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XTO ENERGY, INC.

2/8/2017

GEOTECHNICAL EVALUATION
KOCH EXPLORATION POND NO. 2
NORTHWEST 1/4 of SECTION 26
TOWNSHIP 32 NORTH, RANGE 9 WEST, N.M.P.M.
SAN JUAN COUNTY, NEW MEXICO

AGRA JOB NO. C94-9765

Submitted To:

Frank Liner Fabrications, Inc.
1507 Schofield Lane
Farmington, New Mexico

Submitted By:

AGRA Earth & Environmental, Inc.
2060 Afton Place
Farmington, New Mexico 87401

December 13, 1994

AGRA
Earth & Environmental

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2060 Afton Place
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Tel (505) 327-7928
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December 13, 1994
AGRA Job No. C94-9765

Frank Liner Fabrications, Inc.
1507 Schofield Lane
Farmington, New Mexico 87401

Attention: Mr. Bob Frank

Re: Koch Exploration Evaporation Pond No. 2
Northwest 1/4 of Section 26, T32N, R9W, N.M.P.M.
San Juan County, New Mexico

Ladies and Gentlemen:

This report presents the results of our geotechnical evaluation for the proposed Koch Exploration Evaporation Pond No. 2 to be constructed in the Northwest 1/4 of Section 26, Township 32 North, Range 9 West, New Mexico Principal Meridian (N.M.P.M.) in San Juan County, New Mexico. Based on our study, the soils underlying the proposed evaporation pond site generally consist of native clayey sand to sandy clay soils overlying moderately weathered sandstone or siltstone. The sandstone weathering was found to decrease with depth. Auger refusal was encountered at two of our borings locations on a layer of cobbles. Groundwater was not encountered on this site.

Based on our findings, knowledge of subsurface conditions in the area and our understanding of the proposed facility to be constructed at this site, it is our opinion that the proposed evaporation pond dikes may be constructed on competent native material by placing engineered fill, comprised of the on-site material, in properly compacted and tested lifts to a maximum height of 15 feet. It is understood that the pond will be fully lined and the inside and outside slopes of the dikes will be constructed at a maximum slope of 3:1 (horizontal to vertical). The pond will be double-lined with an upper layer of 30 mil X-R5 and a lower layer of 30 mil PVC. The liner fabric layers will be separated by 7 ounce (on the pond slopes) to 10 ounce (on the pond bottom) geotextile. The pond lining will be placed to the top of the proposed dikes. It is further understood that the pond will include a leak detection system, allowing continual monitoring of potential leakage of the impounded water into the dike soils or the underlying native soil and rock.

The results of our slope stability analyses for the proposed lined pond dikes is presented as a part of this report. Our analysis resulted in an overall factor of safety greater than 2 for the static stability of the dike slopes. The slope stability analysis was performed for two basic conditions; 1) relatively dry conditions underlying the pond liner system, and 2) assuming that the pond liner system had developed leaks, resulting in saturation of the underlying foundation and embankment soils. Due to the low seismic risk designation of the northwestern portion of New Mexico, dynamic (pseudo-static) analyses were not performed.

We appreciate the opportunity to have provided geotechnical engineering services for this project. We are available for further geotechnical and materials engineering consultation during the design and construction of the project. In order to provide professional continuity to the project, we recommend that AGRA be retained to perform construction observation and materials testing services. If you have any questions about this report, or require additional consultation or services, please contact us.

Respectfully submitted,
AGRA Earth & Environmental, Inc.

KIM M. PRESTON
NEW MEXICO
11871
REGISTERED PROFESSIONAL ENGINEER
12/14/94

G. Alexander Rush, P.E.
Senior Engineer

Reviewed by:

Kim M. Preston, P.E.
Four Corners Area Manager

c: Addressee (8)

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APPENDICES

1.0 INTRODUCTION

The proposed Koch Exploration Evaporation Pond No. 2 will be constructed in the Northwest 1/4 of Section 26, Township 32 North, Range 9 West, N.M.P.M., in San Juan County, New Mexico. We understand that the evaporation pond will be used to dissipate the production water resulting from development of natural gas wells in the area near the site of the evaporation pond.

Our services were performed to provide recommendations for use in design of the proposed dike structures to be constructed around the perimeter of the pond, and in preparing drainage and earthwork guidelines for the project. Results of the field subsurface exploration, laboratory testing, and our conclusions and recommendations are presented in this report.

2.0 PROJECT DESCRIPTION

It is understood that the proposed evaporation pond will have plan dimensions of 285 feet by 285 feet to top inside of the finished dikes and will be about 14 feet deep from top of finished dike elevation. The slopes of the proposed dikes will 3:1 (horizontal to vertical), with a minimum crest width of 12 feet, in accordance with the guidelines provided by the New Mexico State Engineer Office (NMSEO, 1987)*. The plan dimensions of the bottom of the pond, between the toes of the interior dike slopes, will be approximately 195 feet by 195 feet.

It is further understood that the pond will be fully lined and the inside and outside slopes of the dikes will be a maximum of 3:1 (horizontal to vertical). The pond will be double-lined with an upper layer of 30 mil X-R5 and a lower layer of 30 mil PVC. The liner fabric layers will be separated by 7 ounce (on the slopes) to 10 ounce (on the bottom) geotextile. The pond lining will be placed to the top of the proposed dikes. It is further understood that the pond will include a leak detection system, allowing continual monitoring of potential leakage of the impounded water into the dike soils or the underlying native soil and rock.

3.0 SITE DESCRIPTION AND EXISTING CONSTRUCTION

The project site has moderately dense sagebrush, sparse small conifer trees, and other natural vegetation. The site consists of rolling topography, with a maximum elevation differential of approximately 15 feet. The site slopes downward from the northwest corner toward the south and northeast. An area of higher elevation is present near the eastern side of the proposed pond area. The site was surveyed by others, and it was also approved for development by an archeological team, provided by the client, prior to beginning our subsurface exploration. There is a cleared roadway area along the west side of the proposed evaporation pond location.

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*References are listed at the end of this report.

4.0 GEOTECHNICAL EVALUATION

4.1 SUBSURFACE EXPLORATION

Our field subsurface exploration consisted of the excavation and sampling of nine small-diameter borings spaced across the site of the proposed evaporation pond. The spacing of the boring locations was intended to provide a profile of the site subsurface conditions and the geotechnical information necessary to perform slope stability analyses of the proposed dikes. The field exploration was performed using a truck-mounted, CME-55 drill rig utilizing small-diameter, hollow-stem, flight augers. The borings were advanced to depths ranging from about 3 1/2 feet to about 19 1/2 feet. Auger refusal was encountered in borings B-5 and B-8. The approximate locations of the borings are shown on the attached site plan, and detailed descriptions of conditions encountered underlying the site, at our boring locations, are presented on the boring logs in Appendix A of this report. Standard penetration test (SPT), bulk and relatively undisturbed, driven ring samples were obtained at selected depths and transported to our laboratory.

4.2 LABORATORY TESTING

Laboratory testing of representative samples was performed to evaluate in-situ moisture and dry density, grain size distribution (sieve analysis), plasticity index and shear strength parameters of the soils encountered. The results of the laboratory testing are presented in Appendix B.

The soils were classified in general accordance with the Unified Soil Classification System. The soil classification symbols appear on the boring logs and are briefly described in Appendix B of this report.

5.0 SUBSURFACE CONDITIONS

The materials underlying the evaporation pond site generally consist of native clayey sand (SC) to sandy clay (CL) soils overlying moderately weathered sandstone or siltstone. The sandstone weathering was found to decrease with depth. The depth to weathered sandstone or siltstone encountered in the exploratory borings ranged from 6 1/2 to 12 feet below existing grade. It is noted that practical refusal of the drilling equipment, on a layer of cobbles, was encountered in Borings B-5 and B-8 at depths of 3 1/2 and 7 feet, respectively. The consistency of the native clayey sands and sandy clays encountered below the site ranges from soft to very firm. In general, the firmness of the soils increases with depth.

Based on our field observation of the recovered samples and the auger cuttings, the soil moisture contents ranged from slightly damp to damp. The boring logs, presented in Appendix A to this report, provide more detailed descriptions of the subsurface conditions encountered. Groundwater was not encountered on this site.

Due to the potential erosion of the exterior dike slopes, the exposed outside slopes of the dikes may need to be graded smooth and bank protection may need to be installed on all slopes on the site. The expected life of the bank protection should be consistent with the expected life of the project. The chosen bank protection system should prevent erosion of the slopes for the life of the project. Recommendations for bank protection systems can be provided, upon request, when the final site development plans are determined.

6.2 SITE GRADING

6.2.1 Site Preparation

The guidelines presented in the Earthwork section of this report should be used in the site preparation for this project. Further, we recommend that the proposed containment dikes be constructed in accordance with the recommendations contained in this report.

Strip and remove any existing fill, soft, loose, or wet soils, vegetation, and debris for a minimum distance of 5 feet beyond the proposed construction limits. All exposed ground surfaces should be level, and free of mounds and depressions which could inhibit uniform engineered fill placement and compaction.

6.2.2 Excavation

Based on the results of our field subsurface exploration, we anticipate that excavation of the on-site materials may be accomplished with the use of conventional heavy duty excavation equipment in good working order. Ripping of some of the denser materials encountered may be necessary.

We recommend that the geotechnical engineer or his representative observe dike configurations in cut areas prior to placement of the liner system and the dike bearing soils prior to placement of the engineered fill for the dike construction. The purpose of this observation will be to evaluate if the disturbed materials resulting from the excavation have been removed and that the exposed bearing conditions are similar to those anticipated for support of the dikes. Any soft, loose or unacceptable materials should be removed and replaced in accordance with the recommendations contained in this report.

6.2.3 Earth Dike Bearing Surface

Containment dikes should be constructed to bear on competent native material. The base of the dike base should be level for the length and width of the embankment. We have assumed that in the cut areas of the site, the dike configuration will be directly cut into the existing materials. The transition between the cut and fill areas should be a series of level benches to accommodate fill placement.

6.2.4 Placement of Earth Dikes

The engineered fill for construction of the dikes should be placed on a level, competent natural soil surface. The engineered fill should be placed and compacted in accordance with the recommendations in this report. The material excavated from the site should be blended such that the dikes are constructed using a homogeneous material. The slopes for the dike should be over-built and cut back at the slope angle recommended in this report such that the surface of the dike slopes meet the recommended compaction requirements.

6.3 SURFACE DRAINAGE

Positive drainage should be provided such that infiltration of water into the subsurface soils and rock, below the evaporation pond and associated dikes, is prevented during construction and for the life of the facility. Saturation of the soils and rock underlying the proposed evaporation pond could affect the slope stability of the containment dikes.

