INTERNATIONAL TECHNOLOGY CORPORATION

Project No. 202208
August, 1989

Design Report

Asbestos Waste Management Unit Coalinga, California

Prepared For:
Southern Pacific Transportation Company
and Atec Environmental Consultants

INTERNATIONAL TECHNOLOGY CORPORATION

August 15, 1989

Project No. 202208-06-03

Mr. Dan Meer
U.S. Environmental Protection Agency
Region IX
215 Fremont Street
Section T-4-3
San Francisco, California 94105

90% SUBMITTAL
DESIGN REPORT
ASBESTOS WASTE MANAGEMENT UNIT
SOUTHERN PACIFIC TRANSPORTATION COMPANY
COALINGA, CALIFORNIA

Gentlemen:

Enclosed for your review is one copy of the 90% submittal of the above referenced design report in accordance with the Consent Decree agreed to and signed by Southern Pacific Transportation Company and the U.S. EPA.

The design report incorporates a revised final cover which is lower in profile. In addition, the revised cover now incorporates a synthetic liner, a granular and synthetic drainage layer, and a soil cover with vegetation. The specification for an irrigation system is also included.

The revisions to the original text are underlined for ease of review. Major revisions were made to the specifications (Appendix C) and were not underlined. The contingent ground-water monitoring plan (Appendix H) is a new section.

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If there are any questions, please call.

Very truly yours,
IT CORPORATION

Len Yamamoto

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LOY/lmh

Enclosure

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DESIGN REPORT
ASBESTOS WASTE MANAGEMENT UNIT
SOUTHERN PACIFIC TRANSPORTATION COMPANY
COALINGA, CALIFORNIA

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PREPARED FOR

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August 1989

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1.0 INTRODUCTION

Southern Pacific Transportation Company (SPTC) proposes to construct an on-site asbestos mining waste disposal unit at its Coalinga site in compliance with U.S. Environmental Protection Agency (EPA) Administrative Order No. 87-04. This report has been prepared to describe and document the design of the asbestos waste management unit (WMU), including the excavation plan, vadose zone monitoring plan, and closure plan.

1.1 PROJECT SITE DESCRIPTION

The Coalinga site is located near the southwestern corner of the City of Coalinga (Figure 1). The site covers an area of approximately 107 acres. It is bounded to the north by Fourth Street and approximately 1/4 mile to the south by the intersection of Lucille Avenue and Highway 198. Glenn Street represents the eastern border, and Forest Street and Elm Avenue mark the western boundary.

1.2 BACKGROUND

The project site is owned by the Southern Pacific Transportation Company (SPTC). All or parts of the site were or are leased by SPTC to the Atlas Asbestos Company, U.S. Asbestos Company, Marmac Industries, and perhaps others for use as distribution centers for milled asbestos ore.

Following the EPA's initial inspection of the site on April 22, 1987, and subsequent special studies, EPA Administrative Order No. 87-04 was issued on August 24, 1987. This order required SPTC to clean up the asbestos-contaminated site.

The characteristics of the waste, in terms of extent and concentration, have been reported in the "Hazardous Substance Containment Report" (IT Corporation, 1988). The cleanup will include excavation, removal, and disposal of the asbestos-contaminated materials into a permitted waste management unit. Based on economic and safety reasons, an on-site WMU is proposed to be constructed to receive the waste from the cleanup operation. The WMU will receive a final cap at the completion of the waste filling. Siting and design criteria and final closure design of the WMU will be in compliance with applicable regulations. Applicable State regulations are the California Code of Regulations, Title 23, Water Resources Control Board, Subchapter 15, Discharges of Waste to Land (23 CCR).

2.0 ASBESTOS WASTE MANAGEMENT UNIT (WMU) DESIGN AND CONSTRUCTION

2.1 LOCATION AND SITE CHARACTERIZATION

The proposed WMU will be located at the south end of the site, near the intersection of Lucille Avenue and Highway 198 (Figure 1). During the investigation for the site characterization study, five soil borings were drilled to study the subsurface and hydrogeologic conditions. Detailed studies and results are reported in the "Site Characterization Report, Coalinga, California," prepared by IT Corporation and presented in Appendix A.

The findings and conclusions of the site characterization are as follows:

1. Natural geologic materials with permeabilities much less than 1 x 10^{-6} cm/s underlie the site at depths of 20 to 50 feet and should prevent vertical movement of fluid from the proposed WMU.
2. The proposed location of the unit is within a Zone C flood hazard zone and will not be subject to inundation from a 100-year flood.
3. The proposed unit location is not within 200 feet from a known Holocene fault.
4. The proposed unit location is not subject to rapid geologic change.
5. Precipitation in the area averages approximately 7 inches per year.
6. Pan evaporation rate in the area averages about 88 inches per year.
7. Ground water beneath the site occurs at depths of 100 to 150 feet.
8. Ground-water quality is poor. The water contains sulfate, chloride, and total dissolved solids (TDS) concentrations above drinking water action levels.

The waste proposed for disposal in the WMU consists primarily of asbestos-contaminated materials, which have the following characteristics:

- The waste is presently in a relatively dry condition
- The waste does not have an acid-generating potential
- The asbestos is relatively insoluble and poses little or no threat to ground water

- The asbestos is considered a health hazard only when it is friable and becomes airborne.

Based on the above findings and conclusions, the California Regional Water Quality Control Board (RWQCB) agreed, as indicated in their letter dated August 29, 1988 (Appendix B), that the waste should be classified as a Group B mining waste covered under 23 CCR 2571. The RWQCB further concluded that the siting of the WMU is suitable for the waste and meets the criteria of 23 CCR 2570(c)(2) and (3) for exemption from requirements for liners and leachate collection and removal systems provided that a vadose zone monitoring plan (Section 3.0) and a contingency ground-water monitoring plan (Appendix H) are submitted to the RWQCB for review prior to construction.

2.2 CONFIGURATION AND CAPACITY

The completed dimensions of the WMU at inside top of slope will be 225 feet by 225 feet. The final elevation of the bottom will be 671.5 feet, which is approximately 20 feet below existing ground surface. Side slopes will be constructed at a ratio of 3:1 (horizontal:vertical) on all sides. A 20-foot-wide embankment will be constructed around the unit to raise the top level of the unit to the adjacent topography after removal of the contaminated soil. The embankment will be constructed with a 2-percent slope away from the unit to minimize run-on into the unit during construction and waste filling operations. The constructed height of the embankment will be approximately 1 to 3 feet depending upon the depth of waste removal in the area and the adjacent topography. The detailed configuration of the unit is shown in the Construction Drawings (Appendix C). Two access ramps have been incorporated into the design to facilitate construction and waste filling operations.

The design capacity of the WMU is 22,000 cubic yards, which will provide a 10-percent tolerance for the estimated amount of waste at the site. The estimated volume of the asbestos-contaminated soil is approximately 20,000 cubic yards.

2.3 SLOPE STABILITY

The slope stability model is based on the configuration of the WMU (Construction Drawing, Sheet 2 of 3, Appendix C) and the generalized soil stratigraphy presented in the Site Characterization Report (Figures 14 and 15 in Appendix A) and is shown in Figure 2. Four soil types were included in the model. The shear strength and unit weight of each soil type were based on the laboratory soil test results (Appendix D) and are shown in Figure 2.

A computer program, PCSTABL5, was used to calculate the theoretical factors of safety for the excavated slope of the WMU. PCSTABL5 is an updated version of the STABL (Purdue University, 1975) program modified for usage on a PC computer. PCSTABL5 provides general solutions to slope stability problems using two-dimensional limit equilibrium theory. The modified Bishop's method of slices was used to model circular failure surfaces. The analyses indicated a computed static factor of safety of 2.0 for the interior cut slope (Figure 2). The design slope is considered safe because the computed factor of safety is greater than the generally accepted design criterion of 1.5. Seismic slope stability was not analyzed because of the short time (approximately 2 months) during which cut slopes will be exposed prior to backfilling with waste.

2.4 CONSTRUCTION PROCEDURES

The construction of the WMU is defined in the Technical Specifications (Appendix C) and includes the following procedures:

1. The excavation of the contaminated soil will be performed within defined areas. The contaminated soil in the construction area is expected to be about 1 to 3 feet from the surface. Sampling procedures for decontamination verification are presented in the "Hazardous Substance Removal Plan" (ATEC Environmental Consultants, 1988).

2. The excavated contaminated soil will be stockpiled in the southeastern corner of the site, within the contaminated area, as shown in Construction Drawing, Sheet 1 of 3 (Appendix C). Measures will be taken to prevent wind dispersal of the stockpile, as detailed in the "Hazardous Substance Removal Plan" (ATEC Environmental Consultants, 1988).

3. Embankments will be constructed to encompass the WMU to the design elevation using clean soils excavated from the area of the WMU. The tops of the embankments will be graded 2 percent away from the unit to minimize run-on.

4. Additional clean materials excavated from the unit during construction will be stockpiled separately to the north of the unit, as shown in the Construction Drawing, Sheet 1 of 3 (Appendix C).

5. When the excavation is completed, two trenches will be excavated across the bottom of the WMU for the installation of two neutron probe access tubes.

6. After the neutron probe access tubes are assembled and lowered into the trenches, the trenches will be backfilled and compacted with native materials.

All construction shall be in conformance with the Technical Specifications (Appendix C) and the Construction Quality Assurance Plan (Appendix E).

4.0 CLOSURE PLAN

4.1 CLOSURE PERFORMANCE STANDARD

The asbestos WMU is classified as a Group B mining waste landfill. Closure plan requirements are outlined in 23 CCR, Subchapter 15. This closure plan is designed to accomplish the following:

- Minimize the need for postclosure maintenance
- Control and minimize, to the extent necessary to protect human health and the environment, postclosure escape of hazardous waste, hazardous waste constituents, leachate, contaminated runoff, or hazardous waste decomposition products to the ground or surface waters or to the atmosphere
- Comply with the closure requirements of the applicable regulations.

4.2 CLOSURE PLAN REQUIREMENTS

The intent of the above standards will be met by providing a final cover designed and constructed to perform the following functions:

- Minimize downward entry of water into the closed WMU throughout the postclosure period
- Function with minimum maintenance
- Promote drainage and minimize erosion or abrasion of the cover
- Accommodate settlement and/or subsidence so that the integrity of the cover is maintained
- Preclude ponding of rainfall and/or of surface run-on over the closed area.

The performance specifications identified above will be achieved by placing compacted fill and installing a final cover over the unit. In accordance with 23 CCR 2581(a), the prescriptive standards of the final cover consist of the following elements (from bottom to top, following the construction sequence):

- A 2-foot-thick layer of selected, compacted materials consisting of contaminated or clean materials

- A 1-foot-thick layer of compacted clay cover liner having a permeability of 1×10^{-6} cm/s or less
- A 1-foot-thick layer of protective soil cover graded to promote drainage and designed to reduce the potential for erosion.

4.3 ENGINEERED ALTERNATIVE

23 CCR 2510(b) provides that alternatives to construction or prescriptive standards may be considered in response to the following:

- The construction of prescriptive standard is not feasible because of cost or impracticality
- A specific engineered alternative is found that (A) is consistent with the performance goal addressed by the particular construction or prescriptive standard, and (B) affords equivalent protection against water quality impairment.

The alternative to the prescriptive final cover is to replace the 1-foot-thick compacted clay cover liner with a layer of ¼-inch Claymax® (manufactured bentonite mat). A compacted clay cover liner is not practical for the following reasons:

- Site investigations indicated that the available clay source in this area would be about 20 feet below existing ground. The cost of obtaining that borrow clay would be exorbitant.
- The cost of obtaining borrow clay from other sources is equally prohibitive because of high transportation charges.
- The quality of the borrow clay from outside sources is unknown and probably cannot be determined within the time constraints of this project.

The proposed engineered alternative of Claymax® is consistent with the performance goal addressed by the prescriptive compacted clay liner and affords equivalent protection against water quality impairment for the following reasons:

- Based on permeability testing performed by GeoServices, Inc., Consulting Engineers of Norcross, Georgia, Claymax® has a hydraulic conductivity of 2×10^{-10} cm/s.

- A performance comparison study of Claymax® and compacted clay liner conducted by GeoServices, Inc. (Appendix F), demonstrated that the seepage velocity (advective flow) through a compacted clay liner ($k = 1 \times 10^{-6}$ cm/s) will always exceed that of a ¼-inch Claymax®, regardless of the thickness of the compacted clay liner (Appendix G). In summary, based on equivalent seepage velocity, the ¼-inch Claymax® is equivalent to an infinite thickness of compacted clay liner ($k = 1 \times 10^{-6}$ cm/s).

- Based on equivalent breakthrough time (Appendix G), the ¼-inch Claymax® is equivalent to at least 20 inches of compacted clay liner ($k = 1 \times 10^{-6}$ cm/s), which is well above the required 12 inches.

- The Claymax® is more flexible than the compacted clay liner and will withstand relatively large deformation without cracking or compromising the integrity of the cover system.

In addition, the Claymax® is manufactured under controlled conditions and is readily available to the site. The handling and installation of Claymax is easier and faster than the compacted clay liner, and the quality control for the Claymax®, which is described in the Construction Quality Assurance Plan (Appendix E), is simpler.

Claymax® has been accepted as an alternative for a compacted clay liner both nationally and internationally. Similar successful usages and installations for a final cover have been implemented at the following sites:

- Ogden Martin Systems of Haverhill, Inc.
  Haverhill, Connecticut

- Shelton Landfill Metal Hydroxide Disposal Area
  Shelton, Connecticut

Similar successful landfill applications and installations using bentonite mat as a moisture barrier have been implemented at the following sites:

- Chemical Waste Management, Inc.
  - Tullytown, Pennsylvania
  - Pottstown, Pennsylvania
  - G.R.O.W.S., Pennsylvania

- Brower County Municipal Landfill
  Ft. Lauderdale, Florida

- Almenno Landfill
  Bergamo, Italy

- Antwerp Landfill
  Antwerp, Belgium

- Municipal Landfill
  Hadsund in Jutland, Denmark

- Crymlgen Bog Landfill
  Synthetic, Wales

4.4 COVER SYSTEM

The cover system for the WMU will consist of the following components (from bottom to top, following the construction sequence):

- A 2-foot foundation layer
- Bentonite mat (Claymax®)
- A 1-foot protective soil cover
- A 40-mil polyvinyl chloride (PVC) liner
- Geocomposite
- A 9-inch gravel layer
- Geotextile
- A 1-foot vegetative soil cover.

The final cover will be graded to provide a 2.5-percent fall from the center of the fill. Design details of the final cover system are presented in the Construction Drawings (Appendix C). All construction work shall conform with the Construction Quality Assurance Plan (Appendix E).

4.4.1 Foundation Layer

A minimum of 2 feet of selected waste or clean fill will be compacted to provide a foundation on which to install the low-permeability clay layer (Claymax®). The foundation layer will be compacted in maximum 1-foot-thick loose lifts to obtain 90 percent of maximum dry density as determined in accordance with ASTM D 1557. The foundation layer will be graded to provide a minimum 2.5-percent slope.

4.4.2 Bentonite Mat (Claymax®)

A layer of ¼-inch-thick bentonite mat, such as Claymax® as manufactured and supplied by Clem Environmental Corporation or an equivalent, will be installed on top of the foundation layer. The bentonite mat is an engineered alternative to the prescriptive standard of a compacted clay liner.

4.4.3 Protective Soil Cover

A minimum of 1-foot-thick protective soil cover will be placed and compacted on top of the bentonite mat. The fill will be compacted in one lift to obtain 90 percent of maximum dry density as determined in accordance with ASTM D 1557. Testing will be performed at a depth of 6 inches in the compacted fill. This layer of fill will provide protection to the underlying bentonite mat and will also function as the foundation for the PVC liner.

4.4.4 PVC Liner

A 40-mil-thick PVC liner will be placed over the compacted soil cover. The PVC liner will serve as an impermeable barrier and will ensure the effectiveness of the overlying gravel drainage layer.

4.4.5 Geocomposite

Geocomposite, a synthetic drainage net sandwiched between two layers of geotextile, will be placed over the PVC liner. The geocomposite will serve as a drainage layer and will also protect the PVC liner from the overlying gravel layer.

4.4.6 Gravel Drainage Layer

A gravel drainage layer composed of pea gravel will be placed over the geocomposite. The gravel layer will serve as a drainage layer and will also minimize root penetration of the vegetation in the overlying soil cover.

4.4.7 Geotextile

A layer of geotextile will be placed over the gravel layer and will serve as a separator between the gravel and the overlying soil cover.

4.4.8 Vegetative Soil Cover

A minimum 1-foot-thick vegetative soil cover will be placed over the geotextile. The soil cover will be hydroseeded for the growth of a grass cover. The grass will minimize erosion and will also provide an aesthetically pleasing area around which commercial development is planned. A sprinkler system will be incorporated into the cover.

4.5 SLOPE STABILITY

The WMU will be filled to the tops of the embankments. The unit will mound slightly at the center due to the 2.5-percent grade to promote drainage. However, the overall configuration of the unit after closure will be relatively flat and nearly conformable to the existing topography. As a result, slope stability is not a concern.

4.6 SETTLEMENT

The WMU will be constructed by excavation and then backfilled to approximately the preconstruction level using similar material. The settlement of the foundation will be negligible because the foundation soils will experience little additional pressure.

Settlement of the waste fill will also be negligible because the waste will be compacted by sheepsfoot roller until the roller "walks" on the fill. In addition, the waste is relatively dry and free of decomposable and organic material.

Two settlement hubs will be installed near the center of the landfill at closure. Settlement of the hubs will be monitored from two permanent benchmarks set outside the fill area, in accordance with 23 CCR 2580(d), by a registered land surveyor or a registered civil engineer certified to do land surveying in California.

4.7 DRAINAGE AND EROSION CONTROL

The completed surfaces of the closed WMU will have a grade of at least 2.5 percent to allow for proper drainage. The elevation of the unit will be generally slightly higher than the adjacent topography to prevent run-on.

The 1-foot-thick protective soil cover will be grassed to provide long-term erosion control to the cover system. The grass will be inspected throughout the postclosure period for damage or erosion. Repairs or maintenance will be performed as necessary to maintain the WMU cover integrity in accordance with 23 CCR 2581(b) and (c). The internal gravel drainage layer will minimize infiltration of rainfall and migration through the soil cover by draining fluids off the cover system.

REFERENCES

REFERENCES

ATEC Environmental Consultants, 1988 "Hazardous Substance Removal Plan, Southern Pacific Transportation Company, Coalinga, California," December 1988.

IT Corporation, 1988, "Hazardous Substance Containment Report," prepared for Southern Pacific Transportation Company.

Purdue University, 1975, "Computer Analysis of General Slope Stability Problems (STABL), Joint Highway Research Project," JHRD-75-8, June 1975.

FIGURES

FIGURES

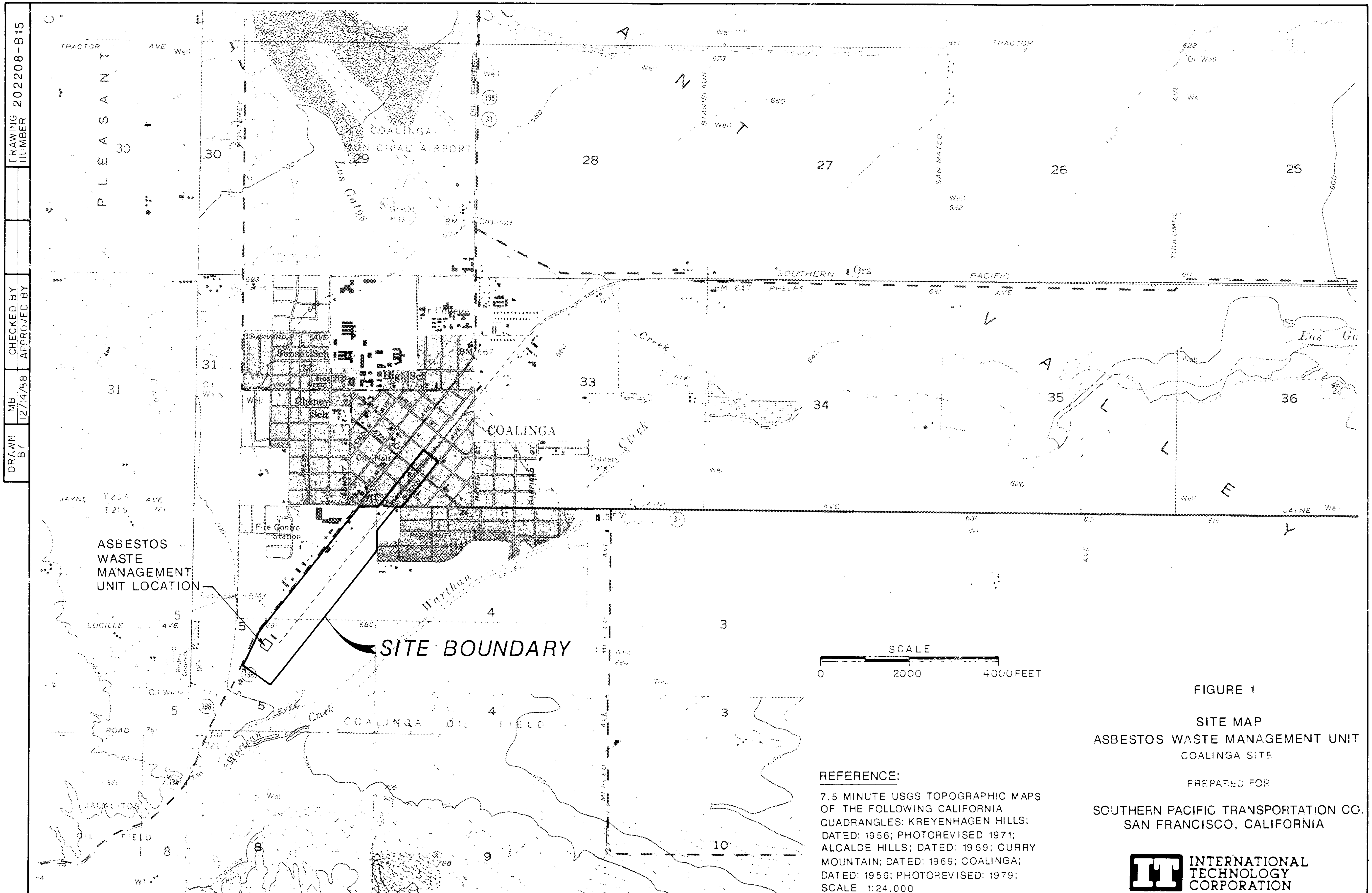


FIGURE 1

SITE MAP
ASBESTOS WASTE MANAGEMENT UNIT
COALINGA SITE

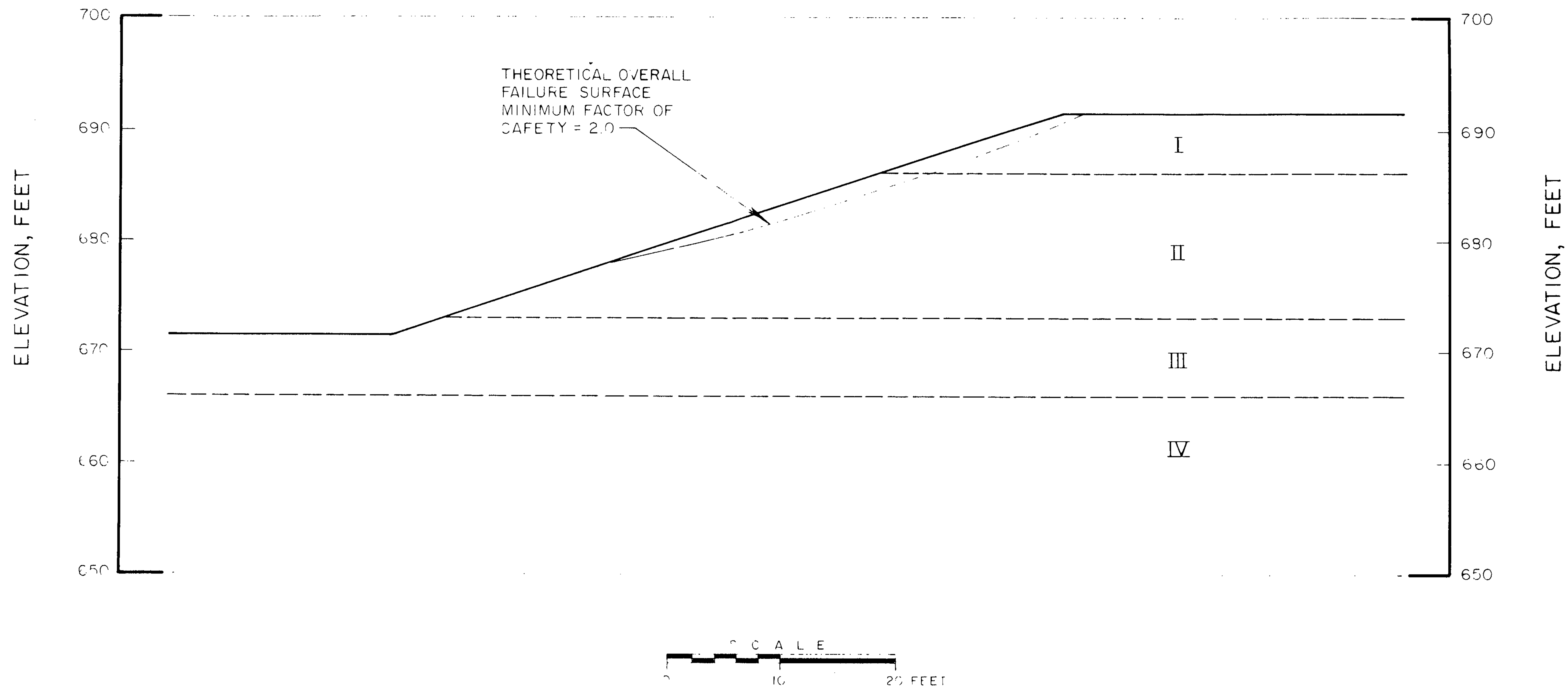
PREPARED FOR

SOUTHERN PACIFIC TRANSPORTATION CO.
SAN FRANCISCO, CALIFORNIA

INTERNATIONAL TECHNOLOGY CORPORATION

REFERENCE:

7.5 MINUTE USGS TOPOGRAPHIC MAPS OF THE FOLLOWING CALIFORNIA QUADRANGLES: KREYENHAGEN HILLS; DATED: 1956; PHOTOREVISED 1971; ALCALDE HILLS; DATED: 1969; CURRY MOUNTAIN; DATED: 1969; COALINGA; DATED: 1956; PHOTOREVISED: 1979; SCALE 1:24,000



SOIL TYPE	DESCRIPTION	UNIT WEIGHT (PCF)	SHEAR STRENGTH PARAMETERS	
			COHESION, c (PSF)	FRICTION ANGLE, Ø (DEGREE)
I	SILTY TO CLAYEY SAND	100	0	30
II	GRAVEL TO SAND	110	0	35
III	SANDY CLAY	115	400	18
IV	SAND-GRAVEL	120	0	35

FIGURE 2

SLOPE STABILITY ANALYSIS
COALINGA SITE

PREPARED FOR

SOUTHERN PACIFIC TRANSPORTATION CO.
SAN FRANCISCO, CALIFORNIA

INTERNATIONAL TECHNOLOGY CORPORATION

DRAWING NUMBER 202208-B16

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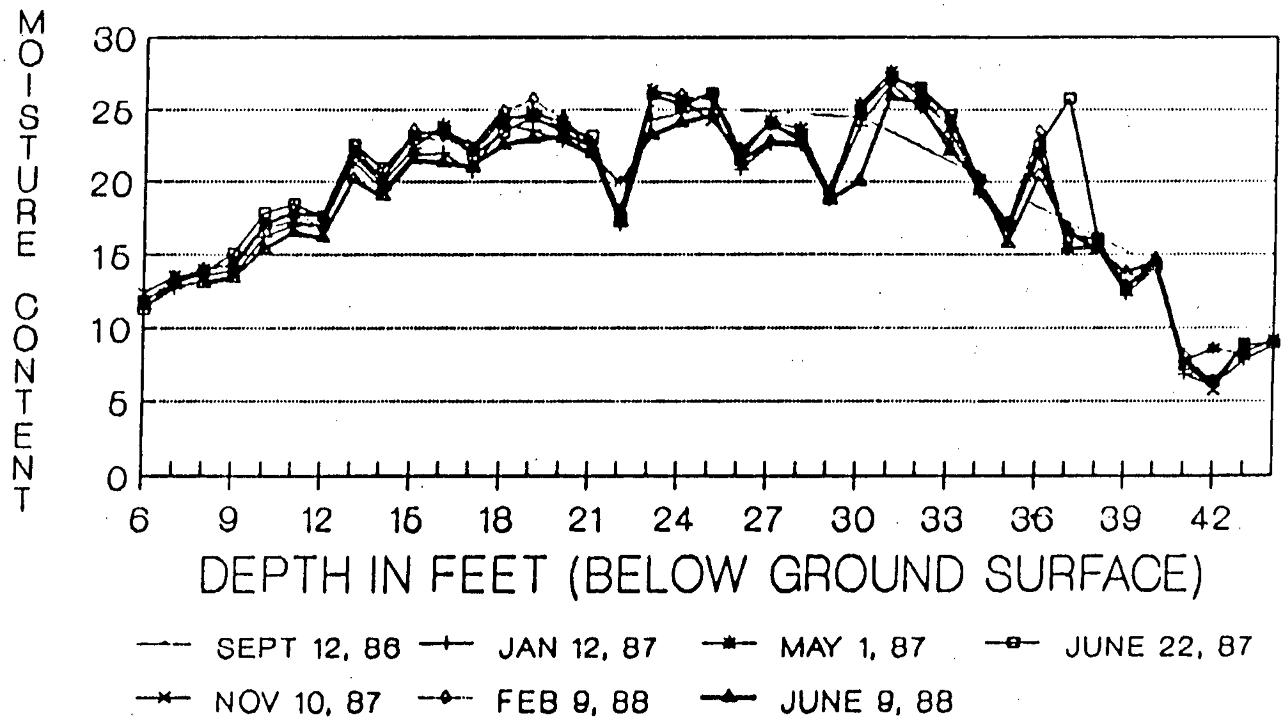

FIGURE 3

TYPICAL MOISTURE DATA READOUT FROM A NEUTRON PROBE

PREPARED FOR

SOUTHERN PACIFIC TRANSPORTATION CO.
SAN FRANCISCO, CALIFORNIA

INTERNATIONAL TECHNOLOGY CORPORATION

DRAWN BY MAM 12-21-88 | CHECKED BY GO 1/12/89 | APPROVED BY 1/12/89 | DRAWING NUMBER 202208-A

14247

"Do Not Scale This Drawing

APPENDIX
A

APPENDIX A

SITE CHARACTERIZATION REPORT

SITE CHARACTERIZATION
COALINGA, CALIFORNIA

Project No. 202208

PREPARED FOR

Southern Pacific Transportation Company

PREPARED BY

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August 1988

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1.0 INTRODUCTION

This site characterization report has been prepared for the the Southern Pacific Transportation Company (SPTC) Coalinga site to characterize the local hydrology and geology as the basis for the design of a mining waste disposal facility. Major objectives of this site characterization are to provide the Regional Water Quality Control Board (RWQCB) with the information necessary to judge whether the wastes should be disposed of as Class A or B mining wastes, as defined by Subchapter 15, Title 23 of the California Code of Regulations; to provide a basis for design of the disposal facility; and to determine the level of monitoring necessary to satisfy Subchapter 15 requirements. This characterization is based on the following assumptions about the proposed landfill (waste pile):

- The waste pile will be located within or near the area defined by the borings shown on Figure 13.
- The waste pile will be approximately 300 feet by 300 feet.
- It will have a total capacity of approximately 30,000 tons.
- An impermeable cap (hydraulic conductivity $\geq 1 \times 10^{-7}$ cm/s) will be installed over the waste soon after it is transferred into the cell.
- The cap will be constructed to provide positive drainage.

The Coalinga site is located near the southwestern corner of the City of Coalinga and is comprised of approximately 107 acres. It is bounded to the north by Fourth Street and to the south by the intersection of Lucille Avenue and Highway 198. Glenn Street represents the eastern border, and Forest Street marks the western boundary (Figure 1).

The site characterization is based on a combination of a literature review and field investigations. From the literature review, ground-water level and ground-water quality data were obtained from wells in the nearby vicinity of the site, plus historical use records and rainfall data. The field investigation was performed from May 18 to 20, 1988, consisted of five exploratory borings. The investigation provided detailed geologic information and soil samples from the southern portion of the site and ground-water sampling to confirm historical water-quality analyses.

Soil samples were collected and submitted to a laboratory for general chemistry and metals analysis, as well as hydraulic conductivity testing. Additional water-quality data were obtained from a water sample taken from a well at West Hills College, approximately 1 mile from the site. This water sample was analyzed to provide general water-quality data for existing aquifer conditions. Three waste samples were retrieved from archived samples at the site and submitted for laboratory analysis to determine the leachate-generating potential of the waste, as well as to provide data on the mobility of the constituents found in the waste.

2.0 WASTE CHARACTERISTICS

This section summarizes the waste characteristics of the Coalinga site. The character of the waste, in terms of extent and concentration, has been previously reported in the "Hazardous Substance Containment Report" (IT Corporation, 1988). Section 2.1 discusses the historic uses and current conditions of the site. Section 2.2 discusses the leachate-generating potential of the waste.

2.1 HISTORY

The site consists of four smaller areas, which are described in order as follows:

> Area 1 - Marmac Warehouse (abandoned) - The warehouse is located on Elm Avenue (Highway 198) in the southwest section of the City of Coalinga, across the road from the California Department of Forestry building. The site is suspected of having been a chromium ore and asbestos distribution center and currently houses approximately 1,400 cubic yards of suspected chromium ore waste.
>
> Area 2 - Storage Yard - Located approximately ½ mile south of the Marmac Warehouse on Elm Avenue (across the road from 926 West Elm Avenue). This storage yard contains stacked pipes that are believed to contain asbestos.
>
> Area 3 - Atlas Shipping Yard - An asbestos distribution center was operated in Coalinga by the Atlas Asbestos Company at the corner of Sixth Street and Glenn Avenue. Lots occupied by the Coalinga Automotive Center and Coalinga Machine Works, located near the Atlas Shipping Yard, are suspected former railroad shipping areas for asbestos.
>
> Area 4 - U.S. Asbestos Company - The property is currently occupied by the Miller Transport Company. Mounds on the premises allegedly are asbestos waste piles.

The land on which these areas are located is currently, or has previously been, owned by SPTC. From 1955 to 1980, these four areas were active in the milling, manufacture, storage, and/or transportation of asbestos-containing materials (ACM). As a result, residual ACM has been found at some or all of these areas.

In addition, the railroad corridor within the 107 acres of the site was the primary means of transportation for the ACM from the Coalinga area and, thus, is suspected to contain asbestos.

2.2 ACID GENERATING POTENTIAL

One of the factors involved in determining the group classification of a mining waste is the acid-generating potential of the waste. An acceptable methodology for determining the acid-generating potential of the waste, according to the RWQCB (July 1988, personal communication), is a laboratory method similar to the CAM extraction preparation procedure for determining metal concentrations. With the exception of replacing the citrate buffer solution with deionized water, the method preparation is identical. The pH of the extractant obtained from the preparation procedure is measured directly. If the pH of the extractant is acidic, then the waste has potential for generating acid leachate.

The acid-generating potential of three composite waste samples (1113A-1117A and 1113B-1117B, 3905A-3909A and 3905B-3909B, and 5005A-5009A and 5005B-5009B) was determined according to the methodology described above. The results of the analyses indicate that the leachate extractant from the waste has a pH of 9.2, 8.8, and 7.3 (Appendix A) simply stated, the waste has little to no acid-generating potential.

3.0 CLIMATOLOGY

This section discusses the climatology of the Coalinga area as it relates to the leachate-generating potential of the waste.

The site is located in a semiarid region, characterized by moderately low amounts of precipitation and relatively high rates of evaporation. Estimates of precipitation for the vicinity have been formulated from data recorded at three precipitation stations and data published by the California Department of Water Resources. The names, locations, periods of record, and relevant data from these stations are listed in Table 1. Figure 2 shows the locations of the precipitation stations with relationship to the site.

The following criteria were used to select these stations:

- Stations within approximately 1 mile or less of the site
- Stations with periods of record greater than 15 years
- Stations with distinctly different directions from the site in order to account for potential differences in mean annual precipitation that may occur near the site

The estimated 7.46 inches mean annual precipitation at the site is considered reasonable based on the criteria used to select the stations from which the estimate was derived.

The mean, maximum and minimum recorded annual precipitation values at the selected nearby precipitation stations are given in Table 1.

The estimated mean annual precipitation, as calculated from the 3 nearby stations, is 189.6 mm (7.46 inches). Estimated minimum recorded annual rainfalls range from 79.6 mm (3.13 in) to 61.3 mm (2.41 in); maximum recorded rainfalls range from 446.4 mm (17.57 in) to 397.8 mm (15.66 in).

The estimate for the mean annual precipitation is considered reasonable because the precipitation data has been provided from stations that are near the site (i.e. approximately 1 mile or less), the differences in elevations are less than 10 feet, and the periods of record are for extended amounts of time (greater than 15 years).

The climate of Coalinga is relatively dry. The estimated annual evaporation rate is 2,253 mm (88.7 inches) (Department of Water Resources, 1979).

Taking the precipitation and evaporation rates into consideration, it appears there is a limited amount of water available to generate a leachate from the waste.

4.0 SURFACE WATER

This section discusses the surface water in the vicinity of Coalinga. Section 4.1 describes the Pleasant Valley watershed. Section 4.2 describes surface water nearby the Coalinga site, and Section 4.3 discusses the 100 year-floodplain as it relates to the site.

4.1 PLEASANT VALLEY WATERSHED

The site is located in the Arroyo Pasajero watershed (Figure 3). Four main tributaries, Los Gatos Creek, Warthan Creek, Jacalitos Creek, and Zapato - Chino Creek, drain an area of approximately 500 square miles. The headwaters of these four tributaries begin in the eastern flanks of the Coast Ranges, at elevations of approximately 500 feet, and flow in a generally easterly direction to the San Joaquin Valley floor, at an elevation of less than 300 feet. Streamflow is intermittent. Water uses in the area include cattle grazing, agricultural development, and oil field development.

The New Idria serpentinite body, which contains naturally occurring asbestos, is exposed at the surface in the upper region of the Los Gatos drainage area (Figure 3). The deposit is described by Matthews (1961) as highly sheared and fractured serpentinite, which is composed predominantly of a matrix of soft, friable, powdery serpentinite-containing blocks and fragments of harder rock. The deposit was mined for asbestos by various companies from the 1960s through the 1970s. Mumpton and Thompson (1975) reported that the serpentinite deposit contained as much as 80-percent asbestos in some locations.

All mining of asbestos in the Arroyo Pasajero watershed has been halted, but mine tailings remain exposed at the surface. Because they are highly erodible, these piles of tailings and naturally occurring outcrops of serpentinite, are susceptible to wind and surface-water transportation. As shown in Figure 3, trace amounts of asbestos have been detected in the stream sediments of the Los Gatos Creek drainage area. Surface water from this drainage system provides ground-water recharge in Pleasant Valley and, therefore, may be a source of asbestos contamination in Pleasant Valley ground water.

4.2 NEAR-SITE SURFACE-WATER OCCURRENCE

Warthan Creek, an intermittent stream approximately 3/8 miles to the southeast of the Coalinga site, is the only naturally occurring surface water nearby. The flow direction of the creek is from the southwest to the northeast towards Pasajero Gap. Historical data from Davis (1961) indicate that Warthan Creek flow ranges from 0.5 to 400 cubic feet per second (cfs), depending on the season and sampling point (Figure 4). Historical water-quality data for Warthan Creek are presented in Table 2.

4.3 100-YEAR FLOOD

The site is located outside of the 100-year floodplain. The floodplain location (Figures 6 and 7) was derived from two Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps for Fresno County, effective September 26, 1978, and January 9, 1979. As of August 23, 1982, FEMA has classified the entire community of Coalinga as Zone C (areas of minimal flooding). The letter from FEMA mandating this change is presented in Appendix B.

5.0 GROUND-WATER HYDROLOGY

This section describes the ground-water hydrology in the area. A general summary of the regional hydrologic setting is described in Section 5.1 to provide background information on the ground-water conditions at the site. The hydrology is described in Section 5.2, and regional water quality and site specific water quality are described in Sections 5.3 and 5.4, respectively.

5.1 REGIONAL HYDROLOGY

The Coalinga area is situated in Pleasant Valley, a structural depression on the western margin of the San Joaquin Valley. Pleasant Valley is underlain by unconsolidated sediments that range in thickness from less than 100 feet to several thousand feet. A historical water-level profile (Davis and Poland, 1957) shows that the depth to ground water in this area ranges from approximately 150 feet in the western end of the valley near Coalinga, to less than 100 feet in the eastern portion of the valley (Figure 8).

Ground water in the area is primarily used for irrigation. In 1951, the irrigation wells in the valley had an average yield of about 900 gallons per minute (gpm), with the yield ranging between 200 to 2,000 gpm. The depths of the irrigation wells range from 200 to 1,900 feet, but the majority are less than 500 feet deep.

The aquifer is unconfined and is considered to be continuous throughout the valley (Davis and Poland, 1957). The water table slopes gently from the west to the east (near Pasajero Gap) at approximately 2 feet per mile (Figure 8).

Based on the water-level contour maps (Figures 9 and 10), the interpolated ground-water flow beneath Coalinga is generally from the southwest to the northeast.

5.2 SITE HYDROLOGY

Three wells (20/15-28D1, 20/15-34B1, and 21/15-10D1) have been constructed in the uppermost aquifer in the vicinity of the site. Total depths in these wells historically range from 200 to 261 feet. Water-level depths in these wells range from 102 to 135 feet. Based on these water-level measurements, the depth to water at the site is estimated to be greater than 100 feet.

5.3 REGIONAL WATER QUALITY

Since at least 1951, the water quality of the aquifer in Pleasant Valley has been poor. The sulfate concentrations in the ground water in all reported wells near Coalinga have exceeded the EPA Drinking Water Regulations and the California Department of Health Drinking Water Standards by as much as six times the recommended concentrations. The chloride concentrations in well 21S/15E-10D01 for 1951 and in well 21S/15E-08F01 for 1980 exceed the California Department of Health Recommended Drinking Water Standards for chloride.

Historical water well data published by Davis and Poland (1957) are summarized in Table 3, and well locations are shown in Figure 5. These data indicate that the water quality of three selected wells (20S/15E-28D1, 20S/15E-34B1, and 21S/15E-10D01) in the area near the Coalinga site exhibit moderate to high sodium-sulfate concentrations. The sum constituents of sodium and sulfate range from 890 to 2,170 parts per million (ppm) and average approximately 1,300 ppm. Sulfate concentrations in ground water from these wells range from 650 to 1,600 ppm and average 1,000 ppm. The percentage of sodium relative to the total major anion concentration ranges from 44 to 52 percent and averages 47 percent. Chloride and bicarbonate occur in moderate concentrations, but are minor constituents compared to sulfate.

Based on the Department of Water Resources' records for mineral analyses of ground water for the period from 1978 to 1985, the water quality of four selected wells (20S/15E-28A01 M, 21S/15E-03F01 M, 21S/15E-04Q01 M, and 21S/15E-08F01 M) exhibit moderate to high sodium-sulfate concentrations. The total major anion concentrations range from 1,100 to 2,600 ppm and average 1,700 ppm. Sulfate concentrations in the ground water range from 660 to 1,900 ppm and average 1,300 ppm. The percentage of sodium concentration relative to the major anion concentration ranges from 45 to 53 percent and averages 49 percent.

5.4 SITE WATER QUALITY

The ground-water quality in the Coalinga vicinity was characterized based on a water sample collected from well 20S/15E-33D at West Hills College in Coalinga on June 22, 1988. Laboratory results indicated that general water quality in the aquifer continues to be poor and that it exhibits moderate to high sodium-sulfate concentrations. The sulfate concentrations exceeded the EPA Drinking Water Regulations and the California Department of Health Services Drinking Water Standards. The chloride concentrations exceeded the EPA Drinking Water Regulations and the California Department of Health Services Recommended Drinking Water Standards.

Chloride and calcium carbonate occur in moderate concentrations ranging from 13 to 20 percent and 9 to 12 percent, respectively, of the major anion concentration. Sulfate is, therefore, a much more prevalent constituent of this ground water.

Asbestos structures were detected in the ground-water sample collected from well 20S/15E-33D located at West Hills College. The concentration reported was 1,112 structures per cubic centimeter or 1.112×10^6 structures per liter.

Comparison of the 1951 water-quality data with the 1978 to 1985 data suggests that the water quality of this aquifer has changed very little over the past 25 years (Table 4). Total mineral concentration has increased slightly with time, but the relative percentages of cations and anions have not changed significantly. Stiff diagrams presented in Appendix C show the variations in the water quality for wells near the site.

For example, well 20S/15E-28D01 has three records of water-quality data from September 1, 1951, through May 23, 1973 (Table 4). The calcium, sodium, sulfate, and chloride concentrations show a slight increase during this period of time, while magnesium shows almost no variance. The relative percentages within the major cation group and the major anion group show essentially no variance for this 22-year period.

6.0 GEOLOGY

This section describes the geology of the site and surrounding area. Section 6.1 describes regional geology, Section 6.2 describes the geology of the Coalinga area, and Section 6.3 describes the subsurface materials at the site based upon the drilling program.

6.1 REGIONAL GEOLOGY

Coalinga is located on the western side near the central portion of the Great Valley province. The Great Valley is exposed as a smooth alluvial plain and is situated between the Sierra Nevada to the east and the Coast Ranges to the west at an elevation a few hundred feet above sea level.

Structurally, the Great Valley occupies a north-trending synclinal trough that is 450 miles long and 50 miles wide. Basement rock is shallow on the east and deepest near the western margin. The trough is filled with sedimentary materials shed from the Sierra Nevada and the Coast Ranges since Paleocene time.

Although the present central floor of the Great Valley is generally flat, the western margin has many folds paralleling the axial trend of the valley. Some of these features are buried, but others are exposed along the western margin from Coalinga southward and include some of the most famous oil producing structures in North America: Kettleman Hills, Elks Hills, and Lost Hills.

The Coalinga site is located in Pleasant Valley, which is bounded to the west by low foothills, identified as the Alcalde Hills and Jacalitos Hills. These hills are composed primarily of Tertiary marine sedimentary rocks consisting of sandstone, siltstone, shale, and gravel (Figure 11). Pliocene Etchegoin and Jacalitos Formation materials are exposed along the western margin of the valley. Pleasant Valley is predominantly filled with Quaternary alluvium. Along the eastern margin of Pleasant Valley, Tulare Formation material separates the alluvium of Pleasant Valley from the alluvial fans of the San Joaquin Valley to the east (Figure 12).

Three earthquakes of moderate magnitude have occurred along three separate faults in the Coalinga area within the last 7 years. The first earthquake occurred on October 25, 1982, and produced a Richter magnitude of 5.0 and was located approximately 15 miles northwest of Coalinga on a previously unnamed fault. The largest earthquake, with a Richter magnitude of 6.5, occurred on May 2, 1983, and was located approximately 9 miles northeast of Coalinga on a previously unmapped fault. Many buildings were destroyed or damaged as a result of this earthquake. On June 10, 1983, the last of the three earthquakes occurred approximately 9 miles northwest of Coalinga on an unnamed fault and produced an earthquake with a Richter magnitude of 6.2.

6.2 SITE GEOLOGY

From the literature search, the proposed location of the landfill is not located in an area subjected to rapid geologic change or within 200 feet from a known Holocene fault.

Five exploration borings were excavated at the proposed location of the waste management unit (Figure 13). Exploration borings penetrated up to 60 feet of alluvial sediments, and five distinct units were recognized. The unit sequence encountered from the ground surface to the bottom consists of olive-brown silty sand; olive-gray sandy gravel to gravelly sand; olive-brown to brown sandy silt to clayey silt; dark-grayish-brown gravelly sand to sandy gravel; and light-olive-brown silt to silty sand. For the purposes of this study, these units are informally named Units 1 through 5, respectively. The units are shown in the cross-sections (Figures 14 and 15), and detailed descriptions are given in the boring logs (Appendix D).

Units 1 through 5 are all Quaternary alluvium, as described in Section 6.1. The alluvial materials were deposited from the erosion of the nearby mountains.

Unit 1, the uppermost unit, is an olive-brown, loosely consolidated, dry, silty sand. The thickness of the unit ranges from 4.5 to 7.5 feet. Borings B-2 and B-3 encountered a silty clay layer within this unit ranging from 1 to 2.5 feet in thickness.

A sandy gravel to gravelly sand makes up Unit 2. It is a loosely consolidated, olive-brown to olive-gray soil, bearing the characteristics of a fluvial deposit. The gravels are rounded to subrounded and range up to 3 inches in diameter. The lower contact of this unit is sharp. The thickness of the unit ranges from 6.5 to 14.5 feet.

Unit 3 is a moderately consolidated, olive brown-brown, clayey silt to sandy silt. Only borings B-1 and B-5 penetrated the entire thickness of the unit which showed an overall thicknesses of 13 and 12 feet, respectively. However, in boring B-4, the total thickness of the unit is greater than the 16.5 feet drilled since the basal portion of the unit was not penetrated.

Underlying Unit 3, a loosely consolidated, dark-grayish-brown to brown soil is found comprising Unit 4. This unit is similar to Unit 2 and has the same characteristics of a fluvial deposit. The gravel is rounded to subrounded and ranges up to 2 inches in diameter. The upper and lower contacts of this unit are sharp.

Unit 5, the basal-most unit encountered during the drilling program, is a medium stiff to loose, olive-brown silt to silty sand. This unit was encountered only in boring B-5 with a total thickness of 11 feet.

No ground water was encountered during the drilling project, which reached a maximum depth of 60 feet below the ground surface.

6.3 FIELD INVESTIGATIONS

This section discusses the field activities performed during this investigation. The activities consisted of drilling five exploratory borings, collecting soil and waste samples at the site, and collecting a water sample from an off-site well.

These activities had a two-fold objective: (1) to characterize the underlying geology of the site, both in terms of soil geochemistry and the potential for fluid mobility through the soil, and (2) to provide geotechnical data needed for the construction design of a landfill.

The five exploratory borings were drilled in the southern portion of the site from June 18 to 20, 1988, at the locations shown in Figure 13. Detailed lithologic descriptions and sampling points for each of the boring logs are presented in Appendix D.

All borings were drilled with a truck-mounted CME-850 auger rig equipped with 8-inch OD continuous-flight, hollow-stem augers. Borings B-1, B-2, B-3, and B-4 were drilled and continuously sampled to a total depth of 30 feet. Boring B-5 was drilled and continuously sampled to a total depth of 60 feet. No ground water was encountered during the drilling.

Samples for geotechnical and geochemical testing were obtained at 5-foot intervals, using a Modified California drive sampler. The samples were retained in 4-inch by 2-inch brass sleeves, which were promptly capped and sealed.

A 5-foot by 2 inch ID split-core barrel was used to obtain core samples between the sampling points. In this method, a core barrel that is attached to rods is lowered through the augers and set 4 to 6 inches in front of the lead auger. Core samples are cut and retained by the barrel as the augers are advanced. Brass sleeves are inserted into the barrel to preserve and retain the samples.

Drive samples and core samples were used both for identification and logging of materials. Geochemical testing of the drive samples included the determination of major anion and cation concentrations, metals concentrations, and pH. The hydraulic conductivity of the samples was also tested as part of field investigation.

Upon completion of the drilling, the boreholes were backfilled with grout to the surface. The grout consisted of a mixture of 95-percent portland Type II cement and 5-percent bentonite powder.

7.0 VADOSE ZONE

This section describes the vadose zone directly beneath the site. The geologic properties of the alluvium are described in Section 7.1. Geochemical characterization is provided in Section 7.2, and the soil moisture is discussed in Section 7.3.

7.1 COMPOSITION AND PHYSICAL PROPERTIES

The vadose zone beneath the site consists of alluvium composed of clay, silt, sand, and gravel. Detailed descriptions are presented in the boring logs in Appendix D. The soils were classified in the field in accordance with the Unified Soil Classification System and were typically identified as sm, cl, gw/gp sw/sp and ml soil groups.

Four soil samples (GT-2, GT-4, GT-6, and GT-9) were collected from exploratory boring B-5 (Figure 12) and submitted to a laboratory for geotechnical testing. Hydraulic conductivity test results for the samples include 6.0 x 10^{-9} cm/s for silty clay material in sample GT-4, collected at a depth of 24.5 to 25.0 feet; 4.5 x 10^{-7} cm/s for clayey silt in sample GT-9, collected at 54.5 to 55.0 feet; 6.0 x 10^{-3} cm/s for gravelly sand in sample GT-6, collected at 34.5 to 35.0 feet; and 4.0 x 10^{-3} cm/s for sandy gravel in GT-2, collected at 9.5 to 10.0 feet. The geotechnical test results are presented in Appendix A.

7.2 CHEMICAL CHARACTERIZATION

The results of the chemical analysis performed on soil samples (GC-3, GC-7, and G-4) from boring B-5 are presented in Appendix A. Samples were collected at depths of 19.5, 29.5, and 54.5 feet. Soil chemistry concentrations were below the Total Threshold Limit Concentration (TTLC) Values for all substances listed on the Hazardous Substances List. These results, along with other cations analyzed, will serve as background vadose zone conditions for the site.

7.3 MOISTURE CONTENT

Four soil samples (GT-2, GT-4, GT-6, and GT-9) collected from boring B-5 during the early summer were submitted to a laboratory for moisture content testing. The laboratory test results of this are presented in Appendix A. In general, moisture content of the silty clay and clayey silt samples ranged from 22.0 to 24.5 percent. The sandy gravel and gravelly sand samples have moisture contents ranging from 4.0 to 4.5 percent.

7.4 VADOSE ZONE MONITORING

The soil moistures described in Section 7.3 are too low to allow the use of standard soil pore-fluid extraction devices such as lysimeters or the BAT probe. A study conducted at a waste disposal facility less than 20 miles from Coalinga, has determined that background soil moistures in a similar climate are "too dry to obtain samples" (Kaman Tempo, 1987). Passive monitoring of moisture contents (e.g., a neutron probe) which work in low moisture environments appear to be the most feasible method to use in this area.

8.0 DISCUSSION

This section discusses the results of the hydrogeologic investigation for the Coalinga site as they relate to leachate generation and the potential for contaminant migration.

The waste is a relatively dry solid, with little or no innate potential for generating leachate. Fluids would have to be introduced to the waste to produce a leachate. Infiltration of precipitation would be the principal source of introducing fluids to the waste. However, the site location is characterized by low amounts of precipitation with relatively high evaporation rates. Very minor amounts of water are available for waste infiltration. Engineering controls planned for the construction of the waste management unit would prevent precipitation from infiltrating the waste. A very low permeability clay cap will cover the waste, and the unit will be constructed to drain surface water. Waste will only be exposed to water during the short time that the unit is actually under construction.

The wastes are primarily asbestos, with some potential nickel. The asbestos is effectively insoluble and poses little or no threat to the ground water. The slow movement of leachate through the unsaturated zone to the ground water is unlikely to carry asbestos in suspension.

The extractable nickel concentrations in the waste exceeded the STLC standards using the citrate buffer extraction method. However, because the waste has little to no acid-generation potential, a deionized water extraction method for determining the CAM metals is acceptable according to the RWQCB. It is expected that future testing of the extractable nickel concentration will be below the Soluble Threshold Limit Concentration (STLC); thus, the nickel will not be considered a hazardous substance in the waste.

The waste provides only a very low hazard of contaminant migration but the possible contaminant migration pathways in the environment of the proposed disposal site restrict the possibility of this hazard further. The following conceptual model is believed to accurately describe the fate of the contaminants in the unlikely event that leachate is generated and migrates downward through the underlying soils.

The depth to ground water at the site is known to be greater than 60 feet, based on the field investigation, and is estimated to be approximately 150 feet. For leachate to reach the ground water, it would have to migrate vertically through this 100-foot-thick vadose zone consisting of varying alluvial sediments. These sediments have markedly different hydraulic conductivities (10^{-9} to 10^{-3} cm/s) and porosities, which provide excellent barriers to vertical migration of leachate. Relatively small quantities of leachate are likely to migrate vertically through the vadose zone to the first low permeability unit, where they will become blocked and then migrate horizontally. Soil suction of the low-permeability materials should retain the largest portion of migrating leachate. The rough calculation in Appendix E shows the result of 12 inches of rainfall (an unlikely event) being converted entirely to leachate and migrating to the vadose zone.

A total of 12 inches of rainfall over the approximately 1 acre waste management unit creates 1 acre-feet or 3.259×10^5 gallons of leachate. If the leachate migrates to the first clay unit at 25 feet depth, it will fully saturate only 4.8 feet of the clay (assuming 50-percent porosity for the clay). Without more head to drive the leachate, it can be expected to remain in the clay. The most likely method of detecting this contaminant is through the use of a vadose zone monitoring system.

Finally, ground water in the area is not used for drinking water purposes due to its poor quality. Both the historical and present water quality has exceeded the current Drinking Water Standards since 1951. In addition, the laboratory results indicate that the ground water presently contains some asbestos, probably a result of aquifer recharge from surface waters that contain asbestos due to natural erosion of serpentinite in the Pleasant Valley watershed.

From the above discussion it can be concluded, a ground-water monitoring system has a reduced chance of protecting the ground water and should be waived or minimized in favor of vadose zone monitoring.

9.0 CONCLUSIONS AND RECOMMENDATIONS

9.1 CONCLUSIONS

The site is suitable for location of a mining waste disposal facility because it will be located where site characteristics and containment structures isolate waste from waters of the state:

- Natural geologic materials with permeabilities much less than 1×10^{-6} are located at depths of 20 and 50 feet and should prevent vertical movement of fluid from the landfill to the waters of the state.
- The proposed location of the landfill is within a Zone C flood hazard zone and will not be subject to inundation from a 100-year flood.
- The proposed landfill location is not within 200 feet from a known Holocene fault.
- The proposed landfill location is not subject to rapid geologic change.
- The proposed landfill location is not within areas subject to tsunamis, sieches or surges.

The hydrogeologic conditions at the Coalinga site are characterized by the following:

- Low amounts of precipitation.
- Relatively high rates of evaporation.
- Considerable depth to ground water.
- Poor ground-water quality.
- Geologic materials with alternating high and low hydraulic conductivities.
- Waste with no acid-generating potential.

Considering the above conditions, the waste appears to pose a low risk to the degradation of ground water.

The site appears to be suitable for location of a mining waste disposal facility.

The potential for generating a leachate from the waste is expected to be low based on the following factors:

- The waste is presently in a relatively dry state
- Precipitation in the area is low
- Rates of evaporation in the area are high.

The potential for leachate generation from the waste can be further limited by the following design features:

- Engineering controls to limits the amount of time the waste is exposed to the elements and divert runon from the waste
- Design of a protective, low permeability cap.

9.2 RECOMMENDATIONS

Based upon the site and waste characterization, the following recommendations are made:

- Because the waste is dry, with no source of liquids to create leachate and will not create an acid leachate even if a liquid is introduced, the mining waste be classified as Group B
- For the same reasons a clay liner and leachate collection system should be waived for the site
- Ground-water monitoring should be minimized in favor of a vadose monitoring network

- A vadose zone monitoring system using neutron probe technology should be designed to detect potential migration.
- Excavation of the landfill should be monitored to assure that the landfill remains in compliance with subchapter 15 siting requirements.

