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CHOLLA LANDFILL

BANK STABILIZATION AND LEVEE REPAIR

December 1989

Mathews Kessler & Associates, Inc.
Engineers, Architects, Planners

A031.601

BFI Waste Systems
BROWNING-FERRIS INDUSTRIES

Brett Frazier
Division Manager

January 5, 1990

Mr. Rob Larson:
Environmental Engineering Specialist
Arizona Dept. of Environmental Quality
2005 North Central Avenue
Phoenix, Arizona 85004

Dear Mr. Larson:

Enclosed are two set of drawings, six drawings each, which were inadvertently left out of the bank stabilization and the Levee Repair Report by Mathews Kessler & Associates, Inc.

If you should have any questions, please do not hesitate to contact me at (602)243-1271.

Sincerely,
BROWNING-FERRIS INDUSTRIES OF ARIZONA, INC.

Lee Schoon
Director of Environmental Affairs

LS/krs
enclosures

1580 E. ELWOOD (85040) • P.O. BOX 21596 • PHOENIX, ARIZONA 85036 • (602) 243-1271

CHOLLA LANDFILL
BANK STABILIZATION AND LEVEE REPAIR

Prepared for

BROWNING-FERRIS INDUSTRIES OF ARIZONA, INC.

December 1989

Prepared by

MATHEWS KESSLER & ASSOCIATES, INC.

Documents incorporated in this report were prepared by:
EMCON Associates
Simons, Li & Associates, Inc.
Dr. Thomas Maddock III / EMCON Associates

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INTRODUCTION,

BACKGROUND,

AND

CONCLUSION

1.0 INTRODUCTION, BACKGROUND & CONCLUSION

The proposed development of the Cholla Landfill along the west bank of the Agua Fria River between Olive Avenue and Northern Avenue has created a need to assure the long-term stability of that west bank in the event of significant flows in the river.

Currently, the riverbank primarily consists of natural riverbank with little evidence of man's impact. However, other portions have been significantly impacted by the sand and gravel extraction operations occurring adjacent to the river. The backwashing of transit mix concrete trucks has resulted in a significant portion of the bank being coated with a low quality concrete-like coating.

The bank in 1978 was breached in two locations when subjected to flooding. This report will address measures which are proposed to be undertaken to remove materials previously placed in these breach areas and replacing that material with engineered fill to provide a stable levee section to protect future development.

Topographic mapping was obtained in the spring of 1989 to demonstrate existing conditions at the site. Geotechnical explorations were performed in the existing bank to define soil types and existing foundations conditions. Other drilling programs were undertaken to more clearly locate the specific areas of prior breaches (bank failure) and to determine density and nature of backfill material.

The most recent flood insurance study being prepared for FEMA was utilized for all design flood information. This study and related work maps are dated February 6, 1989. Information obtained from this study, including related HEC-2 analyses and available soils information, were utilized in preparing a complete scour analysis needed to design a rip-rap bank protection scheme.

For the entire reach of the Agua Fria from Northern Avenue to Olive Avenue, it is the intention of the applicant to excavate all inadequately placed material, replace with suitable engineered fill, grade exterior slopes (riverside) to a 2H:1V

slope and to place on that slope a 48" layer of D_{50} = 24" rip-rap. The rip-rap will be extended below the existing toe of slope to prevent bank undercutting.

At the present time, an abandoned gravel pit occupies a portion of the main river channel extending from approximately 700 feet to 2600 feet downstream of Olive Avenue. Within the gravel pit, the rip-rap will be extended to the existing toe of slope along the west side of the pit. Upstream of the pit, the rip-rap will be extended 8.5 feet below the existing thalweg, or 1.5 feet below the predicted headcut profile, whichever depth is greater. Downstream of the pit, the rip-rap will be extended 7.5 feet below the existing thalweg, or 1.5 feet below the downstream gravel pit degradation profile (due to gravel pit sediment trapping) whichever depth is greater.

Rather than protecting the existing bank from Station 30+50 to Station 50+75, the option of constructing a levee along the alignment of the westerly floodway limit is considered a reasonable alternative to improve the hydraulic properties of the channel. To implement this alternative, a levee would be joined to the existing bank at approximately Station 35+50 and would proceed generally south to rejoin the existing bank at approximately Station 50+75. This levee section with all related design elements, cross-sections, toedown elevations, etc., is shown on attached Drawing No. 5. This levee will be constructed with the same criteria as the design used in the levee repair section, i.e., 2H:1V slopes on the river side protected by 48" of D_{50} 24" rip-rap to an elevation 3' above the 100 year flood level, a 50' crest width and a 3H:1V back slope down to the riverbed elevation or existing native material.

The enclosed text describes the approach taken and summarizes the results of the scour analysis which was prepared to determine the toedown elevations and rip-rap size necessary to preclude erosion damages to the bank under conditions which can be anticipated during a 100 year flow.

This analysis is based on the existing 100-year flood flows (approximately 99,000 cfs) established by FEMA for the Agua Fria River. Upon completion of the new Waddell Dam (estimated for 1992), the 100-year flow will be approximately

33,000 cfs and the 500-year flow will be approximately 54,000 cfs. Thus, the design proposed will satisfy requirements for the existing 100-year flows and will substantially exceed requirements for future 500-year flows.

Based upon the topographic information and hydrologic studies available for this study, an effort was made to conservatively analyze the erosion / scour potential of the Agua Fria River between Olive Avenue and Northern Avenue. The conservative approach to this analysis which is explained in the following pages was exemplified by utilization of worst case scenarios, i.e., highest flow values, maximum velocities, etc.

Considering the relatively short period of time (2 - 3 years) before the completion of new Waddell Dam, the design of this project is certainly leaning toward the ultra-conservative. Numerous approaches were used to size the rip-rap material and the obvious conclusion was that D_{50} = 24" would provide a very high degree of protection to the proposed landfill.

APPLICATION TO FLOODPLAIN ADMINISTRATOR
City of El Mirage, Arizona

Applicant Browning-Ferris Industries of Arizona, Inc. Date: December 20, 1989

Mailing Address 1580 E. Elwood City Phoenix State Arizona

Zip Code 85040 **Phone** 243-1271 **Zoning District** I-3

Floodplain (Watercourse) Agua Fria River **FIRM** 1605 and 1615

Property Address: 8641 N. El Mirage Road, El Mirage, Arizona

Property Legal Description: The West half of Section 36, Township 3 North, Range 1 West of the Gila and Salt River Base and Meridian, Maricopa County, Arizona; EXCEPT the North 55 feet thereof; and EXCEPT the West 55 feet thereof; and EXCEPT the South 55 feet thereof; and EXCEPT the South 115 feet of the North 170 feet of the West 150 feet of the East 845.02 feet of the Northwest quarter of Section 36.

Specific Request: Floodplain development permit for bank stabilization and levee repair per attached plans including regrading existing riverbank to a 2H:1V slope and stabilization with 48" of rock rip-rap D_{50} = 24".

Applicant's Statement (If applicable, state hardship for variance; grounds for appeal): Existing bank is subject to erosion during periods of intermittent flow in the Agua Fria River. Previous breach areas which were backfilled by end dumping to be removed and replaced with engineered fill. Proposed use of the land adjacent requires a stable bank not subject to erosion. Installation of rip-rap will reduce flood hazard and the turbidity of flood flows in the Agua Fria River.

APPLICANT'S SIGNATURE: Brett W. Frazier
Brett W. Frazier, Vice-President

==========

CITY COUNCIL OF EL MIRAGE

ACTION TAKEN: Approved_____ Denied_____ Other_____

Stipulations:_____

Additional Documentation: Elevation/Floodproofing Certification ( )

Notification of Variance ( ) Warning and Disclaimer of Liability ( )

Flood Damage Statement ( ) Performance Bond ( ) Coordination_____

Date:_____ _____
Floodplain Administrator

3.0 SCOUR ANALYSIS

3.1 APPROACH & SUMMARY OF RESULTS

A bank stabilization system is being considered to prevent bank erosion into a proposed landfill along the west bank of the Agua Fria River, immediately downstream of Olive Avenue. The purpose of this analysis is to provide an estimate of a reasonable scour depth that could be used in the selection of a toedown dimension to prevent undercutting of the bank stabilization.

Vertical movement of a streambed profile can be quantified as a function of 6 components:

$$\Delta Z_{tot} = \Delta Z_{agg/deg} + \Delta Z_{gs/d} + \Delta Z_{ls} + \Delta Z_{bs} + \Delta Z_{i} + \Delta Z_{adt}$$

Where:

ΔZ_{tot}	=	total vertical adjustment in bed elevation
$\Delta Z_{agg/deg}$	=	adjustment due to long-term aggradation / degradation
$\Delta Z_{gs/d}$	=	adjustment due to general scour / deposition
ΔZ_{ls}	=	adjustment due to local scour
ΔZ_{bs}	=	adjustment due to bend scour
ΔZ_{i}	=	adjustment due to low-flow incisement
ΔZ_{adt}	=	adjustment due to bed-form troughs (dunes, anti-dunes)

Each of these 6 processes has been considered in developing an estimate of the total scour depth that might occur along the bank of the proposed landfill. The headcutting and downstream degradation processes induced by the

abandoned gravel pit have also been considered in establishing toedown dimensions for the bank stabilization system.

The scour analysis was conducted in phases, with each phase being a refinement of the previous phase. These phased refinements were based on the availability of more detailed information.

The initial analysis was preliminary and used peak discharge approximations of 33,000, 54,000, and 99,000 cfs. These values represent Q_{100} with New Waddell Dam in-place, Q_{500} with New Waddell Dam in-place, and Q_{100} under existing conditions, respectively.

The third and final phase focused exclusively on the 100 year event, under existing conditions, i.e., no new Waddell Dam in-place. This final analysis was based on specific peak discharge values used in the 1989 FEMA Flood Insurance Study (FIS) prepared by Jerry R. Jones & Associates, (JJA) for the Flood Control District of Maricopa County (FCDMC). The peak discharge through the study reach varies from 95,450 cfs to 98,780 cfs.

Due to the existence of the large gravel pit, about 700 feet downstream of Olive Avenue, the scour analysis was performed in two phases:

1. *Scour potential beyond the influence of the gravel pit.*
2. *Scour potential within the influence of the gravel pit.*

Each analysis is summarized in the following paragraphs.

SCOUR POTENTIAL BEYOND EXISTING GRAVEL PIT INFLUENCE

This case would represent the condition that will exist in the future, after the abandoned gravel pit has been filled back to a natural streambed profile. It will also represent the scour potential for those upstream and downstream areas that

are beyond the influence of the additional scour processes induced by the existing abandoned gravel pit.

Hydraulic data used in the calculations were taken from the JJA, HEC-2 Model, 1989, for a Floodplain / Floodway delineation of this reach of the Agua Fria River, with the Olive Avenue bridge in-place. The results of the scour analysis are summarized in the following table. Discussions and calculations of specific scour components are presented in subsequent sections of this report.

SUMMARY OF SCOUR CALCULATIONS

Scour Component	Scour Depth (feet) River Location: Upstream of Abandoned Gravel Pit	Scour Depth (feet) River Location: Downstream of Abandoned Gravel Pit
1. Long-Term Degradation	1.5	1.5 ← judgement
2. General Scour	0.5	0.5 ← from SLA
3. Bend Scour	1.0	0
4. Local Scour	0	0
5. Low-Flow Incisement	0	0
Sub-total:	3.0	2.0
Times Safety Factor:	x1.4	x1.4 ← Why 1.4
Sub-total:	4.2	2.8
6. Antidune (Bed-form) Troughs (based on 1.3 x V_{ch})	4.5	4.5
Grand Total:	8.7	7.3
Rounded To:	8.5	7.5

The safety factor of 1.4 is only applied to the sum of long-term degradation, general scour, bend scour, local scour, and low-flow incisement. Antidune troughs were omitted from this group because of the way in which the velocity term was computed. More specifically, the velocity used in the antidune calculation was based on 1.3 x Vch, where Vch is the mean channel velocity (with full floodway encroachments) of 13.99 fps (XSEC 12.75) taken from the JJA, HEC-2 Model. This is the maximum channel velocity, from the "FLOODWAY" HEC-2 run between Olive Avenue and Northern Avenue. The 1.3 increase in the mean channel velocity is based on velocity measurements documented in Effect of Bridge Piers on Streamflow and Channel Geometry, J.C. Blodgett, TRB 950, Volume 2, 1984. It is our opinion that this upward adjustment of the mean velocity is sufficient justification to omit the application of a safety factor to the antidune trough calculation. This issue is discussed in more detail under the section on Antidune Troughs.

As a matter of practical interest, the soil-cement bank stabilization constructed on the Agua Fria River, between Buckeye Road and I-10, utilized 8.5' of toedown protection through straight reaches of the river (does not include areas immediately downstream of grade control structures). This soil-cement toedown depth was based on an extensive sediment transport study, and scour analysis performed by Simons, Li & Associates, Inc. The design was approved by the Flood Control District of Maricopa County (FCDMC).

LONG-TERM DEGRADATION

Long-term degradation reflects a lowering of the streambed in response to an imbalance between sediment supply and sediment transport capacity for a given river reach. Normally, this type of bed adjustment is initiated by a reduction in the upstream sediment supply, such as would occur if a dam were built across a river. In this case, the dam traps the sediment and creates a deficit in the normal sediment supply to downstream river reaches. The downstream reaches respond to this deficit by reducing their capacity to transport sediment. This

reduction in transport capacity is created through a decrease (flattening) of the stream-bed slope. The flatter slopes decrease the flow velocity and thus the sediment transport capacity. This type of bed-slope adjustment occurs until equilibrium is re-established with the upstream sediment supply.

Given the fact that Waddell Dam has been in-place over 60 years, it is assumed that any long-term degradation due to sediment trapping by this dam will probably have already occurred. Accordingly, the potential for additional long-term degradation is considered minimal.

However, in order to acknowledge any continuing potential for long term degradation, a value of 1.5 feet will be included in the total scour calculation. It should be emphasized that this dimension (1.5 ft.) is judgmental, and is not based on engineering calculations, but it is considered reasonable based on the Agua Fria River conditions. The absence of any nearby stabilized pivot points (grade control structures) makes long term equilibrium slope calculations difficult and subject to engineering judgement.

GENERAL SCOUR

General scour / deposition occurs in response to a contraction or expansion in cross-sectional geometry. The magnitude of this type of scour changes during the passage of a flood hydrograph, as a result of continual variations in sediment transport rates that accompany changes to flow depths and velocities. Unless a steady-state, constant flow condition is assumed, and prismatic (trapezoidal) channel geometry exists, this type of scour should be analyzed with a mobile boundary, sediment transport model.

Accordingly, in order to more accurately define this scour component, Simons, Li & Associates, Inc. (SLA), was retained to perform the analysis with their QUASED Model. A complete copy of the SLA report is included in Appendix 4.2. The SLA analysis indicated a maximum general scour depth of 0.5 feet through the study area.

LOCAL SCOUR

Local scour occurs around "local" obstructions placed in the path of flowing water. The most common examples of local scour are those associated with bridge piers or bridge abutments.

With the exception of the Olive Avenue Bridge, there are no known obstructions to flow along the downstream reach of river adjacent to the proposed landfill. Scour of the bridge piers will be very localized and should have no impact on the downstream scour depth along the west bank of the river. The west bridge abutment is relatively flush with the west bank and should create no downstream scour problems.

Accordingly, local scour should not be a factor in the toedown depth of a bank stabilization system along the west bank of the river, adjacent to the landfill.

BEND SCOUR

The Agua Fria River exhibits some channel curvature as it approaches Olive Avenue from the north. Although this curvature has terminated immediately downstream (south) of Olive Avenue, the secondary currents generated by the upstream curvature may be carried a sufficient distance downstream to have some impact along the proposed landfill levee. However, it should be noted that this is a very conservative assumption. The flow contraction created by the Olive Avenue Bridge may serve to dampen these secondary currents.

A conservative scenario will be used in which the full magnitude of bend scour will be transferred downstream to that section of the landfill levee located between Olive Avenue and the upstream end of the existing, abandoned gravel pit. No bend scour component is included downstream of the abandoned pit.

1. Hydraulic Data used for calculations:

(Use XSEC 13.72 from January 29, 1989 JJA HEC-2 Model)

Parameter	Q (cfs) 98,780
V_{ch} (fps)*	8.64
$Y_{max.}$ (ft.)	9.36
Y_h (ft.)	6.6
S_e (ft./ft.)	.0023
α (degrees)	22°

* Main channel velocity from the "FLOODWAY" run

2. Procedure: (Ref.: Engineering Analysis of Fluvial Systems, Simons, Li & Associates / Arizona Department of Water Resources, 1985)

$$\Delta Z_{bs} = \frac{0.0685Y(V)^{0.8}}{(Y_h)^{0.4} S_e^{0.3}} \left[2.1 \left(\frac{\sin^2\left(\frac{\alpha}{2}\right)}{\cos \alpha} \right)^{0.2} - 1 \right]$$

Where:

ΔZ_{bs}	=	bend scour component of total scour depth (feet)
V_{ch}	=	mean channel velocity of upstream flow (fps)
Y_{Max}	=	maximum depth of upstream flow (feet)
Y_h	=	hydraulic depth of upstream flow (feet)
S_e	=	upstream energy slope (bed slope for uniform flow conditions, feet/feet)
α	=	angle formed by the projection of the channel centerline from the point of curvature to a point which meets a line tangent to the outer bank of the channel (degrees, see Figure 5.25 in procedure reference)

3. SUMMARY OF CALCULATIONS

Depth of Bend Scour	Q (cfs) 98,780
ΔZ_{bs} (ft.)	1.04

LOW-FLOW INCISEMENT

Most all ephemeral channels, with large width/depth ratios, exhibit a tendency to develop an incised low-flow channel that can more efficiently carry flows from small runoff events.

Low-flow channels typically meander within the boundaries of the wider, main channel. This meandering thalweg may frequently come in contact with the bank of the main channel. Accordingly, it is normally prudent to include low-flow incisement in the calculation of total scour depth when constructing channel improvements that result in a level, man-made channel bottom. All other scour processes could theoretically be initiated from a channel invert elevation associated with a low-flow channel.

Low-flow incisement has been excluded from this analysis, with the understanding that the following two conditions must be met relative to the installation of a bank protection system for the proposed landfill:

1. *The existing channel invert, upstream and downstream of the abandoned gravel pit, must be left in a natural incised condition, i.e., no channelization (regrading of the channel bottom) is assumed to occur as part of the bank protection construction.*

2. *All toedown depths for the proposed bank protection must be referenced to the existing channel thalweg.*

The justification for these two conditions is based on the fact that low-flow incisement has already occurred in the natural channel. Accordingly, unless the natural channel geometry is altered by channelization, there is no reason to add additional low-flow incisement onto that which has already occurred. By referencing our computed scour depths to the existing channel thalweg, we are acknowledging the potential for this thalweg to meander within the main channel and possibly be in contact with the proposed bank stabilization at some time in the future.

ANTIDUNE (BED-FORM) TROUGHS

The sand/gravel bed of the Agua Fria River will be subject to the formation of bed-forms, such as dunes and antidunes, during flooding conditions. The troughs created by these bed-forms are capable of undercutting bank protection.

The depth of antidune troughs (below the original bed elevation) can be estimated with the following equation:

$$** \quad \Delta Z_{adt} = 0.0135 \; V^2$$

Where: ΔZ_{adt} = *depth of antidune trough below natural streambed (ft.)*

V = *flow velocity (fps)*

The antidune trough calculations will be based on 1.3 times the maximum channel velocity occurring through that reach of the river adjacent to the landfill. As discussed previously, the maximum channel velocity of 13.99 fps occurs at JJA, HEC-2 XSEC 12.75 during the fully encroached FLOODWAY condition. This velocity was increased by a factor of 1.3 to acknowledge the relationship between mean channel velocity and localized maximum velocity (Blodgett, 1984).

Given the absence of channel curvature through the study reach, it is very unlikely that this maximum velocity filament will ever move into contact with the west bank of the river. For straight channel reaches, the maximum velocity would normally be encountered near the center of the channel. The proposed placement of large diameter rip-rap along the river bank will create substantial hydraulic roughness which will serve to further decrease the potential for high velocity flows along the bank. However, the antidune trough calculation utilized this maximum velocity value as a safety factor mechanism. As a matter of technical interest, it should be noted that those rip-rap analysis procedures presented in subsequent sections of this report utilize, by definition, an <u>average</u> channel velocity. However, safety factors are normally incorporated into these procedures which acknowledge

the potential for transient velocity fluctuations that might exceed average velocity values.

SUMMARY OF CALCULATIONS

	Q (cfs)
	96,890
XSEC NO.	12.75
V_{max} (fps)	13.99 x 1.3 = 18.19
ΔZ_{adt} (ft)	4.47

** Based on research by Kennedy - The Mechanics of Dunes and Antidunes in Erodible-Bed Channels - Journal of Fluid Mechanics - 1963, VOL. 16 Part 4; Pg.521-544

SCOUR POTENTIAL WITHIN THE GRAVEL PIT ENVELOPE

The abandoned, existing gravel pit, located 700 feet downstream of Olive Avenue, will induce two additional scour processes:

1. *Headcutting of the upstream face of the pit.*
2. *"Clear-Water" scour downstream of the pit.*

Headcutting will occur as water accelerates over the steep face of the upstream pit boundary. A headcut profile will be propagated upstream as the river attempts to re-establish an equilibrium slope.

Scour downstream of the pit boundary will occur in response to sediment being trapped by the gravel pit. As a result, downstream flows will have the capacity to transport more sediment than is available. This deficit will be made up by the removal of sediment from the river bed downstream of the pit.

Due to a very complex interaction of river system variables, it is not possible to precisely predict the scour profiles that will be generated by these processes. However, procedures have been developed that provide a reasonable approximation of these phenomena.

For the purpose of this analysis, we selected a procedure presented in a recently published research report titled Effects of In-Stream Mining On Channel Stability, Arizona Department of Transportation (ADOT), June 1989, hereafter referred to as the In-Stream Mining Report. This procedure, which is described in Section 11 of that publication, generates an upstream headcut and downstream scour profile for short term (single-event) conditions.

An important characteristic of the headcut process is that this phenomenon is normally arrested once the pit fills with water. However, the downstream scour process is a function of the sediment wave velocity through the pit and can continue after the pit is filled with water.

In order to evaluate the sensitivity of the procedure to slow-pit-filling versus rapid-pit-filling, we investigated the response of several hypothetical hydrographs, with time bases ranging from 4 to 72 hours and peak flow rates of 2,000, 4,000, 10,000, 50,000, and 95,000 cfs. The hydrographs are enclosed as Figures 1, 2, and 3.

Critical scour profiles were plotted for each hydrograph on a large grid sheet. The critical scour profiles for both downstream and upstream processes have also been transferred to profile sheets included with this report. These critical scour profiles are the basis for recommending bank protection toe-down elevations immediately upstream and downstream of the existing gravel pit boundaries. These recommended elevations are summarized on the enclosed Table 2.

3.2 TECHNICAL ASSUMPTIONS USED FOR GRAVEL PIT ANALYSIS

The proposed Cholla Landfill is located in the west overbank of the Agua Fria River, immediately downstream of Olive Avenue. Approximately 2000 linear feet of river bank that separates the proposed landfill from the main river channel, is located adjacent to an abandoned gravel pit. As part of the scour analysis for the proposed levee/bank improvements, the gravel pit was evaluated for potential headcut and downstream degradation profiles. This analysis was necessary to identify where gravel pit induced scour would exceed the scour dimensions associated with a non-gravel pit condition.

The gravel pit analysis was pursued with both long-term and short-term (single event) scour procedures presented in the In-Stream Mining Report. Each procedure is separately addressed in the following paragraphs.

LONG TERM PROCEDURE

This procedure generates an estimate of vertical riverbed movement that might be expected to occur over a long period of time (multiple flood events) in response to in-stream sand and gravel excavation. From the documentation provided in the technical reference, this procedure appears to have been developed on the basis of active mining operations, i.e., operations that continue to extract materials from the riverbed for a specified time into the future. Since the

abandoned gravel pit to which this procedure is being applied is no longer being mined, the application of this procedure might be expected to produce conservative results, i.e., the predicted degradation may be more severe than what will actually occur. This conservative response is anticipated because the abandoned pit will ultimately be filled with sediment, thus arresting any further long-term degradation. In contrast, an actively mined pit would continue to trap sediment for an indefinite time into the future.

Application of the long-term procedure requires an estimate of production time, i.e., what period of time is required to extract a specified volume of sand and gravel. Since the site under investigation is an abandoned pit, an assumed production time of 2 years was selected to extract the estimated pit volume of 19,701,000 cubic feet. Pit dimensions were measured from the 1989 topography provided by EMCON to Mathews Kessler & Associates, Inc.

The calculation of long-term degradation is shown on Table 1. The magnitude of vertical bed movement associated with this process (maximum of 1.7 feet at the downstream pit face) is substantially smaller than that resulting from a single flood event (short-term procedure).

Accordingly, long-term degradation, due to the existing gravel pit location, is not a controlling factor in the toedown elevations for the proposed bank stabilization measures.

SHORT-TERM PROCEDURE

The short-term procedure evaluates scour profiles both upstream and downstream of the gravel pit, for single-event hydrographs.

The documentation for this procedure does not clearly set forth key assumptions, nor are there example problems that clearly identify the correct use of the algorithms presented in the study. Accordingly, several scenarios were evaluated using different assumptions for key parameters in the procedure.

This multi-scenario approach provided an opportunity to evaluate different interpretations of key parameters, until a worst-case scenario was identified. This worst-case scenario was then used as the basis for the gravel pit scour profile. The assumptions used in the short-term procedure are documented as follows:

1. *Pit Fill Time - Since the pit is located immediately downstream of the Olive Avenue bridge, it is assumed that the pit will capture all of the river flow until pit drown-out occurs. This is a reasonable assumption because the lower flows that occur on the rising limb of the hydrograph would realistically be captured by the small headcut that already exists at the upstream edge of the pit. These smaller flows could be expected to enlarge the headcut to capture even larger flows that occur later on the rising limb of the hydrograph. The 2000 foot length of the pit would also serve to capture (by lateral inflow) any flows that might bypass the upstream pit face.*

2. *Bed-Material - The In-Stream Mining Report, presents scour equations for both sand-bed and gravel-bed conditions. The report states (page 99) that "Gravel-bed conditions are considered to exist if a visible armor layer is found in the channel, otherwise the sand-bed condition should be assumed." No armor layer was observed in the channel. Accordingly, the sand-bed scour equations were used. Even though the Agua Fria River channel does appear somewhat gravelly, the assumption of a sand-bed condition is conservative because it will produce more scour than a gravel-bed.*

3. *Channel Width & Unit Discharge - These two parameters are very influential in the scour calculations. One of the major omissions in the documentation of this procedure is the failure to discuss the different ways in which these two parameters can be defined. A "regime width" equation is included in the procedure but there is no discussion to indicate if this computed width should be used for all unit discharge calculations.*

Certainly at large flow rates, this equation gives unrealistically small channel widths, if one is to assume this computed regime width is to contain the entire flow.

The example problem in the In-Stream Mining Report on downstream scour computes unit discharge using both pit width and regime width, without giving any explanation as to why this was done. The example headcut calculation uses only regime width, again with no explanation as to whether this should be applied without any consideration to the magnitude of incoming flow. Because of this lack of procedural documentation, several combinations of channel width and unit discharge were used in an effort to find a worst-case condition. For headcut scour, the unit discharge used for the calculation of Y_{smax}, Y_s, and L_{s5} was alternately based on: 1) regime width; 2) pit width (450 feet); and 3) channel width of 1400 feet. These three options produced a maximum headcut depth when q was based on regime width, and a maximum headcut length when q reached a minimum value as a result of using a 1400 foot channel bottom width. This 1400 foot dimension is based on the approximate bottom width of the Olive Avenue bridge opening. This bridge opening will dictate the maximum channel width that could be used at the upstream end of the gravel pit.

For downstream scour, different combinations of q were used for computing sediment wave celerity (C_s) and Y_s and L_s. Alternative #1 used the pit width for computing q in the C_s equation and the regime width for computing q in the Y_s and L_s equations. Alternative #2 used an 1800 foot channel bottom width for all q calculations. This 1800 foot dimension is the approximate FLOODWAY width near the downstream end of the abandoned gravel pit. Alternative #3 used regime width for all q calculations. As expected, the narrow regime width option produced the maximum unit q and most severe scour profile.

4. *Dimensionless Time Factor, T** - *The example problem in the ADOT report defines this as a cumulative factor, as one proceeds from one time increment of the hydrograph to the next, i.e., the accumulated value of T* from the previous time step is added to the computed T* from the current time step. However, the Δ t used in the equation for T* is based on the length of the specific time increment being analyzed. These two definitions were adhered to when computing T* for the Cholla Landfill analysis.*

   For downstream scour, T is defined as only being valid for values less than 0.84. The data base used by SLA to generate this procedure indicated that the time of maximum downstream scour occurred at T* = 0.84. For headcut scour, T* is defined as only valid for values less than 1.0 (pit drown-out occurs at this time). These limitations were also adhered to for the Cholla Landfill analysis, i.e., downstream scour calculations were considered unreliable (and not used) when T* exceeded 0.84. In a similar manner, headcut scour calculations were discarded when T* exceeded 1.0.*

5. *Scour Length - Discussions with SLA and Arizona Transportation Research Center (ATRC) indicated that the L_{s5} calculations might be additive from one time step to the next, although this was only speculation. The example calculations in the In-Stream Mining Report do not accumulate L_{s5} values from previous time increments, nor does the text indicate that these values should be considered as cumulative lengths. Accordingly, for the Cholla Landfill analysis, Equations 11.3 and 11.6 (In-Stream Mining Report, Pg. 101) were considered to represent the total scour length that would exist at the end of the time increment being evaluated. This would seem to be a realistic assumption, since both of these equations are a function of the dimensionless time factor, T*, which is a cumulative value.*

6. *Flow Rates - The gravel pit scour calculations were performed for a range of hydrograph conditions in order to examine the impact of long-duration, low-flows versus short-duration high flows.*

   The headcut analysis examined two 4-hour hydrographs with peak flow rates of 2,000 cfs (pit fill time is 4.2 hours) and 10,000 cfs (pit fill time is 1.28 hours), an 8-hour hydrograph with Q_p = 50,000 cfs (pit fill time is 0.66 hours), and a 7-hour hydrograph with Q_p = 95,000 cfs (pit fill time is 0.58 hours).

   The downstream scour analysis evaluated two 8-hour hydrographs with Q_p = 50,000 and 95,000 cfs, as well as a 72-hour constant-flow hydrograph of 4,000 cfs.

   For purposes of selecting a design scour profile for the upstream headcut, the critical time steps from all the hydrographs were superimposed on one graphical plot, and a design envelope was drawn to include the most severe scour profile that would encompass all the plotted profiles. A similar approach was employed for the downstream scour profile.

7. *Reference Line For Scour Measurements - All headcut scour depths were referenced to the actual bed elevation 1069 that currently exists at the upstream edge of the abandoned gravel pit. The maximum headcut scour depth is limited to one-half the pit depth (see In-Stream Mining Report). The upstream pit depth is approximately 28 feet. Accordingly, a maximum headcut depth of 14 feet is a limitation for this project. This maximum dimension is assumed to occur at the upstream pit face STA 6+62. In order to provide a safety factor, the actual bank protection toe-down elevations were carried 1.5 feet below the predicted headcut profile.*

   The headcut scour lengths are all referenced to a stationary pit face located at STA 6+62. An argument might be made that this

reference point will move downstream as the headcutting action transports material into the upper end of the pit. By assuming the reference point does not move downstream, conservatism should be created, since such an assumption will create headcut profiles that extend further upstream than what might actually occur.

Downstream scour depths were referenced to a constant bed-slope that was visually drawn through a plot of actual thalweg elevations. This constant-slope line was drawn to pass through the lowest elevation points in the profile, thus promoting conservatism in the scour profile. The previously referenced 1.5 foot safety factor was also applied to the downstream gravel pit scour profile.

Downstream scour lengths were referenced to the downstream face of the gravel pit. This reference point, which was considered stationary during passage of the hydrograph, is located at STA 26+00.

Except for those areas very near to the upstream and downstream pit faces, the non-gravel pit scour depths of 8.5 feet upstream of the pit and 7.5 feet downstream of the pit, create a much more conservative toedown dimension than the gravel pit scour profiles.

Because of the continual inflow of material into the gravel pit, the vertical depth of the headcut profile should diminish with time. However, the downstream scour profile may continue to degrade the downstream river bed until the pit is filled with sediment. This may take many years. However, the downstream scour profile is not expected to reach the 7.5 foot toedown depth used for the bank protection design downstream of the gravel pit (see discussion for long-term procedure).

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3.3 RIP-RAP ANALYSIS FOR PROPOSED BANK PROTECTION

Accurate rip-rap sizing is complicated by difficulties involved in estimating accurate shear stresses, flow velocities, and energy gradients. Because of this, it is prudent to apply conservative safety factors to the rip-rap sizing procedures. Therefore, four independent procedures have been utilized to obtain theoretical estimates of suitable rip-rap sizes for this project. These procedures are listed as follows:

1. *Stevens, Simons, & Lewis stability method as presented in Highways In The River Environment, Design Considerations, Training & Design Manual, FHA, January 1987.*

2. *Research paper entitled Rip-rap Design, Maynord, Ruff, & Abt, ASCE Journal of Hydraulic Engineering, Vol. 115, No. 7, July 1989;*

3. *Isbash formula for stable rock weights, as published in ASCE Manual No. 54, Sedimentation Engineering, 1975 (pg. 534).*

4. *Design of Rip-Rap Revetment, HEC No. 11, FHA, March, 1989.*

Each of these procedures requires slightly different input parameters. Energy gradients and flow velocities (for non-gravel pit areas) were obtained from the JJA HEC-2 Model. A trapezoidal channel approximation was also employed for some procedures. These methods were applied to a range of depths, velocities, and energy slopes in order to evaluate the sensitivity of the procedures and to determine a stable rip-rap size.

A detailed discussion of each procedure along with a summary of the rip-rap calculations is presented in the following paragraphs.

The calculations from all four procedures indicate that a 24" D_{50} rock diameter should be stable when exposed to the existing 100-year event of approximately 98,000 cfs. The only exception to this conclusion is that reach of

embankment located between Olive Avenue and the upstream end of the abandoned gravel pit. This approximate 700 foot reach will be exposed to possible headcutting, which may generate very high velocities capable of dislodging a D_{50} = 24" rock diameter. Grouting the D_{50} = 24" rip-rap should be considered for this 700 foot section from the toe-down up to the thalweg elevation in the adjacent streambed. This will provide for added protection during the interim period of filling the abandoned gravel pit.

Accordingly, based on all the calculations and consideration of all criteria, it is recommended that rip-rap for existing conditions be D_{50} = 24". However, if development follows the completion of Waddell Dam, reducing the Q_{100} to 33,000 cfs, a D_{50} = 15" would probably be acceptable. However, a complete set of hydraulic calculations for 33,000 cfs would have to be performed in order to provide an equally detailed analysis of this event as is provided herein for the existing 100-year event of approximately 98,000 cfs.

METHOD 1 - HIGHWAYS IN THE RIVER ENVIRONMENT TRAINING & DESIGN MANUAL, SECTION V-11

This procedure evaluates the stability of a discrete rock particle through a comparison of forces promoting rock movement to those forces resisting rock movement. This comparison is expressed in terms of a stability factor (S.F.) which is defined as "the ratio of the moments resisting particle rotation out of the bank to the submerged weight and fluid force moments tending to rotate the particle out of its resting position. If the S.F. is greater than unity, the rip-rap is stable; if the S.F. is unity, the rock is at the condition of incipient motion; if S.F. is less than unity, the rip-rap is unstable." Based on rip-rap embankment model data, a stability factor of 1.5 is recommended for use with this procedure.

Input data for this procedure consists of:

1. *Angle of repose of rip-rap (40° used for this study)*
2. *Angle of bank slope (26.6° @ Z = 2H:1V)*
3. *Specific gravity of rip-rap (2.65 used for this study)*
4. *Shear stress (tractive force) acting on the rip-rap*
5. *Shield's parameter (.047 used in this study)*

Two approaches were taken to estimate a representative shear stress for use in this procedure. The first approach utilized the average channel hydraulics (for a fully encroached FLOODWAY) through the study reach. These average values were based on 12 HEC-2 cross-sections between Olive Avenue and Northern Avenue.

An average channel area of 6994 S.F. and channel width of 819 feet (from the 1989, JJA HEC-2 Model) were used to compute an average hydraulic depth of 8.80 feet. The average channel discharge 77,342 cfs associated with this average width and depth was also computed.

The average channel width, depth, and discharge were applied to Manning's equation (with n = .030 and Z = 2H:1V) to determine the energy slope and hydraulic radius associated with this typical average cross-section. This information was then used to compute the bed shear stress using:

$$\tau_o = \gamma_w R S_e$$

The results of this procedure produced an average velocity of 10.51 fps, and energy slope of .002562 ft./ft. and a shear stress of 1.37 lb./ft.^{2}. Using a D_{50}=24", produced a stability factor of 1.5.

The second approach used for computing shear stress was based on the observation that the average FLOODWAY width through the study reach was

approximately 1800 feet. Again, using Manning's equation (n = .030 and Z = 2H:1V) with the entire 100-year peak discharge of 98,780 cfs, two trapezoidal sections flowing 6.07 feet deep (S_e = .0030 ft./ft.) and 5.57 feet deep (S_e = .0040 ft./ft.) were established. The energy slopes of .0030 and .0040 ft./ft. were taken as typical values from the HEC-2 FLOODWAY run between Olive Avenue and Northern Avenue. The hydraulic characteristics associated with these two trapezoidal approximations were used to compute shear stress values as discussed for the previous approach. The stability factor results are presented in Table 2.

A similar approach was also used in an effort to estimate shear stresses through the steep headcut area that will develop upstream of the abandoned gravel pit. Based on predicted bed slopes of .04 to .05 ft./ft., an energy slope of .07 ft./ft. was assumed for this area. Assuming the headcut would be 450 feet wide and carry 70% of the total 100-year inflow, trapezoidal channel flow characteristics were determined for use in computing shear stresses. These results are also presented in Table 3.

METHOD 2 <u>RIP-RAP DESIGN</u>, MAYNORD, RUFF AND ABT, 1989

This design procedure computes a D_{30} rock diameter as a function of the following variables:

1. *Safety factor, designated by the designer.*
2. *Specific weight of water (62.4 lb./ft.^{3})*
3. *Specific weight of rock (165 lb./ft.^{3}).*
4. *Local average velocity at the toe of the side-slope.*
5. *Depth of flow at the toe of the side-slope.*

This procedure was partially developed from rip-rap stability tests conducted by Maynord in 1988.

Both the rip-rap design equation and the results of the procedure are summarized in Table 4. It should be noted that this procedure computes a D_{30} particle size. Tables are included in the referenced article to convert the computed D_{30} size to an associated minimum and maximum D_{50} weight. These D_{50} weights are then converted to an equivalent spherical diameter using the following equation:

$$D_{50} = 12 \cdot \left[\frac{6\,W}{\pi\,\gamma_s} \right]^{1/3}$$

Where: D_{50} = *rock diameter (inches)*
W = *stone weight (lbs.)*
γ_s = *specific weight of rip-rap*

Table 4 presents a range of velocity and depth combinations that were used to compute a minimum and maximum D_{50} rock diameter. All calculations include a safety factor of 1.5. If the localized velocity over the toe of the bank is assumed equal to the average channel velocity, this procedure indicates that a minimum D_{50} of about 24" is acceptable to a velocity / depth combination of 14 fps and 6 feet, respectively. A maximum channel velocity of 13.99 fps was produced by the HEC-2 Model for a fully encroached FLOODWAY condition. A flow depth of 6 feet exists at several cross-sections downstream of the abandoned gravel pit. Accordingly, this procedure indicates a D_{50} = 24" should be stable through the study reach during a flow of approximately 98,000 cfs.

METHOD 3 ISBASH FORMULA, ASCE
Sedimentation Engineering Manual no. 54

This procedure was developed by Isbash in 1936 for the construction of rock dams in running water. The procedure predicts a stone weight that should be stable when placed on a specified slope and exposed to a design velocity. The

procedure does not address the incorporation of a safety factor mechanism. The input parameters required for this method are:

1. *Specific gravity of stone (use 2.65)*
2. *Flow velocity*
3. *Angle of side-slope*

The Isbash formula, and the results of applying this formula to a range of velocities, are summarized in Table 5. The computed stone weights were converted to an equivalent spherical diameter using the same relationship listed for Method 2.

A review of Table 5 indicates that a D_{50} = 24" would be stable at a maximum velocity of 16.5 fps on a 2H:1V side-slope. This is 1.18 times greater than the maximum FLOODWAY channel velocity of 13.99 fps taken from the HEC-2 Model.

METHOD 4 ***<u>DESIGN OF RIP-RAP REVETMENT</u>***
FHA, 1989

This is a relatively new procedure that was just published in March 1989. This method allows direct calculation of a D_{50} particle diameter by the following equation:

$$D_{50} = \frac{0.001\ V_a^{3}}{(d_{aug}^{.50}\ K_1^{1.5})}$$

Where: D_{50} = *Median rip-rap particle size (ft.)*

V_a = *Average velocity in the main channel (fps)*

d_{aug} = Average flow depth in the main channel (ft.)

$$K_1 = \left[1 - \left[\frac{\sin^2 \theta}{\sin^2 \phi} \right] \right]^{0.5}$$

Where: θ = Bank angle with the horizontal (degrees)

ϕ = Angle of repose of rip-rap (degrees)

This equation incorporates a stability factor of 1.2 . For this method of rip-rap design, the stability factor is defined as the "ratio of the average tractive force exerted by the flow field and the rip-rap materials critical shear stress." This method recommends a stability factor range of 1.0 to 1.2 for straight or mildly curving river reaches with uniform flow, and a factor of 1.3 to 1.6 for gradually varied flow in river reaches with moderate bend curvature.

Table 6 presents the results of this method for stability factors ranging from 1.2 to 1.5 . For the straight reach of river investigated as part of this study, a stability factor of 1.4 would appear justifiable.

The velocity used in Table 6 is the maximum channel velocity (with full FLOODWAY encroachments) that is listed on the JJA HEC-2 run (XSEC 12.75) for that reach of river between Olive Avenue and Northern Avenue. The average flow depth of 8.80 feet is the average hydraulic depth for the main channel for the same reach, under FLOODWAY conditions. The calculation of this depth was previously discussed under Method 1.

A review of Table 6 indicates that a D_{50} = 23" would provide a stability factor of 1.4 at a velocity of 13.99 fps and depth of 8.80 feet.

To insure the integrity of the rip-rap that is installed, there will be a commitment by the landfill owner to periodically inspect the embankment and repair any damage that may occur.

3.4 ALTERNATE LEVEE - STA. 35+50 TO STA. 50+75

Since the bank between the two stations above bends so far to the west, a new levee along a relatively straight line between the two points saves nearly 400 feet of rip-rap construction and a significant amount of levee repair.

As an alternate to making the necessary levee repair between approximate STA. 38+00 and STA. 42+00 (400 ft.) and rip-rap protecting 1525 ft. of bank it was felt that constructing and protecting approximately 1160 ft. of new levee would improve the hydraulic properties of the channel. The alignment of the new levee section would be the floodway encroachment limit shown on the recent JJA flood insurance study. This levee alignment tends to smooth out a large indentation in the west bank and improves the channel hydraulics. Toedown and rip-rap design criteria used was similar to that for the rest of the proposed improvements.

The levee would be constructed with the 2H:1V face, 50' crest width and 3H:1V back slope that is proposed for all the other levee sections of this project. The alignment would be excavated to such depth necessary to satisfy a geotechnical engineer that remaining material will provide a suitable foundation for the levee section. All material placed in the levee would be compacted to 95% of maximum density in accordance to methods described in ASTM 1557 and then protected by the rip-rap design proposed for the entire project.

Table 6
(Method 4)
Summary of Riprap D50 Calculations
Using Procedures In
Design of Riprap Revetment
HEC–11, FHA, 1989

Stability Factor	Va (fps)	davg (ft)	K1	Csf	D50 (inches)
1.2	13.99	8.80	0.717	1.00	18.20
1.3	13.99	8.80	0.717	1.13	20.50
1.4	13.99	8.80	0.717	1.26	23.00
1.5	13.99	8.80	0.717	1.40	25.50

Assumptions: Angle of repose = 40 degrees
Side–slope= 2H:1V
Specific Gravity = 2.65

TABLE 5
(Method 3)

ASCE Sedimentation Engineering Manual No. 54
(page 534, *Isbash* Formula)

This procedure uses the following equation to compute a stable stone weight:

$$W = \frac{4.1 \times 10^{-5} G_s V^6}{(G_s - 1)^3 \cos^3 \phi}$$

where W =Weight of stone that will resist movement under specified design conditions (lbs)

G_s =Specific gravity of stone (use 2.65 for this project)

V =Velocity of flow (fps)

ϕ =Angle of side-slope (26.6 degrees for this project)

Summary of Calculations		
Velocity (fps)	W (lbs)	Equivalent D_{50} (in.) *
10	34	8.8
11	60	10.6
12	101	12.6
13	163	14.8
14	255	17.2
15	385	19.8
16	568	22.5
16.5	685	23.9

* $$D_{50} = 12 \cdot \left(\frac{6W}{\pi \gamma_s} \right)^{1/3}$$

(this equation uses the same variable definitions as in TABLE 4)

TABLE 4 (cont.)

The D_{50} rock sizes listed in the preceding table are taken from the recommended riprap gradation for $\gamma_s = 165\, lb/ft^3$. Since the gradations are published in terms of the rock weight, a conversion to an equivalent stone diameter was made using the following equation:

$$D_{50} = 12 \cdot \left(\frac{6W}{\pi \gamma_s} \right)^{1/3}$$

where D_{50} = Rock diameter (in.) of which 50% are smaller by weight
W = Stone weight (lb)
γ_s = Specific weight of stone (lb/ft^3)

The computed D_{50} (ft) is used to enter the published gradation tables in the referenced article. The minimum and maximum D_{50} weights (corresponding to the minimum D_{50} diameter) are then read from the table.

TABLE 4
(Method 2)

Riprap Design
by Maynord, Ruff, & Abt
ASCE Journal of Hydraulic Engineering, July 1989

This procedure computes a D_{50} particle size through riprap gradation tables included with the referenced article. The equation for computing D_{30} is presented as follows:

$$D_{30} = D \cdot SF \cdot 0.3 \cdot \left[\left(\frac{\gamma_w}{\gamma_s - \gamma_w} \right)^{0.5} \left(\frac{V}{\sqrt{gD}} \right) \right]^{2.5}$$

where D_{30} = Particle size for which 30% is finer by weight
D = Flow depth over toe of bank
V = Average velocity over toe of bank
γ_w = Specific weight of water
γ_s = Specific weight of riprap
g = 32.2 ft/sec²

Summary of Calculations					
Safety Factor	Velocity (fps)	Depth (feet)	D_{30} inches (feet)	Minimum D_{50} (in)	Maximum D_{50} (in)
1.5	10	6	7.6 (0.63)	10.5	12.0
1.5	10	9	6.9 (0.58)	8.8	10.0
1.5	10	12	6.4 (0.53)	8.8	10.0
1.5	12	6	12.1 (1.01)	15.8	18.0
1.5	12	9	10.9 (0.91)	14.0	16.0
1.5	12	12	10.1 (0.84)	12.3	14.0
1.5	14	6	17.7 (1.48)	24.6	28.0
1.5	14	9	16.0 (1.33)	19.3	22.0
1.5	14	12	14.9 (1.24)	19.3	22.0

Table 3
(Method 1)
Summary of Computed Riprap Stability Factors
Using Procedures In
Highways In The River Environment
FHA, 1987

Peak Discharge (cfs)	D50 (inches)	Safety Factor	
Stability Factor Based On Average Channel Hydraulics Of 12 Cross–Sections, Energy Slope = .002562 ft/ft			
98,780	24	1.50	
Stability Factor Based On Trapezoidal Channel Equal To Floodway Width			
		Se = .0030 ft/ft	Se = .0040 ft/ft
98,780	32	1.57	1.54
	24	1.53	1.50
	15	1.45	1.40
54,000	32	1.60	1.58
	24	1.57	1.55
	15	1.51	1.48
33,000	32	1.62	1.61
	24	1.60	1.58
	15	1.55	1.53
Stability Factor Through Steep–Sloped Headcut Area			
		Se = .0700 ft/ft	
98,780	64	0.95	N/A
54,000	64	1.12	N/A
33,000	64	1.23	N/A

Table 2
Recommended Bank Protection Toedown Elevations
Through Abandoned Gravel Pit Area

MKA Station Along Levee Road	Toedown Elevation (MSL)
0+00	1061.5
1+00	1061.5
2+00	1061.5
3+00	1061.5
4+00	1060.9
5+00	1059.4
6+00	1055.7
6+62	1053.5
7+00	1053.0
8+00	1051.5
9+00	1049.7
10+00	1048.0
11+00	1046.2
12+00	1044.5
13+00	1042.8
14+00	1042.5
15+00	1042.0
16+00	1041.7
17+00	1041.4
18+00	1041.0
19+00	1040.3
20+00	1039.7
21+00	1039.0
22+00	1038.5
23+00	1038.0
24+00	1040.1
25+00	1042.2
26+00	1044.5
27+00	1047.1
28+00	1049.4
29+00	1051.3
30+00	1052.5
30+87	1053.3

Downstream of STA 30+87, toedown transitions to 7.5 feet below the channel thalweg.

TABLE 1

(Continued)

6. From Chart C: (use Reach Length = 0.5 mi.)

D/S Distance (Miles)	$\frac{\Delta Z_{D/S}}{\Delta Z_{brink}}$	$\Delta Z_{D/S}$ (ft.)
0	1.0	-1.7 (brink)
1	0.5	-0.85
2	0.24	-0.41
3	0.18	-0.31

TABLE 1

Estimate of Long-Term Degradation for Abandoned
Gravel Pit Downstream of Olive Avenue Bridge

Procedure: Long-term procedure documented in Effects of Instream Mining on Channel Stability, ATRC/SLA, June 1989.

Assumptions:

Pit Length	=	1,900 Ft.
Pit Width	=	450 Ft.
D/S Pit Depth	=	22 Ft.
Pit Volume	=	19,701,000 $Ft.^3$ (450 x 1990 x 22)
@ 100 lb/ft^3	=	985,050 tons

Production Time = 2 years
Gravel Bed (procedure is valid only for gravel)

Calculations:

1. Avg. Annual Prod./Unit Length = (985,050 / (1990/5280)) / 2
   = 1,306,800 ton/mi./yr.

2. From Chart A: ΔZ_{max} = 2.2 ft./yr.
   ΔZ_{max} = (- 2.2) (2 yr.) = - 4.4 ft.

3. Avg. Annual Prod./Unit Width = (985,050/450) / 2
   = 1094.5 tons/ft./yr.

4. From Chart B (extended)

$$\Delta Z_{AVE} = \frac{1094.5}{900} (0.7) = -0.85 \text{ ft./yr.}$$

5. ΔZ_{brink} = (- .85) (2) = - 1.70 ft.

MATHEWS KESSLER & ASSOCIATES, INC.

ENGINEERS/ARCHITECTS/PLANNERS

Client: B.F.I.
Project No.: 8017
Project Name: Cholla Landfill - Agua Fria

Page
Date: 8/21/89
Computed By: RLW

Discretized Hydrographs

Period	$Q_p = 2000$ Δt (hr)	Q (cfs)	$Q_p = 5000$ Δt	Q	$Q_p = 10,000$ Δt	Q
0 - .5	0.5	500	0.5	1250	0.5	2500
.5 - 1.0		1500		3750		7500
1.0 - 1.5		2000		5000		9167
1.5 - 2.0		2000		5000		7500
2.0 - 2.5		1750		4375		5833
↓ etc.		1250		3125		4167
		750		1875		2500
		250		625		833

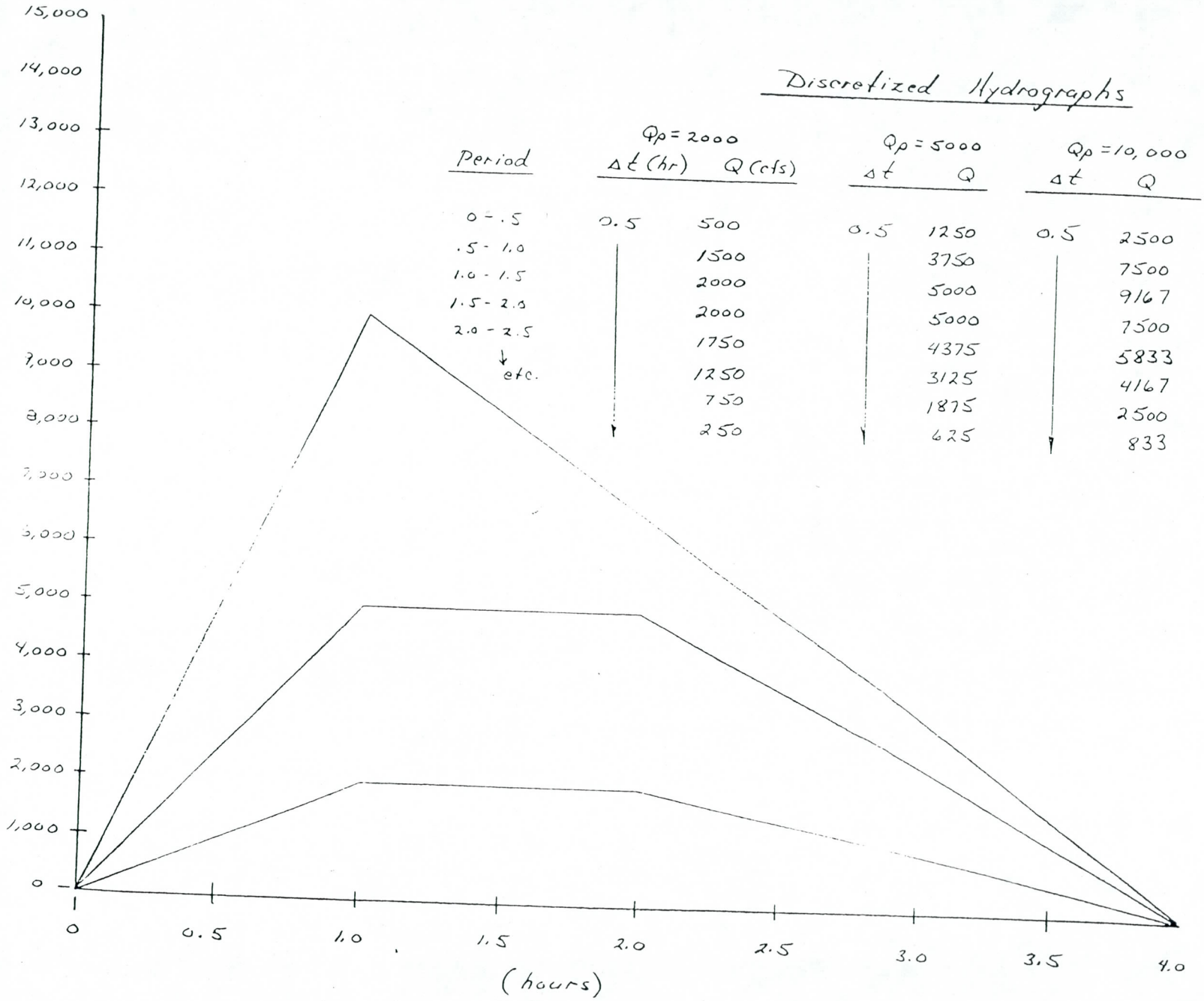

FIGURE 1

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Client B.F.I.
Project No. 8017
Project Name Cholla Landfill - Agua Fria

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Date 8/22/89
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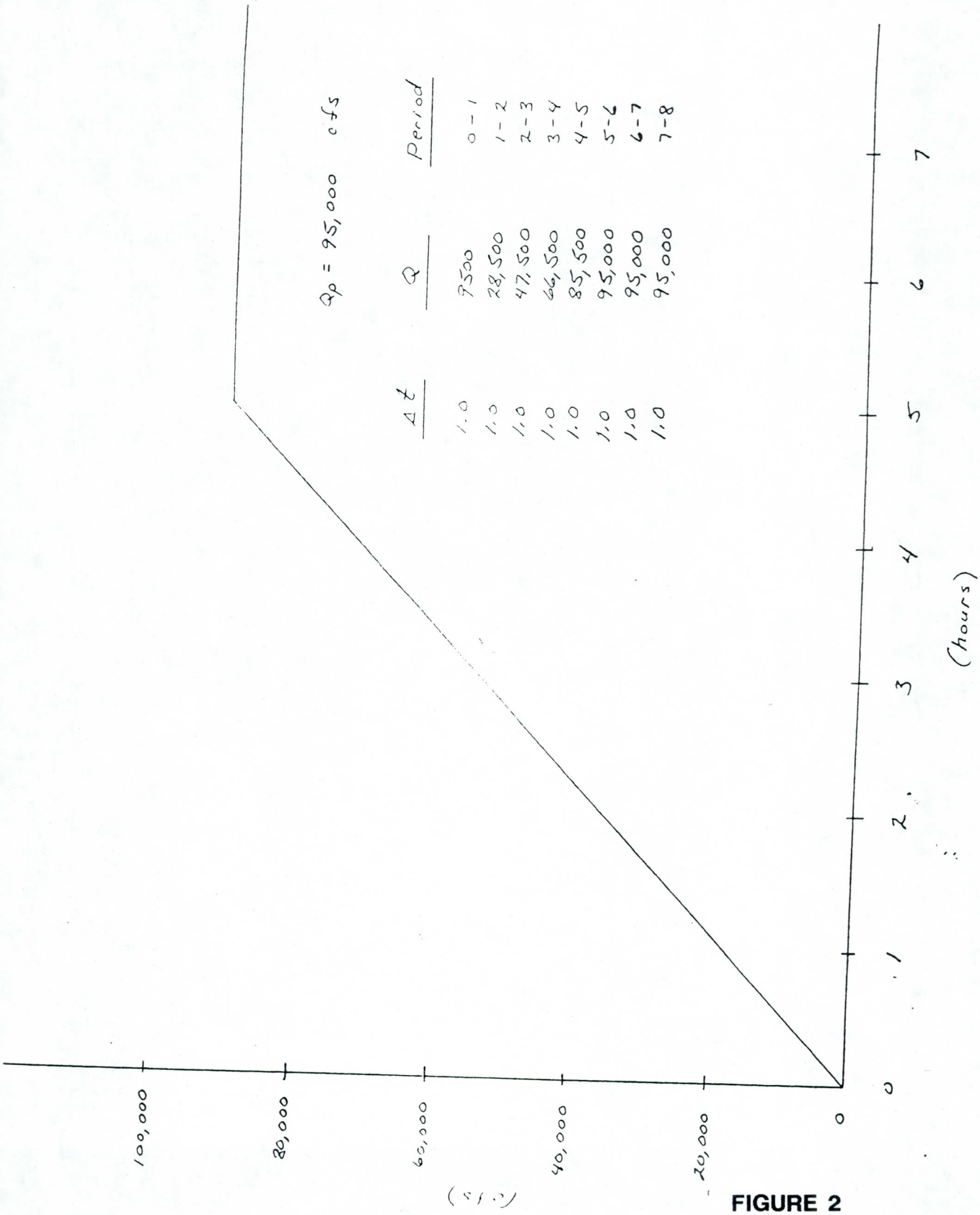

FIGURE 2

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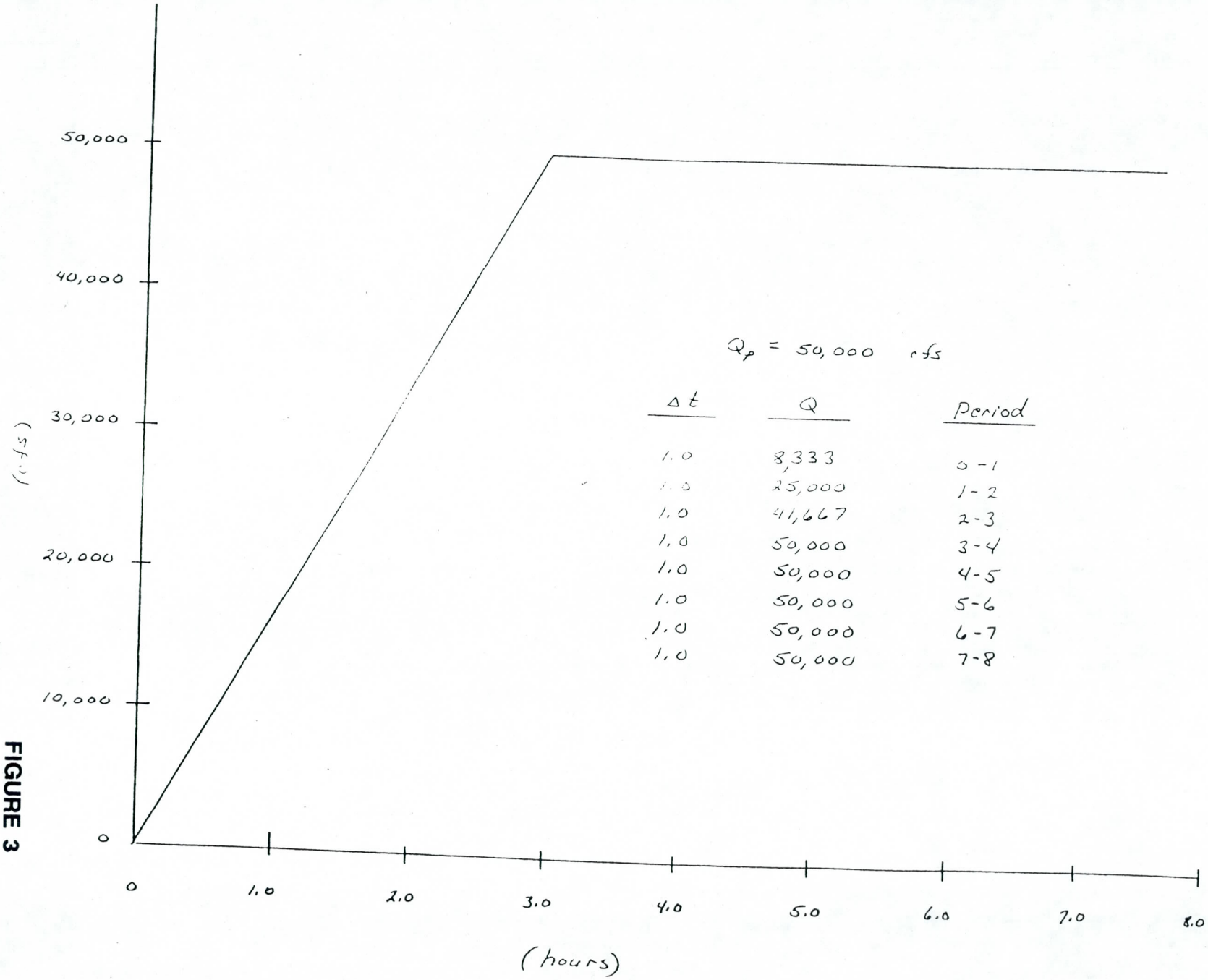
Project No. 8017

Project Name Cholla Landfill - Agua Fria

Page

Date 8/23/89

Computed By: RLW



Q_p = 50,000 cfs

Δt	Q	Period
1.0	8,333	0-1
1.0	25,000	1-2
1.0	41,667	2-3
1.0	50,000	3-4
1.0	50,000	4-5
1.0	50,000	5-6
1.0	50,000	6-7
1.0	50,000	7-8

FIGURE 3

ASSESSMENT OF RIVER BANK BREACH BACKFILL MATERIALS PROPOSED CHOLLA LANDFILL SITE EL MIRAGE, ARIZONA

Prepared for

BROWNING-FERRIS INDUSTRIES OF ARIZONA, INC.

December 1989

REGISTERED GEOLOGIST
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Project 372-15.05

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1.0 INTRODUCTION

Browning-Ferris Industries of Arizona, Inc. (BFI) retained EMCON Associates (EMCON) to evaluate two backfilled sections of the Agua Fria river bank along the east side of the proposed Cholla Landfill site in El Mirage, Arizona (Figure 1). The purpose of the evaluation was to define the nature and extent of fill materials in the repaired sections. Mr. William Mathews of Mathews Kessler & Associates will utilize the results to characterize the repaired sections relative to Federal Emergency Management Agency (FEMA) floodplain guidelines.

In December 1978, flows in the Agua Fria River peaked at approximately 48,000 cfs during a flood. Floodwaters breached the river bank that separated active gravel operations (Plant No. 6, Union Rock & Materials Corporation) from the Agua Fria River channel. The floodwaters entered through a breach along the eastern side of the gravel operation and exited through a breach along the southern side.

According to the best information available, fill operations were initiated within the entrance breach before all floodwaters had receded. Backfill material reportedly consisted of clean, fine-grained sand with little or no debris. It is not known if the fill operation was documented.

The following tasks were completed during the evaluation:

- Identification and delineation of the two breached areas of the river bank through field reconnaissance and photogeologic interpretation prior to drilling.
- Drilling and sampling fill materials in the two breached areas using a CME-75 drill rig.
- Testing selected soil samples for dry density and water content, grain-size distribution, compaction, consolidation, and shear strength.
- Report preparation.

2.0 SITE DESCRIPTION

The repaired river bank parallels the eastern boundary of Union Sand and Rock Plant No. 6, the site of the proposed Cholla Landfill. Plant No. 6 is located in El Mirage, Arizona on El Mirage Road approximately 1,500 feet south of Olive Avenue (Figure 1).

A heavy equipment haul road occupies the surface of the river bank in the vicinity of the two breaches. The river bank surface is relatively flat. Piles of asphaltic concrete and concrete debris cover some portions of the river bank. The river-side slope of the entrance breach (Figure 2) is the wash-out area for concrete trucks and therefore partially covered with an irregular crust of concrete.

3.0 EVALUATION PROGRAM

3.1 PRELIMINARY GEOLOGIC RECONNAISSANCE

On July 31, 1989, EMCON personnel conducted a preliminary geologic reconnaissance of the breached river bank. The approximate widths of the two breach areas were estimated visually and used to determine the number and location of the exploratory borings. A reconnaissance of the river bank north of the entrance breach was also performed, specifically to identify other areas that may have been filled. In addition, the base of the fill materials, used to repair the entrance breach, was delineated at two locations on the east slope of the repaired section.

Aerial photographs aided in the delineation of known and suspected fill areas. In particular, one 1978 photograph depicts the breached parts of the river bank. However, since the photograph depicts conditions as they appeared after the peak flood stage, the original breach channels were larger than those visible in the photograph.

3.2 SUBSURFACE EXPLORATION

Five borings were drilled in the exit breach and eleven borings were drilled in the entrance breach. The borings were advanced along the approximate centerline of the river bank on approximately 50-foot centers. Boring EB-1 was located just west of the eastern boundary (based upon field reconnaissance and aerial photograph interpretation) of the exit breach. Boring EB-5 was located just north of the southern boundary (also based upon field inspection and aerial photograph interpretation) of the entrance breach. Borings were not drilled to the west and north of the respective breaches. The borings were terminated when native materials were encountered (Appendix A).

A split-spoon or modified California sampler was used to obtain samples every 2.5 feet. A 140-pound hammer with a 30-inch drop drove the samplers into undisturbed materials. Blow counts were recorded for each 6-inch penetration interval. Split-spoon samples were transferred to double plastic bags and

labelled. Samples from the modified California sampler were retained in brass sleeves, labelled, and protected with plastic end caps. Selected samples were tested for gradation, dry density and water content, consolidation, and shear strength. A bulk sample of auger cuttings was obtained from each boring. Compaction tests were performed on selected bulk samples.

Field descriptions of samples and auger cuttings were made using ASTM Method D2488-84. Fill and native materials were differentiated based on visual observations, lithology, soil structure (or lack of), and drilling behavior.

3.3 FIELD MAPPING

The fill material/native soil contact of the entrance breach was exposed along the eastern slope of the river bank. The contact was delineated using aerial photographs, boring results, and by field reconnaissance, and is shown on Figure 2.

3.4 LABORATORY TESTING

Laboratory tests were performed on disturbed and relatively undisturbed soil samples obtained during the subsurface exploration. Testing included gradation (ASTM D422), dry density and natural water content (ASTM D2937), compaction (ASTM D1557), consolidation (ASTM D2435), and isotropically consolidated undrained triaxial shear tests. Test results are summarized in Table 1. Complete test results are presented in Appendix B.

Gradation test results indicate that the backfill materials consist of silty sand with varying amounts of gravel. These results are consistent with the field classifications. Breach backfill material also included sand, gravelly sand, cobbles, and asphaltic concrete debris.

Eighteen dry density and water content determinations were made on relatively undisturbed samples. The dry density ranged from 89.3 pounds per cubic foot

(pcf) to 118.7 pcf, and averaged 104.7 pcf. Natural water content ranged from 2.1 to 11.1 percent, and averaged 7.6 percent.

Three compaction tests (ASTM D1557) were performed on bulk samples obtained during the field exploration. The maximum dry density of these samples ranged from 134.0 to 137.0 pcf (average 135.7 pcf) and the optimum water content ranged from 6.5 to 8.0 percent (average 7 percent).

The in-situ dry density of the relatively undisturbed samples of river bank breach backfill material was compared with the average maximum dry density from the compaction tests. The percent compaction ranged from 66 percent to 88 percent and averaged 77 percent.

Two consolidation tests were performed on relatively undisturbed samples of backfill materials to assess their load-deformation characteristics and the potential to collapse (undergo large volume changes on saturation). The test samples had compression indices of 0.10 and 0.09 and a compression on saturation of 0.19 and 0.67 percent.

Three consolidated undrained triaxial tests were performed on relatively undisturbed samples to help assess shear strength characteristics of the backfill material. Triaxial test results are presented in Table 1 and Appendix B. Our interpretation of the results indicates that the material has an effective stress friction angle of 29 degrees with a zero cohesion intercept. The results are consistent with values typically obtained for loose to medium dense silty sand.

4.0 FINDINGS

4.1 GEOLOGIC CONDITIONS

The river bank is now a strip of land 25 to 100 feet wide at the top and 60 to 200 feet wide at the base. Native soils comprising the river bank consist of poorly graded silty sands, well-graded gravelly sands, and well-graded lenses of sands, gravels, and cobbles. Stratification is laterally discontinuous, but generally well-developed and traceable over relatively short distances. Well-developed cross-bed sets were observed in some layers/lenses. Overall, the native soils were relatively cohesionless, except when traces of clay were encountered. The angularity of clasts ranged from subangular to rounded. Heavily cemented zones were observed in the field and encountered during drilling.

Three types of materials were encountered in the borings penetrating the entrance breach (Figure 3). From the surface to depths of 4 to 9 feet, gravelly sand fill and sand and gravel fill were encountered. This material is associated with the haul road used by the heavy equipment of Plant No. 6. The material is heterogeneous and contains moderate amounts of asphaltic concrete debris at some locations. The material ranges from loose to medium dense. Underlying the haul road fill to depths of 7 to 21 feet was the material used to backfill the entrance breach. The backfill material consists mostly of relatively homogeneous, medium dense to dense silty sand fill with a trace of asphaltic concrete debris and some gravel. Native materials underlie the breach backfill and consist mainly of cohesionless sands and gravel-sand mixtures. Heavy cementation was encountered in Borings EB-7, -8, and -9 at a depth of approximately 20 feet.

Two types of materials were encountered in the borings penetrating the exit breach: fill materials and native deposits (Figure 4). The material used to backfill the exit breach consists of loose to medium dense mixtures of sands, gravels, and cobbles. The depths of fill range from 6 to 14 feet. Some asphaltic concrete debris was encountered. The underlying native materials consist of sand, gravel, and cobble mixtures. The native soils are cohesionless and subangular to subrounded.

4.2 CONFIGURATION OF BREACHES

Based upon the subsurface exploration program, interpretation of aerial photographs, and field reconnaissance, we estimate the entrance breach is approximately 600 feet wide and attains a maximum depth of approximately 21 feet. The backfill material is deepest at the south end of the breach and gradually pinches out toward the north as shown on Figure 3.

The exit breach is approximately 300 feet wide, with a maximum depth of 14 feet, as indicated by interpretation of aerial photographs, subsurface exploration, and field reconnaissance. The backfill is deepest near the northeastern end as shown on Figure 4.

5.0 CONCLUSIONS

Based on the field and laboratory investigations, we have made the following conclusions and recommendations.

- Breach backfill materials consist primarily of cohesionless soils (sand, silty sand, and gravelly sand) with some asphaltic concrete debris and cobbles.
- Backfill material was probably placed without engineering or construction quality control measures.
- Backfill material is loose to medium dense and has relatively low densities. The percent compaction is below generally accepted minimum values for engineered fill which is typically 85 to 90 percent of maximum dry density as determined by ASTM D1557.
- We recommend that backfill materials be densified to allow the river bank repair to be certified in accordance with Federal Emergency Management Agency (FEMA) Regulations. The backfill material should be densified so that its percent compaction meets the generally accepted values for engineered fill and design criteria for river bank erosion control work. This could include excavation with subsequent placement and compaction of the backfill or densification in place. In-situ densification by jetting may be only locally successful because of the relatively high fines content of some of the backfill material.

