form boards seen at top of Photo are those of Figures 20 and 21. Looking toward spillway centerline.

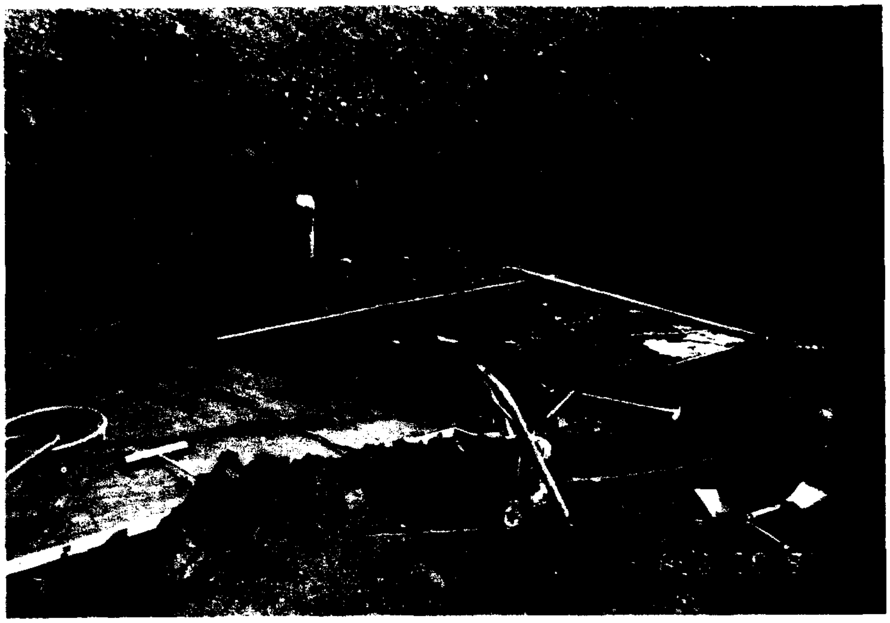


FIGURE 23. Spillway wall footing R-15. Note wheel mounted piece of equipment in lower portion of Photo with angle of form boards immediately behind. Form board angle and foundation fracture trend are those of previous Photos. Fractures in the darker shale to the right (upstream) in the upstream portion of R-15 dip downstream (to the left).

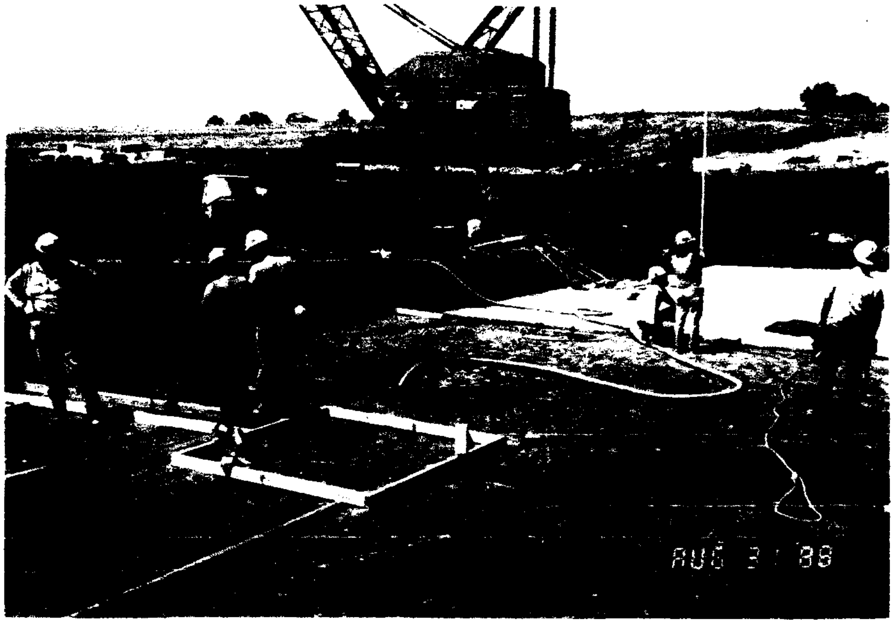


FIGURE 24. Foundation of spillway wall footing R-14. R-15 is covered by protective concrete. Note: Board angle seen here is **not** that of previous photos. Previous form board angle is beyond stacked shovels on concrete in this Photo.

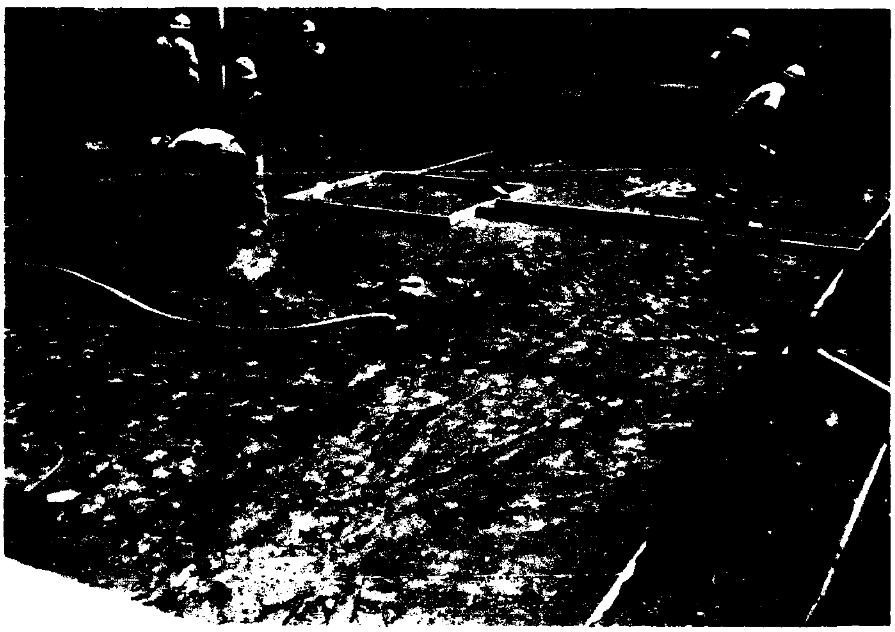


FIGURE 25. Foundation of wall footing R-14, looking up-stream. Note paucity of fractures in foundation shale. This is typical of shale foundations of the lower chute and stilling basin of the spillway.

FIGURE 26. Looking downstream along right wall footing foundations. R-15 (concrete-covered) and R-14, with manhole and drain blockouts are in stilling basin. R-13 (not finished) straddles stilling basin/chute junction.

FIGURE 27. Portion of spillway chute and stilling basin. Chute slope following construction of keys crossing spillway, but prior to excavation for filter/drainage blanket.

FIGURE 28. Typical cross-drain foundation in spillway chute.

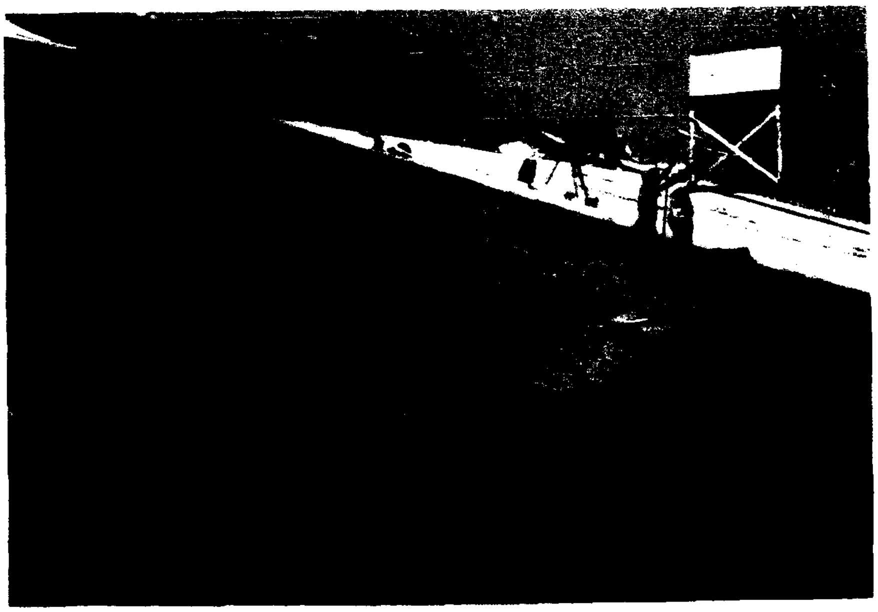


FIGURE 29. Materials comprising chute foundation across spillway in Lane F.

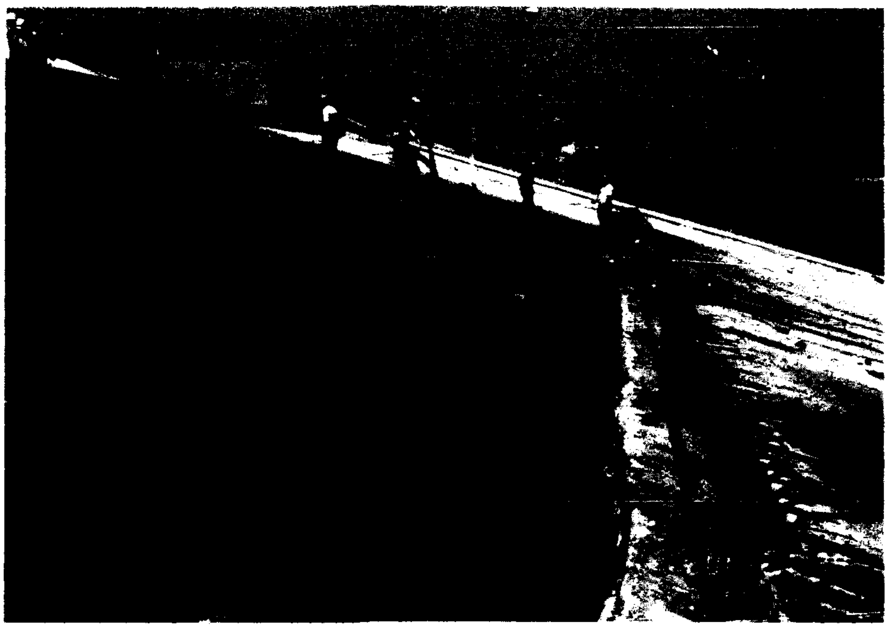
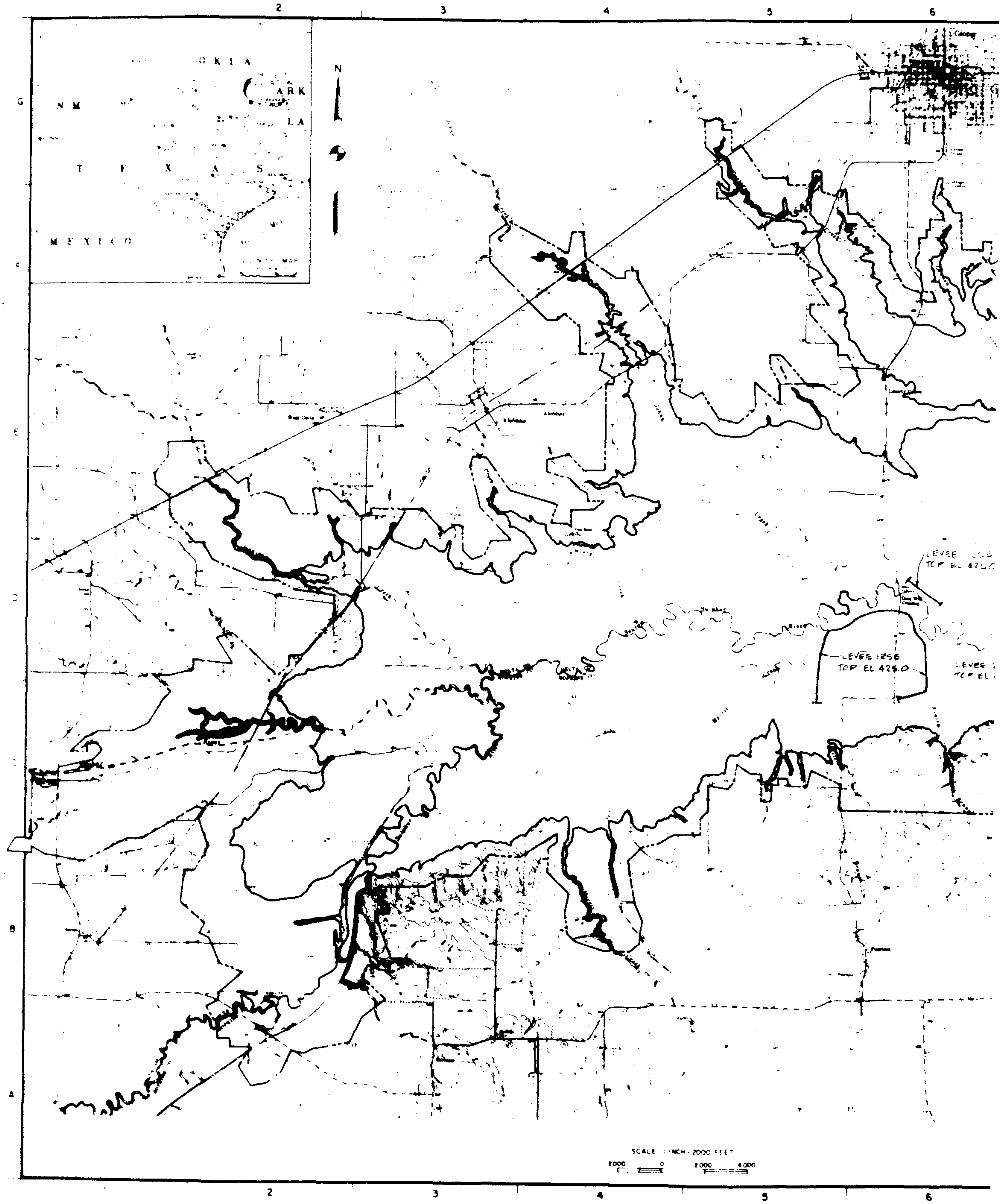
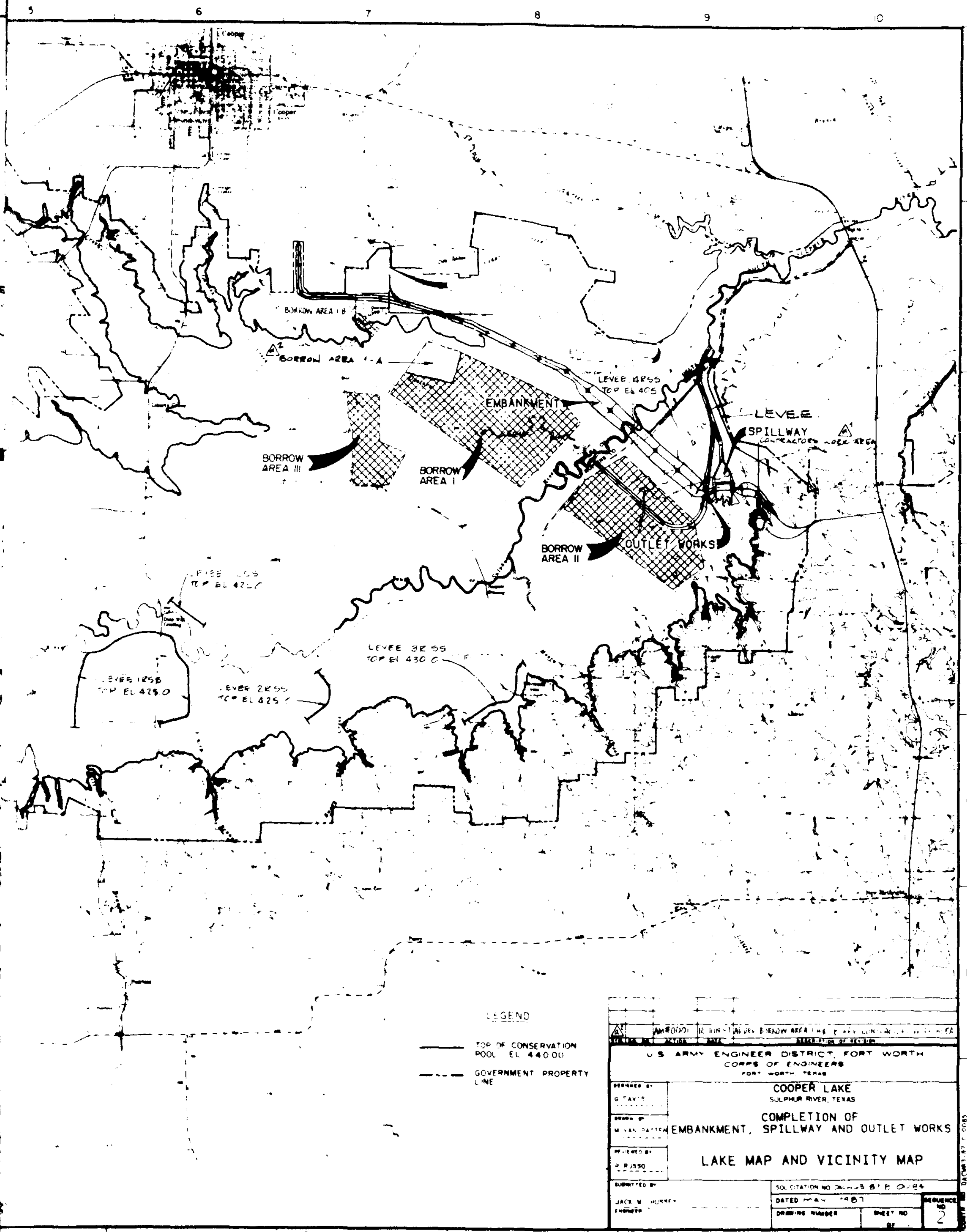
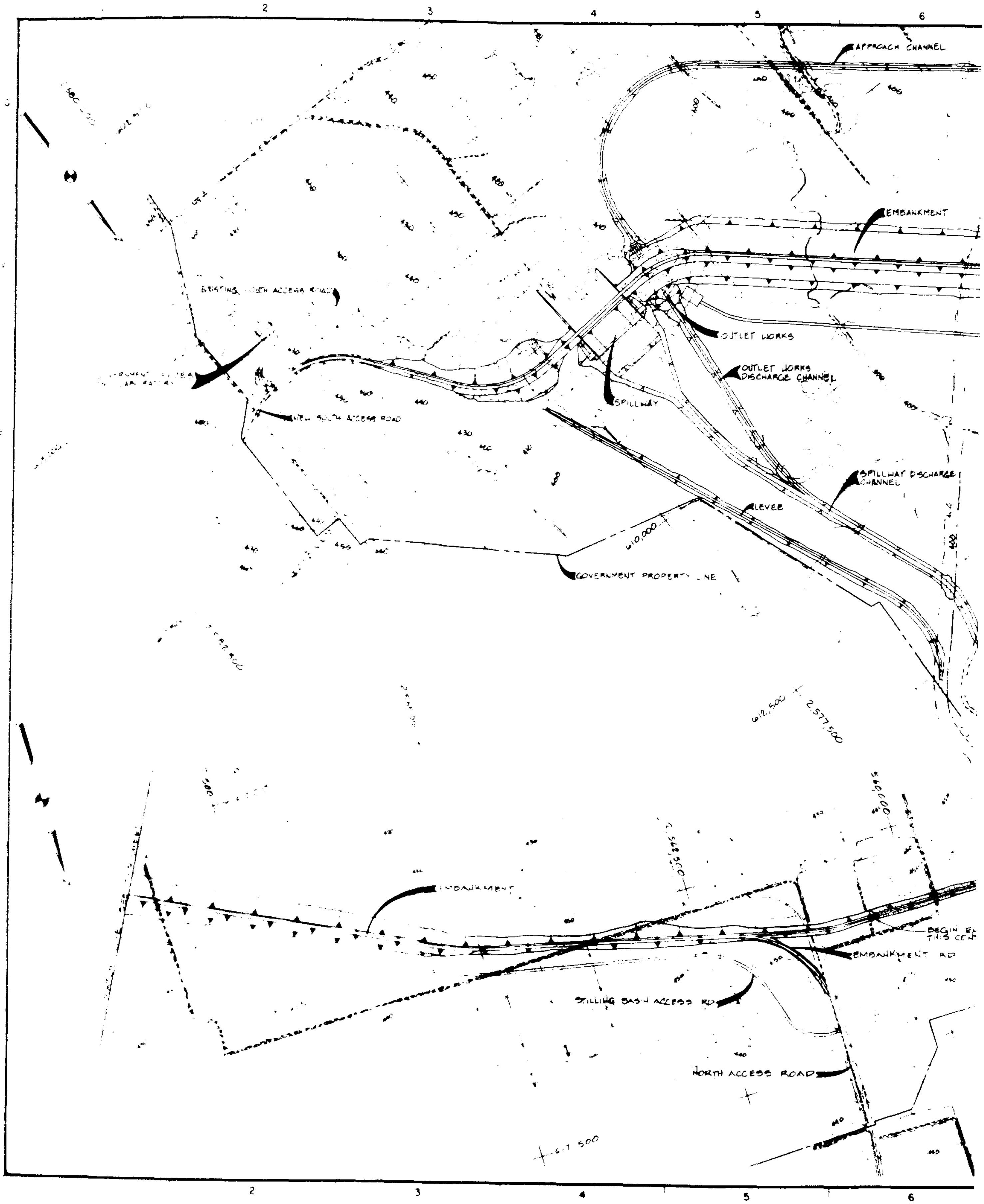


FIGURE 30. Typical foundation in F Lane of spillway chute.

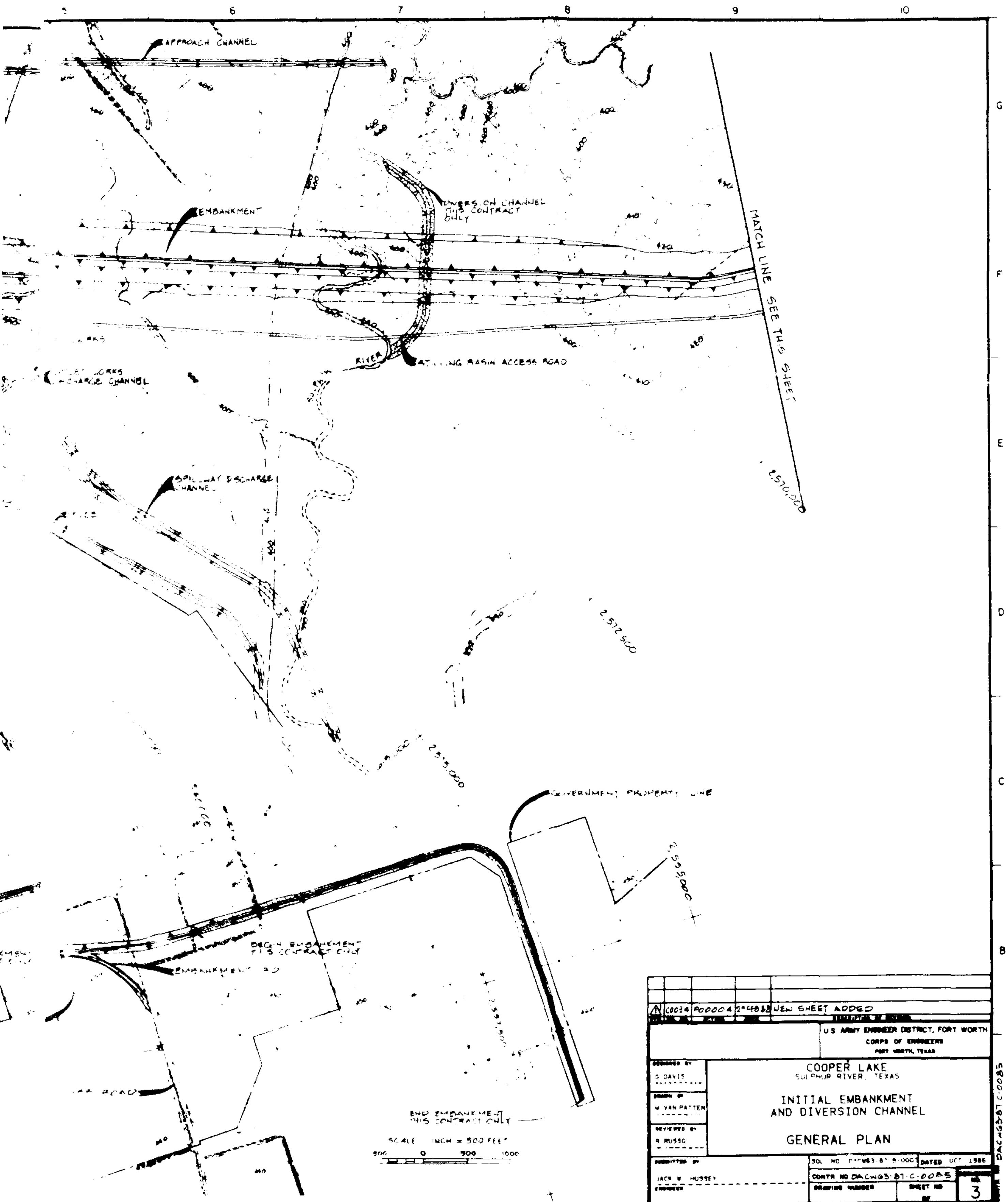

N
OKLA
ARK
LA
N M
T E X A S
M E X I C O
LEVEE 125B
TOP EL 425.0
SCALE 1 INCH = 2000 FEET
2000
0
2000
4000



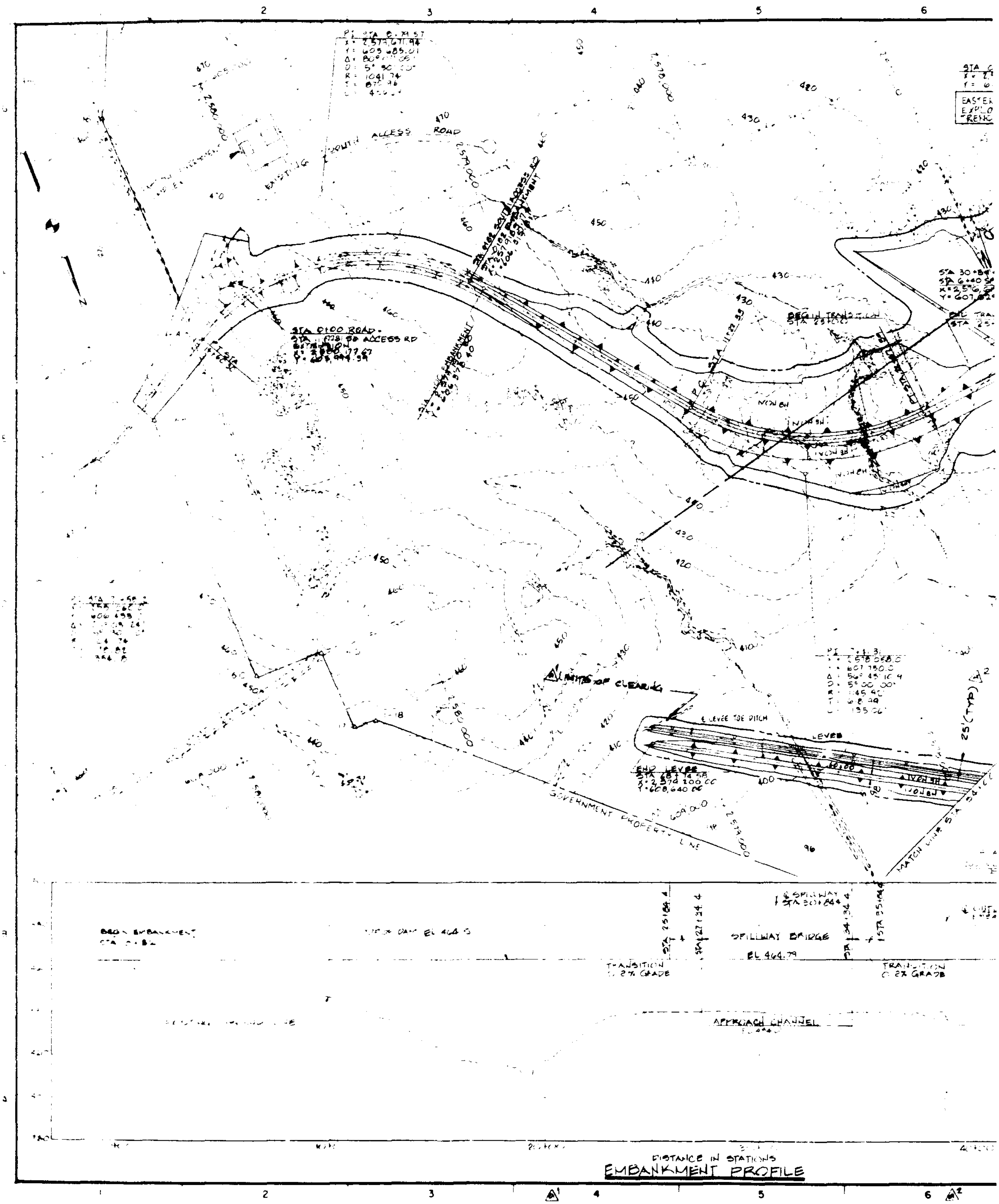
To ACCOMPANY FINAL FOUNDATION REPORT PLATE 1



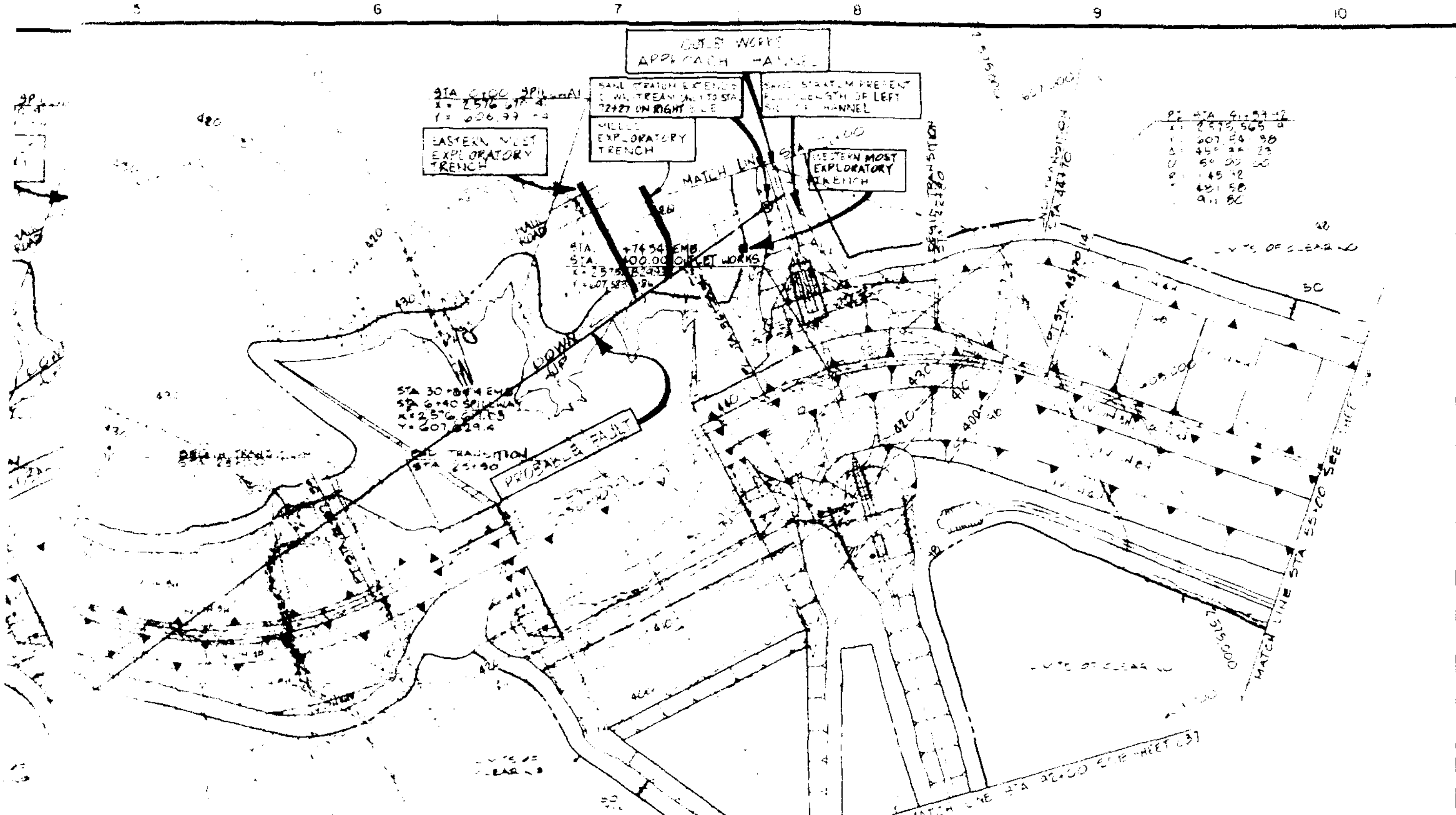
2
3
4
5
6
APPROACH CHANNEL
EMBANKMENT
EXISTING NORTH ACCESS ROAD
OUTLET WORKS
OUTLET WORKS DISCHARGE CHANNEL
SPILLWAY
NEW SOUTH ACCESS ROAD
SPILLWAY DISCHARGE CHANNEL
LEVEE
610,000
GOVERNMENT PROPERTY LINE
612,500
2,577,500
EMBANKMENT
EMBANKMENT RD
STILLING BASIN ACCESS RD
NORTH ACCESS ROAD
B
A

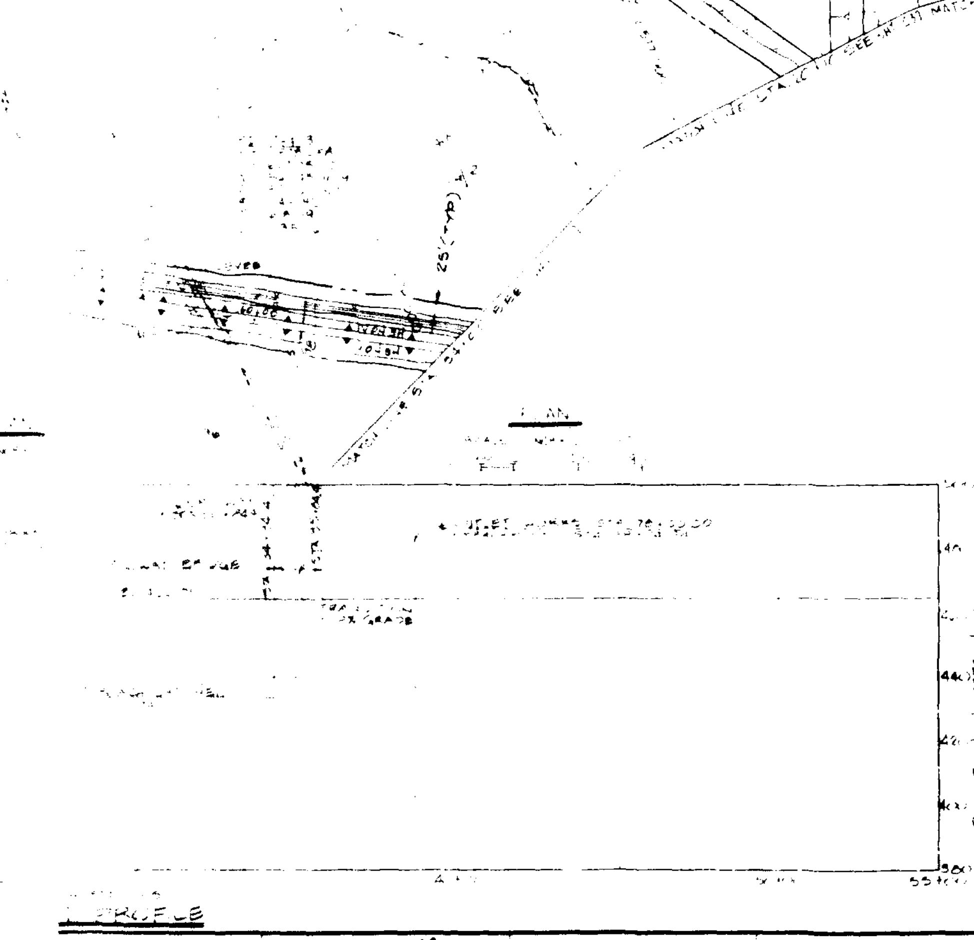


TO ACCOMPANY FINAL FOUNDATION REPORT PLATE 2



EXISTING SOUTH ACCESS ROAD
STA 0+00 ROAD
BEGIN TRANSITION
LIMITS OF CLEARING
℄ LEVEE TOE DITCH
LEVEE
END LEVEE
GOVERNMENT PROPERTY LINE
MATCH LINE STA
25'(TYP)
SPILLWAY BRIDGE
EL 464.79
TRANSITION 0.2% GRADE
APPROACH CHANNEL
DISTANCE IN STATIONS
EMBANKMENT PROFILE





NOTES FROM EXPLORATORY TRENCHES

1. EASTERNMOST TRENCH: ON EMB. STA. 34+94.4 FROM % 495' LT. TO % 899' LT./EL DOWNSTREAM = 428.9'/TOP OF SAND UPSTREAM FROM HAUL ROAD = EL 414.6'/MAX./EL OF MAX. DEPTH IN SANDY CLAY @ UPSTREAM END = 411.0'
2. MIDDLE TRENCH: EMB. STA. 35+44, % 490' LT. TO EMB. STA. 36+09.4 % 749' LT./ALL CLAY, NO ELS TAKEN.
3. WESTERNMOST TRENCH: EMB STA. 37+50, % 441 LT. TO EMB. STA. 37+60, % 470' LT./GROUND SURFACE EL UPSTREAM END OF TRENCH = 424.4 /TOP OF SAND STRATUM = EL 422.9/BOTTOM OF SAND STRATUM = EL 419.3./EL OF UPSTREAM END OF TRENCH = 417.8'.

GENERAL NOTES:

1. FOR EMBANKMENT SECTIONS SEE SHT E1.
2. FOR LEVEE PROFILE SEE SHT [illegible]
3. FOR PLAN OF SPILLWAY, OUTLET WORKS DISCHARGE CHANNEL SEE SHT C37
4. FOR OUTLET WORKS APPROACH CHANNEL SEE SHT C30
5. FOR [illegible] ACCESS ROAD SEE SHT R3 THRU R8
6. STATIONING IS BASED ON GRID DISTANCES
7. EMBANKMENT STATICHING CAN BE CONVERTED TO FIELD DISTANCES BY USING A COMBINATION FACTOR OF 0.99[illegible]
8. FOR PLAN AND PROFILE SOUTH ACCESS ROAD EXTENSION AND ROAD A SEE SHT R1
9. ALL LEVEES ON THE UPSTREAM SIDE OF THE EMBANKMENT SHALL BE GRADED TO EL 424.0 BY CONTRACTOR. LEVEE LOCATIONS SHOWN ON SHT C2
10. LEVEE AREAS ON THE DOWNSTREAM SIDE OF THE EMBANKMENT SHALL BE GRADED TO EXISTING GROUND BY CONTRACTOR SEE SHT C2 FOR LOCATION OF LEVEE AREAS.
11. ALL GRADED MATERIAL FROM THE LEVEES SHALL BE CONSIDERED UNCLASSIFIED EXCAVATION.
12. USE OF BORROW AREA I-A IS PROHIBITED WITHOUT WRITTEN APPROVAL OF THE CONTRACTING OFFICER.

3		AM#0001	12 JUN 87	ADDED CLEARING LIMITS AND NOTE 12.

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

DESIGNED BY: R. RUSSO
DRAWN BY: R. SMITH
REVIEWED BY: R. RUSSO
SUBMITTED BY: JACK W. HUSSEY

COOPER LAKE
SULPHUR RIVER, TEXAS

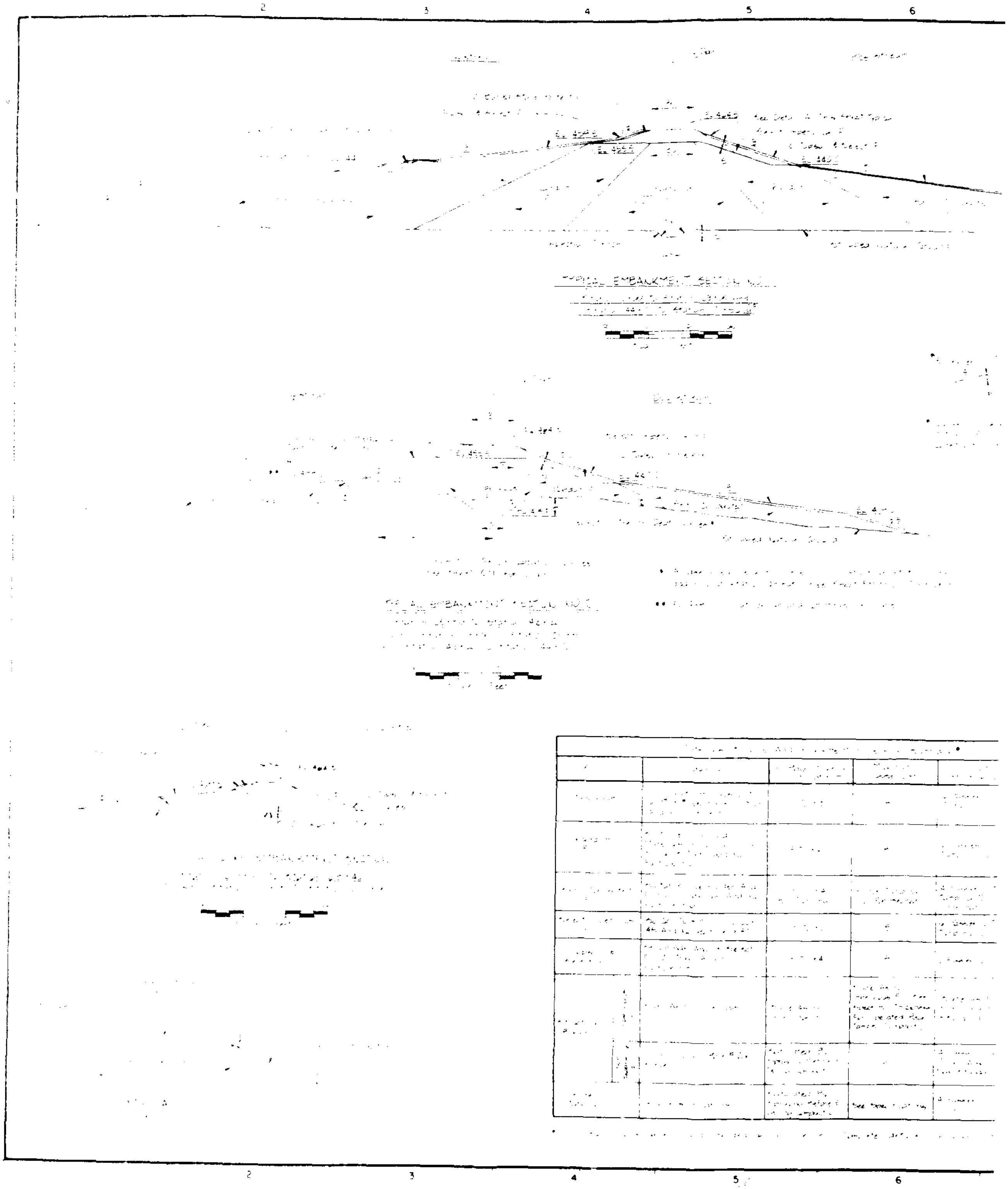
EMBANKMENT

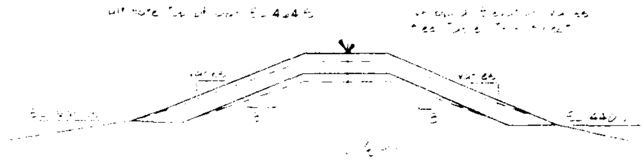
PLAN AND PROFILE
(STA 0+00 TO STA 55+00)

No. DACW63-87-B-0004 DATED MAY 87
CONTR NO DACW63-87-C-0085
SHEET NO 5

DACW63-87-C-0085

3 TO ACCOMPANY FINAL FOUNDATION REPORT PLATE 3

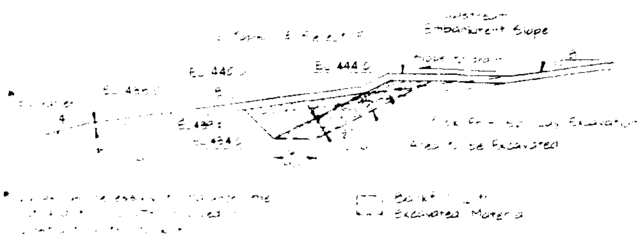

EMBANKMENT



TYPICAL EMBANKMENT OVERBUILD SECTION

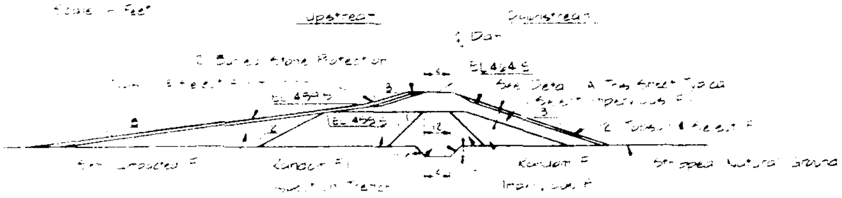
NTS

Overbuild Table	
Embankment Station	Overbuild Feet
0+00	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible] spillway	[illegible]
35+35	[illegible]
40+50	[illegible]
[illegible]	[illegible]
62+00	[illegible]
[illegible]	[illegible] 4
44+00	[illegible] 4
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]



BACKFILL DETAIL

Scale – Feet



TYPICAL EMBANKMENT SECTION No. 3

Scale – Feet

Notes

The embankment zoning does not apply in the area to be backfilled in the outlet works excavation and in the Sulphur River Channel and the [illegible] channel. Impervious Fill [illegible] be used as backfill up to the original natural ground line.

a		A-[illegible]	[illegible] 87	Added Typ Emb Sec No 3, Moved Notes, Rev Sta

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

COOPER LAKE
SULPHUR RIVER TEXAS

EMBANKMENT

TYPICAL EMBANKMENT SECTIONS

DESIGNED BY: J. Bennett, T. Schmidt

DRAWN BY: K. Miller

REVIEWED BY: T. Schmidt

SUBMITTED BY: H. E. Yates, ENGINEER

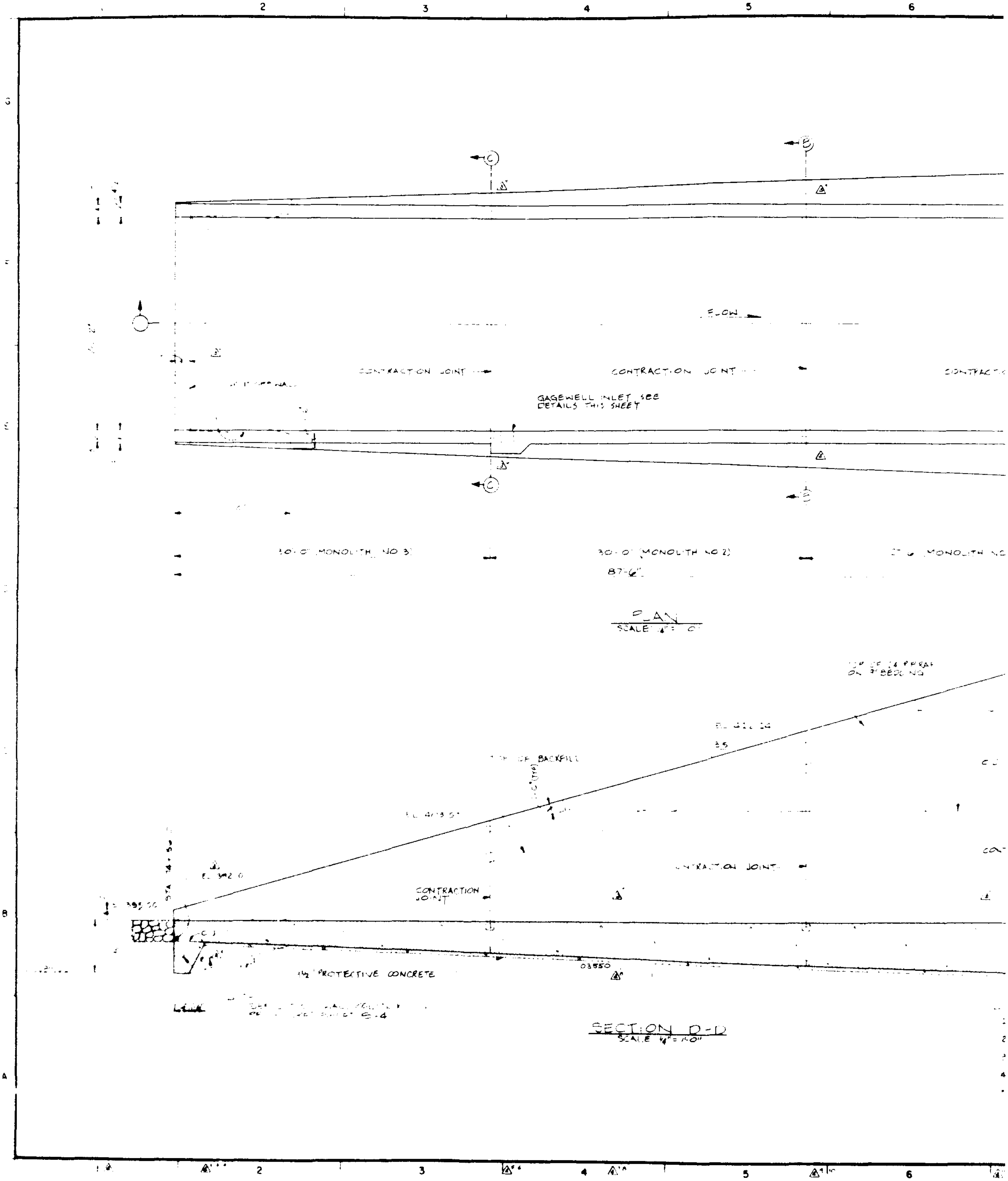
SOL. NO. DACW63-87-B-00[illegible] DATED: MAY 87

CONTR NO. DACW63-87-C-0085

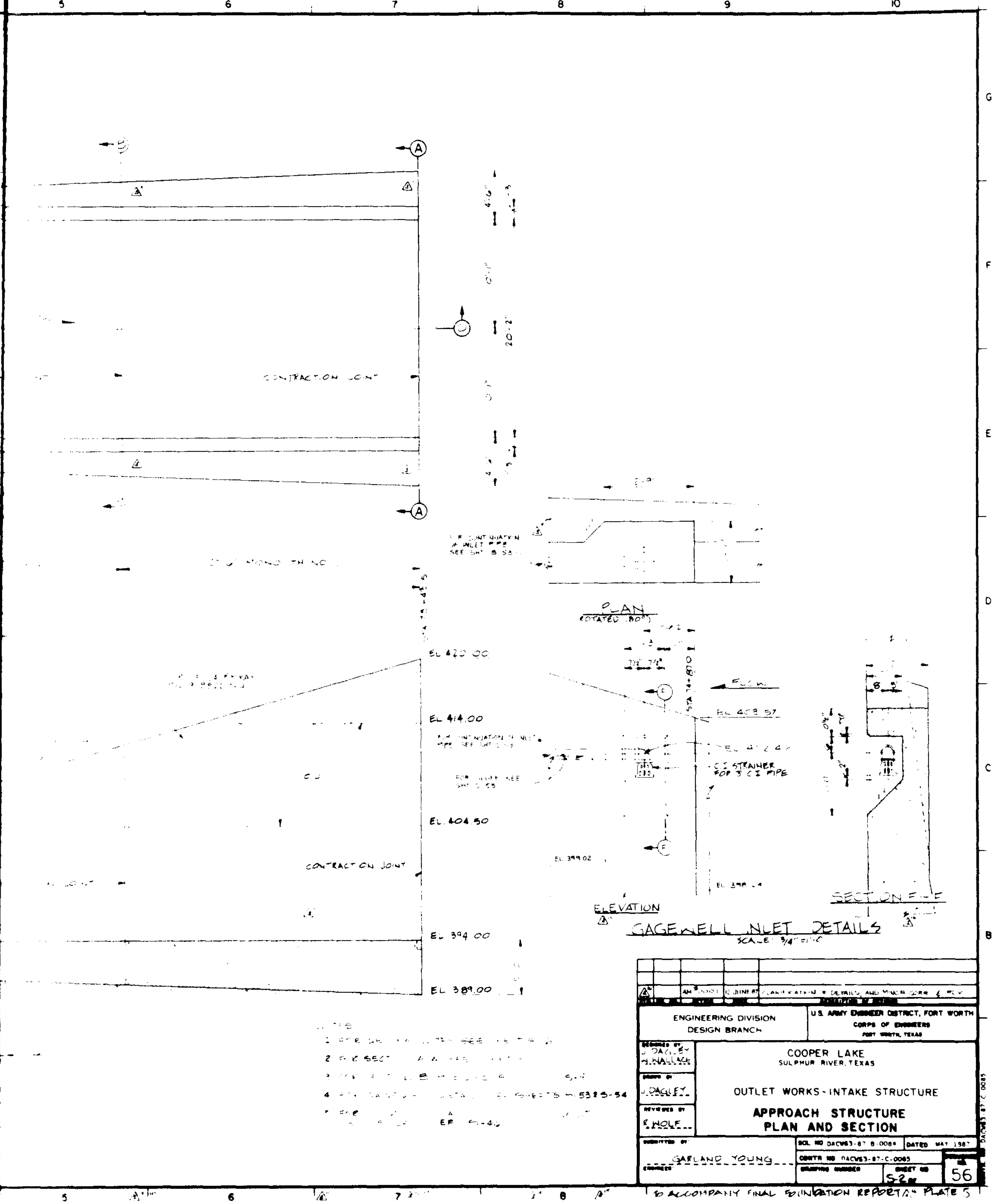
SHEET NO. EI 35

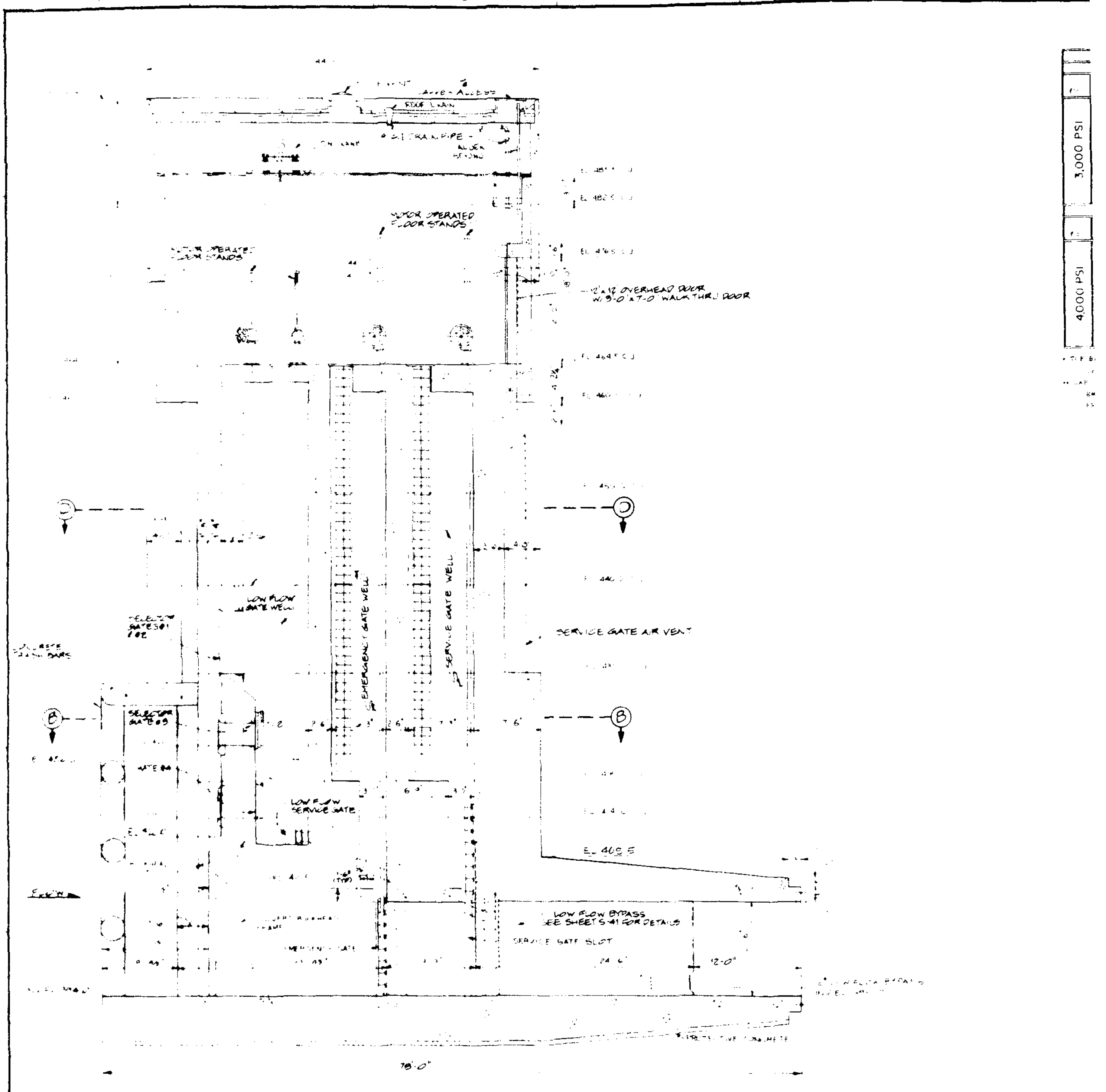
11

To ACCOMPANY FINAL FOUNDATION REPORT PLATE 4



FLOW
CONTRACTION JOINT
CONTRACTION JOINT
GAGEWELL INLET SEE DETAILS THIS SHEET
30'-0" (MONOLITH NO 3)
30'-0" (MONOLITH NO 2)
MONOLITH NO
87'-6"
PLAN
TOP OF BACKFILL
CONTRACTION JOINT
CONTRACTION JOINT
STA 14+50
1½" PROTECTIVE CONCRETE
03550
SECTION D-D
SCALE ¼" = 1'-0"


CONTRACTION JOINT
EL 420.00
EL 414.00
EL 404.50
EL 394.00
EL 389.00
CONTRACTION JOINT
PLAN
ROTATED 180°
FLOW
EL 403.57
C.I. STRAINER FOR 3" C.I. PIPE
ELEVATION
SECTION F-F
GAGEWELL INLET DETAILS
SCALE: 3/4" = 1'-0"
ENGINEERING DIVISION
DESIGN BRANCH
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
J. DAGLEY
H. WALLACE
J. DAGLEY
E. WOLF
COOPER LAKE
SULPHUR RIVER, TEXAS
OUTLET WORKS - INTAKE STRUCTURE
APPROACH STRUCTURE
PLAN AND SECTION
SOL. NO. DACW63-87-B-0084
DATED MAY 1987
CONTR. NO. DACW63-87-C-0085
GARLAND YOUNG
S-2
56
TO ACCOMPANY FINAL FOUNDATION REPORT PLATE 5



VERTICAL SECTION
SCALE: 3/16" = 1'-0"

CLASS "C" TENSION LAP SPLICE AND EMBEDMENT TABLE

TABLE A

f'c	fy	BAR SIZE	LAP LENGTH, IN ** TOP BAR *	LAP LENGTH, IN ** OTHER BAR	EMBEDMENT LENGTH, IN TOP BAR *	EMBEDMENT LENGTH, IN OTHER BAR*
3,000 PSI	60,000 PSI	3	16	13	12	12
		4	23	17	14	12
		5	29	21	17	12
		6	37	27	22	16
		7	51	36	30	21
		8	66	48	39	28
		9	84	60	50	36
		10	106	76	63	45
		11	130	93	77	55

TABLE B

f'c	fy	BAR SIZE	LAP LENGTH, IN ** TOP BAR *	LAP LENGTH, IN ** OTHER BAR	EMBEDMENT LENGTH, IN TOP BAR *	EMBEDMENT LENGTH, IN OTHER BAR
4,000 PSI	60,000 PSI	3	16	13	12	12
		4	23	17	14	12
		5	29	21	17	12
		6	35	25	21	15
		7	44	31	26	19
		8	58	41	34	24
		9	73	52	43	31
		10	92	66	54	39
		11	113	81	67	48

* TOP BARS ARE HORIZONTAL REINFORCEMENT SO PLACED THAT MORE THAN 12" OF CONCRETE IS CAST IN THE MEMBER BELOW THE BAR

** LAP LENGTHS SHOWN ARE FOR CLASS "C" SPLICES. LAP LENGTHS AND EMBEDMENTS SHOWN ARE FOR BARS SPACED LATERALLY ≥6" AND ≥3" FROM THE SIDE FACE IN ACCORDANCE WITH A.C.I. 318-83

THE F[illegible]WING FABRICATED STR[illegible] STEEL ITEMS [illegible] IDENTIFIED BY DESCRIPTION OR LOCATION [illegible]

A. ALL STRUCTURA[illegible] ABOVE [illegible] IN OR ON THE CONTROL HOUSE EXC[illegible]ACES OF MACHINERY AND MOTORS [illegible]ENDED TO BE PAINTED

B. AIR VENTS (PIPE AND TRANSITION PIECES) FOR FLOOD CONTROL AND EMERGENCY GATES, AND FOR LOW FLOW SERVICE GATES

C. ALL STRUCTURAL STEEL ITEMS FOR THE SERVICE BRIDGE, EXCEPT BARRICADE

D. ALL STRUCTURAL STEEL ITEMS FOR STILLING BASIN WALLS

E. ANY ITEM DESIGNED ON THE DRAWINGS TO BE GALVANIZED

8. EXPANSION ANCHORS SHALL MEET THE REQUIREMENTS OF FED [illegible] 325 WITH THE FOLLOWING EXCEPTIONS AND ADDITIONAL REQUIREMENTS (ANCHORS MAY BE [illegible])

A. EXPANSION ANCHORS SHALL [illegible] TYPE(S) THAT ARE INSTALLED IN DRILLED OR SELF DRILLING HOLES. EMBEDMENT OF ANCHOR SHALL BE 5 INCHES MINIMUM

B. THE MINIMUM ACCEPTABLE ULTIMATE CAPACITY OF THE INSTALLED ANCHOR IN KIPS SHALL BE 20 [illegible] S THE NOMINAL DIAMETER OF THE ANCHOR IN IN[illegible] FOR 3/4 IN DIA. AN[illegible] ANCHOR SHALL [illegible] OF THE MINIMUM ACCEPTABLE ULTIMATE CAPACITY. ANCHORS SHALL BE GALVANIZED

MINIMUM SIZE OF FILLET WELD

METAL THICKNESS OF THICKER PART TO BE JOINED (INCHES)	MINIMUM SIZE OF FILLET WELD (INCHES)
[illegible]	BASE METAL THICKNESS [illegible]

NOTES:

1. FOR SECTIONS A-A AND B-B, SEE SHEET [illegible]

1	AM0002	17JUN87	REVISED TO REFLECT WRITE-IN CHANGE(S)
5	AM0001	JUNE 87	REVISED AND ADDED GENERAL NOTES

ENGINEERING DIVISION
DESIGN BRANCH

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

DESIGNED BY: L. HUDDLER, J. DAGLEY

DRAWN BY: A. STEINECKE, B. MABBS, DM KELLEY

REVIEWED BY: K. WOLF

COOPER LAKE
SULPHUR RIVER, TEXAS

OUTLET WORKS - INTAKE STRUCTURE
TYPICAL INSTALLATION AND GENERAL NOTES

SUBMITTED BY: GARLAND YOUNG
ENGINEER

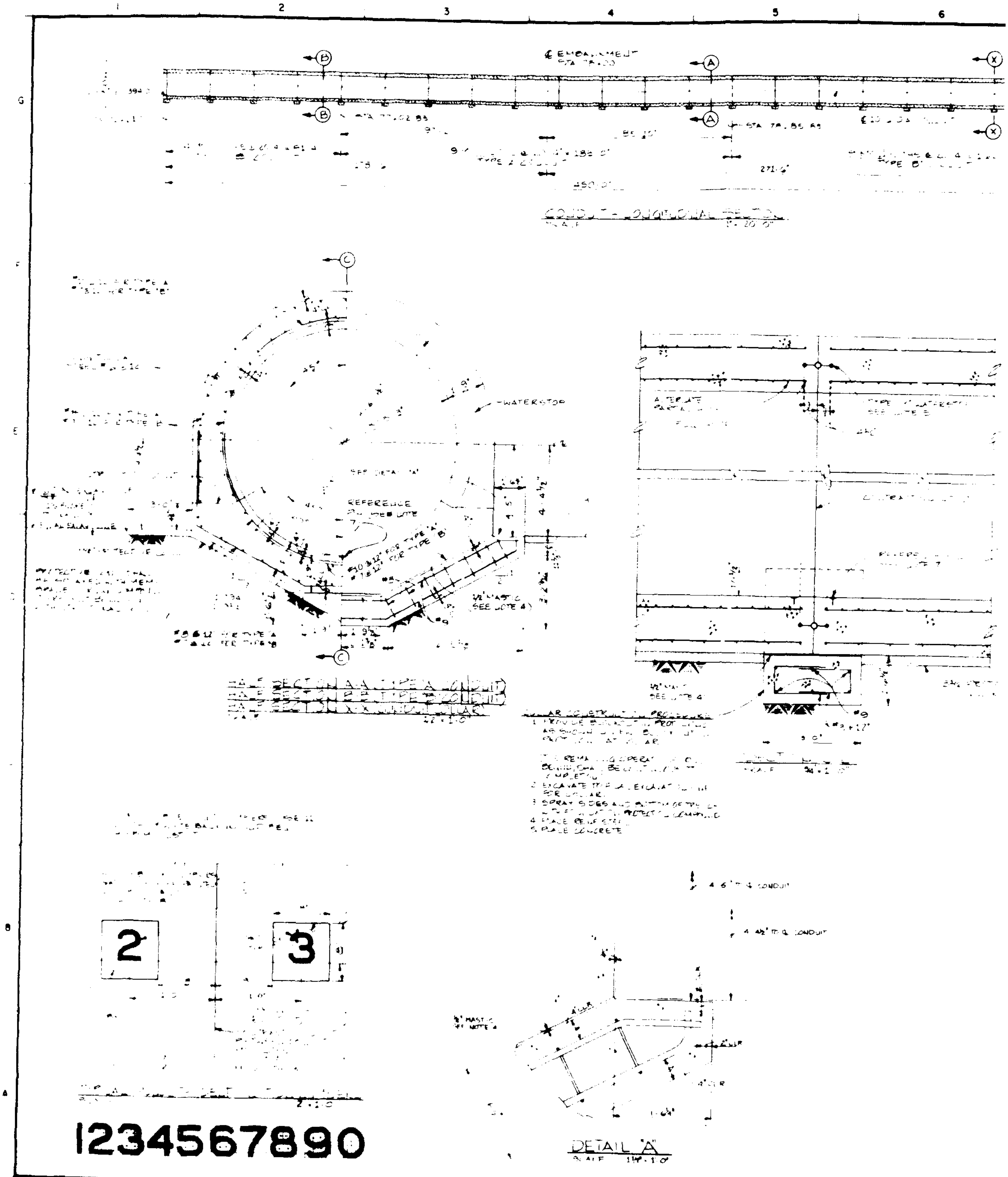
SOL. NO. DACW63-87-B-0084 | DATED: MAY 1987

CONTR. NO. DACW63-87-C-0085

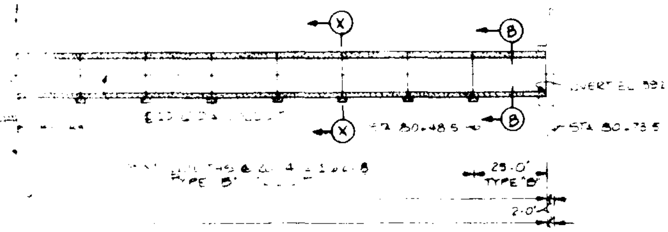
DRAWING NUMBER | SHEET NO.

