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Geotechnical Report
Volume 2
Analysis and Recommendation

FLOOD CONTROL DISTRICT of MARICOPA COUNTY

Flood Control District of Maricopa County
Casandro Wash Dam

CH2M HILL

Casandro Wash Detention Dam

Geotechnical Report

Volume 2

Analysis and Recommendations

Prepared for the

Flood Control District of Maricopa County

Prepared by

CH2M HILL

1620 West Fountainhead Parkway, Suite 550

Tempe, Arizona 85285-8440

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Contents

Introduction

The Flood Control District of Maricopa County (District) retained CH2M HILL on October 18, 1993, to provide professional engineering services for design and preparation of plans, Special Provisions, and cost estimates for an earth dam on Casandro Wash. Volume 1 of the Geotechnical Report presented the results of CH2M HILL's geotechnical exploration and lab testing for the proposed project and was submitted to the District on March 8, 1994. This volume, Volume 2, presents our interpretation of the data, the geotechnical engineering analysis, and the design recommendations for the dam.

Purpose and Scope

The purpose of this report is to present the geotechnical engineering analysis, and provide geotechnical recommendations for the design of Casandro Wash Dam. The specific scope of work for Volume 2 of the Geotechnical Report included the following:

- Interpretation of site conditions including regional and site geology, seismicity, and site subsurface conditions
- Evaluation of the field exploration and laboratory test data
- Engineering analysis based on gathered information leading to geotechnical recommendations for the following:
    - Earthwork
    - Embankment foundation
    - Earthfill dam construction
    - Outlet piping
    - Spillway and stilling basin
    - Construction considerations
- Preparation of this report

Limitations

This report has been prepared for the exclusive use of the Flood Control District of Maricopa County for the specific application to the Casandro Wash Dam in accordance with generally accepted geotechnical engineering practice. No other warranty, expressed or implied, is made. The conclusions and recommendations contained in this report were based on the applicable standards of the consulting profession at the time this report was prepared.

The conclusions and recommendations presented in this report are based on information obtained from the field exploration, laboratory test, and existing data. The results reflect conditions only at specific locations and times, and only to depths penetrated. They do not necessarily reflect strata variations that may exist between such locations. If variations in subsurface conditions from those described are noted during construction, the recommendations in this report must be re-evaluated.

In the event that any changes in the nature, design, or location of the facilities are planned, the conclusions and recommendations contained in this report should not be considered valid unless the changes are reviewed and this report modified or verified in writing by CH2M HILL. CH2M HILL is not responsible for any claims, damages, or liability associated with the interpretations of the subsurface data or reuse of the subsurface data or engineering analysis without the express written authorization of CH2M HILL.

Site Conditions

The information presented in this section is based on a review of existing data and the results of the soil borings, laboratory testing, and observations during site visits. The subsection on subsurface conditions presents our interpretations of the conditions based on the above information.

Site and Regional Geology

The Casandro Wash Detention Dam project area lies within the Basin and Range physiographic province of southwestern Arizona. This province is characterized by somewhat isolated mountain ranges separated by debris-filled desert valleys. The Vulture Mountains lie to the south of the project site. This northeast trending mountain range is composed of a complex, highly-faulted assemblage of Precambrian and late Cretaceous granites surrounded by tilted Tertiary volcanics. Northeast of the project site are the Wickenberg Mountains and Hieroglyphic Mountains which are similar in composition and structure to the Vulture Mountains but the Hieroglyphic Mountains are composed largely of Precambrian high-grade metamorphic schists (Chronic, 1983).

Between these mountain ranges is a northwest-southeast trending alluvial valley which broadens to the northwest of the Casandro Wash project site. The valley is filled with varying thickness of Quaternary and Tertiary unconsolidated gravel, sand, silt, and clay. Thickness of the alluvial deposits range from a few tens of feet near the mountain ranges to more 1,000 feet near Congress, about 10 miles northwest of the project site. The unconsolidated alluvial deposits comprise the main water-bearing unit in the project area, although some wells produce water from fractured crystalline and sedimentary rocks (Sanger and Appel, 1980).

Seismicity

The Central Arizona region is characterized by low level of seismicity during historic time. Local events have been infrequent, of low magnitude ($M_L \leq 4$), and widely scattered. The region has experienced a few instances of low level seismic activity caused by remote events of large magnitude outside of the Central Arizona region. Geologic evidence indicates that the region has been relatively stable throughout Late Tertiary and Quaternary time. Few faults in the site region are considered to be active in the engineering sense. There does not appear to be a significant fault that may be active closer than about 50 miles from the project site. For this project, an active fault is one that has experienced surface movement once in the past 35,000 years or recurring movement during the past 500,000 years.

A review of existing faulting and seismicity was performed to provide seismic design recommendations for use in project engineering analysis. A summary of this review follows.

1. Data search of the USGS National Earthquake Information Center as required by the Soil Conservation Service Technical Release No. 60 (SCS, 1985) and the project scope of work. The USGS data base is a multi-catalog historical earthquake data base. The data base includes the data source catalog, date and time of the event, earthquake location by longitude and latitude, depth, magnitude, radial distance from the project site, and any required qualifiers. The search for this project included an area within a 150 kilometer (km) radius of the site The search resulted in a list of 17 earthquake records ranging from magnitude 2.5 to 4.9. All of the records were from earthquakes located greater than 70 km from the project site. Two closer event records, magnitude 4.1 and 4.5, were from non-tectonic activity. Additional information from these two events were not included in the data base. The closest event was a magnitude 4.9 at a radial distance of 74 km from the site. A copy of the search results is shown in Figure 1.

2. Seismotectonic data and final conclusions for the New Waddell Dam dated July 15, 1986, from Larry Anderson of the USBR (USBR, 1986). The design earthquake was a magnitude 6-3/4 event at a distance of 50 km. Mr. Anderson also stated that a Transition Zone random earthquake of magnitude 6-1/4 at 25 km distance was used. The seismic design acceleration used for the design of New Wadell Dam was approximately 0.1g (Anderson, L. 1994).

3. Soil Conservation Service Technical Release No. 60, dated October 1985, *Earth Dams And Reservoirs*. This document places Arizona in seismic zone 2 with a minimum seismic coefficient of 0.1g.

4. Applied Technology Council (ATC) seismic zonation system for the western United States (ATC, 1978). The ATC study places central Arizona in Seismic Zone 1 for effective peak horizontal ground motion. The design seismic coefficient of 0.05g with a probability of 10 percent exceedance in 50 years.

5. Federal Emergency Management Agency (FEMA), NEHRP recommendations for building seismic regulations (FEMA, 1988). FEMA used the ATC seismic coefficient of 0.05g with a 10 percent probability of exceedance in 50 years. Using the FEMA report annual risk, Figure 1.7, correlates to 0.1g with a 10 percent probability of exceedance in approximately 250 years.

6. Uniform Building Code (UBC). The UBC places the project on the Zone 1/2B border. Zone 1 has a seismic coefficient of 0.05g and Zone 2B has a coefficient of 0.1g.

7. Known faults with Late Pleistocene (30,000-50,000 years) and Holocene displacements in the vicinity of Wickenberg (Scarborough and others, 1986). Table 1 below summarizes the known faults, approximate distance to the site, estimated maximum credible earthquake, and the estimated peak horizontal rock acceleration.

Based on a review of the existing seismicity data and evaluation of nearby known faults, the SCS design value (SCS, 1985) of 0.1g is reasonably conservative as a peak design acceleration.

* E A R T H Q U A K E   D A T A   B A S E   S Y S T E M *

FILE CREATED: 24-FEB-1994 11:43:22.76
Circle Search Earthquakes= 17
Latitude: 34.000N Longitude: 112.660W
Radius: 150.000 km
Selected Catalogs: USHIS SRA PDE DNAG
Duplicate Eliminator Used: Time separation (sec) = 10.0000 Distance separation (km) = 15.0000
Acceptable Catalog(s): USHIS SRA PDE DNAG
Magnitude_Intensity interval
Magnitude: 4.0 - 9.9
Intensity: 5 - 12

CATALOG SOURCE	YEAR	MO	DA	ORIGIN TIME		LAT.	LONG.	DEPTH km	STN DEV	mb	OBS	Ms	OBS	CONTRIBUTED VALUES	F-E REG	STA	INFORMATION IEMFMDIPF NFAPOEDFL TFPS	PHENOMENA DTSVNWG PEDG	RADIAL DIST km
SRA	1870	05	11	1720	Z	34.550	-112.470								042	H	5.......P.	....	63
SRA	1871	02	07	2208	Z	34.100	-112.440								042	H	5.......P.	....	23
SRA	1875	12	05	0015	Z	35.200	-112.200								042	I	5.......P.	....	139
SRA	1922	06	17	2342	Z	34.000	-111.200								495	G	5.......P.	....	134
SRA	1951	07	28	0839	Z	35.000	-112.000								042	G	5.......P.	....	126
PDE	1951	07	28	0840		35.000	-112.000								042		5F........	....	126
SRA	1957	07	20	2249	Z	35.300	-112.900								042	F	5.......P.	....	145
SRA	1971	11	04	021653.70		35.220	-112.168	5						3.70ML GS	042	B	5.......P.	....	142
SRA	1973	04	19	165942.70		34.500	-112.617	0		4.5					042	A	........P.	....N..	33
SRA	1974	03	14	205957.20		34.300	-112.630	0		4.1					042	A	........P.	....N..	33
SRA	1974	12	24	054720.70		33.864	-111.879	4						3.00ML GS	495	C	5.......P.	....	73
USHIS	1976	02	04	000458.10		34.655	-112.500	12		4.9				4.65MWEBB 5.10MLGS	042	B	6F........	....	74
SRA	1976	02	09	030722.0		34.614	-112.550	10		4.6				3.30ML GS	042	B	2.......P.	....	69
USHIS	1976	02	23	140954.40		34.679	-112.432	10						3.50MLGS	042	B	6F........	....	78
DNAG	1976	02	23	141001.05		34.534	-113.063	5						4.19MLPAS	042	021	....	....	71
SRA	1977	10	21	025513.40		34.630	-112.480	10						2.50ML GS	042	C	5.......P.	....	71
SRA	1980	09	15	223022.20		33.590	-111.250	0							495	B	5.......P.	....?..	138

Figure 1
U.S.G.S. Earthquake Data Search
Casandro Wash Detention Dam

SWW35441.GT

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Table 1 Known Faults in Project Area			
Fault	**Distance to Site (KM)**	**MCE**	**Peak Rock Acceleration (g)**
Sand Tank	120	6.6 [1]	0.03
Sugarloaf	174	6.75 [2]	0.03
Horseshoe	94	6.75 to 7 [2]	0.06
Verde	110	7 to 7.25 [2]	0.06
Safford	≥300	7.3 [3]	0.05

(1) Demsey, K.A. and Pearthree, P.A., 1990
(2) USBR, 1986
(3) Bonilla and Others, 1984
(4) USBR, 1976

Subsurface Conditions

The soil encountered at the site generally consisted of well-graded sand with varying amounts of gravel and silts. Two major soil layers were commonly identified in the test pits and soil borings. The upper layer was typically a well-graded sand with some gravel and silt. This material was dry, medium-dense to dense, with approximately 10 to 15 percent gravel and less than 10 percent low plasticity fines. This upper layer varied in thickness from 5 feet to 12 feet in the center and upstream portion of the basin to 16 to greater than 20 feet at the proposed dam site.

Below this surface layer, the material generally contains more gravel (up to 50 percent at TP-15), is very dense or cemented, and contains slightly less fines. Samples typically have a strong reaction to hydrochloric acid indicating a carbonate cementing agent in the soil. These materials were difficult to excavate at some locations (TP-9, TP-14, TP-15, TP-18).

There are graded terraces at both abutment locations of the proposed dam site. Test pits excavated in these terraces indicated that surface soils were moved to the end of terraces to form larger level areas. The ends of these terraces consisted of loose to medium dense silty sand and sand. The material was easily excavated and most likely was placed without much control of compaction.

Groundwater Conditions

Groundwater was not observed in any of the borings drilled during site exploration. The lowest elevation drilled to was approximately 2060 (elevations in this report refer to project datum supplied by the District). Review of well information from Arizona Department of Water Resources listed groundwater elevations in the area of the project site between 2017 and 2052.

Engineering Analysis and Design

This section presents a description of the geotechnical analysis performed and the results of these analyses. The analyses performed included slope stability of the constructed embankments and reservoir side slopes, seepage analysis through the dam, embankment foundation design and estimated settlement, and spillway foundation design. Calculations of the analyses are included in Appendix A.

Slope Stability Analysis

Slope stability analyses were performed for the upstream and downstream slopes of the proposed dam embankment. The typical cross section used to model the embankment in the stability estimates represents the in-place native foundation soil, engineered fill in the foundation with a key trench into the native soil, embankment soil, and a chimney drain. From the stability analyses we conclude that, the embankment except for the rapid drawdown case, has adequate factors of safety.

The computer program UTEXAS3 using Spencer's Method of Slices was used to estimate the critical stability surface for each case considered. The critical stability surface was determined by comparing the factor of safety for each trial surface and selecting the lowest value. Factor of safety is used to characterize each trial surface and is the ratio of the stabilizing forces in the slope system to the displacing forces in the system. Minimum target values for factor of safety are used as a guide and compared to the computed minimum factor of safety values to determine the acceptability of each case. The minimum computed and target values for factor of safety are presented in Table 2. Thousands of individual cases were considered during automatic searches by the computer program to determine the minimum factor of safety values reported in Table 2.

The minimum computer stability estimates for the factor of safety were checked with slope stability chart solutions for the static cases. Charts presented in *An Engineering Manual for Slope Stability Studies* by J.M. Duncan and A.L. Buchignani were used to estimate the factor of safety for the critical cases identified by the computer program. Results of the table solutions compared closely with the computer program results.

All soil zones in the embankment had the same soil strength: a friction angle of 40 degrees and zero cohesion. The foundation soil was modeled with a friction angle of 40 degrees and zero cohesion. The embankment strength was based on the results of direct shear tests on remolded soil samples. The mean average of soil strength data from 5 direct shear tests was 42.8 degrees friction angle and 180 pounds per square foot cohesion. A unit weight of 120 pounds per cubic foot was used in the stability analyses.

Table 2 Summary of Slope Stability Analysis Casandro Wash Dam Embankment Wickenberg, Arizona		
Case	**Factor of Safety**[a]	
	Target[b]	**Estimated**
Upstream slope, 3:1, static, PMF water level	1.5	2.7
Upstream slope, 3:1, seismic acceleration, PMF water level[a]	1.1	1.5
Upstream slope, 3:1, rapid drawdown from PMF water level	1.2	1.2
Downstream slope, 3:1, steady state seepage at PMF water level	1.5	2.7
Downstream slope, 3:1 slope, steady state seepage, seismic acceleration	1.1	1.9

Notes:

[a] All factor of safety values reported for PMF water level.

[b] Target factors of safety based on Soil Conservation Service specified values (SCS, 1985).

A single piezometric surface through the embankment was modeled. Water was impounded in the basin to the PMF Elevation 2162.8, leaving about 1 foot freeboard. The piezometric level through the embankment was controlled by the chimney drain. Groundwater was modeled from the PMF level in the basin to the top of the chimney drain, then dropped through the drain to the top of engineered fill in the foundation. The piezometric surface was held at this elevation from the chimney drain to beyond the downstream toe of the embankment.

Critical circles were reviewed for the static, steady seepage case at probable maximum flood (PMF) and one-half PMF levels with and without seismic acceleration on the upstream and downstream slopes, and for the rapid drawdown case on the upstream slope. The critical surfaces for the upstream and downstream sides of the embankment are either shallow, circular surfaces passing through the slope toe, or shallow, circular surfaces on the slope. These cases either intersect the slope crest just at the top of slope or do not intersect the crest of the slope.

A seismic acceleration of 0.1 times the acceleration of gravity was used to estimate the stability during an earthquake. UTEXAS3 applies a pseudo-static force of 0.1 times the weight of the potentially sliding soil mass to the slope acting in a displacing direction to represent the force of a potential earthquake.

Our stability analysis indicates that should the basin stay full of water for several days and there is significant seepage of water into the dam, instantaneous removal of water may cause upstream slope failure. This may not be a serious concern because the basin will not normally stay full and then be rapidly drawn down. Our stability analysis assumed that the reservoir would remain full until a steady state seepage condition developed (approximately 10 days), then the reservoir was instantaneously dropped to 1/2 the full level. The results of our very conservative assumptions meet the target requirements.

Seepage Analysis

This section presents our analysis of the potential for seepage to enter the dam from the reservoir. This analysis is based on our current understanding of how the dam will be operated. Water will fill the reservoir while the ungated low level outlet continuously discharges. If there is a large storm, the reservoir will fill and continuously discharge through the ungated low level outlet works plus over the spillway.

Seepage into the Dam

Water from the reservoir will seep into the dam due to its presence in the reservoir and the relatively high permeability of the embankment. Based on laboratory permeability tests, we estimate the vertical compacted permeability at 5×10^{-4} cm/sec. Using a Darcy's Law seepage model, water will penetrate the dam in response to water pressure at a velocity equal to the effective permeability times the gradient divided by the porosity. Because the flow is initially unsaturated, it is very difficult to exactly predict the rate of water penetration into the dam, however, with the simple Darcy model we estimate that it will take between 5 and 10 days for the water to reach the proposed chimney drain.

Calculations of seepage quantity were made assuming a horizontal permeability equal to 5×10^{-3} cm/sec. A flow net was created and the calculated seepage into the chimney drain was 390 gallons per minute for a 400 feet length of dam. This value probably has an accuracy of plus or minus 25 percent. The seepage will be collected by the chimney drain and two slotted PVC pipes. Two 8-inch PVC pipes will convey the seepage from the chimney drain.

Chimney Drain Gradation

Calculations were made for the chimney drain gradation based on all the gradations of native soil tested. There is a fairly broad range of natural soil present although it is all called silty sand. Using normal filter criteria for the D-15 size of the filter the following gradation was developed.

The gradation below should be checked during final design if any new information becomes available concerning the length of time water is allowed in the reservoir or the material that will go into the dam.

Sieve Size	% Passing
2-inches	100
1-inch	70-100
3/4-inch	60-100
1/2-inch	50-90
1/4-inch	15-65
No. 4	5-55
No. 8	0-35
No. 16	0-15

Seepage Out of Dam

During drawdown, water will seep out of the dam into the reservoir. This should be done only as fast as the orifice outlet allows, otherwise pore pressures will build up in the embankment. Should the 24-inch slide gate be opened and drawdown greater than about 4 feet per day occur in the upper zone of the reservoir, some surface slope stability problems could occur. The magnitude of sloughing will depend on the depth of water penetration into the dam and the ease with which the water can get out. Our slope stability analysis indicates that the factor of safety for rapid drawdown is approximately 1.2 for instantaneous drawdown of 1/2 of the reservoir. Since it is not physically possible to draw down the reservoir instantaneously some pore pressure dissipation will occur and the slopes should be stable. It is possible that low strength surficial soil could slough. This should be repaired with dozers so that the slope does not progressively deteriorate.

Embankment Settlement

This section presents the results of our settlement analysis of the proposed Casandro Wash Dam. The dam will be approximately 35 feet above the foundation level at its maximum section. This will produce a maximum bearing pressure of approximately 4550 psf. The foundation soils are partially cemented silty sand with a wide range of consistencies. The embankment will be made of the same materials excavated from within the reservoir.

Calculations of settlement of the foundation and compression of the embankment were made using elastic theory. Compressions of 1 to 1.3 inches were calculated for both the embankment and the foundation. This means that the total settlement of the embankment crest is estimated to range from about 2 to 3 inches. These values are typical for small embankments on granular foundations. Most of the settlement should occur during and immediately after the embankment is completed. Some adjustments may also occur after the first major filling of the reservoir. Because of these settlements, we recommend the top of the dam be overbuilt by 6 inches to account for any post-construction settlement.

There will be some variability in settlement as the thickness of the embankment and the foundation compressibility vary. It is intended that the core trench extend down to uniformly partially cemented soil and that no abrupt changes to the fill thickness occur. This will require that the abutments be trimmed back to form positive slopes flatter than 1:1. The overbuild can be put on the dam after it has been completed and no special slope transition is necessary near the dam crest.

Spillway and Stilling Basin

The spillway for the Casandro Wash Dam will consist of an 80-foot-wide opening in the center of the earthfill dam. The height of the opening is approximately 8.5 feet below the crest of the dam. Vertical walls will form the sides of the opening. An ogee crest will be constructed at approximately the centerline of the dam. Retaining walls approximately 11 feet high will form the sides of the chute. A stilling basin approximately 6 feet deep below the downstream channel invert will be constructed at the downstream toe of the dam. Dragons teeth concrete chute blocks will slow the water down and cause a hydraulic jump under the design flows. A concrete slab will form the floor of the chute and stilling basin.

Spillway and Stilling Basin Walls

The allowable bearing capacity was estimated for the spillway and stilling basin walls founded in the constructed embankment. Our analysis assumed a minimum foundation width of 4 feet, with its base 3 feet below the embankment surface. Based on these conditions, an allowable bearing pressure of 1,500 psf was calculated. Settlement is estimated at less than 1 inch

The spillway wall will need to be designed to resist lateral loads from the embankment. For walls allowed to rotate, an active earth pressure of 60 psf per foot of depth was calculated. This pressure assumes embankment material is used as wall backfill and no hydrostatic pressure. An allowable passive resistance was calculated for the spillway walls. A value of 175 psf per foot of soil depth is recommended.

Stilling Basin Uplift

Water will occupy the stilling basin from direct precipitation, flow from the outlet pipe, and flow over the spillway. The flow from direct precipitation and from the outlet pipe will be relatively calm flows and no hydraulic jump is anticipated. The water will simply fill up the stilling basin and go over the downstream lip of the stilling basin into the natural stream channel. The stilling basin will gradually drain through the low level gravity outlet at the bottom of the stilling basin.

When the spillway operates at the design flow of 0.5 PMF, a hydraulic jump will occur in the stilling basin. The hydraulic jump will appear as a series of waves which rise up to a maximum water depth of approximately 10.6 feet based on the hydraulic calculations. We understand that no rip rap will be provided so significant erosion will occur when the flows are high enough to carry off the sandy soil. A concrete cutoff wall has been provided to minimize scour from undermining the stilling basin. As the spillway operates water will tend to seep into the ground downstream of the stilling basin. Seepage will move under the cutoff wall and may reach the underside of the stilling basin floor. This condition will take one or more days to develop if the ground is dry but if the outlet has been flowing for a couple of days then the ground will already be partially saturated and the seepage pressures will develop much quicker.

The magnitude of the seepage or uplift pressure could equal the maximum water surface in the hydraulic jump which was taken to be Elevation 2134.6. With the floor of the stilling basin at Elevation 2122.5, the maximum uplift pressure is estimated to be 755 psf. This force will be resisted by the weight of the concrete and overlying water in the stilling basin.

The calculated pressure distributions under the stilling basin are shown in the calculations in Appendix A. For the specific water surface and hydraulic jump shape shown, the factors of safety against uplift were plotted. With no drainage, the factor of safety was 0.4 in one area of the basin and safety factors below one were calculated for quite large areas. It would take up to approximately 3 additional feet of concrete added to the floor to resist the undrained uplift pressures. The cost for the added concrete is on the order of $20,000 to $30,000. This is much higher than for an underdrain system and therefore an evaluation was made of the uplift pressures with an underdrain system.

The attached calculations show the general layout for relieving pressures under the stilling basin and part way up the spillway chute. A 12-inch thick layer of granular filter material similar to the chiminey drain material would be placed under the horizontal portion of the stilling basin and up to Elevation 2134 on the spillway chute. Several slotted PVC pipes would be placed in the drain material to convey the seepage water to an outlet located in the chute wall at the invert Elevation 2126.0 This drain pipe would have no valves and would only require a screen to prevent rodents from eating and nesting in the pipe. When the spillway operates the pipe would not have any flow until the hydraulic pressure under the slab was equal to Elevation 2126. Based on the attached figures the minimum factor of safety would be 1.3 with the underdrain system normally operating. Should the system deteriorate due to contamination of the filter material with silt then the safety factor could drop to 0.8 over a small area of the basin, however this possiblilty is quite low and any silt that enters the underdrain will likely flush out when the seepage water is discharged. this is an appropirate system for the low frequency that the spillway will be used.

Spillway Chute Uplift

The soil underlying the spillway chute will be embankment material which is a silty sandy soil. The spillway will have a 3:1 slope. The concrete slab will have joints with waterstop material so that seepage through the joints will not occur. The only way seepage could get under the slab is if cracks occur and water seeps into the underlying embankment. This condition is very undesirable because the water could migrate along the soil-concrete interface and build up hydrostatic pressure which could cause the slab to crack or be lifted up. The 12-inch slab can only resist 2.4 feet of water pressure before it is lifted, therefore it is very important that the seepage pressure be minimized under the chute slab.

An 8-inch thick granular filter drain will be provided under the chute slab. This zone will convey seepage water to outlet pipes extending through the chute walls. The outlets will be positioned sufficiently high on the walls to prevent backflow of the water in the chute. The drainage layer will also serve an important function of providing a surface on which to place the rebar and concrete. The sandy embankment soil would be severely disturbed and hard to walk on without a granular drainage layer. The drainage layer will also serve as a filter to prevent silt particles from being sucked up through cracks in the slab. This would occur if negative pressures developed at vertical offsets in the slab and soil particles were sufficiently small to be carried up through the cracks.

Recommendations and Considerations

This section presents geotechnical considerations and recommendations for construction of the embankment dam, reservoir, spillway, and stilling basin, and associated pipes and roadways. These recommendations are for use in preparation of the contract documents. The following design considerations are discussed in the following section:

- Site preparation
- Reservoir grading
- Foundation excavation, preparation, and treatment
- Borrow sources
- Earthfill dam construction
- Spillway and stilling basin
- Outlet pipes
- General construction considerations

Recommendations include terms which are defined as follows:

Relative Compaction. Relative compaction is the ratio (expressed as percent) of the field-compacted dry density to the laboratory maximum dry density determined in accordance with ASTM D698.

Well-Graded. Well-graded is a term used to define a mixture of particles sizes that has no specific concentration or lack thereof, of one or more sizes. Well-graded does not define a numerical value that must be placed on the uniformity coefficient, coefficient of curvature, or other specific grain size parameter. Well-graded is used to define a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

Optimum Moisture Content. optimum moisture content is the soil moisture content determined by ASTM D 698 for maximum dry density for relative compaction.

Site Preparation

Trees, bushes, and ground cover in the vicinity of the embankment, borrow area, and reservoir slopes, should be cleared and grubbed. There is construction debris located throughout the site, primarily along the south slope of the basin and the right dam abutment. This material will need to be removed and properly disposed of offsite.

The upper 6 to 12 inches of soil at the site will contain root balls and vegetative mater. This material should be stripped prior to basin excavation, major roots and deleterious materials removed, and used for final grading of the basin floor.

Reservoir Grading

We recommend that the detention basin slopes be graded to 3H:1V (horizontal to vertical) to reduce sloughing due to reservoir drawdown. Where possible, the slopes should be cut to meet grade requirements. If fill is required to meet minimum grade, the loose soil on the existing surface should be removed. This loose soil could be up to 2 feet thick in some areas. The slope should be cut in a series steps to allow for proper compaction of the new fill into the existing slopes. Thin sliver fills should not be constructed. If necessary, overexcavation of the slope should be performed to allow construction of the basin slope fills in horizontal lifts.

Fill for the basin slopes can be obtained from material excavated from the basin bottom. This material is typically a well graded sand or silty sand. The basin side slope fill should be deposited in loose lifts no greater than 8-inches thick and compacted to 95 percent relative compaction and between -2 and +3 percent of optimum moisture content.

Foundation Excavation

We recommend that the dam embankment be founded on the very dense or cemented material located at the site. Based on our exploration, we estimate that 7 to 12 feet of material below the embankment footprint will need to be removed. Figure 2 shows the estimated depth to foundation material at the dam centerline. Less excavation should be required for the upstream portion of the dam. The final depth of excavation will need to be determined during construction by the Engineer.

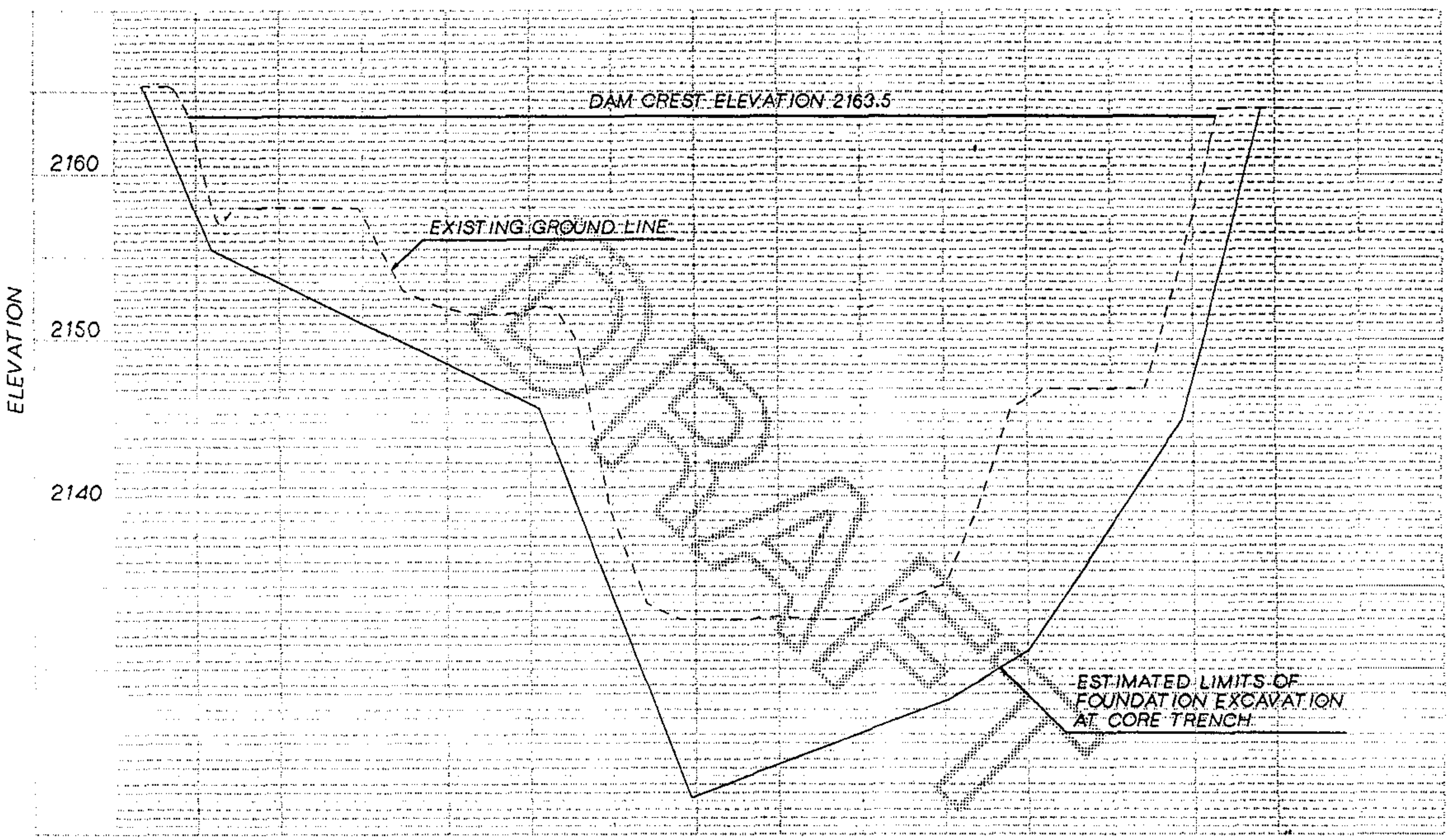
The foundation excavation will have to continue laterally into the dam abutments until the cemented material is encountered. We estimate that the abutment keyway may extend up to 15 to 30 feet horizontally into the current side slopes. Excavations into the abutments should not be steeper than 1H:1V so that rapid changes in embankment do not occur. We understand it is the District's intent to buy the property on the right abutment prior to construction, then sell or use property after the project is completed. Care should be taken to protect the existing structures on this property. The existing shed and chicken coop may need to be removed to construct the dam, as they are located at the edge of the abutment.

After excavation is completed and prior to placement of any backfill, the exposed surface should be observed by the engineer. Any soft or loose material should be removed. All excavations should be free of standing water. If necessary, dewater the site to maintain a water table a minimum of 2 feet below the excavation level.

Borrow Sources

The borrow material for the dam and reservoir grading will come from the detention basin area. This material is typically a dry, medium dense to very dense well graded sand with gravel and silt. The amount of silt and gravel is variable throughout the site. Because of the dry condition of the borrow soil we recommend that the borrow area be prewetted prior to excavation. Prewetting of the borrow soil will take several weeks of continuous watering with irrigation type sprinkler equipment.

5441EXH4.DGN



CROSS-SECTION AT DAM AXIS
LOOKING DOWNSTREAM

SCALE:
1"=100' HORIZONTAL
1"=10' VERTICAL

FIGURE 2
ESTIMATE FOUNDATION EXCAVATION
AT DAM AXIS
CASANDRO WASH DETENTION DAM
SWW35441.GT

CH2M HILL

There were no borrow sources located onsite for chimney drain material, rip-rap, road base, or concrete aggregate. These materials will need to be procured from offsite commercial sources.

Earthfill Dam Construction

We recommend that the dam be a homogenous earthfill dam constructed of the silty sand excavated from the basin site. The dam should be constructed with 3H:1V or flatter slopes both upstream and downstream The crest width of the dam should be a minimum of 14 feet across. The dam should have a minimum 12-foot-wide keyway extending a minimum of 2 feet below the foundation level into dense cemented soil. The dam should be constructed with a central chimney drain along the entire length of the dam. This chimney drain should extend a minimum of 6 feet below the foundation level. A typical cross section of the proposed dam is shown in Figure 3.

Embankment Fill

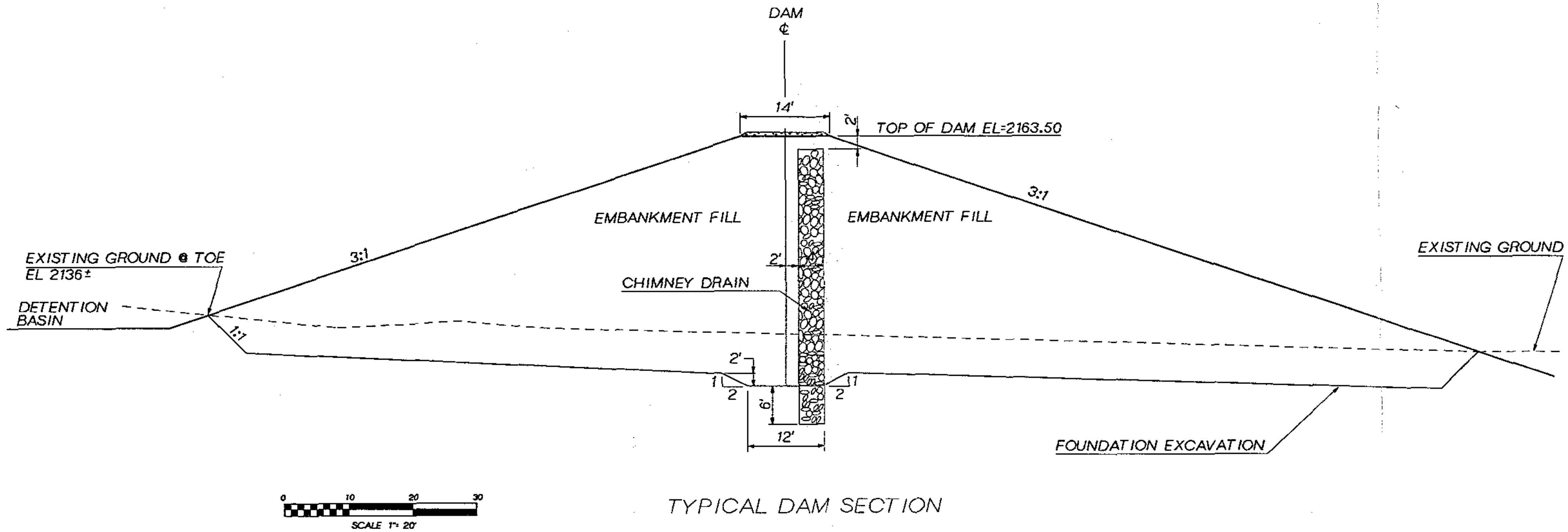
Embankment fill should consist of the silty sandy soil excavated from the basin bottom. Any zones of clean sand or gravel encountered should be well mixed with the silty material prior to placement as embankment fill. This soil should be free of any deleterious material or particles larger than 3 inches in greatest dimension. Embankment fill should be deposited in loose lifts no greater than 8 inches thick. This material should be compacted to an average of 98 percent relative compaction and a minimum of at least 95 percent relative compaction and between -2 and +3 percent of optimum moisture content.

Prior to placement of embankment the foundation material should be scarified to a depth of 6 inches, moisture conditioned, and compacted to a firm and unyielding condition.

We have estimated the settlement of the embankment and underlying foundation material at about 2 to 3 inches. Most of the settlement should occur during and immediately after the embankment is completed. Some adjustments may also occur after the first major filling of the reservoir. Because of these settlements, we recommend the top of the dam be overbuilt by 6 inches to account for any post-construction settlement.

Chimney Drain

We recommend that a 4-foot-wide chimney be constructed 2 feet downstream of the dam centerline, as shown in Figure 3. Based on our seepage analysis, the chimney drain material should be free from clay, organic matter, or other deleterious material and meet the following gradation:



TYPICAL DAM SECTION

FIGURE 3
TYPICAL DAM SECTION
CASANDRO WASH DETENTION DAM
SWW35441.GT

CH2MHILL

Sieve Size	% Passing
2-inches	100
1-inch	70-100
3/4-inch	60-100
1/2-inch	50-90
1/4-inch	15-65
No. 4	5-55
No. 8	0-35
No. 16	0-15

The chimney drain should be constructed at the same time the embankment is constructed. The chimney drain material should be deposited in loose lifts not greater than 8 inches thick and compacted to at least 90 percent relative compaction. A 8-inch slotted Schedule 80 PVC should be installed in the bottom of the chimney drain. This pipe will collect the water in the drain and convey it to the downstream face of the dam. A minimum of 2 solid PVC pipes, 8 inches in diameter, should be installed to convey the water from the drain into the spillway. The location where the pipes outlet the dam should be designed to be accessible for future inspections

Spillway and Stilling Basin

The spillway for the Casandro Wash Dam will consist of an 80-foot-wide opening in the center of the earthfill dam. The height of the opening is approximately 10.7 feet below the crest of the dam. Vertical walls will form the sides of the opening. An ogee crest will be constructed at approximately the centerline of the dam. Retaining walls approximately 11 feet high will form the sides of the chute. A stilling basin approximately 6 feet deep below the downstream channel invert will be placed at the downstream toe of the dam. Dragons teeth concrete chute blocks will slow the water down and cause a hydraulic jump under the design flows. A concrete slab will form the floor of the chute and stilling basin.