TABLE

TABLE 1

SUMMARY OF SOIL TEST RESULTS

Boring No.	Depth (ft)	USCS	Maximum Dry Density (pcf)	Optimum w/c (%)	% passing #4	% passing #200
EB-3	0'-11'	SM	136.0	6.5	67	23
EB-7	4'-18'	SM	137.0	6.5	71	24
EB-11	2'-9'	SM	134.0	8.0	74	28
Average Maximum Dry Density/ Optimum Water Content			135.7	7.0		

Boring No.	Depth (ft)	USCS	Dry Density (pcf)	w/c (%)	% OF COMPACTION	% passing #4	% passing #200
EB-3	10'10"	SM	100.4	2.1	74.0		
EB-4	4'10"	SW	112.5	2.6	82.9		
EB-5	7'11"	SM	102.9	5.1	75.8		
EB-6	7'11"	SM	105.1	8.2	77.5		
EB-6	8'5"	SM	105.9	9.5	78.1	94	44
EB-6	12'10"	SM	96.0	8.0	70.8	97	44
EB-6	13'4"	SM	108.7	10.1	80.1		
EB-7	18'4"	SM	89.3	8.4	65.8		
EB-7	13'5"	SM	111.0	9.5	81.8		
EB-8	7'4"	SW	109.6	3.7	80.8		
EB-9	15'5"	SM	108.3	11.1	79.8	92	40
EB-9	19'10"	SM	118.7	5.9	87.5		
EB-10	8'4"	SM	103.2	9.3	76.1	93	48
EB-10	7'10"	SM	105.4	8.1	77.7	96	42
EB-10	13'5"	SM	101.1	9.4	74.5		
EB-11	12'5"	SM	96.9	8.2	71.4		
EB-12	8'3"	SM	114.2	9.1	84.2		
EB-13	8'4"	SM	94.7	8.8	69.8		

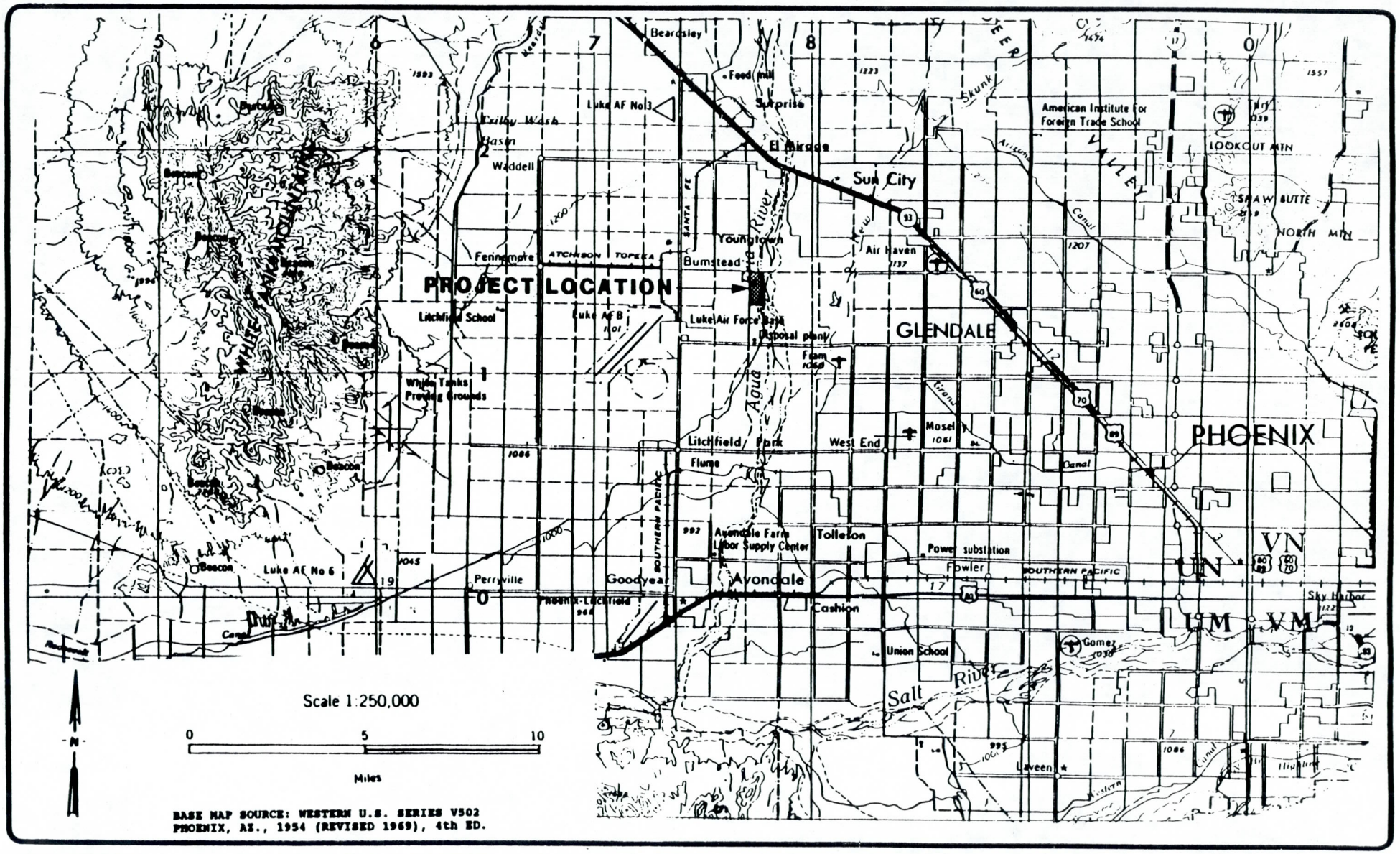
STRENGTH TEST RESULTS (CU TEST)

Boring No.	Depth (ft)	USCS	Dry Density (pcf)	w/c (%)	Confining Pressure (psf)	p @5% (psf)	q @5% (psf)	u @5% (psf)
EB-6	8'5"	SM	105.9	9.5	1008	1685	778	101
EB-6	12'10"	SM	96.0	8.0	1296	994	374	677
EB-10	8'4"	SM	103.2	9.3	720	1771	979	-72

CONSOLIDATION TEST RESULTS

Boring No.	Depth (ft)	USCS	Dry Density (pcf)	w/c (%)	Cc	Pp (psf)	COLLAPSE (%)	CONF. PRESS. @ COLLAPSE (psf)
EB-9	15'5"	SM	108.3	11.1	0.10	3400	0.19	1000
EB-10	7'10"	SM	105.4	8.1	0.09	1900	0.67	1000

FIGURES



BASE MAP SOURCE: WESTERN U.S. SERIES V502
PHOENIX, AZ., 1954 (REVISED 1969), 4th ED.

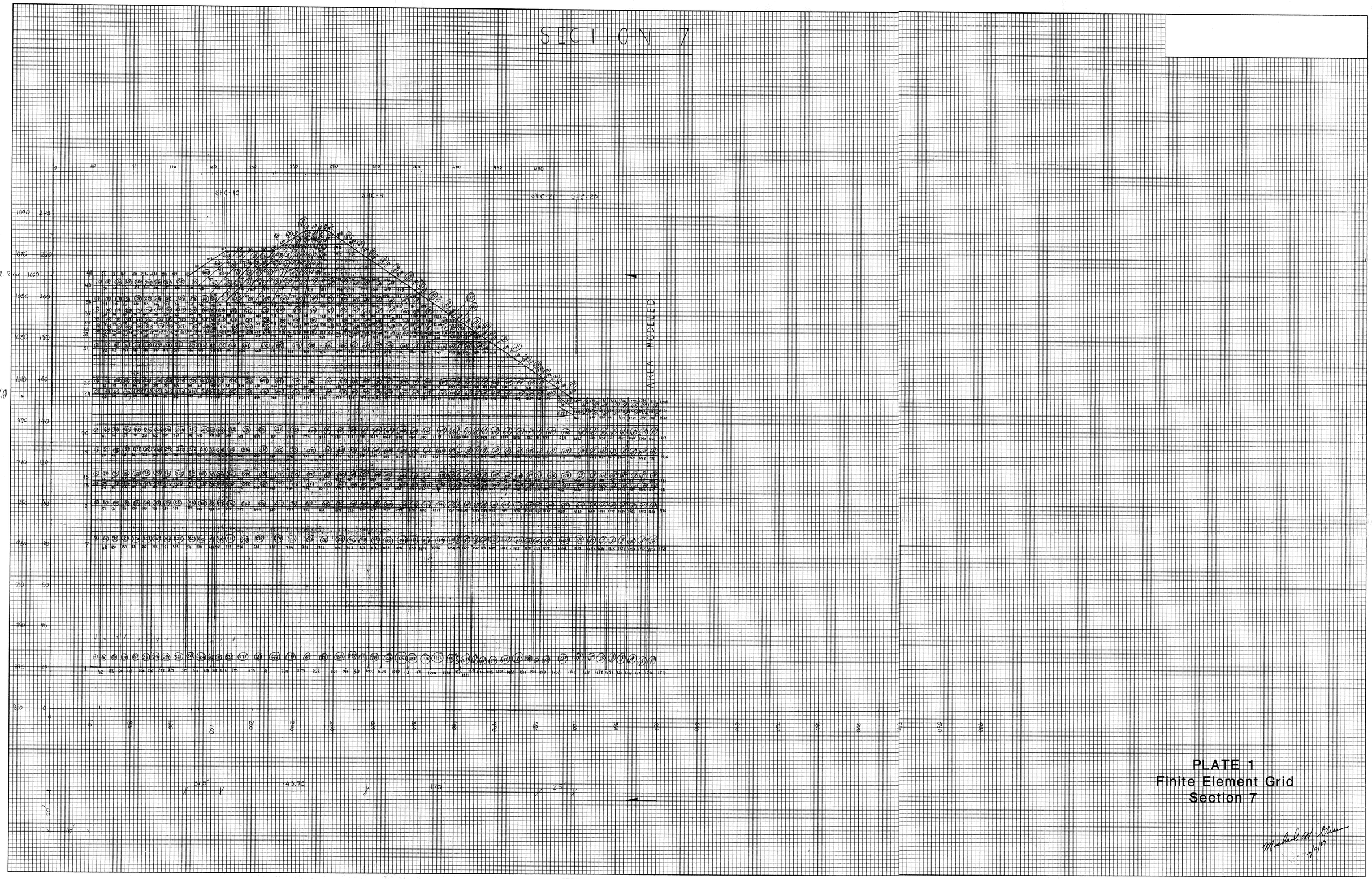
EMCON Associates

ASSESSMENT OF RIVER BANK BREACH BACKFILL MATERIALS
PROPOSED CHOLLA LANDFILL SITE
EL MIRAGE, ARIZONA

LOCATION MAP

FIGURE 1

PROJECT NO 372-15.05



FINAL SURVEY		BY	DATE
NOTE BOOK	SURVEYED		
	PLOTTED		
	TRACED		
	AREAS		
NO.	AREAS CHECKED		

ORIGINAL SURVEY		BY	DATE
NOTE BOOK	SURVEYED		
	PLOTTED		
	TRACED		
	AREAS		
NO.	AREAS CHECKED		

PLATE 1
Finite Element Grid
Section 7

Keuffel & Esser Company PLATE 3, CROSS SECTION 487072 Made in U.S.A.

SECTION 8

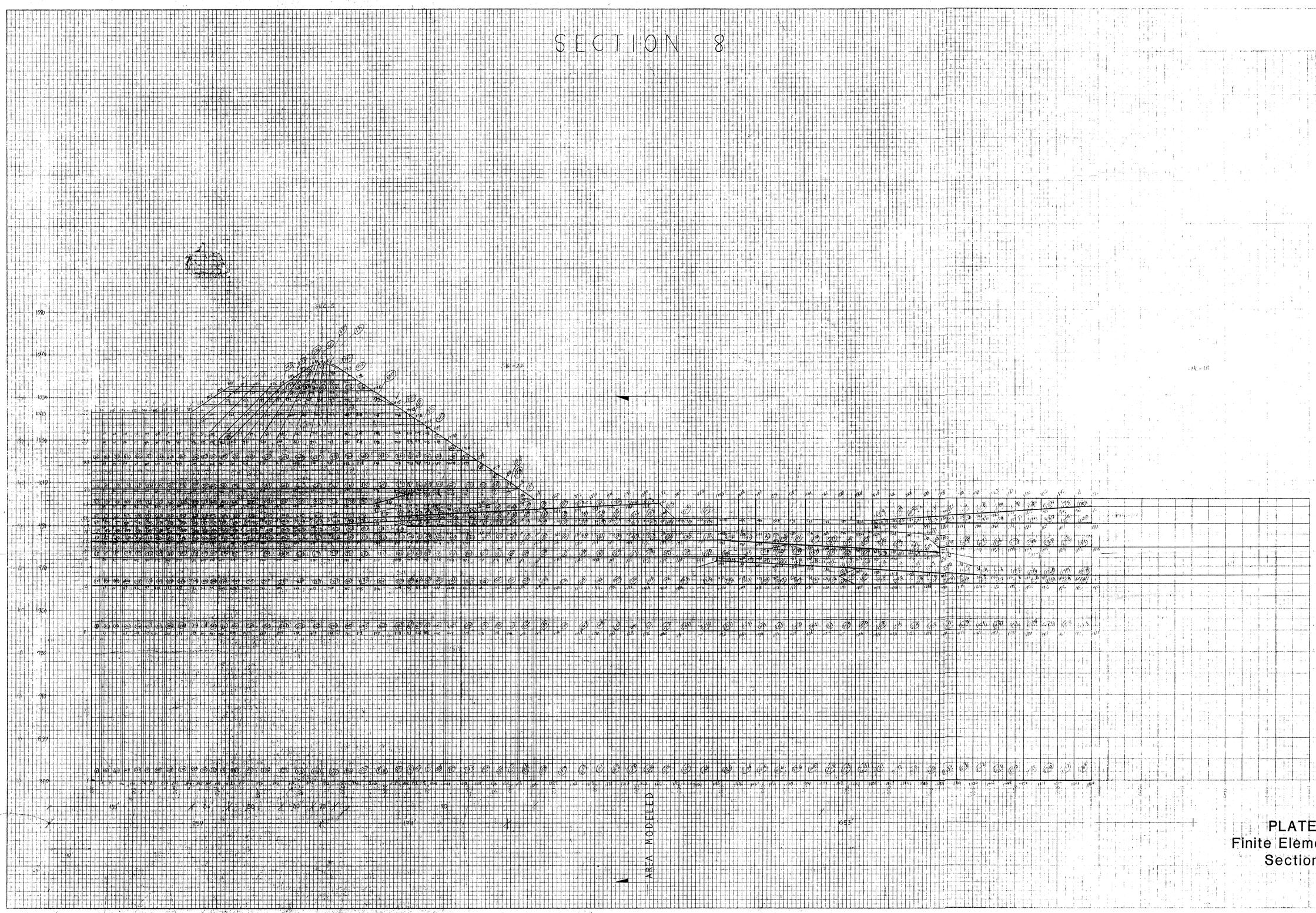


PLATE 2
Finite Element Grid
Section 8

Keuffel & Esser Company PLATE 3, CROSS SECTION 487052 Made in U.S.A.

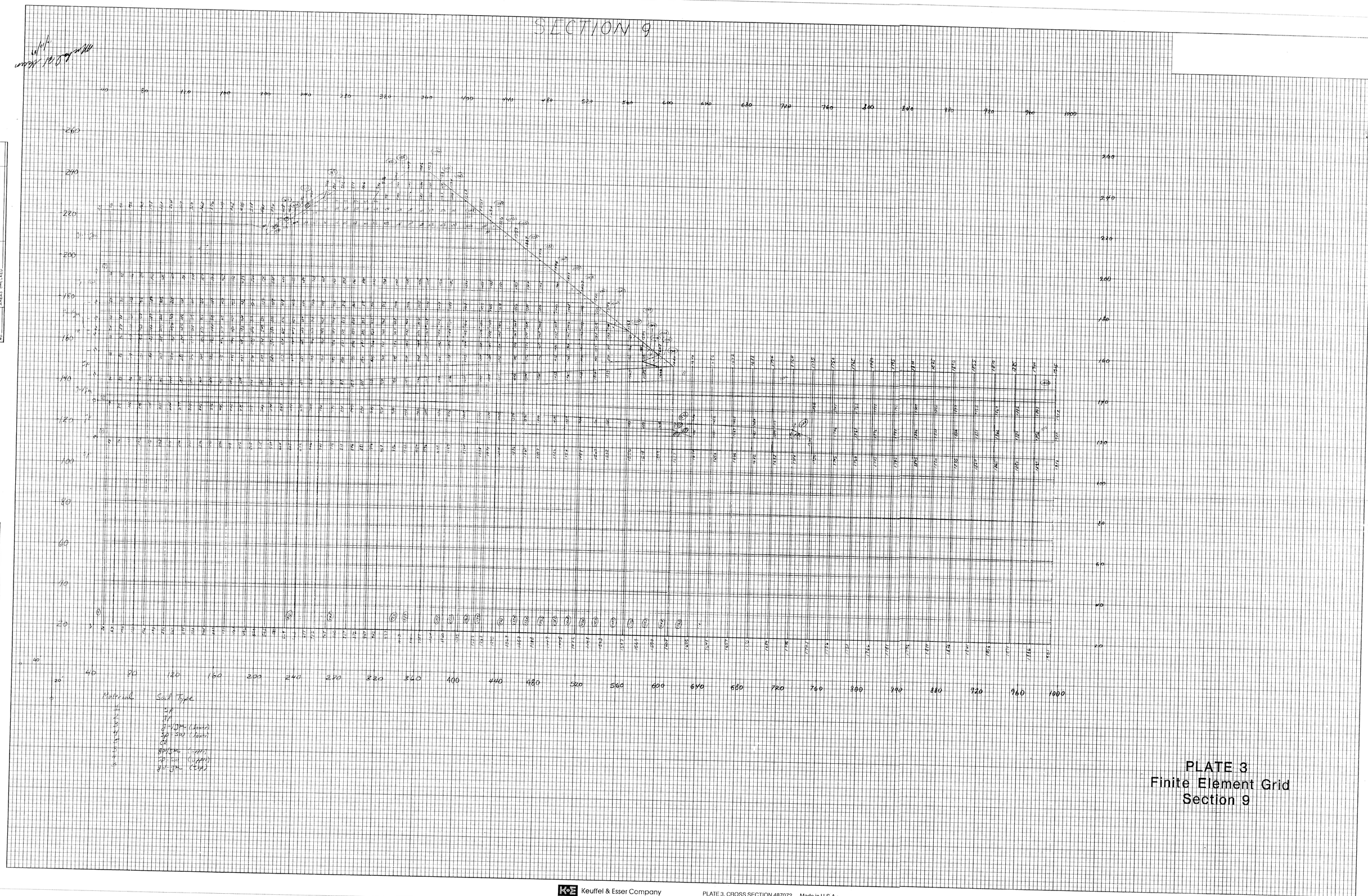
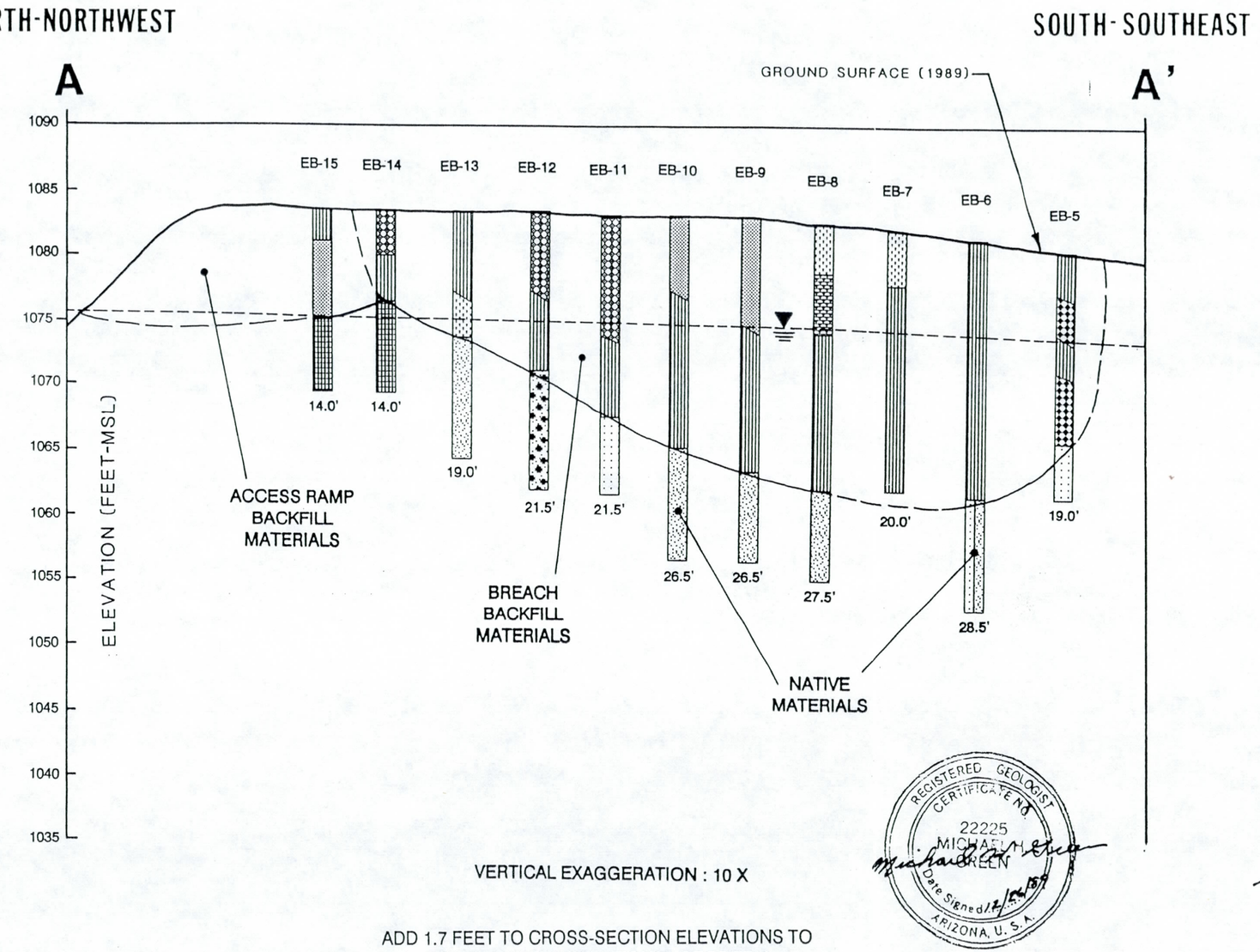


PLATE 3
Finite Element Grid
Section 9

Keuffel & Esser Company
PLATE 3, CROSS SECTION 487072 Made in U.S.A.

124279



LEGEND

- SILTY SAND FILL, SOME GRAVEL (SM)
- SAND WITH GRAVEL, TRACE SILT (SP)
- GRAVELLY SAND FILL WITH SILT (SP-SM)
- SAND FILL WITH GRAVEL, SOME SILT, SOME CLAY (SP-SC)
- SILTY SAND AND GRAVEL FILL, SOME COBBLES (SM-GM)
- GRAVELLY SAND, SOME SILT (SW-SM)
- GRAVELLY SAND FILL (SP)
- SAND WITH SILT, TRACE GRAVEL (SM)
- SAND AND GRAVEL, SOME COBBLES (SW-GW)
- SILTY SAND FILL WITH GRAVEL TRACE COBBLES (SM)
- BACKFILL CONTACT: SOLID WHERE KNOWN, DASHED WHERE INFERRED, BREACH CONTACT PROJECTED TO SURFACE BASED ON FIELD RECONNAISSANCE
- WATER SURFACE, APPROXIMATELY 100 YEAR FLOOD

EMCON Associates

0 100 200 300 FEET
HORIZONTAL SCALE

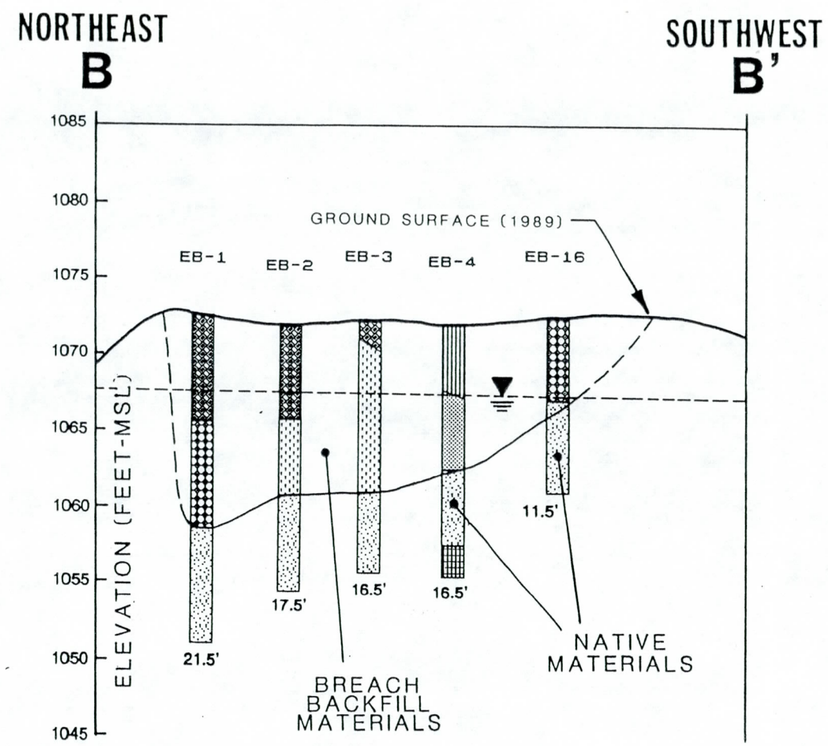
ASSESSMENT OF RIVER BANK BREACH BACKFILL MATERIALS
PROPOSED CHOLLA LANDFILL
EL MIRAGE, ARIZONA

CROSS- SECTION OF ENTRANCE BREACH

FIGURE 3

PROJECT NO. 372-15.05

124279



LEGEND

- SILTY SAND FILL WITH GRAVEL (SM)
- GRAVELLY SAND FILL, SOME SILT (SP-SM)
- SILTY SAND AND GRAVEL FILL WITH COBBLES (SM-GM)
- GRAVELLY SAND (SP-SW)
- SILTY SAND FILL, SOME GRAVEL, TRACE COBBLES (SM)
- SAND, GRAVEL AND COBBLE FILL (GP-GM)
- SILTY SAND, SOME GRAVEL (SM)
- BACKFILL CONTACT: SOLID WHERE KNOWN, DASHED WHERE INFERRED. SURFACE CONTACT BASED ON FIELD RECONNAISSANCE
- WATER SURFACE, APPROXIMATELY 100 YEAR FLOOD

REGISTERED GEOLOGIST
CERTIFICATE NO.
22225
MICHAEL
GREEN
Date Signed 12/26/89
ARIZONA, U.S.A.

VERTICAL EXAGGERATION: 10X

ADD 1.7 FEET TO CROSS-SECTION ELEVATIONS TO CONFORM TO THE NATIONAL GEODETIC VERTICAL DATUM, 1929

EMCON Associates

0 100 200 300 FEET
HORIZONTAL SCALE

ASSESSMENT OF RIVER BANK BREACH
BACKFILL MATERIALS
PROPOSED CHOLLA LANDFILL
EL MIRAGE, ARIZONA

CROSS SECTION OF EXIT BREACH

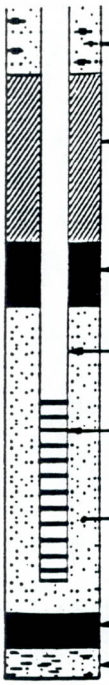
FIGURE
4
PROJECT NO.
372-15.05

APPENDIX A

EXPLORATORY BORING LOGS

EXPLANATION OF SYMBOLS ON EXPLORATORY BORING LOGS

Well Details Column



CONCRETE

BENTONITE-CEMENT GROUT OR NEAT CEMENT GROUT

BENTONITE

} SURFACE SEAL

WELL CASING

WELL SCREEN

FILTER PACK

BENTONITE

NATIVE MATERIAL SLOUGH

} BOTTOM SEAL

Sample Column

BAG/BULK SAMPLES

FIVE-FOOT SPLIT BARREL SAMPLER (CONTINUOUS SAMPLER)

MODIFIED CALIFORNIA SPLIT SPOON (3" O.D.)

OTHER SAMPLERS (SEE REMARKS FOR TYPE AND SIZE)

PITCHER BARREL

ROCK CORE (SEE REMARKS FOR TYPE AND SIZE)

SHELBY TUBE SAMPLER

STANDARD PENETRATION TEST SPLIT SPOON SAMPLER (2" OD)

(OVER)

LOG OF EXPLORATORY BORING

PROJECT NUMBER **372-15.05** BORING NO. **EB-1**

PROJECT NAME **River Bank Breach Backfill Evaluation** PAGE **1 OF 2**

BY **Michael Dennis** DATE **8/4/89** SURFACE ELEV. **1072.66 ft.**

SAMPLE RECOVERY (inches)		PENETRATION (blws/ft)	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOGRAPHIC COLUMN	DESCRIPTION	WELL DETAIL
							SAND, GRAVEL, AND COBBLE FILL (SW-GW), light brown (7.5YR, 6/4); 40% fine sand; 35% fine to coarse gravel; 25% cobbles; dense; damp; well graded; subangular to angular.	
NR		50/0.3						
NR		50/0.5		5				
NR		50/0.1					**SILTY SAND AND GRAVEL FILL WITH COBBLES** (SM-GM), brown (7.5YR, 5/4); 40% fine to medium sand; 25% fine to medium gravel; 20% silt; 15% cobbles; medium dense to dense; moist; poorly graded; subangular.	
7		23		10				
NR		50/0.4						
13		34		15			**GRAVELLY SAND, SOME COBBLES** (SW), yellowish brown (10YR, 5/4); 55% fine to coarse sand; 30% fine to coarse gravel; 15% cobbles; dense; moist; well graded; subrounded.	
NR		50/0.1						
				20				

REMARKS

Bulk sample collected from 5 feet to 14 feet. On all LOGS OF EXPLORATORY BORINGS, only the blow counts for the bottom 12 inches were recorded. Boring EB-1 was backfilled to the surface with gravel/cement grout.

EMCON ASSOCIATES

LOG OF EXPLORATORY BORING

PROJECT NUMBER **372-15.05** BORING NO. **EB-1**

PROJECT NAME **River Bank Breach Backfill Evaluation** PAGE **2 OF 2**

BY **Michael Dennis** DATE **8/4/89** SURFACE ELEV. **1072.66 ft.**

SAMPLE RECOVERY (inches)		PENETRATION (blws/ft)	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOGRAPHIC COLUMN	DESCRIPTION	WELL DETAIL
11		44					BORING TERMINATED AT 21.5 FEET	
				25				
				30				
				35				
				40				

REMARKS

Bulk sample collected from 5 feet to 14 feet. On all LOGS OF EXPLORATORY BORINGS, only the blow counts for the bottom 12 inches were recorded. Boring EB-1 was backfilled to the surface with gravel/cement grout.

EMCON ASSOCIATES

LOG OF EXPLORATORY BORING

PROJECT NUMBER **372-15.05** BORING NO. **EB-2**

PROJECT NAME **River Bank Breach Backfill Evaluation** PAGE **1 OF 1**

BY **Michael Dennis** DATE **8/4/89** SURFACE ELEV. **1071.86 ft.**

SAMPLE RECOVERY (inches)		PENETRATION (blws/ft)	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOGRAPHIC COLUMN	DESCRIPTION	WELL DETAIL
12		35					**SAND, GRAVEL, AND COBBLE FILL, SOME SILT** (GP-GM), dark yellowish brown (10YR, 3/4); 35% fine to medium sand; 35% fine to coarse gravel; 20% cobbles; 10% silt; dense; moist; poorly graded; subangular.	
5		27		5				
12		25					**SILTY SAND FILL, SOME GRAVEL, TRACE COBBLES** (SM), dark yellowish brown (10YR, 4/6); 50% fine sand; 30% silt; 15% fine to coarse gravel; 5% cobbles; medium dense; damp; poorly graded; subangular to subrounded.	
12		11		10				
14		99					**GRAVELLY SAND, SOME COBBLES** (SP), yellowish brown (10YR, 5/4); 50% fine to coarse sand; 30% fine to coarse gravel; 20% cobbles; very dense; moist; poorly graded; subrounded.	
12		61		15				
NR		50/0.2					**BORING TERMINATED AT 17.5 FEET**	
				20				

REMARKS

Bulk sample collected from 0 to 10 feet. Boring EB-2 was backfilled to the surface with gravel/cement grout.

EMCON ASSOCIATES

LOG OF EXPLORATORY BORING

PROJECT NUMBER **372-15.05** BORING NO. **EB-3**

PROJECT NAME **River Bank Breach Backfill Evaluation** PAGE **1 OF 1**

BY **Michael Dennis** DATE **8/4/89** SURFACE ELEV. **1072.1 ft.**

SAMPLE RECOVERY (inches)		PENETRATION (blws/ft)	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOGRAPHIC COLUMN	DESCRIPTION	WELL DETAIL
							SAND, GRAVEL, AND COBBLE FILL (GP), light brown (7.5YR, 6/4); 40% fine to medium sand; 35% fine to coarse gravel; 25% cobbles; medium dense; damp; subangular.	
11		10					**SILTY SAND FILL, SOME GRAVEL, TRACE COBBLES** (SM), yellowish brown (10YR, 5/6); 50% fine sand; 35% silt; 10% fine gravel; 5% cobbles; loose to medium dense; damp to moist; poorly graded; subangular.	
7		13		5				
5		9						
22		15		10				
							GRAVELLY SAND, SOME COBBLES (SP), yellowish brown (10YR, 5/4); 55% fine to medium sand; 30% fine to coarse gravel; 15% cobbles; medium dense; damp to moist; poorly graded; subrounded.	
1		31						
2		25		15				
							BORING TERMINATED AT 16.5 FEET	
				20				

REMARKS

Bulk sample collected from 0 to 11 feet. Boring EB-3 was backfilled to the surface with gravel/cement grout.

EMCON ASSOCIATES

LOG OF EXPLORATORY BORING

PROJECT NUMBER **372-15.05** BORING NO. **EB-4**

PROJECT NAME **River Bank Breach Backfill Evaluation** PAGE **1 OF 1**

BY **Michael Dennis** DATE **8/4/89** SURFACE ELEV. **1071.71 ft.**

SAMPLE RECOVERY (inches)		PENETRATION (blws/ft)	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOGRAPHIC COLUMN	DESCRIPTION	WELL DETAIL
							SILTY SAND FILL WITH GRAVEL (SM), light brown (7.5YR, 6/4); 50% fine sand; 35% silt; 15% fine to medium gravel; medium dense; damp; poorly graded; subangular.	
10		25						
12		25		5			**GRAVELLY SAND FILL, SOME SILT** (SP-SM), pale brown (10YR, 6/3); 60% fine to medium sand; 30% fine to medium gravel; 10% silt; medium dense; damp; cohesionless; subangular.	
6		18						
4		23		10			**GRAVELLY SAND, SOME COBBLES** (SW), yellowish brown (10YR, 5/4); 55% fine to coarse sand; 35% fine to medium gravel; 10% cobbles; medium dense; damp; well graded; cohesionless; subrounded to rounded.	
9		16						
10		14		15			**SILTY SAND, SOME GRAVEL** (SM), brown (10YR, 5/3); 45% fine sand; 35% silt; 20% fine gravel; medium dense; damp; poorly graded; subangular.	
							BORING TERMINATED AT 16.5 FEET	
				20				

REMARKS

Bulk sample collected from 0 to 9 feet. Boring EB-4 was backfilled to the surface with gravel/cement grout.

EMCON ASSOCIATES

LOG OF EXPLORATORY BORING

PROJECT NUMBER **372-15.05** BORING NO. **EB-5**

PROJECT NAME **River Bank Breach Backfill Evaluation** PAGE **1 OF 1**

BY **Michael Dennis** DATE **8/5/89** SURFACE ELEV. **1080.27 ft.**

SAMPLE RECOVERY (inches)		PENETRATION (blws/ft)	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOGRAPHIC COLUMN	DESCRIPTION	WELL DETAIL
12		17					**SILTY SAND FILL, SOME GRAVEL** (SM), light yellowish brown (10YR, 6/4); 50% fine sand; 40% silt: 10% fine gravel; medium dense; moist; poorly graded; subangular.	
12		33		5			**SAND FILL WITH GRAVEL, SOME SILT, SOME CLAY** (SC), dark grayish brown (10YR, 4/2); 55% fine to coarse sand; 30% fine gravel; 10% low plasticity clay; 5% silt; dense; moist; poorly graded; subangular.	
14		53					**SILTY SAND FILL, SOME GRAVEL ,TRACE CLAY** (SM), light yellowish brown (10YR, 6/4); 50% fine sand; 40% silt; 10% fine gravel; dense; moist; poorly graded; subangular.	
9		21		10			**SAND FILL WITH GRAVEL, SOME SILT** (SP-SM), dark grayish brown (10YR, 4/2); 65% fine to medium sand; 25% fine gravel; 10% silt; loose to medium dense; moist; poorly graded; subrounded.	
6		16						
12		10		15			**SAND WITH GRAVEL, TRACE SILT** (SP), grayish brown (10YR, 5/2); 65% fine to medium sand; 30% fine gravel; 5% silt; loose to dense; damp; subrounded.	
12		45					10% low plasticity clay.	
				20			**BORING TERMINATED AT 19.0 FEET**	

REMARKS

Bulk sample collected from 4 feet to 9 feet. Boring EB-5 was backfilled to the surface with gravel/cement grout.

EMCON ASSOCIATES

LOG OF EXPLORATORY BORING

PROJECT NUMBER 372-15.05 | BORING NO. EB-6

PROJECT NAME **River Bank Breach Backfill Evaluation** | PAGE 1 OF 2

BY **Michael Dennis** DATE 8/5/89 | SURFACE ELEV. 1081.24 ft.

SAMPLE RECOVERY (inches)		PENETRATION (blws/ft)	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOGRAPHIC COLUMN	DESCRIPTION	WELL DETAIL
13		13					**SILTY SAND FILL, SOME GRAVEL** (SM), light yellowish brown (10YR, 6/4); 50% fine sand; 40% silt; 10% fine gravel; loose to medium dense; moist; poorly graded; subangular.	
11		13		5				
16		23						
14		14		10				
15		42						
		14		15			50% fine sand; 25% silt; 25% fine gravel.	
NR		66/0.8						
				20				

REMARKS

Bulk sample collected from 2 feet to 15 feet. Boring EB-6 was backfilled to the surface with gravel/cement grout.

EMCON ASSOCIATES

LOG OF EXPLORATORY BORING

PROJECT NUMBER **372-15.05** BORING NO. **EB-6**

PROJECT NAME **River Bank Breach Backfill Evaluation** PAGE **2 OF 2**

BY **Michael Dennis** DATE **8/5/89** SURFACE ELEV. **1081.24 ft.**

SAMPLE RECOVERY (inches)		PENETRATION (blws/ft)	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOGRAPHIC COLUMN	DESCRIPTION	WELL DETAIL
9		22					**GRAVELLY SAND, TRACE SILT** (SP/SW), dark grayish brown (10YR, 4/2); 60% fine to coarse sand; 35% fine to medium gravel; 5% silt; medium dense; moist; well graded; subrounded.	
9		14						
6		16		25				
6		82/0.7						
							BORING TERMINATED AT 28.5 FEET	
				30				
				35				
				40				

REMARKS

Bulk sample collected from 2 feet to 15 feet. Boring EB-6 was backfilled to the surface with gravel/cement grout.

EMCON ASSOCIATES

LOG OF EXPLORATORY BORING

PROJECT NUMBER **372-15.05** BORING NO. **EB-7**

PROJECT NAME **River Bank Breach Backfill Evaluation** PAGE **1 OF 1**

BY **Michael Dennis** DATE **8/5/89** SURFACE ELEV. **1081.91 ft.**

SAMPLE RECOVERY (inches)		PENETRATION (blws/ft)	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOGRAPHIC COLUMN	DESCRIPTION	WELL DETAIL
11		45					**SILTY SAND FILL WITH GRAVEL, TRACE COBBLES** (SM), light yellowish brown (10YR, 6/4); 45% fine to medium sand; 30% silt; 20% fine gravel; 5% cobbles; loose to dense; moist; poorly graded; subangular. 45% fine to medium sand; 25% fine gravel; 20% silt; 10% cobbles	
8		8		5			**SILTY SAND FILL, SOME GRAVEL** (SM), light yellowish brown (10YR, 6/4); 50% fine sand; 40% silt; 10% fine gravel; loose to medium dense; moist; poorly graded; subangular	
17		19						
11		16		10			50% fine sand; 25% silt; 15% fine gravel; 10% cobbles.	
15		30						
13		16		15			gravel layer less than 1 foot thick at 16.5 feet.	
8		58					**AUGER REFUSAL AT 20.0 FEET ON HEAVY CEMENTATION**	
NR		25/0.1		20			**BORING TERMINATED AT 20.0 FEET**	

REMARKS

Bulk sample collected from 4 feet to 18 feet. Boring EB-7 was backfilled to the surface with gravel/cement grout.

EMCON ASSOCIATES

LOG OF EXPLORATORY BORING

PROJECT NUMBER **372-15.05** BORING NO. **EB-8**

PROJECT NAME **River Bank Breach Backfill Evaluation** PAGE **1 OF 2**

BY **Michael Dennis** DATE **8/5/89** SURFACE ELEV. **1082.5 ft.**

SAMPLE RECOVERY (inches)		PENETRATION (blws/ft)	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOGRAPHIC COLUMN	DESCRIPTION	WELL DETAIL
9		35					**SILTY SAND FILL WITH GRAVEL, TRACE COBBLES** (SM), light yellowish brown (10YR, 6/4); 50% fine to medium sand; 35% silt; 10% fine gravel; 5% cobbles; dense; moist; poorly graded; subangular.	
NR		50/0.3					asphaltic concrete debris	
8		24		5			**GRAVELLY SAND FILL** (SP), light grayish brown (10YR, 6/2); 60% fine to coarse sand; 40% fine to medium gravel; medium dense to dense; moist; poorly graded; subangular; contains asphaltic concrete debris.	
9		40						
7		18		10			**SILTY SAND FILL, SOME GRAVEL** (SM), light yellowish brown (10YR, 6/4); 50% fine sand; 30% silt; 20% fine to medium gravel; medium dense to dense; moist; poorly graded; subangular.	
15		50						
9		18		15				
10		49						
				20				

REMARKS

Bulk sample collected from 4 feet to 18 feet. Boring EB-8 was backfilled to the surface with gravel/cement grout.

EMCON ASSOCIATES

LOG OF EXPLORATORY BORING

PROJECT NUMBER **372-15.05** BORING NO. **EB-8**

PROJECT NAME **River Bank Breach Backfill Evaluation** PAGE **2 OF 2**

BY **Michael Dennis** DATE **8/5/89** SURFACE ELEV. **1082.5 ft.**

SAMPLE RECOVERY (inches)		PENETRATION (blws/ft)	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOGRAPHIC COLUMN	DESCRIPTION	WELL DETAIL
7		97/0.8					**GRAVELLY SAND, SOME SILT** (SW-SM), reddish brown (5YR, 4/3); 55% fine to coarse sand; 35% fine to medium gravel; 10% silt; dense; moist; well graded; subrounded.	
10		34					heavily cemented from 19.5 feet to 21.5 feet.	
10		37		25			55% fine to coarse sand; 35% fine to medium gravel; 5% silt; 5% low plasticity clay.	
NR		50/0.1					**BORING TERMINATED AT 27.5 FEET**	
				30				
				35				
				40				

REMARKS

Bulk sample collected from 4 feet to 18 feet. Boring EB-8 was backfilled to the surface with gravel/cement grout.

EMCON ASSOCIATES

LOG OF EXPLORATORY BORING

PROJECT NUMBER **372-15.05** BORING NO. **EB-9**

PROJECT NAME **River Bank Breach Backfill Evaluation** PAGE **1 OF 2**

BY **Michael Dennis** DATE **8/5/89** SURFACE ELEV. **1082.88 ft.**

SAMPLE RECOVERY (inches)		PENETRATION (blws/ft)	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOGRAPHIC COLUMN	DESCRIPTION	WELL DETAIL
9		31					**GRAVELLY SAND FILL WITH SILT** (SM), light reddish brown (5YR, 6/4); 45% fine to coarse sand; 35% fine to medium gravel; 20% silt; medium dense to dense; damp; poorly graded	
NR		50/0.3						
9		21		5			45% fine to coarse sand; 30% silt; 25% gravel.	
							gravel and cobble layer less than 1.5 feet thick.	
NR		100/0.3						
10		24		10			**SILTY SAND FILL, SOME GRAVEL** (SM), light yellowish brown (10YR, 6/4); 55% fine sand; 30% silt; 15% fine to medium gravel; medium dense; moist; poorly graded; subangular.	
6		21						
16		29		15				
14		16						
				20				

REMARKS

Bulk sample collected from 6 feet to 19 feet. Boring EB-9 was backfilled to the surface with gravel/cement grout.

EMCON ASSOCIATES

LOG OF EXPLORATORY BORING

PROJECT NUMBER 372-15.05 BORING NO. EB-9

PROJECT NAME River Bank Breach Backfill Evaluation PAGE 2 OF 2

BY Michael Dennis DATE 8/5/89 SURFACE ELEV. 1082.88 ft.

SAMPLE RECOVERY (inches)		PENETRATION (blws/ft)	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOGRAPHIC COLUMN	DESCRIPTION	WELL DETAIL
NR		98/0.7					**GRAVELLY SAND, SOME COBBLES, TRACE CLAY** (SW), reddish brown (5YR, 4/3); 55% fine to coarse sand; 30% fine to coarse gravel; 10% cobbles; 5% low plasticity clay; very dense; moist; well graded; subrounded.	
4		83/0.7					heavily cemented from 19.5 feet to 21.0 feet.	
8		40		25				
							BORING TERMINATED AT 26.5 FEET	
				30				
				35				
				40				

REMARKS

Bulk sample collected from 6 feet to 19 feet. Boring EB-9 was backfilled to the surface with gravel/cement grout.

EMCON ASSOCIATES

LOG OF EXPLORATORY BORING

PROJECT NUMBER **372-15.05** BORING NO. **EB-10**

PROJECT NAME **River Bank Breach Backfill Evaluation** PAGE **1 OF 2**

BY **Michael Dennis** DATE **8/6/89** SURFACE ELEV. **1082.94 ft.**

SAMPLE RECOVERY (inches)		PENETRATION (blws/ft)	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOGRAPHIC COLUMN	DESCRIPTION	WELL DETAIL
8		17					**GRAVELLY SAND FILL WITH SILT** (SM), reddish brown (10YR, 4/4); 45% fine to coarse sand; 35% fine to medium gravel; 20% silt; medium dense; moist; poorly graded; subangular.	
4		20		5			40% fine to coarse sand; 30% fine to medium gravel; 20% silt; 10% cobbles.	
15		13					**SILTY SAND FILL, SOME GRAVEL** (SM), light yellowish brown (10YR, 6/4); 55% fine to medium sand; 30% silt; 15% fine to medium gravel; loose to medium dense; moist; poorly graded; subangular.	
NR		24		10				
17		19						
10		18		15				
4		96/0.5					**GRAVELLY SAND, SOME COBBLES, TRACE CLAY** (SW), reddish brown (5YR, 5/3); 55% fine to coarse sand; 30% fine to coarse gravel; 10% cobbles; 5% low plasticity clay; very dense;	
				20				

REMARKS

Bulk sample collected from 4 feet to 17 feet. Boring EB-10 was backfilled to the surface with gravel/cement grout.

EMCON ASSOCIATES

LOG OF EXPLORATORY BORING

PROJECT NUMBER 372-15.05 BORING NO. EB-10

PROJECT NAME **River Bank Breach Backfill Evaluation** PAGE 2 OF 2

BY **Michael Dennis** DATE **8/6/89** SURFACE ELEV. 1082.94 ft.

SAMPLE RECOVERY (inches)		PENETRATION (blws/ft)	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOGRAPHIC COLUMN	DESCRIPTION	WELL DETAIL
5		65/0.9					moist; well graded; subangular to subrounded.	
13		53						
12		41		25			55% fine to coarse sand; 30% fine to coarse gravel; 15% cobbles.	
							BORING TERMINATED AT 26.5 FEET	
				30				
				35				
				40				

REMARKS

Bulk sample collected from 4 feet to 17 feet. Boring EB-10 was backfilled to the surface with gravel/cement grout.

EMCON ASSOCIATES

LOG OF EXPLORATORY BORING

PROJECT NUMBER **372-15.05** BORING NO. **EB-11**

PROJECT NAME **River Bank Breach Backfill Evaluation** PAGE **1 OF 2**

BY **Michael Dennis** DATE **8/6/89** SURFACE ELEV. **1083.06 ft.**

SAMPLE RECOVERY (inches)		PENETRATION (blws/ft)	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOGRAPHIC COLUMN	DESCRIPTION	WELL DETAIL
11		26					**SILTY SAND AND GRAVEL FILL, SOME COBBLES** (SM-GM), yellowish brown (10YR, 5/4); 55% fine to medium sand; 30% fine gravel; 15% silt; medium dense; damp; poorly graded; subangular.	
12		27		5			asphaltic concrete debris	
8		20					asphaltic concrete debris	
17		19		10			**SILTY SAND FILL, SOME GRAVEL** (SM), yellowish brown (10YR, 5/4); 55% fine to medium sand; 35% silt; 10% fine to medium gravel; medium dense; moist; poorly graded; subangular.	
7		84/0.8						
6		35		15			**GRAVELLY SAND, SOME COBBLES** (SP), strong brown (7.5YR, 5/4); 60% fine to medium sand; 30% fine to medium gravel; 10% cobbles; dense; moist; poorly graded; subangular to subrounded.	
9		44						
				20				

REMARKS

Bulk sample collected from 2 feet to 9 feet. Boring EB-11 was backfilled to the surface with gravel/cement grout.

EMCON ASSOCIATES

LOG OF EXPLORATORY BORING

PROJECT NUMBER 372-15.05 BORING NO. EB-11

PROJECT NAME River Bank Breach Backfill Evaluation PAGE 2 OF 2

BY Michael Dennis DATE 8/6/89 SURFACE ELEV. 1083.06 ft.

SAMPLE RECOVERY (inches)		PENETRATION (blws/ft)	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOGRAPHIC COLUMN	DESCRIPTION	WELL DETAIL
8		43					BORING TERMINATED AT 21.5 FEET	
				25				
				30				
				35				
				40				

REMARKS

Bulk sample collected from 2 feet to 9 feet. Boring EB-11 was backfilled to the surface with gravel/cement grout.

EMCON ASSOCIATES

LOG OF EXPLORATORY BORING

PROJECT NUMBER **372-15.05** BORING NO. **EB-12**

PROJECT NAME **River Bank Breach Backfill Evaluation** PAGE **1 OF 2**

BY **Michael Dennis** DATE **8/6/89** SURFACE ELEV. **1083.32 ft.**

SAMPLE RECOVERY (inches)		PENETRATION (blws/ft)	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOGRAPHIC COLUMN	DESCRIPTION	WELL DETAIL
9		29					**SILTY SAND AND GRAVEL FILL, SOME COBBLES** (SM-GM), yellowish brown (10YR, 5/4); 55% fine to coarse sand; 30% fine to medium gravel; 15% silt; medium dense; damp; poorly graded; subangular.	
6		16		5				
10		27					**SILTY SAND FILL, SOME GRAVEL** (SM), yellowish brown (10YR, 5/4); 55% fine to medium sand; 35% silt; 10% fine to coarse gravel; medium dense; moist; poorly graded; subangular; contains asphaltic concrete debris.	
4		14		10				
8		48					**SAND AND GRAVEL, SOME COBBLES** (SW-GW), strong brown (7.5YR, 5/6); 50% fine to coarse sand; 40% fine to coarse gravel; 10% cobbles; dense; moist; well graded; subrounded.	
3		50		15				
5		39/0.9					40% fine to coarse sand; 40% fine to coarse gravel; 20% cobbles.	
				20				

REMARKS

Bulk sample collected from 6 feet to 12 feet. Boring EB-12 was backfilled to the surface with gravel/cement grout.

EMCON ASSOCIATES

LOG OF EXPLORATORY BORING

PROJECT NUMBER **372-15.05** BORING NO. **EB-12**

PROJECT NAME **River Bank Breach Backfill Evaluation** PAGE **2 OF 2**

BY **Michael Dennis** DATE **8/6/89** SURFACE ELEV. **1083.32 ft.**

SAMPLE RECOVERY (inches)		PENETRATION (blws/ft)	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOGRAPHIC COLUMN	DESCRIPTION	WELL DETAIL
8		29					**BORING TERMINATED AT 21.5 FEET**	
				25				
				30				
				35				
				40				

REMARKS

Bulk sample collected from 6 feet to 12 feet. Boring EB-12 was backfilled to the surface with gravel/cement grout.

EMCON ASSOCIATES

LOG OF EXPLORATORY BORING

PROJECT NUMBER 372-15.05 BORING NO. EB-13

PROJECT NAME River Bank Breach Backfill Evaluation PAGE 1 OF 1

BY Michael Dennis DATE 8/6/89 SURFACE ELEV. 1083.27 ft.

SAMPLE RECOVERY (inches)		PENETRATION (blws/ft)	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOGRAPHIC COLUMN	DESCRIPTION	WELL DETAIL
10		24					**SILTY SAND FILL WITH GRAVEL, SOME COBBLES** (SM), yellowish brown (10YR, 5/4); 55% fine to medium sand; 25% fine to medium gravel; 15% silt; 5% cobbles; medium dense; damp; poorly graded; subangular.	
10		13		5			asphaltic concrete debris.	
23		32					**SILTY SAND FILL WITH GRAVEL** (SM), yellowish brown (10YR, 5/4); 50% fine to medium sand; 30% silt; 20% fine to medium gravel; medium dense to dense; moist;poorly graded; subangular.	
9		8		10			**SAND, SOME GRAVEL** (SW), strong brown 7.5YR, 5/6); 85% fine to coarse sand; 15% fine to medium gravel; medium dense; moist; cohesionless; well graded; subrounded.	
10		23						
11		33		15				
12		30						
				20			**BORING TERMINATED AT 19.0 FEET**	

REMARKS

Bulk sample collected from 3 feet to 9 feet. Boring EB-13 was backfilled to the surface with gravel/cement grout.

EMCON ASSOCIATES

LOG OF EXPLORATORY BORING

PROJECT NUMBER **372-15.05** BORING NO. **EB-14**

PROJECT NAME **River Bank Breach Backfill Evaluation** PAGE **1 OF 1**

BY **Michael Dennis** DATE **8/6/89** SURFACE ELEV. **1083.39 ft.**

SAMPLE RECOVERY (inches)		PENETRATION (blws/ft)	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOGRAPHIC COLUMN	DESCRIPTION	WELL DETAIL
10		43					**SILTY SAND AND GRAVEL FILL, SOME COBBLES** (SM-GM), yellowish brown (10YR, 5/4); 45% fine to medium sand; 35% fine to medium gravel; 20% silt; medium dense to dense; damp; poorly graded; subangular.	
9		12		5			**SILTY SAND FILL, SOME GRAVEL** (SM), yellowish brown (10YR, 5/4); 50% fine to medium sand; 35% silt; 15% fine gravel; loose to medium dense; moist; poorly graded; subangular.	
4		55/0.5					**SILTY SAND, TRACE GRAVEL** (SM), strong brown (7.5YR, 5/4); 75% fine sand; 20% silt; 5% fine gravel; medium dense to dense; moist; poorly graded; cohesionless; subrounded.	
10		10		10				
5		26						
							BORING TERMINATED AT 14.0 FEET	
				15				
				20				

REMARKS

Boring EB-14 was backfilled to the surface with gravel/cement grout.

EMCON ASSOCIATES

LOG OF EXPLORATORY BORING

PROJECT NUMBER **372-15.05** BORING NO. **EB-15**

PROJECT NAME **River Bank Breach Backfill Evaluation** PAGE **1 OF 1**

BY **Michael Dennis** DATE **8/6/89** SURFACE ELEV. **1083.5 ft.**

SAMPLE RECOVERY (inches)		PENETRATION (blws/ft)	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOGRAPHIC COLUMN	DESCRIPTION	WELL DETAIL
14		71					**SILTY SAND FILL WITH GRAVEL** (SM), yellowish brown (10YR, 5/4); 55% fine to medium sand; 30% silt; 15% fine to medium gravel; dense; damp; poorly graded; subangular.	
16		80		5			**GRAVELLY SAND FILL, SOME SILT, SOME COBBLES** (SP-SM), brown (7.5YR, 5/2); 50% fine to coarse sand; 30% fine to medium gravel; 10% cobbles; 10% silt; medium dense to dense; damp; poorly graded; subangular; contains some asphaltic concrete debris.	
10		27						
9		21		10			**SILTY SAND, SOME GRAVEL** (SM), brown (7.5YR, 5/4); 70% fine sand; 20% silt; 10% fine gravel; medium dense; moist; poorly graded; subangular; cohesionless.	
8		26					well graded	
							BORING TERMINATED AT 14.0 FEET	
				15				
				20				

REMARKS

Boring EB-15 was backfilled to the surface with gravel/cement grout.

EMCON ASSOCIATES

LOG OF EXPLORATORY BORING

PROJECT NUMBER **372-15.05** BORING NO. **EB-16**

PROJECT NAME **River Bank Breach Backfill Evaluation** PAGE **1 OF 1**

BY **Michael Dennis** DATE **8/6/89** SURFACE ELEV. **1072.27 ft.**

SAMPLE RECOVERY (inches)		PENETRATION (blws/ft)	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOGRAPHIC COLUMN	DESCRIPTION	WELL DETAIL
3		31					**SILTY SAND AND GRAVEL FILL, SOME COBBLES** (SM-GM), light brown (7.5YR, 6/4); 40% fine sand; 30% fine to coarse gravel; 20% silt; 10% cobbles; medium dense to dense; damp; poorly graded; subangular.	
8		36		5				
9		7					**GRAVELLY SAND, SOME COBBLES** (SW), yellowish brown (10YR, 5/4); 55% fine to coarse sand; 35% fine to coarse gravel; 10% cobbles; medium dense; moist; well graded; subrounded; cohesionless.	
1		8		10				
							BORING TERMINATED AT 11.5 FEET	
				15				
				20				

REMARKS

Boring EB-16 was backfilled to the surface with gravel/cement grout.

EMCON ASSOCIATES

APPENDIX B

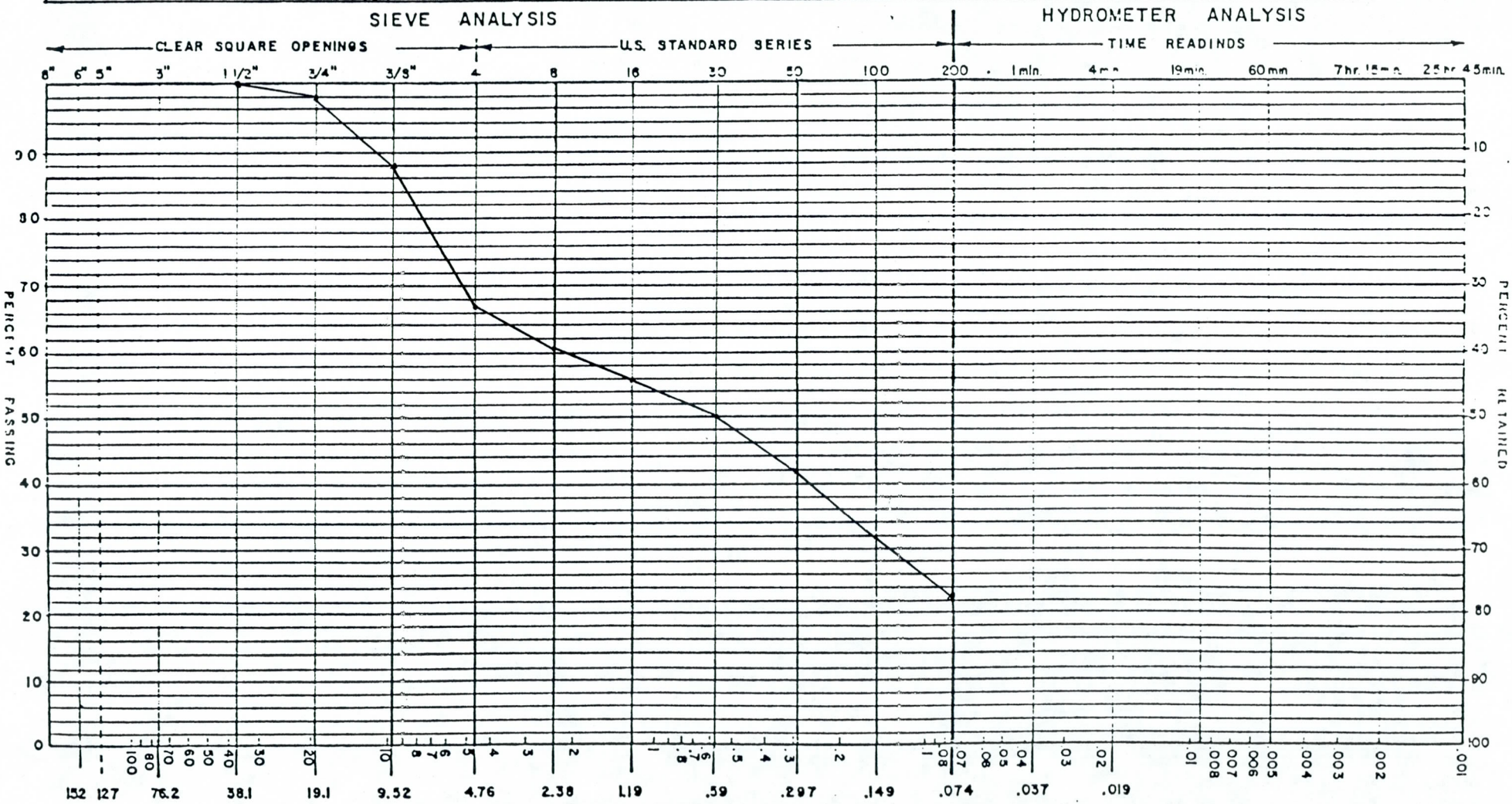
LABORATORY TEST RESULTS

RESULTS OF GRADATION TEST

JOB NO. 372-15.05

JOB NAME CHOLLA

KEY					
BORING NO.	EB-3				
DEPTH IN FEET	0'-11'				
CLASSIFICATION	SM				



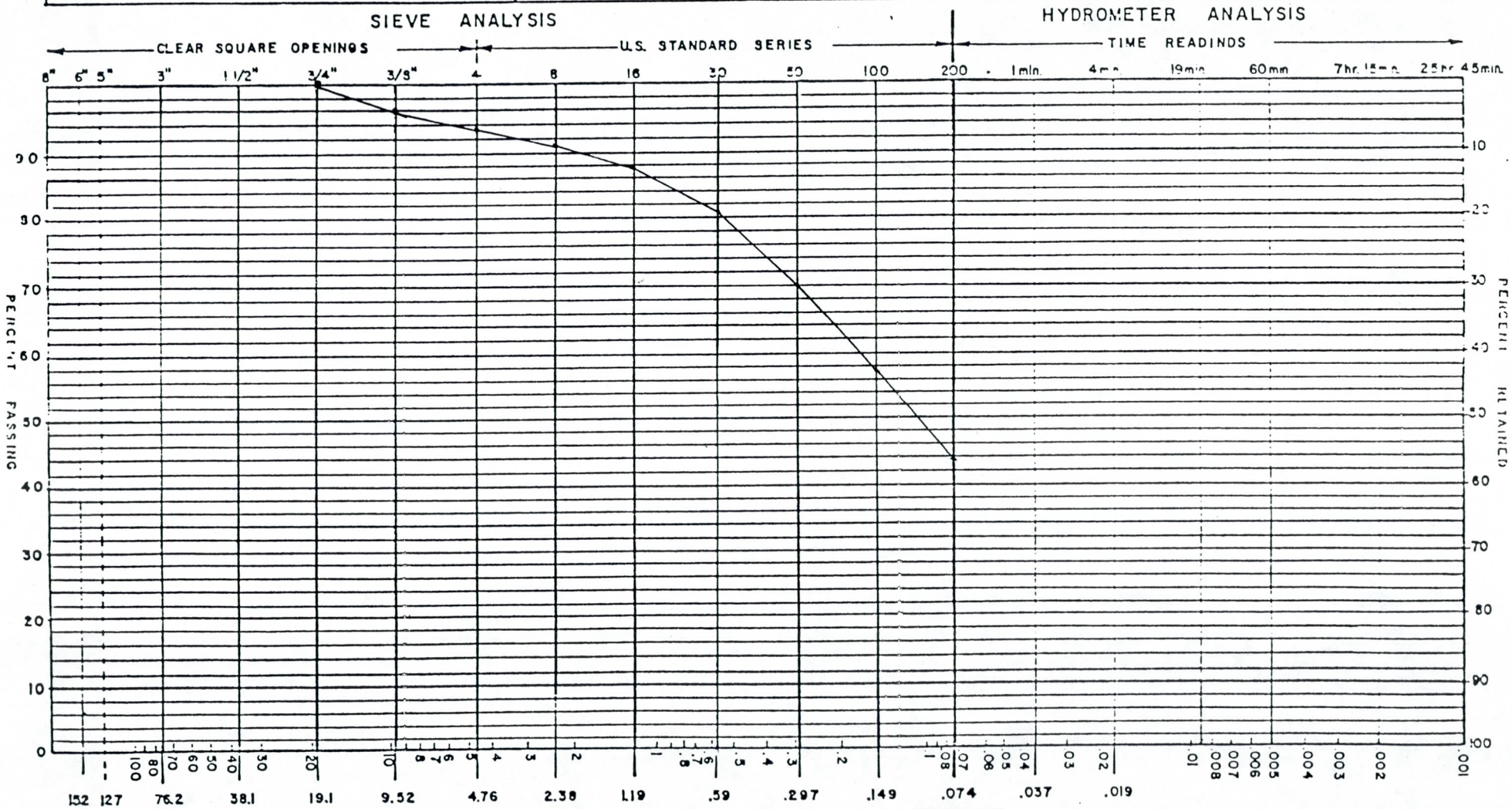
COBBLES	GRAVEL		SAND			SILT (NON-PLASTIC) TO CLAY (PLASTIC)
	COARSE	FINE	COARSE	MEDIUM	FINE	

RESULTS OF GRADATION TEST

JOB NO. 372-15.05

JOB NAME CHOLLA

KEY					
BORING NO.	EB-6				
DEPTH IN FEET	8' 5"				
CLASSIFICATION	SM				



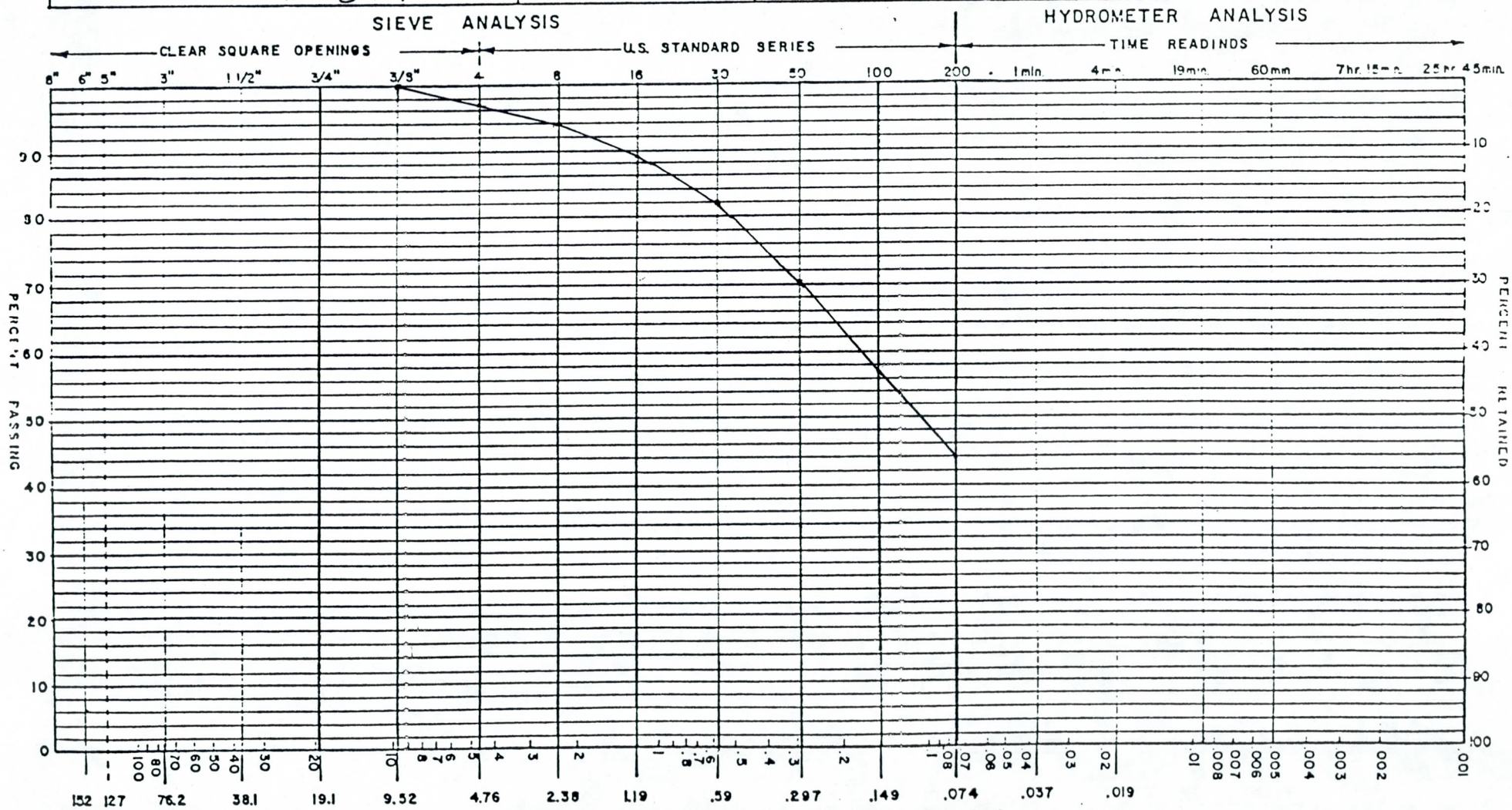
COBBLES	GRAVEL		SAND			SILT (NON-PLASTIC) TO CLAY (PLASTIC)
	COARSE	FINE	COARSE	MEDIUM	FINE	

RESULTS OF GRADATION TEST

JOB NO. 372-15.05

JOB NAME CHOLLA

KEY					
BORING NO.	EB-6				
DEPTH IN FEET	12' 10"				
CLASSIFICATION	SM				



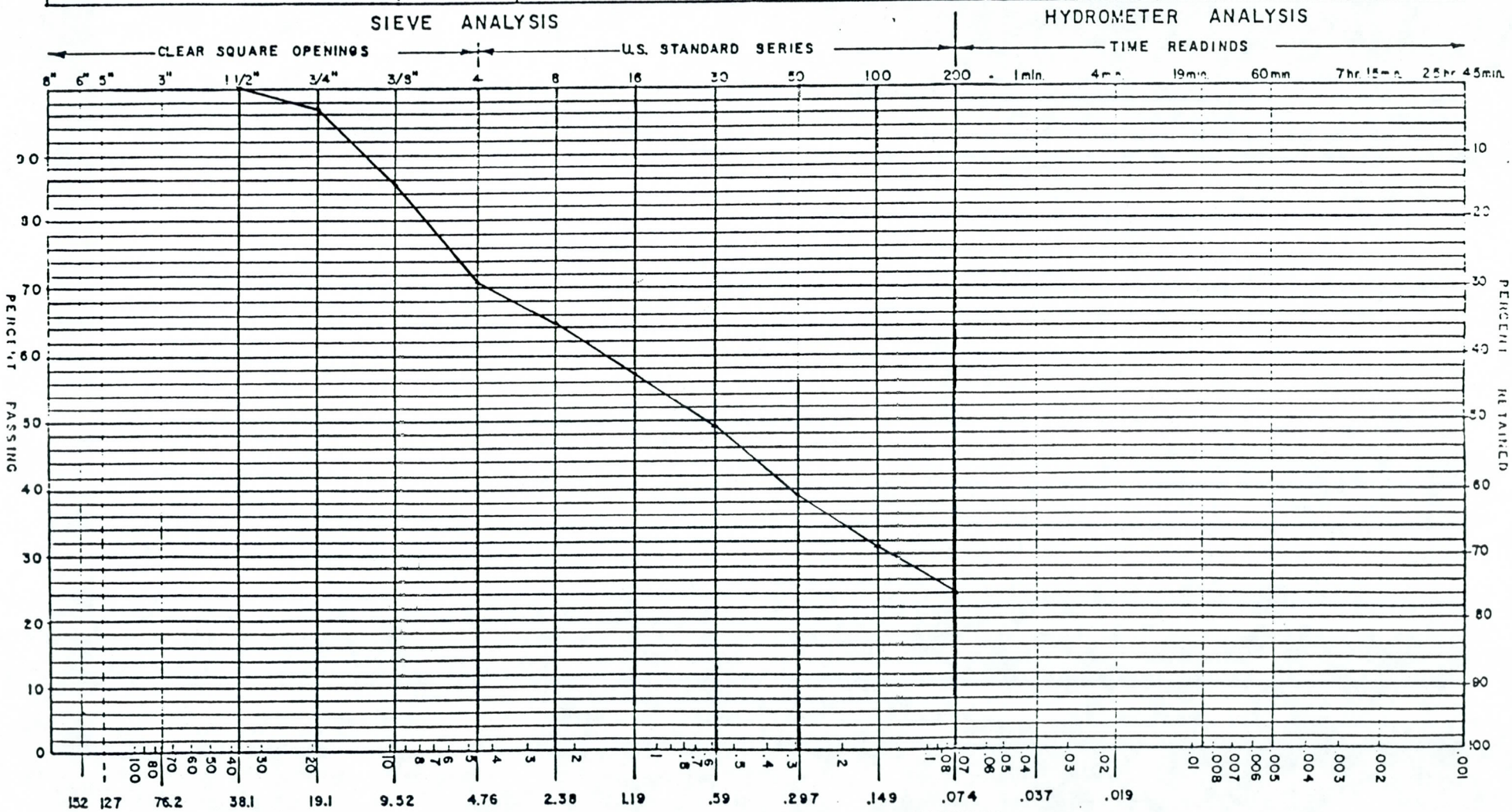
COBBLES	GRAVEL		SAND			SILT (NON-PLASTIC) TO CLAY (PLASTIC)
	COARSE	FINE	COARSE	MEDIUM	FINE	