7.0 LIMITATIONS

The subsurface exploration, laboratory testing, and geotechnical analyses presented in this report have been conducted in general accordance with current engineering practice and standard of care exercised by reputable geotechnical consultants performing similar tasks in the area. No other warranty, either expressed or implied, is made regarding the conclusions, recommendations, and opinions presented in this report. Variations may exist and conditions not observed or described in this report may be encountered during construction. Our conclusions and recommendations are based on an analysis of the observed conditions and apply to the specific project discussed in this report; therefore, any changes in the evaporation pond location or configuration, or site grades should be provided to us so we may review our conclusions and recommendations and make any necessary modifications. If conditions different from those described in this report are encountered, our office should be notified and additional recommendations, if required, will be provided upon request. In the event of any changes in the nature, design, or locations of the proposed improvements, the conclusions and recommendations presented herein may not be valid unless the changes are evaluated and the conclusions of this report are modified in writing.

Our scope of services did not include any environmental assessment or evaluation for the presence or absence of hazardous or toxic materials in the soil, rock, groundwater or air, on, above, or below the surface of this site. Identification of such substances requires alternative exploration techniques and analyses which were beyond the scope of this exploration.

We prepared the report as an aid in design of the proposed project. This report is not a bidding document. Contractors reviewing this report must draw their own conclusions regarding site conditions and specific construction techniques to be used.

Our conclusions and recommendations are based on observation and testing of the earthwork and foundation preparations by a qualified and reputable geotechnical engineer. It would be logical for AGRA Earth & Environmental, Inc. to provide these services since we have prepared this report and are familiar with the project and the field conditions at the site.

Deviations from our recommendations by the plans, written specifications, or field applications shall relieve us of responsibility unless our written concurrence with such deviations has been obtained.

REFERENCES

Achilleos, E., 1988, User Guide for PCSTABL 5M, Joint Highway Research Project, Report JHRP-88/19, Purdue University, West Lafayette, IN.

New Mexico State Engineer Office, 1987, Summary of New Mexico State Engineer Office Procedure on Design Criteria and Safety of Dams, Santa Fe, NM, June 10.

SUBSURFACE EXPLORATION & SAMPLING PROCEDURES

Drilling Equipment

Truck-mounted CME-55 and CME-75 drill rigs powered with industrial engines are used in advancing test borings. The industrial engines are capable of delivering about 6,500 foot-pounds torque to the drill spindle. The spindle is advanced with twin hydraulic rams capable of exerting 12,000 pounds downward force. Drilling through soil or softer rock is performed with 7-1/2 inch O.D., 3-1/4 inch I.D. hollow stem auger or 4-1/2 inch continuous flight auger. Carbide insert teeth are normally used on the auger bits so they can often penetrate rock or very strongly cemented soils which require blasting or very heavy equipment for excavation. Where refusal is experienced in auger drilling, the holes are sometimes advanced with tri-cone gear bits and NX rods using water or air as a drilling fluid.

Test Pit Equipment

Various types of tractor-mounted backhoes are used in the excavation of test pits. Standard, rubber-tired, tractor-mounted backhoes have the capability of excavation to about 12 feet in depth. Extend-a-hoe equipped tractors have the capability of excavation to about 17 feet in depth. For excavation of test pits to greater depths, large track hoe equipment is used. Generally, sampling occurs in test pits to depths up to 8 feet, when the test pits are properly laid back and entering the excavations is safe. Below this depth, the soils in the test pit are profiled and logged by observation from the surface and visual classification of the material removed from the test pit.

Sampling Procedures

Dynamically driven tube samples are usually obtained at selected intervals in the borings by the ASTM D1586 procedures. In most cases, 2 inch O.D., 1-3/8 inch I.D. samplers are used to obtain the standard penetration resistance. "Relatively undisturbed" samples of firmer soils are often obtained with 3 inch O.D. samplers lined with 2.42 inch I.D. brass rings. The driving energy is generally recorded as the number of blows of a 140-pound, 30-inch free fall drop hammer required to advance the samplers in 6-inch increments. However, in stratified soils, driving resistance is sometimes recorded in 2- or 3-inch increments so that soil changes and the presence of scattered gravel or cemented layers can be readily detected and the realistic penetration values obtained for consideration in design. These values are expressed in blows per foot on the logs. "Undisturbed" sampling of softer soils is sometimes performed with thin-wall Shelby tubes (ASTM D1587). Where samples of rock are required, they are obtained by NX diamond core drilling (ASTM D2113). Tube samples are labeled and placed in watertight containers to maintain field moisture contents for testing. When necessary for testing, larger bulk samples are taken from auger cuttings.

To obtain relatively undisturbed samples from test pit excavations, a hand sampler containing three 2.42 inch ID rings is driven into the undisturbed soils at selected depths using a small hand sledge hammer. These samples are sealed in plastic and transported to the laboratory. Larger bulk samples are obtained from the spoils excavated from the test pit.

Continuous Penetration Tests

Continuous penetration tests are performed by driving a 2-inch O.D. blunt nosed penetrometer adjacent to or in the bottom of borings. The penetrometer is attached to 1-5/8 inch O.D. drill rods to provide clearance to minimize side friction so that penetration values are as nearly as possible a measure of end resistance. Penetration values are recorded as the number of blows of a 140-pound, 30-inch free fall drop hammer required to advance the penetrometer in one-foot increments or less.

Boring and Test Pit Records

Drilling operations are directed by our field engineer or geologist, who evaluates soil recovery and prepares boring and test pit logs. Soils are visually classified in accordance with the Unified Soil Classification System (ASTM D2487), with appropriate group symbols being shown on the logs.

DEFINITION OF TERMINOLOGY

Allowable Soil Bearing Capacity	The recommended maximum contact stress developed at the interface of the foundation element and the supporting material.
Backfill	A specified material placed and compacted in a confined area.
Base Course	A layer of specified material placed on a subgrade or subbase.
Base Course Grade	Top of base course.
Bench	A horizontal surface in a sloped deposit.
Caisson	A concrete foundation element cast in a circular excavation which may have an enlarged base. Sometimes referred to as a cast-in-place pier.
Concrete Slabs-on-Grade	A concrete surface layer cast directly upon a base, subbase or subgrade.
Crushed Rock Base Course	A base course composed of crushed rock of a specified gradation.
Differential Settlement	Unequal settlement between or within foundation elements of a structure.
Engineered Fill	Specified material placed and compacted to specified density and/or moisture conditions under observations of a representative of a soil engineer.
Existing Fill	Materials deposited through the action of man prior to exploration of the site.
Existing Grade	The ground surface at the time of field exploration.
Expansive Potential	The potential of a soil to expand (increase in volume) due to absorption of moisture.
Fill	Materials deposited by the actions of man.

DEFINITION OF TERMINOLOGY (continued)

Finished Grade	The final grade created as a part of the project.
Gravel Base Course	A base course composed of naturally occurring gravel with a specified gradation.
Heave	Upward movement.
Native Grade	The naturally occurring ground surface.
Native Soil	Naturally occurring on-site soil.
Rock	A natural aggregate of mineral grains connected by strong and permanent cohesive forces. Usually requires drilling, wedging, blasting or other methods of extraordinary force for excavation.
Sand & Gravel Base	A base course of sand and gravel of a specified gradation.
Sand Base Course	A base course composed primarily of sand of a specified gradation.
Scarify	To mechanically loosen soil or break down existing soil structure.
Settlement	Downward movement.
Soil	Any unconsolidated material composed of discrete soil particles, derived from the physical and/or chemical disintegration of vegetable or mineral matter, which can be separated by gentle mechanical means such as agitation in water.
Strip	To remove from present location
Subbase	A layer of specified material placed to form a layer between the subgrade and base course.
Subbase Grade	Top of subbase.
Subgrade	Prepared native soil surface.

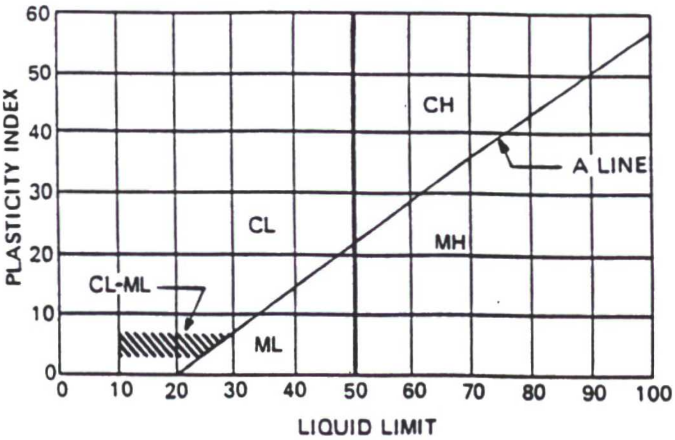
UNIFIED SOIL CLASSIFICATION SYSTEM

Soils are visually classified by the Unified Soil Classification system on the boring logs presented in this report. Grain-size analysis and Atterberg Limits Tests are often performed on selected samples to aid in classification. The classification system is briefly outlined on this chart. For a more detailed description of the system, see "The Unified Soil Classification System" Corp of Engineers, US Army Technical Memorandum No. 3-357 (Revised April 1960) or ASTM Designation: D2487-66T.

MAJOR DIVISIONS				GRAPHIC SYMBOL	GROUP SYMBOL	TYPICAL NAMES
COARSE-GRAINED SOILS (Less than 50% passes No. 200 sieve)	GRAVELS (50% or less of coarse fraction passes No. 4 sieve)	CLEAN GRAVELS (Less than 5% passes No. 200 sieve)			GW	Well graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures.
					GP	Poorly graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures.
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		GM	Silty gravels, gravel-sand-silt mixtures.
			Limits plot above "A" line & hatched zone on plasticity chart		GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (More than 50% of coarse fraction passes No. 4 sieve)	CLEAN SANDS (Less than 5% passes No. 200 seive)			SW	Well graded sands, gravelly sands.
					SP	Poorly graded sands, gravelly sands.
		SANDS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		SM	Silty sands, sand-silt mixtures.
			Limits plot above "A" line & hatched zone on plasticity chart		SC	Clayey sands, sand-clay mixtures.
FINE-GRAINED SOILS (50% or more passes No. 200 sieve)	SILTS (Limits plot below "A" line & hatched zone on plasticity chart)	SILTS OF LOW PLASTICITY (Liquid Limit Less Than 50)			ML	Inorganic silts, clayey silts with slight plasticity.
		SILTS OF HIGH PLASTICITY (Liquid Limit More Than 50)			MH	Inorganic silts, micaceous or diatomaceous silty soils, elastic silts.
	CLAYS (Limits plot above "A" line & hatched zone on plasticity chart)	CLAYS OF LOW PLASTICITY (Liquid Limit Less Than 50)			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		CLAYS OF HIGH PLASTICITY (Liquid Limit More Than 50)			CH	Inorganic clays of high plasticity, fat clays, sandy clays of high plasticity.