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TABLE 1
PRECIPITATION STATIONS IN THE COALINGA AREA

STATION NAME	DWR STATION NUMBER	LATITUDE DEG MIN' SEC"	LONGITUDE DEG MIN' SEC"	TOWNSHIP AND RANGE	COUNTY	MAXIMUM PRECIPIATION MAX. ANNUAL (mm)	YEAR OCCUR	MINIMUM PRECIPITATON MIN. ANNUAL (mm)	YEAR OCCUR	MEAN ANNUAL (mm)	ELEVATION (meter)	RECORD YEAR BEGIN	YEARS OF RECORD
Coalinga	1864-00	36-09-00	120-21-00	20S/15E-32-M	FRE	446.4	1978	79.6	1960	192.9	205	1942	37
Coalinga CDF	1870-80	36-08-03	120-22-00	21S/15E-05	FRE	426.2	1969	69.4	1972	207.0	210	1961	17
Coalinga 1 SE	1867-00	36-07-39	120-20-38	21S/15E-04J-M	FRE	397.8	1969	61.3	1972	168.9	202	1912	63

Note: See Figure 2 for precipitation station locations.

Reference: California Department of Water Resources, 1981, "Index Sources of Hydrologic Data," Bulletin 230-81, p. 542.

TABLE 2
WARTHAN CREEK SURFACE-WATER GEOCHEMICAL ANALYSES

SAMPLING POINT	FLOW (cfs)	DATE SAMPLED	DISSOLVED SOLIDS (ppm)	PARTS PER MILLION (UPPER NUMBER) AND EQUIVALENTS PER MILLION (LOWER NUMBER) FOR INDICATED CATIONS AND ANIONS							BORON (ppm)
				CALCIUM (Ca)	MAGNESIUM (Mg)	SODIUM (Na)	BICARBONATE (HCO_3)	CARBONATE (CO_3)	SULFATE (SO_4)	CHLORIDE (Cl)	
SW1/4 Sec. 7, T. 21 S., R. 15E.	6	1-08-52	1,020	90 4.49	60 4.93	134 5.83	138 2.26	0 .0	568 11.83	59 1.66	1.0
Sec. 7, T. 21 S., R. 15 E.	.5	1-28-53	3,280	209 10.43	201 16.53	554 24.09	283 4.64	0 .0	1,810 37.68	340 9.59	2.9
NW1/4 SW1/4 Sec. 8, T. 21 S., R. 15E.	2.57	1-26-54	1,580	137 6.84	82 6.74	250 10.87	176 2.88	0 .0	854 17.78	140 3.95	2.8
NW1/4 NE1/4 Sec. 4, T. 21 S., R. 15 E.	400	1-25-56	350	28 1.40	14 1.14	70 3.04	156 2.56	0 .0	124 2.58	12 .34	.54
SW1/4 NE1/4 Sec. 13, T. 21 S., R. 14 E.	10	3-14-58	2,850	132 6.59	212 17.41	482 20.97	326 5.34	0 .0	1,540 32.06	290 8.18	4.5

Note: See Figure 4 for sampling point locations.

Reference: Taken from Davis, G.H., 1961, "Geological Control of Mineral Composition of Stream Waters of the Eastern Slope of the Southern Coast Ranges, California," U.S. Geological Survey Water-Supply Paper 1535-B.

TABLE 3
OFFSITE GROUND WATER DATA

DESCRIPTION OF WELLS

WELL NO.	OWNER OR USER AND OWNER'S WELL NO.	DEPTH (feet)	TYPE OF WELL AND CASING DIAMETER (inches)	PERFORATED INTERVAL (feet)		WATER LEVEL		DESCRIPTION OF WATER SAMPLE					
				TOP	BOTTOM	DATE MEASURED	DEPTH TO WATER BELOW LAND-SURFACE DATUM (feet)	TEMP-ERATURE	POINT OF SAMPLING	USE	COLLECTED BY	DATE OF COLLECTION (AUGUST 1951)	APPEARANCE AND REMARKS
20/15-28D1	Pleasant Valley Farms, 8	261	R, 16	170	252	--	--	72	D	Irr	PRW	1	Do.
20/15-34B1	Z. L. Phelps	212	16	--	--	4-25-51	134.7	66	D	Irr	PRW	1	Do.
21/15-10D1	C. N. Gribble	--	12	--	--	--	--	73	D	Irr	PRW	1	Do.

GROUND WATER GEOCHEMICAL ANALYSES

WELL NO.	pH	SPECIFIC CONDUCTANCE K X 10⁶ AT 25°C	SUM OF DETERMINED CONSTITUENTS (ppm)	PARTS PER MILLION (UPPER NUMBER) AND EQUIVALENTS PER MILLION (LOWER NUMBER) FOR INDICATED CATIONS AND ANIONS									BORON (B) (ppm)	FLUORIDE (F) (ppm)	SILICA (SiO_2) (ppm)	HARDNESS as $CaCO_3$ (ppm)	PERCENT SODIUM
				CALCIUM (Ca)	MAGNESIUM (Mg)	SODIUM (Na)	POTASSIUM (K)	CARBONATE (CO_2)	BICARBONATE (HCO_3)	SULFATE (SO_4)	CHLORIDE (Cl)	NITRATE (NO_3)					
20/15-28D1	8.3	1,970	1,390 3.44	69 8.80	107 10.22	235 0.12	4.6	0 4.52	276 13.70	658 4.00	142 0.23	14	2.3	0	26	612	45
20/15-34B1	9.2	2,450	1,740 4.69	94 11.18	136 12.57	289 0.14	5.3 0.93	28 3.57	218 16.11	774 6.99	248 0.42	26	1.6	0	28	794	44*
21/15-10D1	8.5	3,790	2,990 10.23	205 12.25	149 24.35	560 0.22	8.5 0.40	12 4.16	254 33.52	1,610 7.33	260 0.58	36	4.5 0.03	0.6	24	1,124	52

Note: See Figure 6 for well locations.

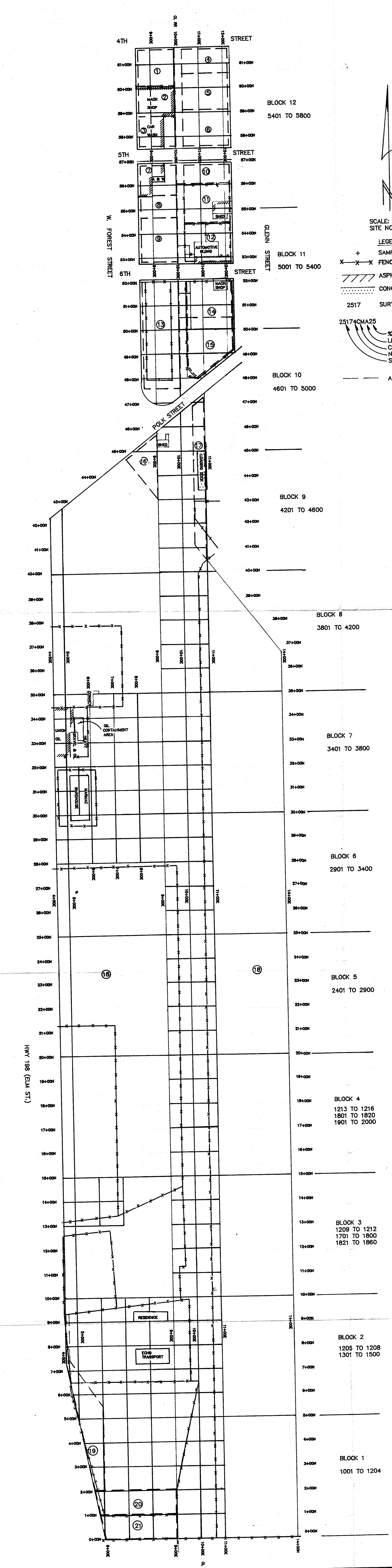
Reference: Davis, G.H., and J.F. Poland, 1957, "Ground-Water Conditions in the Mendota-Huron Area, Fresno and Kings Counties, California" U.S. Geological Survey Water-Survey Paper 1360-G.

TABLE 4
MINERAL ANALYSES OF GROUND WATER IN THE COALINGA AREA

DATE TIME	WELL LOCATION	TEMP	FIELD LABORATORY PH	EC	MINERAL CONSTITUENTS IN CA	MG	NA	K	CACO3	MILLIGRAMS PER LITER MILLIEQUIVALENTS PER LITER PERCENT REACTANCE VALUE SO4	CL	NO3	MILLIGRAMS PER LITER B	F SIO2	TDS SUM
06/15/78	20S/15E-28A01 M	77.0F 25.0C	8.2	2420	101 5.04 19	116 9.54 36	274 11.92 45	8.0 .20 1	168 3.36 12	860 17.91 66	194 5.47 20	19.0 .31 1	2.2	-- --	1900 1675
09/01/51	20S/15E-28D01 M	72F 22C	8.3	1970	69 3.44 15	107 8.80 39	235 10.22 45	4.6 .12 1	226 4.52 20	658 13.70 61	142 4.00 18	14.0 .23 1	2.28	.0 26.0	1393
10/27/55		71F 22C	8.0	2060	77 3.84 16	119 9.79 41	238 10.35 43	6.0 .15 1	293 5.85 24	673 14.01 57	141 3.98 16	48.0 .77 3	1.3	.1 28.0	1507
05/23/73 1150		78.0F 25.5C	7.4 8.0	2100 2380	90 4.49 17	116 9.54 36	280 12.18 46	--	170 3.40	--	185 5.22	10.0 .16	1.6	-- --	
06/22/88	20S/15E-33D	--	--	--	85.5 4.27 15.7	90 7.40 27.1	3.55 15.50 56.8	4 .10 .4	120 2.4 5.5	1300 32.48 75.1	280 7.89 18.2	30 .5 1.1	1 --	2 --	2200
09/01/51	20S/15E-34B01 M	66F 19C	9.2	2450	94 4.69 16	136 11.18 39	289 12.57 44	5.3 .14 0	226 4.52 16	774 16.11 57	248 6.99 25	26.0 .42 1	1.6	.0 28.0	1737
01/17/85 1000	21S/15E-03F01 M	68F 20C	7.6 8.1	2600 2840	146 7.29 23	103 8.47 26	376 16.36 51	6.1 .16 0	173 3.46 11	1100 22.90 73	168 4.74 15	28.0 .45 1	2.4	-- --	2220 2033
08/02/74 1305	21S/15E-04Q01 M	-- --	7.9 7.4	3600	132 6.59 17	86 7.07 18	578 25.14 64	8.0 .20 1	136 2.72 7	1440 29.98 76	231 6.51 17	4.0 .06 0	2.7	-- --	2620 2563
06/14/78		80.0F 26.6C	8.0	3050	152 7.58 21	131 10.77 31	386 16.79 48	6.6 .17 0	156 3.12 9	1330 27.69 78	162 4.57 13	.7 .01 0	1.8	-- --	2530 2264
04/30/80 0800	21S/15E-08F01 M	69.8F 21.0C	7.4 7.9	4100 4570	229 11.43 21	177 14.56 26	681 29.62 53	5.3 .14 0	276 5.51 10	1890 39.35 70	400 11.28 20	1.8 .03 0	6.8	-- --	3950 3556
09/01/51	21S/15E-10D01 M	73F 23C	8.5	3790	205 10.23 22	149 12.25 26	560 24.36 52	8.5 .22 0	228 4.56 10	1610 33.52 73	260 7.33 16	36.0 .58 1	4.5	.6 24.0	2994

Note: See Figure 6 for well locations.

Reference: California Department of Water Resources, 1987, "Mineral Analyses of Ground Water."



SCALE: 1" = 200'
SITE NORTH

LEGEND

+	SAMPLE LOCATION
X—X—X	FENCE LINE
////	ASPHALT
......	CONCRETE
2517	SURVEY & SAMPLE POINT NUMBER
25174CMA25	% DETECTED (AS GIVEN BY I.T. CORP.) / LEVEL / COMPOSITE / NUMBER OF SAMPLES / SAMPLE NUMBER
— —	APPROXIMATE BOUNDARY LINE

T1 TITLE SHEET

SL1 SAMPLE LOCATION, BLOCKS 1,2,3
SL2 SAMPLE LOCATION, BLOCKS 4,5,6
SL3 SAMPLE LOCATION, BLOCKS 7,8,9
SL4 SAMPLE LOCATION, BLOCKS 10,11,12

SR 1A SAMPLE RESULTS "A" LEVEL, BLOCKS 1,2,3
SR 2A SAMPLE RESULTS "A" LEVEL, BLOCKS 4,5,6
SR 3A SAMPLE RESULTS "A" LEVEL, BLOCKS 7,8,9
SR 4A SAMPLE RESULTS "A" LEVEL, BLOCKS 10,11,12

SR 1B SAMPLE RESULTS "B" LEVEL, BLOCKS 1,2,3
SR 2B SAMPLE RESULTS "B" LEVEL, BLOCKS 4,5,6
SR 3B SAMPLE RESULTS "B" LEVEL, BLOCKS 7,8,9
SR 4B SAMPLE RESULTS "B" LEVEL, BLOCKS 10,11,12

LIST OF LAND OWNERS

(1) TODD LARRY ROSS & REBECCA AUDREY
204 S COALINGA ST — COALINGA CA 93210
LOCATION -- SUR RT PAR 3 P/M 019 BK 41 PG 20 — 72-210-05S

(2) COLBERT GARY L & LINDA ELAINE
735 PRINCETON ST — COALINGA CA 93210
LOCATION -- 152 E & FOREST — 72-210-03S

(3) THWEATT BOBBY D & DEBORAH
P O BOX 71 — COALINGA CA 93210
LOCATION -- 105 S & FIFTH — 72-210-01S

(4) VOSBURG CYRIL A
VOSBURG GENE ET AL
107 S JOAQUIN ST — COALINGA CA 93210
LOCATION -- SUR RT PAR 8 P/M 019 BK 41 PG 20 — 72-210-15S

(5) CITY OF COALINGA

(6) HIGGS PAUL E & CHARLETTA M
P O BOX 544 — COALINGA CA 93210
LOCATION -- SUR RT PAR 4 P/M 019 BK 41 PG 20 — 72-210-07S

(7) GRAY AUDREY E
P O BOX 1042 — COALINGA CA 93210
LOCATION -- 102 S & FIFTH — 72-200-14S

(8) CARSON JOE & VICKY G
P O BOX 713 — COALINGA CA 93210
LOCATION -- SUR RT PAR 3 P/M 018 BK 41 PG 19 — 72-200-12S

(9) ROSE R J & PAULINE V
P O BOX 707 — COALINGA CA 93210
LOCATION -- SUR RT PAR 1 P/M 018 BK 41 PG 19 — 72-200-08S

(10) JEWETT EVERETT & ISABELLA
P O BOX 1361 — COALINGA CA 93210
LOCATION -- SUR RT PAR 9 P/M 018 BK 41 PG 19 — 72-200-24S

(11) WESTERN F M OIL WELL TOOL INC
P O BOX 446 — COALINGA CA 93210
LOCATION -- 150 W & GLENN — 72-200-26S

(12) SCRIVNER KEITH
P O BOX 1043 — COALINGA CA 93210
LOCATION -- 175 S & SIXTH — 72-200-27S

(13) O'NEILL CORNELIUS K & DONNETTE D TRS
308 HARVARD ST — COALINGA CA 93210
LOCATION -- SUR RT 1.52 AC PAR 1 P/M 017 BK 40 PGS 94 — 72-200-01S

(14) JOHNS JOHN W & PAMELA J
495 W POLK ST — COALINGA CA 93210
LOCATION -- 210 W & GLENN — 72-200-04S

(15) SCRIVNER KEITH
P O BOX 1043 — COALINGA CA 93210
LOCATION -- SUR RT PAR 2 P/M 017 BK 40 PGS 94 & 95 — 72-200-02S

(16) PARSONS J E
397 WASHINGTON ST — COALINGA CA 93210
LOCATION -- TRIANGLE LOT NW OF RR IN NW 1/4 SEC 4 T21R1 — 83-080-11

(17) OXBORROW HELEN
414 DARTMOUTH — COALINGA CA 93210
LOCATION -- 102 E & POLK — 83-101-04S

(18) SOUTHERN PACIFIC LAND COMPANY
C/O PROPERTY TAX DEPT — 201 MISSION ST.
SAN FRANCISCO CA 94105
LOCATION -- 16.[illegible] AC IN R R R/W N1/2 SEC 5 T21R15 — 83-080-53

(19) SOUTHERN PACIFIC LAND COMPANY
C/O TAX COMMISSIONER — SOUTHERN PACIFIC BLDG.
ONE MARKET PLAZA — SAN FRANCISCO CA 94105
LOCATION -- SUR RT PAR 1 P/M 006 BK 29 PGS 19 & 20 — 83-220-02S

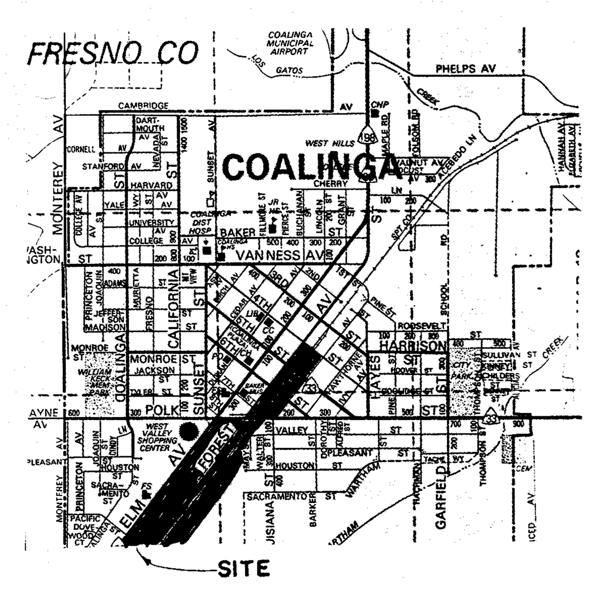
(20) HAMPTON BOB J & JUDITH A
P O BOX 104 — TAFT CA 93268
LOCATION -- SUR RT PAR 2 P/M 006 BK 29 PGS 19 & 20 — 83-220-05S

(21) SQUIER CHARLES K & PATRICIA A
HOWARD RONALD B & BARBARA S
2031 N BRIGHTON — BURBANK CA 91504
LOCATION -- SUR RT PAR 3 P/M 006 BK 29 PGS 19 & 20 — 83-220-06S

SURVEYOR'S CERTIFICATE:

THIS MAP CORRECTLY REPRESENTS A SURVEY MADE BY ME OR UNDER MY DIRECTION IN COFORMANCE WITH THE REQUIREMENTS OF THE LAND SURVEYORS ACT AT THE REQUEST OF I.T. CORPORATION IN DECEMBER 1987.

[signature] 12/28/87
EUGENE P. MARTIN L.S. 4713

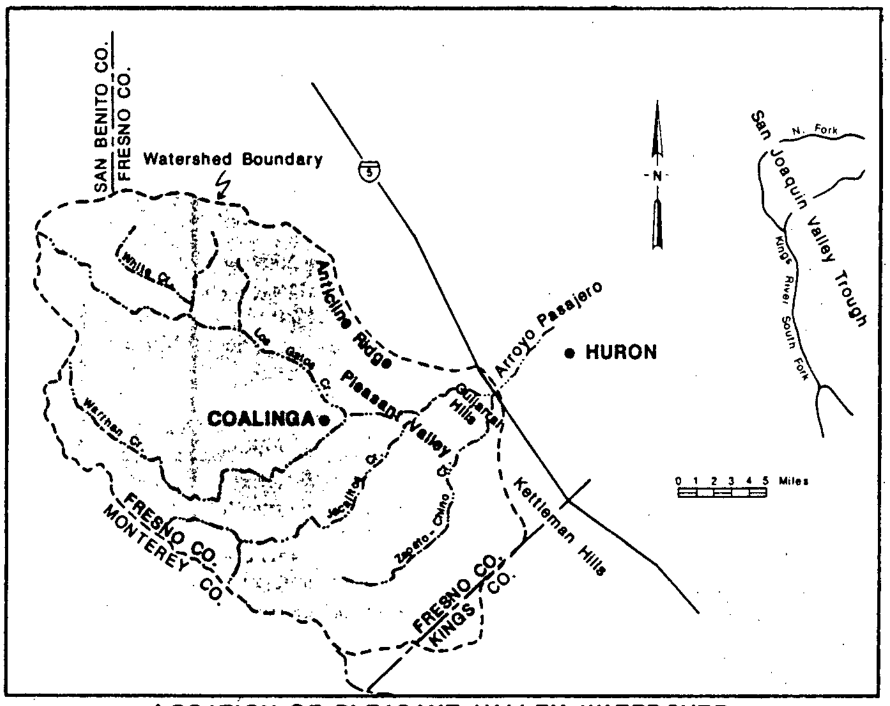


SITE LOCATION MAP

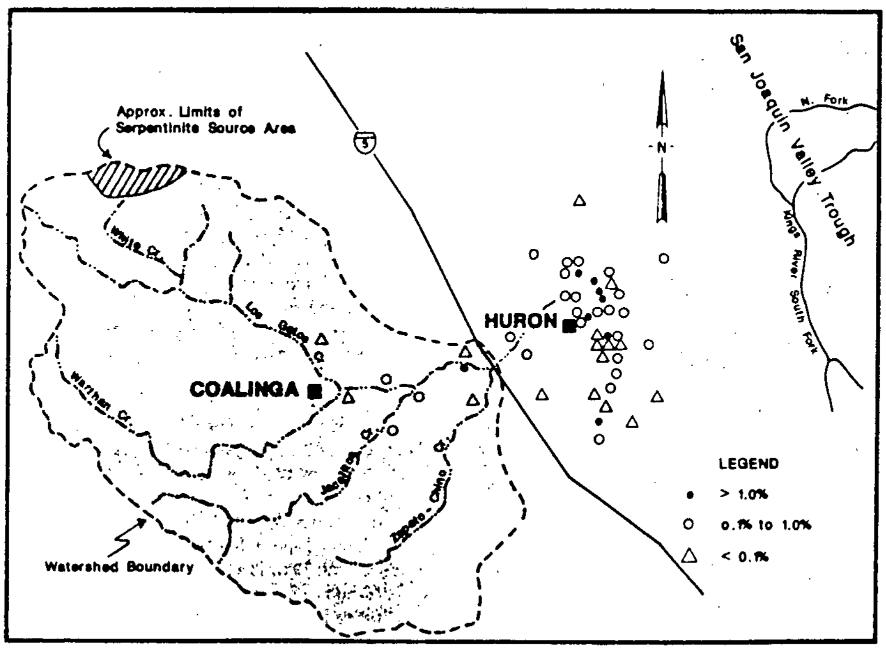
S.P.T. Co. COALINGA
Hazardous Substance Containment Plan
E.P.A. Order No. 87-04
S.P.T. Co. No. E931549/071-02
I.T. PROJECT No. 202208-03-05

S.P.T. Co. COALINGA
"CONTAINMENT PLAN – FINAL REPORT"

SHEET	TITLE	REVISIONS	APPROVED		
T1 OF 13 SHEETS	TITLE SHEET I.T. CORPORATION COALINGA SITE	DATE / BY	APPROVED I.T. CORP. Robert Willey I.T. ROBERT WILLEY DATE 1-14-88	4130 ARDMORE AVE. SUITE 101 BAKERSFIELD, CALIFORNIA 93309 DRAWN BY RN JOB NO. 87-169 CHECKED BY DS DATE 12-28-87	Martin-McIntosh LAND SURVEYING · CIVIL ENGINEERING (805) 834-4814



LOCATION OF PLEASANT VALLEY WATERSHED



DISTRIBUTION OF NATURALLY OCCURRING ASBESTOS FIBERS
(PERCENTAGE OF ASBESTOS CONCENTRATION IN SOIL SHOWN BY SYMBOLS)

FIGURE 3

LOCATION OF
PLEASANT VALLEY WATERSHED AND
DISTRIBUTION OF NATURALLY
OCCURRING ASBESTOS FIBERS

PREPARED FOR

SOUTHERN PACIFIC TRANSPORTATION CO.
COALINGA, CALIFORNIA

INTERNATIONAL
TECHNOLOGY
CORPORATION

REFERENCE:

TAKEN FROM JONES, JEANINE, 1988, ASBESTOS IN THE WESTERN SAN JOAQUIN VALLEY, CALIFORNIA: CALIFORNIA GEOLOGY, V. 41, NO. 7, P. 160-164.

DRAWN BY	BJW	7-19-88
CHECKED BY	G.O.	8/8/88
APPROVED BY	MEU	8-10-88
DRAWING NUMBER	202208-A5	

"Do Not Scale This Drawing"

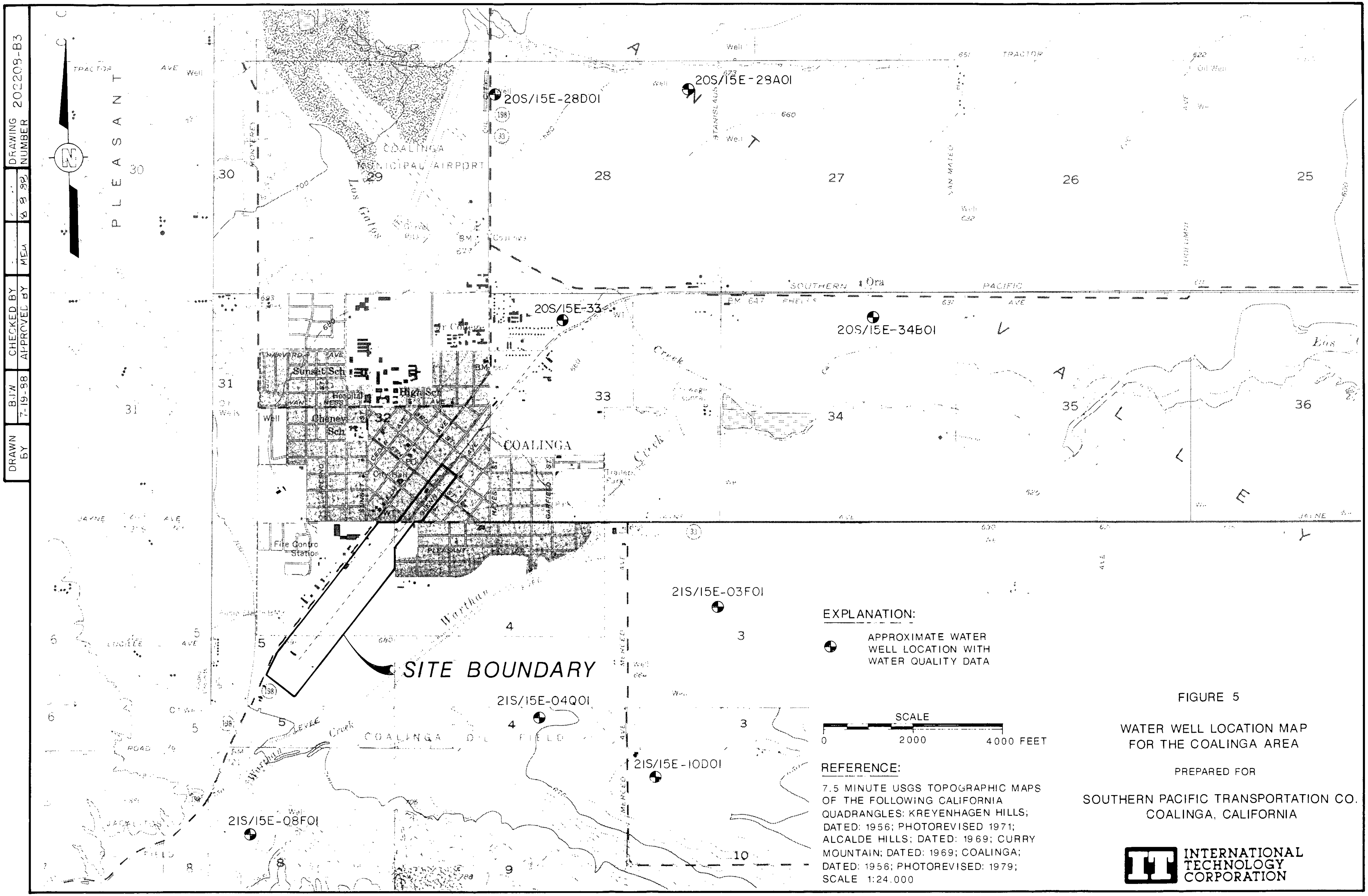
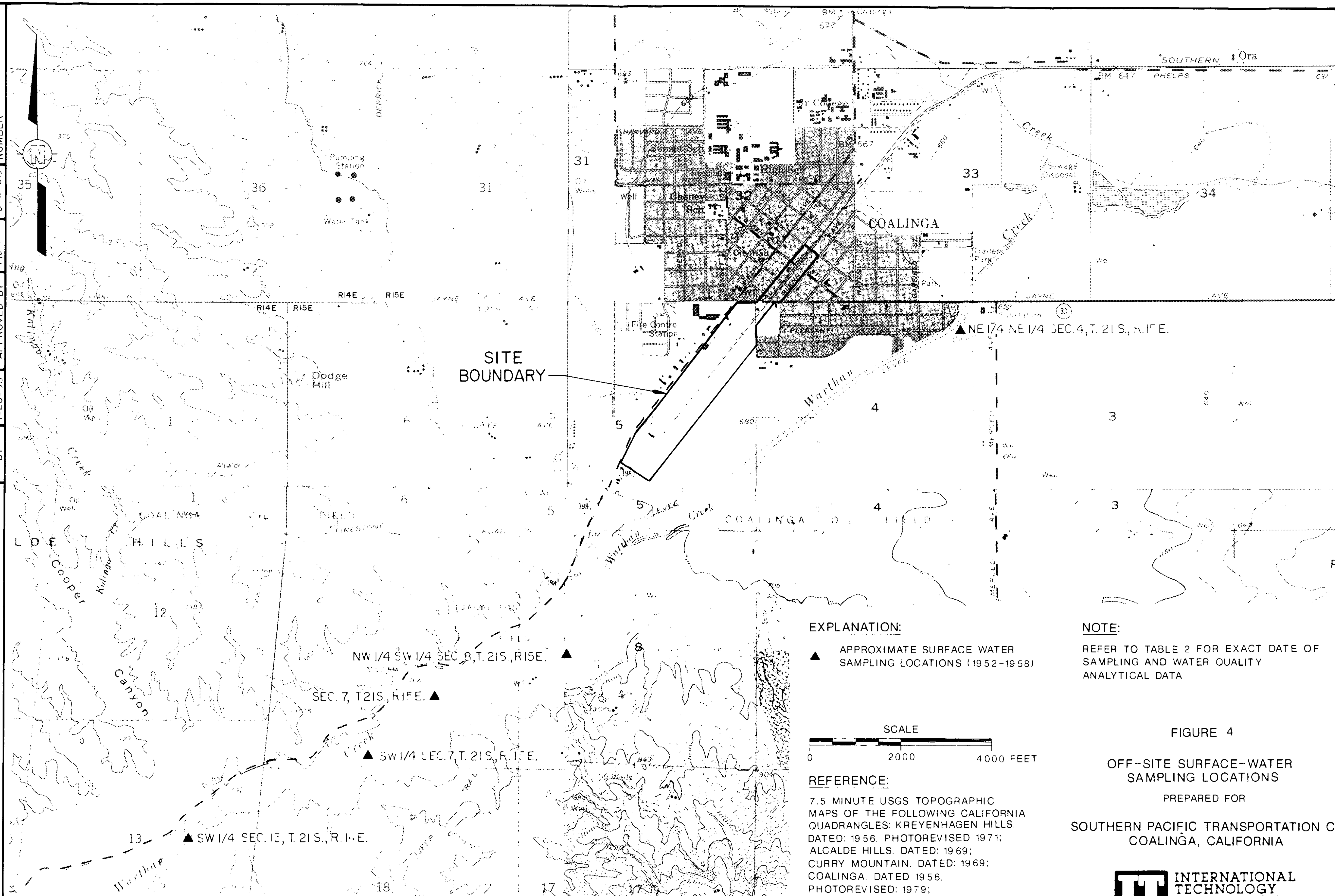


FIGURE 5

WATER WELL LOCATION MAP FOR THE COALINGA AREA

PREPARED FOR

SOUTHERN PACIFIC TRANSPORTATION CO.
COALINGA, CALIFORNIA



EXPLANATION:

▲ APPROXIMATE SURFACE WATER SAMPLING LOCATIONS (1952-1958)

NOTE:

REFER TO TABLE 2 FOR EXACT DATE OF SAMPLING AND WATER QUALITY ANALYTICAL DATA

SCALE

0 2000 4000 FEET

REFERENCE:

7.5 MINUTE USGS TOPOGRAPHIC MAPS OF THE FOLLOWING CALIFORNIA QUADRANGLES: KREYENHAGEN HILLS. DATED: 1956. PHOTOREVISED 1971; ALCALDE HILLS. DATED: 1969; CURRY MOUNTAIN. DATED: 1969; COALINGA. DATED 1956. PHOTOREVISED: 1979; SCALE 1:24,000

FIGURE 4

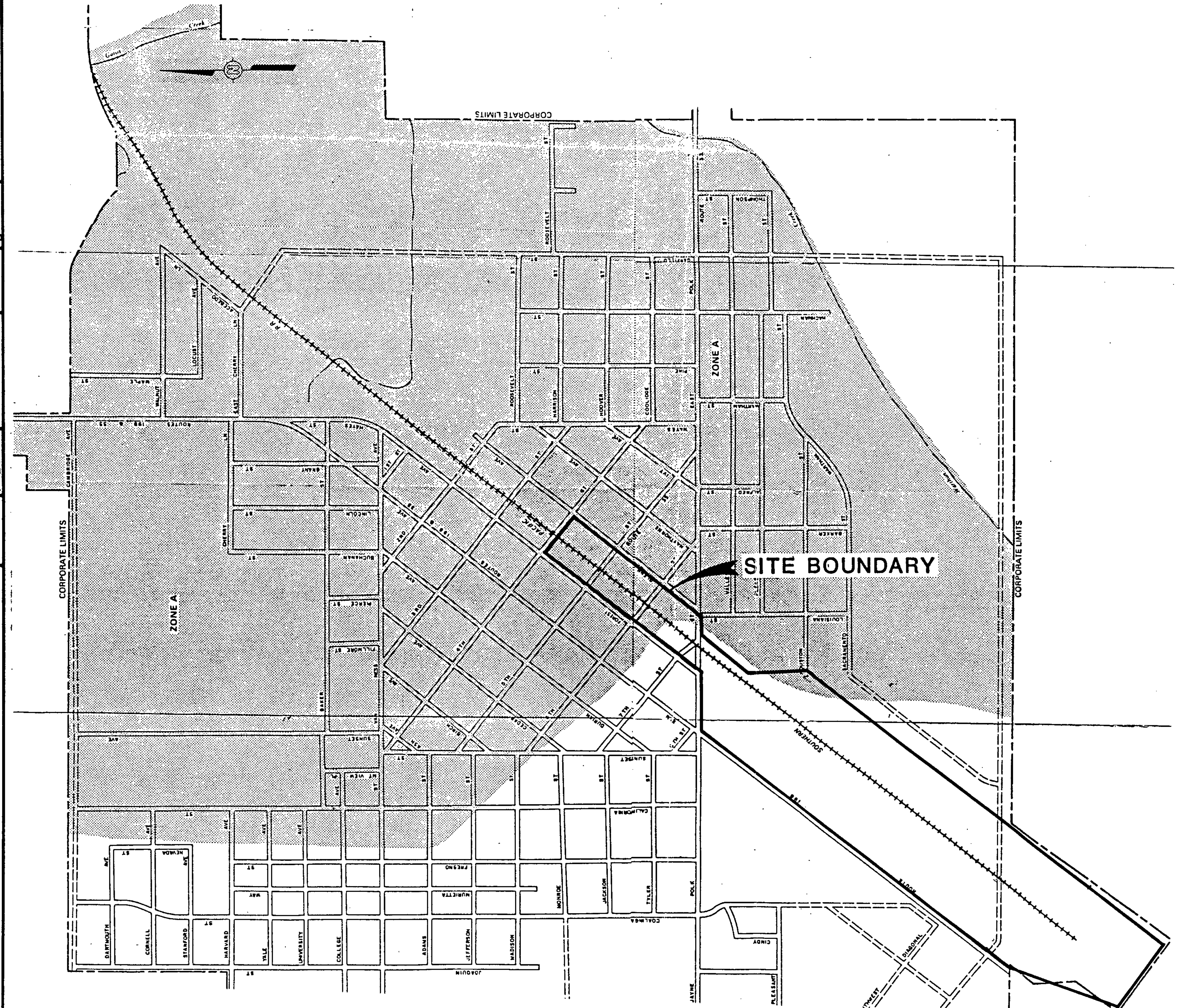
OFF-SITE SURFACE-WATER SAMPLING LOCATIONS

PREPARED FOR

SOUTHERN PACIFIC TRANSPORTATION CO.
COALINGA, CALIFORNIA

INTERNATIONAL TECHNOLOGY CORPORATION

DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
BJW 7-20-88		MEJ 8-8-88	202208-B7



EXPLANTION:

ZONE A - AREA OF 100 YEAR FLOOD

ZONE C - AREA OF MINIMAL FLOODING (NO SHADING).

APPROXIMATE SCALE

0 900 1800 FEET

REFERENCE:

FLOOD ZONE INFORMATION TAKEN FROM FLOOD INSURANCE RATE MAP, CITY OF COALINGA, FRESNO COUNTY, CALIFORNIA. DATED: SEPTEMBER 26, 1978

NOTE:

AS OF AUGUST 23, 1982, THE ENTIRE COMMUNITY OF COALINGA IS NOW CLASSIFIED AS ZONE C.

FIGURE 6

100-YEAR FLOOD MAP
FOR THE CITY OF COALINGA

PREPARED FOR

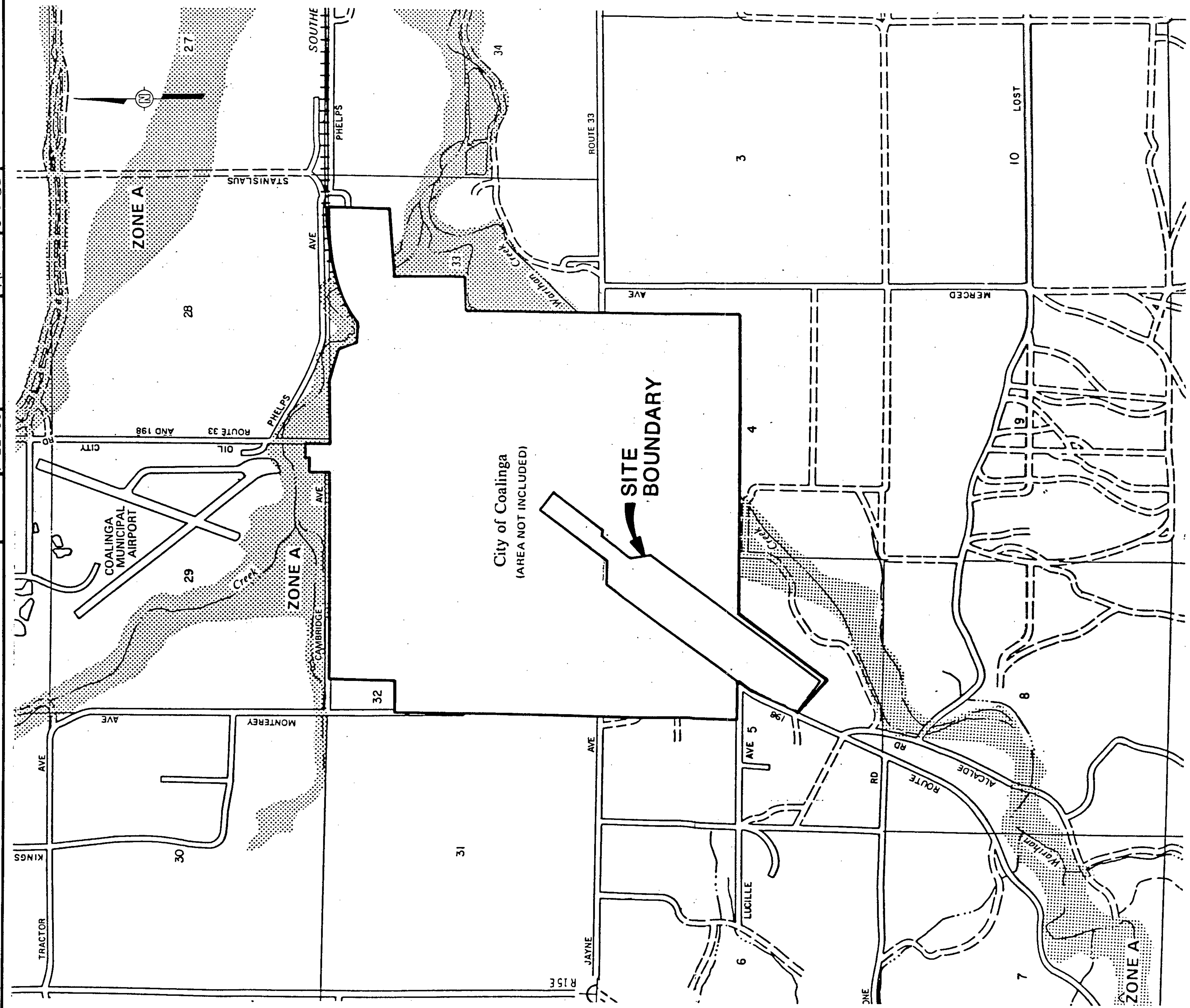
SOUTHERN PACIFIC
TRANSPORTATION COMPANY
COALINGA, CALIFORNIA

INTERNATIONAL TECHNOLOGY CORPORATION

DRAWN BY W. Rieger 7-22-88 | CHECKED BY G.O. 8/8/88 | APPROVED BY MEu 8.9.88 | DRAWING NUMBER 202208-B8

137773

"Do Not Scale This Drawing"



EXPLANTION:

ZONE A – AREA OF 100 YEAR FLOOD

ZONE C – AREA OF MINIMAL FLOODING (NO SHADING)

APPROXIMATE SCALE

0 2000 4000 FEET

REFERENCE:

FLOOD ZONE INFORMATION TAKEN FROM FLOOD INSURANCE RATE MAP, FRESNO COUNTY CALIFORNIA (UNINCORPORATED AREAS). DATED: JANUARY 9, 1979.

FIGURE 7

100-YEAR FLOOD MAP FOR THE SURROUNDING AREA OF COALINGA

PREPARED FOR

SOUTHERN PACIFIC TRANSPORTATION COMPANY COALINGA, CALIFORNIA

INTERNATIONAL TECHNOLOGY CORPORATION

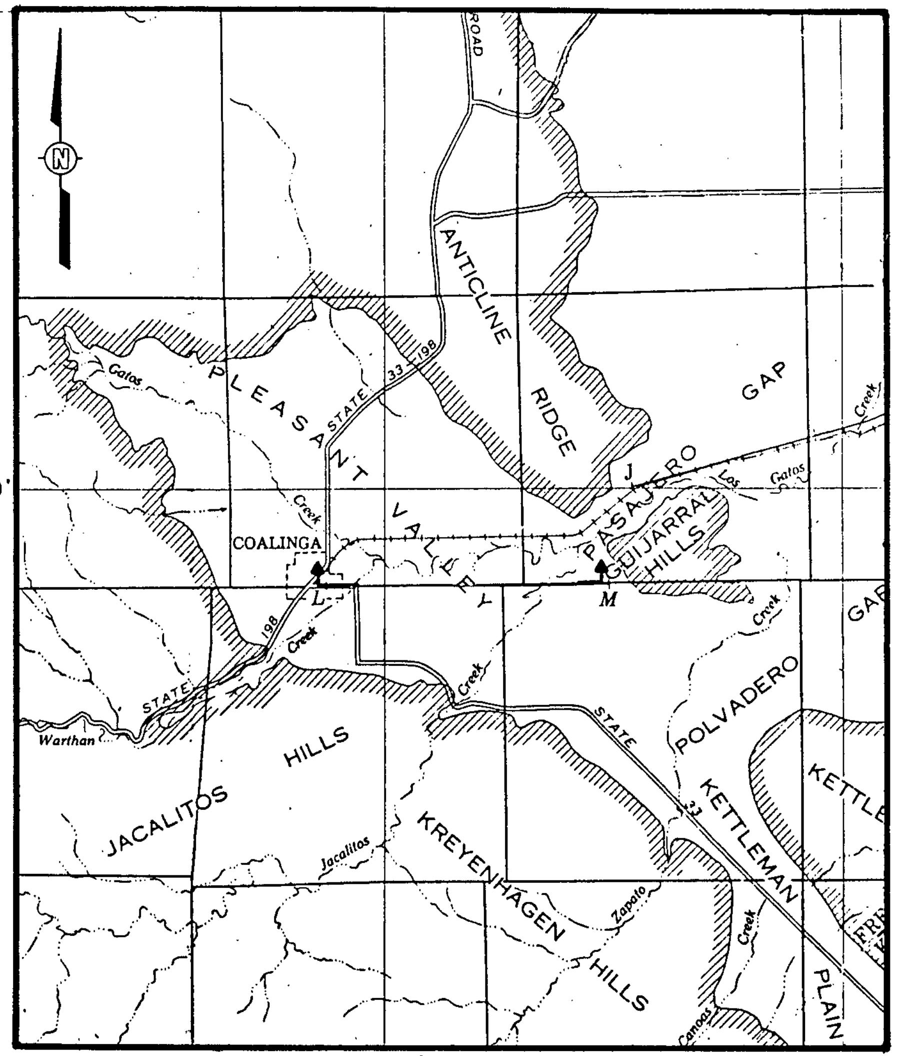
DRAWN BY	W. Rieger 7-22-88	CHECKED BY	G.O. 8/2/88	APPROVED BY	MEU 8-2-88	DRAWING NUMBER	202208-B9

137773

"Do Not Scale This Drawing"

DRAWN BY HDS 7-18-88 | CHECKED BY G.O. 8/8/88 | APPROVED BY MEu 8-8-88 | DRAWING NUMBER 202208-B2

PLESANT VALLEY LOCATION MAP



SCALE
0 4 MILES

EXPLANATION:

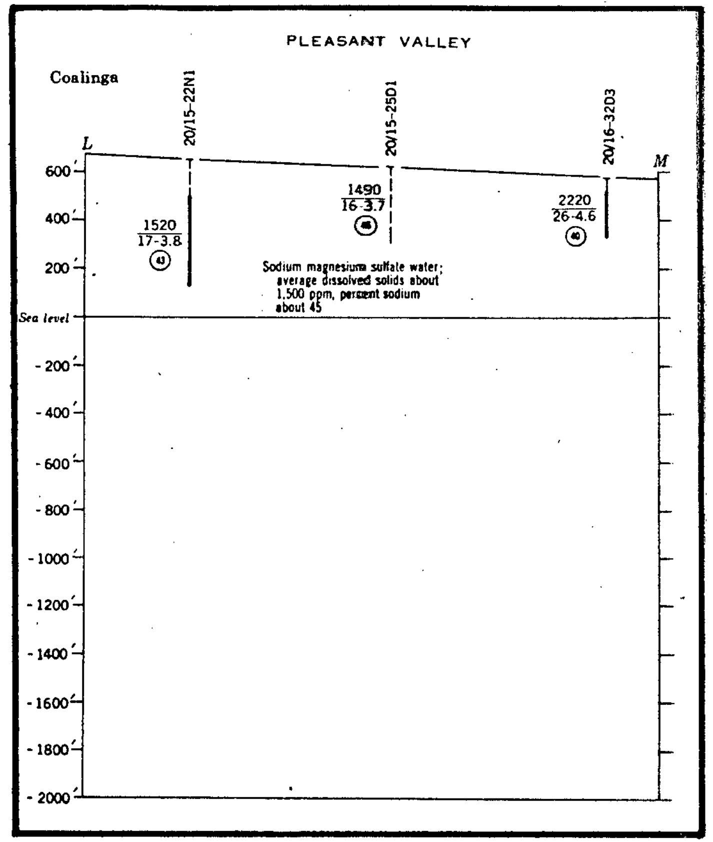
BOUNDARY BETWEEN ALLUVIAL DEPOSITS AND DEFORMED ROCKS

ALIGNMENT OF WATER-LEVEL PROFILES

REFERENCE:

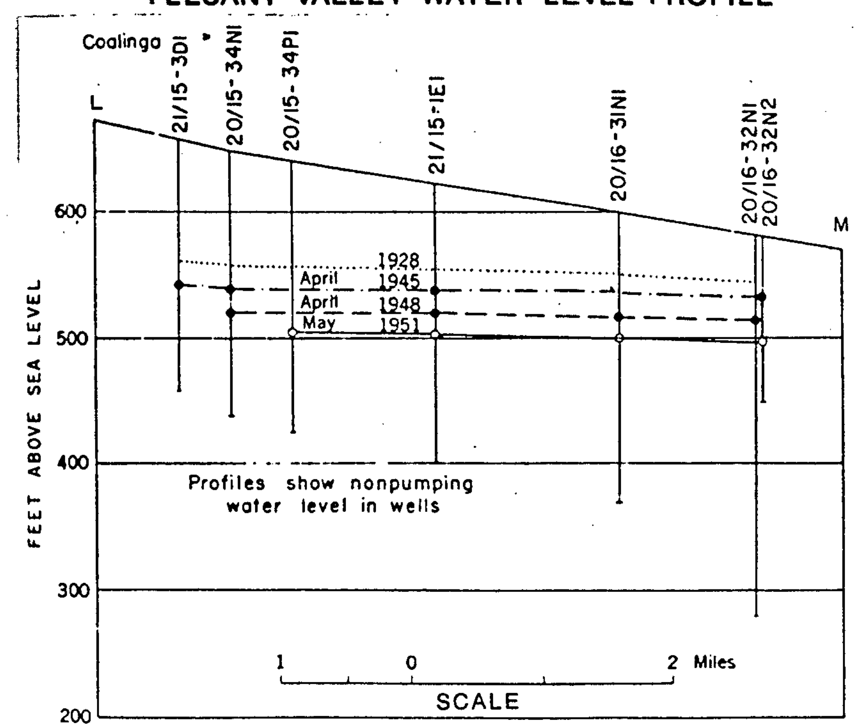
DAVIS, G.H., AND POLAND, J.F., 1957, GROUND-WATER CONDITIONS IN THE MENDOTA-HURON AREA, FRESNO AND KINGS COUNTIES, CALIFORNIA: U.S. GEOLOGICAL SURVEY WATER - SUPPLY PAPER 1360-G.

PLESANT VALLEY GEOCHEMICAL SECTION

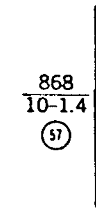


NO HORIZONTAL SCALE

PLESANT VALLEY WATER-LEVEL PROFILE



EXPLANATION:



Wells for which chemical character of water is shown

Position of perforated casing, where known, is indicated by heavy line segment. Wells more than a mile from the profile are shown by dashed lines. The chemical-character symbol, generally to the left of the well, is based on the analysis of water from the discharge. The upper number (above the line) indicates approximate dissolved solids in parts per million sum of determined constituents not including silica. The middle numbers to the left and right of the dash, respectively, represent sulfate and chloride content in equivalents per million. The lower number (circled) is the percent sodium. Upper number in parentheses indicates that dissolved solids have been estimated from specific conductance for analysis in which calcium and magnesium were determined only as total hardness.