RESULTS OF GRADATION TEST

JOB NO. 372-15.05

JOB NAME CHOLLA

KEY					
BORING NO.	EB-7				
DEPTH IN FEET	4'-18'				
CLASSIFICATION	SM				

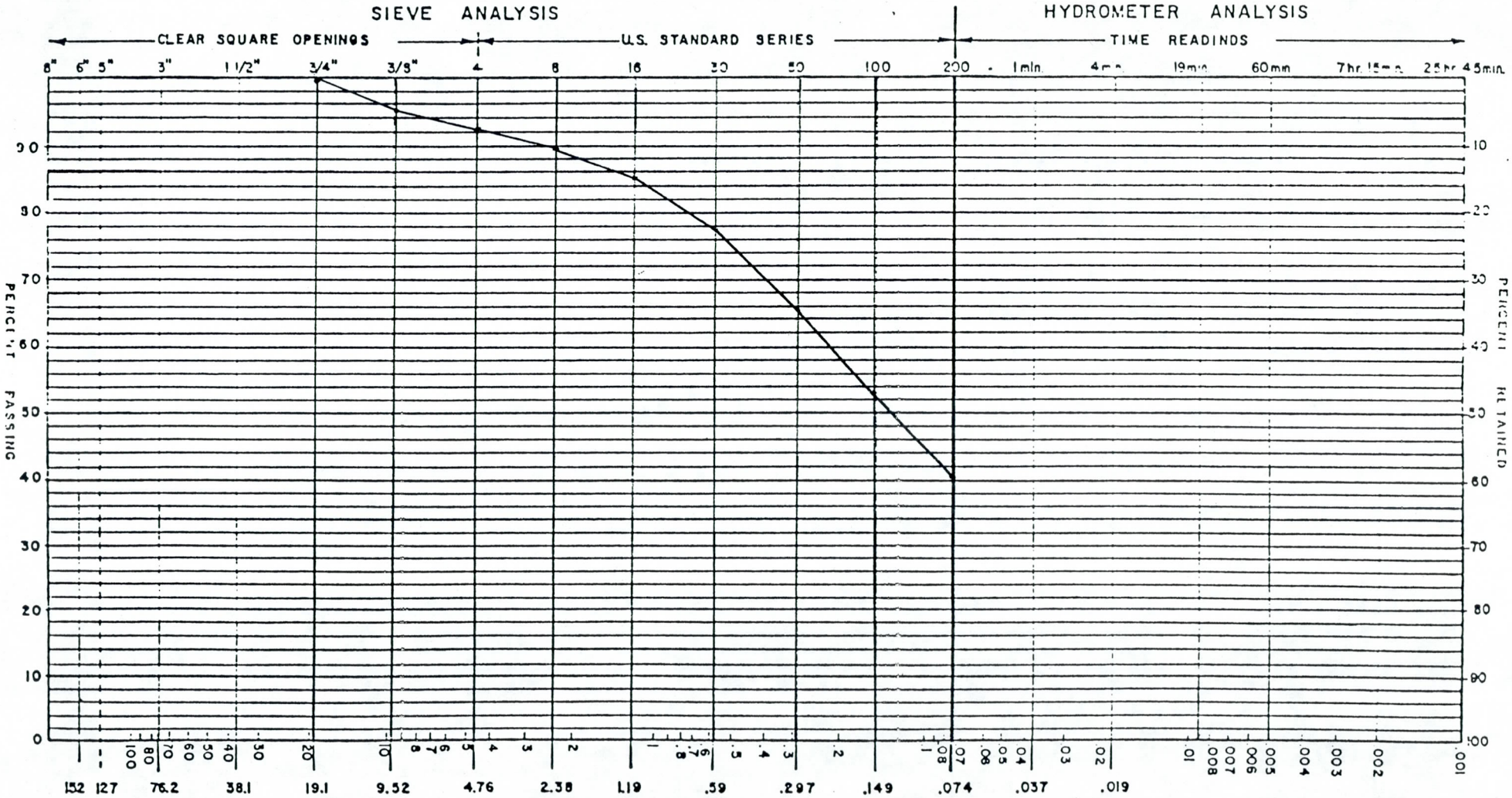


COBBLES	GRAVEL		SAND			SILT (NON-PLASTIC) TO CLAY (PLASTIC)
	COARSE	FINE	COARSE	MEDIUM	FINE	

RESULTS OF GRADATION TEST

JOB NO. 372-15.05
JOB NAME CHOLLA

KEY					
BORING NO.	EB-9				
DEPTH IN FEET	15'5"				
CLASSIFICATION	SM				



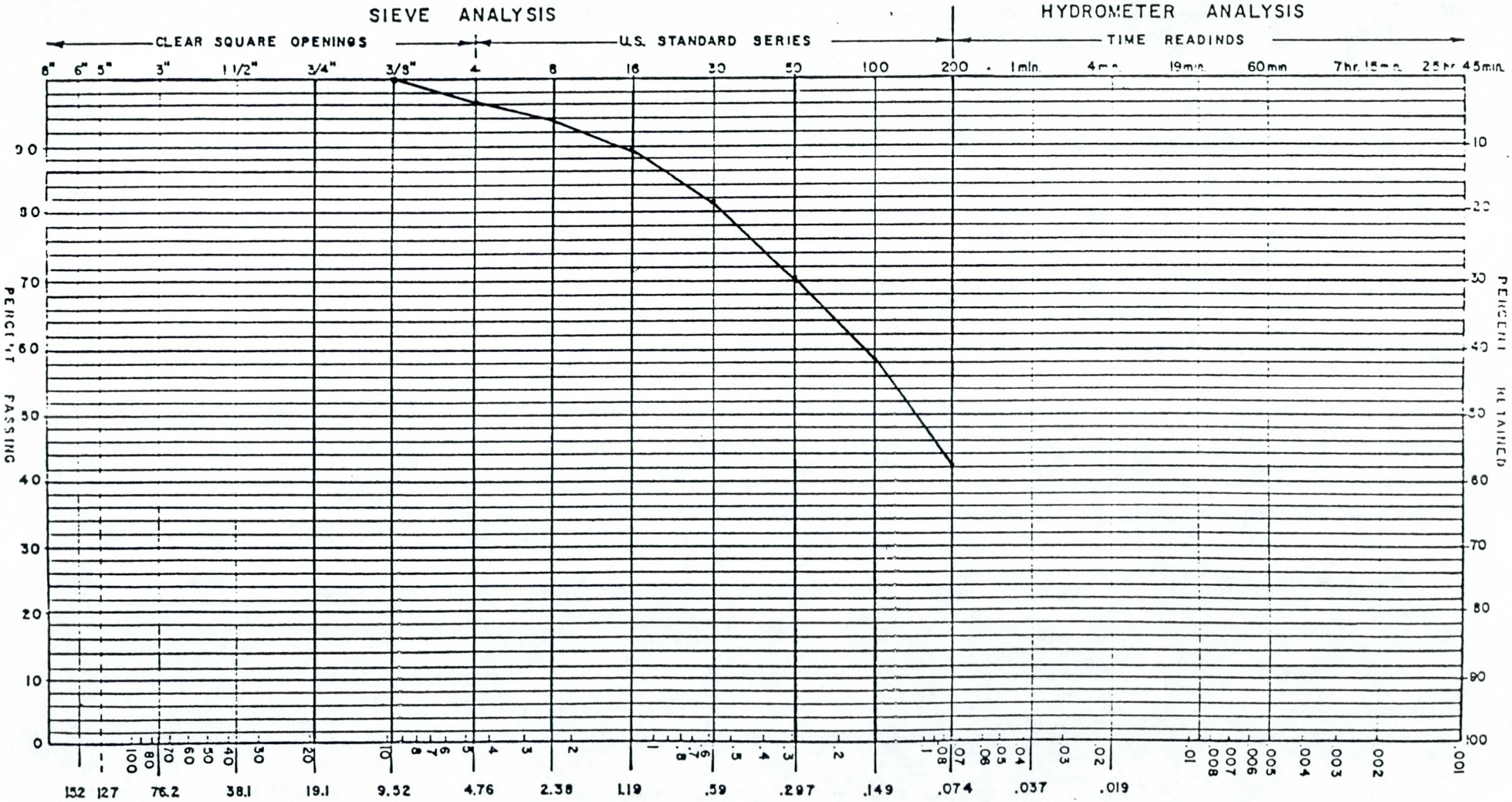
COBBLES	GRAVEL		SAND			SILT (NON-PLASTIC) TO CLAY (PLASTIC)
	COARSE	FINE	COARSE	MEDIUM	FINE	

RESULTS OF GRADATION TEST

JOB NO. 372-15.05

JOB NAME CHOLLA

KEY					
BORING NO.	EB-10				
DEPTH IN FEET	7'10"				
CLASSIFICATION	SM				



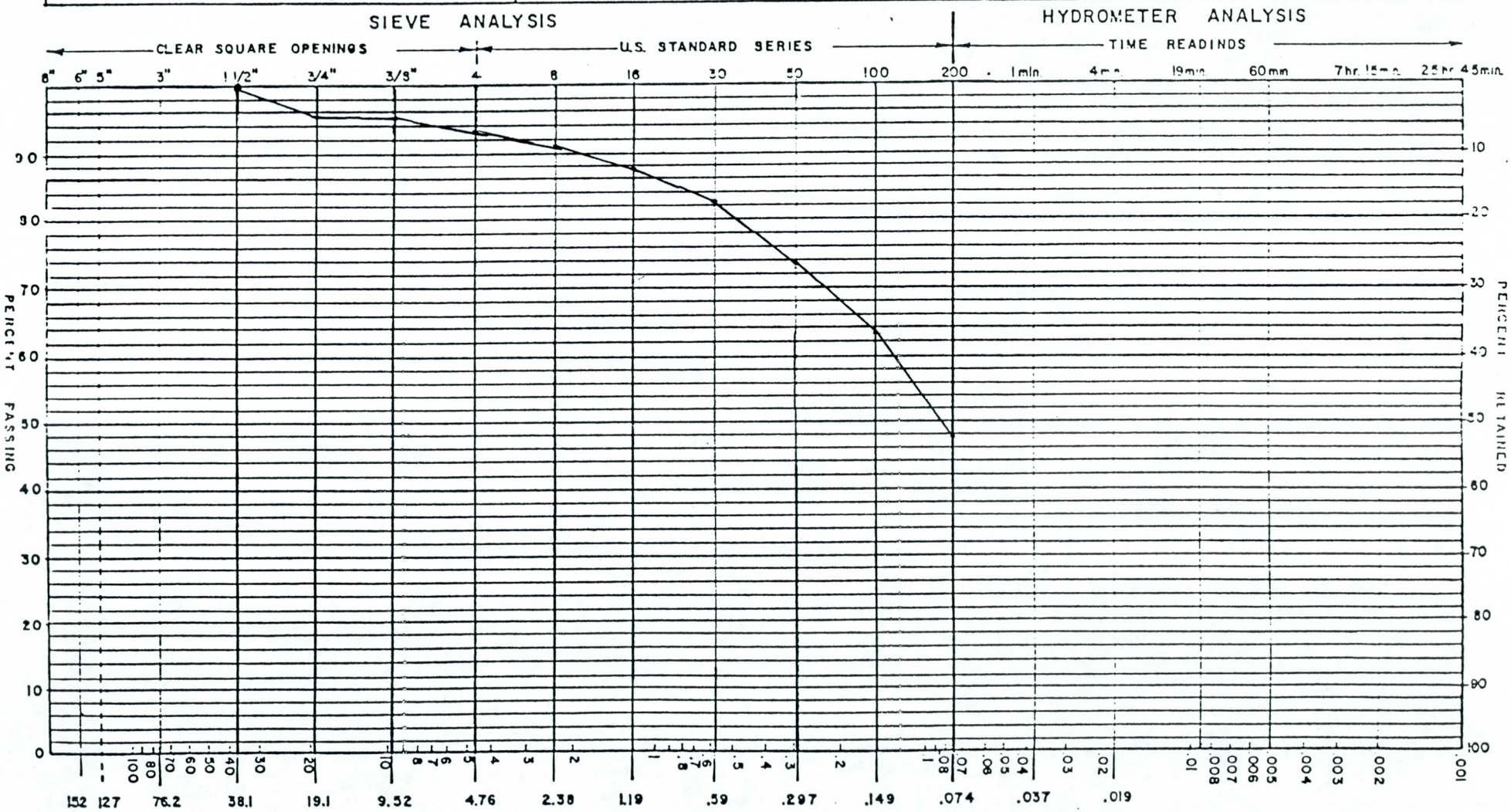
COBBLES	GRAVEL		SAND			SILT (NON-PLASTIC) TO CLAY (PLASTIC)
	COARSE	FINE	COARSE	MEDIUM	FINE	

RESULTS OF GRADATION TEST

JOB NO. 372-15.05

JOB NAME CHOLLA

KEY					
BORING NO.	EB-10				
DEPTH IN FEET	8'-4"				
CLASSIFICATION	SM				



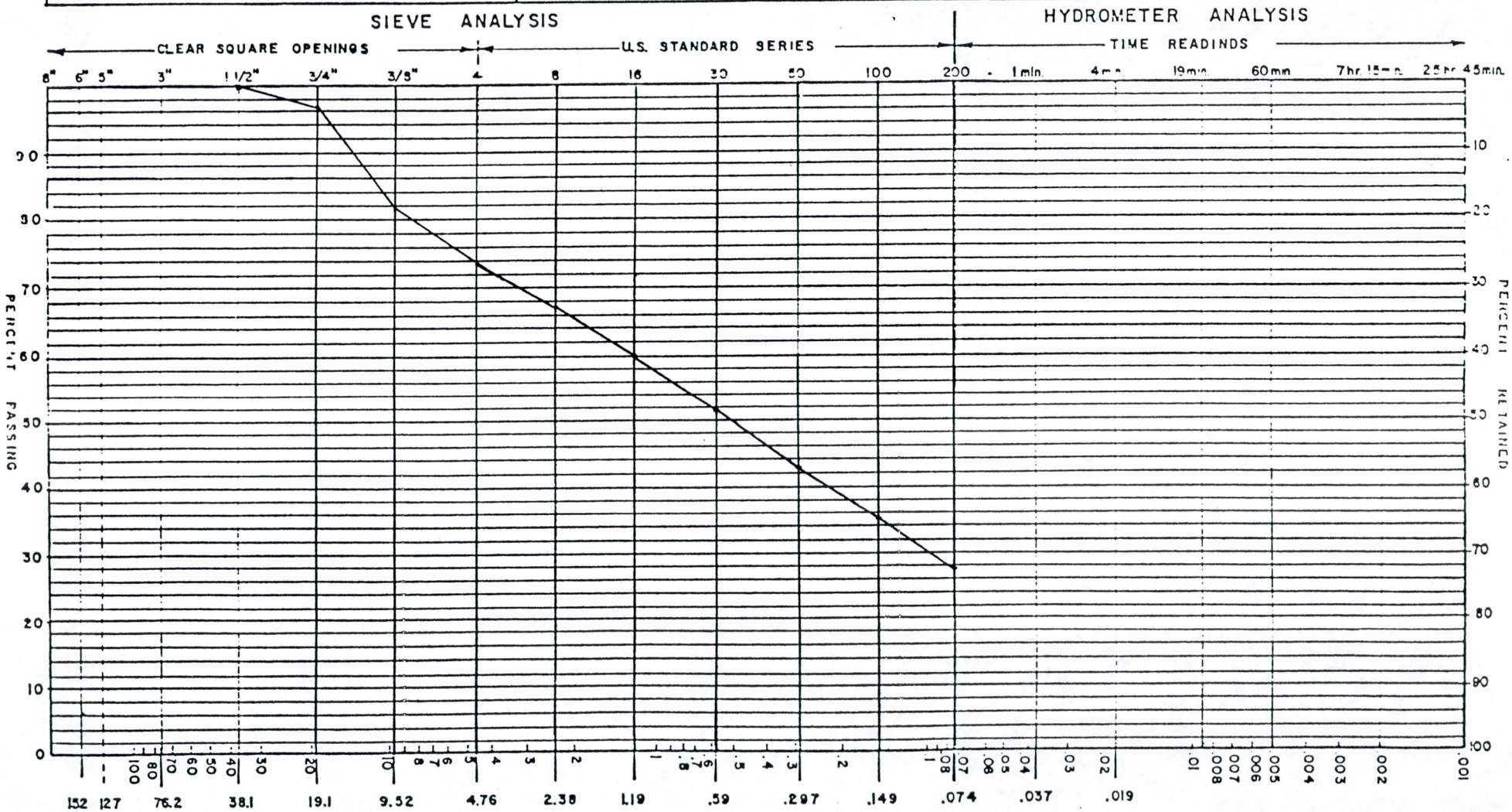
COBBLES	GRAVEL		SAND			SILT (NON-PLASTIC) TO CLAY (PLASTIC)
	COARSE	FINE	COARSE	MEDIUM	FINE	

RESULTS OF GRADATION TEST

JOB NO. 372-15.05

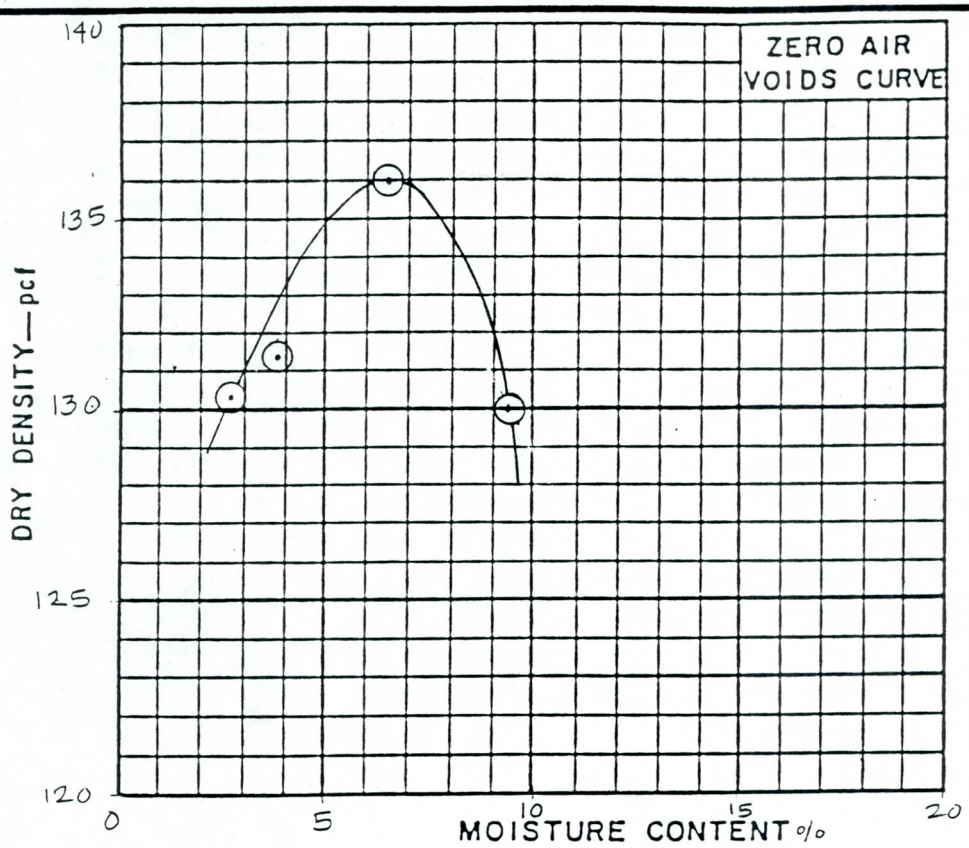
JOB NAME CHOLLA

KEY					
BORING NO.	E13-11				
DEPTH IN FEET	2'-9'				
CLASSIFICATION	SM				

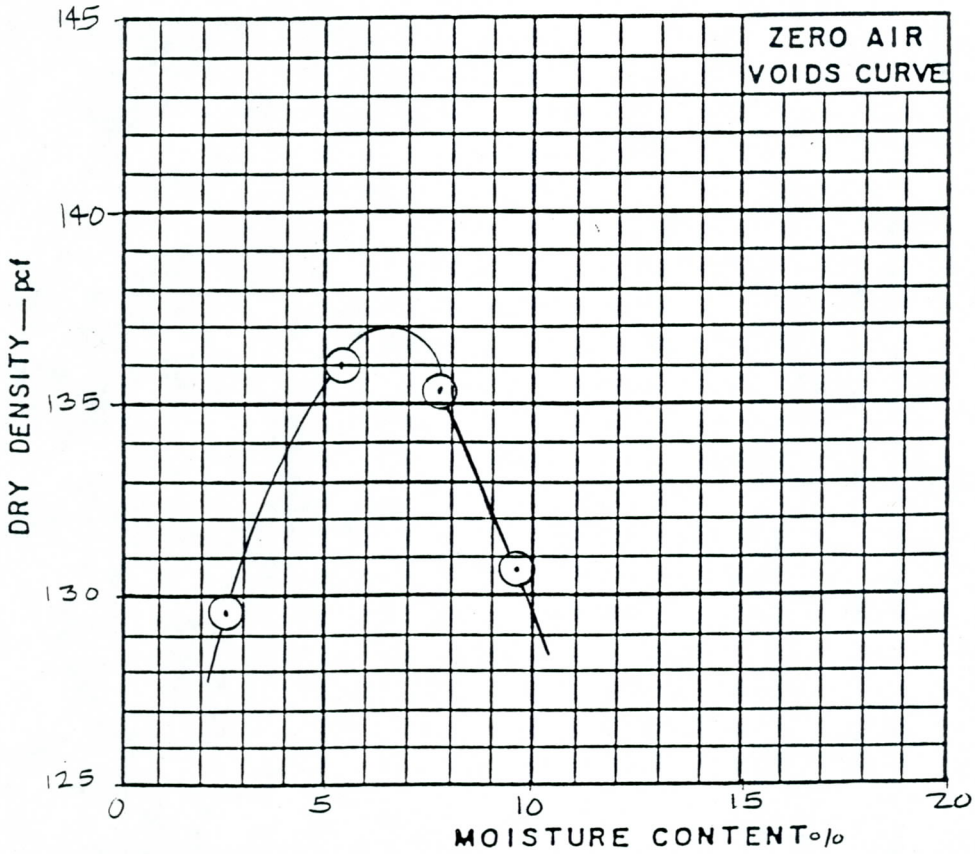


COBBLES	GRAVEL		SAND			SILT (NON-PLASTIC) TO CLAY (PLASTIC)
	COARSE	FINE	COARSE	MEDIUM	FINE	

115363



SAMPLE NO.	EB-3
SAMPLE DEPTH	0'-11'
SAMPLE DESCRIPTION	BROWN SILTY SAND WITH SOME GRAVEL
SPECIFIC GRAVITY	2.75
TEST DESIGNATION	ASTM D-1557 "C"
MAXIMUM DRY DENSITY (pcf)	136.0
OPTIMUM MOISTURE CONTENT, %	6.5



SAMPLE NO.	EB-7
SAMPLE DEPTH	4'-18'
SAMPLE DESCRIPTION	BROWN SILTY SAND WITH SOME GRAVEL
SPECIFIC GRAVITY	2.75
TEST DESIGNATION	ASTM D-1557 "C"
MAXIMUM DRY DENSITY (pcf)	137.0
OPTIMUM MOISTURE CONTENT, %	6.5

EMCON Associates

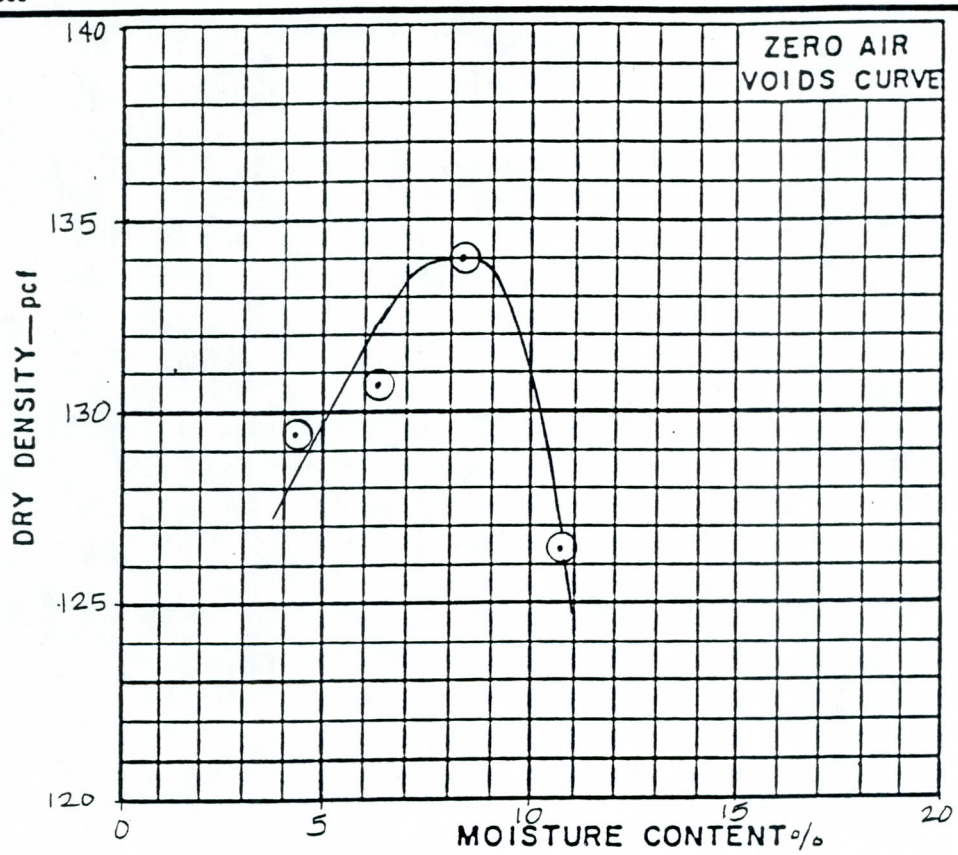
CHOLLA SANITARY LANDFILL

BREACH INVESTIGATION

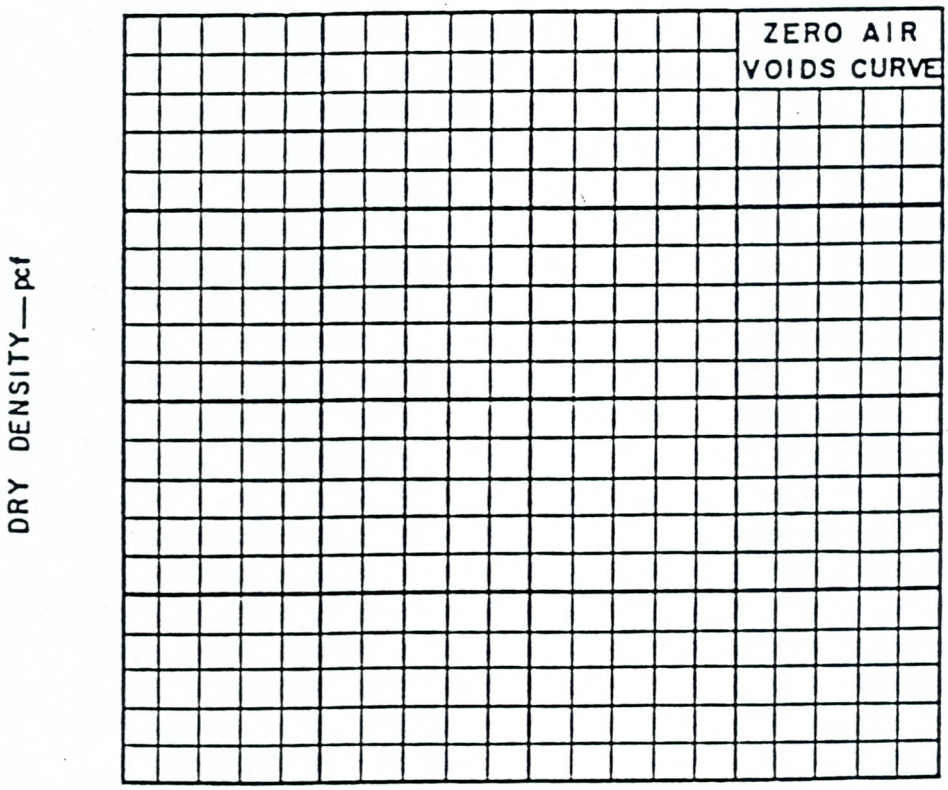
FIGURE

PROJECT NO. 372-15.05

115383



SAMPLE NO.	EB-11
SAMPLE DEPTH	2'-9'
SAMPLE DESCRIPTION	BROWN SILTY SAND WITH SOME GRAVEL
SPECIFIC GRAVITY	2.75
TEST DESIGNATION	ASTM D-1557 "C"
MAXIMUM DRY DENSITY (pcf)	134.0
OPTIMUM MOISTURE CONTENT, %	8.0



SAMPLE NO.	
SAMPLE DEPTH	
SAMPLE DESCRIPTION	
SPECIFIC GRAVITY	
TEST DESIGNATION	
MAXIMUM DRY DENSITY (pcf)	
OPTIMUM MOISTURE CONTENT, %	

EMCON Associates

CHOLLA SANITARY LANDFILL
BREACH INVESTIGATION

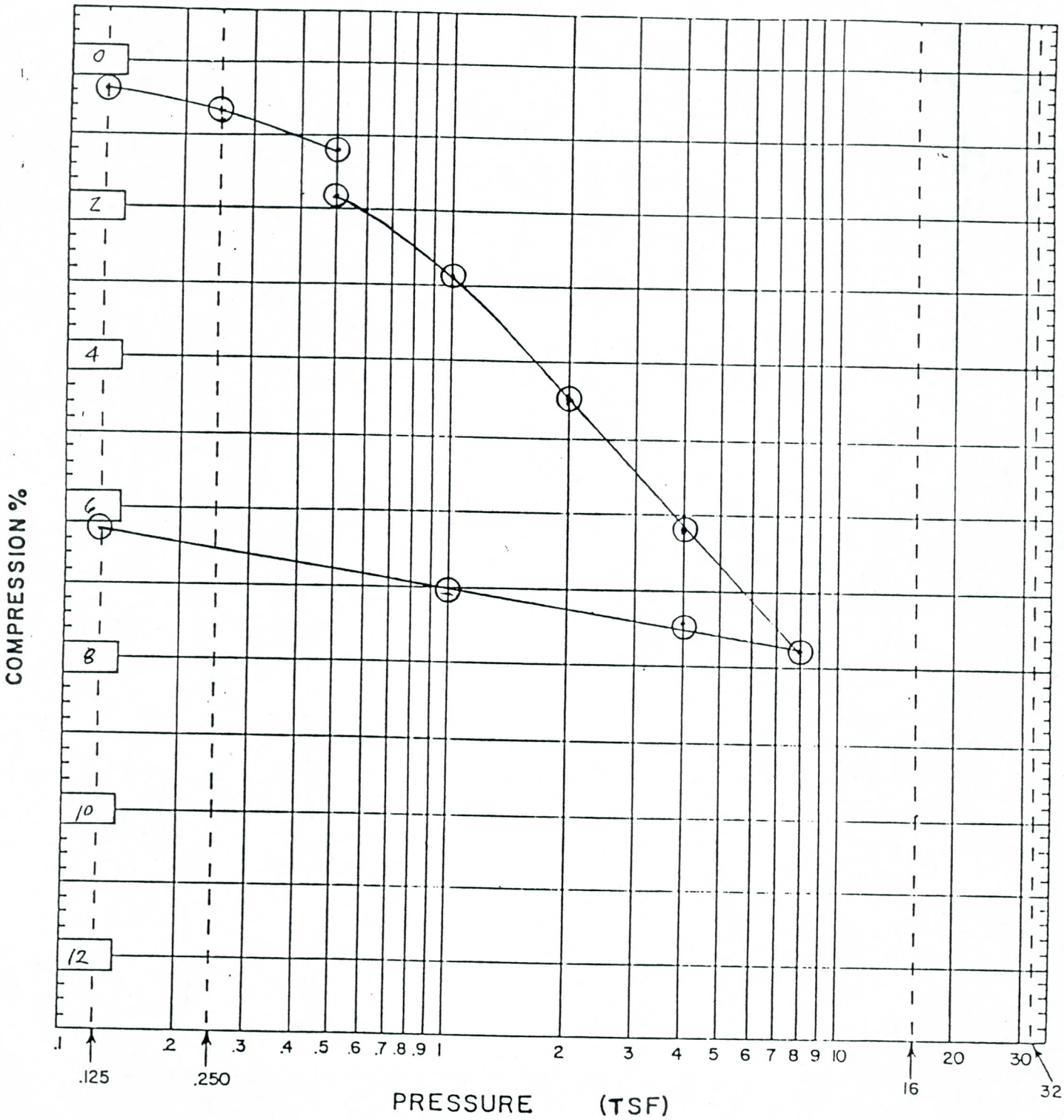
FIGURE

PROJECT NO. 372-15.05

CONSOLIDATION-PRESSURE CURVE

JOB NO. 372-15.05 BORING NO. EB-10

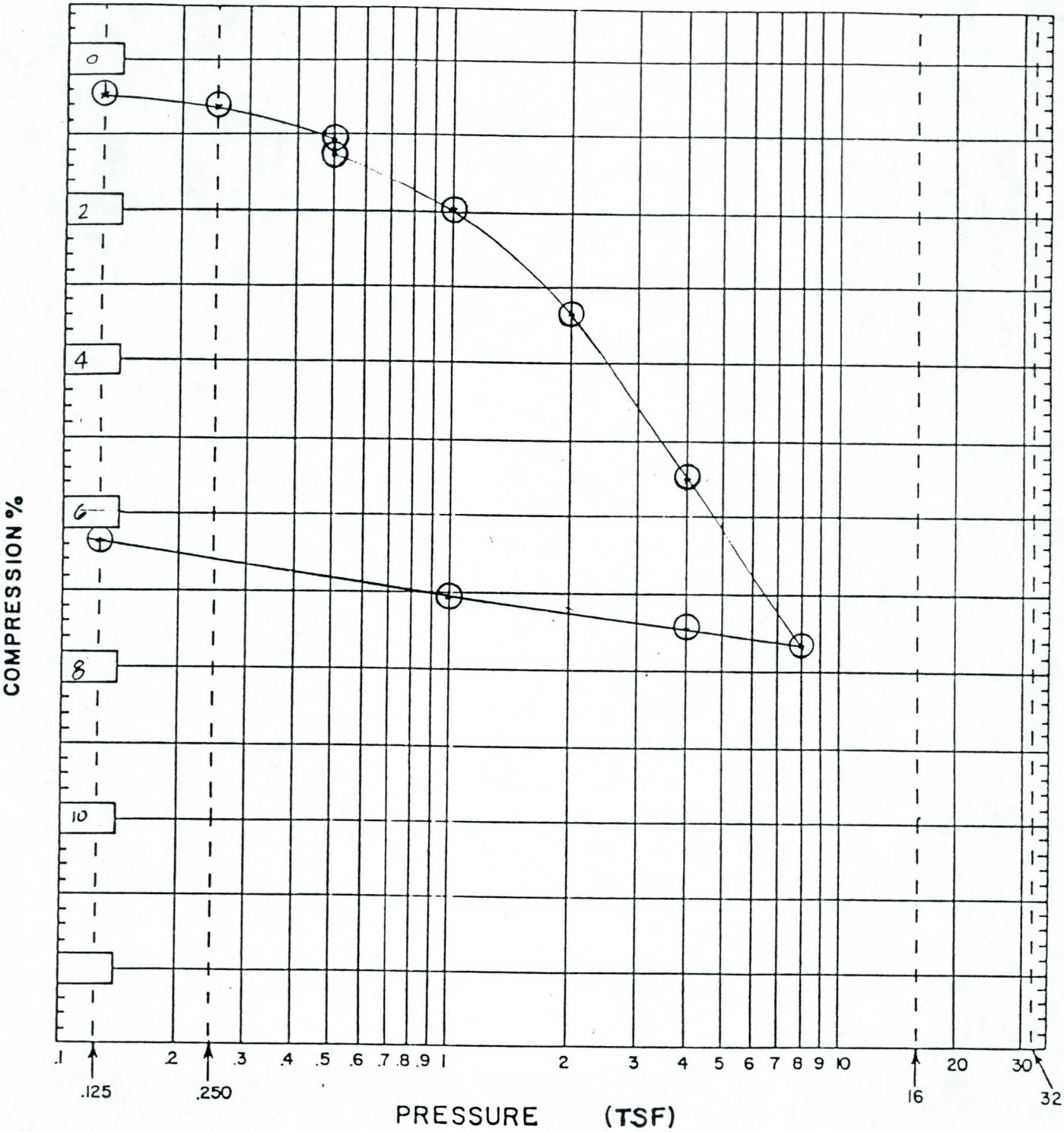
JOB NAME CHDLA DEPTH 7'10"



CONSOLIDATION-PRESSURE CURVE

JOB NO. 372-15.05 BORING NO. EB-9

JOB NAME CHOLA DEPTH 15'5"

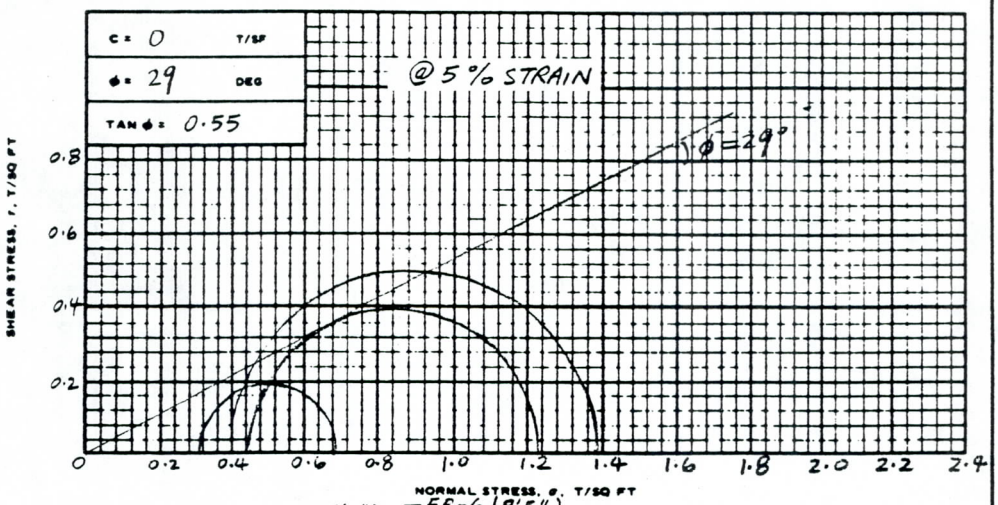


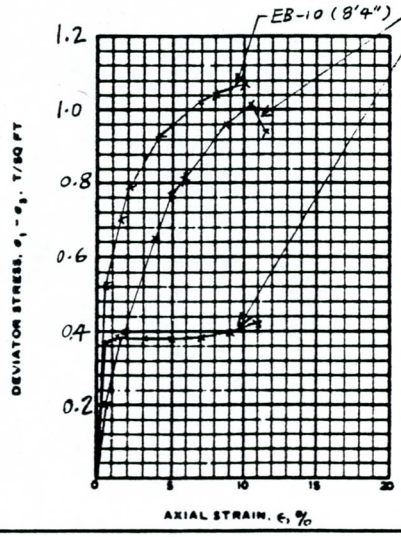
COMPUTATION SHEET

PROJECT TITLE: CHOLLA SANITARY LANDFILL PROJECT NO. 372-15-05

DESCRIPTION: CU TEST RESULTS SHEET ___ OF ___

PREP. BY: D. TANG DATE: 9/14/89 CHKD BY: ___ DATE: ___





	SPECIMEN NO.		EB-6 (8'5")	EB-6 (12'10")	EB-10 (8'4")	
INITIAL	WATER CONTENT, %	w_o	9.5	8.0	9.3	
	DRY DENSITY LB/CU FT	γd_o	105.9	96.0	103.2	
	SATURATION, %	S_o	45	29	41	
	VOID RATIO	e_o	0.56	0.72	0.60	
FINAL	WATER CONTENT, %	w_c	18.1	23.3	19.4	
	DRY DENSITY LB/CU FT	γd_c	111.5	102.3	109.0	
	SATURATION, %	S_c	100	100	100	
	VOID RATIO	e_c	0.48	0.62	0.52	
	FINAL BACK PRESSURE, T/SQ FT	u_b				
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	0.65	0.36	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$				
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f				
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$				
INITIAL DIAMETER, IN.		D_o				
INITIAL HEIGHT, IN.		H_o				

CONTROLLED- TEST

DESCRIPTION OF SPECIMENS BROWN SILTY SAND (SM)

LL	PL	PI	Gs	TYPE OF SPECIMEN	TYPE OF TEST CU TEST

REMARKS:

PROJECT

BORING NO. SAMPLE NO.

DEPTH/ELEV

LABORATORY DATE

TRIAXIAL COMPRESSION TEST REPORT

EMCON Associates

SEDIMENT-ROUTING ANALYSIS

OF THE AGUA FRIA RIVER

FOR THE PROPOSED CHOLLA LANDFILL

EROSION-PROTECTION MEASURES

Prepared For:

Matthews Kessler & Associates, Inc.
4045 E. McDowell Road
Phoenix, Arizona 85005-4405

Prepared By:

Simons, Li & Associates, Inc.
110 South Church Avenue, Suite 2170
P.O. Box 2712
Tucson, Arizona 85702-2712

Registered Professional Engineer (Civil)
CERTIFICATE NO. 18683
ROBERT J. SMOLINSKY
Date Signed 11-15-89
ARIZONA, U.S.A.

November, 1989

Registered Professional Engineer (Civil)
CERTIFICATE NO. 22462
MICHAEL D. ZELLER
Date Signed 11-15-89
ARIZONA, U.S.A.

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Figure 2.	Design Hydrograph	5
Figure 3.	Average Bed-Sediment Gradation	7

LIST OF APPENDICES

APPENDIX A: SEDIMENT-GRADATION DATA

APPENDIX B: DETAILED QUASED OUTPUT

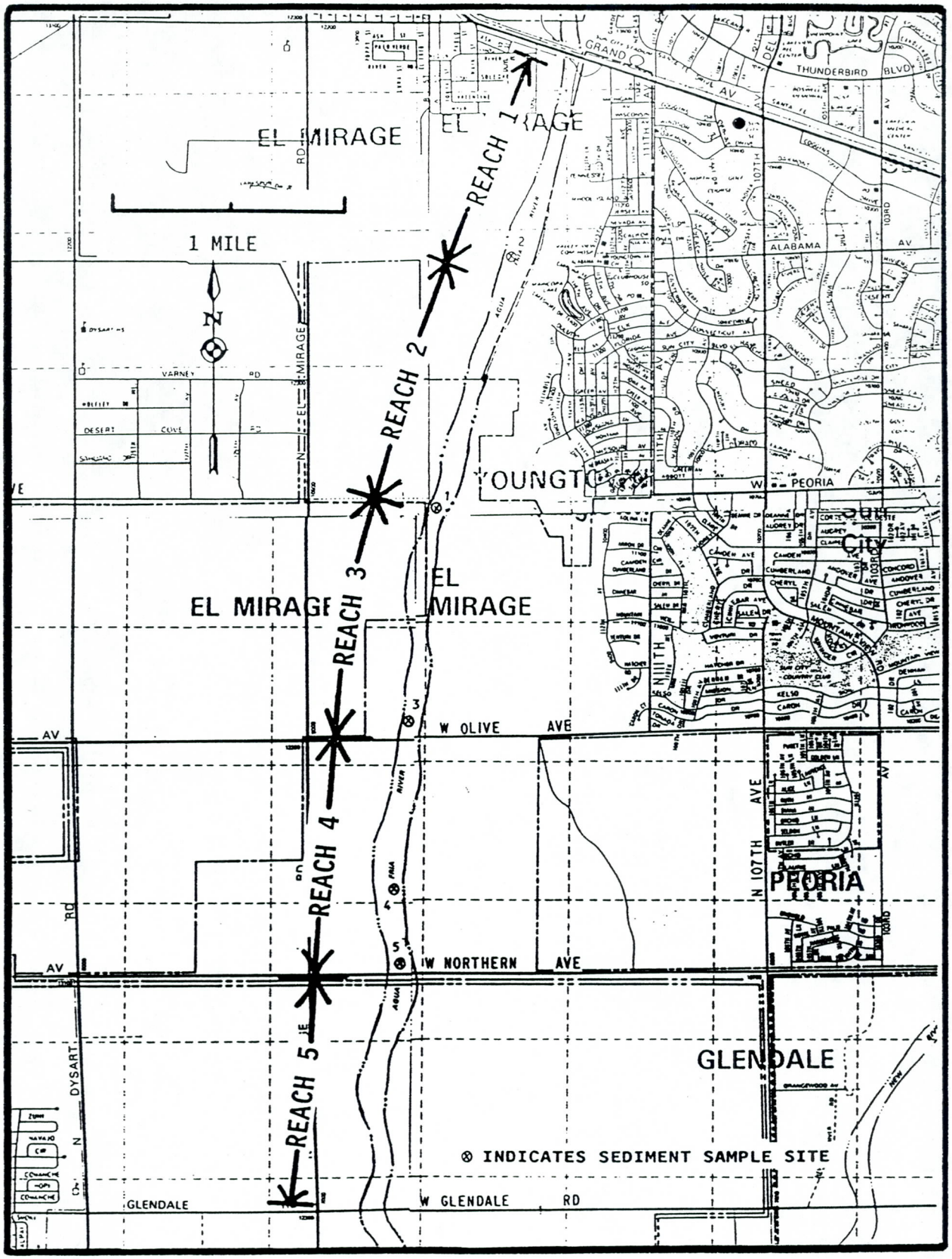
Registered Professional Engineer (Civil) CERTIFICATE NO. 18683 ROBERT J. SMOLINSKY Date Signed 11-15-89 ARIZONA, U.S.A.

Registered Professional Engineer (Civil) CERTIFICATE NO. 12481 MICHAEL F. ZELLER Date Signed 11-15-89 ARIZONA, U.S.A.

I. INTRODUCTION

This report presents the results of a sediment-routing analysis which was performed for a reach of the Agua Fria River from Glendale Avenue to Grande Avenue. The purpose of the analysis was to determine the general-scour component for the toe-down design of erosion protection along a sub-reach of the Agua Fria River located between Northern Avenue and Olive Avenue. A location map showing the project site is provided on Figure 1 of this report.

This project was performed under a subcontract to Matthews Kessler & Associates, Inc. (MKA). The erosion protection is being designed in conjunction with the development of the proposed Cholla Landfill, which is to be located within an abandoned sand and gravel pit on the west overbank of the Agua Fria River.



sla Simons, Li & Associates, Inc.

FIGURE 1
PROJECT LOCATION AND REACH-DEFINITION MAP

II. METHODOLOGY

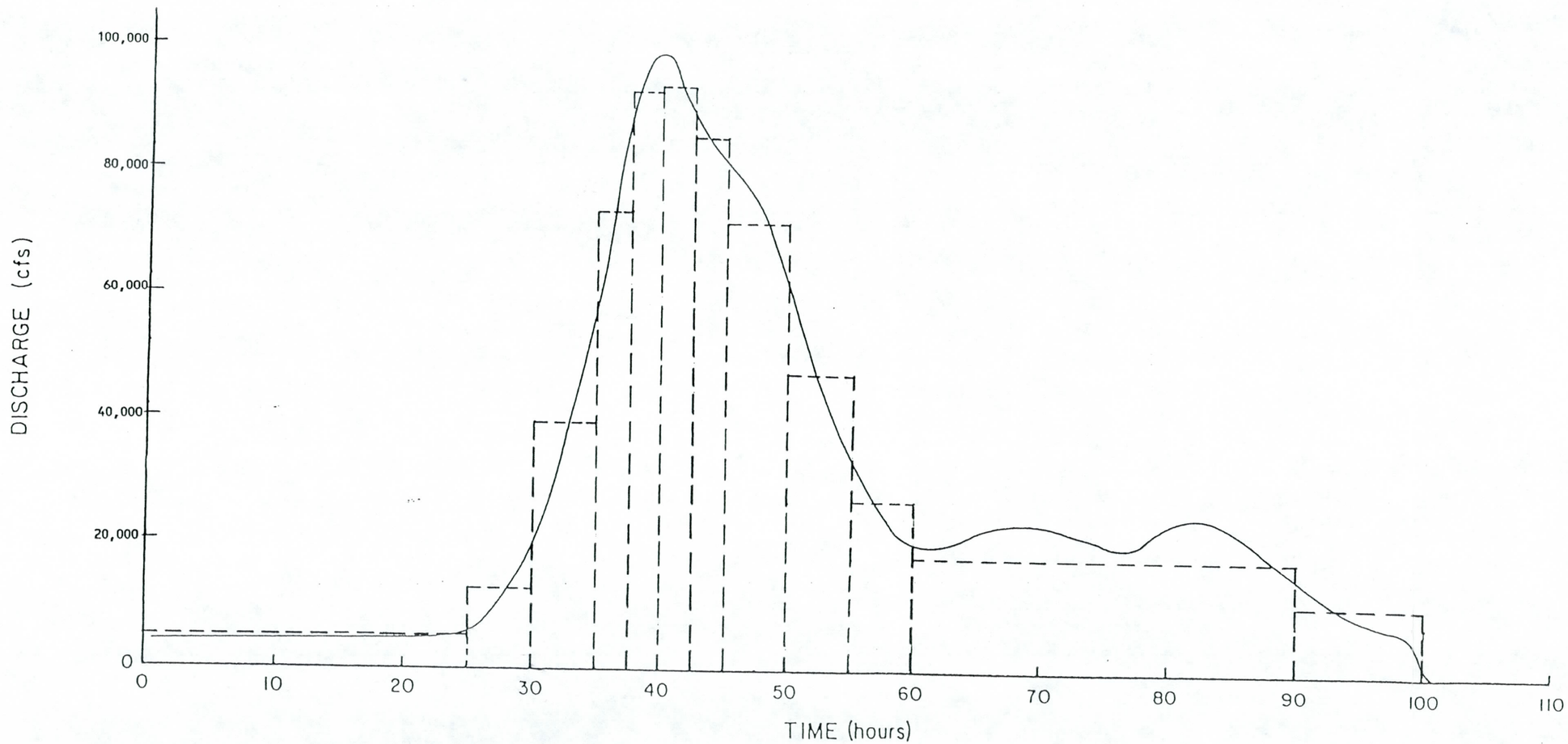
Sediment transport was simulated for a 100-year flow within the Agua Fria River by utilizing the computer model QUASED, which was developed by Simons, Li & Associates, Inc. (1981). The model is considered to be "quasi-dynamic", meaning the flow event is subdivided into a number of time increments--thereby simulating a flood hydrograph. However, during each time increment the flow is assumed to be steady. Additionally, the river system is also subdivided into a number of subreaches, each having similar hydraulic and geomorphic characteristics. For each time increment, the flow is assumed to be constant for a given reach, but it may vary from reach to reach. Reach definitions utilized for this model are shown on Figure 1. Note that the project reach (i.e., the location of the proposed erosion-protection project) is defined as Reach # 4.

Bed-load transport is computed within the model by the Meyer-Peter Muller formula. This formula gives reliable results for bed-load transport over a wide range of sediment sizes. Sediment transport of suspended bed-material load is determined by utilizing a numerical solution of the Einstein integration of the bed-material, sediment-concentration profile as a function of depth. Hydraulic computations were performed with the U.S. Army Corps of Engineers (COE) standard-step backwater model HEC-2. This hydraulic model has been linked to the QUASED model in a manner similar to a subroutine. At the end of each time increment, a new HEC-2 input file is created, in which cross-section geometry (GR cards)

and discharge values (QT cards) are modified. An updated set of hydraulic conditions are then calculated for the next time increment, utilizing HEC-2.

The initial cross-section geometry utilized for the HEC-2 model was taken from the Flood-Insurance Study of the Agua Fria River prepared by Jerry Jones and Associates, Inc. (1989). The 100-year peak discharge used was 98,000 cfs and represents the average peak discharge for the study reach, which was modeled for the Flood-Insurance Study. The hydrograph used for the modeling was one developed by the COE for the Agua Fria River. It was constructed based on the largest general summer storm recorded, which occurred August 28-29, 1951. The flow lasts approximately four days, with the most severe portion of the flood lasting just over one day. The resulting hydrograph, along with the discretization used for the model, is shown on Figure 2 of this report.

Approximately five linear miles of the Agua Fria River was modeled for this analysis. This length was subdivided into five reaches of approximately equal length. The upstream-most reach (Reach 1) was assumed as the sediment-supply reach. This means that the reach is assumed to be transporting sediment at its transport capacity. By locating this "supply reach" far enough (two miles in this case) upstream from the project reach, any errors inherent in this assumption are minimized. Similarly, the backwater model was begun one-mile downstream of the project to minimize any errors relative the starting water-surface elevation assumptions. It should be noted that Reach 1, located downstream of the project reach, has been highly disturbed by man's sand and gravel-mining activities. Because of this situation, the study contractor for



sla Simons, Li & Associates, Inc.

FIGURE 2

DESIGN HYDROGRAPH

the Flood Insurance Study incorporated a number of unusual cross-sections into the hydraulic model in an attempt to model this reach accurately. Additionally, the SLA QUASED model was not developed as a tool for modeling the complex hydraulic conditions and sediment movement which accompanies the flooding of gravel pits. Therefore, the sedimentation results which the QUASED model predicts within Reach 1, downstream of the project, should not be considered to be quantitatively accurate, but rather should be used only as a qualitative indicator of the trend of the river system within this reach.

Since the QUASED model computes sediment transport by grain-size fractions, a sediment gradation for the bed material is required as model input. Therefore, sediment samples were collected at five locations throughout the modeled reach. The location of the sample sites are also noted on Figure 1 of this report. The gradation curve for each sample is provided within Appendix A of this report. Very little variation exists between the grain-size distributions of the five samples. Therefore, a single distribution was developed for the model input, which consisted of an average of the five collected samples. The resulting distribution is provided on Figure 3 of this report.

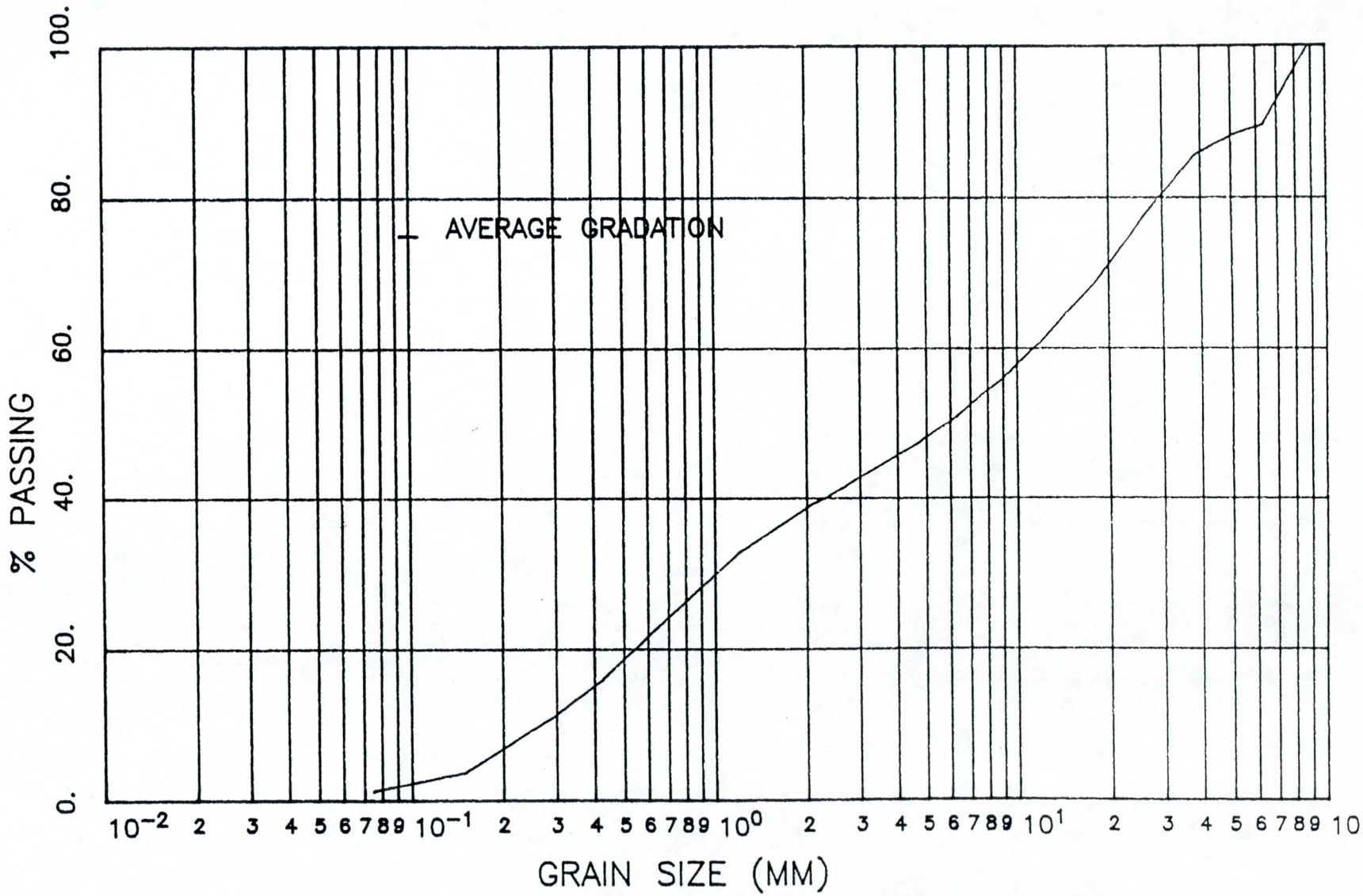


FIGURE 3

AVERAGE BED-SEDIMENT GRADATION

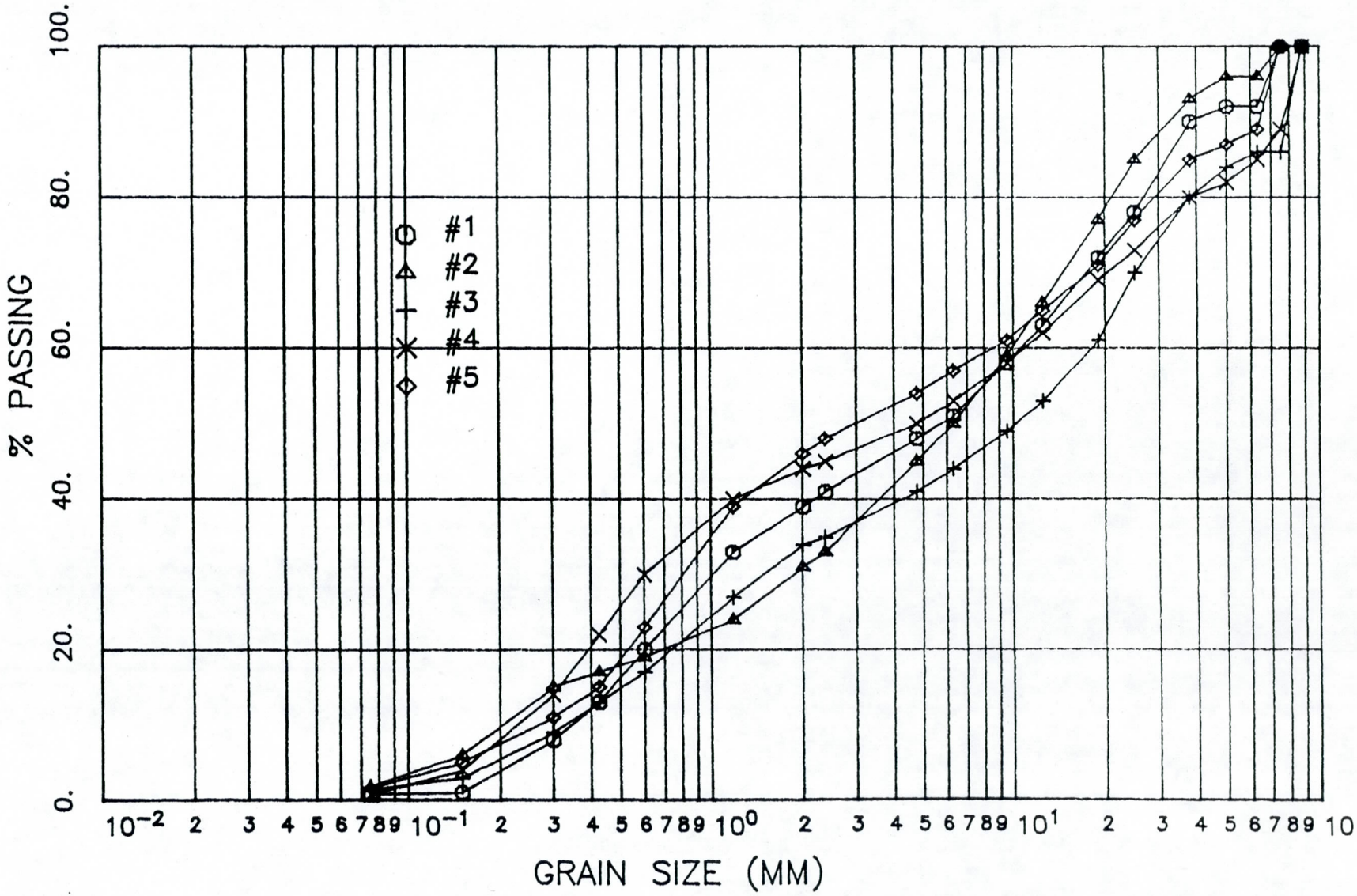
SLA Simons, Li & Associates, Inc.

III. RESULTS AND RECOMMENDATIONS

The QUASED model results indicate that the project reach (i.e., Reach #4) has a slight tendency to degrade during the passage of a major flow. The maximum change predicted by the model along this reach is a lowering of the channel bed by approximately 0.5 feet. A detailed listing of the model results for each cross-section, and each time step, is provided with the QUASED-model output provided within Appendix B of this report. However, for design purposes, it is the recommendation of this study that a value of 0.5 feet be used as the general-scour component for the design of bank protection toe-downs. It should be understood that this report does not address the other scour components which may need to be considered for this type of design, such as antidunes, bend scour, local scour, formation of a low-flow thalweg, long-term degradation, and the application of appropriate safety factors.

APPENDIX A

SEDIMENT-GRADATION DATA


% PASSING
100.
80.
60.
40.
20.
0.
#1
#2
#3
#4
#5
10^{-2} 2 3 4 5 6 7 8 9 10^{-1} 2 3 4 5 6 7 8 9 10^{0} 2 3 4 5 6 7 8 9 10^{1} 2 3 4 5 6 7 8 9 10
GRAIN SIZE (MM)

11029 N. 24th AVE., #805
PHOENIX, ARIZONA 85029
(602) 997-6391

SPEEDIE AND ASSOCIATES

GEOTECHNICAL/MATERIALS/SITE ENGINEERS

540 W. IRON AVE., #109
MESA, ARIZONA 85202
(602) 969-6700

REPORT OF LABORATORY TESTS

PROJECT: Cholla Landfill PROJECT NO.: 899990LA DATE: 11-10-89
LOCATION: Agua Fria River Bed
CLIENT: Mathews-Kessler LAB. SAMPLE NO.: 1
BORING NO.: - FIELD SAMPLE NO.: - SAMPLE DEPTH: -
MATERIAL DESCRIPTION: Pit Run
SAMPLED BY: Client DATE: 11-7-89 TESTED BY: KM DATE: 11-7-89
REMARKS: Sample Location - No. 1, Peoria Avenue & Agua Fria River.

MECHANICAL ANALYSIS:

SIEVE SIZE	PER CENT RETAINED (INDIVIDUAL)	PER CENT PASSING (CUMULATIVE)	SPECIFICATION
3 INCH		100	
2½ INCH		92	
2 INCH		92	
1½ INCH		90	
1⅛ INCH			
1 INCH		78	
¾ INCH		72	
½ INCH		63	
⅜ INCH		58	
¼ INCH		51	
NO. 4		48	
NO. 8		41	
NO. 10		39	
NO. 16		33	
NO. 20			
NO. 30		20	
NO. 40		13	
NO. 50		8	
NO. 60			
NO. 100		1	
NO. 200		0.7	

LIQUID LIMIT
PLASTIC LIMIT
PLASTICITY INDEX
SOIL CLASSIFICATION

NATURAL MOISTURE 0.4
UNIT DENSITY
SPECIFIC GRAVITY

ASPHALT CONTENT
% OF TOTAL SAMPLE
% OF DRY WEIGHT

MARSHALL DENSITY
CORE DENSITY

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GEOTECHNICAL/MATERIALS/SITE ENGINEERS

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MESA, ARIZONA 85202
(602) 969-6700

REPORT OF LABORATORY TESTS

PROJECT: Cholla Landfill PROJECT NO.: 899990LA DATE: 11-10-89
LOCATION: Agua Fria River Bed
CLIENT: Mathews-Kessler LAB. SAMPLE NO.: 2
BORING NO.: - FIELD SAMPLE NO.: - SAMPLE DEPTH: -
MATERIAL DESCRIPTION: Pit Run
SAMPLED BY: Client DATE: 11-7-89 TESTED BY: KM DATE: 11-7-89
REMARKS: Sample Location - No. 2, Cactus Road & Agua Fria River.

MECHANICAL ANALYSIS:

SIEVE SIZE	PER CENT RETAINED (INDIVIDUAL)	PER CENT PASSING (CUMULATIVE)	SPECIFICATION
3 INCH		100	
2½ INCH		96	
2 INCH		96	
1½ INCH		93	
1⅛ INCH			
1 INCH		85	
¾ INCH		77	
½ INCH		66	
⅜ INCH		59	
¼ INCH		50	
NO. 4		45	
NO. 8		33	
NO. 10		31	
NO. 16		24	
NO. 20			
NO. 30		19	
NO. 40		17	
NO. 50		15	
NO. 60			
NO. 100		6	
NO. 200		1.8	

LIQUID LIMIT
PLASTIC LIMIT
PLASTICITY INDEX
SOIL CLASSIFICATION

NATURAL MOISTURE
UNIT DENSITY
SPECIFIC GRAVITY

ASPHALT CONTENT
% OF TOTAL SAMPLE
% OF DRY WEIGHT

MARSHALL DENSITY
CORE DENSITY

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MESA, ARIZONA 85202
(602) 969-6700

REPORT OF LABORATORY TESTS

PROJECT: Cholla Landfill PROJECT NO.: 899990LA DATE: 11-10-89
LOCATION: Agua Fria River Bed
CLIENT: Mathews-Kessler LAB. SAMPLE NO.: 3
BORING NO.: - FIELD SAMPLE NO.: - SAMPLE DEPTH: -
MATERIAL DESCRIPTION: Pit Run
SAMPLED BY: Client DATE: 11-7-89 TESTED BY: - DATE: 11-7-89
REMARKS: Sample Location - No. 3, 500 ft. Upstream of Olive Avenue.

MECHANICAL ANALYSIS:

SIEVE SIZE	PER CENT RETAINED (INDIVIDUAL)	PER CENT PASSING (CUMULATIVE)	SPECIFICATION
3½ INCH		100	
3 INCH		86	
2½ INCH		86	
2 INCH		84	
1½ INCH		80	
1⅛ INCH			
1 INCH		70	
¾ INCH		61	
½ INCH		53	
⅜ INCH		49	
¼ INCH		44	
NO. 4		41	
NO. 8		35	
NO. 10		34	
NO. 16		27	
NO. 20			
NO. 30		17	
NO. 40		13	
NO. 50		9	
NO. 60			
NO. 100		3	
NO. 200		1.4	

LIQUID LIMIT
PLASTIC LIMIT
PLASTICITY INDEX
SOIL CLASSIFICATION

NATURAL MOISTURE
UNIT DENSITY
SPECIFIC GRAVITY

ASPHALT CONTENT
% OF TOTAL SAMPLE
% OF DRY WEIGHT

MARSHALL DENSITY
CORE DENSITY

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SPEEDIE AND ASSOCIATES

GEOTECHNICAL/MATERIALS/SITE ENGINEERS

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MESA, ARIZONA 85202
(602) 969-6700

REPORT OF LABORATORY TESTS

PROJECT: Cholla Landfill PROJECT NO.: 899990LA DATE: 11-10-89
LOCATION: Aqua Fria River Bed
CLIENT: Mathews-Kessler LAB. SAMPLE NO.: 4
BORING NO.: - FIELD SAMPLE NO.: - SAMPLE DEPTH: -
MATERIAL DESCRIPTION: Pit Run
SAMPLED BY: Client DATE: 11-7-89 TESTED BY: KM DATE: 11-7-89
REMARKS: Sample Location - No. 4, approximately 1/2 mile downstream of Olive Avenue.

MECHANICAL ANALYSIS:

SIEVE SIZE	PER CENT RETAINED (INDIVIDUAL)	PER CENT PASSING (CUMULATIVE)	SPECIFICATION
3½ INCH		100	
3 INCH		89	
2½ INCH		85	
2 INCH		82	
1½ INCH		80	
1⅛ INCH			
1 INCH		73	
¾ INCH		69	
½ INCH		62	
⅜ INCH		58	
¼ INCH		53	
NO. 4		50	
NO. 8		45	
NO. 10		44	
NO. 16		40	
NO. 20			
NO. 30		30	
NO. 40		22	
NO. 50		14	
NO. 60			
NO. 100		4	
NO. 200		0.7	

LIQUID LIMIT
PLASTIC LIMIT
PLASTICITY INDEX
SOIL CLASSIFICATION

NATURAL MOISTURE
UNIT DENSITY
SPECIFIC GRAVITY

ASPHALT CONTENT
% OF TOTAL SAMPLE
% OF DRY WEIGHT

MARSHALL DENSITY
CORE DENSITY

11029 N. 24th AVE., #805
PHOENIX, ARIZONA 85029
(602) 997-6391

SPEEDIE AND ASSOCIATES

GEOTECHNICAL/MATERIALS/SITE ENGINEERS

540 W. IRON AVE., #109
MESA, ARIZONA 85202
(602) 969-6700

REPORT OF LABORATORY TESTS

PROJECT: Cholla Landfill PROJECT NO.: 899990LA DATE: 11-10-89
LOCATION: Agua Fria River Bed
CLIENT: Mathews-Kessler LAB. SAMPLE NO.: 5
BORING NO.: - FIELD SAMPLE NO.: - SAMPLE DEPTH: -
MATERIAL DESCRIPTION: Pit Run
SAMPLED BY: Client DATE: 11-7-89 TESTED BY: KM DATE: 11-7-89
REMARKS: Sample Location - No. 5, 500 ft. upstream of Northern Avenue.

MECHANICAL ANALYSIS:

SIEVE SIZE	PER CENT RETAINED (INDIVIDUAL)	PER CENT PASSING (CUMULATIVE)	SPECIFICATION
3 INCH		100	
2½ INCH		89	
2 INCH		87	
1½ INCH		85	
1⅛ INCH			
1 INCH		77	
¾ INCH		71	
½ INCH		65	
⅜ INCH		61	
¼ INCH		57	
NO. 4		54	
NO. 8		48	
NO. 10		46	
NO. 16		39	
NO. 20			
NO. 30		23	
NO. 40		15	
NO. 50		11	
NO. 60			
NO. 100		5	
NO. 200		1.6	

LIQUID LIMIT
PLASTIC LIMIT
PLASTICITY INDEX
SOIL CLASSIFICATION

NATURAL MOISTURE
UNIT DENSITY
SPECIFIC GRAVITY

ASPHALT CONTENT
% OF TOTAL SAMPLE
% OF DRY WEIGHT

MARSHALL DENSITY
CORE DENSITY

APPENDIX B

DETAILED QUASED OUTPUT

QUASED

Quasi-Dynamic Sediment Routing Model

Simons, Li & Assoc.