NOTE: Coarse grained soils with between 5% & 12% passing the No. 200 sieve and fine grained soils with limits plotting in the hatched zone on the plasticity chart to have double symbol.

PLASTICITY CHART



DEFINITIONS OF SOIL FRACTIONS

SOIL COMPONENT	PARTICLE SIZE RANGE
Cobbles	Above 3 in.
Gravel	3 in. to No. 4 sieve
Coarse gravel	3 in. to ¾ in.
Fine gravel	¾ in. to No. 4 sieve
Sand	No. 4 to No. 200
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Fines (silt or clay)	Below No. 200 sieve

TERMINOLOGY USED TO DESCRIBE THE RELATIVE DENSITY, CONSISTENCY, OR FIRMNESS OF SOILS

The terminology used on the boring logs to describe the relative density, consistency, or firmness of soils relative to the standard penetration resistance is presented below. The standard penetration resistance (N) in blows per foot is obtained by ASTM D1586 procedure using 2 inch O.D., 1-3/8 inch I.D. samplers. Density, consistency and firmness equivalent blows/foot for the California Ring Sampler (3 inch O.D., 2.42 inch I.D.), indicated by CS below, were derived using procedures outlined in the Foundation Engineering Handbook by Winterkorn and Fang (1975).

1. **Relative Density** - Terms for description of relative density of cohesionless, un-cemented sands and sand-gravel mixtures.

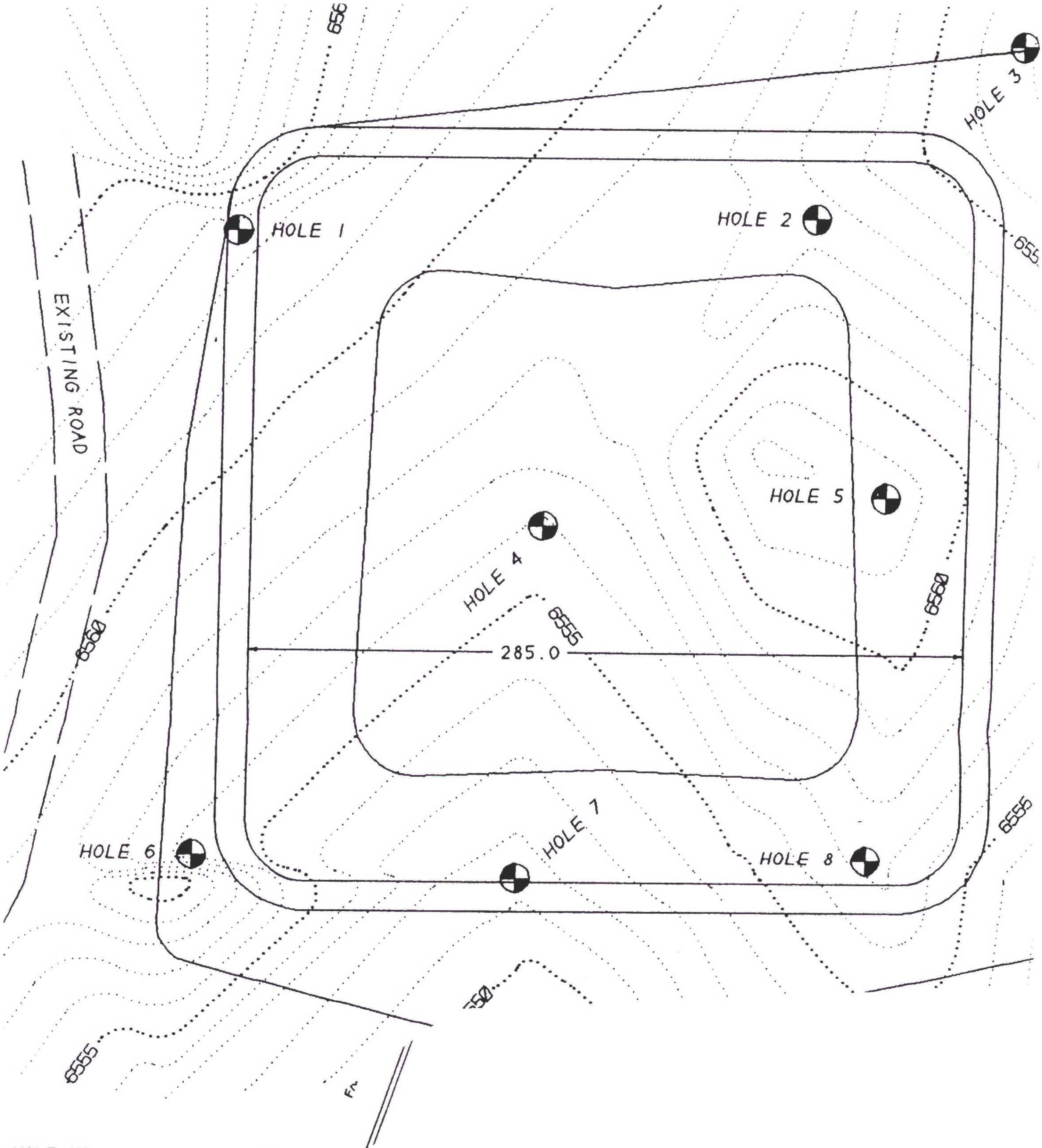
N	CS	Relative Density
0-4	0-8	Very loose
4-10	8-20	Loose
10-30	20-55	Medium Dense
30-50	55-92	Dense
50+	92+	Very Dense

2. **Relative Consistency** - Terms for the description of clays which are saturated or near saturation.

N	CS	Relative Consistency	Remarks
0-2	0-2	Very Soft	Easily penetrated several inches with fist.
2-4	2-5	Soft	Easily penetrated several inches with thumb.
4-8	5-10	Firm	Can be penetrated several inches with thumb with moderate effort.
8-15	10-19	Stiff	Readily indented with thumb, but penetrated only with great effort.
15-30	19-40	Very Stiff	Readily indented with thumbnail.
30+	40+	Hard	Indented only with difficulty by thumbnail.

3. **Relative Firmness** - Terms for the description of partially saturated and/or cemented soils which commonly occur in the Southwest including clays, cemented granular materials, silts and silty and clayey granular soils.

N	CS	Relative Density
0-4	0-4	Very Soft
4-8	4-10	Soft
8-15	10-17	Moderately firm
15-30	17-41	Firm
30-50	41-70	Very firm
50+	70+	Hard


HOLE 1
HOLE 2
HOLE 3
HOLE 4
HOLE 5
HOLE 6
HOLE 7
HOLE 8
EXISTING ROAD
285.0
6560
6555
6555
6560
6555
6555
6550

HOLE NO.

1

2

3

4

PROJECT NAME AND SITE LOCATION	KOCH EXPLORATION EVAPORATION POND, NW 1/4 SECTION 26 T32N, R9W, N.M.P.M., SAN JUAN COUNTY, NEW MEXICO

PROJECT NO.	RIG TYPE	DATE	SHEET	BORING NO.
C94-9765	CME-55	10-13-94	1 OF 1	B-1

BLOWS/FOOT	SAMPLE SYMBOL	DRY DENSITY (PCF)	MOISTURE CONTENT %	UNIFIED CLASSIFICATION	DEPTH IN FEET	DESCRIPTION
				SC		NATIVE: Reddish Brown to Brown, Slightly Damp, Soft, Clayey SAND.
				CL	5	Brown, Slightly Damp, Firm to Very Firm, Sandy CLAY With White Anhydrite and/or Caliche Stringers.
					10	
					15	FORMATION: Gray, Slightly Damp to Damp. Moderately Weathered SILTSTONE.
						Total Depth = 14-1/2 Feet. No Groundwater Encountered. Backfilled With Cuttings.

SUBSURFACE EVALUATION LOG

SAMPLE SYMBOLS: SS = SPLIT SPOON / ST = SHELBY TUBE, 3" O.D. / CS = CALIFORNIA RING SAMPLER, 3" O.D.
MCS = MODIFIED CALIFORNIA RING SAMPLER, 2 3/8" O.D./ AU = AUGER SAMPLE.

PROJECT NAME AND SITE LOCATION: KOCH EXPLORATION EVAPORATION POND, NW 1/4 SECTION 26 T32N, R9W, N.M.P.M., SAN JUAN COUNTY, NEW MEXICO

PROJECT NO.	RIG TYPE	DATE	SHEET	BORING NO.
C94-9765	CME-55	10-13-94	1 OF 1	B-2

BLOWS/FOOT	SAMPLE SYMBOL	DRY DENSITY (PCF)	MOISTURE CONTENT %	UNIFIED CLASSIFICATION	DEPTH IN FEET	DESCRIPTION
				CL		NATIVE: Reddish Brown to Brown, Slightly Damp, Very Firm Sandy CLAY.
44	CS	108	16		5	
				CL		Brown, Slightly Damp, Firm to Very Firm, Sandy CLAY With White Anhydrite and/or Caliche Stringers.
50/5½"	SS				10	FORMATION: Gray, Slightly Damp, Moderately Weathered SILTSTONE

Total Depth = 10 Feet.
No Groundwater Encountered.
Backfilled With Cuttings.

SUBSURFACE EVALUATION LOG

SAMPLE SYMBOLS: SS = SPLIT SPOON / ST = SHELBY TUBE, 3" O.D. / CS = CALIFORNIA RING SAMPLER, 3" O.D. MCS = MODIFIED CALIFORNIA RING SAMPLER, 2 3/8" O.D./ AU = AUGER SAMPLE.

PROJECT NAME AND SITE LOCATION	KOCH EXPLORATION EVAPORATION POND, NW 1/4 SECTION 26 T32N, R9W, N.M.P.M., SAN JUAN COUNTY, NEW MEXICO			

PROJECT NO.	RIG TYPE	DATE	SHEET	BORING NO.
C94-9765	CME-55	10-13-94	1 OF 1	B-3

BLOWS/FOOT	SAMPLE SYMBOL	DRY DENSITY (PCF)	MOISTURE CONTENT %	UNIFIED CLASSIFICATION	DEPTH IN FEET	DESCRIPTION
				SC		NATIVE: Reddish Brown to Brown, Slightly Damp, Firm to Very Firm, Clayey Sand with White Anhydrite and/or Caliche Stringers.
				CL	5	Reddish Brown, Slightly Damp, Very Firm, Sandy CLAY.
51	CS	97	11			
73	SS				10	SANDSTONE In Shoe of Sampler.
						Total Depth = 10 Feet. No Groundwater Encountered. Backfilled With Cuttings.