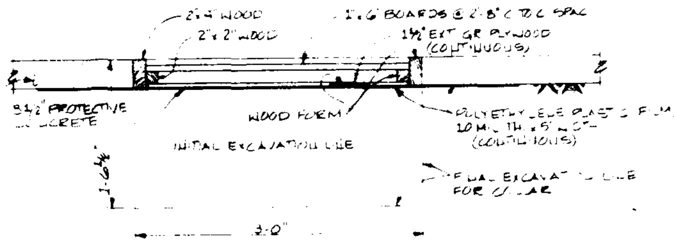
60

To ACCOMPANY FINAL FOUNDATION REPORT PLATE 6



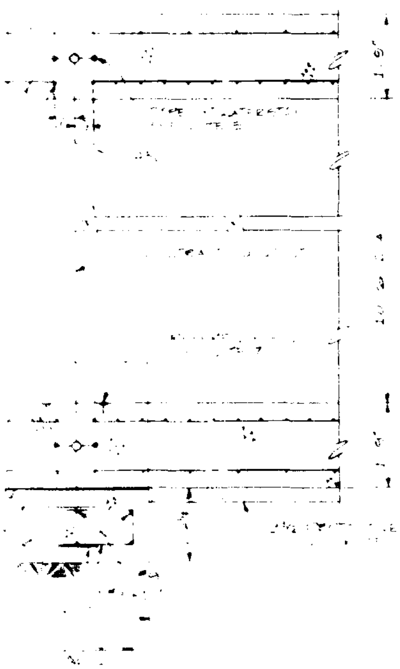
℄ EMBANKMENT
WATERSTOP
SEE DETAIL "A"
REFERENCE
HALF SECTION A-A TYPE A CONDUIT
HALF SECTION B-B TYPE B CONDUIT
HALF SECTION X-X
⅜" MASTIC (SEE NOTE 4)
2
3
1234567890
DETAIL "A"





BLOCKOUT IN PROTECTIVE CONCRETE

SCALE 1½" = 1'-0"



NOTES

1. FOR GENERAL NOTES, SEE SHT S-6
2. CONCRETE FOR CONDUIT SHALL BE 4000 PSI COMPRESSIVE STRENGTH AT 28 DAYS.
3. LONGITUDINAL BARS SHALL NOT EXTEND THRU CONTRACTION JOINTS
4. MASTIC TO BE 1/2 INCH OF ASBESTOS-FIBER BITUMINOUS MASTIC. APPLY PRIMER COAT TO CONCRETE AND APPLY MASTIC IN SEVERAL COATS ALLOWING EACH COAT TO DRY BEFORE SUCCESSIVE COATS
5. FOR WATERSTOP DETAIL, SEE SHT. S-46
6. NOT USED.
7. SEE SHT. F-30 FOR REFERENCE PIN DETAIL
8. SEE DETAIL FOR MONOLITH IDENTIFICATION NUMBERS TO BE PAINTED AT EACH CONDUIT CONTRACTION JOINT. SEE SPECIFICATIONS FOR TYPE OF PAINT.

1		AM 0001	JUNE 87	REVISED TO REFLECT AM 1 CHANGES

ENGINEERING DIVISION
DESIGN BRANCH

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

DESIGNED BY: E. WOLF
DRAWN BY: [illegible]
REVIEWED BY: E. WOLF

COOPER LAKE
SULPHUR RIVER, TEXAS

OUTLET WORKS

CONDUIT DETAILS

SUBMITTED BY: GARLAND E. YOUNG

SOL NO. DACW63-87-B-0084 DATED: MAY 1987

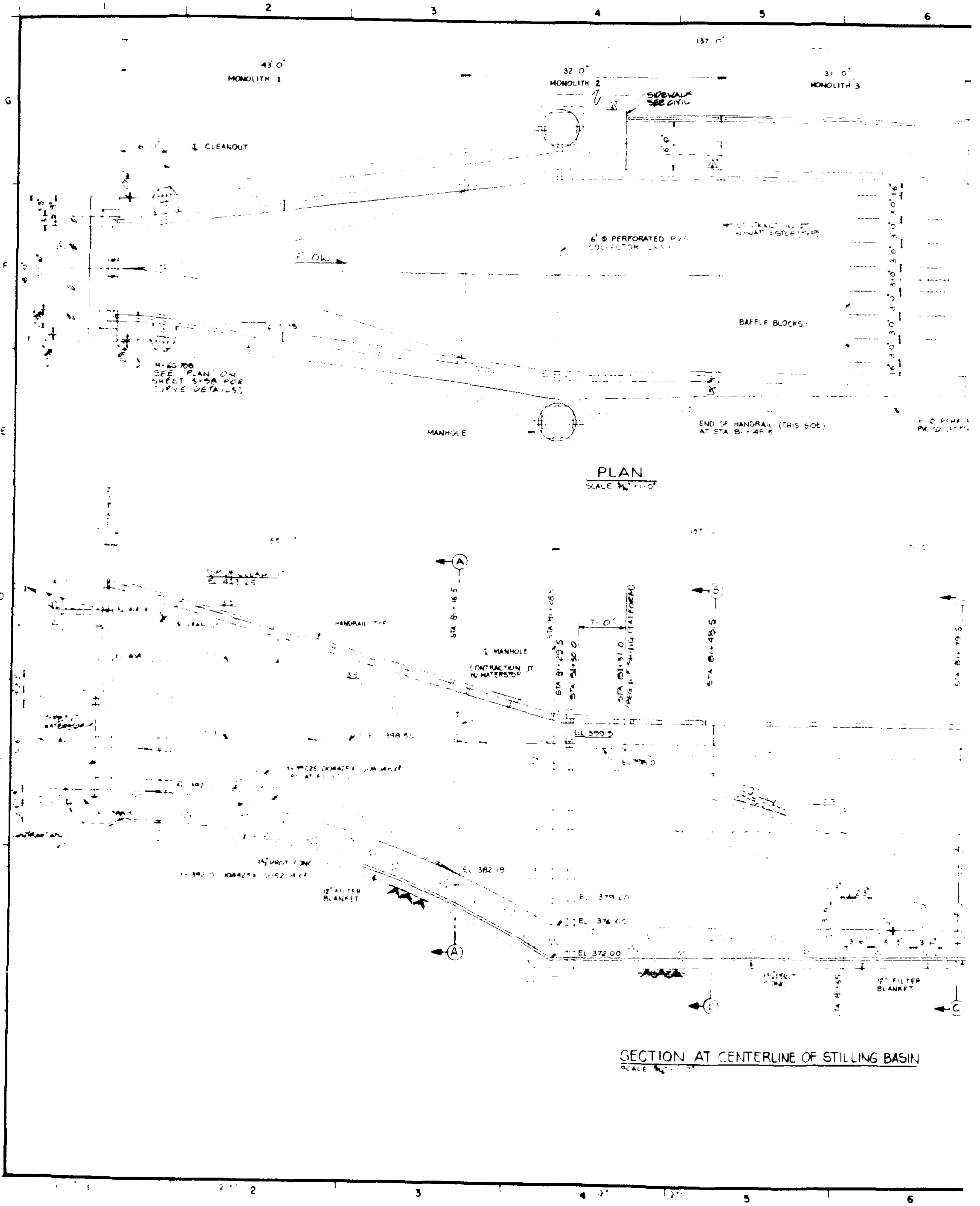
CONTR NO. DACW63-87-C-0085

DRAWING NUMBER

SHEET NO. 112

DACW63-87-C-0085

1 TO ACCOMPANY FINAL FOUNDATION REPORT PLATE 7

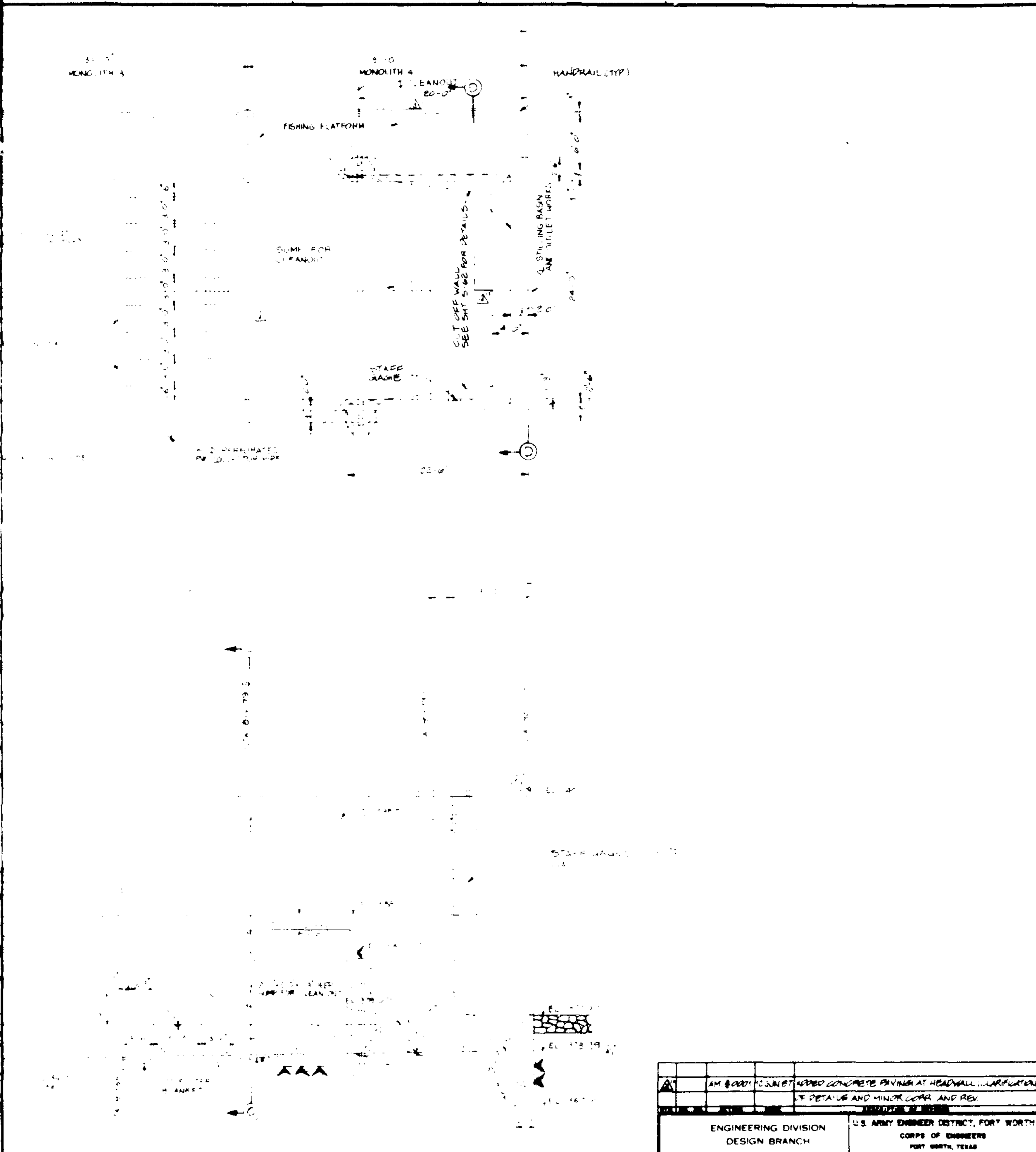


PLAN

SCALE 3/16" = 1'-0"

SECTION AT CENTERLINE OF STILLING BASIN

SCALE 3/16" = 1'-0"



PLAN OF STILLING BASIN

	AM #0001		ADDED CONCRETE PAVING AT HEADWALL, CLARIFICATION OF DETAILS AND MINOR CORR. AND REV.

ENGINEERING DIVISION
DESIGN BRANCH

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

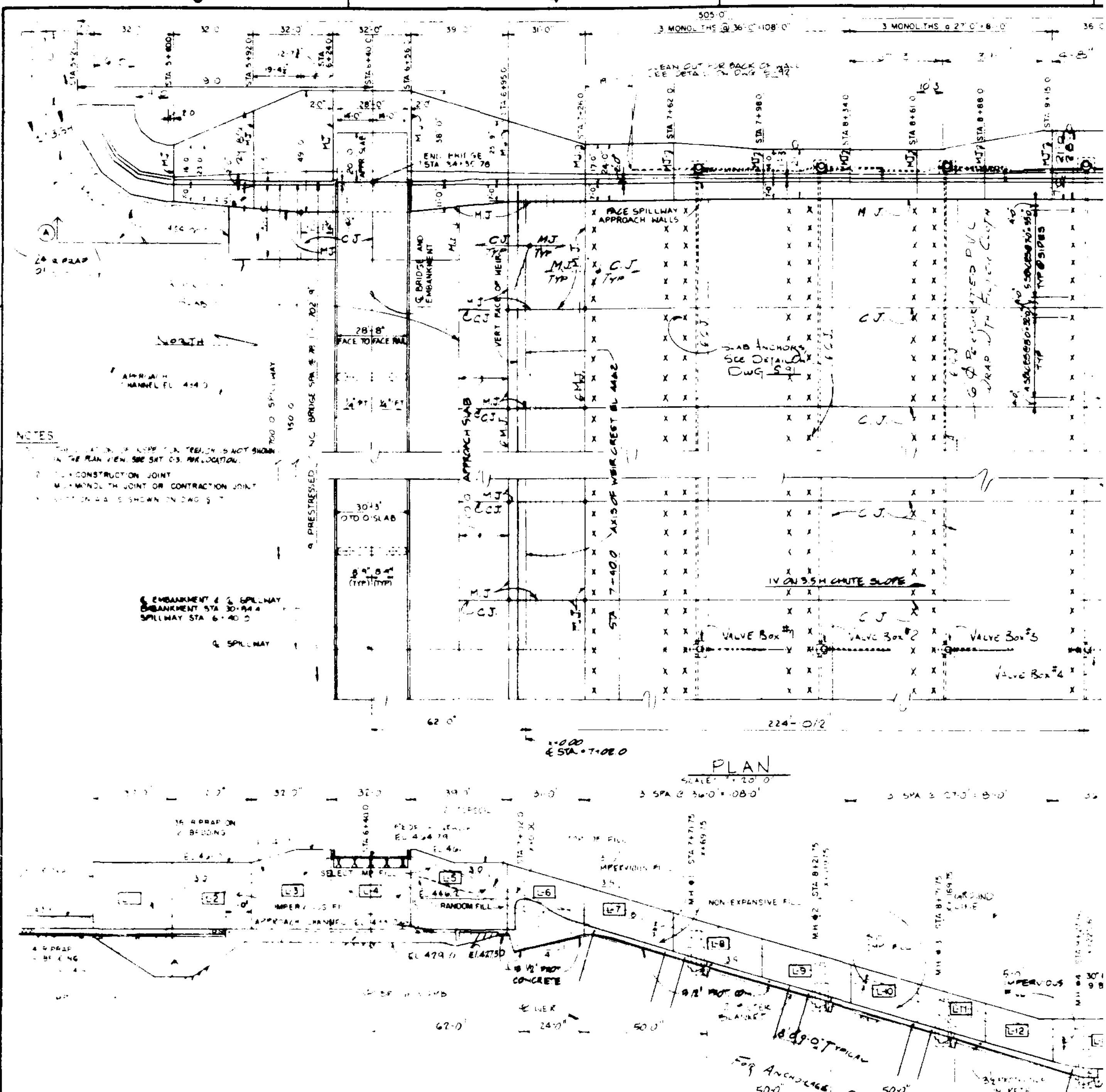
COOPER LAKE
SULPHUR RIVER, TEXAS

OUTLET WORKS - STILLING BASIN

PLAN AND LONGITUDINAL SECTION

DESIGNED BY J. DAGLEY, N. WALLACE
DRAWN BY J. DAGLEY, B. MARKS
REVIEWED BY C. HOLT
SUBMITTED BY GARLAND YOUNG
SOL. NO. DACW63-87-B-0084 DATED MAY 1987
CONTR. NO. DACW63-87-C-0063
DRAWING NUMBER S-57
SHEET NO. 113
DACW63-87-C-0063

To ACCOMPANY FINAL FOUNDATION REPORT PLATE 8



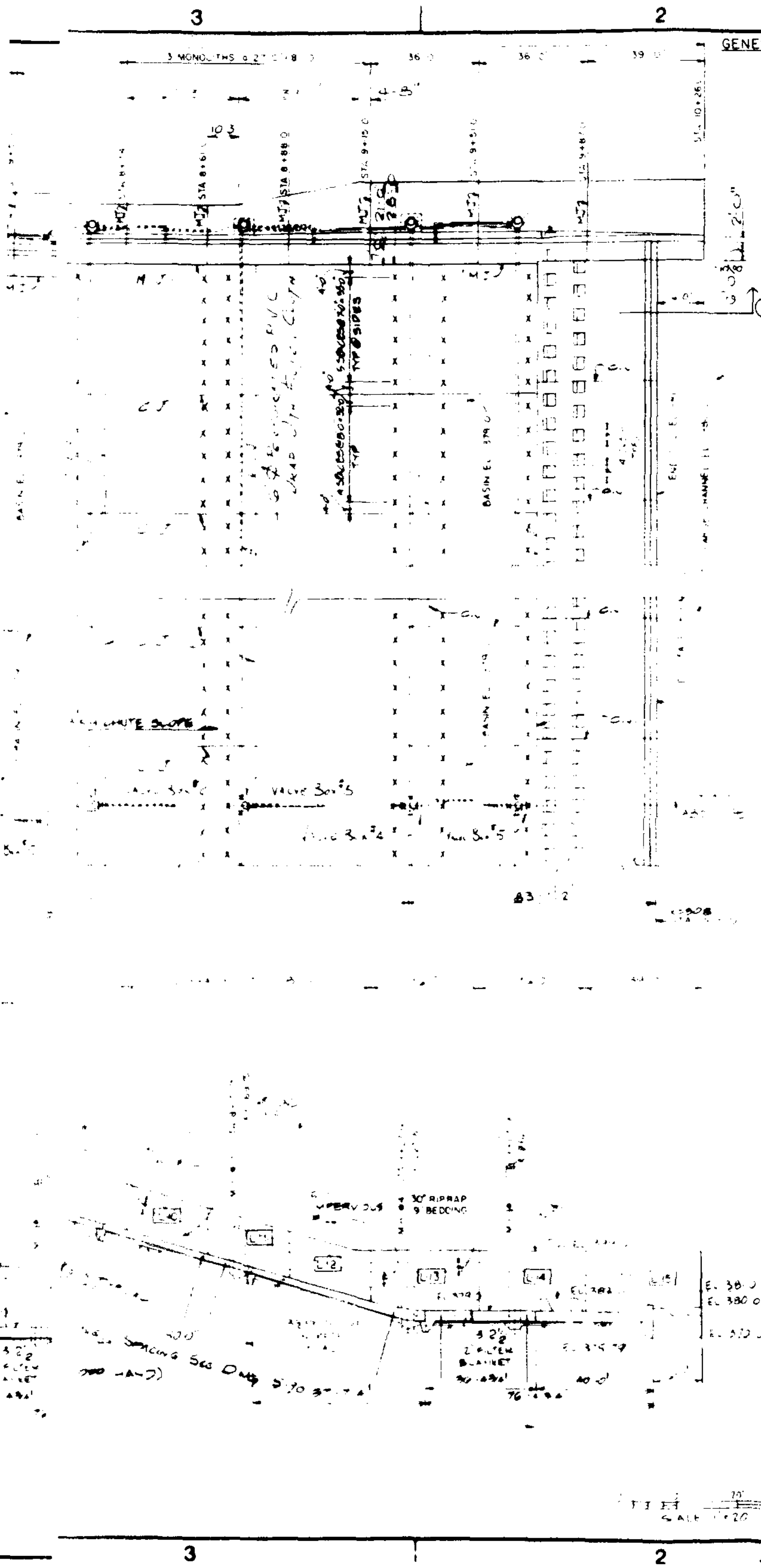
CLASS "C" TENSION LAP SPLICE & EMBEDMENT TABLE

TABLE "A"

		BAR SIZE	LAP LENGTH, IN ** TOP BAR *	LAP LENGTH, IN ** OTHER BAR	EMBEDMENT LENGTH, IN TOP BAR *	EMBEDMENT LENGTH, IN OTHER BAR
3,000 PSI	60,000 PSI	3	8	3	2	12
		4	23	[illegible]	4	2
		5	29	2	[illegible]	12
		6	37	27	22	16
		[illegible]	51	36	30	21
		8	66	48	39	28
		9	84	60	50	36
		10	106	76	63	45
			130	93	77	55

* Top bars are horizontal reinforcement so placed that more than 12" of concrete is cast in the member below the bar.

** Lap lengths shown are for Class "C" splices. Lap lengths and embedments shown are for bars spaced laterally ≥ 6" o.c. and ≥ 3" from the side face in accordance with ACI 318-83.



GENERAL NOTES

A CONCRETE

1 UNLESS OTHERWISE NOTED, MINIMUM CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS SHALL BE 3000 PSI FOR ALL CONCRETE

2 GENERAL NOTES A 2, A 3, AND A 4 FOR THE OUTLET WORKS STRUCTURES SHALL APPLY ALSO TO THE SPILLWAY STRUCTURES

3 ALL UNFORMED SURFACES, EXCEPT CONSTRUCTION JOINTS, SHALL HAVE A WOOD FLOAT FINISH AS INDICATED IN THE SPECIFICATIONS

4 ALL CONTRACTION AND CONSTRUCTION JOINTS OF EXPOSED FORMED SURFACES SHALL BE CHAMFERED 3/4" UNLESS OTHERWISE SHOWN OR NOTED

5 ALL JOINTS IN THE SPILLWAY SLAB SHALL HAVE TOOLED EDGES OF THE RADIUS SHOWN ON THE DRAWINGS

6 CONTRACT ON JOINTS SHALL PREVENT BOND OF CONCRETE ACROSS JOINT BOND BREAKING MATERIAL SHALL BE MEMBRANE CURING COMPOUND OR [illegible] PAINT. WATERSTOPS SHALL BE PROTECTED DURING APPLICATION OF BOND BREAKING MATERIAL TO PREVENT COATING THEM.

7 THE SECTIONS OF THE SPILLWAY SLAB, AS DIVIDED BY CONSTRUCTION JOINTS, SHALL BE PLACED IN ALTERNATE SECTIONS, FORMING A CHECKER BOARD PATTERN. THERE SHALL BE A MINIMUM TIME OF 72 HOURS BETWEEN PLACING ADJACENT SECTIONS. CLOSURE SECTIONS NEXT TO THE RETAINING WALLS SHALL NOT BE PLACED UNTIL RETAINING WALLS AND SPILLWAY SLAB HAVE BEEN PLACED AND THEN PLACED IN ALTERNATE SECTIONS

8 THE CONTRACTOR MAY AT HIS OPTION USE CONTINUOUS PAVING FOR THE CHUTE AND STILLING BASIN SLABS.
THERE IS NO RESTRICTION ON WIDTH OF LANE TO BE USED. IF THIS OPTION IS CHOSEN, THE SLABS SHALL BE PLACED IN ALTERNATE LANES WITH A MINIMUM TIME OF 72 HOURS BETWEEN PLACING ADJACENT LANES. CONSTRUCTION JOINTS ARE REQUIRED BETWEEN LANES, AND AT THE END OF A DAYS RUN

9 TO SECURE A VERTICAL OR NEAR VERTICAL CUT IN THE FOUNDATION MATERIALS, THE CONTRACTOR MAY USE ANY METHOD OF EXCAVATION APPROVED BY THE CONTRACTING OFFICER. NO PAYMENT WILL BE MADE FOR OVERBREAKAGE BEYOND EXCAVATING LIMITS SHOWN. WHERE CONCRETE IS PLACED AGAINST FACE OF THE EXCAVATION, CONTRACTOR WILL BE REQUIRED TO REPLACE ANY OVERBREAKAGE WITH CONCRETE AT HIS EXPENSE

10 FOUNDATION PROTECTION PROCEDURES & REQUIREMENTS & PLACEMENT REQUIREMENTS FOR THE FILTER BLANKET MATERIAL & THE PROTECTIVE CONCRETE ARE PRESENTED IN SPECIFICATION SECTION: EXCAVATION

11 FOR BRIDGE GENERAL NOTES SEE S-97

B REINFORCING

1 GENERAL NOTES B 1 THRU B 4 FOR THE OUTLET WORKS STRUCTURES SHALL APPLY ALSO TO THE SPILLWAY STRUCTURES.

2 ADDITIONAL LAP SPLICES ARE PERMISSIBLE PROVIDED NO MORE THAN ONE-HALF OF THE BARS ARE SPLICED WITHIN ANY ONE LAP LENGTH. IN THE RETAINING WALL BASE, NO LAPS WILL BE PERMITTED WITHIN 5 FEET OF THE FRONT FACE OF THE WALL UNLESS OTHERWISE DETAILED. ALL ADDITIONAL SPLICES ARE AT CONTRACTORS EXPENSE. NO PAYMENT FOR REINFORCEMENT IN THESE SPLICES WILL BE MADE

3 RETAINING WALL REINFORCEMENT HAS BEEN DETAILED PRIMARILY BY THE USE OF CROSS SECTIONS. ADDITIONAL DETAILING OF MONOLITH L-11, L-12 REINFORCEMENT IS SHOWN ON S-87 TO PROVIDE GENERAL GUIDANCE IN DEVELOPING THE PLAN AND ELEVATION VIEWS NECESSARY TO CONSTRUCT THE WALLS

4 LONGITUDINAL REINFORCING IN THE RETAINING WALLS IS NOT DETAILED FULLY IN THE SECTIONS. PROVIDE #7 @ 12" O.C. IN EACH FACE UNLESS OTHERWISE SHOWN

C STRUCTURAL STEEL & MISC ITEMS

1 GENERAL NOTES C 1 THRU C 4 & C 7 FOR THE OUTLET WORKS STRUCTURES SHALL APPLY ALSO TO THE SPILLWAY STRUCTURES

2 WELDING OF CRES SHALL CONFORM TO LATEST AMER WELDING SOCIETY SPECIFICATIONS

SYM	DOC NO.	ACTION	DATE	DESCRIPTION OF REVISION
2		AM #0002	17 JUN 87	REVISE TO REFLECT W.I. CHANGES

U.S. ARMY ENGINEER DISTRICT, TULSA
CORPS OF ENGINEERS
TULSA, OKLAHOMA

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

DESIGNED BY: C. CHANG
DRAWN BY: R. SHURLEY
REVIEWED BY: C. CHANG

COOPER LAKE
SULPHUR RIVER, TEXAS

SPILLWAY

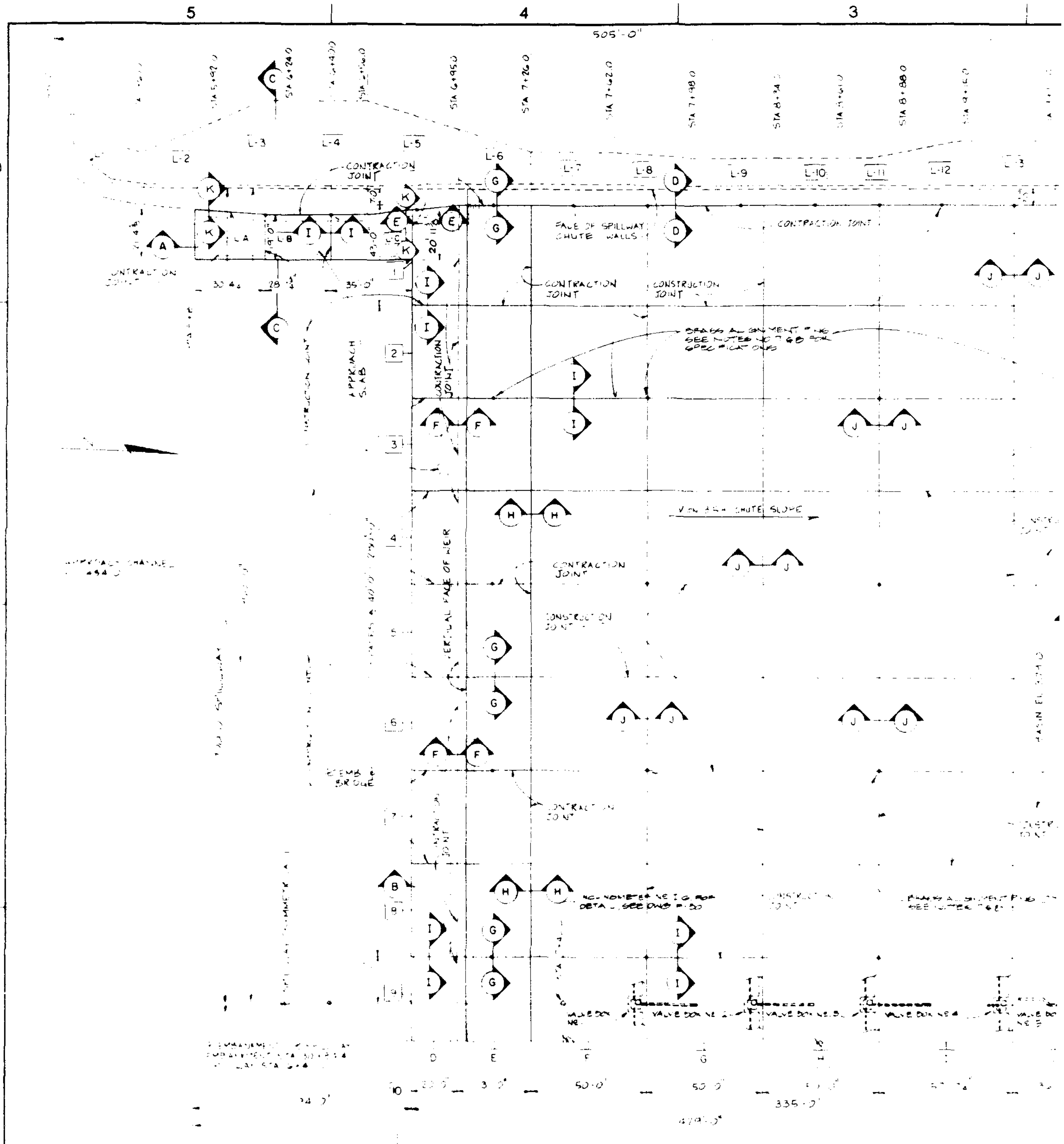
PLAN, ELEVATION, AND GENERAL NOTES

SUBMITTED BY: GEORGE HENSON

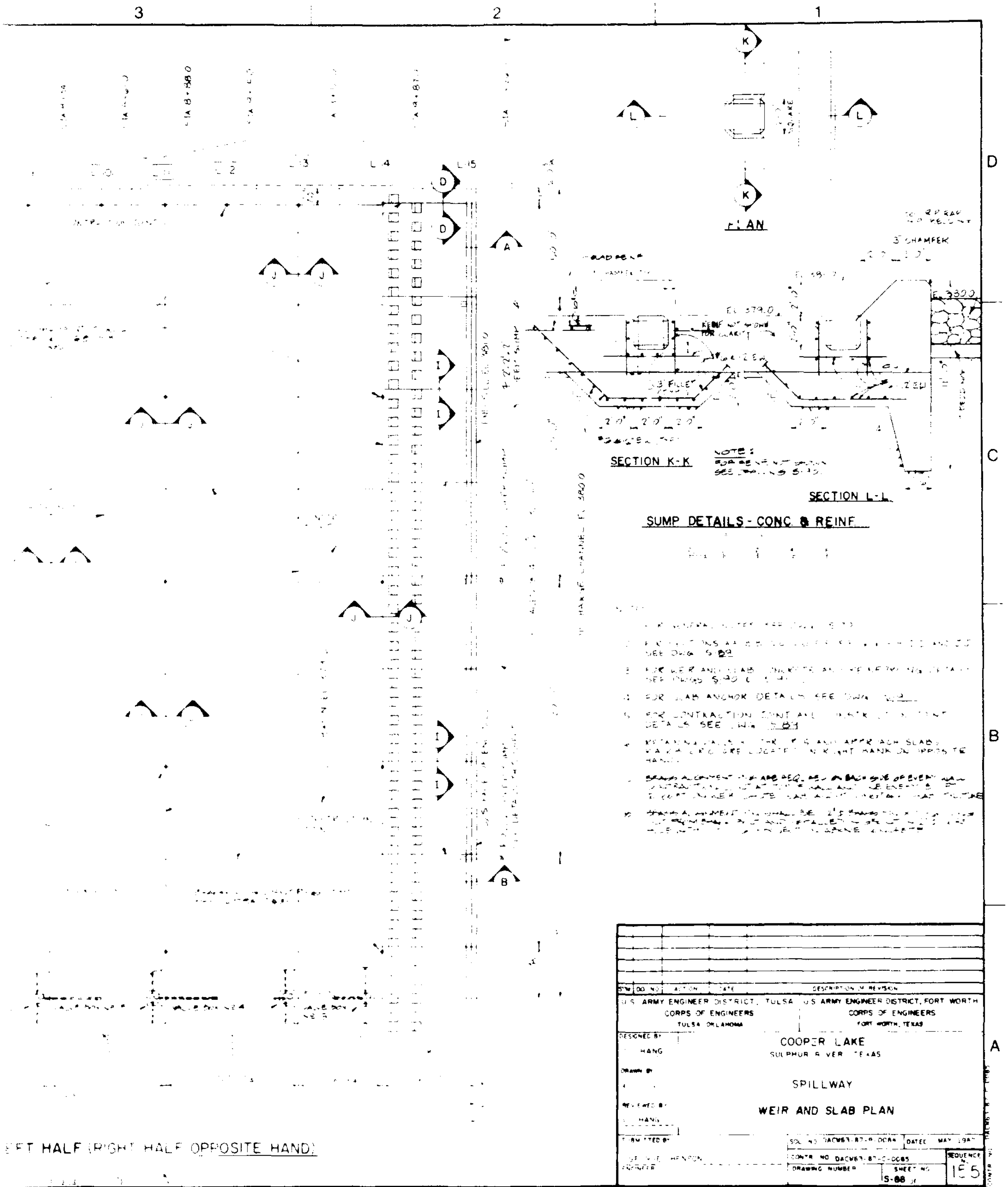
SOL. NO. DACW63-87-B-0084 DATED: MAY 1987
CONTR. NO. DACW63-87-C-0085
DRAWING NUMBER
SHEET NO. S-70
SEQUENCE NO. 137

TO ACCOMPANY FINAL FOUNDATION REPORT

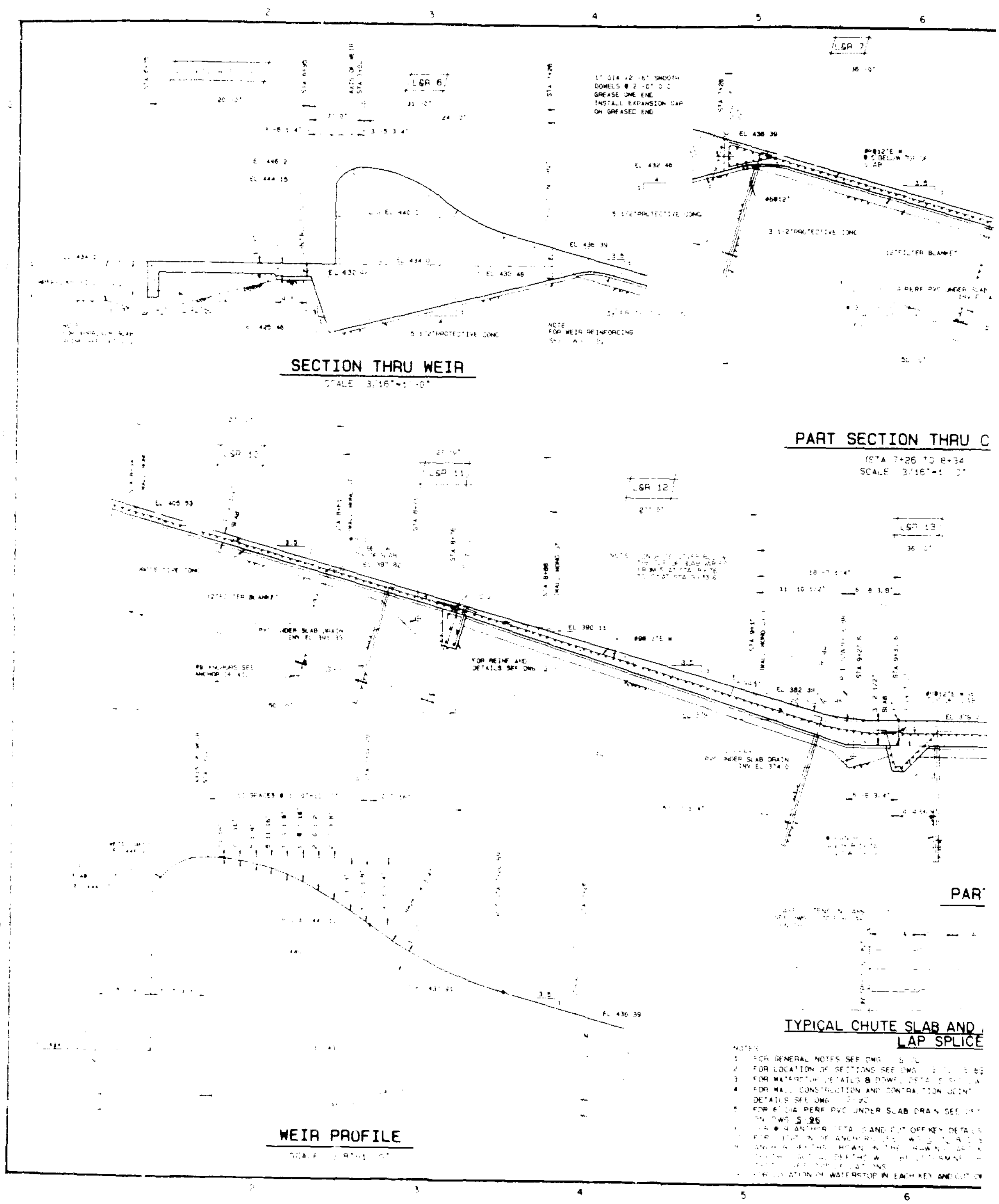
PLATE 9



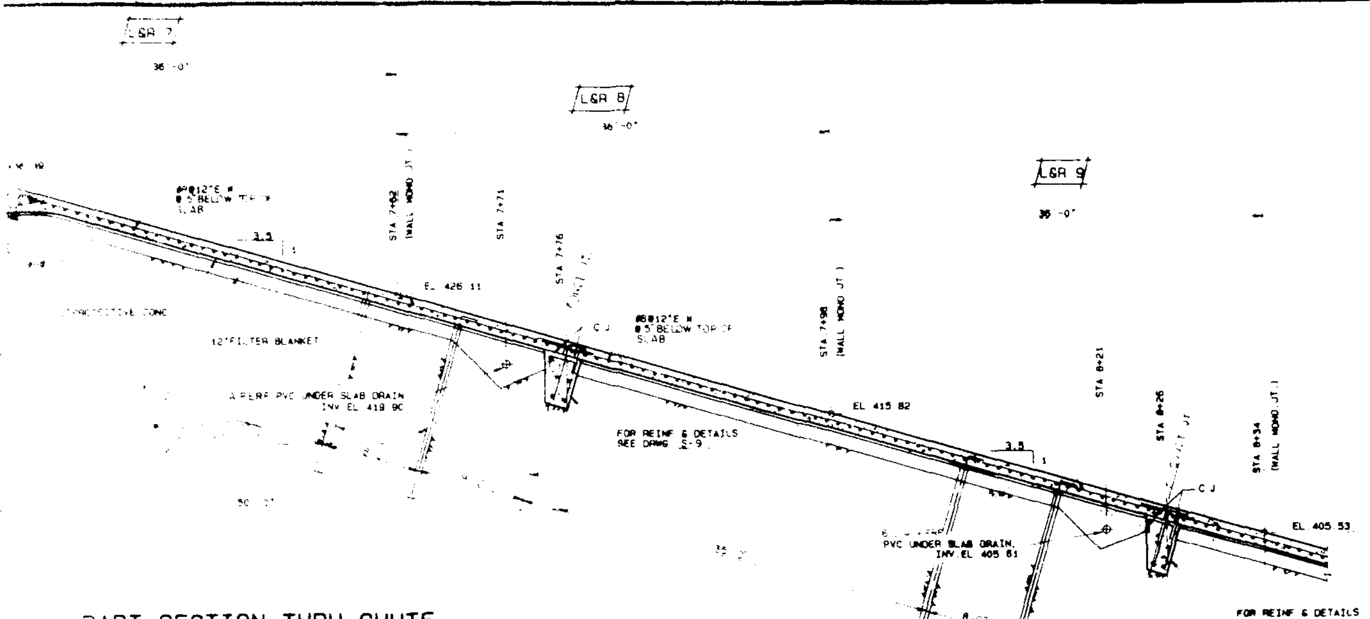
PLAN-SPILLWAY-LEFT HALF (RIGHT HALF OPPOSITE HAND)



TO ACCOMPANY FINAL FOUNDATION REPORT PLATE 10

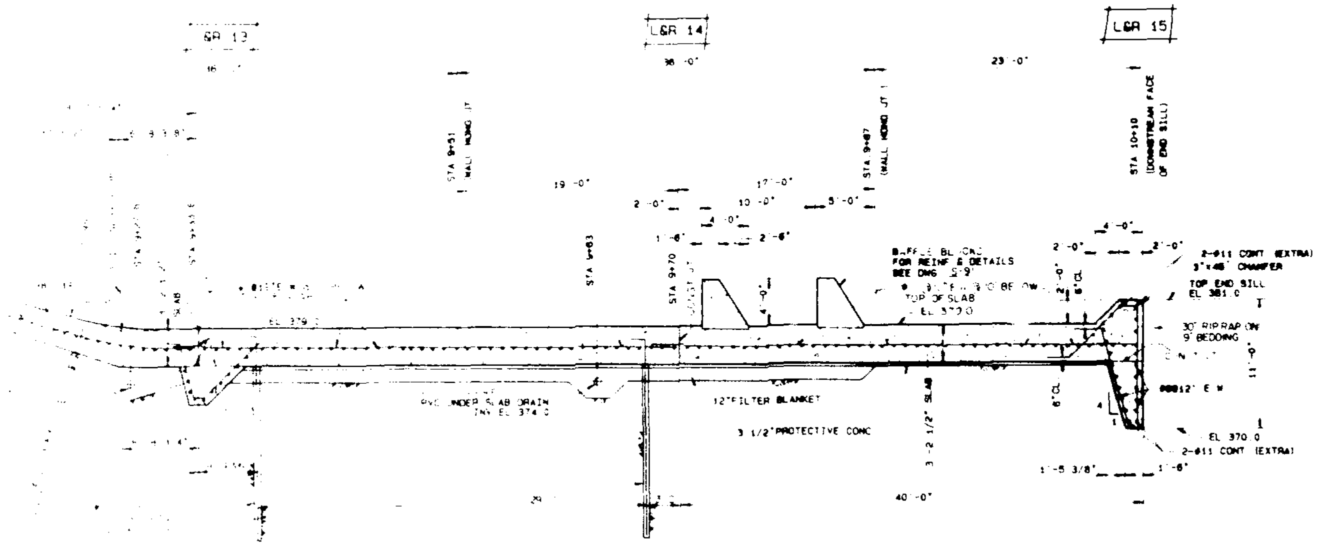


SECTION THRU WEIR
SCALE 3/16"=1'-0"
PART SECTION THRU C
(STA 7+26 TO 8+34
SCALE 3/16"=1'-0"
WEIR PROFILE
TYPICAL CHUTE SLAB AND
LAP SPLICE
NOTES
FOR GENERAL NOTES SEE DWG
FOR LOCATION OF SECTIONS SEE DWG



PART SECTION THRU CHUTE

STA 7+25 TO 8+34
SCALE 3/16"=1'-0"



PART SECTION THRU CHUTE

(STA 8+34 TO STA 10+10)
SCALE 3/16"=1'-0"

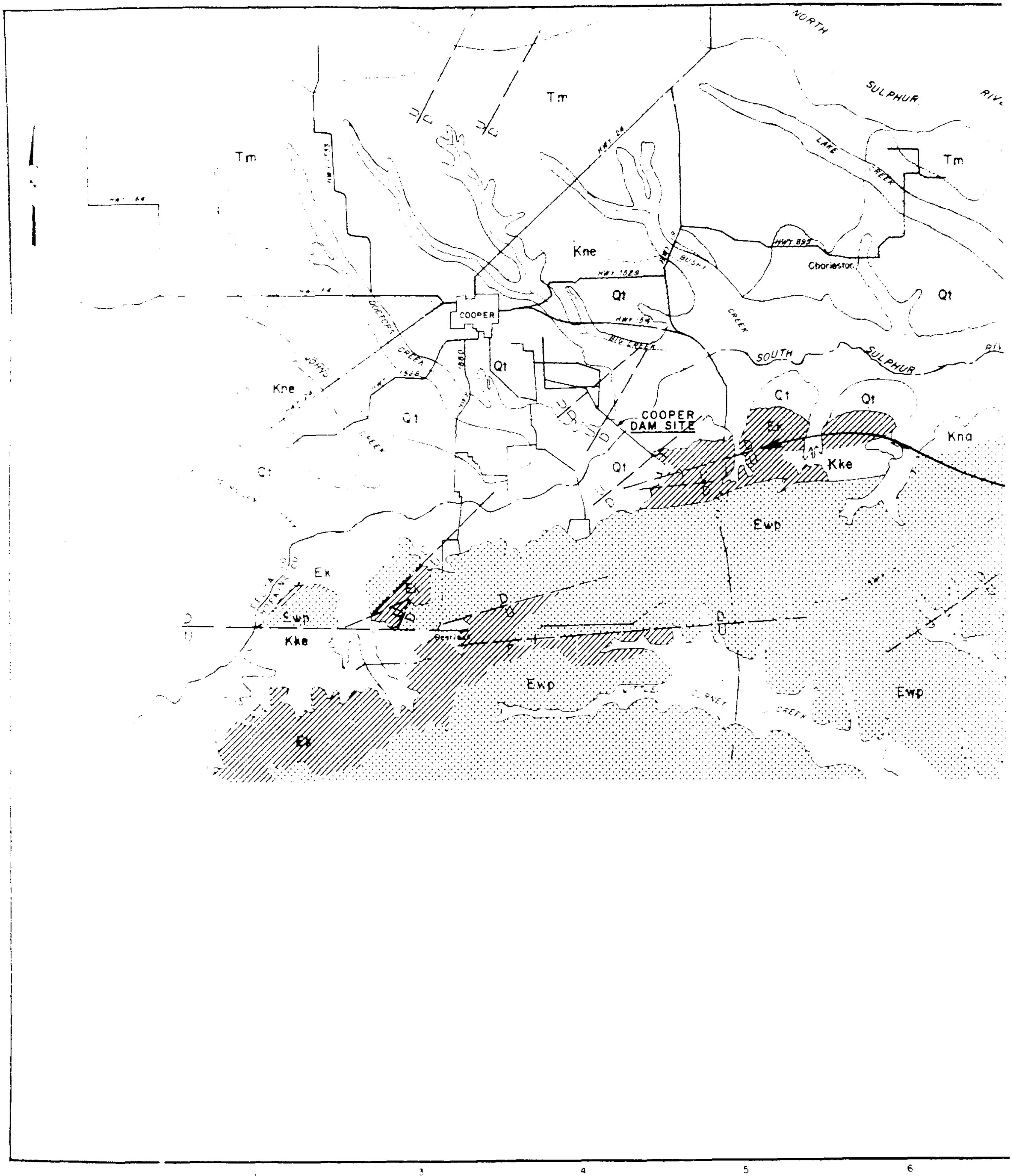
TYPICAL CHUTE SLAB AND APPROACH SLAB LAP SPLICE

A-PERF. PVC UNDER SLAB DRAIN SEE DETAIL
WATERSTOP IN EACH KEY AND CUT OFF KEY CONSTRUCTION PROCEDURE SEE DWG

U.S. ARMY ENGINEER DISTRICT, CORPS OF ENGINEERS, TULSA, OKLAHOMA	U.S. ARMY ENGINEER DISTRICT, FORT WORTH, CORPS OF ENGINEERS, FORT WORTH, TEXAS
DESIGNED BY: C. Chong	COOPER LAKE, SULPHUR RIVER, TEXAS
DRAWN BY:	SPILLWAY
REVIEWED BY: C. Chong	WEIR AND SLAB DETAILS I — CONCRETE AND REINFORCING
SUBMITTED BY: George Henson	SOL NO DACW63-87-B-0089, DATED MAY 1987
	CONTR NO DACW63-87-C-0085
	DRAWING NUMBER S-90, SHEET 1 OF 7

DACW63-87-C-0085

To ACCOMPANY FINAL FOUNDATION REPORT PLATE 11



NORTH
SULPHUR
LAKE
CREEK
Tm
Tm
Tm
HWY 24
Kne
Kne
HWY 1529
BUSHY
HWY 895
Charleston
Qt
Qt
Qt
Qt
COOPER
HWY 54
BIG CREEK
DOCTORS
CREEK
CREEK
SOUTH
SULPHUR
HWY 1528
Qt
COOPER
DAM SITE
Ek
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Kna
Ewp
Ek
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Kke
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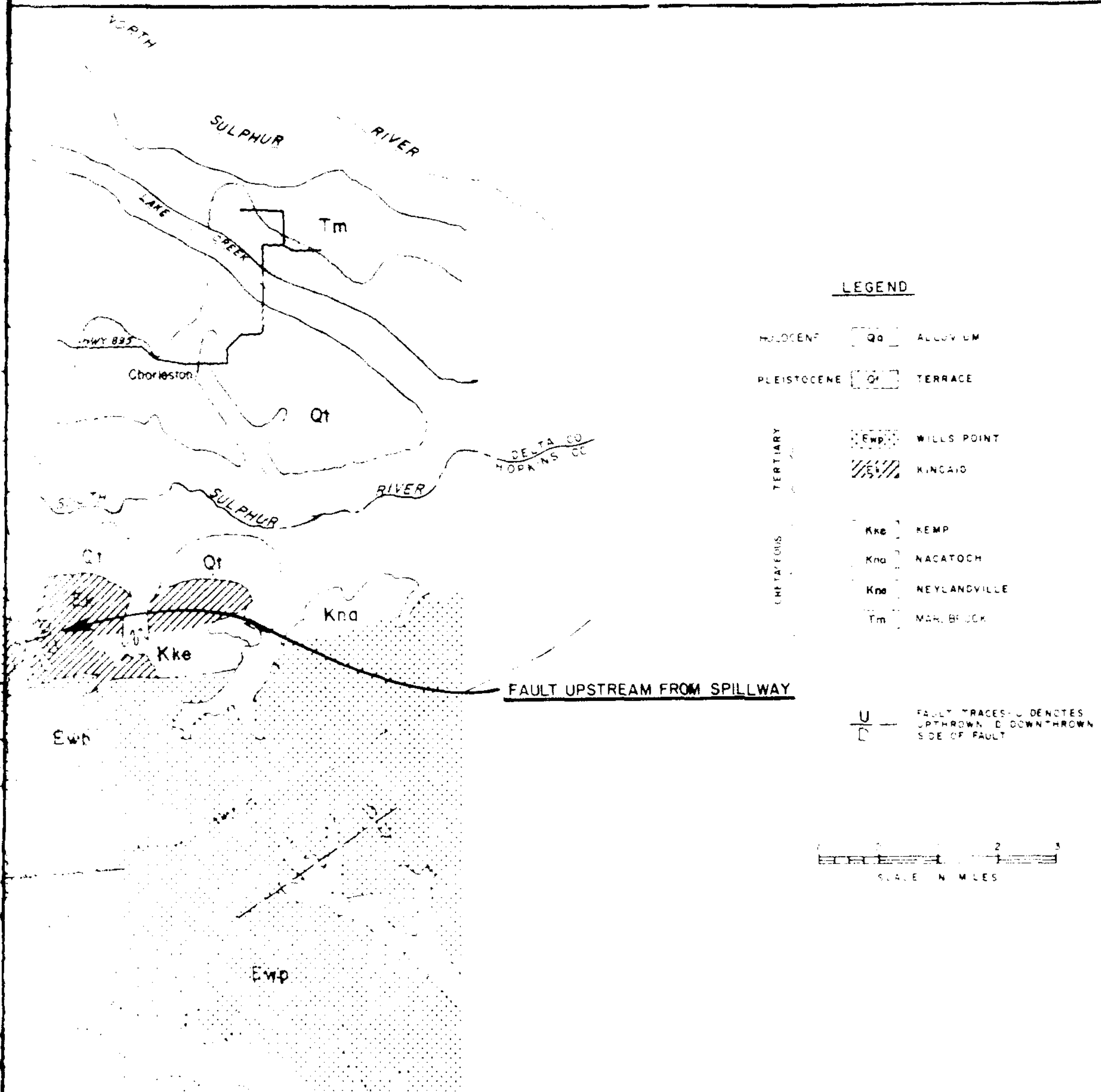
Ewp
Ek
CREEK
3
4
5
6