FIGURE 8

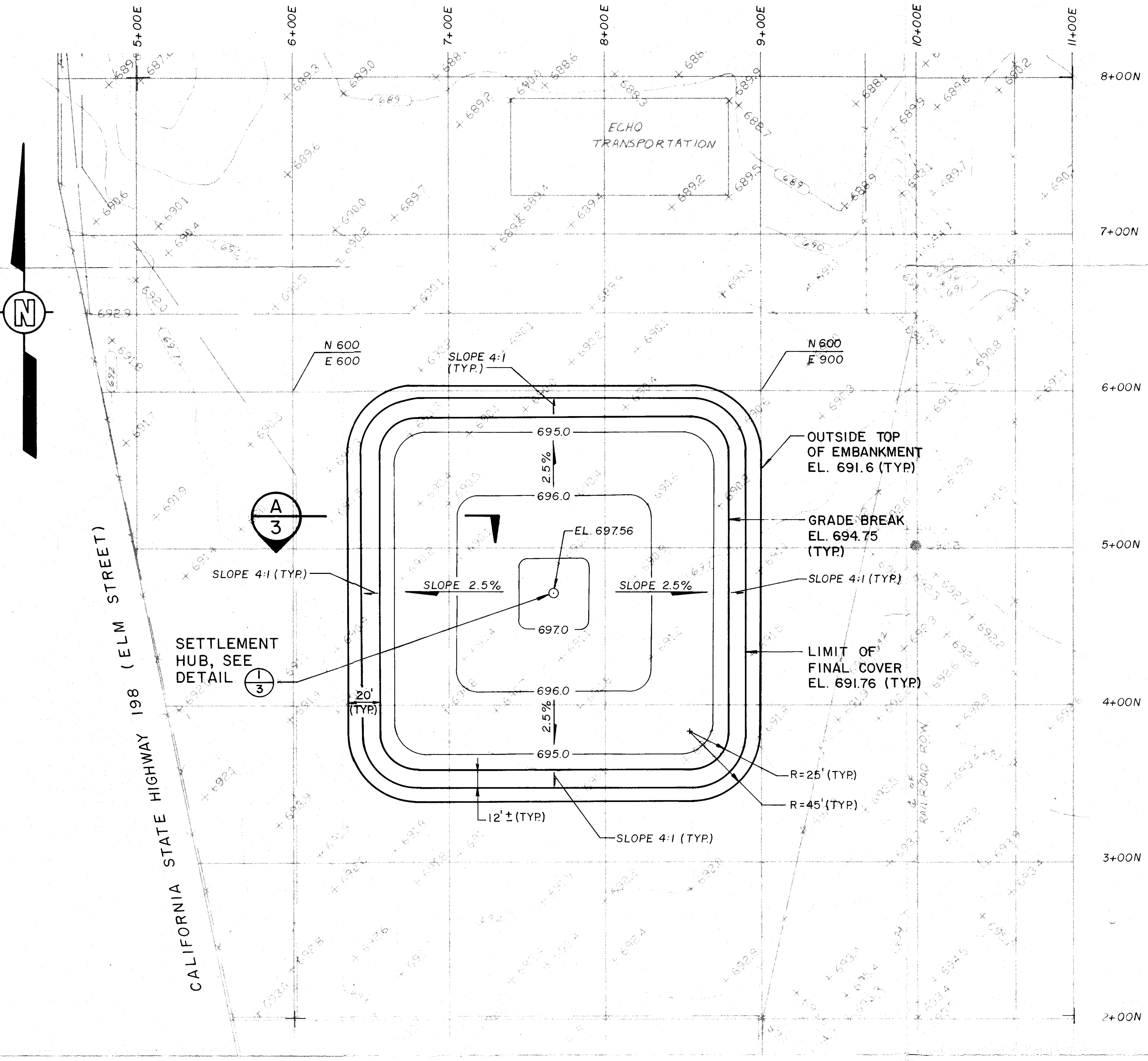
LOCATION MAP, GEOCHEMICAL SECTION AND WATER-LEVEL PROFILE FOR PLEASANT VALLEY, 1951

PREPARED FOR

SOUTHERN PACIFIC TRANSPORTATION CO.
COALINGA, CALIFORNIA

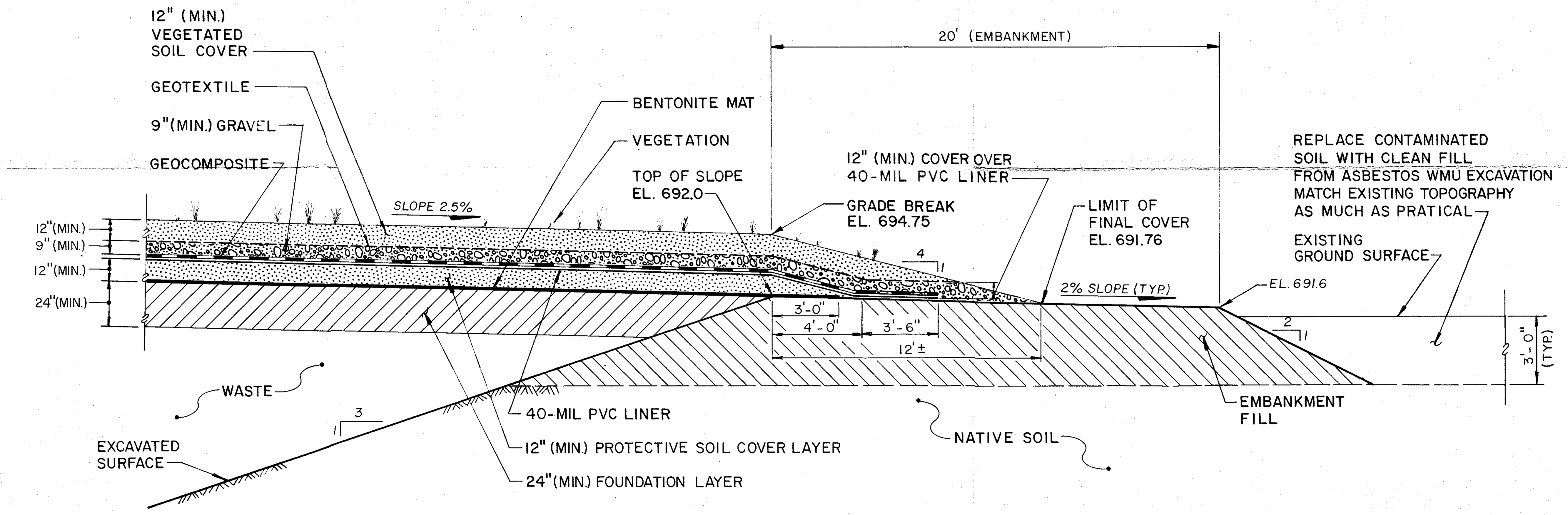
INTERNATIONAL TECHNOLOGY CORPORATION

137773



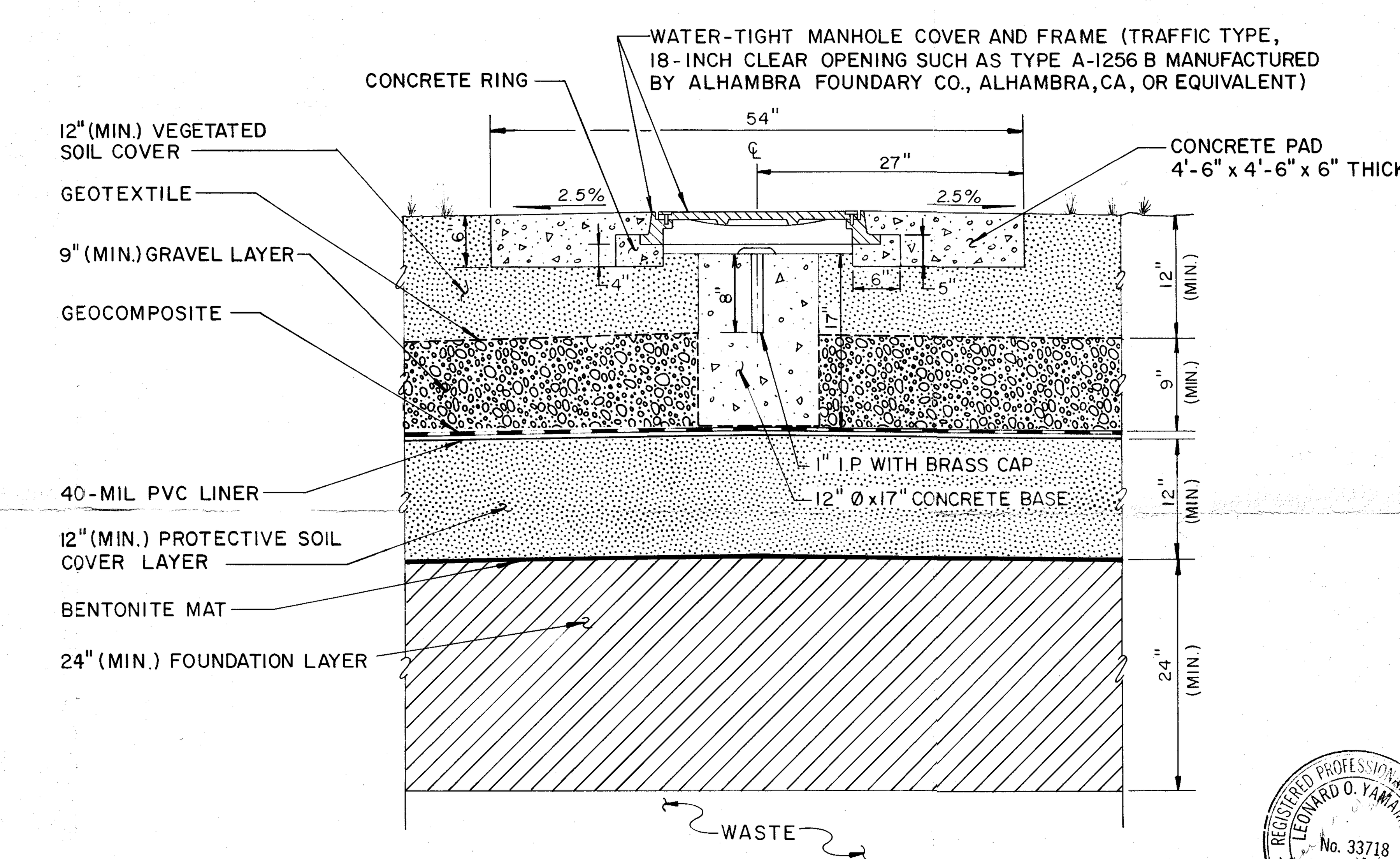
FINAL COVER PLAN

SCALE 0 50 100 FEET



SECTION A/3

SCALE 0 4 8 FEET



SETTLEMENT HUB DETAIL 1/3

NOT TO SCALE

REGISTERED PROFESSIONAL ENGINEER LEONARD O. YAMAMOTO No. 33718 CIVIL STATE OF CALIFORNIA

LEGEND

—x—x—x—	FENCELINE
(EL.)	CONTOUR LINE
R.O.W.	RIGHT OF WAY
℄	CENTERLINE
N	NORTH
E	EAST
EL.	ELEVATION
⬢	BENCHMARK
WMU	WASTE MANAGEMENT UNIT
PVC	POLYVINYL CHLORIDE
MIN.	MINIMUM
TYP.	TYPICAL
R	RADIUS

REFERENCE:

THE TOPOGRAPHY SHOWN REFLECTS THE MARTIN-McINTOSH SURVEY PERFORMED BETWEEN OCTOBER & DECEMBER 1987; NUMBER: 88-179; DATE: NOV. 18, 1988; SCALE: 1" = 50'

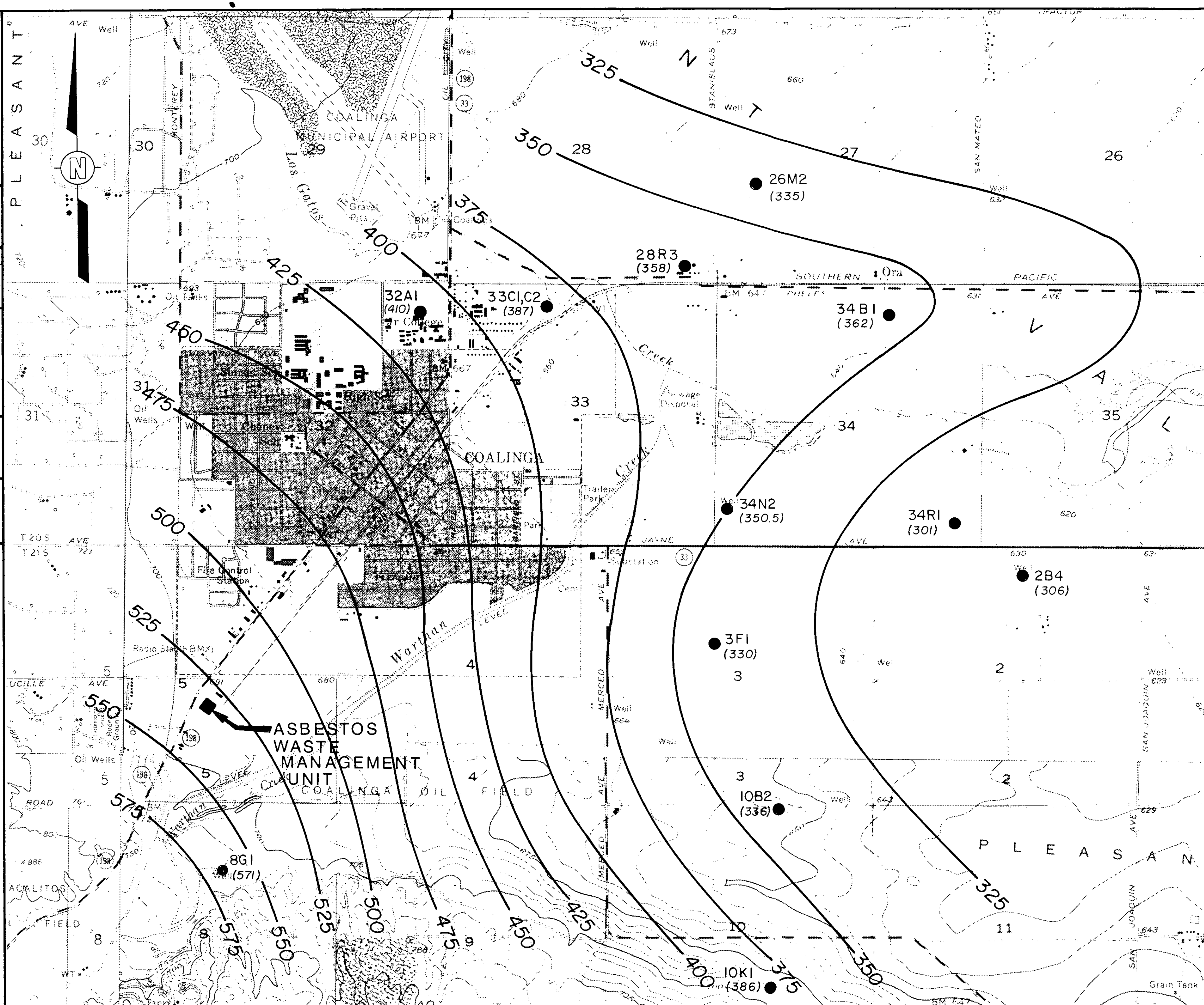
REVISION	DATE	BY	CHK'D	APPR'VD	DESCRIPTION
1	8-10-89	BJW	HHH		GENERAL REVISION
0	12-1-88	BJW			

SOUTHERN PACIFIC TRANSPORTATION CO.
COALINGA, CALIFORNIA

TITLE: FINAL COVER PLAN, SECTION AND DETAIL

INTERNATIONAL TECHNOLOGY CORPORATION
... Creating a Safer Tomorrow

DESIGNED BY	H. Hamparsumian	CHECKED BY	HHH 8/10/89	SHEET 3 OF 3
DRAWN BY	B.J. Whitehead	APPROVED BY	8/14/89	
DATE	12-1-88	DRAWING NO.	202208-E3	



EXPLANATION:

2B4 ● WELL IDENTIFICATION NUMBER (GROUND-WATER ELEVATION IN FEET) FOR 1-14-81 OR 1-15-81

425 GROUND-WATER CONTOUR (CONTOUR INTERVAL 25 FEET)

SCALE

0 2000 4000 FEET

REFERENCE:

7.5 MINUTE USGS TOPOGRAPHIC MAPS OF THE FOLLOWING CALIFORNIA QUADRANGLES: KREYENHAGEN HILLS, DATED: 1956, PHOTOREVISED 1971; ALCALDE HILLS, DATED: 1969; CURRY MOUNTAIN, DATED: 1969; COALINGA, DATED: 1965, PHOTOREVISED: 1979. SCALE 1:24,000

FIGURE 10

LOCATIONS AND SITE WATER LEVEL CONTOUR MAP

PREPARED FOR

SOUTHERN PACIFIC TRANSPORTATION CO.
COALINGA, CALIFORNIA

INTERNATIONAL TECHNOLOGY CORPORATION

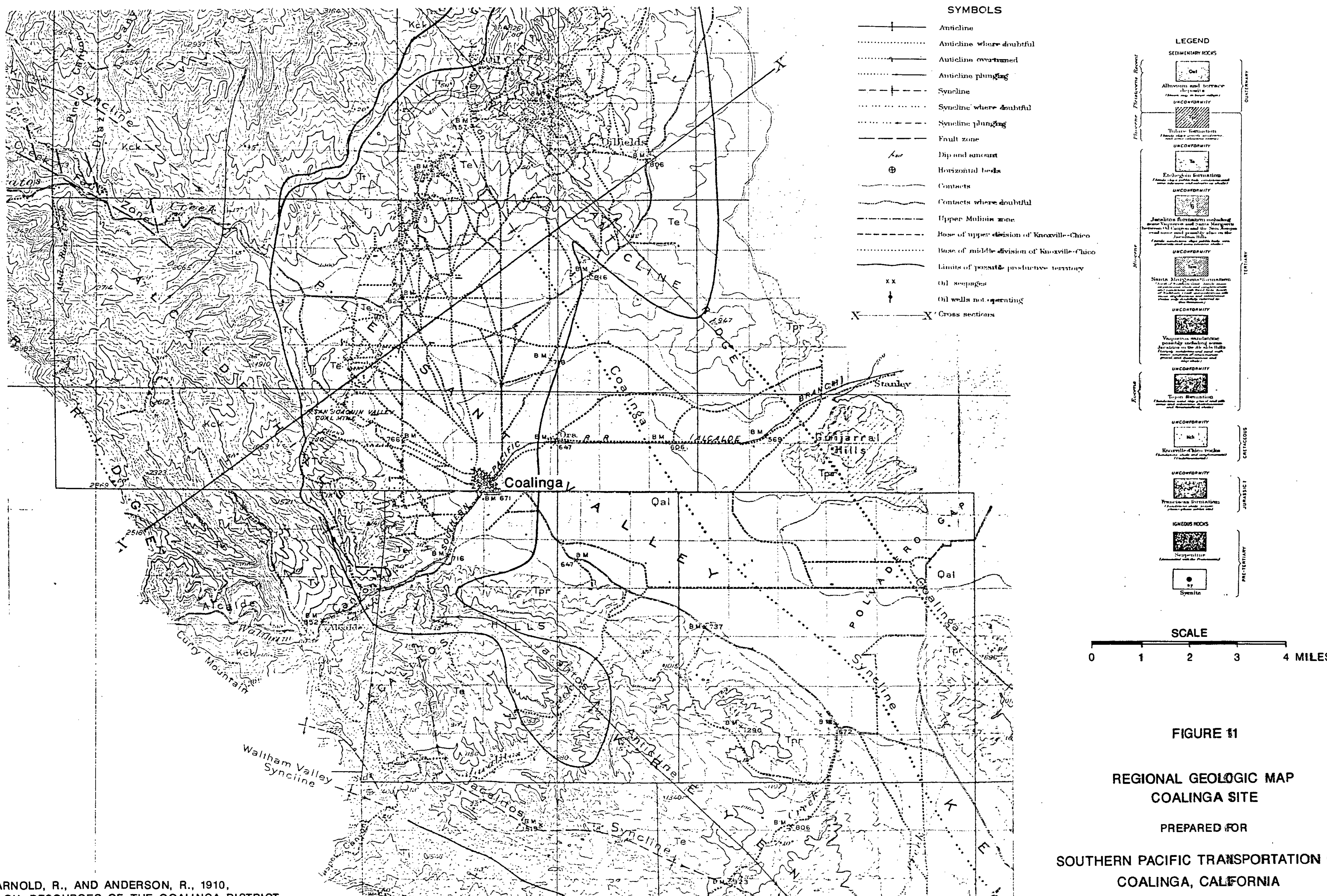
DRAWING NUMBER 202208-B10

DRAWN BY BJW 8-4-88

CHECKED BY / APPROVED BY

REV. 1 8-01-89

DRAWN BY	HDS 7-18-88	CHECKED BY G.O. 8/8/88	APPROVED BY MEU 8.9.88	DRAWING NUMBER 202208-B1



SCALE

0 1 2 3 4 MILES

REFERENCE:

TAKEN FROM ARNOLD, R., AND ANDERSON, R., 1910,
GEOLOGY AND OIL RESOURCES OF THE COALINGA DISTRICT,
CALIFORNIA: U.S. GEOL. SURVEY BUL. 398, 354 PP.,
PL. 1: GEOLOGIC AND STRUCTURAL MAP OF THE COALINGA DISRICT, CALIORNIA,
SCALE 1:125,000

FIGURE 11

REGIONAL GEOLOGIC MAP
COALINGA SITE

PREPARED FOR

SOUTHERN PACIFIC TRANSPORTATION CO.
COALINGA, CALIFORNIA

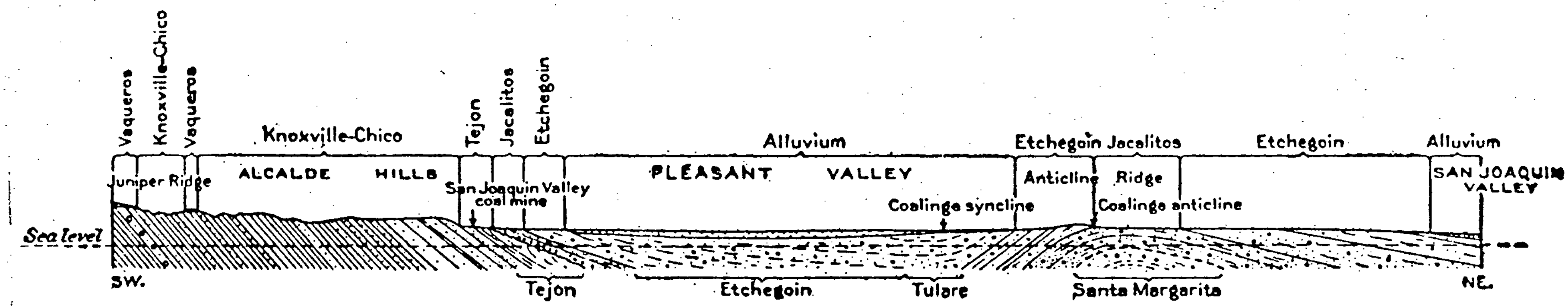
INTERNATIONAL TECHNOLOGY CORPORATION

137773

137773

DRAWN BY	HDS 7-18-88	CHECKED BY	G.O.	8/8/88	DRAWING NUMBER 202208-A4
		APPROVED BY	MBW	8·8·88	

"Do Not Scale This Drawing"



SECTION X-X'

NOT TO SCALE

NOTE:

SEE FIGURE 10 FOR CROSS SECTION LOCATION.

REFERENCE:

TAKEN FROM ARNOLD, R., AND ANDERSON, R., 1910, GEOLOGY AND OIL RESOURCES OF THE COALINGA DISTRICT, CALIFORNIA: U.S. GEOLOGICAL SURVEY BUL. 398
NOT TO SCALE

FIGURE 12

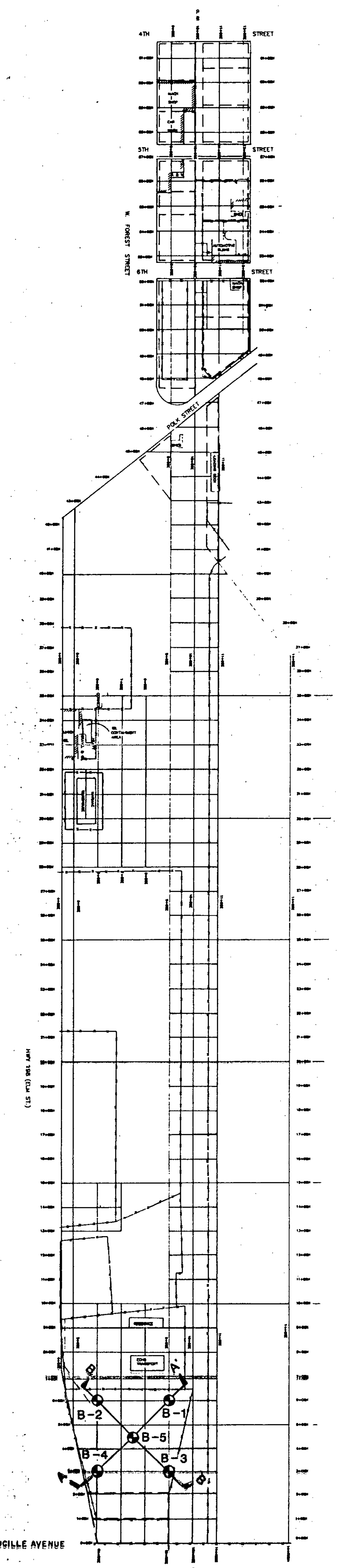
REGIONAL CROSS SECTION X-X'
COALINGA SITE

PREPARED FOR

SOUTHERN PACIFIC TRANSPORTATION CO.
COALINGA, CALIFORNIA

INTERNATIONAL TECHNOLOGY CORPORATION

DRAWN BY	HDS 8-8-88	CHECKED BY / APPROVED BY	G.O. / MEU	8/8/88 / 8·8·88	DRAWING NUMBER	202208-B11



EXPLANTION:

B-1 ● LOCATION OF EXPLORATORY BORE HOLES

A ⌊___⌋ A' CROSS SECTION LOCATION

APPROX. SCALE
0 450 900 FEET

FIGURE 13

BOREHOLE LOCATION MAP
T.T. CORPORATION
COALINGA SITE

SHEET OF SHEETS

REVISIONS

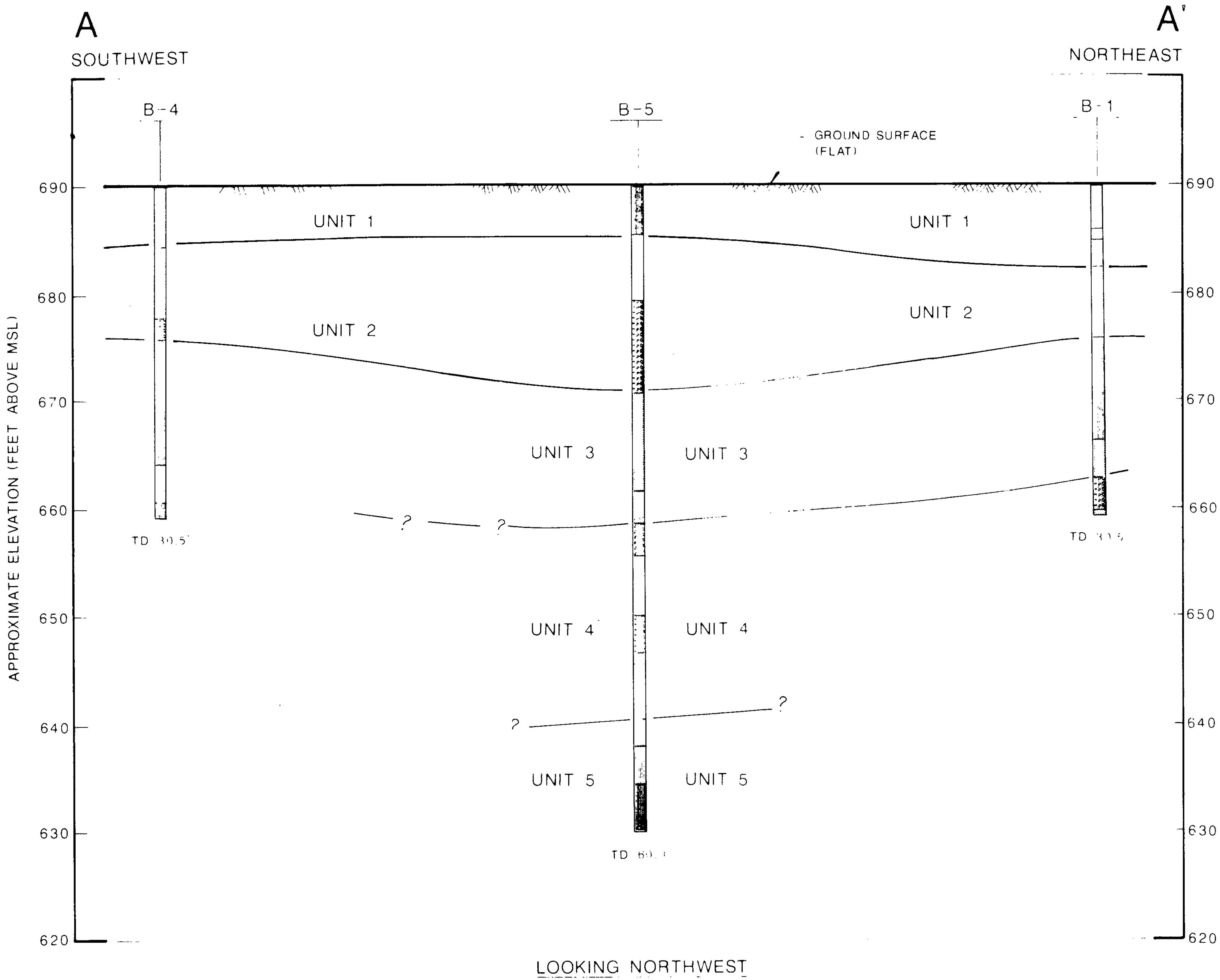
4130 ARDMORE AVE. SUITE 101
BAKERSFIELD, CALIFORNIA 93309

DRAWN BY RN JOB NO 87-69
DATE 12-28-87

Martin-McIntosh
LAND SURVEYING · CIVIL ENGINEERING

202208-B4

BJW 7-19-88



EXPLANATION

GEOLOGIC UNITS

AGE		
QUATERNARY ALLUVIUM	UNIT 1	OLIVE BROWN SILTY SAND
	UNIT 2	OLIVE BROWN-OLIVE GRAY SANDY GRAVEL-GRAVELLY SAND
	UNIT 3	OLIVE BROWN-BROWN CLAYEY SILT-SANDY SILT
	UNIT 4	DARK GRAYISH BROWN-BROWN SANDY GRAVEL-GRAVELLY SAND
	UNIT 5	OLIVE BROWN SILT-SILTY SAND

SYMBOLS

—?— GEOLOGIC CONTACT; DASHED WHERE UNCERTAIN

NOTES:

1. FOR LOCATION OF CROSS SECTION SEE FIGURE
2. SEE TEXT FOR DETAILED DESCRIPTION OF GEOLOGIC UNITS
3. NO GROUND WATER ENCOUNTERED DURING DRILLING

HORIZONTAL SCALE

0 50 100 FEET

VERTICAL SCALE

0 10 20 FEET

5 X VERTICAL EXAGGERATION

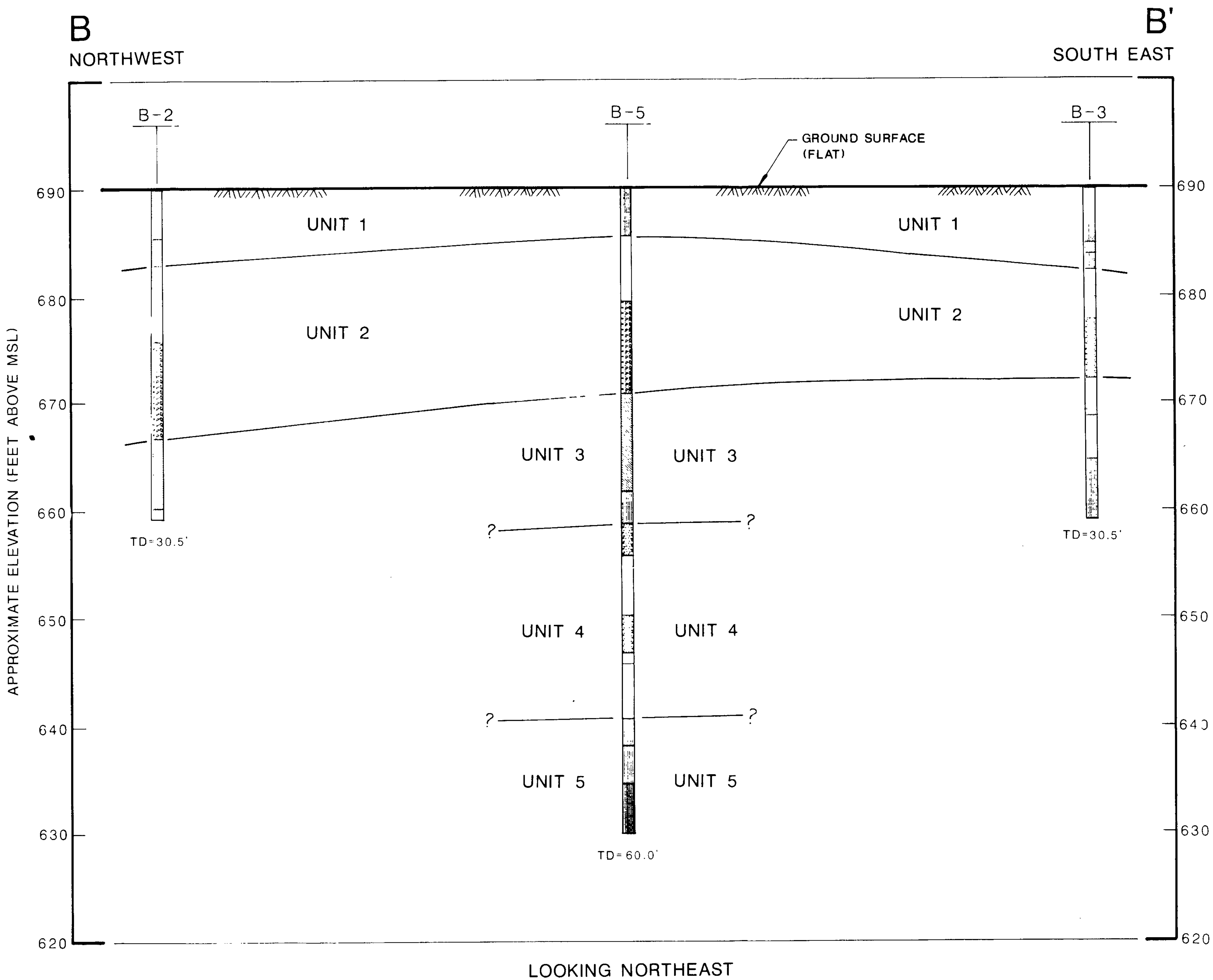
FIGURE 14

GEOLOGIC CROSS SECTION A-A'

PREPARED FOR

SOUTHERN PACIFIC TRANSPORTATION CO.
COALINGA, CALIFORNIA

INTERNATIONAL TECHNOLOGY CORPORATION



EXPLANATION

GEOLOGIC UNITS

AGE: QUATERNARY ALLUVIUM

- UNIT 1 — OLIVE BROWN SILTY SAND
- UNIT 2 — OLIVE BROWN-OLIVE GRAY SANDY GRAVEL-GRAVELLY SAND
- UNIT 3 — OLIVE BROWN-BROWN CLAYEY SILT-SANDY SILT
- UNIT 4 — DARK GRAYISH BROWN-BROWN SANDY GRAVEL-GRAVELLY SAND
- UNIT 5 — OLIVE BROWN SILT-SILTY SAND

SYMBOLS

GEOLOGIC CONTACT; DASHED WHERE UNCERTAIN

NOTES:

1. FOR LOCATION OF CROSS-SECTION SEE FIGURE 12
2. SEE TEXT FOR DETAILED DESCRIPTION OF GEOLOGIC UNITS
3. NO GROUND WATER ENCOUNTERED DURING DRILLING

HORIZONTAL SCALE: 0 — 50 — 100 FEET

VERTICAL SCALE: 0 — 10 — 20 FEET

5 X VERTICAL EXAGGERATION

FIGURE 15

GEOLOGIC CROSS SECTION B-B'

PREPARED FOR

SOUTHERN PACIFIC TRANSPORTATION CO.
COALINGA, CALIFORNIA

INTERNATIONAL TECHNOLOGY CORPORATION

DRAWING NUMBER 202208-B5 | DRAWN BY BJW 7-19-88 | CHECKED BY / APPROVED BY MFJ 8-3-88

APPENDIX A

ANALYTICAL TEST RESULTS

July 14, 1988

IT CORP.
17461 Derian Avenue, Suite 190
Irvine, CA 92714

Attn: Mark Unruh

JOB NO. 10011

WCAS
WEST COAST ANALYTICAL SERVICE, INC.
ANALYTICAL CHEMISTS

LABORATORY REPORT

Samples Received: Three (3) waters, in triplicate, & seven (7) soil samples
Date Received: 6-23-88
Released for Analysis: 6-24-88
Purchase Order No: 148547/Proj: 202208-05-04-02/South Pac. Trans Corp.

The samples were analyzed as follows:

Samples Analyzed	Analysis	Results
One (1) water	General Anions by EPA 300.6/IC	Table I
Three soil composites & two waters	General Cations by EPA 300.7/IC	Table II
One water	Total Dissolved Solids by EPA 160.2	Table III
Three soil composites	pH by EPA 9040	Table IV
Three soil composites & one water	Metals by ICPMS	Quant. Report
Three soil composites	Magnesium & Calcium by ICPMS	Table V

B. Michael Hovanec
Senior Staff Chemist

D.J. Northington, Ph.D.
Technical Director

9840 Alburtis Avenue • Santa Fe Springs, California 90670 • 213/948-2225

WEST COAST ANALYTICAL SERVICE, INC.

IT Corp.
Mr. Mark Unruh

Job # 10011
July 14, 1988

LABORATORY REPORT

TABLE I

Parts Per Million

	WSC-2	Detection Limit
Fluoride (F^-)	2	1.0
Chloride (Cl^-)	280	1.0
Nitrite (NO_2^-)	ND	1.0
Bromide (Br^-)	ND	1.0
Nitrate (NO_3^-)	30	1.0
Ortho-Phosphate (HPO_4^{-2})	ND	2.0
Sulfate (SO_4^{-2})	1300	1.0

Date Analyzed: 7-1-88

ND - Not Detected

WEST COAST ANALYTICAL SERVICE, INC.

IT Corp.
Mr. Mark Unruh

Job # 10011
July 14, 1988

LABORATORY REPORT

TABLE II

Parts Per Million

Compound	WSC-1	WSC-2	Detection Limit
Lithium (Li^{+})	TR<1	TR<1	1
Sodium (Na^{+})	350	360	1
Ammonium (NH_4^{+})	20	30	1
Potassium (K^{+})	3	5	1
Magnesium (Mg^{+2})	91	89	1
Calcium (Ca^{+2})	76	95	2
Date Analyzed:	7-6-88	6-24-88	

TABLE II (CONT.)

Parts Per Million

Component	1113A-1117A 1113B-1117B Composite	5005A-5009A 5005B-5009B Composite	3905A-3909A 3905B-3909B Composite	Detection Limit
Lithium (Li^{+})	ND	ND	ND	10
Sodium (Na^{+})	260	77	45	10
Ammonium (NH_4^{+})	170	170	180	10
Potassium (K^{+})	41	69	88	10

Date Analyzed: 7-6-88

ND - Not Detected
TR - Trace

WEST COAST ANALYTICAL SERVICE, INC.

IT Corp.
Mr. Mark Unruh

Job # 10011
July 14, 1988

LABORATORY REPORT

TABLE III

Parts Per Million (mg/L)

Sample No.	Total Dissolved Solids
WSC-3	2200
Detection Limit	1

Date Analyzed: 6-27-88

TABLE IV

Sample No.	pH (units)
1113A-1117A, 1113B-1117B Composite	9.4
3905A-3909A, 3905B-3909B Composite	8.6
5005A-5009A, 5005B-5009B Composite	7.8

Date Analyzed: 7-5-88

WEST COAST ANALYTICAL SERVICE, INC.

IT Corp.
Mr. Mark Unruh

Job # 10011
July 14, 1988

LABORATORY REPORT

TABLE V

Parts Per Million (mg/Kg)

Sample No.	Calcium	Magnesium
1113A-1117A, 1113B-1117B Composite	7,300	110,000
3905A-3909A, 3905B-3909B Composite	10,000	62,000
5005A-5009A, 5005B-5009B Composite	7,900	63,000
Detection Limit	1,100	90

Date Analyzed: 7-7-88

Client : IT Corporation
Job # : 10011
Analysis date : 6-29-88

Sample : W. S. C. 1
File : 11
14

Quantitative Report for Selected Metals
Inductively Coupled Plasma - Mass Spectrometry
Parts per million (mg/L)

Selected Analyte	Concentration (ppm)	Detection Limit
Aluminum	ND<0.05	0.05
Antimony	ND<0.009	0.009
Arsenic	0.015	0.01
Barium	0.0096	0.001
Beryllium	ND<0.004	0.004
Boron	1	1
Cadmium	0.003	0.001
Chromium	ND<0.03	0.03
Cobalt	ND<0.003	0.003
Copper	ND<0.02	0.02
Iron	ND<2	2
Lead	ND<0.002	0.002
Manganese	0.22	0.01
Mercury	ND<0.007	0.007
Nickel	ND<0.07	0.07
Selenium	ND<0.3	0.3
Silver	ND<0.002	0.002
Thallium	ND<0.001	0.001
Zinc	ND<0.03	0.03

Client : IT Corporation
Job # : 10011
Analysis date : 6-29-88

Sample : 1113A - 1117A
1113B - 1117B
Files : 123 141
31 13

Quantitative Report for Selected Metals
Inductively Coupled Plasma - Mass Spectrometry
Parts per Million (mg/Kg)
composite

Selected Analyte	Concentration (ppm)	Detection Limit
Aluminum	5000	100
Antimony	0.18	0.08
Arsenic	ND<16	16
Barium	2900	1
Beryllium	0.14	0.05
Boron	ND<24	24
Cadmium	0.08	0.04
Chromium	580	1
Cobalt	41	0.02
Copper	9	0.8
Iron	27000	15
Lead	6.9	0.09
Manganese	630	0.7
Mercury	0.08	0.08
Nickel	720	0.5
Selenium	ND<1	1
Silver	ND<0.06	0.06
Thallium	0.04	0.02
Zinc	210	1

Elements Not Analyzed: All Gasses, C, P, S, K, Si, Sc, In, Tb
ND = Not Detected.

WCAS

Client : IT Corporation
Job # : 10011
Analysis date : 6-29-88

Sample : 3905A - 3909A
3905B - 3909B
Files : 123 141
32 12

Quantitative Report for Selected Metals
Inductively Coupled Plasma - Mass Spectrometry
Parts per million (mg/Kg)
composite

Selected Analyte	Concentration (ppm)	Detection Limit
Aluminum	9200	100
Antimony	3.9	0.08
Arsenic	ND<13	13
Barium	1200	1
Beryllium	0.35	0.05
Boron	ND<24	24
Cadmium	0.28	0.04
Chromium	340	1
Cobalt	31	0.02
Copper	22	0.8
Iron	28000	15
Lead	27	0.09
Manganese	4500	0.7
Mercury	0.08	0.08
Nickel	470	0.5
Selenium	3	1
Silver	ND<0.06	0.06
Thallium	0.08	0.02
Zinc	180	1

Elements Not Analyzed: All Gasses, C, P, S, K, Si, Sc, In, Tb
ND = Not Detected.

Client : IT Corporation
Job # : 10011
Analysis date : 6-29-88

Sample : 5005A - 5009A
5005B - 5009B
Files : 123 141
33 14

Quantitative Report for Selected Metals
Inductively Coupled Plasma - Mass Spectrometry
Parts per million (mg/Kg)
composite

Selected Analyte	Concentration (ppm)	Detection Limit
Aluminum	10000	100
Antimony	1.17	0.08
Arsenic	ND<13	13
Barium	493	1
Beryllium	0.28	0.05
Boron	ND<24	24
Cadmium	1.28	0.04
Chromium	304	1
Cobalt	25.7	0.02
Copper	42.6	0.8
Iron	26000	15
Lead	64.2	0.09
Manganese	590	0.7
Mercury	ND<0.08	0.08
Nickel	325	0.5
Selenium	2	1
Silver	ND<0.06	0.06
Thallium	0.08	0.02
Zinc	200	1

Microtech Analytical
Laboratory Services

13 July 1988

I.T.
17461 Derian Suite 190
Irvine, CA 92714
Attn: Mr. Glen Ozima

Subj: TEM ASBESTOS ANALYSIS OF THE WATER SAMPLE WSC-3

INTRODUCTION

The attached TEM analysis report for asbestos is provided for your records. This analysis was completed by Microtech Analytical. The samples were received 07 July 1988 and analysis was finished 12 July 1988. A copy of the sample form submitted with the samples are attached to this report.

INSTRUMENTATION

The asbestos fiber analysis was performed on an Hitachi 7000 Scanning/Transmission Electron Microscope (STEM) with Selected Area Electron Diffraction (SAED) capability, and equipped with a KEVEX Energy Dispersive X-ray Microanalyzer (EDXA) for elemental analysis.

PROCEDURE

Aliquots of 100, 20, 10 and 5mls of the water sample were filtered through a 25mm MCE filter to ensure proper loading and readability. Due to the turbidity of the water, only the 5ml aliquot was readable. The filter preparation and counting procedures are in compliance with AHERA guidlines as per EPA Federal Register, 40 CFR Part 763, Final Rule and Notice for air sample analysis.

RESULTS

The results include a summary and a detailed report of the Asbestos Fiber Analysis. Enclosed is one EDXA readout for each asbestos group found (Chrysotile or Amphibole). Any SAED photographs are recorded and kept in lab.

Should you have any questions regarding this report, please contact me at (407) 631-6561.

Sincerely,

H. L. Capadano / Scott B. Huhel

H.L. Capadano, Jr., I.H. Sr. Electron Microscopist
Laboratory Director

HLC:sbh

MICROTECH
Analytical Services
100 Eyster Blvd.
ROCKLEDGE, FLORIDA 32955

(407) 631-6561

TEM LABORATORY ASBESTOS REPORT
SUMMARY REPORT

To: I.T.
17461 Derian -Suite 190
Irvine, CA 92714

Date: 13 July 1988
TEM Report #: 88-T-1010

Attn: Mr. Glen Ozima

Project: TEM ASBESTOS ANALYSIS OF WATER SENT TO OUR LABORATORY

SAMPLE #	TEM LAB #	LITERS FILTERED	RESULTS ASBESTOS STRUCTURES/cc	COMMENTS
WSC-3	731T	5ml	1112 S/cc [11.12 X 10^5 S/L]	10% load

Microtech Analytical
Laboratory Services

13 July 1988

TEM ASBESTOS ANALYSIS REPORT
TEM Report # 88-T-1010

Client:	I.T.	Date Received:	7 July 1988
Project:	Water Analysis	Date Analyzed:	11 July 1988
Sample Number:	WSC-3	Filter Type:	MCE
EM Lab Number:	731T	Deposit Area:	2.01 cm2
Sample Type:	Water	Preparation:	[signature]
Sample volume:	5 ml	Analyst:	[signature]

Average grid opening area (cm2): 72.25 X 10-6 cm2 [.0072 mm2]
Grid openings examined: 20
Area of filter sample analyzed (cm2): 14.45 X 10-4 cm2 [.0145 mm2]

Detection limit: 278.0 S/cc

Qualitative description of non-asbestos particles: Contaminants include large amounts of Fe and Ca. 10% particulate loading.

Total Number of Asbestos Structures: 4

Chrysotile:	4		
Amphibole:	0		
Amosite:	0	Crocidolite:	0
Anthophyllite:	0	Tremolite:	0
Non-Identified:	0		

Break-down of Asbestos Structures:	# of Structures		Structures/cc	
	<5um	≥5um	<5um	≥5um
Total Chrysotile Fibers:	1	0	278.2	0.000
Bundles:	0	0	0.000	0.000
Clusters:	0	0	0.000	0.000
Matrices:	3	0	834.6	0.000
Total Amphibole Fibers:	0	0	0.000	0.000
Bundles:	0	0	0.000	0.000
Clusters:	0	0	0.000	0.000
Matrices:	0	0	0.000	0.000

General Comments: Only structures >0.5um in length were counted, as per EPA protocol.

TOTAL NUMBER OF ASBESTOS STRUCTURES/CC [S/mm2]: 1112.8 S/cc [1,113,000 S/L]

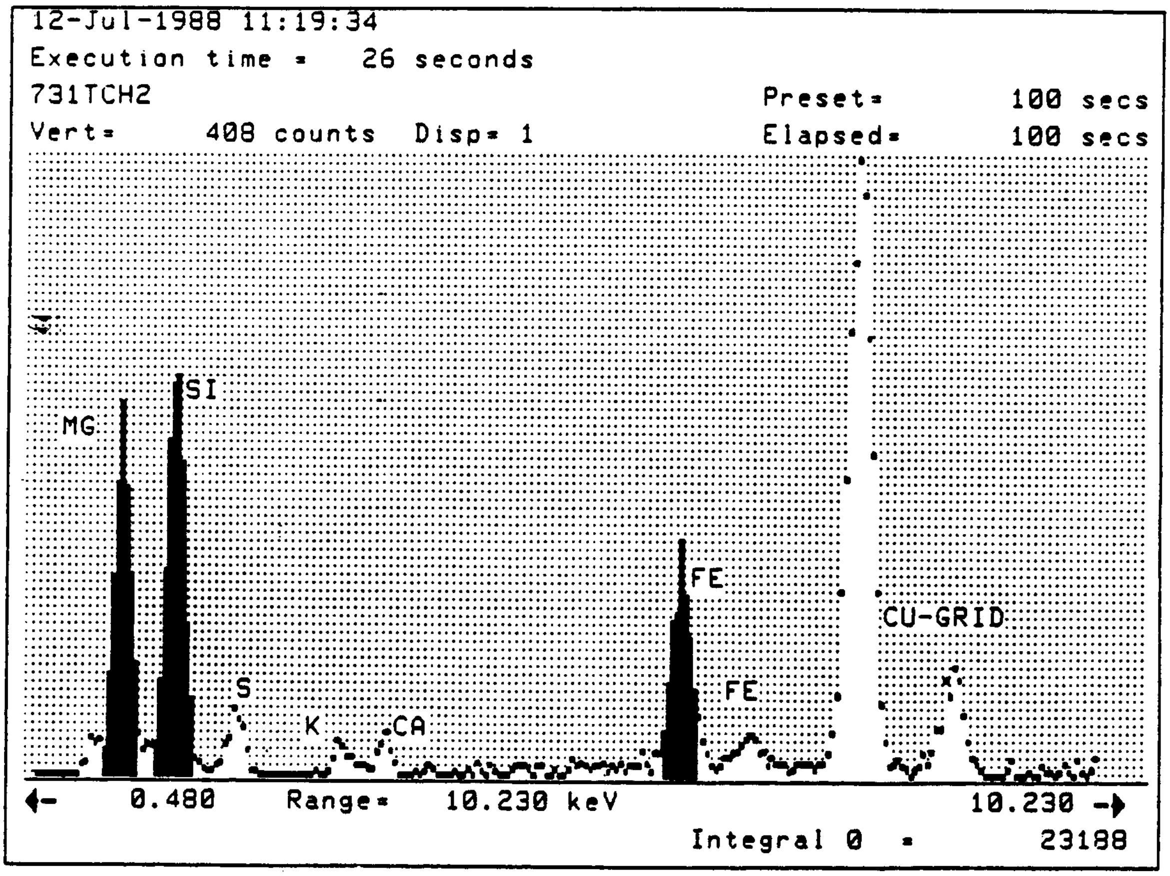
* 0.000 = Below Detection Limits (BDL)

100 Eyster Blvd. • Rockledge, FL 32955 • 1-800-333-2201

TEM LAB SAMPLE #: 731T
ASBESTOS TYPE: Chrysotile
CONTAMINANTS: Small amounts of S, K, and Ca contaminants.

COMMENTS: N/A

VERTICAL AXIS: 408 counts
HORIZONTAL AXIS: 0.480-10.230 keV



WCAS
WEST COAST ANALYTICAL SERVICE, INC.
ANALYTICAL CHEMISTS

July 12, 1988

RECEIVED
JUL 14 1988
IT CORPORATION - IRVINE

IT CORP.
17461 Derian Avenue
Irvine, CA 92714

Attn: Mark Uniuh

JOB NO. 9992

LABORATORY REPORT

Samples Received: Three (3) soil samples
Date Received: 6-22-88
Released for Analysis: 6-24-88
Purchase Order No: 148547/Proj: 202208-05-04-02/Southern Pacific

The samples were analyzed as follows:

Samples Analyzed	Analysis	Results
Three soils	Metals by ICPMS	Quant. Report
Three soils	Cations by EPA 300.7/IC	Table I
Three soils	pH by EPA 9040	Table II
Three soils	Calcium, Magnesium by ICPMS	Table III

Shelley Rinker
Shelley Rinker
Analytical Chemist

D.J. Northington, Ph.D.
Technical Director

9840 Alburtis Avenue • Santa Fe Springs, California 90670 • 213/948-2225

Client: IT Corp.
Job Number: 9992
Date Analyzed: 6-29-88

Quantitative Analysis Report
Inductively Coupled Plasma-Mass Spectrometry

Parts Per Million (mg/Kg)

	B-5 GC-3	B-5 GC-7	B-5 GC-9	Blank DL
Aluminum	8000	17000	17350	20
Antimony	ND<0.3	0.5	ND<0.3	0.3
Arsenic	ND<29	ND<44	ND<35	29
Barium	131	163	86.9	0.9
Beryllium	0.25	0.51	0.49	0.09
Boron	ND<48	ND<48	ND<48	48
Cadmium	0.45	0.6	0.72	0.03
Chromium	109	46	43	2
Cobalt	5.94	12.2	10.6	0.05
Copper	25	26	31	1
Iron	22100	30000	25000	30
Lead	3.2	7.4	6.1	0.2
Manganese	380	480	400	0.8
Mercury	ND<0.2	ND<0.2	ND<0.2	0.2
Nickel	46	42	41	4
Selenium	ND<7	ND<7	ND<7	7
Silver	0.06	ND<0.04	ND<0.04	0.04
Thallium	0.12	0.17	0.11	0.02
Zinc	50	64	58	2

ND-Not Detected. The detection limit (DL) is stated above. Because of sample interferences, Sample DLs may differ from Blank DLs.

WEST COAST ANALYTICAL SERVICE, INC.

IT Corp.
Mr. Mark Uniuh

Job # 9992
July 12, 1988

LABORATORY REPORT

TABLE I

Parts Per Million

Component	B-5 GC-3	B-5 GC-7	B-5 GC-9	Detection Limit
Lithium (Li^+)	ND	ND	ND	1
Sodium (Na^+)	140	40	88	1
Ammonium (NH_4^+)	33	22	29	1
Potassium (K^+)	6	3	4	1

Date Analyzed: 7-6-88

ND - Not Detected

TABLE II

Sample No.	pH (Units)
B-5 GC-3	8.9
B-5 GC-7	9.6
B-5 GC-9	9.2

Date Analyzed: 6-24-88

TABLE III

Parts Per Million

Sample No.	Total Calcium	Total Magnesium
B-5 GC-3	11000	6900
B-5 GC-7	7200	7400
B-5 GC-9	12000	5500
Detection Limit	1200	65

Date Analyzed: 7-12-88

July 27, 1988

IT CORPORATION
17461 Derian Ave., Suite 190
Irvine, CA 92714

Attn: Glenn Ozzima

JOB NO. 10319

WCAS
WEST COAST ANALYTICAL SERVICE, INC.

LABORATORY REPORT

Samples Received: Three (3) composites and one (1) liquid from Previous WCAS Job # 10011
Date Received: 7-25-88
Purchase Order No: 148547/South Pac

The samples were analyzed as follows:

Samples Analyzed	Analysis	Results
Three soil composites	pH by EPA 150.1 on D.I. Water Leachate Solution	Table I
One water	Carbonate, Bicarbonate Determination by SM 403	Table II

B. Michael Hovanec
Senior Staff Chemist

Michael Shelton
Senior Chemist

9840 Alburtis Avenue • Santa Fe Springs, California 90670 • 213/948-2225

WEST COAST ANALYTICAL SERVICE, INC.

IT COPROATION
Mr. Glenn Ozzima

Job # 10319
July 27, 1988

LABORATORY REPORT

TABLE I

Sample No.	pH (Units)
Blank (DI water only)	4.9
5005A-5009A 5005B-5009B Composite	7.3
3905A-3909A 3905B-3909B Composite	8.8
1113A-1117A 1113B-1117B Composite	9.2

Date Analyzed: 7/17/88

TABLE II

($mg\ CaCO_3/L$)

Sample No.	Carbonate	Bicarbonate
WSC-3	ND	120
Detection Limit	1	1

ND-Not Detected

Date Analyzed: 7-27-88

WCAS

The Earth Technology Corporation

Testing Services Group
15481 Electronic Lane, Unit D, Huntington Beach, California 92649
Telephone: (714) 891-7802

July 22, 1988

IT Corporation
17461 Derian Avenue, Suite 190
Irvine, California 92714

ATTENTION: Glen Ozima

SUBJECT: Report
Laboratory Testing
Project: Southern Pacific Transportation Co.
Project No.: 202208
TETC No.: 88-215-1506

Dear Mr. Ozima:

Enclosed please find the report indicating the results of the laboratory geotechnical testing program conducted on the sample from Southern Pacific Transportation Co. Project.

If you have any questions or comments regarding this report feel free to call us at your convenience. We look forward to hearing from you.

Very truly yours,

THE EARTH TECHNOLOGY CORPORATION (Western)

Somsak Poolperm
Environmental Geomechanics Laboratory
Staff Engineer

Bertrand S. Palmer
Manager Environmental Geomechanics Laboratory
Senior Project Engineer

SP/BSP/dlb

Attachment

1.0 INTRODUCTION

This report presents the results of the geotechnical laboratory testing program conducted on the samples from Southern Pacific Transportation Co. Project.

2.0 TESTING PROGRAM

Based on the request for analysis provided by IT Corporation dated July 5, 1988, the testing program included the following tests:

- o Permeability (Rigid Wall Permeameter)
- o Triaxial Permeability (Flexible Wall Permeameter)

The following indicates the specific testing program applied to each sample.

Boring No.	Sample No.	Depth Interval (ft.)	Requested Testing Program
B-5	GT-2	9.5 - 10.0	Permeability
B-5	GT-4	24.5 - 25.0	Triaxial Permeability
B-5	GT-6	34.5 - 35.0	Permeability
B-5	GT-9	54.5 - 55.0	Triaxial Permeability

3.0 TESTING PROCEDURES

This testing program has been performed in general accordance with the following procedures.

Tests	Standard Procedure
Permeability	COE VII (5)
Triaxial Permeability	COE VII (7)

Reference:

COE: U.S. Army Corps of Engineers, "Laboratory Soils Testing." EM1110-21906, 1980. (Roman numeral designation in table refers to appendix and paragraph number in COE Manual.

3.1 PERMEABILITY TEST (USCOE Chapter VII, Section 5)

Permeability tests were conducted on "undisturbed" samples without removing them from the sampling tube. The sampling tube served as the permeameter cylinder. The ends of the samples were fitted with screens. The sampling tube was then placed in a triaxial permeability chamber and fitted with a membrane that covered the top and bottom platens. The membrane was secured on the top and bottom platens by O-rings. The triaxial cell was then filled up with water and pressurized. The cell pressure applied a vertical pressure to the top platen therefore applying a vertical stress on the soil sample contained in the sampling tube. Because of the relatively high permeability of the samples, a constant head permeability test was conducted on the samples tested in rigid wall permeameter.

The permeability test was started by percolating deaired water through the sample and measuring the volume of water collected in the outflow as a function of time. Once a significant amount of water permeated the sample and that the plot of outflow versus time was a straight line the test was terminated.

3.2 TRIAXIAL PERMEABILITY (USCOE Chapter VII, Section 7)

The triaxial permeability tests were performed in general accordance with Section 7 of Chapter VII of USCOE Laboratory Testing Soil Manual (EM1110-2-1906, 1980). The sample was extruded from the sampling tube (undisturbed sample) and placed in a triaxial permeability cell. The porous stones present at the top and bottom of the sample were thoroughly flushed to minimize the amount of air present in the system. This was accomplished by admitting deaired water through the inflow and outflow line of the triaxial permeability cell and draining this water through the flushing line until no air bubbles could be observed in the flushing line. The back pressure was increased until evaluation of the B parameter indicated a degree of saturation close to or equal to 100%. The cell pressure was then increased until the difference between the cell pressure and back pressure was equal to the required effective confining pressure (isotropic effective consolidation stress). Once volume change measurements indicated the end of primary consolidation, the double falling head permeability test was started. A pressure gradient was applied across the sample in order to insure significant fluid movement in the burette over a reasonable period of time. Based on the pressure gradient across the sample, burette level and time measurement and sample size, the permeability of the sample was computed using the double falling head permeability formula.

4.0 TESTING EQUIPMENT

The testing equipment used to perform this testing program meets the general specifications indicated in the testing procedures. The testing equipment is professionally calibrated and traceable to National Bureau of Standards (NBS) and ASTM Standards.

Most of the permeability and triaxial permeability equipment is designed and built by the System Design group of The Earth Technology Corporation. This equipment performs permeability and triaxial permeability tests in general accordance with US Corps of Engineer or USEPA recommended procedures.

5.0 TEST RESULTS

The test results are presented in Table 1 and Table 2.

TABLE 1

SUMMARY OF VERTICAL HYDRAULIC CONDUCTIVITY TEST (RIGID WALL PERMEAMETER)

PROJECT NAME: Southern Pacific Transportation Co. TETC #: 88-215-1506

PROJECT NO.: 202208 CLIENT: IT Corporation

DATE: July 1988 SUMMARIZED BY: S. Poolpera

SAMPLE NO.	DEPTH (ft)	PRE-TEST MEASUREMENT: MOISTURE CONTENT (%)	PRE-TEST MEASUREMENT: DRY DENSITY (pcf)	PRE-TEST MEASUREMENT: VOID * RATIO	PRE-TEST MEASUREMENT: DEGREE OF * SATURATION (%)	POST TEST MOISTURE CONTENT (%)	VERTICAL STRESS (psi)	HYDRAULIC GRADIENT (h/L)	HYDRAULIC CONDUCTIVITY (cm/s)
B-5 / GT-2	9.5-10.0	4.5	97.5	0.694	16.0	20.5	7.0	5	4.0×10^{-3}
B-5 / GT-6	34.5-35.0	4.0	106.5	0.554	19.0	16.0	27.0	5	6.0×10^{-3}

* Assuming specific gravity = 2.65

TABLE 2

SUMMARY OF VERTICAL HYDRAULIC CONDUCTIVITY TEST (FLEXIBLE WALL PERMEAMETER)

PROJECT NAME: Southern Pacific Transportation Co.

TETC #: 88-215-1506

PROJECT NO.: 202208

CLIENT: IT Corporation

DATE: July 1988

SUMMARIZED BY: S. Poolpern

SAMPLE NO.	DEPTH (ft)	PRE-TEST MEASUREMENT				BACK PRESSURE (psi)	B VALUE (%)	POST TEST		EFFECTIVE STRESS (psi)	HYDRAULIC GRADIENT (h/L)	HYDRAULIC CONDUCTIVITY (cm/s)
		MOISTURE CONTENT (%)	DRY DENSITY (pcf)	VOID * RATIO	DEGREE OF * SATURATION (%)			MOISTURE CONTENT	DEGREE OF * SATURATION (%)			
B-5 / GT-4	24.5-25.0	22.0	101.0	0.670	88.0	71	98	25.0	100	21	93	6.0×10^{-9}
B-5 / GT-9	54.5-55.0	24.5	90.5	0.862	77.0	70	98	27.5	94	43	69	4.5×10^{-7}

* Assuming specific gravity = 2.70

APPENDIX B

FEDERAL EMERGENCY MANAGEMENT AGENCY
LETTER OF AUGUST 9, 1982

Feder Emergency Managen .nt Agency
Washington, D.C. 20472

9 AUG 1982

Honorable Edward T. O'Neill
Mayor
City of Coalinga
6th & Elm Street
Coalinga, California 93210

Community: Coalinga
County: Fresno Co.
Flood Hazard Boundary Map Current Effective
Date: September 26, 1978
Map Rescission and Conversion to Regular
Program Effective: 23 AUG 1982
Community No. and New Suffix: 060045C

Dear Mayor O'Neill:

The Federal Insurance Administration issued a Flood Hazard Boundary Map for the City of Coalinga, Fresno Co, California. Information recently made available to us and your community indicates that, for all practical purposes, the community would not be inundated by the base flood, which is the flood having a one percent chance of being equaled or exceeded in any given year. We have, therefore, rescinded the Flood Hazard Boundary Map and converted your community to the Regular Program on the effective date shown above. Please destroy all copies of that map.

We are sending this notice to you, the community's Chief Executive Officer, and the State Coordinating Agency in compliance with Part 60, Chapter 1, Title 44, Code of Federal Regulations. A notice of map withdrawal and conversion to the Regular Program will be published in the Federal Register as soon as possible. All affected Federal Agencies and Instrumentalities and the servicing agent for the National Flood Insurance Program (NFIP) will be notified.

The effects of conversion to the Regular Program without a map are:

1. Your community may have been complying with regulations of the National Flood Insurance Program for managing areas designated as Special Flood Hazard Areas (A Zones). Compliance with these regulations is no longer mandatory as a condition of your community's participation in the National Flood Insurance Program.

It should, however, be recognized that floods larger than the base flood do occur. In view of your community's commitment, as expressed in the Resolution of Intent adopted to qualify for initial eligibility in the NFIP, your community should exercise care in evaluating new development which could aggravate or create flood problems in your community or in adjacent communities.

2. The entire community is now classified as Zone C. In Zone C, insurance coverage is available on a voluntary basis at low actuarial, nonsubsidized rates.

3. Some owners of properties shown as flood-prone on the rescinded map may have been required to purchase flood insurance as a condition to obtaining Federal or federally-related financial assistance under Section 102 of the Flood Disaster Protection Act of 1973, as amended. Those property owners who do not wish to maintain flood insurance coverage may be entitled to a premium refund for the current policy year, provided the lender is willing to release the affected mortgagor from the flood insurance purchase requirement, and provided no claim has been paid or is pending on the policy. To receive a premium refund, the mortgagor should obtain a statement from the bank or mortgagee certifying that flood insurance is no longer required. The mortgagor should submit the statement to the insurance agent who originally sold him or her the flood insurance policy. The agent will then initiate the policy cancellation and refund procedure.

   This map rescission and conversion to the Regular Program are based on information available to us at this time. If authoritative information becomes available showing that special flood hazard areas exist in the community, FEMA will issue a map identifying those areas in accordance with Section 201(c) of the Flood Disaster Protection Act of 1973, as amended. The community, at that time, would need to implement flood plain management regulations for those areas, in accordance with Section 60.3(b) of the NFIP regulations.

In summary, by continuing its participation in the Regular Program of the National Flood Insurance Program, the community makes available to its citizens on a voluntary basis additional amounts of insurance coverage at generally lower rates than would be available under the Emergency Program. While no new flood plain management measures are required, communities are encouraged to implement regulatory measures to protect development against hazards as they are known to exist locally.