SUBSURFACE EVALUATION LOG

SAMPLE SYMBOLS: SS = SPLIT SPOON / ST = SHELBY TUBE, 3" O.D. / CS = CALIFORNIA RING SAMPLER, 3" O.D. MCS = MODIFIED CALIFORNIA RING SAMPLER, 2 3/8" O.D./ AU = AUGER SAMPLE.

PROJECT NAME AND SITE LOCATION	KOCH EXPLORATION EVAPORATION POND, NW 1/4 SECTION 26 T32N, R9W, N.M.P.M., SAN JUAN COUNTY, NEW MEXICO			
PROJECT NO. C94-9765	RIG TYPE CME-55	DATE 10-13-94	SHEET 1 OF 1	BORING NO. B-4

BLOWS/FOOT	SAMPLE SYMBOL	DRY DENSITY (PCF)	MOISTURE CONTENT %	UNIFIED CLASSIFICATION	DEPTH IN FEET	DESCRIPTION
				SC		NATIVE: Reddish Brown to Brown, Slightly Damp, Soft, Clayey SAND. Gravel at 2 Feet.
				CL	5	Brown, Slightly Damp, Firm to Very Firm, Sandy CLAY With White Anhydrite and/or Caliche Stringers.
					10	Gray, Hard, CLAY.
					15	SILTSTONE At 16 Feet.
						Total Depth = 16 Feet. No Groundwater Encountered. Backfilled With Cuttings.

SUBSURFACE EVALUATION LOG

SAMPLE SYMBOLS: SS = SPLIT SPOON / ST = SHELBY TUBE, 3" O.D. / CS = CALIFORNIA RING SAMPLER, 3" O.D.
MCS = MODIFIED CALIFORNIA RING SAMPLER, 2 3/8" O.D./ AU = AUGER SAMPLE.

PROJECT NAME AND SITE LOCATION	KOCH EXPLORATION EVAPORATION POND, NW 1/4 SECTION 26 T32N, R9W, N.M.P.M., SAN JUAN COUNTY, NEW MEXICO

PROJECT NO.	RIG TYPE	DATE	SHEET	BORING NO.
C94-9765	CME-55	10-13-94	1 OF 1	B-5

BLOWS/FOOT	SAMPLE SYMBOL	DRY DENSITY (PCF)	MOISTURE CONTENT %	UNIFIED CLASSIFICATION	DEPTH IN FEET	DESCRIPTION
				SC		NATIVE: Reddish Brown to Brown, Slightly Damp, Soft, Clayey SAND.
				CL		Reddish Brown, Slightly Damp, Very Firm, Sandy CLAY
					5	Auger Refusal At 3-1/2 Feet on Cobbles. No Groundwater Encountered. Backfilled With Cuttings.

SUBSURFACE EVALUATION LOG

SAMPLE SYMBOLS: SS = SPLIT SPOON / ST = SHELBY TUBE, 3" O.D. / CS = CALIFORNIA RING SAMPLER, 3" O.D. MCS = MODIFIED CALIFORNIA RING SAMPLER, 2 3/8" O.D./ AU = AUGER SAMPLE.

si repro Form 551-8

PROJECT NAME AND SITE LOCATION	KOCH EXPLORATION EVAPORATION POND, NW 1/4 SECTION 26 T32N, R9W, .N.M.P.M., SAN JUAN COUNTY, NEW MEXICO

PROJECT NO.	RIG TYPE	DATE	SHEET	BORING NO.
C94-9765	CME-55	10-13-94	1 OF 1	B-6

BLOWS/FOOT	SAMPLE SYMBOL	DRY DENSITY (PCF)	MOISTURE CONTENT %	UNIFIED CLASSIFICATION	DEPTH IN FEET	DESCRIPTION
	AU		4	SC		NATIVE: Reddish Brown, Slightly Damp, Clayey SAND.
31	CS AU		5	CL	5	Brown, Slightly Damp, Sandy CLAY, White Anhydrite and/or Caliche Stringers in Sample.
35	CS				10	FORMATION: Brown, Slightly Damp, Weathered SANDSTONE.
50/2"	SS				15	Weathering Decreases With Depth.
					20	Total Depth = 19-1/2 Feet. No Groundwater Encountered. Backfilled With Cuttings.

SUBSURFACE EVALUATION LOG

SAMPLE SYMBOLS: SS = SPLIT SPOON / ST = SHELBY TUBE, 3"O.D. / CS = CALIFORNIA RING SAMPLER, 3"O.D. MCS = MODIFIED CALIFORNIA RING SAMPLER, 2 3/8"O.D./ AU = AUGER SAMPLE.

PROJECT NAME AND SITE LOCATION	KOCH EXPLORATION EVAPORATION POND, NW 1/4 SECTION 26 T32N, R9W, N.M.P.M., SAN JUAN COUNTY, NEW MEXICO

PROJECT NO.	RIG TYPE	DATE	SHEET	BORING NO.
C94-9765	CME-55	10-13-94	1 OF 1	B-7

BLOWS/FOOT	SAMPLE SYMBOL	DRY DENSITY (PCF)	MOISTURE CONTENT %	UNIFIED CLASSIFICATION	DEPTH IN FEET	DESCRIPTION
				SC		NATIVE: Brown to Reddish Brown, Slightly Damp, Soft, Clayey SAND.
61	CS	104	15	CL	5	Brown, Slightly Damp, Firm to Very Firm, Sandy CLAY With White Anhydrite and/or Cliche Stringers.
50/5"	CS				10	FORMATION: Brown to Light Brown, Slightly Damp, Moderately Weathered SANDSTONE.
						Total Depth = 10 Feet. No Groundwater Encountered. Backfilled With Cuttings.

SUBSURFACE EVALUATION LOG

SAMPLE SYMBOLS: SS = SPLIT SPOON / ST = SHELBY TUBE, 3" O.D. / CS = CALIFORNIA RING SAMPLER, 3" O.D.
MCS = MODIFIED CALIFORNIA RING SAMPLER, 2 3/8" O.D./ AU = AUGER SAMPLE.

si repro Form 551-8

PROJECT NAME AND SITE LOCATION	KOCH EXPLORATION EVAPORATION POND, NW 1/4 SECTION 26 T32N, R9W, N.M.P.M., SAN JUAN COUNTY, NEW MEXICO			
PROJECT NO. C94-9765	RIG TYPE CME-55	DATE 10-13-94	SHEET 1 OF 1	BORING NO. B-8

BLOWS/FOOT	SAMPLE SYMBOL	DRY DENSITY (PCF)	MOISTURE CONTENT %	UNIFIED CLASSIFICATION	DEPTH IN FEET	DESCRIPTION
	AU			SC		NATIVE: Reddish Brown to Brown, Slightly Damp, Soft Clayey SAND.
				CL		Reddish Brown, Slightly Damp, Very Firm, Sandy CLAY.
63	CS				5	Gravel and Cobbles.
						Auger Refusal At 7 Feet on Cobbles.
						Total Depth = 7 Feet. No Groundwater Encountered. Backfilled With Cuttings.

SUBSURFACE EVALUATION LOG

SAMPLE SYMBOLS: SS = SPLIT SPOON / ST = SHELBY TUBE, 3" O.D. / CS = CALIFORNIA RING SAMPLER, 3" O.D.
MCS = MODIFIED CALIFORNIA RING SAMPLER, 2 3/8" O.D./ AU = AUGER SAMPLE.

sj repro Form 551-8

PROJECT NAME AND SITE LOCATION	KOCH EXPLORATION EVAPORATION POND, NW 1.4 SECTION 26 T32N, R9W, N.M.P.M., SAN JUAN COUNTY, NEW MEXICO			
PROJECT NO. C94-9765	RIG TYPE CME-55	DATE 10-13-94	SHEET 1 OF 1	BORING NO. B-9

BLOWS/FOOT	SAMPLE SYMBOL	DRY DENSITY (PCF)	MOISTURE CONTENT %	UNIFIED CLASSIFICATION	DEPTH IN FEET	DESCRIPTION
				SC		NATIVE: Reddish Brown to Brown, Slightly Damp, Soft Clayey SAND.
				CL	5	Brown, Slightly Damp, Firm to Very Firm, Sandy CLAY With White Anhydrite and/or Caliche Stringers.
						FORMATION: Light Brown, Slightly Damp, Moderately Weathered SANDSTONE.
					10	Total Depth = 9-1/2 Feet. No Groundwater Encountered. Backfilled With Cuttings.

SUBSURFACE EVALUATION LOG

SAMPLE SYMBOLS: SS = SPLIT SPOON / ST = SHELBY TUBE, 3"O.D. / CS = CALIFORNIA RING SAMPLER, 3"O.D.
MCS = MODIFIED CALIFORNIA RING SAMPLER, 2 3/8"O.D./ AU = AUGER SAMPLE.

LABORATORY TESTING PROCEDURES

Consolidation Tests Soiltest or Clockhouse apparatus of the "floating-ring" type are employed for the one-dimensional consolidation tests. They are designed to receive one inch high 2.5 inch O.D. brass liner rings with soil specimens as secured in the field. Procedures for the tests generally are those outlined in ASTM D2435. Loads are applied in several increments to the upper surface of the test specimen and the resulting deformations are recorded at selected time intervals for each increment. For soils which are essentially saturated, each increment of load is maintained until the deformation versus log of time curve indicates completion of primary consolidation. For partially saturated soils, each increment of load is maintained until the rate of deformation is equal or less than 1/10,000 inch per hour. Applied loads are such that each new increment is equal to the total previously applied loading. Porous stones are placed in contact with the top and bottom of the specimens to permit free addition or expulsion of water. For partially saturated soils, the tests are normally performed at in situ moisture conditions until consolidation is complete under stresses approximately equal to those which will be imposed by the combined overburden and foundation loads. The samples are then submerged to show the effect of moisture increase and the tests continued under higher loadings. Generally, the tests are continued to about twice the anticipated load due to overburden and structural loads with a rebound curve then being established by releasing loads.