Foundation Parameters

Spillway Entrance Walls and Footings

At the crest of the dam beneath the ogee crest a cutoff wall should be constructed under the concrete slab extending to a depth of 5 feet below the base of the slab. Laterally, the cutoff wall should extend 8 feet beyond the outside of the chute walls into the embankment fill. To the extent possible this wall and all footings in the spillway entrance area should be poured neat against compacted embankment material. All wall footings should be sized for a vertical dead load pressure not to exceed 1500 psf with a one third increase allowed for short term loading caused by wind or seismic forces. Where footings will be close to the upstream face of the dam the footings should be buried sufficiently deep to allow their zone of influence to be entirely within the embankment and not closer to the upstream face than 4 feet. This will allow for some erosion and still provide for adequate embedment. The footing influence zone is a line at 1 horizontal to 1 vertical downward and outward from the base of the footings.

Entrance walls allowed to rotate should be designed for an active earth pressure of 60 pcf per foot of depth. These walls will have compacted embankment backfill with no drainage system. Water will seep behind the walls when the spillway is operating. The water will seep out as the reservoir drains. No large unbalanced water pressures are anticipated.

Chute Walls

Drainage will be provided under the chute floor slab with an 8-inch thick granular material. This drainage layer will wrap around the wall footing and up the chute walls about 2 feet and will prevent hydrostatic pressure from occurring in the chute wall backfill. The chute walls should also be designed for an earth pressure of 60 psf per foot of depth. The drainage system for the chute slab will tie into the chimney drain near the top of the chute. Other outlet pipes will be provided near the main construction joints.

Stilling Basin Walls

The soil backfill behind the walls may become nearly saturated when the stilling basin is operating at maximum flow but the soil should drain as the water in the stilling basin drains. With no water in the stilling basin the lateral earth pressure is anticipated to be 60 psf per foot of depth. Backfill soil unit weight is approximately 115 pcf. Should a passive condition be analyzed, the allowable passive resistance is 175 pcf per foot of soil depth.

An underdrain system is planned for the floor of the stilling basin which will remove uplift pressure on the floor slab. No weep holes will be required in the floor slab. Water will exit the underdrain system through pipes that penetrate the stilling basin walls.

Sliding resistance can be computed by multiplying the footing pressure by a friction coefficient of 0.5.

Stilling Basin Uplift

The potential exists for uplift on the stilling basin floor slab and sloping chute slab caused by groundwater in the vicinity of the stilling basin. To prevent uplift of the concrete slabs, there should be a cutoff wall around the three downstream sides of the stilling basin extending to a depth of 10 feet below the wash channel invert. This wall will decrease the flow of water toward the stilling basin floor and act to prevent undermining erosion.A 12-inch thick layer of granular filter material similar to the chiminey drain material would be placed under the horizontal portion of the stilling basin and up to Elevation 2134 on the spillway chute. Several slotted PVC pipes would be placed in the drain material to convey the seepage water to an outlet located in the chute wall at the invert Elevation 2126.0 This drain pipe would have no valves and would only require a screen to prevent rodents from eating and nesting in the pipe. When the spillway operates the pipe would not have any flow until the hydraulic pressure under the slab was equal to Elevation 2126.

Spillway Chute Recommendations

The soil underlying the spillway chute will be embankment material which is a silty sandy soil. The spillway will have a 3:1 slope. The concrete slab will have joints with waterstop material so that seepage through the joints will not occur. The only way seepage could get under the slab is if cracks occur and water seeps into the underlying embankment. This condition is very undesirable because the water could migrate along the soil-concrete interface and build up hydrostatic pressure which could cause the slab to crack or be lifted up. The 12-inch slab can only resist 2.4 feet of water pressure before it is lifted, therefore it is very important that the seepage pressure be minimized under the chute slab.

An 8-inch-thick granular filter drain will be provided under the chute slab. This zone will convey seepage water to outlet pipes extending through the chute walls. The outlets will be positioned sufficiently high on the walls to prevent backflow of the water in the chute. The drainage layer will also serve an important function of providing a surface on which to place the rebar and concrete. The sandy embankment soil would be severely disturbed and hard to walk on without a granular drainage layer. The drainage layer will also serve as a filter to prevent silt particles from being sucked up through cracks in the slab. This would occur if negative pressures developed at vertical offsets in the slab and soil particles were sufficiently small to be carried up through the cracks.

Piping Through the Embankment

There will be 4 new pipes passing through the new embankment. These include a relocated sewer line, the low flow outlet pipe, and 2 pipes that drain the chimney drain. Except for the sewer pipe, all the new pipes will be constructed in the embankment fill. The sewer line may be installed in the foundation soil below the final foundation excavation level. For pipelines installed within the embankment fill, the embankment should be constructed to a level 2 feet above the top of the pipe. The pipe trench can then be excavated and the pipe installed in the trench.

The sewer line is a 12-inch ductile iron pipe that will be installed approximately 10 feet below the existing ground surface just to the south of the spillway. If the sewer line is installed below the foundation excavation level, it should be backfilled up to the excavation level with a concrete slurry. If the sewer pipe is installed within the embankment fill, the trench should be excavated as stated above. Backfill should consist of concrete slurry up to a height of 1 foot above the top of the pipe. The remaining trench should be backfilled with embankment fill. A cutoff wall may be required where the pipe passes through the chimney drain.

The low flow outlet pipe is a 36-inch-diameter reinforced concrete pipe. Backfill for this pipe should consist of concrete slurry up to the top of the trench from the upstream face to 4 feet downstream of the chimney drain. From that point until the spillway, the pipe backfill should be drain material similar to the chimney drain.

The outlet pipes for the chimney drain consist of 8-inch concrete or PVC pipes. Backfill for these pipes should be the same as for the low flow outlet.

General Construction Considerations

It is neither the intent of this report, nor within the scope of the geotechnical work, to recommend construction methods or procedures. For the proposed project, it is the responsibility of the Contractor to use sound construction methods and procedures in accordance with the strictest government safety standards.

Variations in soil and geologic conditions are possible and may be encountered during construction. We recommend that a geotechnical engineer be retained to provide engineering services during construction of the work. This is to observe compliance with the intent of the design concepts, specifications, or recommendations, and to allow design changes in the event that subsurface conditions differ from those anticipated prior to start of construction.

Excavation

The predominant materials occurring along the pipeline alignment are sand and silty sand with gravel with weak to strong cementation. This material was excavated with a CAT EL200B excavator during field exploration. Excavation of this material using conventional excavation equipment should be possible. There were several areas in the basin where very strongly cemented materials caused difficulty with backhoe excavation. At these locations, specialized excavation equipment may be required. Drilling and blasting excavation methods should not be allowed because of the proximity of the existing homes and buildings to the project site.

Any temporary sloping, sheeting, or shoring of trenches and structure excavations should be made the responsibility of the Contractor. All excavations should be accomplished in accordance with applicable federal, state, and local standards.

Ground and Surface Water

Groundwater is not expected to be encountered in the pipeline and foundation excavations. However, surface water could be a problem during construction. Heavy runoff during and after rainfall should be diverted from excavations. The Contractor should protect the exposed subgrade and all partially completed portions of the project from ponding the water.

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Appendix A

Calculations

MEMORANDUM

CH2M HILL

TO: File

FROM: Dale Smith

DATE: August 11, 1994

SUBJECT: Stability Calculations, Casandro Wash Detention Basin, Wickenberg, Arizona

PROJECT: SWW35441.GT.40

The Casandro Wash Detention Basin in Wickenberg, Arizona, is proposed as an engineered earthfill embankment. The embankment will have a 3 (horizontal) to 1 (vertical) slope on the upstream side and a 3:1 slope on the downstream side. The embankment will consist of soil material processed at the site and will essentially be a well graded sand that may have a small clay content. A chimney drain zone will consist of a cleaner sand. An ogee weir spillway is proposed over the top of the embankment.

The analyses were performed for the maximum vertical section of the embankment only. It is assumed that all other, shorter, sections are at least as safe as the tallest section for the modes of 2-dimensional stability considered. The following topics are presented in these calculations:

- Material strength selection
- Upstream embankment slope stability
  - Static, steady seepage at full PMF water level
  - Rapid drawdown from full PMF water level
  - Steady state seepage at full PMF water level during earthquake
- Downstream embankment slope stability
  - Steady state seepage at full PMF water level
  - Steady state seepage at full PMF water level during earthquake

Material Strength Selection

A series of shear tests were performed on remolded samples. The shear strength of each sample was estimated using a direct shear test with three normal loads. The sample was sheared to failure for each loading. The normal and shear stresses were computed from the normal and shear forces applied to the samples. The shear strengths from these tests and the design shear strength are presented in Table 1. The laboratory data is presented in *Geotechnical Report, Volume 1, Field and Laboratory Data.*

Table 1
Summary of Laboratory and Design Shear Strengths
Casandro Wash Detention Basin
Wickenberg, Arizona

Sample	ASTM Soil Classification	Shear Strength	
		Friction Angle (degrees)	Cohesion (kips per square foot)
TP-2, B-1, 3 ft	SW	39	0.4
TP-4, B-2, 14 ft	SW-SM	45	0.0
TP-8, B-2, 15 ft	SW-SM	40	0.5
TP11, B-3, 14 ft	SM	45	0.0
TP-12, B-1, 4 ft	SM	27	1.55
TP-13, B-1, 4 ft	SP-SM	45	0.0
Average value[a]		42.8	0.2
Design value for engineered fill		40	0.0

Notes:
[a] Considers 5 values, average does not include phi = 27, c = 1.55 ksf strength value.

These shear tests were performed on the sand sized portion of the samples. Grain size index tests were performed on 24 samples. The percentage by weight of these samples larger than the sand size ranges from 10 to 60 percent. The maximum gravel size in these samples was 2 inches, with the gravel size ranging from 0.75 to 2 inches. The soil used for the embankment shells will be a gravelly sand or sandy gravel and is expected to have a higher shear strength than that used in these calculations. A unit weight of 120 pcf was used for all material placed in the foundation and embankment.

A shear strength of phi = 40 degrees and c = 0.3 ksf was used for the undisturbed foundation soil. A 130 pcf unit weight was used for the undisturbed foundation soil.

Embankment Slope Stability

Slope stability estimates were made with 2 methods. The computer program UTEXAS3 was used to locate the potential sliding surface through the soil mass with the least factor of safety. Two of the least factor of safety values determined by the computer program were verified with a chart stability solution. Factor of safety is used to characterize each surface considered for stability. The factor of safety is the ratio of the sum of the stabilizing forces (soil strength) in the slope to the destabilizing forces (soil weight, seepage forces, seismic loading). The factor of safety must always be greater than 1 or the analysis represents an unstable condition. Target factor of safety values greater than 1 are used as a guide to determine the acceptability of each minimum factor of safety case. The computed and target factors of safety are presented in Table 2.

Presentation of UTEXAS3 Computer Program

Spencer's method of slices was used by the UTEXAS3 computer program to compute the factor of safety for each trial case. 100 to 200 individual cases were considered during each computer run and the lowest reported as the critical factor of safety for the case represented by the particular computer run. Spencer's method of slices is a slope stability solution method that divides the mass being considered in the analysis into slices, and assumes that the side force acting between slices acts at a constant angle for all slices. The program assumes the interslice force angle and computes the other forces acting on the slice from the material properties and geometry specified. Prints for output representing the critical, lowest factor of safety circle for each case is attached and is explained below.

Program Logic for Solution and Automatic Search

An initial trial circle is specified by the user. The program computes solutions for circles with centers on a 3 by 3 grid centered around this initial circle. User input indirectly establishes the grid spacing. The program "focuses" on centers that represent lowest relative factors of safety and selects additional circles on progressively closer centers about these. This search logic leads the program toward the circle with the least factor of safety.

UTEXAS3 goes through this process based on 3 different, successive, circle identification criteria. The order of these 3 successive searches may be established by the user or the program default. The program uses the lowest factor of safety circle from each circle identification criteria series to begin the search in the next series. The previous lowest factor of safety circle will be the center of the initial search grid in the next search. The program repeats the search for the lowest factor of safety by focusing on the lowest factor of safety centers. When the lowest factor of safety is determined for the second search, this circle is used as the center of the third and final criteria search. The 3 criteria searches and UTEXAS3 output table numbers where they are reported are listed below:

- All trial circles pass through the same point, Table No. 17
- All trial circles are tangent to the same horizontal line, Table No. 18
- All trial circles have the same radius, Table No. 19

Table 2
Summary of Slope Stability
Casandro Wash Dam Embankment
Wickenberg, Arizona

Case	Factor of Safety[a]	
	Target[b]	Estimated
Upstream slope, 3:1, static, PMF water level	1.5	2.7
Upstream slope, 3:1, seismic acceleration, PMF water level[a]	1.1	1.5
Upstream slope, 3:1, rapid drawdown from PMF water level	1.2	1.2
Downstream slope, 3:1, steady state seepage at PMF water level	1.5	2.7
Downstream slope, 3:1 slope, steady state seepage, seismic acceleration	1.1	1.9

Notes:
[a] All factor of safety values reported for PMF water level.
[b] Target factors of safety based on Soil Conservation Service specified values.

When the third search is complete UTEXAS3 prepares a report (Table No. 21) that summarizes the number of circles tried and the number of circles for which a factor of safety was computed. This report also includes the center and radius of the lowest factor of safety determined in the three successive circle identification criteria searches.

Explanation of Program Input

The information input to describe slope geometry, loading conditions, and material properties is listed in the first several report tables in the attached output. The geometry is described with a series of line segments. For each line segment the X and Y coordinates for each end point and the material type below the line segment are specified. Material properties are stated for each material type. An explanation is provided below for each table in the attached output that describes the input. The tables are not necessarily in ascending numeric order, and some numbers may be missing. The solutions for Casandro did not require the full capacity of the computer program.

Table No. 1. This table presents program identification and a user description of the problem.

Table No. 2. Presents the profile line data that describes the slope geometry and soil profile. Each profile line is a series of line segments associated with a single material type.

Table No. 9. Table 9 presents the slope geometry for the slope. In the UTEXAS3 jargon, slope geometry is the uppermost of profile lines that describes the ground surface and top of embankment. In the cases considered for Casandro this is a simple relationship. This data in this table can be specified by the user or computed by UTEXAS3.

Table No. 10. Surface pressure data is reported in this table. In the Casandro runs surface pressure was used to represent the weight of impounded water on the upstream bottom of basin and upstream embankment slope. The values were computed as the depth of water times the unit weight of water at key points required to describe the water becoming shallower towards the top of the embankment.

Table No. 3. Material properties input by the user are reported for each material in Table 3.

Table No. 5. The input piezometric surface is reported in this table. The piezometric surface specified in the Casandro runs is coincident with the PMF water level in the basin upstream of the embankment. The piezometric surface curves downward through the embankment to the sand drain, where it drops nearly vertically to the bottom of the embankment elevation. The piezometric surface stays at this elevation beneath the downstream embankment shell, daylighting at the downstream embankment toe.

Table No. 15. Location information describing the user specified initial circle for the first automatic search is reported in Table 15. The minimum-spacing-between-grid-point value is used to determine the "fineness" or smallest spacing of the search. The initial-search-grid spacing is also determined by this input value as 30 times the minimum spacing. Comparing this value to the X and Y spacing in the first several lines of Table No. 17 shows this relationship.

Explanation of Program Output Generated by UTEXAS3

The tables described below present information that the UTEXAS3 program computes from the geometry and material property information described above.

Table No. 17. Table 17 reports 6 pieces of information for each trial surface for which the program completes a computation. This table reports computations based on all circles passing through the same point.

Table No. 18. In Table 18 the same 6 pieces of identifying information is reported for each trial surface, but the criteria for the circles is that all are tangent to the same line.

Table No. 19. Table 19 is similar to Table 17 and 18. The search criteria common to the circles reported in Table 19 is that they all have the same radius.

Table No. 21. Table No. 21 identifies the most critical circle (with the lowest factor of safety) from the 3 search criteria computation series. UTEXAS3 will issue a caution statement at the end of this table if some circles that were attempted could not have factors of safety computed. This is not an error message and alerts the user that the "number of circles tried" does not equal the "number of circles factor of safety computed for" as reported in Table No. 21. Review of the circles reported in Tables 17, 18, and 19 will reveal the reason for which factors of safety could not be computed for particular circles.

Table No. 26. Material properties that apply to the critical circle at the base of each slice, slice weight, and pore pressure at the base of the slice are reported in Table 26. The X and Y coordinates determined by the program for the right and left sides and the center of each slice are reported.

Table No. 27. Seismic forces and forces due to surface pressures acting on each slice in the critical circle are reported in this table.

Table No. 29. Corrections the program applies to the assumed side-force magnitude and direction are reported in this table for the circle reported with the lowest factor of safety in Table No. 21.

Table No. 38. Stresses along the bottom of the slices in the critical circle are reported in this table. These values are reviewed for reasonableness (i.e. no negative stresses acting on the base of a slice) for the critical circle.

Table No. 39. Stresses between the slices in the critical circle are reported in this table. These also must be reviewed for reasonableness for the critical circle.

Upstream Embankment Stability

Three cases were considered for the upstream embankment. The cases and computation results for each are presented below. All of the stability computations indicated adequate factor of safety for the full PMF condition. This represents a water level that may never be experienced by the embankment.

Static, Steady Seepage

This case is represented by the piezometric line described above for Table No. 5. Water is modeled impounded to the full PMF level. The factor of safety for this case is 2.7.

Seismic Acceleration at Full PMF

This combination of events occurring simultaneously is an extremely rare event that will most likely not occur during the life of the embankment. However, the factor of safety from a full PMF and a seismic acceleration of 0.1g loading the embankment simultaneously is 1.5 on the upstream slope.

Rapid Drawdown from Full PMF

The rapid drawdown drainage condition was modeled in UTEXAS3 by reducing the surface pressure representing the weight of water and setting the piezometric surface equal to the upstream embankment slope surface elevation from the PMF elevation, down the slope to ½ the PMF elevation, and across the basin away from the embankment. This condition would only develop if the basin was at the full PMF level long enough for steady state flow conditions to develop through the embankment. The critical surface is a shallow slip in the upstream slope. This same critical slip was identified for rapid drawdown from the 1/2 PMF and 100-year water levels also. The two latter cases are not presented since the only difference is the top elevation of the piezometric surface. The factor of safety is 1.2 on the upstream slope. This factor of safety is equal to the target factor of safety of 1.2.

The function of the detention basin is usually to be empty, only filling during storm flows in Casandro Wash. The basin serves as a temporary holding basin, with the primary use of flattening the storm hydrograph in the wash below the basin. Consequently the basin is only "full" for a short time, and is constantly draining through the outlet works. The basin will be operated to empty by continuous draining as soon as it begins to collect water. The rapid drawdown critical surface is shallow, and is based on an analysis that models the basin being reduced to ½ full "instantly" after achieving steady state seepage through the embankment. Considering these factors, the factor of safety of 1.2 is considered acceptable for this embankment.

Downstream Embankment Stability

Two cases were considered for the downstream embankment. The cases and computation results for each are presented below. All of the stability computations indicated adequate factor of safety. Stability estimates were made for downstream slopes at 2:1 and 3:1. All cases considered had adequate factors of safety. The project team selected a 3:1 downstream slope during the week of August 9, 1994, so only cases for the 3:1 slope are presented below.

Static, Steady Seepage

The piezometric surface does not affect the downstream slope since it drains into the chimney drain. The factor of safety for the 3:1 slope is 2.7

Seismic Acceleration

Downstream slope stability for 0.1g horizontal ground acceleration was computed. The factor of safety for a 3:1 slope is 1.9.

INPUT CHECKED D. [illegible] 10/10/94

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:17:1994 Time: 11:42:59 Input file: casan.txt

TABLE NO. 1

```
*****************************************
* COMPUTER PROGRAM DESIGNATION - UTEXAS3 *
* Originally Coded By Stephen G. Wright  *
* Version No. 1.107                      *
* Last Revision Date 10/13/91            *
* (C) Copyright 1985-1991 S. G. Wright   *
* All Rights Reserved                    *
*****************************************

***************************************************************
*                                                             *
*      RESULTS OF COMPUTATIONS PERFORMED USING THIS COMPUTER *
* PROGRAM SHOULD NOT BE USED FOR DESIGN PURPOSES UNLESS THEY *
* HAVE BEEN VERIFIED BY INDEPENDENT ANALYSES, EXPERIMENTAL   *
* DATA OR FIELD EXPERIENCE. THE USER SHOULD UNDERSTAND THE   *
* ALGORITHMS AND ANALYTICAL PROCEDURES USED IN THE COMPUTER  *
* PROGRAM AND MUST HAVE READ ALL DOCUMENTATION FOR THIS      *
* PROGRAM BEFORE ATTEMPTING ITS USE.                         *
*                                                             *
*      NEITHER THE UNIVERSITY OF TEXAS NOR STEPHEN G. WRIGHT *
* MAKE OR ASSUME LIABILITY FOR ANY WARRANTIES, EXPRESSED OR  *
* IMPLIED, CONCERNING THE ACCURACY, RELIABILITY, USEFULNESS  *
* OR ADAPTABILITY OF THIS COMPUTER PROGRAM.                  *
*                                                             *
***************************************************************
```

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CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Static

TABLE NO. 2

```
************************
* NEW PROFILE LINE DATA *
************************
```

PROFILE LINE 1 - MATERIAL TYPE = 4
Ground surface beyond downstream toe

Point	X	Y
1	233.000	50.000
2	300.000	50.000

PROFILE LINE 2 - MATERIAL TYPE = 3
Ground surface beyond toe above foundation soil

Point	X	Y
1	200.000	50.000
2	233.000	50.000

PROFILE LINE 3 - MATERIAL TYPE = 1
Downstream dam slope, crest, upstream dam slope

Point	X	Y
1	4.500	50.000
2	94.500	80.000
3	108.500	80.000
4	200.000	50.000

PROFILE LINE 4 - MATERIAL TYPE = 3
Ground surface upstream above foundation soil

Point	X	Y
1	-8.000	50.000
2	4.500	50.000

PROFILE LINE 5 - MATERIAL TYPE = 4
Ground surface upstream beyond toe

Point	X	Y
1	-50.000	50.000
2	-8.000	50.000

PROFILE LINE 6 - MATERIAL TYPE = 2
Chimney drain

Point	X	Y
1	111.000	42.000
2	111.000	50.000
3	111.000	75.000
4	115.000	75.000
5	115.000	50.000
6	115.000	43.000

PROFILE LINE 7 - MATERIAL TYPE = 3
Bottom of dam embankment, downstream of chimney drain

Point	X	Y
1	115.000	50.000
2	200.000	50.000

PROFILE LINE 8 - MATERIAL TYPE = 3
Bottom of dam embankment, upstream of chimney drain

Point	X	Y
1	4.500	50.000
2	111.000	50.000

PROFILE LINE 9 - MATERIAL TYPE = 4
Bottom of foundation soil above undisturbed native soil

Point	X	Y
1	-8.000	50.000
2	4.500	44.000
3	94.000	44.000
4	100.000	42.000
5	111.000	42.000
6	112.000	42.000
7	115.000	43.000
8	117.000	44.000
9	230.000	44.000
10	233.000	50.000

All new profile lines defined - No old lines retained
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TABLE NO. 3

****

* NEW MATERIAL PROPERTY DATA - CONVENTIONAL/FIRST-STAGE COMPUTATIONS *

****

DATA FOR MATERIAL TYPE 1
embankment fill

Unit weight of material = 120.000

CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS
Cohesion - - - - - - - - .000
Friction angle - - - - - 40.000 degrees

Pore water pressures defined by piezometric line
Number of the piezometric line used = 1
Negative pore pressures set to zero

DATA FOR MATERIAL TYPE 2
chimney drain

Unit weight of material = 120.000

CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS
Cohesion - - - - - - - - .000
Friction angle - - - - - 40.000 degrees

Pore water pressures defined by piezometric line
Number of the piezometric line used = 1
Negative pore pressures set to zero

DATA FOR MATERIAL TYPE 3
compacted fill in cut off trench

Unit weight of material = 120.000

CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS
Cohesion - - - - - - - - .000
Friction angle - - - - - 40.000 degrees

Pore water pressures defined by piezometric line
Number of the piezometric line used = 1
Negative pore pressures set to zero

DATA FOR MATERIAL TYPE 4
native soil

Unit weight of material = 130.000

CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS
Cohesion - - - - - - - - .000
Friction angle - - - - - 40.000 degrees

Pore water pressures defined by piezometric line
Number of the piezometric line used = 1
Negative pore pressures set to zero

All new material properties defined - No old data retained

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3:1 downstream dam embankment slope
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TABLE NO. 5

****

* NEW PIEZOMETRIC LINE DATA - CONVENTIONAL/FIRST-STAGE COMPUTATIONS *

****

Line No.	Point	X	Y	
1 - Unit weight of water =			62.40	Water level through dam at ful
1	1	-50.000	79.000	Water level through dam at ful
1	2	4.500	79.000	Water level through dam at ful
1	3	91.500	79.000	Water level through dam at ful
1	4	101.000	77.500	Water level through dam at ful
1	5	106.000	76.000	Water level through dam at ful
1	6	111.000	71.000	Water level through dam at ful
1	7	115.000	50.000	Water level through dam at ful
1	8	200.000	50.000	Water level through dam at ful
1	9	300.000	40.000	Water level through dam at ful

All new piezometric lines defined - No old lines retained

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TABLE NO. 10

****

* NEW SURFACE PRESSURE DATA - CONVENTIONAL/FIRST-STAGE COMPUTATIONS *

****

ALL NEW DATA INPUT - NO OLD DATA RETAINED

Surface Pressures -

Point	X	Y	Normal Pressure	Shear Stress
1	-50.000	50.000	1800.000	.000
2	4.500	50.000	1800.000	.000
3	69.000	71.500	.000	.000

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CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Static

TABLE NO. 15

****

* NEW ANALYSIS/COMPUTATION DATA *

****

Circular Shear Surface(s)

Automatic Search Performed

Starting Center Coordinate for Search at -
X = 146.000
Y = 110.000

Required accuracy for critical center (= minimum
spacing between grid points) = 1.000

Critical shear surface not allowed to pass below Y = 44.000

For the initial mode of search
all circles are tangent to horizontal line at -

Y = 44.000

Depth of crack = 4.000

THE FOLLOWING REPRESENT EITHER DEFAULT OR PREVIOUSLY DEFINED VALUES:

Initial trial estimate for the factor of safety = 3.000

Initial trial estimate for side force inclination = 15.000 degrees
(Applicable to Spencer's procedure only)

Maximum number of iterations allowed for
calculating the factor of safety = 40

Allowed force imbalance for convergence = 100.000

Allowed moment imbalance for convergence = 100.000

Initial trial values for factor of safety (and side force inclination
for Spencer's procedure) will be kept constant during search

Maximum subtended angle to be used for subdivision of the
circle into slices = 3.00 degrees

Search will be continued to locate a more critical shear
surface (if one exists) after the initial mode is complete

Depth of water in crack = .000

Unit weight of water in crack = 62.400

Seismic coefficient = .000

Conventional (single-stage) computations to be performed

Procedure used to compute the factor of safety: SPENCER

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TABLE NO. 16
****
* NEW SLOPE GEOMETRY DATA *
****

NOTE - NO DATA WERE INPUT, SLOPE GEOMETRY DATA
WERE GENERATED BY THE PROGRAM

Slope Coordinates -

Point	X	Y
1	-50.000	50.000
2	-8.000	50.000
3	4.500	50.000
4	94.500	80.000
5	108.500	80.000
6	200.000	50.000
7	233.000	50.000
8	300.000	50.000

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TABLE NO. 18
INFORMATION FOR CURRENT MODE OF SEARCH - All Circles Are Tangent
to a Horizontal Line at Y = 44.000

Center Coordinates X	Y	Radius	1-Stage Factor of Safety	Side Force Inclination (degrees)	Iterations
116.00	80.00	36.00	7.530	-22.00	14

Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR 6 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW - S1 S6

X	Y	Radius	Factor of Safety	Side Force Inclination (degrees)	Iterations
146.00	80.00	36.00	4.751	-11.06	6
176.00	80.00	36.00	3.318	-13.43	4
116.00	110.00	66.00	8.440	-3.69	14
146.00	110.00	66.00	3.525	-12.22	4
176.00	110.00	66.00	2.864	-15.49	4
116.00	140.00	96.00	8.943	-3.53	15
146.00	140.00	96.00	3.629	-10.38	4
176.00	140.00	96.00	2.789	-15.78	4
206.00	110.00	66.00	4.118	-6.98	6
206.00	140.00	96.00	3.534	-8.85	5
146.00	170.00	126.00	3.917	-9.00	5
176.00	170.00	126.00	2.810	-14.90	3
206.00	170.00	126.00	3.278	-10.20	4
171.00	135.00	91.00	2.846	-15.73	4
176.00	135.00	91.00	2.791	-15.84	4
181.00	135.00	91.00	2.754	-15.52	4
171.00	140.00	96.00	2.835	-15.65	4
181.00	140.00	96.00	2.750	-15.57	4
171.00	145.00	101.00	2.828	-15.53	3
176.00	145.00	101.00	2.786	-15.72	4
181.00	145.00	101.00	2.755	-15.52	4
186.00	135.00	91.00	2.764	-14.65	3
186.00	140.00	96.00	2.761	-14.73	3
186.00	145.00	101.00	2.759	-14.80	3
178.00	137.00	93.00	2.767	-15.82	4
181.00	137.00	93.00	2.752	-15.54	4
184.00	137.00	93.00	2.754	-15.07	3
178.00	140.00	96.00	2.773	-15.72	4
184.00	140.00	96.00	2.752	-15.11	3
178.00	143.00	99.00	2.775	-15.68	4
181.00	143.00	99.00	2.750	-15.57	4
184.00	143.00	99.00	2.751	-15.15	4
180.00	139.00	95.00	2.752	-15.68	4
181.00	139.00	95.00	2.751	-15.56	4
182.00	139.00	95.00	2.750	-15.42	4
180.00	140.00	96.00	2.752	-15.69	4
182.00	140.00	96.00	2.749	-15.44	4
180.00	141.00	97.00	2.754	-15.66	4
181.00	141.00	97.00	2.749	-15.58	4
182.00	141.00	97.00	2.748	-15.45	4
183.00	140.00	96.00	2.750	-15.28	4
183.00	141.00	97.00	2.750	-15.29	4
181.00	142.00	98.00	2.748	-15.59	4

182.00	142.00	98.00	2.748	-15.46	4
183.00	142.00	98.00	2.749	-15.30	4
182.00	143.00	99.00	2.747	-15.47	4
183.00	143.00	99.00	2.748	-15.31	4
181.00	144.00	100.00	2.752	-15.55	4
182.00	144.00	100.00	2.746	-15.48	4
183.00	144.00	100.00	2.748	-15.32	4
182.00	145.00	101.00	2.748	-15.47	4
183.00	145.00	101.00	2.747	-15.33	4

At the end of the current mode of search the most critical
circle which was found has the following values -
X-center = 182.00 Y-center = 144.00 Radius = 100.00
Factor of Safety = 2.746 Side Force Inclination = -15.48

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3:1 downstream dam embankment slope
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TABLE NO. 19
INFORMATION FOR CURRENT MODE OF SEARCH - All Circles Have the
Same Radius - Radius = 100.000

Center Coordinates X	Y	Radius	1-Stage Factor of Safety	Side Force Inclination (degrees)	Iterations
152.00	114.00	100.00	Bottom of circle exceeds allowable depth - CIRCLE REJECTED		
182.00	114.00	100.00	Bottom of circle exceeds allowable depth - CIRCLE REJECTED		
212.00	114.00	100.00	Bottom of circle exceeds allowable depth - CIRCLE REJECTED		
152.00	144.00	100.00	3.356	-11.65	4
212.00	144.00	100.00	4.430	-7.08	6
152.00	174.00	100.00	See Message on Next Line(s)		
CIRCLE DOES NOT INTERSECT SLOPE					
182.00	174.00	100.00	See Message on Next Line(s)		
CIRCLE DOES NOT INTERSECT SLOPE					
212.00	174.00	100.00	See Message on Next Line(s)		
CIRCLE DOES NOT INTERSECT SLOPE					
177.00	139.00	100.00	Bottom of circle exceeds allowable depth - CIRCLE REJECTED		
182.00	139.00	100.00	Bottom of circle exceeds allowable depth - CIRCLE REJECTED		
187.00	139.00	100.00	Bottom of circle exceeds allowable depth - CIRCLE REJECTED		
177.00	144.00	100.00	2.780	-15.71	4
187.00	144.00	100.00	2.766	-14.58	3
177.00	149.00	100.00	2.906	-16.41	4
182.00	149.00	100.00	2.872	-16.48	4
187.00	149.00	100.00	2.844	-16.50	4
179.00	141.00	100.00	Bottom of circle exceeds allowable depth - CIRCLE REJECTED		
182.00	141.00	100.00	Bottom of circle exceeds allowable depth - CIRCLE REJECTED		
185.00	141.00	100.00	Bottom of circle exceeds allowable depth - CIRCLE REJECTED		
179.00	144.00	100.00	2.770	-15.61	4
185.00	144.00	100.00	2.754	-14.98	3
179.00	147.00	100.00	2.806	-16.61	4
182.00	147.00	100.00	2.785	-16.57	4
185.00	147.00	100.00	2.775	-16.40	4
181.00	143.00	100.00	Bottom of circle exceeds allowable depth - CIRCLE REJECTED		
182.00	143.00	100.00	Bottom of circle exceeds allowable depth - CIRCLE REJECTED		
183.00	143.00	100.00	Bottom of circle exceeds allowable depth - CIRCLE REJECTED		
181.00	144.00	100.00	2.752	-15.55	4
183.00	144.00	100.00	2.748	-15.32	4
181.00	145.00	100.00	2.752	-16.03	4
182.00	145.00	100.00	2.751	-15.92	4
183.00	145.00	100.00	2.750	-15.79	4

At the end of the current mode of search the most critical
circle which was found has the following values -
X-center = 182.00 Y-center = 144.00 Radius = 100.00
Factor of Safety = 2.746 Side Force Inclination = -15.48

***** CAUTION ***** FACTOR OF SAFETY COULD NOT BE COMPUTED FOR SOME
OF GRID POINTS AROUND THE MINIMUM
***** RESULTS MAY BE ERRONEOUS *****

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TABLE NO. 21
***** 1-STAGE FINAL CRITICAL CIRCLE INFORMATION *****
X Coordinate of Center - - - - - - - 182.000
Y Coordinate of Center - - - - - - - 144.000
Radius - - - - - - - - - - - - - - - 100.000
Factor of Safety - - - - - - - - - - 2.746
Side Force Inclination - - - - - - - -15.48

Number of circles tried - - - - - - 85
No. of circles F calc. for - - - - - 70

***** CAUTION ***** FACTOR OF SAFETY COULD NOT BE COMPUTED FOR SOME
OF GRID POINTS AROUND THE MINIMUM
***** RESULTS MAY BE ERRONEOUS *****

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TABLE NO. 26
****
* Coordinate, Weight, Strength and Pore Water Pressure *
* Information for Individual Slices for Conventional *
* Computations or First Stage of Multi-Stage Computations. *
* (Information is for the Critical Shear Surface in the *
* Case of an Automatic Search.) *
****

Slice No.	X	Y	Slice Weight	Matl. Type	Cohesion	Friction Angle	Pore Pressure

	108.8	75.9					
1	109.9	74.7	1292.0	1	.00	40.00	.0
	111.0	73.6					
2	111.5	73.1	712.0	2	.00	40.00	.0
	112.0	72.6					
3	113.5	71.2	2586.9	2	.00	40.00	.0
	115.0	69.8					
4	116.0	68.9	2077.4	1	.00	40.00	.0
	117.0	68.0					
5	119.0	66.4	4971.6	1	.00	40.00	.0
	121.1	64.7					
6	123.2	63.2	6104.7	1	.00	40.00	.0
	125.3	61.6					
7	127.5	60.2	7147.2	1	.00	40.00	.0
	129.7	58.8					
8	132.0	57.5	8074.3	1	.00	40.00	.0
	134.2	56.2					
9	136.6	55.0	8863.4	1	.00	40.00	.0
	138.9	53.8					
10	141.3	52.7	9494.4	1	.00	40.00	.0
	143.7	51.6					
11	145.8	50.8	8584.0	1	.00	40.00	.0
	147.9	50.0					
12	150.4	49.2	10192.1	3	.00	40.00	51.7
	152.8	48.3					
13	155.4	47.6	10285.9	3	.00	40.00	146.9
	157.9	46.9					
14	160.5	46.4	10172.9	3	.00	40.00	225.6
	163.0	45.8					
15	165.6	45.4	9848.4	3	.00	40.00	287.6
	168.2	45.0					
16	170.8	44.7	9311.6	3	.00	40.00	332.8
	173.4	44.4					
17	176.0	44.2	8564.9	3	.00	40.00	361.0
	178.6	44.1					
18	180.3	44.0	5071.5	3	.00	40.00	372.6
	182.0	44.0					
19	184.6	44.1	6892.7	3	.00	40.00	370.1
	187.2	44.1					
20	189.8	44.3	5629.1	3	.00	40.00	353.0
	192.5	44.5					
21	195.0	44.9	4194.5	3	.00	40.00	318.9
	197.6	45.2					

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3:1 downstream dam embankment slope
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TABLE NO. 26

```
***************************************************************
*  Coordinate, Weight, Strength and Pore Water Pressure       *
*  Information for Individual Slices for Conventional         *
*  Computations or First Stage of Multi-Stage Computations.   *
*  (Information is for the Critical Shear Surface in the      *
*  Case of an Automatic Search.)                              *
***************************************************************
```

Slice No.	X	Y	Slice Weight	Matl. Type	Cohesion	Friction Angle	Pore Pressure
	197.6	45.2					
22	198.8	45.4	1400.9	3	.00	40.00	285.0
	200.0	45.6					
23	202.6	46.2	2353.6	3	.00	40.00	222.9
	205.1	46.7					
24	207.7	47.4	1589.7	3	.00	40.00	115.6
	210.2	48.1					
25	211.3	48.4	437.0	3	.00	40.00	29.0
	212.5	48.8					
26	214.3	49.4	273.2	3	.00	40.00	.0
	216.1	50.0					