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

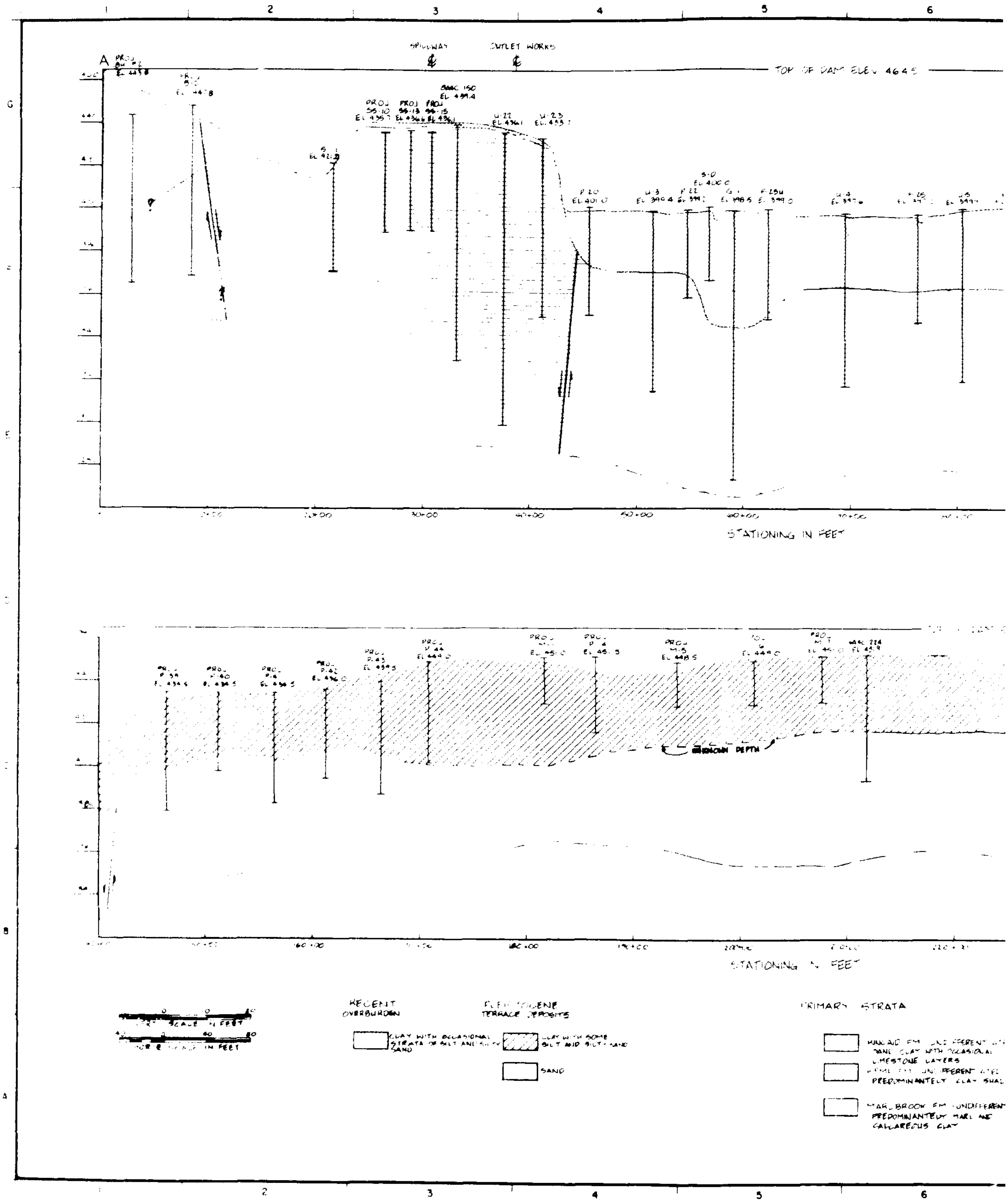
LAKE
SULPHUR RIVER, TEXAS

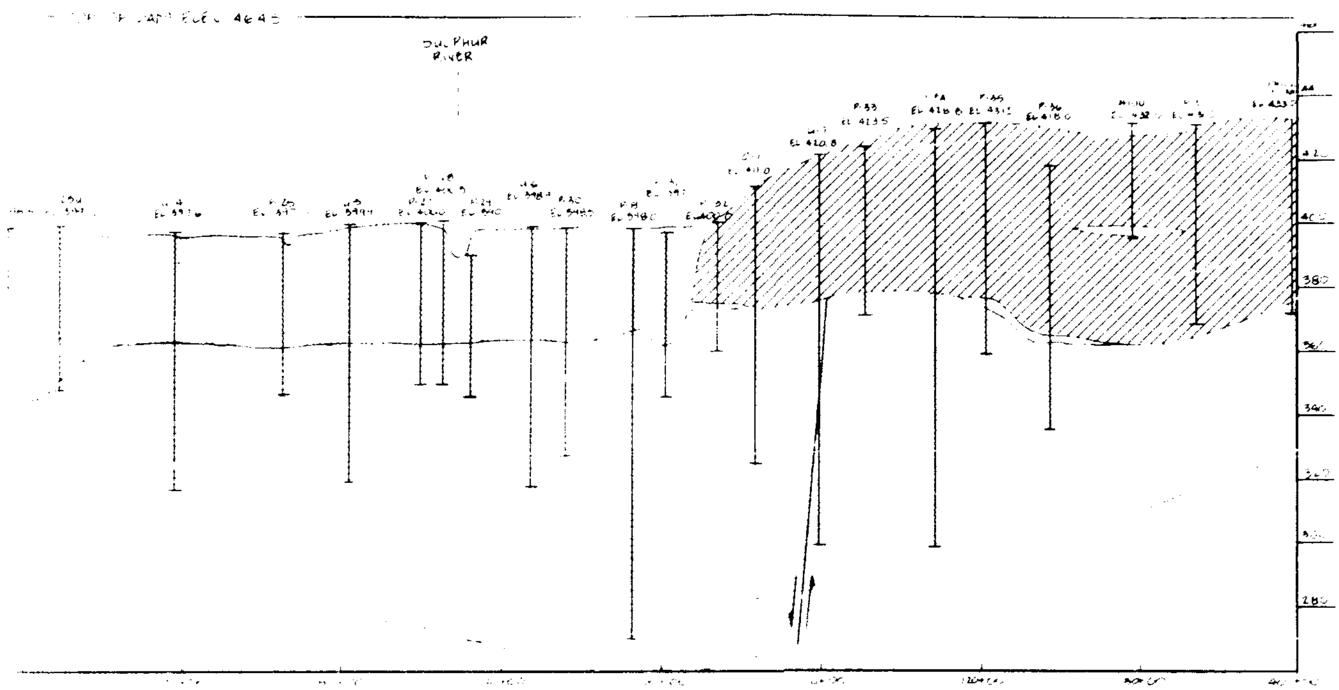
EMBANKMENT, SPILLWAY AND OUTLET WORKS

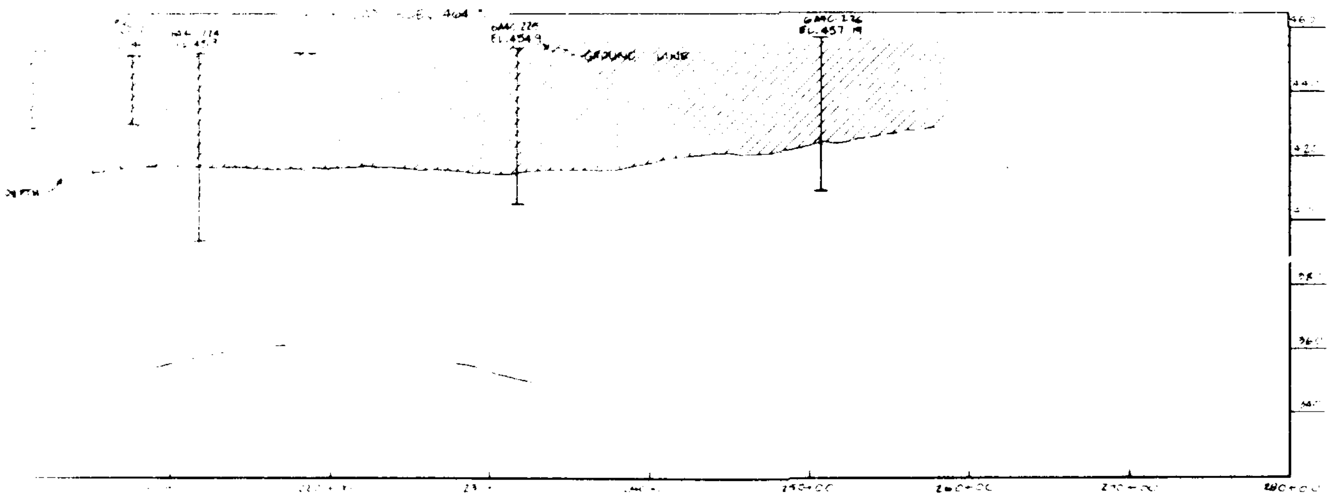
REGIONAL GEOLOGY

DESIGNED BY	H. WEBB
DRAWN BY	C. KIRBY
REVIEWED BY	H. WEBB
SUBMITTED BY	ROBERT BEHM
SOL. NO.	DACW63-87-B-0084
DATED	MAY 1987
SHEET NO.	G-1 OF 67
SEQUENCE NO.	227

To ACCOMPANY FINAL FOUNDATION REPORT PLATE 1[illegible]


SPILLWAY
OUTLET WORKS
TOP OF DAM ELEV 464.5
STATIONING IN FEET
UNKNOWN DEPTH
STATIONING IN FEET
RECENT
OVERBURDEN
PLEISTOCENE
TERRACE DEPOSITS
CLAY WITH SOME SILT AND SILTY SAND
SAND
PRIMARY STRATA





STRATA

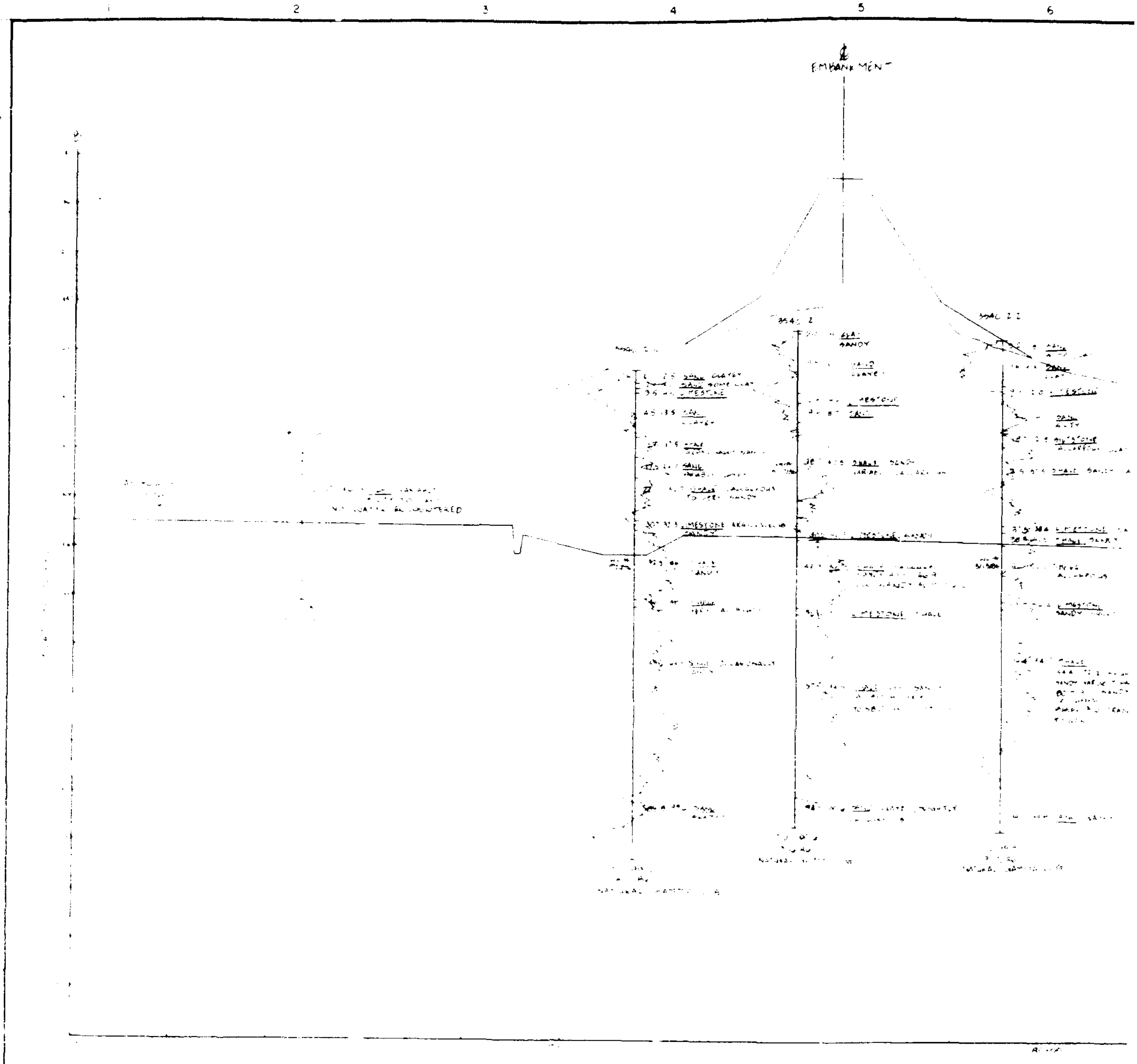
- (dashed box) MAR... UNDIFFERENTIATED ... CLAY WITH OCCASIONAL LIMESTONE LAYERS
- (box) ... UNDIFFERENTIATED PREDOMINANTLY CLAY SHALE
- (box) MARLBROOK FM. UNDIFFERENTIATED PREDOMINANTLY MARL AND CALCAREOUS CLAY

NOTES

1. THE SECTION IS GENERALIZED. FOR DETAILED LITHOLOGIC DESCRIPTION SEE SHEET G-9 THROUGH G-67 LOGS OF BORINGS
2. FOR LOCATION OF SECTION A-A' SEE SHEET G-2 & G-3
3. SEE GEOLOGIC PROFILE C-C' FOR DETAILED GEOLOGIC PROFILE OF RIGHT ABUTMENT

	U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS
DESIGNED BY: R. HAGEN	COOPER LAKE SULPHUR RIVER, TEXAS
DRAWN BY: C. KIRBY	EMBANKMENT
REVIEWED BY: M. GREEN	GEOLOGIC PROFILE - AXIS OF DAM A - A'
SUBMITTED BY: ROBERT BEHM, ENGINEER	SOL. NO. DACW63-... DATED MAY ... CONTR. NO. DACW63-...-0084 DRAWING NUMBER · SHEET NO. G-5 of 67 · 231

To A-COMPANY FINAL FOUNDATION REPORT PLATE 13

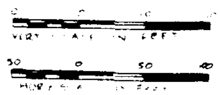


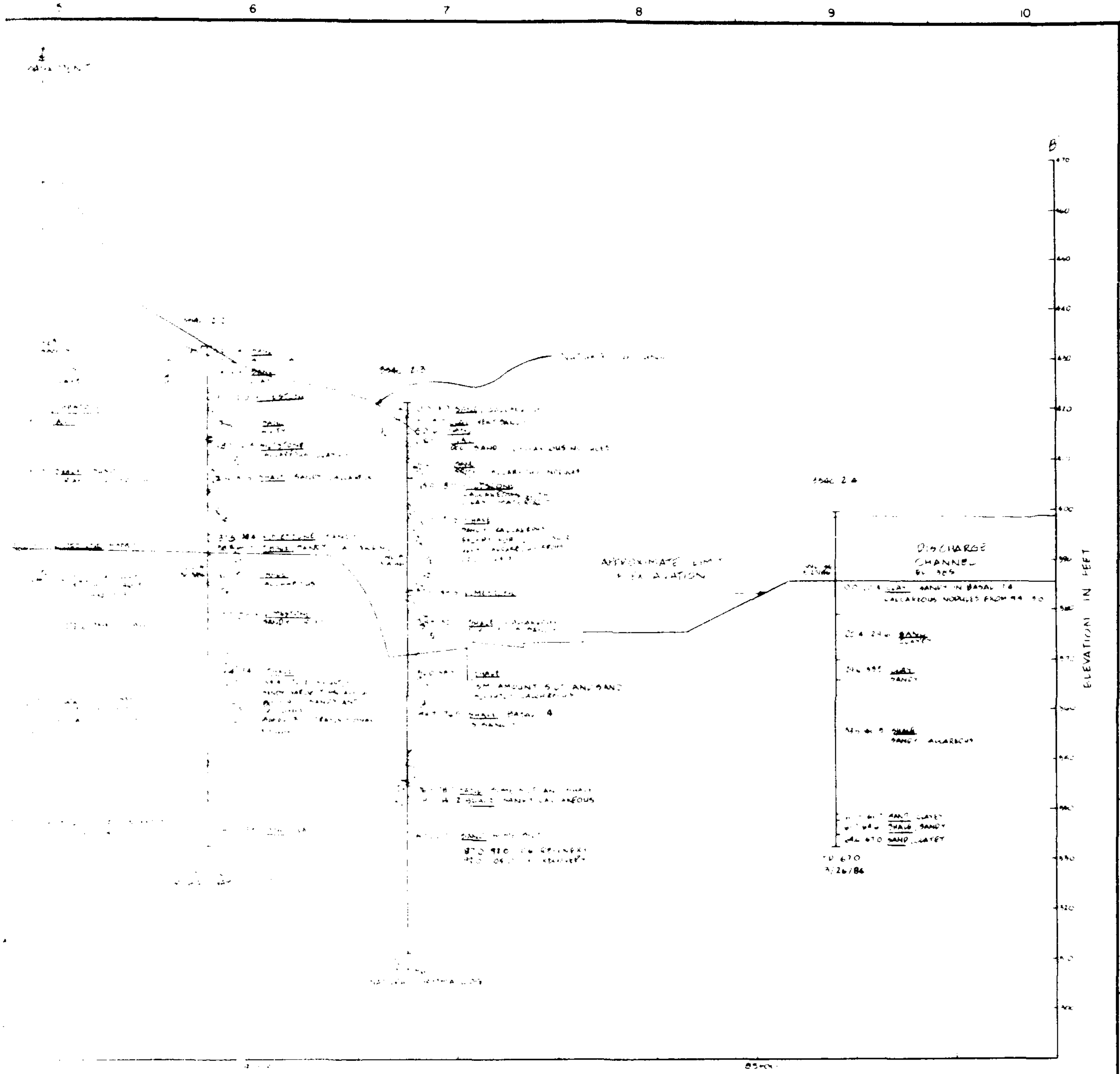
NOTES:

REFER TO [illegible] BORING SHEETS [illegible] THRU [illegible] FOR DETAILED [illegible] DESCRIPTIONS.

FOR LOCATION OF SECTION SEE SHEET [illegible] BORING [illegible] MAP [illegible]

[illegible] = WATER LEVEL [illegible] DEPTH TO WATER MEASURED AFTER [illegible] WAS CASED AND SEALED WITH GROUT

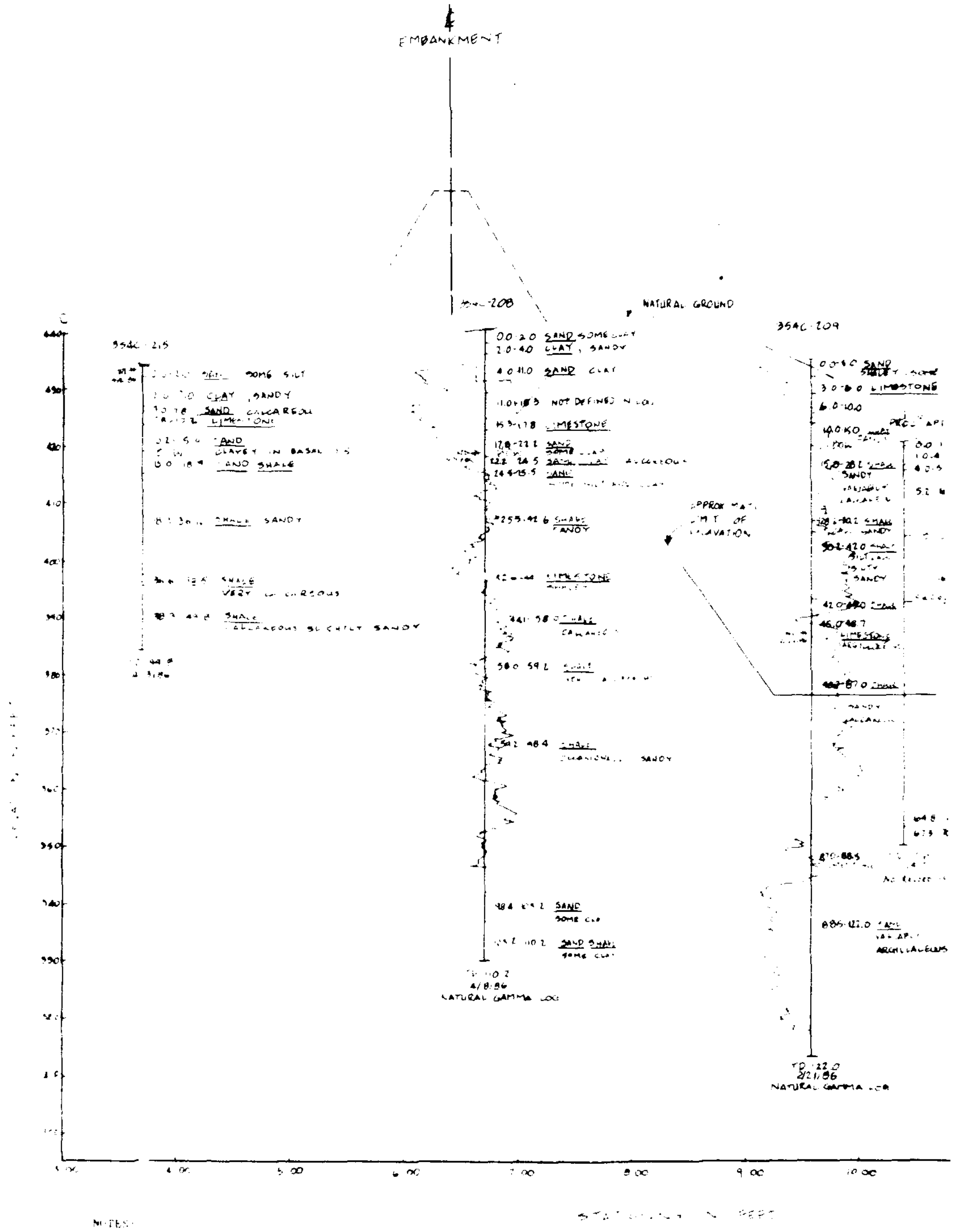




	U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS
DESIGNED BY H. WEBB	COOPER LAKE SULPHUR RIVER, TEXAS
DRAWN BY C. KIRBY	OUTLET WORKS
REVIEWED BY R. BEHM	GEOLOGIC PROFILE - B - B'
SUBMITTED BY ROBERT BEHM, ENGINEER	SOL. NO. DACW63-87-B-0 ; DATED MAY 1987 ; CONTR. NO. DACW63-87-C-0085 ; DRAWING NUMBER ; SHEET NO. 6 of 67 ; 237

To ACCOMPANY FINAL FOUNDATION REPORT PLATE 4

2 3 4 5 6



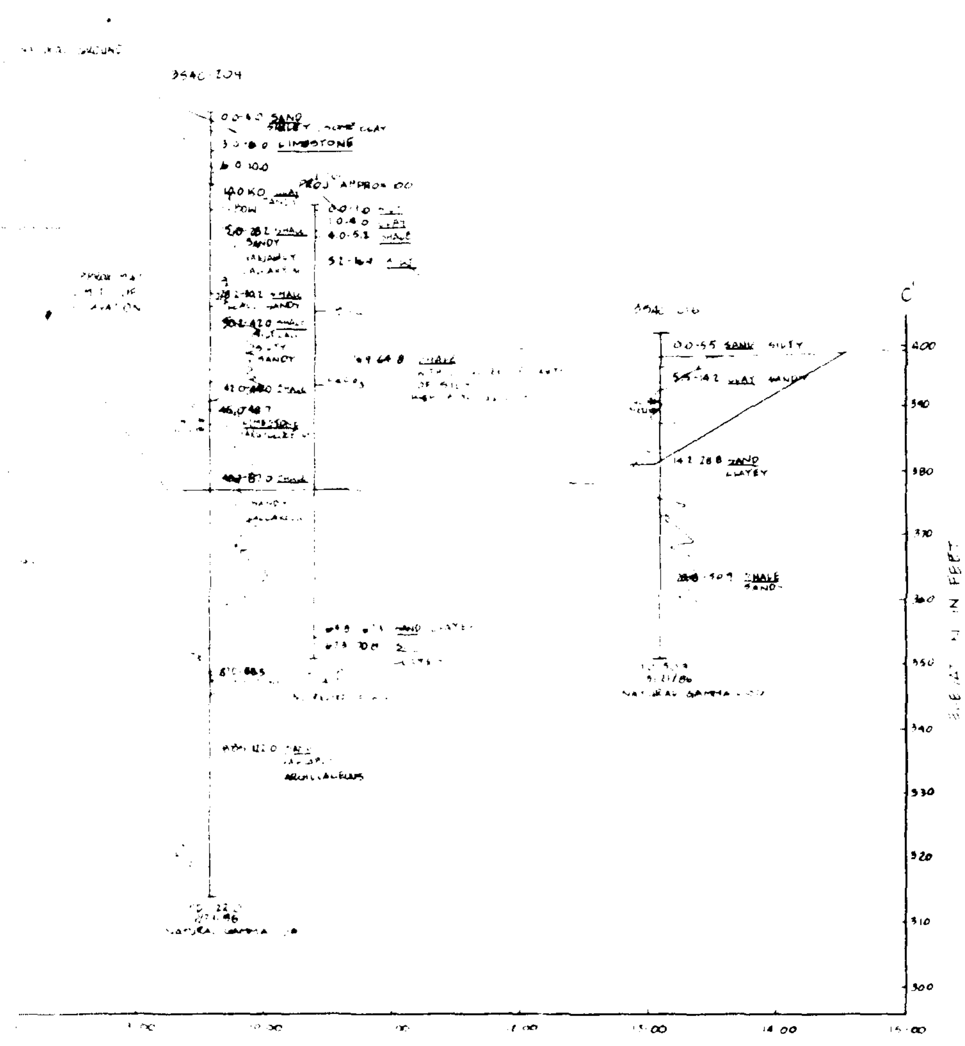
NOTES:

1. REFER TO LOGS OF BORINGS SHEETS G-31, G-61, AND G-65 FOR DETAILED LITHOLOGIC DESCRIPTIONS.
2. FOR LOCATION OF SECTION SEE SHEET G-4, BORING LOCATION MAP III.
3. BOW = BASE OF WEATHERING.
4. WL = WATER LEVEL. DEPTH TO WATER MEASURED AFTER OVERBURDEN WAS CASED AND SEALED WITH GROUT.

10 0 10 20
VERT SCALE IN FEET

50 0 50 100
HORIZ SCALE IN FEET

2 3 4 5 6



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

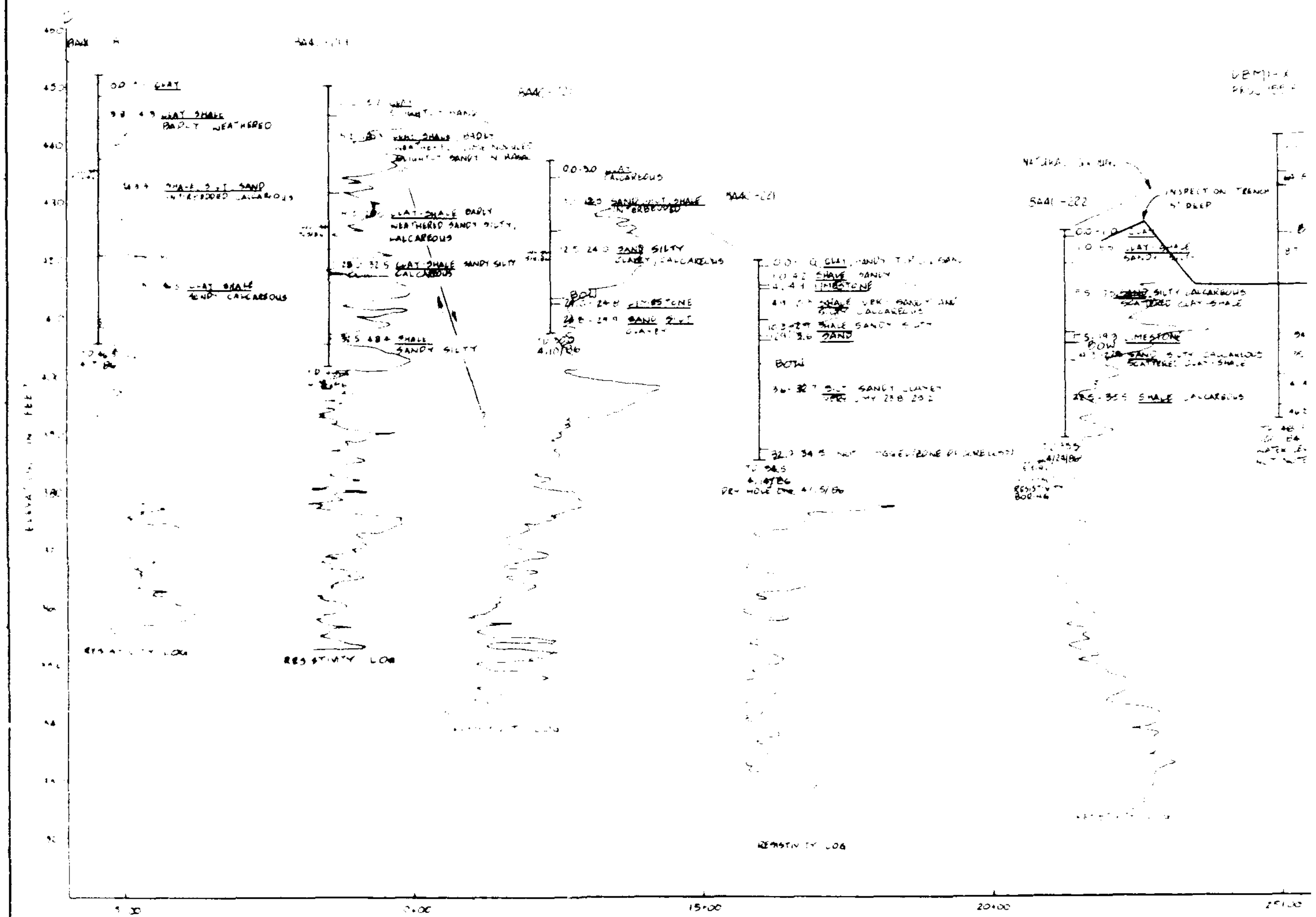
COOPER LAKE
SULPHUR RIVER, TEXAS

SPILLWAY

GEOLOGIC PROFILE - C- C'

DESIGNED BY	H. LIEBB
DRAWN BY	C. KIRBY
REVIEWED BY	R. BEHM
SUBMITTED BY	ROBERT BEHM, ENGINEER
SOL. NO.	DACW63-87-B-0084
DATED	MAY 1987
CONTR. NO.	DACW63-87-C-0085
SHEET NO.	G-7 of 67
	233

TO ACCOMPANY FINAL FOUNDATION REPORT PLATE 15



STATIONING IN FEET

NOTES

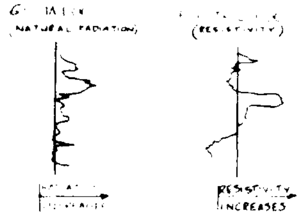
1. REFER TO LOGS OF BORINGS SHEETS G-59 THRU G-66 FOR DETAILED LITHOLOGIC DESCRIPTION.

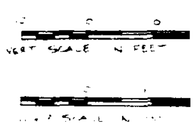
2. FOR LOCATION OF SECTION SEE SHEET G-4, BORING LOCATION MAP III.

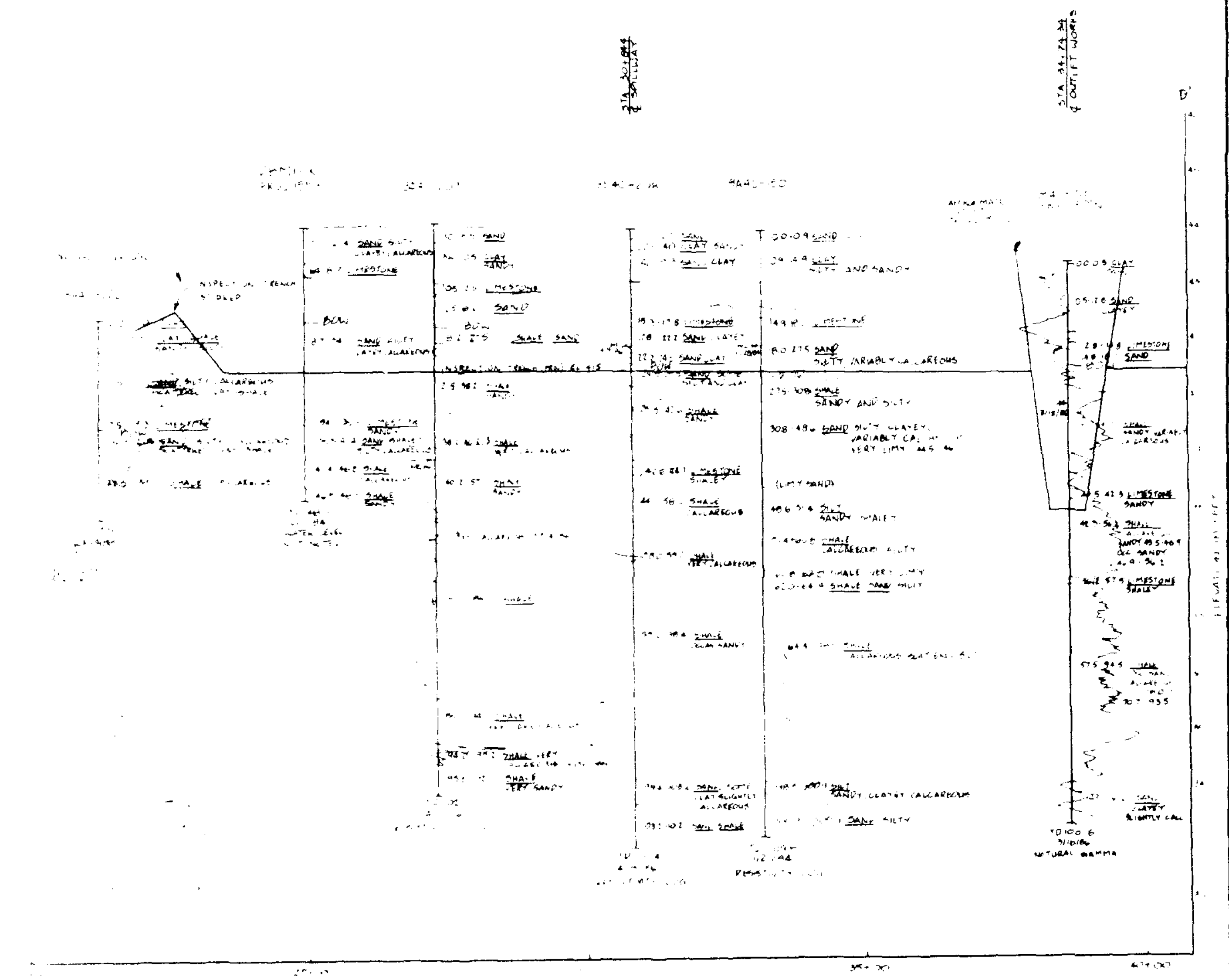
3. BOW = BASE OF WEATHERING.

4. WL = WATER LEVEL. DEPTH TO WATER MEASURED AFTER OVERBURDEN WAS CASED AND SEALED WITH GROUT.

5. AT BORING LOCATIONS BA4C-218, BA4C-219, BA4C-220, BA4C-221, AND BA4C-222 RESISTIVITY LOGS WERE RUN IN AUGERED HOLES OFFSET TO BORINGS.







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

COOPER LAKE
SULPHUR RIVER, TEXAS

EMBANKMENT
RIGHT ABUTMENT

GEOLOGIC PROFILE - D - D'

DESIGNED BY: H. WEBB

DRAWN BY: C. KIRBY

REVIEWED BY: B. BEHM

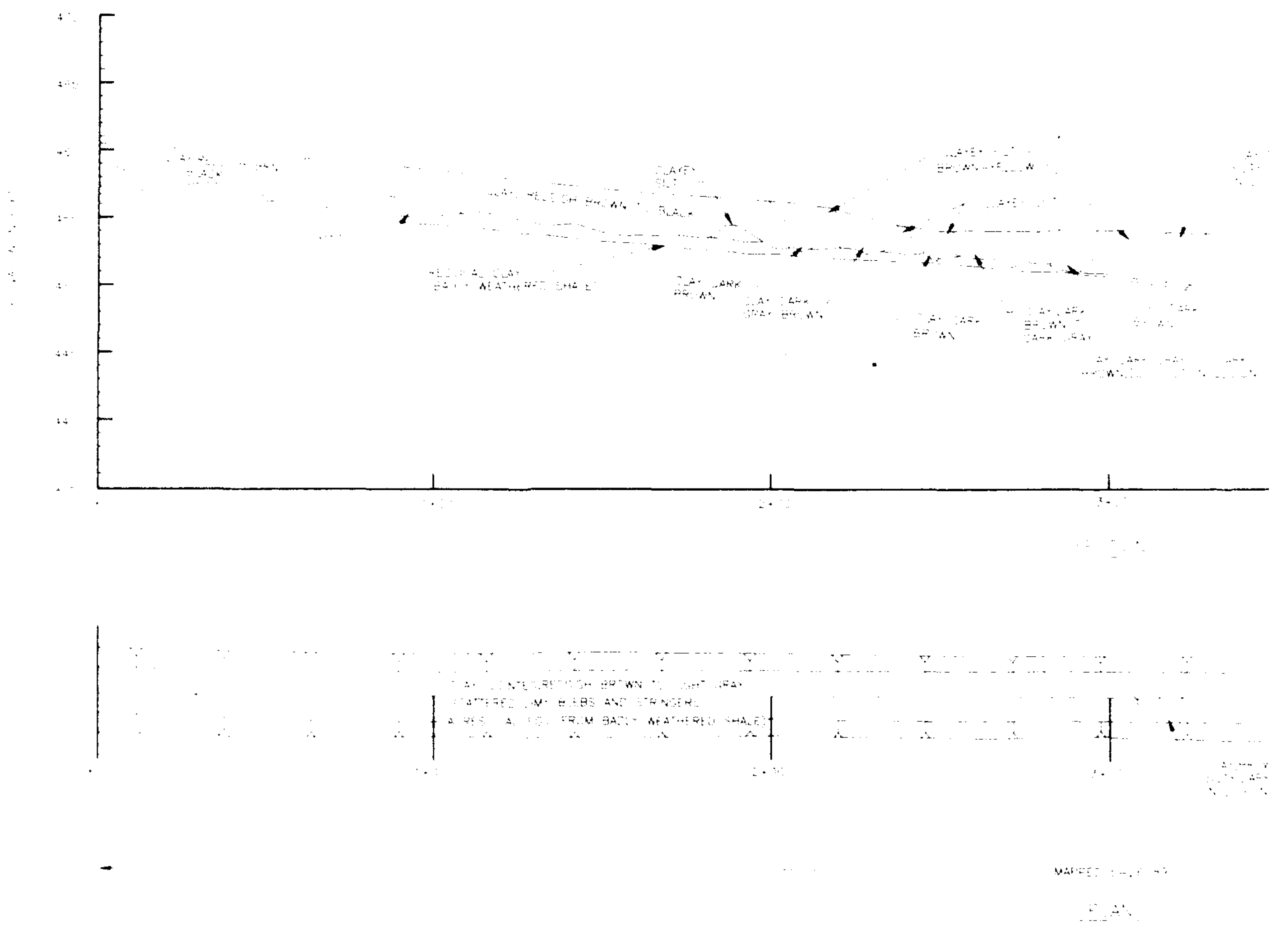
SUBMITTED BY: BEHM
ENGINEER

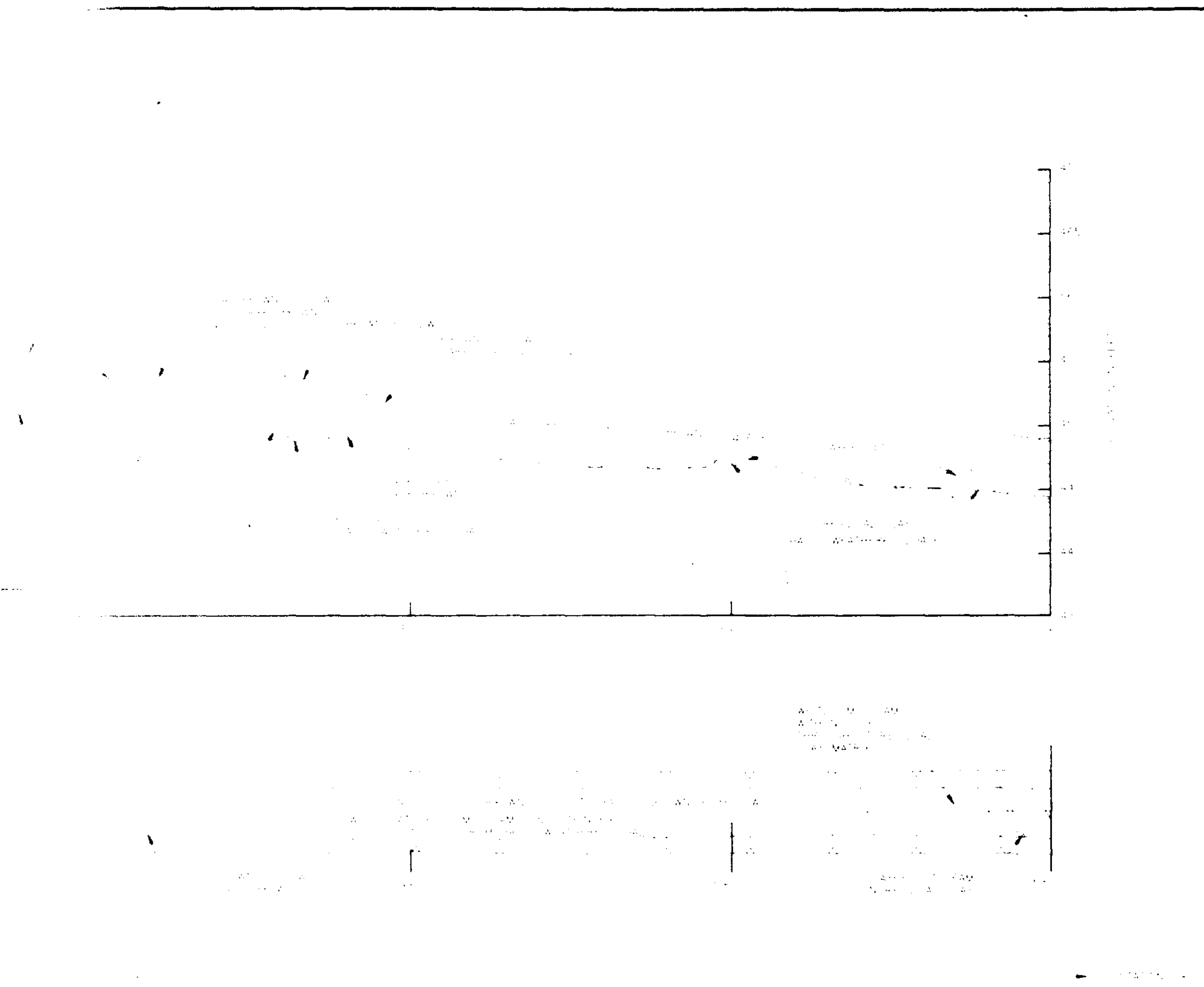
SOL NO DACW63-87-B-0084 | DATED MAY 1987

CONTR NO DACW63-87-C-0085

SHEET NO 8 of 67

TO ACCOMPANY FINAL FOUNDATION REPORT PLATE


CLAYEY SILT
BLACK
RESIDUAL CLAY
BADLY WEATHERED SHALE
CLAY, DARK BROWN
CLAY, DARK TO GRAY BROWN
CLAY CONTAINS REDDISH BROWN TO LIGHT GRAY
SCATTERED LIMY BLEBS AND STRINGERS
RESIDUAL SOIL FROM BADLY WEATHERED SHALE



SYM	D.O. NO	ACTION	DATE	DESCRIPTION OR REVISION

ENGINEERING DIVISION
GEOTECHNICAL BRANCH

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

DESIGNED BY
G RUEDE

CADD BY
J E AMARI

REVIEWED BY
G RUEDE

SUBMITTED BY

GEOLOGIST

INVITATION NO

DATE

CONTRACT NO

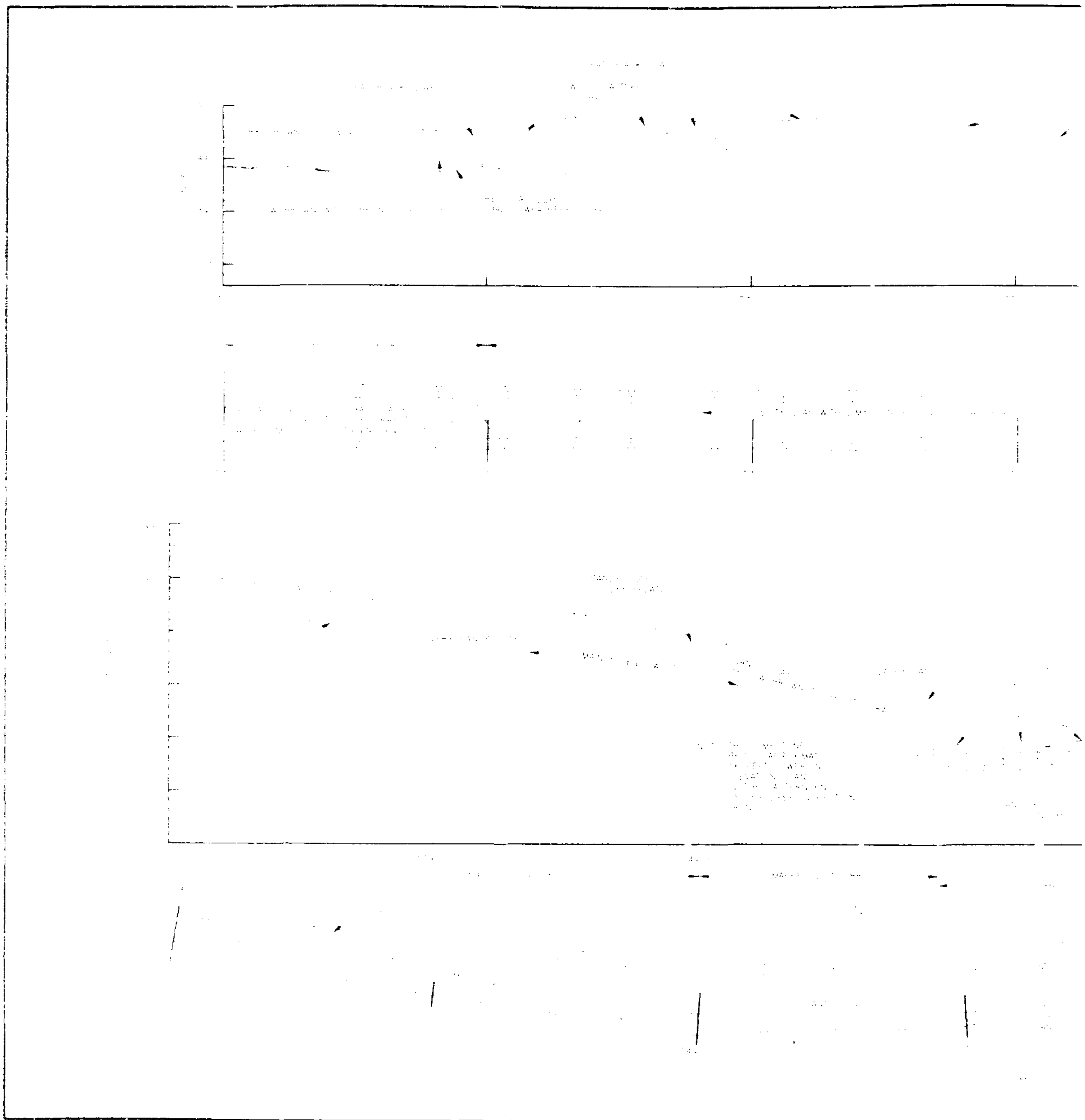
SEQUENC NO

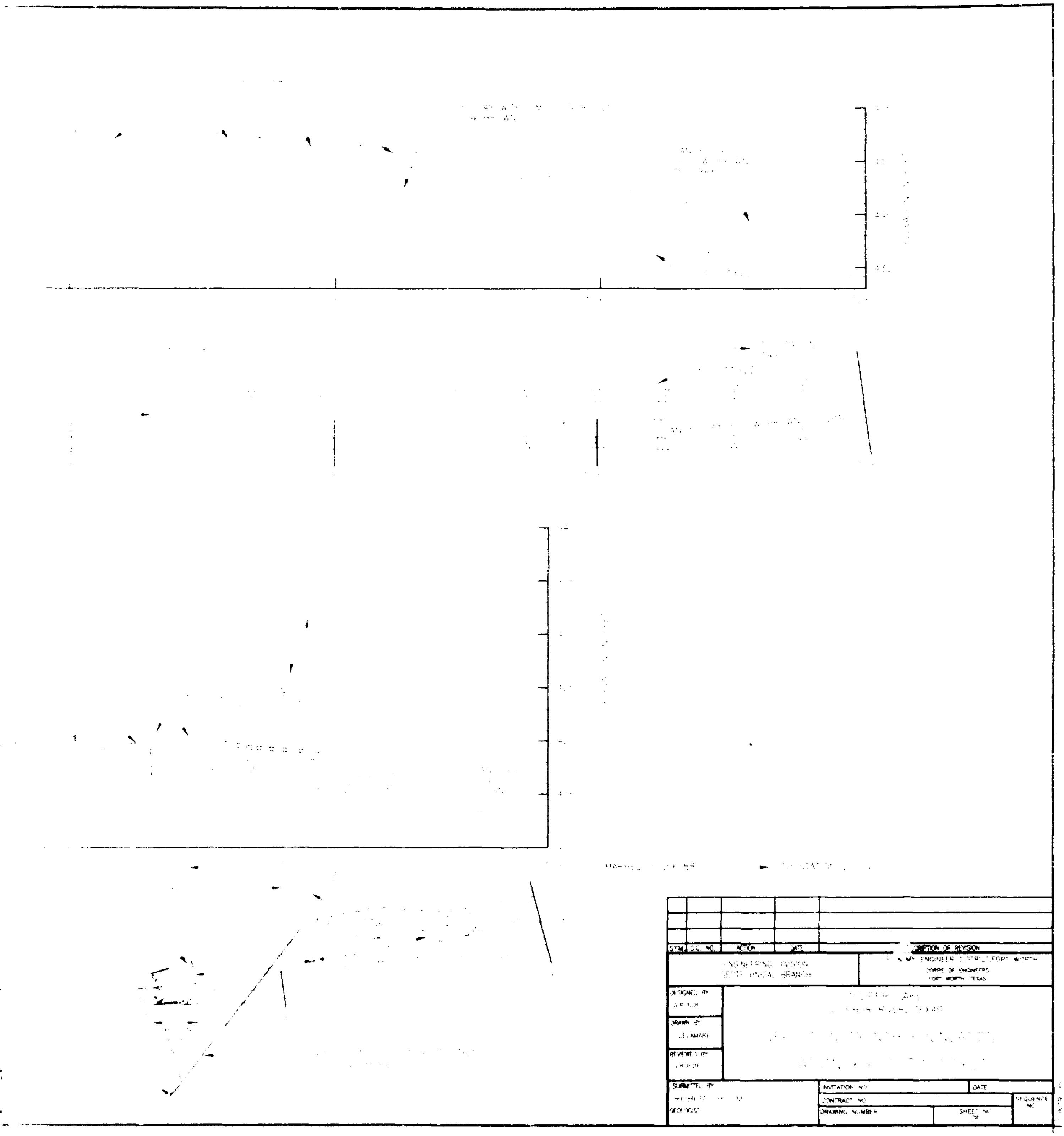
DRAWING NUMBER

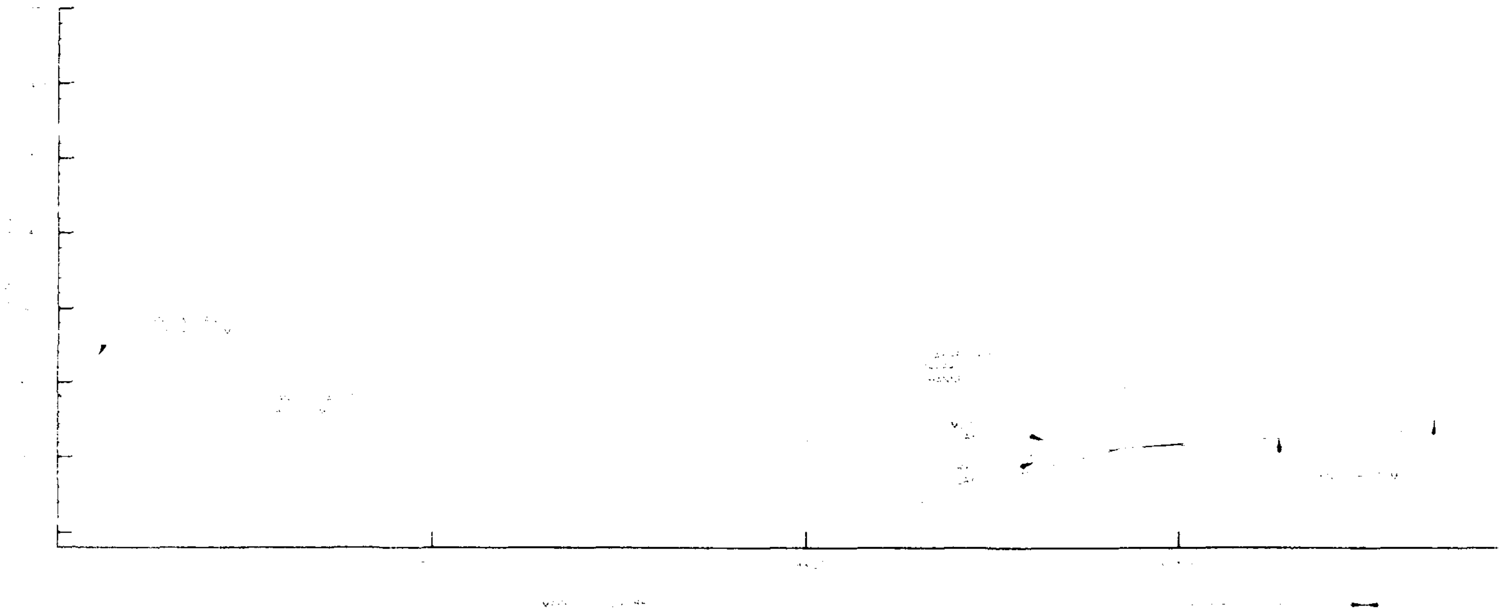
SHEET NO
OF

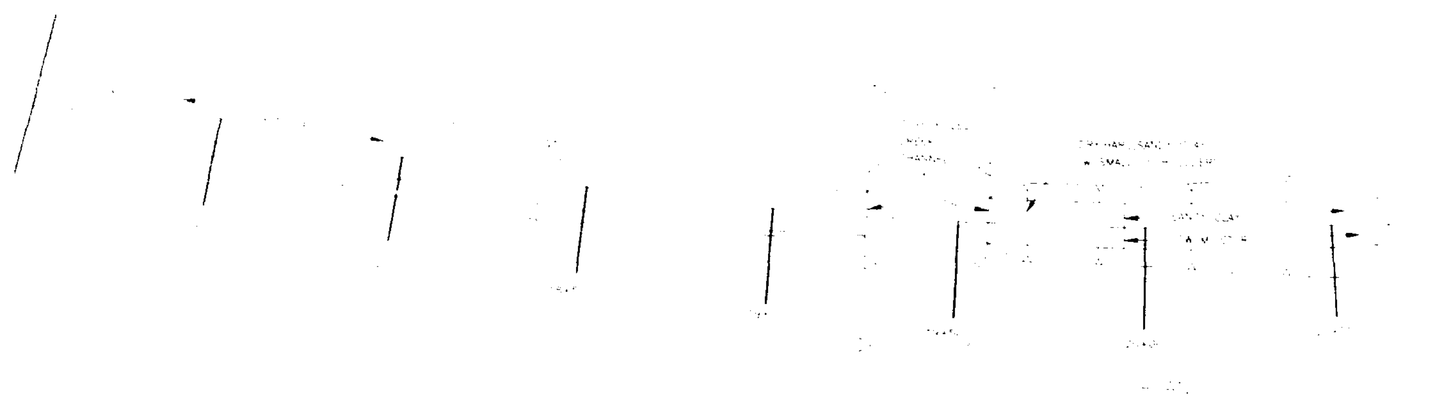
TO ACCOMPANY FOUNDATION REPORT

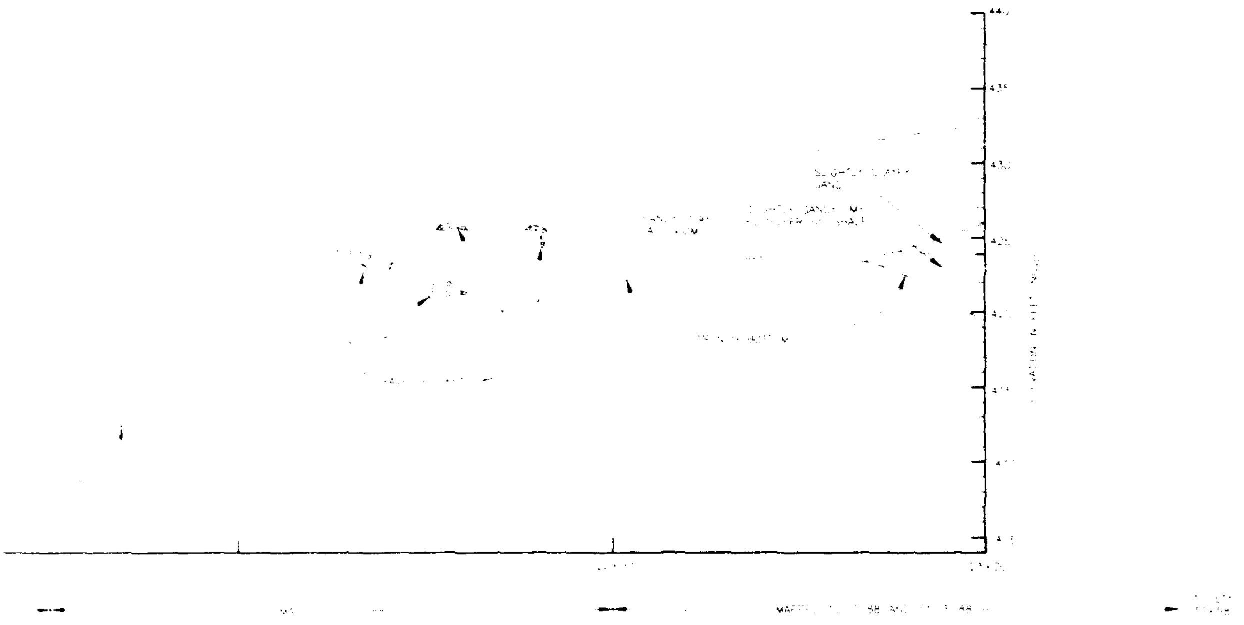
PLATE




SYM
D.C. NO.
ACTION
DATE
DESCRIPTION OF REVISION
ENGINEERING DIVISION
CORPS OF ENGINEERS
FORT WORTH, TEXAS
DESIGNED BY
DRAWN BY
REVIEWED BY
SUBMITTED BY
GEOLOGIST
INVITATION NO.
DATE
CONTRACT NO.
DRAWING NUMBER
SHEET NO.
SEQUENCE NO.