Run Date : 11/14/1989
Run Time : 9:47:12

Input/Output files for :

HEC-2 for sediment transport analysis
AGUA FRIA RIVER
SLA JOB NO. PAZ-MKA-01 : File Name AGUAFRIA.DAT

APPENDIX B

SEDIMENT-ROUTING ANALYSIS FOR CHOLLA LANDFILL EROSION-PROTECTION MEASURES

```
AC
AC
AC
T1 HEC-2 for sediment transport analysis
T2 AGUA FRIA RIVER
T3 SLA JOB NO. PAZ-MKA-01 : File Name AGUAFRIA.DAT
J1   -10      2      0      0     -1      0      0      0     60      0
J2    -1      0     -1      0      0      0      0      0      0      0
J5    38      1      8     26      5     43     39     14     21     22
J3    33
J5   -10    -10
QT     1   5000
NC 0.045  0.055  0.035    0.1    0.3
X1 11.43     42   9694  10153      0      0      0
GR  61.4   5900   61.4   5940   50.1   5986   50.4   6051   55.1   6092
GR  49.3   6117   50.7   6212   50.9   6380   51.1   6549   51.0   6731
GR  50.9   6887   50.3   7027   49.4   7161   49.6   7308   49.7   7431
GR  49.5   7560   50.3   7712   50.6   7861   51.2   7984   50.6   8002
GR  50.5   8179   51.2   8349   51.3   8504   48.7   8619   48.7   9240
GR  57.2   9307   42.9   9369   41.7   9463   40.1   9532   39.6   9613
GR  47.4   9661   47.8   9694   39.3   9730   39.6   9779   43.8   9823
GR  43.7   9844   42.5   9863   42.5  10000   42.8  10103   59.1  10153
GR  62.3  10239   62.6  10362
X1 11.52     36   9873  10117    500    500    500
GR  52.4   5930   52.0   5988   55.4   6027   50.7   6060   51.7   6182
GR  51.2   6305   51.9   6462   50.8   6571   50.9   6715   51.0   6849
GR  51.8   6962   48.2   7089   50.0   7210   50.4   7345   50.6   7465
GR  50.4   7550   50.8   7652   52.4   7800   52.6   7916   51.9   7950
GR  51.9   8550   49.5   8600   49.5   9501   49.3   9665   49.3   9745
GR  53.5   9840   54.1   9873   42.4   9922   45.6   9964   45.6  10000
GR  45.6  10082   58.5  10117   62.5  10209   63.8  10315   65.6  10431
GR  66.9  10534
X1 11.62     46   9870  10089    500    500    500
GR  52.4   5860   54.7   5967   58.8   5994   53.7   6019   53.6   6064
GR  52.7   6192   53.0   6324   53.4   6450   52.6   6562   51.7   6658
GR  52.4   6780   50.1   6842   53.3   6902   53.8   7049   51.7   7109
GR  51.6   7181   52.2   7326   52.7   7486   53.1   7659   52.7   7802
GR  52.0   7893   52.8   7910   52.8   8060   55.9   8257   55.4   8399
GR  54.7   8475   50.3   8536   50.3   9150   60.3   9184   56.8   9253
GR  55.2   9366   55.8   9495   56.4   9637   55.8   9735   55.8   9832
GR  57.2   9870   47.3   9908   46.9   9956   45.9  10000   45.2  10031
GR  59.8  10089   62.5  10167   66.9  10296   72.1  10355   70.3  10423
GR  73.6  10509
X1 11.71     29   9918  10125    490    490    490
GR  56.0   5840   55.9   5945   61.9   5993   54.3   6022   52.9   6106
GR  52.9   7380   53.7   7870   53.7   8290   57.4   8459   51.0   9023
GR  51.0   9087   55.8   9129   56.8   9292   58.5   9424   58.1   9510
GR  57.0   9659   56.5   9787   56.2   9891   58.0   9906   58.0   9918
GR  47.7   9964   47.7  10000   49.0  10094   61.4  10125   63.2  10156
GR  62.3  10169   71.5  10224   74.6  10280   75.7  10485
X1 11.80     46   9893  10110    425    425    425
GR  67.1   5780   59.5   5793   56.6   5830   56.5   5946   59.8   5964
GR  51.8   5983   51.7   5996   56.2   6015   56.2   6032   56.5   6147
GR  54.7   6200   54.7   7200   54.6   7406   59.6   7529   58.4   7629
GR  54.9   7711   54.7   7825   54.1   7909   54.2   8003   63.1   8113
GR  61.9   8139   65.5   8163   66.5   8224   56.7   8280   51.6   8480
GR  51.6   8950   64.5   8998   72.8   9070   61.9   9175   60.0   9249
GR  60.3   9379   59.9   9514   60.2   9635   60.8   9771   59.9   9852
GR  62.2   9893   49.3   9925   49.0  10000   49.0  10062   60.0  10110
GR  63.6  10163   72.3  10233   76.2  10302   75.0  10388   72.1  10447
GR  74.2  10502
X1 11.89     41   9913  10128    480    480    480
GR  62.9   5830   59.7   5844   61.5   5860   55.0   5902   57.0   5972
GR  56.9   6041   61.7   6075   56.7   6097   56.7   6800   47.9   6820
GR  47.9   8121   48.3   8190   46.1   8228   47.6   8328   46.2   8367
GR  49.2   8511   49.2   8645   49.2   8752   63.8   8805   60.1   9000
GR  60.3   9149   78.5   9300   79.5   9357   77.3   9503   71.7   9520
GR  69.7   9567   73.5   9600   57.4   9650   62.5   9723   62.4   9825
GR  62.5   9913   51.8   9943   51.8  10000   51.8  10064   57.0  10095
GR  66.6  10128   75.9  10212   76.9  10294   73.8  10377   77.8  10464
GR  84.2  10533
X1 11.99     47   9895  10053    520    520    520
GR  58.5   5350   58.5   5452   59.3   5569   59.3   5675   58.9   5787
GR  59.3   5885   61.4   5923   58.7   6000   60.7   6088   57.5   6180
GR  57.5   6850   46.6   6900   46.6   8150   50.9   8180   49.9   8328
GR  49.7   8437   48.2   8506   49.0   8585   53.7   8646   53.7   8804
GR  52.9   8930   53.3   9086   54.1   9231   55.3   9365   55.6   9500
GR  56.2   9628   56.9   9745   57.3   9801   54.8   9809   54.8   9819
GR  63.3   9858   62.7   9895   52.2   9937   52.2  10000   52.2  10042
```

GR	63.8	10053	72.6	10122	76.9	10168	76.7	10240	70.1	10278
GR	76.9	10317	78.1	10372	75.9	10422	80.9	10491	80.6	10525
GR	76.3	10549	74.5	10590						
X1	12.08	49	9904	10090	490	490	490			
GR	59.5	5000	59.6	5057	59.7	5169	59.7	5339	59.0	5505
GR	59.1	5656	58.8	5826	58.5	5966	60.3	6017	63.2	6046
GR	60.5	6072	61.7	6180	61.4	6227	57.5	6759	57.6	6795
GR	54.9	8209	54.8	8354	53.9	8446	53.4	8529	53.9	8666
GR	53.5	8751	49.7	8781	50.7	8891	54.1	8997	55.2	9116
GR	53.5	9225	50.1	9258	51.6	9339	53.5	9465	54.1	9584
GR	58.9	9638	59.7	9680	53.8	9702	53.8	9812	61.7	9870
GR	62.0	9904	52.9	9952	52.9	10000	52.9	10042	67.0	10090
GR	66.3	10154	67.6	10197	66.9	10238	70.1	10299	70.9	10373
GR	74.4	10440	77.3	10568	81.4	10703	85.8	10770		
X1	12.18	63	9914	10091	470	470	470			
GR	59.7	4700	59.7	4857	60.1	4995	60.4	5093	60.4	5238
GR	60.8	5385	60.8	5529	60.9	5673	61.1	5860	61.1	6007
GR	61.6	6143	63.2	6224	63.4	6237	61.1	6278	63.4	6385
GR	63.3	6439	60.9	6475	59.1	6500	59.1	7050	45.9	7168
GR	45.8	7248	46.5	7435	46.8	7541	46.2	7612	46.7	7684
GR	46.0	7727	49.3	7764	49.8	7925	50.1	8056	47.9	8104
GR	48.9	8240	49.9	8375	49.8	8533	49.6	8679	50.2	8816
GR	50.1	8905	49.5	9012	51.7	9091	51.7	9170	49.3	9478
GR	53.3	9491	54.7	9515	51.6	9580	52.2	9637	55.5	9688
GR	55.4	9820	60.6	9852	61.6	9895	62.6	9914	53.9	9955
GR	53.9	10000	53.9	10044	65.9	10091	68.5	10187	71.5	10258
GR	71.5	10364	72.8	10472	75.2	10585	79.0	10658	79.6	10735
GR	78.6	10817	79.5	10870	80.0	10918				
NC	.04	.04	.03	.1	.3					
X1	12.27	39.0	9148.0	10137.0	460	460	460			
GR	61.3	5800.0	61.4	5827.0	63.2	6431.0	66.6	6452.0	63.0	6468.0
GR	63.0	6639.0	72.0	6665.0	59.9	6750.0	59.9	7150.0	62.3	7224.0
GR	69.3	7255.0	58.0	7290.0	55.1	7553.0	62.2	7658.0	52.0	7718.0
GR	52.7	7785.0	62.7	7871.0	62.5	7940.0	51.9	8017.0	52.0	8137.0
GR	56.7	8242.0	53.1	8348.0	52.0	8435.0	52.0	8520.0	64.5	8732.0
GR	63.6	9126.0	66.7	9148.0	51.8	9210.0	51.5	9268.0	57.3	9291.0
GR	58.6	9475.0	52.4	9559.0	55.7	9778.0	54.0	10000.0	52.8	10057.0
GR	65.1	10137.0	72.2	10634.0	78.2	11190.0	86.0	11383.0		
X1	12.38	28.0	9379.0	10302	465	465	465			
GR	64.9	6240.0	64.9	7002.0	64.9	7519.0	58.8	7538.0	59.1	7761.0
GR	64.6	7806.0	63.0	8056.0	57.9	8112.0	62.6	8159.0	57.8	8303.0
GR	57.8	8562.0	65.0	8628.0	66.3	9110.0	64.8	9294.0	62.3	9338.0
GR	64.2	9379.0	55.9	9491.0	53.7	9566.0	62.0	9621.0	57.6	9676.0
GR	55.7	9850.0	53.3	10000.0	53.4	10035.0	60.4	10086.0	56.7	10286.0
GR	68.9	10302.0	72.6	10857.0	78.2	11420.0				
X1	12.46	22.0	9502	10351	495	495	495			
GR	66.0	6590.0	66.1	7664.0	61.9	7689.0	65.6	7714.0	66.2	7807.0
GR	60.9	7823.0	61.4	8015.0	65.4	8073.0	64.5	8311.0	59.2	8403.0
GR	61.8	8531.0	59.9	8643.0	65.3	8676.0	68.3	9156.0	65.5	9502.0
GR	57.8	9551.0	58.8	10000.0	60.1	10300.0	54.6	10324.0	68.8	10351.0
GR	73.6	10944.0	78.2	11370.0						
X1	12.56	23.0	9873	10626	505	505	505			
GR	67.6	6940.0	67.7	7227.0	69.3	7760.0	64.0	7815.0	64.0	7959.0
GR	76.6	8070.0	68.8	8112.0	66.6	8215.0	62.7	8235.0	65.2	8302.0
GR	66.2	8445.0	63.0	8616.0	64.6	8781.0	67.6	8835.0	67.2	9451.0
GR	58.6	9480.0	60.4	9873.0	58.6	10000.0	62.5	10194.0	62.3	10550.0
GR	68.5	10626.0	72.7	10739.0	76.3	11275.0				
NC	.045	.045								
X1	12.65	24.0	9548	10392	500	500	500			
GR	69.3	7330.0	69.3	7451.0	64.0	7544.0	64.0	8150.0	66.7	8186.0
GR	67.2	8371.0	67.8	8803.0	68.3	9229.0	75.1	9250.0	76.0	9428.0
GR	70.0	9508.0	69.7	9548.0	59.5	9570.0	59.7	10000.0	63.3	10157.0
GR	63.3	10354.0	74.2	10392.0	74.2	10421.0	68.0	10472.0	68.0	10566.0
GR	69.9	10604.0	68.0	10648.0	68.0	10700.0	76.2	11260.0		
X1	12.75	32.0	9541	10228	495	495	495			
GR	66.1	7720.0	66.2	7875.0	66.8	7885.0	68.1	8084.0	66.0	8100.0
GR	66.0	8250.0	72.5	8280.0	73.5	8363.0	68.7	8476.0	70.8	8573.0
GR	67.5	8658.0	69.4	9053.0	70.4	9541.0	64.6	9564.0	64.5	9605.0
GR	61.2	9621.0	61.9	10000.0	63.8	10165.0	70.9	10228.0	66.1	10254.0
GR	79.5	10297.0	78.7	10344.0	70.0	10387.0	70.0	10414.0	70.0	10885.0
GR	77.6	10907.0	70.0	10973.0	70.0	11013.0	77.7	11047.0	77.7	11077.0
GR	74.8	11099.0	75.9	11210.0						
X1	12.84	26.0	9640	10208	495	485	490			
GR	68.0	8090.0	68.0	8098.0	69.8	8172.0	64.2	8206.0	69.0	8232.0
GR	65.1	8256.0	70.1	8308.0	73.8	8390.0	70.0	8436.0	70.9	8659.0
GR	71.7	8922.0	68.8	8957.0	69.0	9411.0	71.2	9458.0	71.2	9640.0
GR	64.6	9680.0	63.6	10000.0	62.8	10115.0	66.8	10134.0	65.7	10156.0
GR	81.9	10208.0	82.2	10255.0	72.0	10289.0	72.0	10425.0	72.0	10999.0
GR	75.7	11200.0								
X1	12.94	17.0	9701	10209	500	500	500			

GR	73.0	8380.0	72.5	8711.0	70.0	8732.0	70.0	9640.0	71.5	9659.0
GR	70.8	9701.0	64.2	9732.0	64.2	10180.0	82.6	10209.0	82.6	10266.0
GR	76.0	10285.0	76.0	10927.0	80.0	11358.0	83.1	11908.0	87.8	11937.0
GR	88.8	12354.0	91.3	12392.0						
X1	13.03	11.0	9763	10322	505	505	505			
GR	72.0	8650.0	72.2	9763.0	65.6	9801.0	65.6	9830.0	65.6	9835.0
GR	65.6	10284.0	84.1	10322.0	84.5	10371.0	75.7	10420.0	76.5	10826.0
GR	77.3	10925.0								
NC	.04									
X1	13.13	13.0	9784	10413	490	490	490			
GR	74.9	8810.0	74.8	8855.0	76.2	8914.0	76.3	9247.0	72.2	9290.0
GR	73.9	9477.0	74.8	9784.0	67.0	9797.0	67.0	10385.0	85.9	10413.0
GR	85.4	10546.0	80.0	10556.0	80.0	10830.0				
NC				.3	.5					
X1	13.22	11.0	9743	10511	485	485	485			
GR	77.7	8965.0	77.5	9159.0	76.7	9375.0	72.8	9405.0	75.1	9743.0
GR	68.4	9762.0	68.4	10466.8	75.1	10511.0	85.3	10544.0	92.0	10619.0
GR	93.0	10740.0								
X1	13.31	8.0	9461	10677	490	490	490			
GR	78.2	9130.0	77.8	9374.0	76.8	9461.0	69.8	9526.0	71.2	10000.0
GR	71.2	10340.0	76.2	10615.0	91.4	10677.0				
X1	13.32	9.0	9130.0	10655.0	100	100	100			
GR	87.9	9125.0	87.7	9130.0	76.7	9163.0	70.9	9448.0	70.9	9748.0
GR	70.9	10000.0	70.9	10245.0	77.8	10515.0	84.8	10655.0		
NC		.04		.1	.3					
X1	13.43	18.0	9123	10760	605	605	605			
GR	77.9	8600.0	75.1	8626.0	80.1	8731.0	80.1	9123.0	75.1	9171.0
GR	75.1	9396.0	73.7	9449.0	73.6	9563.0	76.9	9917.0	77.2	10000.0
GR	74.7	10248.0	73.0	10636.0	73.2	10739.0	87.3	10760.0	90.9	10833.0
GR	77.2	10925.0	89.8	11042.0	90.8	11150.0				
X1	13.53	22.0	9323	10926	500	500	500			
GR	77.8	8060.0	77.3	8195.0	80.4	8325.0	81.9	8591.0	80.9	9092.0
GR	80.9	9323.0	75.9	9363.0	74.8	9609.0	77.8	9934.0	77.5	9943.0
GR	77.9	10000.0	78.2	10092.0	76.6	10223.0	78.8	10257.0	78.9	10403.0
GR	74.1	10520.0	75.5	10654.0	74.7	10852.0	87.7	10926.0	89.7	11026.0
GR	94.3	11132.0	94.1	11620.0						
X1	13.62	31.0	9313	10950	490	490	490			
GR	84.0	7470.0	84.0	7485.0	78.8	7531.0	82.4	7582.0	83.8	7703.0
GR	79.5	7778.0	82.5	7814.0	83.8	7975.0	80.2	7992.0	82.4	8040.0
GR	78.8	8155.0	83.8	8237.0	83.6	8578.0	83.6	9003.0	80.9	9244.0
GR	83.8	9313.0	78.9	9375.0	79.1	9690.0	75.7	10000.0	75.7	10099.0
GR	77.5	10121.0	79.5	10313.0	78.3	10479.0	76.3	10865.0	90.8	10950.0
GR	94.4	11104.0	92.2	11203.0	92.0	11355.0	94.6	11441.0	96.2	11775.0
GR	96.9	12040.0								
X1	13.72	28.0	9154	10756	490	490	490			
GR	82.0	6850.0	81.0	6939.0	85.4	7162.0	80.1	7245.0	84.5	7281.0
GR	81.1	7492.0	84.9	7635.0	81.5	7807.0	84.3	7846.0	82.4	8113.0
GR	79.6	8148.0	83.4	8194.0	81.4	8258.0	84.7	8373.0	84.4	8943.0
GR	82.3	8997.0	86.2	9154.0	81.1	9290.0	80.5	9533.0	78.3	9681.0
GR	79.7	9738.0	77.4	10000.0	78.7	10158.0	76.7	10679.0	91.2	10756.0
GR	86.2	10868.0	93.9	10966.0	96.4	11780.0				
X1	13.81	30.0	9250	10525	490	490	490			
GR	99.0	6280.0	88.1	6333.0	83.9	6543.0	85.6	6895.0	85.6	7105.0
GR	82.3	7145.0	85.1	7198.0	80.5	7254.0	85.4	7285.0	83.6	7601.0
GR	84.8	7867.0	83.6	8402.0	85.4	8555.0	83.0	8776.0	86.0	8816.0
GR	85.3	9250.0	81.7	9271.0	81.5	9580.0	78.6	9597.0	78.6	10000.0
GR	78.4	10183.0	82.8	10226.0	80.2	10454.0	85.1	10525.0	87.0	10634.0
GR	99.6	10738.0	95.4	10896.0	96.7	11458.0	99.1	11517.0	99.1	11575.0
X1	13.90	45.0	9255	10431	495	505	500			
GR	119.3	5180.0	117.3	5313.0	117.3	5352.0	119.4	5406.0	118.2	5607.0
GR	120.4	5631.0	116.7	5787.0	116.7	5971.0	105.2	6001.0	109.9	6019.0
GR	81.5	6143.0	86.7	6168.0	86.3	6498.0	84.6	6797.0	88.0	6821.0
GR	85.9	6850.0	87.5	7232.0	84.0	7336.0	81.6	7362.0	85.9	7452.0
GR	84.9	7675.0	87.0	7721.0	85.6	8354.0	83.3	8515.0	86.2	8582.0
GR	83.6	8663.0	88.2	8732.0	87.5	9255.0	83.6	9289.0	83.6	9345.0
GR	80.4	9407.0	80.4	9584.0	82.9	9743.0	83.0	9867.0	79.3	10000.0
GR	79.9	10135.0	84.4	10158.0	81.5	10340.0	87.6	10431.0	89.1	10907.0
GR	98.0	11010.0	99.3	11447.0	100.2	11479.0	100.9	12111.0	101.7	12297.0
X1	14.00	30.0	9197	10433	400	585	510			
GR	116	5810	112	5965	104	5985	100	5990	88	6010
GR	87.5	6275	84	6515	83	6675	84	6800	88	7015
GR	89	7210	88	7425	87	7845	84.4	8645	88	8790
GR	89.7	9000	89.9	9197.0	80.3	9235.0	80.4	9412.0	80.9	9530.0
GR	83.1	9726.0	82.9	10000.0	80.9	10211.0	83.8	10239.0	83.9	10368.0
GR	88.3	10433.0	92.0	11228.0	99.2	11354.0	101.4	12110.0	102.8	12344.0
X1	14.10	38.0	9039	10300	390	610	510			
GR	120	5815	116	5835	100	5875	92	5915	88	6205
GR	87	6260	88	6300	88.8	6485	88	6690	86	6835
GR	88	6970	89.3	7285	88	7665	85.8	7810	88	8050
GR	88	8450	85.1	8760	88	8815	88.6	8930	89.6	9039.0

GR	81.8	9068.0	82.3	9208.0	85.9	9333.0	83.6	9404.0	85.5	9438.0
GR	85.2	9622.0	82.0	9682.0	84.3	9734.0	84.5	9849.0	83.5	10000.0
GR	81.5	10269.0	86.6	10300.0	94.4	10560.0	96.0	10910.0	96.3	11567.0
GR	100.2	11671.0	102.0	12177.0	104.4	12392.0				
X1	14.19	33.0	8850	10354	350	560	470			
GR	120	5915	100	6000	92	6020	88	6380	88	6420
GR	89.5	6575	88	6865	90.7	7325	88	7845	86.3	8000
GR	88	8085	89.6	8365	88	8670	86	8765	88	8800
GR	89	8850	83.2	8918.0	82.4	9015.0	85.1	9089.0	82.8	9177.0
GR	87.0	9425.0	85.0	9763.0	83.5	10000.0	83.5	10112.0	88.8	10136.0
GR	88.6	10354.0	88.3	10584.0	94.7	10620.0	96.0	10980.0	96.9	11350.0
GR	98.4	11691.0	104.6	11854.0	105.4	12352.0				
X1	14.28	36.0	8925	10320	385	590	500			
GR	116	5925	112	6050	104	6090	100	6100	96	6150
GR	92	6410	91.5	6920	92	7500	88	8070	87	8135
GR	88	8205	91	8475	88	8745	87.5	8770	88	8830
GR	90.4	8880	90.3	8925.0	84.1	8970.0	84.6	9115.0	86.7	9262.0
GR	87.3	9388.0	88.4	9612.0	85.7	9831.0	83.6	10000.0	83.6	10063.0
GR	89.5	10084.0	89.9	10320.0	89.4	10670.0	94.0	10848.0	94.9	11052.0
GR	98.7	11181.0	92.0	11227.0	95.1	11266.0	102.3	12066.0	106.1	12522.0
GR	104.6	12724.0								
X1	14.38	36.0	9071	10691	390	515	475			
GR	114	6715	112	6750	104	6765	100	6790	92	6830
GR	91	6950	92	7095	93.3	7380	92	7990	92	8125
GR	98	8210	88	8260	92	8390	92	8525	91	8715
GR	92	8985	92.3	9071.0	87.5	9095.0	84.9	9381.0	89.1	9458.0
GR	88.0	9838.0	84.4	10000.0	84.4	10065.0	92.0	10085.0	92.6	10234.0
GR	90.5	10369.0	86.9	10445.0	87.3	10571.0	97.0	10691.0	98.7	11028.0
GR	96.0	11319.0	96.0	11605.0	98.6	11704.0	102.9	12300.0	105.5	12986.0
GR	107.2	13055.0								
X1	14.47	37.0	9240	10658	470	485	485			
GR	118	7195	116	7320	112	7345	104	7365	100	7370
GR	96	7390	92	8350	90	8425	92	8550	93.3	8710
GR	92	8850	90	8920	92	9030	92.7	9165	93.4	9240.0
GR	89.1	9268.0	89.1	9539.0	87.8	9876.0	85.2	10000.0	87.4	10144.0
GR	91.9	10220.0	92.2	10480.0	88.4	10611.0	96.9	10658.0	98.6	10967.0
GR	95.9	11242.0	97.6	11363.0	100.7	11900.0	103.9	12258.0	101.0	12617.0
GR	100.7	12909.0	105.1	12929.0	105.6	12988.0	100.9	13049.0	105.7	13332.0
GR	107.7	13355.0	108.1	13379.0						
X1	14.56	31.0	9375	10674	450	505	475			
GR	116	7800	112	7820	100	7850	96	7890	92	8630
GR	90	8700	92	8790	94.2	9285	94.9	9375.0	91.0	9403.0
GR	91.0	9562.0	87.8	9953.0	88.1	10000.0	88.1	10146.0	92.3	10255.0
GR	94.2	10674.0	88.6	10906.0	97.3	10988.0	99.7	11469.0	103.3	11510.0
GR	102.9	11561.0	95.8	11663.0	98.8	11816.0	104.1	12410.0	103.7	12677.0
GR	103.6	12914.0	101.5	13190.0	99.1	13232.0	105.1	13457.0	108.6	13704.0
GR	108.6	13742.0								
X1	14.66	34.0	9454	10656	405	510	500			
GR	120	8090	100	8205	100	8290	96	8525	94	8600
GR	94.6	9250	94.4	9454.0	90.9	9627.0	90.5	9827.0	88.3	9853.0
GR	88.2	10000.0	88.2	10171.0	95.2	10289.0	94.9	10656.0	92.0	10843.0
GR	96.0	10980.0	93.3	11123.0	96.5	11190.0	96.5	11220.0	93.4	11254.0
GR	91.4	11386.0	91.4	11458.0	99.1	11738.0	103.6	12460.0	103.8	12694.0
GR	101.0	12804.0	102.7	12975.0	97.6	13046.0	105.6	13165.0	105.4	13456.0
GR	102.2	13717.0	99.2	13754.0	106.7	13814.0	108.3	14108.0		
X1	14.75	32.0	9283	10255	425	440	470			
GR	120	8620	100	8710	96	8880	93.5	8975	95.8	9160
GR	94.9	9283.0	90.5	9459.0	91.8	9486.0	94.1	9515.0	89.2	9680.0
GR	90.7	9827.0	87.6	9860.0	88.0	10000.0	89.6	10198.0	97.9	10255.0
GR	97.3	10717.0	95.5	11338.0	97.6	11374.0	94.0	11660.0	94.1	11832.0
GR	100.1	11949.0	103.8	12571.0	99.9	12628.0	100.9	12734.0	103.0	12911.0
GR	105.4	13362.0	103.6	13617.0	100.4	13670.0	100.4	13772.0	109.1	13899.0
GR	109.2	14217.0	109.2	14292.0						
X1	14.85	37.0	9106	10454	540	450	500			
GR	126.8	7870.0	130.3	8231.0	131.5	8555.0	129.3	8905.0	109.1	8978.0
GR	109.1	9053.0	109.1	9106.0	96.7	9197.0	96.6	9259.0	98.5	9354.0
GR	93.6	9431.0	93.5	9545.0	95.7	9695.0	94.3	9862.0	90.5	10000.0
GR	90.5	10077.0	95.6	10178.0	92.8	10404.0	100.9	10454.0	100.0	10870.0
GR	100.4	11172.0	99.7	11409.0	95.9	11456.0	96.9	11575.0	99.9	11720.0
GR	98.0	12018.0	98.8	12225.0	104.1	12350.0	104.3	12771.0	106.2	12981.0
GR	104.0	13275.0	104.0	13521.0	104.0	13777.0	111.1	13842.0	109.6	13895.0
GR	112.3	14491.0	113.0	14537.0						
X1	14.94	39.0	9140	10772	470	470	470			
GR	128.8	7130.0	129.4	7664.0	130.1	8199.0	126.6	8655.0	125.5	8818.0
GR	127.9	9140.0	99.1	9207.0	97.8	9308.0	93.4	9327.0	93.5	9428.0
GR	98.0	9604.0	94.9	9921.0	91.0	10000.0	91.0	10107.0	96.2	10127.0
GR	95.5	10430.0	94.8	10691.0	101.0	10772.0	101.8	11056.0	100.6	11341.0
GR	96.9	11486.0	101.9	11664.0	101.8	11970.0	98.2	12274.0	100.4	12471.0
GR	103.2	12548.0	103.7	12714.0	100.0	12761.0	100.0	12839.0	101.7	12862.0
GR	104.6	13038.0	105.9	13298.0	108.0	13844.0	108.2	14020.0	108.2	14322.0

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GR 108.2 14521.0   110.7 14669.0   109.1 14693.0   114.5 14821.0
X1 15.04    35.0    9277   10653     490     490     490
GR 129.1  7425.0   131.1  8149.0   130.8  8614.0   130.4  8893.0   130.9  9277.0
GR 102.7  9332.0   104.3  9426.0    93.9  9498.0    93.9  9541.0    97.0  9644.0
GR  97.5  9772.0    94.9  9968.0    91.7 10000.0    91.7 10060.0   100.2 10106.0
GR  97.8 10337.0    99.6 10653.0    97.5 11012.0   103.4 11088.0   101.8 11399.0
GR  99.0 11631.0   102.1 11691.0   104.6 12248.0   108.4 12275.0   107.5 12321.0
GR 100.5 12497.0    98.3 12533.0   105.6 12753.0   106.0 13055.0    99.7 13184.0
GR 107.5 13490.0   109.6 13772.0   111.9 14455.0   114.6 14926.0   115.2 15017.0
X1 15.13    38.0    9493   10652     520     435     480
GR 129.9  7855.0   131.9  8500.0   132.8  8982.0   130.8  9195.0   114.4  9252.0
GR 120.7  9291.0   115.9  9317.0   131.7  9406.0   130.7  9493.0    97.5  9552.0
GR  95.1  9869.0    96.8  9908.0    95.0  9956.0    91.4 10000.0    91.4 10030.0
GR 100.0 10059.0   101.2 10157.0    99.1 10499.0   102.1 10652.0   100.9 10975.0
GR  98.1 11192.0   100.1 11215.0   100.1 11335.0   103.0 11362.0   101.7 11682.0
GR 104.2 12126.0   105.9 12463.0   102.2 12745.0   105.4 13126.0   108.5 13288.0
GR 109.3 13605.0   110.2 13657.0   112.0 13925.0   109.8 13982.0   111.5 14091.0
GR 113.0 14553.0   116.1 15159.0   117.2 15229.0
X1 15.23    34.0    9740   10969     525     450     490
GR 129.3  7855.0   132.8  8542.0   134.1  9085.0   135.0  9478.0   131.2  9740.0
GR  96.9  9800.0    95.3  9866.0    94.9 10000.0   101.5 10085.0   100.4 10230.0
GR 101.5 10388.0   102.7 10969.0   100.3 11058.0   102.0 11187.0   101.4 11369.0
GR  99.3 11394.0   101.7 11473.0   101.6 11541.0   103.8 11562.0   105.1 11985.0
GR 106.2 12334.0   109.1 12645.0   103.6 12757.0   103.3 12807.0   105.9 12847.0
GR 106.6 13239.0   108.6 13503.0   111.2 13540.0   109.8 13663.0   110.6 13946.0
GR 112.2 14371.0   114.4 14867.0   117.5 15343.0   119.4 15407.0
X1 15.32      36    9681   10640     530     440     490
GR 130.8  8550.0   130.2  8960.0   123.1  9017.0   123.1  9350.0   130.0  9421.0
GR 130.3  9681.0    97.2  9832.0    96.7  9930.0    93.5 10000.0   101.5 10078.0
GR  99.0 10111.0   101.9 10262.0   102.2 10464.0    99.9 10548.0   102.6 10640.0
GR 104.0 11166.0   101.6 11192.0   101.7 11269.0   103.6 11329.0   103.8 11469.0
GR 101.0 11607.0   106.0 11762.0   106.0 12259.0   108.8 12799.0   108.4 13228.0
GR 110.7 13486.0   114.4 13529.0   114.6 13551.0   111.0 13578.0   111.0 13644.0
GR 112.5 13701.0   112.0 14045.0   115.0 14555.0   113.8 14647.0   116.7 15208.0
GR 120.3 15704.0
NC   .04     .04     .03      .1      .3
X1 15.42    31.0    9700   10692     500     495     495
GR 132.8  8470.0   133.3  8939.0   134.0  9386.0   127.3  9476.0   124.1  9566.0
GR 124.1  9625.0   129.4  9675.0   129.1  9700.0    99.6  9758.0    98.3  9981.0
GR 195.8 10000.0    94.1 10039.0   104.1 10151.0   104.3 10333.0   102.2 10638.0
GR 105.8 10692.0   106.2 11346.0   101.5 11395.0   103.6 11499.0   102.4 11736.0
GR 105.9 11825.0   108.7 12120.0   107.5 12537.0   108.9 12945.0   111.0 13585.0
GR 112.7 14527.0   117.3 15205.0   119.0 15373.0   120.7 15462.0   120.8 15611.0
GR 121.8 15670.0
X1 15.51    26.0    9756   10257     455     520     490
X3    10
GR 132.5  8225.0   133.5  8731.0   134.5  9204.0   135.8  9756.0    99.6  9807.0
GR  97.3 10000.0    97.3 10089.0   106.7 10175.0   106.9 10257.0   105.4 10533.0
GR 103.3 10702.0   107.7 10757.0   109.1 11151.0   108.7 11527.0   103.5 11559.0
GR 106.9 11700.0   103.8 11808.0   110.9 11854.0   107.5 11935.0   110.1 12774.0
GR 110.3 13006.0   112.8 13696.0   114.1 14347.0   117.2 15047.0   122.8 15652.0
GR 124.4 15898.0
X1 15.61    12.0    9833   10594     485     510     495
X3    10
GR 134.9  8445.0   130.4  9211.0   132.2  9497.0   135.2  9833.0    97.9  9889.0
GR  98.3 10000.0    99.8 10103.0   106.7 10161.0   108.6 10345.0   104.0 10396.0
GR 104.0 10520.0   122.5 10594.0
X1 15.70    14.0    9862   10727     510     480     500
X3    10
GR 135.7  8465.0   136.1  9126.0   132.5  9692.0   132.5  9814.0   126.9  9830.0
GR 130.2  9862.0    97.8  9912.0    98.6 10000.0   102.0 10081.0   108.6 10138.0
GR 107.9 10424.0   104.0 10471.0   104.0 10595.0   141.7 10727.0
X1 15.79      11    9884   10779     515     470     490
X3    10
GR 138.1  8330.0   137.7  9137.0   133.2  9884.0    98.0  9951.0    98.2 10000.0
GR 100.9 10075.0   106.7 10104.0   109.5 10429.0   105.0 10480.0   105.0 10666.0
GR 143.6 10779.0
X1 15.89      13    9818   10780     490     480     485
X3    10
GR 139.6  7900.0   139.4  8835.0   135.4  9628.0   134.5  9818.0   102.8  9877.0
GR 101.5 10000.0   100.9 10112.0   107.5 10205.0   108.8 10405.0   105.0 10425.0
GR 105.0 10629.0   158.0 10780.0   159.6 10871.0
X1 15.98    14.0    9825   10836     425     425     425
X3    10
GR 139.6  8040.0   139.5  8983.0   139.6  9505.0   135.9  9825.0   106.8  9884.0
GR 108.1  9954.0   108.6 10000.0   106.3 10158.0   103.9 10238.0   106.2 10332.0
GR 106.0 10456.0   106.0 10684.0   160.3 10836.0   163.1 10929.0
X1 16.08    11.0    9523   10433     475     475     475
X3    10
GR 141.7  8070.0   142.6  8924.0   141.7  9523.0   106.7  9610.0   107.8  9753.0
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GR 107.8 10000.0   106.0 10028.0   106.0 10386.0   125.2 10433.0   126.7 10462.0
GR 179.2 10602.0
X1 16.17    14.0    9541   10577     475     475     475
XS    10
GR 142.2  8180.0   143.3  8663.0   141.5  9184.0   140.4  9404.0   131.6  9431.0
GR 136.5  9464.0   134.2  9541.0   117.3  9584.0   114.8  9879.0   106.7  9963.0
GR 106.7 10350.0   126.7 10405.0   127.0 10432.0   178.8 10577.0
X1 16.27     8.0    9640   10284     485     485     485
GR 117.6  9640.0   117.5  9740.0   112.2  9785.0   111.2  9828.0   107.0  9967.0
GR 107.0 10252.0   125.4 10284.0   125.7 10530.0
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12	5	0	0.4						
0	10	0	4600	0					
0	10	4600	9700	0					
0	11	9700	14500	0					
0	11	14500	19600	0					
0	11	19600	24700	0					
10									
0.14	0.37	0.73	1.50	3.60	8.5	15.5	24.5	44	75
300	300	300	300	300					
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
25	5	5	2.5	2.5	2.5	2.5	5	5	5
30	10								
5000	13000	40000	74000	93000	94000	86000	72000	48000	27000
21000	8000								
0	0	0	0	0	0	0	0	0	1
0									

* SLA Inc. QUASED MODEL -- Time Step # 1

1) SEDIMENT & WATER INFLOW INFORMATION (FROM UPSTREAM TO DOWNSTREAM)

UPSTREAM WATERSHED, SED. 0. CUBIC YARDS
WATER 5000. CFS

REACH 1 NO TRIBUTARY

REACH 2 NO TRIBUTARY

REACH 3 NO TRIBUTARY

REACH 4 NO TRIBUTARY

REACH 5 NO TRIBUTARY

(2) HYDRAULIC CONDITIONS AND CHANNEL GEOMETRY:

EACH	SECNO	W.S.EL.	BEGINNING BED EL.	ENDING BED EL.	CHANNEL TOPWIDTH	CHANNEL DISCHARGE	CHANNEL VELOCITY	CHANNEL LENGTH	CHANNEL FROUDE NO.	GROSS TOPWIDTH
1	16.27	110.48	107.00	107.00	406.1	5000.0	4.16	485.00	.42630	406.1
1	16.17	109.63	106.70	106.70	425.5	5000.0	4.19	475.00	.44144	425.5
1	16.08	109.03	106.00	106.00	789.2	5000.0	2.90	475.00	.34531	789.2
1	15.98	107.13	103.90	103.90	604.8	5000.0	6.47	425.00	1.00878	604.8
1	15.89	105.99	100.90	100.90	524.7	5000.0	3.55	485.00	.38244	524.7
1	15.79	104.77	98.00	98.00	156.2	5000.0	6.26	490.00	.48768	156.2
1	15.70	103.78	97.80	97.80	193.6	5000.0	6.15	500.00	.52831	193.6
1	15.61	102.98	97.90	97.90	248.4	5000.0	4.95	495.00	.43302	248.4
1	15.51	102.59	97.30	97.30	334.5	5000.0	3.57	490.00	.30699	334.5
1	15.42	101.69	94.10	94.10	326.8	5000.0	5.27	495.00	.54495	326.8
2	15.32	100.56	93.50	93.50	400.1	5000.0	4.55	490.00	.48422	400.1
2	15.23	99.07	94.90	94.90	257.5	5000.0	5.92	490.00	.57660	257.5
2	15.13	98.30	91.40	91.40	519.9	4999.0	3.70	480.00	.40511	519.9
2	15.04	97.16	91.70	91.70	500.1	5000.0	4.64	490.00	.55618	500.1
2	14.94	96.26	91.00	91.00	1150.6	5000.0	2.69	470.00	.37295	1150.6
2	14.85	93.99	90.50	90.50	530.3	5000.0	6.82	500.00	1.02291	530.3
2	14.75	92.31	87.60	87.60	746.5	5000.0	2.43	470.00	.25767	746.5
2	14.66	91.83	88.20	88.20	765.3	4973.0	3.18	500.00	.39295	765.3
2	14.56	90.88	87.80	87.80	827.8	4697.0	3.84	475.00	.55656	827.8
2	14.47	89.53	85.20	85.20	959.9	5000.0	3.61	485.00	.52956	959.9
3	14.38	88.21	84.40	84.43	833.9	5000.0	3.47	475.00	.46462	833.9
3	14.28	86.92	83.60	83.64	702.2	5000.0	3.94	500.00	.51719	702.2
3	14.19	85.86	82.40	82.43	974.9	5000.0	3.02	470.00	.40829	974.9
3	14.10	84.59	81.50	81.53	932.7	5000.0	3.77	510.00	.55703	932.7
3	14.00	83.67	80.30	80.32	1207.3	4960.0	2.63	510.00	.36994	1207.3
3	13.90	82.31	79.30	79.34	685.4	4985.0	4.69	500.00	.66414	685.4
3	13.81	80.67	78.40	78.44	671.5	5000.0	3.90	490.00	.49828	671.5
3	13.72	79.84	76.70	76.72	1124.1	5000.0	2.65	490.00	.36001	1124.1
3	13.62	78.50	75.70	75.73	899.2	5000.0	4.15	490.00	.63121	899.2
3	13.53	77.18	74.10	74.13	991.3	5000.0	3.05	500.00	.41697	991.3
3	13.43	75.00	73.00	73.03	838.0	5000.0	5.30	605.00	.87972	838.0
4	13.32	72.65	70.90	70.89	951.1	5000.0	3.28	100.00	.45610	951.1
4	13.31	72.06	69.80	69.78	882.5	5000.0	4.63	490.00	.73862	882.5
4	13.22	70.32	68.40	68.38	722.9	5000.0	3.66	485.00	.46854	722.9
4	13.13	69.17	67.00	66.98	594.8	5000.0	3.90	490.00	.46791	594.8
4	13.03	68.02	65.60	65.57	501.8	5000.0	4.21	505.00	.48292	501.8
4	12.94	67.25	64.20	64.17	467.2	5000.0	3.57	500.00	.36409	467.2
4	12.84	66.04	62.80	62.77	503.6	4954.0	5.06	490.00	.63910	503.6
4	12.75	63.58	61.20	61.17	536.4	5000.0	5.52	495.00	.74925	536.4
4	12.65	62.66	59.50	59.48	566.1	5000.0	3.29	500.00	.35360	566.1
4	12.56	61.87	58.60	58.58	693.8	2066.0	3.64	505.00	.70889	693.8
4	12.46	60.12	54.60	54.58	849.0	4956.0	4.40	495.00	.67323	873.0
5	12.38	56.97	53.30	53.42	454.3	5000.0	6.04	465.00	.78864	454.3
5	12.27	54.08	51.50	51.52	799.3	1401.0	4.32	460.00	1.19641	799.3
5	12.18	54.26	45.80	45.82	177.0	3.0	.08	470.00	.03287	2651.1
5	12.08	54.05	49.70	49.73	186.0	286.0	2.62	490.00	.60370	1161.0
5	11.99	54.15	46.60	46.62	158.0	48.0	.22	520.00	.03390	2485.6

5	11.89	54.14	46.10	46.12	215.0	80.0	.26	480.00	.03852	2105.6
5	11.80	53.98	49.00	49.13	217.0	2705.0	3.60	425.00	.34061	770.2
5	11.71	52.66	47.70	47.92	207.0	4446.0	6.79	490.00	.67258	385.8
5	11.62	51.29	45.20	45.39	219.0	3935.0	5.62	500.00	.55446	848.6
5	11.52	48.34	42.40	42.65	207.2	4999.0	8.46	500.00	.88354	207.2
5	11.43	42.88	39.30	39.34	459.0	1668.0	5.10	.00	1.06320	607.0

(3) SEDIMENT INFLOW AND OUTFLOW FOR EACH REACH FROM UPSTREAM TO DOWNSTREAM

REACH	INFLOW(CFS)	OUTFLOW(CFS)
1	4.010	4.010

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

2.970	.519	.246	.161	.096	.016	.000	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.100	.100	.100	.100	.100	.100	.100	.100	.100	.100

2	4.010	4.020

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

2.820	.565	.303	.207	.119	.010	.000	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.103	.099	.099	.099	.100	.100	.100	.100	.100	.100

3	4.020	3.210

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

2.140	.479	.287	.200	.101	.000	.000	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.107	.100	.099	.099	.099	.099	.099	.099	.099	.099

4	3.210	3.680

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

2.420	.571	.322	.223	.129	.014	.000	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.095	.099	.100	.101	.100	.101	.101	.101	.101	.101

5	3.680	1.900

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

1.300	.295	.164	.096	.047	.001	.000	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.107	.100	.100	.100	.099	.099	.099	.099	.099	.099

(4) EFFECTIVE FLOW CONDITIONS:

		MAIN CHANNEL			LEFT OVERBANK			RIGHT OVERBANK		
REACH	SLOPE	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)
1	.00200	4.75	3.3	400.	.00	.0	0.	.02	.0	40.
2	.00255	4.23	2.2	632.	.11	.0	71.	.32	.1	197.
3	.00264	3.61	1.6	902.	.27	.0	883.	.00	.0	0.
4	.00291	4.16	1.9	645.	.54	.2	232.	.00	.0	0.
5	.00319	3.88	1.8	317.	1.77	1.4	2131.	.00	.0	0.

* SLA Inc. QUASED MODEL -- Time Step # 2

1) SEDIMENT & WATER INFLOW INFORMATION (FROM UPSTREAM TO DOWNSTREAM)

UPSTREAM WATERSHED, SED. 0. CUBIC YARDS
WATER 13000. CFS

REACH 1 NO TRIBUTARY

REACH 2 NO TRIBUTARY

REACH 3 NO TRIBUTARY

REACH 4 NO TRIBUTARY

REACH 5 NO TRIBUTARY

(2) HYDRAULIC CONDITIONS AND CHANNEL GEOMETRY:

EACH	SECNO	W.S.EL.	BEGINNING BED EL.	ENDING BED EL.	CHANNEL TOPWIDTH	CHANNEL DISCHARGE	CHANNEL VELOCITY	CHANNEL LENGTH	CHANNEL FROUDE NO.	GROSS TOPWIDTH
1	16.27	112.56	107.00	107.00	479.8	13000.0	6.10	485.00	.50973	479.8
1	16.17	111.17	106.70	106.70	445.7	13000.0	6.98	475.00	.60213	445.7
1	16.08	110.53	106.00	106.00	796.6	13000.0	4.47	475.00	.41193	796.6
1	15.98	109.66	103.90	103.90	816.1	13000.0	4.87	425.00	.47507	816.1
1	15.89	109.26	100.90	100.90	776.1	13000.0	3.77	485.00	.31541	776.1
1	15.79	108.29	98.00	98.00	590.7	13000.0	5.84	490.00	.53066	590.7
1	15.70	106.88	97.80	97.80	394.0	13000.0	6.89	500.00	.55527	394.0
1	15.61	105.74	97.90	97.90	425.9	13000.0	6.60	495.00	.54088	425.9
1	15.51	105.06	97.30	97.30	360.6	13000.0	5.75	490.00	.40465	360.6
1	15.42	104.22	94.10	94.10	992.0	11581.0	5.43	495.00	.65284	1206.3
2	15.32	103.34	93.50	93.48	959.0	12275.0	4.20	490.00	.42378	1446.8
2	15.23	101.65	94.90	94.88	1040.2	12391.0	6.97	490.00	.94012	1040.2
2	15.13	100.34	91.40	91.38	1124.8	12565.0	4.91	480.00	.57325	1124.8
2	15.04	98.57	91.70	91.68	1050.9	12814.0	6.34	490.00	.80535	1050.9
2	14.94	97.61	91.00	90.98	1420.2	12986.0	3.64	470.00	.40490	1420.2
2	14.85	95.33	90.50	90.47	918.6	13000.0	7.71	500.00	1.00206	918.6
2	14.75	94.02	87.60	87.58	972.0	12992.0	3.73	470.00	.34771	1008.7
2	14.66	93.31	88.20	88.18	1147.2	12295.0	4.72	500.00	.55176	1147.2
2	14.56	92.15	87.80	87.78	1258.1	11645.0	5.14	475.00	.67574	1258.1
2	14.47	90.82	85.20	85.18	1198.1	12932.0	4.83	485.00	.56887	1198.1
3	14.38	89.72	84.43	84.45	1274.4	12914.0	4.24	475.00	.48332	1274.4
3	14.28	88.38	83.64	83.66	1395.0	12664.0	4.90	500.00	.63487	1488.0
3	14.19	87.20	82.43	82.45	1461.5	12890.0	4.09	470.00	.49158	1461.5
3	14.10	85.89	81.53	81.55	1261.0	12954.0	4.80	510.00	.57790	1357.7
3	14.00	85.11	80.32	80.34	1236.0	12095.0	3.44	510.00	.35943	1840.2
3	13.90	83.93	79.34	79.36	1176.0	12698.0	5.17	500.00	.62993	1230.1
3	13.81	82.20	78.44	78.46	1185.9	12948.0	5.00	490.00	.59625	1185.9
3	13.72	81.12	76.72	76.74	1492.6	12950.0	3.79	490.00	.44087	1492.6
3	13.62	79.80	75.73	75.75	1602.5	12948.0	4.53	490.00	.59757	1602.5
3	13.53	78.37	74.13	74.15	1543.6	12790.0	4.23	500.00	.53217	1543.6
3	13.43	76.11	73.03	73.05	1334.2	12970.0	5.89	605.00	.80707	1334.2
4	13.32	73.86	70.89	70.88	1059.2	13000.0	4.71	100.00	.51375	1059.2
4	13.31	73.29	69.78	69.77	962.2	13000.0	5.83	490.00	.67476	962.2
4	13.22	72.03	68.38	68.37	739.1	13000.0	4.93	485.00	.46018	739.1
4	13.13	71.05	66.98	66.96	600.8	13000.0	5.38	490.00	.47209	600.8
4	13.03	70.02	65.57	65.55	517.6	13000.0	5.84	505.00	.49598	517.6
4	12.94	69.14	64.17	64.15	479.0	13000.0	5.65	500.00	.45386	479.0
4	12.84	67.36	62.77	62.75	568.0	12713.0	7.78	490.00	.80783	571.8
4	12.75	65.35	61.17	61.15	617.8	13000.0	6.65	495.00	.65918	617.8
4	12.65	64.37	59.48	59.47	844.0	12848.0	4.69	500.00	.45816	1415.3
4	12.56	63.23	58.58	58.58	753.0	5480.0	4.22	505.00	.56672	1150.2
4	12.46	61.44	54.58	54.57	849.0	12414.0	5.62	495.00	.61337	1253.4
5	12.38	58.37	53.42	53.46	922.9	12642.0	8.15	465.00	1.10748	922.9
5	12.27	55.69	51.52	51.54	989.0	4634.0	4.34	460.00	.73668	1364.9
5	12.18	55.85	45.82	45.83	177.0	76.0	.40	470.00	.06786	2849.5
5	12.08	55.60	49.73	49.75	186.0	1057.0	3.88	490.00	.56470	2002.0
5	11.99	55.66	46.62	46.63	158.0	227.0	.58	520.00	.06452	2792.7

5	11.89	55.64	46.12	46.13	215.0	336.0	.64	480.00	.07150	2153.8
5	11.80	55.32	49.13	49.21	217.0	5248.0	5.44	425.00	.45462	2402.9
5	11.71	54.33	47.92	48.01	207.0	5795.0	6.44	490.00	.54494	2855.3
5	11.62	52.79	45.39	45.49	219.0	6587.0	7.15	500.00	.61435	1851.8
5	11.52	50.73	42.65	42.76	244.0	8241.0	8.08	500.00	.69665	2047.2
5	11.43	44.05	39.34	39.38	459.0	6175.0	8.27	.00	1.14342	672.8

(3) SEDIMENT INFLOW AND OUTFLOW FOR EACH REACH FROM UPSTREAM TO DOWNSTREAM

REACH	INFLOW(CFS)	OUTFLOW(CFS)
1	12.600	12.600

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

9.540	1.600	.667	.405	.258	.095	.000	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.100	.100	.100	.100	.100	.100	.100	.100	.100	.100

2	12.600	16.700

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

11.500	2.390	1.220	.816	.538	.214	.000	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.100	.098	.099	.099	.100	.101	.101	.101	.101	.101

3	16.700	12.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

8.370	1.680	.896	.599	.357	.071	.000	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.110	.100	.099	.099	.099	.099	.098	.098	.098	.098

4	12.000	13.800

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

9.660	2.080	.948	.585	.375	.153	.000	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.092	.098	.101	.101	.101	.101	.101	.101	.101	.101

5	13.800	6.550

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

4.750	.934	.463	.280	.104	.022	.000	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.112	.102	.100	.100	.099	.099	.098	.098	.098	.098

(4) EFFECTIVE FLOW CONDITIONS:

		MAIN CHANNEL			LEFT OVERBANK			RIGHT OVERBANK		
REACH	SLOPE	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)
1	.00197	5.69	4.3	589.	.00	.0	0.	.15	.0	62.
2	.00277	5.25	2.3	1098.	.32	.0	152.	1.43	.3	806.
3	.00268	4.50	2.1	1353.	1.52	.1	1624.	.00	.0	0.
4	.00285	5.60	3.2	738.	1.04	.1	604.	.00	.0	0.
5	.00315	4.73	2.7	379.	2.56	2.0	2864.	.00	.0	0.

* SLA Inc. QUASED MODEL -- Time Step # 3

1) SEDIMENT & WATER INFLOW INFORMATION (FROM UPSTREAM TO DOWNSTREAM)

UPSTREAM WATERSHED, SED. 0. CUBIC YARDS
WATER 40000. CFS

REACH 1 NO TRIBUTARY

REACH 2 NO TRIBUTARY

REACH 3 NO TRIBUTARY

REACH 4 NO TRIBUTARY

REACH 5 NO TRIBUTARY

(2) HYDRAULIC CONDITIONS AND CHANNEL GEOMETRY:

REACH	SECNO	W.S.EL.	BEGINNING BED EL.	ENDING BED EL.	CHANNEL TOPWIDTH	CHANNEL DISCHARGE	CHANNEL VELOCITY	CHANNEL LENGTH	CHANNEL FROUDE NO.	GROSS TOPWIDTH
1	16.27	116.77	107.00	107.00	522.8	40000.0	9.44	485.00	.58395	522.8
1	16.17	114.38	106.70	106.70	487.7	40000.0	11.92	475.00	.80054	487.7
1	16.08	114.44	106.00	106.00	815.9	40000.0	6.59	475.00	.42612	815.9
1	15.98	113.88	103.90	103.90	836.4	40000.0	6.50	425.00	.42257	836.4
1	15.89	113.55	100.90	100.90	796.4	40000.0	5.86	485.00	.35291	796.4
1	15.79	112.67	98.00	98.00	765.4	40000.0	7.36	490.00	.48628	765.4
1	15.70	111.41	97.80	97.80	729.9	40000.0	8.46	500.00	.58572	729.9
1	15.61	109.22	97.90	97.90	668.9	40000.0	10.35	495.00	.75881	668.9
1	15.51	107.66	97.30	97.30	501.0	33389.0	10.11	490.00	.69345	1317.1
1	15.42	106.54	94.10	94.10	992.0	31930.0	7.64	495.00	.65578	2096.9
2	15.32	105.50	93.48	93.54	959.0	32026.0	6.72	490.00	.53152	1952.6
2	15.23	104.13	94.88	94.93	1229.0	32465.0	7.30	490.00	.67563	1955.5
2	15.13	102.62	91.38	91.44	1159.0	34658.0	7.03	480.00	.60017	2289.5
2	15.04	100.92	91.68	91.73	1376.0	35248.0	7.63	490.00	.73335	2001.8
2	14.94	100.07	90.98	91.02	1632.0	38844.0	5.35	470.00	.44728	2197.7
2	14.85	97.36	90.47	90.53	1324.1	39574.0	10.26	500.00	1.05913	1324.1
2	14.75	96.57	87.58	87.65	972.0	36789.0	6.22	470.00	.44443	2203.8
2	14.66	95.81	88.18	88.23	1202.0	29993.0	6.09	500.00	.53032	3017.4
2	14.56	94.58	87.78	87.82	1299.0	30564.0	6.17	475.00	.55727	2766.7
2	14.47	93.25	85.18	85.23	1418.0	36504.0	6.42	485.00	.56440	2557.8
3	14.38	91.80	84.45	84.48	1620.0	38928.0	6.87	475.00	.64713	2074.7
3	14.28	90.54	83.66	83.69	1395.0	34078.0	6.50	500.00	.59055	2922.7
3	14.19	89.39	82.45	82.48	1504.0	35434.0	5.83	470.00	.51169	3751.8
3	14.10	88.10	81.55	81.58	1261.0	36752.0	6.74	510.00	.57172	2969.5
3	14.00	87.51	80.34	80.37	1236.0	31957.0	5.04	510.00	.39165	3071.3
3	13.90	86.11	79.36	79.39	1176.0	36170.0	7.45	500.00	.64656	2514.2
3	13.81	84.25	78.46	78.49	1275.0	39062.0	7.67	490.00	.67670	2213.5
3	13.72	83.16	76.74	76.77	1602.0	38062.0	6.01	490.00	.53205	2419.1
3	13.62	81.74	75.75	75.78	1637.0	38907.0	6.72	490.00	.62924	1966.6
3	13.53	80.19	74.15	74.18	1603.0	38124.0	6.65	500.00	.62037	1810.5
3	13.43	78.44	73.05	73.08	1637.0	39444.0	6.89	605.00	.64930	1723.7
4	13.32	77.14	70.88	70.83	1327.6	40000.0	5.96	100.00	.46744	1327.6
4	13.31	76.76	69.77	69.71	1156.1	40000.0	6.70	490.00	.51964	1156.1
4	13.22	75.94	68.37	68.29	768.0	38466.0	6.86	485.00	.44771	1132.9
4	13.13	74.63	66.96	66.86	629.0	39197.0	8.52	490.00	.55529	1072.2
4	13.03	73.43	65.55	65.44	559.0	37135.0	9.18	505.00	.60175	1650.1
4	12.94	72.62	64.15	64.04	508.0	33502.0	8.35	500.00	.52336	1565.8
4	12.84	70.28	62.75	62.65	568.0	35702.0	11.36	490.00	.85142	1319.9
4	12.75	67.62	61.15	61.06	687.0	38288.0	11.27	495.00	.89309	1147.2
4	12.65	66.80	59.47	59.40	844.0	34661.0	7.36	500.00	.54937	1536.7
4	12.56	65.64	58.58	58.54	753.0	20813.0	6.94	505.00	.61314	1779.9
4	12.46	63.65	54.57	54.51	849.0	33829.0	8.41	495.00	.68033	1422.9
5	12.38	60.52	53.46	53.66	923.0	32972.0	10.64	465.00	1.02265	1492.6
5	12.27	58.20	51.54	51.64	989.0	17443.0	6.13	460.00	.63691	1960.6
5	12.18	58.37	45.83	45.91	177.0	570.0	1.18	470.00	.12541	2909.3
5	12.08	57.99	49.75	49.82	186.0	2921.0	5.17	490.00	.52215	3225.5
5	11.99	57.95	46.63	46.69	158.0	1024.0	1.49	520.00	.12640	3799.8

S	11.89	57.86	46.13	46.18	215.0	1467.0	1.65	480.00	.14244	3035.6
S	11.80	57.30	49.21	49.47	217.0	9869.0	7.49	425.00	.53549	2904.6
S	11.71	56.30	48.01	48.26	207.0	9041.0	7.31	490.00	.52656	3378.3
S	11.62	54.71	45.49	45.78	219.0	10981.0	8.77	500.00	.64685	3153.7
S	11.52	52.34	42.76	43.08	244.0	13768.0	10.24	500.00	.76889	3905.5
S	11.43	46.66	39.38	39.66	459.0	22919.0	12.81	.00	1.14366	719.1

(3) SEDIMENT INFLOW AND OUTFLOW FOR EACH REACH FROM UPSTREAM TO DOWNSTREAM

REACH	INFLOW(CFS)	OUTFLOW(CFS)
1	82.900	82.900

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

62.200	12.500	4.270	1.880	1.090	.668	.311	.027	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.100	.100	.100	.100	.100	.100	.100	.100	.100	.100

2	82.900	70.400

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

52.400	9.670	3.840	2.150	1.350	.720	.222	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.111	.100	.098	.097	.098	.099	.099	.099	.099	.099

3	70.400	63.600

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

47.600	8.510	3.500	2.010	1.230	.617	.125	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.114	.101	.098	.098	.098	.098	.098	.097	.097	.097

4	63.600	74.600

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

52.700	12.300	4.790	2.300	1.330	.807	.387	.043	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.084	.093	.100	.103	.103	.103	.103	.103	.104	.104

5	74.600	35.900

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

28.000	4.480	1.770	1.000	.532	.130	.017	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.132	.105	.099	.097	.096	.095	.095	.095	.095	.095

(4) EFFECTIVE FLOW CONDITIONS:

		MAIN CHANNEL			LEFT OVERBANK			RIGHT OVERBANK		
REACH	SLOPE	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)
1	.00251	8.45	6.9	705.	.00	.0	0.	.65	.2	265.
2	.00277	6.98	4.2	1234.	.85	.5	315.	3.06	1.2	1437.
3	.00271	6.56	4.0	1438.	2.46	.6	2175.	.53	.2	69.
4	.00282	8.30	5.8	804.	2.68	1.0	1136.	.35	.1	14.
5	.00295	6.43	4.4	379.	3.93	3.2	3156.	.00	.0	0.

** SLA Inc. QUASED MODEL -- Time Step # 4

(1) SEDIMENT & WATER INFLOW INFORMATION (FROM UPSTREAM TO DOWNSTREAM)

UPSTREAM WATERSHED, SED. 0. CUBIC YARDS
WATER 74000. CFS

REACH 1 NO TRIBUTARY

REACH 2 NO TRIBUTARY

REACH 3 NO TRIBUTARY

REACH 4 NO TRIBUTARY

REACH 5 NO TRIBUTARY

(2) HYDRAULIC CONDITIONS AND CHANNEL GEOMETRY:

REACH	SECNO	W.S.EL.	BEGINNING BED EL.	ENDING BED EL.	CHANNEL TOPWIDTH	CHANNEL DISCHARGE	CHANNEL VELOCITY	CHANNEL LENGTH	CHANNEL FROUDE NO.	GROSS TOPWIDTH
1	16.27	120.27	107.00	107.00	635.1	74000.0	11.62	485.00	.64656	635.1
1	16.17	117.74	106.70	106.70	797.5	74000.0	13.39	475.00	.89673	797.5
1	16.08	117.86	106.00	106.00	832.8	74000.0	8.33	475.00	.44946	832.8
1	15.98	117.33	103.90	103.90	853.0	74000.0	8.17	425.00	.44149	853.0
1	15.89	116.96	100.90	100.90	812.4	74000.0	7.73	485.00	.39721	812.4
1	15.79	115.92	98.00	98.00	781.1	74000.0	9.31	490.00	.51429	781.1
1	15.70	114.62	97.80	97.80	746.1	74000.0	10.42	500.00	.59555	746.1
1	15.61	110.68	97.90	97.90	676.9	74000.0	15.27	495.00	1.00571	676.9
1	15.51	109.46	97.30	97.30	501.0	52684.0	12.74	490.00	.78109	2731.7
1	15.42	108.33	94.10	94.10	992.0	52845.0	9.14	495.00	.66666	2820.6
2	15.32	107.22	93.54	93.68	959.0	52369.0	8.49	490.00	.58962	2707.1
2	15.23	105.68	94.93	95.05	1229.0	56621.0	9.07	490.00	.70959	2514.3
2	15.13	104.25	91.44	91.57	1159.0	57430.0	8.60	480.00	.63158	2995.9
2	15.04	102.73	91.73	91.84	1376.0	59855.0	8.86	490.00	.70422	2664.3
2	14.94	101.98	91.02	91.12	1632.0	67573.0	6.64	470.00	.46819	3456.9
2	14.85	99.35	90.53	90.66	1348.0	70225.0	11.25	500.00	.92103	1978.3
2	14.75	98.09	87.65	87.81	972.0	61327.0	8.38	470.00	.53796	3118.4
2	14.66	97.33	88.23	88.33	1202.0	49222.0	7.36	500.00	.54958	3225.6
2	14.56	96.16	87.82	87.92	1299.0	51682.0	7.43	475.00	.56596	3112.4
2	14.47	94.85	85.23	85.34	1418.0	61477.0	7.81	485.00	.58468	2979.7
3	14.38	93.25	84.48	84.54	1620.0	65727.0	8.42	475.00	.67613	3697.2
3	14.28	91.84	83.69	83.75	1395.0	57157.0	8.14	500.00	.63920	3983.3
3	14.19	90.83	82.48	82.54	1504.0	56469.0	6.89	470.00	.52006	4473.0
3	14.10	89.70	81.58	81.65	1261.0	57361.0	7.73	510.00	.56137	4322.1
3	14.00	89.09	80.37	80.43	1236.0	51736.0	6.27	510.00	.42737	4320.1
3	13.90	87.62	79.39	79.46	1176.0	57668.0	8.79	500.00	.65546	3865.1
3	13.81	85.89	78.49	78.56	1275.0	63687.0	8.91	490.00	.66356	4063.3
3	13.72	84.90	76.77	76.83	1602.0	64451.0	7.22	490.00	.53930	3752.3
3	13.62	83.36	75.78	75.84	1637.0	69158.0	8.33	490.00	.65162	2501.3
3	13.53	82.00	74.18	74.24	1603.0	67866.0	7.96	500.00	.60881	2833.4
3	13.43	80.87	73.08	73.15	1637.0	71525.0	7.44	605.00	.54154	2209.0
4	13.32	79.90	70.83	70.79	1403.8	74000.0	7.01	100.00	.45044	1403.8
4	13.31	79.50	69.71	69.66	1216.0	72796.0	7.90	490.00	.50614	1498.7
4	13.22	78.65	68.29	68.22	768.0	66466.0	8.58	485.00	.47632	1557.5
4	13.13	76.67	66.86	66.77	629.0	67694.0	11.45	490.00	.65784	1589.4
4	13.03	75.56	65.44	65.35	559.0	59390.0	11.32	505.00	.65152	1654.6
4	12.94	74.56	64.04	63.95	508.0	54034.0	10.76	500.00	.60350	1816.4
4	12.84	72.55	62.65	62.57	568.0	55281.0	12.56	490.00	.79538	2786.7
4	12.75	69.89	61.06	60.98	687.0	63054.0	12.72	495.00	.83484	2032.6
4	12.65	68.71	59.40	59.34	844.0	58187.0	9.18	500.00	.59023	2823.9
4	12.56	67.69	58.54	58.50	753.0	37856.0	8.36	505.00	.60064	2947.8
4	12.46	65.46	54.51	54.45	849.0	58576.0	10.50	495.00	.72138	1779.4
5	12.38	62.16	53.66	53.86	923.0	55634.0	12.79	465.00	1.03770	1662.1
5	12.27	60.21	51.64	51.76	989.0	34278.0	7.45	460.00	.60824	2567.8
5	12.18	60.40	45.91	45.96	177.0	1454.0	1.92	470.00	.16345	3905.6
5	12.08	59.94	49.82	49.87	186.0	4705.0	5.65	490.00	.47025	4586.3
5	11.99	59.82	46.69	46.74	158.0	2172.0	2.31	520.00	.16730	4496.4

5	11.89	59.64	46.18	46.24	215.0	3139.0	2.61	480.00	.19496	3115.1
5	11.80	58.86	49.47	49.68	217.0	13761.0	8.70	425.00	.56751	3083.7
5	11.71	57.83	48.26	48.46	207.0	12038.0	8.09	490.00	.53161	4037.7
5	11.62	55.89	45.78	46.01	219.0	15126.0	10.57	500.00	.72903	3780.9
5	11.52	54.13	43.08	43.29	244.0	15192.0	9.02	500.00	.60543	4150.8
5	11.43	50.06	39.66	39.97	459.0	42052.0	13.47	.00	.90987	2137.2

(3) SEDIMENT INFLOW AND OUTFLOW FOR EACH REACH FROM UPSTREAM TO DOWNSTREAM

REACH	INFLOW(CFS)	OUTFLOW(CFS)
1	248.000	248.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

179.000	43.200	14.700	5.370	2.470	1.580	1.010	.478	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.100	.100	.100	.100	.100	.100	.100	.100	.100	.100

REACH	INFLOW(CFS)	OUTFLOW(CFS)
2	248.000	185.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

142.000	25.200	8.640	4.070	2.410	1.370	.690	.116	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.125	.106	.097	.094	.095	.095	.096	.096	.096	.096

REACH	INFLOW(CFS)	OUTFLOW(CFS)
3	185.000	150.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

116.000	19.200	6.800	3.390	2.020	1.140	.472	.002	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.125	.103	.098	.097	.097	.097	.097	.097	.096	.096

REACH	INFLOW(CFS)	OUTFLOW(CFS)
4	150.000	171.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

121.000	28.800	11.200	4.720	2.410	1.470	.902	.366	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.082	.087	.099	.103	.104	.104	.105	.105	.105	.105

REACH	INFLOW(CFS)	OUTFLOW(CFS)
5	171.000	85.600

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

68.600	10.000	3.600	1.910	1.090	.287	.060	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.147	.108	.098	.094	.094	.092	.092	.091	.091	.091

(4) EFFECTIVE FLOW CONDITIONS:

		MAIN CHANNEL			LEFT OVERBANK			RIGHT OVERBANK		
REACH	SLOPE	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)
1	.00301	10.70	9.2	755.	.00	.0	0.	.80	.3	382.
2	.00281	8.46	5.7	1237.	1.25	.9	375.	3.85	1.7	1735.
3	.00258	7.84	5.5	1438.	3.15	1.6	2354.	1.07	.6	101.
4	.00286	10.02	8.1	812.	3.73	2.2	1349.	.88	.4	129.
5	.00279	7.37	5.8	379.	4.68	3.6	3799.	.00	.0	0.

SLA Inc. QUASED MODEL -- Time Step # 5

1) SEDIMENT & WATER INFLOW INFORMATION (FROM UPSTREAM TO DOWNSTREAM)

UPSTREAM WATERSHED, SED. 0. CUBIC YARDS
WATER 93000. CFS

REACH 1 NO TRIBUTARY

REACH 2 NO TRIBUTARY

REACH 3 NO TRIBUTARY

REACH 4 NO TRIBUTARY

REACH 5 NO TRIBUTARY

2) HYDRAULIC CONDITIONS AND CHANNEL GEOMETRY:

EACH	SECNO	W.S.EL.	BEGINNING BED EL.	ENDING BED EL.	CHANNEL TOPWIDTH	CHANNEL DISCHARGE	CHANNEL VELOCITY	CHANNEL LENGTH	CHANNEL FROUDE NO.	GROSS TOPWIDTH
1	16.27	121.26	107.00	107.00	636.8	93000.0	13.28	485.00	.70546	636.8
1	16.17	119.32	106.70	106.70	805.9	93000.0	13.68	475.00	.83018	805.9
1	16.08	119.46	106.00	106.00	840.7	93000.0	9.10	475.00	.45975	840.7
1	15.98	118.93	103.90	103.90	860.8	93000.0	8.91	425.00	.45075	860.8
1	15.89	118.55	100.90	100.90	819.9	93000.0	8.56	485.00	.41443	819.9
1	15.79	117.44	98.00	98.00	788.5	93000.0	10.17	490.00	.52616	788.5
1	15.70	116.08	97.80	97.80	753.5	93000.0	11.35	500.00	.60668	753.5
1	15.61	111.83	97.90	97.90	683.3	93000.0	16.51	495.00	1.01366	683.3
1	15.51	110.27	97.30	97.30	501.0	60392.0	13.38	490.00	.78598	3161.5
1	15.42	109.17	94.10	94.10	992.0	62595.0	9.57	495.00	.65695	3237.4
2	15.32	108.02	93.68	93.83	959.0	62007.0	9.20	490.00	.61142	2863.0
2	15.23	106.42	95.05	95.18	1229.0	68593.0	9.80	490.00	.72371	3011.5
2	15.13	105.04	91.57	91.71	1159.0	67938.0	9.15	480.00	.63742	3306.3
2	15.04	103.62	91.84	91.96	1376.0	71247.0	9.20	490.00	.68286	3158.9
2	14.94	102.91	91.12	91.24	1632.0	80741.0	7.03	470.00	.46662	3552.3
2	14.85	100.20	90.66	90.81	1348.0	85373.0	11.93	500.00	.91245	2532.0
2	14.75	98.82	87.81	87.99	972.0	72416.0	9.18	470.00	.56763	3163.4
2	14.66	98.06	88.33	88.45	1202.0	58995.0	7.88	500.00	.55687	3309.1
2	14.56	96.91	87.92	88.03	1299.0	62214.0	7.96	475.00	.57146	3175.1
2	14.47	95.48	85.34	85.47	1418.0	74459.0	8.65	485.00	.61913	3134.4
3	14.38	93.84	84.54	84.63	1620.0	78648.0	9.11	475.00	.69512	3750.6
3	14.28	92.44	83.75	83.84	1395.0	67922.0	8.72	500.00	.65078	4414.9
3	14.19	91.46	82.54	82.62	1504.0	66573.0	7.34	470.00	.52645	4533.8
3	14.10	90.38	81.65	81.75	1261.0	66770.0	8.15	510.00	.56348	4393.5
3	14.00	89.74	80.43	80.52	1236.0	61449.0	6.84	510.00	.44702	4579.9
3	13.90	88.19	79.46	79.57	1176.0	67774.0	9.45	500.00	.67428	4506.7
3	13.81	86.65	78.56	78.67	1275.0	73522.0	9.16	490.00	.64357	4208.9
3	13.72	85.71	76.83	76.92	1602.0	76327.0	7.56	490.00	.53105	3843.9
3	13.62	84.16	75.84	75.94	1637.0	83935.0	8.84	490.00	.64674	3440.7
3	13.53	83.00	74.24	74.34	1603.0	81855.0	8.19	500.00	.57783	2839.0
3	13.43	82.00	73.15	73.25	1637.0	88056.0	7.77	605.00	.52032	2228.7
4	13.32	81.04	70.79	70.75	1430.5	93000.0	7.60	100.00	.45834	1430.5
4	13.31	80.64	69.66	69.61	1216.0	90246.0	8.52	490.00	.50861	1503.4
4	13.22	79.76	68.22	68.15	768.0	80866.0	9.36	485.00	.49166	1561.1
4	13.13	77.54	66.77	66.68	629.0	81780.0	12.56	490.00	.68832	1590.8
4	13.03	76.40	65.35	65.26	559.0	71131.0	12.37	505.00	.67954	2015.8
4	12.94	75.22	63.95	63.86	508.0	65295.0	12.11	500.00	.65523	1817.5
4	12.84	73.25	62.57	62.49	568.0	64805.0	13.44	490.00	.81272	2854.0
4	12.75	70.93	60.98	60.91	687.0	73094.0	12.78	495.00	.78054	2956.3
4	12.65	69.52	59.34	59.28	844.0	69400.0	9.84	500.00	.60004	3058.5
4	12.56	68.58	58.50	58.46	753.0	46040.0	8.82	505.00	.59080	3318.8
4	12.46	66.28	54.45	54.39	849.0	71183.0	11.24	495.00	.72512	3187.6
5	12.38	63.06	53.86	54.12	923.0	66944.0	13.42	465.00	1.01699	1760.7
5	12.27	61.12	51.76	51.92	989.0	43068.0	8.05	460.00	.60999	2662.2
5	12.18	61.31	45.96	46.02	177.0	2003.0	2.25	470.00	.17680	4944.6
5	12.08	60.84	49.87	49.93	186.0	5539.0	5.77	490.00	.44744	4774.6
5	11.99	60.69	46.74	46.81	158.0	2826.0	2.67	520.00	.18205	4607.8

5	11.89	60.46	46.24	46.32	215.0	4132.0	3.08	480.00	.21677	3330.8
5	11.80	59.57	49.68	49.94	217.0	15609.0	9.23	425.00	.58279	3193.9
5	11.71	58.50	48.46	48.70	207.0	13512.0	8.51	490.00	.54187	4234.6
5	11.62	56.55	46.01	46.28	219.0	16523.0	10.84	500.00	.72450	4067.6
5	11.52	54.72	43.29	43.54	244.0	16951.0	9.54	500.00	.62291	4163.1
5	11.43	51.35	39.97	40.15	459.0	46242.0	13.02	.00	.82521	4025.9

(3) SEDIMENT INFLOW AND OUTFLOW FOR EACH REACH FROM UPSTREAM TO DOWNSTREAM

REACH	INFLOW(CFS)	OUTFLOW(CFS)
1	348.000	348.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

247.000	63.700	22.100	7.640	3.120	1.940	1.300	.707	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.100	.100	.100	.100	.100	.100	.100	.100	.100	.100

2	348.000	272.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

212.000	37.700	11.900	5.130	2.910	1.680	.910	.257	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.139	.115	.099	.093	.092	.093	.093	.093	.093	.093

3	272.000	216.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

173.000	26.000	8.630	4.050	2.370	1.350	.633	.060	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.138	.105	.097	.095	.095	.094	.094	.094	.094	.094

4	216.000	237.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

171.000	37.400	15.300	6.320	3.060	1.850	1.200	.587	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.085	.079	.095	.103	.105	.105	.106	.106	.107	.107

5	237.000	123.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

101.000	13.600	4.440	2.160	1.210	.369	.083	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.166	.112	.098	.092	.089	.088	.088	.087	.087	.087

(4) EFFECTIVE FLOW CONDITIONS:

		MAIN CHANNEL			LEFT OVERBANK			RIGHT OVERBANK		
REACH	SLOPE	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)
1	.00319	11.51	10.5	761.	.00	.0	0.	.84	.4	442.
2	.00284	9.05	6.4	1237.	1.44	1.1	391.	4.21	2.0	1956.
3	.00250	8.32	6.2	1438.	3.53	2.2	2393.	1.38	.8	180.
4	.00290	10.76	9.0	814.	4.14	2.9	1414.	1.07	.6	255.
5	.00281	7.76	6.5	379.	4.94	4.2	3860.	.00	.0	0.