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TABLE NO. 27

```
*********************************************************
*  Seismic Forces and Forces Due to Surface Pressures for  *
*  Individual Slices for Conventional  Computations or the *
*  First Stage of Multi-Stage Computations.                *
*  (Information is for the Critical Shear Surface in the   *
*  Case of an Automatic Search.)                           *
*********************************************************
```

				FORCES DUE TO SURFACE PRESSURES			
Slice No.	X	Seismic Force	Y for Seismic Force	Normal Force	Shear Force	X	Y
1	109.9	0.	77.1	0.	0.	109.9	79.5
2	111.5	0.	76.0	0.	0.	111.5	79.0
3	113.5	0.	74.8	0.	0.	113.5	78.4
4	116.0	0.	73.2	0.	0.	116.0	77.5
5	119.0	0.	71.5	0.	0.	119.0	76.5
6	123.2	0.	69.2	0.	0.	123.2	75.2
7	127.5	0.	67.0	0.	0.	127.5	73.8
8	132.0	0.	64.9	0.	0.	132.0	72.3
9	136.6	0.	62.9	0.	0.	136.6	70.8
10	141.3	0.	61.0	0.	0.	141.3	69.3
11	145.8	0.	59.3	0.	0.	145.8	67.8
12	150.4	0.	57.7	0.	0.	150.4	66.3
13	155.4	0.	56.1	0.	0.	155.4	64.6
14	160.5	0.	54.7	0.	0.	160.5	63.0
15	165.6	0.	53.3	0.	0.	165.6	61.3
16	170.8	0.	52.1	0.	0.	170.8	59.6
17	176.0	0.	51.0	0.	0.	176.0	57.9
18	180.3	0.	50.2	0.	0.	180.3	56.5
19	184.6	0.	49.6	0.	0.	184.6	55.0
20	189.8	0.	48.8	0.	0.	189.8	53.3
21	195.0	0.	48.3	0.	0.	195.0	51.6
22	198.8	0.	47.9	0.	0.	198.8	50.4
23	202.6	0.	48.1	0.	0.	202.6	50.0
24	207.7	0.	48.7	0.	0.	207.7	50.0
25	211.3	0.	49.2	0.	0.	211.3	50.0
26	214.3	0.	49.7	0.	0.	214.3	50.0

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TABLE NO. 29

```
*******************************************************************
*  Information Generated During Iterative Solution for the Factor *
*  of Safety and Side Force Inclination by Spencer's Procedure    *
*******************************************************************
```

Trial Factor	Trial Side Force	Force	Moment	Delta

Iter-ation	of Safety	Inclination (degrees)	Imbalance (lbs.)	Imbalance (ft.-lbs.)	Delta-F	Theta (degrees)
1	3.00000	-15.0000	-.3500E+04	.3215E+06		

First-order corrections to F and THETA .... -.271E+00 -.987E+00
Second-order correction - Iteration 1 .... -.249E+00 -.987E+00
Second-order correction - Iteration 2 .... -.249E+00 -.987E+00

2 2.75110 -15.9874 .2752E+02 -.1093E+05
First-order corrections to F and THETA .... -.466E-02 .507E+00
Second-order correction - Iteration 1 .... -.462E-02 .507E+00
Second-order correction - Iteration 2 .... -.462E-02 .507E+00

3 2.74647 -15.4800 -.6744E-02 -.6311E+02
First-order corrections to F and THETA .... -.500E-04 .389E-02
Second-order correction - Iteration 1 .... -.496E-04 .386E-02

4 2.74643 -15.4762 -.2686E-02 -.4966E+00
First-order corrections to F and THETA .... -.758E-06 .452E-04

Factor of Safety - - - - - - - - 2.746
Side Force Inclination - - - - - -15.48
Number of Iterations - - - - - - 4

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:17:1994 Time: 11:42:59 Input file: casan.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizonia
3:1 downstream dam embankment slope
Static

TABLE NO. 38
****
* Final Results for Stresses Along the Shear Surface *
* (Results for Critical Shear Surface in Case of a Search.) *
****

SPENCER'S PROCEDURE USED TO COMPUTE FACTOR OF SAFETY
Factor of Safety = 2.746 Side Force Inclination = -15.48 Degrees

-------- VALUES AT CENTER OF BASE OF SLICE---------

Slice No.	X-center	Y-center	Total Normal Stress	Effective Normal Stress	Shear Stress
1	109.9	74.7	378.5	378.5	115.6
2	111.5	73.1	476.5	476.5	145.6
3	113.5	71.2	589.3	589.3	180.1
4	116.0	68.9	727.8	727.8	222.4
5	119.0	66.4	881.0	881.0	269.2
6	123.2	63.2	1076.8	1076.8	329.0
7	127.5	60.2	1258.3	1258.3	384.4
8	132.0	57.5	1422.7	1422.7	434.7
9	136.6	55.0	1567.4	1567.4	478.9
10	141.3	52.7	1689.7	1689.7	516.2
11	145.8	50.8	1782.3	1782.3	544.5
12	150.4	49.2	1850.2	1798.5	549.5
13	155.4	47.6	1893.7	1746.8	533.7
14	160.5	46.4	1902.4	1676.8	512.3
15	165.6	45.4	1874.2	1586.5	484.7
16	170.8	44.7	1807.2	1474.4	450.5
17	176.0	44.2	1699.2	1338.2	408.8
18	180.3	44.0	1580.0	1207.4	368.9
19	184.6	44.1	1425.0	1054.9	322.3
20	189.8	44.3	1196.2	843.2	257.6
21	195.0	44.9	916.0	597.1	182.4
22	198.8	45.4	680.8	395.7	120.9
23	202.6	46.2	537.5	314.6	96.1
24	207.7	47.4	387.8	272.2	83.2
25	211.3	48.4	253.0	224.1	68.5
26	214.3	49.4	104.4	104.4	31.9

CHECK SUMS - (ALL SHOULD BE SMALL)
SUM OF FORCES IN VERTICAL DIRECTION = .00 (= .321E-02)
SHOULD NOT EXCEED .100E+03
SUM OF FORCES IN HORIZONTAL DIRECTION = .00 (= .434E-02)
SHOULD NOT EXCEED .100E+03
SUM OF MOMENTS ABOUT COORDINATE ORIGIN = .37 (= .371E+00)
SHOULD NOT EXCEED .100E+03
SHEAR STRENGTH/SHEAR FORCE CHECK-SUM = .00 (= .121E-02)
SHOULD NOT EXCEED .100E+03

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:17:1994 Time: 11:42:59 Input file: casan.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizonia
3:1 downstream dam embankment slope
Static

TABLE NO. 39
****
* Final Results for Side Forces and Stresses Between Slices. *
* (Results for Critical Shear Surface in Case of a Search.) *
****

SPENCER'S PROCEDURE USED TO COMPUTE FACTOR OF SAFETY
Factor of Safety = 2.746 Side Force Inclination = -15.48 Degrees

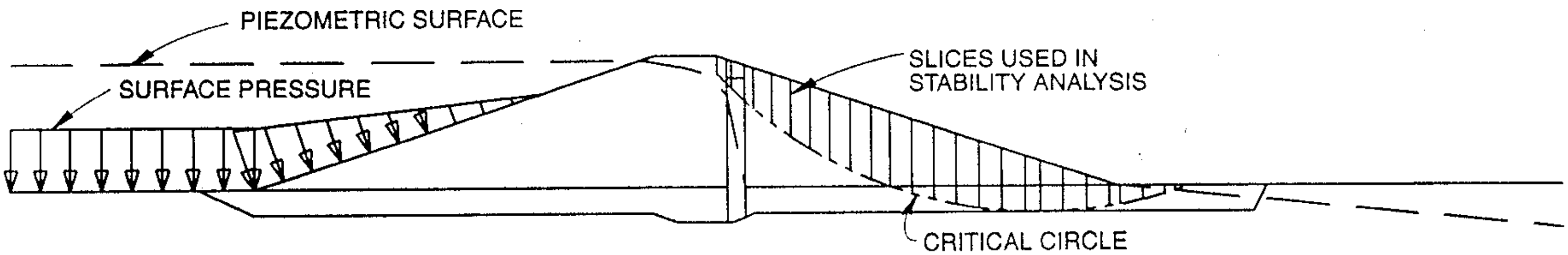
--------------- VALUES AT RIGHT SIDE OF SLICE ---------------

Slice No.	X-Right	Side Force	Y-Coord. of Side Force Location	Fraction of Height	Sigma at Top	Sigma at Bottom
1	111.0	648.	74.4	.153	-120.6	343.7
2	112.0	989.	73.7	.184	-135.8	439.9
3	115.0	2154.	71.7	.245	-136.2	648.4
4	117.0	3019.	70.5	.266	-128.4	760.5
5	121.1	4898.	68.0	.292	-104.6	949.8
6	125.3	6895.	65.6	.307	-81.4	1114.6
7	129.7	8871.	63.3	.317	-58.6	1256.1
8	134.2	10697.	61.2	.325	-34.9	1372.5
9	138.9	12251.	59.2	.331	-8.7	1460.4
10	143.7	13429.	57.3	.338	21.8	1516.1
11	147.9	14079.	55.9	.345	53.7	1534.3
12	152.8	14428.	54.4	.352	90.8	1533.9
13	157.9	14373.	53.0	.359	124.5	1519.0
14	163.0	13883.	51.8	.366	159.8	1481.0
15	168.2	12957.	50.8	.375	201.2	1412.7
16	173.4	11628.	49.9	.387	253.6	1307.5
17	178.6	9967.	49.3	.406	324.3	1158.1
18	182.0	8760.	49.0	.424	385.5	1033.2
19	187.2	6807.	48.8	.466	518.2	787.4
20	192.5	4902.	48.8	.540	739.2	452.8
21	197.6	3270.	49.0	.680	1182.6	-45.2
22	200.0	2690.	49.0	.713	1232.9	-149.6
23	205.1	1579.	49.1	.741	1132.5	-207.5
24	210.2	602.	49.5	.734	715.5	-119.7
25	212.5	256.	49.9	.904	676.9	-281.3
26	216.1	0.	-192.3	BELOW	.0	.0

CHECK SUMS - (ALL SHOULD BE SMALL)
SUM OF FORCES IN VERTICAL DIRECTION = .00 (= .321E-02)

```
     SHOULD NOT EXCEED      .100E+03
SUM OF FORCES IN HORIZONTAL DIRECTION  =        .00  (=  .434E-02)
     SHOULD NOT EXCEED      .100E+03
SUM OF MOMENTS ABOUT COORDINATE ORIGIN =        .37  (=  .371E+00)
     SHOULD NOT EXCEED      .100E+03
SHEAR STRENGTH/SHEAR FORCE CHECK-SUM   =        .00  (=  .121E-02)
     SHOULD NOT EXCEED      .100E+03


END-OF-FILE ENCOUNTERED WHILE READING COMMAND
WORDS - END OF PROBLEM(S) ASSUMED
```



STATIC, DOWNSTREAM SLOPE

SLOPE STABILITY ANALYSIS
CASANDRO WASH RETENTION BASIN
FILE NAME: CASAN

```
1         UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
          Date: 1:10:1995   Time: 14:23:56   Input file: rdcasan.txt


          TABLE NO. 1
          ******************************************
          * COMPUTER PROGRAM DESIGNATION - UTEXAS3 *
          * Originally Coded By Stephen G. Wright  *
          * Version No. 1.107                      *
          * Last Revision Date 10/13/91            *
          * (C) Copyright 1985-1991 S. G. Wright   *
          * All Rights Reserved                    *
          ******************************************

          ************************************************************
          *                                                          *
          *      RESULTS OF COMPUTATIONS PERFORMED USING THIS COMPUTER *
          * PROGRAM SHOULD NOT BE USED FOR DESIGN PURPOSES UNLESS THEY *
          * HAVE BEEN VERIFIED BY INDEPENDENT ANALYSES, EXPERIMENTAL   *
          * DATA OR FIELD EXPERIENCE. THE USER SHOULD UNDERSTAND THE   *
          * ALGORITHMS AND ANALYTICAL PROCEDURES USED IN THE COMPUTER  *
          * PROGRAM AND MUST HAVE READ ALL DOCUMENTATION FOR THIS      *
          * PROGRAM BEFORE ATTEMPTING ITS USE.                         *
          *                                                          *
          *      NEITHER THE UNIVERSITY OF TEXAS NOR STEPHEN G. WRIGHT *
          * MAKE OR ASSUME LIABILITY FOR ANY WARRANTIES, EXPRESSED OR  *
          * IMPLIED, CONCERNING THE ACCURACY, RELIABILITY, USEFULNESS  *
          * OR ADAPTABILITY OF THIS COMPUTER PROGRAM.                  *
          *                                                          *
          ************************************************************
1         UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
          Date: 1:10:1995   Time: 14:23:56   Input file: rdcasan.txt
          CASANDRO WASH DETENTION BASIN, Wickenburg, Arizonia
          3:1 downstream dam embankment slope
          Upstream 3:1 slope, RAPID DRAWDOWN, Water at 1/2 dam height, stea

          TABLE NO.  2
          ************************
          * NEW PROFILE LINE DATA *
          ************************

          PROFILE LINE  1 - MATERIAL TYPE =  4
          Ground surface beyond downstream toe

               Point      X             Y

                 1      233.000       50.000
                 2      300.000       50.000

          PROFILE LINE  2 - MATERIAL TYPE =  3
          Ground surface beyond toe above foundation soil

               Point      X             Y

                 1      200.000       50.000
                 2      233.000       50.000

          PROFILE LINE  3 - MATERIAL TYPE =  1
          Downstream dam slope, crest, upstream dam slope

               Point      X             Y

                 1        4.500       50.000
                 2       94.500       80.000
                 3      108.500       80.000
                 4      200.000       50.000

          PROFILE LINE  4 - MATERIAL TYPE =  3
          Ground surface upstream above foundation soil

               Point      X             Y

                 1       -8.000       50.000
                 2        4.500       50.000

          PROFILE LINE  5 - MATERIAL TYPE =  4
          Ground surface upstream beyond toe

               Point      X             Y

                 1      -50.000       50.000
                 2       -8.000       50.000

          PROFILE LINE  6 - MATERIAL TYPE =  2
          Chimney drain

               Point      X             Y

                 1      111.000       42.000
                 2      111.000       50.000
                 3      111.000       75.000
                 4      115.000       75.000
                 5      115.000       50.000
                 6      115.000       43.000

          PROFILE LINE  7 - MATERIAL TYPE =  3
          Bottom of dam embankment, downstream of chimney drain

               Point      X             Y

                 1      115.000       50.000
                 2      200.000       50.000

          PROFILE LINE  8 - MATERIAL TYPE =  3
          Bottom of dam embankment, upstream of chimney drain

               Point      X             Y

                 1        4.500       50.000
                 2      111.000       50.000

          PROFILE LINE  9 - MATERIAL TYPE =  4
          Bottom of foundation soil above undisturbed native soil

               Point      X             Y

                 1       -8.000       50.000
                 2        4.500       44.000
                 3       94.000       44.000
                 4      100.000       42.000
                 5      111.000       42.000
                 6      112.000       42.000
                 7      115.000       43.000
                 8      117.000       44.000
                 9      230.000       44.000
                10      233.000       50.000

          All new profile lines defined - No old lines retained
1         UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
          Date: 1:10:1995   Time: 14:23:56   Input file: rdcasan.txt
          CASANDRO WASH DETENTION BASIN, Wickenburg, Arizonia
          3:1 downstream dam embankment slope
```

```
Upstream 3:1 slope, RAPID DRAWDOWN, Water at 1/2 dam height, stea

TABLE NO. 10
*********************************************************************
* NEW SURFACE PRESSURE DATA - CONVENTIONAL/FIRST-STAGE COMPUTATIONS *
*********************************************************************

ALL NEW DATA INPUT - NO OLD DATA RETAINED

Surface Pressures -
                                      Normal        Shear
Point        X            Y          Pressure       Stress

   1      -50.000      50.000      750.000          .000
   2        4.500      50.000      750.000          .000
   3       48.000      64.500         .000          .000
1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date:  1:10:1995   Time: 14:23:56   Input file: rdcasan.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Upstream 3:1 slope, RAPID DRAWDOWN, Water at 1/2 dam height, stea

TABLE NO.  3
**********************************************************************
* NEW MATERIAL PROPERTY DATA - CONVENTIONAL/FIRST-STAGE COMPUTATIONS *
**********************************************************************

DATA FOR MATERIAL TYPE  1
embankment fill

     Unit weight of material =  120.000

     CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS
     Cohesion - - - - - - - -         .000
     Friction angle - - - - -  40.000 degrees

     Pore water pressures defined by piezometric line
     Number of the piezometric line used =  1
     Negative pore pressures set to zero

DATA FOR MATERIAL TYPE  2
chimney drain

     Unit weight of material =  120.000

     CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS
     Cohesion - - - - - - - -         .000
     Friction angle - - - - -  40.000 degrees

     Pore water pressures defined by piezometric line
     Number of the piezometric line used =  1
     Negative pore pressures set to zero

DATA FOR MATERIAL TYPE  3
compacted fill in cut off trench

     Unit weight of material =  120.000

     CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS
     Cohesion - - - - - - - -         .000
     Friction angle - - - - -  40.000 degrees

     Pore water pressures defined by piezometric line
     Number of the piezometric line used =  1
     Negative pore pressures set to zero

DATA FOR MATERIAL TYPE  4
native soil

     Unit weight of material =  130.000

     CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS
     Cohesion - - - - - - - -      300.000
     Friction angle - - - - -  40.000 degrees

     Pore water pressures defined by piezometric line
     Number of the piezometric line used =  1
     Negative pore pressures set to zero

All new material properties defined - No old data retained
1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date:  1:10:1995   Time: 14:23:56   Input file: rdcasan.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Upstream 3:1 slope, RAPID DRAWDOWN, Water at 1/2 dam height, stea

TABLE NO.  5
***********************************************************************
* NEW PIEZOMETRIC LINE DATA - CONVENTIONAL/FIRST-STAGE COMPUTATIONS *
***********************************************************************

Line
 No.    Point       X           Y

 1 - Unit weight of water =   62.40   Water level through dam at hig
 1        1     -50.000      50.000   Water level through dam at hig
 1        2       4.500      50.000   Water level through dam at hig
 1        3      91.500      79.000   Water level through dam at hig
 1        4     104.000      76.000   Water level through dam at hig
 1        5     111.000      71.000   Water level through dam at hig
 1        6     115.000      50.000   Water level through dam at hig
 1        7     200.000      50.000   Water level through dam at hig
 1        8     300.000      40.000   Water level through dam at hig

All new piezometric lines defined - No old lines retained
1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date:  1:10:1995   Time: 14:23:56   Input file: rdcasan.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Upstream 3:1 slope, RAPID DRAWDOWN, Water at 1/2 dam height, stea

TABLE NO. 15
********************************
* NEW ANALYSIS/COMPUTATION DATA *
********************************

Circular Shear Surface(s)

Automatic Search Performed

Starting Center Coordinate for Search at -
                                             X =      36.000
                                             Y =     170.000

Required accuracy for critical center (= minimum
spacing between grid points) =        .500

Critical shear surface not allowed to pass below Y =      45.000

For the initial mode of search
all circles pass through the point at -
                                             X =      36.000
```

Y = 50.000

Depth of crack = 2.000

THE FOLLOWING REPRESENT EITHER DEFAULT OR PREVIOUSLY DEFINED VALUES:

Initial trial estimate for the factor of safety = 3.000

Initial trial estimate for side force inclination = 15.000 degrees
(Applicable to Spencer's procedure only)

Maximum number of iterations allowed for
calculating the factor of safety = 40

Allowed force imbalance for convergence = 100.000

Allowed moment imbalance for convergence = 100.000

Initial trial values for factor of safety (and side force inclination
for Spencer's procedure) will be kept constant during search

Maximum subtended angle to be used for subdivision of the
circle into slices = 3.00 degrees

Search will be continued to locate a more critical shear
surface (if one exists) after the initial mode is complete

Depth of water in crack = .000

Unit weight of water in crack = 62.400

Seismic coefficient = .000

Conventional (single-stage) computations to be performed

Procedure used to compute the factor of safety: SPENCER

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 1:10:1995 Time: 14:23:56 Input file: rdcasan.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Upstream 3:1 slope, RAPID DRAWDOWN, Water at 1/2 dam height, stea

TABLE NO. 16
****
* NEW SLOPE GEOMETRY DATA *
****

NOTE - NO DATA WERE INPUT, SLOPE GEOMETRY DATA
WERE GENERATED BY THE PROGRAM

Slope Coordinates -

Point	X	Y
1	-50.000	50.000
2	-8.000	50.000
3	4.500	50.000
4	94.500	80.000
5	108.500	80.000
6	200.000	50.000
7	233.000	50.000
8	300.000	50.000

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 1:10:1995 Time: 14:23:56 Input file: rdcasan.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Upstream 3:1 slope, RAPID DRAWDOWN, Water at 1/2 dam height, stea

TABLE NO. 17
INFORMATION FOR CURRENT MODE OF SEARCH - All Circles Pass Through
the Fixed Point at X = 36.000 and Y = 50.000

Center Coordinates X	Y	Radius	1-Stage Factor of Safety	Side Force Inclination (degrees)	Iterations
21.00	155.00	106.07	2.288	12.35	4
36.00	155.00	105.00	2.058	11.07	5
51.00	155.00	106.07	2.473	8.10	4
21.00	170.00	120.93	2.192	12.14	4
36.00	170.00	120.00	2.147	10.26	4
51.00	170.00	120.93	2.686	7.31	4
21.00	185.00	135.83	2.178	11.63	4
36.00	185.00	135.00	2.271	9.44	5
51.00	185.00	135.83	2.914	6.63	4
21.00	140.00	91.24	2.536	11.73	4
36.00	140.00	90.00	2.021	11.79	5
51.00	140.00	91.24	2.289	9.03	5
21.00	125.00	76.49	2.886	10.83	3
36.00	125.00	75.00	2.066	12.29	5
51.00	125.00	76.49	2.152	10.04	5
33.50	137.50	87.54	2.049	12.16	5
36.00	137.50	87.50	2.021	11.90	5
38.50	137.50	87.54	2.013	11.57	5
33.50	140.00	90.03	2.043	12.07	5
38.50	140.00	90.03	2.018	11.44	5
33.50	142.50	92.53	2.040	11.97	5
36.00	142.50	92.50	2.023	11.67	5
38.50	142.50	92.53	2.025	11.32	5
36.00	135.00	85.00	2.023	12.01	5
38.50	135.00	85.04	2.010	11.69	5
41.00	135.00	85.15	2.015	11.33	5
41.00	137.50	87.64	2.023	11.20	5
41.00	140.00	90.14	2.032	11.08	5
36.00	132.50	82.50	2.028	12.11	5
38.50	132.50	82.54	2.008	11.81	5
41.00	132.50	82.65	2.010	11.46	5
36.00	130.00	80.00	2.036	12.19	5
38.50	130.00	80.04	2.010	11.93	5
41.00	130.00	80.16	2.006	11.59	5
38.50	127.50	77.54	2.014	12.03	5
41.00	127.50	77.66	2.004	11.72	5
43.50	127.50	77.86	2.015	11.33	5
43.50	130.00	80.35	2.021	11.20	5
43.50	132.50	82.84	2.029	11.07	5
38.50	125.00	75.04	2.022	12.12	5
41.00	125.00	75.17	2.005	11.83	5
43.50	125.00	75.37	2.011	11.46	5
39.50	126.00	76.08	2.010	11.98	5
41.00	126.00	76.16	2.004	11.79	5

42.50	126.00	76.28	2.007	11.57	5
39.50	127.50	77.58	2.007	11.92	5
42.50	127.50	77.77	2.008	11.49	5
39.50	129.00	79.08	2.006	11.85	5
41.00	129.00	79.16	2.005	11.64	5
42.50	129.00	79.27	2.011	11.41	5
40.50	127.00	77.13	2.004	11.81	5
41.00	127.00	77.16	2.004	11.74	5
41.50	127.00	77.20	2.004	11.67	5
40.50	127.50	77.63	2.004	11.79	5
41.50	127.50	77.69	2.005	11.64	5
40.50	128.00	78.13	2.004	11.76	5
41.00	128.00	78.16	2.004	11.69	5
41.50	128.00	78.19	2.005	11.61	5
40.50	126.50	76.63	2.005	11.83	5
41.00	126.50	76.66	2.004	11.76	5
41.50	126.50	76.70	2.004	11.69	5

At the end of the current mode of search the most critical
circle which was found has the following values -
X-center = 41.00 Y-center = 127.00 Radius = 77.16
Factor of Safety = 2.004 Side Force Inclination = 11.74
1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 1:10:1995 Time: 14:23:56 Input file: rdcasan.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Upstream 3:1 slope, RAPID DRAWDOWN, Water at 1/2 dam height, stea

TABLE NO. 18
INFORMATION FOR CURRENT MODE OF SEARCH - All Circles Are Tangent
to a Horizontal Line at Y = 49.838

Center Coordinates X	Y	Radius	1-Stage Factor of Safety	Side Force Inclination (degrees)	Iterations
26.00	112.00	62.16	2.884	10.58	3
41.00	112.00	62.16	2.078	12.09	5
56.00	112.00	62.16	2.082	10.53	5
26.00	127.00	77.16	2.493	11.59	4
56.00	127.00	77.16	2.221	9.37	5
26.00	142.00	92.16	2.232	12.30	4
41.00	142.00	92.16	2.041	10.96	5
56.00	142.00	92.16	2.428	8.27	4
38.50	124.50	74.66	2.029	12.11	5
41.00	124.50	74.66	2.005	11.86	5
43.50	124.50	74.66	1.999	11.55	5
38.50	127.00	77.16	2.021	12.02	5
43.50	127.00	77.16	2.003	11.41	5
38.50	129.50	79.66	2.016	11.92	5
41.00	129.50	79.66	2.005	11.61	5
43.50	129.50	79.66	2.009	11.28	5
41.00	122.00	72.16	2.010	11.97	5
43.50	122.00	72.16	1.998	11.68	5
46.00	122.00	72.16	2.001	11.35	5
46.00	124.50	74.66	2.008	11.21	5
46.00	127.00	77.16	2.016	11.07	5
41.00	119.50	69.66	2.018	12.06	5
43.50	119.50	69.66	1.999	11.80	5
46.00	119.50	69.66	1.997	11.49	5
43.50	117.00	67.16	2.004	11.92	6
46.00	117.00	67.16	1.996	11.62	5
48.50	117.00	67.16	2.004	11.30	5
48.50	119.50	69.66	2.010	11.15	5
48.50	122.00	72.16	2.018	11.01	5
43.50	114.50	64.66	2.013	12.01	5
46.00	114.50	64.66	1.998	11.75	5
48.50	114.50	64.66	2.001	11.43	5
44.50	115.50	65.66	2.002	11.88	5
46.00	115.50	65.66	1.997	11.70	5
47.50	115.50	65.66	1.998	11.51	5
44.50	117.00	67.16	1.999	11.81	5
47.50	117.00	67.16	1.999	11.43	5
44.50	118.50	68.66	1.997	11.74	5
46.00	118.50	68.66	1.997	11.54	5
47.50	118.50	68.66	2.002	11.34	5
45.50	116.50	66.66	1.997	11.71	5
46.00	116.50	66.66	1.996	11.65	5
46.50	116.50	66.66	1.997	11.59	5
45.50	117.00	67.16	1.996	11.69	5
46.50	117.00	67.16	1.997	11.56	5
45.50	117.50	67.66	1.996	11.66	5
46.00	117.50	67.66	1.996	11.60	5
46.50	117.50	67.66	1.997	11.53	5
45.50	118.00	68.16	1.996	11.64	5
46.00	118.00	68.16	1.996	11.57	5
46.50	118.00	68.16	1.997	11.50	5
45.00	117.50	67.66	1.997	11.73	5
45.00	118.00	68.16	1.996	11.70	5
45.00	118.50	68.66	1.996	11.67	5
45.50	118.50	68.66	1.996	11.61	5
45.00	119.00	69.16	1.996	11.65	5
45.50	119.00	69.16	1.996	11.58	5
46.00	119.00	69.16	1.997	11.52	5

At the end of the current mode of search the most critical
circle which was found has the following values -
X-center = 45.50 Y-center = 118.50 Radius = 68.66
Factor of Safety = 1.996 Side Force Inclination = 11.61
1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 1:10:1995 Time: 14:23:56 Input file: rdcasan.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Upstream 3:1 slope, RAPID DRAWDOWN, Water at 1/2 dam height, stea

TABLE NO. 19
INFORMATION FOR CURRENT MODE OF SEARCH - All Circles Have the
Same Radius - Radius = 68.662

Center Coordinates X	Y	Radius	1-Stage Factor of Safety	Side Force Inclination (degrees)	Iterations
30.50	103.50	68.66	Bottom of circle exceeds allowable depth - CIRCLE REJECTED		
45.50	103.50	68.66	Bottom of circle exceeds allowable		

```
                              depth - CIRCLE REJECTED
     60.50    103.50     68.66 Bottom of circle exceeds allowable
                              depth - CIRCLE REJECTED
     30.50    118.50     68.66  2.395      11.58          4
     60.50    118.50     68.66  2.284       9.17          5
     30.50    133.50     68.66 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE
     45.50    133.50     68.66  1.286      15.39          8
     60.50    133.50     68.66  1.473      13.95          6

     30.50    148.50     68.66 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE
     45.50    148.50     68.66 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE
     60.50    148.50     68.66 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE

     43.00    131.00     68.66  1.337      15.21          7
     45.50    131.00     68.66  1.300      15.64          7
     48.00    131.00     68.66  1.279      15.95          7
     43.00    133.50     68.66 See Message on Next Line(s)
DEPTH OF CRACK IS GREATER THAN DEPTH OF CIRCLE
     48.00    133.50     68.66  1.222      16.28         10
     43.00    136.00     68.66 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE
     45.50    136.00     68.66 See Message on Next Line(s)
DEPTH OF CRACK IS GREATER THAN DEPTH OF CIRCLE
     48.00    136.00     68.66 See Message on Next Line(s)
DEPTH OF CRACK IS GREATER THAN DEPTH OF CIRCLE

     50.50    131.00     68.66  1.278      16.06          7
     50.50    133.50     68.66  1.207      16.66          7
     50.50    136.00     68.66 See Message on Next Line(s)
DEPTH OF CRACK IS GREATER THAN DEPTH OF CIRCLE

     53.00    131.00     68.66  1.325      15.46          7
     53.00    133.50     68.66  1.209      16.77          7
     53.00    136.00     68.66  1.286      15.39          8

     49.00    132.00     68.66  1.230      16.50          7
     50.50    132.00     68.66  1.228      16.61          7
     52.00    132.00     68.66  1.243      16.46          7
     49.00    133.50     68.66 See Message on Next Line(s)
Last Trial Values =             1.103      -1.75          7
(Last Trial Values Shown Above Are Not Correct Final Values)
VALUE OF SIDE FORCE INCLINATION BECAME OUTSIDE RANGE OF
FROM  -10.00 TO   80.00 DEGREES
     52.00    133.50     68.66  1.205      16.77          7
     49.00    135.00     68.66  1.366      14.53          7
     50.50    135.00     68.66  1.265      15.66          9
     52.00    135.00     68.66  1.229      16.17          9

     53.50    132.00     68.66  1.280      15.99          7
     53.50    133.50     68.66  1.216      16.69          7
     53.50    135.00     68.66  1.213      16.46         10

     51.50    133.00     68.66  1.206      16.81          7
     52.00    133.00     68.66  1.207      16.83          7
     52.50    133.00     68.66  1.212      16.78          7
     51.50    133.50     68.66  1.205      16.75          7
     52.50    133.50     68.66  1.205      16.79          7
     51.50    134.00     68.66  1.208      16.61          7
     52.00    134.00     68.66  1.207      16.66          7
     52.50    134.00     68.66  1.206      16.71          7

At the end of the current mode of search the most critical
circle which was found has the following values -
X-center =     52.00     Y-center =     133.50     Radius =     68.66
Factor of Safety =   1.205    Side Force Inclination =  16.77
1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date:  1:10:1995   Time: 14:23:56   Input file: rdcasan.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Upstream 3:1 slope, RAPID DRAWDOWN, Water at 1/2 dam height, stea

TABLE NO. 18
INFORMATION FOR CURRENT MODE OF SEARCH - All Circles Are Tangent
to a Horizontal Line at   Y =    64.838
-----------------------------------------------------------------
                                     1-Stage
Center Coordinates                   Factor  Side Force
                                       of    Inclination
     X          Y          Radius    Safety  (degrees)   Iterations


     37.00    118.50     53.66 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE
     52.00    118.50     53.66  1.240      16.26          8
     67.00    118.50     53.66  1.599      13.17          6
     37.00    133.50     68.66 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE
     67.00    133.50     68.66  1.813      11.76          6
     37.00    148.50     83.66 See Message on Next Line(s)
DEPTH OF CRACK IS GREATER THAN DEPTH OF CIRCLE
     52.00    148.50     83.66  1.294      15.53          7
     67.00    148.50     83.66  2.057      10.50          6

     49.50    131.00     66.16  1.217      16.44         10
     52.00    131.00     66.16  1.209      16.71          7
     54.50    131.00     66.16  1.225      16.64          7
     49.50    133.50     68.66  1.210      16.54         11
     54.50    133.50     68.66  1.242      16.37          7
     49.50    136.00     71.16  1.205      16.63          7
     52.00    136.00     71.16  1.202      16.82          7
     54.50    136.00     71.16  1.263      16.05          7

     49.50    138.50     73.66  1.200      16.70          7
     52.00    138.50     73.66  1.209      16.72          7
     54.50    138.50     73.66  1.286      15.73          7

     47.00    136.00     71.16  1.226      16.19          9
     47.00    138.50     73.66  1.217      16.33          8
     47.00    141.00     76.16  1.209      16.44          8
     49.50    141.00     76.16  1.195      16.78          7
     52.00    141.00     76.16  1.225      16.47          7

     47.00    143.50     78.66  1.202      16.54          8
     49.50    143.50     78.66  1.191      16.84          7
     52.00    143.50     78.66  1.247      16.16          7

     47.00    146.00     81.16  1.196      16.64          8
     49.50    146.00     81.16  1.194      16.79          7
     52.00    146.00     81.16  1.270      15.84          7

     48.00    142.00     77.16  1.199      16.64          7
     49.50    142.00     77.16  1.193      16.80          7
     51.00    142.00     77.16  1.205      16.72          7
     48.00    143.50     78.66  1.196      16.69          7
     51.00    143.50     78.66  1.215      16.58          7
     48.00    145.00     80.16  1.193      16.74          7
     49.50    145.00     80.16  1.192      16.83          7
     51.00    145.00     80.16  1.227      16.39          7
```

49.00	143.00	78.16	1.193	16.78	7
49.50	143.00	78.16	1.192	16.83	7
50.00	143.00	78.16	1.193	16.84	7
49.00	143.50	78.66	1.192	16.79	7
50.00	143.50	78.66	1.194	16.83	7
49.00	144.00	79.16	1.191	16.80	7
49.50	144.00	79.16	1.191	16.84	7
50.00	144.00	79.16	1.195	16.81	7
49.00	144.50	79.66	1.191	16.82	7
49.50	144.50	79.66	1.191	16.84	7
50.00	144.50	79.66	1.197	16.78	7
48.50	144.00	79.16	1.193	16.76	7
48.50	144.50	79.66	1.192	16.77	7
48.50	145.00	80.16	1.191	16.78	7
49.00	145.00	80.16	1.190	16.83	7
48.50	145.50	80.66	1.190	16.80	7
49.00	145.50	80.66	1.189	16.84	7
49.50	145.50	80.66	1.193	16.81	7
48.50	146.00	81.16	1.189	16.81	7
49.00	146.00	81.16	1.189	16.84	7
48.50	146.50	81.66	1.189	16.82	7
49.00	146.50	81.66	1.189	16.83	7
49.50	146.50	81.66	1.197	16.76	7
48.00	146.00	81.16	1.191	16.77	7
48.00	146.50	81.66	1.190	16.78	7
48.00	147.00	82.16	1.189	16.79	7
48.50	147.00	82.16	1.188	16.84	7
49.00	147.00	82.16	1.190	16.82	7
48.00	147.50	82.66	1.188	16.81	7
48.50	147.50	82.66	1.187	16.84	7
49.00	147.50	82.66	1.192	16.80	7
48.00	148.00	83.16	1.188	16.82	7
48.50	148.00	83.16	1.188	16.84	7
49.00	148.00	83.16	1.194	16.77	7

At the end of the current mode of search the most critical circle which was found has the following values -
X-center = 48.50 Y-center = 147.50 Radius = 82.66
Factor of Safety = 1.187 Side Force Inclination = 16.84

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 1:10:1995 Time: 14:23:56 Input file: rdcasan.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Upstream 3:1 slope, RAPID DRAWDOWN, Water at 1/2 dam height, stea

TABLE NO. 19
INFORMATION FOR CURRENT MODE OF SEARCH - All Circles Have the Same Radius - Radius = 82.662

Center Coordinates X	Y	Radius	1-Stage Factor of Safety	Side Force Inclination (degrees)	Iterations
33.50	132.50	82.66	2.075	12.26	5
48.50	132.50	82.66	2.079	10.36	5
63.50	132.50	82.66	2.681	7.47	4
33.50	147.50	82.66	See Message on Next Line(s)		
CIRCLE DOES NOT INTERSECT SLOPE					
63.50	147.50	82.66	1.811	11.69	6
33.50	162.50	82.66	See Message on Next Line(s)		
CIRCLE DOES NOT INTERSECT SLOPE					
48.50	162.50	82.66	See Message on Next Line(s)		
CIRCLE DOES NOT INTERSECT SLOPE					
63.50	162.50	82.66	See Message on Next Line(s)		
CIRCLE DOES NOT INTERSECT SLOPE					
46.00	145.00	82.66	1.270	15.96	7
48.50	145.00	82.66	1.321	15.30	6
51.00	145.00	82.66	1.386	14.61	6
46.00	147.50	82.66	1.200	16.54	8
51.00	147.50	82.66	1.250	16.07	7
46.00	150.00	82.66	See Message on Next Line(s)		
DEPTH OF CRACK IS GREATER THAN DEPTH OF CIRCLE					
48.50	150.00	82.66	See Message on Next Line(s)		
DEPTH OF CRACK IS GREATER THAN DEPTH OF CIRCLE					
51.00	150.00	82.66	1.250	15.80	8
47.00	146.00	82.66	1.218	16.51	7
48.50	146.00	82.66	1.252	16.10	7
50.00	146.00	82.66	1.294	15.60	7
47.00	147.50	82.66	1.193	16.69	7
50.00	147.50	82.66	1.217	16.50	7
47.00	149.00	82.66	1.307	15.15	7
48.50	149.00	82.66	1.234	16.01	8
50.00	149.00	82.66	1.206	16.43	8
48.00	147.00	82.66	1.189	16.87	7
48.50	147.00	82.66	1.196	16.80	7
49.00	147.00	82.66	1.208	16.65	7
48.00	147.50	82.66	1.188	16.81	7
49.00	147.50	82.66	1.192	16.80	7
48.00	148.00	82.66	1.196	16.62	8
48.50	148.00	82.66	1.193	16.69	7
49.00	148.00	82.66	1.190	16.75	7