SYM		ACTION	DATE	DESCRIPTION OF REVISION

BRANCH

U.S. ARMY ENGINEER

CORPS OF ENGINEERS

DESIGNED BY

RUEDE

CADD BY

REVIEWED BY

LAKE

TRENCH

STATION

SUBMITTED BY

GEOLOGIST

INVITATION NO.

DATE

CONTRACT NO.

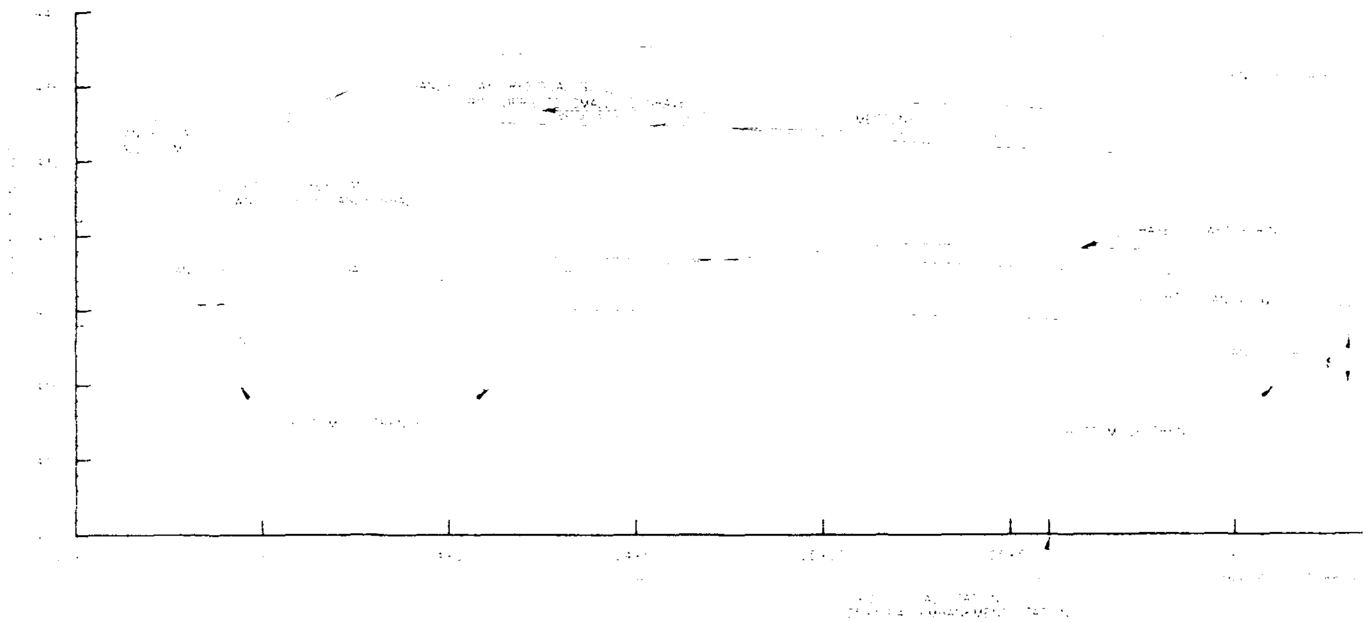
SEQUENCE NO.

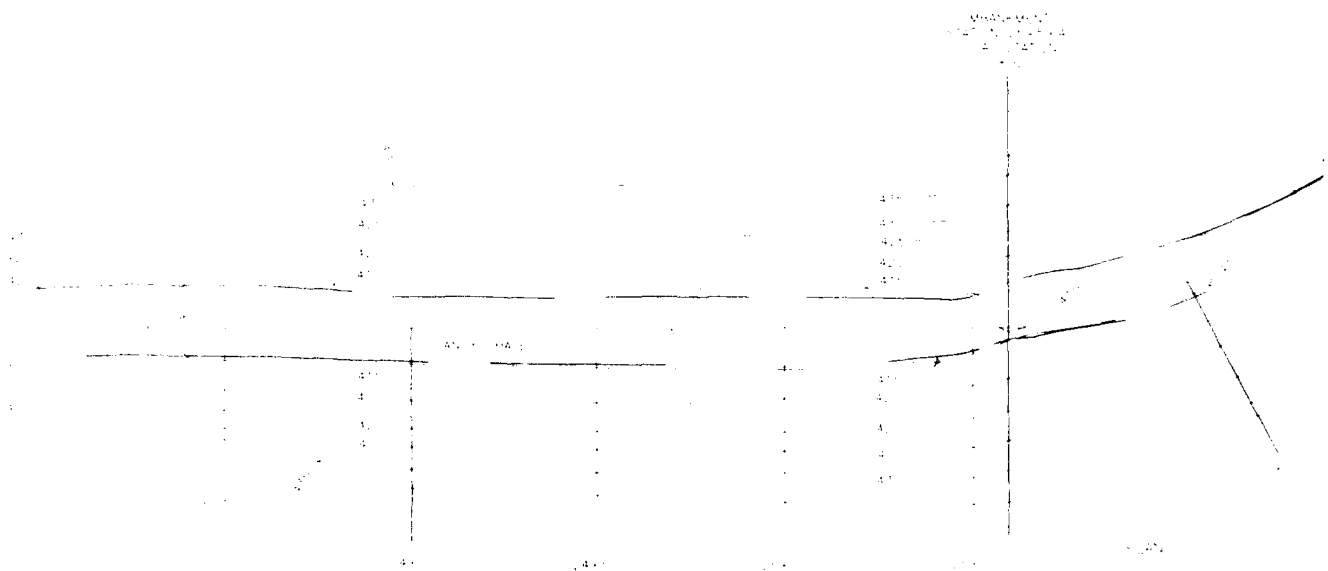
DRAWING NUMBER

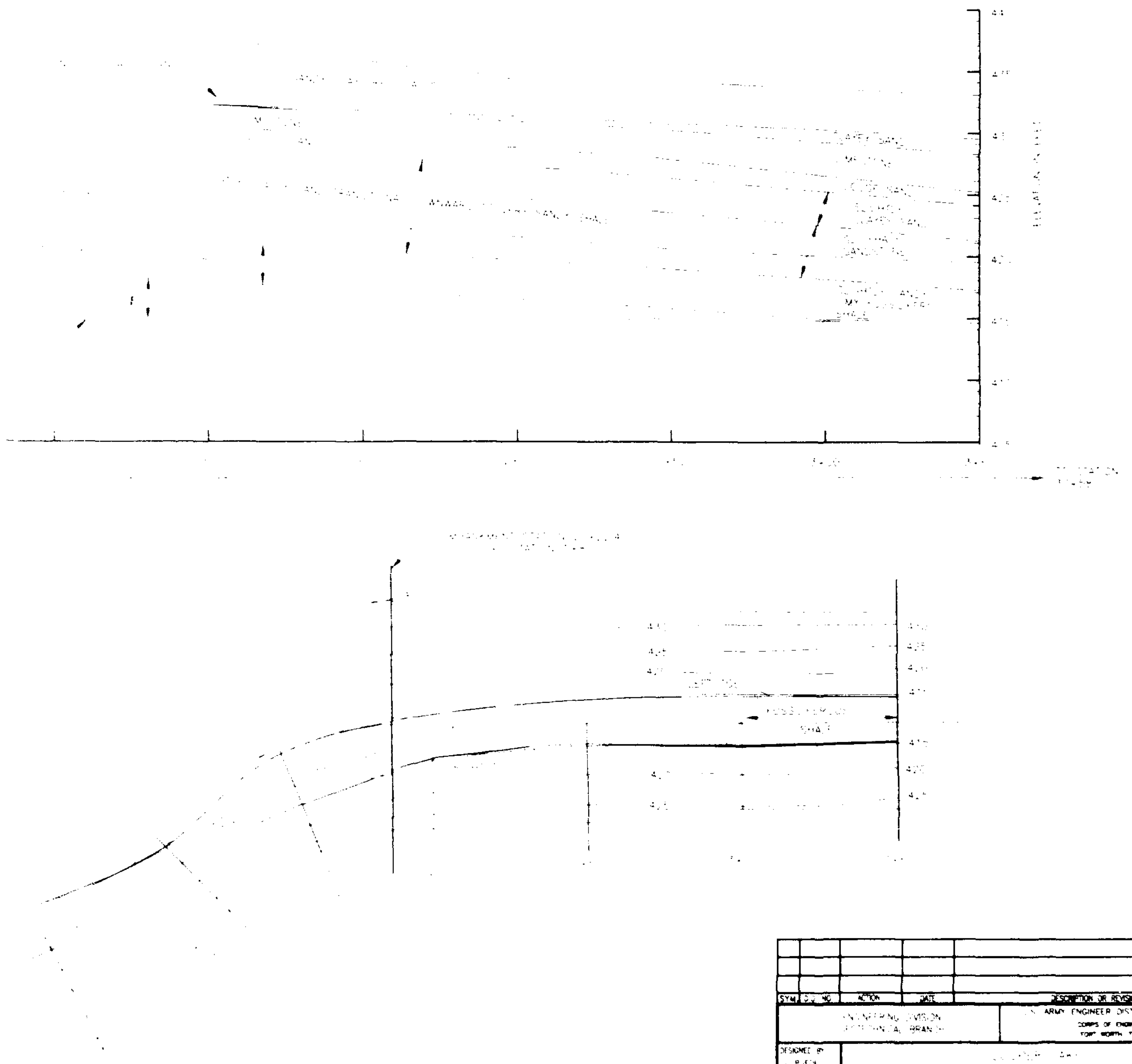
SHEET NO.

ACCOMPANY FOUNDATION REPORT

PLATE 19







SYM	D.O. NO	ACTION	DATE	DESCRIPTION OR REVISION

ENGINEERING DIVISION

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

DESIGNED BY

DRAWN BY

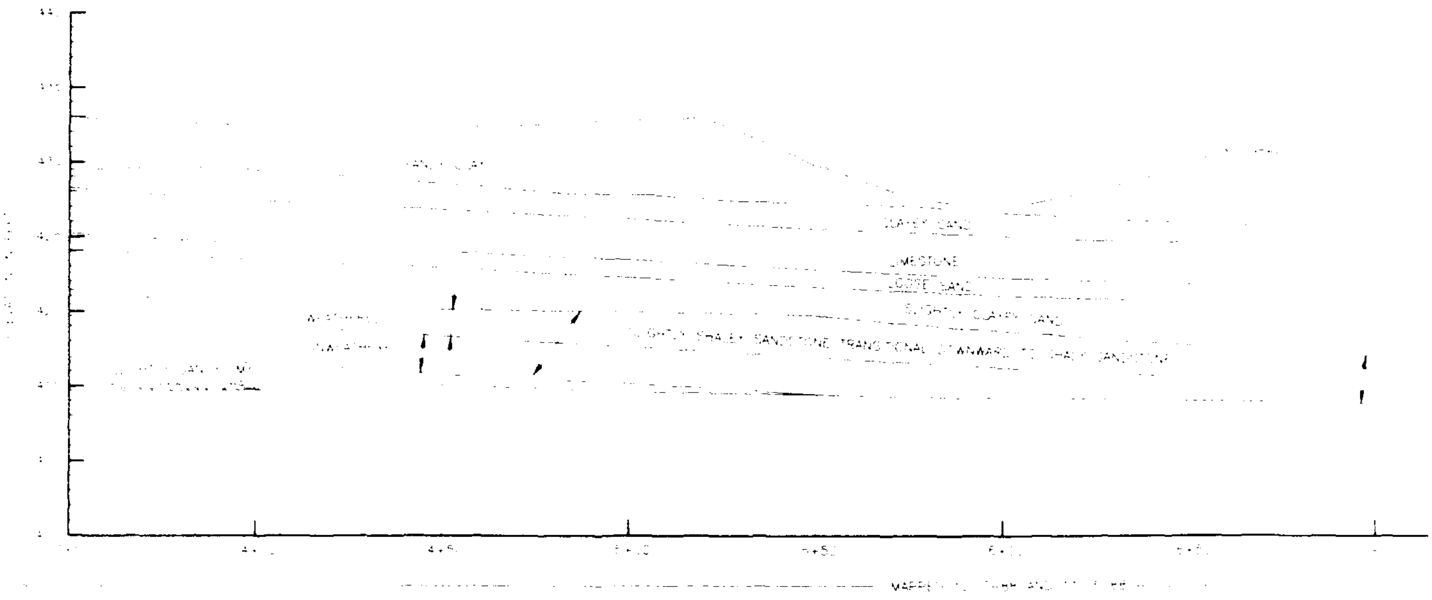
REVIEWED BY

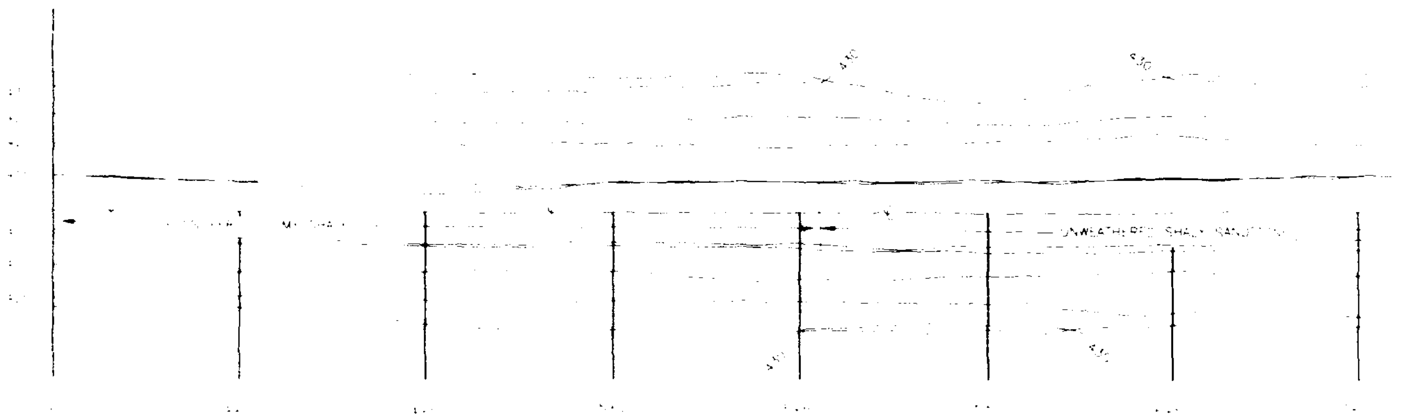
SUBMITTED BY

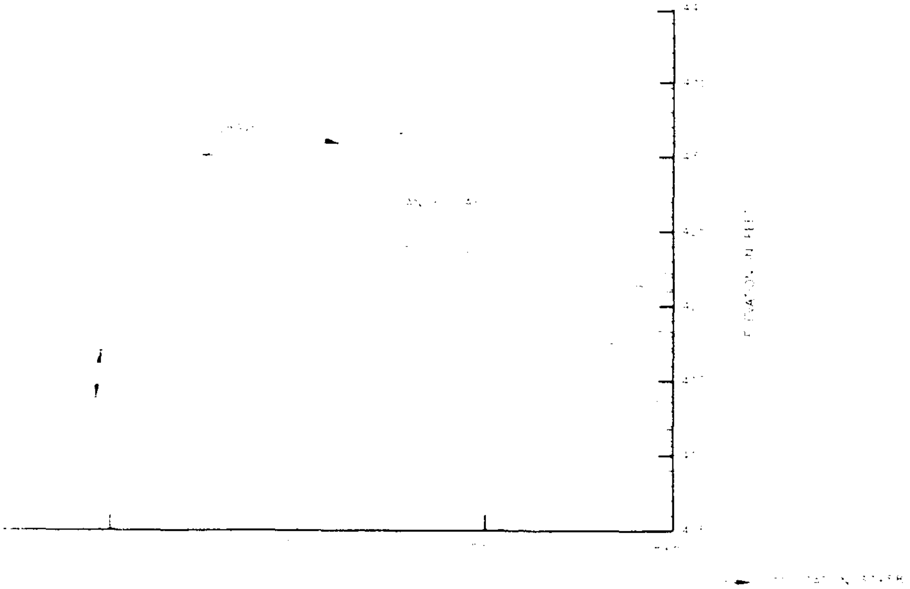
GEOLOGIST

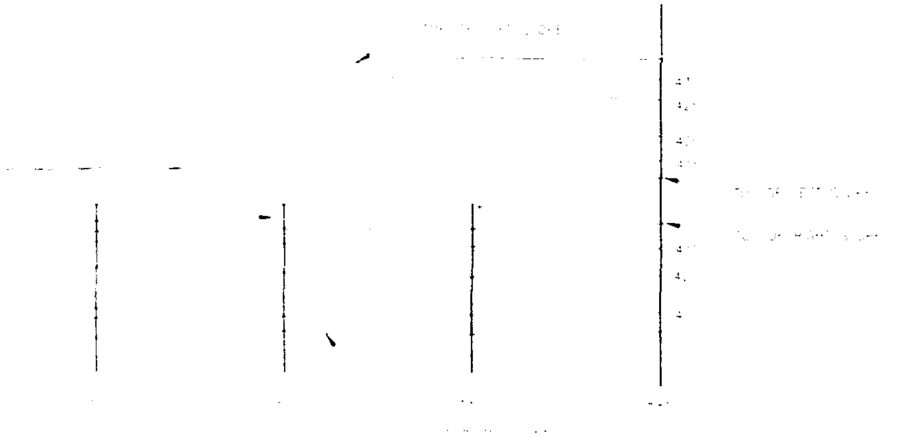
INVITATION NO | DATE
CONTRACT NO | SEQUENCE NO
DRAWING NUMBER | SHEET NO OF

CONTR NO


LIMESTONE







SYM	D.O. NO	ACTION	DATE	DESCRIPTION OR REVISION

ENGINEERING DIVISION
GEOTECHNICAL BRANCH

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

DESIGNED BY G. RUEDE

CADD BY DELAMARE

REVIEWED BY G. RUEDE

COOPER LAKE
SULPHUR RIVER, TEXAS

TRENCH FOUNDATION
8+50 (LOCAL STATION

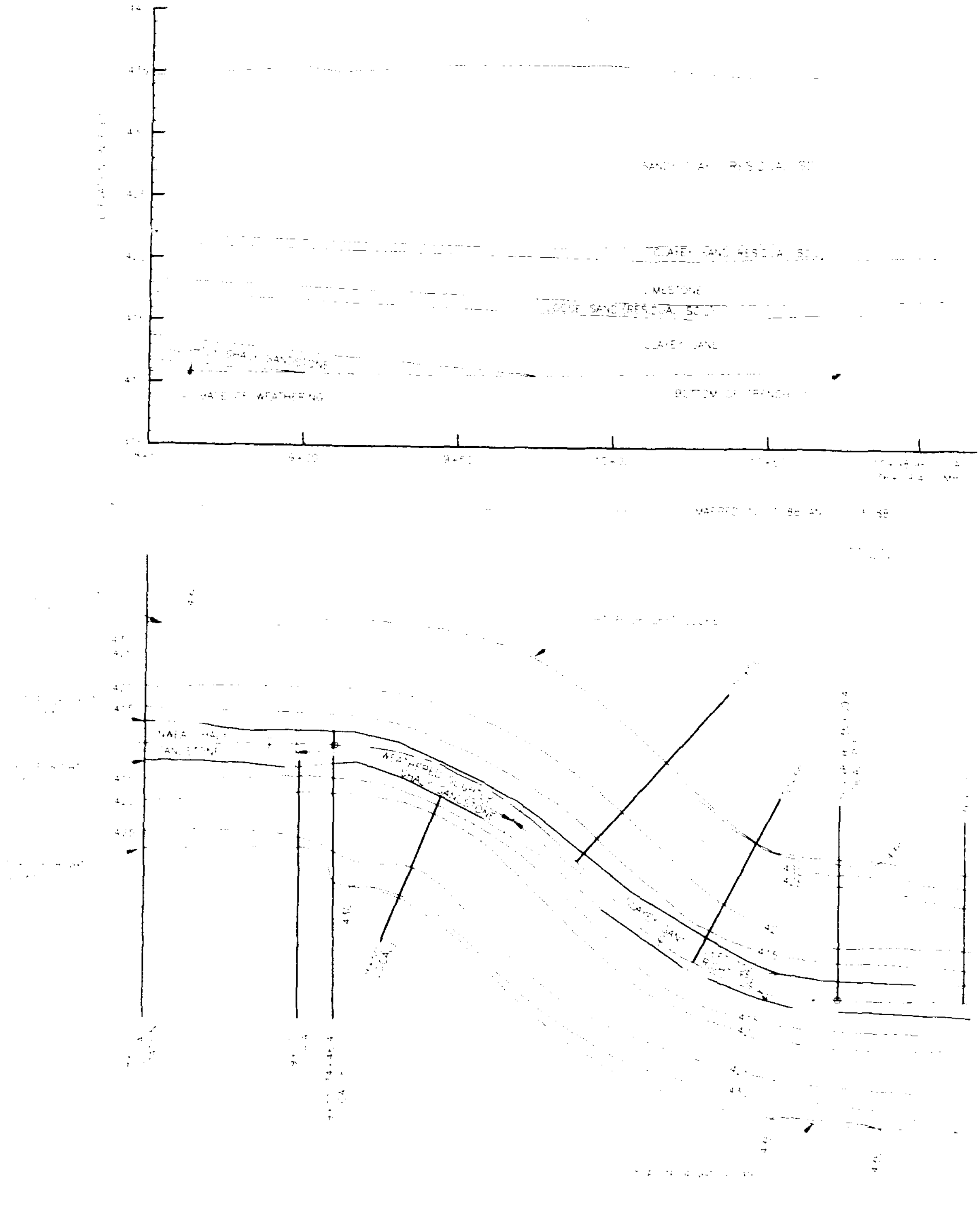
SUBMITTED BY
ENGINEER

INVITATION NO | DATE
CONTRACT NO | SEQUENCE NO
DRAWING NUMBER | SHEET NO. OF

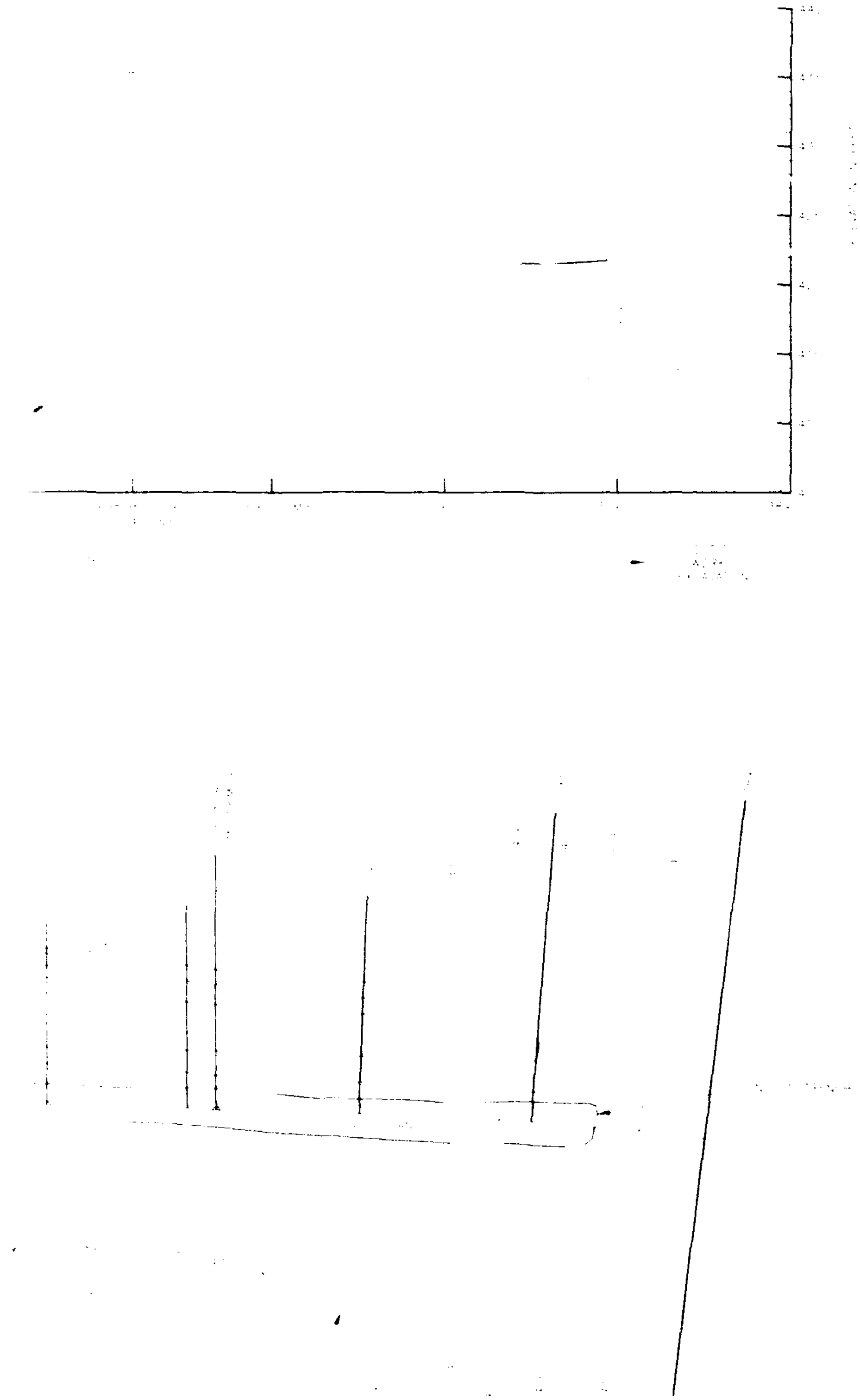
CONTR. NO.

COMPANY FOUNDATION REPORT

PLATE



LIMESTONE
CLAYEY SAND
BOTTOM OF TRENCH



SYM	D.O. NO	ACTION	DATE	DESCRIPTION OR REVISION

ENGINEERING DIVISION
GEOTECHNICAL BRANCH

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

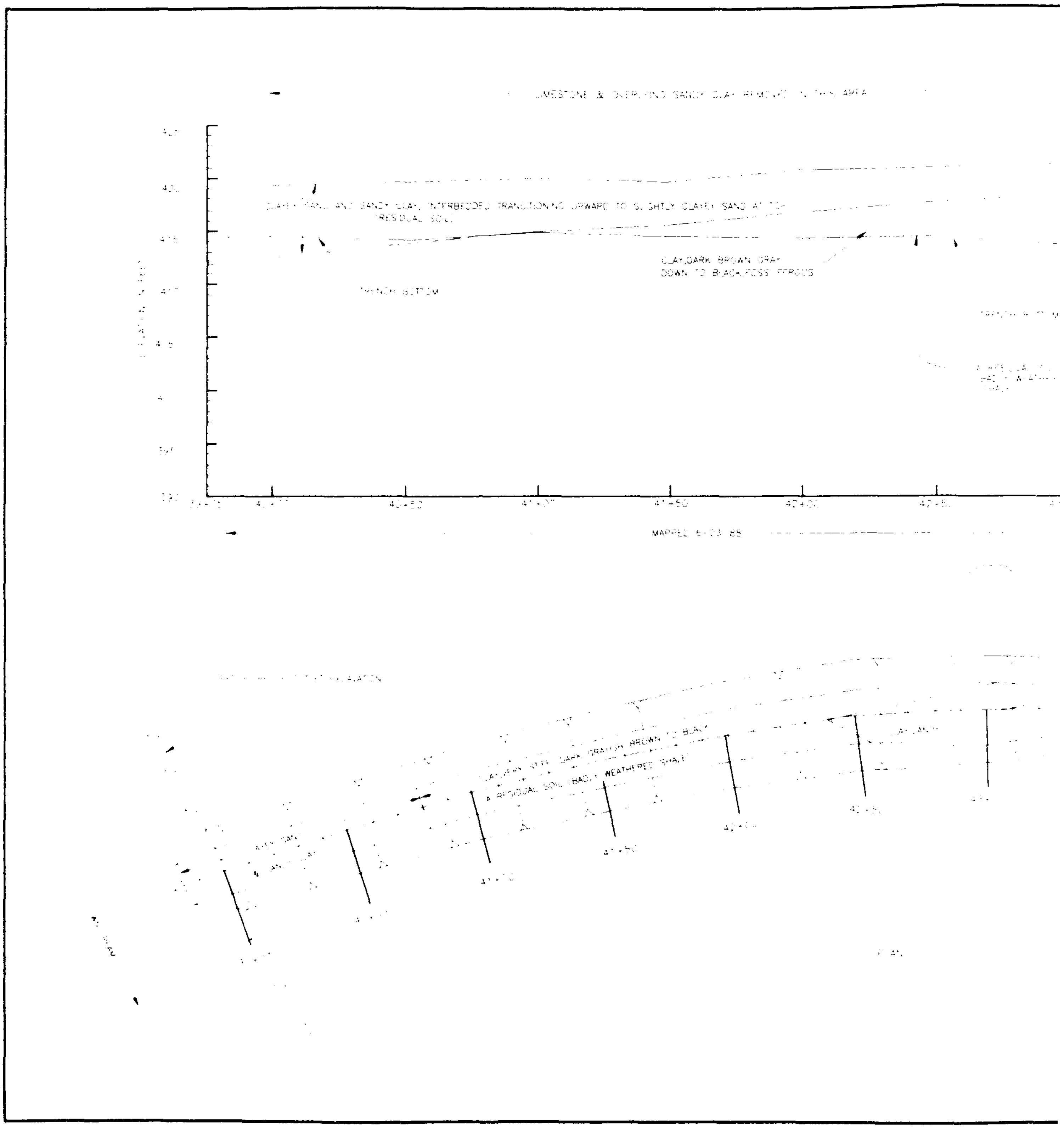
DESIGNED BY
DRAWN BY
REVIEWED BY
SUBMITTED BY
GEOLOGIST

SULPHUR RIVER, TEXAS

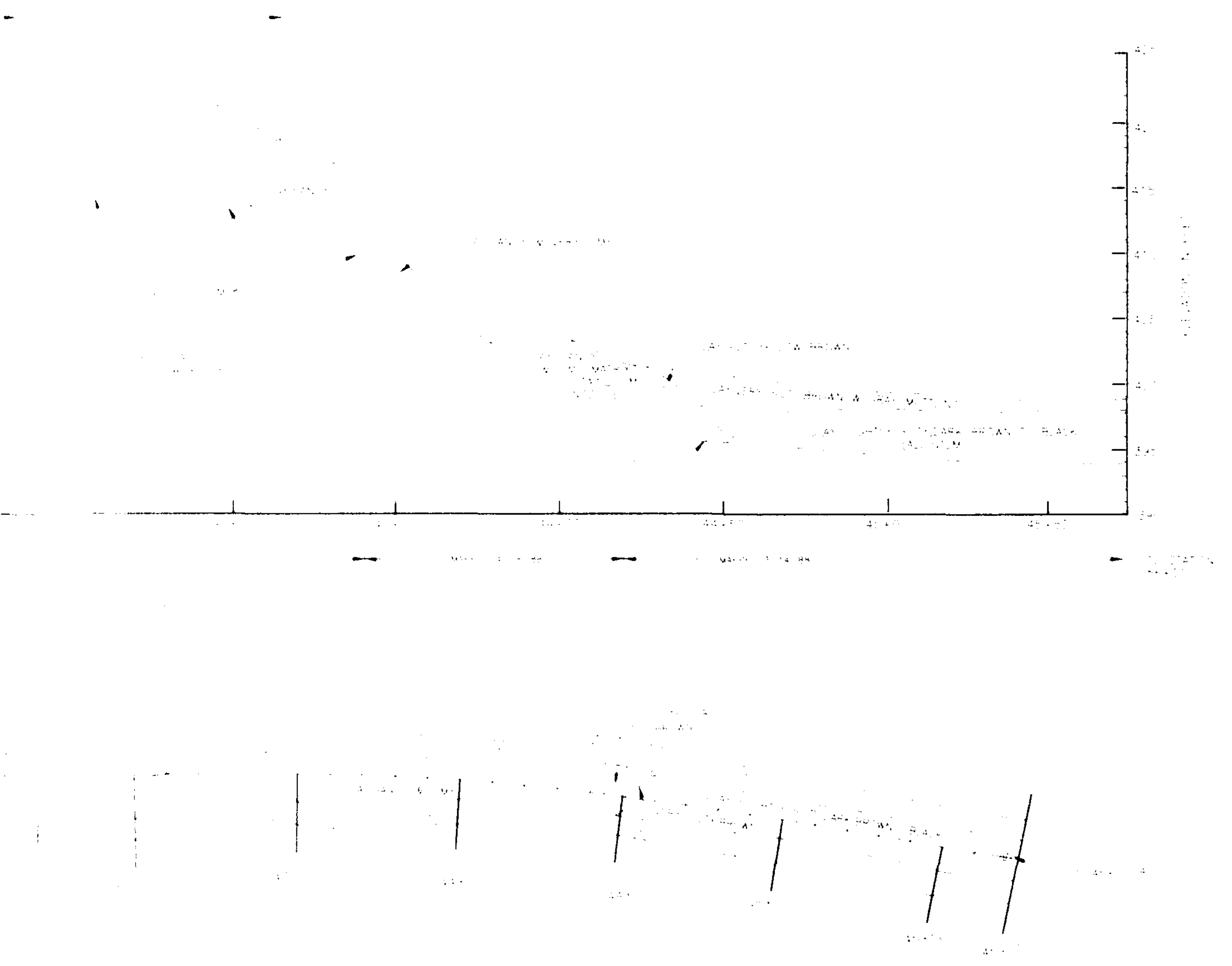
INVITATION NO | DATE
CONTRACT NO
DRAWING NUMBER | SHEET NO. OF
SEQUENCE NO.
CONTR NO

FOUNDATION REPORT

PLATE



RESIDUAL SOIL
CLAY,DARK BROWN GRAY
TRENCH BOTTOM
40+50
41+00
41+50
MAPPED
A RESIDUAL SOIL (BADLY WEATHERED SHALE



STM	C.O. NO	ACTION	DATE	DESCRIPTION OF REVISION

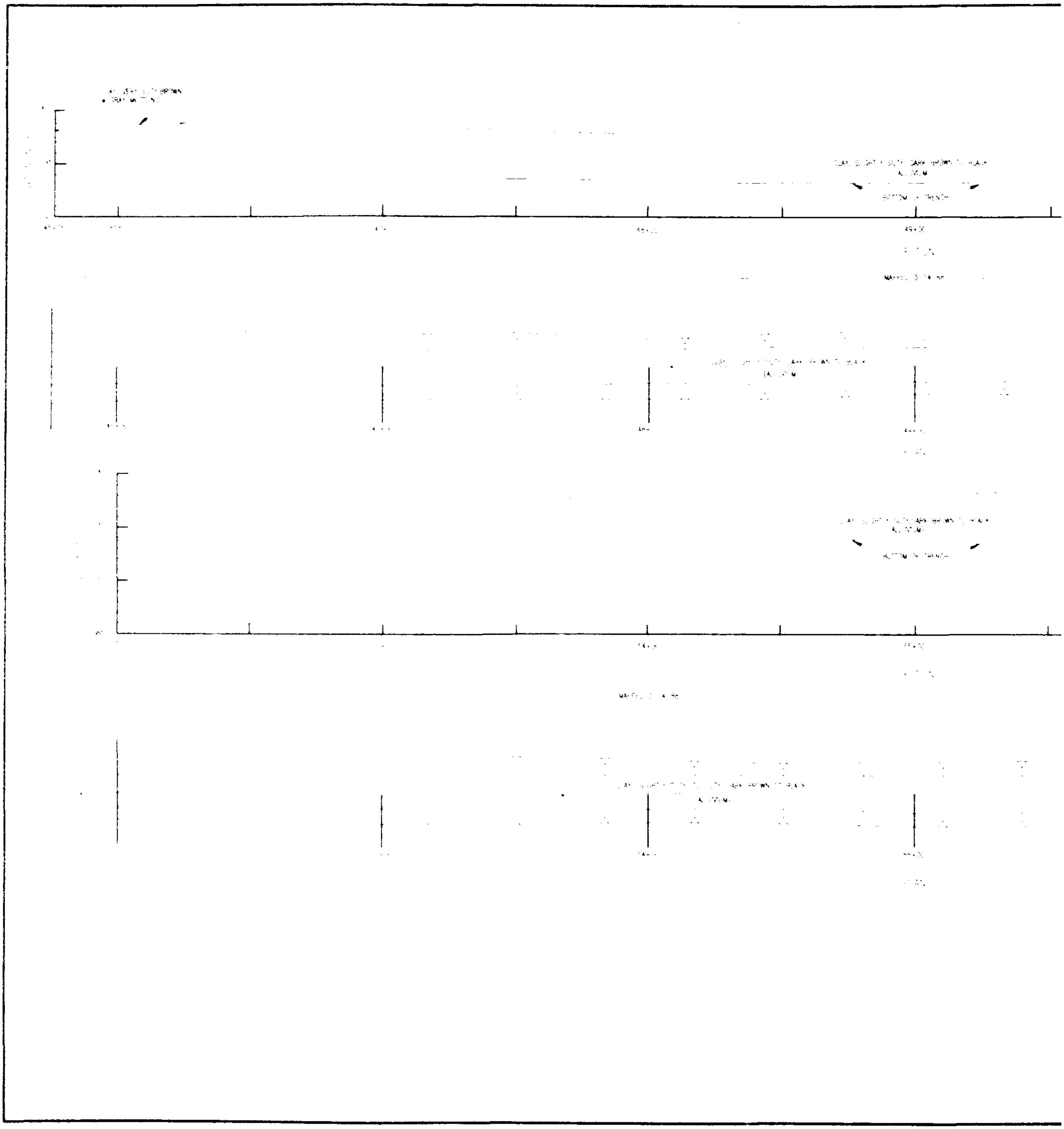
ENGINEERING DIVISION
GEOTECHNICAL BRANCH

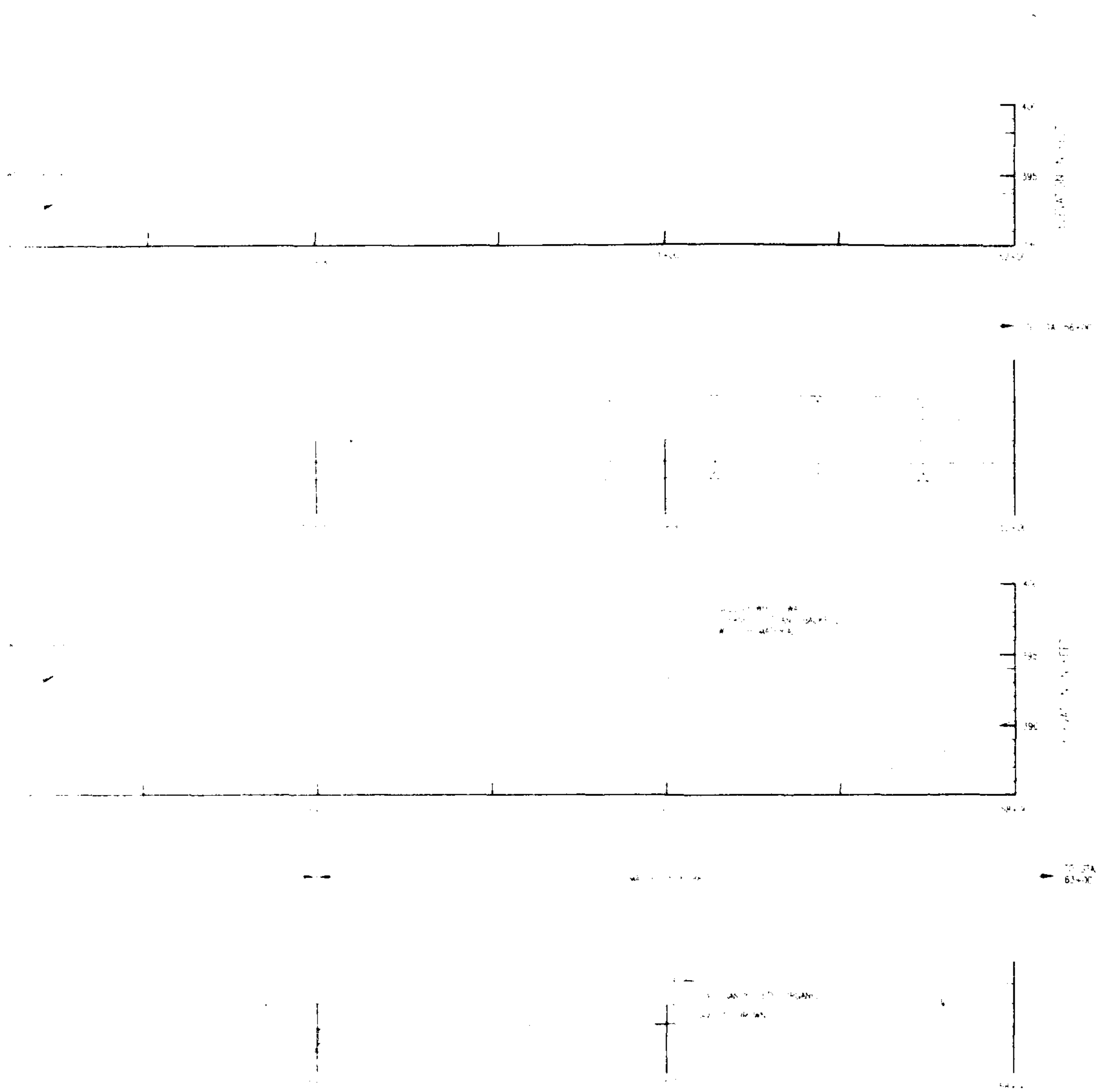
U.S. ARMY ENGINEER DISTRICT FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY
DRAWN BY
REVIEWED BY

SUBMITTED BY
GEOLOGIST

INVITATION NO | DATE
CONTRACT NO | SEQUENCE NO
DRAWING NUMBER | SHEET NO OF





SYM	NO.	ACTION	DATE	DESCRIPTION OF REVISION

ENGINEERING DIVISION
GEOTECHNICAL BRANCH

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

DESIGNED BY: J. RUEDE

CADD BY: [illegible] LAMARE

REVIEWED BY: [illegible]

[illegible] LAKE
SULPHUR RIVER, TEXAS

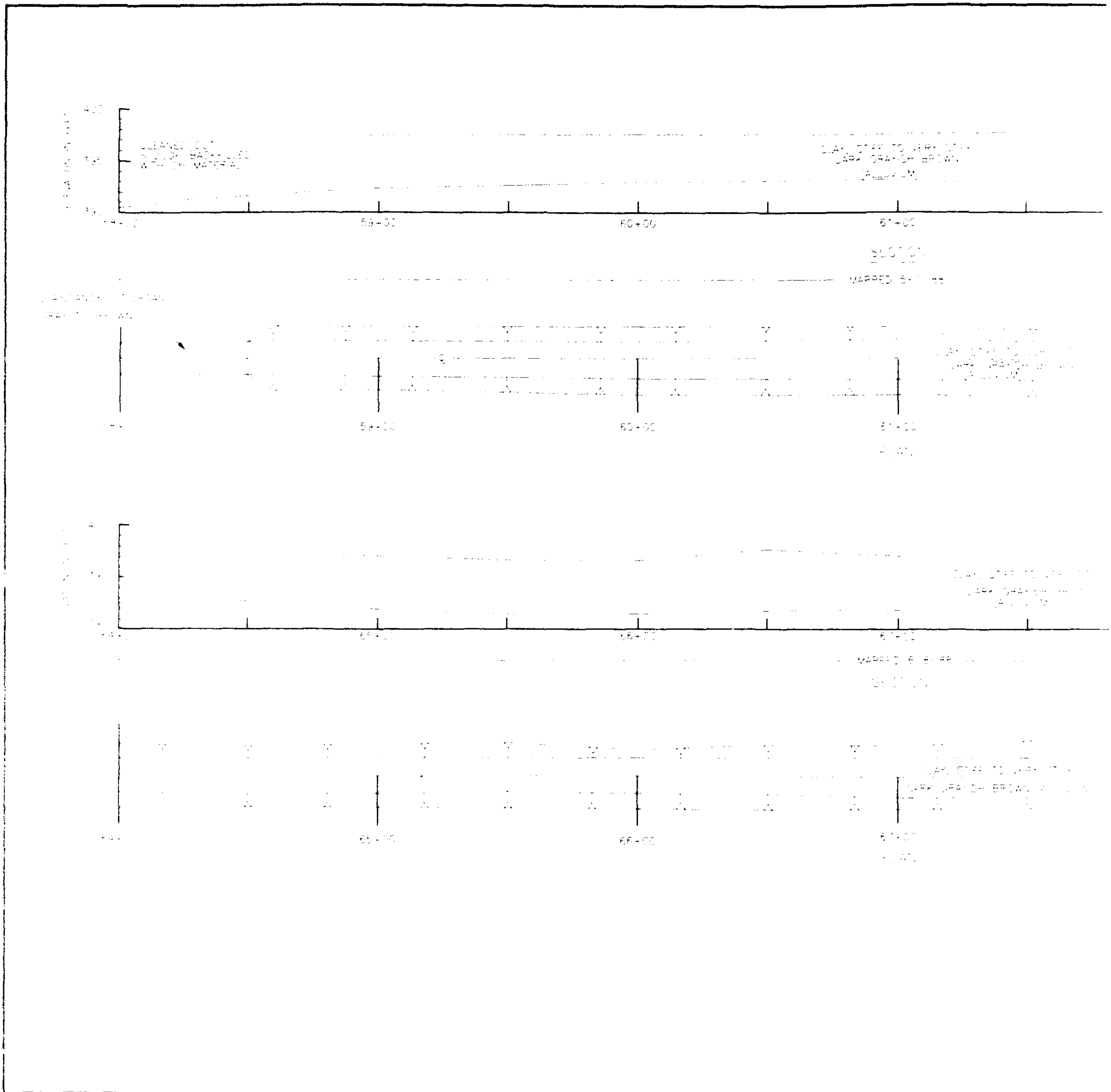
INSPECTION TRENCH FOUNDATION
STATION 4[illegible]+[illegible]5 TO STATION 58+00

SUBMITTED BY: BOB REHM
GEOLOGIST

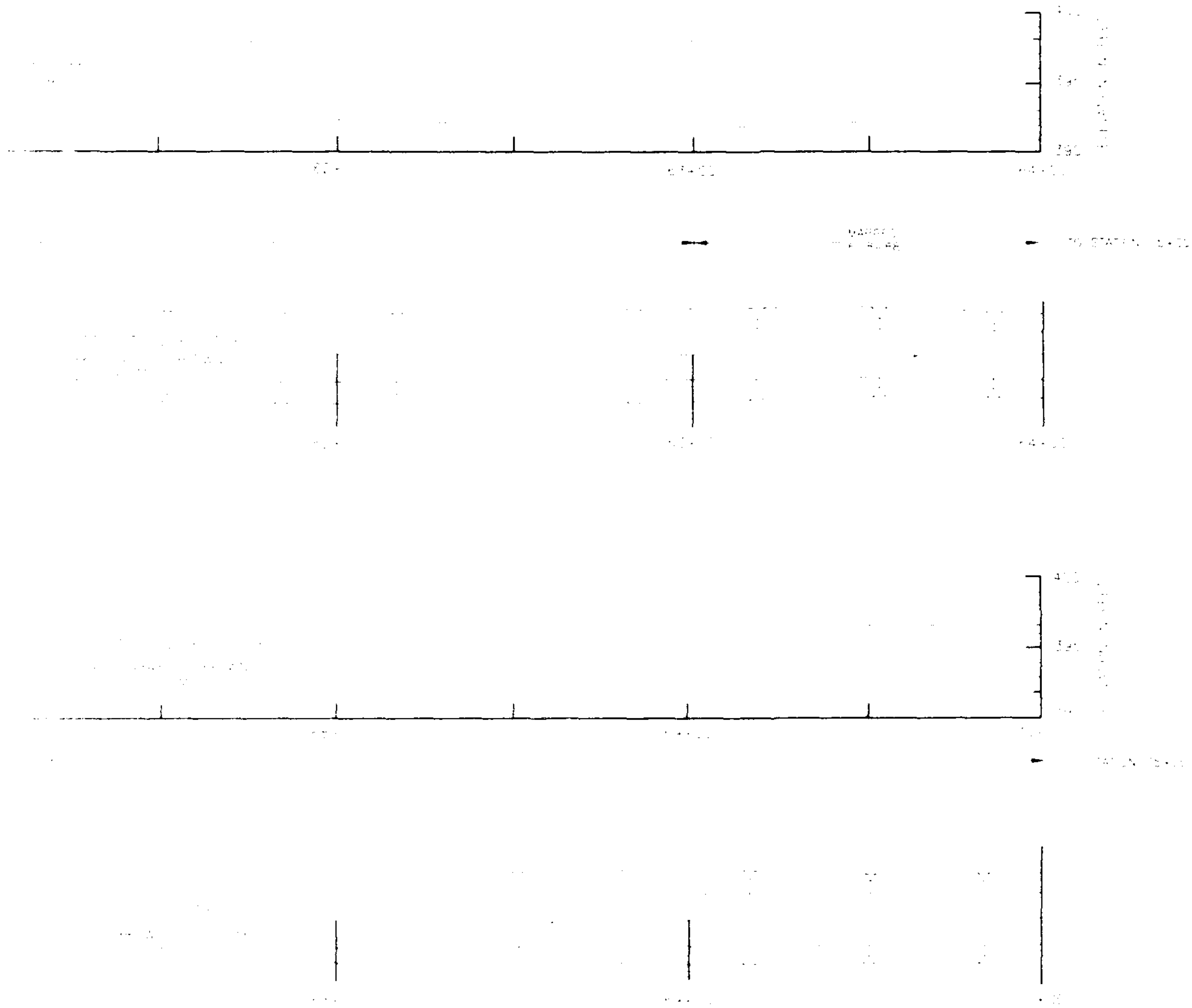
INVITATION NO. | DATE
CONTRACT NO. | SEQUENCE NO.
DRAWING NUMBER | SHEET NO. OF

TO ACCOMPANY FOUNDATION REPORT

PLATE 24



59+00
60+00
61+00
66+00



SYM		ACTION	DATE	DESCRIPTION OF REVISION

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

DESIGNED BY

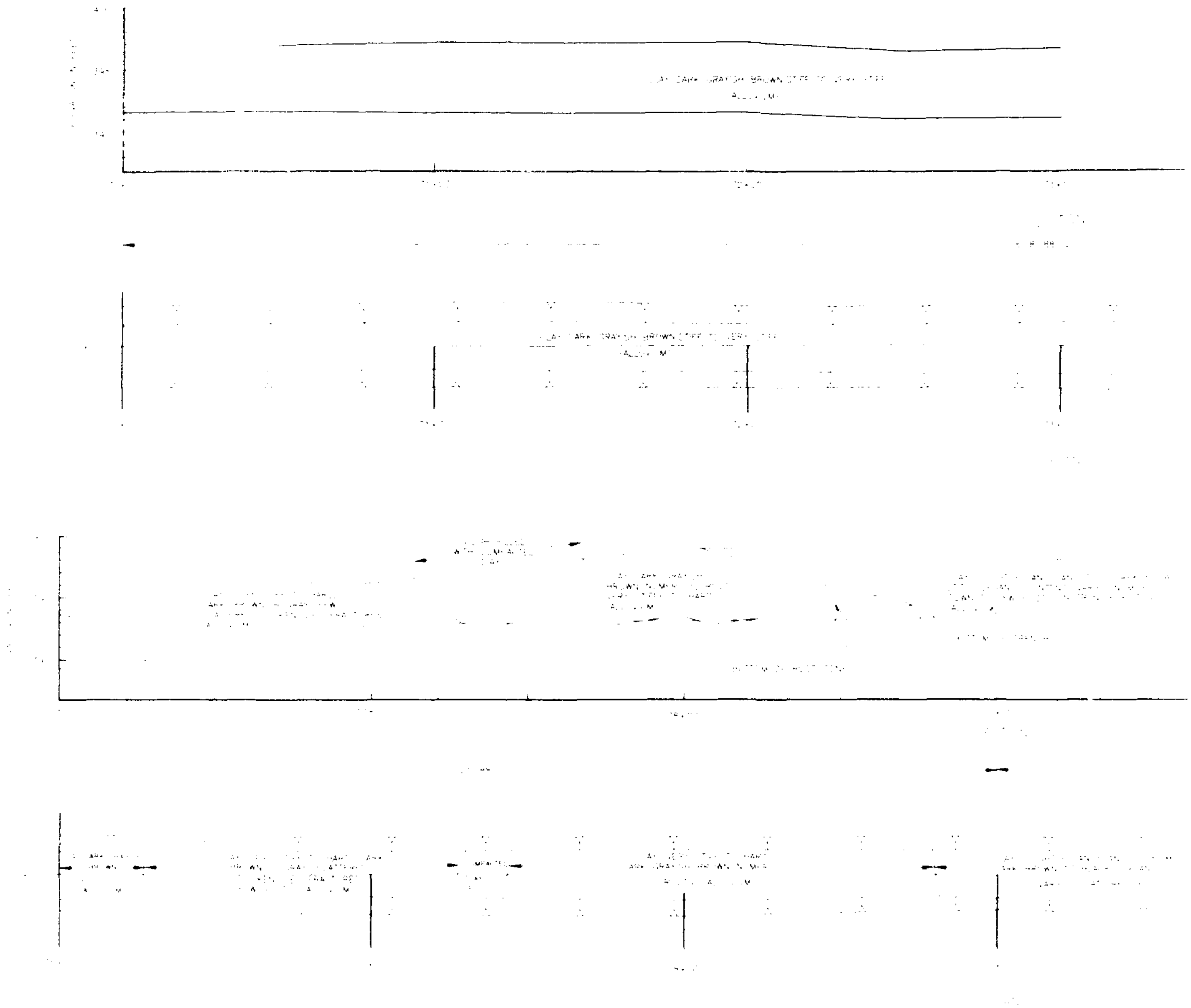
DRAWN BY
AMARE

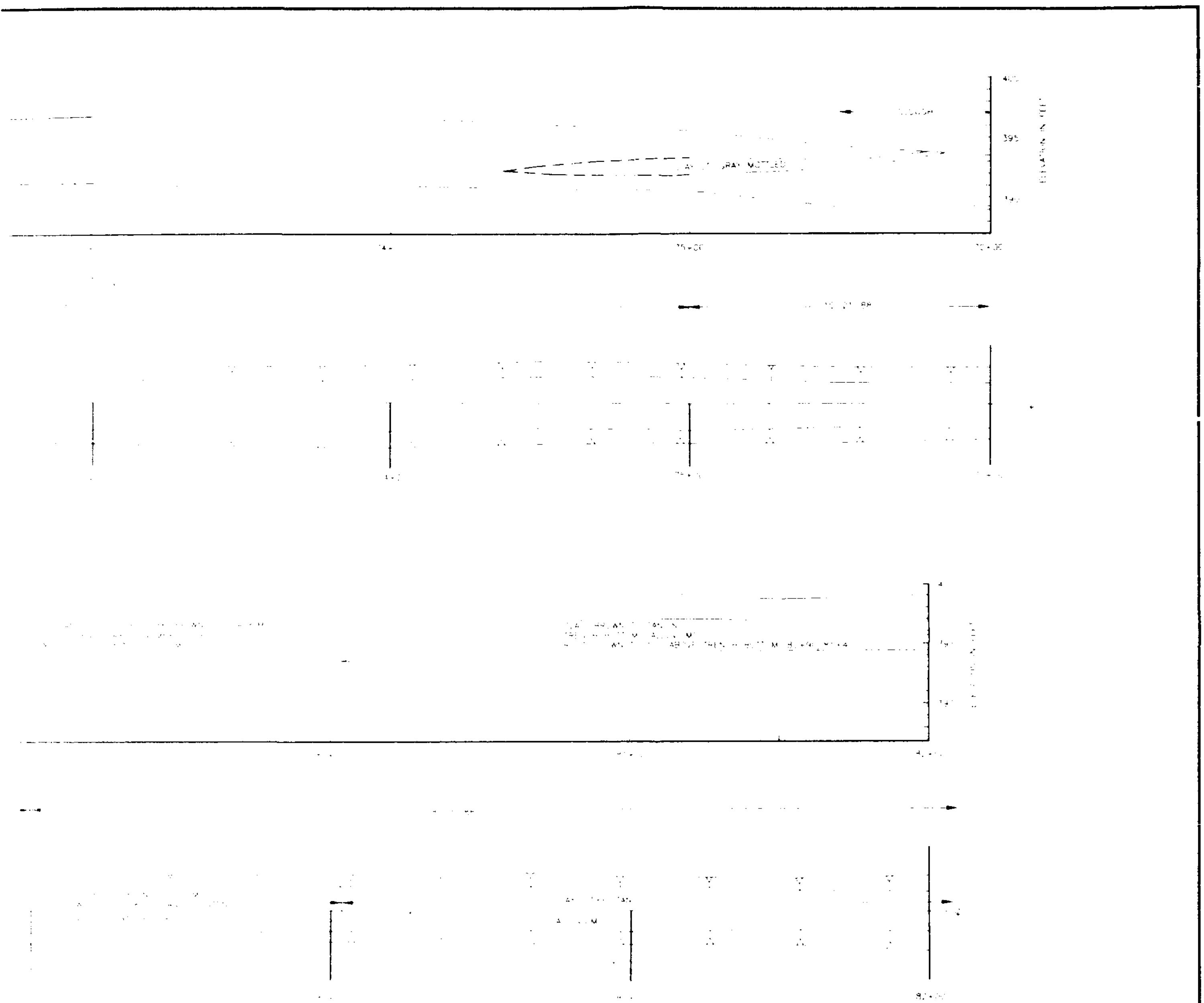
REVIEWED BY

SUBMITTED BY

INVITATION NO.
DATE
CONTRACT NO.
DRAWING NUMBER
SHEET NO.
SEQUENCE NO.