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** SLA Inc. QUASED MODEL -- Time Step # 6

(1) SEDIMENT & WATER INFLOW INFORMATION (FROM UPSTREAM TO DOWNSTREAM)

UPSTREAM WATERSHED, SED. 0. CUBIC YARDS
WATER 94000. CFS

REACH 1 NO TRIBUTARY

REACH 2 NO TRIBUTARY

REACH 3 NO TRIBUTARY

REACH 4 NO TRIBUTARY

REACH 5 NO TRIBUTARY

(2) HYDRAULIC CONDITIONS AND CHANNEL GEOMETRY:

REACH	SECNO	W.S.EL.	BEGINNING BED EL.	ENDING BED EL.	CHANNEL TOPWIDTH	CHANNEL DISCHARGE	CHANNEL VELOCITY	CHANNEL LENGTH	CHANNEL FROUDE NO.	GROSS TOPWIDTH
1	16.27	121.31	107.00	107.00	636.9	94000.0	13.36	485.00	.70853	636.9
1	16.17	119.40	106.70	106.70	806.3	94000.0	13.70	475.00	.82766	806.3
1	16.08	119.54	106.00	106.00	841.1	94000.0	9.14	475.00	.46024	841.1
1	15.98	119.01	103.90	103.90	861.2	94000.0	8.94	425.00	.45120	861.2
1	15.89	118.63	100.90	100.90	820.3	94000.0	8.60	485.00	.41523	820.3
1	15.79	117.51	98.00	98.00	788.8	94000.0	10.21	490.00	.52678	788.8
1	15.70	116.15	97.80	97.80	753.9	94000.0	11.40	500.00	.60726	753.9
1	15.61	111.90	97.90	97.90	683.6	94000.0	16.57	495.00	1.01357	683.6
1	15.51	110.33	97.30	97.30	501.0	60617.0	13.36	490.00	.78194	3204.7
1	15.42	109.28	94.10	94.10	992.0	62719.0	9.44	495.00	.64277	3273.0
2	15.32	108.13	93.83	93.97	959.0	61923.0	9.22	490.00	.61427	2882.8
2	15.23	106.53	95.18	95.30	1229.0	68672.0	9.80	490.00	.72352	3082.8
2	15.13	105.15	91.71	91.83	1159.0	67713.0	9.15	480.00	.63810	3348.5
2	15.04	103.75	91.96	92.07	1376.0	71167.0	9.15	490.00	.67805	3205.4
2	14.94	103.03	91.24	91.34	1632.0	80872.0	7.04	470.00	.46723	3564.0
2	14.85	100.39	90.81	90.94	1348.0	85219.0	11.80	500.00	.89846	2844.1
2	14.75	98.93	87.99	88.15	972.0	72236.0	9.22	470.00	.57190	3169.7
2	14.66	98.17	88.45	88.55	1202.0	58934.0	7.86	500.00	.55505	3321.0
2	14.56	97.03	88.03	88.13	1299.0	62304.0	7.94	475.00	.56923	3183.8
2	14.47	95.57	85.47	85.58	1418.0	74594.0	8.72	485.00	.62575	3156.2
3	14.38	93.92	84.63	84.71	1620.0	78747.0	9.13	475.00	.69725	3753.1
3	14.28	92.52	83.84	83.92	1395.0	67906.0	8.73	500.00	.65097	4423.3
3	14.19	91.55	82.62	82.70	1504.0	66633.0	7.34	470.00	.52609	4541.3
3	14.10	90.46	81.75	81.84	1261.0	66686.0	8.16	510.00	.56510	4401.3
3	14.00	89.82	80.52	80.61	1236.0	61464.0	6.84	510.00	.44740	4672.2
3	13.90	88.29	79.57	79.67	1176.0	67507.0	9.43	500.00	.67378	4536.7
3	13.81	86.76	78.67	78.77	1275.0	73148.0	9.11	490.00	.64025	4220.2
3	13.72	85.82	76.92	77.00	1602.0	76335.0	7.54	490.00	.52831	3851.4
3	13.62	84.27	75.94	76.03	1637.0	84184.0	8.85	490.00	.64725	3441.1
3	13.53	83.08	74.34	74.43	1603.0	82342.0	8.26	500.00	.58412	2839.2
3	13.43	82.01	73.25	73.34	1637.0	88913.0	7.94	605.00	.53480	2229.0
4	13.32	81.05	70.75	70.72	1431.2	94000.0	7.64	100.00	.45937	1431.2
4	13.31	80.65	69.61	69.57	1216.0	91214.0	8.56	490.00	.50916	1503.6
4	13.22	79.76	68.15	68.10	768.0	81792.0	9.41	485.00	.49262	1561.1
4	13.13	77.54	66.68	66.62	629.0	82742.0	12.61	490.00	.68774	1590.8
4	13.03	76.40	65.26	65.20	559.0	72056.0	12.43	505.00	.68006	2015.9
4	12.94	75.22	63.86	63.80	508.0	66193.0	12.18	500.00	.65657	1817.6
4	12.84	73.26	62.49	62.43	568.0	65630.0	13.48	490.00	.81114	2855.2
4	12.75	70.93	60.91	60.86	687.0	73983.0	12.83	495.00	.78026	2956.6
4	12.65	69.51	59.28	59.24	844.0	70289.0	9.90	500.00	.60184	3058.2
4	12.56	68.56	58.46	58.43	753.0	46682.0	8.92	505.00	.59586	3315.8
4	12.46	66.46	54.39	54.35	849.0	71325.0	10.93	495.00	.69428	3238.7
5	12.38	63.25	54.12	54.37	923.0	66219.0	13.42	465.00	1.02335	1794.7
5	12.27	61.23	51.92	52.07	989.0	42930.0	8.09	460.00	.61503	2671.3
5	12.18	61.43	46.02	46.08	177.0	2045.0	2.27	470.00	.17684	4979.3
5	12.08	60.96	49.93	49.99	186.0	5525.0	5.73	490.00	.44340	4800.5
5	11.99	60.80	46.81	46.88	158.0	2869.0	2.69	520.00	.18235	4614.4

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5	11.89	60.57	46.32	46.40	215.0	4192.0	3.10	480.00	.21773	3338.2
5	11.80	59.68	49.94	50.19	217.0	15280.0	9.15	425.00	.58162	3201.2
5	11.71	58.61	48.70	48.93	207.0	13248.0	8.45	490.00	.54147	4237.4
5	11.62	56.67	46.28	46.54	219.0	16095.0	10.72	500.00	.72158	4079.8
5	11.52	54.86	43.54	43.78	244.0	16501.0	9.39	500.00	.61679	4165.7
5	11.43	51.44	40.15	40.20	459.0	45102.0	13.10	.00	.84315	4027.3

(3) SEDIMENT INFLOW AND OUTFLOW FOR EACH REACH FROM UPSTREAM TO DOWNSTREAM

REACH	INFLOW(CFS)	OUTFLOW(CFS)
1	351.000	351.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

250.000	64.500	22.400	7.730	3.140	1.950	1.310	.712	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.100	.100	.100	.100	.100	.100	.100	.100	.100	.100

2	351.000	284.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

222.000	39.800	11.900	4.990	2.790	1.600	.870	.241	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.145	.122	.100	.091	.089	.089	.090	.090	.089	.089

3	284.000	232.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

188.000	27.000	8.640	4.020	2.340	1.330	.625	.062	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.150	.108	.097	.093	.093	.092	.092	.092	.092	.092

4	232.000	248.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

184.000	35.500	15.100	6.410	3.120	1.900	1.240	.610	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.089	.074	.091	.103	.106	.106	.107	.107	.108	.108

5	248.000	135.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

113.000	14.000	4.440	2.110	1.180	.358	.076	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.185	.116	.098	.091	.087	.086	.085	.085	.084	.084

(4) EFFECTIVE FLOW CONDITIONS:

		MAIN CHANNEL			LEFT OVERBANK			RIGHT OVERBANK		
REACH	SLOPE	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)
1	.00319	11.54	10.5	761.	.00	.0	0.	.84	.4	449.
2	.00283	9.03	6.4	1237.	1.46	1.2	393.	4.24	2.0	1969.
3	.00251	8.34	6.2	1438.	3.59	2.3	2396.	1.41	.8	186.
4	.00290	10.81	9.1	814.	4.13	2.9	1414.	1.07	.6	255.
5	.00281	7.72	6.5	379.	4.97	4.3	3860.	.00	.0	0.

* SLA Inc. QUASED MODEL -- Time Step # 7

1) SEDIMENT & WATER INFLOW INFORMATION (FROM UPSTREAM TO DOWNSTREAM)

UPSTREAM WATERSHED, SED. 0. CUBIC YARDS
WATER 86000. CFS

REACH 1 NO TRIBUTARY

REACH 2 NO TRIBUTARY

REACH 3 NO TRIBUTARY

REACH 4 NO TRIBUTARY

REACH 5 NO TRIBUTARY

(2) HYDRAULIC CONDITIONS AND CHANNEL GEOMETRY:

EACH	SECNO	W.S.EL.	BEGINNING BED EL.	ENDING BED EL.	CHANNEL TOPWIDTH	CHANNEL DISCHARGE	CHANNEL VELOCITY	CHANNEL LENGTH	CHANNEL FROUDE NO.	GROSS TOPWIDTH
1	16.27	120.91	107.00	107.00	636.2	86000.0	12.69	485.00	.68510	636.2
1	16.17	118.76	106.70	106.70	802.9	86000.0	13.56	475.00	.85012	802.9
1	16.08	118.89	106.00	106.00	837.9	86000.0	8.83	475.00	.45619	837.9
1	15.98	118.36	103.90	103.90	858.0	86000.0	8.65	425.00	.44753	858.0
1	15.89	117.98	100.90	100.90	817.2	86000.0	8.27	485.00	.40856	817.2
1	15.79	116.90	98.00	98.00	785.8	86000.0	9.86	490.00	.52164	785.8
1	15.70	115.57	97.80	97.80	751.0	86000.0	11.01	500.00	.60153	751.0
1	15.61	111.39	97.90	97.90	680.8	86000.0	16.13	495.00	1.01587	680.8
1	15.51	110.02	97.30	97.30	501.0	57551.0	13.10	490.00	.77935	2928.3
1	15.42	109.05	94.10	94.10	992.0	58411.0	9.08	495.00	.62861	3200.5
2	15.32	107.91	93.97	94.07	959.0	57175.0	8.92	490.00	.60806	2835.3
2	15.23	106.34	95.30	95.39	1229.0	63094.0	9.47	490.00	.71658	2937.2
2	15.13	104.94	91.83	91.92	1159.0	62524.0	8.88	480.00	.63527	3259.7
2	15.04	103.52	92.07	92.15	1376.0	65774.0	8.92	490.00	.67880	3104.2
2	14.94	102.81	91.34	91.42	1632.0	74687.0	6.79	470.00	.46084	3540.9
2	14.85	100.14	90.94	91.04	1348.0	78692.0	11.68	500.00	.92020	2427.1
2	14.75	98.72	88.15	88.27	972.0	66906.0	8.92	470.00	.56616	3156.3
2	14.66	97.96	88.55	88.63	1202.0	54269.0	7.60	500.00	.54931	3293.2
2	14.56	96.83	88.13	88.21	1299.0	57302.0	7.67	475.00	.56344	3165.3
2	14.47	95.40	85.58	85.66	1418.0	68561.0	8.40	485.00	.61733	3112.5
3	14.38	93.75	84.71	84.77	1620.0	72861.0	8.85	475.00	.69166	3746.3
3	14.28	92.34	83.92	83.98	1395.0	62885.0	8.46	500.00	.64585	4400.4
3	14.19	91.35	82.70	82.76	1504.0	61872.0	7.13	470.00	.52268	4522.5
3	14.10	90.25	81.84	81.91	1261.0	62116.0	7.96	510.00	.56381	4379.0
3	14.00	89.62	80.61	80.68	1236.0	56958.0	6.61	510.00	.44075	4496.7
3	13.90	88.12	79.67	79.75	1176.0	62630.0	9.15	500.00	.66870	4407.9
3	13.81	86.54	78.77	78.85	1275.0	68222.0	8.94	490.00	.64410	4197.0
3	13.72	85.60	77.00	77.06	1602.0	70809.0	7.33	490.00	.52627	3834.4
3	13.62	84.02	76.03	76.10	1637.0	77944.0	8.69	490.00	.65371	3439.3
3	13.53	82.72	74.43	74.50	1603.0	76324.0	8.24	500.00	.60414	2836.9
3	13.43	81.51	73.34	73.41	1637.0	82026.0	8.01	605.00	.56488	2220.1
4	13.32	80.54	70.72	70.70	1419.9	86000.0	7.41	100.00	.45654	1419.9
4	13.31	80.13	69.57	69.55	1216.0	83981.0	8.31	490.00	.50786	1501.6
4	13.22	79.26	68.10	68.07	768.0	75974.0	9.10	485.00	.48639	1559.5
4	13.13	77.14	66.62	66.58	629.0	77146.0	12.15	490.00	.67366	1590.3
4	13.03	76.02	65.20	65.16	559.0	67453.0	11.99	505.00	.66628	1821.8
4	12.94	74.92	63.80	63.76	508.0	61807.0	11.64	500.00	.63469	1817.1
4	12.84	72.95	62.43	62.40	568.0	62098.0	13.13	490.00	.80151	2825.6
4	12.75	70.56	60.86	60.83	687.0	70006.0	12.62	495.00	.78276	2916.6
4	12.65	69.18	59.24	59.22	844.0	65853.0	9.62	500.00	.59487	2891.9
4	12.56	68.19	58.43	58.41	753.0	43515.0	8.75	505.00	.60000	3163.5
4	12.46	66.25	54.35	54.33	849.0	66210.0	10.37	495.00	.66618	3179.9
5	12.38	63.08	54.37	54.58	923.0	59896.0	13.10	465.00	1.03712	1747.8
5	12.27	60.95	52.07	52.20	989.0	38654.0	7.89	460.00	.62420	2636.0
5	12.18	61.15	46.08	46.13	177.0	1827.0	2.13	470.00	.17096	4653.1
5	12.08	60.69	49.99	50.04	186.0	5107.0	5.63	490.00	.44882	4719.1
5	11.99	60.55	46.88	46.94	158.0	2600.0	2.54	520.00	.17631	4581.0

5	11.89	60.34	46.40	46.47	215.0	3779.0	2.92	480.00	.20921	3211.9
5	11.80	59.50	50.19	50.40	217.0	14006.0	8.82	425.00	.57488	3171.3
5	11.71	58.44	48.93	49.12	207.0	12190.0	8.15	490.00	.53436	4191.9
5	11.62	56.52	46.54	46.76	219.0	14869.0	10.42	500.00	.71961	4044.5
5	11.52	54.68	43.78	43.99	244.0	15283.0	9.17	500.00	.61833	4161.3
5	11.43	51.30	40.20	40.24	459.0	40892.0	12.64	.00	.83860	3859.2

(3) SEDIMENT INFLOW AND OUTFLOW FOR EACH REACH FROM UPSTREAM TO DOWNSTREAM

REACH	INFLOW(CFS)	OUTFLOW(CFS)
1	307.000	307.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

220.000	55.200	18.900	6.660	2.850	1.790	1.180	.612	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.100	.100	.100	.100	.100	.100	.100	.100	.100	.100

2	307.000	256.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

200.000	35.900	10.600	4.420	2.500	1.420	.740	.169	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.152	.128	.103	.090	.087	.088	.089	.089	.088	.088

3	256.000	216.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

176.000	24.700	7.810	3.660	2.150	1.210	.547	.034	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.158	.111	.096	.092	.092	.091	.090	.090	.090	.090

4	216.000	225.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

171.000	29.500	12.600	5.620	2.840	1.740	1.110	.508	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.094	.070	.088	.102	.106	.107	.107	.108	.109	.109

5	225.000	128.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

108.000	12.600	3.990	1.930	1.070	.304	.058	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.202	.118	.098	.088	.085	.084	.083	.082	.081	.081

(4) EFFECTIVE FLOW CONDITIONS:

		MAIN CHANNEL			LEFT OVERBANK			RIGHT OVERBANK		
REACH	SLOPE	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)
1	.00310	11.20	10.0	759.	.00	.0	0.	.81	.4	414.
2	.00282	8.76	6.1	1237.	1.40	1.1	389.	4.14	1.9	1942.
3	.00256	8.14	5.9	1438.	3.46	2.1	2389.	1.34	.7	174.
4	.00287	10.49	8.7	813.	3.93	2.6	1402.	.92	.4	232.
5	.00279	7.47	6.1	379.	4.87	4.0	3860.	.00	.0	0.

** SLA Inc. QUASED MODEL -- Time Step # 8

(1) SEDIMENT & WATER INFLOW INFORMATION (FROM UPSTREAM TO DOWNSTREAM)

UPSTREAM WATERSHED, SED. 0. CUBIC YARDS
WATER 72000. CFS

REACH 1 NO TRIBUTARY

REACH 2 NO TRIBUTARY

REACH 3 NO TRIBUTARY

REACH 4 NO TRIBUTARY

REACH 5 NO TRIBUTARY

(2) HYDRAULIC CONDITIONS AND CHANNEL GEOMETRY:

REACH	SECNO	W.S.EL.	BEGINNING BED EL.	ENDING BED EL.	CHANNEL TOPWIDTH	CHANNEL DISCHARGE	CHANNEL VELOCITY	CHANNEL LENGTH	CHANNEL FROUDE NO.	GROSS TOPWIDTH
1	16.27	120.16	107.00	107.00	634.9	72000.0	11.43	485.00	.63934	634.9
1	16.17	117.55	106.70	106.70	796.5	72000.0	13.39	475.00	.90829	796.5
1	16.08	117.68	106.00	106.00	831.9	72000.0	8.25	475.00	.44872	831.9
1	15.98	117.14	103.90	103.90	852.1	72000.0	8.09	425.00	.44097	852.1
1	15.89	116.77	100.90	100.90	811.5	72000.0	7.65	485.00	.39565	811.5
1	15.79	115.74	98.00	98.00	780.3	72000.0	9.21	490.00	.51276	780.3
1	15.70	114.44	97.80	97.80	745.2	72000.0	10.34	500.00	.59610	745.2
1	15.61	110.60	97.90	97.90	676.5	72000.0	15.01	495.00	.99380	676.5
1	15.51	109.45	97.30	97.30	501.0	51355.0	12.44	490.00	.76355	2725.7
1	15.42	108.52	94.10	94.10	992.0	50796.0	8.53	495.00	.61395	2959.5
2	15.32	107.42	94.07	94.18	959.0	49374.0	8.35	490.00	.59299	2731.8
2	15.23	105.90	95.39	95.49	1229.0	53627.0	8.85	490.00	.70264	2563.2
2	15.13	104.44	91.92	92.02	1159.0	54052.0	8.46	480.00	.63522	3051.4
2	15.04	103.03	92.15	92.24	1376.0	56501.0	8.46	490.00	.67665	2804.1
2	14.94	102.32	91.42	91.51	1632.0	64161.0	6.35	470.00	.45014	3488.4
2	14.85	99.50	91.04	91.15	1348.0	67442.0	11.62	500.00	.98723	2006.2
2	14.75	98.26	88.27	88.40	972.0	57971.0	8.34	470.00	.54957	3127.1
2	14.66	97.50	88.63	88.72	1202.0	46442.0	7.13	500.00	.53988	3238.6
2	14.56	96.37	88.21	88.29	1299.0	48900.0	7.20	475.00	.55481	3125.2
2	14.47	95.01	85.66	85.75	1418.0	58470.0	7.80	485.00	.59747	3013.3
3	14.38	93.37	84.77	84.85	1620.0	62893.0	8.33	475.00	.68001	3731.9
3	14.28	91.96	83.98	84.06	1395.0	54372.0	7.98	500.00	.63624	4157.7
3	14.19	90.94	82.76	82.83	1504.0	53820.0	6.75	470.00	.51645	4482.0
3	14.10	89.81	81.91	82.00	1261.0	54507.0	7.62	510.00	.56386	4330.5
3	14.00	89.19	80.68	80.76	1236.0	49244.0	6.15	510.00	.42565	4348.1
3	13.90	87.77	79.75	79.85	1176.0	54321.0	8.56	500.00	.64989	4006.7
3	13.81	86.07	78.85	78.95	1275.0	60200.0	8.70	490.00	.65798	4145.1
3	13.72	85.09	77.06	77.14	1602.0	61472.0	7.01	490.00	.52756	3772.7
3	13.62	83.54	76.10	76.18	1637.0	66549.0	8.22	490.00	.65152	2559.3
3	13.53	82.11	74.50	74.59	1603.0	65463.0	7.99	500.00	.62318	2833.2
3	13.43	80.61	73.41	73.50	1637.0	69763.0	8.06	605.00	.61757	2204.2
4	13.32	79.60	70.70	70.68	1399.0	72000.0	6.98	100.00	.45293	1399.0
4	13.31	79.20	69.55	69.53	1216.0	71113.0	7.87	490.00	.50902	1497.9
4	13.22	78.34	68.07	68.04	768.0	65426.0	8.54	485.00	.47642	1556.5
4	13.13	76.41	66.58	66.54	629.0	66729.0	11.26	490.00	.64667	1589.2
4	13.03	75.32	65.16	65.12	559.0	58959.0	11.20	505.00	.64305	1654.4
4	12.94	74.37	63.76	63.72	508.0	53614.0	10.59	500.00	.59154	1816.3
4	12.84	72.34	62.40	62.36	568.0	55330.0	12.52	490.00	.79102	2768.1
4	12.75	69.51	60.83	60.80	687.0	63099.0	13.01	495.00	.86264	1815.3
4	12.65	68.53	59.22	59.20	844.0	57573.0	9.09	500.00	.58488	2797.8
4	12.56	67.49	58.41	58.39	753.0	37439.0	8.40	505.00	.60823	2521.1
4	12.46	65.77	54.33	54.31	849.0	56709.0	9.47	495.00	.62841	1897.6
5	12.38	62.61	54.58	54.89	923.0	50144.0	12.62	465.00	1.07128	1690.7
5	12.27	60.36	52.20	52.38	989.0	31483.0	7.45	460.00	.63450	2565.6
5	12.18	60.56	46.13	46.21	177.0	1440.0	1.88	470.00	.15990	3903.8
5	12.08	60.12	50.04	50.12	186.0	4412.0	5.46	490.00	.46176	4601.8
5	11.99	60.00	46.94	47.03	158.0	2124.0	2.27	520.00	.16427	4501.8

5	11.89	59.83	46.47	46.57	215.0	3062.0	2.57	480.00	.19243	3117.5
5	11.80	59.08	50.40	50.72	217.0	12120.0	8.27	425.00	.56132	3095.8
5	11.71	58.04	49.12	49.42	207.0	10696.0	7.74	490.00	.52763	4045.1
5	11.62	56.14	46.76	47.10	219.0	13115.0	9.96	500.00	.71628	3808.4
5	11.52	54.36	43.99	44.30	244.0	13346.0	8.62	500.00	.60329	4153.3
5	11.43	50.60	40.24	40.30	459.0	35444.0	12.58	.00	.89471	2454.5

(3) SEDIMENT INFLOW AND OUTFLOW FOR EACH REACH FROM UPSTREAM TO DOWNSTREAM

REACH	INFLOW(CFS)	OUTFLOW(CFS)
1	233.000	233.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

169.000	40.100	13.600	5.010	2.350	1.500	.948	.431	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.100	.100	.100	.100	.100	.100	.100	.100	.100	.100

REACH	INFLOW(CFS)	OUTFLOW(CFS)
2	233.000	206.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

161.000	29.100	8.480	3.580	2.060	1.150	.563	.074	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.155	.135	.104	.089	.086	.086	.087	.087	.086	.086

REACH	INFLOW(CFS)	OUTFLOW(CFS)
3	206.000	182.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

148.000	20.900	6.470	3.120	1.850	1.020	.414	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.167	.116	.096	.091	.090	.089	.089	.089	.089	.089

REACH	INFLOW(CFS)	OUTFLOW(CFS)
4	182.000	186.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

145.000	22.200	9.290	4.490	2.420	1.500	.915	.366	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.100	.068	.083	.100	.106	.107	.107	.108	.110	.110

REACH	INFLOW(CFS)	OUTFLOW(CFS)
5	186.000	117.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

99.600	10.600	3.430	1.710	.946	.236	.036	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.222	.120	.098	.087	.082	.081	.080	.079	.077	.077

(4) EFFECTIVE FLOW CONDITIONS:

		MAIN CHANNEL			LEFT OVERBANK			RIGHT OVERBANK		
REACH	SLOPE	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)
1	.00296	10.54	9.1	755.	.00	.0	0.	.77	.4	384.
2	.00279	8.30	5.5	1237.	1.27	1.0	378.	3.91	1.8	1747.
3	.00263	7.75	5.3	1438.	3.23	1.6	2364.	1.16	.7	109.
4	.00284	9.97	8.0	812.	3.63	2.1	1267.	.82	.4	127.
5	.00276	7.07	5.6	379.	4.71	3.6	3805.	.00	.0	0.

** SLA Inc. QUASED MODEL -- Time Step # 9

(1) SEDIMENT & WATER INFLOW INFORMATION (FROM UPSTREAM TO DOWNSTREAM)

UPSTREAM WATERSHED, SED. 0. CUBIC YARDS
WATER 48000. CFS

REACH 1 NO TRIBUTARY

REACH 2 NO TRIBUTARY

REACH 3 NO TRIBUTARY

REACH 4 NO TRIBUTARY

REACH 5 NO TRIBUTARY

(2) HYDRAULIC CONDITIONS AND CHANNEL GEOMETRY:

REACH	SECNO	W.S.EL.	BEGINNING BED EL.	ENDING BED EL.	CHANNEL TOPWIDTH	CHANNEL DISCHARGE	CHANNEL VELOCITY	CHANNEL LENGTH	CHANNEL FROUDE NO.	GROSS TOPWIDTH
1	16.27	118.00	107.00	107.00	631.1	48000.0	9.72	485.00	.61252	631.1
1	16.17	115.10	106.70	106.70	530.1	48000.0	12.90	475.00	.85798	530.1
1	16.08	115.32	106.00	106.00	820.2	48000.0	7.08	475.00	.43375	820.2
1	15.98	114.76	103.90	103.90	840.7	48000.0	6.97	425.00	.42894	840.7
1	15.89	114.42	100.90	100.90	800.5	48000.0	6.39	485.00	.36725	800.5
1	15.79	113.49	98.00	98.00	769.3	48000.0	7.92	490.00	.49708	769.3
1	15.70	112.19	97.80	97.80	733.9	48000.0	9.06	500.00	.59410	733.9
1	15.61	109.73	97.90	97.90	671.7	48000.0	11.42	495.00	.80415	671.7
1	15.51	108.16	97.30	97.30	501.0	38522.0	10.89	490.00	.72243	1630.7
1	15.42	107.40	94.10	94.10	992.0	36310.0	7.33	495.00	.57860	2189.6
2	15.32	106.36	94.18	94.19	959.0	35460.0	7.20	490.00	.55980	2507.9
2	15.23	104.97	95.49	95.50	1229.0	36846.0	7.59	490.00	.67279	2216.8
2	15.13	103.43	92.02	92.03	1159.0	38554.0	7.48	480.00	.62477	2655.3
2	15.04	101.92	92.24	92.25	1376.0	39548.0	7.56	490.00	.68293	2228.4
2	14.94	101.13	91.51	91.52	1632.0	44962.0	5.55	470.00	.43875	2572.2
2	14.85	98.52	91.15	91.16	1348.0	46302.0	10.43	500.00	1.01340	1631.8
2	14.75	97.32	88.40	88.42	972.0	41575.0	7.02	470.00	.50098	2550.6
2	14.66	96.54	88.72	88.73	1202.0	32982.0	6.26	500.00	.52680	3111.7
2	14.56	95.41	88.29	88.30	1299.0	34092.0	6.25	475.00	.53770	2944.6
2	14.47	94.09	85.75	85.76	1418.0	41042.0	6.74	485.00	.57367	2779.4
3	14.38	92.47	84.85	84.87	1620.0	45121.0	7.48	475.00	.68258	2927.9
3	14.28	91.15	84.06	84.08	1395.0	38361.0	6.87	500.00	.60496	3108.5
3	14.19	90.07	82.83	82.85	1504.0	39166.0	5.95	470.00	.50135	4147.3
3	14.10	88.84	82.00	82.02	1261.0	40615.0	6.97	510.00	.57192	3842.9
3	14.00	88.26	80.76	80.78	1236.0	35411.0	5.24	510.00	.39448	3698.6
3	13.90	86.96	79.85	79.87	1176.0	39558.0	7.48	500.00	.62160	3524.4
3	13.81	85.05	78.95	78.97	1275.0	44496.0	8.09	490.00	.68636	3100.8
3	13.72	83.99	77.14	77.16	1602.0	43680.0	6.24	490.00	.52614	2831.4
3	13.62	82.57	76.18	76.20	1637.0	45610.0	7.08	490.00	.62959	2177.2
3	13.53	81.12	74.59	74.61	1603.0	44837.0	6.91	500.00	.60475	2245.5
3	13.43	78.92	73.50	73.52	1637.0	47077.0	8.13	605.00	.76158	1743.9
4	13.32	77.63	70.68	70.67	1354.5	48000.0	6.29	100.00	.46740	1354.5
4	13.31	77.24	69.53	69.52	1198.1	47995.0	7.08	490.00	.52466	1198.1
4	13.22	76.40	68.04	68.02	768.0	45755.0	7.38	485.00	.45730	1138.2
4	13.13	74.95	66.54	66.51	629.0	46719.0	9.25	490.00	.57560	1188.6
4	13.03	73.84	65.12	65.09	559.0	43459.0	9.69	505.00	.60281	1651.5
4	12.94	73.06	63.72	63.69	508.0	39234.0	8.85	500.00	.52787	1814.4
4	12.84	70.56	62.36	62.33	568.0	42407.0	12.16	490.00	.86475	1420.8
4	12.75	67.88	60.80	60.78	687.0	45643.0	12.04	495.00	.90310	1267.8
4	12.65	67.17	59.20	59.18	844.0	41215.0	7.87	500.00	.55696	1700.2
4	12.56	66.06	58.39	58.38	753.0	25519.0	7.44	505.00	.61488	1898.0
4	12.46	64.66	54.31	54.29	849.0	39429.0	7.76	495.00	.55950	1532.4
5	12.38	61.74	54.89	55.06	923.0	33561.0	11.28	465.00	1.10716	1576.7
5	12.27	59.12	52.38	52.47	989.0	19206.0	6.55	460.00	.67046	2031.1
5	12.18	59.32	46.21	46.29	177.0	810.0	1.39	470.00	.13464	2927.0
5	12.08	58.93	50.12	50.17	186.0	3124.0	5.08	490.00	.49189	3403.7
5	11.99	58.87	47.03	47.08	158.0	1313.0	1.71	520.00	.13699	3930.9

5	11.89	58.75	46.57	46.62	215.0	1877.0	1.91	480.00	.15692	3063.1
5	11.80	58.19	50.72	50.92	217.0	8891.0	7.24	425.00	.53624	2966.6
5	11.71	57.16	49.42	49.61	207.0	8159.0	7.02	490.00	.52185	3697.5
5	11.62	55.39	47.10	47.32	219.0	9895.0	8.89	500.00	.69483	3221.8
5	11.52	53.49	44.30	44.51	244.0	10581.0	8.22	500.00	.63012	4086.8
5	11.43	49.20	40.30	40.41	459.0	23154.0	11.35	.00	.94820	1410.9

(3) SEDIMENT INFLOW AND OUTFLOW FOR EACH REACH FROM UPSTREAM TO DOWNSTREAM

REACH	INFLOW(CFS)	OUTFLOW(CFS)
1	114.000	114.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

84.900	18.000	6.050	2.520	1.380	.871	.462	.104	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.100	.100	.100	.100	.100	.100	.100	.100	.100	.100

2	114.000	111.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

86.200	15.600	4.800	2.230	1.320	.697	.244	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.154	.137	.105	.090	.086	.086	.087	.087	.086	.086

3	111.000	107.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

85.800	12.400	4.100	2.150	1.300	.667	.181	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.165	.118	.096	.090	.089	.088	.088	.088	.088	.088

4	107.000	109.000

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

85.500	12.500	5.240	2.850	1.690	1.050	.559	.127	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.101	.069	.082	.099	.106	.107	.107	.108	.111	.111

5	109.000	70.300

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

60.500	6.080	2.050	1.070	.564	.092	.006	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.234	.121	.097	.085	.080	.079	.077	.076	.075	.075

(4) EFFECTIVE FLOW CONDITIONS:

		MAIN CHANNEL			LEFT OVERBANK			RIGHT OVERBANK		
EACH	SLOPE	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)
1	.00263	9.06	7.5	718.	.00	.0	0.	.69	.3	289.
2	.00275	7.24	4.5	1237.	1.02	.7	343.	3.45	1.5	1571.
3	.00273	6.88	4.3	1438.	2.79	1.0	2232.	.72	.4	74.
4	.00280	8.85	6.5	808.	2.94	1.2	1207.	.44	.1	14.
5	.00272	6.25	4.5	379.	4.28	3.4	3344.	.00	.0	0.

** SLA Inc. QUASED MODEL -- Time Step # 10

(1) SEDIMENT & WATER INFLOW INFORMATION (FROM UPSTREAM TO DOWNSTREAM)

UPSTREAM WATERSHED, SED. 0. CUBIC YARDS
WATER 27000. CFS

REACH 1 NO TRIBUTARY

REACH 2 NO TRIBUTARY

REACH 3 NO TRIBUTARY

REACH 4 NO TRIBUTARY

REACH 5 NO TRIBUTARY

(2) HYDRAULIC CONDITIONS AND CHANNEL GEOMETRY:

REACH	SECNO	W.S.EL.	BEGINNING BED EL.	ENDING BED EL.	CHANNEL TOPWIDTH	CHANNEL DISCHARGE	CHANNEL VELOCITY	CHANNEL LENGTH	CHANNEL FROUDE NO.	GROSS TOPWIDTH
1	16.27	114.99	107.00	107.00	504.6	27000.0	8.11	485.00	.55664	504.6
1	16.17	113.09	106.70	106.70	470.9	27000.0	9.85	475.00	.71910	470.9
1	16.08	112.84	106.00	106.00	808.0	27000.0	5.66	475.00	.41092	808.0
1	15.98	112.26	103.90	103.90	828.6	27000.0	5.62	425.00	.41100	828.6
1	15.89	111.96	100.90	100.90	788.9	27000.0	4.85	485.00	.32217	788.9
1	15.79	111.19	98.00	98.00	758.2	27000.0	6.27	490.00	.46323	758.2
1	15.70	109.99	97.80	97.80	722.8	27000.0	7.30	500.00	.56921	722.8
1	15.61	108.38	97.90	97.90	640.4	27000.0	8.17	495.00	.63347	640.4
1	15.51	106.54	97.30	97.30	376.4	27000.0	9.61	490.00	.61973	376.4
1	15.42	106.02	94.10	94.10	992.0	22141.0	5.96	495.00	.54323	1748.7
2	15.32	105.08	94.19	94.15	959.0	21928.0	5.71	490.00	.50331	1930.1
2	15.23	103.81	95.50	95.47	1229.0	21417.0	6.15	490.00	.64377	1830.0
2	15.13	102.27	92.03	92.00	1159.0	23317.0	6.04	480.00	.58351	2007.3
2	15.04	100.55	92.25	92.22	1376.0	23754.0	6.64	490.00	.72507	1875.2
2	14.94	99.65	91.52	91.49	1632.0	26332.0	4.54	470.00	.42484	1993.4
2	14.85	97.20	91.16	91.12	1191.3	26719.0	9.18	500.00	1.03466	1191.3
2	14.75	96.09	88.42	88.38	972.0	25296.0	5.36	470.00	.42872	1917.9
2	14.66	95.32	88.73	88.70	1202.0	21454.0	5.60	500.00	.55291	2669.8
2	14.56	94.26	88.30	88.27	1299.0	20486.0	5.18	475.00	.52364	2586.3
2	14.47	92.75	85.76	85.73	1418.0	25080.0	5.99	485.00	.61497	2147.3
3	14.38	91.37	84.87	84.87	1620.0	26439.0	5.81	475.00	.61126	1636.9
3	14.28	90.09	84.08	84.08	1395.0	23305.0	5.69	500.00	.58533	2689.1
3	14.19	88.88	82.85	82.85	1504.0	24981.0	5.24	470.00	.51886	2950.5
3	14.10	87.59	82.02	82.01	1261.0	25387.0	6.01	510.00	.57889	2153.3
3	14.00	86.97	80.78	80.78	1236.0	22045.0	4.26	510.00	.36747	2708.8
3	13.90	85.74	79.87	79.86	1176.0	24681.0	6.41	500.00	.62375	2050.1
3	13.81	83.84	78.97	78.96	1275.0	26560.0	6.72	490.00	.67272	1611.9
3	13.72	82.72	77.16	77.16	1602.0	25981.0	5.09	490.00	.50258	2147.3
3	13.62	81.39	76.20	76.20	1637.0	26294.0	5.75	490.00	.60622	1864.4
3	13.53	80.12	74.61	74.61	1603.0	25536.0	5.20	500.00	.52346	1800.8
3	13.43	77.40	73.52	73.52	1561.8	26711.0	8.03	605.00	.96926	1561.8
4	13.32	75.36	70.67	70.67	1208.7	27000.0	5.73	100.00	.51162	1208.7
4	13.31	74.93	69.52	69.53	1081.9	27000.0	6.47	490.00	.58104	1081.9
4	13.22	73.98	68.02	68.03	768.0	26881.0	6.17	485.00	.45647	946.2
4	13.13	72.99	66.51	66.52	629.0	26965.0	6.96	490.00	.49385	706.9
4	13.03	71.83	65.09	65.10	532.7	27000.0	7.88	505.00	.54770	532.7
4	12.94	70.94	63.69	63.70	508.0	25733.0	7.56	500.00	.51501	1431.0
4	12.84	68.67	62.33	62.34	568.0	26124.0	10.37	490.00	.86744	660.8
4	12.75	66.48	60.78	60.79	687.0	26825.0	9.22	495.00	.78958	955.2
4	12.65	65.63	59.18	59.19	844.0	24930.0	6.23	500.00	.50437	1463.6
4	12.56	64.43	58.38	58.38	753.0	14012.0	6.17	505.00	.62628	1561.1
4	12.46	63.24	54.29	54.30	849.0	23514.0	6.02	495.00	.49426	1399.1
5	12.38	60.76	55.06	55.13	923.0	19858.0	9.50	465.00	1.11271	1393.8
5	12.27	57.62	52.47	52.50	989.0	10208.0	5.87	460.00	.77973	1668.5
5	12.18	57.84	46.29	46.32	177.0	337.0	.86	470.00	.10232	2890.4
5	12.08	57.52	50.17	50.20	186.0	1875.0	4.49	490.00	.52721	2833.0
5	11.99	57.52	47.08	47.11	158.0	637.0	1.10	520.00	.10068	3075.4

S	11.89	57.46	46.62	46.64	215.0	911.0	1.20	480.00	.11314	2984.9
S	11.80	57.06	50.92	51.01	217.0	6033.0	6.16	425.00	.51128	2844.9
S	11.71	56.08	49.61	49.70	207.0	5755.0	6.18	490.00	.51307	3064.4
S	11.62	54.59	47.32	47.42	219.0	6706.0	7.22	500.00	.61799	3081.3
S	11.52	52.34	44.51	44.63	244.0	8502.0	8.56	500.00	.74757	3777.2
S	11.43	47.32	40.41	40.57	459.0	10542.0	9.14	.00	1.01565	718.5

(3) SEDIMENT INFLOW AND OUTFLOW FOR EACH REACH FROM UPSTREAM TO DOWNSTREAM

REACH	INFLOW(CFS)	OUTFLOW(CFS)
1	39.900	39.900

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

30.400	5.530	1.950	.986	.615	.334	.085	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.100	.100	.100	.100	.100	.100	.100	.100	.100	.100

2	39.900	47.800

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

36.300	6.760	2.360	1.230	.733	.340	.033	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.149	.137	.106	.089	.086	.087	.088	.088	.086	.086

3	47.800	48.900

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

38.300	5.870	2.240	1.320	.792	.319	.006	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.163	.119	.096	.090	.089	.088	.088	.088	.088	.088

4	48.900	47.900

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

37.300	5.220	2.300	1.440	.934	.543	.191	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.103	.070	.081	.099	.105	.106	.107	.108	.110	.110

5	47.900	32.300

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

27.600	2.780	1.020	.556	.254	.041	.000	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.237	.122	.096	.084	.080	.078	.077	.075	.074	.074

(4) EFFECTIVE FLOW CONDITIONS:

		MAIN CHANNEL			LEFT OVERBANK			RIGHT OVERBANK		
REACH	SLOPE	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)
1	.00220	7.19	5.9	680.	.00	.0	0.	.20	.1	65.
2	.00272	6.04	3.3	1221.	.69	.3	295.	2.72	1.0	1279.
3	.00275	5.74	3.1	1435.	2.36	.4	2090.	.32	.1	65.
4	.00284	7.33	4.8	784.	1.88	.4	1013.	.12	.0	12.
5	.00280	5.33	3.3	379.	3.59	2.9	3022.	.00	.0	0.

** SLA Inc. QUASED MODEL -- Time Step # 11

(1) SEDIMENT & WATER INFLOW INFORMATION (FROM UPSTREAM TO DOWNSTREAM)

UPSTREAM WATERSHED, SED. 0. CUBIC YARDS
WATER 21000. CFS

REACH 1 NO TRIBUTARY

REACH 2 NO TRIBUTARY

REACH 3 NO TRIBUTARY

REACH 4 NO TRIBUTARY

REACH 5 NO TRIBUTARY

(2) HYDRAULIC CONDITIONS AND CHANNEL GEOMETRY:

REACH	SECNO	W.S.EL.	BEGINNING BED EL.	ENDING BED EL.	CHANNEL TOPWIDTH	CHANNEL DISCHARGE	CHANNEL VELOCITY	CHANNEL LENGTH	CHANNEL FROUDE NO.	GROSS TOPWIDTH
1	16.27	114.05	107.00	107.00	495.0	21000.0	7.35	485.00	.53958	495.0
1	16.17	112.36	106.70	106.70	461.3	21000.0	8.74	475.00	.67467	461.3
1	16.08	111.98	106.00	106.00	803.7	21000.0	5.16	475.00	.40458	803.7
1	15.98	111.37	103.90	103.90	824.3	21000.0	5.16	425.00	.40961	824.3
1	15.89	111.07	100.90	100.90	784.7	21000.0	4.32	485.00	.30570	784.7
1	15.79	110.34	98.00	98.00	754.1	21000.0	5.73	490.00	.45758	754.1
1	15.70	108.96	97.80	97.80	717.6	21000.0	7.11	500.00	.61749	717.6
1	15.61	107.25	97.90	97.90	511.7	21000.0	7.92	495.00	.61281	511.7
1	15.51	106.09	97.30	97.30	371.6	21000.0	7.95	490.00	.52561	371.6
1	15.42	105.50	94.10	94.10	992.0	17515.0	5.39	495.00	.52531	1350.5
2	15.32	104.61	94.15	93.98	959.0	17836.0	5.14	490.00	.47664	1913.2
2	15.23	103.34	95.47	95.34	1229.0	16933.0	5.73	490.00	.65157	1766.9
2	15.13	101.82	92.00	91.85	1159.0	18559.0	5.45	480.00	.56025	1698.4
2	15.04	100.00	92.22	92.09	1376.0	19141.0	6.43	490.00	.77084	1694.8
2	14.94	99.05	91.49	91.37	1632.0	20712.0	4.21	470.00	.42763	1790.4
2	14.85	96.77	91.12	90.95	1143.0	20916.0	8.35	500.00	.99429	1143.0
2	14.75	95.50	88.38	88.19	972.0	20225.0	4.83	470.00	.41036	1549.6
2	14.66	94.68	88.70	88.56	1202.0	18219.0	5.51	500.00	.58595	2248.7
2	14.56	93.59	88.27	88.15	1299.0	16821.0	5.27	475.00	.59310	2089.1
2	14.47	92.11	85.73	85.60	1418.0	20250.0	5.81	485.00	.65338	1468.3
3	14.38	90.85	84.87	84.82	1346.9	20660.0	5.31	475.00	.55010	1346.9
3	14.28	89.52	84.08	84.04	1395.0	19104.0	5.63	500.00	.63566	1928.9
3	14.19	88.38	82.85	82.81	1504.0	20115.0	4.89	470.00	.52079	2040.4
3	14.10	87.09	82.01	81.96	1261.0	20233.0	5.60	510.00	.58311	1868.1
3	14.00	86.44	80.78	80.74	1236.0	17751.0	3.91	510.00	.35932	2451.1
3	13.90	85.25	79.86	79.81	1176.0	19633.0	5.91	500.00	.62042	1707.5
3	13.81	83.40	78.96	78.91	1275.0	20750.0	6.07	490.00	.65263	1356.8
3	13.72	82.28	77.16	77.12	1602.0	20508.0	4.61	490.00	.48780	1920.1
3	13.62	80.96	76.20	76.16	1637.0	20588.0	5.26	490.00	.59921	1753.0
3	13.53	79.72	74.61	74.57	1603.0	19961.0	4.65	500.00	.50012	1778.3
3	13.43	76.95	73.52	73.48	1438.3	20832.0	7.80	605.00	1.00778	1438.3
4	13.32	74.62	70.67	70.68	1143.6	21000.0	5.47	100.00	.52650	1143.6
4	13.31	74.12	69.53	69.54	1029.6	21000.0	6.37	490.00	.62696	1029.6
4	13.22	73.03	68.03	68.05	768.0	20998.0	5.77	485.00	.46721	791.9
4	13.13	72.08	66.52	66.54	604.8	21000.0	6.33	490.00	.47604	604.8
4	13.03	71.04	65.10	65.13	526.8	21000.0	7.00	505.00	.51667	526.8
4	12.94	70.07	63.70	63.73	508.0	20958.0	7.05	500.00	.51334	1396.5
4	12.84	68.01	62.34	62.36	568.0	20472.0	9.39	490.00	.84440	609.6
4	12.75	65.97	60.79	60.81	629.1	21000.0	8.15	495.00	.70940	629.1
4	12.65	65.08	59.19	59.21	844.0	19975.0	5.62	500.00	.48325	1443.6
4	12.56	63.87	58.38	58.39	753.0	10452.0	5.57	505.00	.62249	1293.1
4	12.46	62.74	54.30	54.31	849.0	18736.0	5.37	495.00	.46655	1368.5
5	12.38	60.36	55.13	55.35	923.0	15892.0	9.00	465.00	1.14658	1317.5
5	12.27	57.08	52.50	52.60	989.0	7226.0	5.36	460.00	.80952	1560.5
5	12.18	57.30	46.32	46.41	177.0	224.0	.69	470.00	.08950	2877.1
5	12.08	57.02	50.20	50.30	186.0	1471.0	4.18	490.00	.53476	2544.4
5	11.99	57.04	47.11	47.20	158.0	461.0	.89	520.00	.08666	2985.7

S	11.89	57.00	46.64	46.70	215.0	661.0	.98	480.00	.09683	2205.0
S	11.80	56.66	51.01	51.31	217.0	5068.0	5.71	425.00	.49692	2558.7
S	11.71	55.70	49.70	50.01	207.0	4971.0	5.86	490.00	.50981	3002.3
S	11.62	54.27	47.42	47.76	219.0	5718.0	6.70	500.00	.59856	3031.6
S	11.52	51.97	44.63	45.02	244.0	7461.0	8.37	500.00	.77152	2883.8
S	11.43	46.76	40.57	41.09	459.0	7305.0	8.19	.00	1.03545	706.1

(3) SEDIMENT INFLOW AND OUTFLOW FOR EACH REACH FROM UPSTREAM TO DOWNSTREAM

REACH	INFLOW(CFS)	OUTFLOW(CFS)
1	25.600	25.600

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

19.600	3.400	1.260	.693	.442	.213	.022	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.100	.100	.100	.100	.100	.100	.100	.100	.100	.100

2	25.600	31.200

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

22.800	4.730	1.800	.985	.598	.264	.005	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.131	.132	.105	.091	.088	.090	.092	.091	.089	.089

3	31.200	32.800

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

25.000	4.300	1.710	1.030	.610	.219	.000	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.152	.123	.097	.090	.090	.089	.089	.089	.089	.089

4	32.800	32.400

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

24.900	3.790	1.590	1.030	.690	.369	.088	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.104	.078	.083	.098	.103	.103	.105	.107	.110	.110

5	32.400	24.800

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

21.200	2.160	.818	.451	.187	.025	.000	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.247	.126	.097	.085	.080	.077	.074	.073	.072	.072

(4) EFFECTIVE FLOW CONDITIONS:

		MAIN CHANNEL			LEFT OVERBANK			RIGHT OVERBANK		
REACH	SLOPE	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)
1	.00208	6.53	5.2	661.	.00	.0	0.	.18	.1	64.
2	.00273	5.65	2.9	1216.	.54	.2	270.	2.38	.9	1127.
3	.00272	5.33	2.7	1405.	2.17	.3	1946.	.09	.0	54.
4	.00285	6.72	4.2	761.	1.40	.2	749.	.00	.0	0.
5	.00281	4.95	2.9	379.	3.34	2.6	2979.	.00	.0	0.

! SLA Inc. QUASED MODEL -- Time Step # 12

1) SEDIMENT & WATER INFLOW INFORMATION (FROM UPSTREAM TO DOWNSTREAM)

UPSTREAM WATERSHED, SED. 0. CUBIC YARDS
WATER 8000. CFS

REACH 1 NO TRIBUTARY

REACH 2 NO TRIBUTARY

REACH 3 NO TRIBUTARY

REACH 4 NO TRIBUTARY

REACH 5 NO TRIBUTARY

(2) HYDRAULIC CONDITIONS AND CHANNEL GEOMETRY:

EACH	SECNO	W.S.EL.	BEGINNING BED EL.	ENDING BED EL.	CHANNEL TOPWIDTH	CHANNEL DISCHARGE	CHANNEL VELOCITY	CHANNEL LENGTH	CHANNEL FROUDE NO.	GROSS TOPWIDTH
1	16.27	111.38	107.00	107.00	439.5	8000.0	5.05	485.00	.46880	439.5
1	16.17	110.30	106.70	106.70	434.1	8000.0	5.43	475.00	.51880	434.1
1	16.08	109.60	106.00	106.00	792.0	8000.0	3.69	475.00	.39305	792.0
1	15.98	108.09	103.90	103.90	727.4	8000.0	5.66	425.00	.71515	727.4
1	15.89	107.59	100.90	100.90	576.6	8000.0	3.51	485.00	.31084	576.6
1	15.79	106.68	98.00	98.00	379.4	8000.0	5.54	490.00	.50083	379.4
1	15.70	105.56	97.80	97.80	360.0	8000.0	5.77	500.00	.51752	360.0
1	15.61	104.48	97.90	97.90	394.6	8000.0	5.50	495.00	.50462	394.6
1	15.51	104.02	97.30	97.30	349.7	8000.0	4.23	490.00	.32042	349.7
1	15.42	103.32	94.10	94.10	829.2	7739.0	4.90	495.00	.62498	829.2
2	15.32	102.27	93.98	93.91	776.5	7897.0	4.61	490.00	.54631	776.5
2	15.23	100.29	95.34	95.17	311.3	7972.0	7.59	490.00	.72825	311.3
2	15.13	99.52	91.85	91.77	625.8	7908.0	4.55	480.00	.48191	625.8
2	15.04	98.15	92.09	92.02	730.2	7966.0	5.56	490.00	.70030	730.2
2	14.94	97.27	91.37	91.33	1273.6	7998.0	3.06	470.00	.37664	1273.6
2	14.85	95.05	90.95	90.87	689.1	8000.0	7.29	500.00	1.01824	689.1
2	14.75	93.45	88.19	88.13	810.8	8000.0	3.19	470.00	.31998	810.8
2	14.66	92.85	88.56	88.51	982.9	7707.0	3.84	500.00	.47302	982.9
2	14.56	91.83	88.15	88.11	1131.8	7103.0	4.18	475.00	.60196	1131.8
2	14.47	90.54	85.60	85.55	1077.0	7988.0	4.03	485.00	.52411	1077.0
3	14.38	89.38	84.82	84.84	1191.0	7955.0	3.65	475.00	.47465	1191.0
3	14.28	88.00	84.04	84.06	1115.5	7907.0	4.41	500.00	.61314	1115.5
3	14.19	86.87	82.81	82.83	1252.7	7970.0	3.47	470.00	.45107	1252.7
3	14.10	85.56	81.96	81.98	1044.8	7993.0	4.38	510.00	.58438	1044.8
3	14.00	84.79	80.74	80.76	1236.0	7489.0	2.82	510.00	.33915	1643.5
3	13.90	83.58	79.81	79.83	1023.3	7815.0	4.75	500.00	.66101	1023.3
3	13.81	81.69	78.91	78.94	754.4	7982.0	4.86	490.00	.58041	754.4
3	13.72	80.86	77.12	77.14	1210.8	7978.0	3.09	490.00	.37350	1210.8
3	13.62	79.61	76.16	76.18	1492.9	7971.0	4.13	490.00	.64024	1492.9
3	13.53	78.28	74.57	74.59	1379.9	7874.0	3.37	500.00	.45634	1379.9
3	13.43	75.82	73.48	73.50	1159.2	7987.0	6.16	605.00	1.02688	1159.2
4	13.32	72.90	70.68	70.69	992.0	8000.0	4.03	100.00	.50142	992.0
4	13.31	72.26	69.54	69.55	911.0	8000.0	5.37	490.00	.73983	911.0
4	13.22	70.58	68.05	68.06	727.6	8000.0	4.41	485.00	.49200	727.6
4	13.13	69.49	66.54	66.56	596.9	8000.0	4.58	490.00	.47206	596.9
4	13.03	68.44	65.13	65.15	507.5	8000.0	4.88	505.00	.47893	507.5
4	12.94	67.66	63.73	63.75	471.4	8000.0	4.43	500.00	.39907	471.4
4	12.84	66.12	62.36	62.38	523.1	7937.0	6.47	490.00	.74514	523.1
4	12.75	64.27	60.81	60.83	608.1	8000.0	5.31	495.00	.59424	608.1
4	12.65	63.36	59.21	59.22	793.8	8000.0	3.70	500.00	.39573	793.8
4	12.56	62.14	58.39	58.40	753.0	3188.0	4.53	505.00	.82479	791.3
4	12.46	61.19	54.31	54.32	849.0	7754.0	3.50	495.00	.38127	1149.9
5	12.38	59.26	55.35	55.36	920.2	6841.0	7.12	465.00	1.22663	920.2
5	12.27	55.56	52.60	52.60	971.7	1877.0	4.14	460.00	1.06646	971.7
5	12.18	55.76	46.41	46.41	177.0	40.0	.26	470.00	.04878	2702.7
5	12.08	55.58	50.30	50.31	186.0	497.0	2.80	490.00	.50465	1646.7
5	11.99	55.64	47.20	47.20	158.0	127.0	.37	520.00	.04502	2609.7

5	11.89	55.63	46.70	46.70	215.0	189.0	.41	480.00	.04996	2123.6
5	11.80	55.45	51.31	51.33	217.0	2482.0	3.96	425.00	.41122	2349.1
5	11.71	54.47	50.01	50.03	207.0	3193.0	5.42	490.00	.56543	2782.3
5	11.62	53.13	47.76	47.78	219.0	3020.0	5.01	500.00	.53193	1641.7
5	11.52	50.92	45.02	45.04	244.0	4309.0	7.17	500.00	.80469	1758.6
5	11.43	45.53	41.09	41.12	459.0	1623.0	4.71	.00	.95888	633.5

(3) SEDIMENT INFLOW AND OUTFLOW FOR EACH REACH FROM UPSTREAM TO DOWNSTREAM

REACH	INFLOW(CFS)	OUTFLOW(CFS)
1	5.980	5.980

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

4.480	.756	.351	.229	.139	.030	.000	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.100	.100	.100	.100	.100	.100	.100	.100	.100	.100

2	5.980	10.400

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

7.300	1.670	.710	.417	.257	.078	.000	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.120	.130	.106	.092	.089	.091	.093	.093	.091	.091

3	10.400	8.350

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

6.150	1.140	.522	.330	.186	.011	.000	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.155	.124	.098	.091	.091	.089	.089	.089	.089	.089

4	8.350	7.500

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

5.540	.866	.451	.351	.229	.060	.000	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.108	.080	.083	.097	.102	.102	.104	.106	.109	.109

5	7.500	6.600

SEDIMENT TRANSPORT RATES FOR EACH PARTICLE SIZE

5.490	.643	.286	.151	.033	.000	.000	.000	.000	.000

WEIGHTED SIZE FRACTIONS FOR EACH PARTICLE SIZE

.245	.125	.096	.084	.079	.078	.074	.072	.071	.071

(4) EFFECTIVE FLOW CONDITIONS:

		MAIN CHANNEL			LEFT OVERBANK			RIGHT OVERBANK		
EACH	SLOPE	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)	VELOCITY (FT/SEC)	DEPTH (FT)	TOPWIDTH (FT)
1	.00187	4.93	3.5	513.	.00	.0	0.	.08	.0	61.
2	.00265	4.84	2.2	827.	.21	.0	114.	.98	.2	477.
3	.00265	4.00	1.8	1165.	1.27	.0	1501.	.00	.0	0.
4	.00291	4.79	2.4	707.	.80	.3	290.	.00	.0	0.
5	.00283	3.70	1.8	377.	2.46	1.8	2779.	.00	.0	0.

THE FOLLOWING TABLE LISTS THE BED ELEVATION AT THE END OF EACH TIME STEP

REACH	SECNO	STEP 1	STEP 2	STEP 3	STEP 4	STEP 5	STEP 6	STEP 7	STEP 8	STEP 9	STEP10	STEP11	STEP12
1	16.27	107.00	107.00	107.00	107.00	107.00	107.00	107.00	107.00	107.00	107.00	107.00	107.00
1	16.17	106.70	106.70	106.70	106.70	106.70	106.70	106.70	106.70	106.70	106.70	106.70	106.70
1	16.08	106.00	106.00	106.00	106.00	106.00	106.00	106.00	106.00	106.00	106.00	106.00	106.00
1	15.98	103.90	103.90	103.90	103.90	103.90	103.90	103.90	103.90	103.90	103.90	103.90	103.90
1	15.89	100.90	100.90	100.90	100.90	100.90	100.90	100.90	100.90	100.90	100.90	100.90	100.90
1	15.79	98.00	98.00	98.00	98.00	98.00	98.00	98.00	98.00	98.00	98.00	98.00	98.00
1	15.70	97.80	97.80	97.80	97.80	97.80	97.80	97.80	97.80	97.80	97.80	97.80	97.80
1	15.61	97.90	97.90	97.90	97.90	97.90	97.90	97.90	97.90	97.90	97.90	97.90	97.90
1	15.51	97.30	97.30	97.30	97.30	97.30	97.30	97.30	97.30	97.30	97.30	97.30	97.30
1	15.42	94.10	94.10	94.10	94.10	94.10	94.10	94.10	94.10	94.10	94.10	94.10	94.10
2	15.32	93.50	93.48	93.54	93.68	93.83	93.97	94.07	94.18	94.19	94.15	93.98	93.91
2	15.23	94.90	94.88	94.93	95.05	95.18	95.30	95.39	95.49	95.50	95.47	95.34	95.17
2	15.13	91.40	91.38	91.44	91.57	91.71	91.83	91.92	92.02	92.03	92.00	91.85	91.77
2	15.04	91.70	91.68	91.73	91.84	91.96	92.07	92.15	92.24	92.25	92.22	92.09	92.02
2	14.94	91.00	90.98	91.02	91.12	91.24	91.34	91.42	91.51	91.52	91.49	91.37	91.33
2	14.85	90.50	90.47	90.53	90.66	90.81	90.94	91.04	91.15	91.16	91.12	90.95	90.87
2	14.75	87.60	87.58	87.65	87.81	87.99	88.15	88.27	88.40	88.42	88.38	88.19	88.13
2	14.66	88.20	88.18	88.23	88.33	88.45	88.55	88.63	88.72	88.73	88.70	88.56	88.51
2	14.56	87.80	87.78	87.82	87.92	88.03	88.13	88.21	88.29	88.30	88.27	88.15	88.11
2	14.47	85.20	85.18	85.23	85.34	85.47	85.58	85.66	85.75	85.76	85.73	85.60	85.55
3	14.38	84.43	84.45	84.48	84.54	84.63	84.71	84.77	84.85	84.87	84.87	84.82	84.84
3	14.28	83.64	83.66	83.69	83.75	83.84	83.92	83.98	84.06	84.08	84.08	84.04	84.06
3	14.19	82.43	82.45	82.48	82.54	82.62	82.70	82.76	82.83	82.85	82.85	82.81	82.83
3	14.10	81.53	81.55	81.58	81.65	81.75	81.84	81.91	82.00	82.02	82.01	81.96	81.98
3	14.00	80.32	80.34	80.37	80.43	80.52	80.61	80.68	80.76	80.78	80.78	80.74	80.76
3	13.90	79.34	79.36	79.39	79.46	79.57	79.67	79.75	79.85	79.87	79.86	79.81	79.83
3	13.81	78.44	78.46	78.49	78.56	78.67	78.77	78.85	78.95	78.97	78.96	78.91	78.94
3	13.72	76.72	76.74	76.77	76.83	76.92	77.00	77.06	77.14	77.16	77.16	77.12	77.14
3	13.62	75.73	75.75	75.78	75.84	75.94	76.03	76.10	76.18	76.20	76.20	76.16	76.18
3	13.53	74.13	74.15	74.18	74.24	74.34	74.43	74.50	74.59	74.61	74.61	74.57	74.59
3	13.43	73.03	73.05	73.08	73.15	73.25	73.34	73.41	73.50	73.52	73.52	73.48	73.50
4	13.32	70.89	70.88	70.83	70.79	70.75	70.72	70.70	70.68	70.67	70.67	70.68	70.69
4	13.31	69.78	69.77	69.71	69.66	69.61	69.57	69.55	69.53	69.52	69.53	69.54	69.55
4	13.22	68.38	68.37	68.29	68.22	68.15	68.10	68.07	68.04	68.02	68.03	68.05	68.06
4	13.13	66.98	66.96	66.86	66.77	66.68	66.62	66.58	66.54	66.51	66.52	66.54	66.56
4	13.03	65.57	65.55	65.44	65.35	65.26	65.20	65.16	65.12	65.09	65.10	65.13	65.15
4	12.94	64.17	64.15	64.04	63.95	63.86	63.80	63.76	63.72	63.69	63.70	63.73	63.75
4	12.84	62.77	62.75	62.65	62.57	62.49	62.43	62.40	62.36	62.33	62.34	62.36	62.38
4	12.75	61.17	61.15	61.06	60.98	60.91	60.86	60.83	60.80	60.78	60.79	60.81	60.83
4	12.65	59.48	59.47	59.40	59.34	59.28	59.24	59.22	59.20	59.18	59.19	59.21	59.22
4	12.56	58.58	58.58	58.54	58.50	58.46	58.43	58.41	58.39	58.38	58.38	58.39	58.40
4	12.46	54.58	54.57	54.51	54.45	54.39	54.35	54.33	54.31	54.29	54.30	54.31	54.32
5	12.38	53.42	53.46	53.66	53.86	54.12	54.37	54.58	54.89	55.06	55.13	55.35	55.36
5	12.27	51.52	51.54	51.64	51.76	51.92	52.07	52.20	52.38	52.47	52.50	52.60	52.60
5	12.18	45.82	45.83	45.91	45.96	46.02	46.08	46.13	46.21	46.29	46.32	46.41	46.41
5	12.08	49.73	49.75	49.82	49.87	49.93	49.99	50.04	50.12	50.17	50.20	50.30	50.31
5	11.99	46.62	46.63	46.69	46.74	46.81	46.88	46.94	47.03	47.08	47.11	47.20	47.20
5	11.89	46.12	46.13	46.18	46.24	46.32	46.40	46.47	46.57	46.62	46.64	46.70	46.70
5	11.80	49.13	49.21	49.47	49.68	49.94	50.19	50.40	50.72	50.92	51.01	51.31	51.33
5	11.71	47.92	48.01	48.26	48.46	48.70	48.93	49.12	49.42	49.61	49.70	50.01	50.03
5	11.62	45.39	45.49	45.78	46.01	46.28	46.54	46.76	47.10	47.32	47.42	47.76	47.78
5	11.52	42.65	42.76	43.08	43.29	43.54	43.78	43.99	44.30	44.51	44.63	45.02	45.04
5	11.43	39.34	39.38	39.66	39.97	40.15	40.20	40.24	40.30	40.41	40.57	41.09	41.12

THE FOLLOWING TABLE LISTS THE CHANGE IN BED ELEVATION DURING EACH TIME STEP

REACH	SECNO	STEP 1	STEP 2	STEP 3	STEP 4	STEP 5	STEP 6	STEP 7	STEP 8	STEP 9	STEP10	STEP11	STEP12
1	16.27	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
1	16.17	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
1	16.08	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
1	15.98	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
1	15.89	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
1	15.79	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
1	15.70	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

1	15.61	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
1	15.51	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
1	15.42	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
2	15.32	.00	-.02	.06	.14	.15	.14	.10	.11	.01	-.04	-.17	-.07
2	15.23	.00	-.02	.05	.12	.13	.12	.09	.10	.01	-.03	-.13	-.17
2	15.13	.00	-.02	.06	.13	.14	.12	.09	.10	.01	-.03	-.15	-.08
2	15.04	.00	-.02	.05	.11	.12	.11	.08	.09	.01	-.03	-.13	-.07
2	14.94	.00	-.02	.04	.10	.12	.10	.08	.09	.01	-.03	-.12	-.04
2	14.85	.00	-.03	.06	.13	.15	.13	.10	.11	.01	-.04	-.17	-.08
2	14.75	.00	-.02	.07	.16	.18	.16	.12	.13	.02	-.04	-.19	-.06
2	14.66	.00	-.02	.05	.10	.12	.10	.08	.09	.01	-.03	-.14	-.05
2	14.56	.00	-.02	.04	.10	.11	.10	.08	.08	.01	-.03	-.12	-.04
2	14.47	.00	-.02	.05	.11	.13	.11	.08	.09	.01	-.03	-.13	-.05
3	14.38	.03	.02	.03	.06	.09	.08	.06	.08	.02	.00	-.05	.02
3	14.28	.04	.02	.03	.06	.09	.08	.06	.08	.02	.00	-.04	.02
3	14.19	.03	.02	.03	.06	.08	.08	.06	.07	.02	.00	-.04	.02
3	14.10	.03	.02	.03	.07	.10	.09	.07	.09	.02	-.01	-.05	.02
3	14.00	.02	.02	.03	.06	.09	.09	.07	.08	.02	.00	-.04	.02
3	13.90	.04	.02	.03	.07	.11	.10	.08	.10	.02	-.01	-.05	.02
3	13.81	.04	.02	.03	.07	.11	.10	.08	.10	.02	-.01	-.05	.03
3	13.72	.02	.02	.03	.06	.09	.08	.06	.08	.02	.00	-.04	.02
3	13.62	.03	.02	.03	.06	.10	.09	.07	.08	.02	.00	-.04	.02
3	13.53	.03	.02	.03	.06	.10	.09	.07	.09	.02	.00	-.04	.02
3	13.43	.03	.02	.03	.07	.10	.09	.07	.09	.02	.00	-.04	.02
4	13.32	-.01	-.01	-.05	-.04	-.04	-.03	-.02	-.02	-.01	.00	.01	.01
4	13.31	-.02	-.01	-.06	-.05	-.05	-.04	-.02	-.02	-.01	.01	.01	.01
4	13.22	-.02	-.01	-.08	-.07	-.07	-.05	-.03	-.03	-.02	.01	.02	.01
4	13.13	-.02	-.02	-.10	-.09	-.09	-.06	-.04	-.04	-.03	.01	.02	.02
4	13.03	-.03	-.02	-.11	-.09	-.09	-.06	-.04	-.04	-.03	.01	.03	.02
4	12.94	-.03	-.02	-.11	-.09	-.09	-.06	-.04	-.04	-.03	.01	.03	.02
4	12.84	-.03	-.02	-.10	-.08	-.08	-.06	-.03	-.04	-.03	.01	.02	.02
4	12.75	-.03	-.02	-.09	-.08	-.07	-.05	-.03	-.03	-.02	.01	.02	.02
4	12.65	-.02	-.01	-.07	-.06	-.06	-.04	-.02	-.02	-.02	.01	.02	.01
4	12.56	-.02	.00	-.04	-.04	-.04	-.03	-.02	-.02	-.01	.00	.01	.01
4	12.46	-.02	-.01	-.06	-.06	-.06	-.04	-.02	-.02	-.02	.01	.01	.01
5	12.38	.12	.04	.20	.20	.26	.25	.21	.31	.17	.07	.22	.01
5	12.27	.02	.02	.10	.12	.16	.15	.13	.18	.09	.03	.10	.00
5	12.18	.02	.01	.08	.05	.06	.06	.05	.08	.08	.03	.09	.00
5	12.08	.03	.02	.07	.05	.06	.06	.05	.08	.05	.03	.10	.01
5	11.99	.02	.01	.06	.05	.07	.07	.06	.09	.05	.03	.09	.00
5	11.89	.02	.01	.05	.06	.08	.08	.07	.10	.05	.02	.06	.00
5	11.80	.13	.08	.26	.21	.26	.25	.21	.32	.20	.09	.30	.02
5	11.71	.22	.09	.25	.20	.24	.23	.19	.30	.19	.09	.31	.02
5	11.62	.19	.10	.29	.23	.27	.26	.22	.34	.22	.10	.34	.02
5	11.52	.25	.11	.32	.21	.25	.24	.21	.31	.21	.12	.39	.02
5	11.43	.04	.04	.28	.31	.18	.05	.04	.06	.11	.16	.52	.03

THE FOLLOWING TABLE LISTS THE MINIMUM AND MAXIMUM BED ELEVATIONS (COLUMNS 2 & 3 , THE MAXIMUM DEGRADATION AND AGGRADATION WITH RESPECT TO THE INITIAL BED ELEV TION (COLUMNS 4 & 5) THAT OCCURS AT EACH SECTION DURING THE HYDROGRAPH AND THE NET CHANGE ("NETCH", COLUMN 6) IN BED ELEVATION THAT OCCURS AT EACH SECTION DU RING THE HYDROGRAPH

REACH	SECNO	MIN	MAX	DEG	AGG	NETCH
1	16.27	107.00	107.00	.00	.00	.00
1	16.17	106.70	106.70	.00	.00	.00
1	16.08	106.00	106.00	.00	.00	.00
1	15.98	103.90	103.90	.00	.00	.00
1	15.89	100.90	100.90	.00	.00	.00
1	15.79	98.00	98.00	.00	.00	.00
1	15.70	97.80	97.80	.00	.00	.00
1	15.61	97.90	97.90	.00	.00	.00
1	15.51	97.30	97.30	.00	.00	.00
1	15.42	94.10	94.10	.00	.00	.00
2	15.32	93.48	94.19	.02	.69	.41
2	15.23	94.88	95.50	.02	.60	.27
2	15.13	91.38	92.03	.02	.63	.37
2	15.04	91.68	92.25	.02	.55	.32
2	14.94	90.98	91.52	.02	.52	.33
2	14.85	90.47	91.16	.03	.66	.37
2	14.75	87.58	88.42	.02	.82	.53
2	14.66	88.18	88.73	.02	.53	.31
2	14.56	87.78	88.30	.02	.50	.31
2	14.47	85.18	85.76	.02	.56	.35

3	14.38	84.40	84.87	.00	.47	.44
3	14.28	83.60	84.08	.00	.48	.46
3	14.19	82.40	82.85	.00	.45	.43
3	14.10	81.50	82.02	.00	.52	.48
3	14.00	80.30	80.78	.00	.48	.46
3	13.90	79.30	79.87	.00	.57	.53
3	13.81	78.40	78.97	.00	.57	.54
3	13.72	76.70	77.16	.00	.46	.44
3	13.62	75.70	76.20	.00	.50	.48
3	13.53	74.10	74.61	.00	.51	.49
3	13.43	73.00	73.52	.00	.52	.50
4	13.32	70.67	70.90	.23	.00	-.21
4	13.31	69.52	69.80	.28	.00	-.25
4	13.22	68.02	68.40	.38	.00	-.34
4	13.13	66.51	67.00	.49	.00	-.44
4	13.03	65.09	65.60	.51	.00	-.45
4	12.94	63.69	64.20	.51	.00	-.45
4	12.84	62.33	62.80	.47	.00	-.42
4	12.75	60.78	61.20	.42	.00	-.37
4	12.65	59.18	59.50	.32	.00	-.28
4	12.56	58.38	58.60	.22	.00	-.20
4	12.46	54.29	54.60	.31	.00	-.28
5	12.38	53.30	55.36	.00	2.06	2.06
5	12.27	51.50	52.60	.00	1.10	1.10
5	12.18	45.80	46.41	.00	.61	.61
5	12.08	49.70	50.31	.00	.61	.61
5	11.99	46.60	47.20	.00	.60	.60
5	11.89	46.10	46.70	.00	.60	.60
5	11.80	49.00	51.33	.00	2.33	2.33
5	11.71	47.70	50.03	.00	2.33	2.33
5	11.62	45.20	47.78	.00	2.58	2.58
5	11.52	42.40	45.04	.00	2.64	2.64
5	11.43	39.30	41.12	.00	1.82	1.82

Unsaturated Ground-water Flow Modeling for Proposed Cholla Landfill

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Executive Summary

The unsaturated flow model UNSAT2 was applied to three representative cross-sections of the proposed Cholla Sanitary Landfill to determine the distributions of pressure head and moisture content in response to an extreme hydrologic surface flow event in the Agua Fria river. These distributions indicated the potential for lateral migration of ground water. The three cross-sections were representative of geologic and lithologic conditions at the site. The modeleled flow event consisted of a flood with a stage hydrograph whose maximum stage reached the approximate 100 year flood boundary for 10 hours. The duration of the hydrograph was 8 days.