At the end of the current mode of search the most critical circle which was found has the following values -
X-center = 48.50 Y-center = 147.50 Radius = 82.66
Factor of Safety = 1.187 Side Force Inclination = 16.84

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 1:10:1995 Time: 14:23:56 Input file: rdcasan.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Upstream 3:1 slope, RAPID DRAWDOWN, Water at 1/2 dam height, stea

TABLE NO. 21
***** 1-STAGE FINAL CRITICAL CIRCLE INFORMATION *****
X Coordinate of Center - - - - - - - 48.500
Y Coordinate of Center - - - - - - - 147.500
Radius - - - - - - - - - - - - - - - 82.662
Factor of Safety - - - - - - - - - - 1.187
Side Force Inclination - - - - - - - 16.84

Number of circles tried - - - - - - 267
No. of circles F calc. for - - - - - 245

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
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CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Upstream 3:1 slope, RAPID DRAWDOWN, Water at 1/2 dam height, stea

TABLE NO. 26
```
****************************************************************
*  Coordinate, Weight, Strength and Pore Water Pressure        *
*  Information for Individual Slices for Conventional          *
*  Computations or First Stage of Multi-Stage Computations.    *
*  (Information is for the Critical Shear Surface in the       *
*  Case of an Automatic Search.)                               *
****************************************************************
```

Slice No.	X	Y	Slice Weight	Matl. Type	Cohesion	Friction Angle	Pore Pressure
	49.0	64.8					
1	51.2	64.9	337.7	1	.00	40.00	40.6
	53.3	65.0					
2	55.5	65.2	950.5	1	.00	40.00	114.6
	57.7	65.3					
3	59.8	65.6	1435.7	1	.00	40.00	174.1
	61.9	65.9					
4	64.1	66.3	1790.2	1	.00	40.00	219.0
	66.2	66.8					
5	68.3	67.3	2013.2	1	.00	40.00	249.1
	70.4	67.8					
6	72.5	68.4	2106.0	1	.00	40.00	264.4
	74.5	69.0					
7	76.6	69.8	2072.7	1	.00	40.00	264.8
	78.6	70.5					
8	80.6	71.4	1919.3	1	.00	40.00	250.3
	82.6	72.2					
9	84.5	73.1	1654.4	1	.00	40.00	220.9
	86.5	74.1					
10	88.4	75.1	1288.4	1	.00	40.00	176.8
	90.3	76.2					
11	90.9	76.5	330.9	1	.00	40.00	141.0
	91.5	76.9					
12	91.7	77.0	86.0	1	.00	40.00	121.6
	91.8	77.1					

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Date: 1:10:1995 Time: 14:23:56 Input file: rdcasan.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Upstream 3:1 slope, RAPID DRAWDOWN, Water at 1/2 dam height, stea

TABLE NO. 27
```
***************************************************************
*  Seismic Forces and Forces Due to Surface Pressures for     *
*  Individual Slices for Conventional Computations or the     *
*  First Stage of Multi-Stage Computations.                   *
*  (Information is for the Critical Shear Surface in the      *
*  Case of an Automatic Search.)                              *
***************************************************************
```

				FORCES DUE TO SURFACE PRESSURES			
Slice No.	X	Seismic Force	Y for Seismic Force	Normal Force	Shear Force	X	Y
1	51.2	0.	65.2	0.	0.	51.2	65.6
2	55.5	0.	66.1	0.	0.	55.5	67.0
3	59.8	0.	67.0	0.	0.	59.8	68.4
4	64.1	0.	68.1	0.	0.	64.1	69.9
5	68.3	0.	69.3	0.	0.	68.3	71.3
6	72.5	0.	70.5	0.	0.	72.5	72.7
7	76.6	0.	71.9	0.	0.	76.6	74.0
8	80.6	0.	73.4	0.	0.	80.6	75.4
9	84.5	0.	74.9	0.	0.	84.5	76.7
10	88.4	0.	76.5	0.	0.	88.4	78.0
11	90.9	0.	77.7	0.	0.	90.9	78.8
12	91.7	0.	78.0	0.	0.	91.7	79.1

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 1:10:1995 Time: 14:23:56 Input file: rdcasan.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Upstream 3:1 slope, RAPID DRAWDOWN, Water at 1/2 dam height, stea

TABLE NO. 29
```
*******************************************************************
*  Information Generated During Iterative Solution for the Factor *
*  of Safety and Side Force Inclination by Spencer's Procedure    *
*******************************************************************

          Trial     Trial
         Factor   Side Force    Force      Moment                Delta
 Iter-     of     Inclination  Imbalance  Imbalance   Delta-F    Theta
 ation   Safety   (degrees)     (lbs.)    (ft.-lbs.)            (degrees)

   1   3.00000   15.0000   .2880E+04  -.1392E+06
 First-order corrections to F and THETA .........  -.458E+01  .185E+00
 Values factored by  .109E+00 - Deltas too large   -.500E+00  .202E-01

   2   2.50000   15.0202   .2503E+04  -.1210E+06
 First-order corrections to F and THETA .........  -.277E+01  .210E+00
 Values factored by  .180E+00 - Deltas too large   -.500E+00  .379E-01

   3   2.00000   15.0581   .1939E+04  -.9386E+05
 First-order corrections to F and THETA .........  -.138E+01  .261E+00
 Values factored by  .363E+00 - Deltas too large   -.500E+00  .946E-01

   4   1.50000   15.1527   .1002E+04  -.4875E+05
 First-order corrections to F and THETA .........  -.401E+00  .427E+00
 Second-order correction - Iteration   1 ........  -.331E+00  .427E+00
 Second-order correction - Iteration   2 ........  -.329E+00  .427E+00
 Second-order correction - Iteration   3 ........  -.329E+00  .428E+00

   5   1.17145   15.5802  -.5282E+02   .1844E+04
 First-order corrections to F and THETA .........   .165E-01  .152E+01
 Second-order correction - Iteration   1 ........   .165E-01  .152E+01
 Second-order correction - Iteration   2 ........   .165E-01  .152E+01

   6   1.18797   17.1010   .1193E-01   .1352E+03
 First-order corrections to F and THETA .........  -.620E-03 -.259E+00
 Second-order correction - Iteration   1 ........  -.618E-03 -.259E+00

   7   1.18735   16.8421   .9346E-04   .5319E+00
 First-order corrections to F and THETA .........  -.246E-05 -.103E-02

 Factor of Safety - - - - - - - -      1.187
 Side Force Inclination - - - - -      16.84
 Number of Iterations - - - - - -      7
```

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 1:10:1995 Time: 14:23:56 Input file: rdcasan.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Upstream 3:1 slope, RAPID DRAWDOWN, Water at 1/2 dam height, stea

TABLE NO. 38
```
***************************************************************
*  Final Results for Stresses Along the Shear Surface         *
*  (Results for Critical Shear Surface in Case of a Search.)  *
***************************************************************
```

SPENCER'S PROCEDURE USED TO COMPUTE FACTOR OF SAFETY

Factor of Safety = 1.187   Side Force Inclination = 16.84 Degrees

--------- VALUES AT CENTER OF BASE OF SLICE---------

Slice No.	X-center	Y-center	Total Normal Stress	Effective Normal Stress	Shear Stress
1	51.2	64.9	85.9	45.3	32.0
2	55.5	65.2	232.6	118.0	83.4
3	59.8	65.6	340.0	165.8	117.2
4	64.1	66.3	412.4	193.4	136.7
5	68.3	67.3	453.4	204.2	144.3
6	72.5	68.4	465.7	201.3	142.3
7	76.6	69.8	452.1	187.3	132.3
8	80.6	71.4	414.6	164.3	116.1
9	84.5	73.1	355.4	134.5	95.0
10	88.4	75.1	276.3	99.6	70.4
11	90.9	76.5	216.3	75.3	53.2
12	91.7	77.0	194.0	72.4	51.2

CHECK SUMS - (ALL SHOULD BE SMALL)
SUM OF FORCES IN VERTICAL DIRECTION = .00 (= .293E-03)
SHOULD NOT EXCEED .100E+03
SUM OF FORCES IN HORIZONTAL DIRECTION = .00 (= .214E-03)
SHOULD NOT EXCEED .100E+03
SUM OF MOMENTS ABOUT COORDINATE ORIGIN = -.54 (= -.539E+00)
SHOULD NOT EXCEED .100E+03
SHEAR STRENGTH/SHEAR FORCE CHECK-SUM = .00 (= .278E-03)
SHOULD NOT EXCEED .100E+03

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 1:10:1995 Time: 14:23:56 Input file: rdcasan.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Upstream 3:1 slope, RAPID DRAWDOWN, Water at 1/2 dam height, stea

TABLE NO. 39
```
**************************************************************
* Final Results for Side Forces and Stresses Between Slices.  *
* (Results for Critical Shear Surface in Case of a Search.)   *
**************************************************************
```

SPENCER'S PROCEDURE USED TO COMPUTE FACTOR OF SAFETY
Factor of Safety = 1.187   Side Force Inclination = 16.84 Degrees

--------------- VALUES AT RIGHT SIDE OF SLICE ---------------

Slice No.	X-Right	Side Force	Y-Coord. of Side Force Location	Fraction of Height	Sigma at Top	Sigma at Bottom
1	53.3	132.	65.6	.449	67.5	126.7
2	57.7	419.	66.1	.338	4.7	333.0
3	61.9	733.	67.0	.315	-23.6	460.9
4	66.2	989.	67.9	.305	-42.8	539.5
5	70.4	1131.	69.0	.296	-58.3	577.0
6	74.5	1136.	70.3	.286	-72.3	578.1
7	78.6	1005.	71.7	.271	-85.5	544.8
8	82.6	760.	73.1	.248	-97.2	476.7
9	86.5	446.	74.7	.204	-102.0	365.1
10	90.3	122.	76.4	.096	-68.5	164.7
11	91.5	25.	77.0	.037	-20.1	42.7
12	91.8	0.	-6385.0	BELOW	.8	-.8

CHECK SUMS - (ALL SHOULD BE SMALL)
SUM OF FORCES IN VERTICAL DIRECTION = .00 (= .293E-03)
SHOULD NOT EXCEED .100E+03
SUM OF FORCES IN HORIZONTAL DIRECTION = .00 (= .214E-03)
SHOULD NOT EXCEED .100E+03
SUM OF MOMENTS ABOUT COORDINATE ORIGIN = -.54 (= -.539E+00)
SHOULD NOT EXCEED .100E+03
SHEAR STRENGTH/SHEAR FORCE CHECK-SUM = .00 (= .278E-03)
SHOULD NOT EXCEED .100E+03

END-OF-FILE ENCOUNTERED WHILE READING COMMAND
WORDS - END OF PROBLEM(S) ASSUMED

INPUT CHECKED [illegible] 10/10/94

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:18:1994 Time: 9:12:34 Input file: CASANS.TXT

TABLE NO. 1

```
****************************************
* COMPUTER PROGRAM DESIGNATION - UTEXAS3 *
* Originally Coded By Stephen G. Wright  *
* Version No. 1.107                      *
* Last Revision Date 10/13/91            *
* (C) Copyright 1985-1991 S. G. Wright   *
* All Rights Reserved                    *
****************************************

*************************************************************
*                                                           *
*      RESULTS OF COMPUTATIONS PERFORMED USING THIS COMPUTER *
* PROGRAM SHOULD NOT BE USED FOR DESIGN PURPOSES UNLESS THEY *
* HAVE BEEN VERIFIED BY INDEPENDENT ANALYSES, EXPERIMENTAL   *
* DATA OR FIELD EXPERIENCE. THE USER SHOULD UNDERSTAND THE   *
* ALGORITHMS AND ANALYTICAL PROCEDURES USED IN THE COMPUTER  *
* PROGRAM AND MUST HAVE READ ALL DOCUMENTATION FOR THIS      *
* PROGRAM BEFORE ATTEMPTING ITS USE.                         *
*                                                           *
*      NEITHER THE UNIVERSITY OF TEXAS NOR STEPHEN G. WRIGHT *
* MAKE OR ASSUME LIABILITY FOR ANY WARRANTIES, EXPRESSED OR  *
* IMPLIED, CONCERNING THE ACCURACY, RELIABILITY, USEFULNESS  *
* OR ADAPTABILITY OF THIS COMPUTER PROGRAM.                  *
*                                                           *
*************************************************************
```

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:18:1994 Time: 9:12:34 Input file: CASANS.TXT
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Seismic with a=0.1g

TABLE NO. 2

```
************************
* NEW PROFILE LINE DATA *
************************
```

PROFILE LINE 1 - MATERIAL TYPE = 4
Ground surface beyond downstream toe

Point	X	Y
1	233.000	50.000
2	300.000	50.000

PROFILE LINE 2 - MATERIAL TYPE = 3
Ground surface beyond toe above foundation soil

Point	X	Y
1	198.500	50.000
2	233.000	50.000

PROFILE LINE 3 - MATERIAL TYPE = 1
Downstream dam slope, crest, upstream dam slope

Point	X	Y
1	4.500	50.000
2	94.500	80.000
3	108.500	80.000
4	198.500	50.000

PROFILE LINE 4 - MATERIAL TYPE = 3
Ground surface upstream above foundation soil

Point	X	Y
1	-8.000	50.000
2	4.500	50.000

PROFILE LINE 5 - MATERIAL TYPE = 4
Ground surface upstream beyond toe

Point	X	Y
1	-50.000	50.000
2	-8.000	50.000

PROFILE LINE 6 - MATERIAL TYPE = 2
Chimney drain

Point	X	Y
1	111.000	42.000
2	111.000	50.000
3	111.000	75.000
4	115.000	75.000
5	115.000	50.000
6	115.000	43.000

PROFILE LINE 7 - MATERIAL TYPE = 3
Bottom of dam embankment, downstream of chimney drain

Point	X	Y
1	115.000	50.000
2	198.500	50.000

PROFILE LINE 8 - MATERIAL TYPE = 3
Bottom of dam embankment, upstream of chimney drain

Point	X	Y
1	4.500	50.000
2	111.000	50.000

PROFILE LINE 9 - MATERIAL TYPE = 4
Bottom of foundation soil above undisturbed native soil

Point	X	Y
1	-8.000	50.000
2	4.500	44.000
3	94.000	44.000
4	100.000	42.000
5	111.000	42.000
6	112.000	42.000
7	115.000	43.000
8	117.000	44.000
9	230.000	44.000
10	233.000	50.000

All new profile lines defined - No old lines retained
1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:18:1994 Time: 9:12:34 Input file: CASANS.TXT
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope

```
Seismic with a=0.1g

TABLE NO.  3
******************************************************************
* NEW MATERIAL PROPERTY DATA - CONVENTIONAL/FIRST-STAGE COMPUTATIONS *
******************************************************************

DATA FOR MATERIAL TYPE  1
embankment fill

     Unit weight of material =  120.000

     CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS
     Cohesion - - - - - - - -          .000
     Friction angle - - - - -  40.000 degrees

     Pore water pressures defined by piezometric line
     Number of the piezometric line used =  1
     Negative pore pressures set to zero

DATA FOR MATERIAL TYPE  2
chimney drain

     Unit weight of material =  120.000

     CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS
     Cohesion - - - - - - - -          .000
     Friction angle - - - - -  40.000 degrees

     Pore water pressures defined by piezometric line
     Number of the piezometric line used =  1
     Negative pore pressures set to zero

DATA FOR MATERIAL TYPE  3
compacted fill in cut off trench

     Unit weight of material =  120.000

     CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS
     Cohesion - - - - - - - -          .000
     Friction angle - - - - -  40.000 degrees

     Pore water pressures defined by piezometric line
     Number of the piezometric line used =  1
     Negative pore pressures set to zero

DATA FOR MATERIAL TYPE  4
native soil

     Unit weight of material =  130.000

     CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS
     Cohesion - - - - - - - -          .000
     Friction angle - - - - -  40.000 degrees

     Pore water pressures defined by piezometric line
     Number of the piezometric line used =  1
     Negative pore pressures set to zero

All new material properties defined - No old data retained
1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date:  8:18:1994   Time:  9:12:34   Input file: CASANS.TXT
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizonia
3:1 downstream dam embankment slope
Seismic with a=0.1g
```



```
TABLE NO.  5
******************************************************************
* NEW PIEZOMETRIC LINE DATA - CONVENTIONAL/FIRST-STAGE COMPUTATIONS *
******************************************************************

Line
 No.   Point        X             Y

  1 - Unit weight of water =    62.40   Water level through dam at ful
  1       1      -50.000       79.000   Water level through dam at ful
  1       2        4.500       79.000   Water level through dam at ful
  1       3       85.500       79.000   Water level through dam at ful
  1       4       95.000       79.000   Water level through dam at ful
  1       5      104.000       76.000   Water level through dam at ful
  1       6      111.000       71.000   Water level through dam at ful
  1       7      115.000       50.000   Water level through dam at ful
  1       8      175.000       50.000   Water level through dam at ful
  1       9      300.000       40.000   Water level through dam at ful

All new piezometric lines defined - No old lines retained
1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date:  8:18:1994   Time:  9:12:34   Input file: CASANS.TXT
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizonia
3:1 downstream dam embankment slope
Seismic with a=0.1g

TABLE NO.  10
******************************************************************
* NEW SURFACE PRESSURE DATA - CONVENTIONAL/FIRST-STAGE COMPUTATIONS *
******************************************************************

ALL NEW DATA INPUT - NO OLD DATA RETAINED

Surface Pressures -
                                   Normal       Shear
Point        X            Y       Pressure      Stress

   1      50.000       50.000     1800.000        .000
   2       4.500       50.000     1800.000        .000
   3      69.000       71.500         .000        .000
1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date:  8:18:1994   Time:  9:12:34   Input file: CASANS.TXT
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizonia
3:1 downstream dam embankment slope
Seismic with a=0.1g

TABLE NO.  15
********************************
* NEW ANALYSIS/COMPUTATION DATA *
********************************

Circular Shear Surface(s)

Automatic Search Performed

Starting Center Coordinate for Search at -
                                              X =     140.000
                                              Y =     110.000

Required accuracy for critical center (= minimum
spacing between grid points) =       1.000

Critical shear surface not allowed to pass below Y =       44.000

For the initial mode of search
all circles are tangent to horizontal line at -
```

Y = 44.000

Seismic coefficient = .100

Depth of crack = 2.000

THE FOLLOWING REPRESENT EITHER DEFAULT OR PREVIOUSLY DEFINED VALUES:

Initial trial estimate for the factor of safety = 3.000

Initial trial estimate for side force inclination = 15.000 degrees
(Applicable to Spencer's procedure only)

Maximum number of iterations allowed for
calculating the factor of safety = 40

Allowed force imbalance for convergence = 100.000

Allowed moment imbalance for convergence = 100.000

Initial trial values for factor of safety (and side force inclination
for Spencer's procedure) will be kept constant during search

Maximum subtended angle to be used for subdivision of the
circle into slices = 3.00 degrees

Search will be continued to locate a more critical shear
surface (if one exists) after the initial mode is complete

Depth of water in crack = .000

Unit weight of water in crack = 62.400

Conventional (single-stage) computations to be performed

Procedure used to compute the factor of safety: SPENCER

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:18:1994 Time: 9:12:34 Input file: CASANS.TXT
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Seismic with a=0.1g ✓

TABLE NO. 16
****
* NEW SLOPE GEOMETRY DATA *
****

NOTE - NO DATA WERE INPUT, SLOPE GEOMETRY DATA
WERE GENERATED BY THE PROGRAM

Slope Coordinates -

Point	X	Y
1	-50.000	50.000
2	-8.000	50.000
3	4.500	50.000
4	94.500	80.000
5	108.500	80.000
6	198.500	50.000
7	233.000	50.000
8	300.000	50.000

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:18:1994 Time: 9:12:34 Input file: CASANS.TXT
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona

3:1 downstream dam embankment slope
Seismic with a=0.1g

TABLE NO. 18
INFORMATION FOR CURRENT MODE OF SEARCH - All Circles Are Tangent
to a Horizontal Line at Y = 44.000

Center Coordinates X	Y	Radius	1-Stage Factor of Safety	Side Force Inclination (degrees)	Iterations
110.00	80.00	36.00	6.265	-20.96	10

Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR 8 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW - 51 58

140.00	80.00	36.00	3.688	-14.51	4

Message on the following line(s) applies to the above circle
DENOMINATOR IN EQUATIONS FOR F WAS SMALL FOR 2 SLICES
FIRST AND LAST SLICES WHERE DENOMINATOR WAS LOW - 53 54

170.00	80.00	36.00	2.647	-17.88	6
110.00	110.00	66.00	4.955	-9.31	7
140.00	110.00	66.00	2.675	-16.05	4
170.00	110.00	66.00	See Message on Next Line(s)		
Last Trial Values =			2.152	4.34	4

(Last Trial Values Shown Above Are Not Correct Final Values)
VALUE OF SIDE FORCE INCLINATION BECAME OUTSIDE RANGE OF
FROM -80.00 TO 10.00 DEGREES

110.00	140.00	96.00	4.404	-10.25	6
140.00	140.00	96.00	2.610	-15.59	4
170.00	140.00	96.00	See Message on Next Line(s)		
Last Trial Values =			2.171	4.38	4

(Last Trial Values Shown Above Are Not Correct Final Values)
VALUE OF SIDE FORCE INCLINATION BECAME OUTSIDE RANGE OF
FROM -80.00 TO 10.00 DEGREES

110.00	170.00	126.00	4.137	-10.76	5
140.00	170.00	126.00	2.648	-15.29	4
170.00	170.00	126.00	See Message on Next Line(s)		
Last Trial Values =			2.267	4.64	4

(Last Trial Values Shown Above Are Not Correct Final Values)
VALUE OF SIDE FORCE INCLINATION BECAME OUTSIDE RANGE OF
FROM -80.00 TO 10.00 DEGREES

135.00	135.00	91.00	2.787	-14.64	3
140.00	135.00	91.00	2.608	-15.65	4
145.00	135.00	91.00	2.465	-16.70	4
135.00	140.00	96.00	2.789	-14.61	3
145.00	140.00	96.00	2.465	-16.61	4
135.00	145.00	101.00	2.792	-14.57	3
140.00	145.00	101.00	2.614	-15.52	4
145.00	145.00	101.00	2.467	-16.52	4
150.00	135.00	91.00	2.353	-17.78	5
150.00	140.00	96.00	2.350	-17.65	5
150.00	145.00	101.00	2.351	-17.54	5
155.00	135.00	91.00	2.263	-18.83	6
155.00	140.00	96.00	2.257	-18.69	6
155.00	145.00	101.00	2.255	-18.56	6
160.00	140.00	96.00	2.183	-19.70	6
160.00	145.00	101.00	2.178	-19.57	6
150.00	150.00	106.00	2.353	-17.42	5
155.00	150.00	106.00	2.257	-18.43	7

```
    160.00     150.00     106.00  2.176      -19.43           6

    165.00     145.00     101.00 See Message on Next Line(s)
Last Trial Values =               2.252        5.13          4
(Last Trial Values Shown Above Are Not Correct Final Values)
VALUE OF SIDE FORCE INCLINATION BECAME OUTSIDE RANGE OF
FROM  -80.00 TO   10.00 DEGREES
    165.00     150.00     106.00 See Message on Next Line(s)
Last Trial Values =               2.267        5.16          4
(Last Trial Values Shown Above Are Not Correct Final Values)
VALUE OF SIDE FORCE INCLINATION BECAME OUTSIDE RANGE OF
FROM  -80.00 TO   10.00 DEGREES
    155.00     155.00     111.00  2.260      -18.31           7
    160.00     155.00     111.00  2.177      -19.29           6
    165.00     155.00     111.00 See Message on Next Line(s)
Last Trial Values =               2.285        5.22          4
(Last Trial Values Shown Above Are Not Correct Final Values)
VALUE OF SIDE FORCE INCLINATION BECAME OUTSIDE RANGE OF
FROM  -80.00 TO   10.00 DEGREES

    157.00     147.00     103.00  2.222      -18.92           6
    160.00     147.00     103.00  2.177      -19.51           6
    163.00     147.00     103.00  2.137      -20.10           6
    157.00     150.00     106.00  2.222      -18.84           6
    163.00     150.00     106.00  2.135      -20.01           6
    157.00     153.00     109.00  2.224      -18.76           6
    160.00     153.00     109.00  2.177      -19.35           6
    163.00     153.00     109.00  2.135      -19.93           6

    166.00     150.00     106.00 See Message on Next Line(s)
Last Trial Values =               2.251        4.98          4
(Last Trial Values Shown Above Are Not Correct Final Values)
VALUE OF SIDE FORCE INCLINATION BECAME OUTSIDE RANGE OF
FROM  -80.00 TO   10.00 DEGREES
    166.00     153.00     109.00 See Message on Next Line(s)
Last Trial Values =               2.261        5.00          4
(Last Trial Values Shown Above Are Not Correct Final Values)
VALUE OF SIDE FORCE INCLINATION BECAME OUTSIDE RANGE OF
FROM  -80.00 TO   10.00 DEGREES
    160.00     156.00     112.00  2.178      -19.26           6
    163.00     156.00     112.00  2.135      -19.85           6
    166.00     156.00     112.00 See Message on Next Line(s)
Last Trial Values =               2.272        5.04          4
(Last Trial Values Shown Above Are Not Correct Final Values)
VALUE OF SIDE FORCE INCLINATION BECAME OUTSIDE RANGE OF
FROM  -80.00 TO   10.00 DEGREES

    162.00     152.00     108.00  2.148      -19.77           5
    163.00     152.00     108.00  2.135      -19.96           6
    164.00     152.00     108.00 See Message on Next Line(s)
Last Trial Values =               2.291        5.40          4
(Last Trial Values Shown Above Are Not Correct Final Values)
VALUE OF SIDE FORCE INCLINATION BECAME OUTSIDE RANGE OF
FROM  -80.00 TO   10.00 DEGREES
    162.00     153.00     109.00  2.148      -19.74           5
    164.00     153.00     109.00  2.122      -20.12           6
    162.00     154.00     110.00  2.148      -19.71           6
    163.00     154.00     110.00  2.135      -19.91           6
    164.00     154.00     110.00  2.122      -20.10           6

    165.00     152.00     108.00 See Message on Next Line(s)
Last Trial Values =               2.274        5.18          4
(Last Trial Values Shown Above Are Not Correct Final Values)
VALUE OF SIDE FORCE INCLINATION BECAME OUTSIDE RANGE OF
FROM  -80.00 TO   10.00 DEGREES
    165.00     153.00     109.00 See Message on Next Line(s)
```

```
Last Trial Values =               2.278        5.19          4
(Last Trial Values Shown Above Are Not Correct Final Values)
VALUE OF SIDE FORCE INCLINATION BECAME OUTSIDE RANGE OF
FROM  -80.00 TO   10.00 DEGREES
    165.00     154.00     110.00 See Message on Next Line(s)
Last Trial Values =               2.282        5.20          4
(Last Trial Values Shown Above Are Not Correct Final Values)
VALUE OF SIDE FORCE INCLINATION BECAME OUTSIDE RANGE OF
FROM  -80.00 TO   10.00 DEGREES

At the end of the current mode of search the most critical
circle which was found has the following values -
X-center =    164.00     Y-center =    153.00     Radius =    109.00
Factor of Safety =   2.122      Side Force Inclination = -20.12


***** CAUTION ***** FACTOR OF SAFETY COULD NOT BE COMPUTED FOR SOME
              OF GRID POINTS AROUND THE MINIMUM
***** RESULTS MAY BE ERRONEOUS *****
1   UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date:  8:18:1994   Time:  9:12:34   Input file: CASANS.TXT
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Seismic with a=0.1g

TABLE NO. 19
INFORMATION FOR CURRENT MODE OF SEARCH - All Circles Have the
Same Radius   -   Radius =   109.000
-----------------------------------------------------------
                                  1-Stage
Center Coordinates                Factor  Side Force
                                    of    Inclination
     X          Y         Radius  Safety   (degrees)   Iterations


    134.00     123.00     109.00 Bottom of circle exceeds allowable
                                 depth - CIRCLE REJECTED
    164.00     123.00     109.00 Bottom of circle exceeds allowable
                                 depth - CIRCLE REJECTED
    194.00     123.00     109.00 Bottom of circle exceeds allowable
                                 depth - CIRCLE REJECTED
    134.00     153.00     109.00  2.838      -14.35           3
    194.00     153.00     109.00  2.108      -17.11           6
    134.00     183.00     109.00  2.763      -32.01           6
    164.00     183.00     109.00 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE
    194.00     183.00     109.00 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE

    224.00     123.00     109.00 Bottom of circle exceeds allowable
                                 depth - CIRCLE REJECTED
    224.00     153.00     109.00  4.991       -7.08           8
    224.00     183.00     109.00 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE

    189.00     148.00     109.00 Bottom of circle exceeds allowable
                                 depth - CIRCLE REJECTED
    194.00     148.00     109.00 Bottom of circle exceeds allowable
                                 depth - CIRCLE REJECTED
    199.00     148.00     109.00 Bottom of circle exceeds allowable
                                 depth - CIRCLE REJECTED
    189.00     153.00     109.00  2.058      -18.71           6
    199.00     153.00     109.00  2.196      -15.37           6
    189.00     158.00     109.00  2.052      -22.45           6
    194.00     158.00     109.00  2.050      -21.95           6
    199.00     158.00     109.00  2.068      -20.74           6
```

```
    189.00    163.00    109.00  1.994     -23.01           6
    194.00    163.00    109.00  2.009     -23.47           5
    199.00    163.00    109.00 See Message on Next Line(s)
DEPTH OF CRACK IS GREATER THAN DEPTH OF CIRCLE

    184.00    158.00    109.00  2.065     -22.51           6
    184.00    163.00    109.00  2.006     -22.89           6
    184.00    168.00    109.00 See Message on Next Line(s)
DEPTH OF CRACK IS GREATER THAN DEPTH OF CIRCLE
    189.00    168.00    109.00 See Message on Next Line(s)
DEPTH OF CRACK IS GREATER THAN DEPTH OF CIRCLE
    194.00    168.00    109.00 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE

    186.00    160.00    109.00  2.036     -22.67           6
    189.00    160.00    109.00  2.022     -22.74           6
    192.00    160.00    109.00  2.010     -22.84           6
    186.00    163.00    109.00  2.000     -22.92           6
    192.00    163.00    109.00  1.997     -23.21           6
    186.00    166.00    109.00  2.022     -23.73           6
    189.00    166.00    109.00  2.198     -27.30           6
    192.00    166.00    109.00 See Message on Next Line(s)
DEPTH OF CRACK IS GREATER THAN DEPTH OF CIRCLE

    188.00    162.00    109.00  2.003     -22.91           6
    189.00    162.00    109.00  2.000     -22.94           6
    190.00    162.00    109.00  1.997     -22.97           6
    188.00    163.00    109.00  1.995     -22.98           6
    190.00    163.00    109.00  1.994     -23.07           6
    188.00    164.00    109.00  1.994     -23.17           6
    189.00    164.00    109.00  1.997     -23.25           6
    190.00    164.00    109.00  2.001     -23.35           6

    191.00    162.00    109.00  1.995     -23.00           6
    191.00    163.00    109.00  1.994     -23.13           6
    191.00    164.00    109.00  2.009     -23.50           5

At the end of the current mode of search the most critical
circle which was found has the following values -
X-center =    190.00     Y-center =    163.00      Radius =    109.00
Factor of Safety =   1.994      Side Force Inclination = -23.07
1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date:  8:18:1994   Time:  9:12:34   Input file: CASANS.TXT
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Seismic with a=0.1g

TABLE NO. 18
INFORMATION FOR CURRENT MODE OF SEARCH - All Circles Are Tangent
to a Horizontal Line at   Y =    54.000
-------------------------------------------------------------

                                     1-Stage
Center Coordinates                   Factor   Side Force
                                       of     Inclination
     X          Y          Radius    Safety   (degrees)    Iterations


    160.00    133.00     79.00 See Message on Next Line(s)
Last Trial Values =             2.268        4.17          4
(Last Trial Values Shown Above Are Not Correct Final Values)
VALUE OF SIDE FORCE INCLINATION BECAME OUTSIDE RANGE OF
FROM  -80.00 TO   10.00 DEGREES
    190.00    133.00     79.00  2.055     -23.35           6
    220.00    133.00     79.00 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE
```



```
    160.00    163.00    109.00 See Message on Next Line(s)
Last Trial Values =             2.340        4.52          4
(Last Trial Values Shown Above Are Not Correct Final Values)
VALUE OF SIDE FORCE INCLINATION BECAME OUTSIDE RANGE OF
FROM  -80.00 TO   10.00 DEGREES
    220.00    163.00    109.00 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE
    160.00    193.00    139.00  2.267     -19.72           6
    190.00    193.00    139.00  1.977     -23.08           6
    220.00    193.00    139.00 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE

    160.00    223.00    169.00  2.350     -18.94           5
    190.00    223.00    169.00  2.027     -23.01           6
    220.00    223.00    169.00 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE


    185.00    188.00    134.00  1.992     -22.95           6
    190.00    188.00    134.00  1.978     -23.08           6
    195.00    188.00    134.00  1.976     -23.31           6
    185.00    193.00    139.00  2.002     -22.91           6
    195.00    193.00    139.00  1.972     -23.27           6
    185.00    198.00    144.00  2.015     -22.87           6
    190.00    198.00    144.00  1.975     -23.07           6
    195.00    198.00    144.00  1.969     -23.26           6

    200.00    193.00    139.00  2.002     -23.93           6
    200.00    198.00    144.00  1.989     -23.75           6
    190.00    203.00    149.00  1.974     -23.07           6
    195.00    203.00    149.00  1.966     -23.24           7
    200.00    203.00    149.00  1.979     -23.62           6

    190.00    208.00    154.00  1.981     -23.06           6
    195.00    208.00    154.00  1.964     -23.22           7
    200.00    208.00    154.00  1.972     -23.50           7

    190.00    213.00    159.00  1.994     -23.04           6
    195.00    213.00    159.00  1.963     -23.20           7
    200.00    213.00    159.00  1.966     -23.44           7

    190.00    218.00    164.00  2.010     -23.01           6
    195.00    218.00    164.00  1.961     -23.17           7
    200.00    218.00    164.00  1.962     -23.39           7

    190.00    223.00    169.00  2.027     -23.01           6
    195.00    223.00    169.00  1.963     -23.16           7
    200.00    223.00    169.00  1.958     -23.35           7

    205.00    218.00    164.00  2.008     -24.54           5
    205.00    223.00    169.00  1.989     -24.17           6
    195.00    228.00    174.00 Center of circle falls outside of
                                    current grid - Grid re-initialized

    195.00    218.00    164.00  1.961     -23.17           7
    200.00    218.00    164.00  1.962     -23.39           7
    205.00    218.00    164.00  2.008     -24.54           5
    195.00    223.00    169.00  1.963     -23.16           7
    205.00    223.00    169.00  1.989     -24.17           6
    195.00    228.00    174.00  1.975     -23.17           6
    200.00    228.00    174.00  1.956     -23.31           7
    205.00    228.00    174.00  1.977     -23.91           7

    195.00    233.00    179.00  1.990     -23.18           6
    200.00    233.00    179.00  1.953     -23.29           7
    205.00    233.00    179.00  1.967     -23.78           7
```

195.00	238.00	184.00	2.006	-23.18	6
200.00	238.00	184.00	1.952	-23.26	7
205.00	238.00	184.00	1.961	-23.68	7
195.00	243.00	189.00	2.023	-23.18	6
200.00	243.00	189.00	1.957	-23.26	7
205.00	243.00	189.00	1.955	-23.58	7
197.00	235.00	181.00	1.970	-23.22	6
200.00	235.00	181.00	1.953	-23.28	7
203.00	235.00	181.00	1.956	-23.46	7
197.00	238.00	184.00	1.979	-23.22	6
203.00	238.00	184.00	1.954	-23.45	7
197.00	241.00	187.00	1.988	-23.22	6
200.00	241.00	187.00	1.952	-23.25	7
203.00	241.00	187.00	1.952	-23.42	7
199.00	237.00	183.00	1.953	-23.24	7
200.00	237.00	183.00	1.952	-23.27	7
201.00	237.00	183.00	1.952	-23.32	7
199.00	238.00	184.00	1.956	-23.24	7
201.00	238.00	184.00	1.952	-23.31	7
199.00	239.00	185.00	1.958	-23.24	7
200.00	239.00	185.00	1.951	-23.26	7
201.00	239.00	185.00	1.951	-23.31	7
202.00	238.00	184.00	1.952	-23.37	7
202.00	239.00	185.00	1.952	-23.37	7
200.00	240.00	186.00	1.951	-23.25	7
201.00	240.00	186.00	1.951	-23.30	7
202.00	240.00	186.00	1.951	-23.36	7
201.00	241.00	187.00	1.951	-23.29	7
202.00	241.00	187.00	1.951	-23.35	7
200.00	242.00	188.00	1.955	-23.25	7
201.00	242.00	188.00	1.950	-23.29	7
202.00	242.00	188.00	1.950	-23.34	7
201.00	243.00	189.00	1.950	-23.28	7
202.00	243.00	189.00	1.950	-23.34	7
200.00	244.00	190.00	1.960	-23.26	7
201.00	244.00	190.00	1.950	-23.28	7
202.00	244.00	190.00	1.950	-23.33	7
200.00	245.00	191.00	1.962	-23.26	7
201.00	245.00	191.00	1.951	-23.28	7
202.00	245.00	191.00	1.949	-23.32	7
203.00	244.00	190.00	1.950	-23.39	7
203.00	245.00	191.00	1.950	-23.38	7
201.00	246.00	192.00	1.954	-23.28	7
202.00	246.00	192.00	1.949	-23.31	7
203.00	246.00	192.00	1.949	-23.37	7
201.00	247.00	193.00	1.956	-23.28	7
202.00	247.00	193.00	1.949	-23.31	7
203.00	247.00	193.00	1.949	-23.36	7
201.00	248.00	194.00	1.959	-23.29	7
202.00	248.00	194.00	1.948	-23.30	7
203.00	248.00	194.00	1.949	-23.35	7
201.00	249.00	195.00	1.961	-23.30	7
202.00	249.00	195.00	1.950	-23.31	7
203.00	249.00	195.00	1.948	-23.35	7
204.00	248.00	194.00	1.950	-23.42	7
204.00	249.00	195.00	1.949	-23.41	7
202.00	250.00	196.00	1.953	-23.32	7
203.00	250.00	196.00	1.948	-23.35	7
204.00	250.00	196.00	1.948	-23.41	7
202.00	251.00	197.00	1.955	-23.33	7
203.00	251.00	197.00	1.947	-23.35	7
204.00	251.00	197.00	1.948	-23.40	7
202.00	252.00	198.00	1.958	-23.34	7
203.00	252.00	198.00	1.947	-23.35	7
204.00	252.00	198.00	1.948	-23.40	7
202.00	253.00	199.00	1.960	-23.35	7
203.00	253.00	199.00	1.949	-23.35	7
204.00	253.00	199.00	1.947	-23.40	7