PLATE





SYM	C.O. NO.	ACTION	DATE	DESCRIPTION OR REVISION

ENGINEERING DIVISION
GEOTECHNICAL BRANCH

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

DESIGNED BY: G. RUEGE [illegible]

CADD BY: DE [illegible]

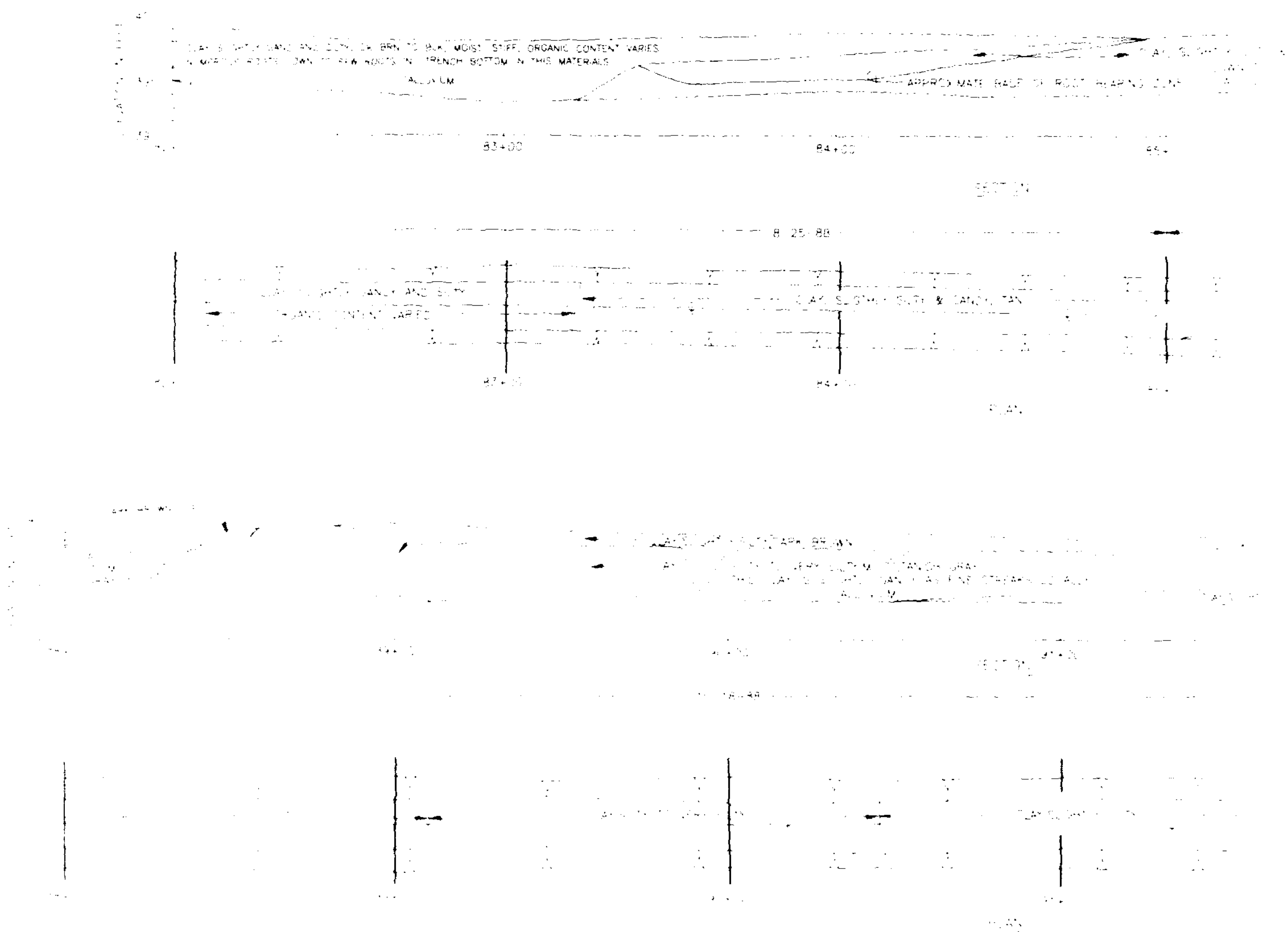
REVIEWED BY: G. RUEGE [illegible]

COOPER LAKE
SULPHUR SPRINGS, TEXAS
[illegible] TRENCH FOUNDATION
STATION 70+00 TO [illegible]

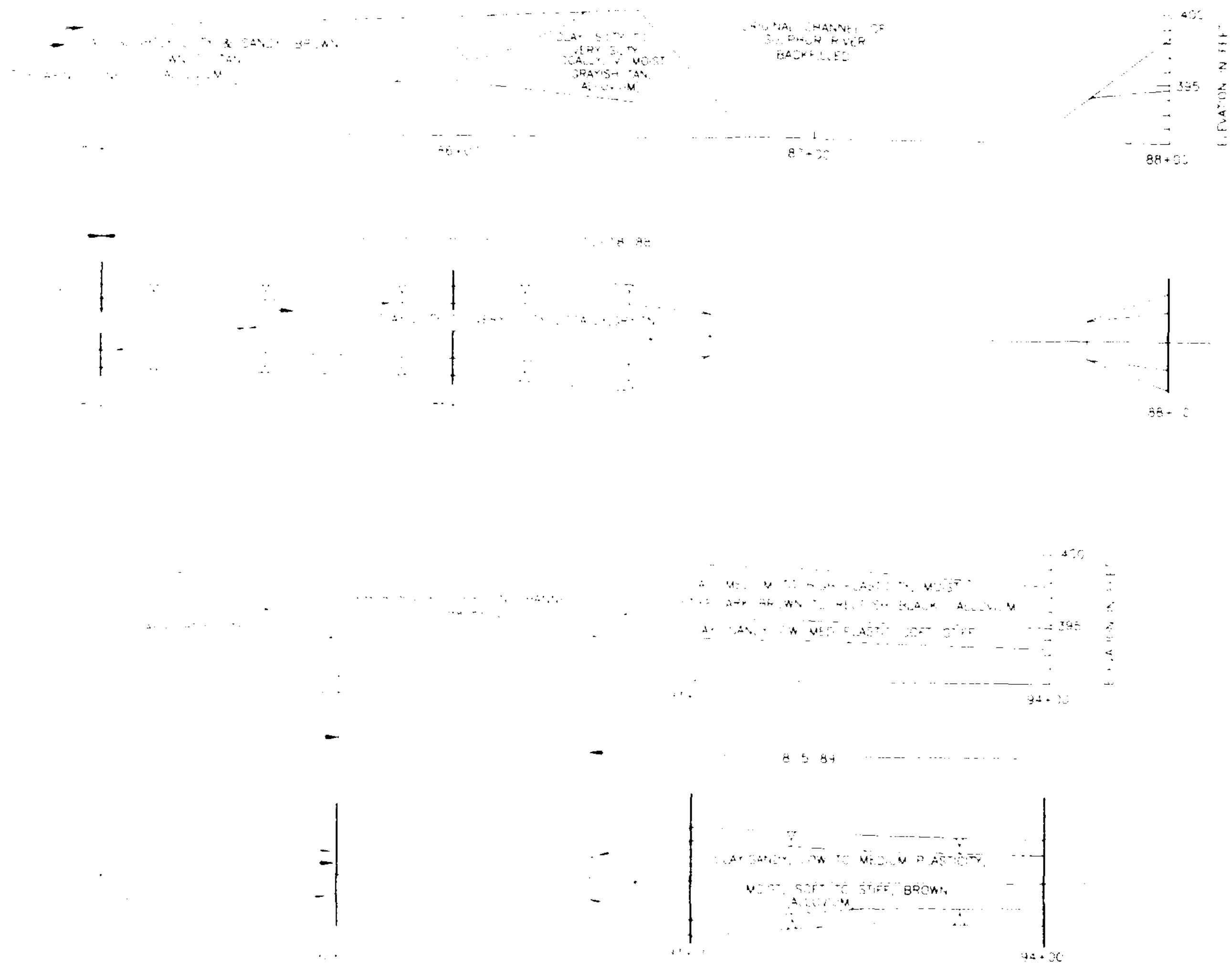
SUBMITTED BY: [illegible]
GEOLOGIST

INVITATION NO. | DATE
CONTRACT NO. | SEQUENCE NO.
DRAWING NUMBER | SHEET NO.

[illegible] FOUNDATION REPORT PLATE [illegible]



ORGANIC CONTENT VARIES
TRENCH BOTTOM
APPROXIMATE
83+00
84+00
8 25 88



SYM	C.O. NO.	ACTION	DATE	DESCRIPTION OR REVISION

ENGINEERING DIVISION
GEOTECHNICAL BRANCH

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

DESIGNED BY: G. RUEDE
CADD BY: DELAMARE
REVIEWED BY: RUEDE

COOPER LAKE
SULPHUR RIVER, TEXAS

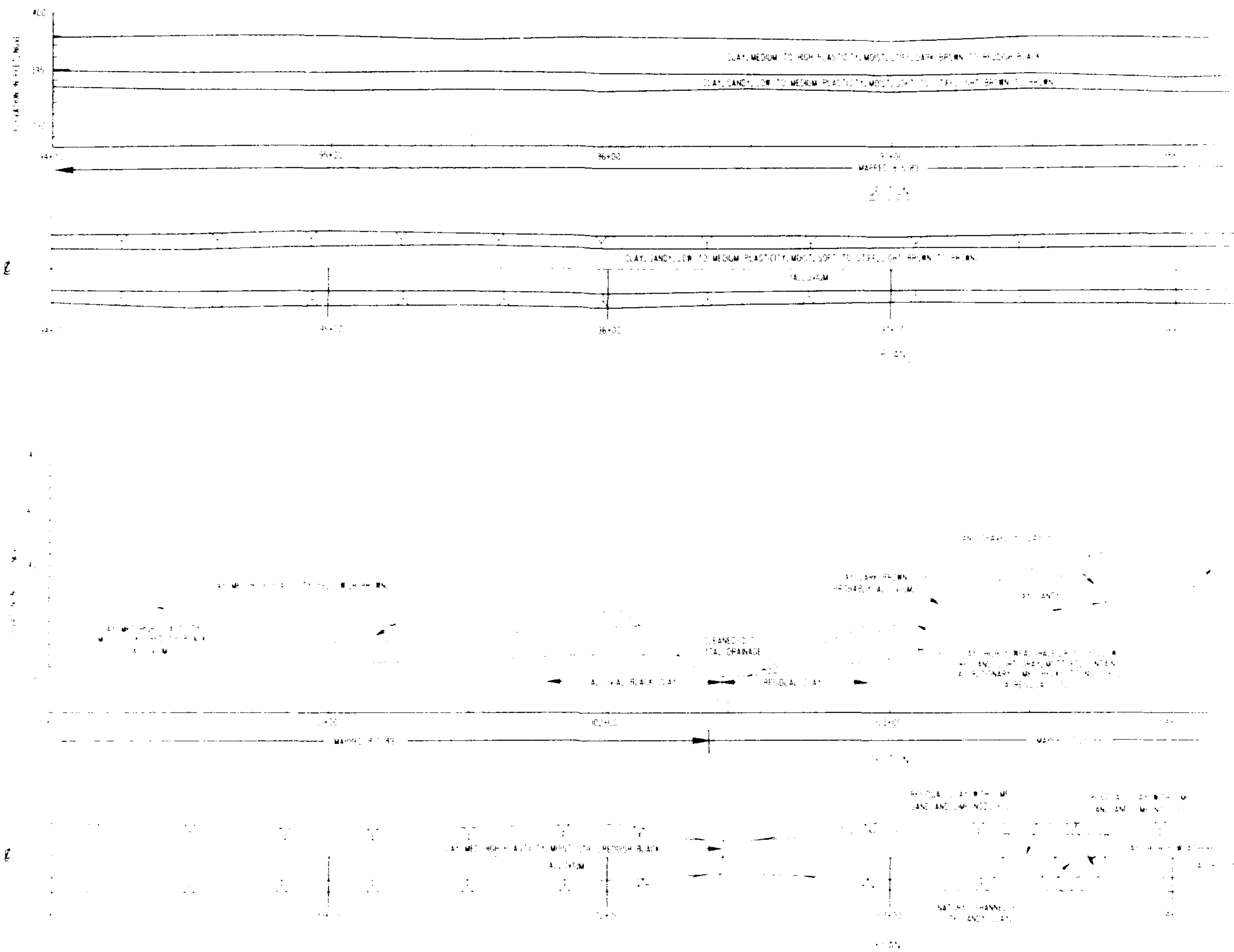
INSPECTION TRENCH FOUNDATION
STATION 82+00 TO STATION 94+00

SUBMITTED BY: ROBERT REHM, GEOLOGIST

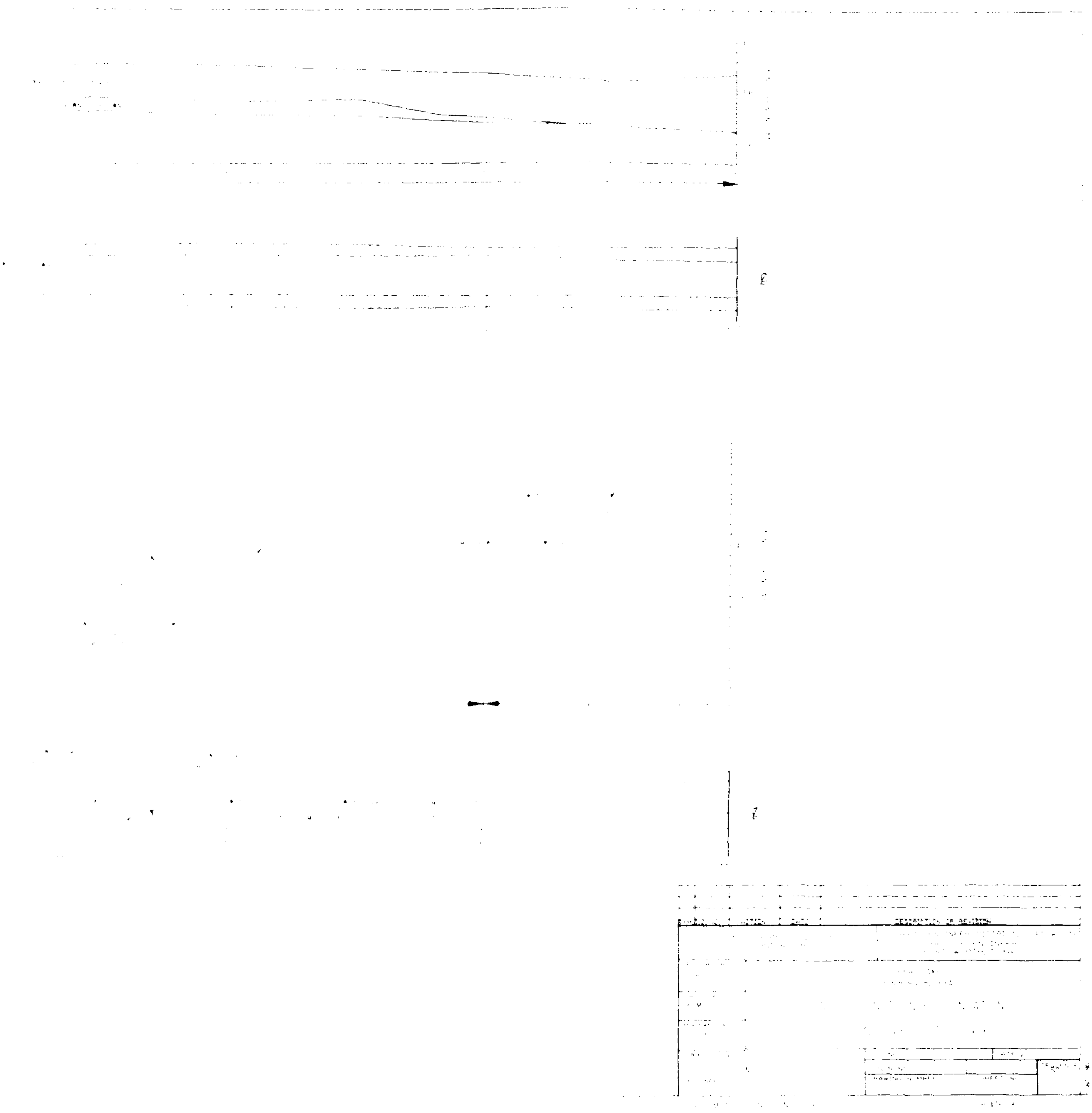
INVITATION NO. | DATE
CONTRACT NO. | SEQUENCE NO.
DRAWING NUMBER | SHEET NO. OF
CONTR. NO.

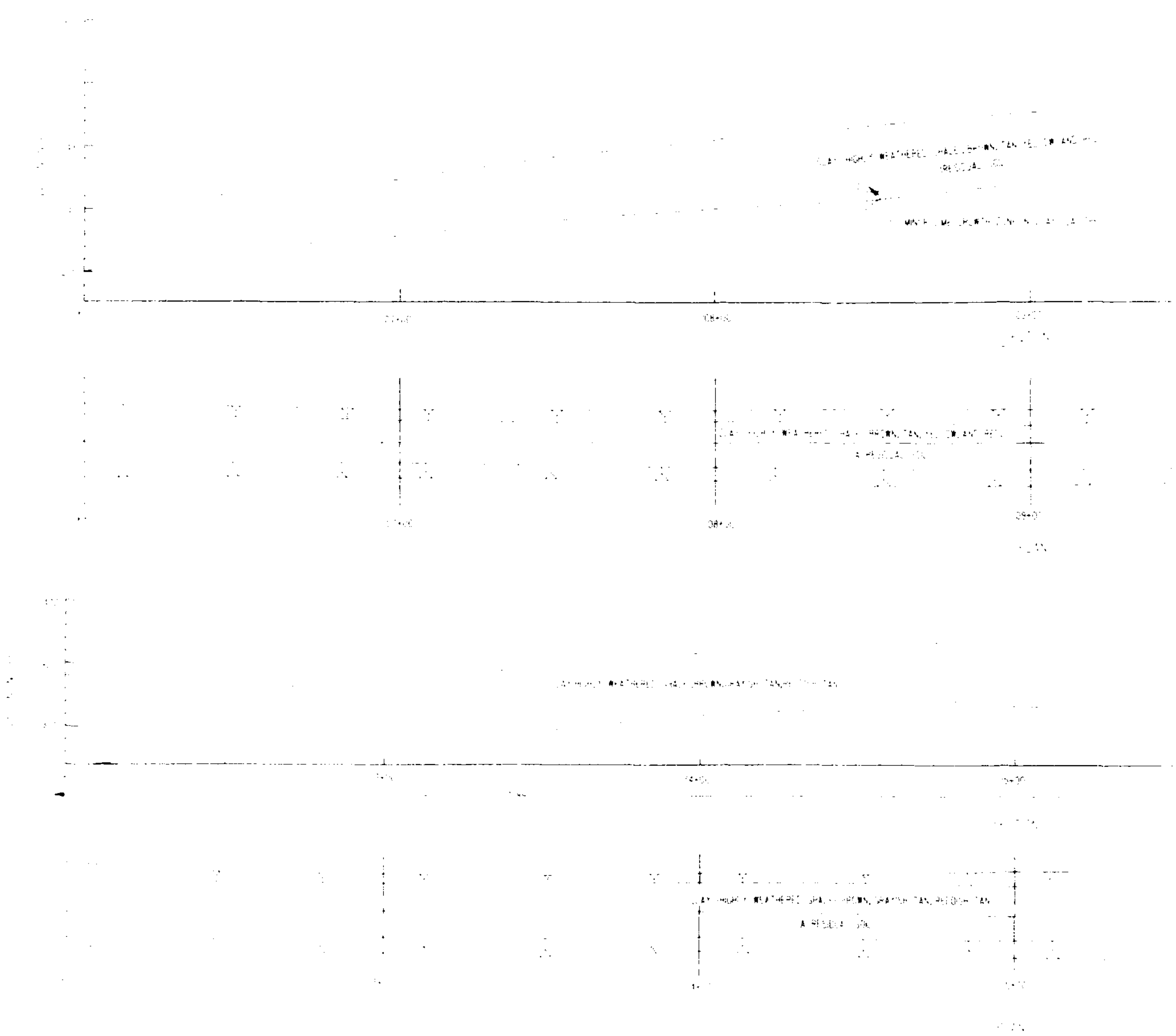
TO ACCOMPANY FOUNDATION REPORT

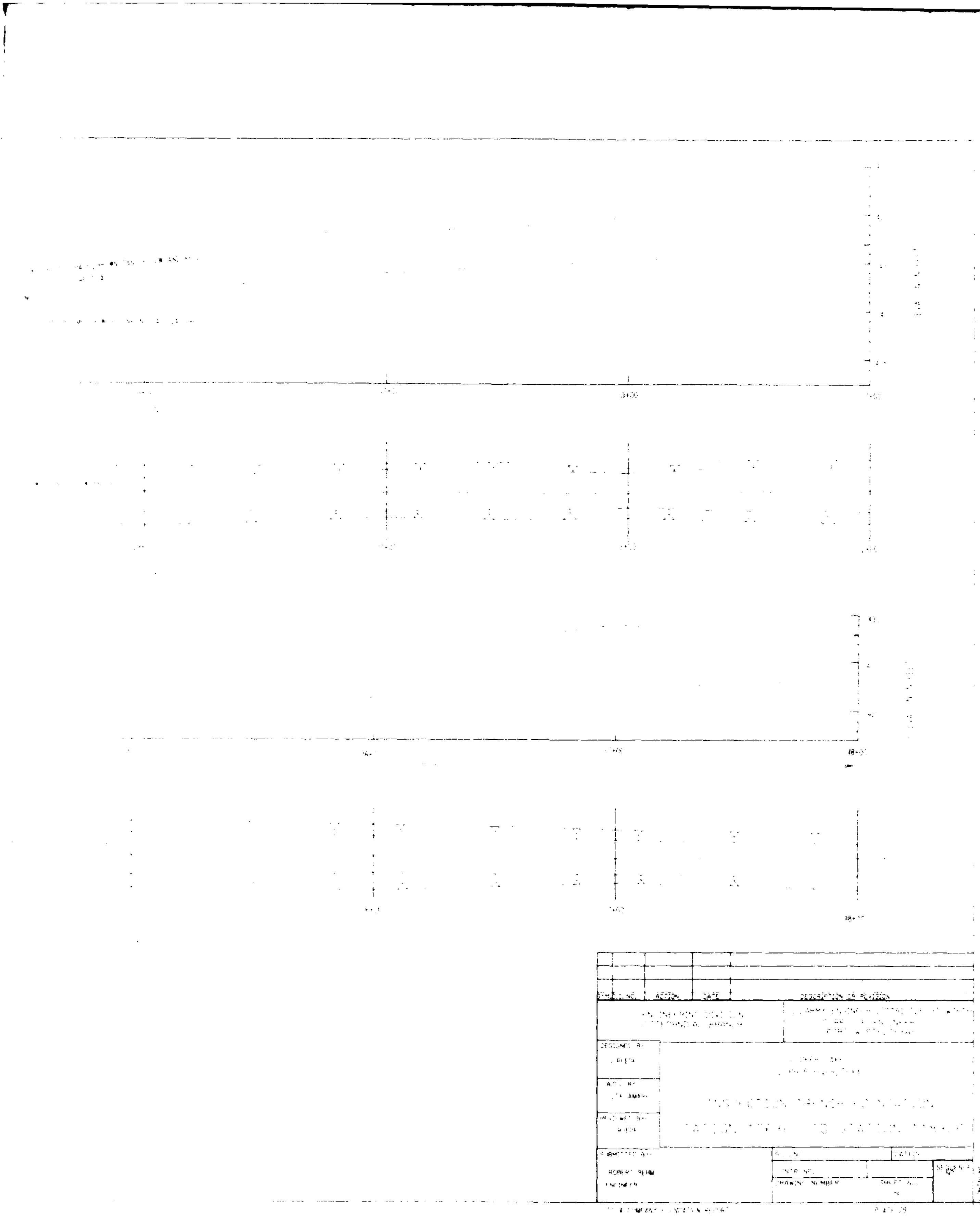
PLATE 27

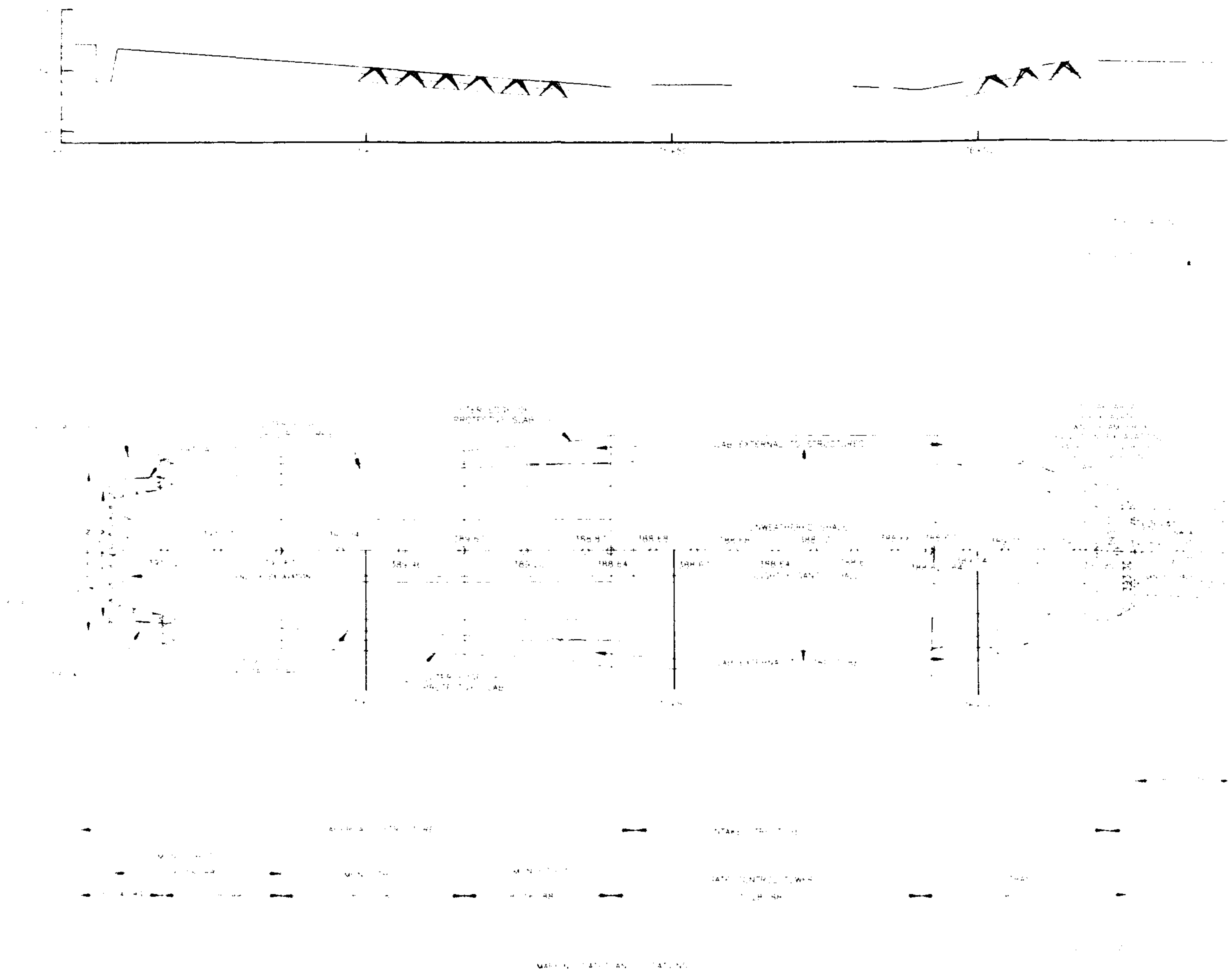


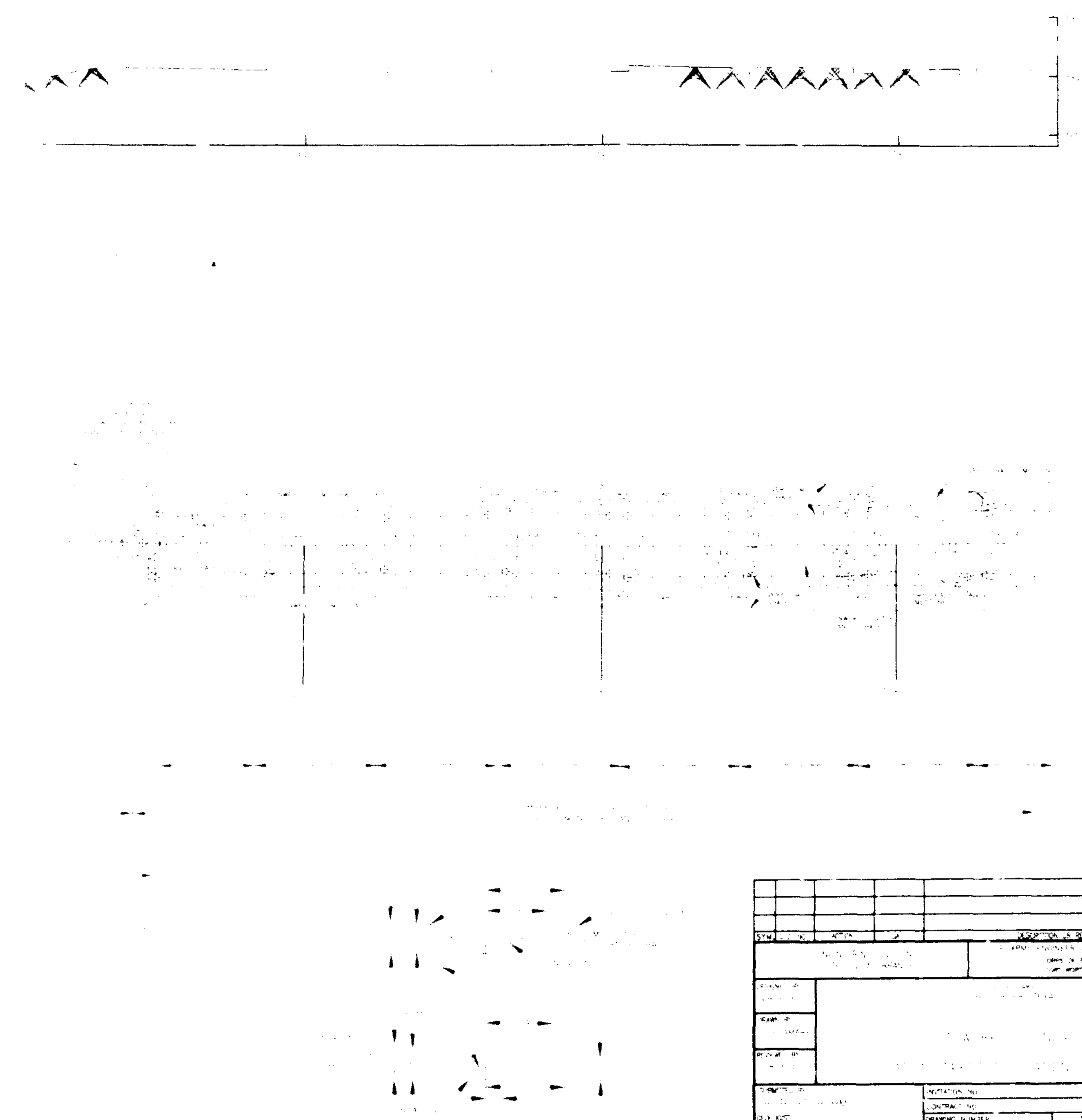
400
395
CLAY, MEDIUM TO HIGH PLASTICITY, MOIST, STIFF, DARK BROWN TO REDDISH BLACK
CLAY, SANDY, LOW TO MEDIUM PLASTICITY, MOIST, LIGHT BROWN TO BROWN
95+00
96+00
CLAY, SANDY, LOW TO MEDIUM PLASTICITY, MOIST, SOFT TO STIFF, LIGHT BROWN TO BROWN
96+00
CLEANED OUT
DRAINAGE
RESIDUAL CLAY
102+00
RESIDUAL CLAY






DATE
DESIGNED BY
SUBMITTED BY
ROBERT REHM
ENGINEER
DRAWING NUMBER





SYM		ACTION		DESCRIPTION OF REVISION

CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY

DRAWN BY

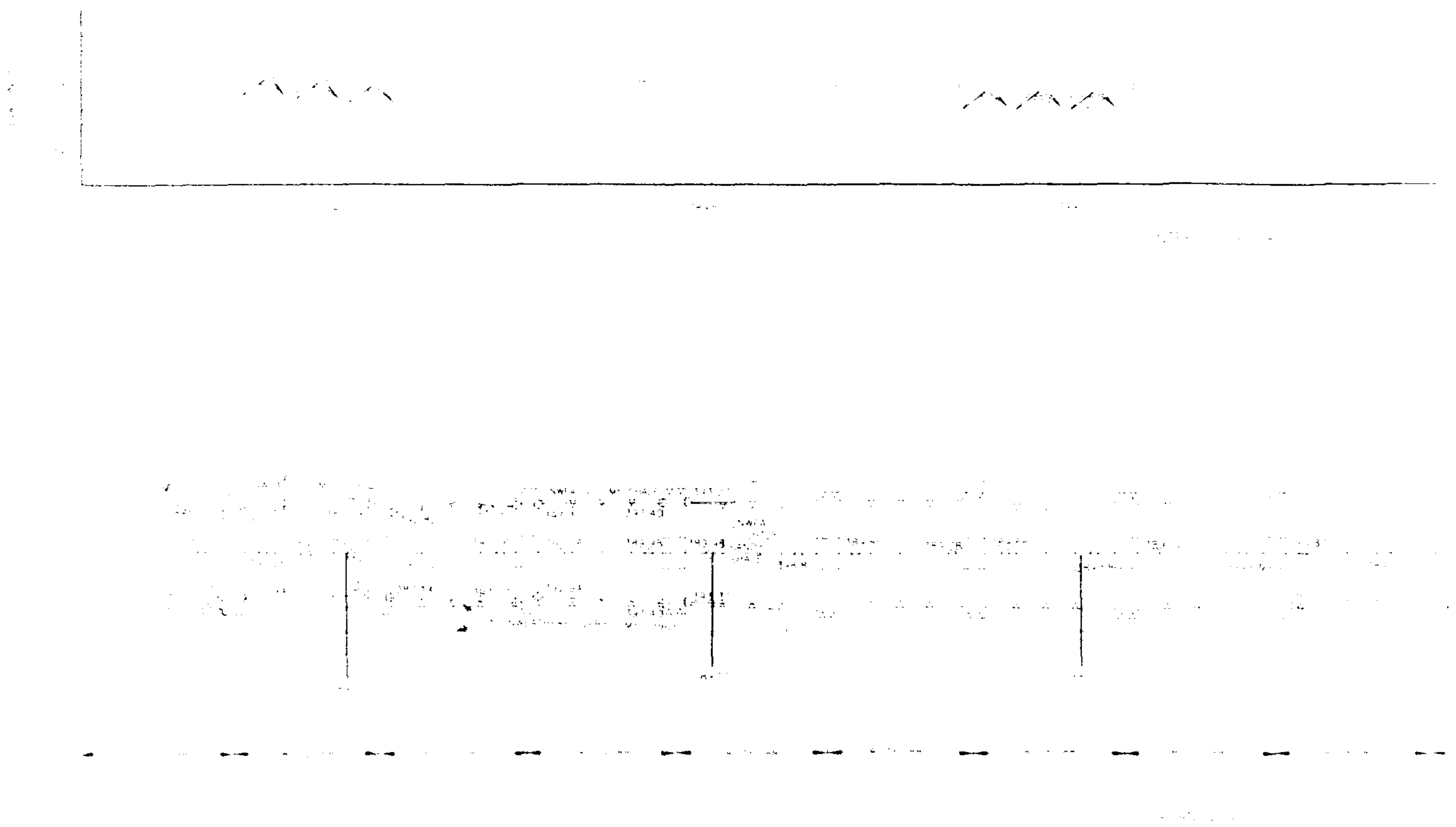
REVIEWED BY

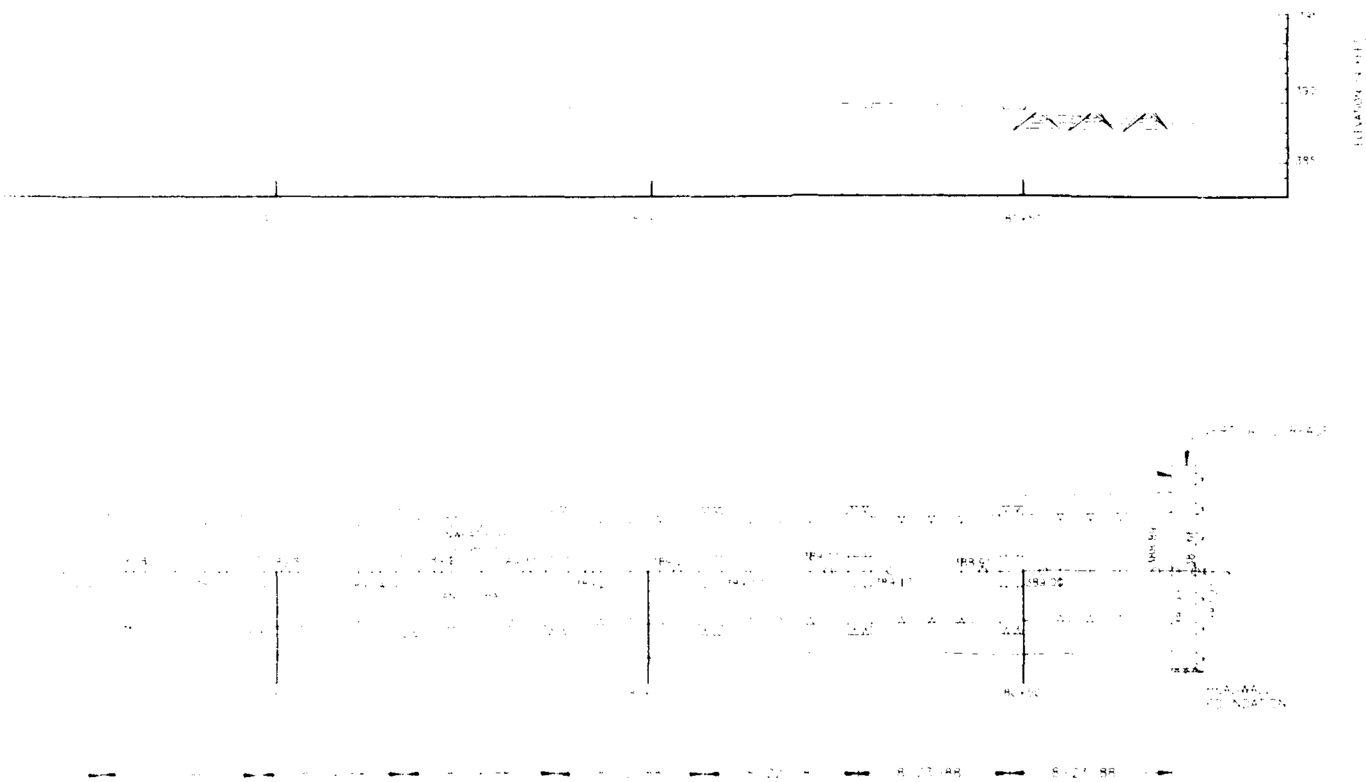
SUBMITTED BY

INVITATION NO. | DATE

CONTRACT NO. | SEQUENCE NO.

DRAWING NUMBER | SHEET NO. OF





SYM.	D.O. NO.	ACTION	DATE	DESCRIPTION OR REVISION

ENGINEERING DIVISION
GEOTECHNICAL BRANCH

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

DESIGNED BY G. RUEDE

DRAWN BY [illegible] DELAMARE

REVIEWED BY G. RUEDE

COOPER LAKE
SULPHUR RIVER, TEXAS

OUTLET WORKS FOUNDATION
STATION [illegible]+26 TO STATION 80+74

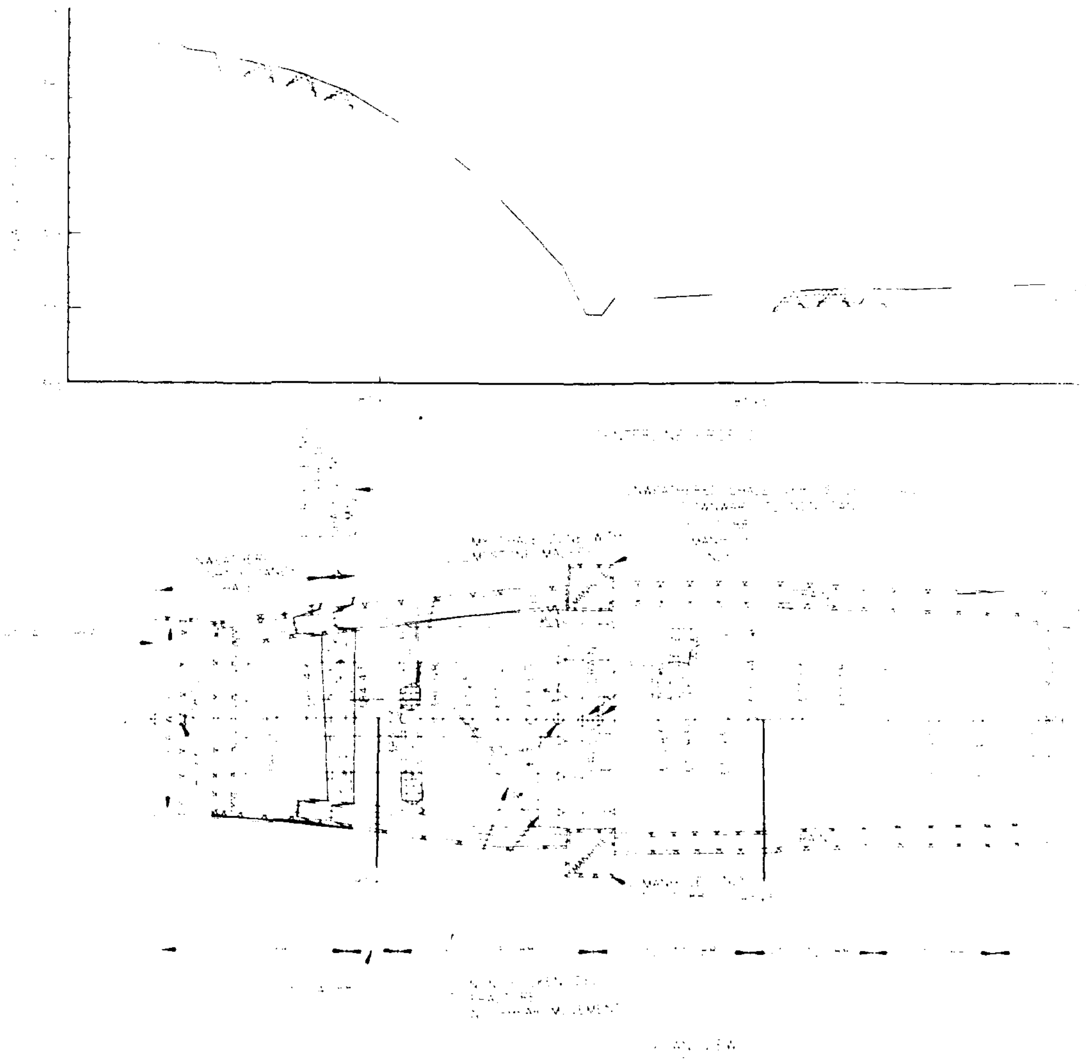
SUBMITTED BY
ROBERT BEHM
GEOLOGIST

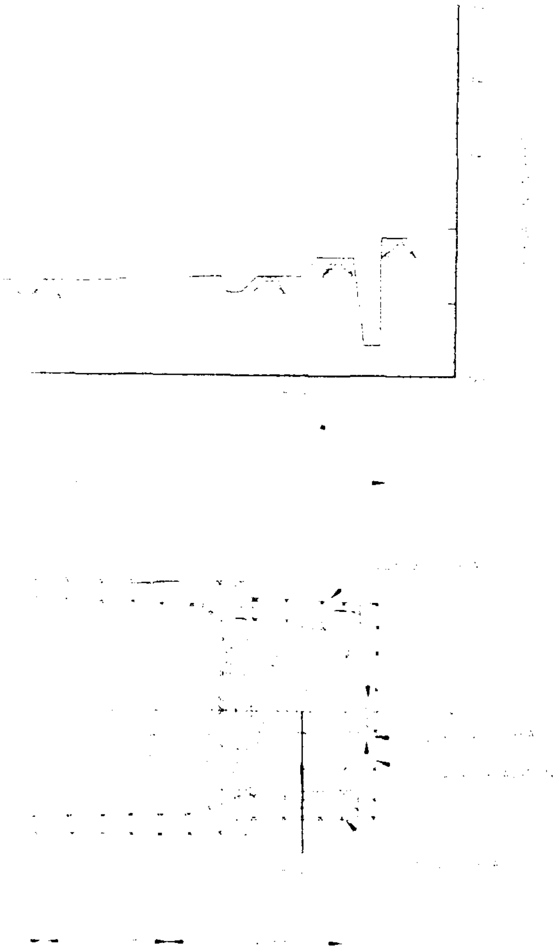
INVITATION NO. | DATE:
CONTRACT NO. | SEQUENCE NO.
DRAWING NUMBER | SHEET NO. OF

COE TR NO.

TO ACCOMPANY FOUNDATION REPORT

PLATE 31





SYM.	C.D. NO	ACTION	DATE	DESCRIPTION OR REVISION

ENGINEERING DIVISION GEOTECHNICAL BRANCH	U.S. ARMY ENGINEER DISTRICT FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS

DESIGNED BY

DRAWN BY
DELAMARE

REVIEWED BY

SUBMITTED BY

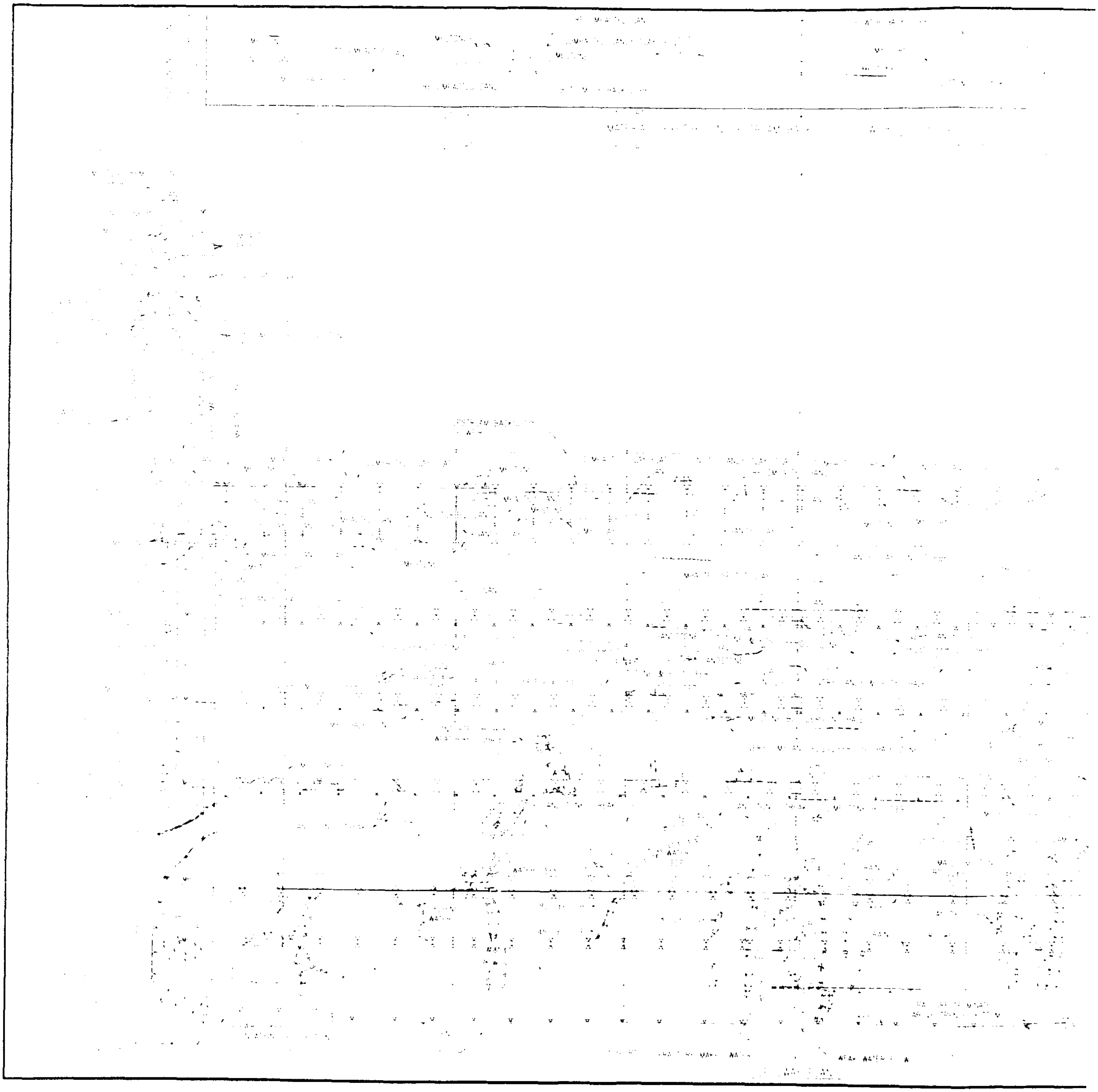
GEOLOGIST

INVITATION NO. | DATE

CONTRACT NO. | SEQUENCE NO.

DRAWING NUMBER | SHEET NO. OF

PLATE 32



SYM	DIG NO	ACTION	DATE	DESCRIPTION OF REVISION

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

COOPER LAKE
SULPHUR RIVER, TEXAS

FOUNDATION REPORT

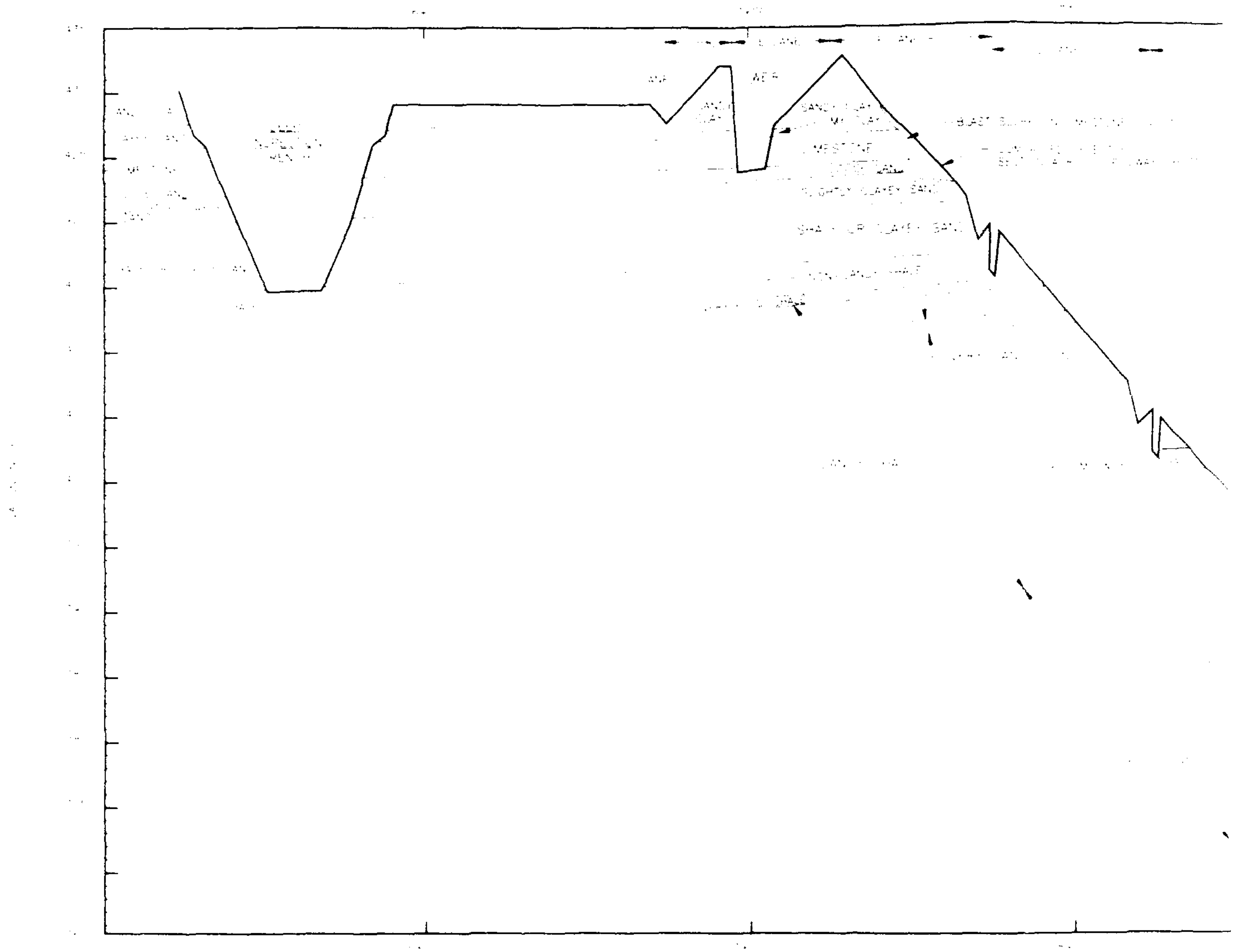
SPILLWAY FOUNDATION PLAN

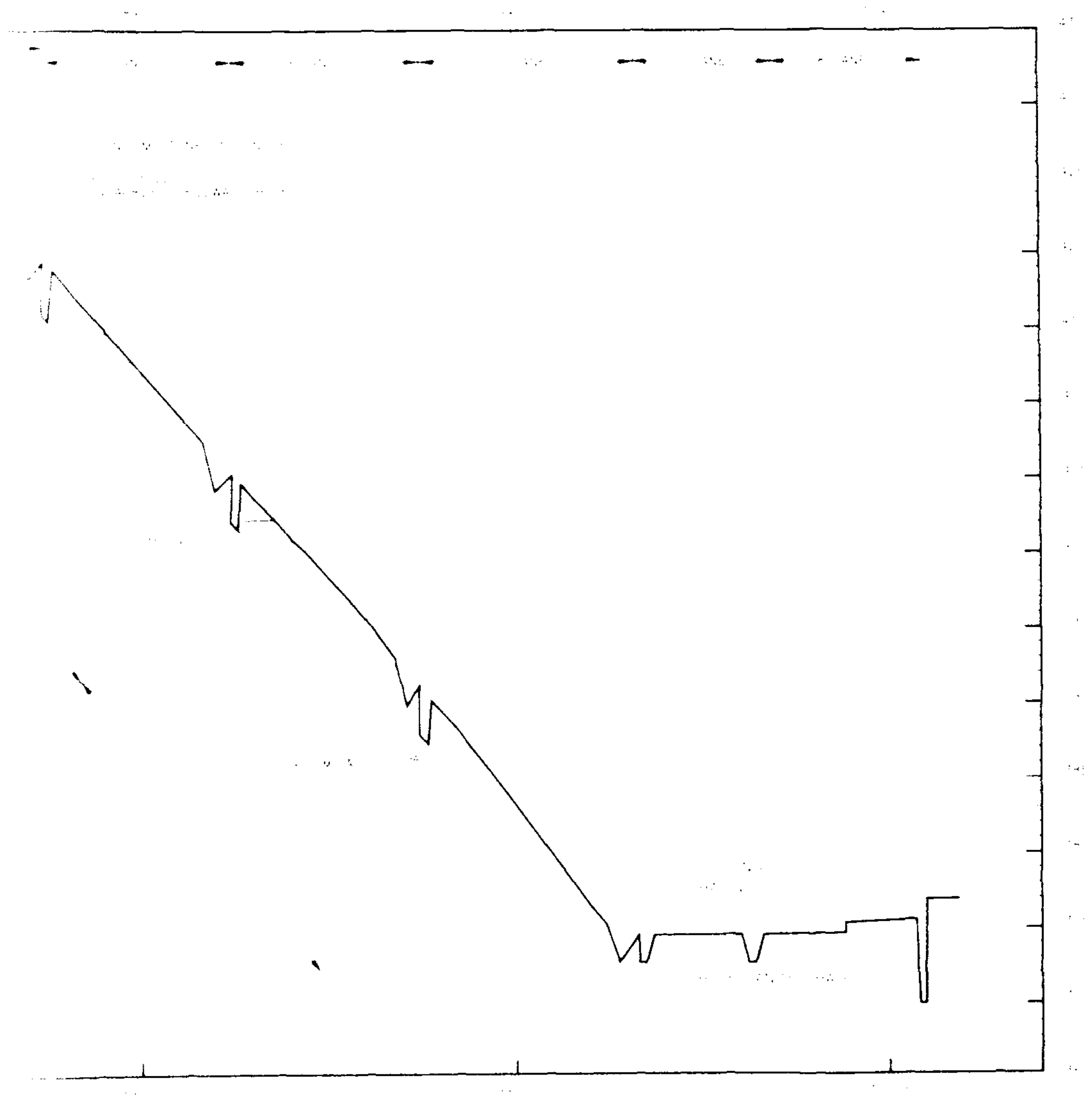
INVITATION NO.
DATE
CONTRACT NO.
SEQUENCE NO.
DRAWING NUMBER
SHEET NO.