The cross-sections were oriented in an east-west direction, with one section in the north, one in the center and one in the south. On the average, the northern section was composed of coarser grain materials such as sands and gravels, the central section was composed of sands and silts and the southern section was composed of silts and clays with some sands and gravels.

Model parameter estimates were obtained from three sources: laboratory permeability measurements, in-situ testing in selected boreholes, and published ranges of parameters based on soil texture. Estimates made on soil texture were biased toward the conservative side and thus permitted more inflow than might actually occur.

The model showed that the saturation front did not move closer than about 100 feet of the landfill excavation. The northern cross-section had the most water infiltration with nearly 100 ft^3/ft^2 of water infiltrating over the 8 day period and 60 ft^3/ft^2 occuring within the first 5 days. The central section had a total of 50 ft^3/ft^2 of water infiltrated over the 8 day period. The southern section had little if any infiltration due to a low permeability layer directly under the streambed. Only 3.5 ft^3/ft^2 of water infiltrated over the 8 day period.

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1.0 Introduction

The unsaturated flow model UNSAT2 (Davis and Neuman, 1983) was applied to three cross-sections of the proposed Cholla Sanitary Landfill to estimate the distributions of pressure head and moisture content in response to an extreme hydrologic surface flow event in the Agua Fria river. These distributions indicate the potential for lateral migration of ground water. Three cross-sections were chosen to be representive of geologic and lithologic conditions at the site. The three sections are referred to in this report as Section 7, Section 8 and Section 9. The extreme flow event consisted of a stage hydrograph that matched the approximate 100 year flood boundary on the Agua Fria river below the New River confluence (EMCON Asssociates, 1989a).

2.0 Mathematical Development

The mathematical model that emulates the flow in unsatured porous media is based on a non-linear partial differential equation (Neuman et al, 1974). For the purposes of this report, flow is assumed to occur in the vertical plane. The region modeled was composed of nonuniform soils so that model parameters were non-homogeneous in space.

2.1 Basic flow equations

The basic flow equation used in this report to describe and model the flow of water in a variably saturated porous medium is:

$$\frac{\partial}{\partial x}\left(K_r(h)K_s(x,z)\,\frac{\partial h(x,z,t)}{\partial x}\right) + \frac{\partial}{\partial z}\left(K_r(h)K_s(x,z)\,\frac{\partial h(x,z,t)}{\partial z}\right) + \frac{\partial}{\partial z}\left(K_r(h)K_s(x,z)\right)$$

$$= C(h)\,\frac{\partial h(x,z,t)}{\partial t} \qquad (1)$$

on D, where D is the spatial domain of the flow region, and where;

x, z = spatial coordinates,

K_r = relative hydraulic conductivity ($0 \leq K_r \leq 1$),

K_s = saturated hydraulic conductivity,

h = pressure head,

C = specific moisture capacity = $-d\theta/dh$,

θ = volumetric water content,

t = time.

The saturated hydraulic conductivity, K_s, is assumed to vary only spatially. The pressure head, h, is positive in saturated zones, zero at the phreatic surface and negative in the unsaturated zone. Hysteresis is not considered in the model.

2.2 Initial conditions

The solution of equation (1) requires that initial conditions be specified within the flow region. Because hysteresis in not considered, h is a single-valued function of volumetric moisture content, θ, and the initial conditions are fully described by the pressure head:

$$h(x,z,0) = h_0(x,z) \tag{2}$$

where h_0 is a prescribed function of (x,z).

2.3 Boundary conditions

In addition to initial conditions, either pressure head or normal flux must be specified along the boundaries of the flow region. Prescribed pressure head boundaries, which may vary with time, are described mathematically as:

$$h(\Gamma,t) = h_c(\Gamma,t) \tag{3}$$

while the fluxes normal to the boundary are represented as:

$$\left(K_r K_s \cdot \nabla h \cdot \hat{n} + V\right)\Big|_{\Gamma} = 0 \tag{4}$$

where Γ is the curve describing the boundary, and h_c and V are prescribed functions of Γ at t. For the purposes of this report, it is assumed that at the soil-air interface, no water is lost to evaporation nor does any water enter as infiltration except through the river bed.

3.0 Numerical Approximation

A Galerkin finite element approach is used to solve the flow equation and its associated initial and boundary conditions (equations (1) - (4)). Construction of the finite element (F.E.) grid followed standard procedures established to produce grids composed of triangular or quadrilateral elements. The corners of these elements are taken to be nodal points. F.E. grids were superimposed over cross-sectional views of the flow region so as to conform with the boundaries or interfaces between materials of different properties.

For a finite element grid superimposed over a cross-section, the pressure head h(x,z,t) within the region is defined as:

$$h^N(x,z,t) = \sum_{n=1}^{N} h_n(t) \bigcup_e \xi_n^e(x,z) \tag{5}$$

where;

N	=	the total number of nodes,
$h_n(t)$	=	value of the pressure head at node n,
$\bigcup_e$	=	union sign taken over all elements containing node *n*, and
$\xi_n^e(x,z)$	=	a local coordinate function associated with node *n* in element *e*.

The coordinate functions, or basis functions as they are sometimes called, are required to satisfy:

$$\xi_n^e(x^m, z^m) = \delta_{nm} \tag{6}$$

where;

δ_{nm} = The Kronecker delta ($\delta_{nm} = 1$ if $n = m$, $\delta_{nm} = 0$ if $n \neq m$), and

x^m, z^m = space coordinates of node m anywhere in the grid.

The values of h_n in equation (5) must be determined such that the initial and boundary conditions of the problem are satisfied.

Substituting equation (5) into equation (1), applying Green's theorem to incorporate boundary conditions and integrating over the area of the elements leads to the set of quasilinear first-order differential equations:

$$\sum_{m=1}^{N} A_{nm}\, h_m + \sum_{m=1}^{N} F_{nm} \frac{dh_m}{dt} + B_n = 0 \qquad n = 1, \ldots, N \tag{7}$$

where;

A_{nm} = a matrix with elements a function of K_r and K_s,

F_{nm} = a matrix with elements a function of C, and

B_n = a vector with elements a function of K_r and K_s.

When the ordinary differential, dh_m/dt, in equation (7) is approximated by finite difference, and an iterative process is incorporated, the resulting equations are linear algebraic and are solved by simple matrix inversion techniques.

4.0 Site Characterization for Modeling

Three cross-sections were modeled using UNSAT2. The cross-sections are oriented in an east-west direction normal to the Agua Fria river, with Section 9 being to the north, Section 8 to the center and Section 7 to the south (Figure 1). On the average, Section 9 is composed of coarser grain material such as sands and gravels, Section 8 is composed of sands and silts with some clays and Section 7 is

composed of silts and clays with some sands and gravel. Three subsurface profiles were synthesized from drilling logs and form the basis for the layers of material properties incorporated into the model. Figures 2, 3 and 4 present the subsurface profiles for sections 7, 8 and 9, respectively. Figure 5 provides the classification chart for the symbols used in the subsurface profiles. Also incorporated in the subsurface profiles for Sections 7 and 8 was a soil/cement region considered as a possible alternative for erosion control. The site geology and hydrogeology are discussed in greater detail by EMCON Associates (section 3.3: Site Geology and section 4.2: Site Hydrogeology, 1989b). The design aspects of the landfill, such as slopes and excavation levels were provided by EMCON Associates (Drawing no. 2, 1989a), and are incorporated in the subsurface profiles.

4.1 Cross-sectional Grids

The grid superimposed over Section 7 consisted of 1842 nodes, 1770 elements and a bandwidth of 49; over Section 8 it consisted of 1382 nodes, 1324 elements and a bandwidth of 43; and over Section 9 it consisted of 1915 nodes, 1839 elements and a bandwidth of 39. Plates 1, 2 and 3 present the grids for Sections 7, 8 and 9, respectively. The large size of the grid insured that infiltrating water did not reach cross-sectional boundaries other than at the streambed.

The product of the number of nodes times the bandwidth governs the storage and memory requirements of UNSAT2 on a computer. The grids for each section were constructed to conform to the various layers of material properties. All layers were composed of at least one element in the vertical direction. Small element sizes were used where extremely large gradients were expected.

4.2 Initial and boundary conditions imposed on site

The initial condition requires that the pressure head be specified at all node points. For the purpose of this study, the initial condition was specified to be -15 feet at all nodes in all Sections. The -15 feet is representative of a dry condition for the material properties.

Other than along the streambed, all the boundary conditions in each Section were no-flow

boundaries. On the streambed for each Section, a time varying pressure head boundary condition was imposed (Figure 6). The time varying pressure head boundary condition was provided by an estimate of a stage hydrograph that was based on the approximate 100 year flood boundary (EMCON Associates, 1989a) and the 100 year flood discharge hydrograph (Corps of Engineers, 1981). The stage hydrograph was not calculated directly from the Corps of Engineers' discharge hydrograph because channel properties (slopes, cross-sections and Manning' n values) at the sites are unknown. However, the maximum height of the stage hydrograph corresponds to the approximate 100 flood boundary. Starting at simulation time t = 0, a head of 1 foot was applied at the streambed boundary nodes for 5 days. This head value created a wet antecedent condition within each of the Sections. At the end of 5 days, the head in the streambed was increased to 5 feet for 3 hours (5.125 days), increased again to 9 feet for another 3 hours (5.25 days) and finally increased to a maximum of 10 feet for 10 hours (5.666 days). The heads in the streambed were then allowed to fall, decreased to 5 feet for 4 hours (5.833 days) and to 1.5 feet for 4 hours (6 days). From the sixth day to the eighth day the head was kept at 0.01 feet.

5.0 Parameter Estimates

The three hydraulic parameters required for the model are the saturated hydraulic conductivity, K_s, the relative hydraulic conductivity, K_r, and the moisture retention curve. The capacity of porous material to yield water under changes in pressure head is represented by the specific moisture capacity, C. The parameter, C, is obtained from the derivative of the moisture retention curve with respect to pressure head. The materials in Sections 7, 8 and 9 that required estimates of hydraulic parameters are shown in Tables 1, 2 and 3, respectively.

5.1 Saturated hydraulic conductivity

Estimates of saturated hydraulic conductivity were obtained from three sources: laboratory permeability measurements, in-situ tests in selected boreholes, and published ranges of saturated

hydraulic conductivity based on soil texture. The laboratory permeability measurements were conducted on cores taken from the vicinity of the sections. The measurements were performed by the EMCON Laboratory in San Jose, California. The in-situ testing was performed in selected boreholes (SHC-3, SHC-5, SHC-7, SHC-9, SHC-11, SHC-21 SHC-22 and SHC-23) over selected depth intervals. The testing was performed using either a falling head test (FH) or a constant head test (CH). Caution is required in the interpretation of these tests in that, typically, constant head tests are accurate to within a few hundred percent while falling head tests are accurate to orders of magnitude (Stephens and Neuman, 1982). Estimates of saturated hydraulic conductivity based on soil texture were taken from Freeze and Cherry (1979). These estimates were used for GP and SP-SW materials of Section 9 and the GM of Section 8 because no measured values of saturated hydraulic conductivity were available for these materials.

Saturated hydraulic conductivity data available and estimated values of saturated hydraulic conductivity and their sources are listed in Tables 1 - 3. Also included in these tables are the parameters of van Genuchten's model for unsaturated soil properties.

5.2 Relative hydraulic conductivity

The relative hydraulic conductivity is given by:

$$K_r = \frac{K(h)}{K_s} \qquad \text{with } 0 \leq K_r \leq 1 \tag{8}$$

where K(h) is hydraulic conductivity as a function of pressure head. The dependence of K_r on water content can be measured directly or estimated by using the closed-form expression for K_r of van Genuchten (1980):

$$\Theta = \begin{cases} \dfrac{1}{[1 + |\alpha h|^n]^{1-1/n}} & h < 0 \\ 1 & h \geq 0 \end{cases} \tag{9}$$

$$K_r = \Theta^{\frac{1}{2}}\left[1 - \left(1 - \Theta^{\frac{n}{n-1}}\right)^{1-\frac{1}{n}}\right]^2 \tag{10}$$

and

$$K = K_r K_s \tag{11}$$

where;

Θ = reduced water content, $\Theta = \dfrac{(\theta - \theta_r)}{(\theta_s - \theta_r)}$

and

θ = volumetric water content,

θ_r = residual volumetric water content,

θ_s = saturated volumetric water content,

n = fitting parameter inversely related to pore size distribution,

α = fitting parameter inversely related to air-entry tension.

At present moisture retention data are not available for materials at the Cholla Landfill site. Parameter values for α, n, and θ_r of materials with similar texture were taken from the literature for use in the model. Values of θ_s were estimated from porosity (ϕ) of materials of similar texture (Freeze and Cherry, 1979).

Values of the van Genuchten parameters α, n, and θ_r used to model the materials in each section are listed in Tables 1-3 along with a reference to their source. The pressure head- hydraulic conductivity relationships calculated from equations (9) and (10) for Sections 7, 8 and 9 are shown in Figures 7, 8a-b and 9, respectively.

The pressure head-volumetric water content relationships calculated from equation (9) for Sections 7,8 and 9 are shown in Figures 10, 11 and 12, respectively.

5.3 Specific moisture capacity

The specific moisture capacity is dependent on the volumetric water content and is taken from the slope of the pressure head - volumetric water content curve. The specific moisture capacity is defined as:

$$C = -\frac{d\theta}{dh} \tag{12}$$

The specific moisture capacity - volumetric water content relationships for Sections 7, 8 and 9 are shown in Figures 13, 14 and 15, respectively.

5.4 Quality of estimates of unsaturated hydraulic properties

The estimates of unsaturated hydraulic properties listed in Tables 1 - 3 and shown in Figures 7 to 15 should not be construed as being more than rough, preliminary approximations. These estimates are based at best on a single measured value of K_s and were often only inferred from textural information. There is little in the scientific literature describing the unsaturated hydraulic properties of unconsolidated sediments, especially those of large particle size. For this reason, the estimates obtained by engineering judgement were highly biased on the conservative side. Saturated hydraulic conductivity and moisture retention data on 14 undisturbed cores taken from borings near sections 7 and 8 are at present being determined by Daniel B Stephens and Associates of Albuquerque, New Mexico. When it becomes available this information will provide a check on the estimates of α, n and θ_r and will be used to develop experimental moisture retention data and estimates of K_s, K_r and C, if necessary.

6.0 Observations and Conclusions

UNSAT2 was run for the three cross-sections on a Dell 310, a 20 mh 386 based machine with a Weitek 3167 coprocessor. Run times for Section 7, 8 and 9 were 3 hours, 60 hours and 30 hours in real-time, a considerable computational feat!

6.1 Section 7

The infiltration into Section 7 is controlled completely by the first layer (SM) under the river bed (Figure 2). This layer, based on in situ measurements, has a permeability similar to that of soil cement, therefore impeding the development of the saturation front (pressure head = 0). The saturation front advanced approximately 3.3 feet in 8 days (Figures 16 - 19). The cumulative inflow per unit area of river bed over the 8 days was 3.4 ft^3/ft^2 (Figure 20).

6.2 Section 8

The material underlying the river bed in Section 8 (GM-SM, Figure 3) is more permeable than that of Section 7. The saturation front advanced rapidly through the alluvial materials up to the first day when it encountered the first clay layer (Figure 21 and 22) . During days 2 through 5 some lateral movement of water occurred at the first clay layer, but the saturation front advanced only to within 200 feet of the excavation face (Figures 23 - 26).

There was little lateral movement of the saturation front during the main peak of the flood from days 5 to 6 (Figures 27 - 31). During this period the saturation front primarily moved vertically downward. Continual vertical downward movement of the saturation front with little lateral advance was observed during the flood recession, days 7 through 8 (Figures 32 and 33) .

The cumulative inflow per unit area of river bed during the 8 day period was 49 ft^3/ft^2 (Figure 34).

The effects of the soil/cement region on the pressure head contours are visible at 5.25 days (Figure 28) but are most pronounced at 8 days (Figure 33).

6.3 Section 9

The materials immediately underlying the river bed in Section 9 (GW-GM, Figure 4) are more permeable than those in Sections 7 and 8. The saturation front advanced rapidly vertically downward

until it encountered a thin clay layer (Figures 35 and 36). Pressure head built up rapidly at the clay layer and the saturation front moved downward, past the clay layer, in about 2 days (Figure 37). The clay layer induced some lateral movement of the saturation front during the first 5 days (Figures 35 - 40). During the flood peak and subsequent recession, the saturation front moved primarily downward with little or no additional lateral movement (figures 41 - 47).

The cumulative inflow per unit area of river bed during the 8 day period was 95 ft^3/ft^2 (Figure 48).

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TABLE 1: HYDRAULIC PROPERTIES - SECTION 7

Material No.	USCS	K_s (ft/day)	Ø	θr	α (ft^{-1})	n
1	SM	0.283	0.38	0.20	0.57	5.15
2	GW	8.76	0.27	0.01	6.10	3.00
3	CL-ML	0.609	0.42	0.15	0.15	1.50
4	SC	0.045	0.40	0.15	0.15	1.50
5	SW	2.72	0.38	0.05	0.49	4.36
6	GW-GM	1.20	0.38	0.10	0.91	4.00
7	GC-GM	1.01	0.38	0.10	1.07	2.50
8	CL	0.49	0.42	0.15	0.15	1.50
9	Soil Cem	0.28	0.42	0.15	0.15	1.50

SOURCES

Material No.	USCS	BORING	INTERVAL (ft.)	K_s TEST	van Genuchten Parameters
1	SP-SM	SHC 11	33.5-36.7	FH	Mualem Cat No. 4004 Stephens et al (1985)
2	GW	SHC 21	21.8	CH	"Fresno Medium Sand" Lappala et al (1987)
3	ML-CL	SHC 9	38.7-39	FH	Modified "Clay." Parker et al (1985)
4	SC	SHC 10	56	Undist Core	Modified "Clay." Parker et al (1985)
5	SW-SM	SHC 10	68	Undist Core	Mualem Cat No. 4108 Stephens et al (1985)
6	GW-GM	SHC 9	88.9-91	FH	Mualem Cat No. 4147 Stephen et al (1985)
7	GC-GM	SHC 7	98.7-101	FH	Modified "Silt loam" Parker et al (1985)
8	CL	SHC 3	61.1-64.1	CH	Modified "Clay" Parker et al (1985)
9	Soil Cem	--	--	Estimate Provided	Modified "clay" Parker et al (1985)

TABLE 2: HYDRAULIC PROPERTIES - SECTION 8

Material No.	USCS	K_s (ft/day)	Ø	θr	α (ft^{-1})	n
1	GM	14.2	0.35	0.10	1.07	1.29
2	SM	2.72	0.38	0.10	1.07	1.29
3	CL	0.49	0.42	0.15	0.15	1.50
4	SM-SC	3.69	0.40	0.11	0.24	2.35
5	GM-GC	20.6	0.38	0.10	1.07	2.50
6	GM-SM	23.8	0.38	0.10	1.07	2.60
7	GW	8.76	0.27	0.01	6.10	3.00
8	GM-GW	23.8	0.38	0.10	0.91	1.29
9	Soil Cem	0.28	0.42	0.15	0.15	1.50

SOURCES

Material No.	USCS	BORING	INTERVAL (ft.)	K_s TEST	van Genuchten Parameters
1	GM	--	--	Estimated	"Silt loam" Parker et al (1985)
2	SW-SM	SHC 10	68	Core	"Silt loam" Parker et al (1985)
3	CL	SHC 3/ SHC 21	61.1-64.1 48.9-50.3	CH CH	Modified "Clay." Parker et al (1985)
4	SC	SHC 5	78.9-80.9	CH	Modified "Sandy loam" Parker et al (1985)
5	GM-GC	SHC 22	9.2-11.2	CH	Modified "Silt loam" Parker et al (1985)
6	SM-GM	SHC 3	19-20.4	FH	Modified "Silt loam" Parker et al (1985)
7	GW	SHC 21	21.8	CH	"Fresno Medium Sand" Lappala et al (1987)
8	SM-GM	SHC 3	19-20.4	FH	"Silt loam" Parker et al (1985)
9	Soil Cem	--	--	Estimate Provided	Modified "Clay." Parker et al (1985)

TABLE 3: HYDRAULIC PROPERTIES - SECTION 9

Material No.	USCS	K_s (ft/day)	Ø	θr	α (ft^{-1})	n
1	SP	2.84	0.25	0.05	2.13	3
2	GP	28.3	0.25	0.02	2.13	5
3	GW-GM	23.8	0.38	0.10	0.914	4
4	SP-SW	14.2	0.28	0.05	1.52	3
5	CL	0.493	0.42	0.15	0.152	1.5

SOURCES

Material No.	USCS	BORING	INTERVAL (ft.)	K_s TEST	van Genuchten Parameters
1	SP	SHC 3	43.8-48	CH	Modified Mualem Cat.No. 4124 Stephens et al (1987)
2	GP	--	--	Esti-mated	Mualem Cat. No. 4124 Stephens et al (1987)
3	SM-GM	SHC 3	19-20.4	FH	Mualem Cat. No. 4147 Stephens et al (1987)
4	SP-SW	--	--	Esti-mated	Modified Mualem Cat.No. 4124 Stephens et al (1987)
5	CL w/cal	SHC 3	61.1-64.1	CH	Modified "Clay." Parker et al (1985)

Figure 1

Location of Three Modeled Cross-sections

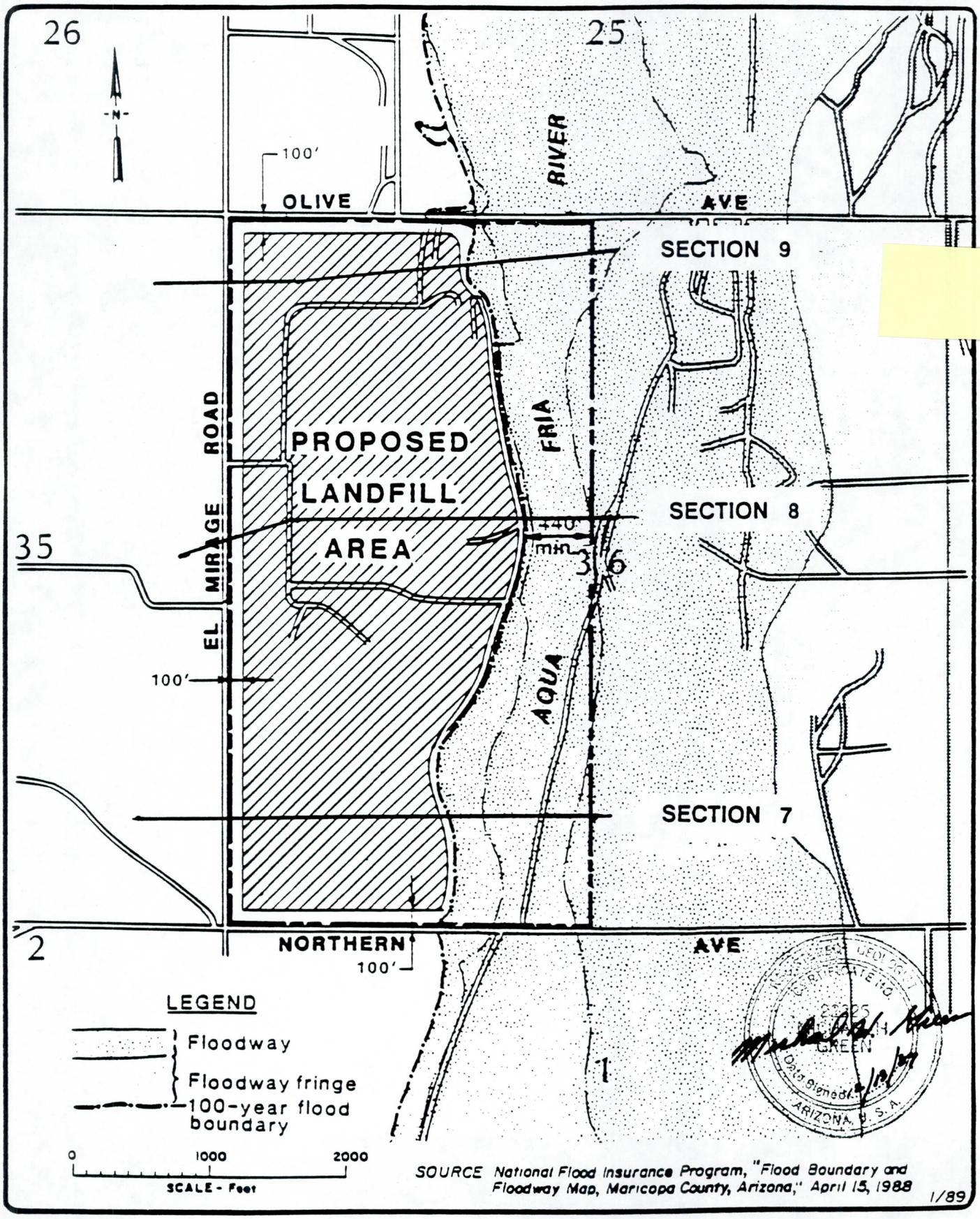


Figure 1

Location of Three Modeled Cross-sections

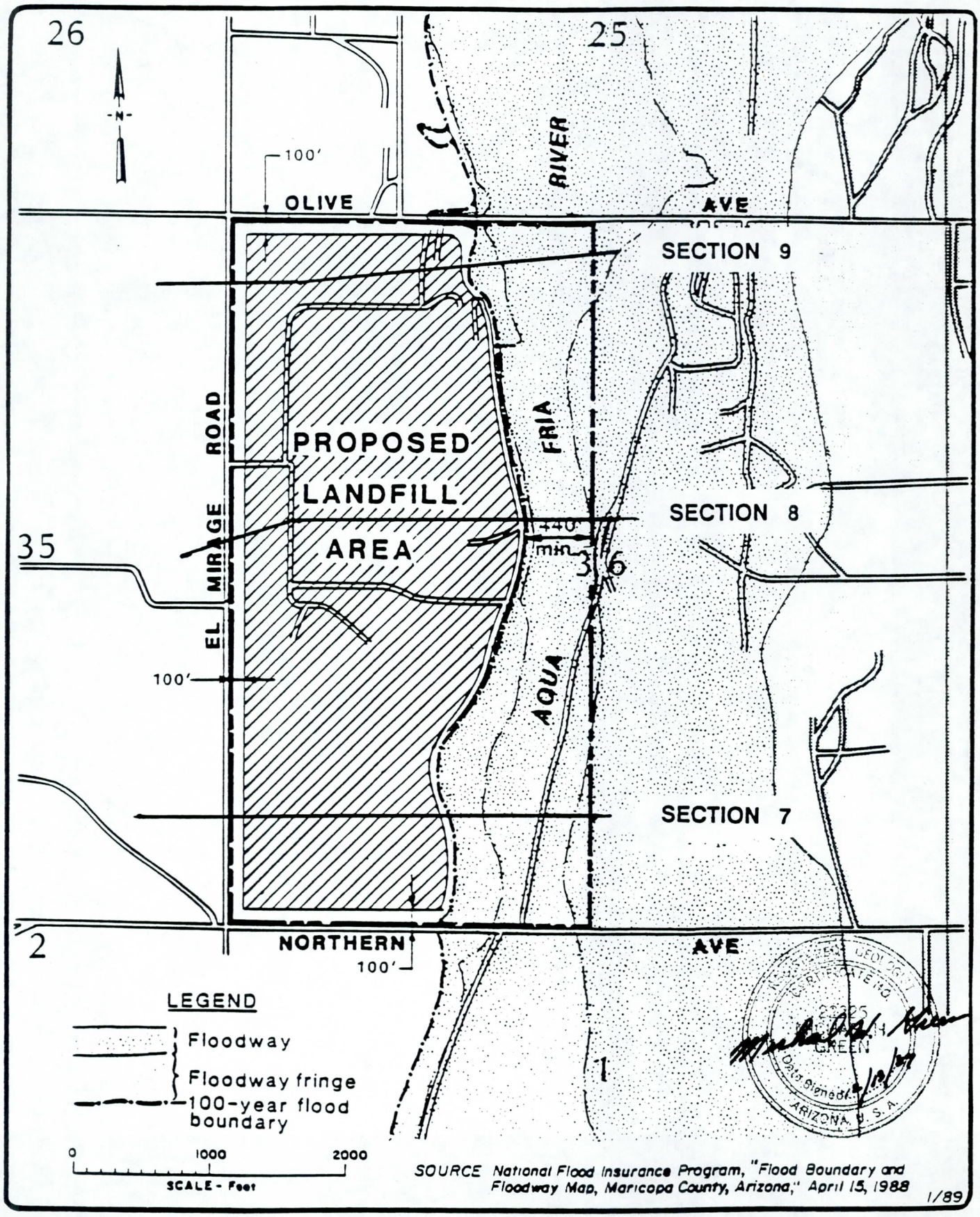


Figure 2

Subsurface Profile for Section 7

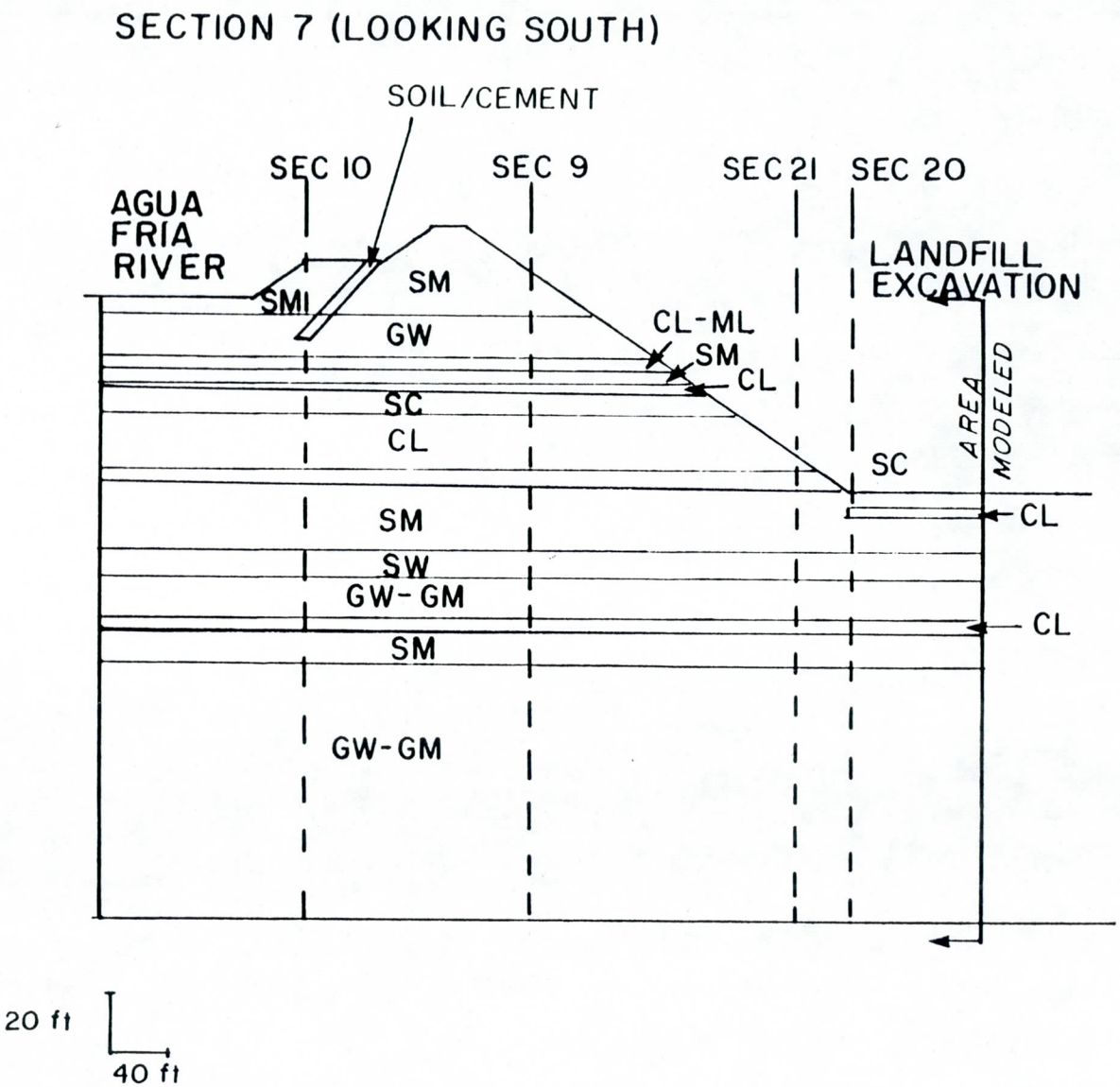


Figure 3

Subsurface Profile for Section 8

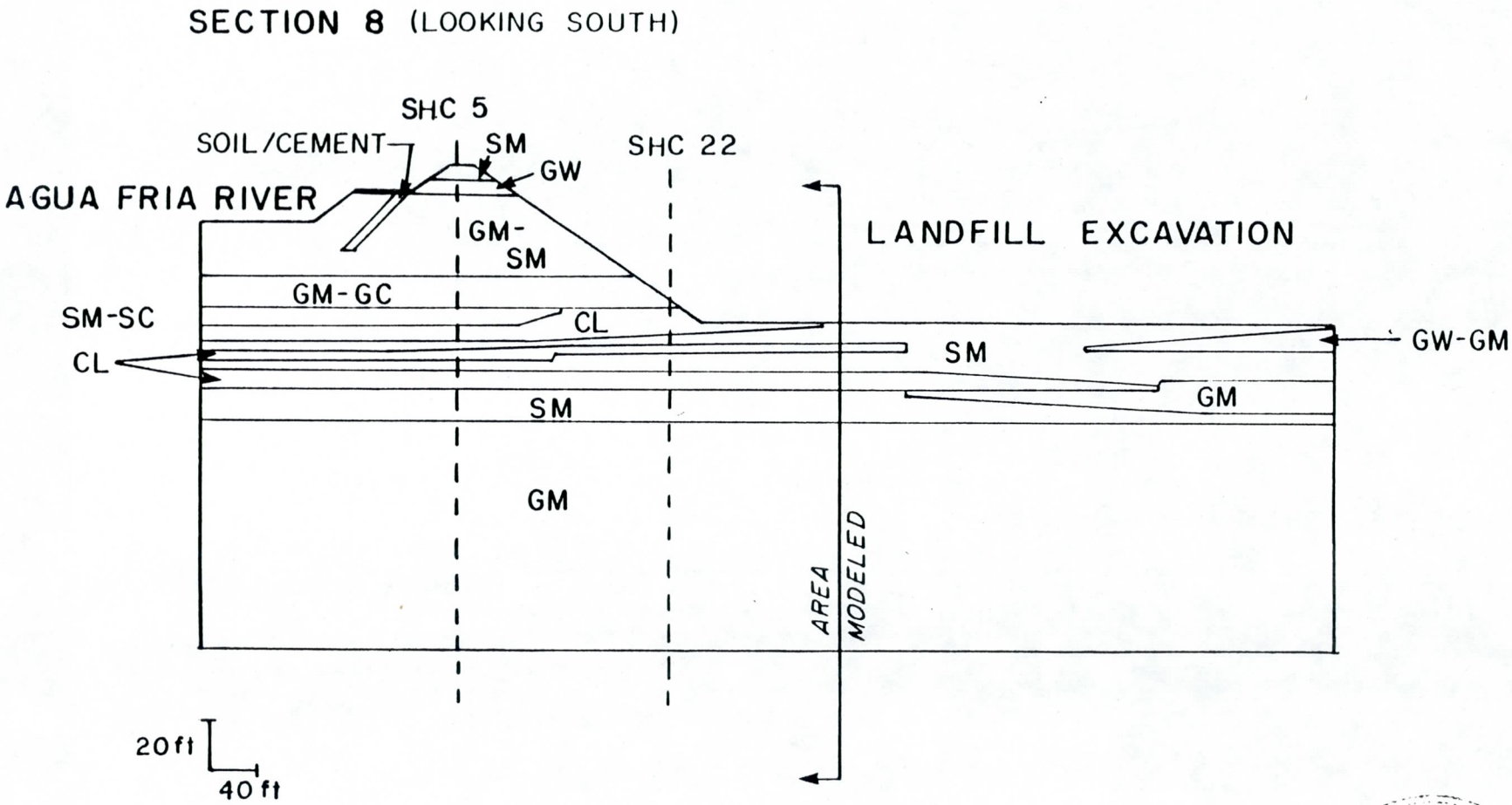
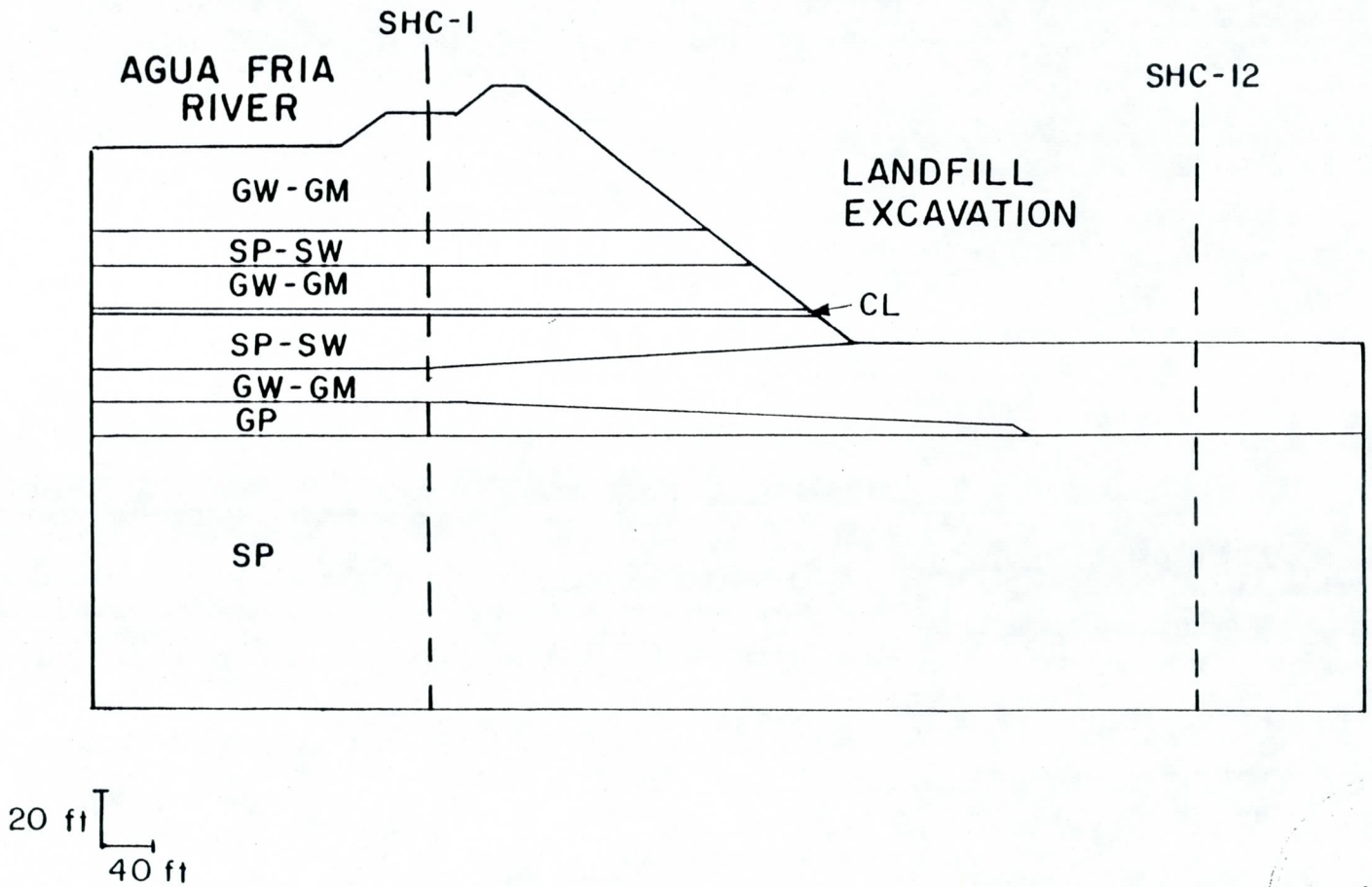


Figure 4

Subsurface Profile for Section 9

SECTION 9 (LOOKING SOUTH)



Michael W. Green
12/12/89

Figure 5

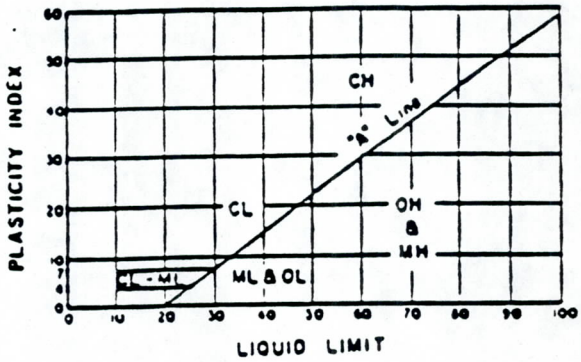
Soil Classification Symbols

MAJOR DIVISIONS		SYMBOLS	TYPICAL SOIL DESCRIPTIONS
COARSE GRAINED SOILS (More than 1/2 of soil > no 200 sieve size)	GRAVELS (More than 1/2 of coarse fraction > no. 4 sieve size)	GW	Well graded gravels or gravel-sand mixtures, little or no fines
		GP	Poorly graded gravels or gravel-sand mixtures, little or no fines
		GM	Silty gravels, gravel-sand-silt mixtures
		GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS (More than 1/2 of coarse fraction < no. 4 sieve size)	SW	Well graded sands or gravelly sands, little or no fines
		SP	Poorly graded sands or gravelly sands, little or no fines
		SM	Silty sands, sand-silt mixtures
		SC	Clayey sands, sand-clay mixtures
FINE GRAINED SOILS (More than 1/2 of soil < no 200 sieve size)	SILTS & CLAYS LL < 50	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		OL	Organic silts and organic silty clays of low plasticity
	SILTS & CLAYS LL > 50	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
		CH	Inorganic clays of high plasticity, fat clays
		OH	Organic clays of medium to high plasticity, organic silty clays, organic silts
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils

CLASSIFICATION - CHART
(Unified Soil Classification System)

CLASSIFICATION	RANGE OF GRAIN SIZES	
	U.S. Standard Sieve Size	Grain Size in Millimeters
BOULDERS	Above 12"	Above 305
COBBLES	12" to 3"	305 to 76.2
GRAVEL	3" to No. 4	76.2 to 4.76
coarse	3" to 3/4"	76.2 to 19.1
fine	3/4" to No. 4	19.1 to 4.76
SAND	No. 4 to No. 200	4.76 to 0.074
coarse	No 4 to No 10	4.76 to 2.00
medium	No. 10 to No. 40	2.00 to 0.420
fine	No. 40 to No. 200	0.420 to 0.074
SILT & CLAY	Below No. 200	Below 0.074

GRAIN SIZE CHART



PLASTICITY CHART

METHOD OF SOIL CLASSIFICATION

Figure 6

River Hydrograph

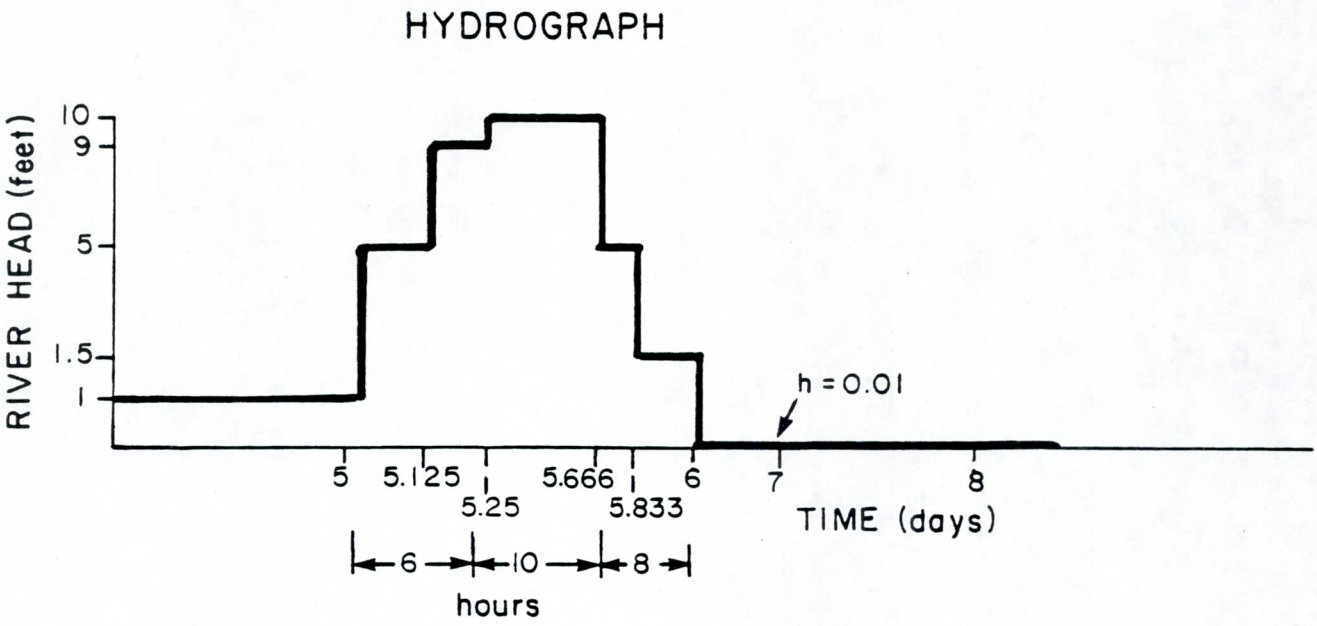


Figure 7

Hydraulic Conductivity as a Function of Pressure Head

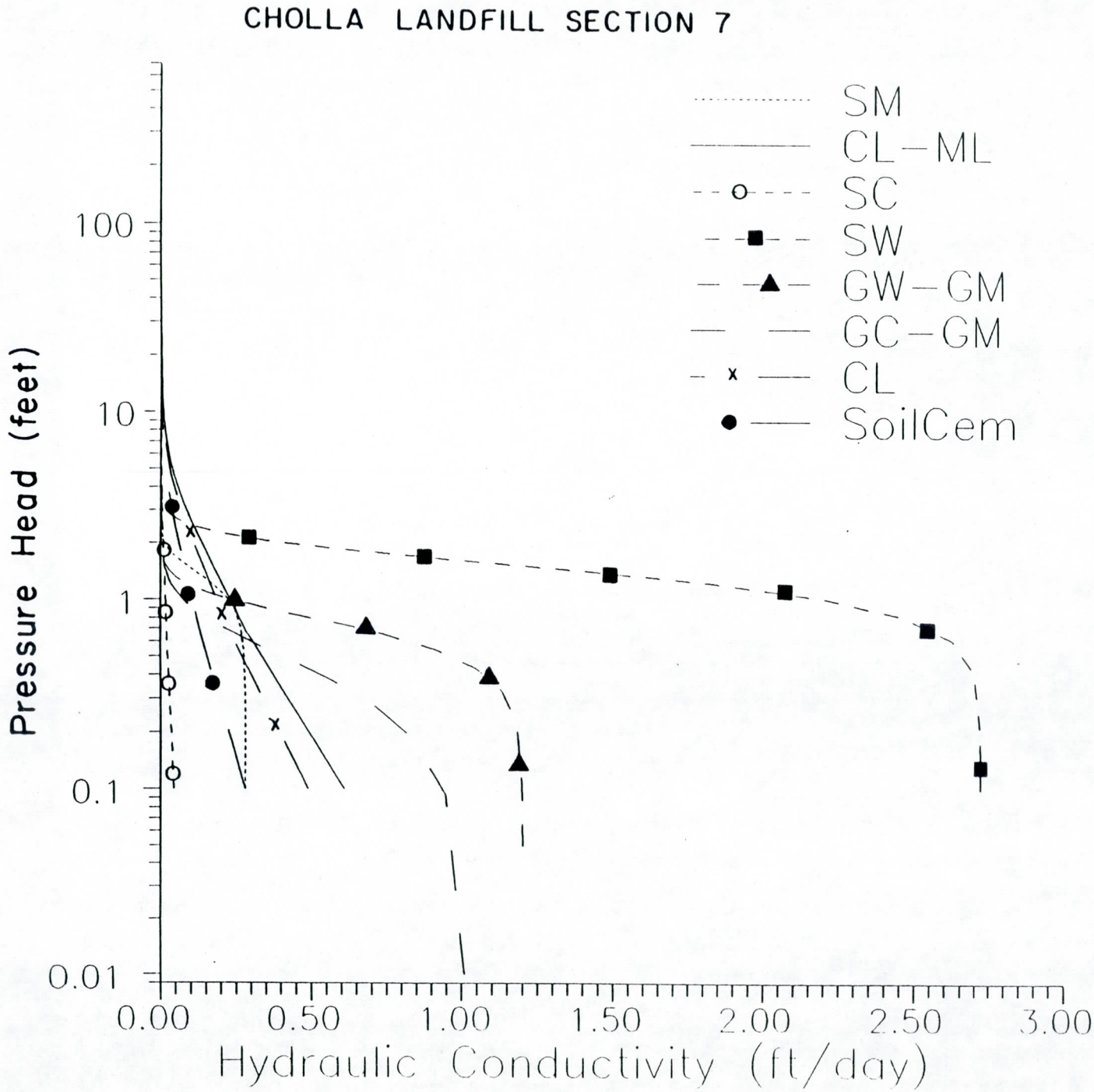


Figure 8a

Hydraulic Conductivity as a Function of Pressure Head

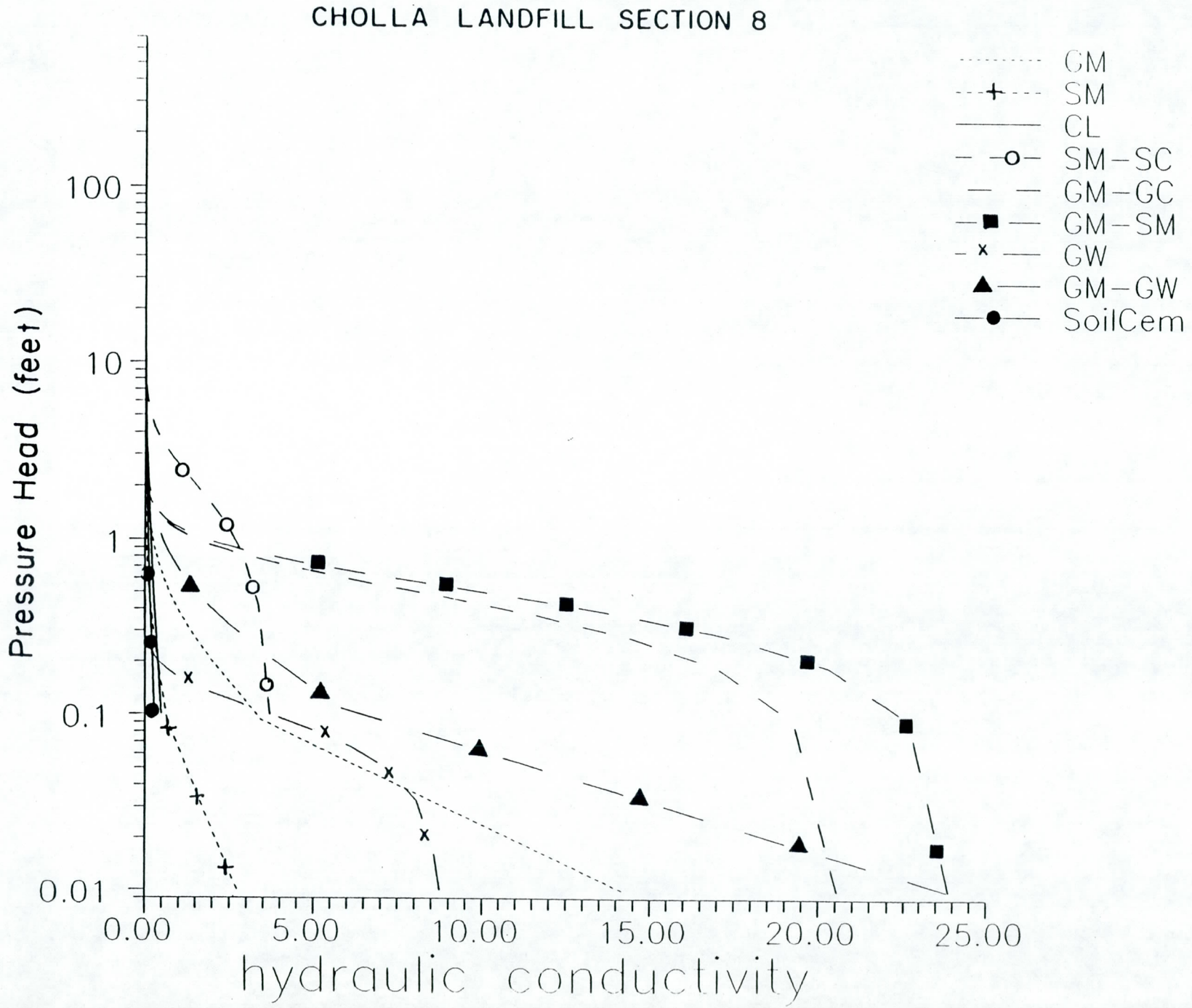


Figure 8b

Hydraulic Conductivity as a Function of Pressure Head

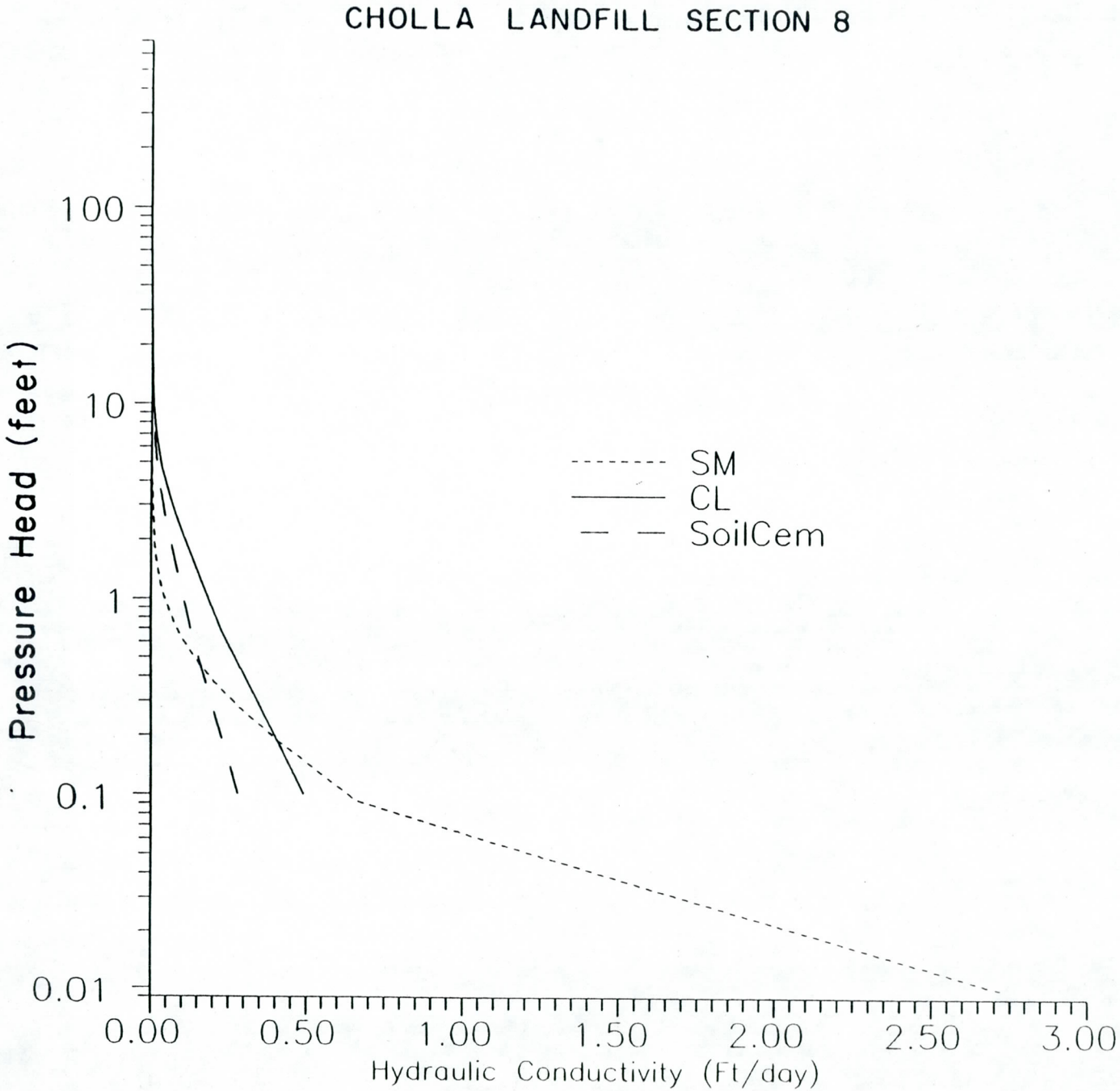


Figure 32

Pressure Head Distribution: Sec-8 (t= 7 day)

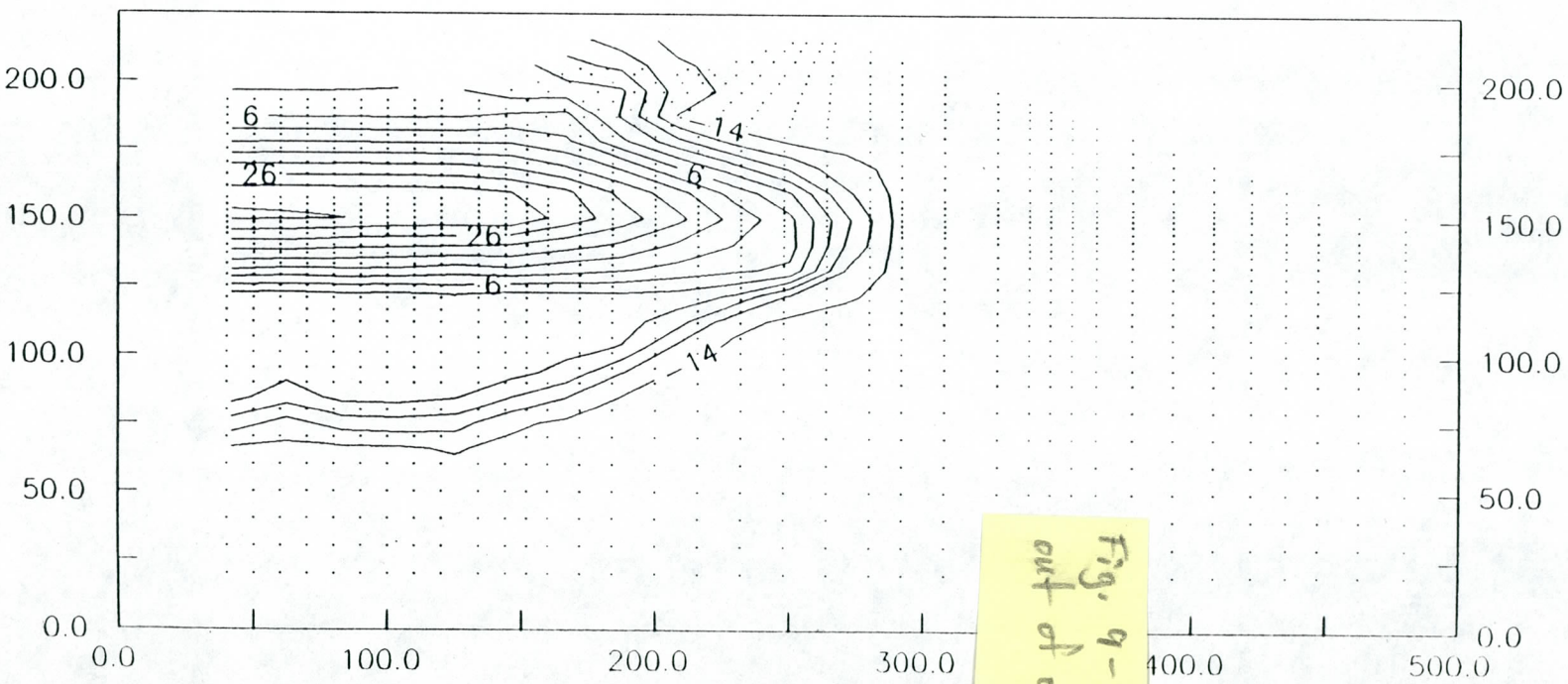


Fig. 9-31
out of order

Figure 32

Pressure Head Distribution: Sec-8 (t= 7 day)

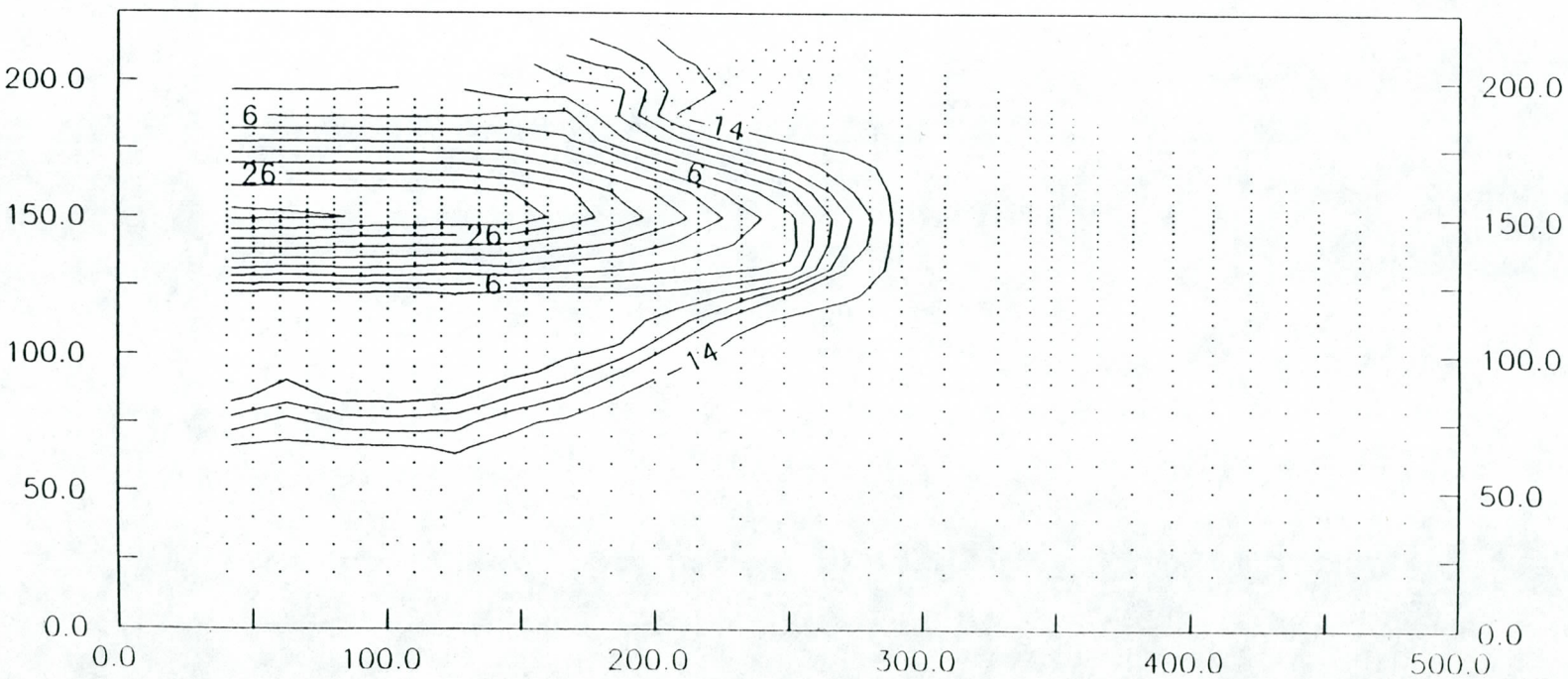


Figure 33

Pressure Head Distribution: Sec-8 (t= 8 day)

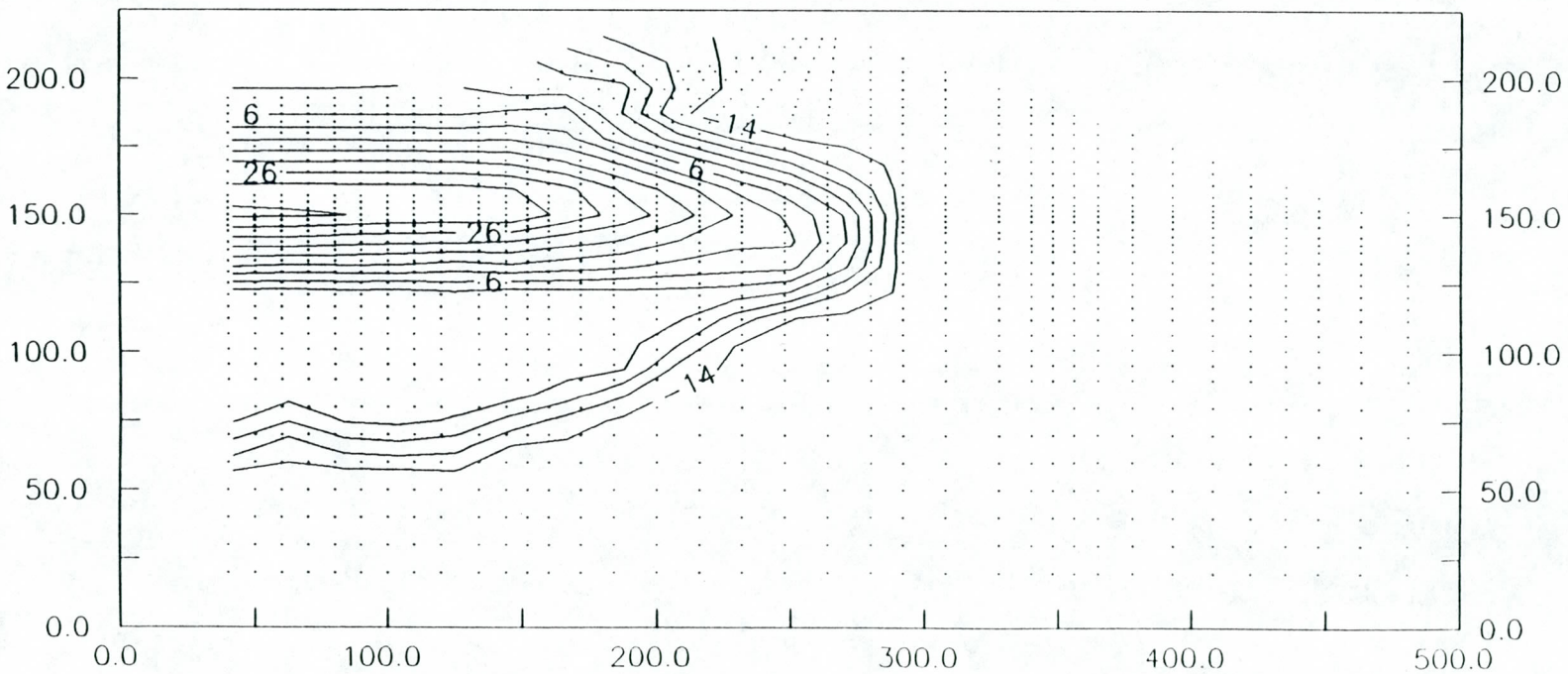


Figure 34

Cumulative Inflow as a Function of Time

Section 8

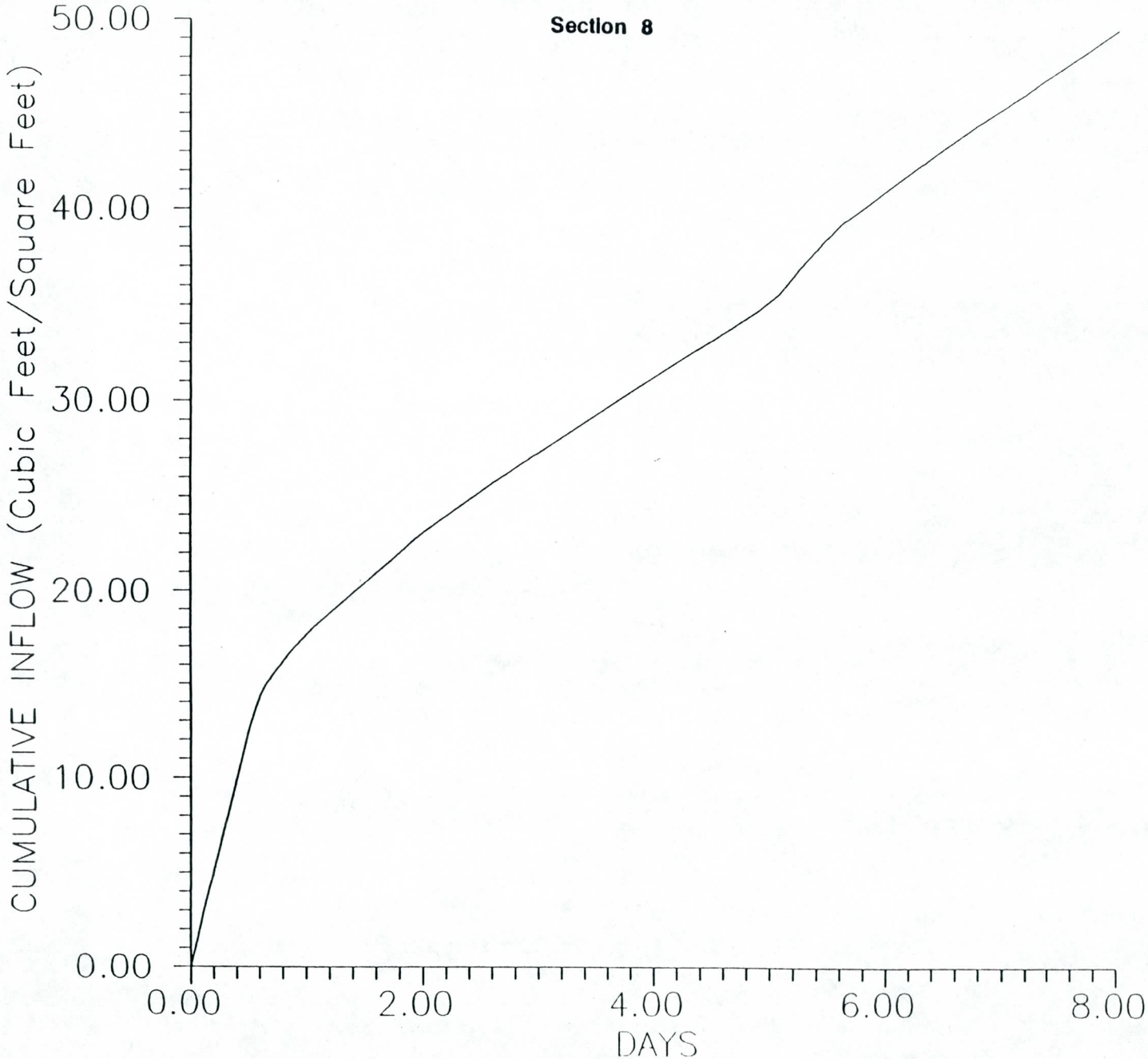


Figure 35

Pressure Head Distribution: Sec9 (t= 0.5 day)