At the end of the current mode of search the most critical circle which was found has the following values -
X-center = 203.00 Y-center = 252.00 Radius = 198.00
Factor of Safety = 1.947 Side Force Inclination = -23.35

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:18:1994 Time: 9:12:34 Input file: CASANS.TXT
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizonia
3:1 downstream dam embankment slope
Seismic with a=0.1g

TABLE NO. 19
INFORMATION FOR CURRENT MODE OF SEARCH - All Circles Have the Same Radius - Radius = 198.000

Center Coordinates X	Y	Radius	1-Stage Factor of Safety	Side Force Inclination (degrees)	Iterations
173.00	222.00	198.00	Bottom of circle exceeds allowable depth - CIRCLE REJECTED		
203.00	222.00	198.00	Bottom of circle exceeds allowable depth - CIRCLE REJECTED		
233.00	222.00	198.00	Bottom of circle exceeds allowable depth - CIRCLE REJECTED		
173.00	252.00	198.00	2.239	-20.15	6
233.00	252.00	198.00	See Message on Next Line(s)		
CIRCLE DOES NOT INTERSECT SLOPE					
173.00	282.00	198.00	See Message on Next Line(s)		
CIRCLE DOES NOT INTERSECT SLOPE					
203.00	282.00	198.00	See Message on Next Line(s)		
CIRCLE DOES NOT INTERSECT SLOPE					
233.00	282.00	198.00	See Message on Next Line(s)		
CIRCLE DOES NOT INTERSECT SLOPE					
198.00	247.00	198.00	2.092	-21.47	6
203.00	247.00	198.00	2.089	-21.15	6
208.00	247.00	198.00	2.053	-20.29	6
198.00	252.00	198.00	2.011	-23.28	6
208.00	252.00	198.00	See Message on Next Line(s)		
Last Trial Values =			1.989	3.23	5
(Last Trial Values Shown Above Are Not Correct Final Values)					
VALUE OF SIDE FORCE INCLINATION BECAME OUTSIDE RANGE OF					
FROM 80.00 TO 10.00 DEGREES					
198.00	257.00	198.00	See Message on Next Line(s)		

```
DEPTH OF CRACK IS GREATER THAN DEPTH OF CIRCLE
    203.00    257.00    198.00 See Message on Next Line(s)
DEPTH OF CRACK IS GREATER THAN DEPTH OF CIRCLE
    208.00    257.00    198.00 See Message on Next Line(s)
CIRCLE DOES NOT INTERSECT SLOPE

    200.00    249.00    198.00  2.048     -23.00        6
    203.00    249.00    198.00  2.007     -23.10        6
    206.00    249.00    198.00  1.972     -23.17        6
    200.00    252.00    198.00  1.983     -23.32        6
    206.00    252.00    198.00  1.951     -23.56        7
    200.00    255.00    198.00  1.969     -24.02        7
    203.00    255.00    198.00  2.055     -26.53        6
    206.00    255.00    198.00 See Message on Next Line(s)
DEPTH OF CRACK IS GREATER THAN DEPTH OF CIRCLE

    202.00    251.00    198.00  1.979     -23.28        6
    203.00    251.00    198.00  1.966     -23.29        6
    204.00    251.00    198.00  1.955     -23.29        7
    202.00    252.00    198.00  1.958     -23.34        7
    204.00    252.00    198.00  1.948     -23.40        7
    202.00    253.00    198.00  1.949     -23.50        7
    203.00    253.00    198.00  1.951     -23.57        7
    204.00    253.00    198.00  1.955     -23.68        7

At the end of the current mode of search the most critical
circle which was found has the following values -
X-center =    203.00     Y-center =    252.00     Radius =    198.00
Factor of Safety =   1.947     Side Force Inclination = -23.35
1  UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:18:1994   Time:  9:12:34   Input file: CASANS.TXT
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Seismic with a=0.1g

TABLE NO. 21
*****  1-STAGE FINAL CRITICAL CIRCLE INFORMATION  *****
X Coordinate of Center - - - - - - -   203.000
Y Coordinate of Center - - - - - - -   252.000
Radius - - - - - - - - - - - - - - -   198.000
Factor of Safety - - - - - - - - - -     1.947
Side Force Inclination - - - - - - -    -23.35

Number of circles tried  - - - - - -  255
No. of circles F calc. for - - - - -  209
1  UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:18:1994   Time:  9:12:34   Input file: CASANS.TXT
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Seismic with a=0.1g

TABLE NO. 26
*************************************************************
*  Coordinate, Weight, Strength and Pore Water Pressure     *
*  Information for Individual Slices for Conventional       *
*  Computations or First Stage of Multi-Stage Computations. *
*  (Information is for the Critical Shear Surface in the    *
*  Case of an Automatic Search.)                            *
*************************************************************

Slice                       Slice   Matl.            Friction    Pore
 No.       X        Y       Weight  Type   Cohesion    Angle    Pressure

         108.5     78.0
   1     109.8     77.3      665.9    1        .00     40.00        .0
         111.0     76.7
   2     111.5     76.4      310.7    1        .00     40.00        .0
         112.0     76.2
   3     113.1     75.6      781.1    1        .00     40.00        .0
         114.3     75.0
   4     114.6     74.8      279.4    2        .00     40.00        .0
         115.0     74.6
   5     116.0     74.1      806.1    1        .00     40.00        .0
         117.0     73.7
   6     121.7     71.5     4613.5    1        .00     40.00        .0
         126.5     69.4
   7     131.3     67.5     5667.4    1        .00     40.00        .0
         136.1     65.6
   8     141.0     64.0     6069.6    1        .00     40.00        .0
         146.0     62.4
   9     151.0     61.0     5779.1    1        .00     40.00        .0
         156.0     59.7
  10     161.0     58.6     4767.5    1        .00     40.00        .0
         166.1     57.5
  11     170.5     56.7     2767.1    1        .00     40.00        .0
         175.0     56.0
  12     179.3     55.5      957.8    1        .00     40.00        .0
         183.7     54.9
1  UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:18:1994   Time:  9:12:34   Input file: CASANS.TXT
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Seismic with a=0.1g

TABLE NO. 27
*************************************************************
*  Seismic Forces and Forces Due to Surface Pressures for   *
*  Individual Slices for Conventional  Computations or the  *
*  First Stage of Multi-Stage Computations.                 *
*  (Information is for the Critical Shear Surface in the    *
*  Case of an Automatic Search.)                            *
*************************************************************

                                    FORCES DUE TO SURFACE PRESSURES
                         Y for
Slice          Seismic  Seismic    Normal   Shear
 No.      X     Force    Force     Force    Force      X        Y

   1    109.8    -67.     78.5       0.       0.     109.8    79.6
   2    111.5    -31.     77.7       0.       0.     111.5    79.0
   3    113.1    -78.     77.0       0.       0.     113.1    78.5
   4    114.6    -28.     76.4       0.       0.     114.6    78.0
   5    116.0    -81.     75.8       0.       0.     116.0    77.5
   6    121.7   -461.     73.6       0.       0.     121.7    75.6
   7    131.3   -567.     70.0       0.       0.     131.3    72.4
   8    141.0   -607.     66.6       0.       0.     141.0    69.2
   9    151.0   -578.     63.4       0.       0.     151.0    65.8
  10    161.0   -477.     60.5       0.       0.     161.0    62.5
  11    170.5   -277.     58.0       0.       0.     170.5    59.3
  12    179.3    -96.     55.9       0.       0.     179.3    56.4
1  UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:18:1994   Time:  9:12:34   Input file: CASANS.TXT
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Seismic with a=0.1g

TABLE NO. 29
*****************************************************************
*  Information Generated During Iterative Solution for the Factor *
*  of Safety and Side Force Inclination by Spencer's Procedure    *
*****************************************************************
```

```
       Trial     Trial
       Factor   Side Force    Force      Moment                 Delta
Iter-    of     Inclination  Imbalance  Imbalance   Delta-F     Theta
ation  Safety   (degrees)     (lbs.)    (ft.-lbs.)            (degrees)

   1  3.00000   -15.0000  -.4718E+04   .4776E+06
First-order corrections to F and THETA .........  -.163E+01  .111E+01
Values factored by  .307E+00 - Deltas too large   -.500E+00  .341E+00

   2  2.50000   -14.6589  -.2985E+04   .3040E+06
First-order corrections to F and THETA ... .....  -.718E+00  .196E+01
Values factored by  .697E+00 - Deltas too large   -.500E+00  .136E+01

   3  2.00000   -13.2959  -.4156E+03   .5150E+05
First-order corrections to F and THETA .........  -.267E-01 -.631E+02
Values factored by  .136E+00 - Deltas too large   -.363E-02 -.859E+01

   4  1.99637   -21.8902  -.3565E+03   .4216E+05
First-order corrections to F and THETA .........  -.502E-01 -.328E+01
Second-order correction - Iteration   1 ........  -.476E-01 -.328E+01
Second-order correction - Iteration   2 ........  -.475E-01 -.328E+01

   5  1.94882   -25.1741   .1726E+01  -.2596E+04
First-order corrections to F and THETA .........  -.186E-02  .179E+01
Second-order correction - Iteration   1 ........  -.181E-02  .179E+01
Second-order correction - Iteration   2 ........  -.181E-02  .179E+01

   6  1.94701   -23.3840  -.1758E-01  -.4759E+02
First-order corrections to F and THETA .........  -.458E-04  .387E-01
Second-order correction - Iteration   1 ........  -.457E-04  .386E-01

   7  1.94696   -23.3454  -.5646E-03  -.3753E-01
First-order corrections to F and THETA .........  -.168E-06  .802E-04

Factor of Safety - - - - - - - -      1.947
Side Force Inclination - - - - -     -23.35
Number of Iterations - - - - - -      7
```

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:18:1994 Time: 9:12:34 Input file: CASANS.TXT
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizonia
3:1 downstream dam embankment slope
Seismic with a=0.1g

TABLE NO. 38

```
**************************************************************
*  Final Results for Stresses Along the Shear Surface        *
*  (Results for Critical Shear Surface in Case of a Search.) *
**************************************************************
```

SPENCER'S PROCEDURE USED TO COMPUTE FACTOR OF SAFETY
Factor of Safety = 1.947 Side Force Inclination = -23.35 Degrees

-------- VALUES AT CENTER OF BASE OF SLICE---------

Slice No.	X-center	Y-center	Total Normal Stress	Effective Normal Stress	Shear Stress
1	109.8	77.3	202.5	202.5	87.3
2	111.5	76.4	235.3	235.3	101.4
3	113.1	75.6	264.0	264.0	113.8
4	114.6	74.8	289.9	289.9	125.0
5	116.0	74.1	312.0	312.0	134.5
6	121.7	71.5	388.4	388.4	167.4
7	131.3	67.5	488.3	488.3	210.5
8	141.0	64.0	537.1	537.1	231.5
9	151.0	61.0	527.0	527.0	227.1
10	161.0	58.6	449.8	449.8	193.8
11	170.5	56.7	310.4	310.4	133.8
12	179.3	55.5	115.3	115.3	49.7

CHECK SUMS - (ALL SHOULD BE SMALL)
SUM OF FORCES IN VERTICAL DIRECTION = .00 (= .805E-03)
SHOULD NOT EXCEED .100E+03
SUM OF FORCES IN HORIZONTAL DIRECTION = .00 (= .287E-03)
SHOULD NOT EXCEED .100E+03
SUM OF MOMENTS ABOUT COORDINATE ORIGIN = .00 (= -.227E-02)
SHOULD NOT EXCEED .100E+03
SHEAR STRENGTH/SHEAR FORCE CHECK-SUM = .00 (= .331E-03)
SHOULD NOT EXCEED .100E+03

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:18:1994 Time: 9:12:34 Input file: CASANS.TXT
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizonia
3:1 downstream dam embankment slope
Seismic with a=0.1g

TABLE NO. 39

```
***************************************************************
*  Final Results for Side Forces and Stresses Between Slices. *
*  (Results for Critical Shear Surface in Case of a Search.)  *
***************************************************************
```

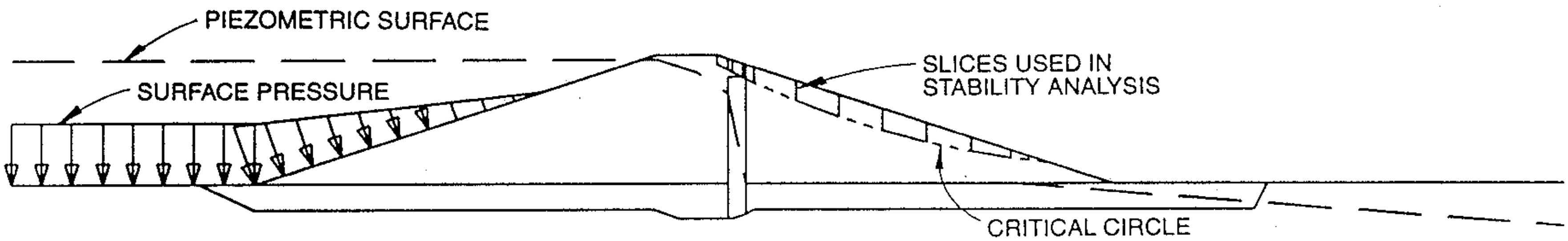
SPENCER'S PROCEDURE USED TO COMPUTE FACTOR OF SAFETY
Factor of Safety = 1.947 Side Force Inclination = -23.35 Degrees

--------------- VALUES AT RIGHT SIDE OF SLICE ---------------

Slice No.	X-Right	Side Force	Y-Coord. of Side Force Location	Fraction of Height	Sigma at Top	Sigma at Bottom
1	111.0	129.	77.4	.305	-8.1	102.7
2	112.0	185.	77.0	.313	-7.9	134.8
3	114.3	321.	76.0	.326	-4.3	195.9
4	115.0	368.	75.7	.329	-2.7	213.5
5	117.0	495.	74.8	.336	2.1	256.6
6	126.5	1075.	71.0	.351	23.2	404.0
7	136.1	1475.	67.5	.358	39.6	485.8
8	146.0	1553.	64.3	.365	53.6	503.3
9	156.0	1272.	61.4	.379	70.3	447.6
10	166.1	730.	58.9	.417	101.4	300.6
11	175.0	233.	57.1	.619	199.1	33.4
12	183.7	0.	-65.5	BELOW	-10000000.0	10000000.0

CHECK SUMS - (ALL SHOULD BE SMALL)
SUM OF FORCES IN VERTICAL DIRECTION = .00 (= .805E-03)
SHOULD NOT EXCEED .100E+03
SUM OF FORCES IN HORIZONTAL DIRECTION = .00 (= .287E-03)
SHOULD NOT EXCEED .100E+03
SUM OF MOMENTS ABOUT COORDINATE ORIGIN = .00 (= -.227E-02)
SHOULD NOT EXCEED .100E+03
SHEAR STRENGTH/SHEAR FORCE CHECK-SUM = .00 (= .331E-03)
SHOULD NOT EXCEED .100E+03

END-OF-FILE ENCOUNTERED WHILE READING COMMAND
WORDS - END OF PROBLEM(S) ASSUMED



SEISMIC, DOWNSTREAM SLOPE

SLOPE STABILITY ANALYSIS
CASANDRO WASH RETENTION BASIN
FILE NAME: CASAN S

INPUT CHECKED D. ALLORD 10/10/94

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:17:1994 Time: 14:38:40 Input file: casan10.txt

TABLE NO. 1

```
****************************************
* COMPUTER PROGRAM DESIGNATION - UTEXAS3 *
* Originally Coded By Stephen G. Wright  *
* Version No. 1.107                      *
* Last Revision Date 10/13/91            *
* (C) Copyright 1985-1991 S. G. Wright   *
* All Rights Reserved                    *
****************************************

**************************************************************
*                                                            *
*     RESULTS OF COMPUTATIONS PERFORMED USING THIS COMPUTER *
* PROGRAM SHOULD NOT BE USED FOR DESIGN PURPOSES UNLESS THEY *
* HAVE BEEN VERIFIED BY INDEPENDENT ANALYSES, EXPERIMENTAL   *
* DATA OR FIELD EXPERIENCE. THE USER SHOULD UNDERSTAND THE   *
* ALGORITHMS AND ANALYTICAL PROCEDURES USED IN THE COMPUTER  *
* PROGRAM AND MUST HAVE READ ALL DOCUMENTATION FOR THIS      *
* PROGRAM BEFORE ATTEMPTING ITS USE.                         *
*                                                            *
*     NEITHER THE UNIVERSITY OF TEXAS NOR STEPHEN G. WRIGHT *
* MAKE OR ASSUME LIABILITY FOR ANY WARRANTIES, EXPRESSED OR  *
* IMPLIED, CONCERNING THE ACCURACY, RELIABILITY, USEFULNESS  *
* OR ADAPTABILITY OF THIS COMPUTER PROGRAM.                  *
*                                                            *
**************************************************************
```

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:17:1994 Time: 14:38:40 Input file: casan10.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Upstream slope analysis, 3:1 slope, PMF piezometric surface

TABLE NO. 2

```
************************
* NEW PROFILE LINE DATA *
************************
```

PROFILE LINE 1 - MATERIAL TYPE = 4
Ground surface beyond downstream toe

Point	X	Y
1	233.000	50.000
2	300.000	50.000

PROFILE LINE 2 - MATERIAL TYPE = 3
Ground surface beyond toe above foundation soil

Point	X	Y
1	198.500	50.000
2	233.000	50.000

PROFILE LINE 3 - MATERIAL TYPE = 1
Downstream dam slope, crest, upstream dam slope

Point	X	Y
1	4.500	50.000
2	94.500	80.000
3	108.500	80.000
4	198.500	50.000

PROFILE LINE 4 - MATERIAL TYPE = 3
Ground surface upstream above foundation soil

Point	X	Y
1	-8.000	50.000
2	4.500	50.000

PROFILE LINE 5 - MATERIAL TYPE = 4
Ground surface upstream beyond toe

Point	X	Y
1	-50.000	50.000
2	-8.000	50.000

PROFILE LINE 6 - MATERIAL TYPE = 2
Chimney drain

Point	X	Y
1	111.000	42.000
2	111.000	50.000
3	111.000	75.000
4	115.000	75.000
5	115.000	50.000
6	115.000	43.000

PROFILE LINE 7 - MATERIAL TYPE = 3
Bottom of dam embankment, downstream of chimney drain

Point	X	Y
1	115.000	50.000
2	198.500	50.000

PROFILE LINE 8 - MATERIAL TYPE = 3
Bottom of dam embankment, upstream of chimney drain

Point	X	Y
1	4.500	50.000
2	111.000	50.000

PROFILE LINE 9 - MATERIAL TYPE = 4
Bottom of foundation soil above undisturbed native soil

Point	X	Y
1	-8.000	50.000
2	4.500	44.000
3	94.000	44.000
4	100.000	42.000
5	111.000	42.000
6	112.000	42.000
7	115.000	43.000
8	117.000	44.000
9	230.000	44.000
10	233.000	50.000

All new profile lines defined - No old lines retained
1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:17:1994 Time: 14:38:40 Input file: casan10.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope

Upstream slope analysis, 3:1 slope, PMF piezometric surface

TABLE NO. 10

```
***********************************************************************
* NEW SURFACE PRESSURE DATA - CONVENTIONAL/FIRST-STAGE COMPUTATIONS *
***********************************************************************
```

ALL NEW DATA INPUT - NO OLD DATA RETAINED

Surface Pressures -

Point	X	Y	Normal Pressure	Shear Stress
1	-50.000	50.000	1800.000	.000
2	4.500	50.000	1800.000	.000
3	91.500	79.000	.000	.000

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:17:1994 Time: 14:38:40 Input file: casan10.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizonia
3:1 downstream dam embankment slope
Upstream slope analysis, 3:1 slope, PMF piezometric surface

TABLE NO. 5

```
***********************************************************************
* NEW PIEZOMETRIC LINE DATA - CONVENTIONAL/FIRST-STAGE COMPUTATIONS *
***********************************************************************
```

1 - Unit weight of water = 62.40 Water level through dam at hig

Line No.	Point	X	Y	
1	1	-50.000	79.000	Water level through dam at hig
1	2	91.500	79.000	Water level through dam at hig
1	3	106.000	74.000	Water level through dam at hig
1	4	111.000	69.000	Water level through dam at hig
1	5	115.000	50.000	Water level through dam at hig
1	6	198.500	50.000	Water level through dam at hig
1	7	300.000	40.000	Water level through dam at hig

All new piezometric lines defined - No old lines retained
1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:17:1994 Time: 14:38:40 Input file: casan10.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizonia
3:1 downstream dam embankment slope
Upstream slope analysis, 3:1 slope, PMF piezometric surface

TABLE NO. 3

```
***********************************************************************
* NEW MATERIAL PROPERTY DATA - CONVENTIONAL/FIRST-STAGE COMPUTATIONS *
***********************************************************************
```

DATA FOR MATERIAL TYPE 1
embankment fill

Unit weight of material = 120.000

CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS
Cohesion - - - - - - - - .000
Friction angle - - - - - 40.000 degrees

Pore water pressures defined by piezometric line
Number of the piezometric line used = 1
Negative pore pressures set to zero

DATA FOR MATERIAL TYPE 2
chimney drain

Unit weight of material = 120.000

CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS
Cohesion - - - - - - - - .000
Friction angle - - - - - 40.000 degrees

Pore water pressures defined by piezometric line
Number of the piezometric line used = 1
Negative pore pressures set to zero

DATA FOR MATERIAL TYPE 3
compacted fill in cut off trench

Unit weight of material = 120.000

CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS
Cohesion - - - - - - - - .000
Friction angle - - - - - 40.000 degrees

Pore water pressures defined by piezometric line
Number of the piezometric line used = 1
Negative pore pressures set to zero

DATA FOR MATERIAL TYPE 4
native soil

Unit weight of material = 130.000

CONVENTIONAL (ISOTROPIC) SHEAR STRENGTHS
Cohesion - - - - - - - - 300.000
Friction angle - - - - - 40.000 degrees

Pore water pressures defined by piezometric line
Number of the piezometric line used = 1
Negative pore pressures set to zero

All new material properties defined - No old data retained
1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:17:1994 Time: 14:38:40 Input file: casan10.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizonia
3:1 downstream dam embankment slope
Upstream slope analysis, 3:1 slope, PMF piezometric surface

TABLE NO. 15

```
*******************************
* NEW ANALYSIS/COMPUTATION DATA *
*******************************
```

Circular Shear Surface(s)

Automatic Search Performed

Starting Center Coordinate for Search at -
X = 21.000
Y = 140.000

Required accuracy for critical center (= minimum
spacing between grid points) = .500

Critical shear surface not allowed to pass below Y = 44.000

For the initial mode of search
all circles are tangent to horizontal line at -
Y = 44.000

Depth of crack = 2.000

THE FOLLOWING REPRESENT EITHER DEFAULT OR PREVIOUSLY DEFINED VALUES:

Initial trial estimate for the factor of safety = 3.000

Initial trial estimate for side force inclination = 15.000 degrees
(Applicable to Spencer's procedure only)

Maximum number of iterations allowed for
calculating the factor of safety = 40

Allowed force imbalance for convergence = 100.000

Allowed moment imbalance for convergence = 100.000

Initial trial values for factor of safety (and side force inclination
for Spencer's procedure) will be kept constant during search

Maximum subtended angle to be used for subdivision of the
circle into slices = 3.00 degrees

Search will be continued to locate a more critical shear
surface (if one exists) after the initial mode is complete

Depth of water in crack = .000

Unit weight of water in crack = 62.400

Seismic coefficient = .000

Conventional (single-stage) computations to be performed

Procedure used to compute the factor of safety: SPENCER

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:17:1994 Time: 14:38:40 Input file: casan10.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Upstream slope analysis, 3:1 slope, PMF piezometric surface

TABLE NO. 16
****
* NEW SLOPE GEOMETRY DATA *
****

NOTE - NO DATA WERE INPUT, SLOPE GEOMETRY DATA
WERE GENERATED BY THE PROGRAM

Slope Coordinates -

Point	X	Y
1	-50.000	50.000
2	-8.000	50.000
3	4.500	50.000
4	94.500	80.000
5	108.500	80.000
6	198.500	50.000
7	233.000	50.000
8	300.000	50.000

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:17:1994 Time: 14:38:40 Input file: casan10.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Upstream slope analysis, 3:1 slope, PMF piezometric surface

TABLE NO. 18
INFORMATION FOR CURRENT MODE OF SEARCH - All Circles Are Tangent
to a Horizontal Line at Y = 44.000

Center Coordinates X	Center Coordinates Y	Radius	1-Stage Factor of Safety	Side Force Inclination (degrees)	Iterations
6.00	125.00	81.00	5.491	1.32	8
21.00	125.00	81.00	3.305	2.99	5
36.00	125.00	81.00	3.225	4.04	5
6.00	140.00	96.00	4.908	2.03	7
21.00	140.00	96.00	3.288	3.66	5
36.00	140.00	96.00	3.320	3.73	5
6.00	155.00	111.00	4.510	2.70	6
21.00	155.00	111.00	3.356	3.73	5
36.00	155.00	111.00	3.556	3.08	5
21.00	110.00	66.00	3.287	2.31	5
36.00	110.00	66.00	3.279	3.98	5
51.00	110.00	66.00	3.821	3.83	6
51.00	125.00	81.00	4.086	2.98	6
51.00	140.00	96.00	4.572	2.07	7
33.50	122.50	78.50	3.152	4.08	5
36.00	122.50	78.50	3.219	4.07	5
38.50	122.50	78.50	3.301	4.03	5
33.50	125.00	81.00	3.152	4.06	5
38.50	125.00	81.00	3.311	3.98	5
33.50	127.50	83.50	3.157	4.03	5
36.00	127.50	83.50	3.233	3.99	5
38.50	127.50	83.50	3.324	3.93	5
31.00	120.00	76.00	3.119	3.96	5
33.50	120.00	76.00	3.157	4.08	5
36.00	120.00	76.00	3.218	4.10	5
31.00	122.50	78.50	3.107	4.01	5
31.00	125.00	81.00	3.101	4.03	5
28.50	122.50	78.50	See Message on Next Line(s)		
ONLY ONE SLICE GENERATED - CIRCLE REJECTED					
28.50	125.00	81.00	3.074	3.91	5
28.50	127.50	83.50	3.067	3.95	5
31.00	127.50	83.50	3.101	4.03	5
26.00	125.00	81.00	3.083	3.63	5
26.00	127.50	83.50	3.065	3.74	5
26.00	130.00	86.00	3.049	3.84	5
28.50	130.00	86.00	3.065	3.96	5
31.00	130.00	86.00	3.105	4.01	5
23.50	127.50	83.50	3.087	3.44	5
23.50	130.00	86.00	3.077	3.55	5
23.50	132.50	88.50	3.104	3.64	5
26.00	132.50	88.50	3.045	3.88	5
28.50	132.50	88.50	3.068	3.97	5
23.50	135.00	91.00	3.120	3.74	5
26.00	135.00	91.00	3.045	3.89	5
28.50	135.00	91.00	3.074	3.95	5
24.50	131.00	87.00	3.053	3.71	5
26.00	131.00	87.00	3.047	3.86	5

27.50	131.00	87.00	3.055	3.93	5
24.50	132.50	88.50	3.044	3.78	5
27.50	132.50	88.50	3.056	3.94	5
24.50	134.00	90.00	3.040	3.82	5
26.00	134.00	90.00	3.044	3.89	5
27.50	134.00	90.00	3.058	3.94	5
23.00	132.50	88.50	3.149	3.58	5
23.00	134.00	90.00	3.154	3.64	5
23.00	135.50	91.50	3.159	3.70	5
24.50	135.50	91.50	3.046	3.83	5
26.00	135.50	91.50	3.045	3.89	5
24.00	133.50	89.50	3.065	3.75	5
24.50	133.50	89.50	3.040	3.81	5
25.00	133.50	89.50	3.041	3.84	5
24.00	134.00	90.00	3.070	3.77	5
25.00	134.00	90.00	3.040	3.84	5
24.00	134.50	90.50	3.076	3.78	5
24.50	134.50	90.50	3.039	3.82	5
25.00	134.50	90.50	3.040	3.85	5
24.00	135.00	91.00	3.082	3.78	5
24.50	135.00	91.00	3.038	3.83	5
25.00	135.00	91.00	3.039	3.85	5
24.00	135.50	91.50	3.087	3.79	5
25.00	135.50	91.50	3.039	3.85	5

At the end of the current mode of search the most critical
circle which was found has the following values -
X-center = 24.50 Y-center = 135.00 Radius = 91.00
Factor of Safety = 3.038 Side Force Inclination = 3.83

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:17:1994 Time: 14:38:40 Input file: casan10.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizonia
3:1 downstream dam embankment slope
Upstream slope analysis, 3:1 slope, PMF piezometric surface

TABLE NO. 19
INFORMATION FOR CURRENT MODE OF SEARCH - All Circles Have the
Same Radius - Radius = 91.000

Center Coordinates X	Y	Radius	1-Stage Factor of Safety	Side Force Inclination (degrees)	Iterations
9.50	120.00	91.00	Bottom of circle exceeds allowable depth - CIRCLE REJECTED		
24.50	120.00	91.00	Bottom of circle exceeds allowable depth - CIRCLE REJECTED		
39.50	120.00	91.00	Bottom of circle exceeds allowable depth - CIRCLE REJECTED		
9.50	135.00	91.00	4.442	2.20	6
39.50	135.00	91.00	3.431	3.68	5
9.50	150.00	91.00	See Message on Next Line(s)		

CIRCLE DOES NOT INTERSECT SLOPE

24.50	150.00	91.00	See Message on Next Line(s)		

Last Trial Values = 23.000 38.80 41
(Last Trial Values Shown Above Are Not Correct Final Values)
FATAL ERROR IN CALCULATING FACTOR OF SAFETY
SOLU... ...NOT CONVERGE WITHIN 40 ITERATIONS

39.50	150.00	91.00	2.735	3.50	4
54.50	135.00	91.00	4.878	1.88	8
54.50	150.00	91.00	3.537	3.04	5
24.50	165.00	91.00	See Message on Next Line(s)		

CIRCLE DOES NOT INTERSECT SLOPE

39.50	165.00	91.00	See Message on Next Line(s)		

CIRCLE DOES NOT INTERSECT SLOPE

54.50	165.00	91.00	See Message on Next Line(s)		

CIRCLE DOES NOT INTERSECT SLOPE

37.00	147.50	91.00	2.769	3.60	4
39.50	147.50	91.00	2.842	3.63	4
42.00	147.50	91.00	2.937	3.62	4
37.00	150.00	91.00	2.760	2.95	4
42.00	150.00	91.00	2.814	3.56	4
37.00	152.50	91.00	3.240	.59	5
39.50	152.50	91.00	2.863	2.26	5
42.00	152.50	91.00	2.715	3.39	4
44.50	150.00	91.00	2.917	3.52	4
44.50	152.50	91.00	2.786	3.49	4
39.50	155.00	91.00	9.094	-3.77	37
42.00	155.00	91.00	3.489	.32	6
44.50	155.00	91.00	2.841	2.74	4
40.50	151.00	91.00	2.722	3.48	4
42.00	151.00	91.00	2.767	3.52	4
43.50	151.00	91.00	2.822	3.50	4
40.50	152.50	91.00	2.781	2.78	4
43.50	152.50	91.00	2.748	3.48	4
40.50	154.00	91.00	3.203	.94	5
42.00	154.00	91.00	2.912	2.18	5
43.50	154.00	91.00	2.755	3.11	4
41.50	152.00	91.00	2.712	3.45	4
42.00	152.00	91.00	2.724	3.49	4
42.50	152.00	91.00	2.738	3.50	4
41.50	152.50	91.00	2.729	3.22	4
42.50	152.50	91.00	2.717	3.46	4
41.50	153.00	91.00	2.772	2.90	4
42.00	153.00	91.00	2.742	3.13	4
42.50	153.00	91.00	2.722	3.30	4
41.00	151.50	91.00	2.716	3.48	4
41.50	151.50	91.00	2.730	3.50	4
42.00	151.50	91.00	2.745	3.51	4
41.00	152.00	91.00	2.721	3.29	4
41.00	152.50	91.00	2.750	3.01	4

At the end of the current mode of search the most critical
circle which was found has the following values -
X-center = 41.50 Y-center = 152.00 Radius = 91.00
Factor of Safety = 2.712 Side Force Inclination = 3.45

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:17:1994 Time: 14:38:40 Input file: casan10.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizonia
3:1 downstream dam embankment slope
Upstream slope analysis, 3:1 slope, PMF piezometric surface

TABLE NO. 18
INFORMATION FOR CURRENT MODE OF SEARCH - All Circles Are Tangent
to a Horizontal Line at Y = 61.000

Center Coordinates X	Y	Radius	1-Stage Factor of Safety	Side Force Inclination (degrees)	Iterations

```
    26.50    137.00     76.00 See Message on Next Line(s)
DEPTH OF CRACK IS GREATER THAN DEPTH OF CIRCLE
    41.50    137.00     76.00  3.018       1.36          5
    56.50    137.00     76.00  3.253       3.39          5
    26.50    152.00     91.00 See Message on Next Line(s)
DEPTH OF CRACK IS GREATER THAN DEPTH OF CIRCLE
    56.50    152.00     91.00  3.566       2.97          5
    26.50    167.00    106.00 See Message on Next Line(s)
Last Trial Values =            23.000      18.99         41
(Last Trial Values Shown Above Are Not Correct Final Values)
FATAL ERROR IN CALCULATING FACTOR OF SAFETY
SOLUTION DID NOT CONVERGE WITHIN  40 ITERATIONS
    41.50    167.00    106.00  2.862       3.40          4
    56.50    167.00    106.00  4.004       2.34          6

    39.00    149.50     88.50  2.889       2.02          5
    41.50    149.50     88.50  2.735       3.19          4
    44.00    149.50     88.50  2.767       3.50          4
    39.00    152.00     91.00  2.826       2.42          4
    44.00    152.00     91.00  2.791       3.48          4
    39.00    154.50     93.50  2.771       2.81          4
    41.50    154.50     93.50  2.726       3.47          4
    44.00    154.50     93.50  2.819       3.48          4

    40.00    150.50     89.50  2.790       2.68          4
    41.50    150.50     89.50  2.724       3.30          4
    43.00    150.50     89.50  2.742       3.50          4
    40.00    152.00     91.00  2.760       2.90          4
    43.00    152.00     91.00  2.755       3.49          4
    40.00    153.50     92.50  2.735       3.11          4
    41.50    153.50     92.50  2.719       3.47          4
    43.00    153.50     92.50  2.768       3.49          4

    41.00    151.50     90.50  2.726       3.24          4
    41.50    151.50     90.50  2.715       3.40          4
    42.00    151.50     90.50  2.720       3.48          4
    41.00    152.00     91.00  2.721       3.29          4
    42.00    152.00     91.00  2.724       3.49          4
    41.00    152.50     91.50  2.716       3.35          4
    41.50    152.50     91.50  2.713       3.47          4
    42.00    152.50     91.50  2.727       3.48          4

At the end of the current mode of search the most critical
circle which was found has the following values -
X-center =     41.50    Y-center =    152.00      Radius =      91.00
Factor of Safety =   2.712     Side Force Inclination =   3.45
1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date:  8:17:1994   Time: 14:38:40   Input file: casan10.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Upstream slope analysis, 3:1 slope, PMF piezometric surface

TABLE NO. 21
***** 1-STAGE FINAL CRITICAL CIRCLE INFORMATION  *****
X Coordinate of Center - - - - - - -     41.500
Y Coordinate of Center - - - - - - -    152.000
Radius - - - - - - - - - - - - - - -     91.000
Factor of Safety - - - - - - - - - -      2.712
Side Force Inclination - - - - - - -       3.45

Number of circles tried  - - - - - -  149
No. of circles F calc. for - - - - -  137
1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
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```



```
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Upstream slope analysis, 3:1 slope, PMF piezometric surface

TABLE NO. 26
***********************************************************
*  Coordinate, Weight, Strength and Pore Water Pressure    *
*  Information for Individual Slices for Conventional      *
*  Computations or First Stage of Multi-Stage Computations. *
*  (Information is for the Critical Shear Surface in the   *
*  Case of an Automatic Search.)                            *
***********************************************************
```

Slice No.	X	Y	Slice Weight	Matl. Type	Cohesion	Friction Angle	Pore Pressure
	37.7	61.1					
1	39.6	61.0	301.3	1	.00	40.00	1120.8
	41.5	61.0					
2	43.9	61.1	1180.0	1	.00	40.00	1119.3
	46.3	61.1					
3	48.6	61.3	1938.3	1	.00	40.00	1103.8
	51.0	61.5					
4	53.4	61.8	2540.4	1	.00	40.00	1072.7
	55.7	62.1					
5	58.1	62.6	2982.0	1	.00	40.00	1026.2
	60.4	63.0					
6	62.7	63.5	3261.7	1	.00	40.00	964.4
	65.1	64.1					
7	67.3	64.8	3381.2	1	.00	40.00	887.5
	69.6	65.5					
8	71.9	66.2	3344.7	1	.00	40.00	795.7
	74.1	67.0					
9	76.3	68.0	3159.4	1	.00	40.00	689.2
	78.5	68.9					
10	80.7	69.9	2835.4	1	.00	40.00	568.3
	82.8	70.9					
11	84.9	72.1	2385.1	1	.00	40.00	433.4
	87.0	73.2					
12	89.0	74.4	1823.4	1	.00	40.00	284.8
	91.1	75.7					
13	91.3	75.8	163.0	1	.00	40.00	198.2
	91.5	76.0					
14	92.8	76.8	779.2	1	.00	40.00	109.2
	94.0	77.7					
15	94.2	77.8	107.2	1	.00	40.00	15.0
	94.4	78.0					

```
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CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Upstream slope analysis, 3:1 slope, PMF piezometric surface

TABLE NO. 27
***********************************************************
*  Seismic Forces and Forces Due to Surface Pressures for  *
*  Individual Slices for Conventional  Computations or the *
*  First Stage of Multi-Stage Computations.                 *
*  (Information is for the Critical Shear Surface in the   *
*  Case of an Automatic Search.)                            *
***********************************************************