SUBMITTED BY
ENGINEER

TO ACCOMPANY FOUNDATION REPORT

PLATE NO. 33





SYM	D.C. NO.	ACTION	DATE	DESCRIPTION OR REVISION

ENGINEERING DIVISION
GEOTECHNICAL BRANCH

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

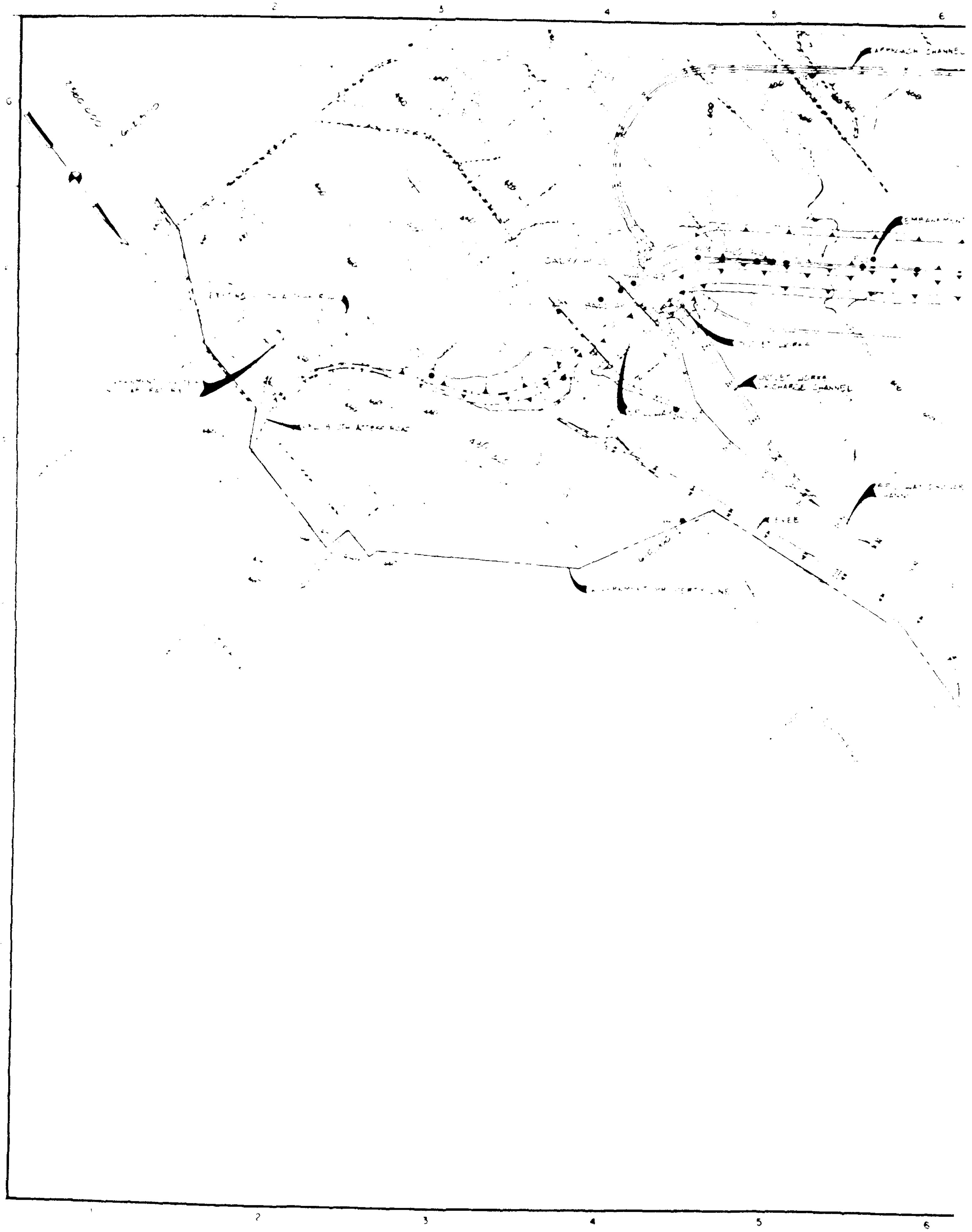
DESIGNED BY: ... RUEDE
CADD BY: ... DELAMARE
REVIEWED BY: G. RUEDE

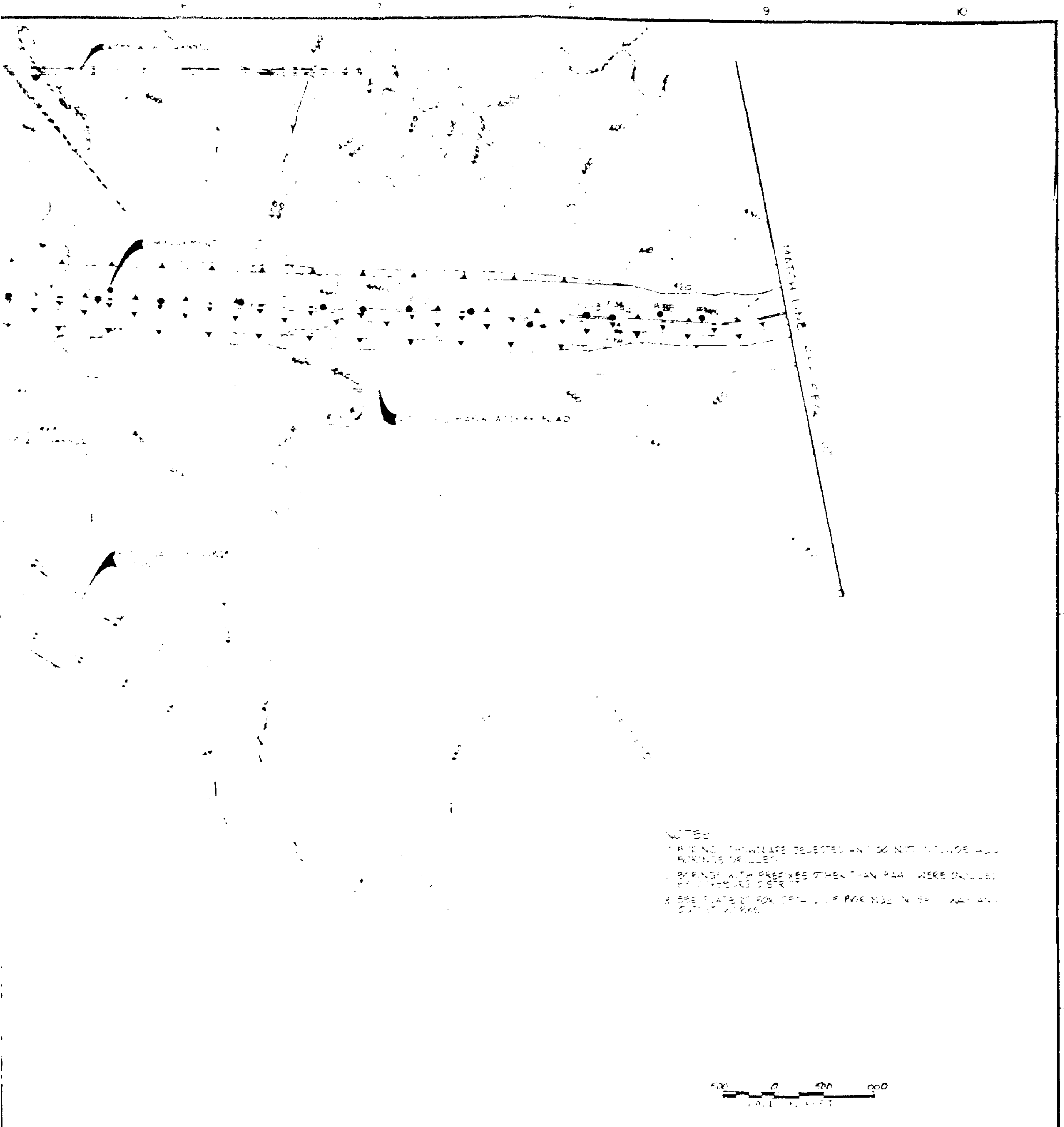
... LAKE
... RIVER, TEXAS

SPILLWAY CENTERLINE PROFILE

SUBMITTED BY: ROBERT ... GEOLOGIST

INVITATION NO. | DATE
CONTRACT NO. | SEQUENCE NO.
DRAWING NUMBER | SHEET NO. OF


APPROACH CHANNEL
OUTLET DISCHARGE CHANNEL



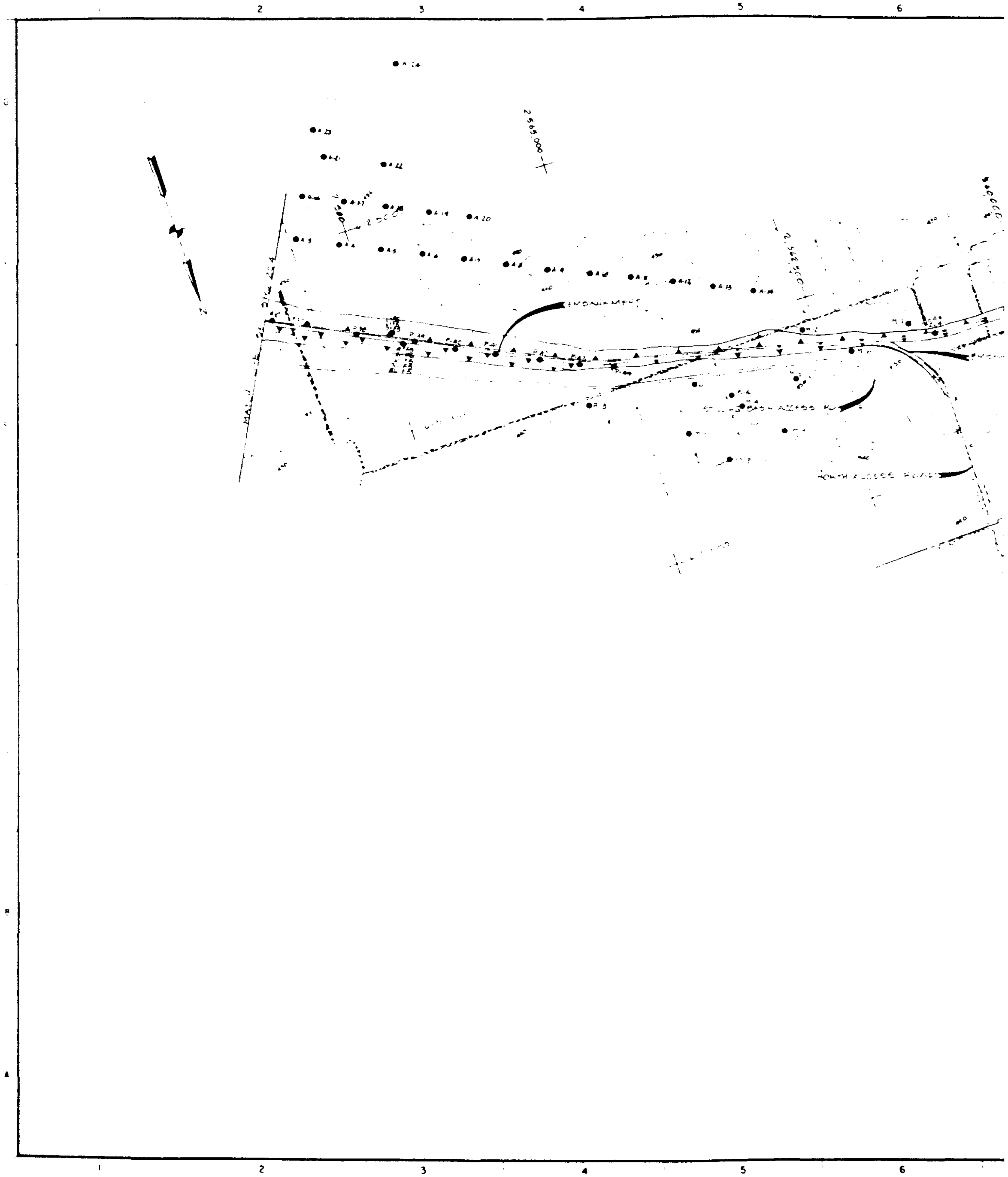
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

COOPER LAKE
SULPHUR RIVER, TEXAS

EMBANKMENT, SPILLWAY, AND OUTLET WORKS

BORING LOCATION MAP I

DESIGNED BY
DRAWN BY
REVIEWED BY
SUBMITTED BY
ENGINEER
DATED
CONTR NO
DRAWING NUMBER
SHEET NO
SEQUENCE NO



EMBANKMENT
NORTH ACCESS ROAD
2,565,000
2,562,500

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

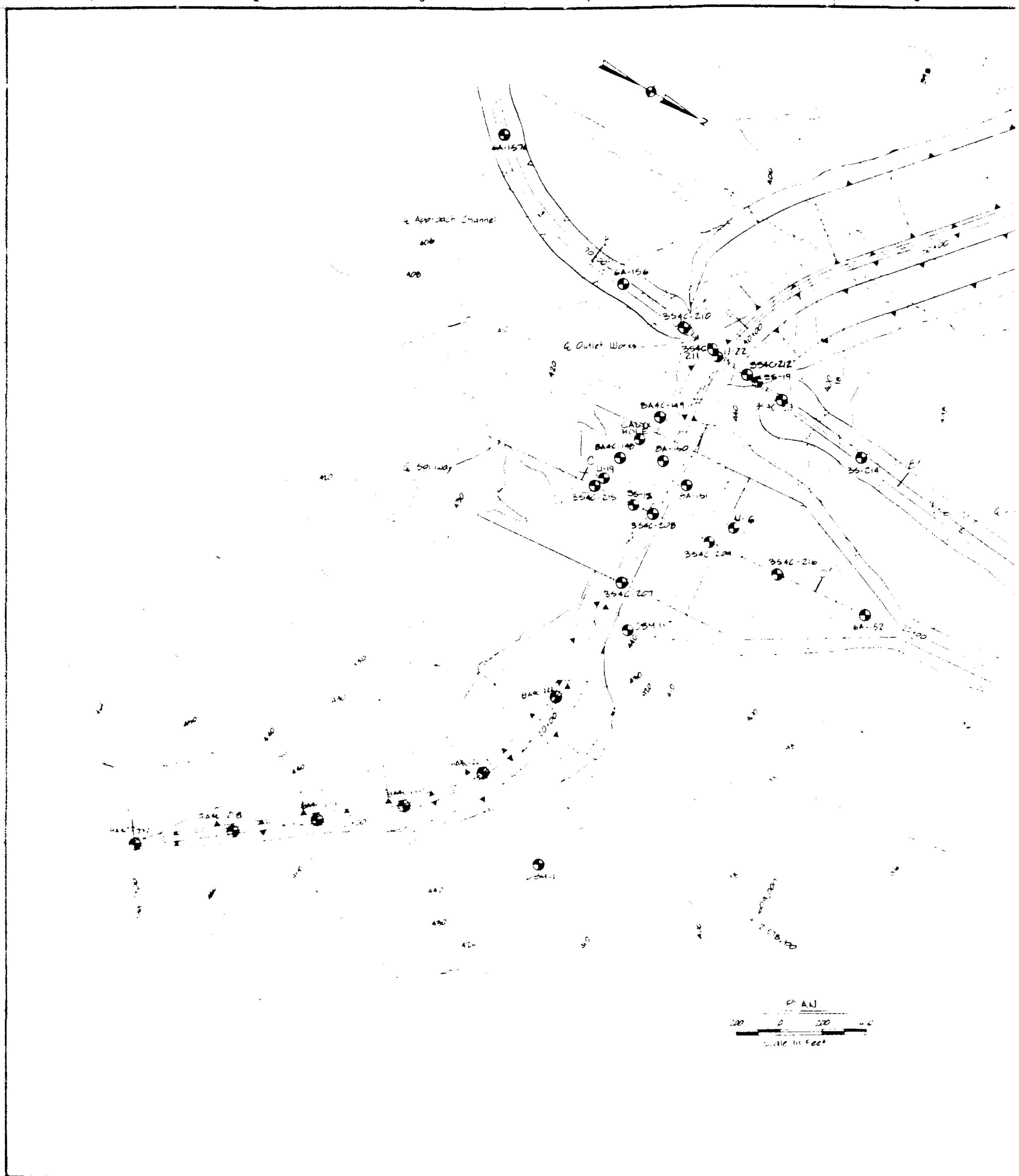
COOPER LAKE
SULPHUR RIVER, TEXAS

EMBANKMENT, SPILLWAY, AND OUTLET WORKS

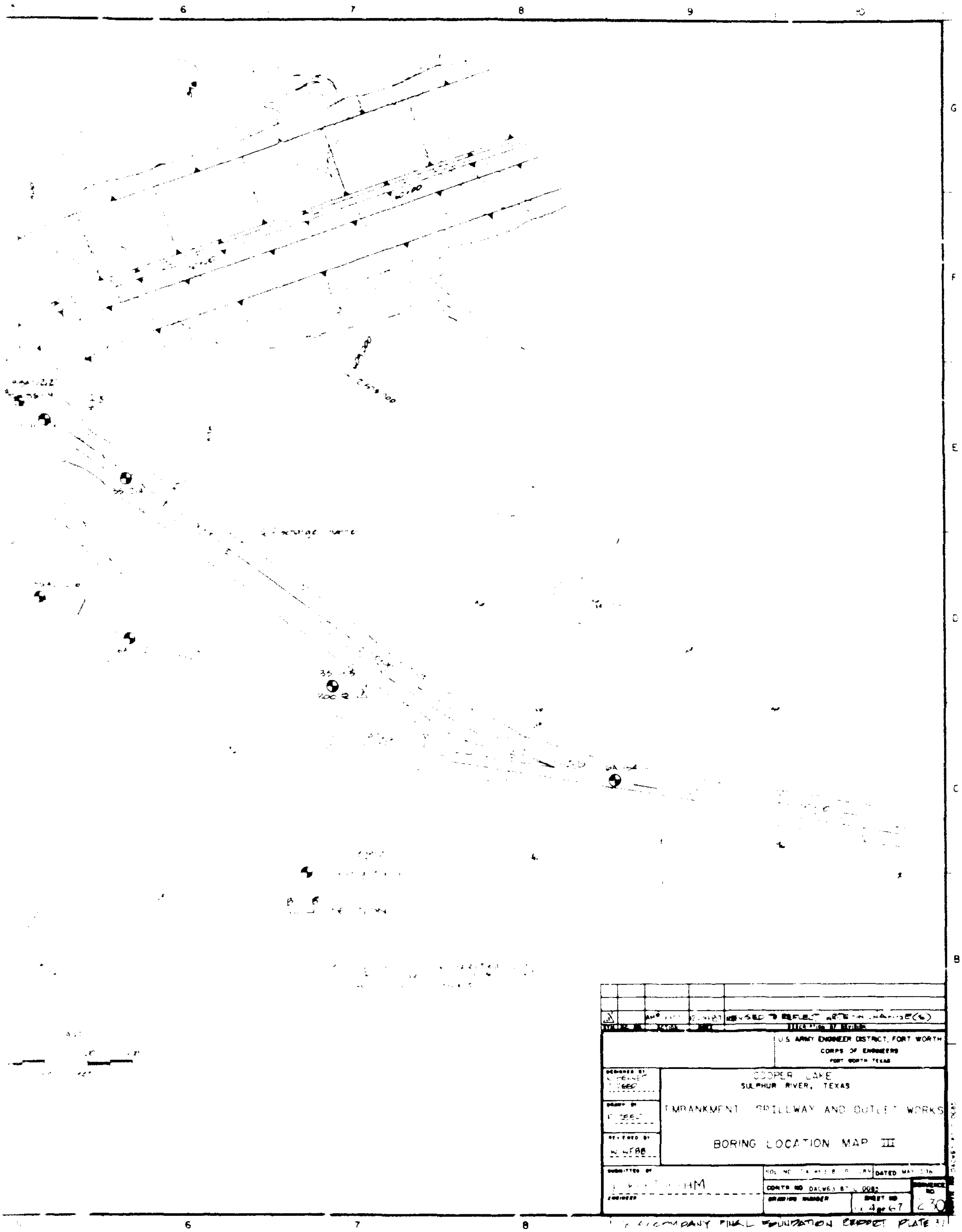
BORING LOCATION MAP II

DESIGNED BY: R. RUSSO
DRAWN BY: E. SMITH
REVIEWED BY: W. LIEBB
SUBMITTED BY:
ENGINEER
SOL. NO.
DATED
CONTR. NO.
DRAWING NUMBER
SHEET NO.

To ACCOMPANY FINAL FOUNDATION REPORT PLATE



6A-156
354C-210
Outlet Works
354C-212
BA4C-149
BA4C-148
BA-150
Spillway
354C-215
354C-208
354C-209
354C-207
354C-216
6A-52
35-214
U-6
PLAN
Scale in Feet



REVISED TO REFLECT WRITTEN CHANGE(S)

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

COOPER LAKE
SULPHUR RIVER, TEXAS

EMBANKMENT, SPILLWAY AND OUTLET WORKS

BORING LOCATION MAP III

DESIGNED BY | DRAWN BY | REVIEWED BY W. WEBB | SUBMITTED BY ENGINEER

DATED MAY 1976

CONTR NO DACW63 ...

SHEET NO 4 of 67

SEQUENCE NO 230

TO ACCOMPANY FINAL FOUNDATION REPORT PLATE 3

2 3 4 5 6

DRILLING LOG

Division: SWD | Installation: Ft Worth

1. Project: Cooper Dam, Borrow Area

3. Drilling Agency: USCE

Manufacturer's Designation of Drill: Acker

Elevation Ground Water: Dry Hole

Date Hole: Started 14 Jan 86, Completed 14 Jan 86

Thickness of Overburden: 2.0

Depth Drilled into Rock: 20

Total Depth of Hole: 20

Classification of Materials	Remarks
0.0 to 20.0	* Drilling
SAND	0 to 3.7 - 3" shelby, refusal. 3.7 to 20 - 5" auger.
0.0 to 3.7 - fine grained, loose to medium dense, moist, dark brown, very silty, clayey, non calc.	Note: All samples collected by drill crew.
3.7 to 20.0 - fine grained dense medium dense, moist to slightly moist, light gray and yellow brown, silty and clayey, non calcareous, non cemented, gravelly zone from 14.8 to 20.0.	Bags
	Shelby
	refusal

DRILLING LOG

Installation: Ft Worth

1. Project: Cooper Dam

3. Drilling Agency: USCE

Manufacturer's Designation of Drill: Failing 1500

Name of Driller: Bettis/Brewer

Total Depth of Hole: 30.0

Depth	Classification of Materials	Box or Sample No.	Remarks
	0.0 to 19.5	1	* Drilling
	CLAY	2	shelby, shelby refusal during ... and augered ... refusal, ... and augered to 19.5 with 4" auger, 19.5 to 30.0 - 3" shelby, with 4" auger clean out.
	0.0 to 2.3 - high plasticity, soft, moist, dark brown, silty, non calcareous.	3	
	2.3 to 10.5 - high plasticity, very stiff to hard (soil classification), moist, yellow brown and light gray, sandy/silty, slightly calcareous, primary? Possibly reworked.	4, 5	... check at 25.0
10	10.5 to 15.5 - high to low plasticity, stiff to medium stiff, moist, yellow brown and white, plant roots, sandy lime nodules, sandy/silty, calcareous.	A	
	15.5 to 19.5 - medium to low plast, medium stiff, moist, yellow brown and light gray, very sandy with sand seams, limey sand sized nodules, calc.	5	
20	19.5 to 29.0	6, 7, 8, 9	refusal
	SAND - fine grained, medium dense, moist, yellow brown and white, clayey & silty, calcareous, non cemented, massive.	10, 11, 12, 13, 14, 15, 16	
	29.0 to 30.0	17, 18, 19	
30	CLAY - medium to high plasticity, soft, moist, yellow brown and light gray, calcareous, silty, plant roots.		Jars

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT) | PROJECT | HOLE NO.

DRILLING LOG

Division: SWD | Installation: Ft Worth

1. Project: Cooper Dam, Borrow Area

3. Drilling Agency: USCE

Hole No.: 35-104

Name of Driller: Brewer

Manufacturer's Designation of Drill: Acker

Date Hole: Started 29 Jan, Completed 29 Jan 86

Depth	Classification of Materials	Remarks
	0.0 to 20.8	* Drilling
	CLAY	Refusal at surface with the 3" shelby push. 0.0 to 30' - 5" auger.
	0.0 to 10.0 - high plasticity, very stiff to hard, slightly moist, dark gray.	Note
	10.0 to 20.8 - high plast, very stiff to stiff, moist, dark gray, very slightly sandy/silty.	All samples taken by the drill crew members.
10	20.8 to 30.0	*** water level taken 29 Jan. 86 and at 12'.
	SAND borderline CLAY - sand is fine grained and non cemented, the clay is high plasticity and soft, both are moist, yellowish brown and light gray, very silty.	Bags
		... 25.0 to 30.0
20		Jars
		A. 0.0 to 5.0 B. 5.0 to 10.0 C. 10.0 to 15.0 D. 15.0 to 20.8 E. 20.8 to 30.0

DRILLING LOG

Division: SWD

Cooper Dam, Borrow Area

USCE

Brewer

0.0 to 3.4

3.4 to 8.8

8.8 to 21.

21. to 30.

SAND borderline ...

DRILLING LOG

Cooper Dam, Borrow Area

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT)

2 3 4 5 6

DRILLING LOG

Division: SWD — Installation: Ft. Worth — Hole No. [illegible]

1. Project: Cooper Dam, Borrow Area
3. Drilling Agency: USCE
5. Name of Driller: Brewer
6. Direction of Hole: Vertical
9. Total Depth of Hole: 30.0
12. Manufacturer's Designation of Drill: Acker
13. Total No. of Over-Burden Samples Taken — Disturbed: 12
14. Total Number Core Boxes: 0
15. Elevation Ground Water: ***
16. Date Hole — Started: 25 Jan 85 — Completed: 25 Jan 85
19. Signature of Inspector: Robert McVey

Classification of Materials	Box or Sample No.	Remarks
0.0 to 3.8 CLAY - high to medium plasticity, medium stiff, moist, dark brown, very silty.	A	* Drilling 0 to 12.2' - 3" shelby refusal at 12.2'. 12.2 to 30' - [illegible] auger.
3.8 to 8.8 SILT - low plasticity, medium [illegible], moist, brown, very clayey, sandy, slightly gravelly, concretions.		*** water level taken on 29 Jan. 85, and was at 2.1' and blocked off at [illegible]
8.8 to 23.0 CLAY 8.8 to 13.0 - high, some medium plastic seams, stiff, moist, yellow brown and gray, silty sandy, gravel concretions. 13.0 to 18.0 - high plast., stiff to very stiff, moist, yellow brown, slightly silty and sandy. 18.0 to 23.0 - high plast., stiff, moist, light gray and yellow brown, silty, slightly sandy, some remnant shale structure.	C	Note: All samples taken by drill crew. Jars A. 0.0 to 3.8 B. 3.8 to 8.8 C. 8.8 to 13.0 D. 13.0 to 18.0 E. 18.0 to 23.0 F. 23.0 to 30.0 Bags [illegible] [illegible] Shelby [illegible] [illegible] 8. [illegible] to 8.9 9. 8.9 to 9.4 10. 9.4 to 10.[illegible] 11. [illegible] 12. [illegible] to 12.2
23.0 to 30.0 SAND borderline CLAY - sand is fine grained and not cemented, clay is high plasticity and soft, both are moist, yellow brown and light gray.		

DRILLING LOG

Division: SWD — Installation: Ft. Worth — Hole No. [illegible]

1. Project: Cooper Dam
3. Drilling Agency: USCE
4. Hole No.: 8A-107
5. Name of Driller: Bettis
6. Direction of Hole: Vertical
7. Thickness of Overburden: [illegible]
8. Depth Drilled into Rock: 28.[illegible]
9. Total Depth of Hole: 31.0
10. Size and Type of Bit: [illegible] auger
12. Manufacturer's Designation of Drill: Failing 1500
13. Total No. of Over-Burden Samples Taken: 1
14. Total Number Core Boxes: 0
15. Elevation Ground Water: ***
16. Date Hole — Started: 18 Oct 84 — Completed: 18 Oct 84
19. Signature of Inspector: Robert McVey

Depth	Classification of Materials	Box or Sample No.	Remarks
	0.0 to 2.7 CLAY - high plasticity, soft, moist, black, silty, non calcareous.	A	*** Made water immediately to 19.3'.
	2.7 to 18.6 CLAY - primary 2.7 to 7.7 - high plasticity, hard (soil classification), moist, strong brown and gray, sandy/silty, non calc.	B, C	Jars A. 0.0 to 2.7 B. 2.7 to 7.7 C. 7.7 to 11.0 D. 11.0 to 16.0 E. 16.0 to 18.6 F. 18.6 to 23.6 G. 23.6 to 31.0
10'	7.7 to 11.0 - high plasticity, hard to very stiff, moist, yellow brown and gray, sandy/silty, non calc. 11.0 to 16.0 - high plast., medium stiff, moist, gray and yellow brown, sandy & silty, non calcareous. 16.0 to 18.6 - high plast., medium stiff, moist, gray, sand seams, non calcareous.	D, E	
20	18.6 to 31.0 SAND - fine grained, loose to very loose, very moist to wet, gray, silty and clayey, non calcareous.	F, G	
30			

DRILLING LOG

Installation: Ft. Worth

Project: [illegible] Borrow Area

Manufacturer's Designation of Drill: Failing 1500

Signature of Inspector: Robert McVey

* Drilling

CLAY - primary

SAND

NOTE 3S-103 NEVER DRILLED

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

COOPER LAKE
SULPHUR RIVER, TEXAS

EMBANKMENT

LOGS OF BORINGS
3S-100, 6A-101, 2S-102, 3S-104,
3S-105, 2S-106, 8A-107

DESIGNED BY — DRAWN BY — CHECKED BY — SUBMITTED BY — ENGINEER — DATED — CONTR NO. [illegible] — DRAWING NUMBER — SHEET NO. [illegible] — SEQUENCE NO. 27[illegible]

DESCRIPTION OF REVISION — SYMBOL — DATE — APPR.

TO ACCOMPANY FINAL FOUNDATION REPORT PLATE 58

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

DRILLING LOG — Hole No. 3S-110

Division	SWD
Installation	Ft Worth
Sheet	1 of 1 sheets
Project	Cooper Dam, Borrow Area
Drilling agency	USCE
Hole No.	3S-110
Name of driller	Nerva
Manufacturer's designation of drill	Acker
Total no. of overburden samples taken	Disturbed: 8
Total number core boxes	0
Elevation ground water	***
Date hole	Started: 16 Jan 85; Completed: 16 Jan 85
Thickness of overburden	2.2
Depth drilled into rock	27.8
Total depth of hole	30.0
Signature of inspector	Robert McVey

Classification of materials

0.0 to 2.2

SILT - low plasticity, loose, moist, dark brown, sandy, clayey, non calcareous.

2.2 to 19.7

CLAY - medium to low plasticity, hard to very stiff, slightly moist, yellow brown and light gray, very silty and sandy with seams of each, some local laminations, non calcareous.

19.7 to 30.0

SILT - low to me plasticity, dense, moist, light gray and yellow brown, sandy, very clayey, non calcareous, non cemented.

Remarks

* Drilling

0 to 2.7' - 3" shelby, no recovery from 0 to 2' re-push to 3' recovered some sample, but after first push to 2' an open hole to 1.8' existed(compressed).
2.7 to 21' - 5" auger,
21 to 22' - 3" shelby,
22 to 30' - 5" auger.

***

Dry hole - blocked off at 16.3'.

Note Hole offset 42' west to avoid wet conditions.

Shelby

1. 0.0 to 2.5
2. 22.0 to 23.0

Bags

1. 0.0 to 5.0
2. 5.0 to 10.0
3. 10.0 to 15.0
4. 15.0 to 20.0
5. 20.0 to 25.0
6. 25.0 to 30.0

DRILLING LOG — Hole No. 3S-112

Division	SWD
Installation	Ft Worth
Sheet	1 of 1 sheets
Project	Cooper Dam, Borrow Area
Drilling agency	USCE
Hole No.	3S-112
Name of driller	Nerva
Manufacturer's designation of drill	Acker
Total no. of overburden samples taken	Disturbed: 13
Total number core boxes	0
Elevation ground water	***
Date hole	Started: 18 Jan 85; Completed: 18 Jan 85
Total depth of hole	30'
Signature of inspector	Robert McVey

Classification of materials

0.0 to 30.0

CLAY

0.0 to 14.0 - high plasticity, stiff to hard, moist, dark brown to dark gray, non calcareous.

14.0 to 19.0 - as above except selenite crystals within veins.

19.0 to 30.0 - high plast, stiff to medium stiff, moist, yellow brown and light gray, silty, non calcareous.

Remarks

* Drilling

0 to 3.7' - 3" shelby, refusal @ 3.7',
3.7 to 23' - 5" auger,
23 to 29' - 3" shelby,
29 to 30' - 5" auger.

Note: Hole offset 9A' west to avoid wet conditions.

***

Water stabilized immediately at 15'(within one hour is my definition of immediately).

Shelby

1. 0.0 to 2.0
2. 2.0 to 3.7
3. 23.0 to 24.0
4. 24.0 to 25.0
5. 25.0 to 26.0
6. 26.0 to 27.0
7. 27.0 to 28.0
8. 28.0 to 29.0

Jars

A. 3.7 to 8.7
B. 8.7 to 14.0
C. 14.0 to 19.0
D. 19.0 to 23.0
E. 29.0 to 30.0

DRILLING LOG — Hole No. 3S-113

Division	SWD
Project	Cooper Dam, Borrow Area
Drilling agency	USCE
Hole No.	3S-113
Name of driller	Brewer
Thickness of overburden	0
Depth drilled into rock	X
Total depth of hole	30

Classification of materials

0.0 to 3.3

SAND - fine grained, medium dense to very loose, moist to saturated(2.0 to 2.5') dark brown to yellow br..., very silty, clayey non cemented & non clacareous

3.3 to 8.6

CLAY - high plasticity, stiff to very stiff, moist, light gray, silty, non calc.

8.6 to 17.2

SAND and CLAY interbedded - clay is high to low plasticity, very stiff, sand is fine grained, non cemented, both are thinly laminated to massive, slightly moist, yellow brown and some light gray, very silty, non calcareous, few scattered limonite sand sized grains.

17.2 to 22.0

CLAY - high to low plasticity, stiff, slightly moist, dark olive over a... with very thin dark gray and green gray sand seams very silty, non calcareous.

22.0 to 30.0

CLAY - high to medium plasticity, stiff to hard, slightly moist, dark gra... silty/sandy, calcareous, limey.

DRILLING LOG — Hole No. 6A-111

Division	SWD
Installation	Ft Worth
Sheet	1 of 1 sheets
Project	Cooper Dam, Borrow Area
Size and type of bit	5" auger
Drilling agency	USCE
Hole No.	6A-111
Name of driller	Nerva
Manufacturer's designation of drill	Acker
Total no. of overburden samples taken	Disturbed: 13
Total number core boxes	0
Elevation ground water	***
Date hole	Started: 21 Jan 85; Completed: 21 Jan 85
Total depth of hole	30
Signature of inspector	Robert McVey

Classification of materials

0.0 to 30.0

CLAY

0.0 to 10.0 - high plasticity, medium stiff to stiff, moist, black, non calcareous

10.0 to 21.5 - high plast, stiff to medium stiff, moist, dark yellow brown to yellow brown, non calc.

[illegible] to [illegible] - low plast, soft, very moist, blue gray and yellow brown, very silty and sandy with seams of each, non calc.

Remarks

***

24 hr. Dry hole, but hole blocked off at 21.5'. Water check 25 Jan. at 12.1'.

Bags

1. 0.0 to 5.0
2. 5.0 to 10.0
3. 10.0 to 15.0
4. 15.0 to 20.0
5. 20.0 to 25.0
6. 25.0 to 30.0

Jars

A. [illegible] to 5.[illegible]
B. 5.[illegible] to [illegible]
C. [illegible] to [illegible]
D. [illegible] to 2[illegible]
E. 2[illegible] to 2[illegible]
F. 2[illegible] to 2[illegible]
G. 2[illegible] to 3[illegible]

DRILLING LOG — Hole No. 3S-114

Division	SWD
Installation	Ft Worth
Sheet	1 of 1 sheets
Project	Cooper Dam, Borrow Area
Drilling agency	USCE
Hole No.	3S-114
Name of driller	Brewer
Manufacturer's designation of drill	Acker
Total no. of overburden samples taken	Disturbed: 13
Total number core boxes	0
Elevation ground water	***
Date hole	Started: 25 Jan 85; Completed: 25 Jan 85
Total depth of hole	30'
Signature of inspector	Robert McVey

Classification of materials

0.0 to 30.0

CLAY

0.0 to 16.5 - high plasticity, stiff to very stiff, moist, brown and yellow brown, silty, slightly sandy, non calcareous.

16.5 to 24.5 - high plast, medium stiff to soft, very moist, yellow brown, silty.

24.5 to 30.0 - high plast, stiff to very stiff, moist, dark gray and strong brown, carbonaceous.

Remarks

* Drilling

Shelby refusal at surface.
0 to 30' - 5" auger.

Note: All samples taken by drill crew members.

Jars

A. 0.0 to 5.0
B. 5.0 to 10.0
C. 10.0 to 15.0
D. 15.0 to 16.5
E. 16.5 to 24.5
F. 24.5 to 29.0
G. 29.0 to 30.0

Bags

1. 0.0 to 5.0
2. 5.0 to 10.0
3. 10.0 to 15.0
4. 15.0 to 20.0
5. 20.0 to 25.0
6. 25.0 to 30.0

DRILLING LOG — Hole No. 6A-116

Division	SWD
Project	Cooper Dam, Borrow Area
Drilling agency	USCE
Hole No.	6A-116
Name of driller	Nerva
Thickness of overburden	0
Depth drilled into rock	22.5
Total depth of hole	22.5

Classification of materials

0.0 to 8.2

CLAY

0.0 to 3.2 - high to ... plasticity, soft to ... stiff, moist, dark ... sandy/silty, non ca...

3.2 to 8.2 - high to ... plast, very stiff, ... moist, white, light ... and some brown, sandy ... silty, non calcareous ... some laminations.

8.2 to 22.5

SAND borderline SILT - is fine grained, dense ... moist, light gray and ... brown, clayey, non cal... eous, non cemented.

DRILLING LOG — Hole No. 3S-115

Division: SWD | Installation: Ft Worth | Sheet 1 of 1 sheets

Project: Cooper Dam, Borrow Area

Drilling agency: USCE | Hole No.: 3S-115 | Name of driller: Brewer

Direction of hole: Vertical

Manufacturer's designation of drill: Acker

Total no. of overburden samples taken: Disturbed 12

Total number core boxes: 0

Elevation ground water: ***

Date hole: Started 9 Jan 85 | Completed 9 Jan 85

Thickness of overburden: 0 | Depth drilled into rock: 30 | Total depth of hole: 30

Signature of inspector: Robert McVey

Elevation	Depth	Legend	Classification of materials (Description)	% Core recovery	Box or sample no.	Remarks
			0.0 to 3.3 SAND - fine grained, medium dense to very loose, moist to saturated (2.0 to 2.5'), dark brown to yellow brown, very silty, clayey, non cemented & non clacareous.		1, 2, 3, 4, 5, 6, 7	* Drilling 0 to 8' - 3" shelby, refusal @ 8', 8 to 30' - 5" auger. *** Hole observed making water at 2'. Hole squeezed shut at 2' after completion of drilling.
			3.3 to 8.6 CLAY - high plasticity, stiff to very stiff, moist, light gray, silty, non calc.		A	Shelby 1. 0.0 to 2.0 2. 2.0 to 3.0 3. 3.0 to 4.0 4. 4.0 to 5.0 5. 5.0 to 6.0 6. 6.0 to 7.0 7. 7.0 to 8.0 refusal @ 8'.
	10		8.6 to 17.2 SAND and CLAY interbedded - clay is high to low plasticity, very stiff, sand is fine grained, non cemented, both are thinly laminated to massive, slightly moist, yellow brown and some light gray, very silty, non calcareous, few scattered limonite sand sized grains.		B	Jars A. 8.6 to 13.6 B. 13.6 to 17.2 C. 17.2 to 22.0 D. 22.0 to 27.0 E. 27.0 to 30.0
	20		17.2 to 22.0 CLAY - high to low plasticity, stiff, slightly moist, dark olive over al., with very thin dark gray and green gray sand seams, very silty, non calcareous.		C, D	Note: Hole had to be offset 60' southwest toward hole 12w to avoid wet conditions.
	30		22.0 to 30.0 CLAY - high to medium plasticity, stiff to hard, slightly moist, dark gray, silty/sandy, calcareous, limey.		E	

DRILLING LOG — Hole No. 3S-117

Division: SWD | Installation: Ft Worth | Sheet 1 of 1 sheets

Project: Cooper Dam, Borrow Area

Drilling agency: USCE | Hole No.: 3S-117 | Name of driller: Marva

Direction of hole: Vertical

Manufacturer's designation of drill: Acker

Total no. of overburden samples taken: Disturbed 16

Total number core boxes: 0

Elevation ground water: ***

Date hole: Started 10 Jan 85 | Completed 10 Jan 85

Thickness of overburden: 0 | Depth drilled into rock: 25 | Total depth of hole: 25'

Signature of inspector: Robert McVey

Elevation	Depth	Legend	Classification of materials (Description)	% Core recovery	Box or sample no.	Remarks
			0.0 to 12.4 CLAY 0.0 to 7.0 - high plasticity, stiff to very stiff, moist, black, non calcareous. 7.0 to 12.4 - high to medium plasticity, hard, slightly moist, gray to light gray and yellow brown, silty to very silty, some laminations locally, carbon spheres, mostly non calcareous, but some lime.		1, 2, 3, 4, 5, 6, A	* Drilling 0 to 8.6' - 3" shelby, refusal, 8.6 to 16' - 5" auger, 16 to 23' - 3" shelby, 23 to 25' - 5" auger, auger refusal @ 25'. *** Dry hole 15 Jan 85.
	10		12.4 to 22.5 SAND borderline SILT - sand is fine grained, dense to loose, both are moist, light gray and yellow brown, some green and red minerals within (possibly glauconite and feldspar), very clayey but varies much, non calcareous, non cemented. @ 21.7' - thin gravel seam.		B, 7, 8, 9, 10, 11, 12	Shelby 1. 0.0 to 2.0 2. 2.0 to 4.0 3. 4.0 to 5.0 4. 5.0 to 6.0 5. 6.0 to 8.0 6. 8.0 to 8.6 7. 16.0 to 17.0 8. 17.0 to 18.0 9. 18.0 to 19.0 10. 19.0 to 20.0 11. 20.0 to 21.0 12. 21.0 to 22.0 13. 22.0 to 23.0
	20		22.5 to 25' - Sand and Clay clay is high plasticity & very stiff, sand is fine grained, both are moist, dark brown to dark gray, plant roots, medium laminated, non calcareous		13, C	Jars A. 8.6 to 12.4 B. 12.4 to 16.0 C. 23.0 to 25.0

DRILLING LOG — Hole No. 6A-119

Division: SWD | Installation: Ft Worth | Sheet 1 of 1 sheets

Project: Cooper Dam, Borrow Area

Size and type of bit: 8" Auger.

Drilling agency: USCE | Hole No.: 6A-119 | Name of driller: Brewer

Direction of hole: Vertical

Manufacturer's designation of drill: Failing 1500

Total number core boxes: 0

Date hole: Started 17 Dec 84 | Completed 17 Dec 84

Thickness of overburden: 0 | Depth drilled into rock: 20 | Total depth of hole: 20'

Signature of inspector: Robert McVey

Elevation	Depth	Legend	Classification of materials (Description)	% Core recovery	Box or sample no.	Remarks
			0.0 to 20.0 CLAY 0.0 to 6.8 - high plasticity, stiff to very stiff, moist, dark gray to gray, some selenite crystals within very thin veins, silty, non calcareous.		A, B	Jars A. 0.0 to 5.0 B. 5.0 to 6.8 C. 6.8 to 8.0 D. 8.0 to 12.5 E. 12.5 to 15.0 F. 15.0 to 20.0
			6.8 to 8.0 - high plast, stiff, moist, gray, silty, non calcareous.		C	
	10		8.0 to 15.0 - high plast, stiff, moist, light gray and strong brown (weathered limonite).		D, E	
	20		15.0 to 20.0 - high plasticity, medium stiff to soft, moist, light gray and strong brown (limonite concretions weathered to silt consistency).		F	

DRILLING LOG — Hole No. 6A-116

Division: SWD | Installation: Ft Worth | Sheet 1 of 1 sheets

Project: Cooper Dam, Borrow Area

Drilling agency: USCE | Hole No.: 6A-116 | Name of driller: Marva

Direction of hole: Vertical

Manufacturer's designation of drill: Acker

Total no. of overburden samples taken: Disturbed 10

Total number core boxes: 0

Elevation ground water: ***

Date hole: Started 10 Jan 85 | Completed 10 Jan 85

Depth drilled into rock: 22.5 | Total depth of hole: 22.5'

Signature of inspector: Robert McVey

Elevation	Depth	Legend	Classification of materials (Description)	% Core recovery	Box or sample no.	Remarks
			0.0 to 8.2 CLAY 0.0 to 3.2 - high to low plasticity, soft to medium stiff, moist, dark brown, sandy/silty, non calcareous. 3.2 to 8.2 - high to medium plast, very stiff, slightly moist, white, light gray and some brown, sandy and silty, non calcareous, some laminations.		A, B 2	* Drilling 0 to 22.5' - 5" auger. *** Water check taken 15 Jan 85 - dry hole.
	10		8.2 to 22.5 SAND borderline SILT - sand is fine grained, dense, moist, light gray and yellow brown, clayey, non calcareous, non cemented.		C 3, D 4	Jars A. 0.0 to 3.2 B. 3.2 to 8.2 C. 8.2 to 12.0 D. 12.0 to 17.0 E. 17.0 to 22.5 Bags 1. 0.0 to 3.2 2. 3.2 to 8.2 3. 8.2 to 12.0 4. 12.0 to 17.0 5. 17.0 to 22.5
	20				E 5	

NOTE 6A-113 & 6A-118 NEVER DRILLED

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

COOPER LAKE
SULPHUR RIVER, TEXAS

EMBANKMENT

LOGS OF BORINGS
3S-110, 6A-111, 3S-112, 3S-114, 3S-115, 6A-116, 3S-117, 6A-119

DESIGNED BY | DRAWN BY | REVIEWED BY | SUBMITTED BY | ENGINEER

DATED MAY 85 | CONTR NO | DRAWING NUMBER | SHEET NO | 278

TO ACCOMPANY FINAL FOUNDATION REPORT PLATE 34

2 3 4 5 6

DRILLING LOG

Division	SWD
Installation	Ft Worth
Hole No.	[illegible]
Sheet	1 of 1 sheets
1. Project	Cooper Dam, Borrow Area
3. Drilling Agency	USCE
4. Hole No.	5S-120
5. Name of Driller	Marva
6. Direction of Hole	Vertical
9. Total Depth of Hole	20'
12. Manufacturer's Designation of Drill	Acker
14. Total Number Core Boxes	0
15. Elevation Ground Water	***
16. Date Hole	Started 22 Jan 85 / Completed 22 Jan 85
19. Signature of Inspector	Robert McVay

Classification of materials:

0.0 to 20.0

CLAY

[illegible] to [illegible] - high plasticity, stiff to very stiff, pentrometer readings: @ [illegible] = 2.6, @ [illegible] = 2.6, @ 8 = 2.[illegible], moist, black, non calcareous.

8.4 to [illegible] - high plast, very stiff, moist, dark gray, some yellow brown, mottled appearance, non calcareous.

[illegible] to 20.0 - high plasticity, stiff, moist, yellow brown and light gray, very slightly limey.

Remarks:

* Drilling

0 to 8.4' - 3" shelby, refusal.
8.4 to 20' - 5" auger

***

Dry hole after completion of drilling. On 25 Jan, the water was at 10.5'.

Shelby

1. [illegible]0 to 2.0
2. 2.0 to 4.0
3. 4.0 to 6.0
4. 6.0 to 8.0

refusal at 8.4.

Jars

A. 8.4 to 11.4
B. 11.4 to [illegible]
C. [illegible] to 20.0

DRILLING LOG

Division	SWD
Installation	Ft Worth
Hole No.	5S-122
Sheet	1 of 1 sheets
1. Project	Cooper Dam, Borrow Area
3. Drilling Agency	USCE
4. Hole No.	5S-122
5. Name of Driller	Marva
6. Direction of Hole	Vertical
9. Total Depth of Hole	20'
12. Manufacturer's Designation of Drill	Acker
13. Total No. of Over-burden Samples Taken	15
14. Total Number Core Boxes	0
15. Elevation Ground Water	***
16. Date Hole	Started 18 Jan 85 / Completed 18 Jan 85
19. Signature of Inspector	Robert McVay

Classification of materials:

0.0 to 16.2

CLAY

0.0 to 14.7 - high plasticity, medium stiff to very stiff, pentrometer readings: @ 2'= .7, at 5' = 1.7, and at 14.5'= 3.2, moist, dark brown to gray, non calcareous.

14.7 to 16.2 - high plast, stiff, moist, yellow brown and light gray, some slickensides, lime nodules.

16.2 to 20.0

CLAY borderline SILT - low plasticity, soft, very moist, yellow brown and light gray, very sandy, non calcareous.

Remarks:

* Drilling

0 to 14.5' - 3" shelby, refusal @ 14.5'.
14.5 to 20' - 5" auger.

***

18 hour check at 9.2'.

Shelby

1. 0.0 to 2.0
2. 2.0 to 3.0
3. 3.0 to 4.0
4. 4.0 to 5.0
5. 5.0 to 6.0
6. 6.0 to 7.0
7. 7.0 to 8.0
8. 8.0 to 9.0
9. 9.0 to 10.0
10. 10.0 to 11.0
11. 11.0 to 12.0
12. 12.0 to 13.0
13. 13.0 to 14.0

refusal at 14.5

Jars

A. 14.7 to 16.2
B. 16.2 to 20.0

DRILLING LOG

Division	SWD
Hole No.	5A-[illegible]
1. Project	Cooper Dam, Borrow Area
3. Drilling Agency	USCE
5. Name of Driller	Brewer
6. Direction of Hole	Vertical

0.0 to 30.0

CLAY - [illegible]

[illegible]

DRILLING LOG

Division	SWD
Installation	Ft Worth
Hole No.	9A-[illegible]
Sheet	1 of 1 sheets
1. Project	Cooper Dam, Borrow Area
3. Drilling Agency	USCE
4. Hole No.	9A-121
5. Name of Driller	Marva
9. Total Depth of Hole	30'
10. Size and Type of Bit	5" auger
12. Manufacturer's Designation of Drill	Acker
13. Total No. of Over-burden Samples Taken	13
14. Total Number Core Boxes	0
15. Elevation Ground Water	***
16. Date Hole	Started 21 Jan 85 / Completed 21 Jan 85
19. Signature of Inspector	Robert McVay

Classification of materials:

0.0 to 30.0

CLAY

0.0 to 10.0 - high plasticity, medium stiff to stiff, moist, black to very dark gray, non calc.

10.0 to 15.5 - high plast, very stiff, dark yellow brown, very slightly limey, slightly carbonaceous.

15.5 to 17.5 - high plast, very stiff, moist, light gray and yellow brown sandy/silty carbonaceous.

17.5 to 30.0 - borderline SAND sand is fine grained and non cemented, clay is high to medium plasticity, medium stiff, very moist, yellow brown and light gray, very silty, this unit gets softer with depth.

Remarks:

***

Water stabilized at 12.6' within one hour. On 25 Jan, water at 10.8'.

Bags

1. 0.0 to 5.0
2. 5.0 to 10.0
3. 10.0 to 15.0
4. 15.0 to 20.0
5. 20.0 to 25.0
6. 25.0 to 30.0

Jars

A. 0.0 to 5.0
B. 5.0 to 10.0
C. 10.0 to 15.5
D. 15.5 to 17.5
E. 17.5 to 22.5
F. 22.5 to 27.5
G. 27.5 to 30.0

DRILLING LOG

Division	SWD
Installation	Ft Worth
Hole No.	6A-123
Sheet	1 of 1 sheets
1. Project	Cooper Dam, Borrow Area
3. Drilling Agency	USCE
4. Hole No.	6A-123
5. Name of Driller	Marva
6. Direction of Hole	Vertical
9. Total Depth of Hole	20'
10. Size and Type of Bit	6" auger
12. Manufacturer's Designation of Drill	Acker
13. Total No. of Over-burden Samples Taken	5
15. Elevation Ground Water	***
16. Date Hole	Started 18 Jan 85 / Completed 18 Jan 85
19. Signature of Inspector	Robert McVay

Classification of materials:

0.0 to 2.2

SILT - low plasticity, moist, brown, sandy, non calcareous.

2.2 to 20.0

CLAY

2.2 to 3.5 - high plasticity, medium stiff to stiff, moist, black, non calcareous.

3.5 to 5.0 - high plast, very stiff to hard, very slightly moist, black, some carbon spheres, lime nodules.

5.0 to 20.0 - high plast, hard to very stiff, slightly moist to moist, gray and yellow brown, slightly sandy/silty, essentially non calcareous, lime nodules scattered, some shale structure apparent, selenite crystals scattered.

Remarks:

Note: Hole offset 96' due east to avoid wet conditions.

***

Dry hole, but blocked off at 15.6'.

Jars

A. 0.0 to 2.2
B. 2.2 to 3.5
C. 3.5 to 5.0
D. 5.0 to 10.0
E. 10.0 to 15.0
F. 15.0 to 20.0

DRILLING LOG

Division	SWD
1. Project	Cooper Dam, Borrow Area
5. Name of Driller	Brewer
6. Direction of Hole	Vertical
9. Total Depth of Hole	30'

0.0 to 30.0

CLAY

[illegible]

2 3 4 5 6

DRILLING LOG — Division: SWD — Installation: Ft Worth — Hole No. 6A-124

1. Project: Cooper Dam, Borrow area
2. Drilling agency: USCE
3. Hole No.: 6A-124
4. Name of driller: Brewer
5. Size and type of bit: 5" auger
6. Manufacturer's designation of drill: Acker
7. Total no. of overburden samples taken: 6
8. Total number core boxes: 0
9. Date hole: Started 17 Dec 84; Completed 7 Jan 85
10. Depth drilled into rock: 30'
11. Total depth of hole: 30'
12. Signature of inspector: Robert [illegible]

Classification of materials	Box or sample no.	Remarks
0.0 to 30.0 CLAY - Midway 0.0 to 9.0 - high plasticity, stiff to very stiff by 6', moist, light gray to light olive, silty, non calcareous. 9.0 to 13.0 - as above except gray and some blocky structure. 13.0 to 18.0 - high plasticity, stiff to medium stiff, moist, yellowish brown and light gray, non calcareous. 18.0 to 30.0 - high plast, medium stiff, moist, yellow brown and light gray, sandy and silty, non calcareous.	A B C D E F	Jars A. 0.0 to 5.0 B. 5.0 to 9.0 C. 9.0 to 13.0 D. 13.0 to 18.0 E. 18.0 to 24.0 F. 24.0 to 30.0 Bags 1. 0.0 to 5.0 2. 5.0 to 9.0 3. 9.0 to 13.0 4. 13.0 to 19.0 5. 19.0 to 25.0 6. 25.0 to 30.0 Note: All samples collected by drill crew from 13.0 to 30. Note: Hole had to be offset 130' south to avoid wet conditions. Also a duplication of numbers on the layout caused me to redesignate the hole north of the Sulphur River as 6A-124. The hole south of the river is now 6A-124a.

DRILLING LOG — Division: SWD — Installation: Ft Worth — Hole No. 6A-124a

1. Project: Cooper Dam, Borrow Area
2. Drilling agency: USCE
3. Hole No.: 6A-124a
4. Name of driller: Brewer
5. Size and type of bit: 5" auger
6. Manufacturer's designation of drill: Acker
7. Date hole: Started 17 Jan 85; Completed 17 Jan 85
8. Total depth of hole: 30'
9. Signature of inspector: Robert [illegible]

Classification of materials	Box or sample no.	Remarks
0.0 to 30.0 CLAY 0.0 to 2.0 - high plasticity, soft, moist, dark brown, non calcareous. 2.0 to 7.0 - high plasticity, very stiff to hard, moist, black, non calc. 7.0 to 12.0 - high plast, very stiff/hard, slightly moist, dark gray, some white lime. 12.0 to 17.0 - high plast, very stiff, moist, dark brown, mostly non calcareous, but some lime nodules. 17.0 to 22.0 - high plast, stiff, moist, gray, lime nodules scattered. 22.0 to 27.0 - high plast, medium stiff, moist, yellow brown and light gray, sandy/silty, non calcareous. 27.0 to 30.0 - high plast, stiff to very stiff, moist, yellow brown, gray, and some black, lime nodules.	A B C D E F G	Note: Hole offset 226' east to avoid wet conditions. *** 24 hour check at 11.2' Jars A. 0.0 to 2.0 B. 2.0 to 7.0 C. 7.0 to 12.0 D. 12.0 to 17.0 E. 17.0 to 22.0 F. 22.0 to 27.0 G. 27.0 to 30.0

DRILLING LOG — Division: SWD — Installation: Ft Worth — Sheet 1 of 1

1. Project: Cooper Dam, Borrow Area
2. Drilling agency: USCE
3. Hole No.: 3S-125
4. Name of driller: Berva
5. Manufacturer's designation of drill: Acker
6. Date hole: Started 9 Jan 85; Completed 10 Jan 85
7. Depth drilled into rock: 20
8. Total depth of hole: 20'
9. Signature of inspector: Robert [illegible]

Classification of materials	Box or sample no.	Remarks
0.0 to 4.7 SILT 0.0 to 3.5 - low plasticity, loose, moist, dark brown, sandy, clayey, non calcareous, non cemented. 3.5 to 4.7 - low plast, dense, dry, brown to light gray, clayey and sandy. 4.7 to 6.8 SAND and CLAY interbedded, sand is fine grained and non cemented, clay is high to low plasticity, hard, both are thinly bedded to massive, dry, reddish brown, very silty, non calcareous. 6.8 to 16.8 SAND borderline SILT - fine grained and down, low plasticity, dense, very slightly moist to dry, yellow and light gray to yellow brown, very clayey, non calcareous, non cemented, clay seams. 16.8 to 20.0 SAND - fine grained, dense, slightly moist, yellow brown and light gray, very silty, non calcareous.	1 2 3 A B C D	* Drilling 0 to 4.2 - 3" shelby, refusal. 4.2 to 20' - 5" auger. *** Hole inadvertently backfilled before water check. Shelby 1. 0.0 to 2.0 2. 2.0 to 3.0 3. 3.0 to 4.0 Jars A. 4.7 to 6.8 B. 6.8 to 11.8 C. 11.8 to 16.8 D. 16.8 to 20.0

DRILLING LOG — Division: SWD — Installation: Ft Worth — Sheet 1 of 1

1. Project: Cooper Dam, Borrow Area
2. Drilling agency: USCE
3. Hole No.: 3S-126
4. Name of driller: Brewer
5. Manufacturer's designation of drill: Failing 1500
6. Total number core boxes: 0
7. Date hole: Started 12 Dec 84; Completed 17 Dec 84
8. Thickness of overburden: 0
9. Depth drilled into rock: 20
10. Total depth of hole: 20'
11. Signature of inspector: Robert [illegible]

Classification of materials	Box or sample no.	Remarks
0.0 to 1.0 SAND - fine grained, loose, moist, dark brown, very silty, non calcareous, non cemented, Midway Group. 1.0 to 8.0 SILT - low plasticity, hard, very slightly moist, white, some yellow brown, very sandy and clayey, non cemented, non calcareous. 8.0 to 18.0 SAND - fine, dense, non cemented, slightly moist, pale brown, white, and some brownish yellow, very silty, clayey, non calcareous. 18.0 to 20.0 SILT borderline SAND - sand is fine grained, well graded to silt, non cemented, dense, slightly moist, pale brown/white, non calc.	A B C D E	* Drilling 0 to 3' - 2" shelby push refusal @ 3'. 3 to 20' - 8" auger. Note: This hole offset 250' east to avoid wet conditions and trees. Jars A. 0.0 to 1.0 B. 1.0 to 8.0 C. 8.0 to 13.0 D. 13.0 to 18.0 E. 18.0 to 20.0 Shelby 1. 1.0 to 2.0 2. 2.0 to 3.0 - refusal - Note: Samples taken by drill crew member Steve Berva.

SYMBOL	DESCRIPTION	DATE	APPROVAL

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

COOPER LAKE
SULPHUR RIVER, TEXAS

EMBANKMENT

LOGS OF BORINGS
3S-120 THROUGH 3S-126

DESIGNED BY — DRAWN BY — REVIEWED BY — SUBMITTED BY — ENGINEER

CON'T NO. — DRAWING NUMBER — SHEET NO. — SEQUENCE NO. 279

TO ACCOMPANY FINAL FOUNDATION REPORT — PLATE 40

Hole No. 6A-127

DRILLING LOG	DIVISION SWD	INSTALLATION Ft Worth	SHEET 1 OF 1 SHEETS

PROJECT: Cooper Dam, Borrow Area
DRILLING AGENCY: USCE
HOLE NO.: 6A-127
NAME OF DRILLER: Brewer
DIRECTION OF HOLE: Vertical
THICKNESS OF OVERBURDEN: 5.8
DEPTH DRILLED INTO ROCK: 25.0
TOTAL DEPTH OF HOLE: 25.0
SIZE AND TYPE OF BIT: 5" auger.
MANUFACTURER'S DESIGNATION OF DRILL: Acker
TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: 16
TOTAL NUMBER CORE BOXES: 0
ELEVATION GROUND WATER: ***
DATE HOLE: STARTED 11 Jan 85 COMPLETED 11 Jan 85
SIGNATURE OF INSPECTOR: Robert McVay

0.0 to 15.0

CLAY

0.0 to 3.0 - high to medium plasticity, very soft, very moist, black, very silty, non calcareous.

3.0 to 5.0 - high/medium plasticity, very stiff to hard, dry, very dark gray, silty, slightly limey.

5.0 to 15.0 - high plasticity, stiff to very stiff, slightly moist, yellow brown and light gray, silty and sandy, non calc.

15.0 to 20.0

SILT - low plasticity moist, yellow brown and light gray, very sandy, non calcareous.

20.0 to 22.3

SAND - fine grained, moist, dark yellow brown and some light gray, very silty, clayey, non calcareous, non cemented.

22.3 to 24.0

CLAY - high to low plasticity, stiff, moist, dark yellow brown, very sandy, gravelly, limey.

24.0 to 25.7

SAND - fine to medium, moist, yellow brown and light gray, very silty, clayey, non calc.