Expansion Tests The same type of consolidometer apparatus described above is used in expansion testing. Undisturbed samples contained in brass liner rings are placed in the consolidometers, subjected to appropriate surcharge loads and submerged. The loads are maintained until the expansion versus log of time curve indicates the completion of "primary swell".

Direct Shear Tests Direct shear tests are run using a Clockhouse or Soiltest apparatus of the strain-control type at a rate of approximately 0.05 inches per minute. The machine is designed to receive one of the one inch high 2.42 inch diameter specimens obtained by tube sampling. Generally, each sample is sheared under a normal load equivalent to the effective overburden pressure at the point of sampling. In some instances, samples are sheared at several normal loads to obtain the cohesion and angle of internal friction. When necessary, samples are saturated and/or consolidated before shearing in order to approximate the anticipated controlling field loading conditions.

TABULATION OF CLASSIFICATION TEST RESULTS

PROJECT: KOCH EVAPORATION POND NO. 2
JOB NO.: C94-9765

BORING/ TEST PIT NO.	DEPTH, Feet	USC SYSTEM SYMBOL	LL	PI	SIEVE ANALYSIS - ACCUMULATED PERCENT PASSING														
					200	100	50	40	30	16	10	8	4	1/4	3/8	3/4	1	1 1/2	3
B-6	0-3	CL	32	16	53	67	85	92	96	99	100								
B-6	5-7	CL	41	25	70	80	89	93	96	99	99	99	100						

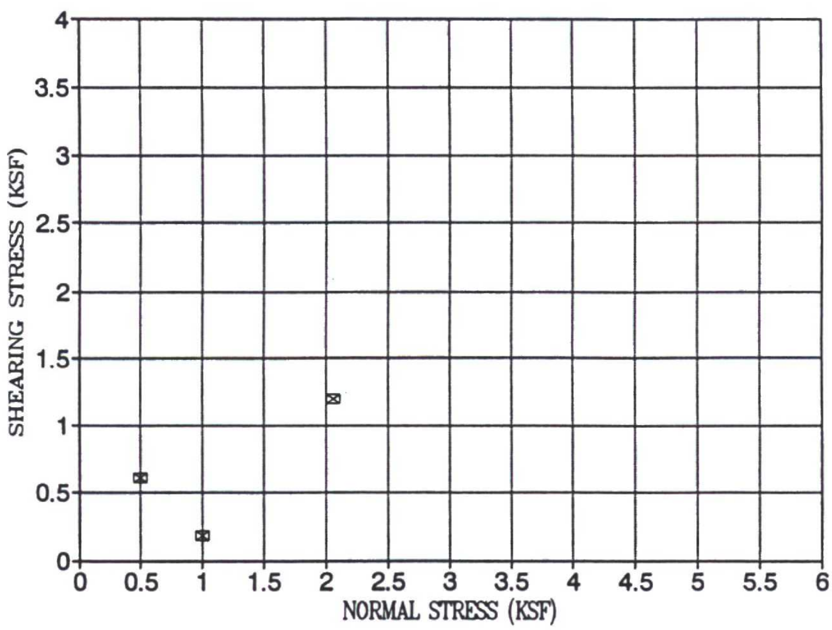
AGRA Earth & Environmental

PROJECT:	FRANK/KOCH EVAPORATION POND	**DATE**	11/01/94
LOCATION:	B-2 @ 4 1/2'-6'	**JOB NO.**	C94-9765
		W.O.NO.	1
		LAB NO.	1

DIRECT SHEAR TEST (SATURATED) (ASTM D-3080)

Normal Stress	0.495	KSF	0.995	KSF	2.059	KSF
Initial Moisture Content	15.9%		15.5%		17.4%	
Dry Density	107.8	LB/CU FT	106.5	LB/CU F	101.1	LB/CU FT
Moisture at Saturation	25.4%		24.5%		30.1%	
Maximum Vertical Deformation @ T max.	0.0088	IN	-0.0013	IN	-0.1	IN
Shearing Stress, T max.	0.6	KSF	0.2	KSF*	1.2	KSF

*NOTE: PROVING RING MALFUNCTION AT THIS POINT-DISREGARD



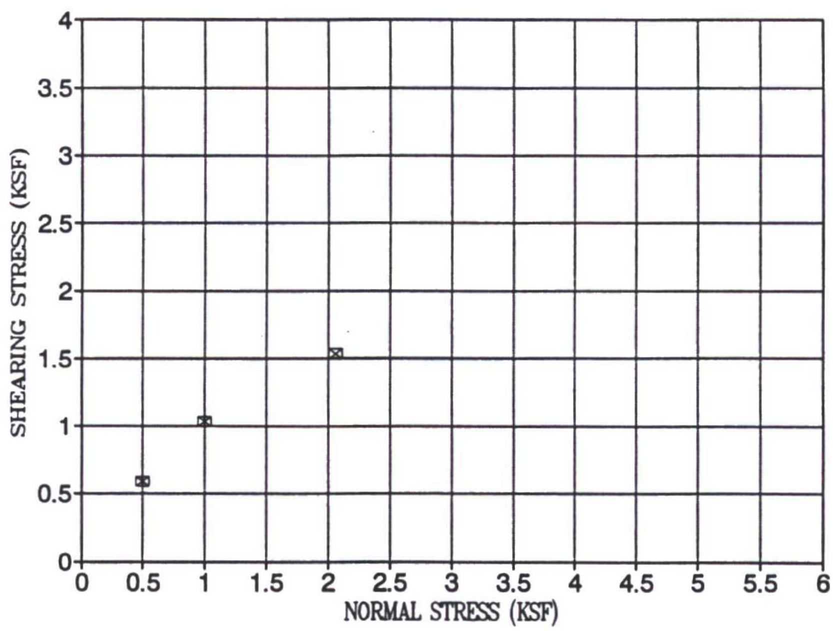
AGRA Earth & Environmental

AGRA Earth & Environmental

PROJECT:	FRANK/KOCH EVAPORATION POND	**DATE**	11/01/94
LOCATION:	B-3 @ 4 1/2'-6'	**JOB NO.**	C94-9765
		W.O.NO.	1
		LAB NO.	2

DIRECT SHEAR TEST (SATURATED) (ASTM D-3080)

Normal Stress	0.495	KSF	0.995	KSF	2.059	KSF
Initial Moisture Content	11.0%		12.1%		11.8%	
Dry Density	97.3	LB/CU FT	103.4	LB/CU F	94.6	LB/CU FT
Moisture at Saturation	26.3%		24.5%		26.4%	
Maximum Vertical Deformation @ T max.	0	IN	-0.0007	IN	-0.0112	IN
Shearing Stress, T max.	0.6	KSF	1.0	KSF	1.5	KSF



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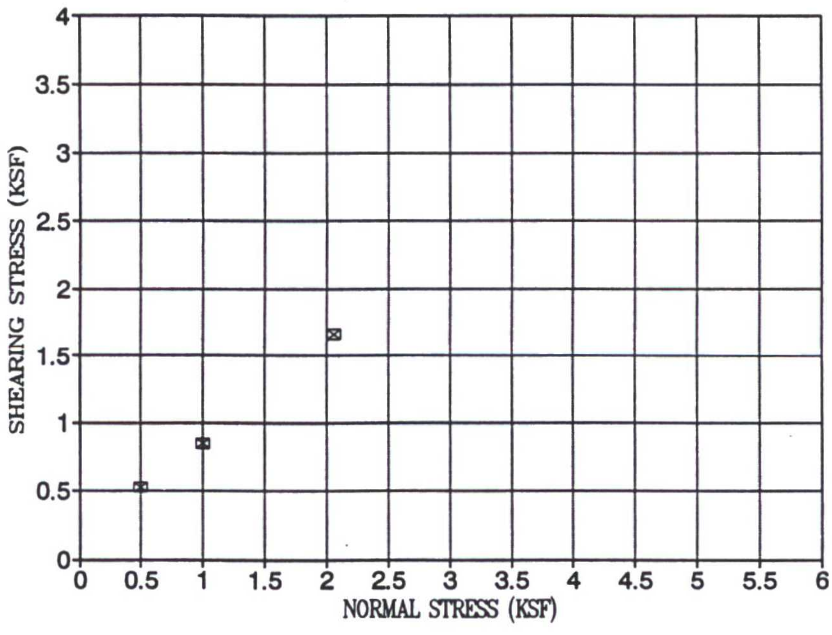
PROJECT:	FRANK/KOCH EVAPORATION POND	**DATE**	11/01/94
LOCATION:	B-7 @ 4 1/2'-6'	**JOB NO.**	C94-9765
		W.O.NO.	1
		LAB NO.	3

DIRECT SHEAR TEST (SATURATED) (ASTM D-3080)

Normal Stress	0.495	KSF	0.995	KSF	2.059	KSF
Initial Moisture Content	15.0%		15.0%		15.8%	
Dry Density	103.5	LB/CU FT	102.6	LB/CU F	104.2	LB/CU FT
Moisture at Saturation	24.7%		23.5%		23.6%	
Maximum Vertical Deformation @ T max.	0.002	IN	-0.0059	IN	-0.001	IN
Shearing Stress, T max.	0.5	KSF	0.8	KSF	1.7	KSF