If you have any questions, please contact the Natural Hazards Division at (202) 287-0270. Also, our Regional Office will be pleased to answer any questions you may have. The address for our Regional Office is:

Federal Emergency Management Agency
Natural and Technological Hazards Division
211 Main Street
Room 220
San Francisco, California 94105

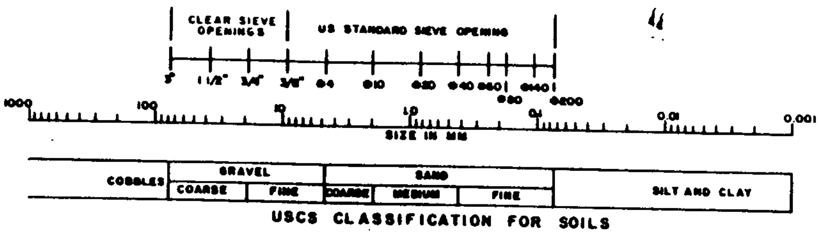
Sincerely,

Richard E. Sanderson, Chief
Natural Hazards Division
Office of Natural and Technological Hazards

APPENDIX C

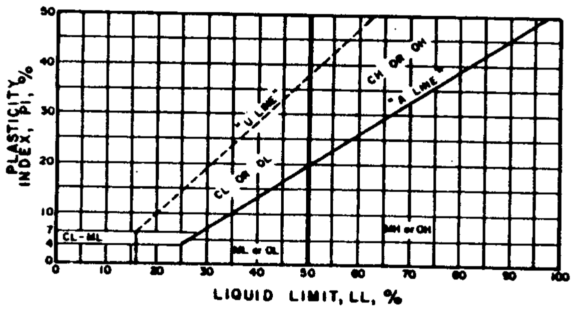
BORING LOGS

USCS CLASSIFICATION OF COARSE GRAINED MATERIALS



USCS CLASSIFICATION FOR SOILS

USCS CLASSIFICATION OF FINE GRAINED MATERIALS



ABBREVIATIONS FOR LABORATORY TESTS

COMP – COMPACTION TEST
PI – ATTERBERG LIMITS
SA – SIEVE ANALYSIS
MA – MECHANICAL ANALYSIS
HYD – HYDROMETER ANALYSIS
CONS – CONSOLIDATION TEST

CONSISTENCY OF COHESIVE SOIL

CONSISTENCY	FIELD IDENTIFICATION	UNCONFINED COMPRESSIVE STRENGTH qu (TONS/SQ.FT)
VERY SOFT	EASILY PENETRATED SEVERAL INCHES BY FIST	LESS THAN 0.25
SOFT	EASILY PENETRATED SEVERAL INCHES BY THUMB	0.25 — 0.5
MEDIUM STIFF	PENETRATED SEVERAL INCHES BY THUMB WITH MODERATE PRESSURE	0.5 — 1.0
STIFF	READILY INDENTED BY THUMB BUT PENETRATED WITH GREAT EFFORT	1.0 — 2.0
VERY STIFF	READILY INDENTED BY THUMBNAIL	2.0 — 4.0
HARD	INDENTED WITH DIFFICULTY BY THUMBNAIL	OVER 4.0

DENSITY OF GRANULAR SOILS

DENSITY	SPT BLOWS PER FOOT
VERY LOOSE	0 — 4
LOOSE	5 — 10
MEDIUM DENSITY	11 — 30
DENSE	31 — 50
VERY DENSE	OVER 50

SAMPLE TYPES

	2.5" O.D. MODIFIED CALIFORNIA SAMPLER	3.0" O.D. MODIFIED CALIFORNIA SAMPLER	S.P.T. SAMPLER	SHELBY TUBE	PITCHER SAMPLER	PLASTIC BAG	SACK	JAR	RING/ THIN WALLED TUBE
RELATIVELY UNDISTURBED	MD	3M	S	ST	P				
NO RECOVERY	MD	3M	S	ST	P				
BULK						PB	SK	J	R

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)(ASTM D2487-85)

MAJOR DIVISIONS			GROUP SYMBOL	GRAPHIC SYMBOL	GROUP NAME
COARSE-GRAINED SOILS MORE THAN 50% RETAINED ON NO. 200 SIEVE*	GRAVELS 50% Or More of Coarse Fraction Retained on No. 4 Sieve	CLEAN GRAVELS	GW		Well-graded gravel Well-graded gravel with sand
			GP		Poorly graded gravel Poorly graded gravel with sand
		GRAVELS WITH FINES	GM		Silty gravel Silty gravel with sand
			GC		Clayey gravel Clayey gravel with sand
	SANDS More than 50% of Coarse Fraction Passes No. 4 Sieve	CLEAN SANDS	SW		Well-graded sand Well-graded sand with gravel
			SP		Poorly graded sand Poorly graded sand with gravel
		SANDS WITH FINES	SM		Silty sand Silty sand with gravel
			SC		Clayey sand Clayey sand with gravel
FINE-GRAINED SOILS 50% OR MORE PASSES NO. 200 SIEVE*	SILTS AND CLAYS Liquid Limit 50% or Less		ML		Silt - Silt with sand or gravel Sandy silt - Sandy silt with gravel Gravelly silt - Gravelly silt with sand
			CL		Lean clay - Lean clay with sand or gravel Sandy lean clay - Sandy lean clay with gravel Gravelly lean clay - Gravelly lean clay with sand
			OL		Organic silts or organic clays of low plasticity
	SILTS AND CLAYS Liquid Limit Greater Than 50%		MH		Elastic silt - Elastic silt with sand or gravel Sandy elastic silt - Sandy elastic silt with gravel Gravelly elastic silt - Gravelly elastic silt with sand
			CH		Fat clay - Fat clay with sand or gravel Sandy fat clay - Sandy fat clay with gravel Gravelly fat clay - Gravelly fat clay with sand
			OH		Organic clays or organic silts of medium to high plasticity
HIGHLY ORGANIC SOILS			PT		Peat, muck and other highly organic soils

*BASED ON THE MATERIAL PASSING THE 3-INCH (75-mm) SIEVE
REFERENCE: ASTM STANDARD D2487-85

NOTES:

(1) UPPER CASE USED FOR LABORATORY VERIFIED USCS CLASSIFICATIONS.

(2) LOWER CASE USED FOR FIELD USCS CLASSIFICATIONS.

(3) DUAL USCS SYMBOL, SUCH AS (SP-SM) DENOTES 5 TO 12% OF MINOR CONSTITUENT.

(4) BORDER LINE SYMBOL, SUCH AS (CL/CH) DENOTES SOIL HAVING PROPERTIES THAT DO NOT DISTINCTLY PLACE THE SOIL IN A SPECIFIC GROUP.

(5) SUBSURFACE INFORMATION FROM BORING AND TEST PIT LOGS DEPICT CONDITIONS ONLY AT THE SPECIFIC LOCATIONS AND DATES INDICATED. SOIL CONDITIONS AND WATER LEVELS AT OTHER LOCATIONS MAY DIFFER FROM CONDITIONS AT THESE LOCATIONS. ALSO THE CONDITIONS AT THESE LOCATIONS MAY CHANGE WITH TIME.

(6) BLOW COUNTS ON LOGS ARE THE NUMBER OF BLOWS TO DRIVE THE SAMPLER 12 INCHES WITH A 140 POUND HAMMER FALLING 30 INCHES.

▽ GROUND WATER FIRST ENCOUNTERED

▼ 1-1-87 WATER LEVEL AND DATE MEASURED

LEGEND FOR LOG OF BORINGS AND TEST PITS

IT ... Creating a Safer Tomorrow

DRAWN BY A.R.A. 9/30/87 | CHECKED BY | APPROVED BY | DRAWING NUMBER B3551A-B2

132297

Do Not Scale This Drawing

BORING NO. B-1

COORDINATES N Not surveyed
E Not surveyed

FIELD ENGINEER G. Ozima DATE BEGAN 5-18-88
EDITED BY G. Ozima DATE FINISHED 5-18-88
CHECKED BY R. Kraft GROUND SURFACE EL. Not meas.

LABORATORY TEST DATA: TESTS REPORTED ELSEWHERE | ATTERBERG LIMITS: LIQUID LIMIT (%), PLASTICITY INDEX (%) | MOISTURE CONTENT (%) | DRY DENSITY (PCF) | PERMEABILITY (cm/sec)

WELL SUMMARY/ BACKFILL

DEPTH IN FEET	PENETRATION RESISTANCE (BLOWS/FT) / SAMPLE	USCS	DESCRIPTION
0–4.0		sm	Loose, olive brown (2.5Y 4/4) silty SAND, dry, moderately graded, moderately sorted, subrounded, fine grained sand.
4.0–5.0	GT-1, GC-1 (12)	cl	Medium stiff, light yellowish brown (2.5Y 6/4) silty CLAY, dry, low plasticity, fractured with calcium carbonate (?) infilling.
5.0–7.5		sm	Loose, olive brown (2.5Y 4/4) silty SAND, dry, moderately graded, moderately sorted, subrounded, fine grained sand.
7.5–10.0	GT-2, GC-2 (31)	sp	Loose, olive gray (5Y 5/2) to light olive gray (5Y 6/2) SAND, dry, moderately graded, moderate to well sorted, subangular, fine to medium-grained.
10.0–14.0		sw	Loose, olive brown (2.5Y 4/4) gravelly SAND with trace silt, dry, moderately to well graded, poorly sorted. Gravel is rounded to sub-rounded, over 1 inch in diameter. Sand is fine to medium grained, subrounded to subangular.
14.0–23.5	GT-3, GC-3 (15); GT-4, GC-4 (25)	sm	Medium dense, light yellowish brown (2.5Y 6/4) to light olive brown (2.5Y 5/4) silty SAND, dry, modertely graded, moderately to well sorted, subrounded to subangular, medium to fine grained. Contains clay and becomes dense to very dense at 18.0 feet. Becoming fractured with abundant calcium carbonate infilling the fractures, slightly cemented.
23.5–27.0	GT-5, GC-5 (25)	cl	Medium dense, light yellowish brown (2.5Y 6/4) to light olive brown (2.5Y 5/4) silty CLAY with trace fine to medium sand, dry, low plasticity, moderately to well graded, moderately sorted, highly fractured with abundant amounts of calcium carbonate infilling the fractures and some of the pore space.
27.0–30.0	GT-6, GC-6 (60)	gw	Loose, light brownish gray (2.5Y 6/2) to grayish brown (2.5Y 5/2) sandy GRAVEL with trace silt, slightly moist, moderately to well graded, poorly sorted. Gravel is subrounded to rounded and over 3 inches in diameter. Sand is predominantly fine to medium-grained and subrounded to subangular.
30.0–30.5		cl	Medium dense, light yellowish brown (2.5Y 6/4) to light olive brown (2.5Y 5/4) silty CLAY, with trace fine to medium sand, dry, moderately to well sorted, absence of fractures and calcium carbonate.

TOTAL DEPTH 30.5 FEET

PROJECT NO. 202208
CLIENT: SOUTHERN PACIFIC TRANSPORTATION CO.

SEE LEGEND FOR LOGS AND TEST PITS FOR EXPLANATION OF SYMBOLS AND TERMS

IT ...Creating a Safer Tomorrow

BORING NO. B-2

COORDINATES N Not surveyed / E Not surveyed

FIELD ENGINEER G. Ozima — DATE BEGAN 5-18-88
EDITED BY G. Ozima — DATE FINISHED 5-18-88
CHECKED BY R. Kraft — GROUND SURFACE EL. Not meas.

LABORATORY TEST DATA: Tests Reported Elsewhere; Atterberg Limits (Liquid Limit (%), Plasticity Index (%)); Moisture Content (%); Dry Density (PCF); Permeability (cm/sec). No laboratory test values are entered. The Well Summary/Backfill column is hatched from 0 to 30.5 ft.

Depth in Feet	Penetration Resistance (Blows/Ft) / Sample	USCS	Description
0–4.5'		sm	Loose, olive brown (2.5Y 4/4) silty SAND, slightly moist, poorly to moderately graded, well sorted, subangular to subrounded.
4.5–7.0'	GT-1, GC-1 (3)	cl	Medium stiff, olive (5Y 5/4 to 4/4) silty CLAY, slightly moist, low plasticity.
7.0–9.0'		sp	Loose, light olive brown (2.5Y 5/4) to olive brown (2.5Y 4/4) SAND with trace silt, slightly moist, poorly graded, well sorted, subrounded to subangular, fine-grained.
9.0–14.0'	GT-2, GC-2 (15)	sw	Loose, olive brown (2.5Y 4/4) SAND with some gravel, moist, moderately graded, poorly sorted, subrounded, fine to medium-grained. Gravel is rounded to subrounded, average diameter 1/4 inch to 3 inches.
14.0–23.0'	GT-3, GC-3 (34); GT-4, GC-4 (51)	gw	Loose, light olive brown (2.5Y 5/4) sandy GRAVEL, moist, moderately to well graded, poorly sorted, subrounded to rounded. Gravel is up to 1-1/2 inches in diameter. Sand is predominantly fine to medium-grained, some coarse grains. Coarsens downward, gravel up to 3 inches in diameter. Slight iron staining present.
23.0–29.5'	GT-5, GC-5 (31)	cl	Stiff, light olive brown (2.5Y 5/4) silty CLAY with trace sand, moist, low plasticity, highly fractured with calcium carbonate infilling the fractures and some of the pore space. At 24 feet, unfractured, contains rare amounts of calcium carbonate black organic grains.
29.5–30.5'	GT-6, GC-6 (11)	ml	Soft, light olive brown (2.5Y 5/4) SILT with trace clay, poorly graded well sorted.

TOTAL DEPTH 30.5 FEET

PROJECT NO. 202208
CLIENT: SOUTHERN PACIFIC TRANSPORTATION CO.

SEE LEGEND FOR LOGS AND TEST PITS FOR EXPLANATION OF SYMBOLS AND TERMS

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BORING NO. B-3

COORDINATES N Not surveyed / E Not surveyed

FIELD ENGINEER G. Ozima DATE BEGAN 5-19-88
EDITED BY G. Ozima DATE FINISHED 5-19-88
CHECKED BY R. Kraft GROUND SURFACE EL. Not meas.

DEPTH IN FEET	TESTS REPORTED ELSEWHERE	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERMEABILITY (cm/sec)	WELL SUMMARY/ BACKFILL	PENETRATION RESISTANCE (BLOWS/FT) SAMPLE	USCS	DESCRIPTION
0								(11)	sm	Loose, olive brown (2.5Y 4/4) silty SAND, dry, moderately graded, moderately sorted, subrounded. At 1.5 feet, no sample retained.
5.0'								GT-1, GC-1 (9)	cl	Medium stiff, light yellowish brown (2.5Y 6/4) silty CLAY, dry, low plasticity.
6.0'									sm	Loose, olive brown (2.5Y 4/4) silty SAND, dry, moderately graded, moderately soarted, subrounded.
7.5'									sp	Loose, olive gray (5Y 5/2) to light olive gray (5Y 6/2) SAND with some silt, dry, moderately to poorly graded, moderately sorted, subangular, fine to medium-grained.
9.0'								GT-2, GC-2 (15)	sw	Loose, olive gray (5Y 5/2) gravelly SAND, moist, well graded, moderately sorted, rounded to subrounded. Sand is medium to coarse-grained. Gravel is predominantly 2/5 inch in diameter.
10.0'									sp/ sw	Loose, olive gray (5Y 6/2) SAND with some silt, dry, moderately graded, moderately sorted, subangular, fine to medium-grained.
12.0'								(20)	gp	Loose, olive gray (5Y 6/2) sandy GRAVEL, damp, poorly graded, poorly sorted, rounded to subrounded. Gravel greater than 2 inches in diameter. Sand is fine to medium-grained. At 15 feet, no samples collected due to high gravel content.
17.5'								GT-3, GC-3 (24)	ml	Dense, brown (10YR 5/3) to yellowish brown (10YR 5/4) sandy SILT, moist, poorly graded, well sorted, subrounded, fractured with calcium carbonate infilling. Sand is predominantly fine-grained.
21.0'								GT-4, GC-4 (48)	ml	Stiff, light olive brown (2.5Y 5/4) clayey SILT with some fine sand, slightly fractured, with rare amounts of calcium carbonate.
25.0'								GT-5, GC-5 (28)	sm	Medium dense, light olive brown (2.5Y 5/4) silty SAND with trace 1/5 inch diameter gravel, moist well graded, moderately sorted, rounded to subrounded. Sand is fine to medium-grained with trace coarse. Absence of gravel below 26.0 feet.
30.5'										TOTAL DEPTH 30.5 FEET

PROJECT NO. 202208
CLIENT: SOUTHERN PACIFIC TRANSPORTATION CO.

SEE LEGEND FOR LOGS AND TEST PITS
FOR EXPLANATION OF SYMBOLS AND TERMS

IT ...Creating a Safer Tomorrow

BORING NO. B-4

COORDINATES N Not surveyed / E Not surveyed

FIELD ENGINEER G. Ozima — DATE BEGAN 5-20-88
EDITED BY G. Ozima — DATE FINISHED 5-20-88
CHECKED BY R. Kraft — GROUND SURFACE EL. Not meas.

Depth (ft)	Sample	Penetration Resistance (Blows/Ft)	USCS	Description
0–5.5	GT-1, GC-1	(7)	sm	Loose, olive brown (2.5Y 4/4) silty SAND, dry, poorly graded, well sorted, subrounded, fine-grained.
5.5–12.0	GT-2, GC-2	(12)	sp	Loose, light olive brown (2.5Y 5/4) to olive brown (2.5Y 4/4) SAND with some silt, slighty moist, poorly graded, well sorted, subrounded to subangular, fine-grained.
12.0–14.0			gw	Loose, grayish brown (2.5Y 5/2) gravelly SAND, dry, well graded, moderately to poorly sorted, subangular to subrounded. Sand is fine to coarse-grained. Gravel is up to 3/4 inch in diameter.
14.0–25.5	GT-3, GC-3; GT-4, GC-4; GT-5, GC-5	(24); (39); (31)	sm	Medium dense to dense, brown (10YR 5/3) to yellowish brown (10YR 5/4) silty SAND, dry, moderately graded, well sorted, subrounded to subangular, fractured with calcium coabonate infilling fractures, slightly cemented. Becoming unfractured and uncemented.
25.5–29.0			ml	Stiff, light olive brown (2.5Y 5/4) clayey SILT with trace fine sand, black organics present.
29.0–30.5	GT-6, GC-6	(13)	sm	Medium dense, light olive brown (2.5Y 5/4) silty SAND, slightly moist, poorly graded, well sorted, fine-grained.

TOTAL DEPTH 30.5 FEET

Column headings: DEPTH IN FEET; LABORATORY TEST DATA: TESTS REPORTED ELSEWHERE, ATTERBERG LIMITS (LIQUID LIMIT (%), PLASTICITY INDEX (%)), MOISTURE CONTENT (%), DRY DENSITY (PCF), PERMEABILITY (cm/sec); WELL SUMMARY/ BACKFILL; PENETRATION RESISTANCE (BLOWS/FT) — SAMPLE; USCS; PROFILE; DESCRIPTION

PROJECT NO. 202208
CLIENT: SOUTHERN PACIFIC TRANSPORTATION CO.

SEE LEGEND FOR LOGS AND TEST PITS
FOR EXPLANATION OF SYMBOLS AND TERMS

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BORING NO. B-5

COORDINATES N Not surveyed / E Not surveyed

FIELD ENGINEER	G. Ozima	DATE BEGAN	5-18-88
EDITED BY	G. Ozima	DATE FINISHED	5-19-88
CHECKED BY	R. Kraft	GROUND SURFACE EL.	Not meas.

DEPTH IN FEET	USCS	DESCRIPTION
0–4.5'	sm	Loose, olive brown (2.5Y 4/4) silty SAND, dry, moderately graded, moderately sorted, subrounded, fine-grained sand.
4.5'–10.5'	sw/sp	Loose, olive gray (5Y 5/2) to light olive gray (5Y 6/2) gravelly SAND with trace silt, slightly moist, moderately graded, moderately sorted, subrounded to subangular, sand predominantly medium to fine-grained.
10.5'–19.0'	gw	Loose, light olive brown (2.5Y 5/4) to olive brown (2.5Y 4/4) sandy GRAVEL, slightly moist, moderately to well graded, poorly sorted. Gravel is rounded to subrounded and up to 3 inches in diameter. Sand is subrounded, medium to coarse-grained. Cobbles blocked off sampler.
19.0'–28.0'	cl	Medium stiff, light yellowish brown (2.5Y 6/4) to light olive brown (2.5Y 5/4) silty CLAY, moist, low plasticity, highly fractured, contains calcium carbonate. AT 21.0 feet, unfractured and contains decreasing amounts of calcium carbonate. Contains grains of black organics. Slower drilling rate from 25.0 to 30.0 feet.
28.0'–31.0'	ml	Medium dense, light olive brown (2.5Y 5/4) to olive brown (2.5Y 4/4) SILT, with some fine sand and trace clay, slightly moist, poorly graded, well sorted.
31.0'–34.0'	gp/gw	Loose, dark grayish brown (2.5Y 4/2) sandy GRAVEL, moist, moderately graded, poorly sorted, rounded to subrounded. Gravel is rounded and ranges from 1/2 to 2 inches in diameter. Sand is subrounded and predominantly fine to medium-grained with some coarse grains.
34.0'–39.5'	sp/sw	Grades to a gravelly SAND with gravel ranging in diameter from 1/4 to 1 inch in diameter. Slow drilling rate.
39.5'–43.0'	gp/gw	Grades to a sandy GRAVEL. Gravel size decreasing.
43.0'–44.0'	sp	Interbed of loose brown (10YR 5/3 to 5/4) SAND with trace silt, moist, fine-grained, poorly graded, well sorted, subrounded, graditional upper and lower contact.
44.0'–49.0'	sp/sw	Grades to a gravelly SAND with gravel up to 2 inches in diameter. Interval from 44 to 49 feet, drilled out with no samples collected due to very slow drilling rate.
49.0'–51.5'	ml	Medium stiff, light olive brown (2.5Y 5/4) SILT with some fine sand, moist, poorly graded, well sorted, no clay.
51.5'–55.0'	ml	Medium stiff, light olive brown (2.5Y 5/4) clayey SILT, moist, lean clay, low plasticity, contains fine sand, interbeds less than 1/10 inch thick. Slow drilling rate. At 53.5 feet, becomes fractured and contains stringers and black organic grains.
55.0'–60.0'	sm	Loose, light olive brown (2.5Y 5/4) silty SAND, moist, poorly graded, well sorted, subrounded, fine-grained.

TOTAL DEPTH 60.0 FEET

Approx. depth (ft)	Sample	Penetration resistance (blows/ft)	Moisture content (%)	Dry density (PCF)	Permeability (cm/sec)
5	GT-1, GC-1	(12)			
10	GT-2, GC-2	(29)	4.5	97.5	4×10^{-3}
15		(31)			
20	GT-3, GC-3	(32)			
25	GT-4, GC-4	(29)	22	101.0	6×10^{-9}
30	GT-5, GC-5	(17)			
35	GT-6, GC-6	(65)	4.0	106.5	6×10^{-3}
40	GT-7, GC-7	(35)			
50	GT-8, GC-8	(25)			
55	GT-9, GC-9	(27)	24.5	90.5	4.5×10^{-7}
60	GT-10, GC-10	(24)			

PROJECT NO. 202208
CLIENT: SOUTHERN PACIFIC TRANSPORTATION CO.

SEE LEGEND FOR LOGS AND TEST PITS FOR EXPLANATION OF SYMBOLS AND TERMS

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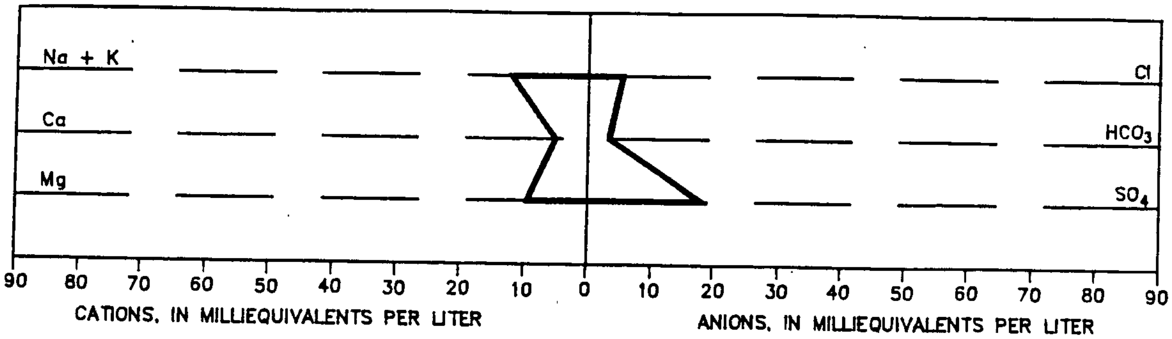
APPENDIX D

STIFF DIAGRAMS

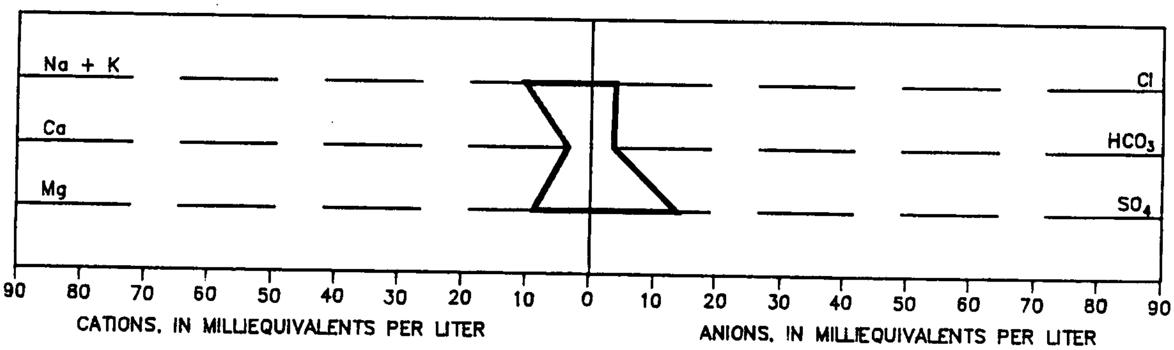
STIFF DIAGRAM
WELL NO. 20/15-28A01

JUNE 15, 1978



STIFF DIAGRAM
WELL NO. 20/15-28D01

SEPT. 1, 1951



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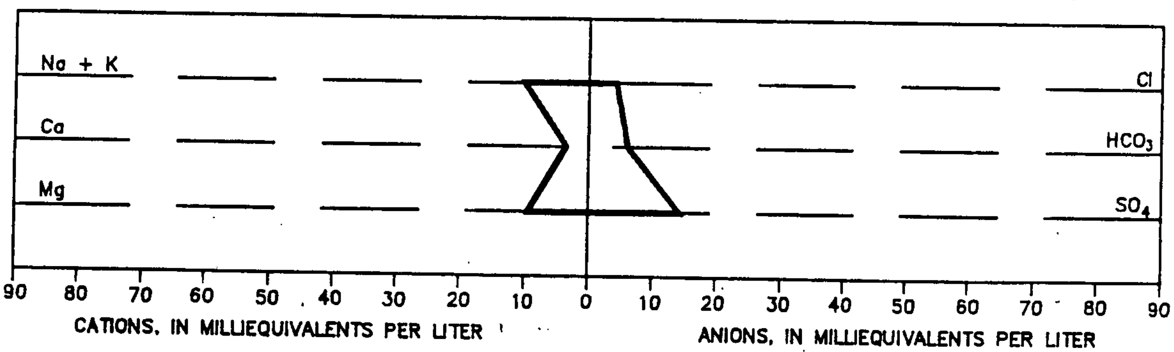

STIFF DIAGRAMS
PREPARED FOR
SOUTHERN PACIFIC TRANSPORATATION COMPANY
COALINGA SITE

INTERNATIONAL TECHNOLOGY CORPORATION

DRAWN BY	RRA	07/08/88
CHECKED BY	G.O.	8/8/88
APPROVED BY	MEW	[illegible]
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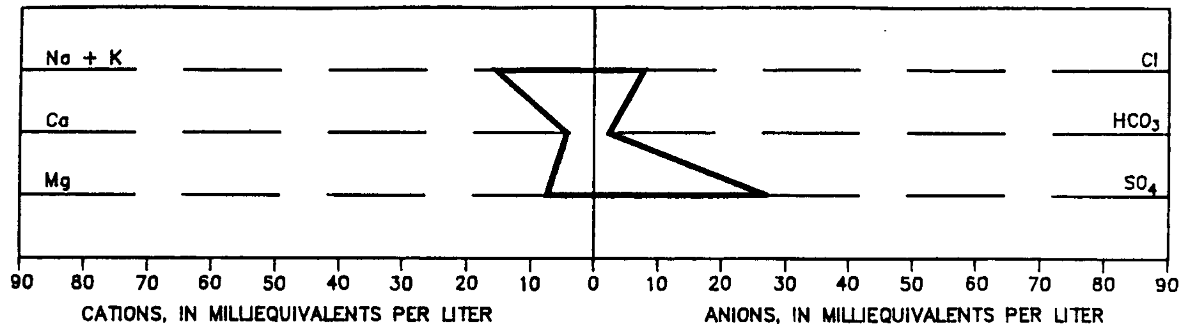

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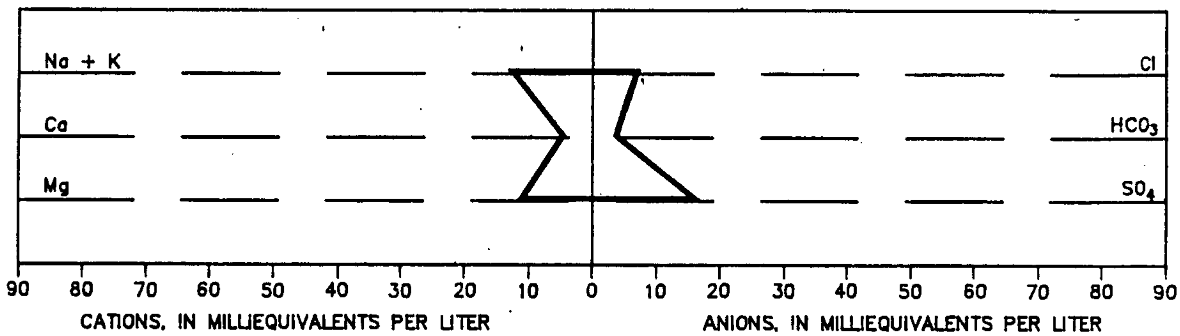
SEPT. 1, 1951



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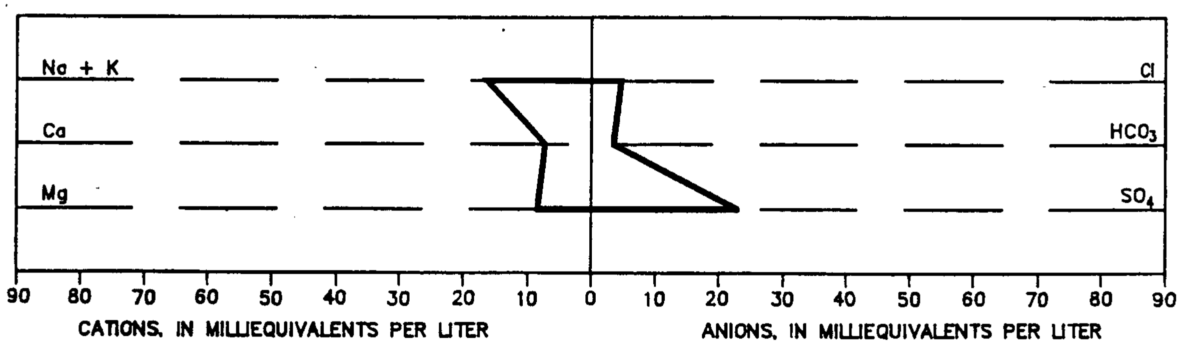

STIFF DIAGRAMS
PREPARED FOR
SOUTHERN PACIFIC TRANSPORATATION
COMPANY
COALINGA SITE

INTERNATIONAL
TECHNOLOGY
CORPORATION

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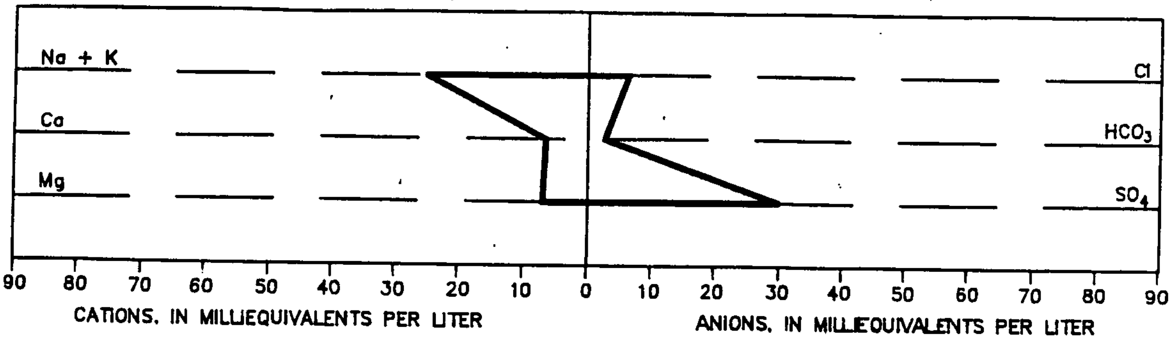
AUG. 2, 1974



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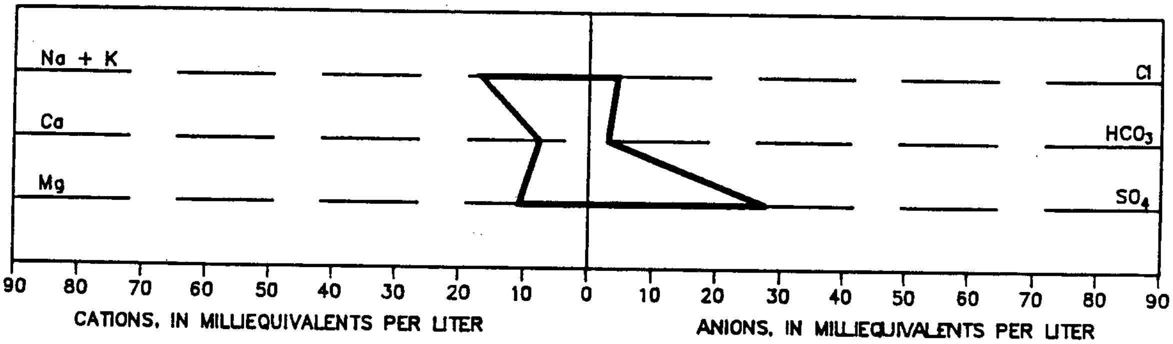

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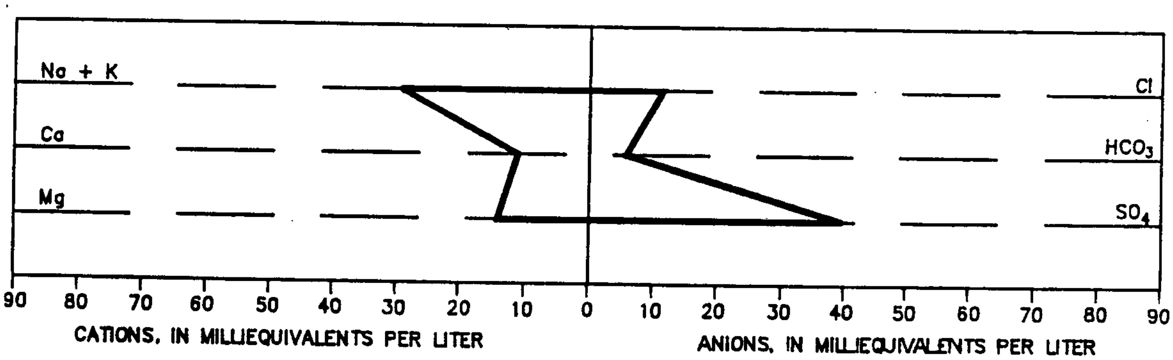

STIFF DIAGRAMS
PREPARED FOR
SOUTHERN PACIFIC TRANSPORATATION COMPANY
COALINGA SITE

INTERNATIONAL TECHNOLOGY CORPORATION

DRAWN BY RRA 07/08/88
CHECKED BY G.D. 8/8/88
APPROVED BY MEU 8/8/88
DRAWING NUMBER 202208-A11

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STIFF DIAGRAM
WELL NO. 21/15-10D01

SEPT. 1, 1951

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PREPARED FOR
SOUTHERN PACIFIC TRANSPORATATION COMPANY
COALINGA SITE

INTERNATIONAL TECHNOLOGY CORPORATION

DRAWN BY	RRA 07/08/88	CHECKED BY / APPROVED BY	GD. MBU	8/8/88 8/8/88	DRAWING NUMBER	202208-A12

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APPENDIX E

ESTIMATE OF LEACHATE CONTAINMENT CAPACITY OF THE UNDERLYING CLAY

INTERNATIONAL TECHNOLOGY CORPORATION

By MEU Date 8-1-88 Subject Estimate of capacity of clay beneath proposed unit Sheet No. 1 of 1

Chkd. By [initials] Date 8-8-88 Proj. No. 242106

0.5cm. X 0.5cm.

Assume:

- Clay under site has average thickness of 5'
- Clay has 50% porosity, (from Heath, 1983 "Basic Ground-Water Hydrology," USGS Prof. Paper 2220
- Clay has uniform moisture content of ≈ 22%
- A very conservation 12" of rainfall is all converted to leachate
- All leachate (12" for each square foot of landfill) reaches the clay, inother words each square foot of clay in area will get one cubic foot of water when full.

The volume available to hold leachate in the underlying clays will be:

$$V_A = V_T - V_w - V_s$$

where
V_A = Volume available
V_T = Total Volume
V_w = Volume water in clays
V_s = Volume of solids
W_w = Weight of Water
W_s = Weight of Soils
n = porosity

$V_T = 1.0 \text{ ft}^3$

$V_T \times n = 0.5 \times 1$

$V_s = 0.5 \text{ ft}^3$

$V_w = W_w (0.016 \text{ ft}^3/\text{lb}) = .29 \text{ ft}^3$

$W_s = (V_s)(2.65)(62.4 \text{ lbs/ft}^3) = 82.68 \text{ lbs}$

$W_w = (W_s)(22\%) = 18.19 \text{ lbs}$

Therefore the capacity of the underlying clays is:

$V_A = 1.0 \text{ ft}^3 - 0.5 \text{ ft}^3 - 0.29 \text{ ft}^3$

or ≈ 0.21 or 21%

Therefore five feet in thickness will hold more than 12 inches of leachate.

4.8 ft will be saturated

APPENDIX B

APPENDIX B

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD'S LETTER DATED 8/29/88

STATE OF CALIFORNIA

GEORGE DEUKMEJIAN, *Governor*

**CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD—
CENTRAL VALLEY REGION**

'AN JOAQUIN WATERSHED BRANCH OFFICE:
3614 EAST ASHLAN AVENUE
FRESNO, CALIFORNIA 93726
PHONE: (209) 445-5116

RECEIVED
AUG ? ? 1988
IT CORPORATION - IRVINE

29 August 1988

Mr. Mark Unruh
International Technology Corporation
17461 Derian Ave., Suite 190
Irvine, CA 92714

SOUTHERN PACIFIC TRANSPORTATION COMPANY, COALINGA SITE CHARACTERIZATION

Enclosed for your information is a copy of a memorandum concerning the applicable or relevant and appropriate requirements (ARARs) for the proposed mining waste management unit located in the City of Coalinga. The memorandum indicates that the recommendations presented are appropriate provided a pre-construction and water quality monitoring plan are submitted for our review and approval prior to construction and use of the proposed facility.

If you should have any questions regarding this matter please contact Chris Chalfant at (209) 445-5550.

Ruben Moreno

RUBEN MORENO
Senior Engineer

CCC

cc: Greg Baker, Environmental Protection Agency, San Francisco
Remelito Briones, Department of Health Services, Sacramento
Tim Casagrande, Fresno County Health Department, Fresno

memorandum

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD • CENTRAL VALLEY REGION

3614 E. Ashlan
Fresno, CA 93726-6905

SAN JOAQUIN WATERSHED BRANCH

Telephone: (209) 445-5116
State Lease Line: 421-5116

TO: Ruben Moreno
Senior Engineer

FROM: Chris Chalfant
Staff Engineer

DATE: 29 August 1988

SIGNATURE: Chris Chalfant

SUBJECT: SITE CHARACTERIZATION FOR SOUTHERN PACIFIC TRANSPORTATION COMPANY'S COALINGA PROPERTY

BACKGROUND

Southern Pacific Transportation Company (SPTC) is currently working with the Environmental Protection Agency (EPA) under a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Order for two mining waste sites in the Coalinga area. One site is located in the hills outside Coalinga, and is being addressed separately. A waste management unit (WMU) is being proposed for the second site located in the City of Coalinga. The purpose of the unit is to manage mining wastes, now stored at the site, per CERCLA mandates. As such, the EPA and SPTC are required to comply with applicable or relevant and appropriate requirements (ARARs). To this end, the Regional Board has been contacted to provide guidance with the ARARs of Title 23, CCR, Chapter 3, Subchapter 15.

OBJECTIVE

The subject report was prepared by International Technology Corporation (IT) for the SPTC to characterize local hydrology and geology as the basis for design of the proposed mining WMU disposal site. The objective of the report is to provide the information necessary to:

1. Judge whether the wastes should be disposed of as Group A or B mining wastes.

2. To provide a basis for design of the disposal facility.

3. To determine the level of monitoring necessary to satisfy Subchapter 15 requirements.

CHARACTERISTICS

The following conclusions with regard to site characteristics are made in the submitted report.

Reviewed by:	RM 8/29			

1. Natural geologic materials with permeabilities much less than 1 x 10^{-6} (based on cores tested in the laboratory) are located at depths of 20 and 50 feet beneath the site and should prevent vertical movement of fluid from the proposed waste management unit.

2. The proposed location of the unit is within a Zone C flood hazard zone and will not be subject to inundation from a 100-year flood.

3. The proposed unit location is not within 200 feet from a known Holocene fault.

4. The proposed WMU location is not subject to rapid geologic change.

5. Precipitation in the area averages approximately 7 inches per year.

6. Evaporation in the area averages about 88 inches per year.

7. Groundwater beneath the site is found at a depth of between 100 and 150 feet.

8. Groundwater quality is poor with sulfate, chloride and Total Dissolves solids concentrations above drinking water action levels.

The waste proposed for disposal in the unit consists primarily of asbestos, with some potential nickel. The following conclusions with regard to waste characteristic are made in the submitted report.

1. The waste is presently in a relative dry state.

2. The asbestos is effectively insoluble and poses little or no threat to groundwater.

3. The wastes do not have an acid generating potential.

RECOMMENDATIONS

The following recommendations are made in the report. Each recommendation is followed by my comments.

1. **The mining waste should be classified as a Group B waste.**

Comment

Section 2571 of Subchapter 15 defines a group B mining waste as a waste that poses low risk to water quality. Based upon the submitted site and waste characterization such a designation is appropriate.

2. **A clay liner and leachate collection system should be waived for the proposed unit.**

Comment

Section 2570(c) of Subchapter 15 states that, "Regional Boards may exempt a Group A or B mining waste management unit from certain provisions of this article if a comprehensive hydrogeologic investigation demonstrates that:

1. there are only very minor amounts of ground water underlying the area; or

2. the discharge is in compliance with water quality objectives in the applicable water quality control plan and complies with the States Board's nondegradation policy; and

3. either natural conditions or containment structures will prevent lateral hydraulic interconnections with natural geologic materials containing groundwater suitable for agricultural, domestic, or municipal beneficial uses. There is no detectable vertical hydraulic interconnections between the natural geologic materials underlying the unit and natural geologic materials containing such groundwater.

If the above demonstration is acceptable to the regional board, the discharger may be exempt from requirements for liners and leachate collection and removal systems."

The submitted report indicates that the proposed WMU should not generate a discharge, once capped, due to the characteristics presented above. The geologic characterization indicates that interconnections with other groundwater dose not exist at the site. Therefore, the WMU meets the criteria of Section 2570(c 2 & 3) of subchapter 15.

3. **Groundwater monitoring should be minimized in favor of a vadose monitoring network. The vadose monitoring network should use neutron probe technology to detect potential discharges from the WMU.**

Comment

Due to the depth (100 to 150 feet below grade) and the poor quality of the groundwater beneath the site, use of vadose monitoring is appropriate. However, a contingency plan should be formulated to include groundwater monitoring if a discharge is detected from the site. The details of the vadose monitoring network and the requested contingency plan will have to be submitted for our review and approval. Neutron probe technology is an appropriate method to detect leakage from the proposed WMU.

4. **Excavation of the WMU should be monitored to assure that the WMU remains in compliance with Subchapter 15 siting requirements.**

Comment

During the construction process daily detailed notes should be kept on all construction activities to assure maintenance of construction quality. Upon completion of the WMU a report detailing construction must be submitted for review and approval. The WMU must be inspected and approved by Regional Board or State Board staff prior to use.

Conclusions:

Based upon the submitted site characterization and my review of the ARARs, the recommendations presented are appropriate for the proposed WMU provided that the following are submitted for our review and approval.

1. A pre-construction report including construction details and quality assurance and quality control procedures for the excavation, filling, and capping of the proposed WMU.

2. A water quality monitoring plan for the proposed vadose monitoring network including locations and details of monitoring points and a contingency plan for implantation of groundwater monitoring upon detection of a discharge from the WMU.

CCC

APPENDIX
C

APPENDIX C

TECHNICAL SPECIFICATIONS AND CONSTRUCTION DRAWINGS

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LIST OF CONSTRUCTION DRAWINGS

APPENDIX C

TECHNICAL SPECIFICATIONS AND CONSTRUCTION DRAWINGS

1.0 INTRODUCTION

These specifications and the construction drawings, together with the Construction Quality Assurance Plan (Appendix E of the Design Report), provide the direction for the construction of an asbestos waste management unit (WMU) at Southern Pacific Transportation Company's property located at Coalinga, California.

The construction specifications contain the following sections pertinent to the performance of the work:

- Section 2.0 - Definition of Terms and Special Provisions
- Section 3.0 - Excavation and Embankment Earthwork Technical Specifications
- Section 4.0 - Neutron Probe Access Tubes Installation Specifications
- Section 5.0 - Final Cover System Construction Technical Specifications
- Section 6.0 - Irrigation System Specifications
- Section 7.0 - Specification for Surveying and Monuments

2.0 DEFINITION OF TERMS AND SPECIAL PROVISIONS

The following definitions and special provisions are applicable to these specifications and the construction drawings. Additional information on organization and position responsibilities is presented in the Construction Quality Assurance Project Plan (Appendix E).

2.1 DEFINITION OF TERMS

- Specifications - defined as the requirements, provisions, and directions referenced herein pertaining to the manner and method of performing and completing the described work or furnishing materials for the described work.

- Owner - defined as Southern Pacific Transportation Company (SPTC) or an authorized agent of SPTC. During construction, the authorized agent for verification of the construction work is the Resident Engineer.

- Project Manager - the person appointed by SPTC to supervise the overall design and construction of the asbestos waste management unit (WMU). The Project Manager is responsible for all activities.

- Engineer of Record - defined as the person who approves all design-related documents and who, with the Resident Engineer, verifies that the design is properly constructed and that design changes are properly evaluated and documented.

- Resident Engineer - the representative of SPTC at the Coalinga site during the WMU construction. The Resident Engineer is responsible for performing the inspections and verification tests as specified in the Construction Quality Assurance Program and for preparing the as-built drawings. In these specifications, the term Resident Engineer includes the Resident Engineering staff consisting of Field Engineers, Surveyors, and QC Inspectors, unless specifically indicated as only Resident Engineer. All work pertinent to these specifications must be performed to the acceptance of the Resident Engineer.

- Contractor - in these Specifications, Contractor means an independent organization(s) contracted by SPTC to perform the construction or parts of the construction.

- Registered Land Surveyor - in these specifications, registered land surveyor means a land surveyor or civil engineer registered to perform land surveying in the State of California.

- Compaction - defined as the stated percentage of maximum dry density defined by ASTM D1557, which determines the maximum Modified Proctor density.

- Moisture Content - defined in ASTM D2216 as the percentage of water contained in a soil in relation to its dry weight.

- Optimum Moisture Content - defined in ASTM D1557 as the water content which results in the maximum dry density.

- Slopes - described in terms of horizontal distance to vertical distance (H:V).

- Sieve Sizes - defined as U.S. Standard sieve sizes.

- Foundation Layer - a 2-foot-thick layer of select materials (clean or contaminated) to be placed on top of the waste to act as a foundation for the cover system.

- Technical specifications and construction drawings are equivalent to the terms design specifications or specifications and design drawings or drawings, respectively.

2.2 SPECIAL PROVISIONS

2.2.1 Contractor's Responsibility

The Contractor shall examine the specifications and construction drawings and be aware of conditions at the site affecting execution of the work. These conditions may include, but are not necessarily limited to, the following:

- Location of underground utility lines
- Applicable health and safety regulations
- Applicable local grading ordinances
- Transportation and access conditions
- Availability of utilities
- Subsoil conditions
- Location, availability, and condition of construction materials
- Climate and construction conditions at the site.

2.2.2 Mobilization

Upon receipt of notice to proceed, the Contractor shall furnish, mobilize, and install such temporary works, materials, equipment, and construction plant as necessary for the successful completion of the work. The Contractor shall also operate and maintain temporary works, equipment, and construction plant throughout the construction. All temporary works, such as sanitation facilities, shall fully comply with applicable rules and regulations of governing authorities.

The Contractor shall obtain all necessary permits and permissions to use public roads for mobilization, demobilization, and access to the site. Access to the site is available via existing public roads. Vehicle access is shown on the construction drawings.

The Contractor shall provide and maintain a field office at the job site. In addition, the Contractor shall provide, for the Resident Engineer's use, a temporary on-site office with not less than 200 square feet of space. The Resident Engineer's office shall be complete with lighting, heating, plan racks, four-drawer metal file cabinet with locks, shelves for samples, tables, and chairs. The Contractor shall arrange and pay for temporary utility services, including water, electricity, and telephone services.

2.2.3 Inspection of Work

Inspection of construction activities related to the WMU will be provided by the Resident Engineer while the work is in progress. All work done by the Contractor related to the construction shall be approved by the Resident Engineer. Construction methods shall be approved by the Resident Engineer prior to implementation.

The presence of the Resident Engineer on the job site is not presumed to relieve, in any degree, the responsibility of the Contractor. Any item of work that does not comply with the requirements of these specifications or that is improperly located or constructed shall be removed and replaced to the satisfaction of the Resident Engineer, wholly at the Contractor's expense.

2.2.4 Environmental Requirements

The Contractor shall store materials, confine equipment, and maintain construction operations within limits indicated by applicable laws, ordinances, and permits and as outlined by the Resident Engineer. Care shall be exercised to avoid blocking roads or interfering with the Owner's operations or presenting a hazard to Owner's personnel and equipment or to the public.

The Contractor shall, at all times, keep the site neat, tidy, and free of waste materials or rubbish resulting from work. Fuel, lubricating oils, and chemicals shall be stored and dispensed to prevent spillage.

The Contractor shall stockpile material excavated from the WMU site in areas specified by the Resident Engineer.

2.2.5 Diversion and Care of Water

Depending on the time of year in which the work is done, the Contractor shall design, construct, and maintain all temporary diversion and protective works required to divert runoff around work areas and to protect persons and property downstream of the work. The Contractor shall furnish, install, maintain, and operate all equipment required to keep excavations and other work areas free from water.

2.2.6 Suspension and Resumption of Operations

The Contractor shall suspend fill placement and foundation preparation operations whenever, in the opinion of the Resident Engineer, conditions for such operations are unsatisfactory due to rain, wind, or any other reason. Whenever operations have been suspended, the effects of rain, wind, or other adverse conditions will be assessed by the Resident Engineer before approval to resume construction is given. Equipment shall not be allowed to travel over fill materials until the fill has dried sufficiently to prevent excessive rutting and to allow proper operation of the equipment. If rutting occurs, the Contractor shall relevel, scarify, and recompact the material to whatever depth is required.

2.2.7 Protection and Maintenance

The Contractor shall undertake to protect and safeguard all completed portions of the earthwork, including excavation, embankment, waste fill, and final cover system. Any repairs to the earthwork necessitated by activities of the Contractor shall be made at the expense of the Contractor. The Contractor shall report any damage to any component of the earthwork to the Resident Engineer and repair it immediately to the satisfaction of the Resident Engineer. The Contractor shall take all steps necessary to prevent damage to the synthetic liners and other synthetic materials.

2.2.8 Decontamination of Equipment

Equipment shall be decontaminated upon leaving the contaminated area or upon completion of construction, in accordance with detailed procedures described in the "Hazardous Substance Removal Plan" prepared by ATEC Environmental Consultants, dated December 1988.

2.2.9 Demobilization

Demobilization consists of the removal of temporary structures and shaping, contouring, and grading to provide suitable surfaces as required by the Resident Engineer.

The Contractor shall remove and properly dispose of all trash, debris, and waste material from the construction site. The Owner shall have the right to determine what is waste material or rubbish and the manner and place of on-site disposal. All materials furnished for the execution of the work and all purchases made by the Owner shall remain the property of the Owner.

The Contractor shall clean installations and tear down and remove all temporary structures built by the Contractor.

Any existing structures or installations shall be left in a condition at least as good as the condition prior to construction. The Contractor shall also grade the construction site to provide proper drainage.

The final condition of the construction site shall be subject to approval by the Owner.

2.2.10 Utilities

The Contractor shall be responsible for making appropriate arrangements for obtaining water, power, and other utilities required for performance of the work. All pumps, piping, and vehicles required to obtain and transport the water shall be the responsibility of the Contractor.

2.2.11 Support Facilities

The Contractor shall provide and maintain sanitary and any additional facilities necessary for the safety and well-being of the Contractor's personnel and the Resident Engineer.

2.2.12 Dust Control

The Contractor shall conduct the work and control the speed of vehicles and equipment as required to minimize dust, both inside and outside the work area. Watering of dirt surfaces shall be required and shall be the responsibility of the Contractor. Speed on the site access road and on the site shall be limited to 15 mph. Additional requirements during the waste excavation and filling operation are detailed in the "Hazardous Substance Removal Plan" prepared by ATEC Environmental Consultants, dated December 1988.

2.2.13 Storage of Materials

Areas for material and equipment storage will be made available as mutually agreed upon by the Owner and the Contractor. The Contractor shall coordinate the transportation and storage of materials and equipment with the Resident Engineer.

2.2.14 Contractor's Health and Safety Requirements

The construction of the WMU will involve areas of contamination at certain stages (i.e., initial excavation and waste filling operation). General health and safety requirements in the clear area shall include the following:

- A complete physical examination shall be administered to each worker to provide a base line for each worker's health. Results of physical examinations shall be provided to SPTC's Health and Safety Division, or appropriate designee, prior to the start of work. A description of the minimum requirements for such physicals shall be provided by the Health and Safety Division.
- Eating and drinking shall be allowed only in Owner-designated areas.
- No smoking shall be allowed within the SPTC facility.

Additional health and safety requirements for work involved in the contaminated area are detailed in the "Hazardous Substance Removal Plan" prepared by ATEC Environmental Consultants, dated December 1988.

3.0 EXCAVATION AND EMBANKMENT EARTHWORK TECHNICAL SPECIFICATIONS

3.1 GENERAL

This specification discusses the earthwork activities and the materials for the excavation, embankment fill, and waste fill placement.

All work shall be constructed to the lines and grades shown in the construction drawings and shall comply with this specification.

All changes or revisions in the WMU construction or design must be approved in writing by the Resident Engineer prior to execution.

3.2 SCOPE OF WORK

The scope of work performed under this section shall include, but not necessarily be limited to, the items outlined below and as detailed on the construction drawings:

- All excavation, including removal of asbestos waste and construction of the WMU
- Stockpiling of excavated materials
- Construction of embankment
- Finish grading
- All backfilling and waste placement.

3.3 EXCAVATION

All clean materials excavated from the WMU construction shall be used as backfill material within the construction and decontaminated areas. All excavations shall be made to the lines and elevations shown in the construction drawings. Excess excavation or overexcavation shall be refilled, at the expense of the Contractor, with approved materials placed and compacted to the satisfaction of the Resident Engineer.

Boring logs and laboratory test data from the geotechnical site investigation are available for general background information. These data shall not relieve the Contractor from determining site-specific conditions. Copies of these data will be available for the Contractor's review at the following location: IT Corporation, 17461 Derian Avenue, Suite 190, Irvine, California (714) 261-6441. All asbestos-contaminated material in the construction area of the WMU shall be excavated to establish the clean level defined in the "Hazardous Substances Removal Plan" prepared by ATEC Environmental Consultants and/or as directed by the Resident Engineer. The excavated contaminated material shall be stockpiled in the southeastern corner of the site, within the contaminated area, as shown on sheet 1 of the construction drawings. The stockpiled contaminated material will be disposed of in the completed WMU. The remaining asbestos ore waste or asbestos-contaminated material from other site areas will be handled as directed by the Resident Engineer. The approximate limits of the asbestos-contaminated areas are shown in sheet 1 of the construction drawings. Exact boundaries of the contaminated areas will be defined in the field by the Resident Engineer.

3.4 EMBANKMENTS

3.4.1 General

All embankments shall be constructed to the lines and grades shown in the construction drawings. All areas to receive fill shall be cleared of all trash, debris, vegetation, and other deleterious material and shall be inspected by the Resident Engineer prior to embankment construction.

3.4.2 Material

All embankment fill materials shall be clean soils excavated from the construction of the WMU. Fill material shall not contain organic matter in detrimental amounts or irreducible material or rocks larger than 3 inches in greatest dimension. All material shall be inspected and approved by the Resident Engineer prior to placement.

3.4.3 Placement

All embankment fill material shall be placed in lifts not exceeding 12 inches in thickness prior to compaction. All areas to receive embankment fill shall be scarified to a depth of 3 inches.

3.4.4 Compaction

The embankment fill shall be compacted to a minimum relative compaction of 90 percent. The Contractor shall maintain proper moisture control for embankment fill during compaction operation, as specified in Section 3.6. The Resident Engineer shall perform at least one field density/moisture test per 500 cubic yards of material placed. The Contractor shall supply labor for preparing test sites as requested by the Resident Engineer. A reasonable period of time shall be allowed for testing. When material has not been properly placed or compacted, as determined by inspection and/or verification testing, such material shall be removed or reworked and retested as necessary to obtain the required compaction. The cost of this work shall be borne by the Contractor.

3.5 WASTE FILL

3.5.1 General

All asbestos waste shall be placed and compacted in the WMU. No asbestos waste material is to be placed outside the WMU area. The temporary waste stockpile within the contaminated area (shown in sheet 1 of the construction drawings) shall be used only during WMU construction.

3.5.2 Material

The asbestos waste material includes on-site asbestos-contaminated soil and demolition waste of on-site contaminated structures. The demolition waste, such as concrete slabs, shall be broken up into pieces no larger than 2 feet in any dimension.

3.5.3 Placement

The waste material shall be spread in lifts not exceeding 12 inches in thickness prior to compaction. For demolition, asbestos wastes greater than 12 inches thick, a hole large enough to completely encompass the waste shall be dug into the waste fill. The waste shall then be placed into the hole and soil waste shall be compacted around the demolition waste in 12-inch loose lifts. The Contractor shall make every effort to fill voids in the demolition waste.

3.5.4 Compaction

The waste fill shall be compacted by a sheepsfoot roller until the roller "walks" on top of the waste. No additional material shall be placed on a lift until that lift has obtained the specified compaction.

3.6 MOISTURE CONTROL FOR EMBANKMENT FILL

During compaction operations, the Contractor shall maintain soils used for embankment fill at the moisture content required for the specified compaction. The moisture content of the fill materials for the embankment shall be uniform throughout each lift of the material, both prior to and during compaction. The moisture content for compacted materials shall be within 2 percent below or above (±2%) optimum moisture content. These values shall be verified by the Resident Engineer during construction.

If the material is drier than specified for compaction, the Contractor shall spray water on each lift and work the moisture by harrowing or other methods approved by the Resident Engineer until a uniform distribution of moisture and the proper moisture content is obtained. Material that is too wet for proper compaction shall be removed or permitted to dry, assisted by discing and harrowing as necessary, until the moisture content is reduced to the range specified for compaction. No material shall be placed over the wet material until it has been properly moisture conditioned, reworked, and properly compacted.

Mixing of wet and dry material to obtain the proper moisture content shall not be permitted.

3.7 VERIFICATION OF EMBANKMENT CONSTRUCTION

All work shall be performed under the observation of the Resident Engineer. During installation of the embankment, the Resident Engineer has complete authority to stop work due to inclement weather, the use of improper installation procedures, or for any reason that may result in a defective embankment.