25.7 to 30.0

SILT - low plasticity, moist, black, sandy/clayey, micaceous, sl. calc.

Note: All samples were collected by drill crew members.

***

Dry hole recorded 15 Jan 85.

Jars

A. 0.0 to 3.0
B. 3.0 to 5.0
C. 5.0 to 10.0
D. 10.0 to 15.0
E. 15.0 to 20.0
F. 20.0 to 22.3
G. 22.3 to 24.0
H. 24.0 to 25.7
I. 25.7 to 30.0

Bags

1. 0.0 to 5.0
2. 5.0 to 10.0
3. 10.0 to 15.0
4. 15.0 to 20.0
5. 20.0 to 25.0

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT HOLE NO.

Hole No. 6A-129

DRILLING LOG	DIVISION SWD	INSTALLATION Ft Worth	SHEET 1 OF 1 SHEETS

PROJECT: Cooper Dam, Borrow Area
DRILLING AGENCY: USCE
HOLE NO.: 6A-129
NAME OF DRILLER: Brewer
DIRECTION OF HOLE: Vertical
THICKNESS OF OVERBURDEN: 0
DEPTH DRILLED INTO ROCK: 30
TOTAL DEPTH OF HOLE: 30
SIZE AND TYPE OF BIT: 8" auger
MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
TOTAL NUMBER CORE BOXES: 0
ELEVATION GROUND WATER: ***
DATE HOLE: STARTED 17 Dec 84 COMPLETED 17 Dec 84
SIGNATURE OF INSPECTOR: Robert McVay

0.0 to 9.2

CLAY

0.0 to 2.2 - high plasticity, very soft, very moist, gray, silty.

2.2 to 7.0 - high plasticity, very stiff/hard, slightly moist, light gray to pale brown with some yellow brown, silty, sandy, non calcareous.

7.0 to 9.2 - high to medium plasticity, stiff to medium stiff, moist, lt. gray and yellow brn, non calcareous, sandy & silty.

9.2 to 19.1

SILT

9.2 to 14.1 - low plasticity, moist, pale brown and yellow brown, sandy, very clayey.

14.1 to 19.1 - no plast, wet, yellow brown and light gray, very sandy with sand seams, clayey, non calcareous, non cemented.

19.1 to 30.0

SAND

19.1 to 26.0 - fine grained, very moist, light gray & yellow brown, very silty, non cemented.

26.0 to 30.0 - fine, wet, olive, very silty/clayey.

***

Observed making at and after 14'. Water movement stabilized at 13.2' within .5 hour.

Jars

A. 0.0 to 2.2
B. 2.2 to 7.0
C. 7.0 to 9.2
D. 9.2 to 14.1
E. 14.1 to 19.1
F. 19.1 to 26.0
G. 26.0 to 30.0

Note: Hole offset 122' east to avoid wet conditions.

DRILLING LOG	DIVISION SWD

PROJECT: Cooper Dam, Borrow Area
DRILLING AGENCY: USCE
NAME OF DRILLER: Reeve
TOTAL DEPTH OF HOLE: 20

0.0 to 20.0

CLAY

0.0 to 3.0 - [illegible] city, mediu[illegible] yellow brow[illegible] brown, no[illegible]

3.0 to 10.7 [illegible] stiff to ha[illegible] dark brown [illegible] gray, some [illegible] nodules.

10.7 to 16.4 [illegible] stiff, moi[illegible] brown.

16.4 to 20.0 [illegible] lum plast, [illegible] yellow brow[illegible] gray, very [illegible] calcareous

DRILLING LOG	DIVISION SWD	INSTALLATION Ft Worth	SHEET OF SHEETS

PROJECT: Cooper Dam, Borrow Area
DRILLING AGENCY: USCE
HOLE NO.: 6A-128
NAME OF DRILLER: Brewer
DIRECTION OF HOLE: Vertical
THICKNESS OF OVERBURDEN: 0
DEPTH DRILLED INTO ROCK: 20
TOTAL DEPTH OF HOLE: 20
MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
TOTAL NUMBER CORE BOXES: 2
ELEVATION GROUND WATER: ***
DATE HOLE: STARTED 18 Dec 84 COMPLETED 18 Dec 84
SIGNATURE OF INSPECTOR: Robert McVay

0.0 to 9.0

CLAY

0.0 to 1.8 - high to medium plasticity, soft to medium stiff, moist, silty, dark brown.

1.8 to 5.8 - high to medium plasticity, hard, dry, pale brown, some white, very silty/sandy with sand seams, selenite crystals.

5.8 to 9.0 - medium to low plast, stiff, very slightly moist, pale brn, very sandy and silty.

9.0 to 11.2

SILT - low plasticity, dense, non cemented, slightly moist, light gray and strong brown, very sandy and clayey.

11.2 to 16.0

SAND - fine grained, dense, slightly moist, pale brown, some yellow brown, non cemented, very silty with silt seams.

16.0 to 20.0

SILT - low plast, medium dense to loose, moist, light gray and some yellow brown, very sandy, non calcareous.

* Drilling

0 to 4.8' - 3" shelby, would not extrude the 1.9 to 4.8' push.
4.8 to 20' - 8" auger.

Jars

A. 4.8 to 9.0
B. 9.0 to 11.2
C. 11.2 to 16.0
D. 16.0 to 20.0

Shelby

1. 0.0 to 0.9
2. 0.9 to 1.9
3. 1.9 to 2.9
4. 2.9 to 3.9
3.9 to 4.8 - would not push.

***

Hole No. 6A-130

DRILLING LOG	DIVISION SWD	INSTALLATION Ft Worth	SHEET 1 OF 1 SHEETS

PROJECT: Cooper Dam, Borrow Area
DRILLING AGENCY: USCE
HOLE NO.: 6A-130
NAME OF DRILLER: Reeve
DIRECTION OF HOLE: Vertical
TOTAL DEPTH OF HOLE: 20'
SIZE AND TYPE OF BIT: 5" auger
MANUFACTURER'S DESIGNATION OF DRILL: Acker
TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: 8
TOTAL NUMBER CORE BOXES: 0
ELEVATION GROUND WATER: Dry hole, ***
DATE HOLE: STARTED 22 Jan 85 COMPLETED 22 Jan 85
SIGNATURE OF INSPECTOR: Robert McVay

0.0 to 20.0

CLAY

0.0 to 10.0 - high plasticity, medium stiff to stiff, moist, black, non calcareous.

10.0 to 20.0 - high plast, very stiff until 15', then stiff to medium stiff, moist, yellowish brown and light gray, non calcareous.

Bags

1. 0.0 to 5.0
2. 5.0 to 10.0
3. 10.0 to 15.0
4. 15.0 to 20.0

Jars

A. 0.0 to 5.0
B. 5.0 to 10.0
C. 10.0 to 15.0
D. 15.0 to 20.0

***

Dry hole after completion of drilling. On 25 Jan. the water recorded on my Lufkin nylon tape measure was read to be 13.2'.

DRILLING LOG	DIVISION SWD

PROJECT: Cooper Dam, Borrow Area.
DRILLING AGENCY: USCE
HOLE NO.: 6A-132
NAME OF DRILLER: Brewer
DIRECTION OF HOLE: Vertical
THICKNESS OF OVERBURDEN: 7
DEPTH DRILLED INTO ROCK: 20
TOTAL DEPTH OF HOLE: 20'

0.0 to 20.0

CLAY

0.0 to 5.0 - high [illegible] city, stiff to ve[illegible] moist, dark brown[illegible]

5.0 to 6.7 - high [illegible] hard, very slight[illegible] very dark brown, [illegible]

6.7 to 11.0 - high [illegible] hard to very stiff [illegible] ghtly moist, yello[illegible] some white lime an[illegible] carbon, sandy/silt[illegible] scattered concreti[illegible] mottled appearance[illegible] blocky structure'

11.0 to 17.0 - high [illegible] very stiff to stif[illegible] moist, yellow brown [illegible] light gray, sandy [illegible] concretions, scatt[illegible] non calcareous.

17.0 to 18.5 - high [illegible] medium stiff, mois[illegible] low brown and light [illegible] silty.

18.5 to 20.0 - high [illegible] soft, moist, yellow [illegible] and light gray, ver[illegible] and sandy.

Hole No. 6A-131

DRILLING LOG	Division SWD	Installation Ft Worth	Sheet 1 of 1 sheets

1. Project	Cooper Dam, Borrow Area
3. Drilling agency	USCE
4. Hole No.	6A-131
5. Name of driller	Reeve
6. Direction of hole	Vertical
9. Total depth of hole	20'
12. Manufacturer's designation of drill	Acker
13. Total no. of over-burden samples taken	Disturbed 9
14. Total number core boxes	0
15. Elevation ground water	***
16. Date hole	Started 23 Jan 85 / Completed 23 Jan 85
19. Signature of inspector	[signature]

0.0 to 20.0

CLAY

0.0 to 3.0 - high plasticity, medium stiff, moist, yellow brown and dark brown, non calcareous.

3.0 to 10.7 - high plast, stiff to hard, moist, dark brown and very dark gray, scattered lime nodules.

10.7 to 16.4 - high plast, stiff, moist, yellow brown.

16.4 to 20.0 - high to medium plast, stiff, moist, yellow brown and light gray, very silty, non calcareous.

Remarks:

* Drilling

0 to 7' - 3" shelby, refusal @ 7'.
7 to 20' - 5" auger.

Jars

A. 7.0 to 11.7
B. 11.7 to 16.4
C. 16.4 to 20.0

Shelby

1. 0.0 to 2.0
2. 2.0 to 3.0
3. 3.0 to 4.0
4. 4.0 to 5.0
5. 5.0 to 6.0
6. 6.0 to 7.0

refusal -

***

Dry hole, but caved to 15.2', immediately after completion of drilling. On 25 Jan. the water level was non existent, but the hole was blocked off at 11.2'.

Hole No. 6A-133

DRILLING LOG	Division SWD	Installation Ft Worth	Sheet 1 of 1 sheets

1. Project	Cooper Dam, Borrow Area
3. Drilling agency	USCE
4. Hole No.	6A-133
5. Name of driller	Reeve
6. Direction of hole	Vertical
9. Total depth of hole	20'
10. Size and type of bit	5" auger.
12. Manufacturer's designation of drill	Acker
13. Total no. of over-burden samples taken	Disturbed 5
14. Total number core boxes	0
15. Elevation ground water	***
16. Date hole	Started 24 Jan 85 / Completed 24 Jan 85
19. Signature of inspector	[signature]

0.0 to 3.6

SILT - low plasticity, loose to medium dense, moist, brown, clayey.

3.6 to 20.0

CLAY

3.6 to 11.8 - high to medium plasticity, very stiff to hard, very slightly moist, yellow brown, gray, and strong brown, very silty and sandy, thin sand/silt seams, non calcareous, carbonaceous

11.8 to 16.0 - high plast, hard to very stiff, slightly moist, yellow brown and light gray, sandy/silty.

16.0 to 20.0 - high plast, very stiff to stiff, moist, yellow brown, carbonaceous, sandy/silty, slightly gravelly.

Jars

A. 0.0 to 3.6
B. 3.6 to 8.6
C. 8.6 to 11.8
D. 11.8 to 16.0
E. 16.0 to 20.0

Hole No. 6A-134

DRILLING LOG	Division SWD	Installation Ft Worth	Sheet 1 of 1 sheets

1. Project	Cooper Dam, Borrow Area
3. Drilling agency	USCE
4. Hole No.	6A-134
5. Name of driller	Brewer
6. Direction of hole	Vertical
8. Depth drilled into rock	20
9. Total depth of hole	20
10. Size and type of bit	5" auger.
12. Manufacturer's designation of drill	Acker
13. Total no. of over-burden samples taken	Disturbed 6
14. Total number core boxes	0
15. Elevation ground water	***
16. Date hole	Started 11 Jan 85 / Completed 11 Jan 85
19. Signature of inspector	[signature]

0.0 to 2.8

SILT - low plasticity, very moist, dark brown, very clayey and sandy, non calcareous.

2.8 to 20.0

CLAY

2.8 to 4.0 - low plasticity, moist, medium stiff, yellow brown, silty/sandy, mostly non calcareous, but some lime.

4.0 to 9.0 - medium plasticity, stiff to very stiff, very slightly moist, yellow brown, silty, sandy, non calcareous.

9.0 to 20.0 - low plasticity, medium stiff, moist, light gray and yellow brown, sandy and silty, sand/silt seams scattered, non calcareous.

***

Dry hole when checked 15 Jan. 85.

Note: All samples taken by crew members.

Jars

A. 0.0 to 2.8
B. 2.8 to 4.0
C. 4.0 to 9.0
D. 9.0 to 14.0
E. 14.0 to 19.0
F. 19.0 to 20.0

Hole No. 6A-132

DRILLING LOG	Division SWD	Installation Ft Worth	Sheet 1 of 1 sheets

1. Project	Cooper Dam, Borrow Area
3. Drilling agency	USCE
4. Hole No.	6A-132
5. Name of driller	Brewer
6. Direction of hole	Vertical
8. Depth drilled into rock	20
9. Total depth of hole	20'
10. Size and type of bit	auger
12. Manufacturer's designation of drill	Acker
13. Total no. of over-burden samples taken	Disturbed 6
14. Total number core boxes	0
15. Elevation ground water	***
16. Date hole	Started 25 Jan 85 / Completed 25 Jan 85
19. Signature of inspector	[signature]

0.0 to 20.0

CLAY

0.0 to 3.0 - high plasticity, stiff to very stiff, moist, dark brown, silty.

3.0 to 6.0 - high plast, hard, very slightly moist, very dark brown, silty

6.0 to 11.3 - high plast, hard to very stiff, slightly moist, yellow brown, some white lime and black carbon, sandy/silty, few scattered concretions, mottled appearance, some blocky structure

11.3 to 13.0 - high plast, very stiff to stiff, moist, yellow brown, some light gray, sandy/silty, concretions, essentially non calcareous.

13.0 to 18.5 - high plast, medium stiff, moist, yellow brown and light gray, silty.

18.5 to 20.0 - high plast, soft, moist, yellow brown and light gray, very silty and sandy.

***

Jars

A. 0.0 to 3.0
B. 3.0 to 6.0
C. 6.0 to 11.0
D. 11.0 to 13.0
E. 13.0 to 18.5
F. 18.5 to 20.0

	U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS
DESIGNED BY	COOPER LAKE SULPHUR RIVER, TEXAS
DRAWN BY	EMBANKMENT
REVIEWED BY	LOGS OF BORINGS 6A-127 THROUGH 6A-134
SUBMITTED BY	DATED
ENGINEER	CONT'R NO. / DRAWING NUMBER / SHEET NO. 280

TO ACCOMPANY FINAL FOUNDATION REPORT PLATE 41

Hole No. 6A-135

DRILLING LOG — Division: SWD — Installation: Ft Worth — Sheet 1 of 1 sheets

1. Project	Cooper Dam, Borrow Area
2. Location	
3. Drilling agency	USCE
4. Hole no.	6A-135
5. Name of driller	Brewer
6. Direction of hole	Vertical
7. Thickness of overburden	0
8. Depth drilled into rock	20
9. Total depth of hole	20'
10. Size and type of bit	*
12. Manufacturer's designation of drill	Failing 1500
14. Total number core boxes	0
15. Elevation ground water	Dry hole.
16. Date hole	Started 12 Dec 84 — Completed 12 Dec 84
19. Signature of inspector	Robert McVey

Classification of materials

0.0 to 12.1

CLAY - Kidney

0.0 to 2.8 - high plasticity, soft, moist, dark brown, silty, non calcareous.

2.8 to 7.1 - high plasticity, hard (soils classification), dry, dark brown, slightly sandy, carbon spheres, non calcareous.

7.1 to 12.1 - high plast., very stiff, slightly moist, light gray, some yellow brown, non calc., carbon spheres, very sandy/silty, remnant blocky structure.

12.1 to 20.0

SILT borderline SAND - fine sand, low to no plasticity, dense, non cemented, non calcareous, slightly moist, light gray with some strong brown, clayey.

Box or sample no.: A, B, C, D, E

Remarks

* Drilling

0 to 2' - 2" shelby, would not extrude.
2 to 20' - 8" auger.

Jars

A. 0.0 to 2.8
B. 2.8 to 7.1
C. 7.1 to 12.1
D. 12.1 to 16.9
E. 16.9 to 20.0

Hole No. 6A-137

DRILLING LOG — Division: SWD — Installation: Ft Worth — Sheet 1 of 1 sheets

1. Project	Cooper Dam, Borrow Area
2. Location	
3. Drilling agency	USCE
4. Hole no.	6A-137
5. Name of driller	Brewer
6. Direction of hole	Vertical
7. Thickness of overburden	0
8. Depth drilled into rock	20'
9. Total depth of hole	20'
10. Size and type of bit	8" auger
12. Manufacturer's designation of drill	Failing 1500
14. Total number core boxes	0
15. Elevation ground water	***
16. Date hole	Started 14 Dec 84 — Completed 14 Dec 84
19. Signature of inspector	Robert McVey

Classification of materials

0.0 to 3.1

CLAY

0.0 to 2.6 - high plasticity, soft, moist, dark brown, slightly silty, non calcareous.

2.6 to 3.1 - high to low plasticity, hard, dry, dark brown, very silty, sandy, non calcareous. Kidney Group.

3.1 to 16.8

SILT

3.1 to 8.1 - low plasticity, hard/very dense, dry, light gray, very sandy, clayey, non calc., non cemented, massive.

8.1 to 12.3 - low plast, very dense to dense, very slightly moist, light gray with some yellowish brown, very sandy/clayey, non cemented & non calc.

12.3 to 16.8 - low plast, dense to medium dense, slightly moist, yellowish brown and light gray, non cemented, very sandy, clayey, non calc.

16.8 to 20.0

CLAY - high plasticity, soft, moist, light gray, very silty, non calcareous.

Box or sample no.: A, B, C, D, E, F

Remarks

Jars

A. 0.0 to 2.6
B. 2.6 to 3.1
C. 3.1 to 8.1
D. 8.1 to 12.3
E. 12.3 to 16.8
F. 16.8 to 20.0

***
72 hour water check at 17.2'.

Hole No. 6A-136

DRILLING LOG — Division: SWD — Installation: Ft Worth — Sheet 1 of 1 sheets

1. Project	Cooper Dam, Borrow Area
2. Location	
3. Drilling agency	USCE
4. Hole no.	6A-136
5. Name of driller	Brewer
6. Direction of hole	Vertical
7. Thickness of overburden	0
8. Depth drilled into rock	20
9. Total depth of hole	20'
10. Size and type of bit	8" auger
12. Manufacturer's designation of drill	Failing 1500
14. Total number core boxes	0
15. Elevation ground water	Dry hole.
16. Date hole	Started 12 Dec 84 — Completed 12 Dec 84
19. Signature of inspector	Robert McVey

Classification of materials

0.0 to 2.2

CLAY - high plasticity, medium stiff, moist, dark brown to red, silty, non calcareous.

2.2 to 7.1

SILT - low plasticity, hard, very slightly moist, white to light gray, very sandy and clayey, non calcareous, non cemented.

7.1 to 20.0

CLAY

7.1 to 9.3 - high to medium plasticity, very stiff, slightly moist, white, very silty/sandy, non calc.

9.3 to 17.8 - high plast, very stiff, slightly moist, light gray, non calc.

17.8 to 20.0 - high/medium plasticity, stiff, very slightly moist, yellow brown and light gray, very silty, sandy, non calcareous.

Box or sample no.: A, B, C, D, E, F

Remarks

Jars

A. 0.0 to 2.2
B. 2.2 to 7.1
C. 7.1 to 9.3
D. 9.3 to 14.3
E. 14.3 to 17.8
F. 17.8 to 20.0

Samples collected by crew member Steve Norma.

Hole No. 35-1-8

DRILLING LOG — Division: SWD — Installation: Ft Worth — Sheet of sheets

1. Project	Cooper Dam, Borrow Area
2. Location	
3. Drilling agency	USCE
4. Hole no.	35-1-8
5. Name of driller	Norma
6. Direction of hole	Vertical
7. Thickness of overburden	
8. Depth drilled into rock	
9. Total depth of hole	30'
10. Size and type of bit	*
12. Manufacturer's designation of drill	Acker
13. Total no. of overburden samples taken	Disturbed 10
14. Total number core boxes	0
15. Elevation ground water	***
16. Date hole	Started 22 Jan 85 — Completed 22 Jan 85
19. Signature of inspector	Robert McVey

Classification of materials

0.0 to 30.0

CLAY

0.0 to 11.2 - high plasticity, stiff to hard, moist, dark brown, limey after 10'.

11.2 to 18.0 - high plast, very stiff (pentrometer reading = 3.3), moist, yellow brown, silty, very slightly limey, carbonaceous.

18.0 to 23.0 - high plast, hard, slightly moist, yellow brown and light gray, silty.

23.0 to 30.0 - high plast, hard, slightly moist, dark gray, some black and yellow brown, carbon spheres.

Box or sample no.: 1, 2, 3, 4, A, B, C, D, E, F

Remarks

* Drilling

0 to 5' - 3" shelby, refusal @ 5'.
5 to 30' - 5" auger.

Note: All samples taken by drill crew members

Shelby

1. 0.0 to 2.0
2. 2.0 to 3.0
3. 3.0 to 4.0
4. 4.0 to 5.0

Jars

A. 5.0 to 9.7
B. 9.7 to 11.2
C. 11.2 to 18.0
D. 18.0 to 23.0
E. 23.0 to 28.0
F. 28.0 to 30.0

***
Water check on 25 Jan, was read as 17.3'.

Hole No. 6A-137

DRILLING LOG	DIVISION: SWD	INSTALLATION: Ft Worth
PROJECT: Lower Dam, Borrow Area	MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500	HOLE NO.: 6A-137
DATE HOLE: STARTED 14 Dec 84	COMPLETED 14 Dec 84	TOTAL DEPTH OF HOLE: 20

Hole No. 6A-139

DRILLING LOG	DIVISION: SWD	INSTALLATION: Ft Worth	SHEET 1 OF 1 SHEETS
1. PROJECT: Lower Dam, Borrow Area		10. SIZE AND TYPE OF BIT: 5" auger.	
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY: USCE		12. MANUFACTURER'S DESIGNATION OF DRILL: Acker	
4. HOLE NO. (As shown on drawing title and file number): 6A-139		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 5	UNDISTURBED
5. NAME OF DRILLER: Moran		14. TOTAL NUMBER CORE BOXES: 0	
6. DIRECTION OF HOLE: (X) VERTICAL ( ) INCLINED ___ DEG. FROM VERT.		15. ELEVATION GROUND WATER: ***	
7. THICKNESS OF OVERBURDEN		16. DATE HOLE: STARTED 22 Jan 85	COMPLETED 22 Jan 85
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE	
9. TOTAL DEPTH OF HOLE: 20'		18. TOTAL CORE RECOVERY FOR BORING %	
		19. SIGNATURE OF INSPECTOR: Robert McVey	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
			0.0 to 20.0 CLAY 0.0 to 4.5 - high plasticity, stiff to very stiff, moist, black, non calcareous. 4.5 to 20.0 - high plast. very stiff to hard, moist, dark brown to gray, non calcareous.		A B C D E	Note: All samples taken by drill crew members. Jars A. 0.0 to 4.5 B. 4.5 to 9.5 C. 9.5 to 14.5 D. 14.5 to 19.0 E. 19.0 to 20.0 *** Water level taken on 25 Jan. and looked to be at 10.8'.
	10					
	20					

	U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS
DESIGNED BY	COOPER LAKE SULPHUR RIVER, TEXAS
DRAWN BY	EMBANKMENT
REVIEWED BY	LOGS OF BORINGS 6A-135 THROUGH 6A-139
SUBMITTED BY	DATED MAY 85
ENGINEER	CONTR NO.
DRAWING NUMBER	SHEET NO. 281

to accompany final foundation report PLATE 42

Hole No. 5A-140

DRILLING LOG — Division: SWD — Installation: Ft Worth — Sheet 1 of 1 sheets

1. Project: Cooper Dam, Borrow Area
10. Size and type of bit: 5" auger
12. Manufacturer's designation of drill: Acker
3. Drilling agency: USCE
4. Hole No.: 5A-140
13. Total no. of overburden samples taken: Disturbed 6
14. Total number core boxes: 0
5. Name of driller: Barba
15. Elevation ground water: ---
6. Direction of hole: Vertical
16. Date hole: Started 23 Jan 85 — Completed 23 Jan 85
9. Total depth of hole: 20'
19. Signature of inspector: [signature]

Classification of materials	Box or sample no.	Remarks
0.0 to 18.5 CLAY 0.0 to 4.8 - high plasticity, medium stiff to stiff, moist, dark brown and very dark gray, silty. 4.8 to 6.3 - high plast. very stiff moist, black, slightly silty. 6.3 to 18.5 - high plast. very stiff, moist, gray and yellow brown, sand and gravel lime nodules throughout. 18.5 to 20.0 SAND borderline CLAY - - sand is fine grained and non cemented, the clay is medium to low plasticity, soft, both are moist, yellow brown and light gray, carbon spheres, non calcareous.	A B C D E F	Jars A. 0.0 to 4.8 B. 4.8 to 6.3 C. 6.3 to 11.3 D. 11.3 to 16.3 E. 16.3 to 18.5 F. 18.5 to 20.0 *** 72 hour water check showed water level at 11.5' and blocked off at 11.8'.

Hole No. 6A-142

DRILLING LOG — Division: SWD — Installation: Ft Worth — Sheet 1 of 1 sheets

1. Project: Cooper Dam, Borrow Area
10. Size and type of bit: 5" auger
12. Manufacturer's designation of drill: Acker
3. Drilling agency: USCE
4. Hole No.: 6A-142
13. Total no. of overburden samples taken: Disturbed 4
14. Total number core boxes: 0
5. Name of driller: Nerva
15. Elevation ground water: Dry hole.
6. Direction of hole: Vertical
16. Date hole: Started 24 Jan 85 — Completed 24 Jan 85
7. Thickness of overburden: 4.2
8. Depth drilled into rock: 11.8
9. Total depth of hole: 16'
19. Signature of inspector: [signature]

Depth	Classification of materials	Box or sample no.	Remarks
10' 16	0.0 to 4.2 CLAY - high plasticity, stiff to very stiff, moist, dark brown to dark yellow brown, silty, limey. 4.2 to 16.0 4.2 to 12.3 - highly weathered primary with remnant blocky structure, a very stiff to hard clay consistency, very slightly moist, white, yellow, yellow brown, and dark gray mixed, thinly laminated to massive, silty & sandy with seams of each, essentially non calcareous some lime. 12.3 to 16.0 - an unweathered dark gray, good shale structure, somewhat friable, silty/sandy with seams, massive, no cement,	A B C D	Jars A. 0.0 to 4.2 B. 4.2 to 9.2 C. 9.2 to 12.3 D. 12.3 to 16.0 Unweathered at 12.3'.

DRILLING LOG — Division: SWD

1. Project: Cooper Dam, Borrow Area
3. Drilling agency: USCE
4. Hole No.: 3A-144
5. Name of driller: Brewer
6. Direction of hole: Vertical
7. Thickness of overburden: 2.2
8. Depth drilled into rock: 17.8
9. Total depth of hole: 20.0

Depth	Classification of materials
10 20	0.0 to 2.2 SAND - fine, loose, very moist, dark brown, very silty, non calcareous. 2.2 to 8.0 CLAY - high plasticity, hard, very slightly mo[ist], yellow brown and light gray, very sandy/silty non calcareous. Midway group. 8.0 to 10.3 SILT - no plasticity, [...] very slightly moist, [...] gray, some yellow brown, non cemented, non calc[areous], very sandy/clayey. 10.3 to 20.0 SAND 10.3 to 13.9 - fine gra[ined], medium dense, very sli[ght]ly moist, light gray a[nd] brownish yellow, non cemented, non calcareo[us], very silty with silt se[ams]. 13.9 to 15.3 - fine, [...] slightly moist, medium dense, light gray and yellow brown, non cem[ented], non calcareous, silty. 15.3 to 20.0 - fine, med[ium] dense to loose, mo[ist], light gray, very silty

Hole No. 3B-141

DRILLING LOG — Division: SWD — Installation: Ft Worth — Sheet 1 of 1 sheets

1. Project: Cooper Dam, Borrow Area
12. Manufacturer's designation of drill: Acker
3. Drilling agency: USCE
4. Hole No.: 3B-141
13. Total no. of overburden samples taken: Disturbed 5
14. Total number core boxes: 0
5. Name of driller: Nerva
15. Elevation ground water: ---
16. Date hole: Started 23 Jan 85 — Completed 23 Jan 85
9. Total depth of hole: 20
19. Signature of inspector: [signature]

Depth	Classification of materials	Box or sample no.	Remarks
10 20	0.0 to 20.0 CLAY 0.0 to 6.3 - high to medium plasticity, stiff to hard, moist, dark brown, silty. 6.3 to 20.0 - high plast, very stiff, slightly moist to very slightly moist, yellow brown and strong brown, scattered sandy lime.	A	* Drilling 0 to 2.2' - 3" shelby, - refusal @ 2.2', 2.2 to 20' - 5" auger. Shelby 1. 0.0 to 2.2 Jars A. 2.0 to 4.3 B. 4.3 to 9.3 C. 9.3 to 14.0 D. 14.0 to 20.0 *** 72 hour water check showed a dry hole and blockage was at 18'.

DRILLING LOG — Division: SWD — Installation: Ft Worth — Sheet 1 of 1 sheets

1. Project: Cooper Dam, Borrow Area
10. Size and type of bit: 6" auger
12. Manufacturer's designation of drill: Failing 1500
3. Drilling agency: USCE
4. Hole No.: 6A-143
14. Total number core boxes: 0
5. Name of driller: Brewer
15. Elevation ground water: Dry hole.
6. Direction of hole: Vertical
16. Date hole: Started 17 Dec 84 — Completed 17 Dec 84
7. Thickness of overburden: 0
8. Depth drilled into rock: 20
9. Total depth of hole: 20'
19. Signature of inspector: [signature]

Depth	Classification of materials	Box or sample no.	Remarks
10 20	0.0 to 8.0 CLAY - high plasticity, hard(soils classification), very slightly moist, dark gray, silty, non calcareous, looks to be of the Midway group-no shale structure. The clay grades to very stiff by 3' and the color grades to pale brown by 3'. 8.0 to 13.0 SILT - low plasticity, dense, very slightly moist, pale brown and yellow brown, non cemented, sandy and clayey, non calcareous. 13.0 to 20.0 SAND - fine grained and subangular, well graded to silt, slightly moist, light gray, silty, non cemented, non calcareous.	1 A 2 B 3 C 4 D 5 E	Bags 1. 0.0 to 3.0 2. 3.0 to 8.0 3. 8.0 to 13.0 4. 13.0 to 18.0 5. 18.0 to 20.0 Jars A. 0.0 to 3.0 B. 3.0 to 8.0 C. 8.0 to 13.0 D. 13.0 to 18.0 E. 18.0 to 20.0 Note: Samples collected by drill crew - Steve Nerva.

DRILLING LOG — Division: SWD

1. Project: Cooper Dam, Borrow Area
3. Drilling agency: USCE
4. Hole No.: Dallas
5. Name of driller: Nerva
6. Direction of hole: Vertical
9. Total depth of hole: 20'

Depth	Classification of materials
10 20	0.0 to 18.0 CLAY - high plasticity, stiff to very stiff, moist, dark gray and [...] brown, some laminat[ed], carbon spheres, silty, limey. 18.0 to 20.0 CLAY borderline SAND - - sand is fine grained a[nd] non cemented, the clay high to low plasticity, soft, both are moist, gray and yellow brown, silty, non calcareous.

DRILLING LOG

Division: SWD · Installation: Ft Worth · Sheet 1 of 1 sheets

1. Project: Cooper Dam, Borrow Area
2. Location (Coordinates or Station)
3. Drilling Agency: USCE
4. Hole No. (As shown on drawing title and file number): 6A-140
5. Name of Driller: Brewer
6. Direction of Hole: Vertical
7. Thickness of Overburden: 2.2
8. Depth Drilled into Rock: 8
9. Total Depth of Hole: 20.0

10. Size and Type of Bit
11. Datum for Elevation Shown (TBM or MSL)
12. Manufacturer's Designation of Drill: Failing 1500
13. Total No. of Overburden Samples Taken
14. Total Number Core Boxes
15. Elevation Ground Water: Dry Hole
16. Date Hole: Started 11 Dec 84; Completed 11 Dec 84
17. Elevation Top of Hole
18. Total Core Recovery for Boring
19. Signature of Inspector: Robert Meyer

Elevation	Depth	Legend	Classification of Materials (Description)	% Core Recovery	Box or Sample No.	Remarks
			0.0 to 2.2 SAND - fine, loose, very moist, dark brown, very silty, non calcareous.			* Drilling 0 to 3' - 2" shelby refusal @ 3'. 3 to 12' - 8" auger. 12 to 14' - shelby push would not extrude (too stiff/dense). 14 to 20' - auger.
	10		2.2 to 8.0 CLAY - high plasticity, hard, very slightly moist, yellow brown and light gray, very sandy/silty, non calcareous, Midway group.			Shelby 1. 0 to 3.5 2. 3.5 to 3.8
			8.0 to 10.3 SILT - no plasticity, dense, very slightly moist, light gray, some yellow brown, non cemented, non calcareous, very sandy/clayey.			Jars A. 3.0 to 8.0 B. 8.0 to 10.3 C. 10.3 to 13.9 D. 13.9 to 15.3 E. 15.3 to 20.0
	20		10.3 to 20.0 SAND 10.3 to 13.9 - fine grained, medium dense, very slightly moist, light gray and brownish yellow, non cemented, non calcareous, very silty with silt seams. 13.9 to 15.3 - fine, very slightly moist, medium dense, light gray and yellow brown, non cemented, non calcareous, silty. 15.3 to 20.0 - fine, medium dense to loose, moist, light gray, very silty			

DRILLING LOG

Division: SWD · Installation: Ft Worth · Sheet 1 of 1 sheets

1. Project: Cooper Dam, Borrow Area
2. Location (Coordinates or Station)
3. Drilling Agency: USCE
4. Hole No. (As shown on drawing title and file number): 6A-146
5. Name of Driller: Reeves
6. Direction of Hole: Vertical
7. Thickness of Overburden
8. Depth Drilled into Rock
9. Total Depth of Hole: 20'

10. Size and Type of Bit
11. Datum for Elevation Shown (TBM or MSL)
12. Manufacturer's Designation of Drill: Acker
13. Total No. of Overburden Samples Taken: 6
14. Total Number Core Boxes: 0
15. Elevation Ground Water: ***
16. Date Hole: Started 24 Jan 85; Completed 24 Jan 85
17. Elevation Top of Hole
18. Total Core Recovery for Boring
19. Signature of Inspector: Robert Meyer

Elevation	Depth	Legend	Classification of Materials (Description)	% Core Recovery	Box or Sample No.	Remarks
			0.0 to 4.2 SILT - low plasticity, dense to very dense, moist to very slightly moist, brown yellow with some light gray, carbon spheres.		A B	* Drilling 0 to 3' - 3" shelby, refusal. 3.0 to 20' - 4" auger. *** 18 hour check - dry hole and caved to 16.2'.
	10		4.2 to 6.3 SILT borderline CLAY - low plasticity, very dense, slightly moist, dark yellow brown, non calcareous.		C	Shelby 1. 0 to 3.0
	20		6.3 to 20.0 CLAY 6.3 to 11.3 - high to medium plasticity, stiff to very stiff, moist, yellow brown and light gray, very silty/sandy, limey. 11.3 to 16.1 - high plast, very stiff to stiff, moist, yellow brown and light gray, limey, silty. 16.1 to 20.0 - high plast, stiff, moist, yellow brown and light gray, silty, limey.		D E	Jars A. 3.0 to 4.2 B. 4.2 to 6.3 C. 6.3 to 11.3 D. 11.3 to 16.1 E. 16.1 to 20.0

DRILLING LOG

Division: SWD · Installation: Ft Worth · Sheet 1 of 1 sheets

1. Project: Cooper Dam, Borrow Area
2. Location (Coordinates or Station)
3. Drilling Agency: USCE
4. Hole No. (As shown on drawing title and file number): 6A-145
5. Name of Driller: Reeves
6. Direction of Hole
7. Thickness of Overburden
8. Depth Drilled into Rock
9. Total Depth of Hole: 20'

10. Size and Type of Bit: 4" auger
11. Datum for Elevation Shown (TBM or MSL)
12. Manufacturer's Designation of Drill: Acker
13. Total No. of Overburden Samples Taken
14. Total Number Core Boxes
15. Elevation Ground Water: ***
16. Date Hole: Started 24 Jan 85; Completed 24 Jan 85
17. Elevation Top of Hole
18. Total Core Recovery for Boring
19. Signature of Inspector: Robert Meyer

Elevation	Depth	Legend	Classification of Materials (Description)	% Core Recovery	Box or Sample No.	Remarks
			0.0 to 18 CLAY - high plasticity, stiff to very stiff, moist, dark gray and dark brown, some laminations, carbon spheres, slightly limey.			Jars [illegible]
			18.0 to 20.0 CLAY border on SAND - the sand is fine grained and non cemented, the clay is high to low plasticity, soft, both are moist, light gray and yellow brown, very silty, non calcareous			*** 18 hour water check at 15.8'.

DRILLING LOG

Division: SWD · Installation: Ft Worth · Sheet 1 of 1 sheets

1. Project: Cooper Dam, Borrow Area
2. Location (Coordinates or Station)
3. Drilling Agency: USCE
4. Hole No. (As shown on drawing title and file number): 6A-147
5. Name of Driller: Reeves
6. Direction of Hole: Vertical
7. Thickness of Overburden
8. Depth Drilled into Rock
9. Total Depth of Hole: 20'

10. Size and Type of Bit: 4" auger
11. Datum for Elevation Shown (TBM or MSL)
12. Manufacturer's Designation of Drill: Acker
13. Total No. of Overburden Samples Taken: 5
14. Total Number Core Boxes: 0
15. Elevation Ground Water: ***
16. Date Hole: Started 22 Jan 85; Completed 22 Jan 85
17. Elevation Top of Hole
18. Total Core Recovery for Boring
19. Signature of Inspector: Robert Meyer

Elevation	Depth	Legend	Classification of Materials (Description)	% Core Recovery	Box or Sample No.	Remarks
			0.0 to 20.0 CLAY 0.0 to 2.6 - high to medium plasticity, medium stiff, moist, yellow brown. 2.6 to 6.7 - high plasticity, stiff, moist, dark gray, some brownish yellow, silty, non calcareous.		A B	Jars A. 0.0 to 2.6 B. 2.6 to 6.7 C. 6.7 to 11.7 D. 11.7 to 16.5 E. 16.5 to 20.0
	10		6.7 to 11.7 - high plast, very stiff (pentrometer readings of 3.5 to 3.75), slightly moist, yellowish brown, carbon spheres, sand and gravel lime.		C	*** Water level taken on 25 Jan, was read at 11.2'.
	20		11.7 to 16.5 - high plast, stiff, moist, yellow brown and light gray, silty and sandy, carbonaceous, lime at 15.5'. 16.5 to 20.0 - high plast, soft (pentrometer @ 18' = 0.4), very moist, yellow brown, light gray, brown, and black, silty and sandy, carbon spheres, limey.		D E	

Symbol	Date	Action	Description of Revision

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

Designed by: ...... Drawn by: ...... Reviewed by: ......

COOPER LAKE
SULPHUR RIVER, TEXAS

EMBANKMENT

LOGS OF BORINGS
6A-140 THROUGH 6A-147

Submitted by · Dated · Contr No · Engineer · Drawing Number · Sheet No. · Sequence No. 28

TO ACCOMPANY FINAL FOUNDATION REPORT PLATE 48

2 3 4 5 6

DRILLING LOG

Hole No. HAW-...

LOWER DAM SITE

RALLING 1305

R.K. Anselotta

0.0 to 1.5

SAND, fine to coarse grained, loose, moist, clayey, tan

1.5 to 3.4

CLAY, medium to high plasticity, stiff, moist, sandy, calcareous gray

3.4 to 7.1

SAND, fine to coarse grained, medium dense to dense, moist, clayey, iron oxides throughout, tan to rust

7.1 to 12.1

SANDSTONE, fine to coarse grained, weakly cemented friable, very thin shale seams and blebs noted in section, ferric oxide stains on core, weathered, in-place fractures noted, soft

12.1 to 15.0

LIMESTONE, ... fine grained, gray, moderately siliceous throughout, prominent healed vertical fracture in section with some alteration and discoloration along fracture plane, easily scratched with knife, moderately hard

15.0 to 24.8

SAND, fine to coarse grained, cohesionless, but with relict texture; graded bedding noted along a coherent zone located near a gradational contact with underlying shale, tan to strongly rust colored to brown

24.8 to 40.8

SHALE, dark gray, fossiliferous, arenaceous with scattered sand rich ... zones in section, in part laminated to thinly bedded to thick bedded, scattered in-place fractures noted, unjointed, soft

40.8 to 42.5

LIMESTONE, light gray, fine to coarse grained, fossiliferous, numerous shale stringers, seams, and blebs throughout, fractured, easily scratched with knife, moderately hard.

42.5 to 58.2

SHALE, dark gray, fossiliferous, laminated to thinly bedded with ripple marks noted, becoming increasingly calcareous from 57.1 to 58.2, in-place fractures, soft

58.2 to 58.7

SANDSTONE, tan to dark gray, fine grained, silty, very shaly throughout, calcareous, soft

(1) Immediately after bailing boring bridged in @ 16.0' bail depth approximately at 65.0 ft. After installation of ... pipe free water level taped at ... ft. below grade.

SAMPLES

CARTONS

DRILLING

... to top of primary, reamed and set core barrel.

... core, boring taped to depth after ...

41.8 - 110.0, 4" core, ... core barrel to depth.

COMMENTS

(1) 5' wooden core boxes used when drilling with 6" barrel; 4" (2.5ft) styrofoam inserts used when drilling with 4" core barrel.

(2) Carboloy bit refuse, @1. ft set diamond bit and drilled to 15.0ft with very slow drilling, carboloy bit reset @...ft

(3) Core from top of primary to 41.8' below grade placed in 8 five foot long wooden core boxes. From 41.8' to depth all core stored in nine cartons with three styrofoam inserts per carton and all labeled with regard to footages.

(4) pressure test ... ft east. bottom packer @... ft. generated ... no readout.

bottom packer @... ft. generated ... no readout

58.7 to 95.7

SHALE, dark gray, fossiliferous, laminated to thinly bedded with ripple marks noted; very thin sand/shale laminae noted ... zone between 78.2' ... 86... ... fractures, ... soft.

95.7 to 96.0

SANDSTONE, tan to dark gray, fine grained, silty, very shaly throughout, calcareous, soft.

96.0 to 96.4

LIMESTONE, light gray, fine to coarse grained, highly fossiliferous throughout, fractured, moderately hard.

96.4 to 110.0

SAND, tan to gray, cohesionless, fine to coarse grained, certain compacted (friable) zones showing relict texture (graded bedding), other zones are cohesive especially from 96.9'-99.1'; 99.2'-101.8'; 102.7'-103.5' with numerous shale seams, stringers and blebs throughout, prominent limestone interbed noted from 102.5'-102.65', soft.

T.D.-110.0'

DRILLING LOG

Cooper Dam - Embankment station

sta. 28 + 60, centerline

USCE

Brewer/Schoonover

0.0 to 1.9

SAND - fine ... loose, wet, ... silty, non cal...

1.9 to 19.4

CLAY - high ... tion grading ... icity, hard ... stiff ... 19... yellow brown ... very silty and ... seams of ... non calcare... then slightly ...

19.4 to 19.9

CLAY - as clay ... very limey and ... ately hard ...

19.9 to 22.5

LIMESTONE - ... yellow brown ... massive, dense ... ed, hard ... classification ... siliferous ... and gastropods

22.5 to 27.5

SAND - fine gr... ered yellow ... gray, non ceme... friable, non ... massive to a ... coarsely ... slightly ... a few thin ...

27.5 to 30.0

SAND and SHALE ... fine grained ... mented, the ... what plastic ... tion, but ... structure throu... thered until ...

27.5 to 30.0 ...

SAND and SHALE ... an unweathered ... after 29.0' ... to moderately ... classification ... non calcareous ... within very ... scattered thr... calc... ...

30.0 to 31.0

SAND - fine ... massive, gray ... soft ...

31.0 to 36.0

SHALE - unweathered ... gray, massive ... soft rock ... slightly ...

36.0 to 47...

SILT - non ... sandy and ... soft ... non to slightly ... slightly fossil... dark gray ... tered through...

47... to 49.6

LIMESTONE - ... ification ... fossiliferous ... gastropods ... moderately ... vuggy.

49.6 to 56...

SILT - as silt ...

2 3 4 5 6

Hole No. 8A4C-149

DRILLING LOG	DIVISION SWD	INSTALLATION Ft. Worth	SHEET 1 OF 1 SHEETS

1. PROJECT: Cooper Dam embankment stat[illegible]
2. LOCATION: sta. 28 + 4[illegible] centerline
3. DRILLING AGENCY: SCE
4. HOLE NO.: 8A4C-149
5. NAME OF DRILLER: Brewer/Schoono
6. DIRECTION OF HOLE: Vertical
7. THICKNESS OF OVERBURDEN: [illegible]
8. DEPTH DRILLED INTO ROCK: [illegible]
9. TOTAL DEPTH OF HOLE: 110.0
10. SIZE AND TYPE OF BIT: [illegible]
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): [illegible]
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 2 UNDISTURBED [illegible]
14. TOTAL NUMBER CORE BOXES: [illegible]
15. ELEVATION GROUND WATER: [illegible]
16. DATE HOLE: STARTED 27 Nov. 86 COMPLETED 30 Nov. 86
17. ELEVATION TOP OF HOLE: 438.7[illegible]
18. TOTAL CORE RECOVERY FOR BORING: 97.[illegible]
19. SIGNATURE OF INSPECTOR: [illegible]

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
			0.0 to 1.9 SAND - fine grained, very loose, wet, yellow brown, silty, non calcareous.		A	0 to [illegible] - 8" auger, [illegible] to 110' - [illegible] core, diamond bit 20.5 to 22.[illegible], then carboloid bit to [illegible]
			[illegible] to [illegible] CLAY - high at top of section grading to low plasticity, hard to [illegible], stiff [illegible], moist, yellow brown to light gray, very silty and sandy with seams of [illegible] scattered, non calcareous [illegible], then slightly calcareous.		Box	Hole logged with gamma and electric, then hole bailed and 2" pvc pipe set to 70 with slots also to [illegible]. Hole bailed after completion of drilling. Check made [illegible] Dec. 86 and water at [illegible].
			[illegible] to [illegible] CLAY - as clay above except [illegible] and now moderately hard rock classification.		[illegible]	Date [illegible]
			[illegible] to [illegible] LIMESTONE - weather stained [illegible], dense, [illegible] cemented, hard to very hard rock classification, [illegible] and gastropods.			[illegible]
			[illegible] to [illegible] SAND - fine grained, weathered yellow [illegible], non cemented and friable [illegible] massive [illegible] a few scattered [illegible] slightly fossiliferous with a few thin dense seams.			
			[illegible] to 30.0 SAND and SHALE - sand is fine grained and non cemented, the shale is [illegible] plastic at top of section [illegible] good [illegible] structure throughout, weathered until 28.9' - cont.			
			[illegible] to 30.0 cont. SAND and SHALE - [illegible] unweathered dark gray after [illegible], both are [illegible] moderately soft rock classification, massive, [illegible] calcareous, crystals [illegible] very thin veins scattered throughout, [illegible] yellow].			Pressure Test Location: sta. 28 + 50, centerline Hole was drilled with [illegible] bit and first extended down to 23' and several attempts to seal packer failed. Hole was then extended down to 46.5' and again several attempts to seal packer failed. Now with the hole at [illegible], the packer was raised up to 17' and sealed within the limestone. The test then showed no water loss [illegible] 10 minutes with a reading of 15 psi.
			[illegible] to [illegible] SAND - fine, non cemented, massive, gray, moderately soft (rx class.), non [illegible].		Box	
			[illegible] to [illegible] SHALE - unweathered dark gray, massive, moderately soft rock classification, slightly limy, silt seams.			
			[illegible] to [illegible] SAND - non cemented, very sandy and [illegible] moderately soft (rx class.), massive, non to slightly calcareous, slightly fossiliferous, dark gray, sand seams scattered throughout.		Box	
			[illegible] to 49.0 LIMESTONE - hard rock classification, white, massive, fossiliferous, [illegible] and gastropods, well cemented, moderately dense, slightly [illegible]			
			49.0 to 56.[illegible] SHALE - as above from [illegible]		Box	
			96.7 to 102.6 SHALE - unweathered dark gray, massive, moderately soft-rock classification, calcareous to non calc., no apparent dips or bedding, silty with scattered very thin seams except where noted, silt increases with depth after 90'. 96.0 to 65.3 - very limy, moderately hard (rx class.), dark gray/white mixed. 65.3 to 65.8 - SILT - non cemented, [illegible]/sandy.		Box 12	
			102.6 to 105.1 SAND and SHALE interbedded, sand is fine grained and non cemented, both are dark gray to gray, moderately soft (rx class.), massive to medium laminations that are scattered throughout, calc. [illegible]2.6 to 103.1 - lime lenses, very silty.		Box 13	
			105.1 to 109.9 SAND - fine grained, soft from moderately soft (rx classification), massive, friable, non cemented, very silty with silt seams, slightly shaley stringers.		Box 14 Box 15	

				DESCRIPTION OF REVISION

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

DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY:
ENGINEER:

COOPER LAKE
SULPHUR RIVER, TEXAS

EMBANKMENT

LOGS OF BORINGS
8A4C-148 THROUGH 8A4C-149

DATED: [illegible]
CONTR NO.:
DRAWING NUMBER:
SHEET NO. OF
SEQUENCE NO. 483

Hole No. DAMC-150

DRILLING LOG — DIVISION: SWD — INSTALLATION: Ft. Worth — SHEET 1 of 3 sheets

1. PROJECT: Cooper Dam, Spillway station
2. LOCATION: Sta. 101 + 55, centerline
3. DRILLING AGENCY: USCE
4. HOLE NO.: DAMC-150
5. NAME OF DRILLER: Schoonover
6. DIRECTION OF HOLE: vertical
7. THICKNESS OF OVERBURDEN: 0.9
8. DEPTH DRILLED INTO ROCK: 108.9
9. TOTAL DEPTH OF HOLE: 109.8
10. SIZE AND TYPE OF BIT: *
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 2, UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: 14 **
15. ELEVATION GROUND WATER: ***
16. DATE HOLE: STARTED 19 Nov. 84; COMPLETED 21 Nov 84
17. ELEVATION TOP OF HOLE: 439.61'
18. TOTAL CORE RECOVERY FOR BORING
19. SIGNATURE OF INSPECTOR: Robert McVey

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
			0.0 to 0.9 — SAND - fine grained, loose, wet, yellow brown, silty, non calcareous.		A	DRILLING: 0 to 6.8' - 8" auger, 6.8 to 109.8' - 4" core.
			0.9 to 14.9 — CLAY - high plasticity at top of section that grades down to a low plasticity, hard grades to stiff by 7.7', moist, yellow brown and light gray, silty and sandy with seams of each, non calcareous.	Loss 0.4	B; Box 1	** Boxes are cardboard & can hold 7.5'. *** Hole bailed after completion of drilling. Water check 28 Nov. 84 at 20.5'.
	10		14.9 to 18.0 — LIMESTONE - weather stained yellow brown within white, hard/very hard(rock classification), massive, well cemented, dense, fossils of bi-valves & gastropods.	L 4.2; L 3	Box 2	Hole was logged with gamma and electric. All slotted 2" pvc pipe was installed after hole was bailed(110') with 1.2' stickup and capped. Hole was then plugged and grouted at surface(about 1.5').
	20		18.0 to 27.5 — SAND - fine, moist, soft to moderately soft(rock classification), non cemented, friable, weathered yellow brown to dark yellow brn, silty, massive, calcareous to non calc, slightly fossiliferous. Unweathered dark gray at 26.0'.	L 2.0; L 4.2; L 4.9	12 (Pitcher Samp)	JARS: A. 0.0 to 0.9; B. 0.9 to 6.8. No carton samples taken this hole.
	30		27.5 to 30.8 — SHALE - unweathered dark gray, massive, moderately soft(rock classification), scattered fossils, sandy and silty, some lime.	L 5; G 4.4	Box 3	Unweathered at 26.0'. See next page for pressure test.
			30.8 to 48.6 — SAND — 30.8 to 44.5 - fine grained, non cemented, massive, unweathered dark gray, slightly fossiliferous, calc. to non calc, soft to moderately soft(rx class), silty & clayey.	G 4; L 4.5	Box 4; Box 5	
	40		30.8 to 48.6(continued) — 44.5 to 46.1 - as surrounding sand except very limey and now moderately hard(rock classification), gray/white. 46.1 to 48.6 - same as sand from 30.8 to 44.5'.	G 4; G 4.4	Box 5	Pressure Test — Location: 101 + 25, 35' u/s. Hole drilled with 3 1/8" bit and first test taken with with hole down to 20.5' and bottom of packer at 15'. Reading of 10 psi showed no water loss - reading of 15 psi caused water to channel around packer, end of first test. The hole was extended to 44.5' and packer set at 42' i.e. not felt by drill action, set psi at 42 and held for 10 minutes with no water loss.
	50		48.6 to 51.4 — SILT - non cemented, dark gray, very sandy, shaley, moderately soft(rx class), massive.	L 4.6	Box 6	
	60		51.4 to 98.5 — SHALE — 51.4 to 60.8 - unweathered dark gray, massive, moderately soft(rock classification), calcareous, silty after 58.1' very sand/silty seams at 59.9' to 60.8'. 60.8 to 62.0 - very limey zone, dark gray to white, moderately hard(rx class). 62.0 to 90.0 - SHALE and SAND interbedded, sand is fine grained, non cemented, silty, gray, shale is as shale from 51.4' to 60.8'. 90.0 to 98.5 - dark gray, massive, moderately soft rock classification, calcareous, slightly fossiliferous(scattered bi-valve shells), silt seams scattered, no apparent dip or jointing).	G 4.7; L 4.5; G 3; L 4.6; L 4.7	Box 7; Box 8; Box 9	
	70			G 4.3	Box 10	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.
			98.5 to 100.9 — SILT - no plasticity, dark gray, massive, moderately soft(rock classification), non cemented and friable, calcareous, very sandy and clayey throughout.	G 4; G 4.5	10; Box 11
	90'		100.9 to 109.1 — SAND - fine grained, non cemented, friable, gray, moderately soft to soft (rx class), mostly non calcareous, but a few scattered lime concretions, moist, silty, a few shells.	L 4.2; L 4.7	Box 12
	100			G 4.7; L 4.1	Box 13
	110'			L 4.7	Box 14

DRILLING LOG — DIVISION: SWD — INSTALLATION: Ft. Worth

1. PROJECT: Cooper Dam
2. LOCATION: 102+00, centerline
3. DRILLING AGENCY: USCE
4. HOLE NO.: DAMC-151
5. NAME OF DRILLER: Schoonover
6. DIRECTION OF HOLE: vertical
7. THICKNESS OF OVERBURDEN: 0.7
8. DEPTH DRILLED INTO ROCK: 109.3
9. TOTAL DEPTH OF HOLE: 110.0

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.
			0.0 to 0.7 — SAND - fine grained, very loose/loose, moist, dark brown, silty, non calcareous.		
	10		0.7 to 15.5 — CLAY — 0.7 to 5.2 - high to medium plasticity, medium stiff, moist, red and dark yellow brown, sandy with thin seams scattered, non calcareous. 5.2 to 9.1 - medium to low plasticity, hard(rock classification), slightly moist, yellow brown and light gray, very sandy with thin seams, very slightly gravelly, non calcareous.	Loss 1.4	
	20		9.1 to 14.2 - low plasticity, very stiff, moist, yellow brown, very sandy, silty, non calcareous, no rock structure. 14.2 to 15.5 - low plast. moderately hard rock classification, very limey, yellow brown and white, fossiliferous massive, no structure.	L 4.3	
	30		Note: Above clay could be extremely weathered primary. No distinction noted between non calcareous clay and very limey zone at bottom of this section.		
			15.5 to 18.1 — LIMESTONE - some weather staining, yellow brown, dark gray, and white, hard to very hard(rock classification), massive, dense, well cemented, very fossiliferous mostly bi-valves and gastropods.	L 4.4	
	40		18.1 to 25.5 — SAND — 18.1 to 22.5 - fine grained, weathered yellowish brown and light gray, non cemented, moist, calcareous, soft(rock classification very silty. 22.5 to 25.5 - fine, an unweathered dark gray, moderately soft(rock classification), massive, non cemented, calcareous, fossiliferous.	G 4.2; L 4.2	
	50'		25.5 to 28.7 — SHALE - unweathered dark gray, massive, slightly moist, moderately soft(rx class), silty and sandy with thin seams and lenses, fossiliferous.	G 4.4	
	60		28.7 to 42.6 — SAND - fine grained, unweathered dark gray, moist, massive, non cemented and generally friable, very silty, shaley seams scattered, moderately soft(rx class), calcareous, fossils.	G 4.4	
	70		42.6 to 43.9 — ARENACEOUS LIMESTONE - unweathered dark gray and white, moderately hard(rx class), massive, dense, moderately cemented.	L 4.3	
			43.9 to 47.4 — SAND - fine, dark gray, non cemented, massive, moderately soft(rx class), calc, shaley/silty with thin seams of each scattered, some fossils.	G 4.8; L 4.6; G 4.4	

DRILLING LOG | Division: [illegible] | Installation: Ft. Worth | Sheet 1 of [illegible] sheets

Hole No. [illegible]

1. Project: Cooper Dam
2. Location: 1[illegible]+95, centerline
3. Drilling agency: [illegible]
4. Hole No.: [illegible]
5. Name of driller: Schoonover
6. Direction of hole: Vertical
7. Thickness of overburden: [illegible]
8. Depth drilled into rock: 109.5
9. Total depth of hole: [illegible]
10. Size and type of bit: [illegible]
11. Datum for elevation shown: [illegible]
12. Manufacturer's designation of drill: Failing 1500
13. Total no. of overburden samples taken: Disturbed 3; Undisturbed [illegible]
14. Total number core boxes: 14
15. Elevation ground water: ***
16. Date hole: Started 1[illegible] Nov 8[illegible]; Completed [illegible] Nov 8[illegible]
17. Elevation top of hole: 440.6[illegible]
18. Total core recovery for boring: 97 %
19. Signature of inspector: Robert McVey

Elevation	Depth	Legend	Classification of materials (Description)	% Core recovery	Box or sample no.	Remarks
			[illegible] to [illegible]		A	* Drilling
			SAND - fine grained, very loose/loose, moist, dark brown, silty, non calcareous.		B	0 to 6.8 - 8" auger. 6.8 to 110' - 4" core.
			[illegible] to 14.5		C	After completion of drilling, hole was logged with resistivity and gamma probes.
			CLAY			***
	0		[illegible] to 5.2 - high to medium plasticity, medium stiff, moist, red and dark yellow brown, sandy with thin seams scattered, non calcareous.		Box 1	Hole was then bailed. 1½" pvc pipe was installed to 110' with the bottom 90' slotted up to 20' from surface. Pipe was then packed at surface with clay and grouted.
			5.2 to [illegible] - medium to low plasticity, hard(soil classification), slightly moist, yellow brown and light gray, very sandy w/ thin seams, very slightly gravelly, non calcareous.			*** Water check after installation was 50.3. 1 hour check showed water level at 24.97.
	20		[illegible] to 14.5 - low plasticity, very stiff, moist, yellow brown, very sandy, silty, non calcareous, no rock structure.		Box 2	Jars: A. [illegible] to [illegible]; B. [illegible] to [illegible]; C. 5.2 to 6.8
			14.5 to 15.5 - low plast. moderately hard rock classification, very [illegible], yellow brown and white, fossiliferous, massive, no structure.			Cartons: [illegible]
	30		Note: Above clay could be extremely weathered [illegible]. No distinction noted between [illegible] and [illegible] zone at bottom of this section.		Box 3	The core box is cardboard with a [illegible] capacity for recovery. Doser ran over core box # 10 - non salvageable.
			[illegible] to [illegible]			
			LIMESTONE - some weather staining, yellow brown, dark gray and white, hard to very hard rock classification, massive, dense, [illegible] cemented, very fossiliferous, [illegible] valves and gastropods.		Box 4	
	40				Box 5	Pressure Test
			[illegible] to [illegible]			Location: sta. 103 + 17, 11' u/s.
			SAND		Box 5	Hole was drilled with [illegible] bit and first extended down to 19', the bottom of the packer was set at 15' and and the pressure set a 15 psi for ten minutes no water loss. The hole was then extended down to 45 and the packer at 41'. With the pressure at 25 psi water was rising up around packer. The packer was then reset at 42' and held without water loss until 25 psi, then water lost around packer. Test called off.
			[illegible] to [illegible] - fine grained, weathered yellowish brown and light gray, non cemented, moist, calcareous, soft rock classification, very silty.			
	50		[illegible] to [illegible] - fine, [illegible] unweathered dark gray, moderately soft rock classification, massive, non cemented, calcareous, fossiliferous.		Box 6	
			25.5 to 28.[illegible]			
			SHALE - unweathered dark gray, massive, [illegible] moist, moderately soft(rk class.), silty and sandy with thin seams and lenses, fossiliferous.		Box 7	
	60		2[illegible] to 42.[illegible]			
			SAND - fine grained, unweathered dark gray, moist, massive, non cemented and generally friable, very silty, shaley seams scattered, moderately soft rk class, calcareous, fossil[illegible].		Box 8	
			42.[illegible] to 43.9			
	70		ARENACEOUS LIMESTONE - unweathered dark gray and white, moderately hard rk class, massive, dense, moderately cemented		Box 9	
			43.9 to 47.[illegible]			
			SAND - fine, dark gray, non cemented, massive, moderately soft(rk class.), calc, shaley/silty with thin seams of each scattered, some fossils.		Box 10	

Depth	Classification of materials	% Core recovery	Box or sample no.	Remarks
	47.4 to 49.5		10	
	SAND borderline SHALE - - very silty, transition zone, sand is fine grained, non cemented, both are dark gray, massive, moderately soft(rk class), calc	100	Box 11	
	49.5 to 97.0			
90	SHALE - unweathered dark gray, massive, moderately soft(rock classification),	100		
	calc, fossiliferous(mostly bi-valves and gastropods), thin plastic seams scattered throughout.	100	Box 12	
	soft seams at 50.2 to 50.3 and 51.3 to 51.5'.			
	97.0 to 108			
	SAND	100		
100	97.0 to 99.0 - mostly fine grained with a few thin fine to medium seams, non cemented, massive to medium laminated, fossiliferous, silty/clayey, dip of less than 5°, dark gray.	100	Box 13	
	99.0 to 108.0 - fine grained, dark gray to gray, massive to medium laminated, some convoluted bedding at 102.7 to 102.9, silty, mod. soft(rk class).	115	Box 14	
110	108 to 110' - [illegible] this section as Sa. [illegible] very soft- drill [illegible] through section rapidly - all lost(washed out).			