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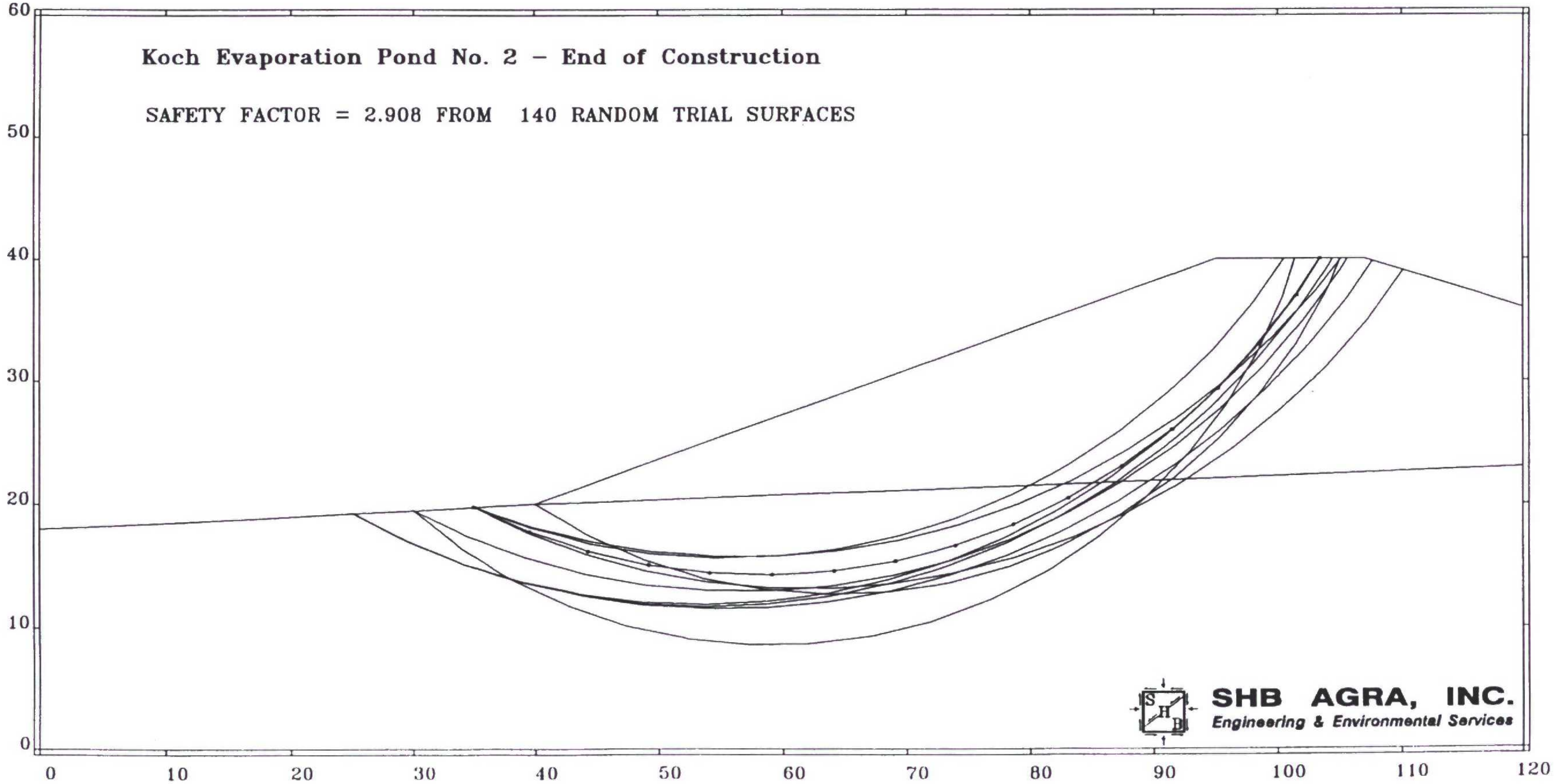
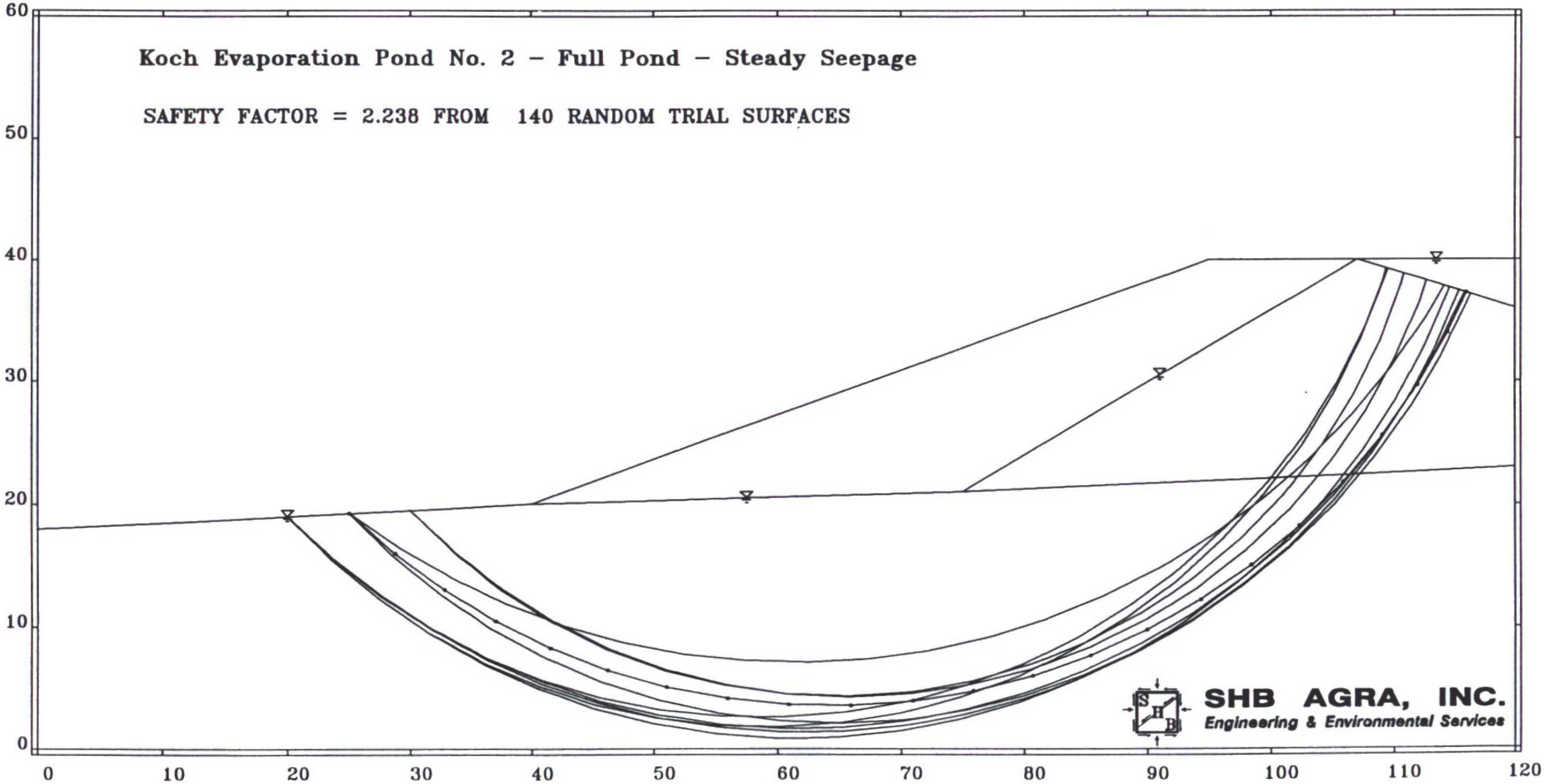

Koch Evaporation Pond No. 2 - End of Construction
SAFETY FACTOR = 2.908 FROM 140 RANDOM TRIAL SURFACES
SHB AGRA, INC.
Engineering & Environmental Services
0
10
20
30
40
50
60
0
10
20
30
40
50
60
70
80
90
100
110
120


Koch Evaporation Pond No. 2 - Full Pond - Steady Seepage
SAFETY FACTOR = 2.238 FROM 140 RANDOM TRIAL SURFACES
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
80
90
100
110
120
SHB AGRA, INC.
Engineering & Environmental Services

** PCSTABL5 **

BY
PURDUE UNIVERSITY

--SLOPE STABILITY ANALYSIS--
SIMPLIFIED JANBU, SIMPLIFIED BISHOP
OR SPENCER'S METHOD OF SLICES

RUN DATE : 12-12-1994
RUN TIME : 14:58:10

PROJECT Koch Evaporation Pond No. 2 - End of Construction

BOUNDARY COORDINATES

4 TOP BOUNDARIES
5 TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT (ft)	Y-LEFT (ft)	X-RIGHT (ft)	Y-RIGHT (ft)	SOIL TYPE BELOW BND
1	.00	18.00	40.00	20.00	2
2	40.00	20.00	95.00	40.00	1
3	95.00	40.00	107.00	40.00	1
4	107.00	40.00	120.00	36.00	1
5	40.00	20.00	120.00	23.00	2

ISOTROPIC SOIL PARAMETERS

2 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT. (pcf)	SATURATED UNIT WT. (pcf)	COHESION INTERCEPT (psf)	FRICTION ANGLE (deg)	PORE PRESSURE PARAM.	PRESSURE CONSTANT (psf)	PIEZ. SURFACE NO.
1	120.0	125.0	500.0	25.0	.00	.0	0
2	120.0	130.0	300.0	28.0	.00	.0	0

A CRITICAL FAILURE SURFACE SEARCHING METHOD, USING A RANDOM TECHNIQUE FOR GENERATING CIRCULAR SURFACES, HAS BEEN SPECIFIED.

140 TRIAL SURFACES HAVE BEEN GENERATED.

20 SURFACES INITIATE FROM EACH OF 7 POINTS EQUALLY SPACED
ALONG THE GROUND SURFACE BETWEEN X = 20.00 ft.
AND X = 50.00 ft.

EACH SURFACE TERMINATES BETWEEN X = 96.00 ft.
AND X = 120.00 ft.

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION AT WHICH A SURFACE EXTENDS IS Y = .00 ft.

5.00 FT. LINE SEGMENTS DEFINE EACH TRIAL FAILURE SURFACE.

FOLLOWING ARE DISPLAYED THE TEN MOST CRITICAL OF THE TRIAL FAILURE SURFACES EXAMINED. THEY ARE ORDERED - MOST CRITICAL FIRST.