Tests on the embankment fill shall be performed as described below:

- Moisture/Density Tests - In situ moisture and density tests shall be performed by the Resident Engineer. The moisture and density shall be tested by nuclear methods performed in accordance with ASTM D 2922 and ASTM D 3017. One moisture/density test shall be performed for every 500 cubic yards of materials placed or more frequently as directed by the Resident Engineer. In situ moisture/density measurements shall be verified at least once during the construction of embankment fill using oven-dried samples and sand cone tests performed in accordance with ASTM D 2216 and ASTM D 1556, respectively. The Contractor shall cooperate fully and supply backfill material with any testing. The Resident Engineer shall backfill all holes in the layer resulting from moisture/density tests. Backfill shall be hand tamped into place.

  Sufficient laboratory tests shall be performed prior to fill placement to determine compaction characteristics in accordance with ASTM D 1557. These tests shall also be performed when materials change, sources change, or compaction, density, or moisture control results indicate changes in material type.

3.8 LINE AND GRADE FOR EXCAVATION AND EMBANKMENTS

3.8.1 Survey Data

The Contractor shall be responsible for all construction surveying. The Resident Engineer will not assume the responsibility for construction surveying.

The Contractor shall establish necessary reference lines and permanent benchmarks from which the construction lines and elevations shall be established. The Contractor shall engage a registered land surveyor for construction surveying. A minimum of two permanent benchmarks, outside any fill area, shall be set at this site as directed by the Resident Engineer.

The Contractor shall furnish certification from a registered land surveyor verifying that the work is performed in accordance with the construction drawings. Upon completion of the work, the Contractor shall prepare and furnish the Engineer with a certificate survey showing that the dimensions, elevations, and locations of the various elements of the work executed are in accordance with the contract documents.

3.8.2 Tolerances

The Contractor shall control all earthwork construction to a final horizontal line tolerance of plus or minus 0.5 foot. The allowable vertical elevation tolerance for the subgrade and embankment elevations are 0 and 0.2 foot below and above, respectively.

The final slope gradients must conform with the construction drawings.

4.0 NEUTRON PROBE ACCESS TUBE INSTALLATION SPECIFICATIONS

Prior to waste filling operations, two neutron probe access tubes (NPATs) shall be installed across the bottom of the asbestos WMU to the lines and grades shown in the construction drawings.

The NPATs shall be 6-inch-diameter, Schedule 40, standard A-53 grade B steel. Connections between sections shall be machine chamfered and fused with a continuous butt weld. All welding shall be visually inspected and approved by the Resident Engineer prior to installation.

A 5/16-inch steel wire rope (to be used as a pull line), such as the 8 x 19 construction Nevr-Fray Preformed Extra Flexible Hoisting Rope supplied by McMaster-Carr Supply Company or an equivalent approved by the Resident Engineer, shall be preinserted inside each NPAT during assembly and secured on both ends to prevent it from slipping back into the NPAT. The Contractor shall take precautions to prevent the wire roped from being fused to the pipe during welding. A trial run shall be performed to test for obstructions inside the tube during field fabrication of the NPAT, prior to trench back-filling. The test shall be performed at 50-foot intervals or less, using an object with weight and dimensions similar to the probe. A complete trial test run shall be performed for the entire length of the NPAT at completion of the field fabrication, prior to waste placement.

The 6-inch steel pipe (NPAT) shall be installed in a trench that shall have been cleaned of loose material or rocks. The width tolerance of the trench shall be plus or minus 1 inch. The horizontal and vertical line tolerances of the trench shall be 6 and 3 inches, respectively. Backfilling the trench on top of the NPAT shall be in 1-foot maximum lifts, compacted with a portable compaction machine or equivalent to a dry density equal to or greater than that of the adjacent native material. Native material from the excavation of the trench shall be used for backfill.

The Contractor shall not damage or cause any unschedule bend to the NPAT during installation. Any damage or unschedule bend during installation shall immediately be reported to the Resident Engineer and replaced or repaired at the Contractor's expense.

5.0 FINAL COVER SYSTEM CONSTRUCTION TECHNICAL SPECIFICATIONS

5.1 GENERAL

This specification discusses the activities and materials for the final cover earthwork, the foundation layer, the protective soil cover, and the vegetative soil cover. Placement activities and materials for the bentonite mat, PVC liner, geocomposite, 9-inch-thick gravel layer, geotextile, and vegetative soil cover are also included.

All work shall be constructed to the lines and grades shown in the construction drawings and shall comply with this specification.

All changes or revisions in the construction or design of the WMU final cover system must be approved in writing by the Resident Engineer prior to execution.

5.2 SCOPE OF WORK

The scope of work performed under this section shall include, but not necessarily be limited to, items as outlined below and as specifically detailed in the construction drawings:

- Construction of the 2-foot-thick foundation layer
- Installation of the bentonite mat
- Construction of the 1-foot-thick protective soil cover
- Installation of 40-mil-thick polyvinyl chloride (PVC) liner
- Installation of geocomposite
- Placement of 9-inch-thick gravel layer
- Installation of geotextile
- Construction of 1-foot-thick vegetative soil cover.

5.3 FOUNDATION LAYER

5.3.1 General

The 2-foot-thick foundation layer will be constructed directly on top of the waste to provide adequate support to the final cover and to provide a foundation on which to install the low-permeability clay layer.

Foundation layer earthwork shall be constructed to the lines and grades shown in the construction drawings. Materials shall not be placed until the subgrade of each layer has been inspected and approved by the Resident Engineer.

After each lift of moisture-conditioned material has been placed and spread, the lift shall be compacted to the required compaction. If the surface becomes rutted or uneven subsequent to compaction, it shall be releveled and recompacted before the next lift is placed.

Verification tests will be conducted by the Resident Engineer to determine that the final cover system is compacted as specified and that the materials meet specifications. The Contractor shall supply labor for preparing test sites as requested by the Resident Engineer. A reasonable period of time shall be allowed for testing. Material that has not been properly placed or compacted, as determined by inspection and/or verification testing, shall be removed or reworked and retested as necessary to obtain the required compaction. The cost of this work shall be borne by the Contractor.

5.3.2 Material

All foundation layer material shall be compacted as specified. The material may be on-site clean or contaminated soils that are free of detrimental amounts of organic matter as approved by the Resident Engineer.

5.3.3 Placement

Soil materials shall be spread in lifts not exceeding 12 inches in thickness prior to compaction. The maximum allowable particle size of soils prior to compaction shall be no more than 2 inches.

5.3.4 Compaction

The foundation layer shall be moisture conditioned and compacted with a sheepsfoot roller until the roller "walks" on top of the fill. The compacted surface shall be smooth and free of rocks.

5.4 BENTONITE MAT

5.4.1 General

The bentonite mat shall be installed on top of the foundation layer overlying the asbestos waste, as shown in the construction drawings.

5.4.2 Material

The bentonite mat shall be Claymax® as manufactured by Clem Environmental Corporation of Chicago, Illinois, or an equivalent approved by the Resident Engineer. The Claymax® consists of bentonite sandwiched between a layer of woven polypropylene geotextile and a layer of 100-percent spunlace polyester. The standard width is 13.5 feet, with a maximum length of 105 feet.

The bentonite mat shall conform to the following specifications:

PROPERTY	VALUE	TEST METHOD
Mat Specification		
Bentonite Content (psf)	1.0	-
Mat thickness (inches)	¼	-
Permeability Coefficient (cm/s)	2×10^{-10}	-
Material Specifications		
Geotextile Backing		
Tensile Strength (pounds per inch width)	70	ASTM D 1682
Elongation (percent)	15	ASTM D 1682
Bentonite		
Sizing	6 mesh and 30 mesh	-
Mineralogical Composition (min)	90% Montmorillonite	-

5.4.3 Handling and Protection

The bentonite mat shall be handled at all times in a manner that prevents damage. Any bentonite mat in a damaged or degraded condition shall be removed from the job and replaced at the Contractor's expense. The bentonite mat must be kept dry. The mat shall be left in its protective wrap prior to use.

5.4.4 Installation

Prior to the placement of bentonite mat, the subgrade surface shall be smooth and free of rocks and shall be inspected and approved by the Resident Engineer. Sides and ends of adjoining sheets shall be lapped a minimum of 6 inches. Whenever horizontal lapping is required, the upgradient panel shall always overlap the downgradient panel, similar to a roof shingle orientation. A shop drawing showing the proposed layout of the bentonite mat panels shall be submitted to the Resident Engineer for approval prior to panel installation.

The bentonite mat shall be placed with the woven polypropylene geotextile facing upward. Installation of bentonite mat shall cease immediately during rainfall. No bentonite mat shall be placed in areas of standing water. The bentonite mat shall be installed such that no creases or irregularities occur in the mat. To protect the installed bentonite mats from the elements, the overlying protective soil cover shall be installed as soon as practical. To protect temporarily exposed bentonite mat from moisture, the mat shall be covered with Visqueen or a similar protective sheeting. No bentonite mats shall be left exposed overnight. Any bentonite mat that becomes wet due to circumstances/actions within the Contractor's control shall be replaced at the Contractor's expense.

5.5 PROTECTIVE SOIL COVER

5.5.1 General

A 1-foot-thick protective soil cover will be constructed directly on top of the bentonite mat. The protective soil cover shall be constructed to the lines and grades shown in the construction drawings.

To determine that the protective soil cover layer is compacted as specified and that the materials meet specification, verification tests will be conducted by the Resident Engineer. The Contractor shall supply labor for preparing test sites as requested by the Resident Engineer. A reasonable period of time shall be allowed for testing. Material that has not been properly placed or compacted, as determined by inspection and/or verification testing, shall be removed or reworked and retested as necessary to obtain the required compaction.

5.5.2 Material

Native uncontaminated soil material free of detrimental amounts of organic material shall be used for the protective soil cover as approved by the Resident Engineer. The soil shall be free of rocks larger than 2 inches in particle size and of any other deleterious matter that could damage the underlying low-permeability layer.

5.5.3 Placement

The protective soil cover shall be installed over the low-permeability layer in such a manner that prevents damage to the low-permeability layer. The cover shall be placed in one lift achieving a required compacted thickness of 12 inches.

5.5.4 Compaction

The protective soil cover shall be compacted to a minimum relative compaction of 90 percent. The Resident Engineer shall perform at least one field density/moisture test per 500 cubic yards of material placed. The finished surface of the protective soil cover shall be smooth and free of voids and shall be finished with a smooth drum roller.

5.6 PVC LINER

The following specification describes the materials and installation of the 40-mil-thick PVC liner system required for the construction of the unit.

5.6.1 General

The 40-mil-thick polyvinyl chloride (PVC) liner shall be installed over the compacted 12-inch protective soil cover, as shown in construction drawing, sheet 3 of 3.

5.6.2 PVC Liner Material

The 40-mil-thick PVC liner shall be as manufactured by Dynamit Nobel of America (DNA) or an equivalent approved by the Resident Engineer. Material shall be 40-mil-thick polyvinyl chloride (PVC).

5.6.2.1 Property Values

The PVC liner shall have the following property values:

PROPERTY	VALUES	TEST METHOD
Thickness (mils)	40 ±5	ASTM D 1593
Specific Gravity	1.23	ASTM D 792
Tensile Properties (each direction)		
1. Tensile Strength at Break	2,300	ASTM D 882
2. Elongation at Break (percent)	400	ASTM D 882
3. Modulus @ 100% Elongation (pounds/square inch)	1,000	ASTM D 882
Tear Resistance (pounds/square inch)	300	ASTM D 1004
Low Temperature	-25°F	ASTM D 1790
Dimensional Stability (% change)	3.5	ASTM D 1204 (212°F, 15 min.)
Water Extraction (% loss)	0.35	ASTM D 3083
Hydrostatic Resistance (pounds/square inch)	110	ASTM D 751
Volatility (% loss)	0.50	ASTM D 1203

5.6.2.2 Manufacturer's Verification

The manufacturer shall provide written verification to the Fabricator and Owner of the properties of the liner materials supplied. Test results for thickness and tensile properties shall be submitted for a minimum of 10 percent of all rolls delivered.

The manufacturer shall also provide written verification to the fabricator and Owner confirming that the raw materials comply with the manufacturer's product properties and performance requirements as set forth in Section 5.6.2.1.

5.6.3 Factory Fabrication

Fabrication of the 40-mil-thick PVC liners shall be completed by an experienced Fabricator customarily engaged in factory-fabricating individual widths of PVC material into large sheets.

The rolls shall be fabricated into the designed panel sizes using one of the following seaming techniques: adhesive, heat, or dielectric seaming.

The rolls shall be laid out without tension and seamed without wrinkles or fishmouths. If wrinkles occur within the sheet due to the seaming process, the wrinkle shall not extend into the seamed width. Wrinkles that extend into the seamed width shall be treated as specified in Section 5.6.5.4.

The overlap shall provide the minimum required seam width. The overlap area to be seamed shall be free of moisture, dust, dirt, debris of any kind, and foreign material. The fabrication area shall be in a clean, enclosed facility.

The dielectric and heat seaming devices shall be accurately monitored and controlled at all times to effect a consistently acceptable seamed width. Dielectric bars or wheels with ribs shall effect the full specified seam width. Space between the bar ribs shall not be counted in the seam width.

The PVC adhesive used for seaming the rolls together shall be as recommended by the PVC manufacturer and shall not be deleterious to the PVC material in any way after seaming. The adhesive product shall be applied as specified by the PVC manufacturer, with special attention to the ambient temperature. Prepared adhesive tapes shall not be used.

The minimum seam widths shall be as follows:

	UNREINFORCED	REINFORCED
PVC adhesive seaming	1 inch	2 inches
Heat seaming	1 inch	1 inch
Dielectric seaming	3/4 inch	1 inch

5.6.4 PVC Liner Transportation and Storage

The fabricator shall ship all seamed liners to the Owner on pallets. The fabricated liners shall be folded and placed on a pallet covered with a piece of 40-mil-thick PVC liner of the same type and thickness. The pallet and liner shall be covered with a polyethylene liner.

The pallets shall be stored on site and covered to protect against adverse weather.

5.6.5 PVC Liner Installation

5.6.5.1 Surface Preparation

The upper 4 inches of the supporting soil shall not contain stones larger than 1 inch. The surface to be lined shall be rolled with a smooth drum vibrating steel roller so as to be free of irregularities, loose earth, and abrupt changes in grade. The surface preparation shall be done by the Earthwork Contractor.

Prior to placement of 40-mil-thick PVC liner materials, the Lining Installer shall review the condition of the prepared surface. Any comments on the suitability of the surface to accept the PVC liner material shall be made to the Resident Engineer prior to PVC liner placement.

No PVC liner shall be placed in an area that has become softened by precipitation (i.e., unconfined compressive strength less than 0.5 ton/ft^2).

5.6.5.2 Panel Placement and Inspections

The Resident Engineer shall verify all delivery tickets and manufacturer's and fabricator's documentation to determine that the materials meet this specification. The Resident Engineer shall document all reviewing inspections.

Each roll or panel shall be redesignated with a panel number. A panel is the unit area of in-place liner that is to be seamed (i.e., one roll may be cut into several panels). The PVC liner shall be positioned on the site as shown in the layout drawings provided by the Lining Installer prior to starting work. The layout drawings must be approved by the Resident Engineer prior to starting work. Only the panels that are to be anchored or seamed together on the given day shall be unrolled or unfolded. Care shall be exercised to prevent damage to the PVC liner during this operation.

All workers shall wear shoes that will not damage the PVC liner. Pulling PVC liner panels shall be minimized to reduce permanent tension. Horizontal seams on slope shall be kept to a minimum and shall be allowed only with the approval of the Resident Engineer.

The following precautions should be taken to minimize the risk of wind damage during panel placement:

- No more than one panel shall be unrolled prior to seaming (unless authorized by the Resident Engineer).
- Work shall be oriented according to the direction of prevailing winds if possible.
- Adequate loading on panels to prevent uplift by wind shall be provided by sand bags, tires, or any other means that will not damage the PVC liners. Loading along the edges shall be continuous to avoid possible wind flow under the panels.

Any panels that, in the judgment of the Resident Engineer, become seriously damaged shall be replaced.

PVC liner placement shall not proceed when ambient temperature is below 40°F or above 95°F, unless approved by the Resident Engineer. PVC shall not be placed during rainfall or in an area of ponded water.

Unless otherwise specified, the PVC panels shall be installed in a slack, untensioned condition.

5.6.5.3 Layout Drawings

The Liner Installer shall produce layout drawings of the proposed PVC liner placement pattern and seams prior to placement. The drawings shall indicate the panel configuration and location of seams. Field seams shall be differentiated from factory seams (if any). These drawings shall be approved by the Resident Engineer prior to the commencement of work.

5.6.5.4 Field Seaming

Requirements of Personnel

All personnel performing seaming operations shall be experienced to the satisfaction of the Resident Engineer.

At least one seamer shall have experience seaming at least 1 million square feet of a PVC liner of the same generic type as the PVC liner used for the project, using the same type of seaming method. The master seamer shall provide direct supervision of other seamers.

Overlapping

The panels shall be overlapped a minimum of 3 inches.

Preparation

Prior to seaming, the seam area shall be clean and free of moisture, dust, dirt, debris of any kind, and foreign material.

Seaming Equipment and Products

The adhesive (bodied solvent compound or cement) shall be formulated in accordance with the Manufacturer's specifications.

Weather Conditions for Seaming

Weather conditions required for seaming are as follows: (1) no seam shall be made when the temperature is below 40°F; (2) seaming is possible when the temperature is between 40 and 50°F if the PVC liner is preheated by either the sun or a hot air device and if no excessive cooling results from wind (as determined by the Resident Engineer); and (3) no preheating is required above 50°F. In all cases, the PVC liner shall be dry.

Seaming Procedure

Seaming on horizontal surfaces shall commence at the center of a panel side and proceed to either end of the side (if possible) in an effort to reduce wrinkles and subsequent fishmouths at the seam interface. The direction of seaming on slopes shall be the most expedient direction for the type of seaming used. Seaming shall extend to the outside edge of panels to be placed in the anchor trench.

The width of the bonded seam shall be 2 inches measured from the edge of the top PVC liner. Any loose flap shall be bonded using an adhesive.

Procedure for Seaming Wrinkles

Fishmouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle back into the panel so as to effect a flat overlap. The cut fishmouths or wrinkles shall be seamed and shall then be patched with an oval or round patch of the same generic PVC liner, extending a minimum of 6 inches beyond the cut in all directions.

5.6.5.5 Seaming Inspections

Inspection activities performed and documented by the Resident Engineer will include the following:

- Observations that the liner is not damaged by equipment or personnel
- Measurements of weather conditions
- Observations to verify that a firm foundation is provided for seaming
- Observations to verify that all seaming materials and equipment are as specified
- Observations to verify that the liner is free from dirt, dust, and moisture.

5.6.5.6 Seam Tests

All seams, both factory-fabricated and field-fabricated, shall be visually inspected and tested both in the field and laboratory as described below. The Liner Installer shall provide all materials, labor, and equipment necessary to obtain all required samples as directed by the Resident Engineer. All field testing and sample taking shall be done in the presence of the Resident Engineer.

Field Testing

All factory-fabricated seams shall be tested by the Liner Installer using an "Air Lance" operated at a minimum of 80 psi and a maximum of 110 psi, as measured at the compressor. A stream of air shall be directed at the edge of the seam through a 3/16-inch-diameter nozzle. The stream of air will tend to inflate leak paths and will also lift unbonded edges. Unbonded edges will also tend to vibrate when subjected to the air stream, resulting in an audible signal. All defects shall be marked for repair. All defects shall be repaired to the satisfaction of the Resident Engineer.

Laboratory Testing

Random samples shall be taken from the installed liner. Exact locations of sample cutouts will be determined by the Resident Engineer. The destructive samples shall be taken from the installed liner at a rate of one per 500 feet of field seam and one per 2,500 feet of factory seam. Each cutout sample shall measure no less than 18 inches square. All cutout areas of liner shall be patched using the same PVC liner material specified. The patches shall be field seamed to the liner. All patches shall extend a minimum of 6 inches beyond the hole in all directions. All patches shall be vacuum tested.

All samples shall be numbered, dated, and keyed to the location from which they were taken on a print of the sheet layout.

Each sample shall be tested for the following properties:

- Thickness - The liner samples shall be measured for thickness using a micrometer. The measured values shall be compared to the values in this specification. Nonconformance shall be cause for rejection of the material.

- Bonded Seam Strength in Shear - The bonded seam strength in shear of each sample shall be determined in accordance with ASTM D 3083 (NSF Modified). The breaking factor values as determined by this test shall be a minimum of 70 percent of the material tensile strength as defined in this specification. Nonconformance shall be cause for rejection of the seams.

- Bonded Seam Strength in Peel - The bonded seam strength in peel of each sample shall be determined in accordance with ASTM D 413 (NSF Modified). Properly bonded seams will fail by the elongation and tearing of one of the sheets rather than parting at the seam interface or have a minimum strength of 10 pounds per inch. Nonconformance shall be cause for rejection of the seam.

5.6.5.7 Failed Seams

Seams that fail the testing shall be reconstructed and retested or the entire failed seam area shall be removed and replaced, at the Resident Engineer's request. The repaired area shall be retested as defined in Section 5.6.5.6.

Documentation of repairs shall be made by the Resident Engineer in accordance with the Construction Quality Assurance Program.

5.7 GEOCOMPOSITE

5.7.1 General

A geocomposite shall be placed on top of the 40-mil-thick PVC liner. The geocomposite will protect the PVC liner from the overlying gravel and will also serve as additional drainage media.

5.7.2 Materials

The geocomposite shall consist of a synthetic drainage net with geotextile fused to both sides. The geotextile shall be flame fused to the drainage net to form the geocomposite. The flame shall be applied such that the surfaces of the drainage net become molten. The geotextile shall be immediately placed in contact with the molten net, run through a nip, and allowed to cool. No adhesives or foreign matter of any kind shall be introduced or utilized during the bonding process. Each component is separately described below.

5.7.2.1 Drainage Net

The drainage net shall consist of two sets of parallel strands of high-density polyethylene, overlaid and intersecting at a constant angle of about 70°. The two sets of strands are fused at the intersections. The drainage net shall be Tensar DN5 as distributed by the Tensar Corporation, Pleasant Hill, California, or equivalent as approved by the Resident Engineer. Physical and chemical property values shall be as follows:

PROPERTY	VALUE	TEST METHOD
Peak Tensile Strength (machine direction) (pounds/foot width)	600	ASTM D 638 (Modified)
Thickness (inches), min.	0.25	--
Polymer Density (g/cm^3), min.	0.945	ASTM D 1505
Carbon Black Stabilization (%)	2.5	ASTM D 4218
Sunlight Resistance	UV stabilized	--

5.7.2.2 Geotextile

The geotextile shall be nonwoven, needle-punched, polypropylene fabric, such as Amoco CEF Style 4545 as manufactured by Amoco Fabrics and Fibers Company or an equivalent approved by the Resident Engineer. Typical properties shall be as follows:

PROPERTY	VALUE	TEST METHOD
Weight	4.5 oz/yd^2	ASTM D 3776
Thickness	60 mil	ASTM D 1777
Grab Strength	120 lbs	ASTM D 4632
Elongation at Break	55%	ASTM D 4632

PROPERTY	VALUE	TEST METHOD
Trapezoid Tear Strength	50 lbs	ASTM D 4523
Burst Strength	210 psi	ASTM D 3786
Water Permeability	0.20 cm/s	-
Equivalent Opening Size	>No. 100 (U.S. Sieve)	-

The geocomposite formed from the combination of the drainage net and geotextile shall have a minimum transmissivity of 6 x 10^{-4} m^2/s at a normal stress of 10,000 psf and hydraulic gradient of 0.25. The testing method (soil and HDPE liner boundary conditions) was developed by the Tensar Corporation.

5.7.3 Handling and Protection

The geocomposite shall be handled at all times in a manner that will prevent damage. Any geocomposite that is damaged or degraded, either before or after placement, shall be removed from the job and replaced at the Contractor's expense. The geocomposite shall be kept wrapped and protected from moisture and UV light prior to use.

5.7.4 Installation

A continuous geocomposite layer shall be placed on top of the completed 40-mil-thick PVC liner as shown in the construction drawings.

Sides and ends of adjoining drainage net sheets shall be butted together and tied in accordance with manufacturer's recommendations. The geotextile portion of the geocomposite shall have a minimum 6-inch overlap to adjoining sheets. Sand bags may be used to temporarily hold the geocomposite in place. Securing pins or any device that may penetrate or damage the underlying PVC liner are prohibited.

All dirt and debris shall be removed from the top of the synthetic liner and also from the geocomposite prior to installation. Any debris that subsequently falls onto the geocomposite shall also be removed.

5.8 GRAVEL

5.8.1 General

A minimum of 9 inches of gravel shall be placed over the geocomposite as shown in the construction drawings.

5.8.2 Materials

The gravel shall be clean, sound, durable, subrounded, and natural rock fragments containing no organic substances, anhydrite, gypsum, mica, calcareous material, or other deleterious matter. Drain rock shall be washed granitic, basic igneous, or quartzitic material, as approved by the Resident Engineer.

Particle size shall conform to the following gradation:

U.S. STANDARD SIEVE	PERCENT PASSING
3/8-inch	100
No. 4	95-100
No. 8	65-95
No. 16	55-75
No. 30	36-54
No. 50	12-28
No. 100	2-10
No. 200	0-4

Prior to delivery to the site, a minimum 25-pound sample of drain rock shall be submitted for testing and approval by the Resident Engineer.

5.8.3 Installation

The 9-inch-thick layer of gravel shall be placed over the geocomposite to the lines and grade shown in the construction drawings. The rock shall be placed in such a manner as to prevent damage to the underlying geocomposite material.

5.8.4 Line and Grade

The Contractor shall control all gravel placement to a final horizontal line tolerance of plus or minus 0.5 foot. The vertical elevation tolerance for general earthwork shall be plus or minus 0.25 foot.

5.9 GEOTEXTILE

5.9.1 General

A continuous layer of geotextile shall be installed over the 9-inch-thick gravel layer, as shown on the construction drawings.

5.9.2 Materials

The geotextile shall be nonwoven, needle-punched, polypropylene fabric, such as Amoco CEF Style 4545 or an equivalent approved by the Resident Engineer. Fabric shall be of uniform thickness and surface texture. Typical properties shall be as follows:

PROPERTY	VALUE	TEST METHOD
Weight	4.5 oz/yd^2	ASTM D 3776
Thickness	60 mil	ASTM D 1777
Grab Strength	120 lbs	ASTM D 4632
Elongation at Break	55%	ASTM D 4632
Trapezoid Tear Strength	50 lbs	ASTM D 4523
Burst Strength	210 psi	ASTM D 3786
Water Permeability	0.20 cm/s	---
Equivalent Opening Size	>No. 100	---
	(U.S. Sieve)	---

5.9.3 Handling and Protection

The geotextile shall be handled at all times in a manner that will prevent damage. Any geotextile that is damaged or degraded, either before or after placement, shall be removed from the job and replaced at the Contractor's expense. The geotextile shall be kept wrapped and protected from moisture and UV light prior to use.

5.9.4 Installation

A continuous layer of geotextile shall be used to serve as a separator and filter between the rock and overlying soil covers, as shown in the construction drawings. The geotextile shall have a minimum overlap of 12 inches to adjoining sheets. Sand bags may be used to temporarily hold the geotextile in place.

5.10 VEGETATIVE SOIL COVER

The vegetative soil cover shall be installed over the geotextile of the final cover system in accordance with the lines and grades shown in the construction drawings.

5.10.1 Material

The vegetative soil cover layer shall be constructed of native uncontaminated soils available on site. All soil to be used shall be approved by the Resident Engineer prior to its use. The soil shall be free of deleterious substances, including any rocks or other irreducible material larger than 2 inches in greatest dimension.

5.10.2 Placement

The vegetative soil cover layer shall be installed over the geotextile layer in a manner that prevents damage to the geotextile layer. Vegetative soil cover layer material shall be installed in a minimum of two loose lifts (each intended to achieve a 6-inch maximum compacted thickness).

5.10.3 Compaction

The first lift installed over the geotextile shall have a minimum thickness of 6 inches and a minimum compaction of 90 percent of maximum dry density and shall be placed at optimum moisture. The second lift shall be only lightly compacted to facilitate vegetative growth.

5.11 VEGETATION

The soil cover layer of the closure cover shall be vegetated by hydroseeding. A mix of 12 pounds of Pubesent weed grass shall be planted per acre. Nitrogen fertilizer and phosphorous fertilizer shall be applied at rates of 50 and 100 pounds per acre, respectively. Straw shall be placed at a rate of 2 tons per acre to prevent wind dispersal and erosion and to promote water retention.

5.12 MOISTURE CONTROL FOR FINAL COVER CONSTRUCTION

During compaction operations, the Contractor shall maintain soils for the protective soil cover and vegetative soil cover at the moisture content required for the specified compaction. The moisture content of the fill materials for the protective soil cover and vegetative soil cover prior to and during compaction shall be uniform throughout each lift of the material. The moisture content for compacted materials shall be within 4 percent above or below optimum moisture content. These values shall be verified by the Resident Engineer during construction.

If the material is drier than specified for compaction, the Contractor shall spray water on each lift and work the moisture by harrowing or other methods approved by the Resident Engineer until a uniform distribution of moisture at the proper moisture content is obtained. Material that is too wet for proper compaction shall be removed or permitted to dry, assisted by discing and harrowing as necessary, until the moisture content is reduced to the range specified for compaction.

5.13 VERIFICATION OF FINAL COVER CONSTRUCTION

All earthwork for the 2-foot-thick foundation layer, the 1-foot-thick protective soil cover, and the 1-foot-thick vegetative soil cover shall be performed under the observation of the Resident Engineer. During construction of the final cover earthwork, the Resident Engineer has complete authority to stop work due to inclement weather, the use of improper placement procedures, or for any reason that may result in defective construction.

Tests on the protective soil cover and the vegetative soil cover shall be performed as discussed below:

- Moisture/Density Tests - In situ moisture and density tests shall be performed by the Resident Engineer. The moisture and density shall be tested by nuclear methods performed in accordance with ASTM D 2922 and ASTM D 3017. One moisture/density test shall be performed for every 500 cubic yards of material placed or more frequently as directed by the Resident Engineer. In situ moisture/density measured by nuclear methods shall be verified at least once during the construction of the protective soil cover and vegetative soil cover using oven-dried samples and sand-cone tests performed in accordance with ASTM D 2216 and ASTM D 1556, respectively. The Contractor shall cooperate fully with any testing. The Resident Engineer shall backfill all holes resulting from moisture/density tests. Backfill shall be hand tamped into place.

Sufficient laboratory tests shall be performed prior to fill placement to determine compaction characteristics in accordance with ASTM D 1557. These tests shall also be performed when materials change, sources change, or compaction, density, or moisture control results indicate changes in material type.

- Layer Thickness Measurements - The Resident Engineer shall perform surveys, certified by a registered land surveyor or registered engineer licensed to perform land surveying, to verify that the foundation layer, protective soil cover, and vegetative soil cover thicknesses, slopes, and elevations conform to the construction drawings.

5.14 LINE AND GRADE FOR EARTHWORK

5.14.1 Survey Data

The Contractor shall be responsible for all construction surveying. The Resident Engineer will not assume responsibility for construction surveying. The Resident Engineer shall only be responsible for verification surveys of completed work.

The Contractor shall establish necessary reference lines and permanent benchmarks from which the construction lines and elevations shall be established. The Contractor shall engage a registered land surveyor for construction surveying. A minimum of two permanent bench marks, outside any fill area, shall be set at this site as directed by the Resident Engineer.

The Contractor shall furnish certification from a registered land surveyor, verifying that the work is performed in accordance with the construction drawings. Upon completion of the work, the Contractor shall prepare and furnish the Resident Engineer with a certificate survey showing that the dimensions, elevations, and locations of the various elements of the work executed are in accordance with the construction drawings.

The Contractor shall control all earthwork construction to a final horizontal line tolerance of plus or minus 0.5 foot. The allowable vertical tolerance shall be plus or minus 0.2 foot. The final slopes must conform to the construction drawings.

6.0 IRRIGATION SYSTEM SPECIFICATIONS

6.1 GENERAL

This section describes the labor, materials, and equipment required to complete the irrigation system construction. The work shall be performed in accordance with the best standards of practice relating to the various trades and under the continuous supervision of a competent foreman capable of interpreting the approved drawings and these specifications. The work included in this section is as follows:

- Submittals
- Materials
- Installation
- Quality Control
- Responsibility and Guarantee
- Inspection.

The intent of the approved drawings and specifications is to indicate and specify a complete irrigation system, installed and ready for use without further cost in labor or materials to the Owner.

Any item detailed in the specifications and not on the approved drawings or on the approved drawings and not in the specifications shall be considered to appear in both.

Manufacturer's directions and detailed drawings shall be followed in all cases.

All local, municipal, and State laws, rules, and regulations governing or relating to any portion of this work are hereby incorporated into and made a part of these specifications and their provisions shall be carried out by the Contractor.

6.2 SUBMITTALS

6.2.1 Construction Drawings

The Contractor shall submit a proposed layout and detailed drawings of the irrigation system for the Resident Engineer's approval prior to the construction. These drawings are referred to in these specifications as "approved drawings."

6.2.2 Material List

The Contractor shall furnish the articles, equipment, materials, or processes specified by name in the approved drawings and specifications. The Contractor shall also submit a complete material list prior to performing any work.

6.2.3 As-Built Drawings

The Contractor shall provide and keep up to date a complete "as-built" set of prints that shall show every change from the original drawings and specifications and the exact "as-built" locations, sizes, and kinds of equipment.

6.2.4 Operation and Maintenance Manuals

The Contractor shall prepare and deliver to the Resident Engineer at final inspection two covered binders containing the following information:

- Catalog and parts sheets on every material and equipment installed
- Guarantee statements
- Complete operating and maintenance instruction on all major equipment
- List of equipment and keys submitted to Owner.

6.2.5 Equipment and Tools

The Contractor shall supply as a part of this contract two sets of special tools required for removing, disassembling, and adjusting each type of sprinkler valve and automatic controller supplied on this project at the conclusion of the project.

6.3 MATERIALS

6.3.1 General

The Contractor shall use only new materials of brands and types noted on the approved drawings and specifications or an equivalent approved by the Resident Engineer.

6.3.2 Pressure-Rated PVC Pipe

All PVC pipe used on this project shall be approved by the IAPMO. The following sizes are acceptable minimums for pressure rated pipe:

- ½- to 1½-inch-diameter pipe and fittings, approved Schedule 40
- 2-inch-diameter and up, approved Schedule 80, Class 315 or Ring Tite PVC Class 160
- 2-inch-diameter and larger fittings, approved Schedule 80.

All PVC pipe must bear the manufacturer's name, nominal pipe size, schedule or class, pressure rating in psi, National Sanitation Foundation (NSF) seal of approval, and date of extrusion.

Ring-tite pipe shall be made from an NSF-approved Type I, Grade I, PVC compound conforming to ASTM resin specification D 1784. All pipe must meet requirements as set forth in Federal Specification PS-22-70, with an appropriate standard dimension ratio (SDR).

PVC solvent weld pipe shall be made from NSF-approved Type I, Grade PVC compound conforming to ASTM resin specification D 1785. All pipe must meet requirements as set forth in Federal Specification PS-21-70.

6.3.3 Nonpressure PVC Lateral Pipe

Nonpressure buried lateral line piping shall be PVC Class 200 with solvent-weld joints.

Pipe shall be made from NSF-approved, Type I, Grade II, PVC compound conforming to ASTM resin specification D 1785. All pipe must meet requirements set forth in Federal Specification PS-21-70, with an appropriate standard dimension ratio.

6.3.4 PVC Pipe Fittings and Connections

All fittings shall bear the manufacturer's name or trademark, material designation, size, applicable International Pipe Standard (IPS) schedule, and NSF seal of approval.

Ring-tite PVC fittings shall be fabricated from Schedule 40, 1-2, II-I, NSF-approved solvent-weld PVC fittings conforming to ASTM testing procedure D 2466 and PVC ring-tite bell adapter using solvent and solvent procedures recommended by the manufacturer. Fabrication shall be performed at the manufacturer's plant location or at an authorized distributor shop location. Field fabrication of ring-tite fittings will not be allowed.

PVC solvent-weld fittings shall be Schedule 40, 1-2, II-I NSF-approved fittings conforming to ASTM test procedure D 2466. Solvent cement and primer for PVC solvent-weld pipe and fittings shall be of the type and installation methods prescribed by the manufacturer. Fittings shall be 45° type at all changes in depth of pipe. When connection is plastic to metal, male adapters shall be used. The male adapter shall be hand tightened, plus one turn with a strap wrench. Joint compound shall be Permatex Type II or equal.

Risers shall be Schedule 80 PVC pipe with fittings to permit lowering of the heads.

6.3.5 Brass Pipe and Fittings

Where indicated on the approved drawings, the Contractor shall use red brass screwed pipe and fittings conforming to Federal Specifications #WW-P-351 and #WW-P-460.

6.3.6 Galvanized Pipe Fittings

Where indicated on the approved drawings, the Contractor shall use galvanized steel pipe, ASA Schedule 40, mild steel screwed pipe.

Fittings shall be medium galvanized, screwed, beaded, malleable iron. Galvanized couplings may be merchant couplings.

All galvanized pipe and fittings installed below grade shall be painted with two coats of Koppers #50 Bitumastic. .

6.3.7 Thrust Blocks

Thrust blocks for ring-tite pipe shall be of size and type required by the manufacturer's installation guide. Thrust blocks shall be formed in a manner to prevent any concrete from coming in contact with the pipe. Thrust blocks shall be between solid soil and the fitting.

6.3.8 Backflow Prevention Units

As required by local or State ordinances, the Contractor shall provide and install backflow preventers to protect the domestic water supply against back-siphonage from the lawn sprinkler system. Each backflow prevention device shall be as approved by the Local County Health Department and shall be of the size and type as indicated. All backflow devices shall be installed in accordance with the requirements set forth by the local plumbing code having jurisdiction over the work in this area. Backflow preventers shall be placed 12 inches above grade or as required by code. The backflow unit shall be approved by local authorities.

6.3.9 Valves

6.3.9.1 Remote Control Valves, Electric Solenoid Type

The remote control valve shall be normally closed, 24-volt, 60-cycle, 2.0-watt, and shall operate with 18 to 30 volts of power to the solenoid. The valve shall be pressure rated at 150 psi. Electric control valves shall be by the same manufacturer as the automatic controller.

6.3.9.2 Gate Valves

Gate valves 3 inches and smaller shall be 125-lb SWP bronze gate valves. Gate valves 3 inches and smaller shall be similar to those manufactured by Nibco or approved equal. All gate valves shall be installed per installation detail.

6.3.9.3 Quick Coupling Valves

Quick coupling valves shall have a brass two-piece body designed for a working pressure of 150 psi, operable with a quick coupler.

6.3.10 Valve Boxes

All remote control valves and gate valves shall be installed in suitable valve boxes, as shown in details, complete with cover.

A 9-inch by 24-inch round box shall be used for all gate valves, such as Brooks #9 or approved equal. A 9½-inch by 16-inch by 11-inch rectangular box shall be used for all electrical control valves, such as Carson Industries, Ameter, or approved equal.

6.3.11 Automatic Controller

The automatic controller shall have minimum number of stations as indicated on the approved drawings, shall be completely automatic in operation, and shall electronically start the sprinkler cycle and electronically time the individual stations. Controller and valve shall be by the same manufacturer.

The controller shall have a standard 117-volt, 60-cycle power input and a 26.5-volt, 2.2-amp output and shall be housed in a locking, weatherproof cabinet.

6.3.12 Control Wiring (Low Voltage)

Connections between the automatic controllers and the electric control valves shall be made with UF-approved direct burial copper wire and shall be installed in accordance with the valve manufacturer's specifications and wire chart. In no case shall the wire size be less than #14.

6.3.13 Sprinkler Heads

All sprinkler heads shall be of the same size and type and shall deliver the same rate of precipitation with the diameter (or radius) of throw, pressure, and discharge as shown on the approved drawings and/or as specified herein.

6.4 INSTALLATION

6.4.1 Site Conditions

The Contractor shall check and verify all size dimensions and shall obtain the Resident Engineer's approval prior to proceeding with work under this section.

The Contractor shall carefully check all grades to determine that the work may safely proceed before starting work on the sprinkler irrigation system.

The Contractor shall exercise extreme care in excavating and working near existing utilities. The Contractor shall be responsible for any damage to utilities caused by the installation. The Contractor shall be responsible for checking drawings for existing utility locations.

6.4.2 Irrigation Layout

Prior to installation, the Contractor shall stake out all pressure-supply lines, routing, and the location of sprinkler heads. All layouts shall be approved by the Resident Engineer prior to installation.

6.4.3 Water Supply

Sprinkler irrigation system shall be connected to water-supply points of connection as indicated on the approved drawings.

6.4.4 Electrical Supply

Electrical connections for the automatic controller shall be made to electrical points of connection as indicated on the approved drawings.

6.4.5 Trenching

Trenches shall be dug straight and pipe shall be supported continuously on the bottom of the trench. Pipe shall be laid to an even grade. Trenching excavation shall follow layout indicated on the approved drawings and as noted below:

- Pressure main line - a minimum cover of 18 inches shall be provided
- Nonpressure lateral line - a minimum cover of 12 inches shall be provided
- Control wire - a minimum cover of 18 inches shall be provided.

When two pipes are to be placed in the same trench, a 6-inch spacing shall be maintained between pipes. Parallel lines shall not be installed directly over one another.

6.4.6 Backfilling

The trenches shall not be backfilled until all required tests are performed. Trenches shall be backfilled carefully with the excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand, or other approved materials, free from large clods of earth or stones. Backfill shall be mechanically compacted in landscaped areas to a dry density equal to adjacent undisturbed soil in planting areas. Backfill shall conform to adjacent grades and shall be free of dips, sunken areas, humps, or other surface irregularities.

A fine granular material backfill will be initially placed on all lines. No foreign matter larger than ½ inch in largest diameter will be permitted in the initial backfill.

6.4.7 Automatic Controller

The automatic controller shall be installed in accordance with the manufacturer's instructions. Remote control valves shall be connected to the controller as shown on the approved drawings and in accordance with all local and other applicable codes.

6.4.8 High-Voltage Wiring for Automatic Controller

All electrical work shall be provided by the Irrigation Contractor and shall conform to local codes, ordinances, and authorities having jurisdiction.

6.4.9 Valves

Piping systems shall be supplied with valves at all points shown on the approved drawings or as specified herein and shall be arranged to give complete regulating control throughout. Valves shall be the full size of the line in which they are installed unless otherwise indicated. All valves shall be installed as shown in approved details and in accordance with the manufacturer's recommendations.

6.4.10 Valve Boxes

Valves boxes shall be set 1 inch above the designated finish grade in ground cover areas and 6 inches below grade in turf play areas (where indicated on the approved drawings).

6.4.11 Flushing of System

After all new sprinkler pipe lines and risers are in place and connected, all necessary diversion work has been completed, and prior to installation of sprinkler heads, the control valves shall be opened and a full head of water shall be used to flush out the system.

Sprinkler heads shall be installed only after flushing of the system has been accomplished to the complete satisfaction of the Resident Engineer.

6.4.12 Sprinkler Heads

The Contractor shall install the sprinkler heads as designated on the approved drawings. Spacing of heads shall not exceed the maximum indicated on the approved drawings and/or the maximum recommended by the manufacturer.

6.5 RESPONSIBILITY AND GUARANTEE

6.5.1 Responsibility

The Contractor shall be responsible for all work performed under this Contract. No Subcontractor shall relieve the Contractor of the liability to complete the work shown on the approved drawings and indicated in the specifications.

The Contractor shall at all times protect the work and the Owner's property from injury or loss or damage and shall replace all damages at Contractor's expense until the work is accepted in writing by the Owner. The Contractor shall protect the Owners' property from injury or loss. The Contractor shall restore any finish grade changed during the course of the work. The Contractor or Contractors shall coordinate all work with other Contractors.

6.5.2 Guarantee

The Contractor shall unconditionally guarantee the materials and workmanship of the entire sprinkler system, including settling of backfilled areas below grade, for a period of 1 year following the date of final acceptance of the work.

If operational difficulties develop in connection with the sprinkler system within the specified guarantee period that, in the opinion of the Owner, may be due to inferior materials and/or workmanship, said difficulties shall be immediately corrected by the Contractor to the satisfaction of the Owner, and at no additional cost to the Owner, including any and all other damage caused by such defects.

6.6 INSPECTION

The Contractor shall flush and adjust all sprinkler heads for optimum performance.

The Contractor shall, in the presence of the Resident Engineer, test all pressure lines under hydrostatic pressure and prove watertight prior to installation of electric control valves. The entire sprinkler irrigation system shall be under full automatic operation for a period of 7 days prior to any planting.

The Contractor shall, in the presence of the Resident Engineer or appropriate representative, perform hydrostatic pressure testing on irrigation main lines. No main line shall be backfilled until it has been inspected, tested, and approved in writing.

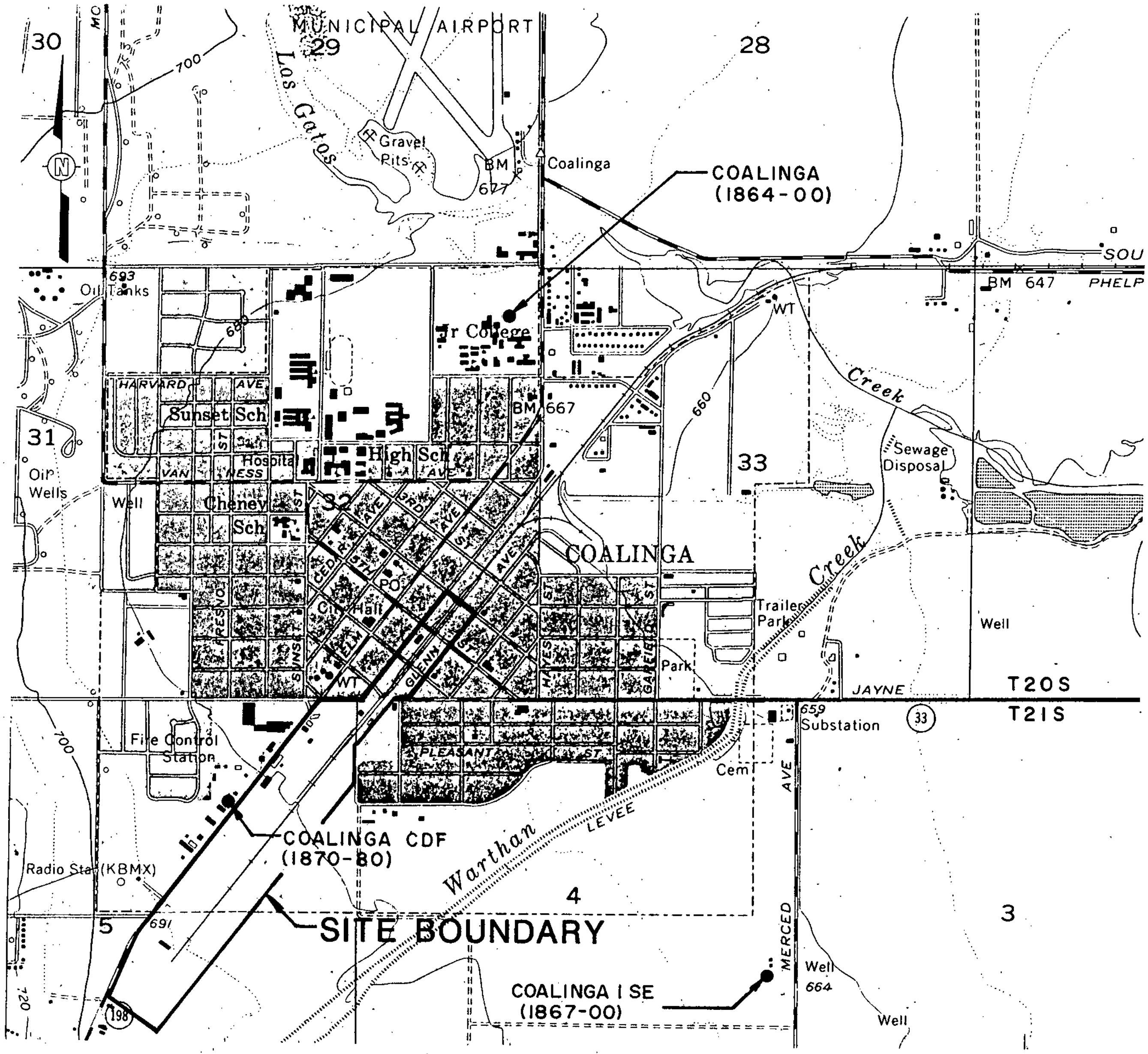
When the irrigation system is completed, the Contractor shall perform a coverage test, in the presence of the Resident Engineer, to determine whether the water coverage for planting areas is complete and adequate. This test shall be accomplished before any ground cover is planted.

The Contractor shall submit as-built plans to the Resident Engineer prior to the coverage test. After landscape planting or during final inspection, the Contractor shall operate each irrigation system in its entirety for the Resident Engineer. Any items deemed not acceptable by the Resident Engineer shall be reworked to his complete satisfaction. During final inspection, the Contractor shall show evidence to the Resident Engineer that the Owner has received all accessories, manuals, and equipment as required in the submittals.

7.0 SPECIFICATION FOR SURVEYING AND MONUMENTS

The Contractor shall arrange for two permanent survey monuments and two settlement hubs to be installed by a registered land surveyor or a registered civil engineer certified to survey in California. The Contractor shall take precautions to prevent any damage to the synthetic materials underlying the vegetative soil cover during the installation of the settlement hubs. Any sign of damage to the synthetic materials shall be reported to the Resident Engineer immediately and repaired or replaced at the Contractor's expense. The permanent monuments shall be installed and located outside any recently filled area such that the horizontal and vertical distances to the final cover and monitoring facilities can be determined throughout the postclosure maintenance period. The monuments and the hubs shall be constructed in accordance with the construction drawings.

1044



EXPLANATION:

● (1867-00) STATION NAME (DWR STATION NUMBER)

SCALE

0 2000 4000 FEET

CONTOUR INTERVAL = 20 FEET

FIGURE 2

LOCATION OF PRECIPITATION RECORDING STATIONS

PREPARED FOR

SOUTHERN PACIFIC TRANSPORTATION
COALINGA, CALIFORNIA

INTERNATIONAL TECHNOLOGY CORPORATION

REFERENCE:

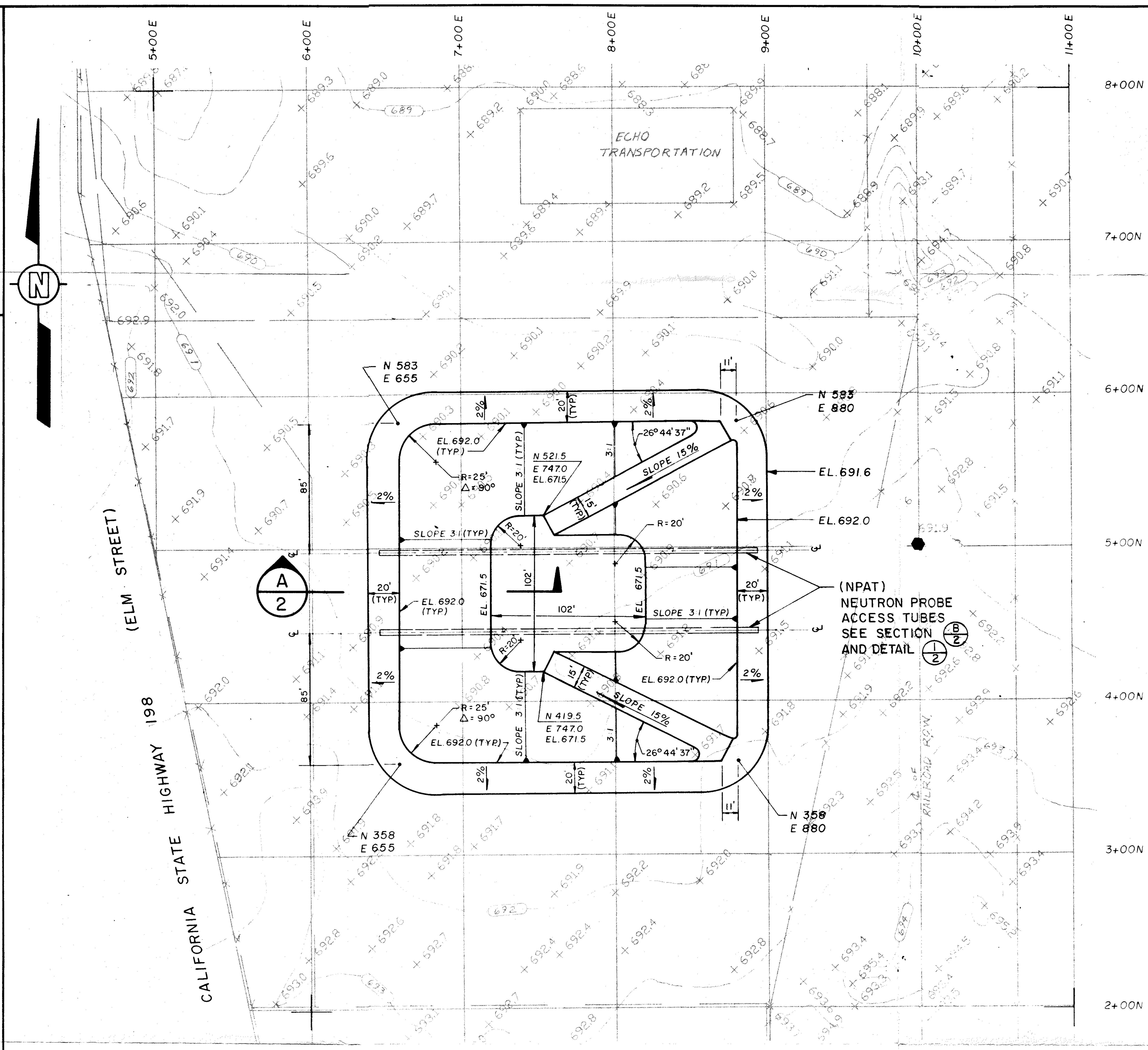
USGS 7.5 MINUTE TOPOGRAPHIC MAP OF COALINGA, CALIFORNIA QUADRANGLE, DATED 1956 PHOTOREVISED 1979 SCALE: 1:24000

DRAWN BY W.Rieger 7-15-88
CHECKED BY G.O. 8/8/88
APPROVED BY MEU 8-8-88
DRAWING NUMBER 202208-A3

137773

"Do Not Scale This Drawing"