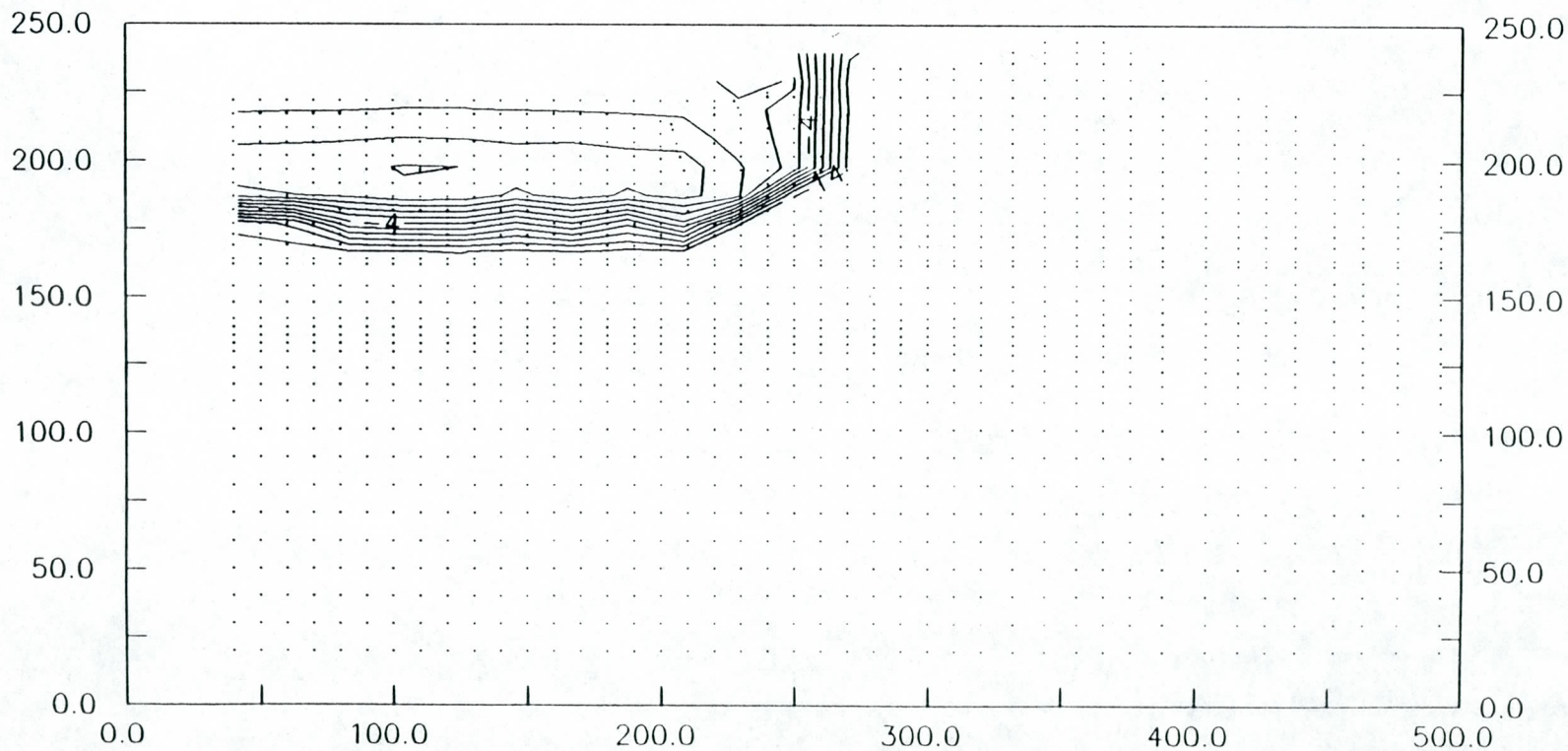


Figure 36

Pressure Head Distribution: Sec9 (t= 1 day)

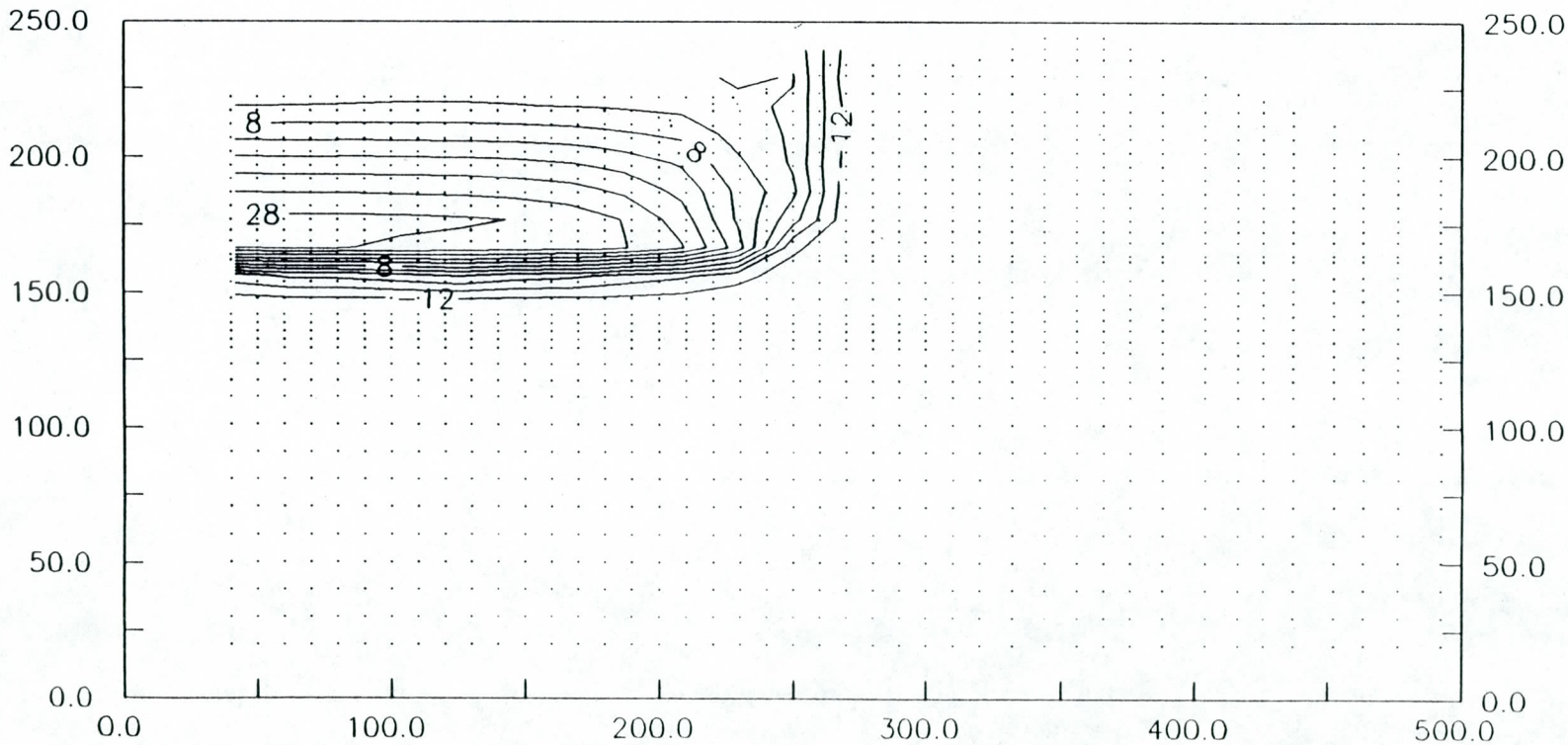


Figure 37

Pressure Head Distribution: Sec9 (t= 2 days)

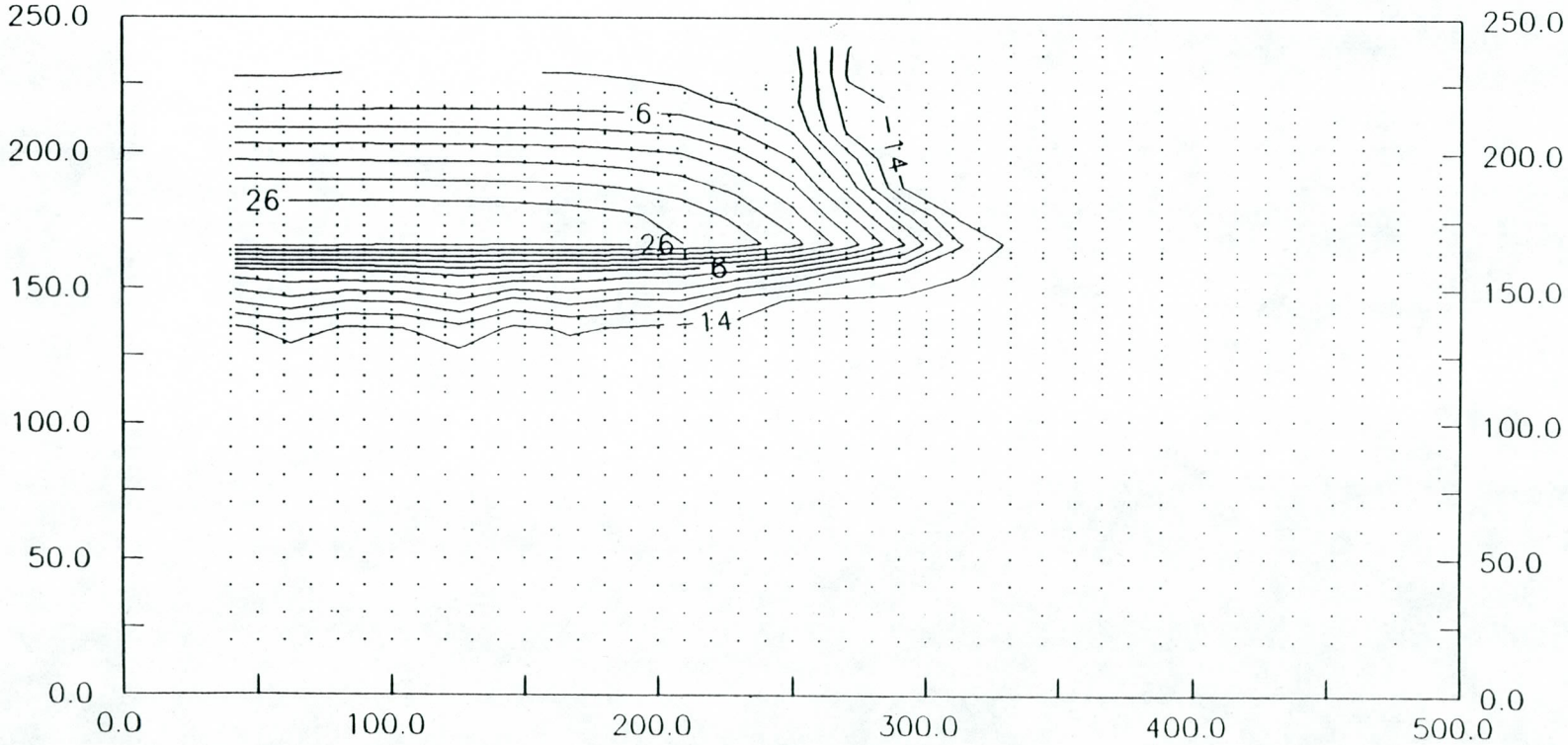


Figure 38

Pressure Head Distribution: Sec9 (t= 3 days)

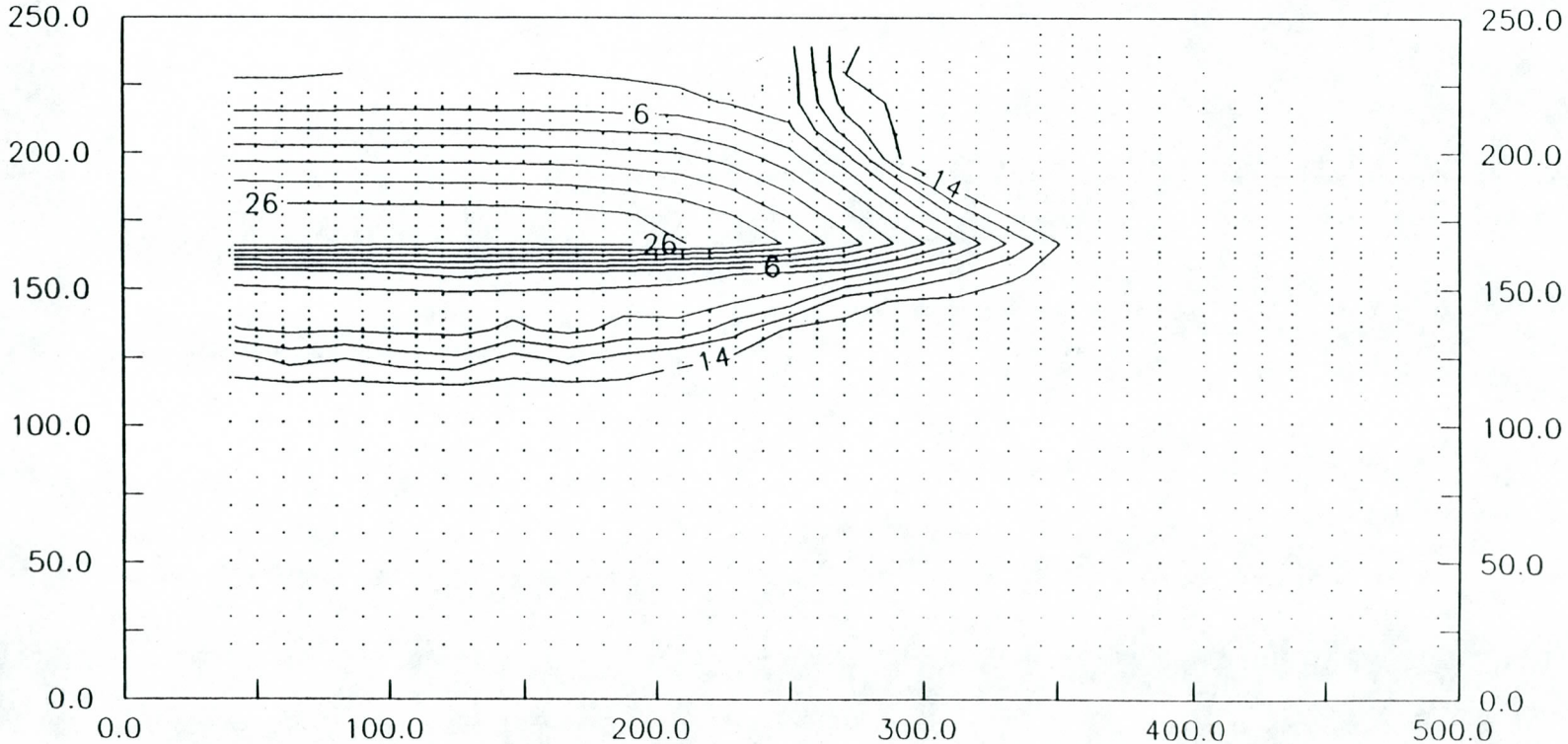


Figure 39

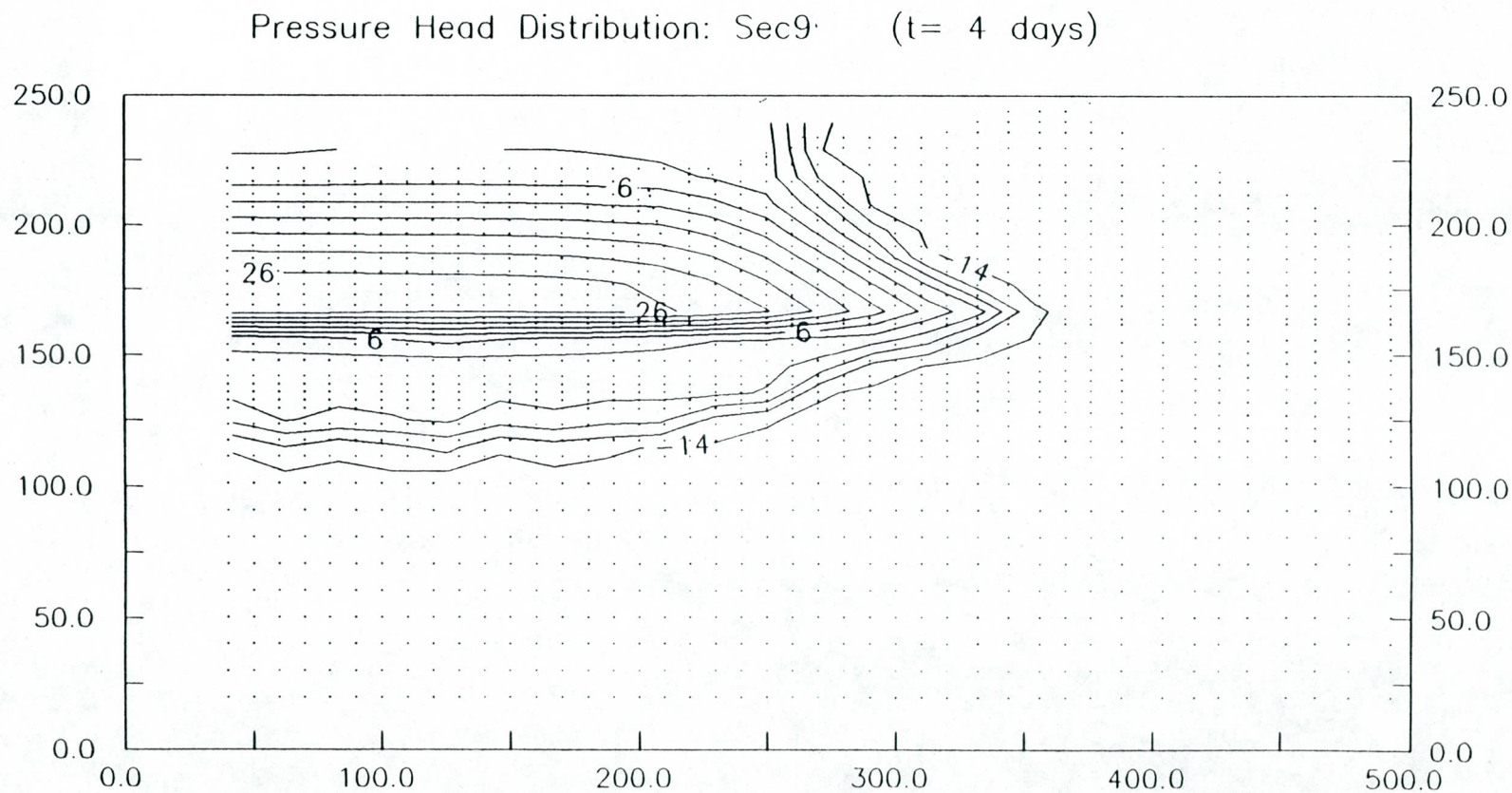

Pressure Head Distribution: Sec9 (t= 4 days)
250.0
200.0
150.0
100.0
50.0
0.0
0.0
100.0
200.0
300.0
400.0
500.0
6
26
26
6
6
-14
-14

Figure 40

Pressure Head Distribution: Sec9. (t= 5 days)

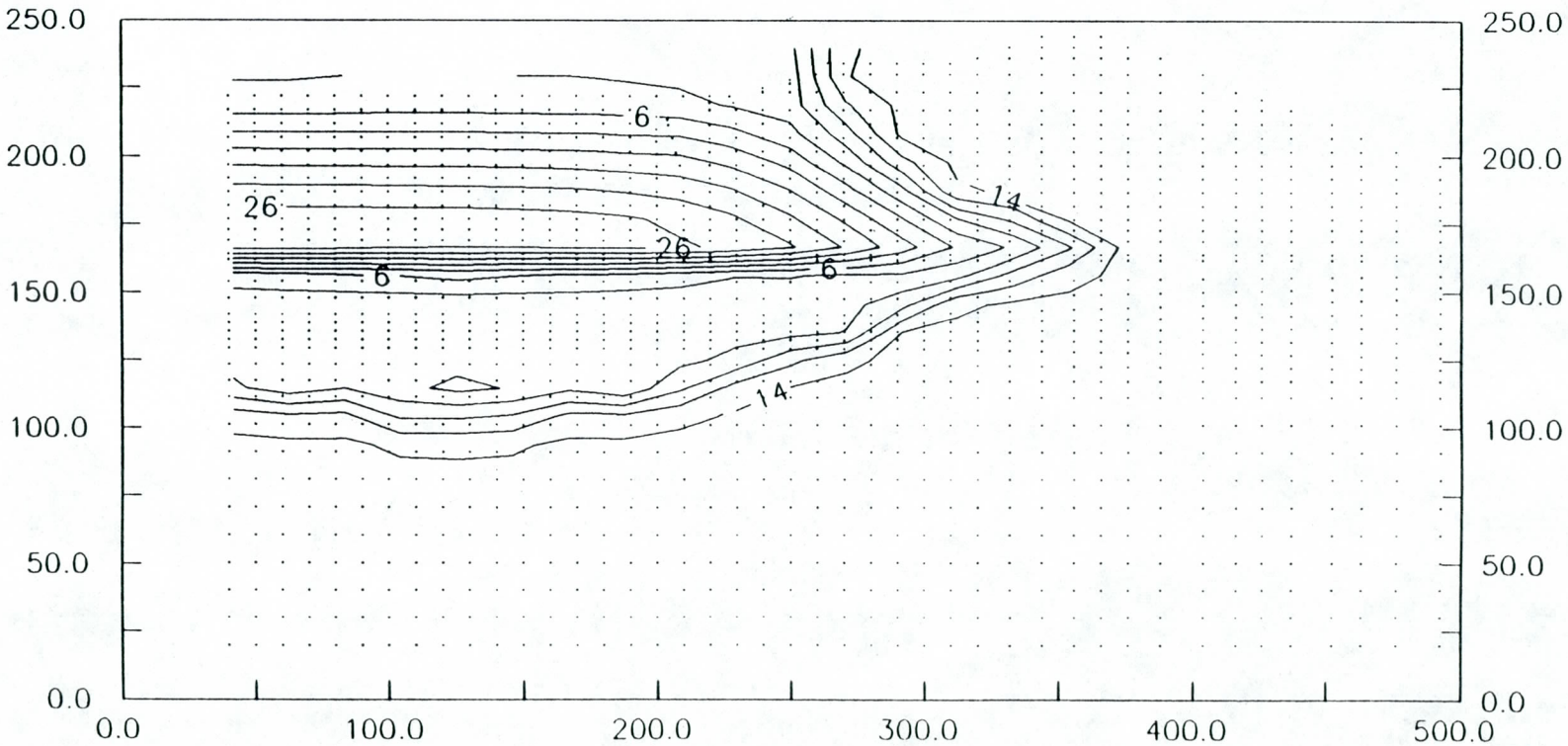


Figure 41

Pressure Head Distribution: Sec9 (t= 5.125 days)

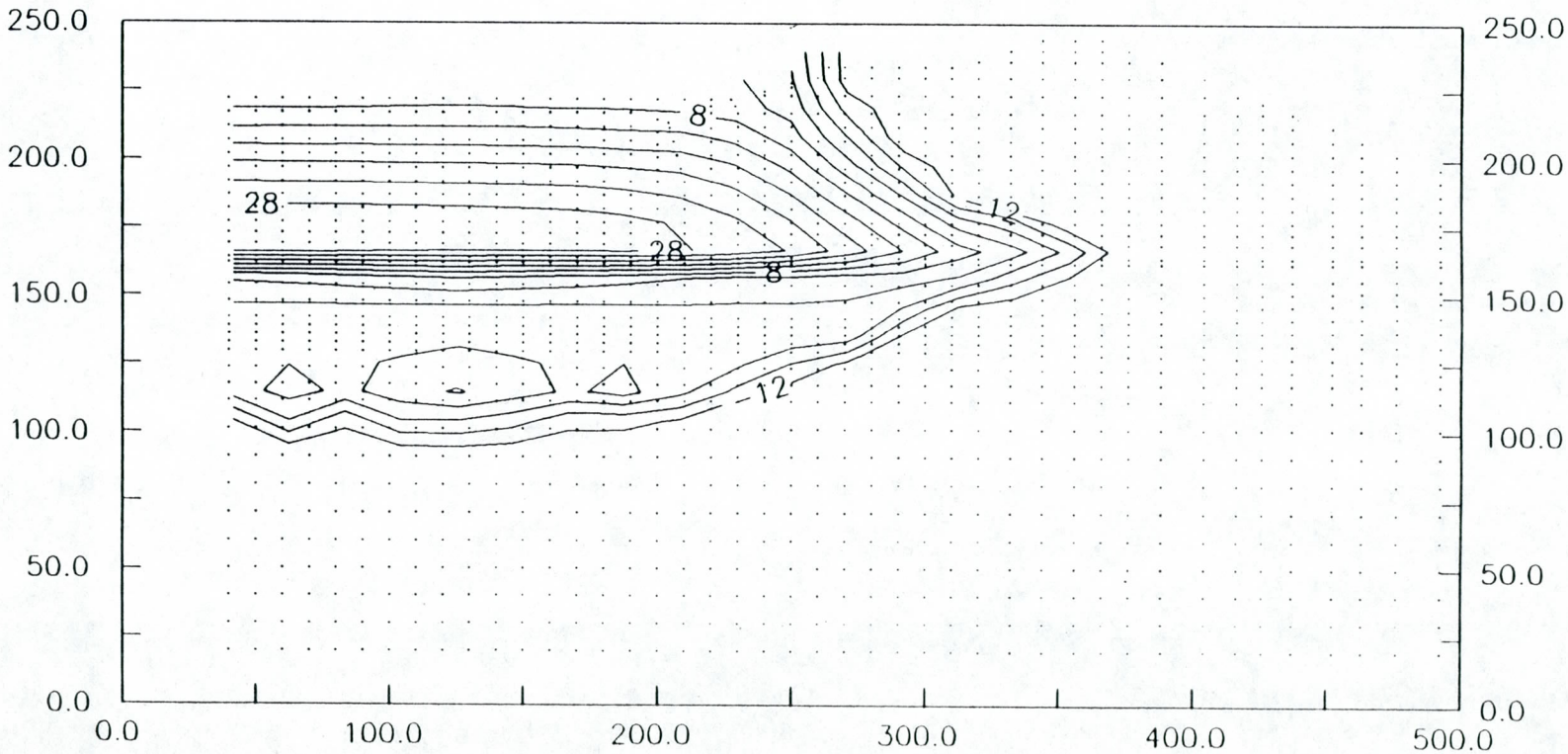


Figure 42

Pressure Head Distribution: Sec9 (t= 5.25 days)

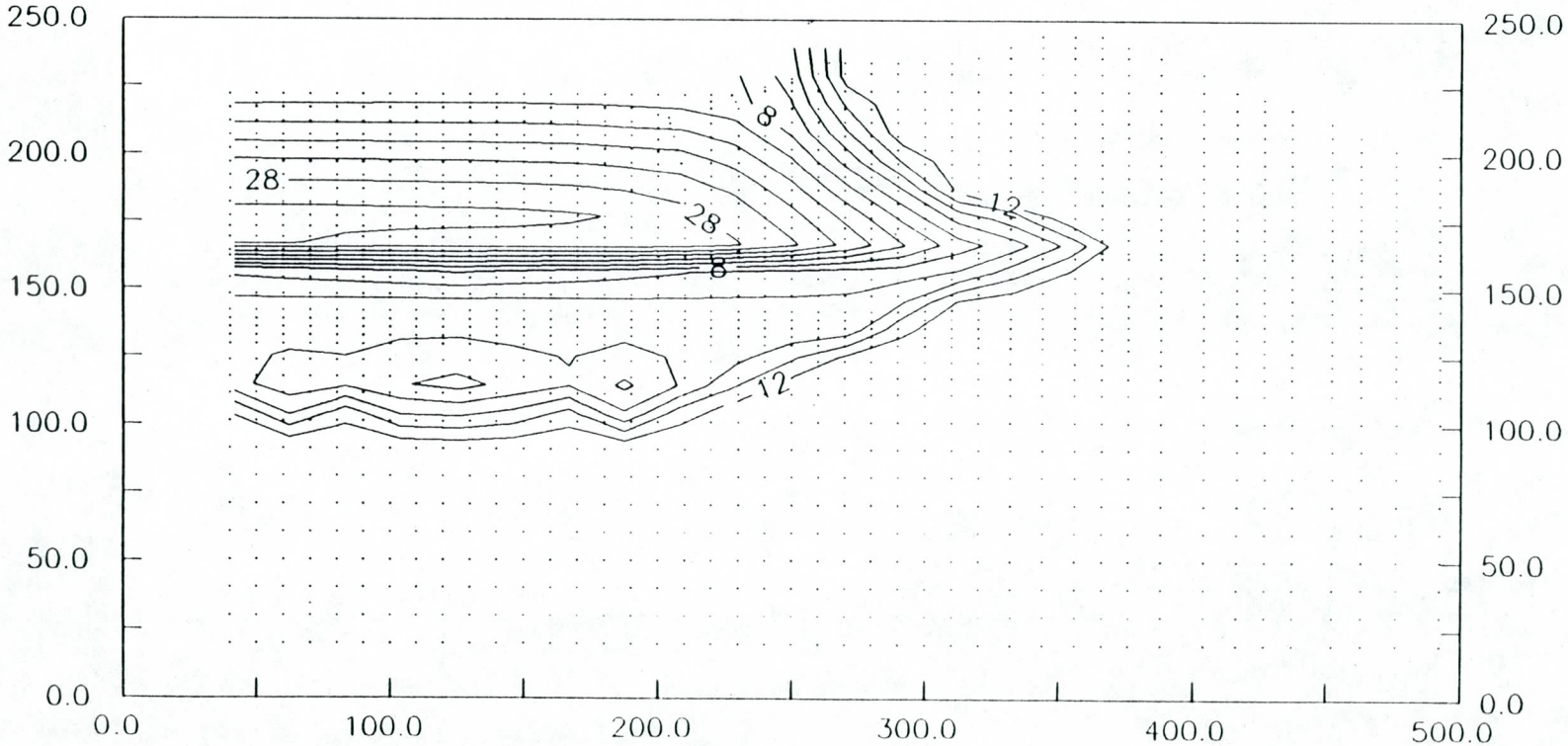


Figure 43

Pressure Head Distribution: Sec9 (t= 5.66 days)

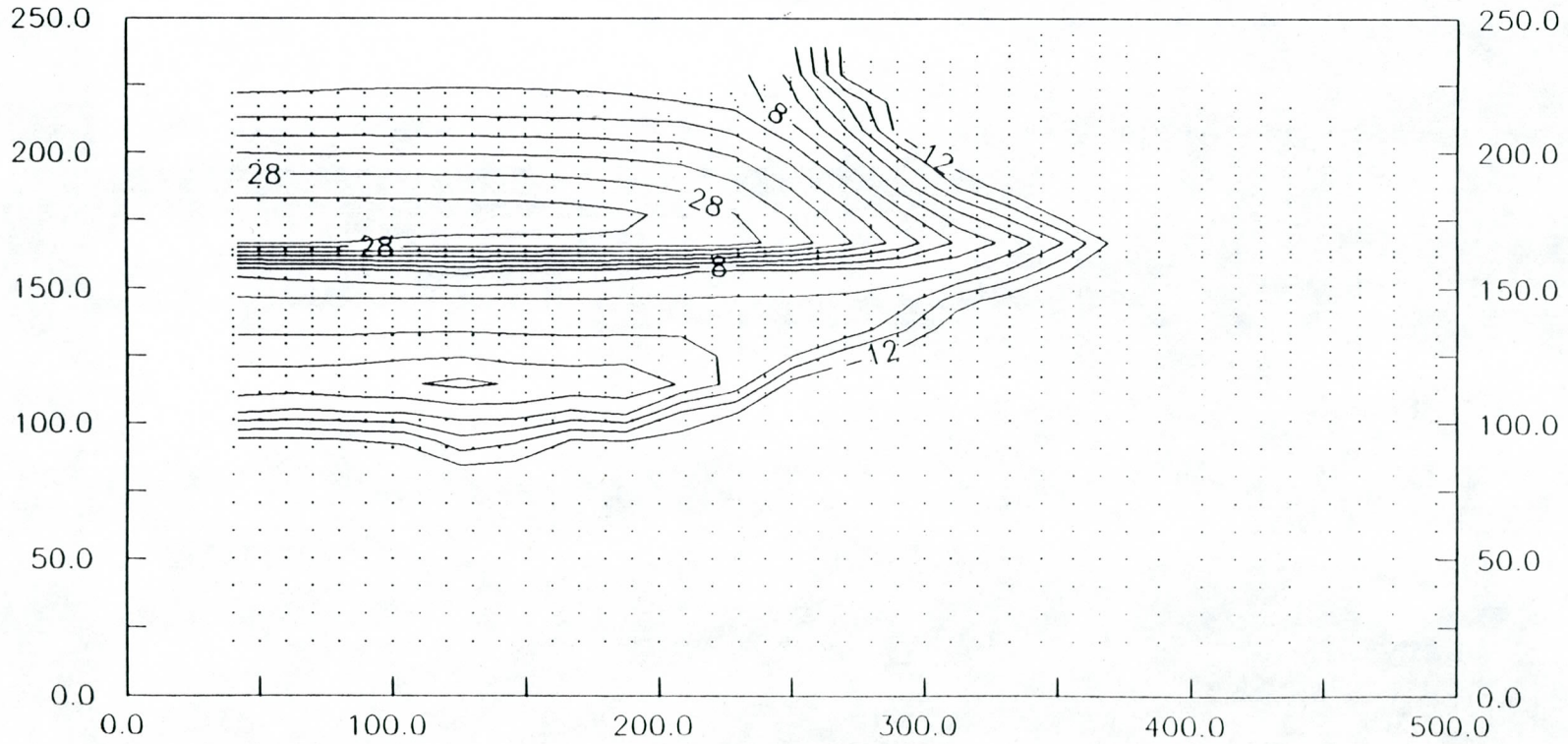


Figure 44

Pressure Head Distribution: Sec9 (t= 5.833 days)

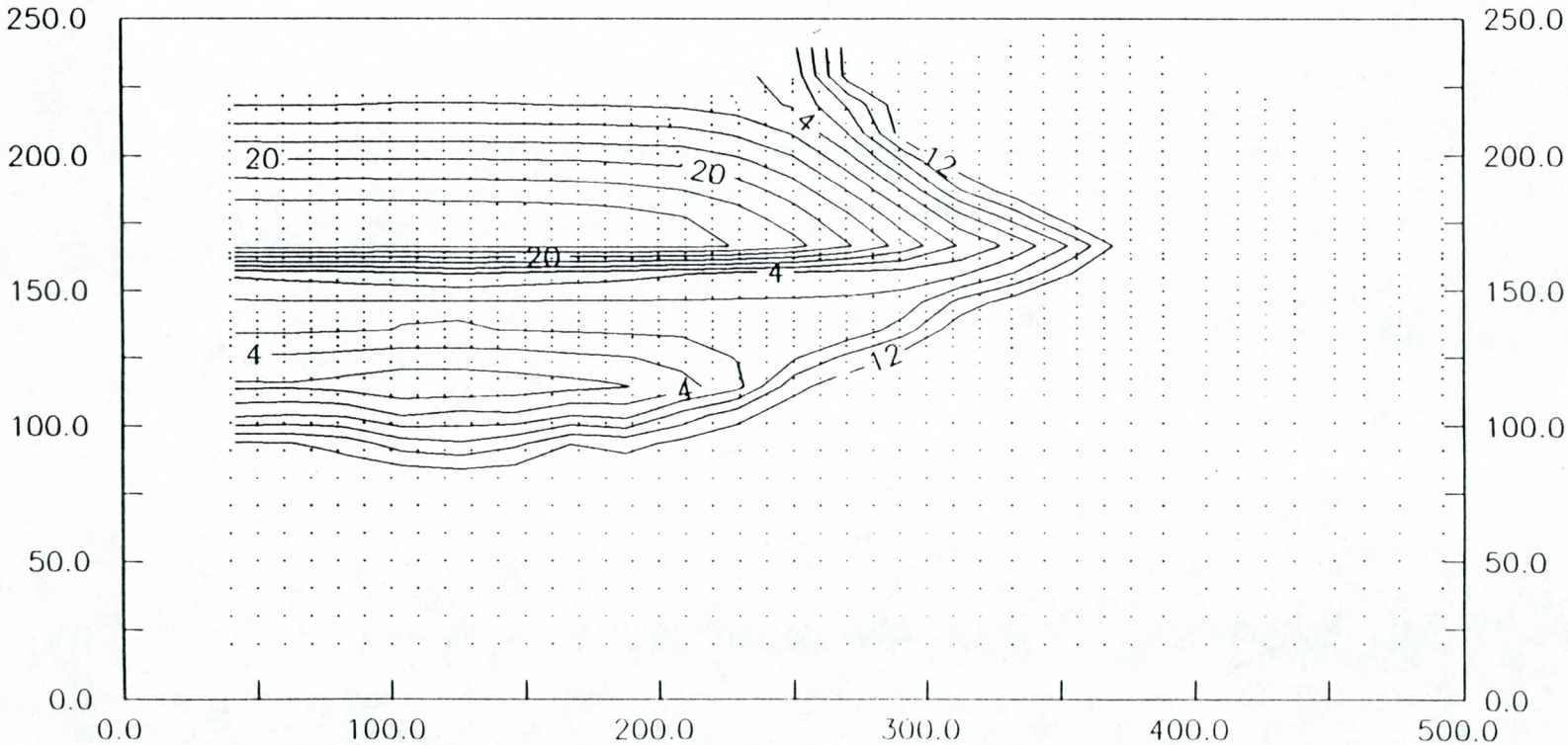


Figure 45

Pressure Head Distribution: Sec9 (t= 6 days)

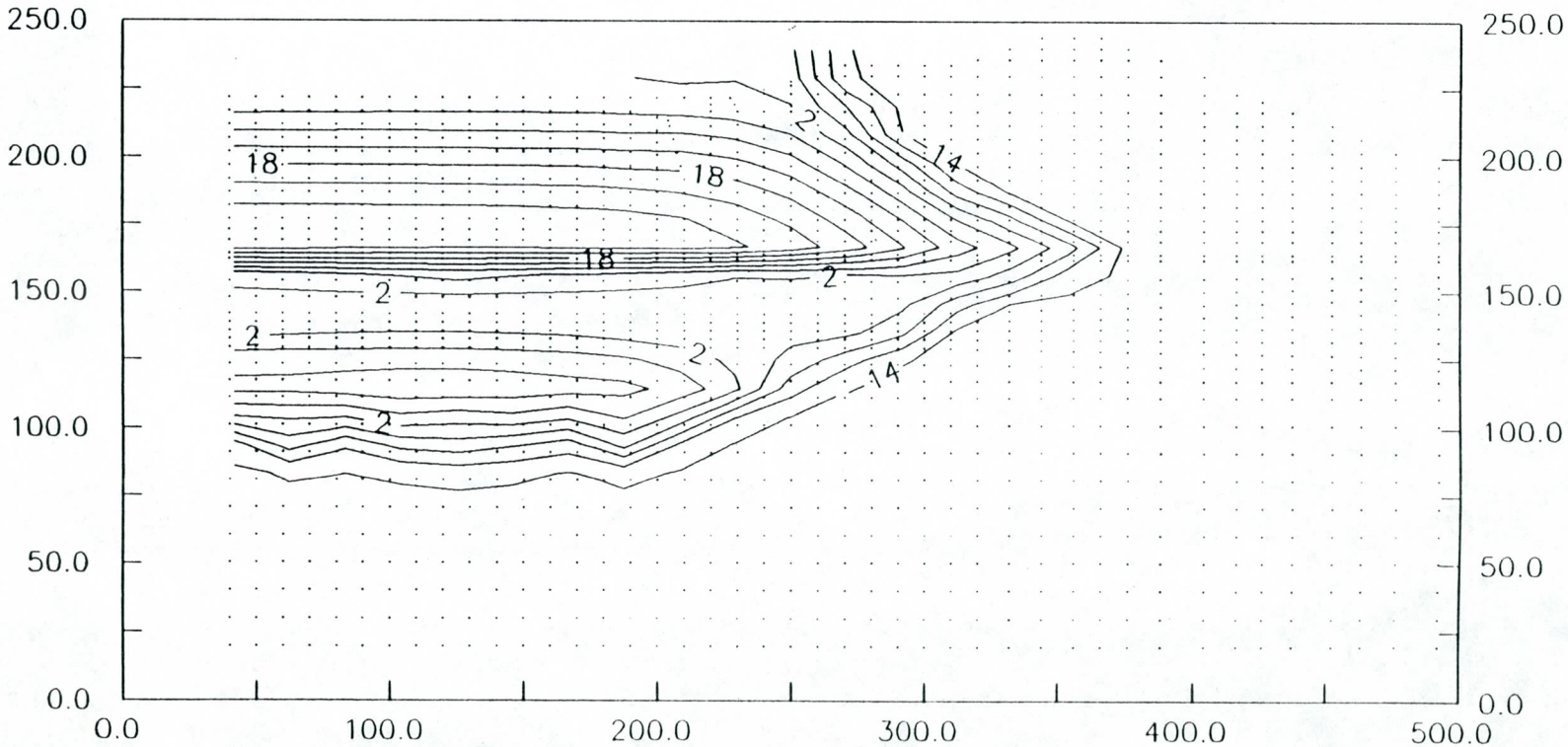


Figure 46

Pressure Head Distribution: Sec9 (t= 7 days)

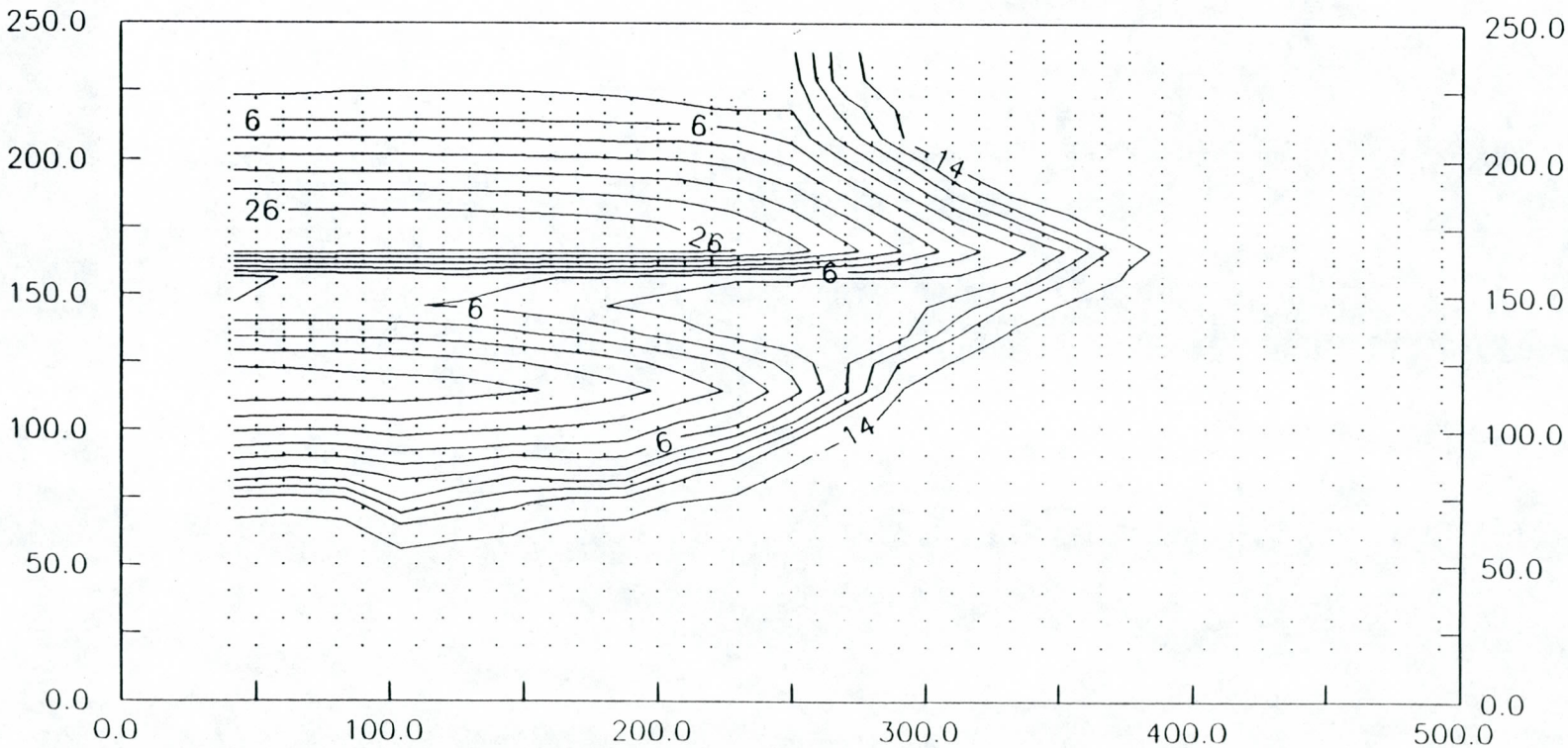


Figure 47

Pressure Head Distribution: Sec9 (t= 8 days)

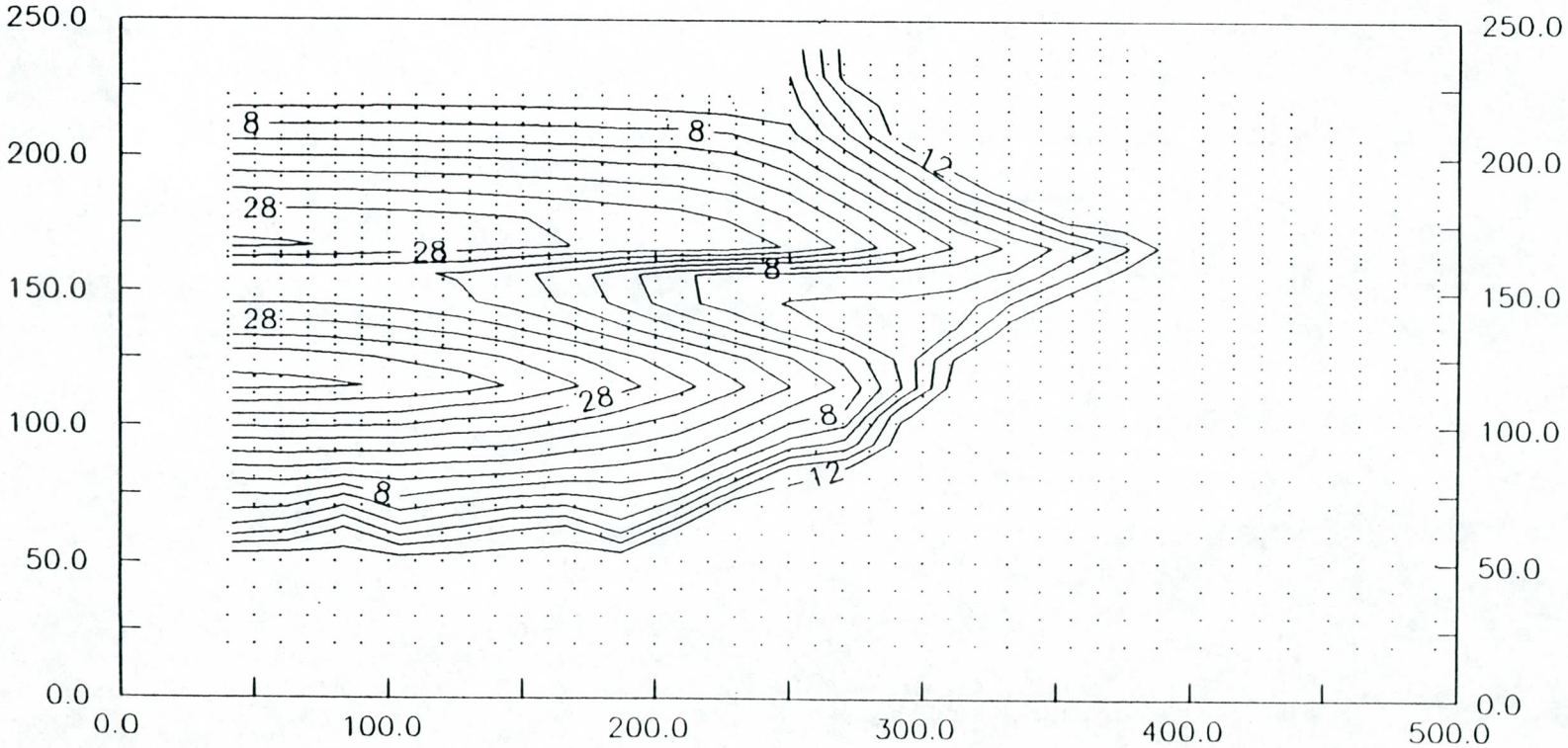
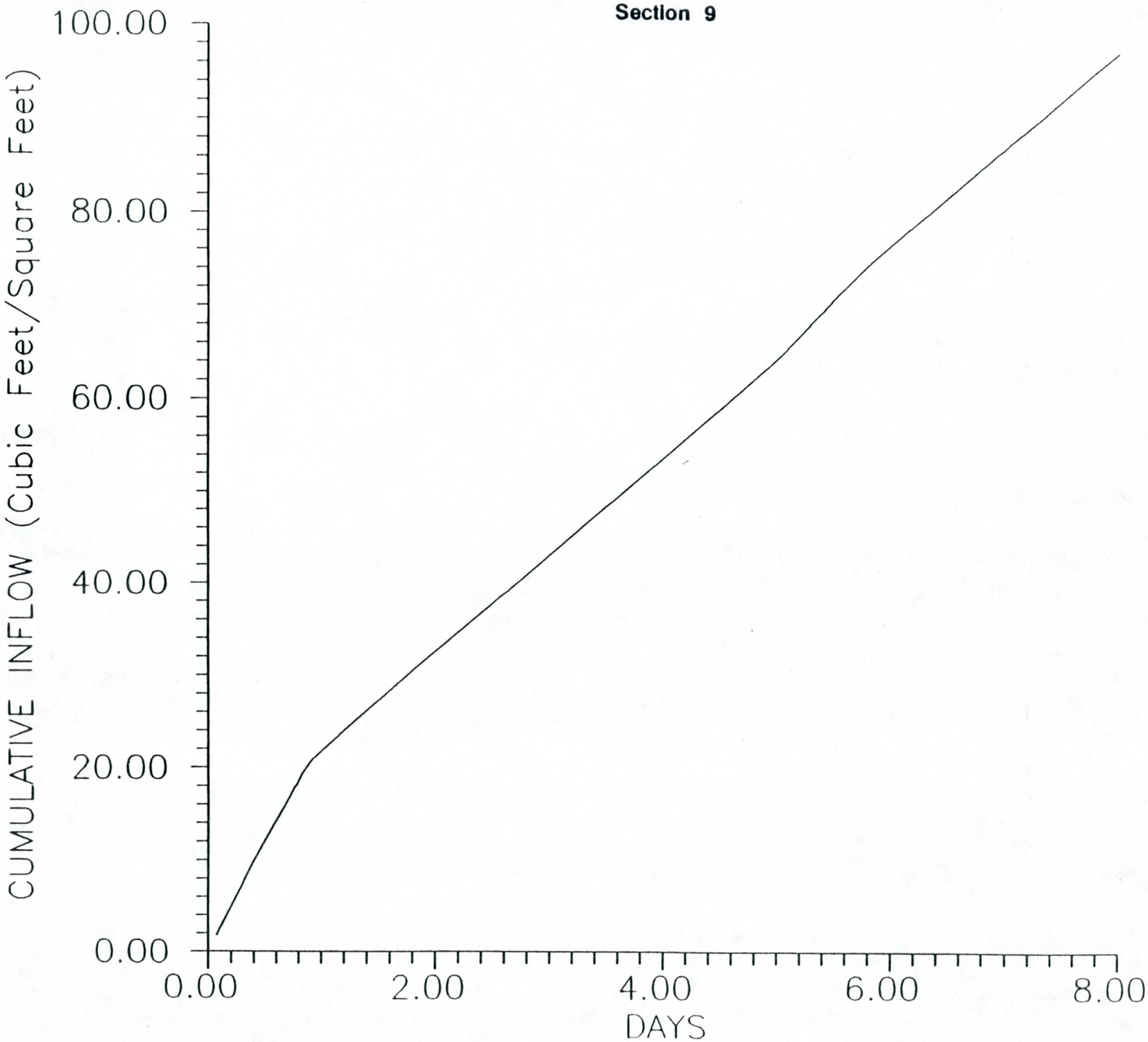


Figure 48

Cumulative Inflow as a Function of Time

Section 9



Igu 9

Hydraulic Conductivity as a Function of Pressure Head

CHOLLA LANDFILL: SECTION 9

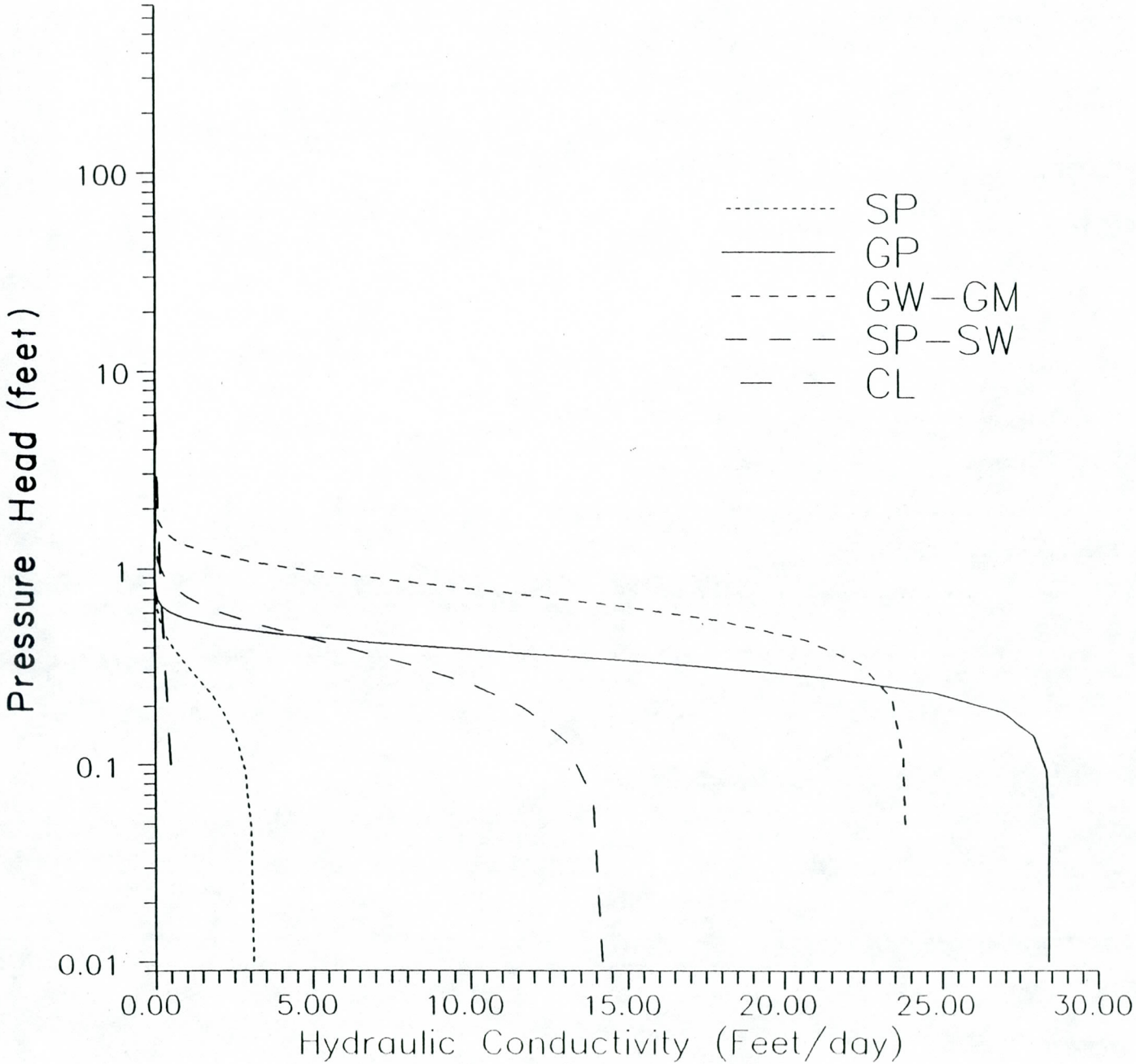
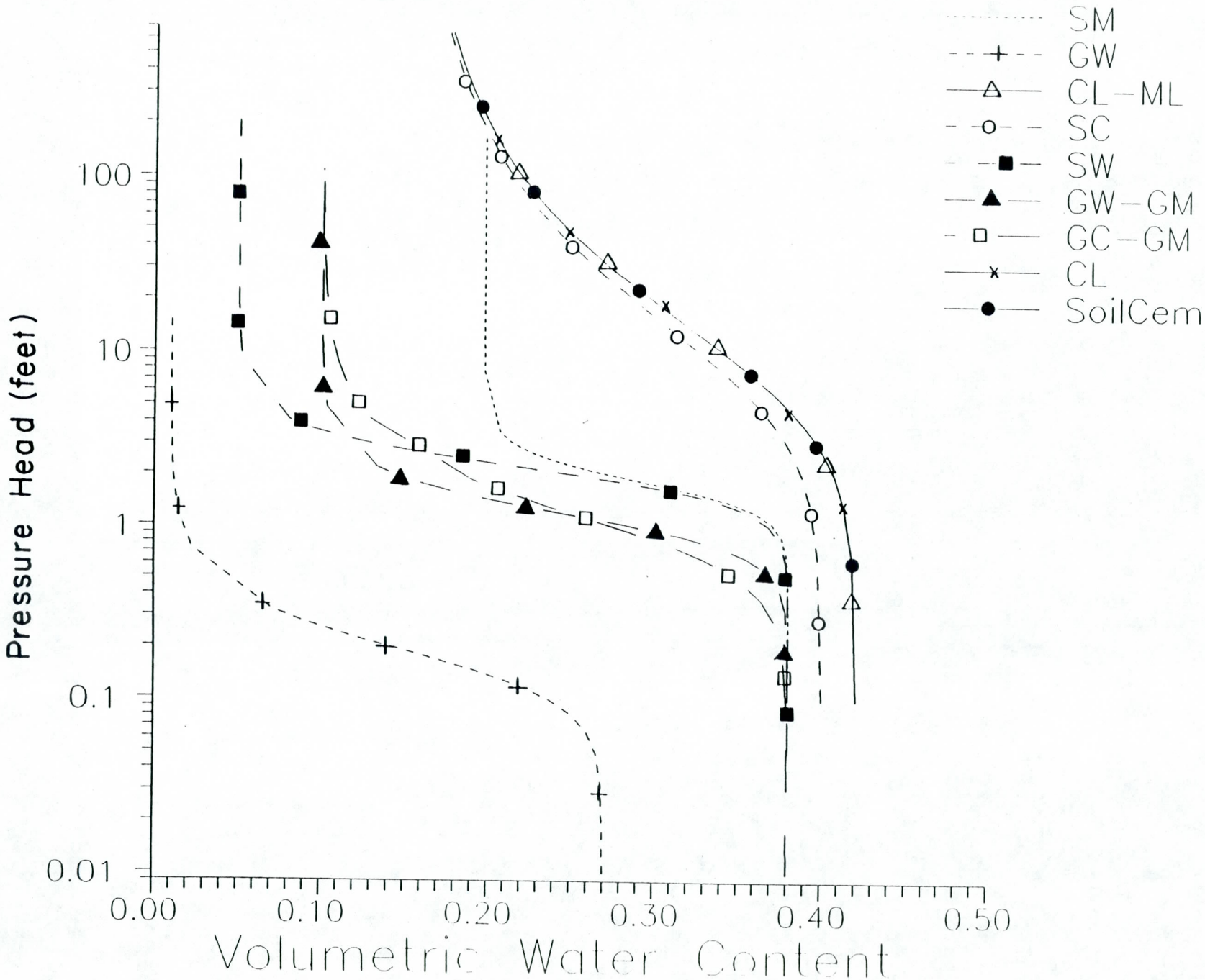