* * SAFETY FACTORS ARE CALCULATED BY THE MODIFIED JANBU METHOD * *

FAILURE SURFACE SPECIFIED BY 17 COORDINATE POINTS

POINT NO.	X-SURF (ft)	Y-SURF (ft)
1	35.00	19.75
2	39.57	17.73
3	44.32	16.16
4	49.19	15.04
5	54.15	14.40
6	59.15	14.23
7	64.14	14.54
8	69.08	15.33
9	73.92	16.58
10	78.62	18.30
11	83.13	20.45
12	87.42	23.02
13	91.44	25.99
14	95.16	29.33
15	98.54	33.01
16	101.56	37.00
17	103.41	40.00

*** safety factor 2.908 ***

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (ft)	Y-SURF (ft)
1	30.00	19.50
2	34.52	17.37
3	39.22	15.64
4	44.04	14.32
5	48.96	13.43
6	53.94	12.97
7	58.94	12.94
8	63.92	13.34
9	68.85	14.17
10	73.69	15.43
11	78.40	17.10
12	82.95	19.18
13	87.30	21.64
14	91.43	24.47
15	95.29	27.64
16	98.86	31.14
17	102.11	34.94
18	105.03	39.00
19	105.62	40.00

*** safety factor 2.927 ***

FAILURE SURFACE SPECIFIED BY 20 COORDINATE POINTS

POINT NO.	X-SURF (ft)	Y-SURF (ft)
1	25.00	19.25
2	29.46	16.99
3	34.09	15.11
4	38.87	13.63
5	43.75	12.56
6	48.71	11.90
7	53.70	11.66
8	58.70	11.85
9	63.66	12.46
10	68.56	13.49
11	73.35	14.92
12	78.00	16.76
13	82.48	18.98
14	86.75	21.57
15	90.79	24.51
16	94.57	27.79
17	98.06	31.37
18	101.24	35.23
19	104.07	39.35
20	104.45	40.00

*** safety factor 2.956 ***

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (ft)	Y-SURF (ft)
1	25.00	19.25
2	29.47	17.00
3	34.11	15.14
4	38.89	13.69
5	43.78	12.65
6	48.75	12.04
7	53.74	11.85
8	58.74	12.09
9	63.69	12.75
10	68.57	13.84
11	73.34	15.34
12	77.96	17.24
13	82.41	19.54
14	86.64	22.20
15	90.63	25.22
16	94.34	28.57
17	97.75	32.22
18	100.84	36.15
19	103.36	40.00

*** safety factor 2.958 ***

FAILURE SURFACE SPECIFIED BY 17 COORDINATE POINTS

POINT NO.	X-SURF (ft)	Y-SURF (ft)
1	40.00	20.00
2	44.31	17.47
3	48.88	15.45
4	53.66	13.95
5	58.57	13.01
6	63.55	12.63
7	68.55	12.82
8	73.49	13.58
9	78.32	14.89
10	82.96	16.74
11	87.37	19.11
12	91.47	21.96
13	95.23	25.26
14	98.59	28.96
15	101.51	33.02
16	103.95	37.39
17	105.04	40.00

*** safety factor 2.959 ***

FAILURE SURFACE SPECIFIED BY 20 COORDINATE POINTS

POINT NO.	X-SURF (ft)	Y-SURF (ft)
1	25.00	19.25
2	29.47	17.01
3	34.11	15.14
4	38.88	13.65
5	43.75	12.53
6	48.70	11.81
7	53.69	11.49
8	58.69	11.56
9	63.67	12.04
10	68.59	12.90
11	73.43	14.16
12	78.16	15.80
13	82.74	17.81
14	87.14	20.17
15	91.34	22.89
16	95.31	25.92
17	99.03	29.27
18	102.47	32.90
19	105.61	36.79
20	107.66	39.80

*** safety factor 2.968 ***

FAILURE SURFACE SPECIFIED BY 17 COORDINATE POINTS

POINT NO.	X-SURF (ft)	Y-SURF (ft)
1	35.00	19.75
2	39.73	18.14
3	44.59	16.93
4	49.52	16.13
5	54.51	15.73
6	59.51	15.75
7	64.49	16.19
8	69.41	17.03
9	74.26	18.28
10	78.98	19.93
11	83.55	21.96
12	87.93	24.36
13	92.10	27.12
14	96.03	30.21
15	99.69	33.62
16	103.06	37.31
17	105.12	40.00

*** safety factor 2.976 ***

FAILURE SURFACE SPECIFIED BY 19 COORDINATE POINTS

POINT NO.	X-SURF (ft)	Y-SURF (ft)
1	35.00	19.75
2	39.52	17.62
3	44.21	15.88
4	49.03	14.56
5	53.95	13.66
6	58.93	13.18
7	63.93	13.14
8	68.91	13.53
9	73.85	14.35
10	78.69	15.59
11	83.41	17.24
12	87.97	19.30
13	92.33	21.74
14	96.47	24.54
15	100.35	27.70
16	103.94	31.17
17	107.22	34.95
18	110.16	38.99
19	110.18	39.02

*** safety factor 2.977 ***

** PCSTABL5 **

BY
PURDUE UNIVERSITY

--SLOPE STABILITY ANALYSIS--
SIMPLIFIED JANBU, SIMPLIFIED BISHOP
OR SPENCER'S METHOD OF SLICES

RUN DATE : 12-12-1994
RUN TIME : 15:27:35

PROJECT Koch Evaporation Pond No. 2 - Full Pond - Steady Seepage

BOUNDARY COORDINATES

4 TOP BOUNDARIES
6 TOTAL BOUNDARIES

BOUNDARY NO.	X-LEFT (ft)	Y-LEFT (ft)	X-RIGHT (ft)	Y-RIGHT (ft)	SOIL TYPE BELOW BND
1	.00	18.00	40.00	20.00	2
2	40.00	20.00	95.00	40.00	1
3	95.00	40.00	107.00	40.00	1
4	107.00	40.00	120.00	36.00	1
5	40.00	20.00	75.00	21.00	2
6	75.00	21.00	120.00	23.00	2

ISOTROPIC SOIL PARAMETERS

2 TYPE(S) OF SOIL

SOIL TYPE NO.	TOTAL UNIT WT. (pcf)	SATURATED UNIT WT. (pcf)	COHESION INTERCEPT (psf)	FRICTION ANGLE (deg)	PORE PRESSURE PARAM.	PRESSURE CONSTANT (psf)	PIEZ. SURFACE NO.
1	120.0	125.0	500.0	25.0	.00	.0	1
2	120.0	130.0	300.0	28.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

UNIT WEIGHT OF WATER = 62.40

PIEZOMETRIC SURFACE NO. 1 SPECIFIED BY 5 COORDINATE POINTS

POINT NO.	X-WATER (ft)	Y-WATER (ft)
1	.00	18.00
2	40.00	20.00
3	75.00	21.00
4	107.00	40.00
5	120.00	40.00

A CRITICAL FAILURE SURFACE SEARCHING METHOD, USING A RANDOM TECHNIQUE FOR GENERATING CIRCULAR SURFACES, HAS BEEN SPECIFIED.

140 TRIAL SURFACES HAVE BEEN GENERATED.

20 SURFACES INITIATE FROM EACH OF 7 POINTS EQUALLY SPACED
ALONG THE GROUND SURFACE BETWEEN X = 20.00 ft.
AND X = 50.00 ft.

EACH SURFACE TERMINATES BETWEEN X = 96.00 ft.
AND X = 120.00 ft.

UNLESS FURTHER LIMITATIONS WERE IMPOSED, THE MINIMUM ELEVATION AT WHICH A SURFACE EXTENDS IS Y = .00 ft.

5.00 FT. LINE SEGMENTS DEFINE EACH TRIAL FAILURE SURFACE.

FOLLOWING ARE DISPLAYED THE TEN MOST CRITICAL OF THE TRIAL FAILURE SURFACES EXAMINED. THEY ARE ORDERED - MOST CRITICAL FIRST.

* * SAFETY FACTORS ARE CALCULATED BY THE MODIFIED JANBU METHOD * *

FAILURE SURFACE SPECIFIED BY 23 COORDINATE POINTS

POINT NO.	X-SURF (ft)	Y-SURF (ft)
1	25.00	19.25
2	28.76	15.95
3	32.80	13.00
4	37.08	10.42
5	41.57	8.22
6	46.23	6.43
7	51.04	5.05
8	55.95	4.11
9	60.93	3.60
10	65.93	3.53
11	70.91	3.90
12	75.85	4.71
13	80.69	5.96
14	85.40	7.62
15	89.95	9.69
16	94.30	12.16
17	98.42	15.00
18	102.27	18.19
19	105.82	21.71
20	109.05	25.53
21	111.92	29.62
22	114.43	33.94
23	115.97	37.24

*** safety factor 2.238 ***

FAILURE SURFACE SPECIFIED BY 22 COORDINATE POINTS

POINT NO.	X-SURF (ft)	Y-SURF (ft)
1	25.00	19.25
2	29.12	16.41
3	33.45	13.92
4	37.98	11.79
5	42.66	10.05
6	47.48	8.70
7	52.39	7.75
8	57.36	7.20
9	62.35	7.07
10	67.35	7.35
11	72.30	8.04
12	77.18	9.14
13	81.95	10.64
14	86.58	12.52
15	91.04	14.78
16	95.30	17.40
17	99.33	20.36
18	103.10	23.64
19	106.58	27.23
20	109.76	31.09
21	112.62	35.19
22	114.13	37.81

*** safety factor 2.239 ***

FAILURE SURFACE SPECIFIED BY 24 COORDINATE POINTS

POINT NO.	X-SURF (ft)	Y-SURF (ft)
1	20.00	19.00
2	23.67	15.61
3	27.62	12.54
4	31.81	9.81
5	36.22	7.46
6	40.82	5.48
7	45.56	3.90
8	50.42	2.74
9	55.37	1.98
10	60.35	1.65
11	65.35	1.75
12	70.33	2.27
13	75.24	3.21
14	80.05	4.56
15	84.73	6.32
16	89.25	8.46
17	93.56	10.99
18	97.65	13.87
19	101.48	17.08
20	105.02	20.61
21	108.25	24.43
22	111.14	28.51
23	113.68	32.82
24	115.82	37.29

*** safety factor 2.240 ***

FAILURE SURFACE SPECIFIED BY 24 COORDINATE POINTS

POINT NO.	X-SURF (ft)	Y-SURF (ft)
1	20.00	19.00
2	23.63	15.56
3	27.57	12.48
4	31.77	9.77
5	36.21	7.47
6	40.84	5.59
7	45.63	4.15
8	50.53	3.17
9	55.51	2.64
10	60.50	2.58
11	65.49	2.98
12	70.41	3.85
13	75.23	5.17
14	79.91	6.94
15	84.41	9.13
16	88.67	11.73
17	92.68	14.72
18	96.40	18.07
19	99.78	21.75
20	102.81	25.73
21	105.45	29.98
22	107.69	34.45
23	109.50	39.11
24	109.53	39.22

*** safety factor 2.241 ***

FAILURE SURFACE SPECIFIED BY 22 COORDINATE POINTS

POINT NO.	X-SURF (ft)	Y-SURF (ft)
1	30.00	19.50
2	33.63	16.06
3	37.60	13.01
4	41.84	10.38
5	46.34	8.19
6	51.03	6.46
7	55.87	5.22
8	60.82	4.47
9	65.81	4.22
10	70.80	4.48
11	75.75	5.25
12	80.58	6.51
13	85.27	8.25
14	89.76	10.45
15	94.00	13.10
16	97.95	16.16
17	101.58	19.61
18	104.83	23.40
19	107.69	27.51
20	110.12	31.88
21	112.09	36.47
22	112.65	38.26