                                  FORCES DUE TO SURFACE PRESSURES
                         Y for
Slice          Seismic  Seismic   Normal   Shear
 No.      X     Force    Force    Force    Force     X        Y
```

1	39.6	0.	61.4	4261.	0.	39 6	61.7
2	43.9	0.	62.1	4946.	0.	43.8	63.1
3	48.6	0.	63.0	4440.	0.	48.6	64.7
4	53.4	0.	64.1	3927.	0.	53.3	66.3
5	58.1	0.	65.2	3414.	0.	58.0	67.8
6	62.7	0.	66.5	2906.	0.	62.7	69.4
7	67.3	0.	67.9	2407.	0.	67.3	70.9
8	71.9	0.	69.4	1923.	0.	71.8	72.4
9	76.3	0.	70.9	1458.	0.	76.2	73.9
10	80.7	0.	72.6	1016.	0.	80.5	75.3
11	84.9	0.	74.4	602.	0.	84.7	76.7
12	89.0	0.	76.3	219.	0.	88.5	78.0
13	91.3	0.	77.4	2.	0.	91.2	78.9
14	92.8	0.	78.1	0.	0.	92.8	79.4
15	94.2	0.	78.9	0.	0.	94.2	79.9

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CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Upstream slope analysis, 3:1 slope, PMF piezometric surface

TABLE NO. 29
****
* Information Generated During Iterative Solution for the Factor *
* of Safety and Side Force Inclination by Spencer's Procedure *
****

Iter-ation	Trial Factor of Safety	Trial Side Force Inclination (degrees)	Force Imbalance (lbs.)	Moment Imbalance (ft.-lbs.)	Delta-F	Delta Theta (degrees)
1	3.00000	15.0000	-.6277E+02	.4281E+05		
First-order corrections to F and THETA					-.325E+00	-.112E+02
Values factored by .768E+00 - Deltas too large					-.249E+00	-.859E+01
2	2.75082	6.4056	-.5676E+02	.1314E+05		
First-order corrections to F and THETA					-.415E-01	-.299E+01
Second-order correction - Iteration 1					-.399E-01	-.299E+01
Second-order correction - Iteration 2					-.399E-01	-.299E+01
3	2.71093	3.4153	.1776E+00	-.1218E+03		
First-order corrections to F and THETA					.732E-03	.336E-01
Second-order correction - Iteration 1					.752E-03	.344E-01
Second-order correction - Iteration 2					.771E-03	.352E-01
Second-order correction - Iteration 3					.791E-03	.360E-01
Second-order correction - Iteration 4					.811E-03	.368E-01
Second-order correction - Iteration 5					.830E-03	.376E-01
Second-order correction - Iteration 6					.850E-03	.383E-01
Second-order correction - Iteration 7					.870E-03	.391E-01
Second-order correction - Iteration 8					.889E-03	.399E-01
Second-order correction - Iteration 9					.909E-03	.407E-01
Second-order correction - Iteration 10					.928E-03	.415E-01

SECOND-ORDER CORRECTIONS DID NOT CONVERGE
IN 10 ITERATIONS - FIRST-ORDER CORRECTIONS
USED

4	2.71166	3.4489	-.1095E-02	.5069E-01		
First-order corrections to F and THETA					.836E-06	.524E-05

Factor of Safety - - - - - - - - - 2.712
Side Force Inclination - - - - - - 3.45
Number of Iterations - - - - - - - 4
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CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Upstream slope analysis, 3:1 slope, PMF piezometric surface

TABLE NO. 38
****
* Final Results for Stresses Along the Shear Surface *
* (Results for Critical Shear Surface in Case of a Search.) *
****

SPENCER'S PROCEDURE USED TO COMPUTE FACTOR OF SAFETY
Factor of Safety = 2.712 Side Force Inclination = 3.45 Degrees

-------- VALUES AT CENTER OF BASE OF SLICE---------

Slice No.	X-center	Y-center	Total Normal Stress	Effective Normal Stress	Shear Stress
1	39.6	61.0	1177.9	57.1	17.7
2	43.9	61.1	1252.2	132.9	41.1
3	48.6	61.3	1305.4	201.6	62.4
4	53.4	61.8	1326.4	253.7	78.5
5	58.1	62.6	1316.0	289.8	89.7
6	62.7	63.5	1275.4	311.0	96.2
7	67.3	64.8	1205.4	317.9	98.4
8	71.9	66.2	1107.2	311.5	96.4
9	76.3	68.0	981.8	292.6	90.5
10	80.7	69.9	830.4	262.1	81.1
11	84.9	72.1	654.4	221.0	68.4
12	89.0	74.4	455.1	170.3	52.7
13	91.3	75.8	338.0	139.8	43.3
14	92.8	76.8	269.7	160.6	49.7
15	94.2	77.8	203.1	188.2	58.2

CHECK SUMS - (ALL SHOULD BE SMALL)
SUM OF FORCES IN VERTICAL DIRECTION = .00 (= .136E-02)
SHOULD NOT EXCEED .100E+03
SUM OF FORCES IN HORIZONTAL DIRECTION = .00 (= .773E-03)
SHOULD NOT EXCEED .100E+03
SUM OF MOMENTS ABOUT COORDINATE ORIGIN = -.01 (= -.133E-01)
SHOULD NOT EXCEED .100E+03
SHEAR STRENGTH/SHEAR FORCE CHECK-SUM = .00 (= .729E-03)
SHOULD NOT EXCEED .100E+03

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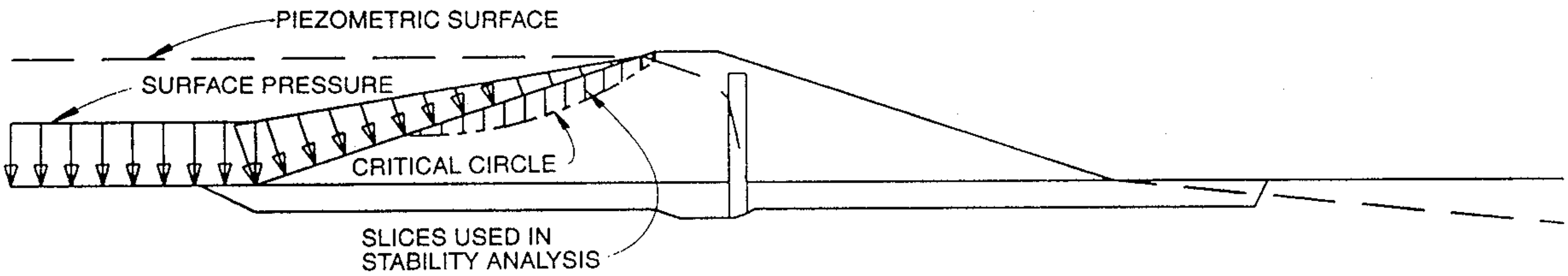
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Upstream slope analysis, 3:1 slope, PMF piezometric surface

TABLE NO. 39
****
* Final Results for Side Forces and Stresses Between Slices. *
* (Results for Critical Shear Surface in Case of a Search.) *
****

SPENCER'S PROCEDURE USED TO COMPUTE FACTOR OF SAFETY
Factor of Safety = 2.712 Side Force Inclination = 3.45 Degrees

--------------- VALUES AT RIGHT SIDE OF SLICE ---------------

Slice No.	X-Right	Side Force	Y-Coord. of Side Force Location	Fraction of Height	Sigma at Top	Sigma at Bottom



STATIC, UPSTREAM SLOPE

SLOPE STABILITY ANALYSIS
CASANDRO WASH RETENTION BASIN
FILE NAME: CASAN 10

1	41.5	1509.	61.7	.511	1202.6	1056.4
2	46.3	3115.	62.5	.509	1169.7	1054.6
3	51.0	4330.	63.5	.501	1083.0	1075.1
4	55.7	5119.	64.6	.491	975.2	1086.1
5	60.4	5477.	65.7	.481	859.3	1075.6
6	65.1	5423.	67.0	.472	740.2	1039.6
7	69.6	5002.	68.3	.463	620.0	977.1
8	74.1	4281.	69.8	.453	499.6	887.9
9	78.5	3349.	71.4	.443	379.1	773.0
10	82.8	2314.	73.1	.429	256.7	634.1
11	87.0	1302.	74.9	.404	127.5	475.6
12	91.1	450.	76.6	.300	-28.3	311.7
13	91.5	373.	76.8	.286	-34.8	280.4
14	94.0	37.	77.8	.064	-27.7	61.9
15	94.4	0.	26.9	BELOW	-.1	.1

CHECK SUMS - (ALL SHOULD BE SMALL)
SUM OF FORCES IN VERTICAL DIRECTION = .00 (= .136E-02)
SHOULD NOT EXCEED .100E+03
SUM OF FORCES IN HORIZONTAL DIRECTION = .00 (= .773E-03)
SHOULD NOT EXCEED .100E+03
SUM OF MOMENTS ABOUT COORDINATE ORIGIN = -.01 (= -.133E-01)
SHOULD NOT EXCEED .100E+03
SHEAR STRENGTH/SHEAR FORCE CHECK-SUM = .00 (= .729E-03)
SHOULD NOT EXCEED .100E+03

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CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Upstream slope analysis, 3:1 slope, PMF piezometric surface

TABLE NO. 15
****
* NEW ANALYSIS/COMPUTATION DATA *
****

Circular Shear Surface(s)

Automatic Search Performed

Starting Center Coordinate for Search at -
X = 21.000
Y = 140.000

Required accuracy for critical center (= minimum spacing between grid points) = .500

Critical shear surface not allowed to pass below Y = 44.000

For the initial mode of search
all circles are tangent to horizontal line at -
Y = 44.000

Seismic coefficient = .100

Depth of crack = 2.000

THE FOLLOWING REPRESENT EITHER DEFAULT OR PREVIOUSLY DEFINED VALUES:

Initial trial estimate for the factor of safety = 3.000

Initial trial estimate for side force inclination = 15.000 degrees
(Applicable to Spencer's procedure only)

Maximum number of iterations allowed for
calculating the factor of safety = 40

Allowed force imbalance for convergence = 100.000

Allowed moment imbalance for convergence = 100.000

Initial trial values for factor of safety (and side force inclination for Spencer's procedure) will be kept constant during search

Maximum subtended angle to be used for subdivision of the circle into slices = 3.00 degrees

Search will be continued to locate a more critical shear surface (if one exists) after the initial mode is complete

Depth of water in crack = .000

Unit weight of water in crack = 62.400

Conventional (single-stage) computations to be performed

Procedure used to compute the factor of safety: SPENCER
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CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Upstream slope analysis, 3:1 slope, PMF piezometric surface

TABLE NO. 18
INFORMATION FOR CURRENT MODE OF SEARCH - All Circles Are Tangent to a Horizontal Line at Y = 44.000

Center Coordinates X	Y	Radius	1-Stage Factor of Safety	Side Force Inclination (degrees)	Iterations
6.00	125.00	81.00	2.834	2.79	4
21.00	125.00	81.00	1.923	5.78	5
36.00	125.00	81.00	1.907	7.17	5
6.00	140.00	96.00	2.621	3.62	4
21.00	140.00	96.00	1.926	6.04	5
36.00	140.00	96.00	1.926	7.10	5
6.00	155.00	111.00	2.465	4.40	4
21.00	155.00	111.00	1.954	6.22	5
36.00	155.00	111.00	1.998	6.75	5
21.00	110.00	66.00	1.890	4.55	6
36.00	110.00	66.00	1.958	6.88	4
51.00	110.00	66.00	2.249	7.26	6
51.00	125.00	81.00	2.288	6.86	5
51.00	140.00	96.00	2.408	6.35	4
6.00	95.00	51.00	3.641	.83	6
21.00	95.00	51.00	2.008	3.56	5
36.00	95.00	51.00	2.124	5.77	4
6.00	110.00	66.00	3.144	1.88	5
18.50	107.50	63.50	2.020	3.81	5
21.00	107 50	63.50	1.906	4.40	6
23.50	107.50	63.50	1.900	4.84	6
18.50	110.00	66.00	2.044	3.94	5
23.50	110.00	66.00	1.884	5.00	5
18.50	112.50	68.50	2.053	4.08	5

21.00	112.50	68.50	1.875	4.71	5
23.50	112.50	68.50	1.869	5.16	5
26.00	110.00	66.00	1.887	5.43	5
26.00	112.50	68.50	1.871	5.59	5
21.00	115.00	71.00	1.861	4.86	5
23.50	115.00	71.00	1.856	5.31	5
26.00	115.00	71.00	1.857	5.74	5
21.00	117.50	73.50	1.863	4.98	5
23.50	117.50	73.50	1.843	5.46	5
26.00	117.50	73.50	1.844	5.89	5
21.00	120.00	76.00	1.899	5.05	5
23.50	120.00	76.00	1.831	5.61	5
26.00	120.00	76.00	1.832	6.04	5
21.00	122.50	78.50	1.915	5.16	5
23.50	122.50	78.50	1.820	5.76	5
26.00	122.50	78.50	1.820	6.19	5
21.00	125.00	81.00	1.923	5.28	5
23.50	125.00	81.00	1.809	5.90	5
26.00	125.00	81.00	1.809	6.34	5
21.00	127.50	83.50 Center of circle falls outside of current grid - Grid re-initialized			
21.00	122.50	78.50	1.915	5.16	5
23.50	122.50	78.50	1.820	5.76	5
26.00	122.50	78.50	1.820	6.19	5
21.00	125.00	81.00	1.923	5.28	5
26.00	125.00	81.00	1.809	6.34	5
21.00	127.50	83.50	1.927	5.41	5
23.50	127.50	83.50	1.799	6.05	6
26.00	127.50	83.50	1.800	6.48	5
21.00	130.00	86.00	1.929	5.54	5
23.50	130.00	86.00	1.795	6.18	7
26.00	130.00	86.00	1.792	6.60	6
28.50	127.50	83.50	1.811	6.79	5
28.50	130.00	86.00	1.808	6.84	6
23.50	132.50	88.50	1.816	6.24	5
26.00	132.50	88.50	1.788	6.66	6
28.50	132.50	88.50	1.807	6.87	6
23.50	135.00	91.00	1.830	6.32	5
26.00	135.00	91.00	1.787	6.70	6
28.50	135.00	91.00	1.807	6.88	6
23.50	137.50	93.50	1.842	6.35	5
26.00	137.50	93.50	1.787	6.73	6
28.50	137.50	93.50	1.809	6.89	6
24.50	133.50	89.50	1.780	6.52	7
26.00	133.50	89.50	1.787	6.67	6
27.50	133.50	89.50	1.798	6.80	6
24.50	135.00	91.00	1.779	6.56	6
27.50	135.00	91.00	1.798	6.82	6
24.50	136.50	92.50	1.794	6.54	6
26.00	136.50	92.50	1.787	6.72	6
27.50	136.50	92.50	1.799	6.82	6
23.00	133.50	89.50	1.846	6.15	5
23.00	135.00	91.00	1.851	6.21	5
23.00	136.50	92.50	1.856	6.25	5
24.00	134.50	90.50	1.803	6.43	5
24.50	134.50	90.50	1.779	6.55	6
25.00	134.50	90.50	1.781	6.60	6
24.00	135.00	91.00	1.807	6.43	5
25.00	135.00	91.00	1.781	6.60	6
24.00	135.50	91.50	1.810	6.43	5
24.50	135.50	91.50	1.784	6.55	6
25.00	135.50	91.50	1.781	6.61	6

At the end of the current mode of search the most critical
circle which was found has the following values -
X-center = 24.50 Y-center = 135.00 Radius = 91.00
Factor of Safety = 1.779 Side Force Inclination = 6.56
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Date: 8:17:1994 Time: 14:38:40 Input file: casan10.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Upstream slope analysis, 3:1 slope, PMF piezometric surface

TABLE NO. 19
INFORMATION FOR CURRENT MODE OF SEARCH - All Circles Have the
Same Radius - Radius = 91.000

Center Coordinates X	Y	Radius	1-Stage Factor of Safety	Side Force Inclination (degrees)	Iterations
9.50	120.00	91.00 Bottom of circle exceeds allowable depth - CIRCLE REJECTED			
24.50	120.00	91.00 Bottom of circle exceeds allowable depth - CIRCLE REJECTED			
39.50	120.00	91.00 Bottom of circle exceeds allowable depth - CIRCLE REJECTED			
9.50	135.00	91.00	2.442	3.90	4
39.50	135.00	91.00	1.987	7.14	5
9.50	150.00	91.00 See Message on Next Line(s)			
CIRCLE DOES NOT INTERSECT SLOPE					
24.50	150.00	91.00 See Message on Next Line(s)			
Last Trial Values =			12.873	72.05	35
(Last Trial Values Shown Above Are Not Correct Final Values)					
VALUE OF SIDE FORCE INCLINATION BECAME OUTSIDE RANGE OF FROM -10.00 TO 80.00 DEGREES					
39.50	150.00	91.00	1.583	6.04	6
54.50	135.00	91.00	2.528	6.26	4
54.50	150.00	91.00	1.970	6.84	5
24.50	165.00	91.00 See Message on Next Line(s)			
CIRCLE DOES NOT INTERSECT SLOPE					
39.50	165.00	91.00 See Message on Next Line(s)			
CIRCLE DOES NOT INTERSECT SLOPE					
54.50	165.00	91.00 See Message on Next Line(s)			
CIRCLE DOES NOT INTERSECT SLOPE					
37.00	147.50	91.00	1.609	6.23	6
39.50	147.50	91.00	1.651	6.44	6
42.00	147.50	91.00	1.701	6.60	6
37.00	150.00	91.00	1.575	5.33	6
42.00	150.00	91.00	1.629	6.29	6
37.00	152.50	91.00	1.709	2.44	6
39.50	152.50	91.00	1.596	4.45	6
42.00	152.50	91.00	1.559	5.81	7

44.50	150.00	91.00	1.684	6.45	6
44.50	152.50	91.00	1.606	6.10	6
39.50	155.00	91.00	2.717	-2.60	5
42.00	155.00	91.00	1.776	2.17	6
44.50	155.00	91.00	1.582	5.02	6
40.50	151.00	91.00	1.572	5.97	6
42.00	151.00	91.00	1.599	6.12	6
43.50	151.00	91.00	1.630	6.23	6
40.50	152.50	91.00	1.571	5.09	6
43.50	152.50	91.00	1.584	6.00	6
40.50	154.00	91.00	1.695	2.88	6
42.00	154.00	91.00	1.607	4.35	6
43.50	154.00	91.00	1.559	5.46	7
41.50	152.00	91.00	1.562	5.88	7
42.00	152.00	91.00	1.570	5.96	6
42.50	152.00	91.00	1.580	6.01	6
41.50	152.50	91.00	1.558	5.62	7
42.50	152.50	91.00	1.565	5.90	7
41.50	153.00	91.00	1.566	5.24	7
42.00	153.00	91.00	1.559	5.51	7
42.50	153.00	91.00	1.557	5.70	7
43.00	152.50	91.00	1.574	5.95	6
43.00	153.00	91.00	1.559	5.85	7
42.00	153.50	91.00	1.575	5.03	6
42.50	153.50	91.00	1.562	5.35	7
43.00	153.50	91.00	1.557	5.59	7
43.50	153.00	91.00	1.569	5.90	6
43.50	153.50	91.00	1.557	5.78	7
42.50	154.00	91.00	1.587	4.75	6
43.00	154.00	91.00	1.570	5.14	8
44.00	153.00	91.00	1.579	5.95	6
44.00	153.50	91.00	1.564	5.87	6
44.00	154.00	91.00	1.556	5.69	7
44.50	153.50	91.00	1.574	5.92	6
44.50	154.00	91.00	1.559	5.85	7
43.50	154.50	91.00	1.585	4.90	6
44.00	154.50	91.00	1.567	5.29	6
44.50	154.50	91.00	1.558	5.59	7

At the end of the current mode of search the most critical
circle which was found has the following values -
X-center = 44.00 Y-center = 154.00 Radius = 91.00
Factor of Safety = 1.556 Side Force Inclination = 5.69

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:17:1994 Time: 14:38:40 Input file: casan10.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizonia
3:1 downstream dam embankment slope
Upstream slope analysis, 3:1 slope, PMF piezometric surface

TABLE NO. 18
INFORMATION FOR CURRENT MODE OF SEARCH - All Circles Are Tangent
to a Horizontal Line at Y = 63.000

Center Coordinates X	Center Coordinates Y	Radius	1-Stage Factor of Safety	Side Force Inclination (degrees)	Iterations
29.00	139.00	76.00	See Message on Next Line(s)		
CIRCLE DOES NOT INTERSECT SLOPE					
44.00	139.00	76.00	1.729	2.37	6
59.00	139.00	76.00	1.074	6.80	6
29.00	154.00	91.00	See Message on Next Line(s)		
DEPTH OF CRACK IS GREATER THAN DEPTH OF CIRCLE					
59.00	154.00	91.00	2.011	6.83	5
29.00	169.00	106.00	See Message on Next Line(s)		
DEPTH OF CRACK IS GREATER THAN DEPTH OF CIRCLE					
44.00	169.00	106.00	1.642	6.11	6
59.00	169.00	106.00	2.173	6.74	5
41.50	151.50	88.50	1.670	3.22	6
44.00	151.50	88.50	1.566	5.33	7
46.50	151.50	88.50	1.589	5.99	6
41.50	154.00	91.00	1.631	3.88	6
46.50	154.00	91.00	1.604	6.03	6
41.50	156.50	93.50	1.598	4.53	6
44.00	156.50	93.50	1.561	5.89	7
46.50	156.50	93.50	1.621	6.05	6
42.50	152.50	89.50	1.604	4.39	6
44.00	152.50	89.50	1.560	5.49	7
45.50	152.50	89.50	1.572	5.91	7
42.50	154.00	91.00	1.587	4.75	6
45.50	154.00	91.00	1.580	5.95	6
42.50	155.50	92.50	1.571	5.10	8
44.00	155.50	92.50	1.556	5.85	7
45.50	155.50	92.50	1.589	5.98	6
43.50	153.50	90.50	1.562	5.38	6
44.00	153.50	90.50	1.557	5.63	7
44.50	153.50	90.50	1.557	5.81	7
43.50	154.00	91.00	1.559	5.46	7
44.50	154.00	91.00	1.559	5.85	7
43.50	154.50	91.50	1.557	5.54	7
44.00	154.50	91.50	1.555	5.75	7
44.50	154.50	91.50	1.561	5.87	7
43.50	155.00	92.00	1.555	5.61	7
44.00	155.00	92.00	1.555	5.81	7
44.50	155.00	92.00	1.564	5.88	6

At the end of the current mode of search the most critical
circle which was found has the following values -
X-center = 44.00 Y-center = 154.50 Radius = 91.50
Factor of Safety = 1.555 Side Force Inclination = 5.75

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:17:1994 Time: 14:38:40 Input file: casan10.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizonia
3:1 downstream dam embankment slope
Upstream slope analysis, 3:1 slope, PMF piezometric surface

TABLE NO. 21
***** 1-STAGE FINAL CRITICAL CIRCLE INFORMATION *****
X Coordinate of Center - - - - - - - 44.000
Y Coordinate of Center - - - - - - - 154.500
Radius - - - - - - - - - - - - - - - 91.500
Factor of Safety - - - - - - - - - - 1.555
Side Force Inclination - - - - - - - 5.75

Number of circles tried - - - - - - 178
No. of circles F calc. for - - - - - 167

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
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CASANDRO WASH DETENTION BASIN, Wickenburg, Arizonia
3:1 downstream dam embankment slope

Upstream slope analysis, 3:1 slope, PMF piezometric surface

TABLE NO. 26

```
************************************************************
*  Coordinate, Weight, Strength and Pore Water Pressure     *
*  Information for Individual Slices for Conventional       *
*  Computations or First Stage of Multi-Stage Computations. *
*  (Information is for the Critical Shear Surface in the    *
*  Case of an Automatic Search.)                            *
************************************************************
```

Slice No.	X	Y	Slice Weight	Matl. Type	Cohesion	Friction Angle	Pore Pressure
	43.5	63.0					
1	43.8	63.0	5.0	1	.00	40.00	998.4
	44.0	63.0					
2	46.4	63.1	518.4	1	.00	40.00	994.5
	48.8	63.1					
3	51.2	63.3	1286.8	1	.00	40.00	978.8
	53.6	63.5					
4	55.9	63.8	1899.3	1	.00	40.00	947.6
	58.3	64.1					
5	60.7	64.6	2351.3	1	.00	40.00	900.9
	63.0	65.0					
6	65.4	65.6	2641.5	1	.00	40.00	838.7
	67.7	66.1					
7	70.0	66.8	2771.4	1	.00	40.00	761.4
	72.3	67.5					
8	74.5	68.3	2745.4	1	.00	40.00	669.1
	76.8	69.1					
9	79.0	70.0	2570.7	1	.00	40.00	562.0
	81.2	70.9					
10	83.4	71.9	2257.5	1	.00	40.00	440.4
	85.5	73.0					
11	87.6	74.1	1818.3	1	.00	40.00	304.8
	89.7	75.3					
12	90.6	75.8	615.6	1	.00	40.00	201.1
	91.5	76.3					
13	92.7	77.0	673.7	1	.00	40.00	96.3
	93.9	77.8					

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:17:1994 Time: 14:38:40 Input file: casan10.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizonia
3:1 downstream dam embankment slope
Upstream slope analysis, 3:1 slope, PMF piezometric surface

TABLE NO. 27

```
************************************************************
*  Seismic Forces and Forces Due to Surface Pressures for   *
*  Individual Slices for Conventional Computations or the   *
*  First Stage of Multi-Stage Computations.                 *
*  (Information is for the Critical Shear Surface in the    *
*  Case of an Automatic Search.)                            *
************************************************************
```

				FORCES DUE TO SURFACE PRESSURES			
Slice No.	X	Seismic Force	Y for Seismic Force	Normal Force	Shear Force	X	Y
1	43.8	0.	63.0	516.	0.	43.8	63.1
2	46.4	52.	63.5	4711.	0.	46.4	64.0
3	51.2	129.	64.4	4200	0.	51.1	65.5
4	55.9	190.	65.5	3683	0.	55.9	67.1
5	60.7	235.	66.6	3167.	0.	60.6	68.7
6	65.4	264.	67.9	2656.	0.	65.3	70.3
7	70.0	277.	69.3	2156.	0.	69.9	71.8
8	74.5	275.	70.8	1671.	0.	74.4	73.3
9	79.0	257.	72.4	1206.	0.	78.9	74.8
10	83.4	226.	74.1	766.	0.	83.2	76.2
11	87.6	182.	75.9	354.	0.	87.3	77.6
12	90.6	62.	77.2	33.	0.	90.3	78.6
13	92.7	67.	78.2	0.	0.	92.7	79.4

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:17:1994 Time: 14:38:40 Input file: casan10.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizonia
3:1 downstream dam embankment slope
Upstream slope analysis, 3:1 slope, PMF piezometric surface

TABLE NO. 29

```
****************************************************************
*  Information Generated During Iterative Solution for the Factor *
*  of Safety and Side Force Inclination by Spencer's Procedure    *
****************************************************************

         Trial     Trial
        Factor   Side Force    Force      Moment                 Delta
Iter-     of     Inclination  Imbalance  Imbalance    Delta-F     Theta
ation   Safety    (degrees)    (lbs.)    (ft.-lbs.)             (degrees)

   1   3.00000    15.0000   .2270E+04  -.8706E+05
First-order corrections to F and THETA .........  -.254E+01 -.362E+01
Values factored by  .197E+00 - Deltas too large   -.500E+00 -.715E+00

   2   2.50000    14.2855   .1732E+04  -.6503E+05
First-order corrections to F and THETA .........  -.137E+01 -.388E+01
Values factored by  .365E+00 - Deltas too large   -.500E+00 -.142E+01

   3   2.00000    12.8675   .9413E+03  -.3196E+05
First-order corrections to F and THETA .........  -.511E+00 -.425E+01
Values factored by  .978E+00 - Deltas too large   -.500E+00 -.415E+01

   4   1.50000     8.7142  -.2691E+03   .2139E+05
First-order corrections to F and THETA .........   .459E-01 -.350E+01
Second-order correction - Iteration   1 ........   .512E-01 -.350E+01
Second-order correction - Iteration   2 ........   .512E-01 -.350E+01

   5   1.55121     5.2138   .1872E+01  -.1217E+04
First-order corrections to F and THETA .........   .414E-02  .540E+00
Second-order correction - Iteration   1 ........   .417E-02  .540E+00
Second-order correction - Iteration   2 ........   .417E-02  .540E+00

   6   1.55538     5.7541  -.1068E-03   .4361E+01
First-order corrections to F and THETA .........  -.188E-04 -.212E-02
Second-order correction - Iteration   1 ........  -.165E-04 -.186E-02

   7   1.55537     5.7522  -.3052E-03   .5308E+00
First-order corrections to F and THETA .........  -.211E-05 -.249E-03

Factor of Safety - - - - - - - - -       1.555
Side Force Inclination - - - - - -        5.75
Number of Iterations - - - - - - -       7
```

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:17:1994 Time: 14:38:40 Input file: casan10.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizonia
3:1 downstream dam embankment slope
Upstream slope analysis, 3:1 slope, PMF piezometric surface

TABLE NO. 38