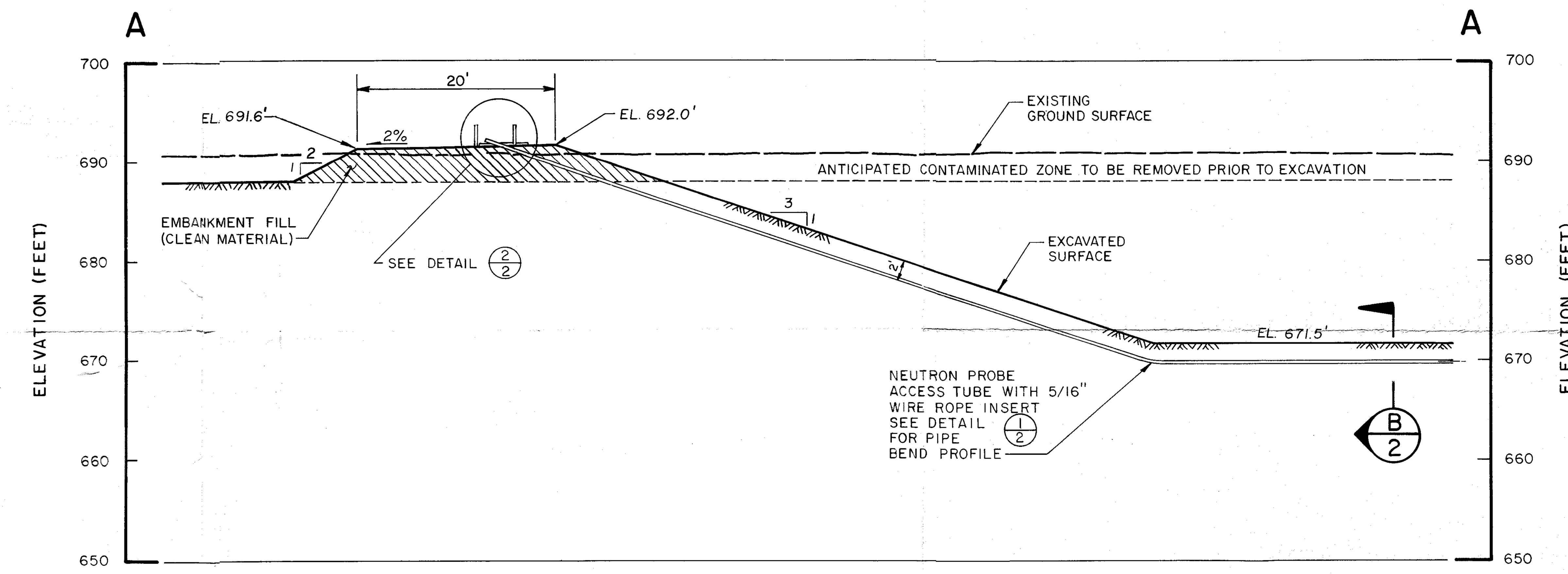
DRAWING NUMBER 202208-E2



ASBESTOS WASTE MANAGEMENT UNIT

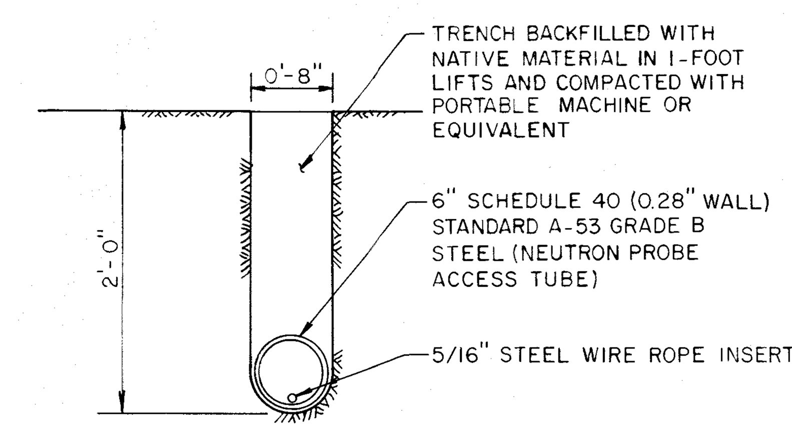
GRADING PLAN

SCALE 0 50 100 FEET



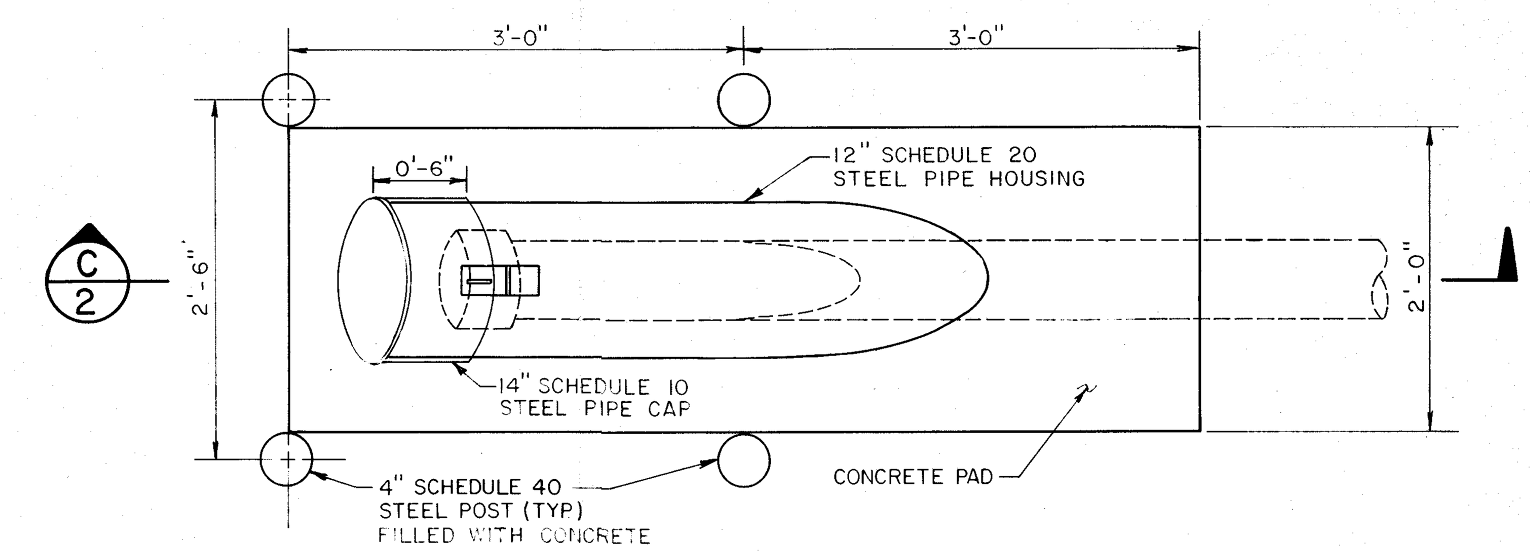
SECTION A/2 2

SCALE 0 10 20 FEET



SECTION B/2 2

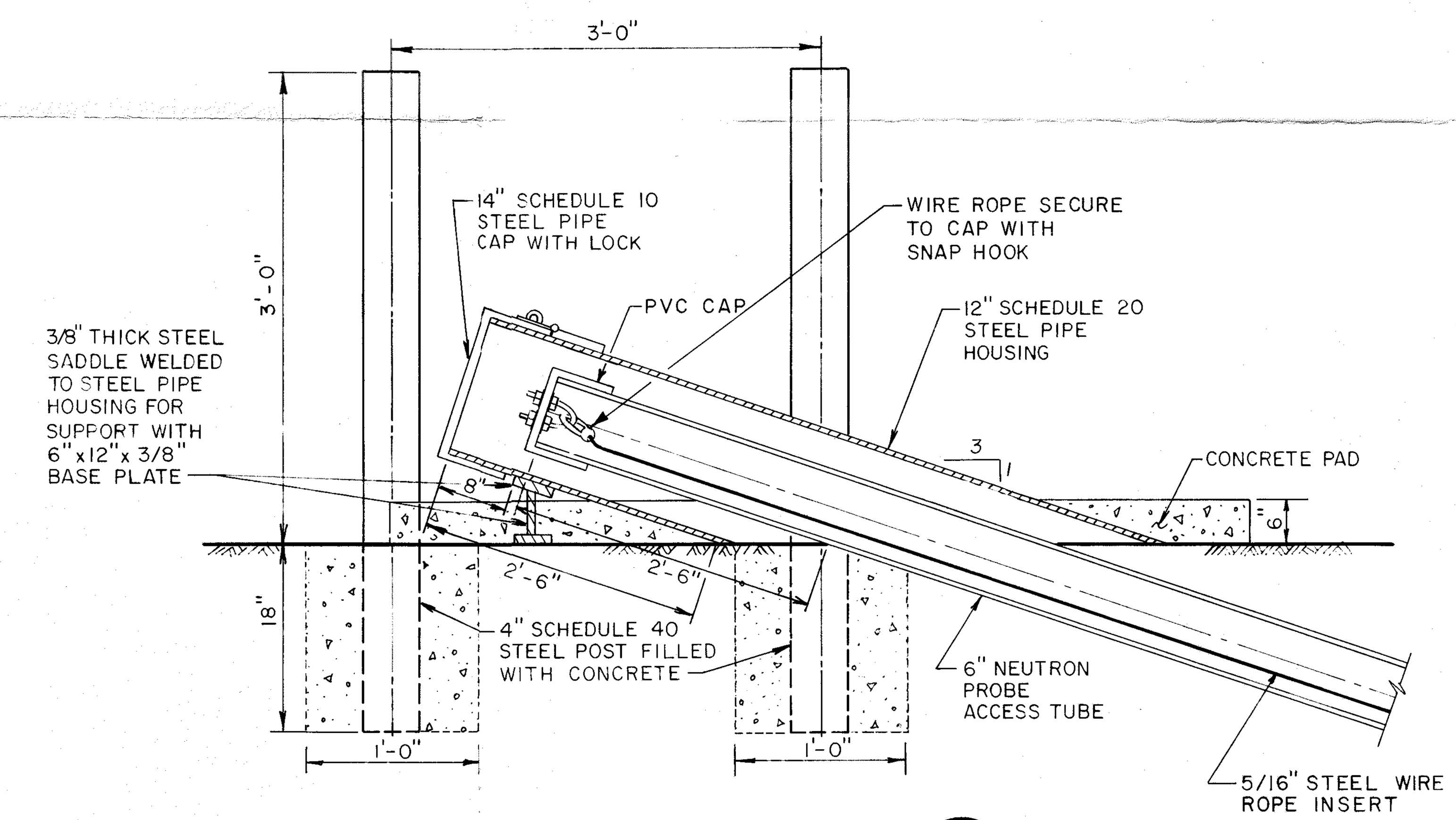
NOT TO SCALE



TYPICAL NEUTRON PROBE ACCESS TUBE OUTLET HOUSING

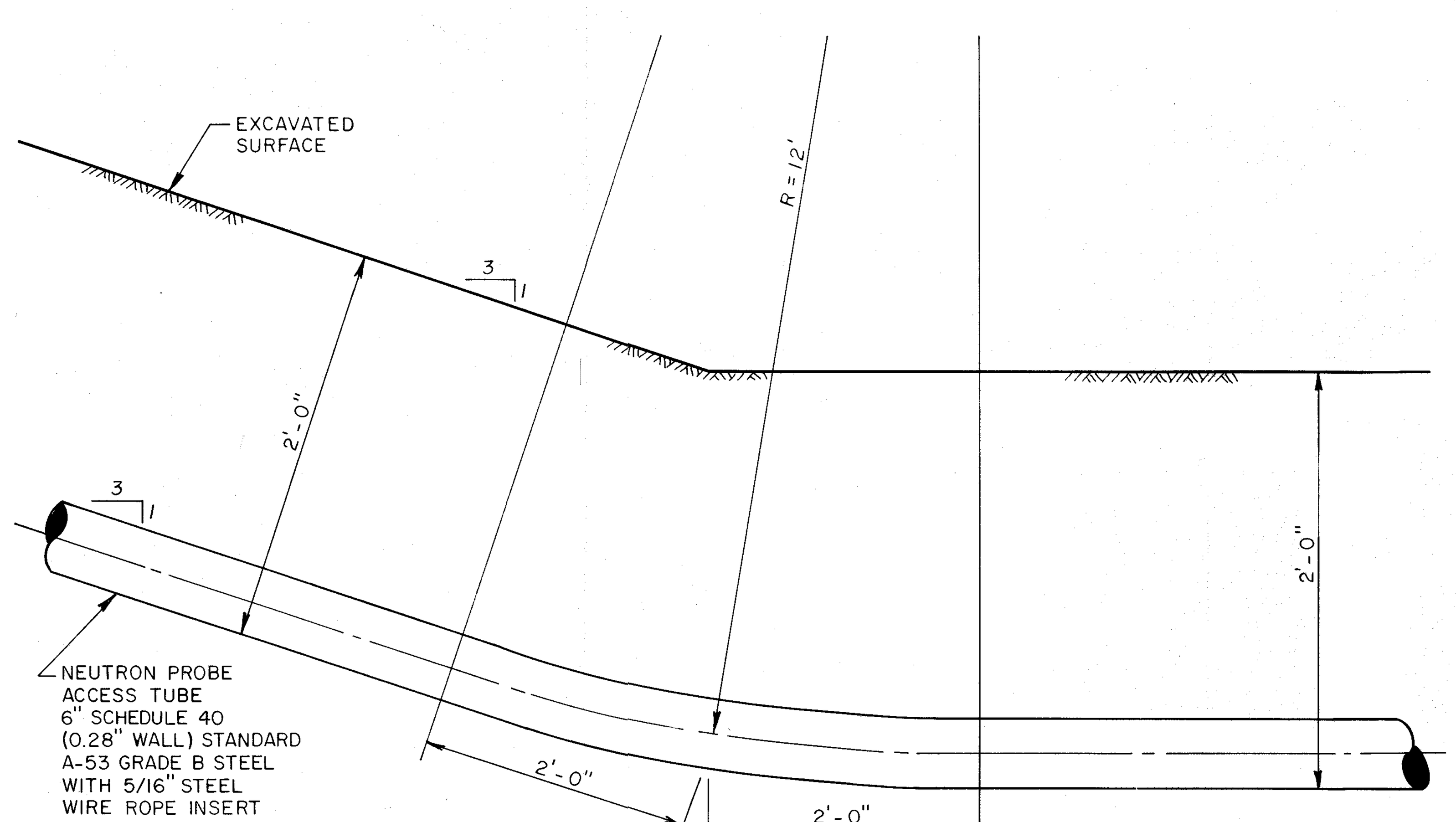
DETAIL 2/2 2

NOT TO SCALE



SECTION C/2 2

NOT TO SCALE



PIPE BEND PROFILE

DETAIL 1/2 2

NOT TO SCALE

LEGEND:

- FENCELINE
- CONTOUR LINE
- R.O.W. RIGHT OF WAY
- ℄ CENTERLINE
- N NORTH
- E EAST
- EL ELEVATION
- ● BENCHMARK

REFERENCE:

THE TOPOGRAPHY SHOWN REFLECTS THE MARTIN-McINTOSH SURVEY PERFORMED BETWEEN OCTOBER & DECEMBER 1987, SHOWN ON THEIR DRAWING:
NUMBER: 88-179
DATED: NOV. 18, 1988
SCALE: 1" = 50'

REGISTERED PROFESSIONAL ENGINEER LEONARD O. YAMAMOTO No. 33718 CIVIL STATE OF CALIFORNIA

REVISION	DATE	BY	CHK'D	APP'VD	DESCRIPTION
1	8-3-89	BJW			GENERAL REVISION
0	11-30-88	BJW			

SOUTHERN PACIFIC TRANSPORTATION CO.
COALINGA, CALIFORNIA

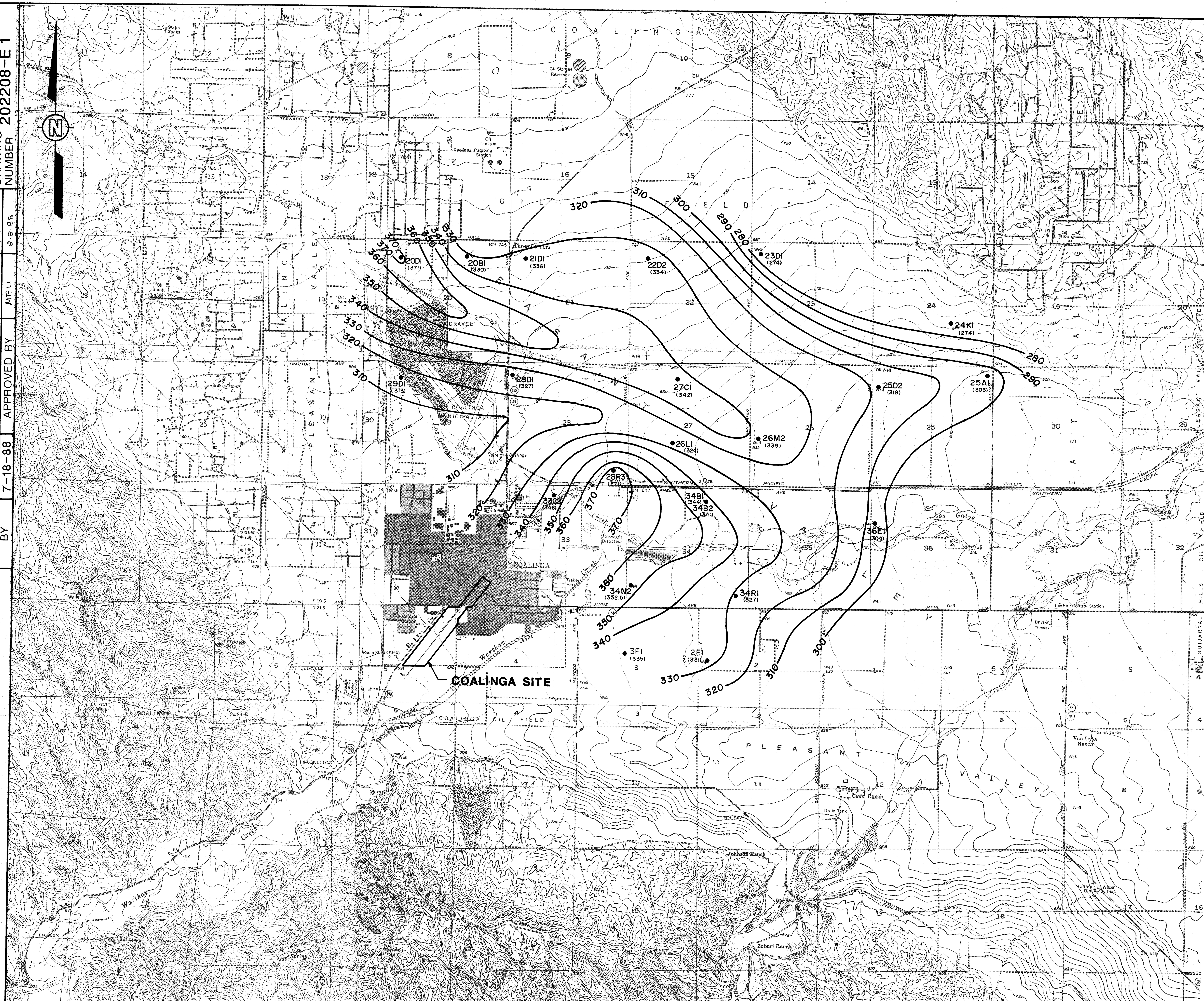
TITLE: GRADING PLAN, NEUTRON PROBE ACCESS TUBE, SECTIONS AND DETAILS

INTERNATIONAL TECHNOLOGY CORPORATION
... Creating a Safer Tomorrow

DESIGNED BY	G. Chow	CHECKED BY		SHEET 2 OF 3
DRAWN BY	B.J. Whitehead	APPROVED BY		
DATE	11-30-88	DRAWING NO.	202208-E2	

DRAWING NUMBER 202208-E1

DRAWN BY HDS 7-18-88 | CHECKED BY | APPROVED BY



REFERENCE:

7.5 MIN. USGS TOPOGRAPHIC MAPS OF THE FOLLOWING CALIFORNIA QUADRANGELS: KREYENHAGEN HILLS, DATED: 1956, PHOTOREVISED 1971; ALCALDE HILLS, DATED: 1969; CURRY MOUNTAIN, DATED: 1969; COALINGA, DATED: 1956, PHOTOREVISED: 1979. SCALE: 1:24000

EXPLANATION:

26L1 (324) — WELL INDENTIFICATION NUMBER (GROUNDWATER ELEVATION IN FEET FOR 12/9/87)

350 — GROUND-WATER CONTOUR (CONTOUR INTERVAL 10 FEET)

REFERENCE:

WATER LEVELS WERE PROVIDED BY THE DEPARTMENT OF WATER RESOURCES, SAN JOAQUIN DISTRICT, CALIFORNIA

SCALE: 0 2000 4000 6000 FEET

FIGURE 9

WATER LEVEL CONTOUR MAP

PREPARED FOR

SOUTHERN PACIFIC TRANSPORTATION CO.
COALINGA, CALIFORNIA

INTERNATIONAL TECHNOLOGY CORPORATION

APPENDIX D

APPENDIX D
LABORATORY SOIL TEST RESULTS

The Earth Technology Corporation

Testing Services Group
15481 Electronic Lane, Unit D, Huntington Beach, California 92649
Telephone: (714) 891-7802

January 9, 1989

Mr. Gary Chow
IT Corporation
17461 Derian Avenue, Suite 190
Irvine, CA 92714

Subject: Preliminary Report - Laboratory Testing of Soils
Southern Pacific Transport.
Project No. 202208-06-03

Dear Mr. Chow:

Enclosed please find results of your laboratory testing program conducted on samples from the Southern Pacific Transport Project.

TESTING PROGRAM

The testing performed for this program was conducted in general accordance with ASTM testing procedures as follows:

TYPE OF TEST	TEST PROCEDURE
Grain Size Distribution	ASTM D422
Moisture Content	ASTM D2217
Density Determinations	ASTM D2937
Atterberg Limits	ASTM D4318
Consolidation	ASTM D2435
Unconsolidated Undrained Triaxial	ASTM D2850

ASTM: American Society for Testing and Materials, Annual Book of ASTM Standards, Section 4, Volume 04.08, Soil and Rock, Building Stones, Geotextiles, 1987.

TEST RESULTS

Test results are presented in the attached tables and figures. Grain size distributions are shown in Figures 1 to 10. Table 1 presents the results of the moisture content and density determinations along with visual classifications. A summary of the Atterberg limits are shown in Table 2. The consolidation test results are shown in Figure 11; the direct shear test results are presented in Table 3 with plots in Figures 12 to 16. The unconsolidated undrained triaxial test stress/strain plot and Mohr's circles are presented in Figures 17 and 18, respectively, with additional data in Table 4.

We appreciate the opportunity to provide testing services to IT Corporation. If you have any questions regarding the test results, please contact me. We look forward to hearing from you.

Very truly yours,

THE EARTH TECHNOLOGY CORPORATION (Western)

Brenda S. Meyer
Manager, Laboratory Testing Services
Senior Engineer

Somsak Poolperm
Laboratory Supervisor, EGL Laboratory
Staff Engineer

TABLE 1

SUMMARY OF MOISTURE/DENSITY RESULTS

PROJECT NAME: SOUTHERN PACIFIC TRANS. TETC #: 89-220-1503

PROJECT NO.: 202208-06-03 CLIENT: IT CORPORATION

DATE: DECEMBER 14, 1988 SUMMARIZED BY: BRENDA MEYER

SAMPLE NO.	DEPTH (ft)	FLUID CONTENT (%)	DRY DENSITY (PCF)	VISUAL CLASSIFICATION
B-1 GT-1	4.0-4.5	4.7	87.1	Dark gray brown clayey sand
B-1 GT-2	9.5-10.0	2.8	124.5	Olive brown clayey sandy gravel
B-1 GT-4	19.5-20.0	16.3	101.1	Gray brown clayey sand
B-2 GT-1	4.5-5.0	19	78.3	Gray brown clayey sand
B-2 GT-3	14.5-15.0	3.6	114.2	Gray brown clayey sand with gravel
B-2 GT-5	24.5-25.0	24.7	95.3	Gray brown sandy clay
B-2 GC-6	29.5-30.0	16.5	93.1	Gray brown sandy clay
B-3 GT-1	4.5-5.0	7.8	67.1	Olive gray plastic clay
B-3 GT-2	9.5-10.0	2.3	92.1	Gray to brown fine sand
B-3 GT-3	19.5-20.0	16.6	106.5	Gray brown sandy clay
B-3 GT-4	24.5-25.0	4.2	104.8	Gray brown clayey sand
B-4 GT-1	4.5-5.0	11.4	94.1	Gray brown sandy clay
B-4 GT-3	14.5-15.0	6.1	82.5	Gray to brown fine sand
B-4 GT-6	29.5-30.0	23	95.4	Gray brown sandy clay
B-5 GT-1	4.5-5.0	4.5	86.5	Light olive brown fine sand to clayey sand
B-5 GT-3	19.5-20.0	18.4	103.3	Light olive brown sandy clay
B-5 GC-6	35.0-35.5	2.9	117.2	Light gray to brown sand with gravel
B-5 GT-10	59.5-60.0	10.5	87.9	Gray brown clayey sand

TABLE 2

SUMMARY OF ATTERBERG LIMITS TEST

PROJECT NAME: Southern Pacific Transportation | TETC #: 89-220-1503

PROJECT NO.: 202208-06-03 | CLIENT: IT Corporation

DATE: January 1989 | SUMMARIZED BY: S. Poolperm

SAMPLE NO.	DEPTH (ft)	ATTERBERG LIMITS % LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX	REMARKS
B-1/GT-5	24.5-25.0	--	--	N.P.	Silty gravelly sand, very loose, olive brown.
B-2/GT-1	4.5-5.0	29	18	11	
B-2/GT-5	24.5-25.0	N/A	N/A	N/A	Not enough sample to perform
B-5/GC-4	25.0-25.5	57	27	30	

TABLE 3

DIRECT SHEAR TEST RESULTS

PROJECT NAME: Southern Pacific Transportation

TETC #: 89-220-1503

PROJECT NO.: 202208-06-03

CLIENT: IT Corporation

DATE: January 6, 1989

SUMMARIZED BY: S. Poolperm

SAMPLE NO.	DEPTH (ft)	SAMPLE TYPE	MOISTURE CONTENT %	DRY DENSITY (pcf)	NORMAL STRESS (psf)	SHEAR STRESS (psf)	REMARKS
B-1/GT-3	14.5-15.0	Undist.	11.0	83.0	500	831	
					1000	1001	
					2000	2018	
B-1/GC-3	15.0-15.5	Undist.	13.0	86.0	500	763	
					1000	1230	
					2000	1654	
B-2/GT-2	9.5-10.0	Undist.	4.5	83.5	500	441	
					1000	678	
					2000	1391	
B-4/GT-2	9.5-10.0	Undist.	4.5	82.5	500	449	
					1000	755	
					2000	1543	
B-4/GT-4	19.5-20.0	Undist.	15.0	107.5	500	1993	
					1000	2900	
					2000	4410	

TABLE 4

SUMMARY OF RESULTS

PROJECT NAME: Southern Pacific Trans.

PROJECT NO.: 202208-06-03

DATE: Janauary 6, 1989

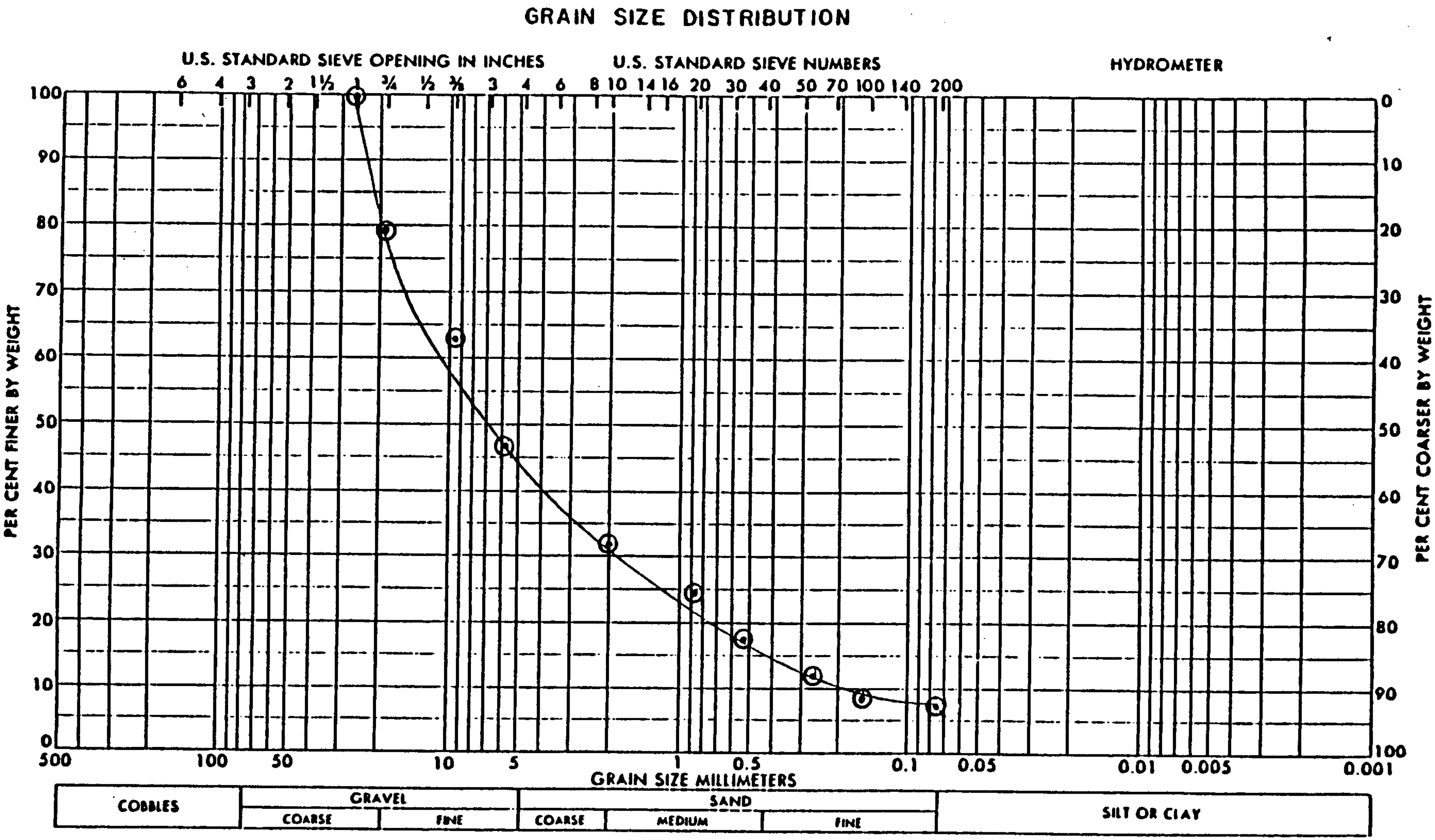
TETC #: 89-220-1503

CLIENT: IT Corporation

SUMMARIZED BY: S. Poolperm

Soil Description: Fat clay, with find sand, moist, firm, olive brown.

SAMPLE NO.	DEPTH (ft)	FLUID CONTENT (%)	DRY DENSITY (PCF)	CONFINING STRESS (KSF)	AXIAL STRAIN (%)	SHEAR STRESS (KSF)
B-5 GC-4	25.0-25.5	27.5	91.5	0.5	5.00	1.67
				1.0	9.83	2.21
				1.5	16.03	2.44



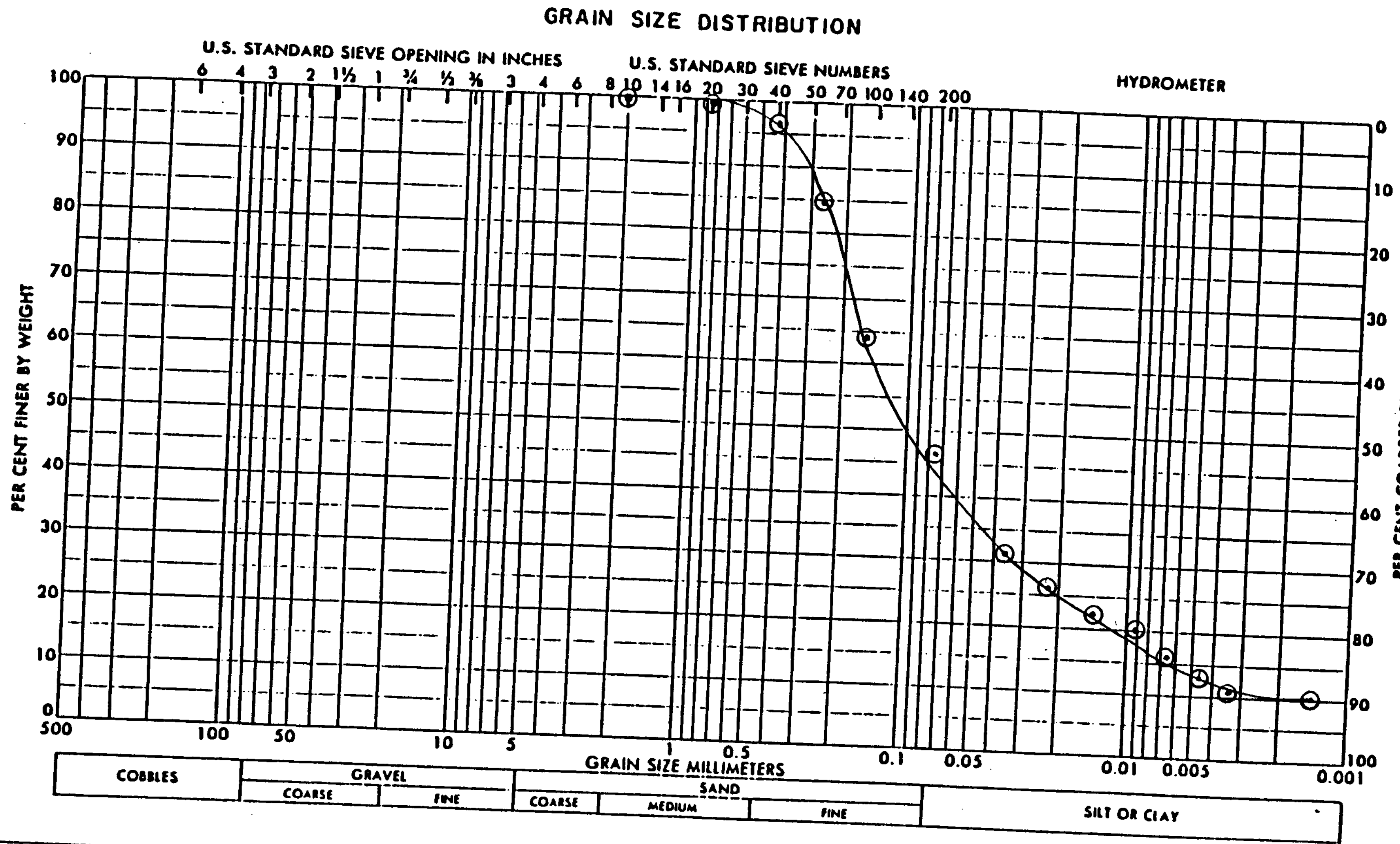
Symbol	Boring No.	Elev. or Depth	U.S.C.S.
⊙	B1GT2	9.5-10	

CLIENT: IT Corporation
PROJECT: Southern Pacific Trans.
PROJECT NO.: 202208-06-03

The Earth Technology Corporation

GRAIN SIZE DISTRIBUTION CURVE

Project No:	Date:	Figure No:
89-220-1503	12/14/88	1



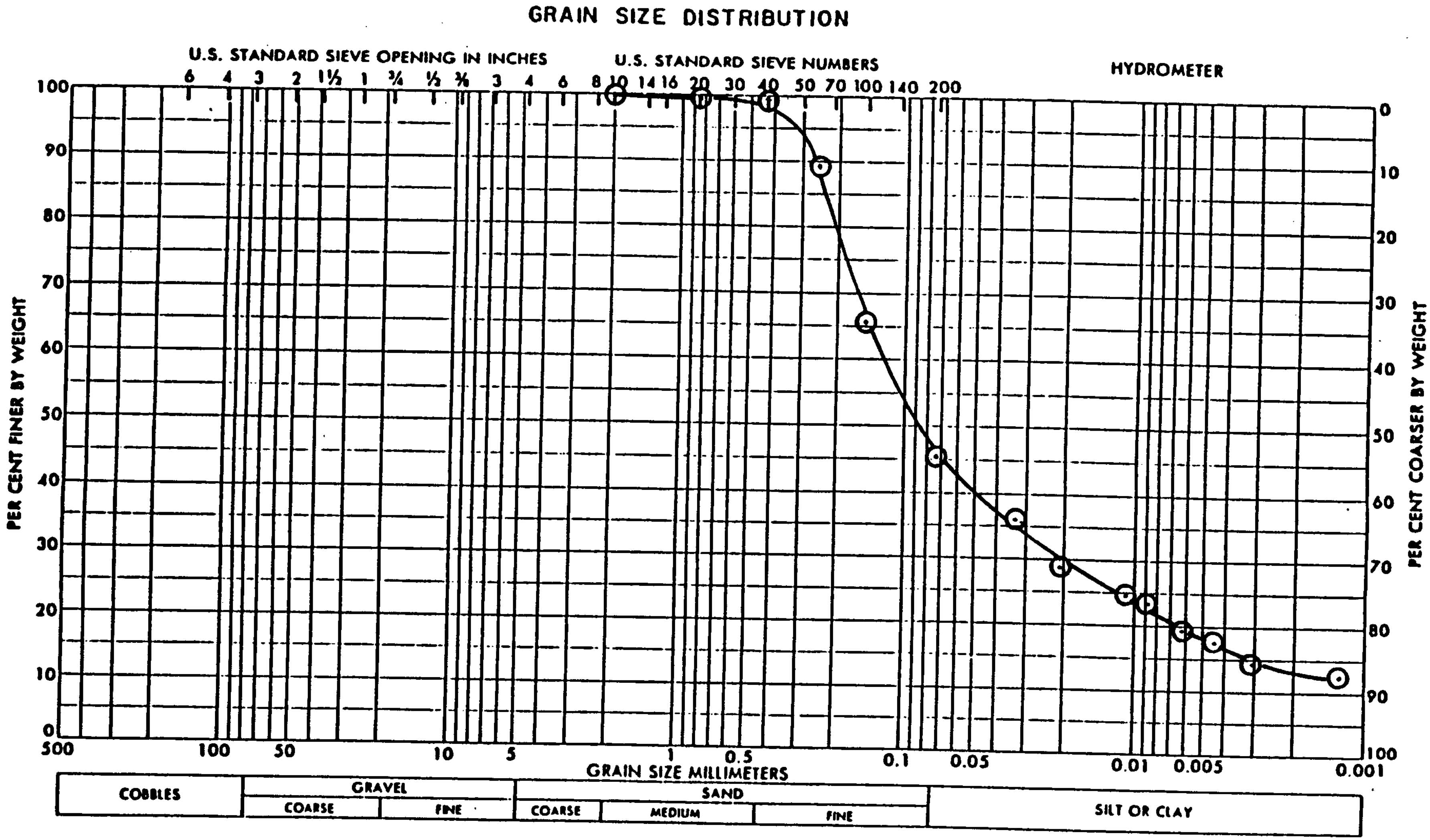
Symbol	Boring No	Elev. or Depth	U.S.C.S.
⊙	B1GT3	14.5-15	

CLIENT: I.T. CORPORATION
PROJECT: So.Pacific Transportation
PROJECT NO: 202208-0603

The Earth Technology Corporation

GRAIN SIZE DISTRIBUTION CURVE

Project No: 89-220-3301 | Date: 12/88 | Figure No: 2



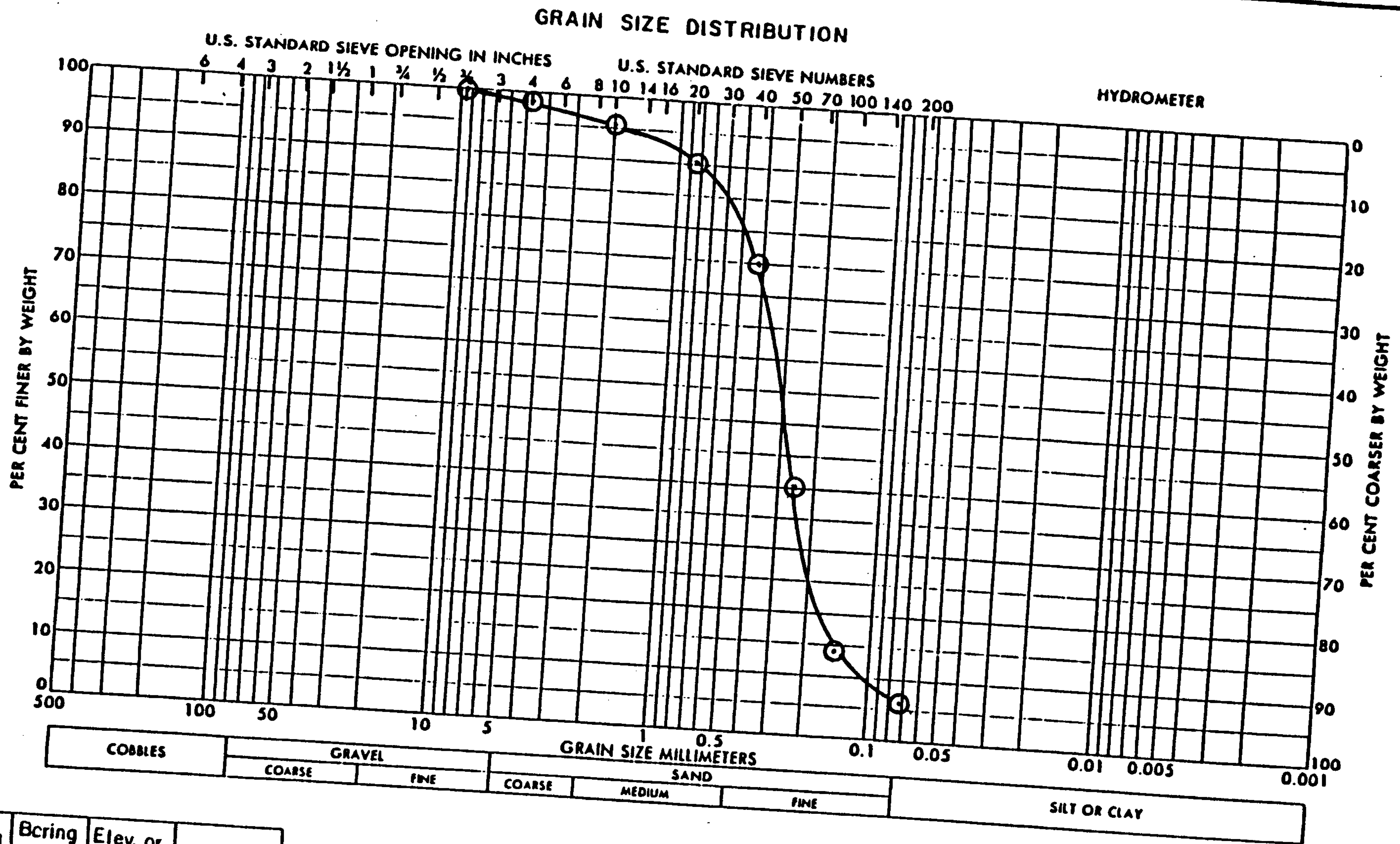
Symbol	Boring No.	Elev. or Depth	U.S.C.S.
⊙	B1/GC3	15-15.5	

CLIENT: IT Corportion
PROJECT: So. Pacific Trans.
PROJECT NO: 202208-06-03

The Earth Technology Corporation

GRAIN SIZE DISTRIBUTION
CURVE

Project No:	Date:	Figure No:
89-220-1503	1/6/89	2-A



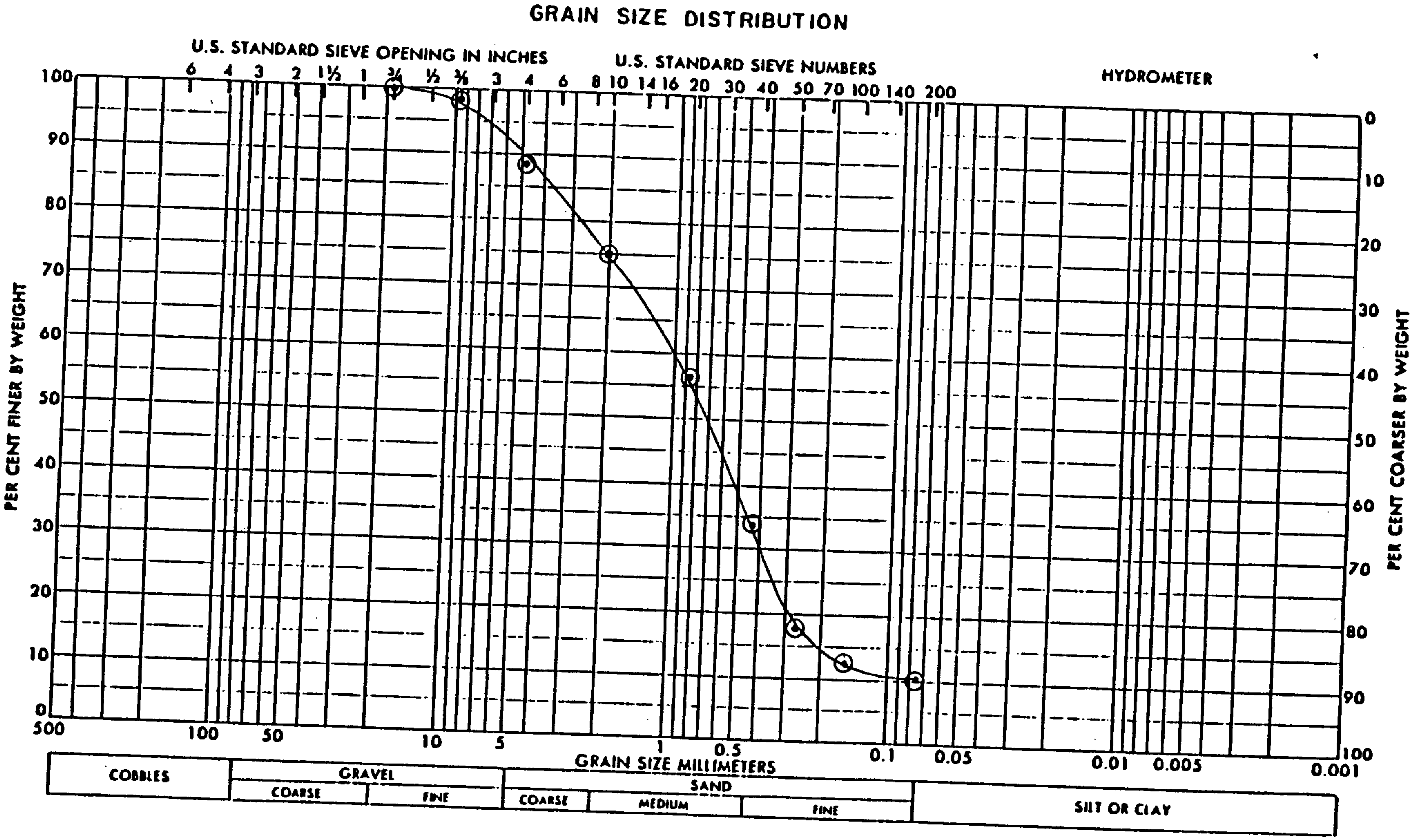
Symbol	Boring No.	Elev. or Depth	U.S.C.S.
⊙	B2GT2	9.5-10.	

CLIENT: IT Corporation
PROJECT: So. Pacific Trans.
PROJECT NO: 202208-06-03

The Earth Technology Corporation

GRAIN SIZE DISTRIBUTION
CURVE

Project No:	Date:	Figure No:
89-220-1503		



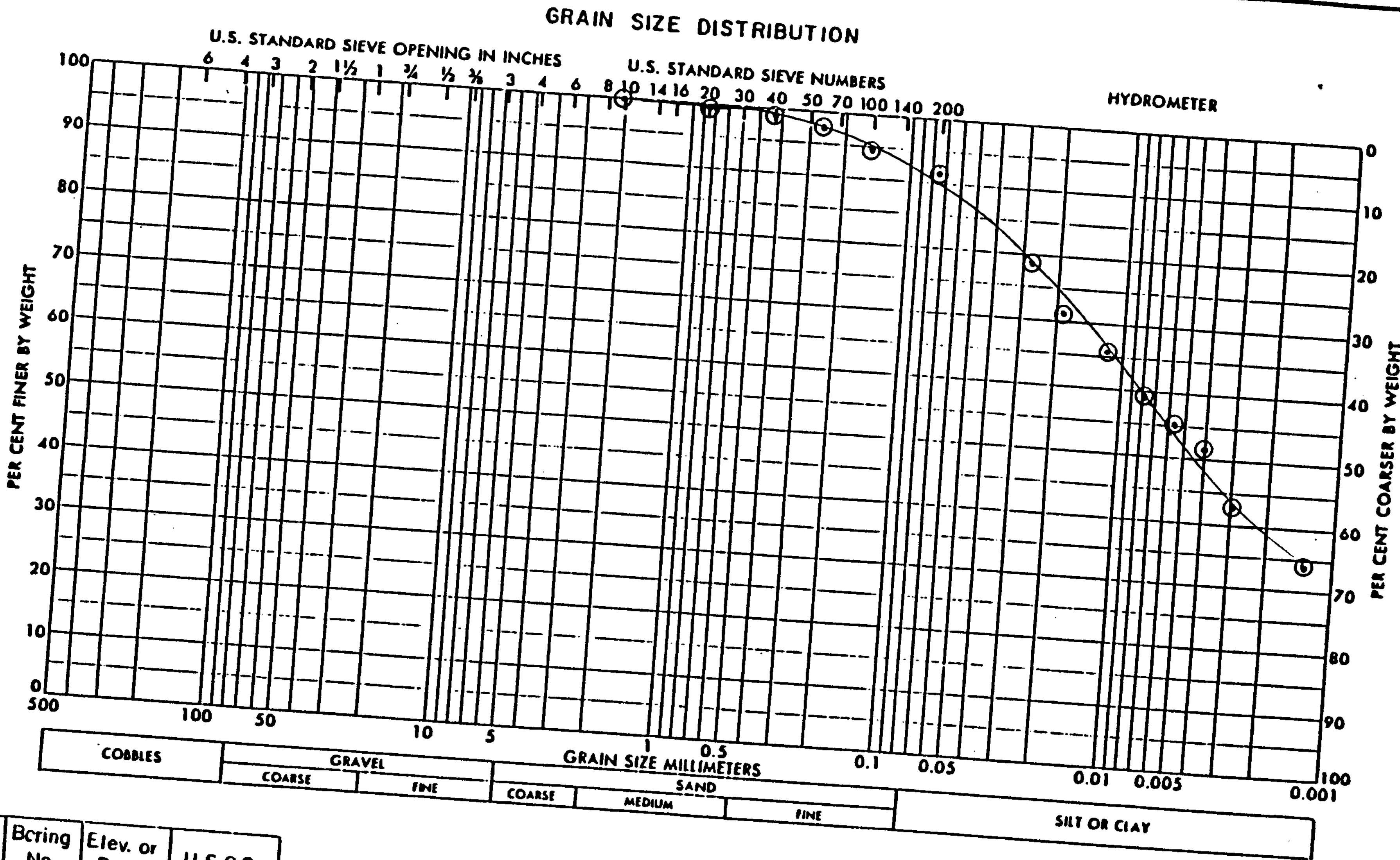
Symbol	Boring No.	Elev. or Depth	U.S.C.S.
⊙	B2GT3	14.5-15	

CLIENT: IT Corporation
PROJECT: Southern Pacific Trans.
PROJECT NO.: 202208-06-03

The Earth Technology Corporation

GRAIN SIZE DISTRIBUTION CURVE

Project No: 89-220-1503 | Date: 12/14/88 | Figure No:



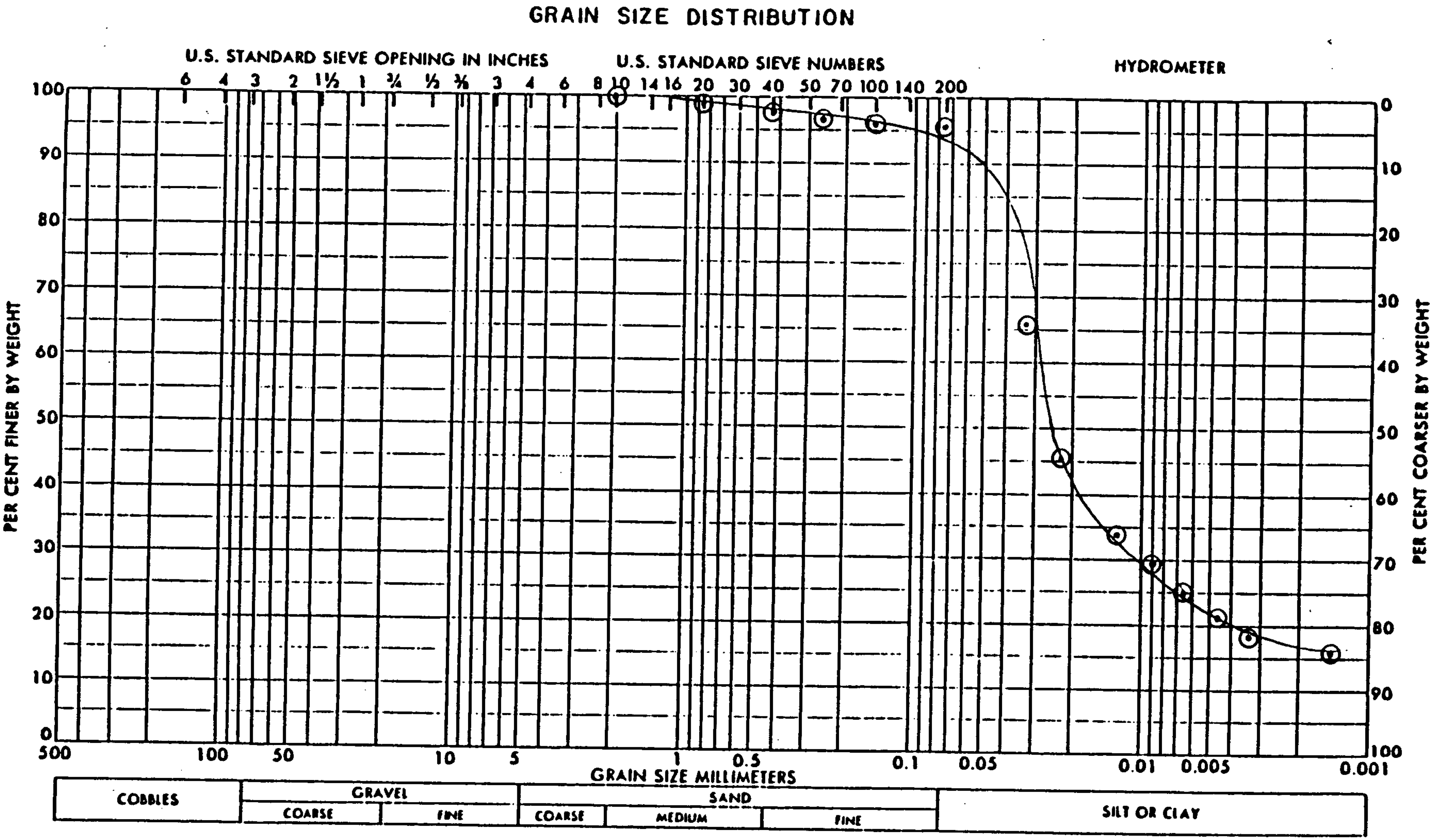
Symbol	Boring No.	Elev. or Depth	U.S.C.S.
⊙	B2GT5	24.5-25	

CLIENT: IT Corporation
PROJECT: Southern Pacific Trans.
PROJECT NO.: 202208-06-03

The Earth Technology Corporation

GRAIN SIZE DISTRIBUTION CURVE

Project No: 89-220-1503 | Date: | Fi...



Symbol	Boring No.	Elev. or Depth	U.S.C.S.
⊙	B3GT1	4.5-5	

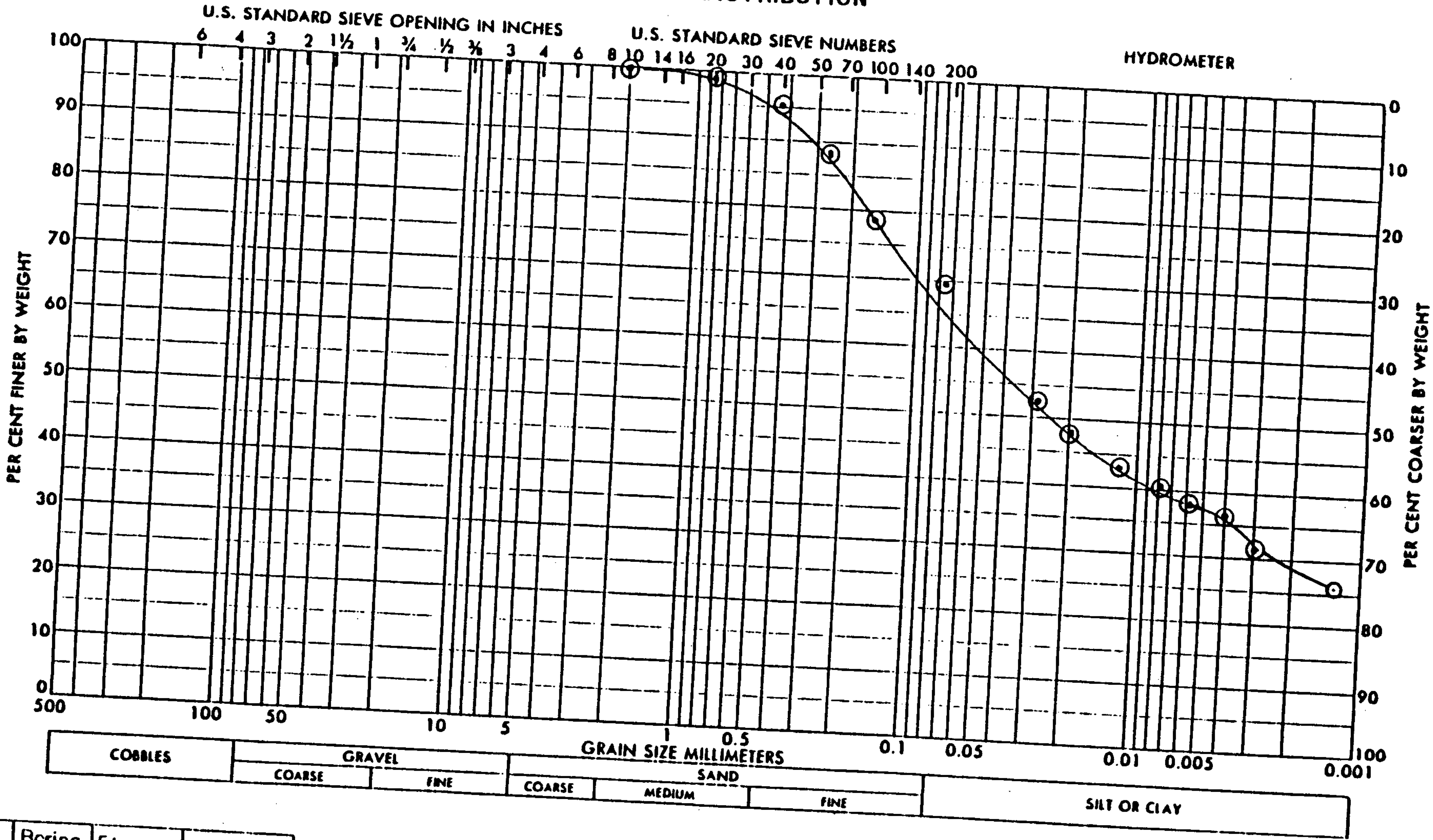
CLIENT: IT Corporation
PROJECT: Southern Pacific Trans.
PROJECT NO.: 202208-06-03

The Earth Technology Corporation

GRAIN SIZE DISTRIBUTION CURVE

Project No: 89-220-1503	Date: 12/14/88	Figure No: 6

GRAIN SIZE DISTRIBUTION



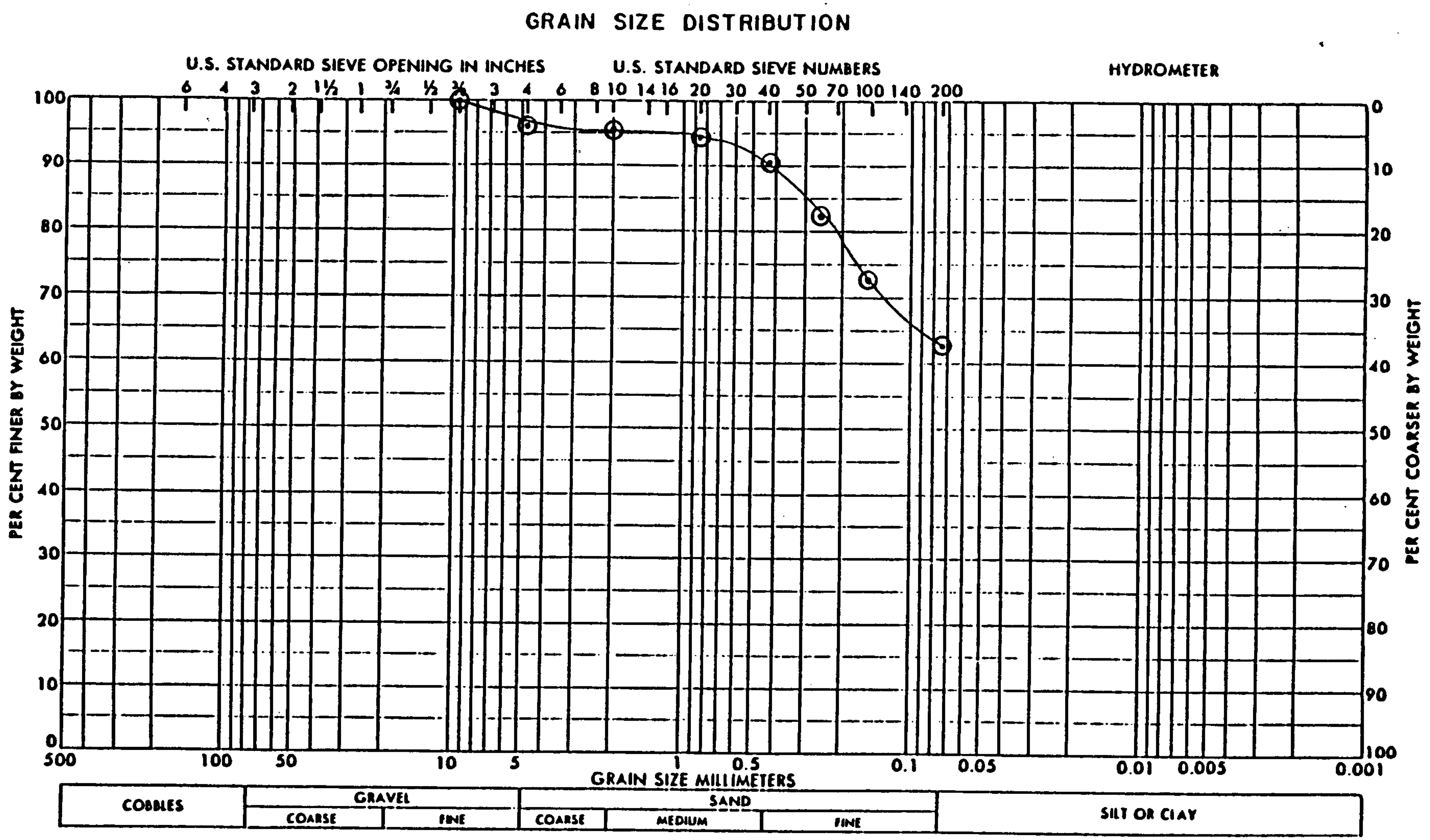
Symbol	Boring No.	Elev. or Depth	U.S.C.S.
⊙	B3GT3	19.5-20	

CLIENT: IT Corporation
PROJECT: Southern Pacific Trans.
PROJECT NO.: 202208-06-03

The Earth Technology Corporation

GRAIN SIZE DISTRIBUTION CURVE

Project No: 89-220-1503	Date: 12/14/8[illegible]	Figure No: 7



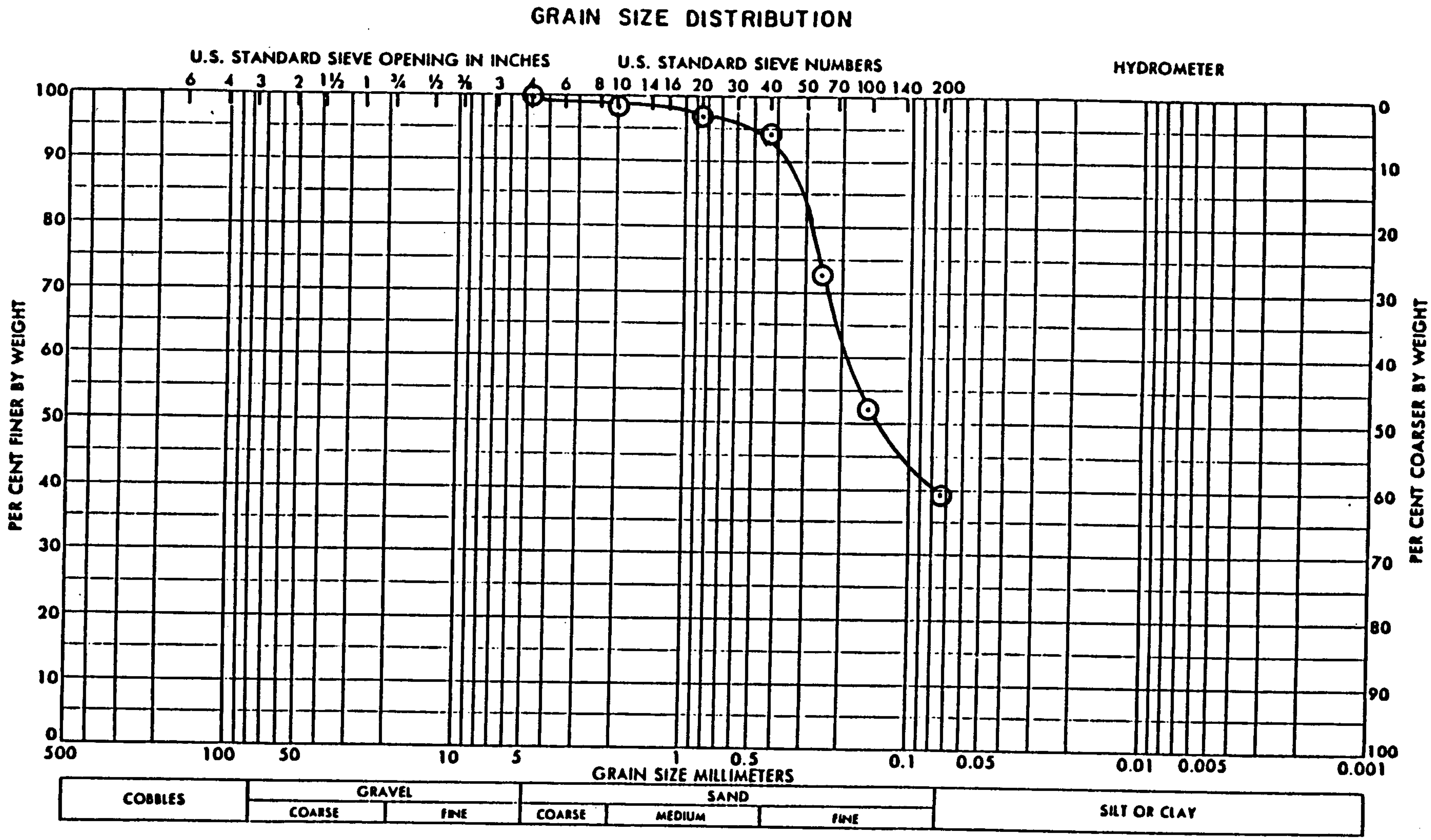
Symbol	Boring No.	Elev. or Depth	U.S.C.S.
⊙	B4GT1	4.5-5	

CLIENT: IT Corporation
PROJECT: Southern Pacific Trans.
PROJECT NO.: 202208-06-03

The Earth Technology Corporation

GRAIN SIZE DISTRIBUTION CURVE

Project No: 89-220-1503	Date: 12/14/88	Figure No: 8



Symbol	Boring No.	Elev. or Depth	U.S.C.S.
	B4/GT2	9.5-10.	