*** safety factor 2.241 ***

FAILURE SURFACE SPECIFIED BY 22 COORDINATE POINTS

POINT NO.	X-SURF (ft)	Y-SURF (ft)
1	30.00	19.50
2	33.60	16.02
3	37.53	12.94
4	41.77	10.29
5	46.27	8.10
6	50.96	6.39
7	55.81	5.17
8	60.76	4.48
9	65.76	4.30
10	70.75	4.64
11	75.67	5.51
12	80.48	6.88
13	85.12	8.75
14	89.53	11.10
15	93.68	13.89
16	97.51	17.10
17	100.99	20.70
18	104.07	24.64
19	106.72	28.87
20	108.92	33.37
21	110.63	38.06
22	110.82	38.82

*** safety factor 2.242 ***

FAILURE SURFACE SPECIFIED BY 25 COORDINATE POINTS

POINT NO.	X-SURF (ft)	Y-SURF (ft)
1	20.00	19.00
2	23.55	15.48
3	27.41	12.29
4	31.52	9.46
5	35.87	6.99
6	40.43	4.92
7	45.14	3.26
8	49.99	2.03
9	54.92	1.22
10	59.91	.86
11	64.91	.93
12	69.88	1.45
13	74.79	2.40
14	79.59	3.79
15	84.26	5.59
16	88.74	7.79
17	93.02	10.39
18	97.05	13.35
19	100.80	16.65
20	104.25	20.28
21	107.36	24.19
22	110.11	28.36
23	112.49	32.76
24	114.47	37.35
25	114.57	37.67

*** safety factor 2.242 ***

FAILURE SURFACE SPECIFIED BY 24 COORDINATE POINTS

POINT NO.	X-SURF (ft)	Y-SURF (ft)
1	25.00	19.25
2	28.58	15.76
3	32.47	12.61
4	36.63	9.84
5	41.02	7.46
6	45.62	5.50
7	50.38	3.97
8	55.26	2.88
9	60.22	2.25
10	65.22	2.08
11	70.21	2.37
12	75.16	3.12
13	80.01	4.32
14	84.73	5.96
15	89.28	8.04
16	93.62	10.52
17	97.71	13.39
18	101.53	16.63
19	105.02	20.20
20	108.17	24.08
21	110.95	28.24
22	113.34	32.63
23	115.31	37.23
24	115.37	37.42

*** safety factor 2.244 ***

FAILURE SURFACE SPECIFIED BY 25 COORDINATE POINTS

POINT NO.	X-SURF (ft)	Y-SURF (ft)
1	20.00	19.00
2	23.65	15.58
3	27.58	12.49
4	31.75	9.73
5	36.14	7.35
6	40.72	5.34
7	45.45	3.72
8	50.31	2.52
9	55.24	1.72
10	60.23	1.35
11	65.23	1.41
12	70.21	1.88
13	75.13	2.78
14	79.95	4.09
15	84.65	5.80
16	89.18	7.91
17	93.52	10.39
18	97.64	13.23
19	101.50	16.41
20	105.08	19.90
21	108.34	23.68
22	111.28	27.73
23	113.86	32.01
24	116.07	36.50
25	116.32	37.13

*** safety factor 2.246 ***

FAILURE SURFACE SPECIFIED BY 24 COORDINATE POINTS

POINT NO.	X-SURF (ft)	Y-SURF (ft)
1	20.00	19.00
2	23.54	15.46
3	27.39	12.28
4	31.53	9.48
5	35.92	7.08
6	40.51	5.10
7	45.27	3.58
8	50.16	2.51
9	55.12	1.90
10	60.12	1.78
11	65.11	2.12
12	70.04	2.94
13	74.87	4.22
14	79.56	5.95
15	84.07	8.12
16	88.34	10.71
17	92.36	13.69
18	96.07	17.04
19	99.45	20.73
20	102.46	24.72
21	105.08	28.98
22	107.29	33.46
23	109.06	38.14
24	109.37	39.27

*** safety factor 2.250 ***

SITE GRADING & EARTHWORK

1.0 SCOPE

Includes all clearing and grubbing, removal of obstructions, general excavating, grading and filling, and any related items necessary to complete the grading for the entire project in accordance with these recommendations.

2.0 SUBSURFACE SOIL DATA

A subsurface soil exploration has been performed, and the results are available for review by the Contractor. The report was prepared as an aid in design of the proposed project. This report is not a bidding document. Contractors reviewing this report must draw their own conclusions regarding site conditions and specific construction techniques to be used. The Contractor should visit the site and evaluate for himself the character of materials which may be encountered.

3.0 CLEARING & GRUBBING

A. **General**: Clearing and grubbing should be performed in all areas to be excavated or within which embankment fill is to be constructed as shown on the Plans.

B. **Clearing**: Strip and remove any existing construction, fill, soft, loose, wet, or otherwise unsuitable soils, vegetation, debris and any existing or abandoned utilities for a distance of 5 feet beyond the proposed limits of construction. All exposed ground surfaces should be smooth and free of mounds and depressions which could inhibit uniform engineered fill placement and compaction.

C. **Grubbing**: Stumps, matted roots, and roots larger than 2 inches in diameter should be removed from within 8 inches of the surface of areas on which fills are to be constructed. Areas disturbed by grubbing should be filled as recommended herein for EMBANKMENT.

D. **Grass & Topsoil**: Grass, grass roots and incidental topsoil should not be left beneath a fill area, nor should this material be used as fill material.

4.0 EARTH EXCAVATION

A. Earth excavation should consist of the excavation and stockpiling of soils suitable for use as embankment fill, as well as the satisfactory disposal of all vegetation, debris, and deleterious materials encountered within the area to be graded and/or in borrow areas.

B. Excavated areas should be continuously maintained such that the surface is smooth and has sufficient slope to allow water to drain.

C. Excavation of the on-site materials should generally be possible with the use of conventional heavy-duty excavation equipment in good working order. Ripping of some of the denser materials encountered during the subsurface exploration may be necessary. The correct equipment for site conditions should be selected by the contractor to perform the earthwork at the project site.

D. For safety of workmen, temporary excavations deeper than 4 feet, to be entered by workers, should be rigidly braced or laid back at a slope ratio no steeper than 1:1 (horizontal to vertical). Equipment and spoil piles should be allowed no closer than 15 feet from the edge of the excavation or slopes.

5.0 EMBANKMENT

A. **General**: Embankments should consist of a controlled (engineered) fill constructed in areas indicated on the grading plans.

B. **Materials**: The on-site, native materials are suitable and recommended for use as engineered fill material in construction of the dikes for the evaporation pond at this location. Soils are be generally suitable for fill provided they are free of organic material, clay lumps, debris, and rocks larger than 3 inches in diameter. The material excavated at the site should be processed to a uniform, homogeneous material prior to placement as engineered fill. Imported fill soils should be evaluated at the borrow site for suitability, by the project Geotechnical Engineer.

C. **Construction**:

(1) Embankment (Dike) Area Treatment: Strip and remove any existing fill, soft, loose, or wet soils, vegetation, and debris from below the areas to receive embankment fill. Fill soils should be placed on competent native subgrade material. The presence of competent native subgrade materials should be observed and evaluated by the Geotechnical Engineer during construction. The surfaces to receive fill should be moistened and proof-rolled, under the observation of a representative of the project Geotechnical Engineer, prior to placement of the first lift of engineered fill. Where fill, soft, loose or wet soils are encountered at the bottom of cut surfaces, the unacceptable soils should be removed and replaced with engineered fill in accordance with the recommendations contained in this report.

(2) Compaction: All areas to receive engineered fill should be stripped of existing construction, fill, vegetation, debris and other deleterious materials, as well as loose, wet or soft soil. Engineered fill should be placed on competent, native, moistened and proof-rolled material. The presence of competent native subgrade soils should be observed and evaluated by the Geotechnical Engineer during construction. The maximum lift thickness for fill soils will be dependent on the type of compaction equipment utilized, but fill should generally be placed in uniform lifts not exceeding 8 inches in loose thickness. Placement and compaction of fills should be performed in accordance with the recommendations in this report and good construction practices. Engineered fill should be placed and compacted in horizontal lifts using equipment and procedures that will produce recommended water contents and densities throughout the lift. Sloping areas steeper than 5:1 (horizontal:vertical) should be benched to reduce the potential for slippage between existing slopes and fills. Benches should be level and wide enough to accommodate compaction and earth moving equipment.

Proof-rolling should be performed after a suitable period of relatively dry weather to avoid degrading an otherwise acceptable subgrade. Proof-rolling should be performed with a heavily loaded dump truck or with similar approved construction equipment. The proof-rolling equipment should make at least four passes over each section, with the last two passes perpendicular to the first two. A pass is defined herein as a complete round trip.

Compacted, granular pipe bedding should be provided for a depth of at least 6 inches above and below underground utility pipes to distribute vertical loads and to protect the pipe during backfill and compaction operations. The pipe bedding should have a maximum particle size of 3/8 inch and a maximum of 5 percent passing the No. 200 sieve.

Materials should be compacted at the following recommended dry densities as evaluated by ASTM D698-91 (Standard Proctor):

Material	**Minimum Percent Compaction (ASTM D698-91)**
On-site native subgrade material and dike engineered fill	95

Engineered fill soils should be compacted within three percent of optimum moisture content as evaluated by ASTM D698-91.

(3) Weather Limitations: Controlled fill should not be constructed when the atmospheric temperature is below 35 degrees F. When the temperature falls below 35 degrees, it should be the responsibility of the Contractor to protect all areas of completed work against any detrimental effects of ground freezing by methods approved by the Geotechnical Engineer. Any areas that are damaged by freezing should be reconditioned, reshaped, and compacted by the Contractor in accordance with the recommendations of this report without additional cost to the Owner.

D. **Slope Protection & Drainage**: The edges of the controlled fill embankments should be graded to the contours shown on the Plans and compacted to the density required in paragraph 5.C (2). Slopes steeper than 3:1 (horizontal to vertical) should be protected from erosion.

6.0 OBSERVATION & TESTING

A. **Field Observation & Testing**: A registered, licensed, civil engineer, specializing in geotechnical engineering, should be retained to observe and test all controlled earthwork. The Geotechnical Engineer should provide continuous on-site observation and testing by experienced personnel during construction of controlled earthwork. The party responsible for securing and paying for these observation and testing services will be determined by the Owner.

The Contractor should notify the Engineer at least two working days in advance of any field operations of controlled earthwork or of any resumption of operations after stoppages. Tests of fill materials and embankments should be performed at the following suggested minimum rates:

(1) One field density test for each 500 cubic yards of fill placed or each layer of fill for each work area, whichever results in the greater number of tests.

(2) One moisture-density curve (ASTM D698-91 Standard Proctor) for each type of material used.

B. **Report of Field Density Tests**: The Geotechnical Engineer should submit, on a daily basis, the results of field density tests as recommended herein.