```
************************************************************
*  Final Results for Stresses Along the Shear Surface       *
```

* (Results for Critical Shear Surface in Case of a Search.) *
****

SPENCER'S PROCEDURE USED TO COMPUTE FACTOR OF SAFETY
Factor of Safety = 1.555   Side Force Inclination = 5.75 Degrees

-------- VALUES AT CENTER OF BASE OF SLICE---------

Slice No.	X-center	Y-center	Total Normal Stress	Effective Normal Stress	Shear Stress
1	43.8	63.0	1033.2	34.8	18.8
2	46.4	63.1	1072.0	77.5	41.8
3	51.2	63.3	1121.8	143.0	77.1
4	55.9	63.8	1138.0	190.4	102.7
5	60.7	64.6	1122.4	221.5	119.5
6	65.4	65.6	1076.6	237.8	128.3
7	70.0	66.8	1002.2	240.8	129.9
8	74.5	68.3	900.9	231.8	125.1
9	79.0	70.0	774.1	212.1	114.4
10	83.4	71.9	623.4	183.0	98.7
11	87.6	74.1	450.6	145.8	78.7
12	90.6	75.8	317.2	116.1	62.6
13	92.7	77.0	227.6	131.3	70.9

CHECK SUMS - (ALL SHOULD BE SMALL)
SUM OF FORCES IN VERTICAL DIRECTION = .00 (= .859E-03)
SHOULD NOT EXCEED .100E+03
SUM OF FORCES IN HORIZONTAL DIRECTION = .00 (= .552E-03)
SHOULD NOT EXCEED .100E+03
SUM OF MOMENTS ABOUT COORDINATE ORIGIN = -.50 (= -.500E+00)
SHOULD NOT EXCEED .100E+03
SHEAR STRENGTH/SHEAR FORCE CHECK-SUM = .00 (= .602E-03)
SHOULD NOT EXCEED .100E+03

1 UTEXAS3 - VER. 1.107 - 10/13/91 - (C) 1985-1991 S. G. WRIGHT
Date: 8:17:1994   Time: 14:38:40   Input file: casan10.txt
CASANDRO WASH DETENTION BASIN, Wickenburg, Arizona
3:1 downstream dam embankment slope
Upstream slope analysis, 3:1 slope, PMF piezometric surface

TABLE NO. 39
****
* Final Results for Side Forces and Stresses Between Slices. *
* (Results for Critical Shear Surface in Case of a Search.) *
****

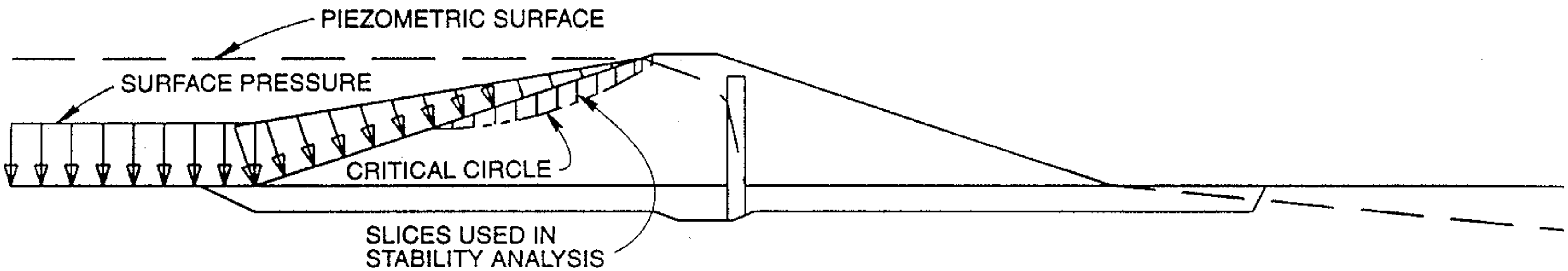
SPENCER'S PROCEDURE USED TO COMPUTE FACTOR OF SAFETY
Factor of Safety = 1.555   Side Force Inclination = 5.75 Degrees

--------------- VALUES AT RIGHT SIDE OF SLICE ---------------

Slice No.	X-Right	Side Force	Y-Coord. of Side Force Location	Fraction of Height	Sigma at Top	Sigma at Bottom
1	44.0	174.	63.1	.616	1763.6	318.8
2	48.8	1686.	64.0	.531	1214.4	834.0
3	53.6	2838.	65.0	.537	1207.4	771.5
4	58.3	3593.	66.1	.530	1104.0	771.7
5	63.0	3944.	67.3	.520	974.1	766.6
6	67.7	3913.	68.6	.510	834.1	741.3
7	72.3	3549.	70.0	.500	689.5	691.7
8	76.8	2924.	71.5	.489	542.1	617.1
9	81.2	2132.	73.1	.477	391.2	518.8
10	85.5	1285.	74.8	.456	232.6	400.3
11	89.7	513.	76.5	.387	51.7	271.2
12	91.5	241.	77.3	.356	12.0	165.3
13	93.9	0.	1821.4	ABOVE	.8	-.8

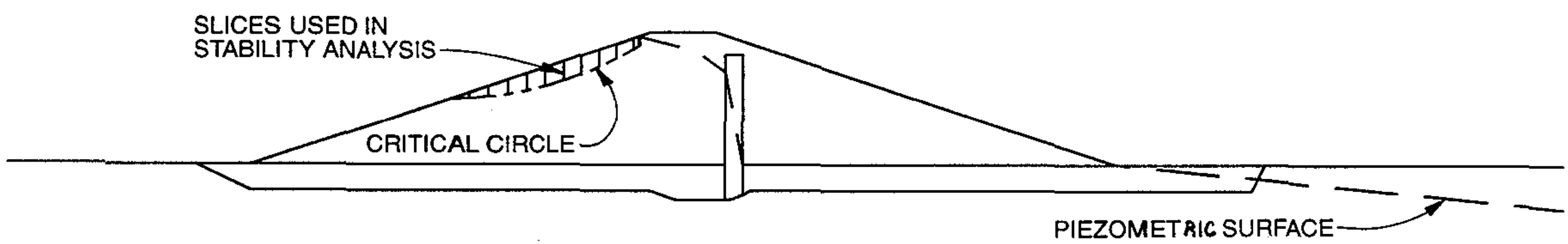
CHECK SUMS - (ALL SHOULD BE SMALL)
SUM OF FORCES IN VERTICAL DIRECTION = .00 (= .859E-03)
SHOULD NOT EXCEED .100E+03
SUM OF FORCES IN HORIZONTAL DIRECTION = .00 (= .552E-03)
SHOULD NOT EXCEED .100E+03
SUM OF MOMENTS ABOUT COORDINATE ORIGIN = -.50 (= -.500E+00)
SHOULD NOT EXCEED .100E+03
SHEAR STRENGTH/SHEAR FORCE CHECK-SUM = .00 (= .602E-03)
SHOULD NOT EXCEED .100E+03

END-OF-FILE ENCOUNTERED WHILE READING COMMAND
WORDS - END OF PROBLEM(S) ASSUMED



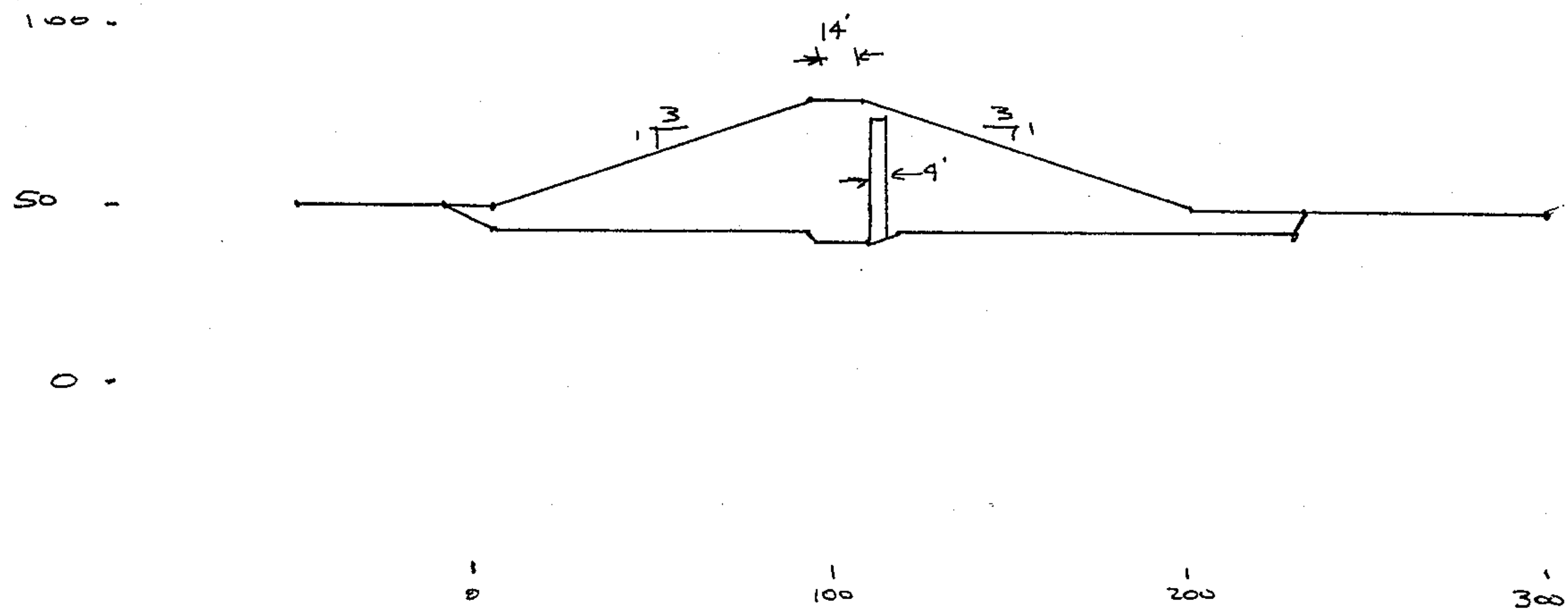
SEISMIC, UPSTREAM SLOPE

SLOPE STABILITY ANALYSIS
CASANDRO WASH RETENTION BASIN
FILE NAME: CASAN 10S



RAPID DRAWDOWN, UPSTREAM SLOPE

SLOPE STABILITY ANALYSIS
CASANDRO WASH RETENTION BASIN
FILE NAME: RDCASAN



CH2M HILL

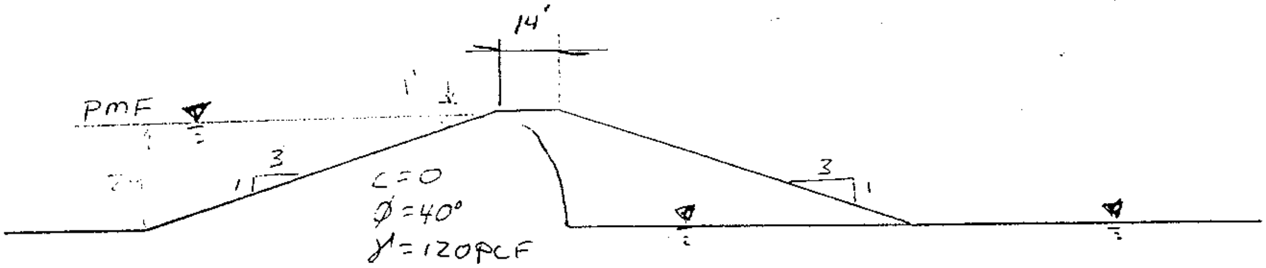
SUBJECT Cassandra Wash Dam
Slope Stability
Check UTEXAS 2 Input Geometry

BY D. Alvarado
SHEET NO. 1 of 1 DATE 11/13/94
PROJECT NO. SWW35441.GT.90

PROBLEM: Estimate stability of upstream and downstream slopes of Casandro Wash Detention Basin for static case.

REFERENCE: An Engineering Manual for Slope Stabilities, by J.M. Duncan and A.L. Buchignani, Figure 9, Slope Stability chart after Janbu, 1968.

SLOPE MATERIAL AND GEOMETRY: The embankment will be constructed with a cohesionless soil with $\phi = 40°$. Upstream and downstream slopes are 3:1. Upstream slope is submerged to the PMF water level. The piezometric surface is steady state at PMF, draining into chimney drain and out of downstream slope at the toe.



For $c = 0$

$$FS = \frac{P_a}{P_d}\, b \tan\phi$$

$$P_e = \frac{\gamma H + q - \gamma_w H_w'}{\mu_q\, \mu_w'}$$

$$P_d = \frac{\gamma H + q - \gamma_w H_w}{\mu_q\, \mu_w\, \mu_t}$$

γ = unit wt of soil
H = total height of slope
q = load on slope
H_w' = height from toe of slope to water level
H_w = depth of impounded water
μ_q, μ_w, μ_t = correction factors for load, water, and tension crack

b = slope ratio

UPSTREAM SLOPE

$$P_e = \frac{(120\ PCF)(30\ ft) + 0 - \gamma_w (29\ ft)}{1.1}$$

P_e = 3600 PSF − 1810 PSF

P_e = 1790 PSF

$$P_D = \frac{(120\ PCF)(30\ ft) + 0 - \gamma_w (29\ ft)}{1.1 \cdot 1}$$

P_D = 3600 PSF − 1810 PSF

P_D = 1790 PSF

$$FS = \frac{1790}{1790} \cdot 3 \cdot \tan 40° = 2.5$$

SUBJECT CASANDRO WASH DETENTION BASIN BY D.M. SMITH DATE 8/16/94
MANUAL ESTIMATE - SLOPE STABILITY SHEET 2 OF 2
PROJECT NO. SWW 35441. GT.40
Checked D. ALLISON

DOWNSTREAM SLOPE:

$$P_e = \frac{(120\ pcf)(30\ ft) + 0 - \gamma_w(0)}{1.1}$$

$P_e = 3600\ psf$

$$P_D = \frac{(120\ pcf)(30\ ft) + 0 - \gamma_w(0)}{1.1.1}$$

$P_D = 3600\ psf$

$$FS = \frac{3600}{3600} \cdot 3 \cdot \tan 40°$$

$FS = 2.5$

These table computed factors of safety are slightly less than the UTEXAS3 values. These provide a reasonable check of the computer estimated values.

Checked D. Aurora 10/12/94

ESTIMATE MAXIMUM SETTLEMENT OF DAM SECTION

FROM TERZAGHI & PECK, 1948.

BEARING LOAD $(2163-2128)130 = 4550$ psf.

FOR DENSE FDN SOIL ($N_{SPT} > 30$) SETTLEMENT ~ 1" ⟵

FROM LAMBE AND WHITMAN - SOIL MECHANICS 1969 p221

$$\Delta q_s = \frac{N\rho}{12}\left(\frac{B+1}{B}\right)^2$$

$B \cong 50'$ WIDE PRIMARY DAM

Δq_s (Tons/ft^2)

ρ = settlement in inches

$N = 30$ - SPT

$$\frac{4550}{2000} = \frac{30\rho}{12}\left(\frac{51}{50}\right)^2$$

$\rho = 0.87$ inches ⟵

CHECK USING MEYERHOFF (FROM DUNCAN & BUCHIGNANI)

$$\rho_i = \frac{5p}{(N-1.5)C_B} = \frac{5\left(\frac{4550\ psf}{2000\ \#/ton}\right)}{(30-1.5)\,0.8} = \underline{0.50\ in}$$

C_B = width correction = 0.80

EMBANKMENT COMPRESSION MUST ALSO BE CONSIDERED

$N \leq 10$ FOR NEW EMBANKMENT

AT MIDHEIGHT OF EMBANKMENT SAY 18' FROM CREST

$18(130) = 2340$ psf

$$\frac{2340}{2000} = \frac{10\rho}{12}\left(\frac{51}{50}\right)^2 \qquad \rho = 1.3" ⟵$$

MEYERHOFF $\rho_i = \frac{5\left(\frac{2340}{2000}\right)}{(10-1.5)\,0.8} = 0.86$ in

TOTAL IMMEDIATE SETTLMT $0.5 + 0.86 = 1.36"$

AFTER 1 YEAR $\rho = 1.36(1.4) \sim \underline{1.9"}$

$C_t = 1 + 0.2\log\left(\frac{time}{0.1}\right)$

DUNCAN & BUCHIGNANI TABLE 5

LOOKING AT ELASTIC THEORY

REF: FOUNDATION ENGINEERING HANDBOOK
WINTERKORN AND FANG 1975

E = Youngs Modulus page 156

$E = 2q_c$

$q_c = 3.5N$ where N = SPT VALUE

SAY FOR FDN N=30 COMPUTE FDN COMPRESSION

$q_c = 3.5(30) = 105$ Tons/ft²

$E = 2(105) = 210$ TSF $= 420{,}000$ psf

$\epsilon = \frac{\Delta P}{E} I_z \; 50'$ I_z = STRAIN INFLUENCE FACTOR = 0.2 AVG

$\epsilon = \frac{4550 \text{ lb}}{\text{ft}^2} \; \frac{\text{ft}^2}{420{,}000 \text{ lb}} \; 0.2 \; 50 \text{ ft} = 1.3$ inches ←

FOR EMBANKMENT

$N = 5$ $q_c = 3.5(5) = 17.5$ TSF

$E = 2q_c = 2(17.5) = 35$ TSF $= 70{,}000$ psf

$\epsilon = 0.2 \frac{(63-28)}{2} 130 \frac{17}{70{,}000} = 0.11' = 1.3''$ ←

CONCLUSION:

FDN COMPRESSION ESTIMATE 1-1.5"

EMBANKMENT COMPRESSION ESTIMATE 1-1.5"

TOTAL SETTLEMENT 2-3" OK

SUBJECT FOUNDATION ANALYSIS — SPILLWAY STRUCTURES — CASANDRO WASH DAM
BY J. LIVINGSTON DATE 9/20/94
SHEET 1 OF
PROJECT NO. SWW35441.GT.30
CHECKED 10/10/94

SPILLWAY WALLS

BEARING PRESSURE TO LIMIT SETTLEMENT

REFERENCE: LAMBE AND WHITMAN 1968. p221

IF N_{SPT} of Embankment = 5 q_{all} = 2000 psf. for 1"

CHECK MEYERHOF RELATIONSHIP

$$\Delta q = \frac{N \rho}{8} \quad \text{if } B < 4'$$

if Δq_{all} = 1500 psf & N = 5

$$\rho = \frac{8 \; 1500}{2000 \; 5} = 1.2 \text{ inches}$$

ENTIRE Embankment WILL SETTLE DUE TO ITS OWN WEIGHT

CHECK FS AGAINST BEARING CAPACITY FAILURE

REFERENCE: PECK HANSEN THORNBURN 1953. p311.

$\phi = 35°$ $N_q = 35$ $N_\gamma = 35$

$$Q_{ULT} = \frac{1}{2} B \gamma N_\gamma + \gamma D_f N_q$$

SAY B = 4' γ = 130 − 62.4 = 67 pcf

at D_f = 3' minimum.

$$Q_{ULT} = \frac{1}{2} 4 \; 67 \; 35 + 67 \; 3 \; 35$$

$$= 4690 + 7035 = 11,725 \text{ psf}$$

$$FS = \frac{11,725}{1500} = 7.8 \text{ ok.}$$

RETAINING WALLS.

USE ACTIVE PRESSURE OR AT REST PRESSURE

$$k_A = \tan^2(45 - \phi/2) = \tan^2(45 - 35/2) = 0.27$$

WALLS ARE DRAINED

EQUIVALENT FLUID DENSITY 0.27(130) = 35 pcf.

FOR AT REST CASE $k_o = (1 - \sin\phi) = 1 - \sin 35 = 0.42$

EQUIVALENT FLUID DENSITY = 0.42(130)(.95) = 53 pcf.

USE 60pcf FOR NON SATURATED WALL BACKFILL.

PASSIVE RESISTANCE

$K_p = \tan^2(45 + \phi/2) = \tan^2(45 + 35/2) = 3.7$

EQUIVALENT FLUID DENSITY $3.7(130 \times .95 - 62.4) = 226$ pcf

TO LIMIT MOVEMENT REDUCE PASSIVE RESISTANCE BY 25%

$0.75(226) = 170$ pcf use 175 pcf.

SLIDING RESISTANCE $(\tan 35)\delta$

$\delta = 0.7 \quad (\tan 35)0. = 0.49$

SLIDING FACTOR 0.5

ESTIMATE RATE OF PENETRATION INTO DAM

$$\gamma_T = \left(\frac{1+w}{1+e}\right) G \gamma_w \qquad (1)$$

$G = 2.62$

γ_d = Average of 6 curves $\gamma_{d\,max} = 115.3$ pcf

$w_{opt} = 12.7\%$

$\gamma_T = 1.127(115.3) = 129.9$ pcf

SAY $95\% = .95(129.9) = 123.4$ pcf. $= \gamma_T$

INSERTING INTO (1)

$$123.4 = \left(\frac{1+.127}{1+e}\right) 2.62(62.4)$$

$1+e = 1.493$

$e = .493$

$$n = \frac{e}{1+e} = \frac{.493}{1.493} = 0.33$$

$Q = kiA$

$Q = VA$

$V = \frac{ki}{n}$ THROUGH DAM

AVG k from lab tests $5(10^{-4})$ cm/sec

NORMALLY USE $k_h = 10k_v = 5(10^{-3})$ cm/sec

POSSIBLE RANGE OF k's $1(10^{-3})$, $5(10^{-3})$, $1(10^{-2})$ cm/sec

DISTANCE = V (TIME) Time = 1 day 5 days 10 days

$$DISTANCE = \frac{ki(T)}{n}$$

$$D = \frac{K}{n}\frac{H}{D}T$$

$$D^2 = \frac{k}{n}HT \qquad D = \left(\frac{k}{.35}HT\right)^{\frac{1}{2}}$$

FOR $n = 0.35$

SAY $k = 1(10^{-3})$ cm/sec.

$$1\frac{cm}{sec}\;\frac{3600\,sec}{hr}\;\frac{24\,hr}{d}\;\frac{IN}{2.54\,cm}\;\frac{ft}{12\,IN} = 2834.6\ FT/d.$$

THEREFORE

$$D = \left(\frac{2834.6\ k\ H\ T}{.35}\right)^{\frac{1}{2}} = \left(8{,}098.987\ kHT\right)^{\frac{1}{2}}$$

SEE SPREADSHEET FOR ESTIMATED DISTANCES.

GROUPS 3,4 ARE MOST LIKELY WITH A RAPIDLY FILLING RESERVOIR.

IN 5 DAYS SEEPAGE MAY REACH CHIMNEY DRAIN.
PROBABLY MORE LIKE 5-10 DAYS.

Casandro Wash
Seepage Analysis

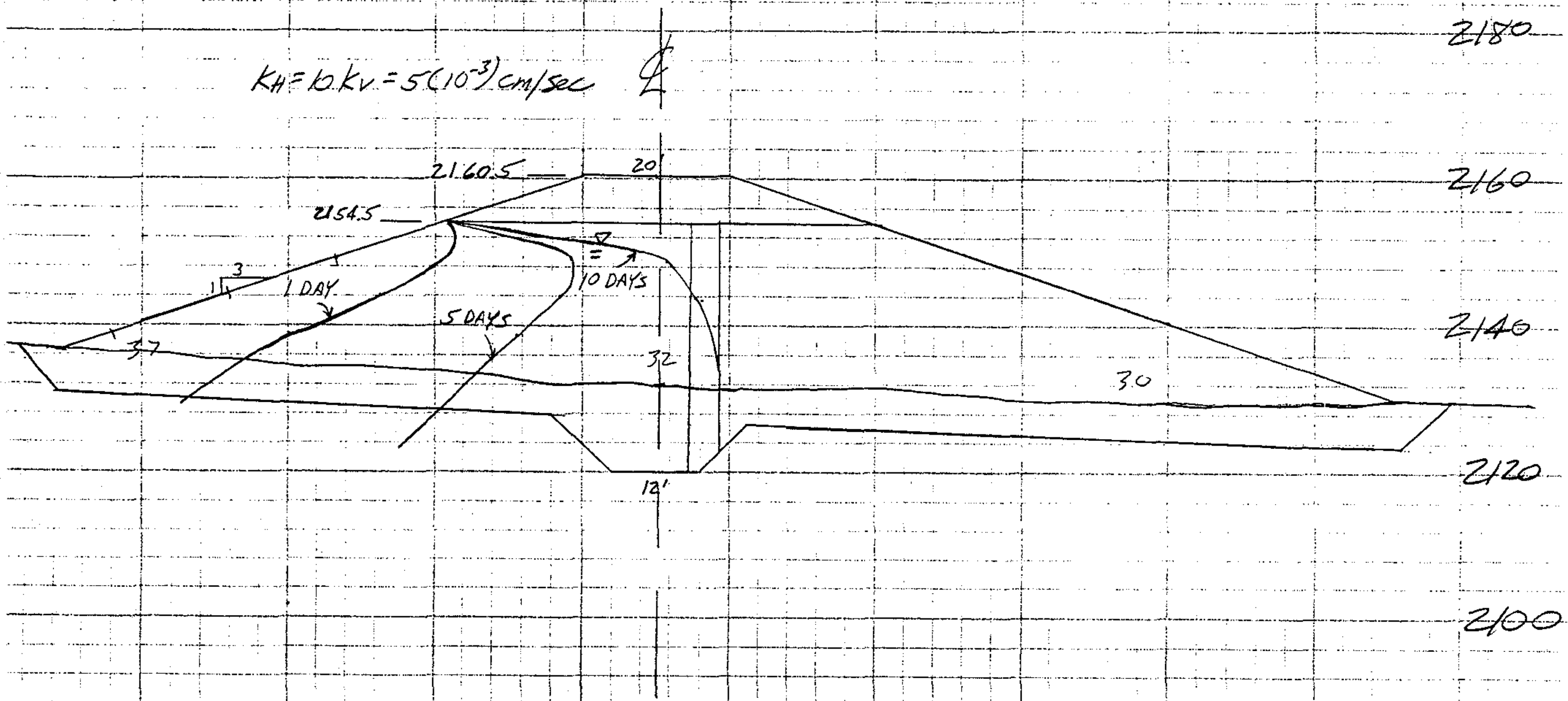
Group		H (ft)	K (cm/sec)	T = 1 day	T = 5 days	T = 10 days	T = 20 days
1	Avg Vert K	5	0.0005	4.5	10.1	14.2	20.1
		10	0.0005	6.4	14.2	20.1	28.5
		15	0.0005	7.8	17.4	24.6	34.9
		20	0.0005	9.0	20.1	28.5	40.2
2	2xAvg Vert	5	0.001	6.4	14.2	20.1	28.5
		10	0.001	9.0	20.1	28.5	40.2
		15	0.001	11.0	24.6	34.9	49.3
		20	0.001	12.7	28.5	40.2	56.9
3	10xAvg Vert	5	0.005	14.2	31.8	45.0	63.6
		10	0.005	20.1	45.0	63.6	90.0
		15	0.005	24.6	55.1	77.9	110.2
		20	0.005	28.5	63.6	90.0	127.3
4	20x Avg Ver	5	0.01	20.1	45.0	63.6	90.0
		10	0.01	28.5	63.6	90.0	127.3
		15	0.01	34.9	77.9	110.2	155.9
		20	0.01	40.2	90.0	127.3	180.0

John Livingston
13-Apr-94

3/20/94.
J. LIVINGSTON

1" = 20'

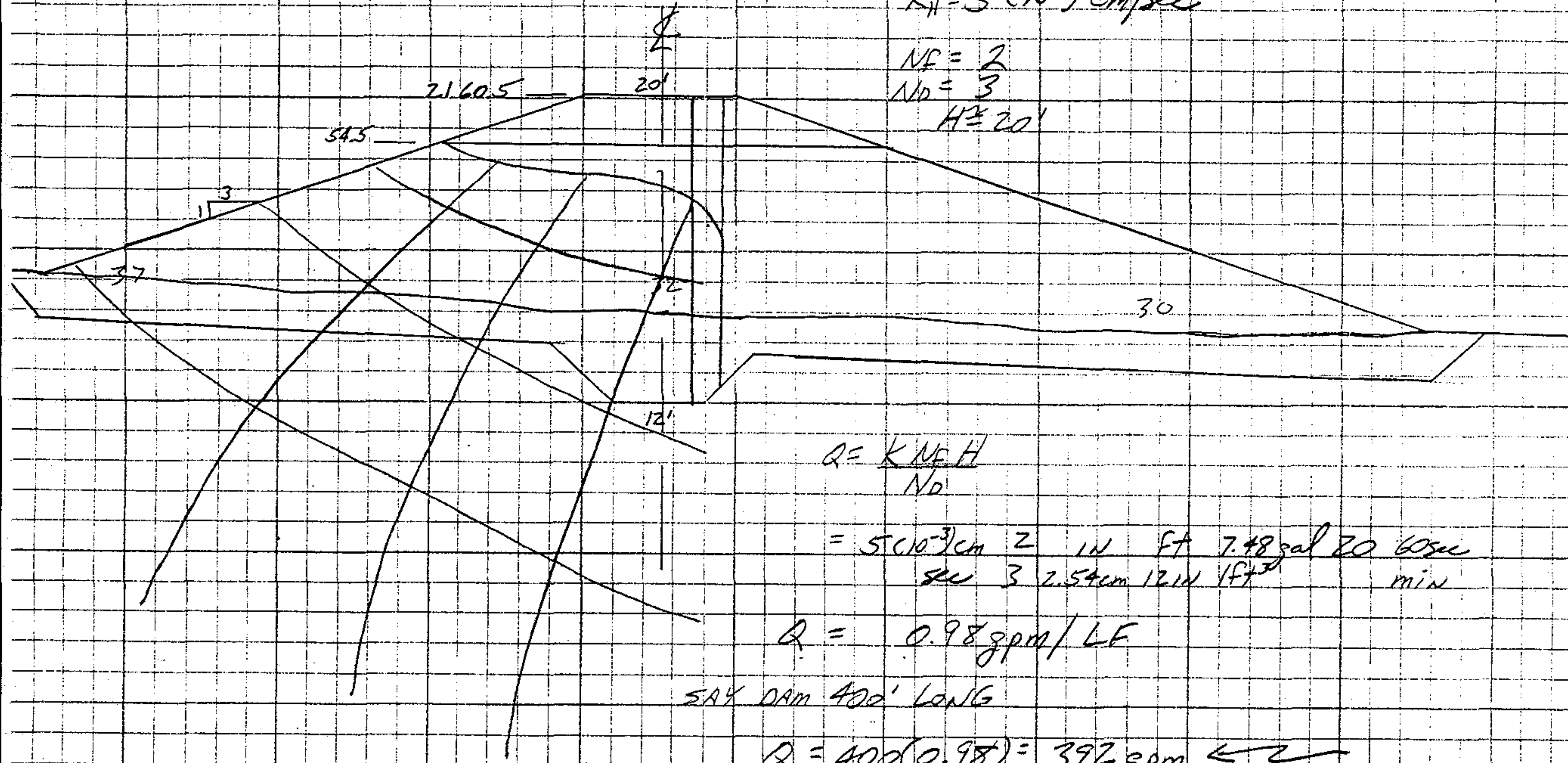
CASSANDRO WASH DAM
SEEPAGE.



1" = 20'

SEEPAGE QUANTITY

CASANDRO WASH. DAM



$K_H = 5(10^{-3})$ cm/sec

$N_f = 2$

$N_D = 3$

$H \doteq 20'$

$$Q = \frac{K N_f H}{N_D}$$

$$= \frac{5(10^{-3})\,cm}{sec} \cdot \frac{2}{3} \cdot \frac{1\,IN}{2.54\,cm} \cdot \frac{ft}{12\,IN} \cdot \frac{7.48\,gal}{1\,ft^3} \cdot 20 \cdot \frac{60\,sec}{min}$$

Q = 0.98 gpm/LF

SAY DAM 400' LONG

Q = 400(0.98) = 392 gpm. ←

SUBJECT CASANDRO WASH DAM BY J. LIVINGSTON DATE 3/20/94
CHIMNEY DRAIN CAPACITY SHEET ___ OF ___
PROJECT NO. SWW35441.GT

CAPACITY OF CHIMNEY DRAIN

$k = 1\text{-}5 \text{ ft/min} = 0.5 - 2.54 \text{ cm/sec}$

IF $K_{CHIMNEY} = 1 \text{ FT/min}$ AVG HEAD 10'

$Q = k i A$

$= \frac{1 \text{ FT}}{\text{min}} \; \frac{10}{4} \; 1 \; 7.48 = 18.7 \text{ gpm/SF}$

$Q = 18.7 \times 15 \times 400 = 122{,}000 \text{ gpm}$ PERPENDICULAR TO FACE OF CHIMNEY DRAIN

if $k = 10^{-1} \text{ FT/min}$ $Q = 12{,}200 \text{ gpm}$. ok

CHECK FLOW TO DRAIN PIPE - VERTICAL FLOW

$Q = k i A$

$Q = 10^{-1} \; \frac{15}{15} \; 4 \; 7.48 \times 400 = 1197 \text{ gpm}$. ok

DAM SHOULD PRODUCE LESS THAN 400 gpm

DRAIN SHOULD PASS AT LEAST 1200 gpm.

FS = 3.0

USE SLOTTED DRAIN PIPE

CH2M HILL

SUBJECT CASANDRO WASH CHIMNEY DRAIN OUTLET

BY [illegible]

SHEET NO. 1 of 1 DATE 1/10/95

PROJECT NO. SWW35441.PS

PJA 1/17/95

CHIMNEY DRAIN OUTLET PIPE CAPACITY

$$Q = \frac{1.486 R^{2/3} S^{1/2} A}{n}$$

n = 0.014

DROP 1' IN 80' TRY 8" PIPE

$$A = \frac{\pi}{4}\left(\frac{8}{12}\right)^2 = 0.35^{\square'}$$

$$R = \frac{A}{\pi D} = \frac{0.35}{\pi\ 0.67} = 0.166 \qquad R^{2/3} = 0.30$$

$$S = \frac{1}{80} = 0.0125 \qquad S^{1/2} = 0.1118$$

$$Q = \frac{1.486}{0.014}\ 0.30\ 0.1118\ 0.35 = 1.246 \text{ cfs}$$

$$Q = 559 \text{ gpm} \leftarrow$$

SEEPAGE INTO DAM AT STEADY STATE IS ~400 gpm.

MAX CAPACITY OF 4' CHIMNEY DRAIN ~ 1200 gpm.

USE 2 8" ϕ PIPES Q = 1118 gpm ⇒ close to 1200 gpm.

CH2M HILL SUBJECT CASANDRO WASH DETENTION DAM. BY J. LIVINGSTON DATE 7/14/94 PROJECT NO. SWW35441.G1 SHT OF

CHIMNEY DRAIN FILTER CRITERIA
REFERENCE: NAVFAC DM-7.1 MAY 1992.

$\frac{D_{15F}}{D_{15B}} > 4$ TO MINIMIZE HEAD LOSS - Fig 4. pp 273

$\frac{D_{15F}}{D_{85B}} < 5$ $\frac{D_{50F}}{D_{50B}} < 25$ $\frac{D_{15F}}{D_{15B}} < 20$

D_{85B} = 3 TO 30 mm per all sieve analyses, gradations attached
$5(3) = 15_{mm}$
$5(30) = 150_{mm}$
$D_{15F} < 15$ mm. ←

D_{50B} = 0.8 TO 9.0 mm - ONSITE SOILS

$D_{50F} < 25(D_{50B})$
< 20 TO 225 mm. ←

D_{15B} = .03 TO 0.6 mm - ONSITE SOILS

$D_{15F} \leq 20(D_{15B}) \leq 0.6$ TO 12 mm ←

$20 \geq \frac{D_{15F}}{D_{15B}} \geq 4$

D_{15F} = 0.6 TO 12 MM COMBINED FROM ABOVE VALUES

D_{15B} = .03 to 0.6 mm PER GRADATIONS ATTACHED

$\frac{0.6}{.03} = 20$ $\frac{0.6}{0.6} = 1.0$
$\frac{12}{.03} = 400$ $\frac{12}{.6} = 20$
} SELECTED GRADATION - SEE ATTACHED FIGURE

K = .07'/MIN concrete sand.
= 1'/MIN per DM 7.1 Fig 6. pp 7.1-277

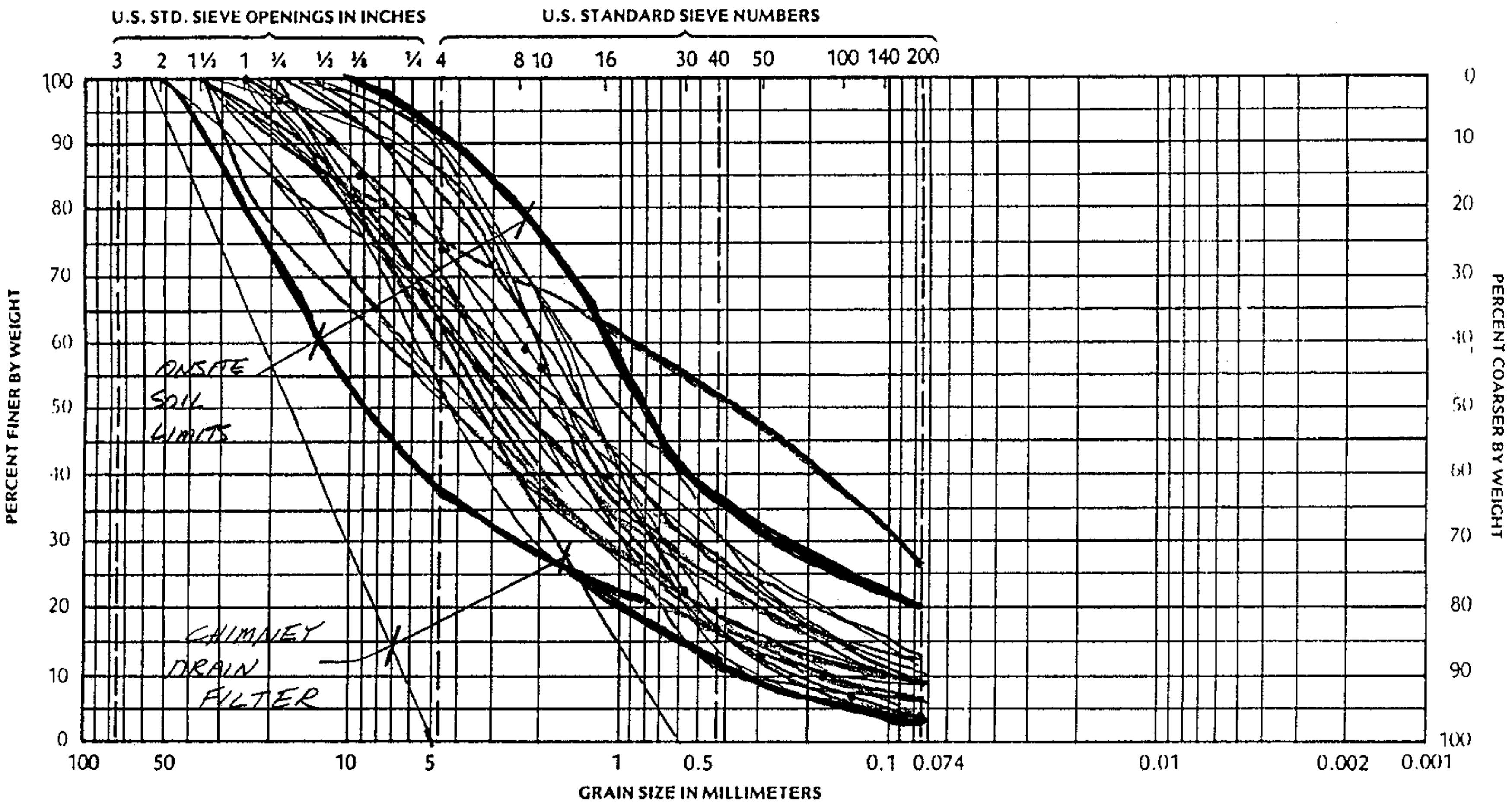
Allow < 2% fines - 200 sieve

Type of Material Casandro Wash Detention Dam Job No. 2123JH240

Source of Material ALL SAMPLES Lab/Inv. No. N/A

Test Procedure ASTM D422 Tested/Calc. By Simpson Date 2/7/94

Reviewed By JCR Date 2/15/94



PARTICLE SIZE DISTRIBUTION CHART

Unified	Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt or Clay	
AASHTO	Gravel		Coarse Sand	Fine Sand	Silt	Clay

Particle Size, Percent Passing														Atterberg Limits			
2"		1"	100	½"	90	#10	56	#30	23	#100	7	0.05 mm		Liquid Limit		P.I.	
1½"		¾"	97	#4	74	#16	40	#50	13	#200	4.3	0.002 mm		Plastic Limit		Sp. Gr.	

SUBJECT __________ BY J. LIVINGSTON DATE 10/20/94
SHEET ___ OF ___
PROJECT NO. SWW35441.GT

CHIMNEY DRAIN MATERIAL - PRELIM. DESIGN.

SIEVE	% PASSING
2"	100
1"	70-100
3/4	60-100
1/2	50-90
1/4	15-65
NO 4	5-55
NO 8	0-35
NO 16	0-15

CH2M HILL

SUBJECT Casandro Wash – depth of cut-off wall BELOW STILLING BASIN

BY H. Allen

SHEET NO. ___ of ___ DATE 9/22/94

PROJECT NO. SWW35441.PS

Goal: Estimate the depth of the cutoff wall

Assume depth of wall = depth of scour hole

using procedure in FCDMC Hydraulics manual:
- assume basin outlet is an 80' x 10' box culvert
- Dimensionless scour geometry for non-circular culverts:

$$DSG = \alpha_e \left(\frac{Q}{g^{1/2} Y_e^{5/2}}\right)^{\beta} \left(\frac{t}{t_o}\right)^{\theta}$$

where $\alpha_e = \alpha \cdot 0.63^{2.5\beta - 1}$ for h_s and L_s

$Y_e = (A/2)^{0.5} = (80 \cdot 4/2)^{0.5} = 12.6'$

$t = 20$ min, $Q = 3700$ cfs

gradation $d_{84} = 0.4$

$d_{50} = 1.4$

$d_{16} = 4.0$

$\sigma = (d_{84}/d_{16})^{0.5} = (4/.4)^{0.5} = 3.16$ ∴ material is graded

from Table 4.7

	h_s	L_s
α_e:	0.75	12.62
β:	0.85	0.41
θ:	0.07	.04

$$\therefore \frac{h_s}{Y_e} = 0.75 \left(\frac{3700}{(32.2)^{1/2}(12.6)^{5/2}}\right)^{0.85} \left(\frac{20}{316}\right)^{0.07} = 0.7$$

$h_s = 0.7(12.6) = 8.8'$ = depth of scour hole ←

$$\frac{L_s}{Y_e} = 12.62\,(1.16)^{0.41}(20/316)^{0.04} = 12.0$$

$L_s = 12(12.6) = 151'$

distance to max scour hole depth $= 0.4 L_s = 0.4(151) = 60'$

(See attached sheets)

Results were verified using HY-8 (attached)

3. When outlet velocities exceed 2.5 times the allowable channel velocity, an energy dissipator should be provided. Several energy dissipators are described in Chapter 6.

Cutoff Walls: A cutoff wall placed at the culvert outlet in a natural stream provides adequate protection downstream when the scour will not be excessive, or where the development of a scour hole will not undermine nearby structures so that it is practical to allow localized scour.

The following criteria applicable to cutoff walls is based on the computed scour hole geometry. The procedure for determining the scour hole geometry is presented in Section 4.5.3.1.

1. The depth of the cutoff wall shall be equal to the maximum depth of scour.

2. The width of the cutoff wall shall be a minimum of one-third the maximum scour width.

3. The depth of the cutoff wall should not normally exceed six feet. Where a deeper wall is necessary to meet the above criteria, either another form of protection should be employed or an analysis will be required to substantiate the walls structural stability.

4.5.2.4 Safety: Inlets and outlets to closed conduits may present dangers to the public when access is not controlled. Refer to Section 4.3.2.7 for the safety requirements related to conduit inlets and outlets.

4.5.3 Design Procedures

4.5.3.1 Scour Hole Geometry: The objective of this section is to present a method for predicting local scour at the outlet of structures based on soil and flow data and culvert geometry. This section has been adapted from the *Hydraulic Design of Energy Dissipators for Culverts and Channels* (FHWA, HEC-14, 1983).

The scour hole geometry varies with tailwater conditions with the maximum scour geometry occurring at tailwater depths less than half the culvert diameter with the maximum depth of scour (h_s) occurring at a location approximately 0.4 L_s downstream of the culvert outlet, where L_s is the length of scour.