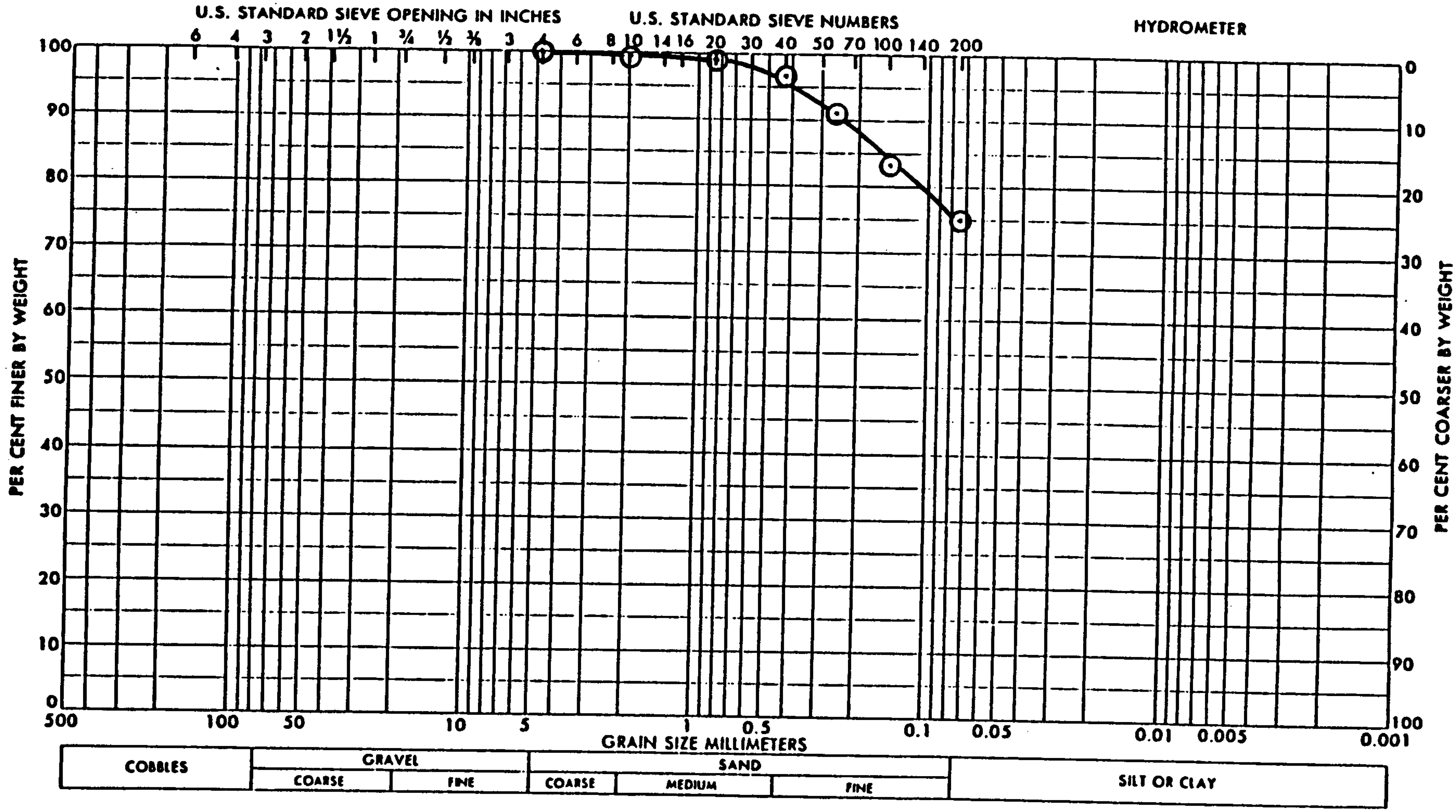
CLIENT: IT Corporation
PROJECT: So. Pacific Trans.
PROJECT NO: 202208-06-03

The Earth Technology Corporation

GRAIN SIZE DISTRIBUTION CURVE

Project No:	Date:	Figure No: 9
89-220-1503	1/6/89	

GRAIN SIZE DISTRIBUTION



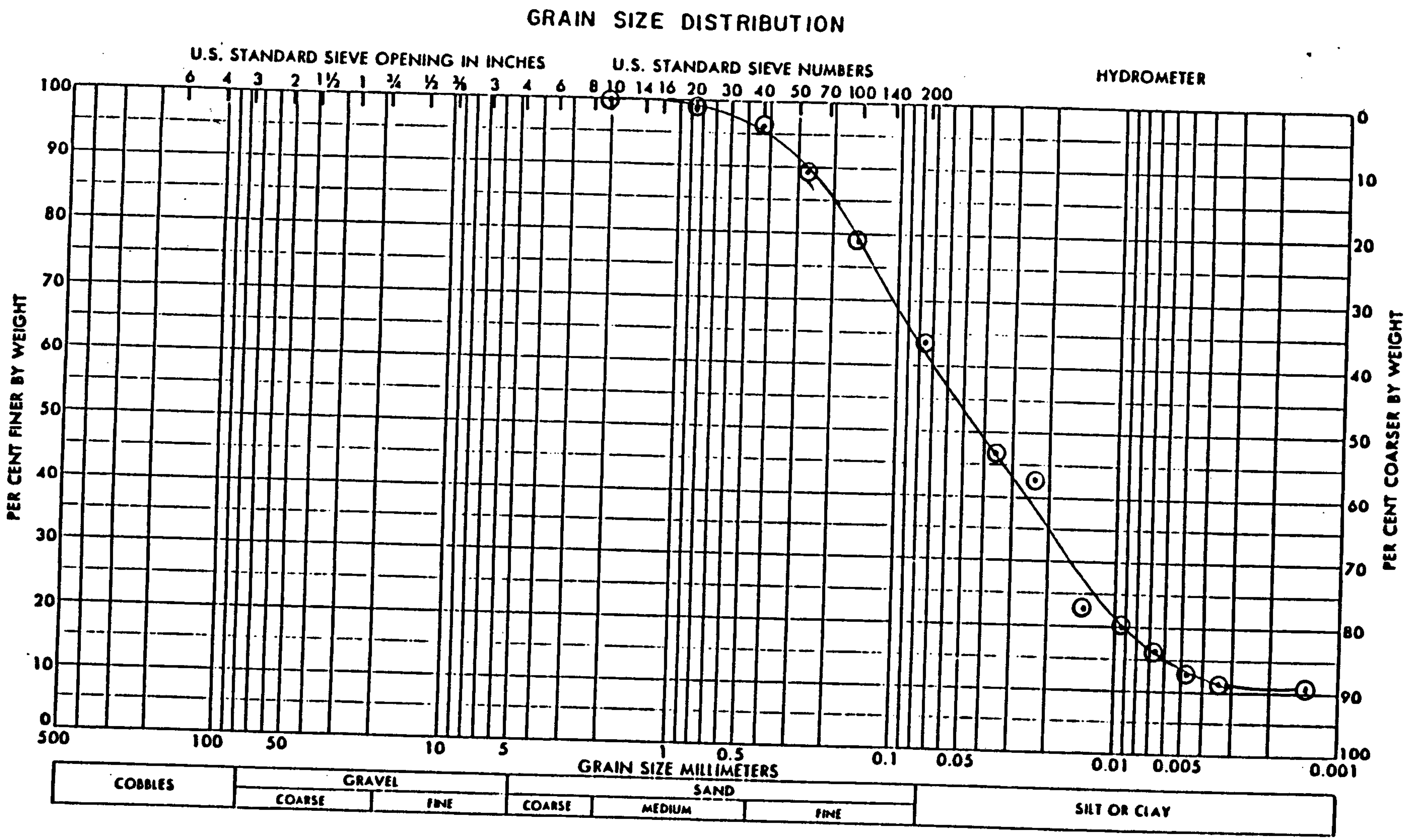
Symbol	Boring No.	Elev. or Depth	U.S.C.S.
⊙	B4GT4	19.5-20	

CLIENT: IT Corporation
PROJECT: So.Pacific Trans.
PROJECT NO: 202208-06-03

The Earth Technology Corporation

GRAIN SIZE DISTRIBUTION CURVE

Project No:	Date:	Figure No:
89-220-1503	1/6/89	9-A



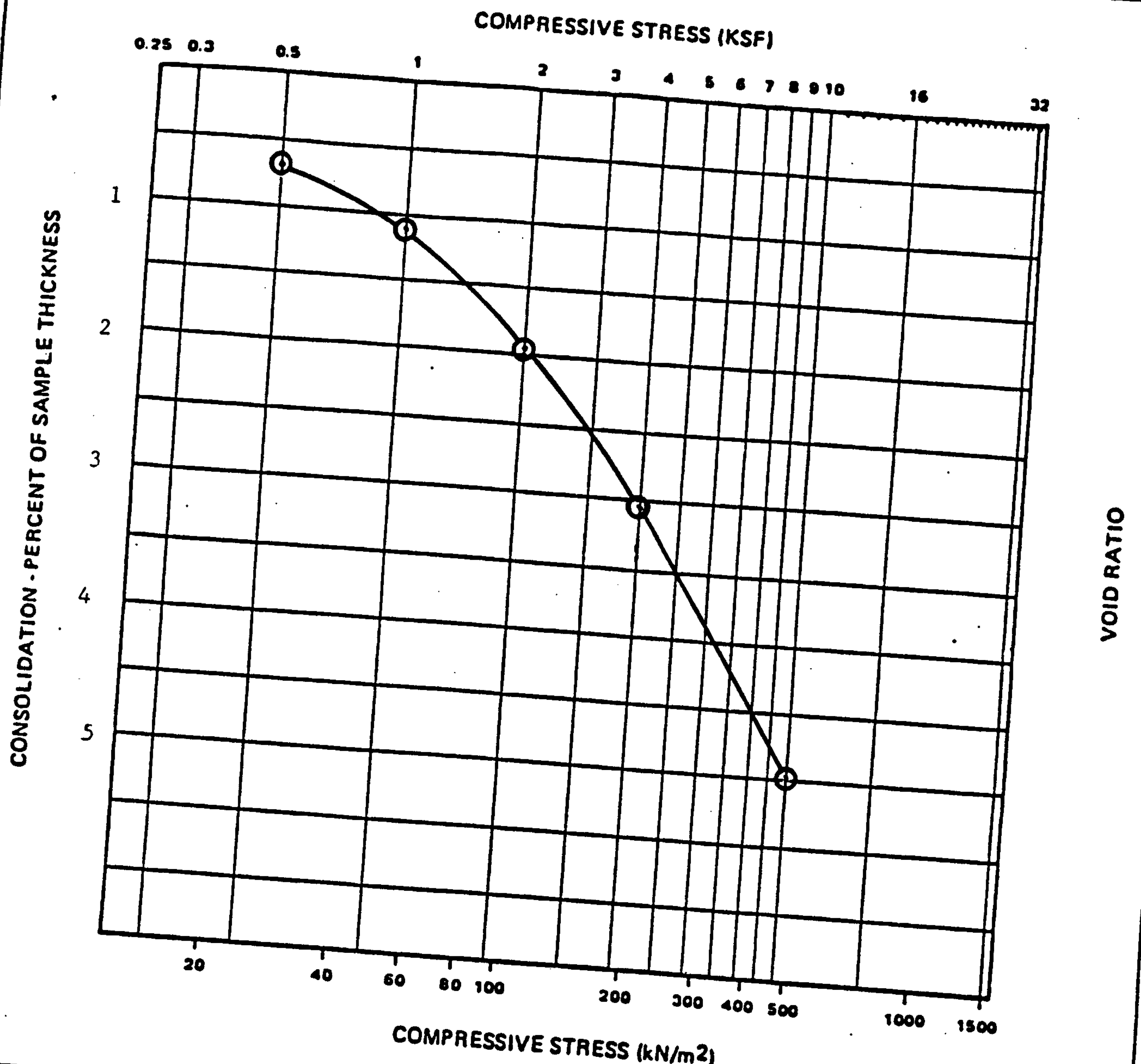
Symbol	Boring No.	Elev. or Depth	U.S.C.S.
⊙	B5GT8	49.5-50	

CLIENT: IT Corporation
PROJECT: Southern Pacific Trans.
PROJECT NO.: 202208-06-03

The Earth Technology Corporation

GRAIN SIZE DISTRIBUTION CURVE

Project No: 89-220-1503 | Date: 12/14/88 | Figure No: 10



SYMBOL	BORING NUMBER	SAMPLE NUMBER	SAMPLE INTERVAL FEET	SAMPLE INTERVAL METERS	SOIL TYPE	INITIAL DRY DENSITY PCF	INITIAL DRY DENSITY KG/M3	INITIAL MOISTURE CONTENT (%)	INITIAL VOID RATIO	INITIAL DEGREE OF SATURATION (%)
⊙	B-5	GT-8	49.5		SM	104.5		10.0	.610	43.5

Soil Description: Silty Sand,medium dense, moist, non-plastic,light brown.

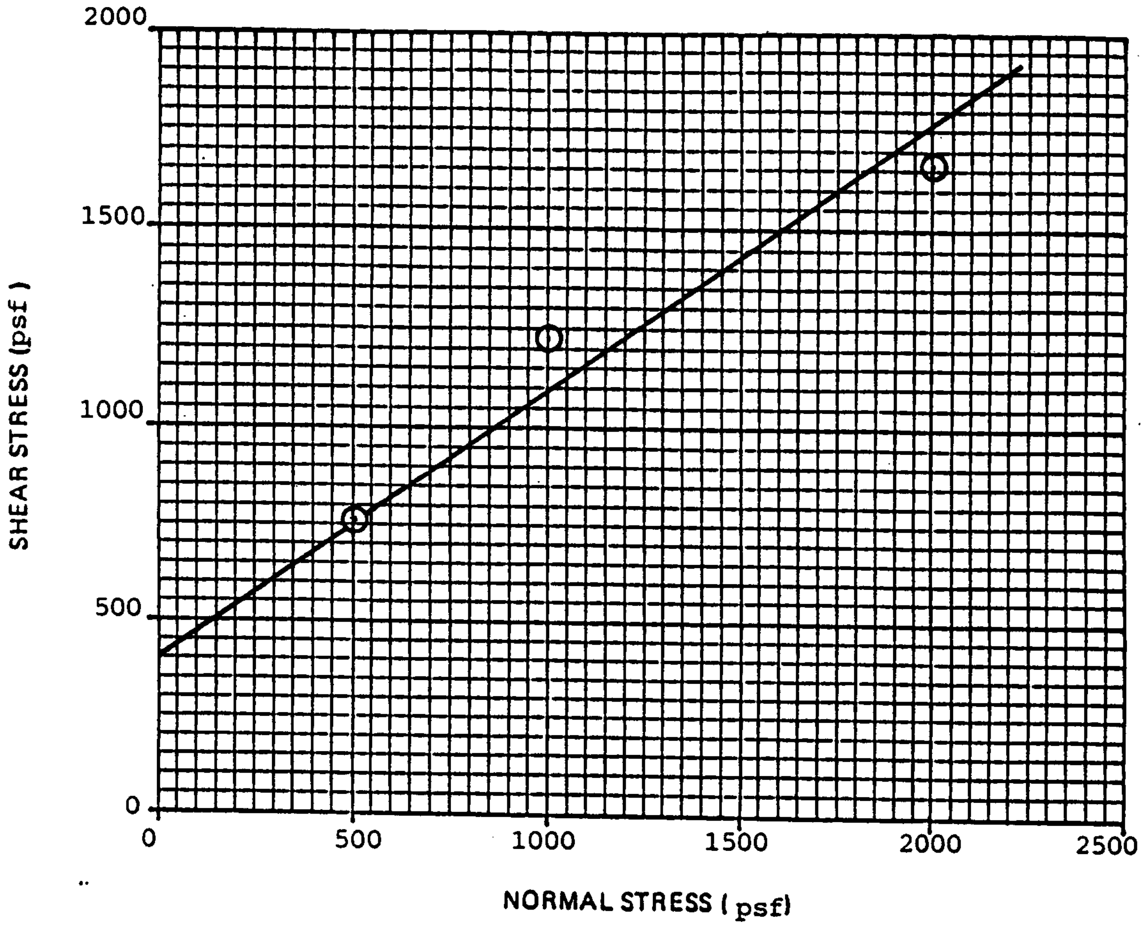
○ AT FIELD MOISTURE
● AFTER ADDITION OF WATER
——— COMPRESSION
– – – REBOUND

The Earth Technology Corporation
89-220-1503

Project No. 202208-06-03
So. Pacific Trans.
IT Corporation

ONE DIMENSIONAL
CONSOLIDATION TEST
RESULTS

FIGURE 11



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH ( )	SAMPLE TYPE	SOIL TYPE	COHESION C (psf)	FRICTION ANGLE ϕ	REMARKS
⊙	B-1	GC-3	15.0-15.5	Undist	SM	400	35°	

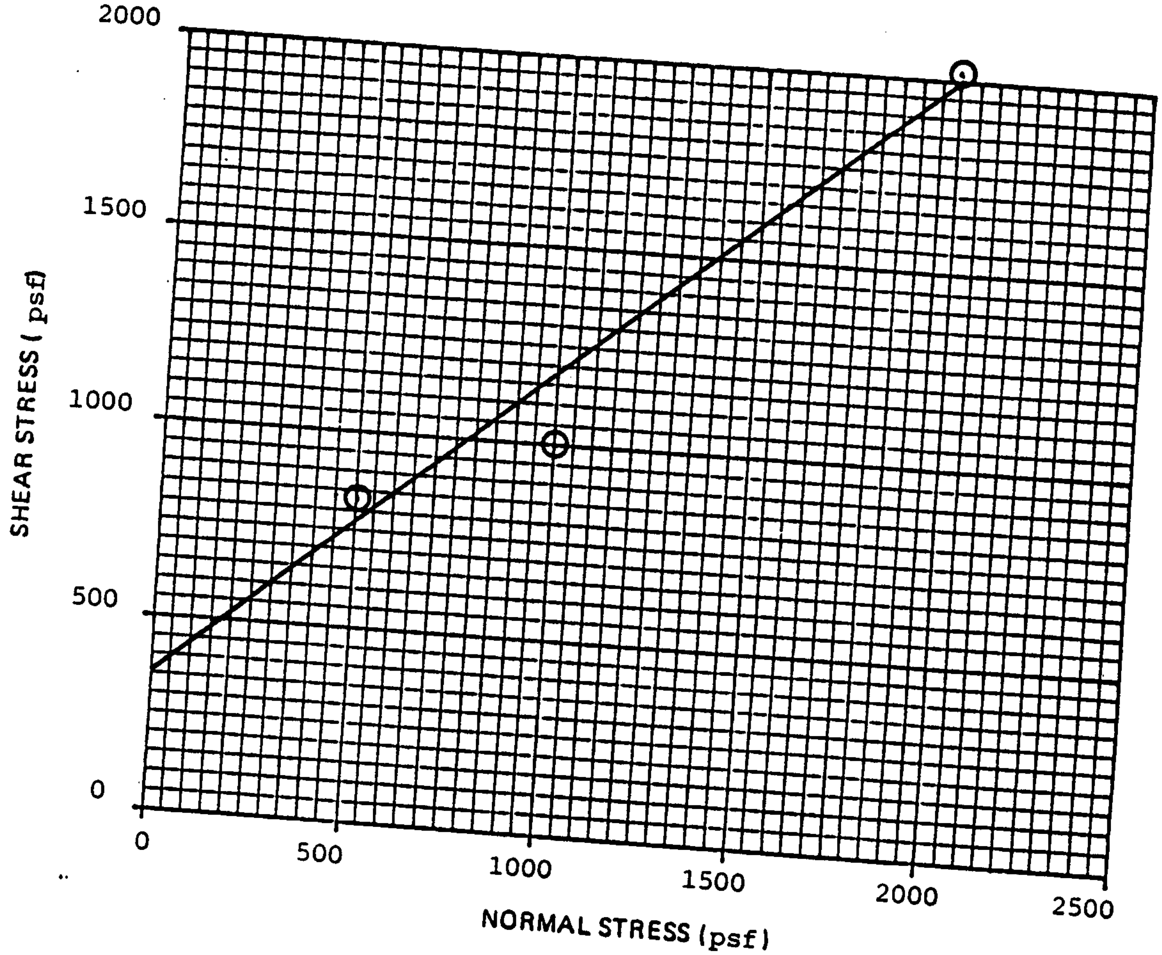
Soil Description: Silty sand, olive brown very dense, moist

89-220-1503
The Earth Technology Corporation

PROJECT NO.: 2202208-06-03
So. Pacific Trans
IT Corporation

DIRECT SHEAR TEST RESULTS

January 1989 | Figure 12



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH ( )	SAMPLE TYPE	SOIL TYPE	COHESION C psf)	FRICTION ANGLE Ø	REMARKS
⊙	B-1	GT-3	14.5-15.0	Undist	ML	350	40	

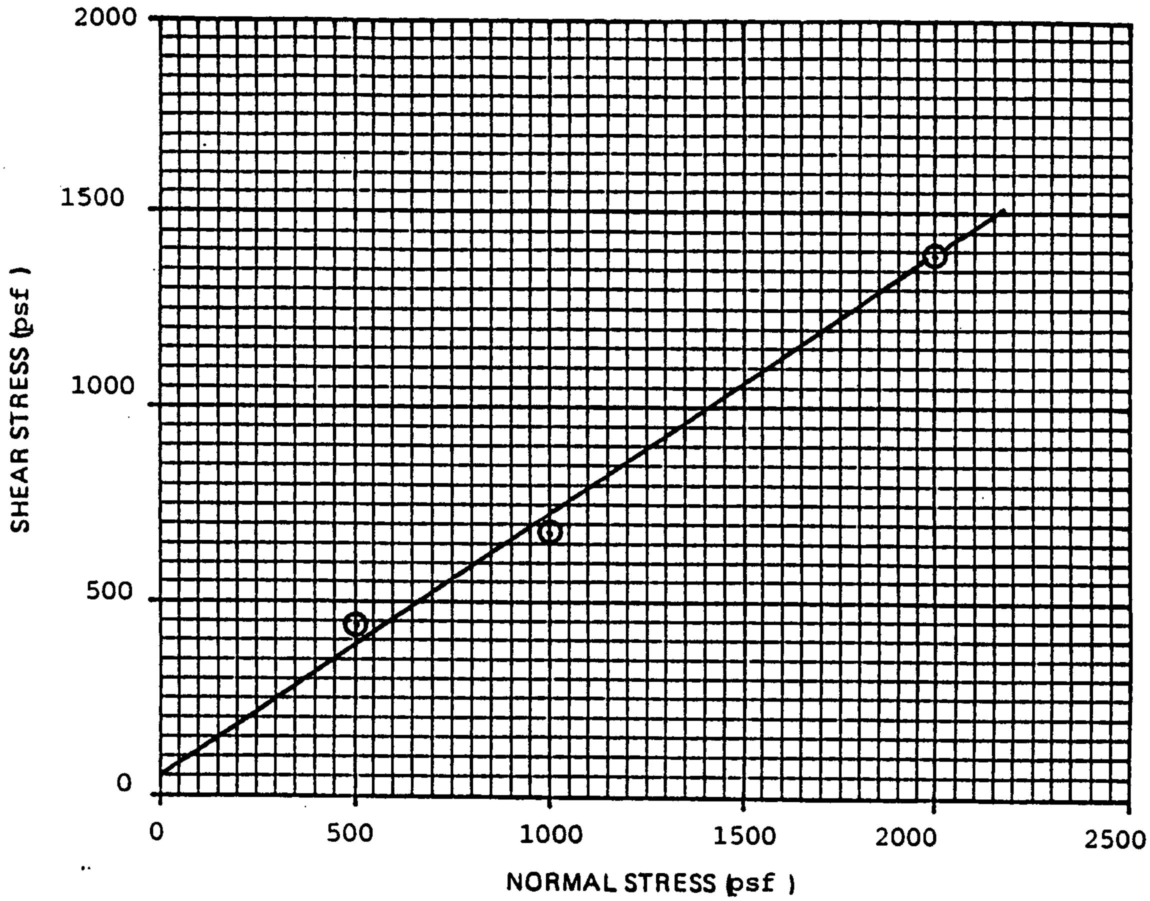
Soil Description: Sandy silt trace fine gravel, loose, moist, olive brown

The Earth Technology Corporation 89-220-1503	PROJECT NO.: 22002208-06-03 So. Pacific Trans. IT Corporation

DIRECT SHEAR TEST RESULTS

January 1989

Figure 13



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH ( )	SAMPLE TYPE	SOIL TYPE	COHESION C (psf)	FRICTION ANGLE ϕ	REMARKS
⊙	B-2	GT-2	9.5-10.0	Undist	SP-SM	50	35	

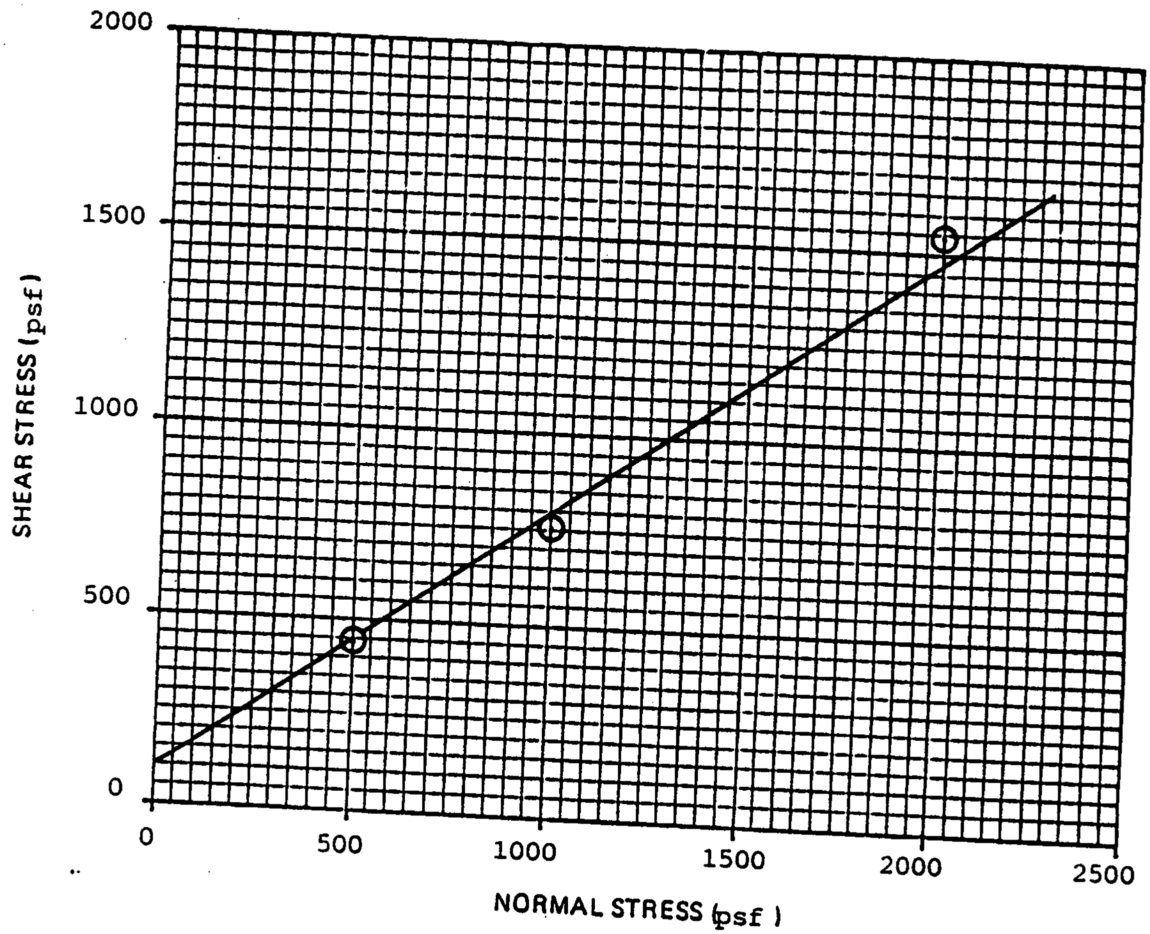
Soil Description: Poorly graded sand with silt, slightly loose, dark grey & black

89-220-1503 The Earth Technology Corporation	PROJECT NO.: 2202208-06-03 So. Pacific Trans. IT Corporation

DIRECT SHEAR TEST RESULTS

January 1989

Figure 14



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH ( )	SAMPLE TYPE	SOIL TYPE	COHESION C psf)	FRICTION ANGLE Ø	REMARKS
⊙	B-4	GT-2	9.5-10.0	Undist	SM	100	34	

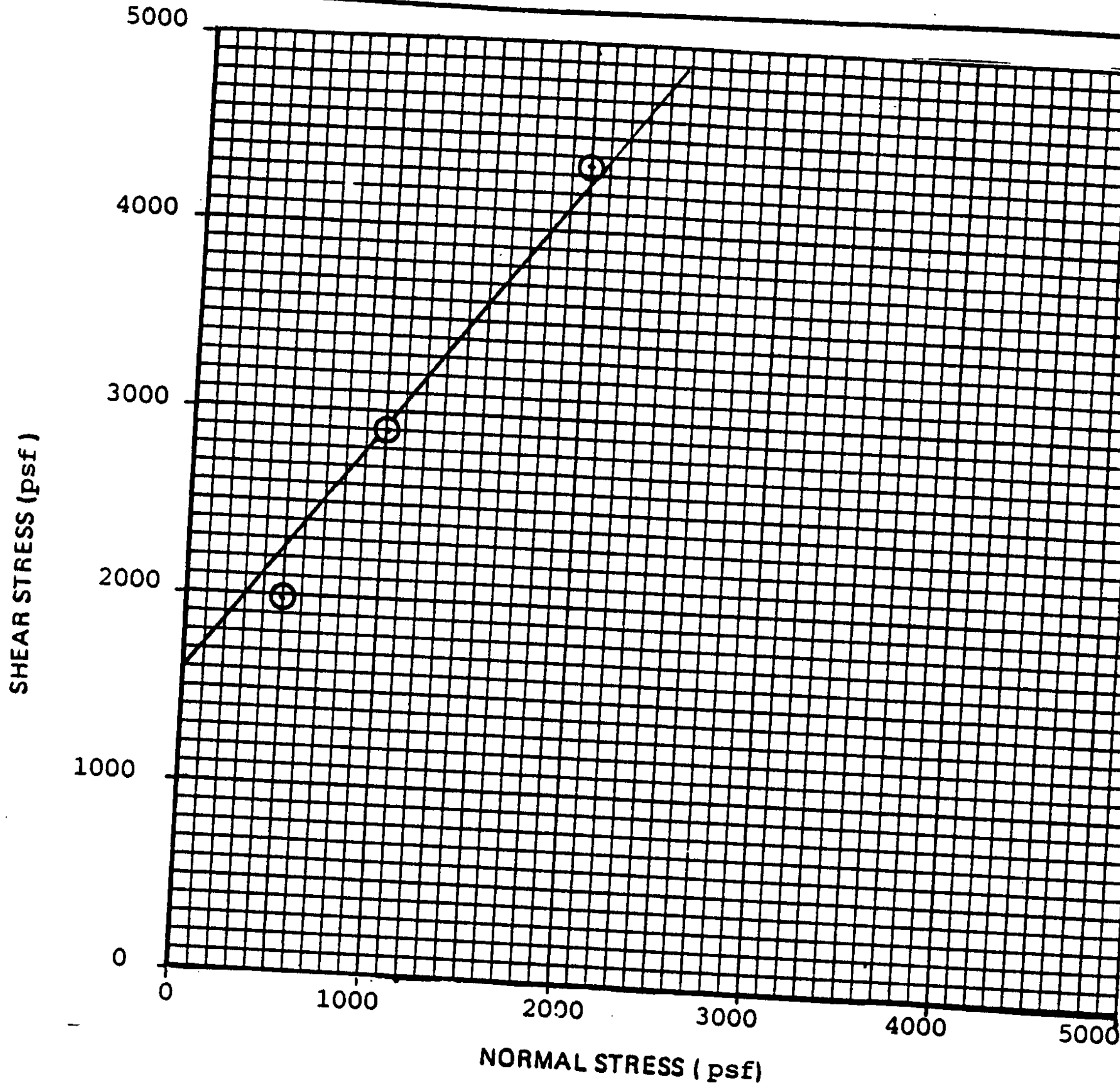
Soil Description: Silty sand trace fine gravel, loose, dry, olive brown

89-220-1503 The Earth Technology Corporation	PROJECT NO.: 2202208-06-03 So. Pacific Trans IT Corporation

DIRECT SHEAR TEST RESULTS

January 1989

Figure 15



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH ( )	SAMPLE TYPE	SOIL TYPE	COHESION C (psf)	FRICTION ANGLE ø	REMARKS
⊙	B-4	GT-4	19.5-20.0	Undist	Silt Stone	1600	52	Strong Cementation

Soil Description: Silt stone with fine sand, strong cementation, hard olive brown, slightly dry

89-220-1503 The Earth Technology Corporation	PROJECT NO.: 2202208-06-03 So. Pacific Trans. IT Corporation

DIRECT SHEAR TEST RESULTS

January 1989

Figure 16

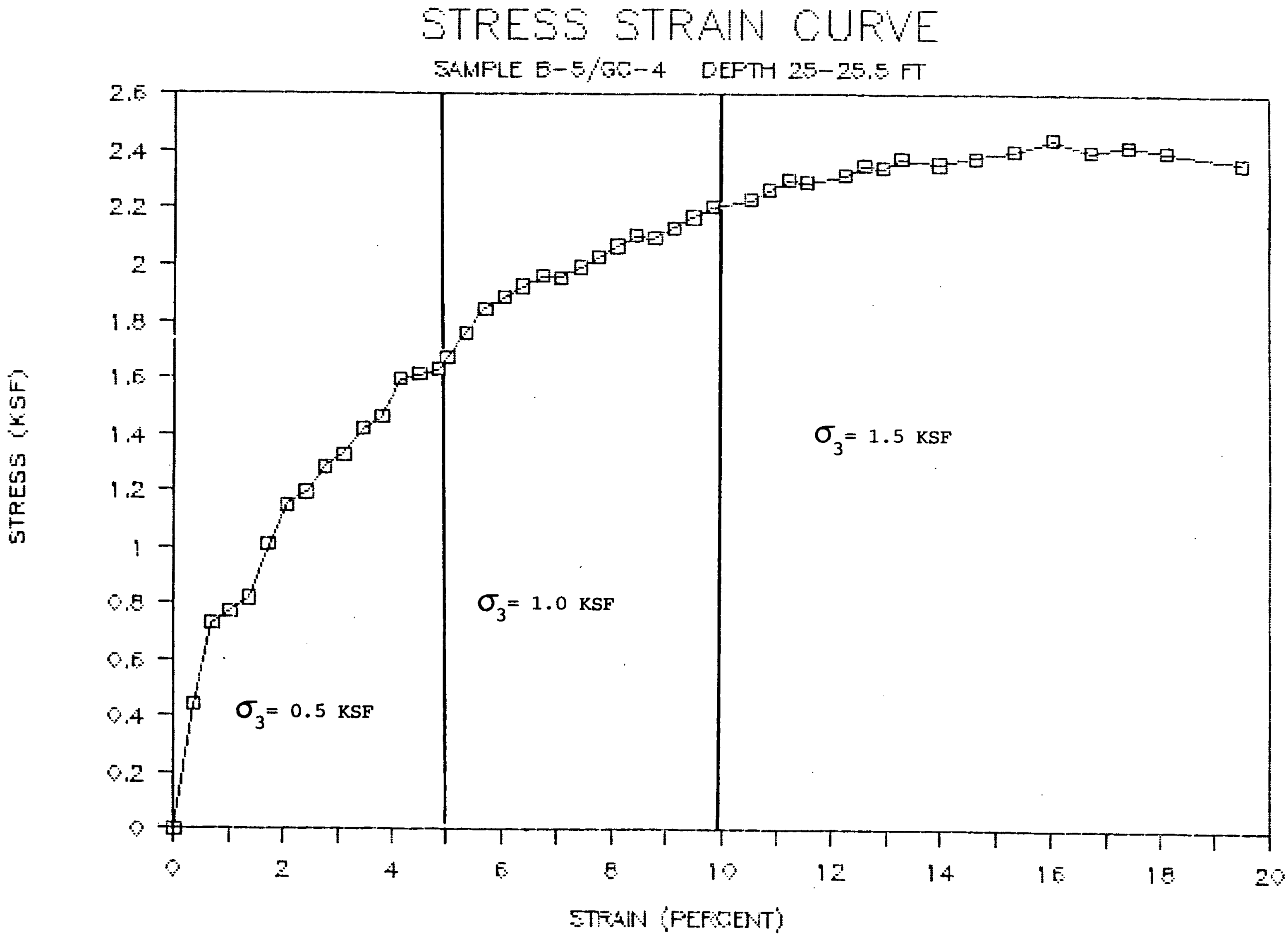
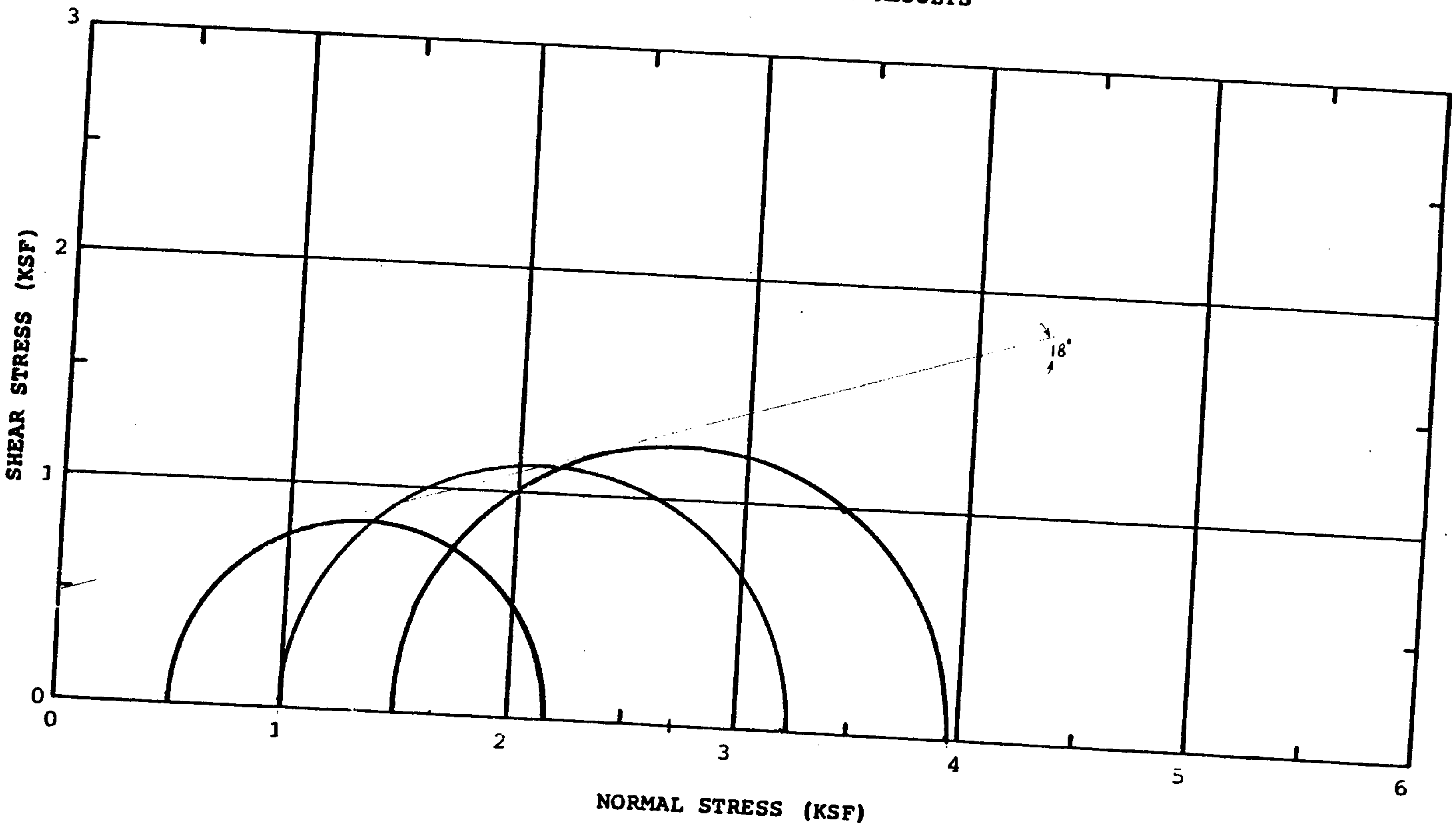

STRESS STRAIN CURVE
SAMPLE B-5/GC-4 DEPTH 25-25.5 FT
STRESS (KSF)
STRAIN (PERCENT)
σ3= 0.5 KSF
σ3= 1.0 KSF
σ3= 1.5 KSF
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
0
2
4
6
8
10
12
14
16
18
20

FIGURE 17

U.U.TRIAXIAL TEST RESULTS



Boring no. B-5 Sample no. GC-4

PROJECT: Southern Pacific Transportation

PROJECT No.: 202208-06-03

FIGURE 18

The Earth Technology Corporation

APPENDIX E

APPENDIX E

CONSTRUCTION QUALITY ASSURANCE PLAN

CONSTRUCTION QUALITY ASSURANCE PLAN
SOUTHERN PACIFIC TRANSPORTATION COMPANY
ASBESTOS WASTE MANAGEMENT UNIT
COALINGA, CALIFORNIA

REVISION 1

AUGUST 1989

PREPARED BY IT CORPORATION

PREPARED BY ~~Harold H. Hamparsumian~~ DATE 8-15-1989

Jari D. Cooley

APPROVED BY Howard O. Yamamoto DATE 8-15-89
DESIGN MANAGER

APPROVED BY Mary Parker DATE 8-15-89
QUALITY ASSURANCE

TABLE OF CONTENTS

1.0 INTRODUCTION

The Southern Pacific Transportation Company's (SPTC) asbestos waste management unit (WMU) has been designed to receive asbestos-contaminated soil. The construction of the asbestos WMU will involve excavation of the area to design grade, construction of embankments (dikes) to design grade, installation of neutron probe access tubes (NPATs), and construction of the final cover system. The final cover system consists of the following components (described from bottom to top):

- 2-foot-thick foundation layer
- Bentonite mat
- 1-foot-thick protective soil cover
- 40-mil-thick PVC liner
- Geocomposite
- 9-inch-thick gravel layer
- Geotextile
- 1-foot-thick vegetative soil cover.

In addition to the above items, the construction of the WMU will include the installation of an irrigation system.

This Construction Quality Assurance (QA) Plan discusses quality-related activities that are specific to the construction of the WMU and that are required to demonstrate that the design has been implemented and performance requirements have been met. This document fulfills two purposes: (1) it documents the specific technical requirements of the quality program for the construction of the WMU, and (2) it serves as a reference source for the personnel performing and monitoring the construction.

Two aspects of the construction process are discussed in this appendix:

- Construction verification
- Specific inspections and tests to be performed.

Inspection checklists are presented in Attachment A of this Plan to indicate the checks to be made for each inspection.

2.0 CONSTRUCTION VERIFICATION

To verify and demonstrate that design requirements are properly incorporated during the construction of the WMU, a specific program of field controls (e.g., inspections and verification tests) is provided. The program is divided into seven segments of construction: (1) earthwork, which includes excavation of existing materials and placement of embankment, foundation layer fill, protective soil cover fill, and vegetative soil cover fill; (2) NPAT installation; (3) bentonite mat installation; (4) 40-mil PVC liner installation; (5) geocomposite installation; (6) gravel layer placement; and (7) geotextile installation.

The control activities to be performed during the construction phase can be characterized as the following types:

- Field inspections to be performed by the Resident Engineer, QC Inspectors or Field Engineers, depending on the activity. The inspections are primarily visual examinations, but may include measurements of materials and equipment used, techniques employed, and the final products. The purpose of these inspections is to demonstrate that a specific guideline, specification, or procedure for the activity is successfully completed.

- Field testing to be performed on site by Quality Control (QC) Inspectors according to specified procedures. Field tests are to be performed on samples or in situ portions of the as-built WMU to assess whether construction performance meets project requirements.

- Laboratory testing to be performed by on-site or off-site laboratories on samples of materials used for construction of the WMU. The purpose of the laboratory tests is to characterize materials and confirm performance.

- Surveying, including establishment of horizontal and/or vertical position as appropriate.

- Receiving inspections to be performed by the Resident Engineer, Field Engineers, and QC Inspectors. The inspections include, as necessary, visual examinations and measurements of materials obtained from suppliers prior to installation. The purpose of these inspections is to verify that the materials used meet specifications and are free from defects.

- Manufacturer's certificates obtained from suppliers for specified shipments of materials received. They entail a statement that the materials meet required specifications.

- Checklist required for critical inspections. These checklists are to be filled out during the course of inspection to document inspection results.

3.0 SPECIFIC INSPECTIONS AND TESTS

This section specifies the inspections and verification testing necessary to control, verify, and document satisfactory work performance. The inspection and testing activities are described for the different phases and the various materials of construction. The construction of the WMU may be divided into seven separate phases: (1) earthwork, (2) NPAT installation, (3) bentonite mat installation, (4) 40-mil PVC liner installation, (5) geocomposite installation, (6) gravel placement, and (7) geotextile installation.

3.1 EARTHWORK, INCLUDING EMBANKMENTS, FOUNDATION LAYER, PROTECTIVE SOIL COVER, AND VEGETATIVE SOIL COVER

Quality-related activities during the earthwork phase of construction include the following:

- Inspection and logging, as necessary, of excavated and finished subgrade.
- Inspection of materials for embankment fill, protective cover, and vegetative soil cover.

  The fill materials to be used for the construction of the embankments and protective soil cover are expected to be obtained from the excavated material. The foundation layer may be composed of waste and on-site native soil. The excavated materials are expected to consist of fine-grained granular materials. Visual inspections of the excavated materials shall be made by the construction personnel and QC Inspectors to detect the presence of organic matter and irreducible matter larger than 2 inches in any dimension, prior to placement in the embankments, foundation layer, protective soil cover, or vegetative soil cover.

- Laboratory testing of fill materials.

  Laboratory tests of fill materials for the embankments, protective soil cover, and vegetative soil cover shall be performed to document engineering properties and to verify the acceptability (native material with greatest dimension less than 2 inches) of the material for use in construction. Testing of contaminated soils shall be performed in compliance with safety measures described in the "Hazardous Substance Removal Plan" by ATEC Environmental Consultants, dated December 1988. The laboratory tests shall include the following:

- Determination of the relationship between moisture content and density in accordance with ASTM D 1557, performed at a minimum frequency of one test (one point) per day when fill is being placed. If the test result deviates from the preestablished moisture-density curve by more than 2 pounds per cubic foot and/or 2 percent of moisture, a new moisture-density curve shall be established and used for field density monitoring. A minimum of two tests shall be performed on the fill material prior to its use to determine the moisture-density curve.

- Determination of specific gravity in accordance with ASTM D 854. A minimum of one test shall be performed per moisture-density curve determination.

• Field testing of in situ portions of the as-built embankments, protective soil cover, and vegetative soil cover to determine whether construction performance meets project requirements. Fill placed at densities and/or moisture contents not conforming to the specifications (90 percent of the maximum dry density and moisture content at ±4 percent of optimum as determined by ASTM D 1557) shall be removed and replaced or reworked to meet the requirements of the specifications.

The field tests shall include the following:

- Determination of the soil in situ density and moisture content by nuclear methods performed in accordance with ASTM D 2922 and ASTM D 3017. Testing shall be performed at a minimum frequency of one per 500 cubic yards of the embankment, protective soil cover, and lower 6 inches of the vegetative soil cover. Standard forms shall be used for recording test data. All holes in the compacted fill resulting from nuclear gage testing shall be backfilled with similar quality material, hand tamped into place.

- In situ density tests using a sand cone performed in accordance with ASTM D 1556 or suitable alternative. The purpose of these tests is to verify the nuclear gage results. At least one test each shall be performed for the embankments, protective soil cover, and vegetative soil cover. Sand used in the testing of the compacted fill shall be removed from the compacted fill at the completion of the test and replaced with similar quality soil, hand tamped into place.

- Determination of moisture content of the compacted embankment fill in accordance with ASTM D 2216. The purpose of these tests is to verify the nuclear gage results. At least one test each shall be performed for the embankments, protective soil cover, and vegetative soil cover.

- Surveying lines and grade of subgrade prior to construction of the embankments, foundation layer, protective soil cover, and vegetative soil cover. The survey shall be certified by a licensed land surveyor or a registered civil engineer certified to perform surveying in California.

- Visual inspection during placement.

  During fill placement, the following shall be observed and documented:

  - Type and quantity of earthwork equipment used.
  - Coverage and number of passes made by compaction equipment.
  - Lift thickness.
  - Lines and grade of the completed embankments, protective soil cover, and vegetative soil cover. The survey shall be certified by a licensed land surveyor or a registered civil engineer certified to perform surveying in California.
  - Method of installation of protective soil cover layer for damage to the underlying bentonite mat.
  - Method of installation of vegetative soil cover for damage to the underlying geotextile.

Checklists relevant to earthwork are included in Attachment A.

3.2 NEUTRON PROBE ACCESS TUBES

The NPATs shall be installed in the subgrade of the excavated WMU. The following inspections and tests will be performed by the QC Inspectors during field fabrication and installation of the NPATs:

- Visual inspection upon receipt of materials for damage and for manufacturer's identification to verify that the proper materials were received and meet specifications.
- Inspection of steel pipe for cracks, defects, and cleanliness prior to field-fabrication and/or installation.
- Visual inspections of all field welds in the NPATs for continuity and irregularities.

- Verification of smooth welds on the interior of the NPAT by observing trial test runs involving passing a "blank" neutron probe and accessories through the pipe in 50-foot increments.
- Inspection of the dimensions of the NPAT trench and of the NPAT installation.
- Inspection of the NPAT trench backfill for proper lift thickness and moisture/density relationship requirements.

Checklists relevant to the NPATs are included in Attachment A.

3.3 BENTONITE MAT

The bentonite mat shall be installed over the foundation layer and beneath the protective soil cover. The following inspections will be performed by the QC Inspectors during installation of the bentonite mat:

- Manufacturer's certification that material meets specification.
- Visual inspection upon receipt of material for damage and for manufacturer's identification to verify that the proper material was received.
- Visual inspection of prepared subgrade for rocks, other foreign material, and general condition prior to installation of the mat.
- Visual inspection of each mat sheet for damage after it is unrolled during construction.
- Inspection of sides and ends of adjoining sheet for minimum overlap.
- Visual inspection of mat installation for creases or irregularities.
- Visual inspection of mats for proper cover before and after each shift.

Checklists relevant to the bentonite mat, including receiving and construction inspections, are included in Attachment A.

3.4 40-MIL PVC LINER

The 40-mil PVC liner shall be installed over the protective soil cover and beneath the geocomposite. The following inspections and tests will be performed by the QC Inspectors for the 40-mil PVC liner:

- Manufacturer's certification that material meets specifications.
- Visual inspection upon receipt of material for damage and for manufacturer's identification to verify that the proper material was received.
- Visual inspection of prepared subgrade for rocks, other foreign material, and general condition prior to installation of the liner.
- Visual inspection for damage of each liner sheet after it is unrolled or unfolded during installation.
- Observation of start-up seams prepared by the installer and of the testing prior to actual seaming.
- Inspection of the overlap of the sheets composing the seam for conformance with specifications.
- Observation of the temperature of the seam welding unit, if applicable.
- Inspection of all seams for visible discontinuities in the seam weld or any other noticeable defects. Defective areas shall be marked on the liner and on the construction inspection form. All defective areas shall be repaired.
- Observation of all seam field testing (air lance testing) performed by the contractor and marking of the defective areas. Seam testing shall be performed for the entire length of all seams.
- Laboratory testing of seam samples taken from the installed liner at a minimum frequency of one per 500 linear feet. Laboratory tests include verification of thickness, determination of bonded seam strength in shear, and bonded seam strength in peel as described in the technical specifications (Appendix C).
- Walk-through inspection of the liner prior to placing the geocomposite.

Checklists relevant to the PVC liner, including the receiving inspection and the PVC liner placement, seaming, and air lance field testing inspections, are included in Attachment A.

3.5 GEOCOMPOSITE

One geocomposite shall be installed over the PVC liner and beneath the gravel layer. The following inspections will be performed by the QC Inspectors for the geocomposite:

- Manufacturer's certification that the geocomposite meets specifications.
- Inspection upon receipt of geocomposite for damage during shipment and for manufacturer's identification to verify that the proper material is received.
- Inspection of cleanliness of geocomposite and underlying PVC liner prior to installation.
- Inspection for damage of geocomposite sheet after it is unrolled during installation.
- Inspection of the geocomposite sheets for defects and for conformance with specifications.
- Inspection of jointing of geocomposite for compliance with specifications.

Checklists relevant to the geocomposite, including the receiving and construction inspections, are included in Attachment A.

3.6 GRAVEL

The gravel layer shall be placed over the geocomposite in a 9-inch thickness. The following inspections and analyses will be performed by the QC Inspectors for the gravel:

- Inspection of gravel for cleanliness and appearance and to verify that the rock is subrounded in accordance with the specifications.
- Grain-size analyses.
- Inspection for cleanliness of the geocomposite prior to installation of gravel.
- Observation of the method of installing the gravel for damage to the geocomposite and underlying PVC liner.
- Inspection of final grade of the gravel for conformance with plans.

- Surveying lines and grades of the gravel subgrade prior to installation of the geotextile. The survey shall be performed by or under the direction of a licensed land surveyor or registered civil engineer certified to perform surveying in California.

Attachment A includes checklists relevant to the gravel placement, including checklists for receiving and construction inspections.

3.7 GEOTEXTILE

The following inspections will be performed by the QC Inspectors for the geotextile:

- Manufacturer's certification that the geotextile wrap meets specifications.
- Inspection upon receipt of geotextile for damage during shipment and for manufacturer's identification to verify that the proper material is received.
- Inspection of prepared subgrade for rocks, other foreign materials, and general condition prior to installation of the geotextile.
- Visual inspection for damage of each sheet after it is unrolled during construction.
- Inspection of cleanliness of geotextile prior to installation.
- Inspection of ends of adjoining sheet for minimum overlaps.
- Inspection of the geotextile sheets for defects and for conformance with specifications.
- Verification that the geotextile is properly covered by vegetative soil cover material within 48 hours of placement.

Checklists relevant to the geotextile, including the receiving and construction inspections, are included in Attachment A.

ATTACHMENT A

INSPECTION CHECKLISTS

The inspection checklists in this attachment indicate the checks to be made for each inspection. The format of the inspection checklists may be modified by the Resident Engineer. However, the revised form must include all checks and information contained in the original form.

Date: 8/15/89
Revision No. 1

LIST OF FORMS FOR SOUTHERN PACIFIC TRANSPORTATION ASBESTOS WMU

RECEIVING INSPECTION	FORM
PVC Liner/Geocomposite/Bentonite Mat/Geotextile	SP-1
Steel Pipe	SP-2
Wire Rope	SP-3
Gravel	SP-4
CONSTRUCTION INSPECTION	
Embankment Fill (Field Form)	SP-5
Embankment Fill (Field Office Form)	SP-6
Foundation Layer (Field Form)	SP-7
Foundation Layer (Field Office Form)	SP-8
Protective Soil Cover Layer (Field Form)	SP-9
Protective Soil Cover Layer (Field Office Form)	SP-10
Vegetative Soil Cover Layer (Field Form)	SP-11
Vegetative Soil Cover Layer (Field Office Form)	SP-12
Field Density Test Results	SP-13
Bentonite Mat	SP-14
NPAT Field-Fabrication and Installation	SP-15
PVC Liner Placement	SP-16
PVC Liner - Seaming	SP-17
Pre Liner - Air Lance Field Testing	SP-18
Geocomposite	SP-19
Gravel	SP-20
Geotextile	SP-21

FORM NO. SP-1
Revision No. 1

ONE FORM FOR EACH DELIVERY

RECEIVING INSPECTION
PVC LINER/GEOCOMPOSITE/BENTONITE MAT/GEOTEXTILE

Project Name ______________________
Project No. ______________________
Type of Material ______________________
Transporter/Supplier ______________________

Date ______________________
Received by ______________________
Inspected by ______________________
Delivery Slip No. ______________________
Storage Location ______________________
Number of Rolls Delivered ______________________

	SPECIFICATION	MATERIAL RECEIVED	NOTE NO.
Manufacturer	________	________	________
Manufacturer's Designation	________	________	________
Material Width/Length/ Thickness	________	________	________

	YES/NO*	NOTE NO.
Checks before unloading:		
• Is the material free of damage?	________	________
• Is the material acceptable for use?	________	________
Checks after unloading:		
• Is the material free of damage?	________	________
• Is the material properly stored?	________	________
• Have all required repairs been completed?	________	________

NOTES:

*Provide explanatory note, including any remedial steps required.