EXTENSION

Depth	Classification of materials	% Core recovery	Box or sample no.	Remarks
110	111.0 to 149.5'			* Drilling
	SAND/SANDSTONE		Box 1	0 to 111' - 8" auger, set up over existing hole. 111 to 150' - 4" core.
	111.0 to 120.9 - fine grained, noncemented, friable, massive, dry, white and black(salt & pepper look), scattered and thin shale seams, non weathered, non calcareous.	100		*** Water at 14', 30 Jan 1986 in existing hole. Hole squeezed shut at 22' while bailing. Bailing called off.
	120.9 to 123.4 - moderately hard to hard(rock classification), moderately to well cemented, gray to white, calcareous, massive, few thin shale lenses at 122.1'.	100		No samples taken.
130	123.4 to 132.5 - fine grained, mostly weak and non cemented with some moderately cemented areas, moderately hard to moderately soft(rock class.), slightly calcareous to non calc, mostly massive with isolated zones of thin to coarse laminations, silty, dark gray, very slightly fossiliferous, scattered thin shale seams and stringers.	100	Box 2	
140	132.5 to 149.5 - Sand and Shale interbedded - non cemented, silty, dark gray, massive to coarse laminations, moderately soft(rk class), sand is fine grained, unweathered, mostly non calcareous.	100	Box 3	
		100	Box 4	
150		102	Box 5	

MRC FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT)

Symbol	Description	Date	Approval

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

Designed by: | Drawn by: | Reviewed by: | Submitted by: | Engineer:

COOPER LAKE
SULPHUR RIVER, TEXAS

EMBANKMENT

LOGS OF BORINGS
8A4C-150 THROUGH 8A4C-151 ext.

Dated: [illegible] | Contr No: [illegible] | Drawing Number: | Sheet No: [illegible]

Sequence No. 234

To Accompany Final Foundation Report Plate 45

2 3 4 5 6

Hole No. UBM-1

DRILLING LOG	DIVISION SWD	INSTALLATION Ft Worth	SHEET 1 OF 2 SHEETS

1. PROJECT Cooper Dam
2. LOCATION (Coordinates or Station) Sta. 20+00, 400' D/S
3. DRILLING AGENCY USCE
4. HOLE NO. (As shown on drawing title and file number) UBM-1
5. NAME OF DRILLER Bettis
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN 6.4
8. DEPTH DRILLED INTO ROCK 43.6
9. TOTAL DEPTH OF HOLE 50.0
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED 1 — UNDISTURBED 2
14. TOTAL NUMBER CORE BOXES 8
15. ELEVATION GROUND WATER
16. DATE HOLE — STARTED 10 Oct 84 — COMPLETED 11 Oct 84
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING
19. SIGNATURE OF INSPECTOR Robert McCoy

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
			0.0 to 6.4 SAND - fine grained, loose to medium dense, no cement, moist, brown, silty and clayey, calcareous, some gray color at 6'.		A 1 2	* Drilling 0 to 2' - 8" auger, 2 to 6.4' - 6" denison, set 2" casing, 6.4 to 50' - 6" core; diamond bit from 6.4' to 11.5', then a carbaloid bit used to 50'.
			6.4 to 8.7 LIMESTONE - weather stained yellow brown, brown, and gray when moist, white when dry, massive, hard - rock classification, well cemented, fossiliferous.	Lost 0.6		** Hole bailed to 46.8' 11 Oct 84.
	10			Lost 0.4 all between Lim.	Box 1	
			8.7 to 16.7 SAND - weather stained yellowish brown, non cemented, moist, silty and clayey, soft rock classification, massive, slightly fossiliferous, calcareous.	Lost 0 Lost 0 Lost 0.6 At	2 Box 2 3	Jar A. 0.0 to 2.0 Denison 1. 2.0 to 4.0 2. 4.0 to 6.0 6.0 to 6.4 - refusal -
	20		16.7 to 34.1 SAND - fine grained, dark gray, unweathered, massive, soft rock class., clayey and silty, non cemented, scattered very thin seams of clay, very thin veinlets of white lime, very shaley from 18 to 20.8', shale has blocky structure but any given sample can be compressed with two fingers with moderate pressure.	Lost 0.1 Lost 0.3 Gain 0.4	Box 3 C-4 Box 4	Cartons 1. 7.8 to 8.7 2. 11.9 to 12.4 3. 16.0 to 17.0 4. 24.1 to 25.2 5. 32.9 to 33.7 6. 40.1 to 41.3
	30		34.1 to 35.1 ARENACEOUS LIMESTONE - unweathered, white, moderately hard rock class., massive, very sandy from 35.1 to 35.3'.	Lost 0 Lost 0.4	Box 5 5	
			continued	Lost 0	Box 6	
	40		35.1 to 41.4 SAND - fine grained, unweathered dark gray, massive, shaley and silty, non cemented, moderately soft rock classification, calcareous.	Lost 0 Lost 0	C-6 Box 7	
			41.4 to 46.8 SHALE - unweathered dark gray, massive, moderately soft rock classification, calcareous.	Lost 0.6	Box 8	
	50		46.8 to 48.9 ARENACEOUS SHALE - as above except very sandy with sand seams scattered.			

DRILLING LOG	DIVISION SWD

1. PROJECT Cooper Dam Site
2. LOCATION (Coordinates or Station)
3. DRILLING AGENCY USCE
4. HOLE NO. (As shown on drawing title and file number) UBM-1
5. NAME OF DRILLER Brewer/Bettis
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN 3.2
8. DEPTH DRILLED INTO ROCK primary 46.8
9. TOTAL DEPTH OF HOLE [illegible]

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)
			0 to 3.2 CLAY - medium st[illegible] silty, soft, m[illegible] brown, very [illegible] sandy, non calcare[illegible]
			3.2 to 5.0 CLAY - primary, wea[illegible] hard clay classif[illegible] slightly moist, [illegible] ticity, massive, [illegible] moist, brown, sl[illegible] sandy, non calcare[illegible]
	10		5.0 to 9.6 CLAY - weather stai[illegible] yellow brown and [illegible] high plasticity, ma[illegible] slightly moist, [illegible] some blocky struct[illegible] finger pressure [illegible] flatter sample.
	20		9.6 to 13.4 CLAY - as above exc[illegible] light gray and re[illegible] brown, some carbo[illegible]
			13.4 to 15.2 SILT and CLAY - as above, silt has [illegible] silty, non cemented [illegible] are slightly moist, [illegible] erately soft rock [illegible] ification).
	30		15.2 to 31.5 SAND and CLAY - prim[illegible] sand is fine grained [illegible] cemented, massive [illegible] thin coarse [illegible] silty and claye[illegible] high plasticity [illegible] both are silty [illegible] light gray and [illegible] brown, moderately [illegible] class., non calca[illegible] slightly calc after [illegible] few veins of CaCO[illegible]
			31.5 to 34.8 SAND and CLAY - as sa[illegible] clay above except [illegible] weathered dark gray, [illegible] brown, and light gra[illegible]
	50		34.8 to 49.1 SAND and CLAY intern[illegible] sand is fine, non [illegible] massive, silty and [illegible] clay is plastic [illegible] blocky structure [illegible] can be compressed [illegible] finger pressure, ma[illegible] silty and sandy, b[illegible] slightly moist, dar[illegible] unweathered, modera[illegible] soft rock classific[illegible] calcareous. Very limey zone [illegible] 46.7 to 47.7 [illegible] dark gray, moist, [illegible] hard/mod. soft r[illegible]

2 3 4 5 6

Hole No. [illegible]

DRILLING LOG | DIVISION SWD | INSTALLATION [illegible] | SHEET 1 OF [illegible] SHEETS

1. PROJECT: Cooper Dam Site
2. LOCATION (Coordinates or Station):
3. DRILLING AGENCY: USCE
4. HOLE NO. (As shown on drawing title and file number): DBM-3
5. NAME OF DRILLER: Brewer/Bettis
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: 3.2
8. DEPTH DRILLED INTO ROCK: primary 46.8
9. TOTAL DEPTH OF HOLE: 50.0
10. SIZE AND TYPE OF BIT:
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 1, UNDISTURBED 2
14. TOTAL NUMBER CORE BOXES: 8
15. ELEVATION GROUND WATER: ***
16. DATE HOLE: STARTED 17 Oct 86, COMPLETED 17 Oct 86
17. ELEVATION TOP OF HOLE:
18. TOTAL CORE RECOVERY FOR BORING:
19. SIGNATURE OF INSPECTOR: Robert McVey

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
			0 to 3.2 CLAY - medium to high plasticity, soft, moist, dark brown, very silty and sandy, non calcareous.		A 1 2	* Drilling 0 to 2' - 8" auger, 2 to 6' - 6" denison, 6 to 50' - 4" core. *** Hole bailed, 24 hour check at 38'. Might be circulation fluid return. Re-bail to 48.5', 24 hour check @ [illegible]
	10		3.2 to 5.0 CLAY - primary, weathered, hard clay classification, slightly moist, high plasticity, massive, slightly moist, brown, silty and sandy, non calcareous.	Lost 6.4	Box 1	
			5.0 to 9.6 CLAY - weather stained yellow brown and white, high plasticity, massive, slightly moist, non calc., some blocky structure, but finger pressure will flatten sample.	100	Box 2	Jar A. 0.0 to 2.0 Denison ** 1. 2.0 to 4.0 2. 4.0 to 6.0
				101	Box 3	Cartons 1. 23.5 to 24.4 2. 32.0 to 33.0 3. 45.9 to 46.9 4. 48.4 to 49.2 all recovery before #1 was too broken up to sample.
	20		9.6 to 13.6 CLAY - as above except light gray and yellow brown, some carbon spheres.	122 (Actual [illegible])	Box 3	
				0.6	1	
			13.6 to 15.2 SILT and CLAY - clay as above, silt has no plasticity, non cemented, both are slightly moist, moderately soft rock classification.	100	Box 4	(**) Driller noted a quick gravel feel during the denison from 4' to 6' about 4.[illegible]. No gravel seen in recovery from 4' to 6', but a few scattered coarse gravels appeared during coreing; must be a very thin seam or scattered.
	30		15.2 to 31.5 SAND and CLAY - primary, sand is fine grained, non cemented, massive, few thin coarse to fine seams, silty and clayey, clay is high plasticity, massive, both are slightly moist, light gray and yellowish brown, moderately soft rock class., non calcareous to slightly calc after 17.2', few veins of CaCO3.	102	Box 5 2	
				102	Box 6	Note: In all the sand and clay sections I see a predominance of sand during visual examination.
				102	Box 7	
			31.5 to 36.8 SAND and CLAY - as sand and clay above except slightly weathered dark gray, yellow brown, and light gray.	102	Box 7	
				100	Box 8 3	
	50		36.8 to 49.1 SAND and CLAY interbedded, sand is fine, non cemented, massive, silty and clayey, clay is plastic, but has blocky structure and still can be compressed with finger pressure, massive, silty and sandy, both are slightly moist, dark gray, unweathered, moderately soft rock classification, calcareous. very clayey sand fine [illegible] white and dark gray, moderately hard and, soft rock class.	101	[illegible]	

NOTE DBM-2 NEVER DRILLED

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

DESIGNED BY: | DRAWN BY: | CHECKED BY:

COOPER LAKE
SULPHUR RIVER, TEXAS

EMBANKMENT

LOGS OF BORINGS
DBM - 1, DBM - 3

SUBMITTED BY: | ENGINEER: | DATED | CONTR NO | DRAWING NUMBER | SHEET NO ___ OF ___ | SEQUENCE NO. 285

TO ACCOMPANY FINAL FOUNDATION REPORT PLATE 46

DRILLING LOG — Hole No. 6A-152

Division	SWD
Installation	Fort Worth
Sheet	1 of 1 sheets
1. Project	Cooper Lake Dam
2. Location (Coordinates or Station)	Spillway area (2,576,523.72x, 608,745.42y)
3. Drilling Agency	Bone Engineers
4. Hole No.	6A - 152
5. Name of Driller	Brent Thomason
6. Direction of Hole	Vertical
7. Thickness of Overburden	30'
8. Depth Drilled into Rock	0'
9. Total Depth of Hole	30'
10. Size and Type of Bit	6" Fishtail Auger Bit
11. Datum for Elevation Shown	MSL
12. Manufacturer's Designation of Drill	Mobile B-53
13. Total No. of Overburden Samples Taken	Disturbed 7
15. Elevation Ground Water	394.78
16. Date Hole	Started 02-12-86; Completed 02-12-86
17. Elevation Top of Hole	398.95

Classification of Materials

0.0 - 30.0

CLAY

0.0 to 11.0 - SILTY, brown, soft to medium stiff to 5' wet

11.0 to 17.0 - SILTY, brown w/occasional gray tint, stiff to very stiff, small iron stains w/sand

17.0 to 20.0 - light brown to brown, medium stiff to stiff, small iron stains

20.0 to 25.0 - SILTY, brown medium stiff to stiff, slightly darker than above

25.0 to 28.4 - light brown, very wet and soupy

28.4 to 30.0 - light brown to brown, stiff w/occasional small gravel

Remarks

Jar Samples

1. 4.0 to 5.0
2. 8.0 to 9.0
3. 13.0 to 14.0
4. 18.0 to 19.0
5. 23.0 to 24.0
6. 27.0 to 28.0
7. 29.0 to 30.0

NOTES

Seepage encountered @ 20' during drilling

Water level @ 16.5' and caved depth @ 22' at the end of drilling

Water level is @ 14.17' and caved depth @ 15.0' one hour after drilling

6" augers used during drilling

DRILLING LOG — Hole No. 6A-154

Division	SWD
Installation	Fort Worth
Sheet	1 of 1 sheets
1. Project	Cooper Lake Dam
2. Location (Coordinates or Station)	Spillway area (2,575,956.86x, 610,967.16y)
3. Drilling Agency	Bone Engineers
4. Hole No.	6A - 154
5. Name of Driller	Brent Thomason
6. Direction of Hole	Vertical
7. Thickness of Overburden	30'
8. Depth Drilled into Rock	0'
9. Total Depth of Hole	30'
10. Size and Type of Bit	6" Fishtail Auger Bit
11. Datum for Elevation Shown	MSL
12. Manufacturer's Designation of Drill	Mobile B-53
13. Total No. of Overburden Samples Taken	Undisturbed 6
15. Elevation Ground Water	385.94
16. Date Hole	Started 02-12-86; Completed 02-12-86
17. Elevation Top of Hole	396.69

Classification of Materials

0.0 - 30.0

CLAY

0.0 to 11.4 - SILTY, brown, stiff w/iron stains

As above w/gray color tint

11.4 to 15.0 - gray w/brown seams and sandy seams, stiff to very stiff, high P.I.

15.0 to 28.0 - SANDY, light brown, very wet and soupy

28.0 to 30.0 - slightly less wet than above w/gray color and occasional small gravel

Remarks

Jar Samples

S-1 4.0 to 5.0

S-2 5.0 to 9.0

S-3 13.0 to 14.0

S-4 18.0 to 19.0

S-5 23.0 to 24.0

S-6 28.0 to 29.0

NOTES:

Seepage noted @ 15.0' during drilling

Water level @ 12.5' and caved depth @ 16.0' at the end of drilling

Water @ 10.75' and caved depth @ 12.0' one hour after end of drilling

6" augers used during drilling

DRILLING LOG — Hole No. 6A-153

Division	SWD
Installation	Fort Worth
Sheet	1 of 1 sheets
1. Project	Cooper Lake Dam
2. Location (Coordinates or Station)	Spillway area (2,576,241.91x, 609,646.32y)
3. Drilling Agency	Bone Engineers
4. Hole No.	6A - 153
5. Name of Driller	Brent Thomason
6. Direction of Hole	Vertical
7. Thickness of Overburden	30'
8. Depth Drilled into Rock	0'
9. Total Depth of Hole	30'
10. Size and Type of Bit	6" Fishtail Auger Bit
11. Datum for Elevation Shown	MSL
12. Manufacturer's Designation of Drill	Mobile B-53
13. Total No. of Overburden Samples Taken	Undisturbed 6
15. Elevation Ground Water	386.15
16. Date Hole	Started 02-11-86; Completed 02-11-86
17. Elevation Top of Hole	397.15

Classification of Materials

0.0 - 30.0

CLAY

0.0 to 7.0 - dark brown to dark gray, fat clay w/some silt to 7'

7.0 to 15.0 - light gray and tan mottled silt clay @ 7' w/ferrous oxide stains

15.0 to 27.5 - increase in silt @ 15', silt w/ferrous stains, see page @ 17'

27.5 to 30.0 - very [illegible] silty clay w/sand seams, some dark, slightly consolidated clay w/silt and sand gravel present

13.8" H_2O at completion

Remarks

SHELBY SAMPLES

S-1 2.0 to 4.0

S-2 8.0 to 10.0

S-3 12.0 to 14.0

S-4 16.0 to 18.0

S-5 22.0 to 24.0

S-6 28.0 to 30.0

NOTES

Water level @ 7.5' and caved depth @ 17.25' below ground surface at the end of the day

Water level @ 11.0' and caved depth @ 16.83' after 24 hours

DRILLING LOG — Hole No. 6A-156

Division	SWD
Installation	Fort Worth
Sheet	1 of 1 sheets
1. Project	Cooper Lake Dam
2. Location (Coordinates or Station)	Outlet Works (2,575,796.14x, 607,002.81y)
3. Drilling Agency	Bone Engineers
4. Hole No.	6A - 156
5. Name of Driller	[illegible] Branco and Brent Thomason
6. Direction of Hole	Vertical
7. Thickness of Overburden	30'
8. Depth Drilled into Rock	0
9. Total Depth of Hole	30'
10. Size and Type of Bit	6" Fishtail Auger Bit
11. Datum for Elevation Shown	MSL
12. Manufacturer's Designation of Drill	Mobile B-53
13. Total No. of Overburden Samples Taken	Disturbed 6
15. Elevation Ground Water	Dry hole
16. Date Hole	Started 02-17-86; Completed 02-17-86
17. Elevation Top of Hole	409.00

Classification of Materials

0.0 - 30.0

CLAY

0.0 to 5.0 - SILTY, tan w/traces of fine grain sand, very moist

5.0 to 10.0 - SANDY, light brown w/moisture

10.0 to 15.0 - SANDY, light brown, occasional light gray w/less sand

15.0 to 26.0 - SILTY, light brown, occasional light gray w/traces of sand

26.0 to 30 - dark olive brown w/traces of fine sand

Remarks

Bags

1. 0.0 to 5.0
2. 5.0 to 10.0
3. 10.0 to 15.0
4. 15.0 to 20.0
5. 20.0 to 25.0
6. 25.0 to 30.0

NOTES

Dry at completion and after 24 hours

Hole No. 6A - 154

DRILLING LOG — Division: SWD — Installation: Fort Worth — Sheet 1 of 1 sheets

Location: (2,575,956.86x, 610,967.16y)

Hole No.: 6A - 154

Size and type of bit: 6" Fishtail Auger Bit

Datum for elevation shown: MSL

Manufacturer's designation of drill: Mobile B-52

Total no. of over-burden samples taken: Undisturbed 6

Elevation ground water: 385.94

Date hole: Started 02-12-86, Completed 02-12-86

Elevation top of hole: 396.69

Thickness of overburden: 30'

Depth drilled into rock: 0

Total depth of hole: 30'

Classification of Materials	Remarks
0.0 - 30.0	Jar Samples
CLAY	S 1 4.0 to 5.0
0.0 to 11.4 - Silty, brown, stiff w/iron stains	S 2 5.0 to 9.0
	S 3 13.0 to 14.0
As above w/gray color tint	S 4 18.0 to 19.0
11.4 to 15.0 - gray w/brown seams and sandy seams, stiff to very stiff, high PI	S 5 23.0 to 24.0
15.0 to 28.0 - SANDY, light brown, very wet and soupy	S 6 29.0 to 29.0
28.0 to 30.0 - slightly less wet than above w/gray color and occasional small gravel	NOTES
	Seepage noted @ 15.0' during drilling
	Water level @ 17.5 and caved depth @ 15.0' at the end of drilling
	Water @ 10.75 and caved depth @ 12.0 one hour after end of drilling
	6" augers used during drilling

Hole No. 6A - 156

Mobile B-52

Undisturbed 6

NOTES

Hole No. 6A - 157A

DRILLING LOG — Division: SWD — Installation: Fort Worth — Sheet 1 of 1 sheets

Project: Cooper Lake Dam

Location: (2,575,478.82x, 606,175.79y) (Borrow 11)

Drilling agency: Rone Engineers

Hole No.: 6A - 157A

Name of driller: Mike Chism

Direction of hole: [X] Vertical [ ] Inclined

Thickness of overburden: 30'

Depth drilled into rock: 0

Total depth of hole: 30'

Size and type of bit: 6" Fishtail Auger Bit

Datum for elevation shown: MSL

Manufacturer's designation of drill: Mobile B-50

Total no. of over-burden samples taken: Disturbed 13

Elevation ground water: 388.80

Date hole: Started 08-29-86, Completed 08-29-86

Elevation top of hole: 401.40

Depth	Classification of Materials	Box or Sample No.	Remarks
	0.0 to 30.0		Jar Samples
	CLAY		1 0.0' to 5.0'
	0.0 to 5.5 - medium brown, sandy, low plasticity index, stiff	A 1	2 5.0' to 10.0'
	5.5 to 13.5 - medium gray & tan, mottled, silty, some fine sand, moist, w/FeO_2 stains, soft, w/increase in silt & fine sand below 11.5' to 13.5'	B 2	3 10.0' to 13.0'
	13.5 to 19.5 - medium brown to grayish brown, w/decrease in clastics, becoming less moist & stiff, medium to high plasticity index	3, C 4	4 13.0' to 16.0
	19.5 to 30.0 - medium brown, sandy, moist, soft, medium to low plasticity, becoming borderline sand-clay below 2?' - medium brown, saturated to 30.0	D 5, F 6, F 7	5 16.0' to 20.0'
			6 20.0' to 25.0'
			7 25.0' to 30.0'
			Bags
			A 0.0' to 5.0'
			B 5.0' to 12.0'
			C 12.0' to 15.0
			D 15.0' to 20.0
			E 20.0' to 25.0'
			F 25.0' to 30.0
			Seepage encountered @ 22.0' during drilling. Water @ 14.8' @ completion

ENG FORM 1836 — Project: Cooper Lake Dam — Hole No. 6A - 157A

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

COOPER LAKE
SULPHUR RIVER, TEXAS

SPILLWAY AND OUTLET WORKS

LOGS OF BORINGS
6A-152, 3S-153, 6A-154, 6A-156, 6A-157A

Designed by: H. WEBB
Drawn by: C. KIRBY
Reviewed by: R. BEHM
Submitted by: ROBERT BEHM, Engineer

SOL. NO. DACW63-87-B-0005 DATED MAY 87
CONTR. NO. DACW63-87-C-0085
Sheet No. G-60 of 67
Sequence No. 286

TO ACCOMPANY FINAL FOUNDATION REPORT PLATE 47

Hole No. 3540-202

DRILLING LOG

Fort Worth

Lower Lake [illegible]

Area

Pope Engineers

3540-202

Brent Thompson

4" Carboloy Core Bit

Mobile B-53

6

15

399.71 @ 24 hours

04-09-86

04-11-86

441.71

16.5

91

CLASSIFICATION OF MATERIALS (Description)

REMARKS

SAND

Offset 4.0' West

Shelby Samples

1	0'	to	2
2	2	to	4
3	4'	to	6
4	6'	to	8
5	8'	to	10
6	10	to	10.6

w/some clay, organics, non plastic

medium brown, moist, dense, non plastic

Refusal @ 10.6'

Begin core run @ 10.2'

Actual loss ... due to dense sand unable to fill barrel

CLAY

Carton Samples

light to medium brown, w/ interbedded sand laminae, medium to low plasticity, becoming harder ... dense w/some clay ... plasticity

10.5 to ...

LIMESTONE

weathered, stained ... becomes medium gray, fossiliferous ... hard to very hard (By classification)

Cores

SAND

SHALE AND

SHALE

Box

95.2 to 102.1 very sandy, soft to moderately hard, w/dense, slightly cemented sand laminae and clay varves, 96.9' to 97.9' wash out of less consolidated medium fine grained sand

Box 12

Box 13

Box 14

Box 15

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE

DRILLING LOG

Lower Lake [illegible]

Pope Engineers

Brent Thompson

SAND

LIMESTONE

SAND

SHALE

SHALEY LIMESTONE

44.1 to 98.4

SHALE

2

3

4

5

6

DRILLING LOG

SAND

SAND

SAND SHALE

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE

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

COOPER LAKE
SULPHUR RIVER, TEXAS

[illegible] WAY

LOGS OF BORINGS
3S4C-207, 3S4C-208

DESIGNED BY

DRAWN BY

CHECKED BY

SUBMITTED BY
[illegible] BERT PEHM
ENGINEER

[illegible] NO DACA [illegible] 87 [illegible] 0084 | DATED MAY 87

CONTR NO DACW63 [illegible] C-0085

DRAWING NUMBER

SHEET NO [illegible] 64 OF 67

SEQUENCE NO [illegible]87

To Accompany Final Foundation Report PLATE 48

DRILLING LOG

Cooper Lake Dam

Fort Worth

of 4 sheets

Bone Engineers

Failing 250

SAND

Bags

LIMESTONE

Standard Penetration Test

SHALE

ENG FORM 1836

DRILLING LOG

Cooper Lake Dam

Bone Engineers

SHALE

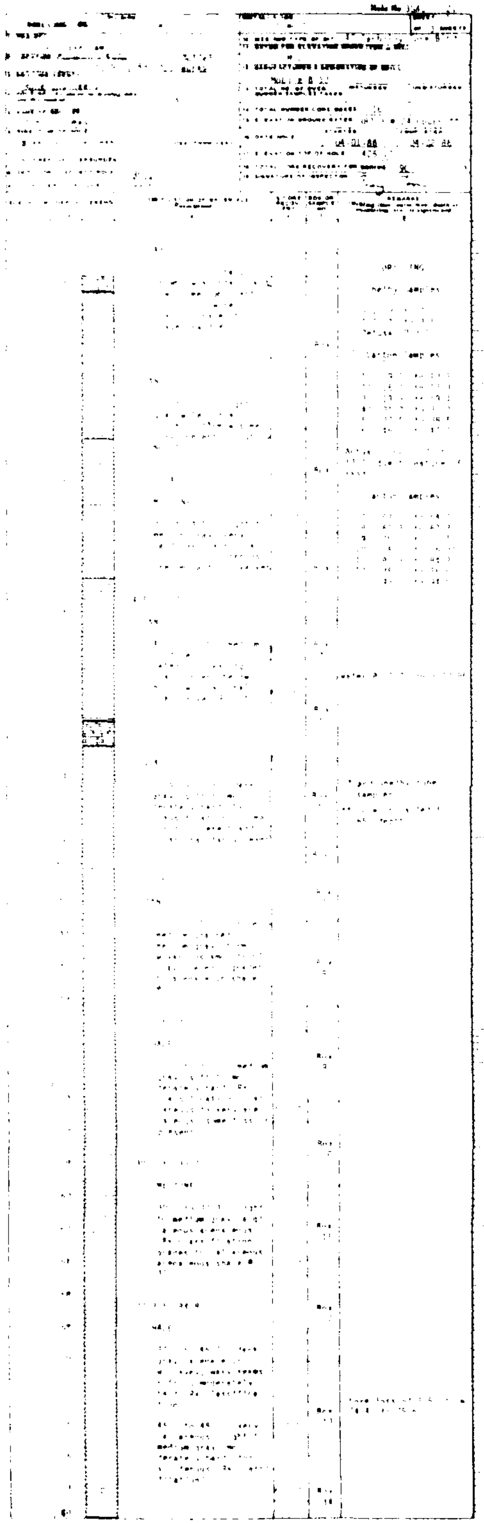
2

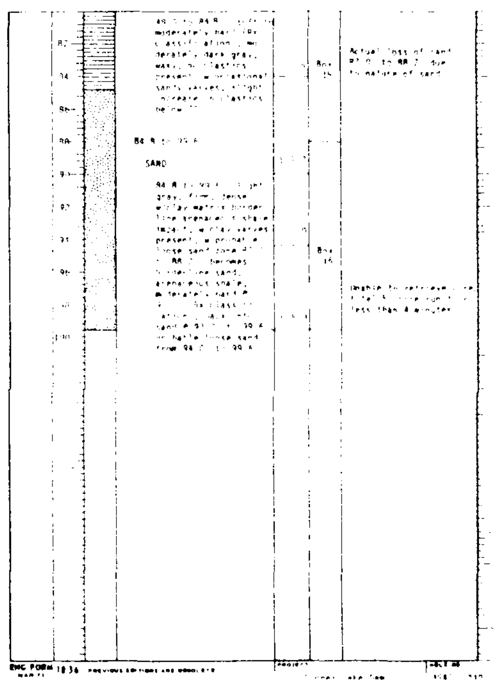
3

4

5

6





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

COOPER LAKE
SULPHUR RIVER, TEXAS

SPILLWAY AND OUTLET WORKS

LOGS OF BORINGS
3S4C-209, 3S4C-210

SUBMITTED BY: ROBERT SERM
ENGINEER

DATED: MAY 87
CONTR NO DACW63-87-C-0085
SHEET NO: G-62 OF 67
SEQUENCE NO: 288

To accompany Final Foundation Report PLATE 49

Hole No. 354C [illegible]

DRILLING LOG

DIVISION: SWL

INSTALLATION: Fort Worth

SHEET [illegible] OF 4 SHEETS

1. PROJECT: Cooper Lake Dam

2. LOCATION (Coordinates or Station): [illegible] 615 [illegible] Buffet [illegible] Works

3. DRILLING AGENCY: Rone Engineers

4. HOLE NO. (As shown on drawing title and file number): 354C [illegible]

5. NAME OF DRILLER: [illegible] Thomason

6. DIRECTION OF HOLE: VERTICAL / INCLINED [illegible] DEG. FROM VERT.

7. THICKNESS OF OVERBURDEN: 12.8

8. DEPTH DRILLED INTO ROCK: 87.0

9. TOTAL DEPTH OF HOLE: 100.6

10. SIZE AND TYPE OF BIT: [illegible] core bit (carboloy)

11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL

12. MANUFACTURER'S DESIGNATION OF DRILL: Mobile B [illegible]

13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED [illegible] UNDISTURBED 1

14. TOTAL NUMBER CORE BOXES: 1[illegible]

15. ELEVATION GROUND WATER: 40[illegible] @ 24 hours [illegible]

16. DATE HOLE: STARTED [illegible] 86 COMPLETED 03-16-86

17. ELEVATION TOP OF HOLE: 434

18. TOTAL CORE RECOVERY FOR BORING: 95

19. SIGNATURE OF INSPECTOR: [illegible]

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
			0.0 to .5			Boring offset 6 ft west due to location of mud pit
			CLAY			
			0.0 to .5 medium brown, soft, moist, low to medium plasticity, Fe stained, sandy			Shelby Tube Samples
			.5 to 12.8		Box [illegible]	[illegible] to [illegible]
			SAND			Begin core @ 4 [illegible] Actual loss [illegible]
			[illegible] to 12.8 [illegible] light gray to tan, mottled Fe stain, low plasticity, soft to moderately firm [illegible] nodules present, low to medium plasticity		Box 2	Note: [illegible] barrel [illegible] hole [illegible] damage offset [illegible] south. Began core [illegible] sand [illegible] due to nature of material recovered
			12.8 to 14.8		Box [illegible]	[illegible] next run [illegible]
			LIMESTONE			
			12.8 to 14.8 [illegible] light gray [illegible] ferous, very hard [illegible] classification			
			14.8 to [illegible]		Box 4	Carbon Samples
			SAND			[illegible]
			14.8 to [illegible] tan [illegible] brown, fine grain [illegible] to moderately [illegible] w/some Fe [illegible] coming [illegible] gray content increasing to 18			
			18.[illegible] to 40.5			
			SHALE		Box [illegible]	
			[illegible] sandy [illegible] medium gray [illegible] shale w/varying amounts of fine grain sand [illegible] (continued on next page)			* and Shelby tube samples ** [illegible] barrel [illegible] depth
			[illegible] soft [illegible] moderately [illegible]		Box [illegible]	
			23.4 to 40.5			
			SHALE			
			23.4 to 40.5 dark gray, soft [illegible] classification, sandy, arenaceous w/decreasing amount of [illegible] w/depth [illegible] w/arenaceous seams and some fossiliferous zones, massive [illegible] the fossils [illegible] in sand content from 35 [illegible] to 40.5		Box 9	
			40.5 to 42.1			
			LIMESTONE			
			40.5 to 42.1 light gray to medium gray fossiliferous [illegible] and [illegible] arenaceous, moderately hard to hard, Rx classification		Box [illegible]	
			42.1 to 56.2			
			SHALE			
			42.1 to 4[illegible] medium dark gray [illegible] slight fossiliferous, soft to moderately hard (Rx classification)		Box [illegible]	
			4[illegible] to 46.9 moderately hard, arenaceous [illegible]		Box [illegible]	
			46.9 to 56.2 soft to moderately hard w/decrease in [illegible] careous, becoming waxy (continued on next page)			

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS
			46.9 to 56.2 (cont.) becoming waxy in texture w/occasional sandy seams, some fossils present			
			56.2 to 57.5			
			LIMESTONE			
			56.2 to 57.5 [illegible] gray to medium gray, shaley, soft [illegible] moderately hard, Rx classification			
			57.5 to [illegible]			
			SHALE			
			57.5 to 59.0 dark gray, soft, Rx classification, slightly arenaceous, calcareous			[illegible]
			59.[illegible] dark gray, soft to moderately hard w/decrease in [illegible] some fossils [illegible] varves			
			[illegible] dark gray, soft to moderately hard (Rx classification) waxy [illegible] fossils present [illegible]			
			[illegible] to 94.5 dark gray, soft to moderately hard, arenaceous, grades to shaley sand			
			94.5 to 100.6			
			SAND			
			94.5 to 96.9 [illegible] fine grain, medium to light gray, friable, slightly cemented, slightly calcareous, argillaceous w/clay varves, firm to dense (coarse grain) (continued on next page)			
			96.9 to 98.4 sand becoming less fine and decreasing amount of clay, also less dense, loose to firm (coarse grain soil classification)			
			98.4 to 100.6 fine, light to medium gray w/some clay matrix, loose to firm (coarse grain soil classification)			

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE

PROJECT [illegible] HOLE NO. [illegible]

DRILLING LOG

1. PROJECT: Cooper Lake Dam

3. DRILLING AGENCY: Rone Engineers

5. NAME OF DRILLER: [illegible] Thomason

2 3 4 5 6

DRILLING LOG

SAND

Shelby advance ... unable to push ... began core ...

Shelby tube samples

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

COOPER LAKE
SULPHUR RIVER, TEXAS

OUTLET WORKS

LOGS OF BORINGS
3S40-211, 3S40-212

DATED MAY 87

SEQUENCE NO. 289

TO ACCOMPANY FINAL FOUNDATION REPORT PLATE 30

Hole No.

DRILLING LOG

Notes

Bags

DRILLING LOG

3 4 5 6

DRILLING LOG

Hole No.

[illegible]

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

COOPER LAKE
SULPHUR RIVER, TEXAS

LOGS OF BORINGS
3S4C-213, 3S4C-214

DATE: MAY 87

SHEET NO. [illegible] of 67

SEQUENCE NO. 230

TO ACCOMPANY FINAL FOUNDATION REPORT PLATE 5

Hole No. [illegible]

DRILLING LOG	Division: SWD	Installation: Fort Worth	Sheet 1 of 2 sheets

1. Project: Cooper Lake Dam
2. Location: [illegible] Area
3. Drilling Agency: Rone Engineers
4. Hole No.: 3545 - 215
5. Name of Driller: Brent Thomason
6. Direction of Hole: Vertical
7. Thickness of Overburden: 8
8. Depth Drilled into Rock: 42
9. Total Depth of Hole: 50
10. Size and Type of Bit: 4 Carboloy Core Bit
11. Datum for Elevation Shown: MSL
12. Manufacturer's Designation of Drill: Mobile B-53
13. Total No. of Over-burden Samples Taken: Undisturbed 5
14. Total Number Core Boxes: 8
15. Elevation Ground Water: 433.8 @ 24 hours
16. Date Hole: Started 04-03-86; Completed 04-03-86
17. Elevation Top of Hole: 434.20
18. Total Core Recovery for Boring: 93
19. Signature of Inspector: [signature]

Elevation	Depth	Legend	Classification of Materials (Description)	% Core Recovery	Box or Sample No.	Remarks
			0.0 to 2.0 SAND. 0.0 to 2.0 - tan and brown, dry, fine grain w/ some silt			Shelby Tube Samples
			[illegible] CLAY [illegible] brown, very sandy, soft to firm, low plasticity, moist, becomes firm w/ sand lenses and carbon specks [illegible] nodules			Refusal @ [illegible]. Begin core @ [illegible]
			[illegible] SAND [illegible] fine grain, gray [illegible] moist [illegible] nonplastic [illegible]			[illegible] Shelby Tube samples
			[illegible] LIMESTONE [illegible]			
			[illegible] SAND [illegible]			
			[illegible] SAND - SHALE [illegible]			
			[illegible] to 49.8 SHALE [illegible]			

Hole No. [illegible] 215

DRILLING LOG	Division: SWD	Installation: Fort Worth	Sheet 1 of 2 sheets

1. Project: Cooper Lake Dam
2. Location: [illegible] 576,587 97x, 608,299 [illegible] Spillway Area
3. Drilling Agency: Rone Engineers
4. Hole No.: 3545 - 216
5. Name of Driller: Brent Thomason
6. Direction of Hole: [X] Vertical
7. Thickness of Overburden: 28.8'
8. Depth Drilled into Rock: 22.1'
9. Total Depth of Hole: 50.9'
10. Size and Type of Bit: 4 Carboloy Core Bit
11. Datum for Elevation Shown: MSL
12. Manufacturer's Designation of Drill: Mobile B-53
13. Total No. of Over-burden Samples Taken: Undisturbed 15
14. Total Number Core Boxes: 5
15. Elevation Ground Water: 390.7 @ 24 hours
16. Date Hole: Started 02-20-86; Completed 02-21-86
17. Elevation Top of Hole: 401.5'
18. Total Core Recovery for Boring: 96
19. Signature of Inspector: [signature]

Elevation	Depth	Legend	Classification of Materials (Description)	% Core Recovery	Box or Sample No.	Remarks
			0.0 to 5.5 SAND. 0.0 to 5.5 - medium brown, [illegible] w/ abundant silt, moist to very moist, nonplastic			Shelby Tube Samples: 1 0 to 2; 2 2 to 4 (no recovery); 3 4 to 6; 4 6 to 8; 5 8 to 10; 6 10 to 12; 7 12 to 14; 8 14 to 16; 9 16 to 18; 10 18 to 21; 11 21 to 22; 12 22 to 24; 13 24 to 26; 14 26 to 29; 15 28 to 30
			5.5 to 14.2 CLAY. 5.5 to 10.0 - dark gray w/ fe[illegible] stains, firm, carbon specks, some sand and sand varves, moist, low to medium plasticity. [illegible] to 14.2 - light gray, very sandy w/ [illegible] stains, soft to firm, low plasticity			
			14.2 to 28.8 SAND. 14.2 to 24.2 - light gray, fine grain w/ some clay, moist, loose to firm, low plasticity to nonplastic, becoming very moist and increasing in clay @ 17.2. 24.2 to 28.6 - clayey, light gray, soft, very moist, low to medium plasticity, fine grain. 28.6 to 28.8 - weathered contact of shale, sand, coarse sand and gravels w/ fe[illegible] nodules			[illegible] * and Shelby tube samples. ** [illegible] 55' depth
			28.8 to 50.9 SHALE. 28.8 to [illegible] - dark gray, very [illegible] w/ [illegible] and sand varves, moderately [illegible]. Sand layers and light gray, fine grain, firm to dense, silty w/ some clay			

DRILLING LOG [illegible]

Cooper Lake [illegible]

[illegible]

DRILLING LOG

COOPER LAKE

DRILLING LOG

COOPER LAKE

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

COOPER LAKE
SULPHUR RIVER, TEXAS

EMBANKMENT

LOGS OF BORINGS
3S4C-215, 3S4C-216, 8A4C-217, 8A4C-218

SUBMITTED BY: ROBERT BEHN

DACW63-87-B-0084 DATED MAY 87

CONTR NO. DACW63-87-C-0085

SHEET NO. 65 of 67

SEQUENCE NO. 291

To ACCOMPANY FINAL FOUNDATION REPORT PLATE 52

DRILLING LOG

Project: Cooper Lake
Location: Sta. 12+.. ... see remarks
Installation: Ft. Worth
Manufacturer's designation of drill: Mobile [illegible]
Hole No.: [illegible]
Name of driller: Texian [illegible] Drilling
Direction of hole: Vertical
Date hole: Started 8 April [illegible]; Completed 10 April [illegible]
Elevation top of hole: [illegible]
Thickness of overburden: 1.0
Depth drilled into rock: 22.0
Total depth of hole: 30.0
Signature of inspector: W. J. Moody

Elevation	Depth	Legend	Classification of materials (Description)	% Core recovery	Box or sample no.	Remarks
			0.0 to 1.0		A	* Drilling
			CLAY - high plasticity, stiff, moist, dark brown, calcareous.		B	[illegible] to [illegible] - [illegible] auger, [illegible] to [illegible] - [illegible] core, sample [illegible], [illegible] to [illegible] - [illegible] shelby push placed in core box, 19 to 22' - [illegible] core, because the limestone recovered was [illegible] as [illegible] by driller, [illegible] the [illegible] offset to recover [illegible] as explained below.
			1.0 to 12.5			
			SAND/SILT/SHALE - interbedded, sand is fine grained, non cemented and friable, shale is badly weathered to medium stiff to very stiff and plastic clay consistency, both are interbedded with silt seams, moist, light gray, [illegible] brown, white lime concentrations, slightly fossiliferous.			
	10					
			12.5 to 24.0			[illegible] encountered, again we offset to sta. 12+[illegible], [illegible] where [illegible] to 25' - [illegible] (Shelby), 25 to 28 - [illegible] core, [illegible] on [illegible] Apr [illegible], we [illegible] to sta. [illegible] for [illegible] hole for [illegible]; see [illegible] for details.
			SAND - fine, medium dense/dense, [illegible], soft rock classification, moist, mottled appearance of gray to [illegible] brown and yellow brown, silty and clayey with thin seams of each, calcareous.	Shelby		
	20					
			24.0 to 24.8			*** Hole bailed [illegible]. [illegible] hour check at [illegible], [illegible] May [illegible] check at [illegible].
			LIMESTONE - this unit was only observed at sta. 12+[illegible], centerline, hard to very hard rock classification, white, massive, [illegible] with [illegible].			The [illegible] was [illegible] 2" [illegible] pipe [illegible] centerline, [illegible].
	30					
			24.8 to [illegible]			Box [illegible] [illegible] above at sta. 12+[illegible], centerline. Box [illegible] at sta. [illegible]. Box [illegible] at sta. [illegible].
			SAND/SILT - [illegible] fine, non cemented and friable, [illegible], very [illegible] with [illegible], light gray and yellow [illegible], dark gray, slightly fossiliferous, [illegible].			

DRILLING LOG

Hole No. PAH-[illegible]

DRILLING LOG	Division: [illegible]	Installation: Ft Worth	Sheet 1 of 1 sheets
1. Project: Cooper Lake		10. Size and type of bit: [illegible]	
2. Location: sta. 15+[illegible], [illegible]		11. Datum for elevation shown: [illegible]	
3. Drilling agency: USCE		12. Manufacturer's designation of drill: Damco 1250A	
4. Hole No.: PAH-2[illegible]		13. Total no. of over-burden samples taken: Disturbed 5 / Undisturbed [illegible]	
5. Name of driller: Davies - Hamilton Drilling		14. Total number core boxes: [illegible]	
6. Direction of hole: Vertical		15. Elevation ground water: ***	
7. Thickness of overburden: [illegible]		16. Date hole: Started [illegible] April 86 / Completed 16 Apr 86	
8. Depth drilled into rock: 33.5		17. Elevation top of hole: Survey hole in creek	
9. Total depth of hole: [illegible]		18. Total core recovery for boring: [illegible]	
		19. Signature of inspector: Robert McVey	

Classification of materials:

0.0 to 1.2

SAND - fine, loose, slightly moist, plant roots.

1.2 to 3.0

CLAY - high plasticity, very stiff, moist, dark red, slightly sandy, black specks.

3.0 to 4.2

SHALE - badly weathered to a high/medium plasticity and very stiff hard clay consistency, slightly [illegible], light gray and yellow brown, [illegible] nodules, very sandy with [illegible] sand after [illegible].

4.2 to [illegible]

LIMESTONE - white, very hard rock classification, well cemented, massive, [illegible]

[illegible]

Remarks:

* Drilling

0 to 4.5' - 8" auger.

4.5 to [illegible] - 4" core with diamond bit used from 4.5 to 5'.

On 14-15 Apr 86, we offset to sta. 15+91, 27' d/s for the log hole (see below for details) using a 5¼" fishtail except from 4 to 5' and [illegible] to 42.8', where a rockbit was used.

***

Water levels taken from fishtail hole. Hole bailed to [illegible] [illegible]

Jars

Box

[illegible]

DRILLING LOG

Hole No. PAH-[illegible]

DRILLING LOG	Division: SWD	Installation: Ft Worth	Sheet 1 of 1 sheets
1. Project: Cooper Lake		10. Size and type of bit: [illegible]	
2. Location: sta. 21+31, 11' u/s & 21+33, 13' u/s		11. Datum for elevation shown: [illegible]	
3. Drilling agency: USCE		12. Manufacturer's designation of drill: Damco 1250A	
4. Hole No.: PAH-222		13. Total no. of over-burden samples taken: Disturbed 6 / Undisturbed 0	
5. Name of driller: Davies- Hamilton Drilling		14. Total number core boxes: [illegible]	
6. Direction of hole: Vertical		15. Elevation ground water: ***	
7. Thickness of overburden: 1.0		16. Date hole: Started 21 Apr 86 / Completed 24 Apr 86	
8. Depth drilled into rock: 30.5		17. Elevation top of hole: 424.[illegible]	
9. Total depth of hole: 35.5		18. Total core recovery for boring: [illegible]	
		19. Signature of inspector: Robert McVey	

Classification of materials:

0.0 to 1.0

CLAY - high plasticity, stiff, moist, brown to dark red, slightly gravelly/cobbly.

1.0 to 5.5

CLAY SHALE - badly weathered to a high/medium plastic medium stiff to stiff clay consistency, moist, color varies from red and light gray to strong brn, yellow brown, and light gray, sandy and gravelly with seams of each, black carbon sheres, silty, increased sand/silt after [illegible].

5.5 to 17.5

SAND - fine, non cemented, friable, slightly damp to dry, yellow brown to yellow and light gray, very silty, thin clay shale seams, [illegible] red, soft core [illegible] [illegible], calcareous.

17.5 to 19.3

LIMESTONE - hard to very hard rock class, [illegible] stained yellow brown to white, some light gray, massive, well cemented, slightly fossiliferous.

19.3 to 22.5

SAND - as seen [illegible] except [illegible] unweathered dark gray, [illegible] fossiliferous.

22.5 to 35.5

SHALE - unweathered, dark gray, massive, [illegible] [illegible] fossiliferous, blocky structure, [illegible]

Remarks:

* Drilling

0 to 5.5' - 8" auger.

5.5 to 12.5' - 4" core, [illegible] of core lost due to washing out. This occurred at sta 21+31, 11' u/s. Offset to sta 21+33, 13' u/s:

0 to 4.5' - 8" auger.

4.5 to 8.5' - 2" shelby (pressed)

8.5 to 10' - 4" core all washed out - bailed hole.

10 to 10.5' - [illegible] auger.

10.5 to [illegible] - [illegible] shelby (pushed)

[illegible] to 35.5' - [illegible] core.

On 18-22 April [illegible] at sta. 21+30, centerline for 101' of 5¼" fishtail hole for SP, resistivity, and gamma log. Hole flushed after drilling, then bailed after logging, then 101' of slotted 2" PVC pipe installed with [illegible] [illegible]. Surface grouted and pipe capped.

***

Bailed hole [illegible] making water [illegible] [illegible] check on 24 Apr 86 at [illegible] [illegible] at 33.2'.

Jars

A. [illegible]
B. [illegible]
C. [illegible]
D. [illegible]
E. [illegible]
F. [illegible]

Boxes

1. [illegible]
2. 12.5 to 18.[illegible]
3. [illegible]
4. 25.[illegible] to 35.5*

* tape [illegible]

US ARMY ENGINEER DISTRICT FORT WORTH
CORPS OF ENGINEERS
FORT WORTH TEXAS

COOPER LAKE
SULPHUR RIVER, TEXAS

EMBANKMENT

LOGS OF BORINGS
8A4C-219, 8A4C-220, 8A4C-221, 8A4C-222

Submitted by: ROBERT BEHM	[illegible] DACW63-87-B-0064	Dated MAY 87	Sequence No. 292
Engineer	Contract No. DACW63-87-C-0085		
	Drawing number	Sheet No. G 66 of 67	

To ACCOMPANY FINAL FOUNDATION REPORT PLATE 55

Hole No. [illegible]

DRILLING LOG — Division: SWD — Installation: Ft. Worth — Sheet 1 of 2 sheets

Project: Cooper Dam

Name of driller: Brothers - Hamilton Drilling

Direction of hole: Vertical

Signature of inspector: Bob McCoy

Elevation	Depth	Legend	Classification of materials (Description)	% Core Recovery	Box or Sample No.	Remarks
			0.0 to 16.0			* Drilling
			CLAY		A	0 to 50' - 8" auger, 50 to 58' - 6" core, bailed hole to 55.6'.
			0.0 to 3.0 - medium to low plasticity, soft to medium stiff, moist, dark brown to [illegible] yellow brown, silty, sandy, non calcareous.		B	*** 18 hour check at 22.9'.
			3.0 to 5.0 - low plast., very stiff, dry, brown, very silty sandy, non calc.		C	Jars: A. [illegible]; B. [illegible]; C. [illegible]; D. [illegible] to 16.0; E. [illegible] to 24.0; F. 24.0 to 29.0; G. 29.0 to 32.0; H. [illegible]; I. [illegible]; J. [illegible] to 50.0
			5.0 to [illegible] - [illegible] plast., very stiff, slightly damp, yellow brown, strong brown, some white, silty, non calc.		D	
			12.0 to 16.0 - clay and sand interbedded, sand is fine grained, silty, the clay is medium to low plast., very stiff, damp, both are light gray with some black and strong brown, non calc., unit has a massive and consolidated appearance.		E	Carton: 52.5 to [illegible]. This sample was wrapped in aluminum foil and placed in box at proper depth position.
	10		16.0 to 24.0			Note: primary called at 50' because this unit was dry under a water bearing unit.
			SAND - fine grained, medium dense, damp, light gray, very silty and clayey, non calc.		F	
	20		24.0 to 32.0			
			CLAY		G	
			24.0 to 28.0 - medium to low plasticity, stiff, moist, light gray and yellow brown, very silty, sandy, non calc.		H	
	30		28.0 to 32.0 - high to medium plast., medium stiff, very moist, yellow brown, some strong brown, very silty sandy, non calc.		I	
	40		[illegible]		L	
			[illegible]			
			[illegible] to 48.0		J	
			SHALE - weathered [illegible] brown and strong brown to dark yellow brown and light gray, [illegible] moist, silty and sandy with scattered [illegible] seams [illegible], slightly calcareous, very soft to soft rock classification; [illegible] plastic and stiff clay [illegible] plastic and [illegible] to massive.	Lost 0.0	Box 1	
	50		48.0 to 57.0	1.0	Box 2	
			SAND - unweathered, dark gray, fine grained, silty, clayey, [illegible] cemented [illegible] to [illegible] cemented seams [illegible], slightly calc.			
	60					

Hole No. [illegible]

DRILLING LOG — Division: SWD — Installation: Ft. Worth — Sheet 1 of 2 sheets

Project: Cooper Dam

Location: Sta. 131+50, centerline

Datum for elevation shown: [illegible] 1250

Hole No.: [illegible]

Name of driller: Brothers - Hamilton Drilling

Direction of hole: Vertical

Thickness of overburden: 38.0

Depth drilled into rock: 12.0

Total depth of hole: 47.0

Signature of inspector: Bob McCoy

Elevation	Depth	Legend	Classification of materials (Description)	% Core Recovery	Box or Sample No.	Remarks
			0.0 to 14.0			* Drilling
			CLAY		A	0.0 to 40' - 8" auger, 40 to 50' - [illegible] core. Water level taken after [illegible] was completed and before [illegible] was begun.
			0.0 to 4.0 - high plasticity, soft, moist, dark gray, slightly silty, non calc.		B	*** 18 hour check at [illegible]
			4.0 to 7.0 - high to medium plast., hard (soils classification), slightly damp, dark brown, silty, sandy, non calc.			Jars: A. [illegible]; B. [illegible]; [illegible]; G. 26.0 to 28.0; H. 28.0 to [illegible]; [illegible]
	10		7.0 to 14.0 - high plast., very stiff, slightly moist, brown, silty, non calc.		C	
			14.0 to 38.0			
			SAND			
			14.0 to 17.0 - fine grained, slightly moist, white, some strong brown, [illegible] gray, silty, non calc.		D	[illegible]
	20		17.0 to 22.0 - fine, moist, white with some yellow brown, silty, less [illegible] than above, non calc.		E	
			22.0 to 24.0 - fine, slightly moist, yellow brown and light gray, very silty, clayey, non calc.		F	Note: [illegible] weathered [illegible]
			24.0 to 28.0 - fine grained, dry, brown, non calc.		G	
	30		28.0 to 30.0 - fine, slightly moist, yellow/light yellow, silty, non calc.		H	
			30.0 to 36.0 - fine grained, moist, brownish yellow, yellow brown, and light gray, very silty, very clayey, non calcareous		I	
					J	
	40				K	
			[illegible] to [illegible]			
			GRAVEL - fine grained, moist, brownish yellow, very clayey, sandy, silty, calc., limey.		Box 1	
			38.0 to 47.0	1.0	Box 2	
			SHALE			
	50		38.0 to 43.0 - weathered yellow brown and light gray, color grades to dark gray with some [illegible] brown at 42.0', thin sand and or silt seams scattered throughout (non cemented), except for a very thin and weakly cemented seam at [illegible] less than [illegible] thick, this unit tends to be friable, massive, jointed throughout, soft rock classification, slightly [illegible] from 40 to 42.0', slightly calc.			
			43.0 to 46.0 - unweathered dark gray, highly jointed (horizontal only observed), joints are frequently gypsum filled, massive, soft (rock class), thin sand and silt seams scattered, slightly calc.			

DRILLING LOG [illegible]

Project: Cooper Dam

[illegible]

DRILLING LOG

INSTALLATION: Ft. Worth

HOLE NO. Wn[illegible]

Elevation	Depth	Legend	Classification of Materials (Description)	% Core Recovery	Box or Sample No.	Remarks
			0.0 to 22.0 CLAY		A	Drilling: 0 to [illegible] auger, [illegible] to [illegible] core, water level taken after auger and before coring began.
			0.0 to 4.0 - high to medium plasticity, stiff, moist, brown, silty, sandy, non calc.		B	
			4.0 to 6.0 - low plast., very stiff, slightly damp, brown, very silty, sandy, non calc., silt zones within section		C	24 hour check at [illegible]
		10	6.0 to 12.0 - as above except hard with [illegible] (fissured), also a medium to low plasticity			JARS
			12.0 to 18.0 - medium to low plast., very stiff to hard, slightly moist, light brown, some yellow brown, very silty, sandy, non calcareous.		D	
		20	18.0 to 22.0 - high to medium plast., stiff, moist, brown, yellow brown, and light gray, very silty sandy, silt and sand seams scattered, non calc.		E	
			22.0 to 32.0 SAND		F	
			22.0 to 26.0 - fine grained, moist, [illegible] brown and [illegible] gray, [illegible] silty and clayey, [illegible]		G	
		30	[illegible]		H	
			[illegible]		I	
			[illegible]		J	
		40	[illegible]			
		50	[illegible]			

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

COOFER LAKE
SULPHUR RIVER, TEXAS

EMBANKMENT

LOGS OF BORINGS
8A6C-224, 8A6C-225, 8A6C-226

SUBMITTED BY: ROBERT HEHN

DATED: MAY 87

CONTR NO. DACW63-87-C-0085

SHEET NO. G-67 OF 67

SEQUENCE NO. 293

TO A. COMPANY FINAL FOUNDATION REPORT PLATE 54