Empirical equations defining the relationship between the culvert discharge intensity, time, and the length, width, depth, and volume of scour hole are presented for the maximum or extreme scour case. The dimensionless scour hole geometry is shown in Figure 4.78.

Cohesionless Material: The general expression for determining scour geometry in a cohesionless soil for a circular pipe flowing full is:

$$\text{Dimensionless Scour Geometry} = \alpha \left(Q/g^{1/2}D^{5/2}\right)^{\beta} (t/t_o)^{\theta} \qquad (4.14)$$

For noncircular or partly full culverts, the diameter D can be replaced by an equivalent depth, y_e:

$$y_e = (A/2)^{1/2} \tag{4.15}$$

A is the cross sectional area of flow. Modifying Equation 4.14 to include the equivalent depth results in the general expression:

$$\text{Dimensionless Scour Geometry} = \alpha_e\left(Q/g^{1/2}y_e^{5/2}\right)^{\beta}(t/t_o)^{\theta} \tag{4.16}$$

where:

α_e	=	$\alpha\, 0.63^{2.5\beta-1}$ for hs, W_s, and L_s
α_e	=	$\alpha\, 0.63^{2.5\beta-3}$ for Vs

The values of the coefficients α, α_e, β, and θ in Equations 4.14 and 4.15 are given in Table 4.7.

Gradation: The cohesionless bed materials presented in Table 4.7 are categorized as either uniform (U) or graded (G). The grain size distribution is determined by performing a sieve analysis (ASTM DA22-63). The standard deviation (σ) is computed as:

$$\sigma = (d_{84}/d_{16})^{1/2} \tag{4.17}$$

where the values of d_{84} and d_{16} are extracted from the grain size distribution. If $\sigma \leq 1.5$, the material is considered to be uniform; if $\sigma > 1.5$, the material is classified as graded.

Cohesive Soils: If the cohesive soil is a sandy clay similar to the one tested at Colorado State University by Abt, et al, Equations 4.14 or 4.16 and the appropriate coefficients in Table 4.7 can be used to estimate the scour hole dimensions. The sandy clay tested had 58 percent sand, 27 percent clay, 15 percent silt, and 1 percent organic matter; had a mean grain size of 0.15 mm, and had a plasticity index (PI) of 15.

Since Equations 4.14 and 4.16 do not include soil characteristics, they can only be used for soils similar to the ones tested. Shear number expressions, that related scour to the critical shear stress of the soil, were derived to have a wider range of applicability for cohesive soils besides the one specific sandy clay that was tested. The shear number expressions for circular culverts are:

$$h_s/D, W_s/D, L_s/D, \text{ or } V_s/D^3 = \alpha(\rho V^2/\tau_c)^{\beta}(t/t_o)^{\theta} \tag{4.18}$$

and for other shaped culverts:

$$h_s/y_e, W_s/y_e, L_s/y_e, \text{ or } V_s/y_e^3 = \alpha_e(\rho V^2/\tau_c)^{\beta}(t/t_o)^{\theta} \tag{4.19}$$

where:

α_e	=	$\alpha/(0.63)$ for h_s, W_s, and L_s
α_e	=	$\alpha/(0.63)^3$ for V_s

Table 4.7
Experimental Coefficients for Culvert Outlet Scour

Material	Nominal Grain Size d_{50}, mm	Scour Equation (below)	Depth, h_s				Width, W_s				Length, L_s				Volume, V_s			
			α	β	θ	α_e	α	β	θ	α_e	α	β	θ	α_e	α	β	θ	α_o
Uniform Sand	0.20	V-1 or V-2	2.72	0.375	0.10	2.79	11.73	0.92	0.15	6.44	16.82	0.71	0.125	11.75	203.36	2.0	0.375	80.71
Uniform Sand	2.0	V-1 or V-2	1.86	0.45	0.09	1.76	8.44	0.57	0.06	6.94	18.28	0.51	0.17	16.10	101.48	1.41	0.34	79.62
Graded Sand	2.0	V-1 or V-2	1.22	0.85	0.07	0.75	7.25	0.76	0.06	4.78	12.77	0.41	0.04	12.62	36.17	2.09	0.19	12.94
Uniform Gravel	8.0	V-1 or V-2	1.78	0.45	0.04	1.68	9.13	0.62	0.08	7.08	14.36	0.95	0.12	7.61	65.91	1.86	0.19	12.15
Graded Gravel	8.0	V-1 or V-2	1.49	0.50	0.03	1.33	8.76	0.89	0.10	4.97	13.09	0.62	0.07	10.15	42.31	2.28	0.17	32.82
Cohesive Sandy Clay 60% Sand PI 15	0.15	V-1 or V-2	1.86	0.57	0.10	1.53	8.63	0.35	0.07	9.14	15.30	0.43	0.09	14.78	79.73	1.42	0.23	61.84
Clay PI 5-16	Various	V-3 or V-4	0.86	0.18	0.10	1.37	3.55	0.17	0.07	5.63	2.82	0.33	0.09	4.48	0.62	0.93	0.23	2.48

Equations

V-1. **For Circular Culverts.** Cohesionless material or the 0.15mm cohesive sandy clay:

$$\left[\frac{h_s}{D}, \frac{W_s}{D}, \frac{L_s}{D}, \text{or } \frac{V_s}{D^3}\right] = \alpha\left(\frac{Q}{\sqrt{g}\, D^{5/2}}\right)^{\beta}\left(\frac{t}{t_o}\right)^{\theta}$$

where t_o = 316 min.

V-2. ***For Other Culvert Shapes.*** *Same material as above:*

$$\left[\frac{h_s}{y_e}, \frac{W_s}{y_e}, \frac{L_s}{y_e}, \text{or } \frac{V_s}{y_e^3}\right] = \alpha_e\left(\frac{Q}{\sqrt{g}\, y_e^{5/2}}\right)^{\beta}\left(\frac{t}{t_o}\right)^{\theta}$$

where t_o = 316 min.

V-3. **For Circular Culverts.** Cohesive sandy clay with PI = 5-16:

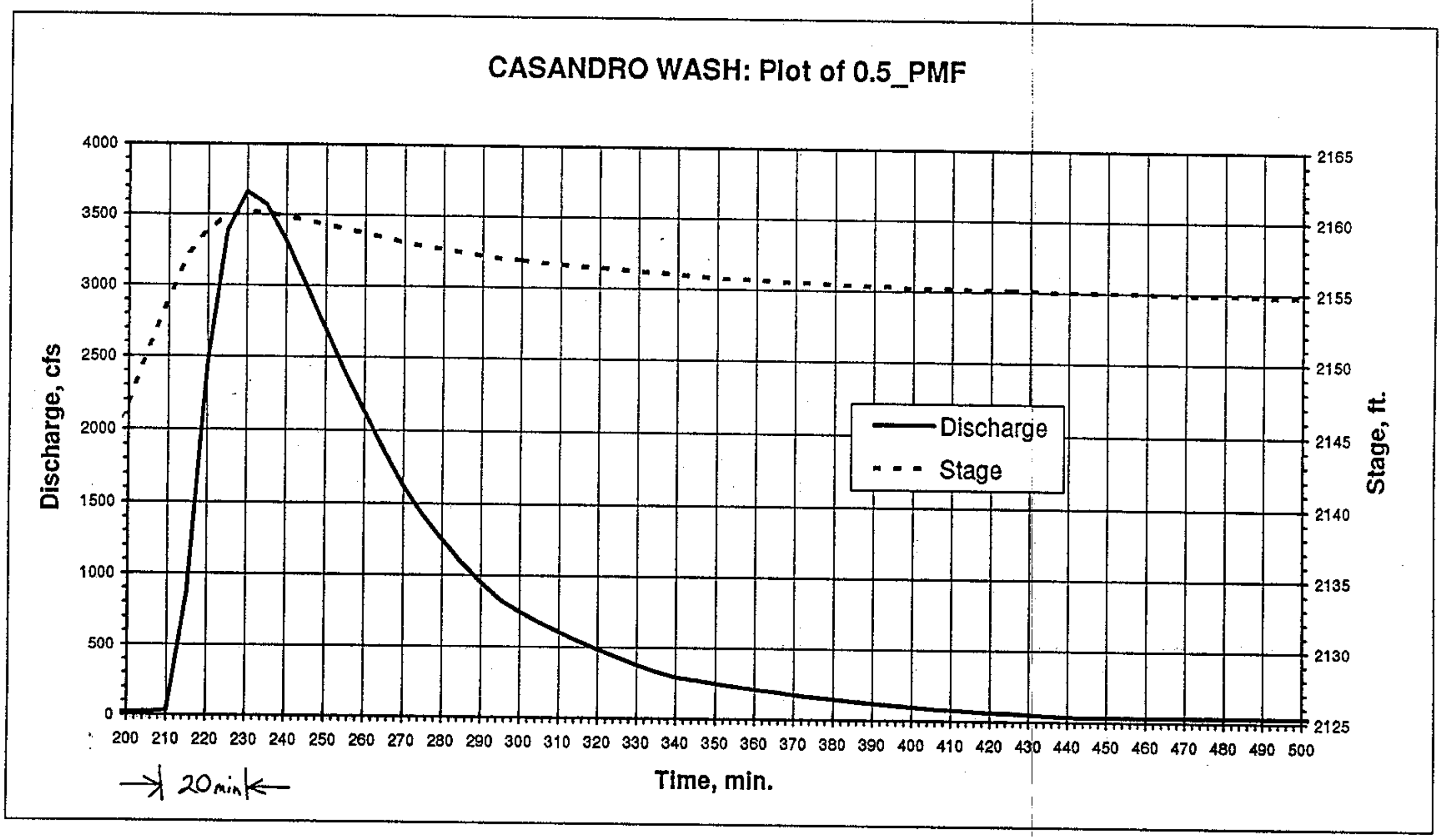
$$\left[\frac{h_s}{D}, \frac{W_s}{D}, \frac{L_s}{D}, \text{or } \frac{V_s}{D^3}\right] = \alpha\left(\frac{\rho V^2}{\tau_c}\right)^{\beta}\left(\frac{t}{t_o}\right)^{\theta}$$

where t_o = 316 min.

V-4. **For Other Culvert Shapes.** Cohesive sandy clay with PI = 5-16:

$$\left[\frac{h_s}{y_e}, \frac{W_s}{y_e}, \frac{L_s}{y_e}, \text{or } \frac{V_s}{y_e^3}\right] = \alpha_e\left(\frac{\rho V^2}{\tau_c}\right)^{\beta}\left(\frac{t}{t_o}\right)^{\theta}$$

where t_o = 316 min.

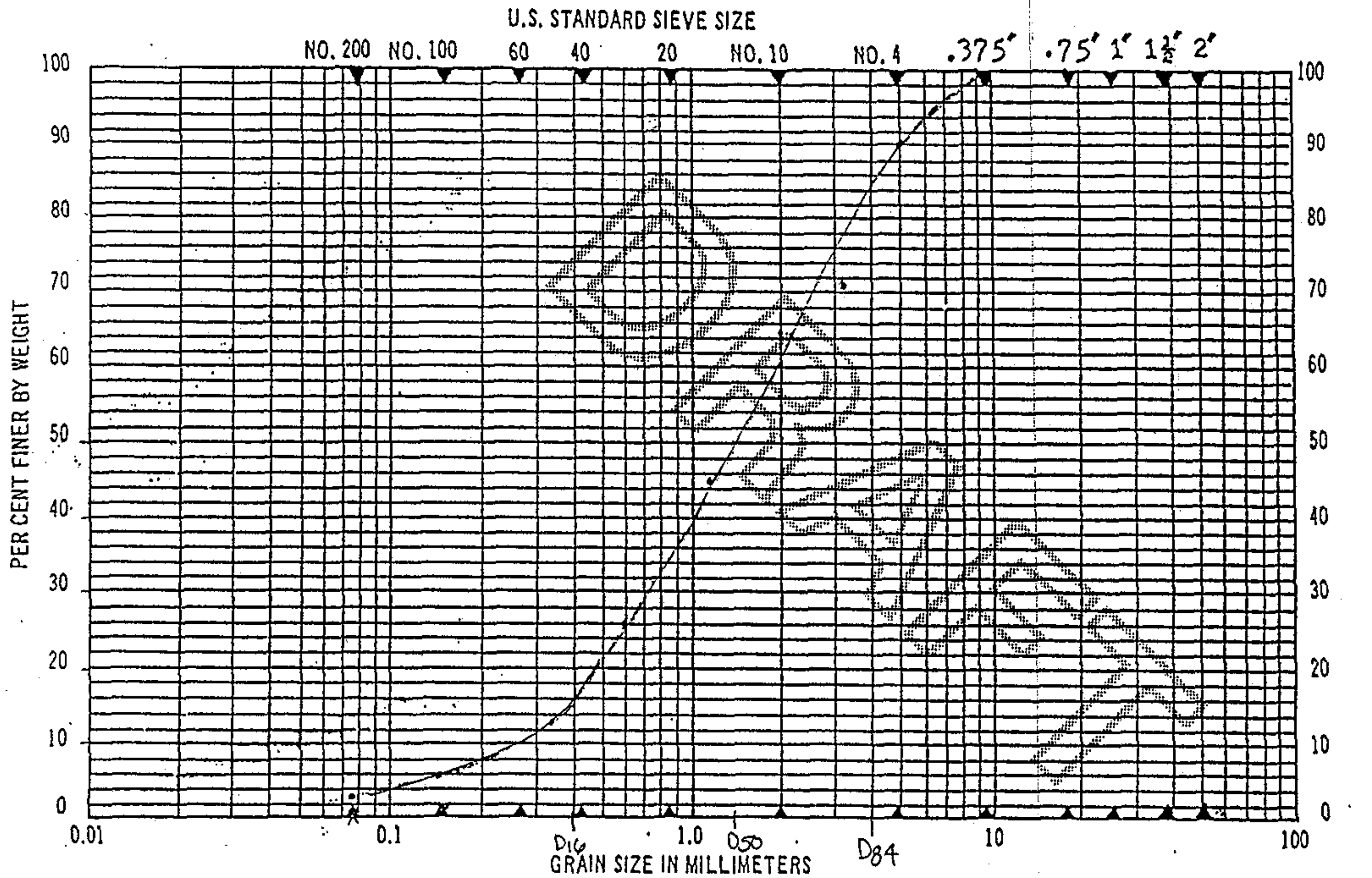

CASANDRO WASH: Plot of 0.5_PMF
Discharge, cfs
Stage, ft.
Time, min.
Discharge
Stage
4000
3500
3000
2500
2000
1500
1000
500
0
2165
2160
2155
2150
2145
2140
2135
2130
2125
200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350 360 370 380 390 400 410 420 430 440 450 460 470 480 490 500
20min

HPMF-HG.XLS

JOB NO. ________ BY ________ DATE ________

KEY	BORING	DEPTH	ELEV.	SOIL CLASSIFICATION

GRAIN-SIZE DISTRIBUTION
(UNIFIED SOIL CLASSIFICATION SYSTEM)



SILT OR CLAY	SAND			GRAVEL		*
	FINE	MEDIUM	COARSE	FINE	COARSE	

*COBBLES

URRENT DATE: 09-22-1994　　FILE DATE: 09-22-1994

U[illegible]ENT TIME: 14:39:16　　FILE NAME: CW-BASIN

FHWA CULVERT ANALYSIS

HY-8, VERSION 3.2

C V	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	32.20	32.00	100.00	1 RCB	80.00	10.00	.012	CONVENTIONAL
2								
[illegible]								
4								
5								

[illegible]ARY OF CULVERT FLOWS (CFS)　　FILE: CW-BASIN　　DATE: 09-22-1994

[illegible]LEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
32.20	0	0	0	0	0	0	0	0	1
37.44	370	370	0	0	0	0	0	0	1
37.71	740	740	0	0	0	0	0	0	1
37.95	1110	1110	0	0	0	0	0	0	1
38.17	1480	1480	0	0	0	0	0	0	1
38.38	1850	1850	0	0	0	0	0	0	1
38.59	2220	2220	0	0	0	0	0	0	1
38.80	2590	2590	0	0	0	0	0	0	1
39.02	2960	2960	0	0	0	0	0	0	1
39.23	3330	3330	0	0	0	0	0	0	1
39.45	3700	3700	0	0	0	0	0	0	1
[illegible]0.00	33219	33219	0	0	0	0	0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS　　FILE: CW-BASIN　　DATE: 09-22-1994

HEAD ELEV(FT)	HEAD ERROR(FT)	TOTAL FLOW(CFS)	FLOW ERROR(CFS)	% FLOW ERROR
32.20	0.00	0	0	0.00
37.44	0.00	370	0	0.00
37.71	0.00	740	0	0.00
37.95	0.00	1110	0	0.00
38.17	0.00	1480	0	0.00
38.38	0.00	1850	0	0.00
38.59	0.00	2220	0	0.00
38.80	0.00	2590	0	0.00
39.02	0.00	2960	0	0.00
39.23	0.00	3330	0	0.00
39.45	0.00	3700	0	0.00

[illegible] TOLERANCE (FT) = 0.010　　<2> TOLERANCE (%) = 1.000

Culvert file to simulate flow at basin outlet for input into scour-hole-dimension routine

[illegible]ENT DATE: 09-22-1994 FILE DATE: 09-22-1994
[illegible]ENT TIME: 14:39:16 FILE NAME: CW-BASIN

****
*********************** CULVERT # 1 ***************************
****

PERFORMANCE CURVE FOR 1 BARREL(S)

[illegible] (cfs)	HWE (ft)	TWE (ft)	ICH (ft)	OCH (ft)	FLOW TYPE	CCE (ft)	FCE (ft)	TCE (ft)	VO (fps)
0	32.20	32.00	0.00	-0.20	0-NF	0.00	32.20	0.00	0.00
[illegible]70	37.44	32.75	1.31	5.24	6-FF	0.00	0.00	0.00	5.29
740	37.71	33.14	2.07	5.51	6-FF	0.00	0.00	0.00	6.66
[illegible]110	37.95	33.46	2.71	5.75	6-FF	0.00	0.00	0.00	7.63
[illegible]80	38.17	33.74	3.28	5.97	6-FF	0.00	0.00	0.00	8.40
1850	38.38	33.99	3.81	6.18	6-FF	0.00	0.00	0.00	9.04
2220	38.59	34.23	4.30	6.39	6-FF	0.00	0.00	0.00	9.61
[illegible]90	38.80	34.45	4.76	6.60	6-FF	0.00	0.00	0.00	10.12
[illegible]60	39.02	34.66	5.22	6.82	6-FF	0.00	0.00	0.00	10.58
3330	39.23	34.86	5.67	7.03	6-FF	0.00	0.00	0.00	11.00
[illegible]00	39.45	35.05	6.11	7.25	6-FF	0.00	0.00	0.00	11.40

El. inlet face invert 32.20 ft El. outlet invert 32.00 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

****

* SITE DATA ***** CULVERT INVERT **************

INLET STATION (FT)	0.00
INLET ELEVATION (FT)	32.20
OUTLET STATION (FT)	100.00
OUTLET ELEVATION (FT)	32.00
NUMBER OF BARRELS	1.00
SLOPE (V-FT/H-FT)	0.0020
CULVERT LENGTH ALONG SLOPE (FT)	100.00

*** CULVERT DATA SUMMARY ************************

BARREL SHAPE	BOX
BARREL SPAN	80.00 FT
BARREL RISE	10.00 FT
BARREL MATERIAL	CONCRETE
BARREL MANNING'S N	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	BEVELED EDGE (1.5:1)
INLET DEPRESSION	NONE

****

RENT DATE: 09-22-1994 FILE DATE: 09-22-1994
RENT TIME: 14:39:16 FILE NAME: CW-BASIN

****
************************ TAILWATER ****************************
****

**** REGULAR CHANNEL CROSS SECTION ****************

BOTTOM WIDTH (FT)	100.00
SIDE SLOPE H/V (X:1)	0.0
CHANNEL SLOPE V/H (FT/FT)	0.020
MANNING'S N (.01-0.1)	0.035
CHANNEL INVERT ELEVATION (FT)	32.00
CULVERT NO.1 OUTLET INVERT ELEVATION	32.00 FT

**** UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (CFS)	W.S.E. (FT)	FROUDE NUMBER	VEL. (FPS)	SHEAR (PSF)
0.00	32.00	0.000	0.00	0.00
370.00	32.75	0.999	4.92	0.94
740.00	33.14	1.066	6.47	1.43
1110.00	33.46	1.106	7.59	1.83
1480.00	33.74	1.135	8.50	2.17
1850.00	33.99	1.157	9.27	2.49
2220.00	34.23	1.175	9.95	2.78
2590.00	34.45	1.190	10.57	3.06
2960.00	34.66	1.203	11.13	3.32
3330.00	34.86	1.215	11.65	3.57
3700.00	35.05	1.225	12.14	3.81

****
*********************** ROADWAY OVERTOPPING DATA ***************************
****

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH (FT)	10.00
CREST LENGTH (FT)	100.00
OVERTOPPING CREST ELEVATION (FT)	100.00

****

ULVERTNALYSISERSION

Results from scour-hole-dimension routine

URRENT DATEURRENT TIMEILE NAMEILE DATE
09-22-19 14:37:55 CW-BASIN 09-22-199

CULVERT AND CHANNEL DATA

CULVERT NO. 1	DOWNSTREAM CHANNEL
CULVERT TYPE: 80.0 X 10.0 BOX	CHANNEL TYPE : RECTANGULAR
CULVERT LENGTH = 100.0 FT	BOTTOM WIDTH = 100.0 FT
NO. OF BARRELS = 1.0	TAILWATER DEPTH = 3.0 FT
FLOW PER BARREL = 3700.0 CFS	TOTAL DESIGN FLOW = 3700.0 CFS
INVERT ELEVATION = 32.0 FT	BOTTOM ELEVATION = 32.0 FT
OUTLET VELOCITY = 11.4 FPS	NORMAL VELOCITY = 12.1 FPS

SCOUR HOLE GEOMETRY AND SOIL DATA

LENGTH = 151.1 FT WIDTH = 56.5 FT

DEPTH = 8.7 FT VOLUME = 20277.8 CU FT

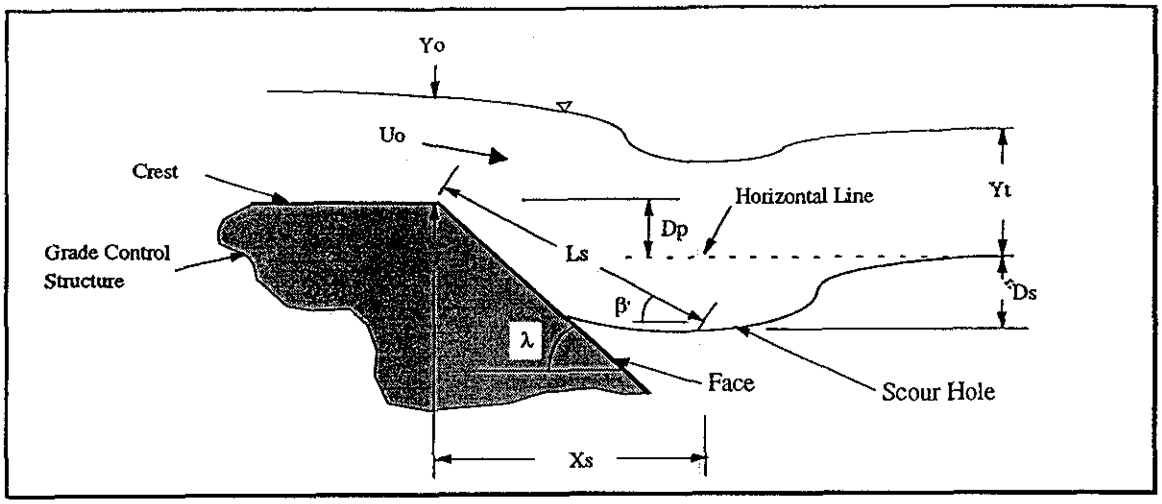
MAXIMUM SCOUR OCCURS 60.4 FT DOWNSTREAM OF CULVERT

SOIL TYPE : NONCOHESIVE

SAND SIZES:
D16 = 0 mm
D50 = 1 mm
D84 = 4 mm

Project: CASANDRO WASH
Scour d.s. of Basin for 0.5 PMF

By: H. Allen
Date: 9/22/1994
Project #: SWW35441



Equations from "Scour Downstream of Grade-Control Structures", N. E. Bormann and P. Y. Julien, J. of Hydraulic Engineering, Vol. 117, No. 5

INPUT:

Constants

Gravitational Accel., g =	32.2	ft/s^2	
Diffusion Coeff., Cd =	1.8		
Local Friction Equ.:			
Exponent x =	0.5		
Coefficient B =	2.0		

Water/Flow

Jet Thickness, Yo =	4.04	ft.	(assume critical flow)
Jet Velocity, Uo =	11.5	ft./s.	(assume critical flow)
Tailwater Depth, Yt. =	3	ft.	(normal depth rating)

Channel Material

Specific Gravity, Gs =	2.65		
Submerged angle of repose, ϕ =	25	degrees	
Effective diameter, ds[(1)] =	1.4	mm.	

Structure

Drop Height, Dp =	1	ft.	(Depth for max. Ds.)
Face Angle, λ =	90	degrees	

CALCULATIONS:

Jet Angle Near Bed, β' =	0.310	radians
(=	17.8	degrees)
Diffused Length of Jet, Ls =	52.6	ft.
Scour Length, Xs =	50.1	ft.
Equilibrium Scour Depth, Ds =	15.0	ft.

Notes:
(1) N. Bormann recommends using D84 if armoring can occur, otherwise D50 is often used.

HPMF-SCR.XLS

CASSCEPAGE

MEMORANDUM

CH2M HILL

TO: Steve Walker
Bob Morrison

FROM: John Livingston

DATE: January 12, 1995

SUBJECT: Casandro Wash Dam Stilling Basin Uplift Analysis

PROJECT: SWW35441.PS

I have performed an uplift analysis for the stilling basin and spillway chute for Casandro Wash Dam. This memo presents the analysis and recommendations for drainage.

Stilling Basin Analysis and Recommendations

Water will occupy the stilling basin from direct precipitation, flow from the outlet pipe, and flow over the spillway. The flow from direct precipitation and from the outlet pipe will be relatively calm flows and no hydraulic jump is anticipated. The water will simply fill up the stilling basin and go over the downstream lip of the stilling basin into the natural stream channel. The stilling basin will gradually drain through the low level gravity outlet at the bottom of the stilling basin.

When the spillway operates at the design flow of 0.5 PMF a hydraulic jump will occur in the stilling basin. The hydraulic jump will appear as a series of waves which rise up to a maximum water depth of approximately 10.6 feet based on the hydraulic calculations. I understand that no rip rap will be provided so significant erosion will occur when the flows are high enough to carry off the sandy soil. A concrete cutoff wall has been provided to prevent scour from undermining the stilling basin. As the spillway operates water will tend to seep into the ground downstream of the stilling basin. Seepage will move under the cutoff wall and may reach the underside of the stilling basin floor. This condition will take one or more days to develop if the ground is dry but if the outlet has been flowing for a couple of days then the ground will already be partially saturated and the seepage pressures will develop much quicker.

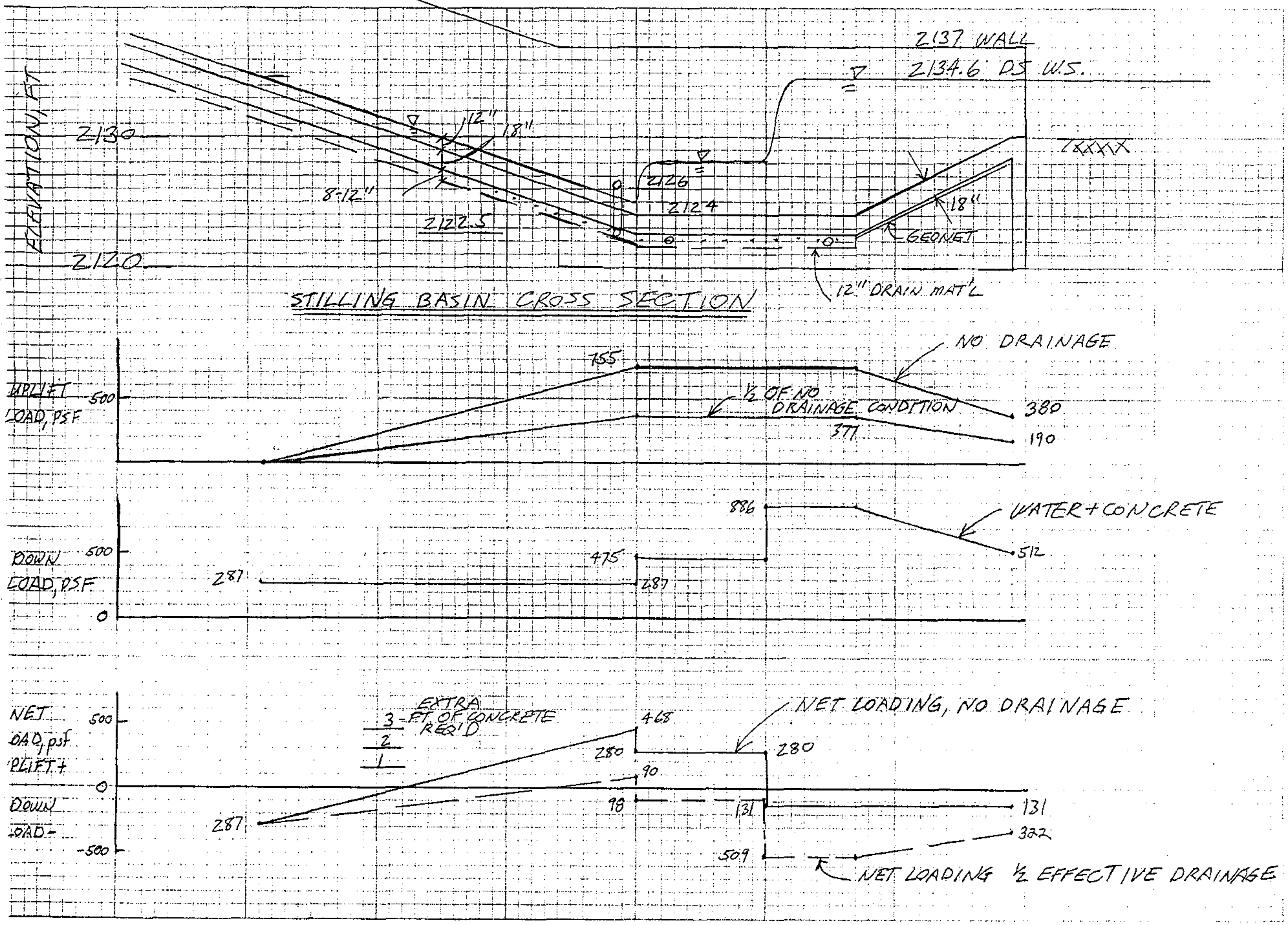
The magnitude of the seepage or uplift pressure could equal the maximum water surface in the hydraulic jump which was taken to be Elevation 2134.6. With the floor of the stilling basin at Elevation 2122.5 the maximum uplift pressure is estimated to be 755 psf. This force will be resisted by the weight of the concrete and overlying water in the stilling basin.

The calculated pressure distributions under the stilling basin are shown on the attached two figures. For the specific water surface and hydraulic jump shape shown the factors of safety against uplift were plotted. With no drainage, the factor of safety was 0.4 in one area of the basin and safety factors below one were calculated for quite large areas. It would take up to approximately 3 additional feet of concrete added to the floor to resist the undrained uplift pressures. The cost for the added concrete is on the order of $20-30,000. This is much higher than for an underdrain system and therefore an evaluation was made of the uplift pressures with an underdrain system.

The attached figures show the general layout for relieving pressures under the stilling basin and part way up the spillway chute. A 12-inch thick layer of granular filter material similar to the chiminey drain material would be placed under the horizontal portion of the stilling basin and up to Elevation 2134 on the spillway chute. Several slotted PVC pipes would be placed in the drain material to convey the seepage water to an outlet located in the chute wall at the invert Elevation 2126.0 This drain pipe would have no valves and would only require a screen to prevent rodents from eating and nesting in the pipe. When the spillway operates the pipe would not have any flow until the hydraulic pressure under the slab was equal to Elevation 2126. Based on the attached figures the minimum factor of safety would be 1.3 with the underdrain system normally operating. Should the system deteriorate due to contamination of the filter material with silt then the safety factor could drop to 0.8 over a small area of the basin, however this possiblilty is quite low and any silt that enters the underdrain will likely flush out when the seepage water is discharged. this is an appropirate system for the low frequency that the spillway will be used.

Spillway Chute Analysis and Recommendations
The soil underlying the spillway chute will be embankment material which is a silty sandy soil. The spillway will have a 3:1 slope. The concrete slab will have joints with waterstop material so that seepage through the joints will not occur. The only way seepage could get under the slab is if cracks occur and water seeps into the underlying embankment. This condition is very undesirable because the water could migrate along the soil-concrete interface and build up hydrostatic pressure which could cause the slab to crack or be lifted up. The 12-inch slab can only resist 2.4 feet of water pressure before it is lifted, therefore it is very important that the seepage pressure be minimized under the chute slab.

An 8-inch thick granular filter drain will be provided under the chute slab. This zone will convey seepage water to outlet pipes extending through the chute walls. The outlets will be positioned sufficiently high on the walls to prevent backflow of the water in the chute. The drainage layer will also serve an important function of providing a surface on which to place the rebar and concrete. The sandy embankment soil would be severely disturbed and hard to walk on without a granular drainage layer. The drainage layer will also serve as a filter to prevent silt particles from being sucked up through cracks in the slab. This would occur if negative pressures developed at vertical offsets in the slab and soil particles were sufficiently small to be carried up through the cracks.



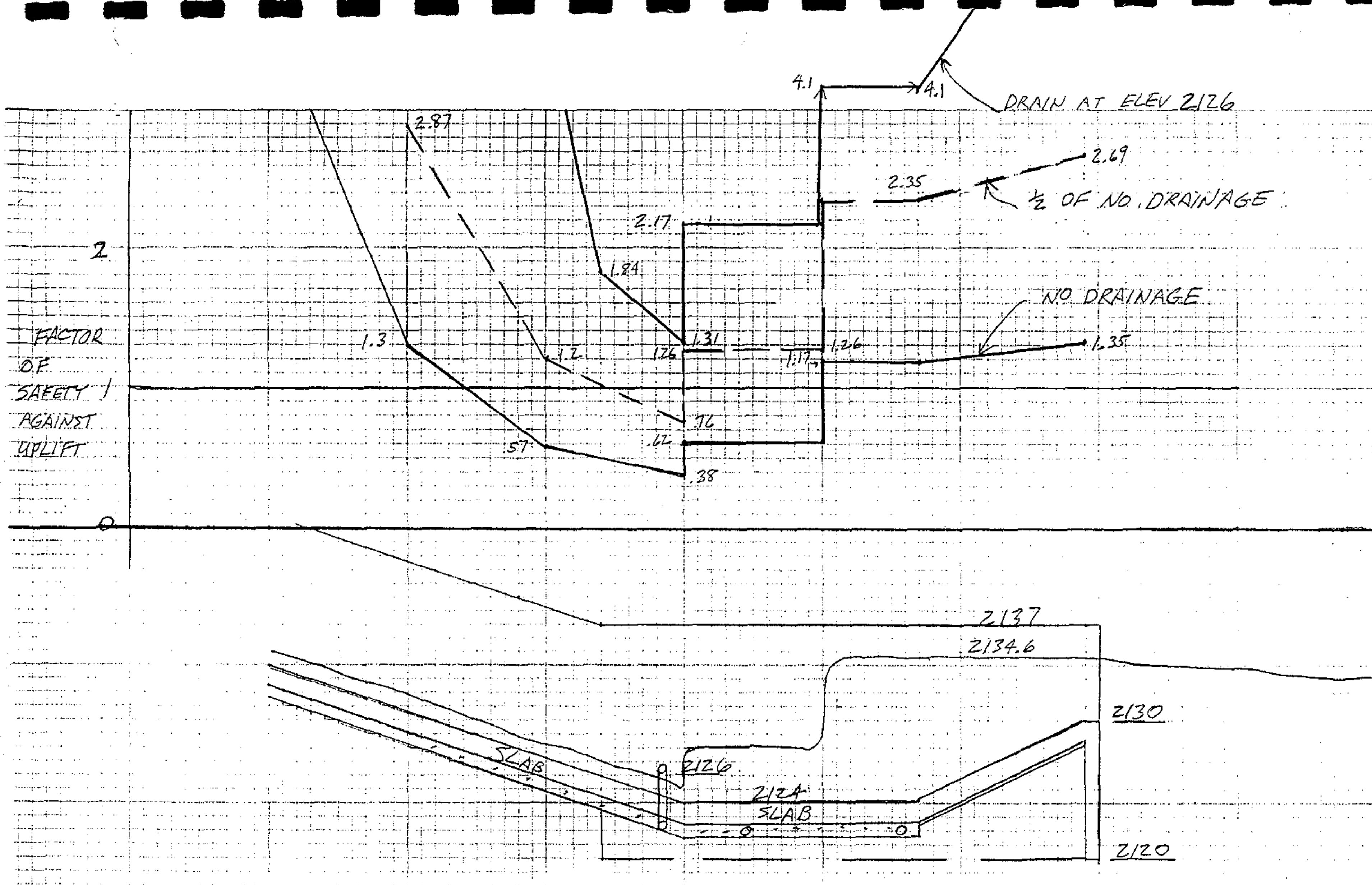
CH2M HILL

SUBJECT CASANDRO WASH STILLING BASIN

BY J. LIVINGSTON DATE 1/19/95

SHEET NO. ___ of ___

PROJECT NO. SWW35444.PS

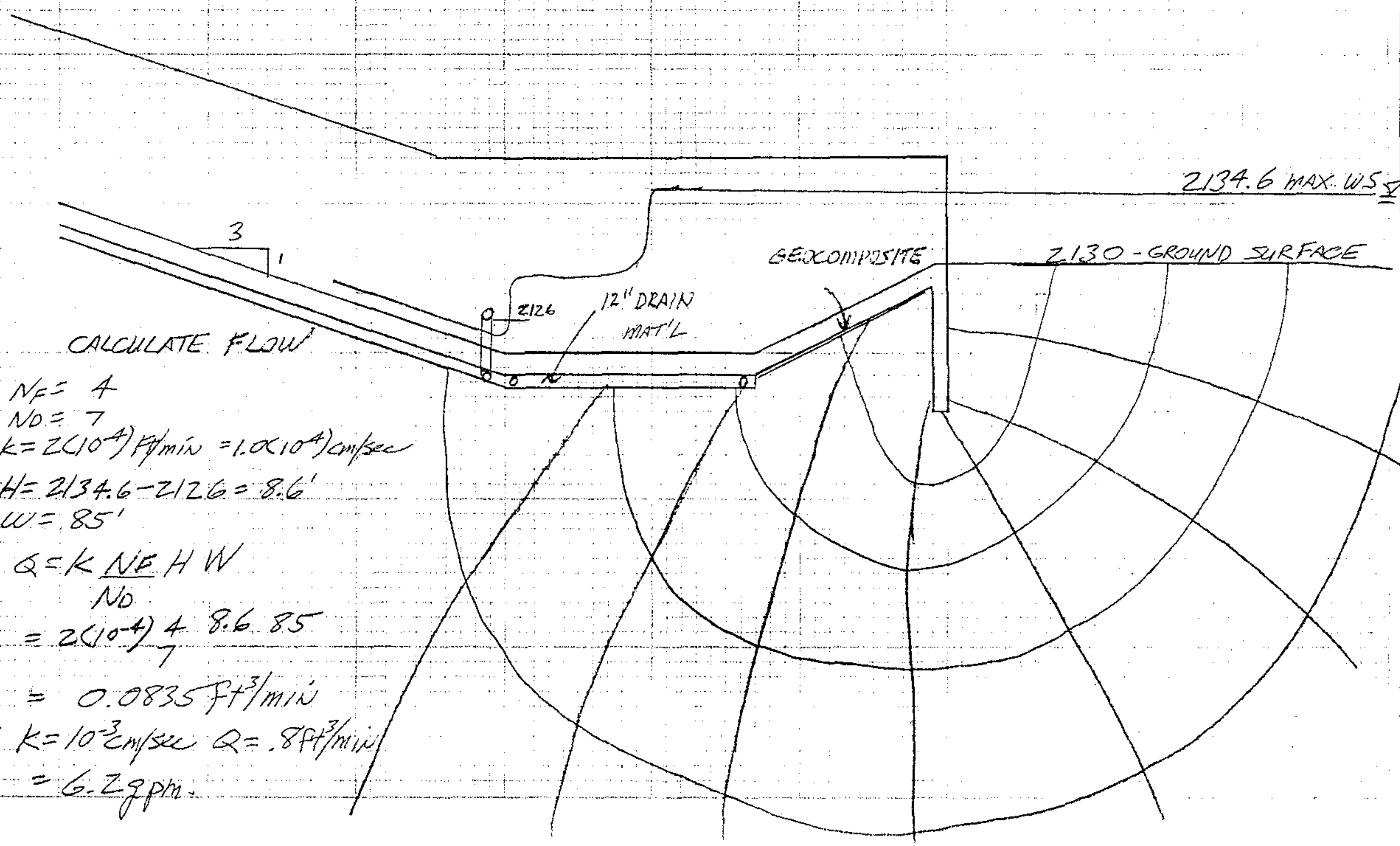


STILLING BASIN
1" = 10'

SUBJECT CASANDRO WASH STILLING BASIN
BY J. LIVINGSTON
SHEET NO. ___ of ___ DATE 4/9/95
PROJECT NO. SWW35441.95

1" = 5'

STILLING BASIN UPLIFT ANALYSIS



CALCULATE FLOW

$N_F = 4$

$N_D = 7$

$k = 2(10^{-4})$ ft/min $= 1.0(10^{-4})$ cm/sec

$H = 2134.6 - 2126 = 8.6'$

$W = 85'$

$$Q = k \frac{N_F}{N_D} H W$$

$$= 2(10^{-4}) \frac{4}{7}\ 8.6 \cdot 85$$

$= 0.0835$ ft^3/min

if $k = 10^{-3}$ cm/sec $Q = .8$ ft^3/min

$= 6.2$ gpm.

CH2M HILL

SUBJECT CASANDRO WASH
STILLING BASIN

BY T. LIVINGSTON

DATE 1/9/95

SHEET NO. ___ of ___

PROJECT NO. SEW 35414.D5