FORM NO. SP-2

ONE FORM FOR EACH DELIVERY

RECEIVING INSPECTION
STEEL PIPE

Project Name ____________	Date ____________
Project No. ____________	Received by ____________
Inspected by ____________	Delivery Slip/Truck No. ____________
Transporter/Supplier ____________	____________
Quantity Delivered ____________	Storage Location ____________

	SPECIFICATION	AS RECEIVED	NOTE NO.
Manufacturer			
Diameter			
Material and Schedule			
Length			
Joint Type			

	YES/NO*	NOTE NO.
Before unloading:		
• Is the material free from damage?		
After unloading:		
• Was unloading completed without damage?		
• Is the material properly stored?		

NOTES:

*If the answer is no, provide explanatory note, including any remedial steps required.

UST:2208-R6fm

FORM NO. SP-3

ONE FORM FOR EACH DELIVERY

RECEIVING INSPECTION
WIRE ROPE

Project Name ______________ Date ______________
Project No. ______________ Received by ______________
Inspected by ______________ Delivery Slip/Truck No. ______________
Transporter/Supplier ______________
Quantity Delivered ______________ Storage Location ______________

	SPECIFICATION	AS RECEIVED	NOTE NO.
Manufacturer			
Diameter			

	YES/NO*	NOTE NO.
Before unloading:		
• Is the material free from damage?		
After unloading:		
• Was unloading completed without damage?		
• Is the material properly stored?		

NOTES:

*If the answer is no, provide explanatory note, including any remedial steps required.

UST:2208-R6fm

FORM NO. SP-4
Revision No. 1

ONE FORM FOR EVERY THREE TRUCKS

RECEIVING INSPECTION
GRAVEL

Project Name ____________________ Date ____________________

Project No. ____________________ Received by ____________________

Inspected by ____________________

Specification Requirements:

Grain Size Distribution ______________________________

Common Material Name ______________________________

(Gravel rock shall be washed, subrounded, granitic, or basic igneous or quartzitic rock.)

Transporter Supplier	______	______	______
Delivery Slip/Truck No.	______	______	______
Volume per load	______	______	______
Does material visually conform with specifications (e.g. size, shape, rock type, or gradation)?*	______	______	______
Has one 25 pound bulk sample per 100 tons been taken for laboratory testing?*	______	______	______

NOTES:

*If the answer to any of these questions is "no," indicate note number in brackets and provide corresponding explanatory notes.

UST:2208-R6fm

FORM NO. SP-5
Revision No. 1

ONE FORM PER SHIFT WHEN THIS WORK IS DONE

CONSTRUCTION INSPECTION
EMBANKMENT FILL
(FIELD FORM)

Project Name ______________ Date/Time ______________
Project No. ______________ Inspected by ______________
Borrow Area ______________ Max. Dry Density (pcf) ______________
Opt. Moisture (%) ______________

Compaction Equipment ______________

Soil Description ______________

Weather ______________

Volume and Location of Material Placed During Shift ______________

	YES/NO*	NOTE NO.
• Is the fill free of irreducible material larger than 2 inches in any dimension?	____	____
• Is the fill free of a detrimental amount of organic material and organic odor?	____	____
• Is the surface of the area to be filled acceptable (not desiccated or excessively wet)?	____	____
• Is the loose lift thickness 12 inches or less?	____	____
• Has one moisture/density test by nuclear gage been performed for every 500 cubic yards?	____	____

NOTES:

*If the answer is no, provide explanatory note, including any remedial steps required.

UST:2208-R6fm

FORM NO. SP-6

ONE FORM PER SHIFT
WHEN THIS WORK IS DONE

CONSTRUCTION INSPECTION
EMBANKMENT FILL
(FIELD OFFICE FORM)

Project Name ____________________ Date ____________________
Project No. ____________________ Inspected by ____________________
Borrow Area ____________________ Max. Dry Density (pcf) __________
Opt. Moisture (%) __________

Volume and Location of Material Placed During Shift ____________________
____

	YES/NO*	NOTE NO.
• Has one confirmation density and moisture test been performed on the embankment fill?	______	______
• For each nuclear density test, is a running plot of density count versus calculated wet density being kept?	______	______
• Have standard density count and moisture content been recorded daily?	______	______
• Have field density test locations and elevations been plotted and checked?	______	______
• Has surveying been completed to check the thickness and grade of the embankment fill?	______	______

NOTES:

*If the answer is no, provide explanatory note, including any remedial steps required.

UST:2208-R6fm

FORM NO. SP-7
Revision No. 1

ONE FORM PER SHIFT
WHEN THIS WORK IS DONE

CONSTRUCTION INSPECTION
FOUNDATION LAYER
(FIELD FORM)

Project Name ____________________ Date/Time ____________________
Project No. ____________________ Inspected by ____________________
Borrow Area ____________________ Max. Dry Density (pcf) __________
Opt. Moisture (%) __________

Compaction Equipment ____
Soil Description ____
Weather ____________________
Volume and Location of Material Placed During Shift ____________________

	YES/NO*	NOTE NO.
• Is the fill free of irreducible material larger than 2 inches in any dimension?	______	______
• Is the fill free of a detrimental amount of organic material and organic odor?	______	______
• Is the surface of the area to be filled acceptable (not desiccated or excessively wet)?	______	______
• Is the loose lift thickness 12 inches or less?	______	______
• Is the compacted surface smooth and free of rocks?	______	______

NOTES:

*If the answer is no, provide explanatory note, including any remedial steps required.

UST:2208-R6fm

FORM NO. SP-8
Revision No. 1

ONE FORM PER SHIFT WHEN THIS WORK IS DONE.

CONSTRUCTION INSPECTION
FOUNDATION LAYER
(FIELD OFFICE FORM)

Project Name ______________________
Project No. ______________________
Borrow Area ______________________

Date ______________________
Inspected by ______________________
Max. Dry Density (pcf) __________
Opt. Moisture (%) __________

Volume and Location of Material Placed During Shift ______________________

	YES/NO*	NOTE NO.
• Has surveying been completed to check the thickness and grade of the foundation layer?	______	______

NOTES:

*If the answer is no, provide explanatory note, including any remedial steps required.

UST:2208-R6fm

FORM NO. SP-9
Revision No. 1

ONE FORM PER SHIFT WHEN THIS WORK IS DONE

CONSTRUCTION INSPECTION
PROTECTIVE SOIL COVER LAYER
(FIELD FORM)

Project Name ______________________ Date ______________________
Project No. ______________________ Inspected by ______________________
Borrow Area ______________________ Max. Dry Density (pcf) __________
Opt. Moisture (%) __________
Compaction Equipment ______________________
Soil Description ______________________
Weather ______________________
Volume and Location of Material Placed During Shift ______________________

	YES/NO*	NOTE NO.
• Is the soil free of irreducible material larger than 2 inches in any dimension?	______	______
• Is the soil free of any visible organic substance?	______	______
• Is the surface of the area to be filled acceptable (not desiccated or excessively wet)?	______	______
• Does each lift have a minimum compacted thickness of 12 inches?	______	______
• Has one moisture/density test by nuclear gage been performed for every 500 cubic yards of fill?	______	______
• Has the finished surface been rolled smooth with a smooth drum roller?	______	______

NOTES:

*If the answer is no, provide explanatory note, including any remedial steps required.

UST:2208-R6fm

FORM NO. SP-10
Revision No. 1

ONE FORM PER SHIFT
WHEN THIS WORK IS DONE

CONSTRUCTION INSPECTION
PROTECTIVE SOIL COVER LAYER
(FIELD OFFICE FORM)

Project Name ____________ Date ____________
Project No. ____________ Inspected by ____________
Unit No. ____________ Max. Dry Density (pcf) ____________
Borrow Area ____________ Opt. Moisture (%) ____________

Volume and Location of Material Placed During Shift ____________

	YES/NO*	NOTE NO.
• Has one confirmation density and moisture test been performed for the protective soil cover layer?	____	____
• For each nuclear density test, is a running plot of density count versus calculated wet density being kept?	____	____
• Have field density test locations and elevations been plotted and checked?	____	____
• Has surveying been completed to check the thickness and grade of the compacted clay liner?	____	____
• Has the finished surface been rolled smooth with a smooth drum roller?	____	____

NOTES:

*If the answer is no, provide explanatory note, including any remedial steps required.

UST:2208-R6fm

FORM NO. SP-11
Revision No. 1

ONE FORM PER SHIFT WHEN THIS WORK IS DONE

CONSTRUCTION INSPECTION
VEGETATIVE SOIL COVER LAYER
(FIELD FORM)

Project Name ____________ Date ____________
Project No. ____________ Inspected by ____________
Unit No. ____________ Max. Dry Density (pcf) ____________
Borrow Area ____________ Opt. Moisture (%) ____________

Compaction Equipment ____________
Soil Description ____________
Weather ____________
Volume and Location of Material Placed During Shift ____________

	YES/NO*	NOTE NO.
• Is the soil free of irreducible material larger than 2 inches in any dimension?	______	______
• Is the soil free of any visible organic substance?	______	______
• Is the surface of the area to be filled acceptable (not desiccated or excessively wet)?	______	______
• Does each lift have a minimum compacted thickness of 6 inches?	______	______
• Has one moisture/density test by nuclear gage been performed for every 500 cubic yards of fill for the lower lift only?	______	______

NOTES:

*If the answer is no, provide explanatory note, including any remedial steps required.

UST:2208-R6fm

FORM NO. SP-12
Revision No. 1

ONE FORM PER SHIFT WHEN THIS WORK IS DONE

CONSTRUCTION INSPECTION
VEGETATIVE SOIL COVER LAYER
(FIELD OFFICE FORM)

Project Name ____________________ Date ____________________
Project No. ____________________ Inspected by ____________________
Unit No. ____________________ Max. Dry Density (pcf) __________
Borrow Area ____________________ Opt. Moisture (%) __________

Volume and Location of Material Placed During Shift ____________________
____

	YES/NO*	NOTE NO.
• Has one confirmatory density and moisture test been performed for every 500 cubic yards of vegetative soil cover?	______	______
• For each nuclear density test, is a running plot of density count versus calculated wet density being kept?	______	______
• Have field density test locations and elevations been plotted and checked?	______	______
• Has surveying been completed to check the thickness and grade of the vegetative soil cover?	______	______

NOTES:

*If the answer is no, provide explanatory note, including any remedial steps required.

UST:2208-R6fm

FORM NO. SP-13

ONE FORM PER
TEN DENSITY TEST

FIELD DENSITY TEST RESULTS

LOCATION SKETCH

Project Name ____________________

Project No. ____________________

Borrow Area ____________________

Maximum Dry Density (pcf) ____________

Optimum Moisture (%) ______________

Test No.	Approximate N	E	Location Elev.	In Situ Dry Density (pcf)	Percent Compaction	In Situ Water Content (Wc) (%)	Percent Wc Variation	Soil Description

UST:2208-R6fm

FORM NO. SP-14
Revision No. 1

ONE FORM PER SHIFT
WHEN THIS WORK IS BEING DONE

CONSTRUCTION INSPECTION
BENTONITE MAT

Project Name ____________________ Date ____________________
Project No. ____________________ Inspector ____________________
Weather ____________________

Surface Area and Location of Mat Installed During Shift ____________________
____

	YES/NO*	NOTE NO.
• Is the mat free from damage after it is unrolled?	______	______
• Is the mat installed shingle fashion and in a manner that prevents damage to underlying materials?	______	______
• Are the adjoining mats lapped a minimum of 6 inches?	______	______
• Are the mats being covered by the overlying protective soil cover during the same shift?	______	______

NOTES:

*If the answer is no, provide explanatory note, including any remedial steps required.

UST:2208-R6fm

FORM NO. SP-15
Revision No. 1

ONE FORM PER SHIFT
WHEN THIS WORK IS DONE

CONSTRUCTION INSPECTION
NPAT FIELD-FABRICATION AND INSTALLATION

Project Name ____________ Date ____________
Project No. ____________ Inspector ____________
Weather ____________

Quantity and Location of Pipe Installed During Shift ____________

	YES/NO*	NOTE NO.
FIELD-FABRICATION		
• Is the pipe free from defects, dirt, and debris prior to fabrication?	____	____
• Are welds uniform and free of irregularities?	____	____
• Is wire rope advanced with each section of pipe during fabrication?	____	____
• Has a trial run been performed every 50 feet in the presence of the Resident Engineer?	____	____
INSTALLATION		
• Is the pipe installed in a manner that prevents damage to the NPAT?	____	____
• Is backfill placed in 1-foot minimum compacted thickness?	____	____
• Are the layout and location of the installed pipe in accordance with drawings?	____	____
• Have two nuclear density tests been performed for every 20 feet of NPAT trench (one on native soil and one on trench backfill)?	____	____
- Is the relative density of the backfill equal to or greater than that of the native soil?	____	____

NOTES:

*If the answer is no, provide explanatory note, including any remedial steps required.

UST:2208-R6fm

FORM NO. SP-16
Revision No. 1

CONSTRUCTION INSPECTION
PVC LINER PLACEMENT

ONE FORM PER 5 PANELS

PROJECT NAME ____________ UNIT NO. ____________

PROJECT NUMBER ____________ INSPECTOR ____________ DATE ____________

WEATHER ____________

PANEL NUMBER ________ ________ ________ ________ ________

ROLL NUMBER ________ ________ ________ ________ ________

	YES/NO*	NOTE NO.	YES/NO*	NOTE NO.	YES/NO*	NOTE NO.	YES/NO*	NOTE NO.	YES/NO*	NOTE NO.
o Are all personnel wearing shoes that do not damage the liner?										
o Is the liner subgrade free from debris or protrusions?										
o Does the method used to unroll the panel prevent damage to the panel or underlying materials?										
o Is the panel uniform in appearance and free from defects?										
o Is the panel rectangular?										
o Is the anchor trench constructed according to the dimensions shown on the drawings (if necessary)?										
o Is the liner properly placed in the anchor trench and adequately anchored (if necessary)?										
o Is the anchor trench free of debris prior to placing the backfill (if necessary)?										
o Are sand bags being properly used to prevent movement or uplift of panel?										
o Are sand bags of adequate strength and tied properly to prevent breakage and spillage?										
o Are the panels installed in accordance with the approved panel layout plan?										
o Have the panel and roll identification numbers been marked on the panel?										
o Has an as-built panel layout been prepared?										

NOTES

*If the answer is no, provide explanatory note, including any remedial steps required.

FORM NO. SP-17
Revision No. 1

CONSTRUCTION INSPECTION
PVC LINER - SEAMING

ONE FORM PER 5 SEAMS

PROJECT NAME ______________ DATE ______________ DATE ______________

PROJECT NUMBER ______________ INSPECTOR ______________ WEATHER ______________

SEAM NO.										
SEAMER ID										
o Which synthetic liner is being installed?										
	YES/NO*	NOTE NO.	YES/NO*	NOTE NO.	YES/NO*	NOTE NO.	YES/NO*	NOTE NO.	YES/NO*	NOTE NO.
o Is a minimum 3-inch overlap provided between panels?										
o Is the seam overlap clean?										
o Is the adhesive uniformly applied?										
o Is excess adhesive wiped up?										
o Is the seam extended to the end of the PVC panels at top of slope?										
o Does each roll stock of the panels to be seamed conform to a thickness of 40 mils $\pm 10\%$?										

NOTES

*If the answer is no, provide explanatory note, including any remedial steps required.

UST:2208-R6frm

FORM NO. SP-18
Revision No. 1

CONSTRUCTION INSPECTION
PVC LINER - AIR LANCE FIELD TESTING
OF FACTORY-FABRICATRED SEAMS

PROJECT NAME ____________ PROJECT NO. ____________ UNIT NO. ____________

SEAM NO. ____________ SEAM LENGTH ____________ DATE ____________

TYPE OF FIELD TEST ____________ TEST PERSONNEL ID ____________ INSPECTOR ____________

FIELD TESTING UNIT ID ____________ WEATHER ____________

CHECKS TO BE MADE PRIOR TO TESTING	YES/NO*	NOTE NO.
Is the air pressure a minimum of 80 psi at the compressor?	______	______
Is the diameter of the lance orifice 3/16 inch?	______	______
Have all the defects detected been marked on the panel and recorded on the following table?	______	______
After repairing all defects, have the defects been successfully retested?	______	______

RETEST	YES/NO*	NOTE NO.
After a successful retest of a repair, has the inspector initialed and dated the repair on the panel and recorded it on the following table?	______	______

DEFECT ID	TYPE OF REPAIR/DATE	TYPE OF RETEST	DATE	REMARK

SUMMARY	YES/NO*	NOTE NO.
Is the seam 100-percent tested?	______	______
Have total number of defects been marked on the end of the seam?	______	______
Have all defects been repaired and successfully retested?	______	______
Is a seam sample required for testing? (Minimum one sample per 500 feet of seam length required. Include details on the following table.)	______	______

SEAM SAMPLE ID	ROLL ID	DATE SAMPLED	DATE PATCHED

NOTES:

*If the answer is no, provide explanatory note, including any remedial steps required.

UST:2208-R6frm

FORM NO. SP-19
Revision No. 1

ONE FORM PER SHIFT
WHEN THIS WORK IS DONE

CONSTRUCTION INSPECTION
GEOCOMPOSITE

Project Name ________________ Date ________________
Project No. ________________ Inspector ________________
Weather ________________

Surface Area and Location Covered During Shift ________________

	YES/NO*/NA	NOTE NO.
• Is the geocomposite installed in a manner that prevents damage to underlying materials?	______	______
• Is the geocomposite free from damage, dirt, and debris?	______	______
• Is the geocomposite installed over a clean subgrade?	______	______
• Are the adjoining sides and ends of geocomposite net tied together and lapped according to the specifications?	______	______
• Is the geocomposite anchored in the liner anchor trench at top of slope (if applicable)?	______	______

NOTES:

*If the answer is no, provide explanatory note, including any remedial steps required.

UST:2208-R6fm

FORM NO. SP-20
Revision No. 1

ONE FORM PER SHIFT
WHEN THIS WORK IS DONE

CONSTRUCTION INSPECTION
GRAVEL

Project Name ______________ Date ______________
Project No. ______________ Inspector ______________
Weather ______________

Surface Area and Location Covered During Shift ______________

	YES/NO*	NOTE NO.
• Is the granular fill installed in a manner that prevents damage to underlying materials?	____	____
• Is the granular fill installed over a clean subgrade?	____	____
• Is the granular fill installed to the lines and grade shown on the drawings?	____	____

NOTES:

*If the answer is no, provide explanatory note, including any remedial steps required.

UST:2208-R6fm

FORM NO. SP-21
Revision No. 1

ONE FORM PER SHIFT WHEN THIS WORK IS DONE

CONSTRUCTION INSPECTION
GEOTEXTILE

Project Name ____________ Date ____________
Project No. ____________ Inspector ____________
Weather ____________
Surface Area and Location Covered During Shift ____________

	YES/NO*	NOTE NO.
• Is the geotextile installed in a manner that prevents damage to underlying materials?	______	______
• Is the geotextile free from defects, dirt, and debris?	______	______
• Is the geotextile installed with a minimum 12-inch overlap of adjoining sheets?	______	______

NOTES:

*If the answer is no, provide explanatory note, including any remedial steps required.

UST:2208-R6fm

APPENDIX
F

APPENDIX F

"TESTING ON THE CAPABILITIES OF CLAYMAX AND COMPACTED CLAY LINERS", GEOSERVICES, INC. CONSULTING ENGINEERS, NORCROSS, GEORGIA, NOVEMBER 29, 1988

Testing On The Capabilities Of
CLAYMAX And COMPACTED CLAY LINERS

by

GeoServices Inc. Consulting Engineers
5950 Live Oak Parkway, Suite 330
Norcross, Georgia 30093

29 November 1988

If you require additional information, please contact:

The Soil Stabilization Products Company
P.O. BOX 2779, MERCED, CA 95344 (209) 383-3296 TELEX 171598 AAA COM SUVL
FAX NUMBER (209) 383-7849

4. ADVECTIVE FLOW: A COMPARISON BETWEEN CLAYMAX AND COMPACTED SOIL LINERS

4.1 Introduction

Advection is the process by which solutes are transported in response to a hydraulic gradient. The solutes are transported at an average rate equal to the seepage velocity, v_s, given by a modified form of Darcy's equation:

$$v_s = \frac{Ki}{n} \qquad \text{(Equation 1)}$$

where: v_s = seepage velocity; K = hydraulic conductivity; n = total porosity of the soil; and i = hydraulic gradient.

The analysis presented in this section compares the rate of advective flow of a nonreacting solute through a compacted clay layer and CLAYMAX. The analysis assumes one-dimensional, steady-state flow. The notation used in the analysis is as follows:

- h_w = head of liquid on top of liner (ft or m);
- v_c = seepage velocity through CLAYMAX (ft/s or m/s);
- K_c = hydraulic conductivity of CLAYMAX (cm/s or m/s);
- D_c = thickness of CLAYMAX (ft or m);
- n_c = porosity of CLAYMAX (dimensionless);
- i_c = hydraulic gradient of CLAYMAX (dimensionless), given by:

$$i_c = (h_w + D_c)/D_c \qquad \text{(Equation 2)}$$

- v_s = seepage velocity through compacted clay layer (ft/s or m/s);
- K_s = hydraulic conductivity of compacted clay layer (cm/s or m/s);
- D_s = thickness of compacted clay layer (ft or m);
- n_s = porosity of compacted clay layer (dimensionless); and
- i_s = hydraulic gradient of compacted clay layer (dimensionless), given by:

$$i_s = (h_w + D_s)/D_s \qquad \text{(Equation 3)}$$

If it is assumed that Darcy's equation is valid, the steady-state flow rate through a compacted clay liner, q_s, may be computed as follows:

$$q_s = K_s i_s A \qquad \text{(Equation 4)}$$

where: A = the cross-sectional area of flow (ft^2 or m^2). Similarly, the steady-state flow rate through a CLAYMAX liner is given by:

$$q_c = K_c i_c A \qquad \text{(Equation 5)}$$

4.2 Seepage Velocity

The seepage velocity, given by Equation 1, is a function of the hydraulic conductivity of the clay or CLAYMAX, the porosity of the clay or CLAYMAX, and the hydraulic gradient acting on the clay or CLAYMAX.

GeoServices has recently measured the hydraulic conductivity of CLAYMAX. The tests were carried out in a flexible wall permeameter with an aqueous sodium solution as the permeant. A hydraulic conductivity of

2×10^{-10} cm/s was obtained. This value of hydraulic conductivity is lower than the hydraulic conductivity of compacted clay layers and also lower than the maximum hydraulic conductivity of 10^{-7} cm/s allowed by USEPA regulations for hazardous waste regulations (40 CFR 264). Based on Equation 1, for an equal hydraulic gradient and cross-sectional area of flow, the lower hydraulic conductivity of CLAYMAX results in a lower advective seepage velocity than that for compacted clay. For a given hydraulic head, however, the hydraulic gradient acting on CLAYMAX will be higher than the hydraulic gradient acting on a compacted clay. This is because CLAYMAX is relatively thin: the difference in hydraulic head across CLAYMAX must be dissipated over a shorter distance than for compacted clay.

The higher hydraulic gradient of CLAYMAX acts to counteract the beneficial effect of its lower hydraulic conductivity, especially at higher values of h_w. At low hydraulic heads, the difference in hydraulic gradient between a compacted clay and CLAYMAX becomes small, and the seepage velocity is primarily a function of the hydraulic conductivities of the two materials.

4.3 Comparison of Seepage Velocity

If it is assumed that advective flow is the only mechanism contributing to leachate migration through a liner, CLAYMAX would provide equivalent performance to a compacted clay layer if the advective seepage velocities through the two materials were equal. This can be expressed by the equation:

$$v_s = v_c \qquad \text{(Equation 6)}$$

Substituting the appropriate terms into Equations 1 and 6, and assuming $n_s = n_c$:

$$K_s i_s = K_c i_c \qquad \text{(Equation 7)}$$

Substituting Equations 2 and 3 into Equation 7 yields:

$$K_s \; (D_s + h_w)/D_s = K_c \; (D_c + h_w)/D_c \qquad \text{(Equation 8)}$$

Solving this equation for D_s results in:

$$D_s = \frac{h_w}{\frac{K_c}{K_s}\left[\frac{D_c + h_w}{D_c}\right] - 1} \qquad \text{(Equation 9)}$$

This equation is interesting in that it shows that under steady-state conditions, the required compacted clay layer thickness, D_s, can become very large to obtain equivalency with CLAYMAX. In fact, the equation shows that for a given ratio of K_c/K_s, there is a hydraulic head below which the steady-state seepage velocity of compacted clay will be larger than the advective seepage velocity of CLAYMAX, no matter what the thickness of the compacted clay. Inspection of Equation 9 shows that as the denominator approaches zero, D_s approaches infinity, so that an infinite thickness of compacted clay is required to give a seepage velocity equal to that of CLAYMAX. Solving for the point at which the denominator of Equation 9 equals zero gives the following result:

$$h_w = D_c \; (K_s/K_c - 1) \qquad \text{(Equation 10)}$$

Any value of hydraulic head on the liner less than or equal to the value of h_w obtained from Equation 10 results in a lower steady-state seepage velocity through CLAYMAX than through any thickness of compacted clay liner. Figure 2 illustrates this result.

For values of h_w greater than that given by Equation 10, Equation 9 can be solved for the required thickness of compacted clay, D_s, to obtain a compacted clay steady-state seepage velocity equal to the steady-state seepage velocity in CLAYMAX. The results of these calculations are presented in Figure 3.

Typical numerical results from Figure 3 are given in the table below:

EQUIVALENT DEPTH OF SOIL

K_c (cm/s)	K_s (cm/s)	h_w (m)	D_c (m)	D_s (m)
10^{-9}	10^{-8}	.10	0.01	1.00
10^{-10}	10^{-8}	1.00	0.01	100.00
10^{-10}	10^{-7}	10.00	0.01	10000.00

4.3 Breakthrough Time

Breakthrough time is defined as the time required for a drop of leachate entering a layer of compacted soil or CLAYMAX to pass through the layer and into the surrounding environment. The analysis presented in this section is conducted using the assumption of one-dimensional steady-state flow conditions. For this case, the breakthrough time is equal to the thickness of the liner divided by the steady-state seepage velocity.

To find the depth of soil needed to provide a breakthrough time equal to that of CLAYMAX, the following equation applies:

$$D_s/v_s = D_c/v_c \qquad \text{(Equation 11)}$$

Substituting Equations 1, 2, and 3 into Equation 11, and assuming $n_s = n_c$ gives:

$$\frac{D_s^2}{K_s\,(h_w + D_s)} = \frac{D_c^2}{K_c\,(h_w + D_c)} \qquad \text{(Equation 12)}$$

Solving this equation in a dimensionless form results in:

$$D_s/D_c = \frac{K_s}{2K_c}\left(\frac{1}{h_w/D_c + 1}\right) + \left[\frac{1}{4}\left(\frac{K_s}{K_c}\right)^2\left(\frac{1}{(h_w/D_c)^2+2h_w/D_c+1}\right) + \left(\frac{K_s}{K_c}\right)\left(\frac{1}{1+D_c/h_w}\right)\right]^{1/2}$$

(Equation 13)

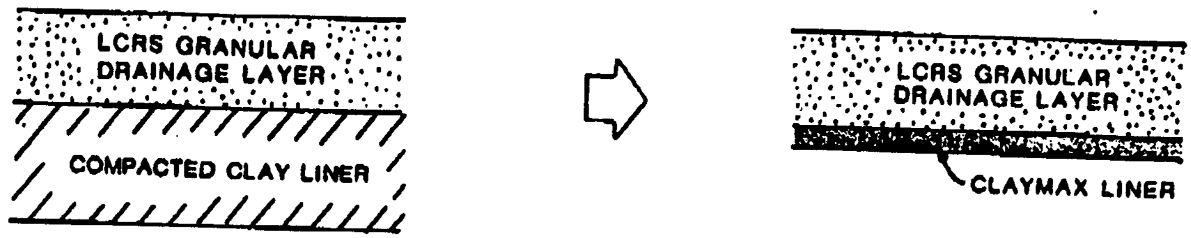
Calculations have been carried out using Equation 13 and a range of ratios of hydraulic conductivities. The calculation results are shown in Figure 4. The figure shows that Equation 13 is bounded asymptotically at low hydraulic heads by the ratio of K_s/K_c; for example, for $K_s/K_c = 100$, at low hydraulic heads the compacted clay must be 100 times thicker than CLAYMAX to provide an equal breakthrough time. For larger hydraulic heads, the required depth of compacted clay decreases.

Numerical results provided by Figure 4 are given in the table below:

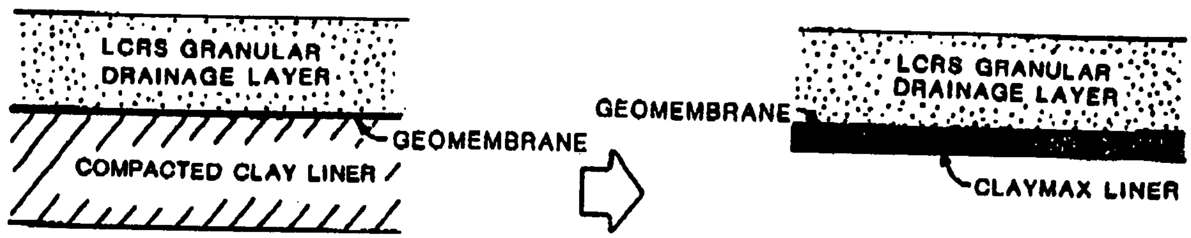
EQUIVALENT DEPTH OF SOIL FOR BREAKTHROUGH TIME

K_c (cm/s)	K_s (cm/s)	h_w (m)	D_c (m)	D_s (m)
10^{-9}	10^{-8}	.01	0.1	0.035
10^{-9}	10^{-7}	.01	1×10^{-4}	0.99
10^{-10}	10^{-7}	.01	0.01	5.01

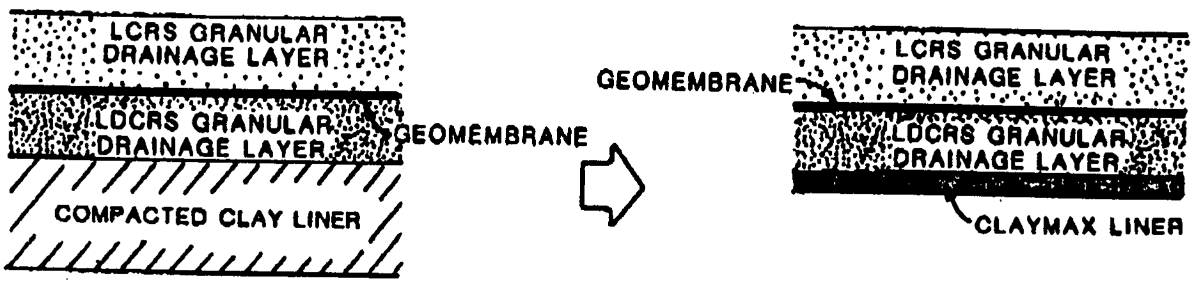
USES FOR CLAYMAX



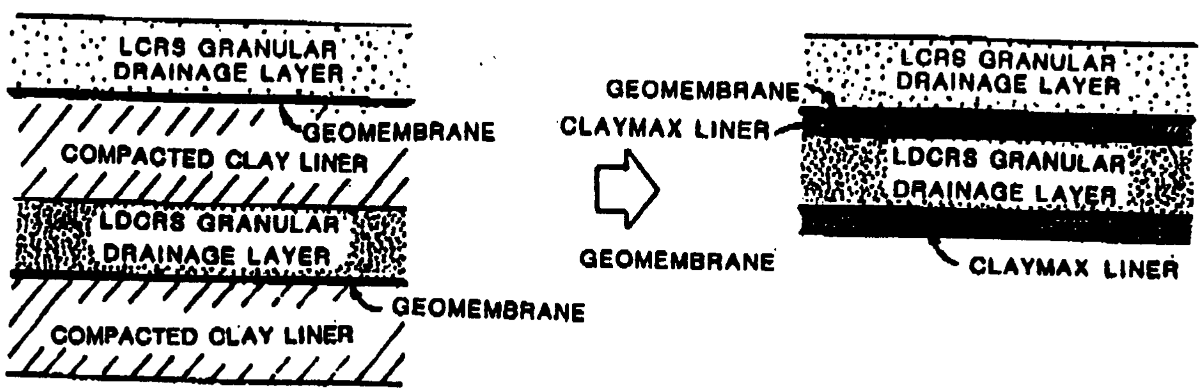
SINGLE LINER SYSTEM



SINGLE COMPOSITE LINER SYSTEM



DOUBLE LINER SYSTEM



DOUBLE COMPOSITE LINER SYSTEM

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FIGURE NO.	1
PROJECT NO.	P1061
DOCUMENT NO.	
PAGE NO.	

LIMITING HYDRAULIC HEAD AT WHICH STEADY-STATE SEEPAGE VELOCITIES THROUGH CLAY WILL ALWAYS EXCEED THOSE THROUGH CLAYMAX (ADVECTION ONLY)

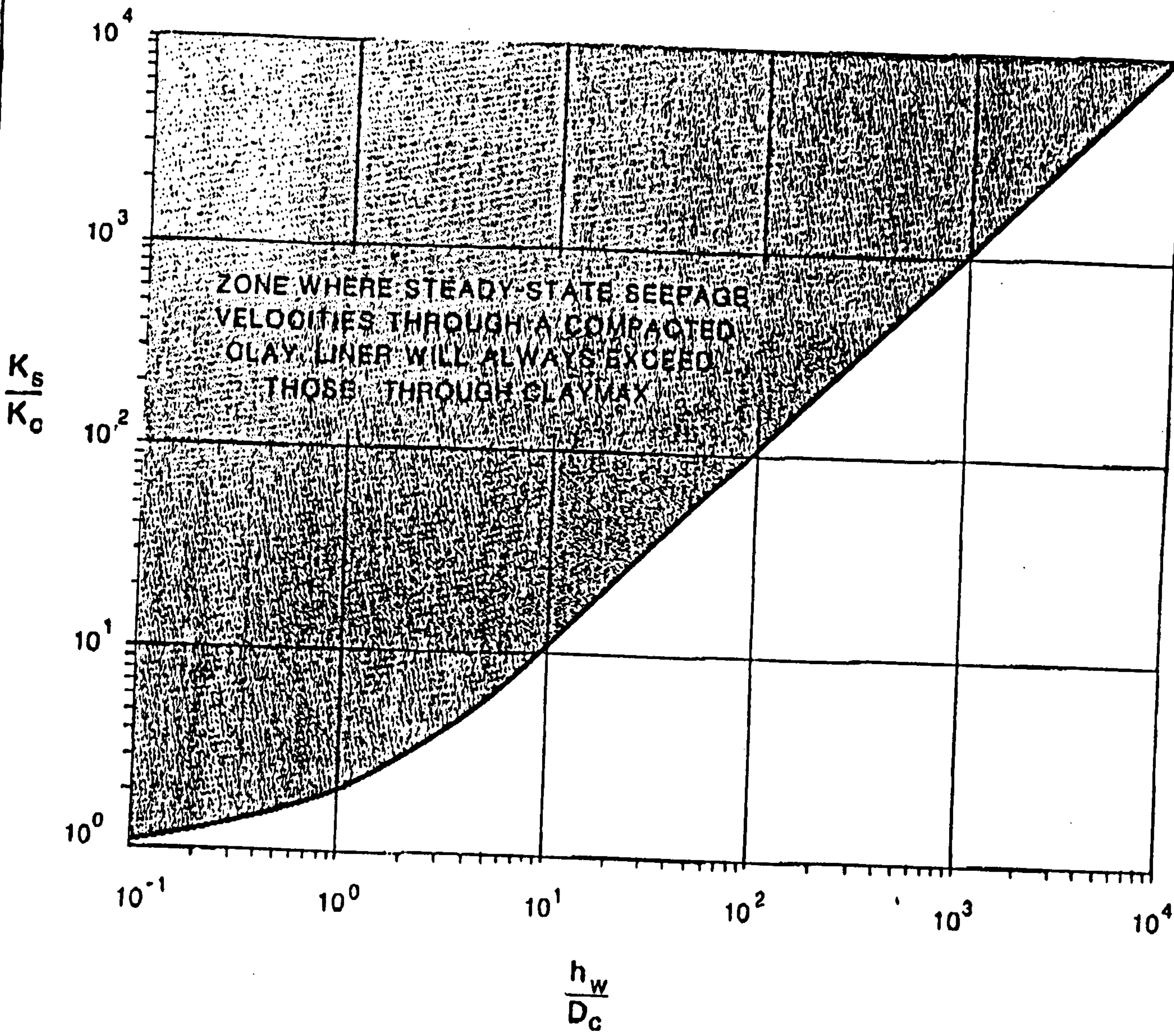

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FIGURE NO.	2
PROJECT NO.	P1061
DOCUMENT NO.	
PAGE NO.	

DEPTH OF COMPACTED CLAY REQUIRED FOR EQUAL STEADY-STATE SEEPAGE VELOCITY (ADVECTION ONLY)

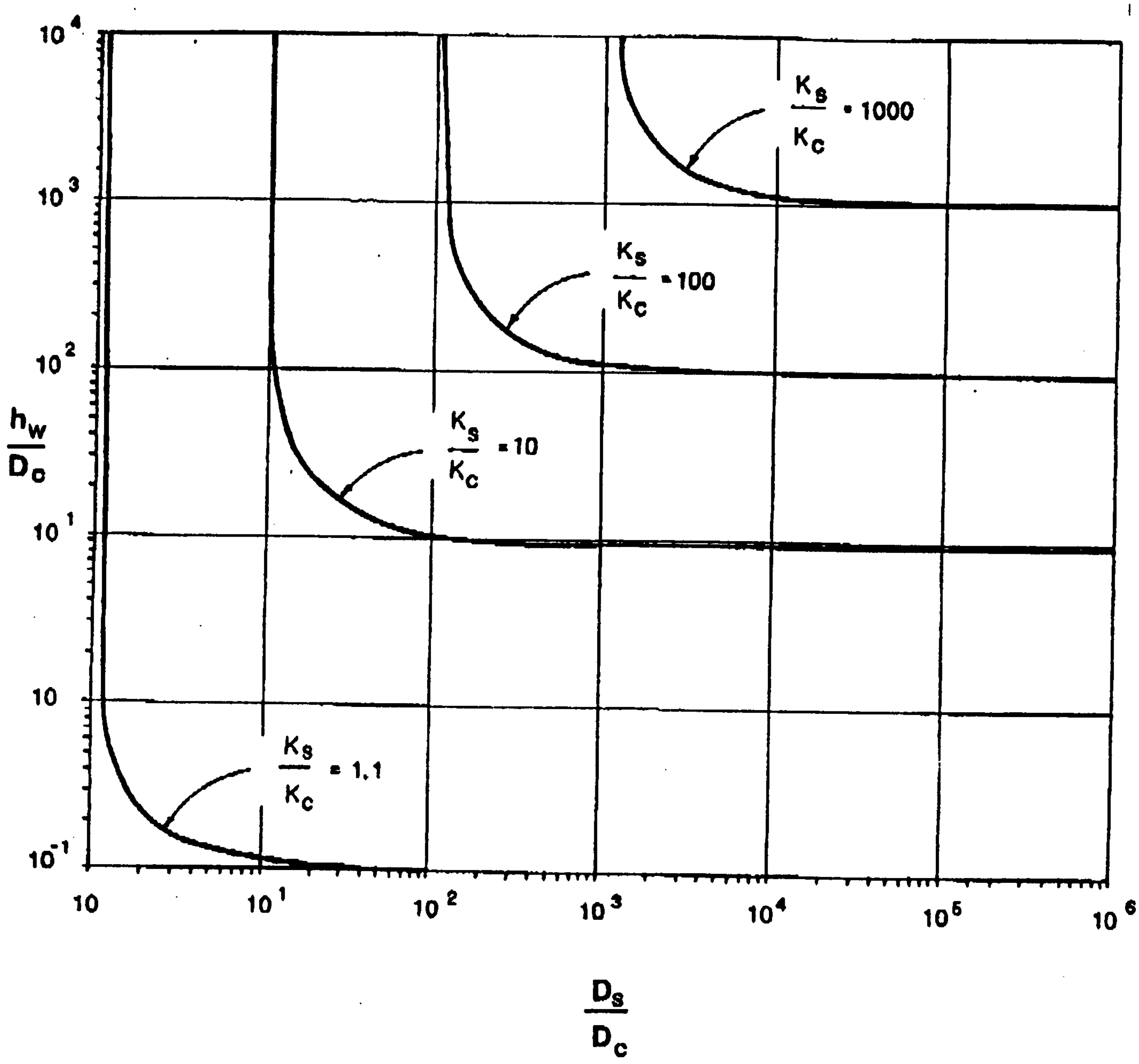

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FIGURE NO.	3
PROJECT NO.	P1061
DOCUMENT NO.	
PAGE NO.	

DEPTH OF COMPACTED CLAY REQUIRED FOR EQUAL STEADY-STATE BREAKTHROUGH TIME (ADVECTION ONLY)

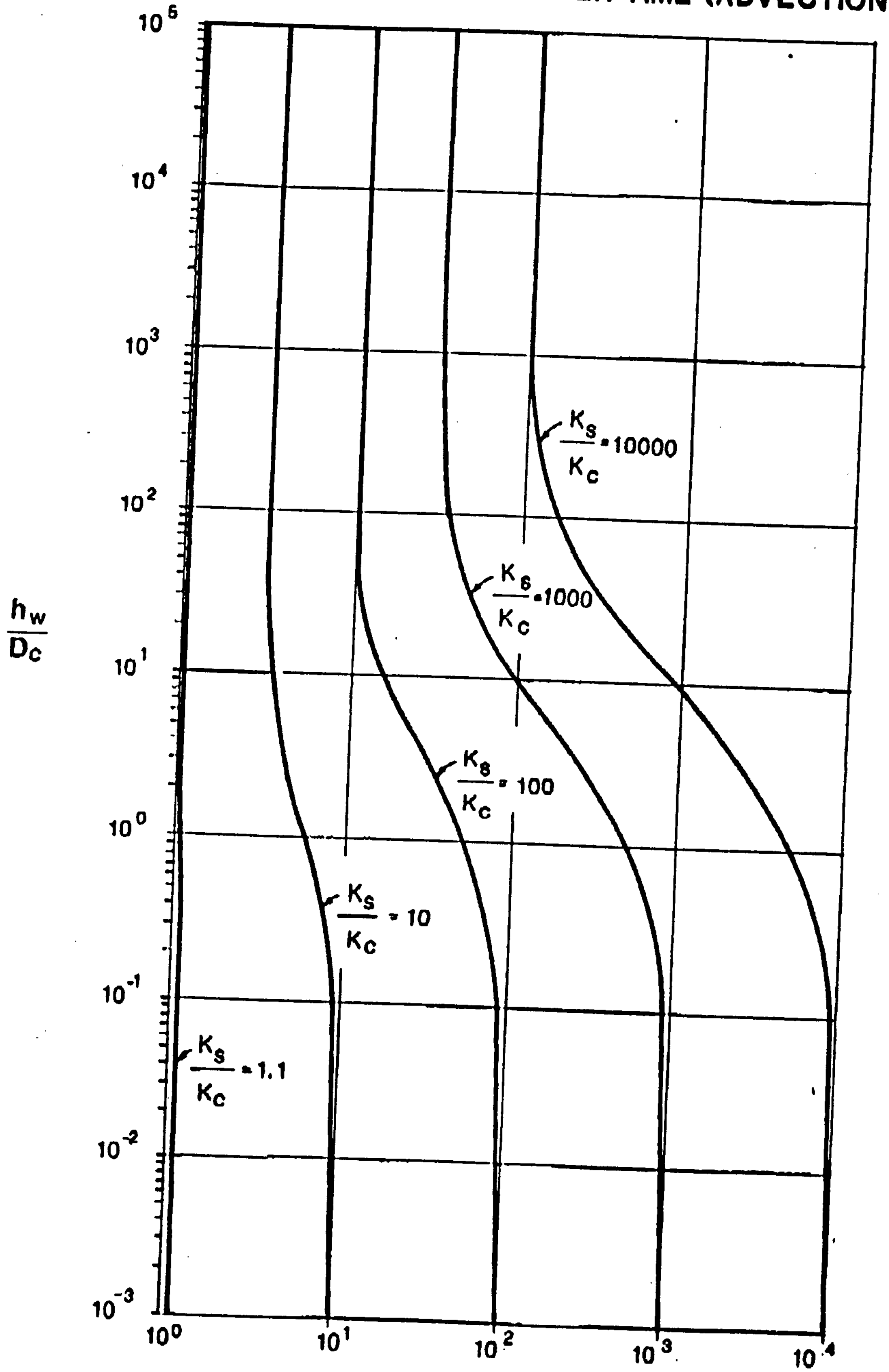

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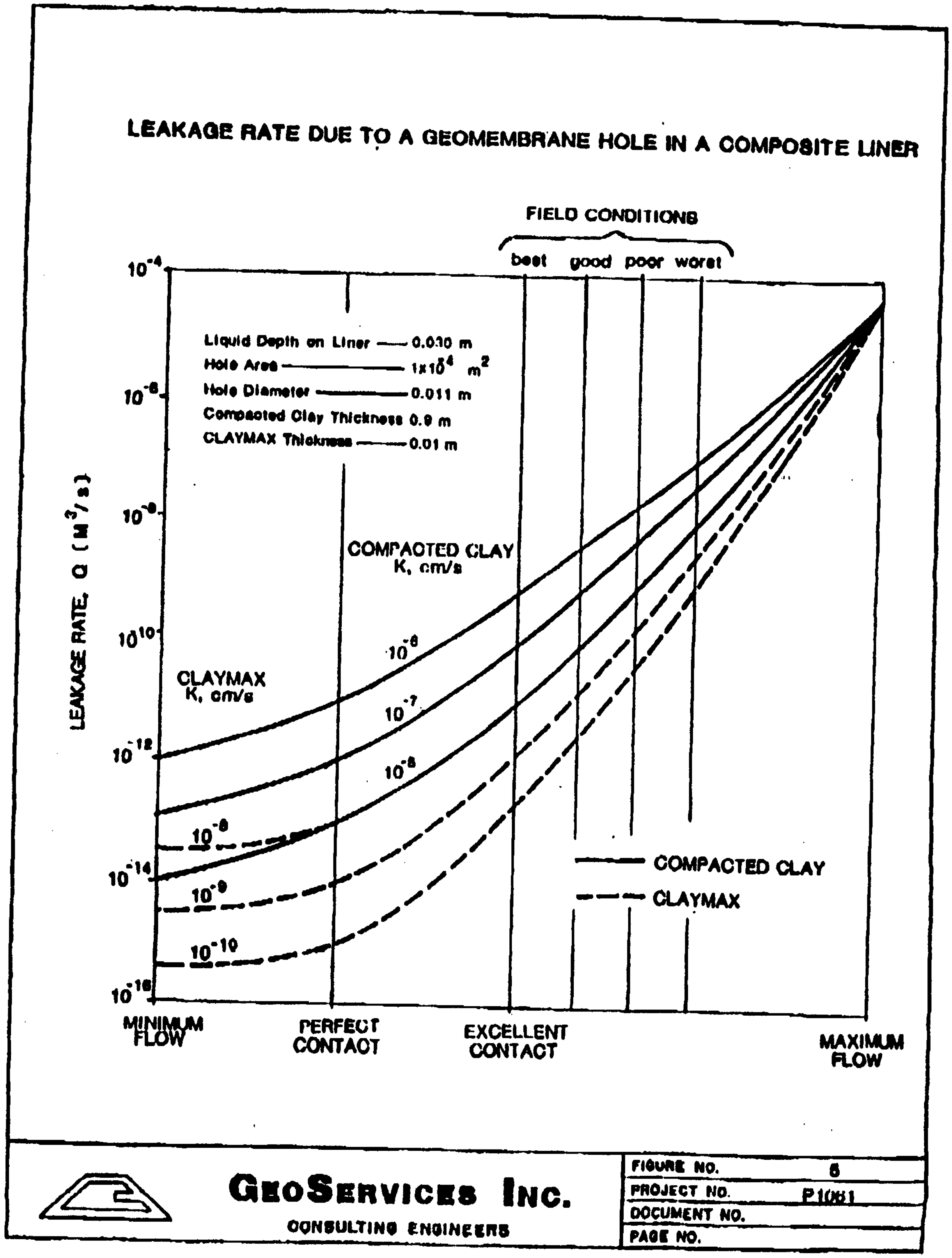
FIGURE NO.	4
PROJECT NO.	P1061
DOCUMENT NO.	
PAGE NO.	

As shown in Figure 5, for the range of hydraulic conductivities which can be expected for compacted clay and CLAYMAX, the steady-state rate of leachate migration due to advection through composite liners underlain with CLAYMAX are in general several orders of magnitude lower than those associated with composite liners underlain with a layer of compacted clay.



APPENDIX G

APPENDIX G

CALCULATION - PERFORMANCE COMPARISON OF CLAYMAX AND COMPACTED CLAY LINER

INTERNATIONAL TECHNOLOGY CORPORATION

(1)

By H.H.H Date 8/9/89 Subject Southern Pacific Transportation Sheet No. 1 of 2
Chkd. By WY Date 8/10/89 Coalinga Proj. No. 202208
0.5cm. X 0.5cm.

Calculations for Performance Comparison of Claymax and Compacted Clay Liner

Objective : To obtain the equivalent thickness of a compacted clay liner for equal steady-state seepage velocity and breakthrough time using Claymax.

Reference : 1) Geo Services Inc. Consulting Engineers. Norcross, Georgia "Testing on the Capabilities of Claymax and Compacted Clay liners", November 29, 1988 (Figures Attached)

Parameters:

D_s = Thickness of Compacted Clay.

k_s = Hydraulic conductivity of compacted clay
= 1×10^{-6} cm/s (prescriptive).

h_w = Head of liquid on top of liner.

D_c = Thickness of Claymax = 0.25 inch.

K_c = Hydraulic conductivity of Claymax
= 2×10^{-10} cm/s (Ref. 1)

Assumption = Because the Claymax or Clay liner will be covered with one-foot protective soil cover, 9 inches of gravel and another one-foot of vegetated soil cover, and graded to promote drainage and prevent ponding, the maximum head of liquid will be equal to the total overlying thickness. This conservatively assumes that the drainage layer is not functioning and that the synthetic liner is permeable.

$\therefore h_w$ = 12 inches (soil cover) + 9 inches (gravel) + 12 inches (soil cover)
= 33 inches

Calculation for Performance Comparison of Claymax and Compacted Clay Liner

Calculation :

$$\frac{K_s}{K_c} = \frac{1 \times 10^{-6}}{2 \times 10^{-10}} = 5,000$$

$$\frac{K_w}{D_c} = \frac{33}{0.25} = 132$$

SEEPAGE VELOCITY

See figure 2 of Appendix G (Ref. 1)

* Based on the above, the figure indicates that the seepage velocities through the compacted clay liner will always exceed those through Claymax regardless of the thickness of the compacted clay liner.

BREAKTHROUGH TIME

See figure 4 of Appendix G (Ref. 1)

$$\frac{D_s}{D_c} = 80$$

$D_s = 80 \times 0.25 = 25$ inches

LIMITING HYDRAULIC HEAD AT WHICH STEADY-STATE SEEPAGE VELOCITIES THROUGH CLAY WILL ALWAYS EXCEED THOSE THROUGH CLAYMAX (ADVECTION ONLY)

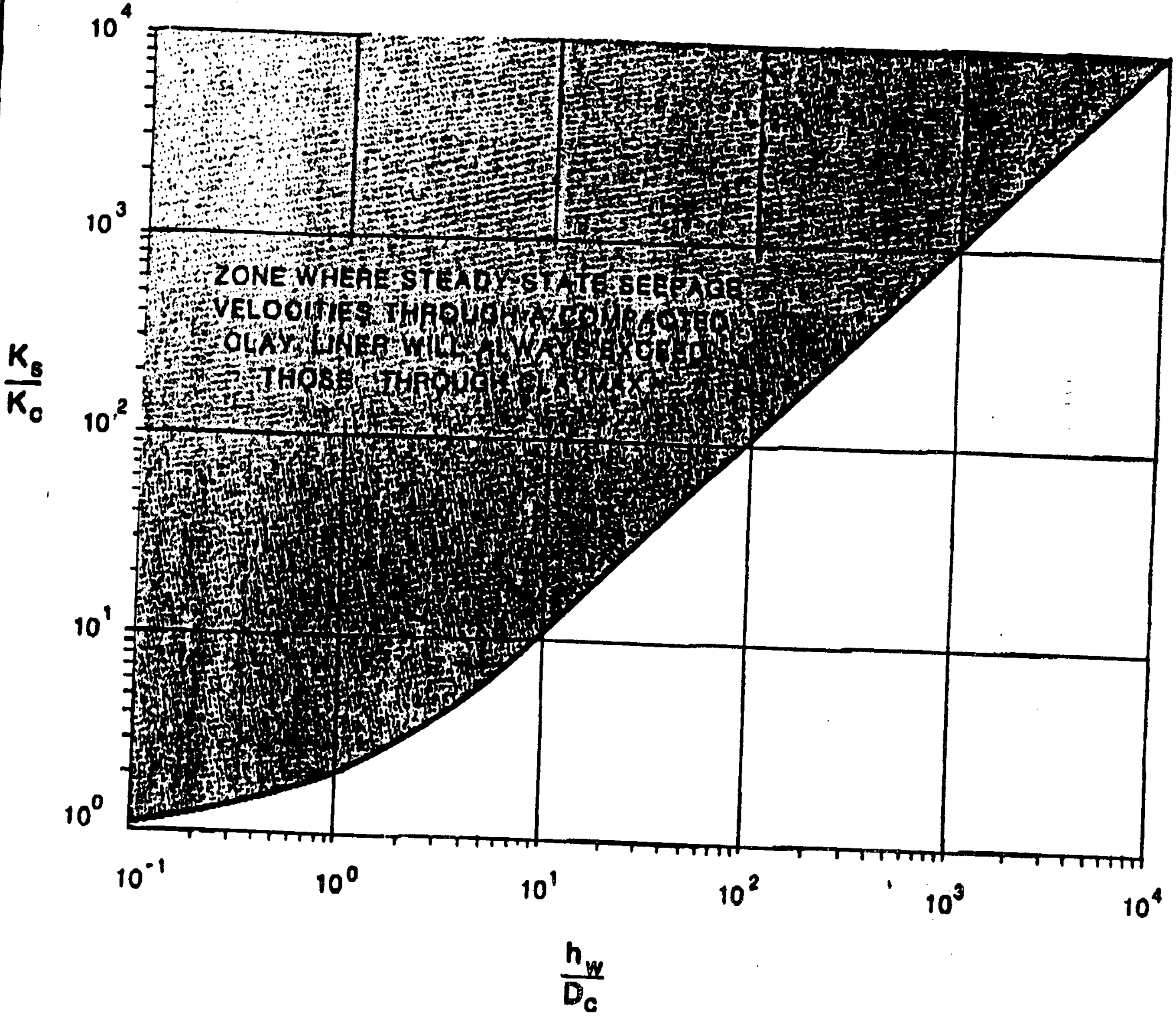


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FIGURE NO.	2
PROJECT NO.	P1061
DOCUMENT NO.	
PAGE NO.	

DEPTH OF COMPACTED CLAY REQUIRED FOR EQUAL STEADY-STATE BREAKTHROUGH TIME (ADVECTION ONLY)

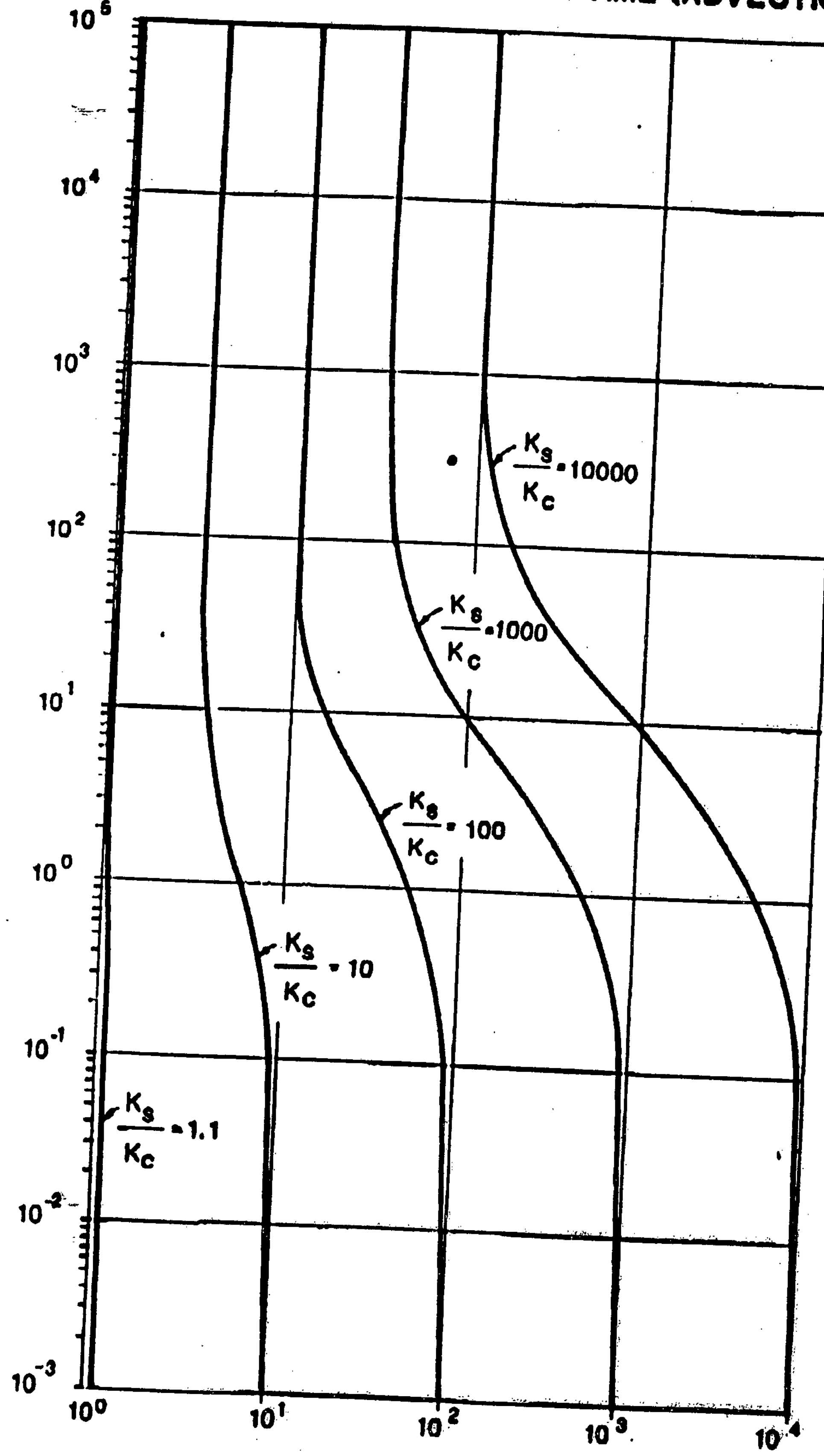

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FIGURE NO.	4
PROJECT NO.	P1061
DOCUMENT NO.	
PAGE NO.	

APPENDIX
H