Figure 16

Volumetric Water Content as a Function of Pressure Head

CHOLLA LANDFILL SECTION 7



F_ re

Volumetric Water Content as a Function of Pressure Head

CHOLLA LANDFILL SECTION 8

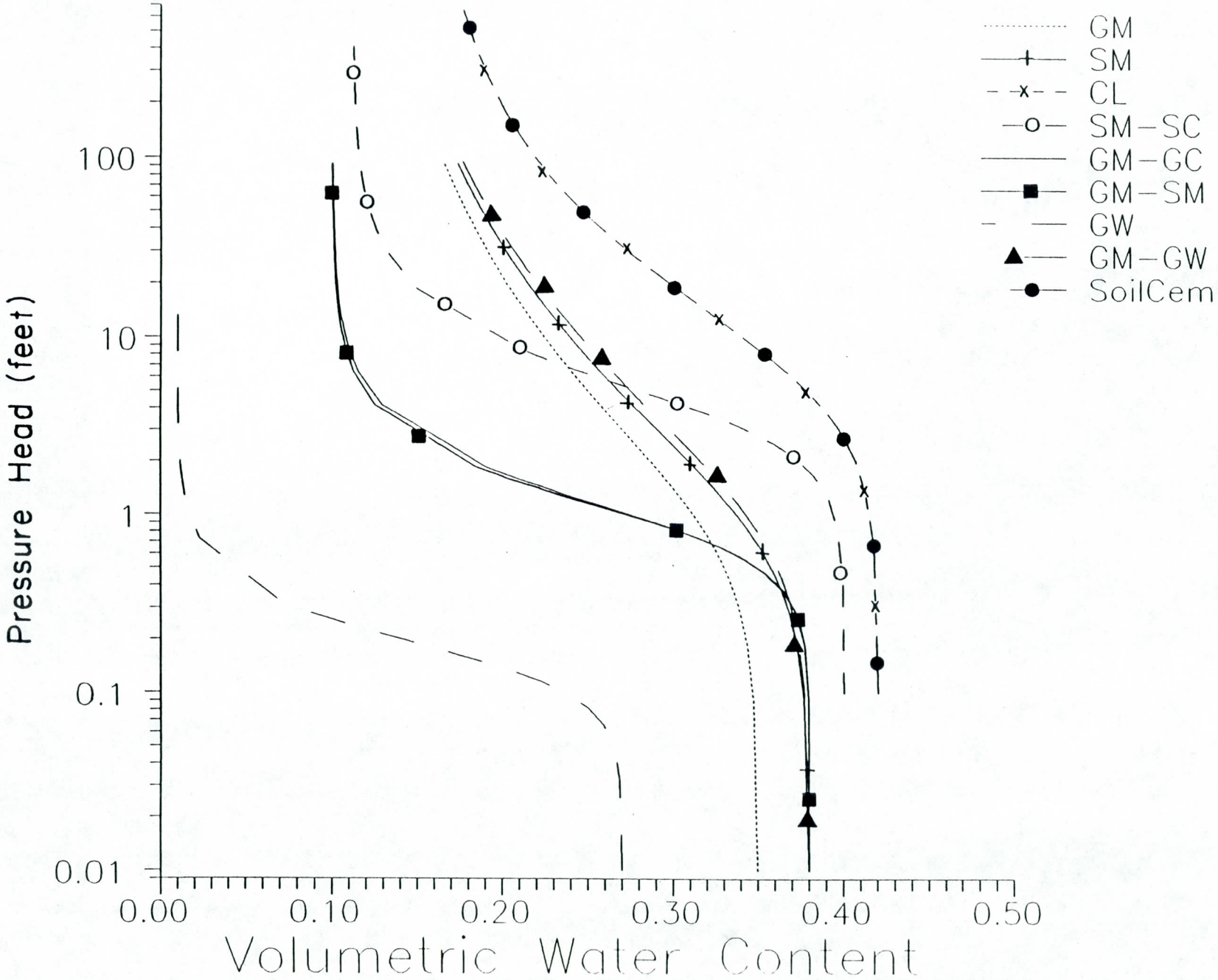


Figure 12

Volumetric Water Content as a Function of Pressure Head

CHOLLA LANDFILL: SECTION 9

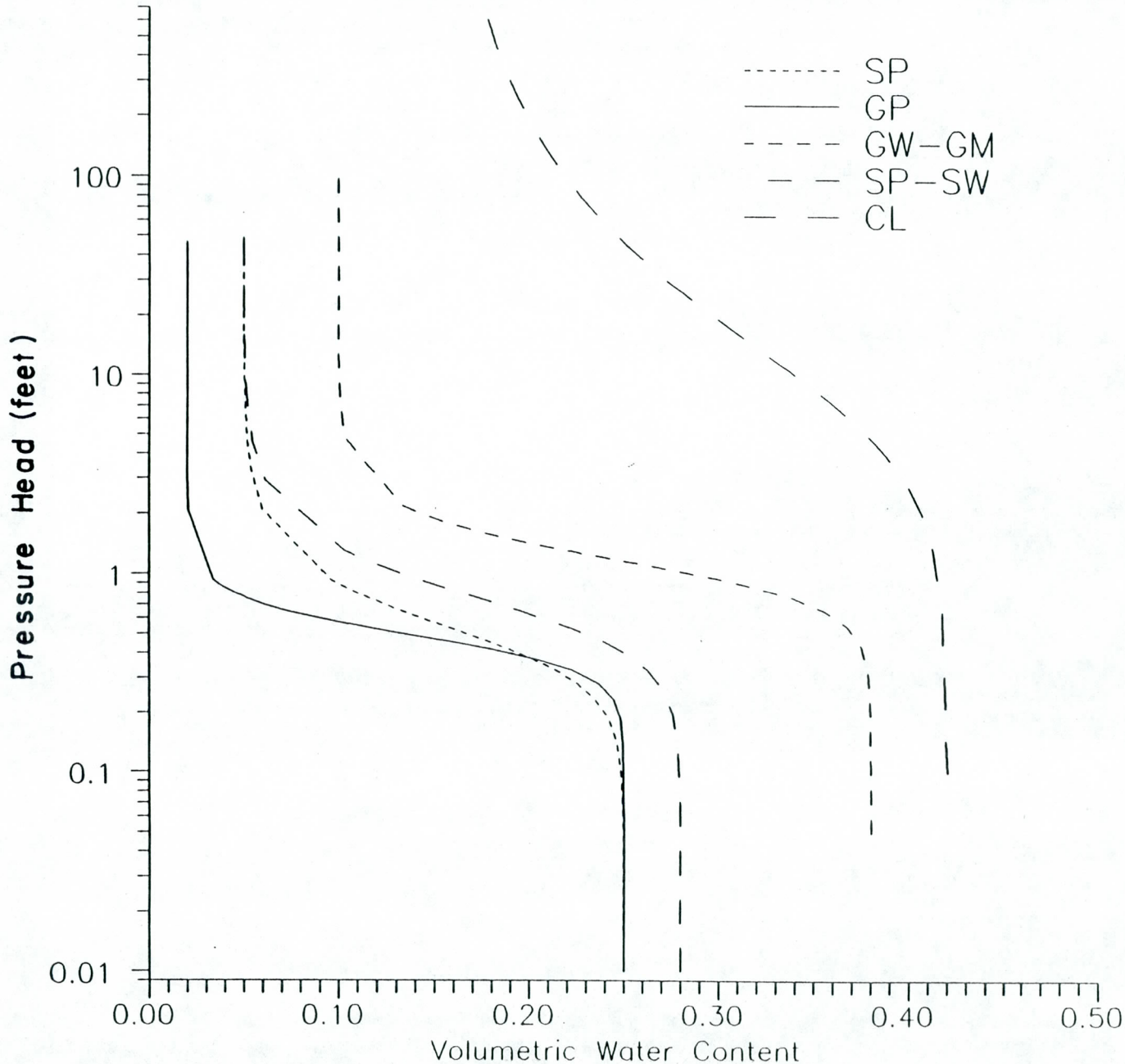


Figure 13

Specific Moisture Capacity as a Function of Pressure Head

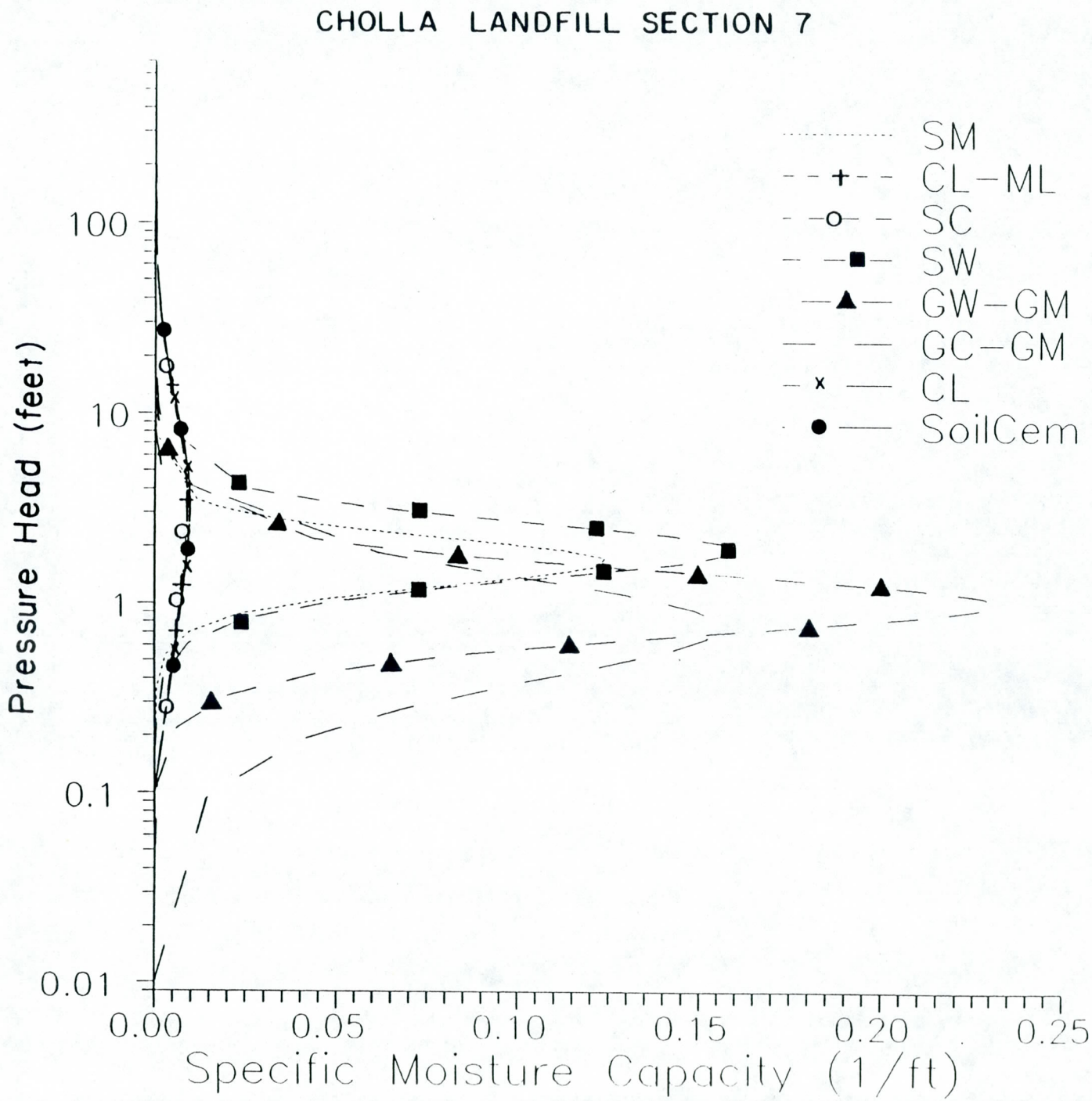


Figure 14

Specific Moisture Capacity as a Function of Pressure Head

CHOLLA LANDFILL SECTION 8

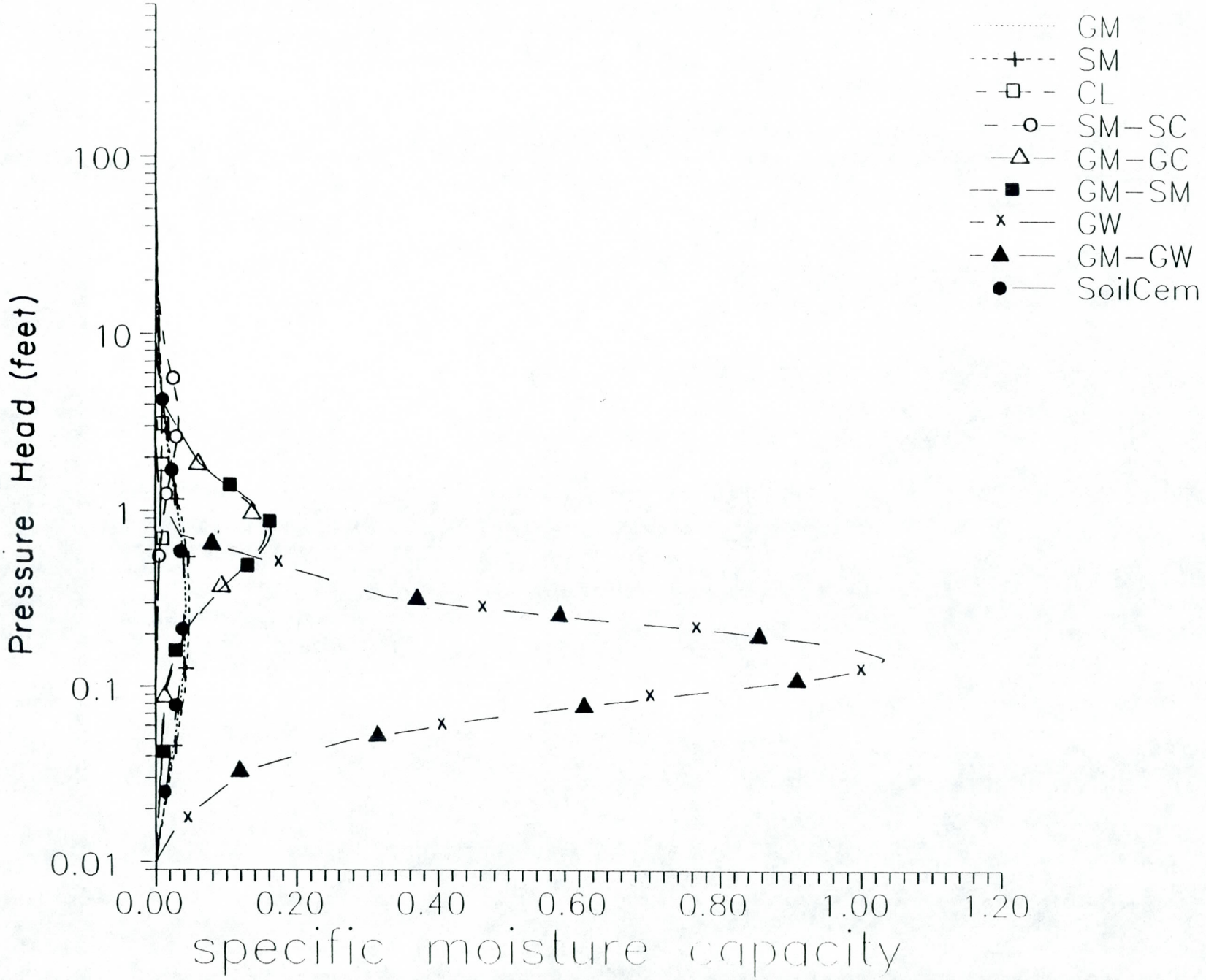


Figure 15

Specific Moisture Capacity as a Function of Pressure Head

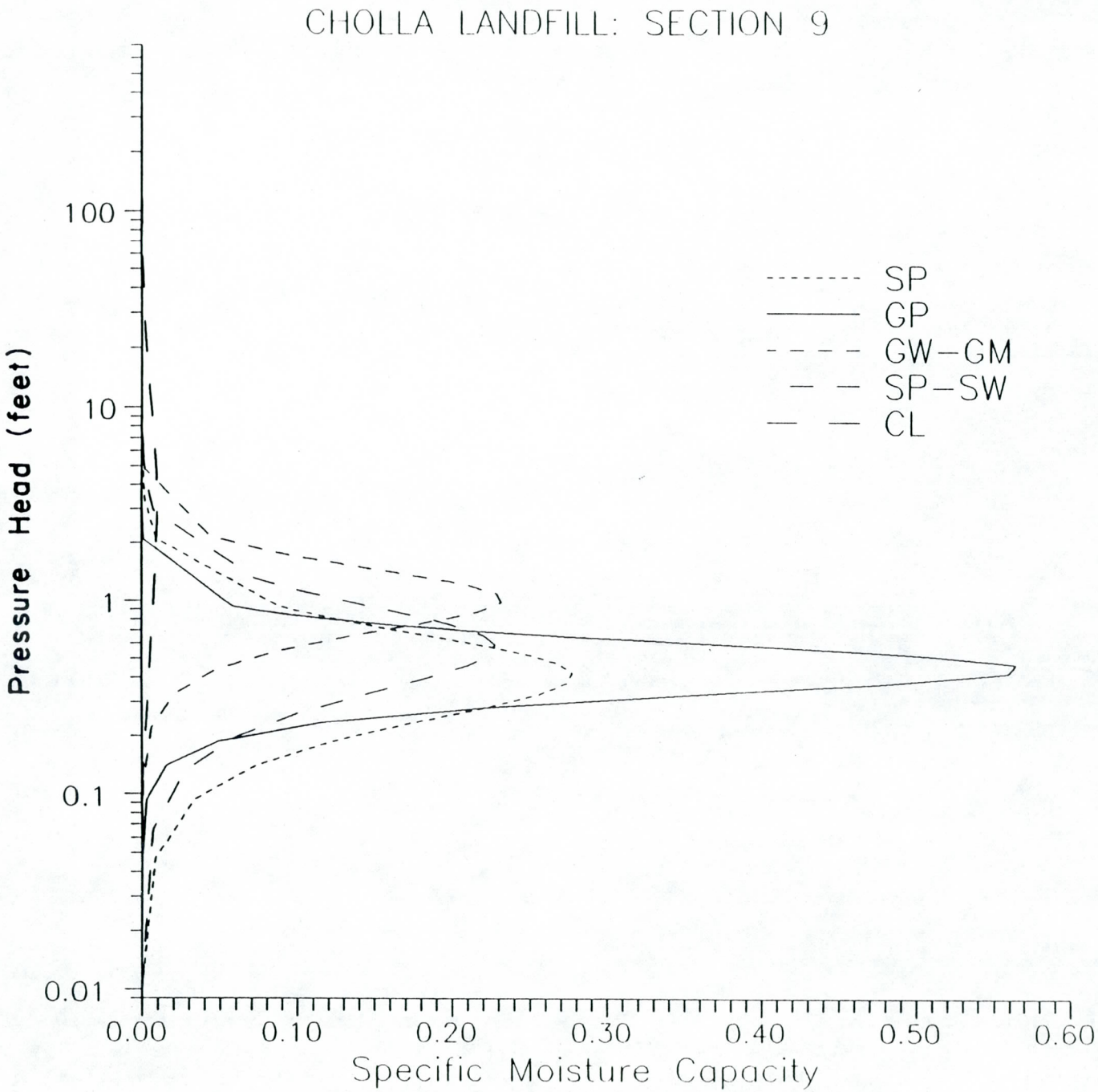


Figure 16

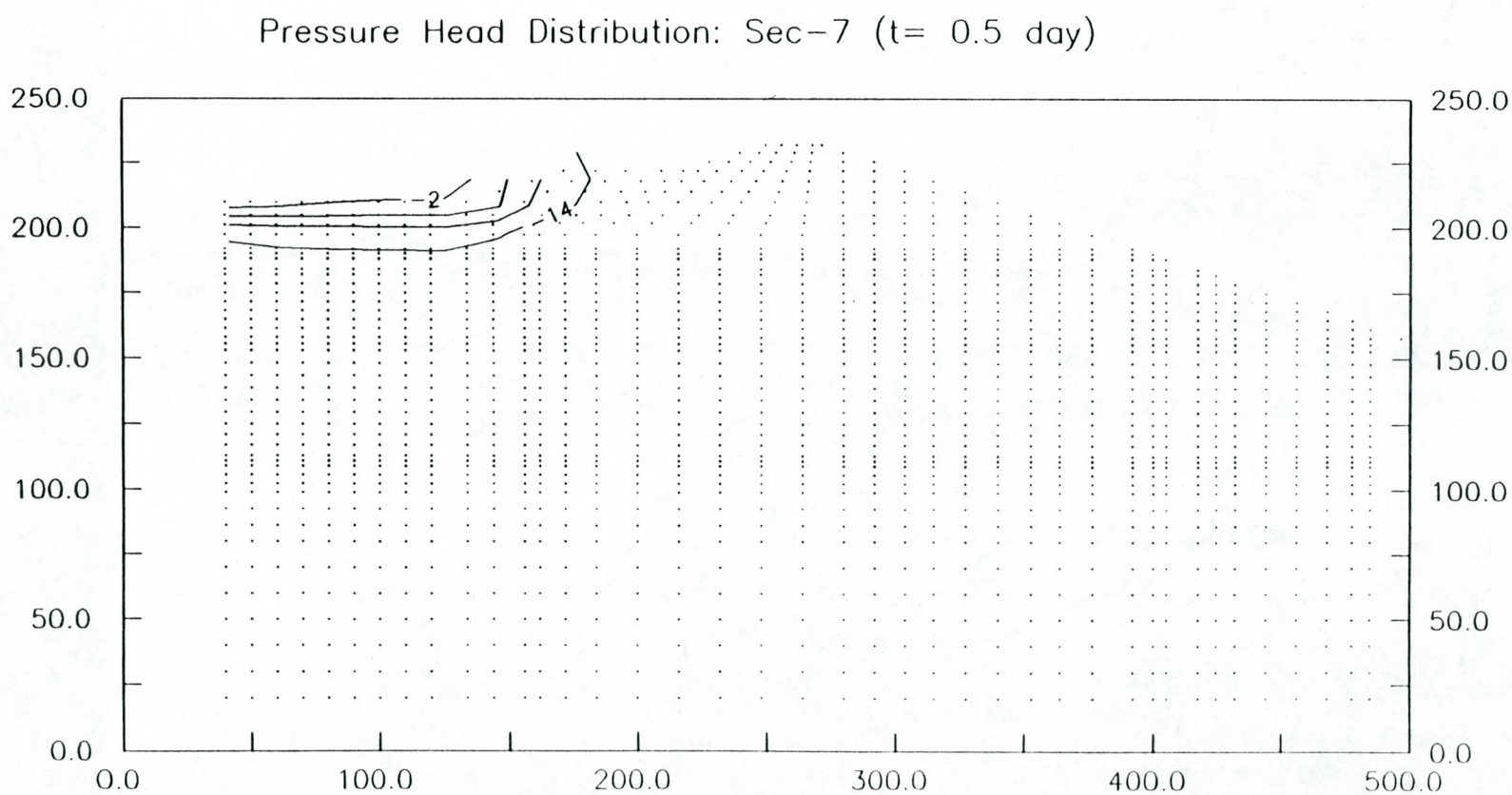

Pressure Head Distribution: Sec-7 (t= 0.5 day)
250.0
200.0
150.0
100.0
50.0
0.0
0.0
100.0
200.0
300.0
400.0
500.0
2
1
4

Figure 17

Pressure Head Distribution: Sec-7 (t= 5 day)

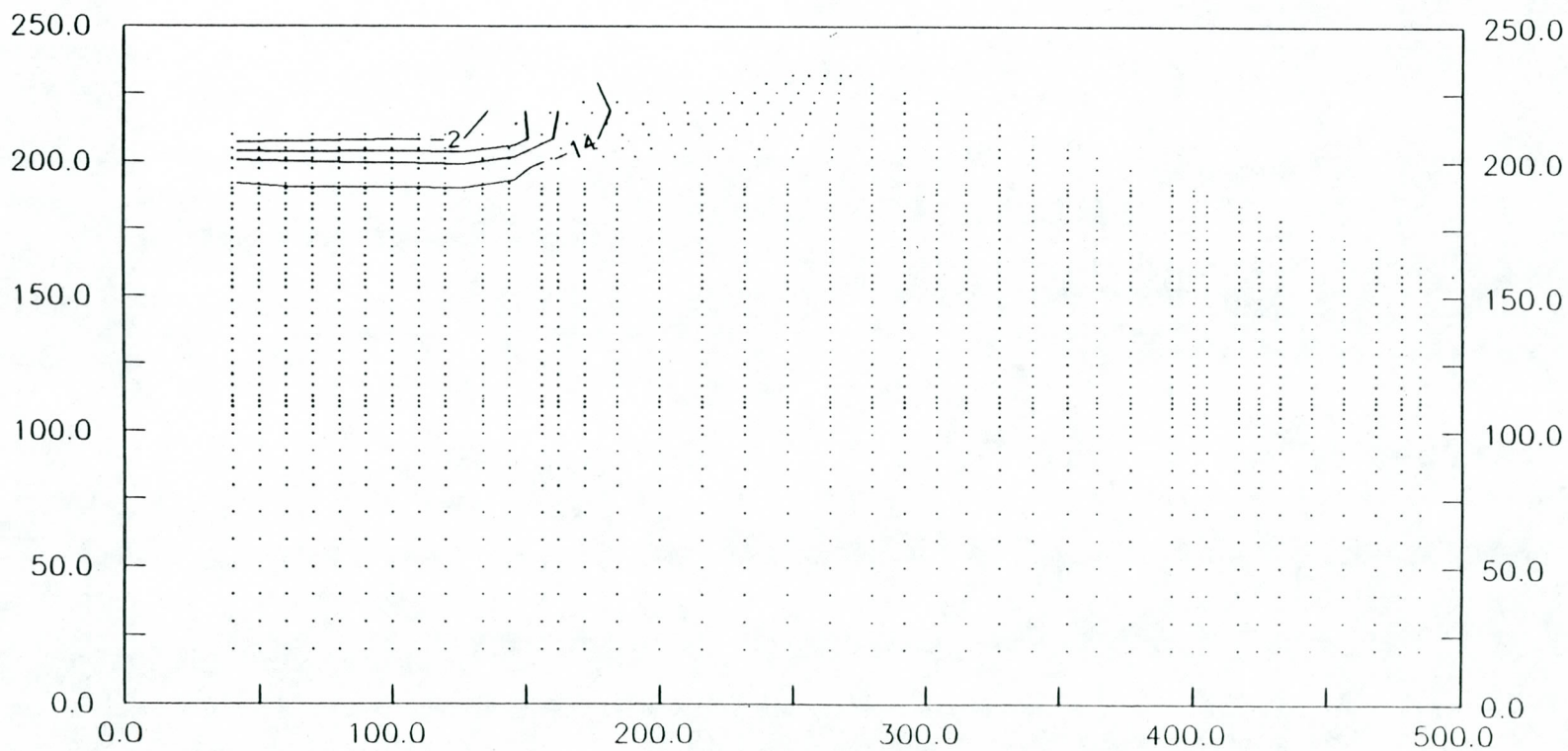


Figure 18

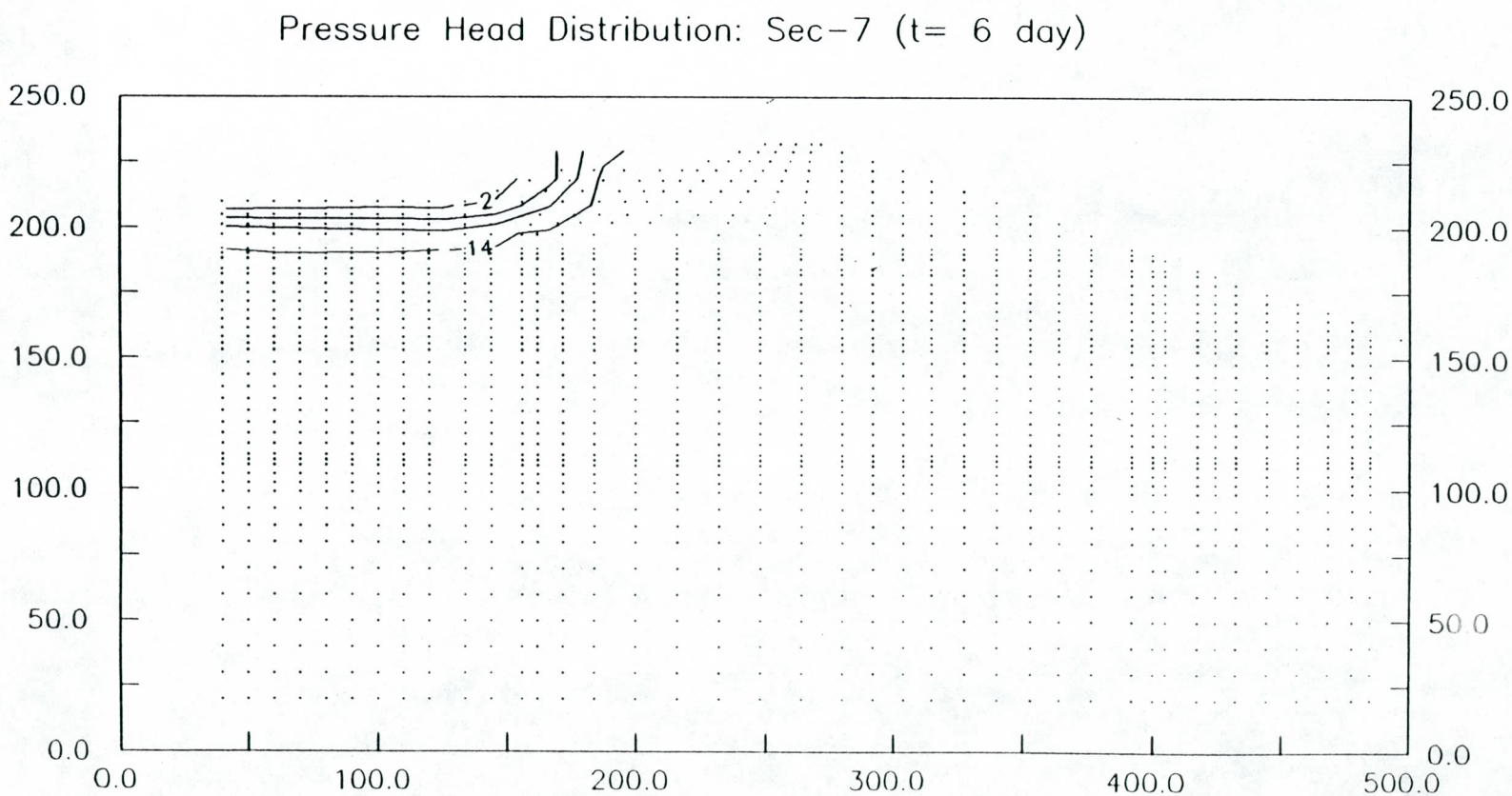

Pressure Head Distribution: Sec-7 (t= 6 day)
250.0
200.0
150.0
100.0
50.0
0.0
0.0
100.0
200.0
300.0
400.0
500.0
-2
-14

Figure 19

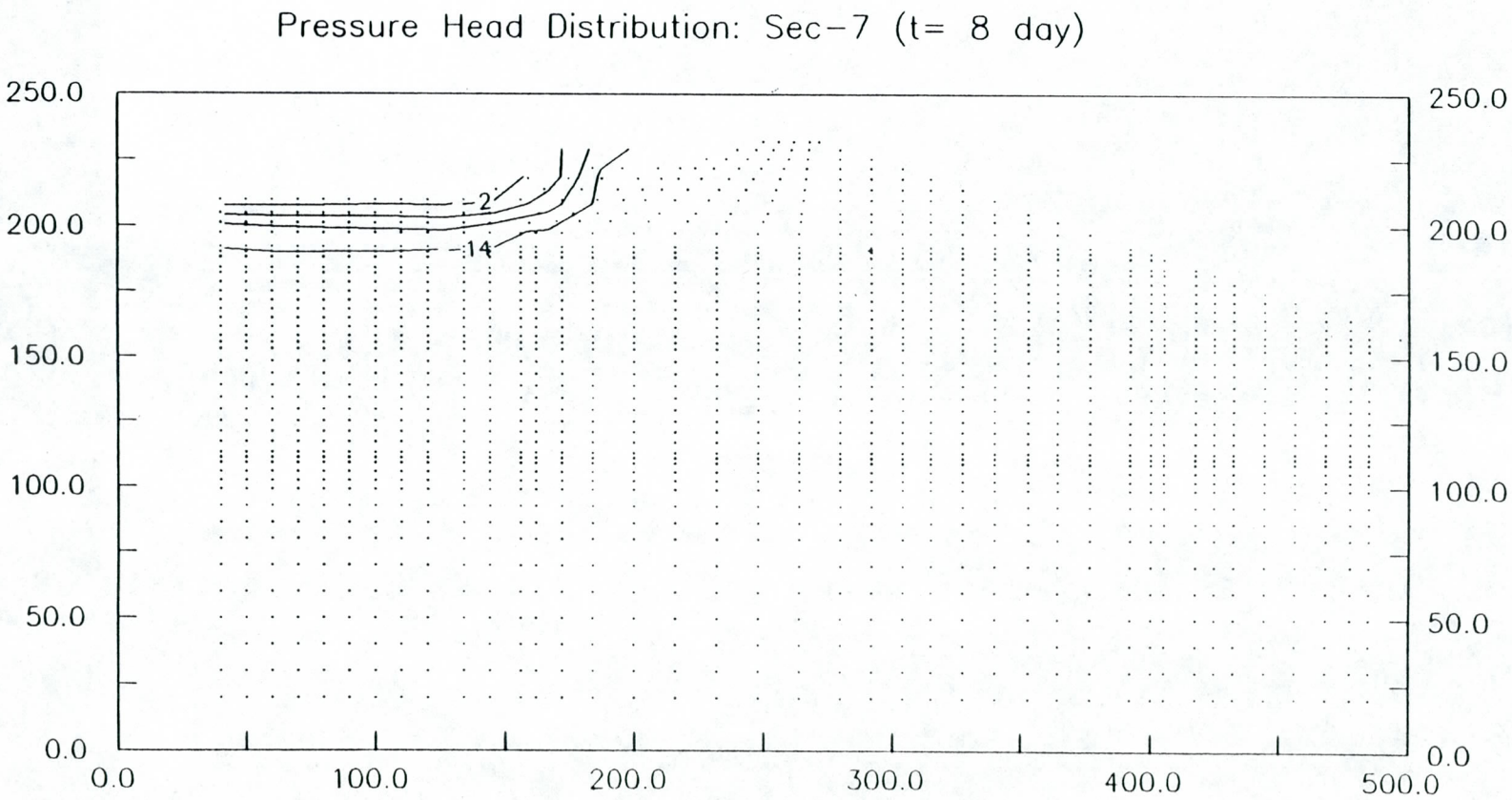

Pressure Head Distribution: Sec-7 (t= 8 day)
250.0
200.0
150.0
100.0
50.0
0.0
0.0
100.0
200.0
300.0
400.0
500.0
2
14

Figure 20

Cumulative Inflow as a Function of Time

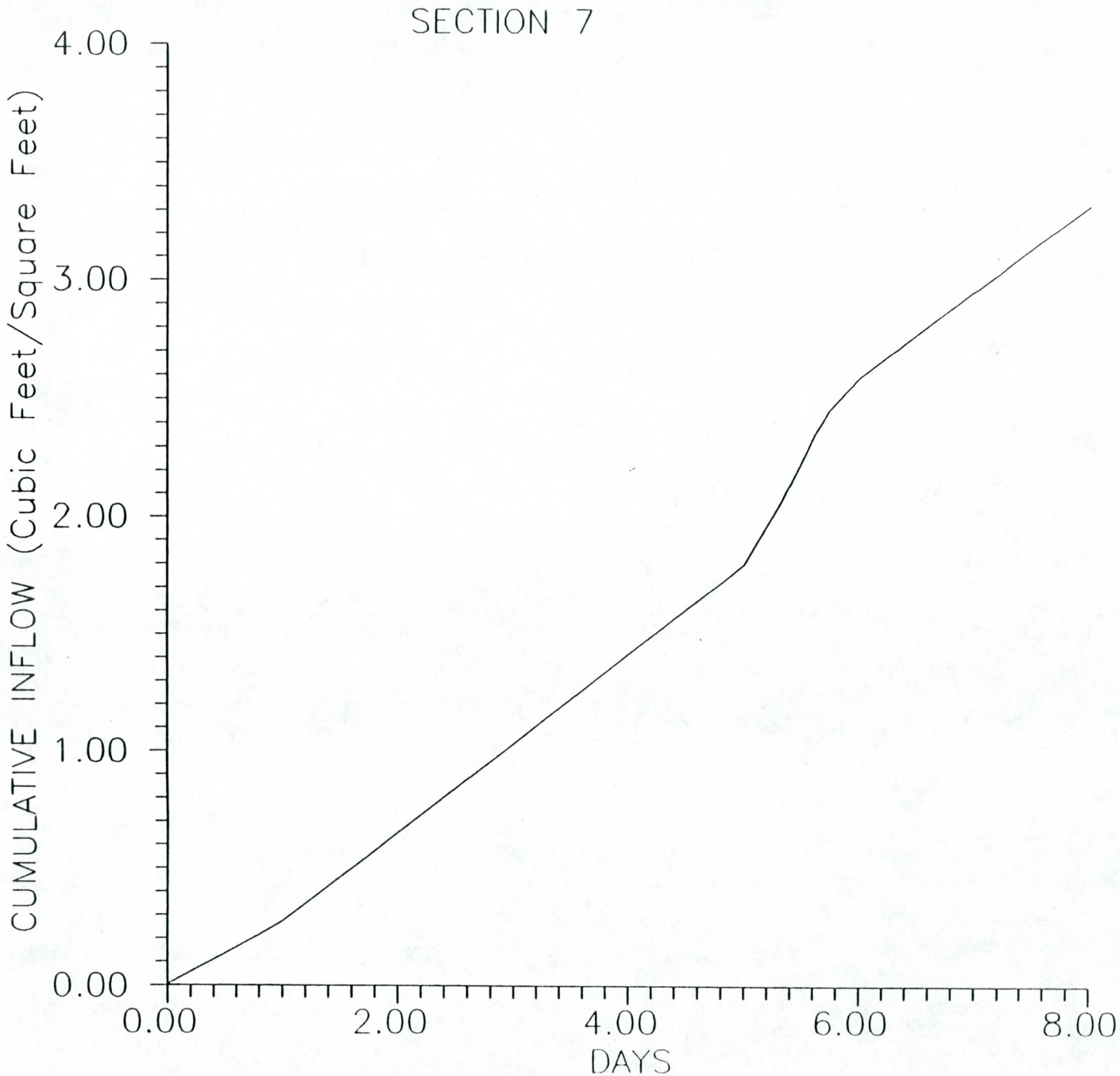


Figure 21

Pressure Head Distribution: Sec-8 (t= 0.5 day)

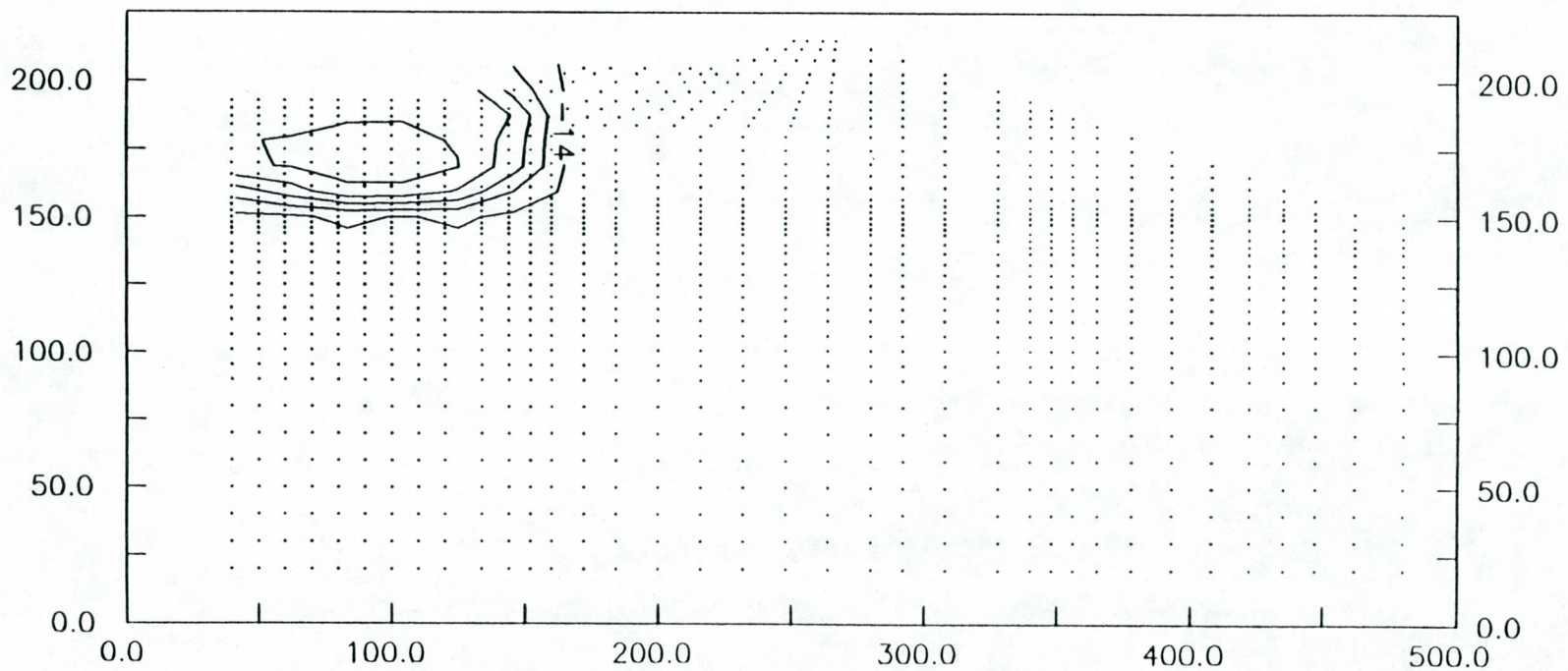


Figure 22

Pressure Head Distribution: Sec-8 (t= 1 day)

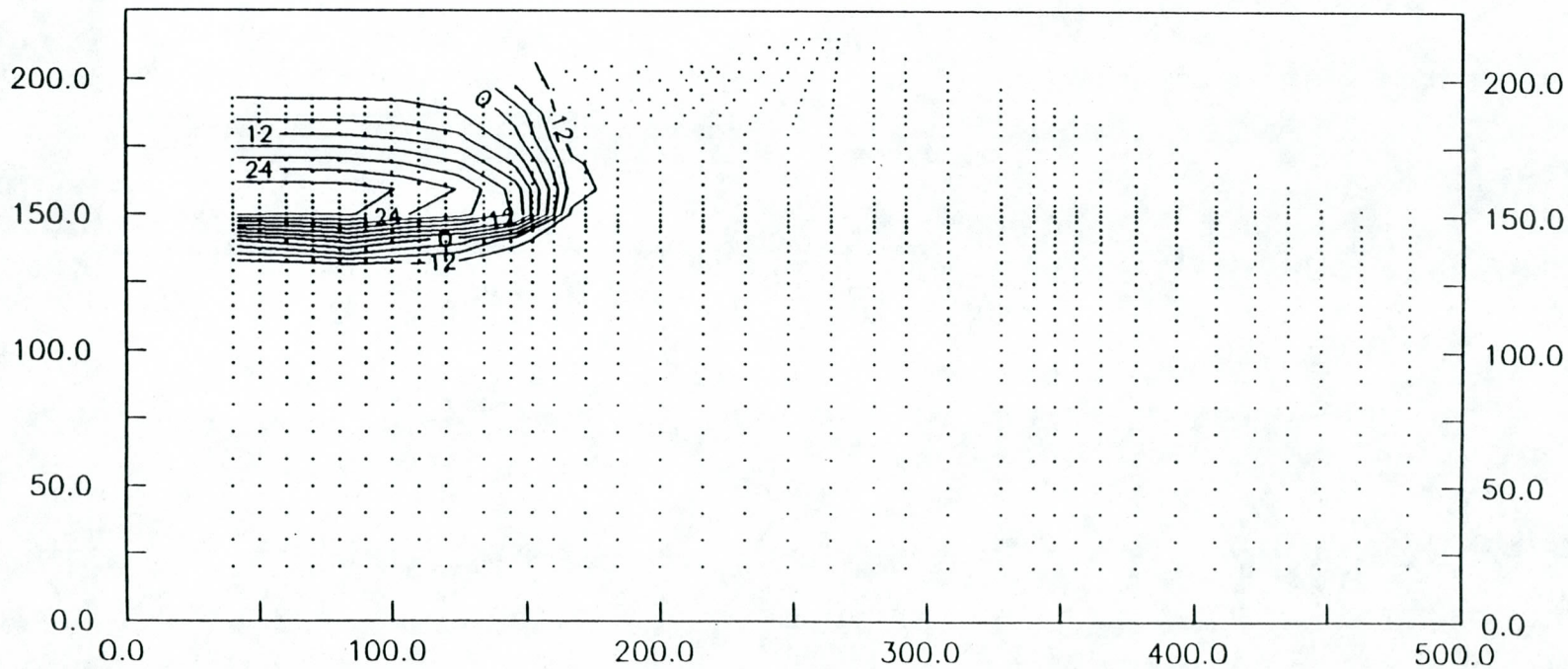


Figure 23

Pressure Head Distribution: Sec-8 (t= 2 day)

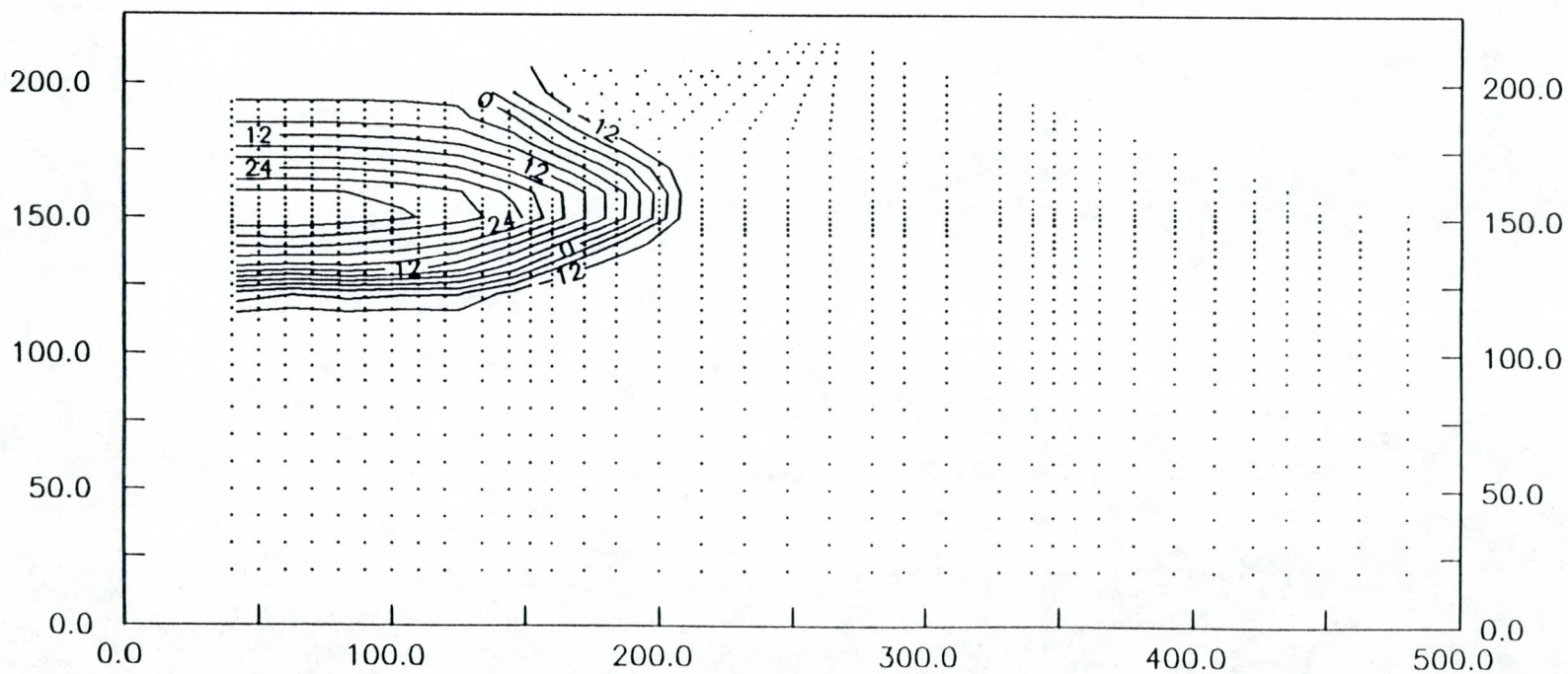


Figure 24

Pressure Head Distribution: Sec-8 (t= 3 day)

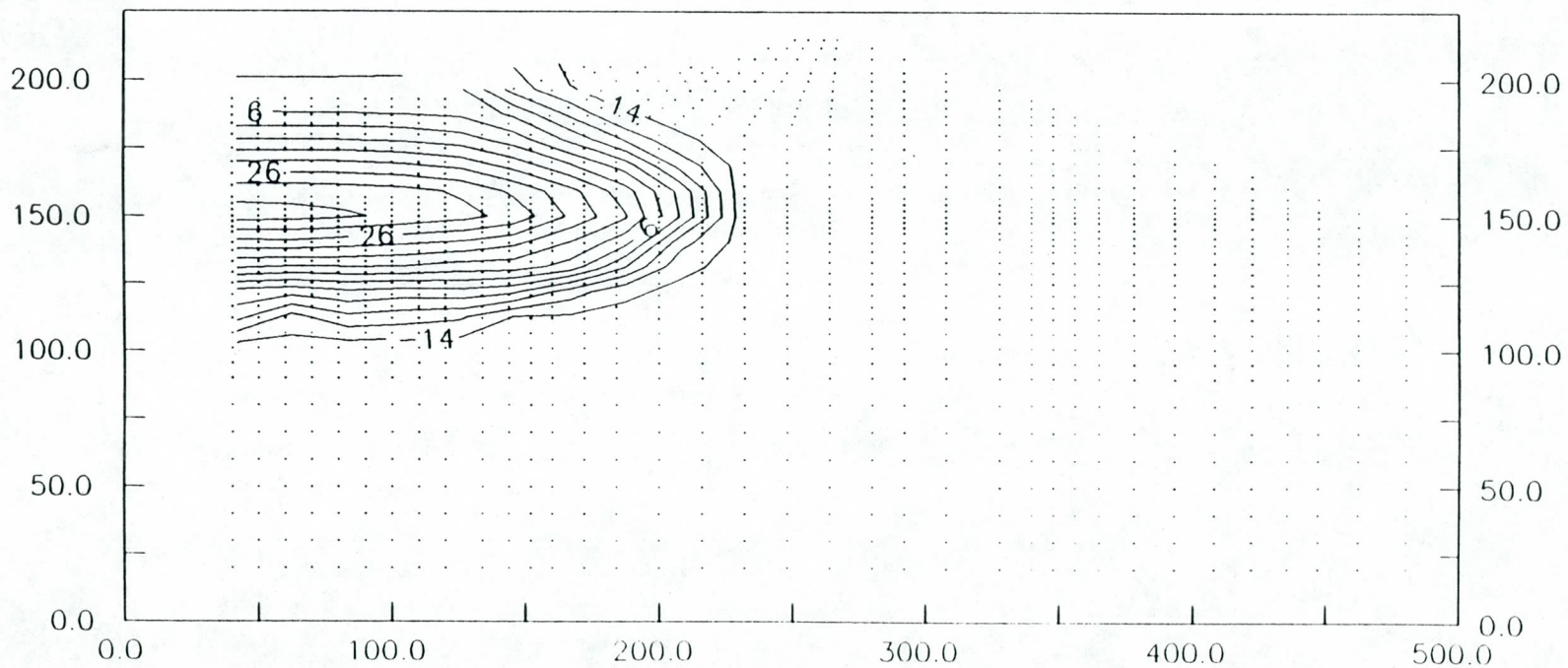


Figure 25

Pressure Head Distribution: Sec-8 (t= 4 day)

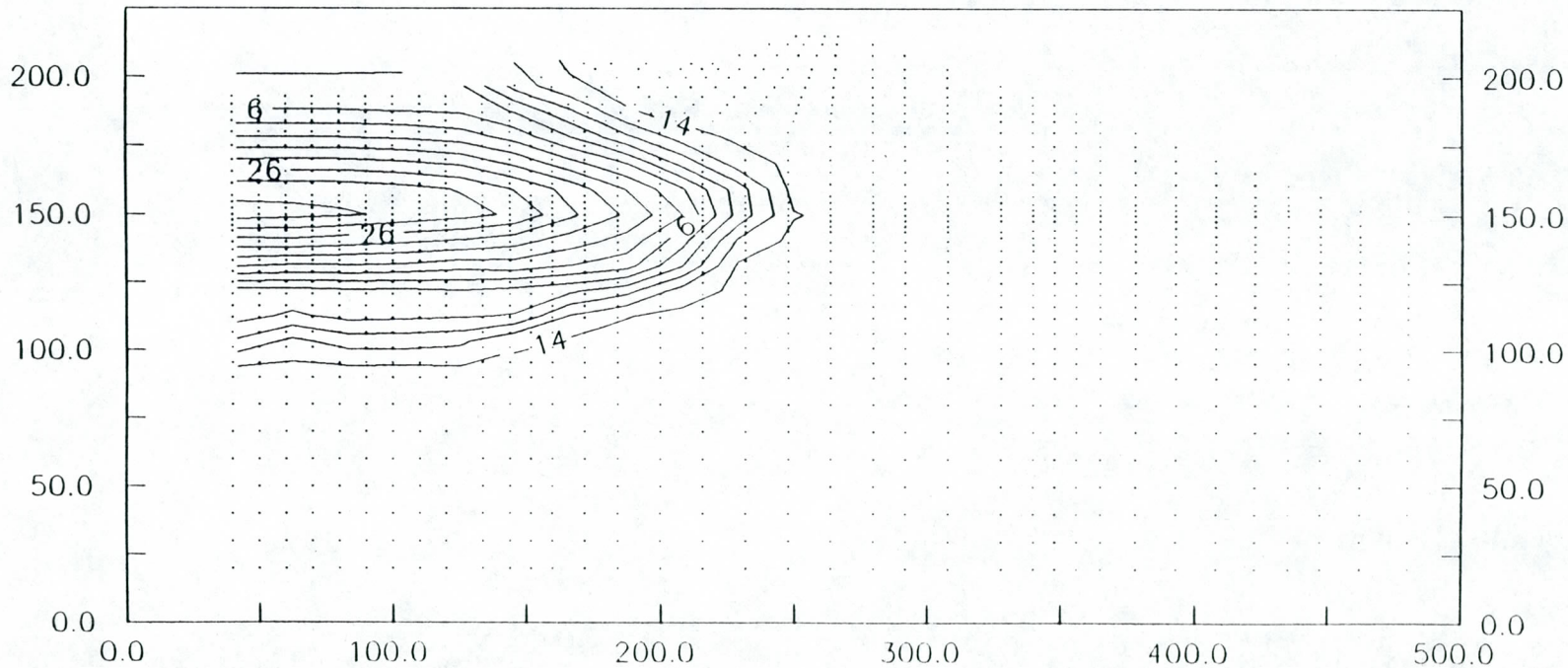


Figure 26

Pressure Head Distribution: Sec-8 (t= 5 day)

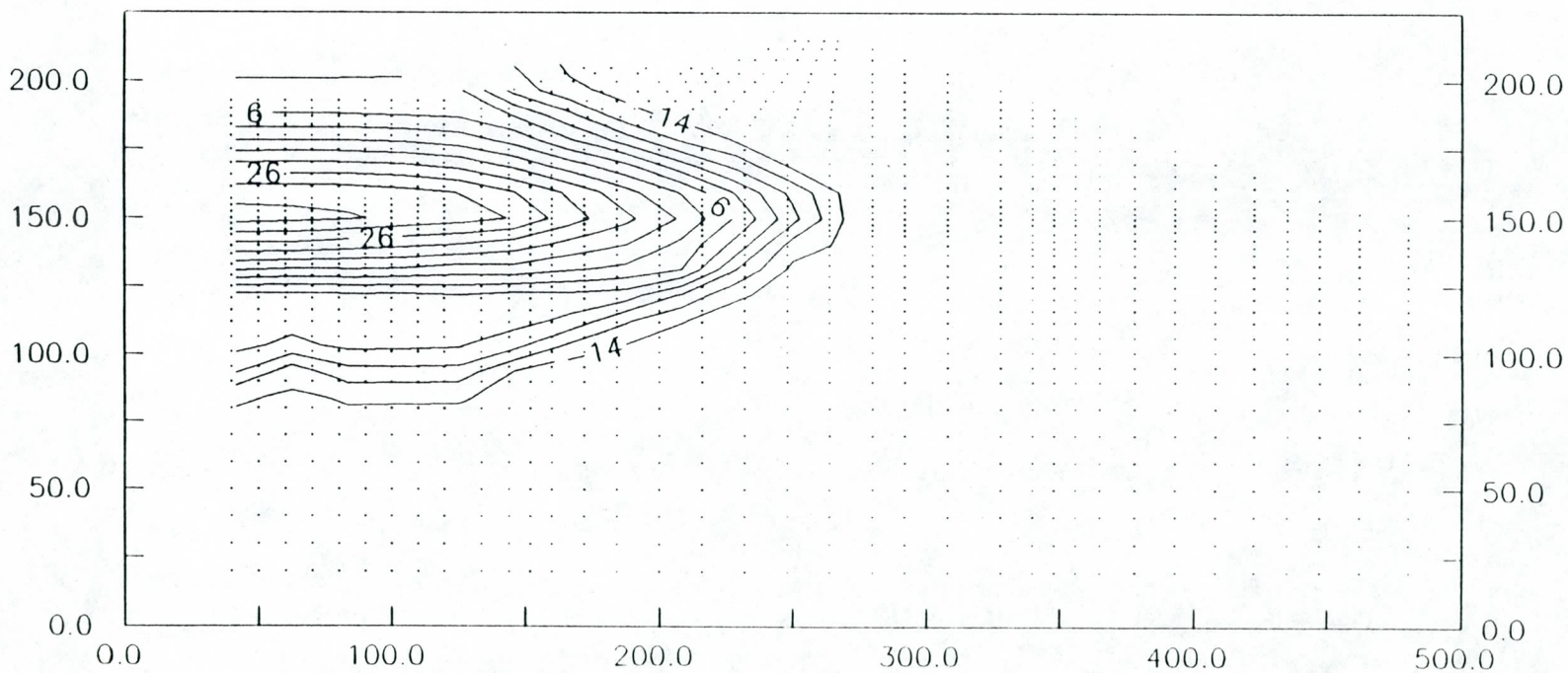


Figure 27

Pressure Head Distribution: Sec-8 (t= 5.125day)

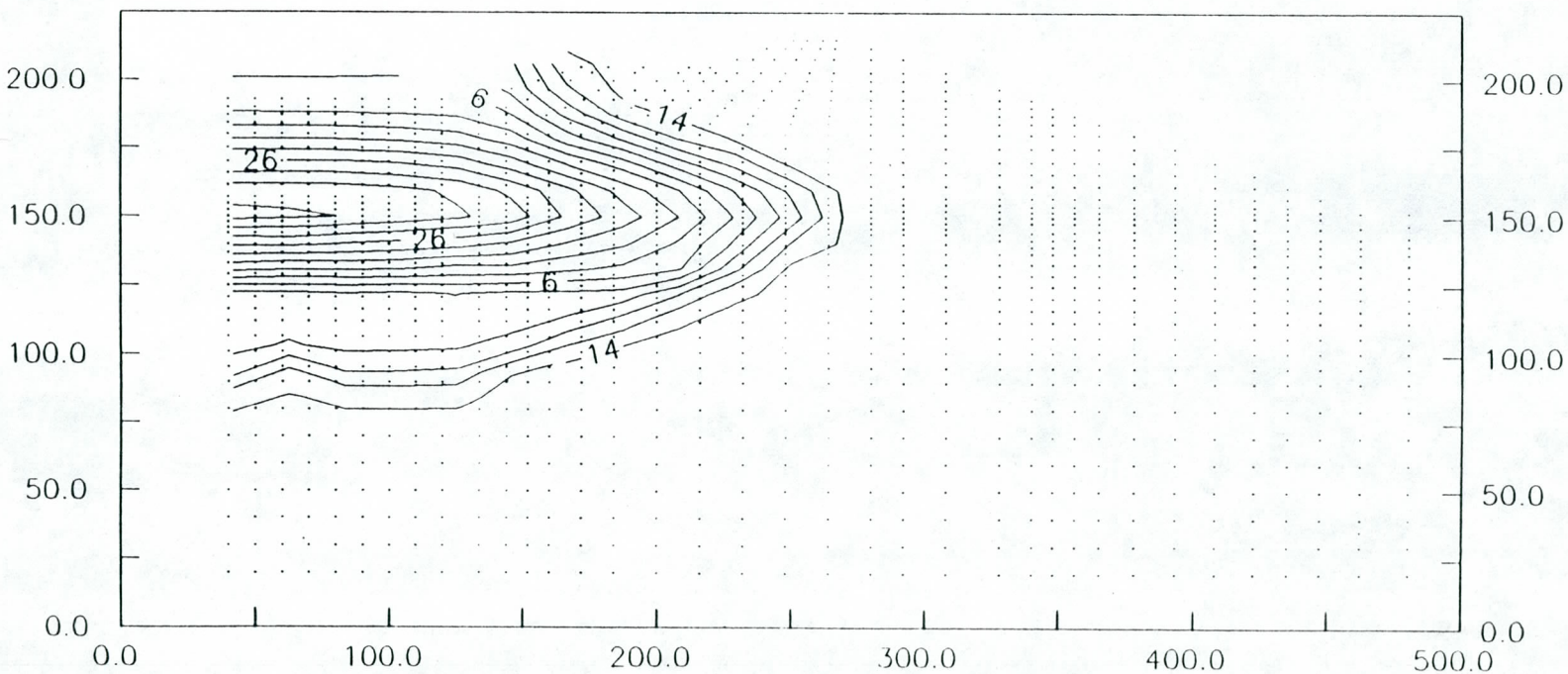


Figure 28

Pressure Head Distribution: Sec-8 (t=5.25 day)

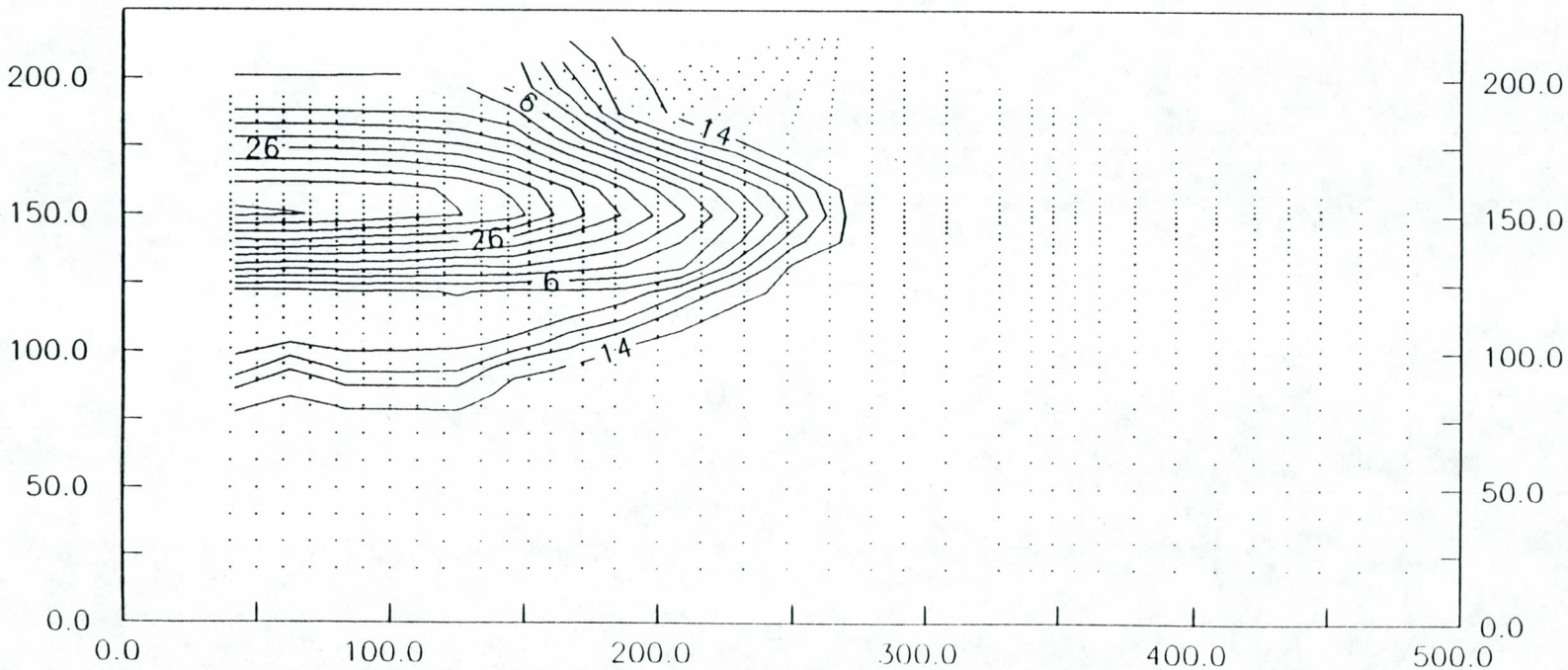


Figure 29

Pressure Head Distribution: Sec-8 (t= 5.666 day)

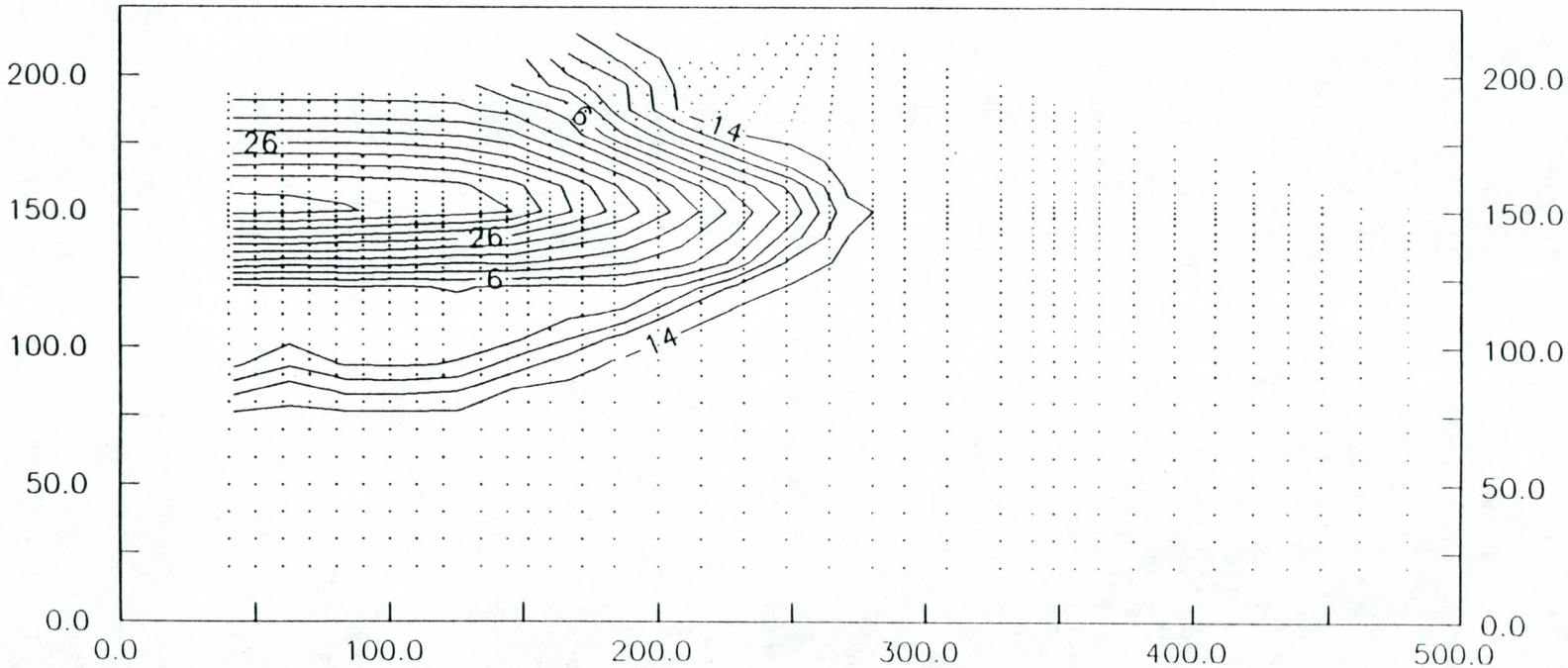


Figure 30

Pressure Head Distribution: Sec-8 (t= 5.833 day)

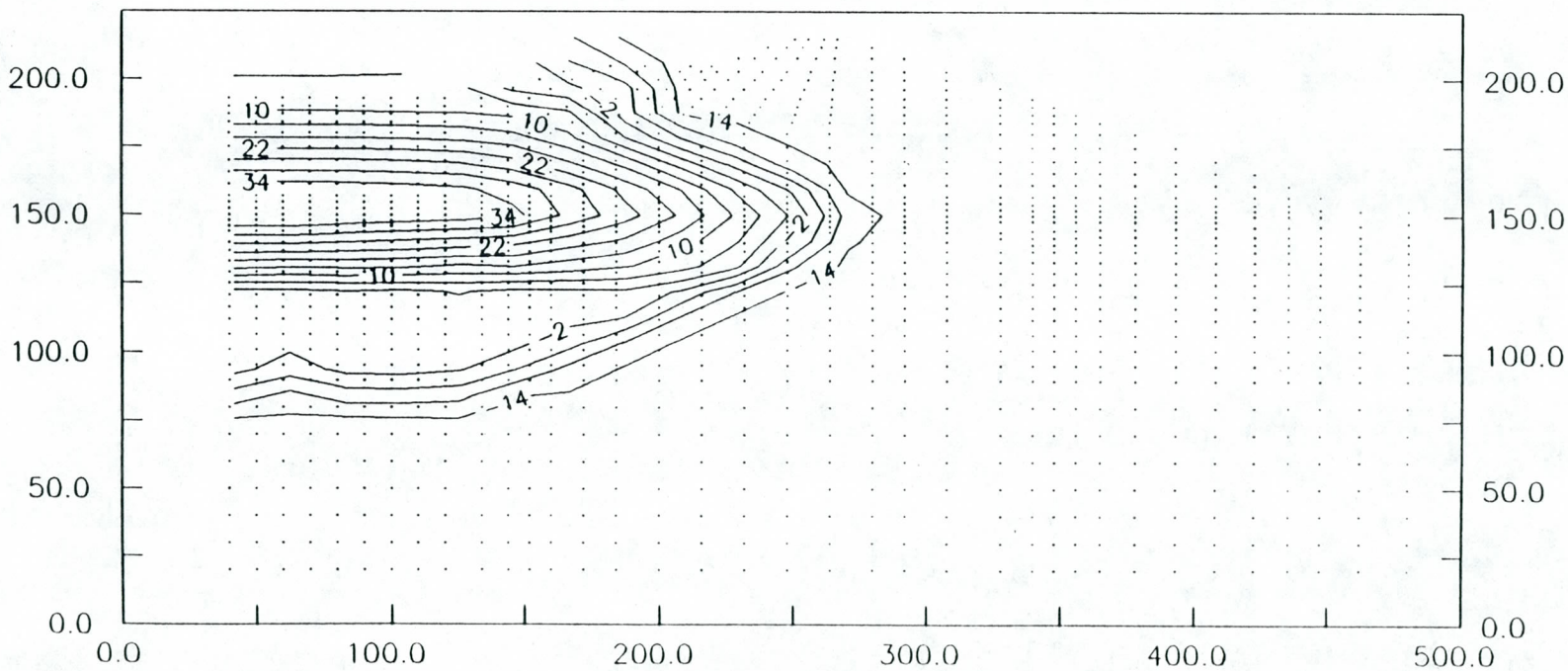
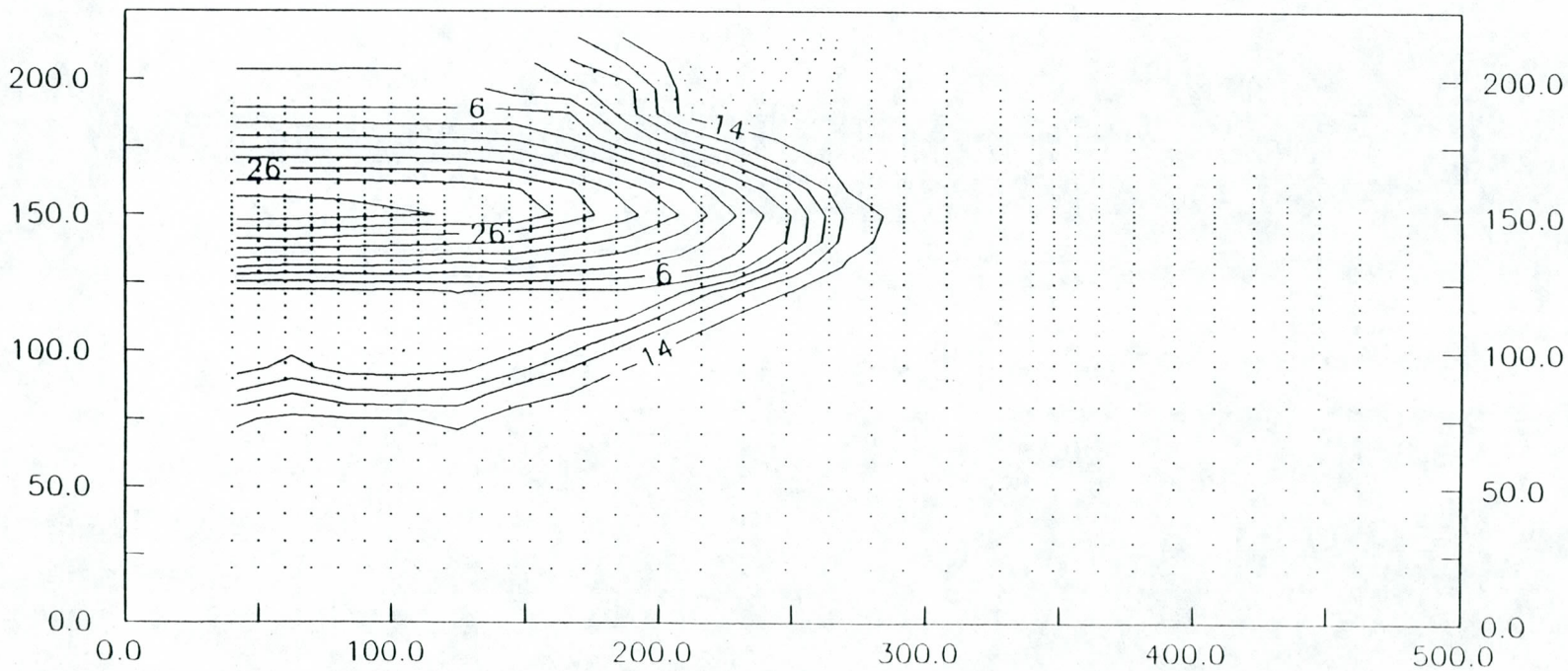


Figure 31

Pressure Head Distribution: Sec-8 (t= 6 day)



October 26, 1989
Project 372-15.04

Mr. Bill Mathews
Mathews Kessler & Associates, Inc.
4045 E. McDowell Road
Phoenix, Arizona 85008-4405

Re: Cholla Landfill - Stability and Settlement Analyses of Proposed Aqua Fria River Bank Stabilization

Dear Bill:

At Browning-Ferriis Industries of Arizona, Inc. request, we have completed the stability and settlement analyses of your proposed Aqua Fria River Bank stabilization for the Cholla Sanitary Landfill. These analyses indicated that the proposed stabilization section has minimum computed factors of safety against sliding that meet generally accepted criteria and that post-construction settlement of the stabilized bank will be negligible. EMCON's analyses have been performed in accordance with the principles and practices generally employed by the geotechnical engineering profession. This is in lieu of all other warranties, express or implied.

STABILITY ANALYSIS RESULTS

Our stability analyses included evaluation of the proposed (1) landfill 3:1 (horizontal to vertical) excavation slope, (2) the stabilized river bank in a dry condition, (3) the stabilized river bank assuming a water filled channel (100 year flood) and that a phreatic surface had developed in the river bank due to flood flows, (4) the stabilized bank after the 100 year flood flows had receded but with a phreatic surface still developed in the river bank, and (5) the stabilized river bank with a partially full channel and that a phreatic surface had developed in the river bank. A typical section of your proposed river bank stabilizatoin is shown on Figure 1.

The soil parameters used in the stability analyses are presented on Figures 2 through 6 and summarized in Table 1. The selected insitu river bank material parameters were based on the results of laboratory testing of relatively undisturbed samples performed as part of the proposed landfill design. Parameters used for the earthfill (slope flattening), riprap, and riprap bedding materials were estimated based on typical values for well compacted sand and gravel, and rock

riprap. Earthfill and riprap bedding strength parameters should be confirmed by laboratory testing during final design.

We have assumed that the river bank will be flattened to a slope of 2:1 (horizontal to vertical) with granular sand and sand and gravel fill or a combination cut and fill. The construction should be performed so that the slope of the river bank, prior to filter fabric placement, consists of a series of small benches rather than a smooth 2:1 slope. Benching the slope, which will occur naturally as part of the construction process as each lift of material is placed or cuts are made to flatten the slope, will eliminate the relatively smooth continuous plane between the fill slope and the filter fabric (geotextile). Friction angles between geotextiles and sand range between about 22 degrees and 30 degrees, depending on the type of geotextile and sand. These friction angles are lower than friction angles of the sand fill.

The results of the stability analyses are presented on Figures 2 through 6 and summarized in Table 2. The analysis results of the proposed landfill excavation slope are shown on Figure 2. The minimum computed factor of safety for this slope was 2.3.

The river bank section analyzed was one adjacent to the sand and gravel excavation located within the Aqua Fria River channel. This represents a worst case condition from a stability analysis view point, since it is higher than other sections of the bank. We understand that your scour analysis indicates that this excavation will be filled due to natural river deposition processes. The minimum computed factors of safety were 1.4 or higher except for the post 100 year flood condition. The minimum computed factor of safety for this condition was 1.3. For the post flood condition, we conservatively assumed that (1) the excavation had not been filled and (2) the water level in the channel dropped from the 100 year flood level to the base of the channel (approximately 25 feet) while the phreatic surface within the river bank only dropped 11 feet. With the river channel filled, the factor of safety will be higher.

Settlement Analysis

It is not anticipated that there will be any noticeable settlement of the river bank or its foundation due to river bank stabilization construction. The majority of the river bank and foundation consists of cemented sands, gravel, and cobbles. There are lenses of clayey materials at depth, especially beneath the southern part of the bank. However, the loads imposed by the fills for flattering of the river bank slope to 2:1 and placing rip rap will be minor. The maximum depth of fill for river bank slope flattening will be about 22 feet (located in the area of the sand and gravel excavation in the river channel). The conservatively calculated post construction ultimate settlement of the river bank stabilization fill and foundation is 0.4 feet. However, since much of the 22 foot fill thickness for slope flattening will involve replacement of previously excavated material (sand and gravel excavation in the channel), the settlement in this area will probably be less than computed. It is anticipated that post construction settlement of the other portions of the stabilized bank will be less than those computed for the area adjacent to the sand and gravel excavation in the channel.

If you have any questions, please contact us.

Very truly yours,

EMCON Associates

Dennis Buranek

Dennis Buranek
Project Geotechnical Manager

Richard J. Leach
Senior Vice President

Registered Professional Engineer (Civil)
CERTIFICATE NO.
12888
RICHARD J.
LEACH
Date Signed 10/26/89
ARIZONA, U.S.A.

DB/RL:ljt

Attachments

cc: Lee Schoon
Doug Jorden
Dirk Dudgeon

Table 1

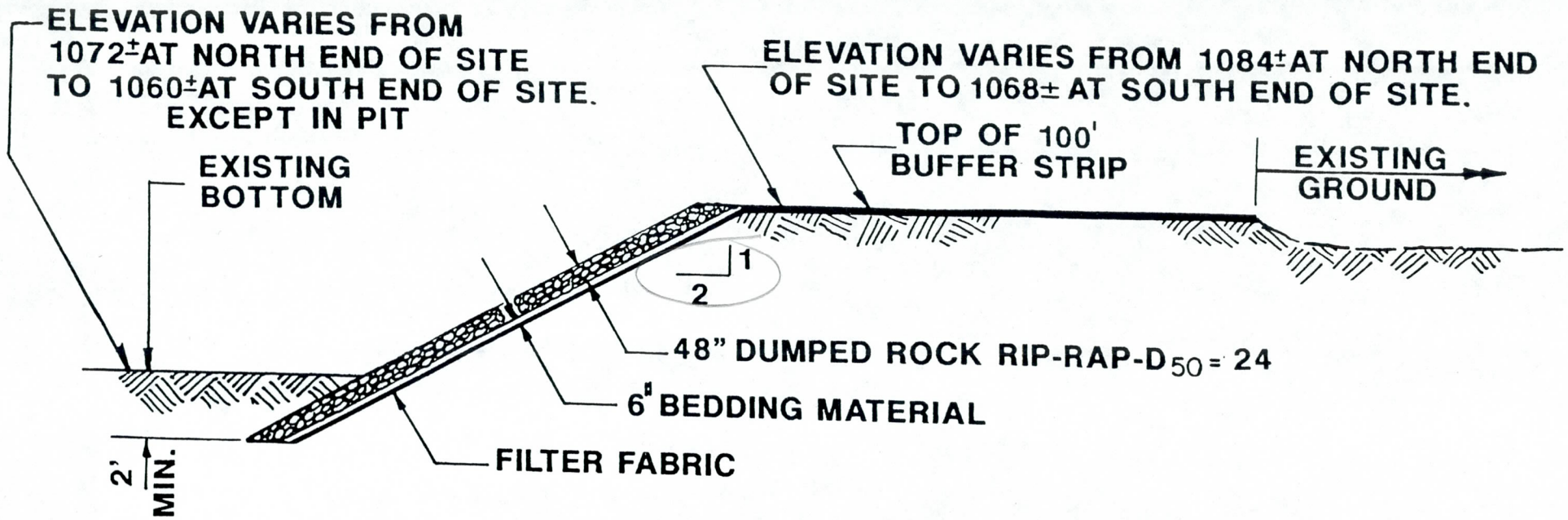
MATERIAL PROPERTIES

Material Description	Total Unit Weight (PCF)	Cohesion (PSF)	Internal Friction Angle (Degrees)
Silts and clays	120	400	27.5
Insitu sands	120	300	34
Compacted sand earthfill	120	0	34
Rip Rap Bedding	120	0	34
Rock Rip Rap	150	0	40

Table 2

STABILITY ANALYSES RESULTS

Condition	Minimum Computed Factor of Safety
Landfill Excavation slope	2.3
Stabilized River Bank-Dry	1.5
Stabilized River Bank - 100 year Flood Level	1.5
Stabilized River Bank - Post 100 year Flood Level	1.3
Stabilized River Bank - Partially Full Channel	1.4



TYPICAL BANK SECTION

NOT TO SCALE

NOTES:

BEDDING MATERIAL SHALL CONFORM TO ADOT STD. SPEC. 913-2.03. FILTER FABRIC SHALL CONFORM TO ADOT STD. SPEC. 913-2.05. DUMPED RIP-RAP SHALL CONFORM TO ADOT STD. SPEC. 913-2.01 (A) & (D).

ALL MATERIALS SHALL BE PLACED AS PER ADOT STD. SPEC. 913-3

ALL EXCAVATION FOR RIP-RAP SHALL BE BACKFILLED TO THE APPROXIMATE GRADE OF EXISTING RIVERBED. NO SPECIAL COMPACTION OF THIS MATERIAL IS REQUIRED.

EROSION PROTECTION SHALL GENERALLY EXTEND FROM 2 FT. ABOVE THE 100 YEAR FLOOD ELEVATION TO 22' BELOW THE 100 YEAR FLOOD ELEVATION. WHERE THE CHANNEL IS EXCAVATED SUCH THAT THE TOEDOWN WOULD NOT BE COVERED UNDER CURRENT CONDITIONS, THE RIP-RAP SHALL BE EXTENDED DOWNWARD TO SUCH A POINT THAT A MINIMUM 2' IS COVERED.

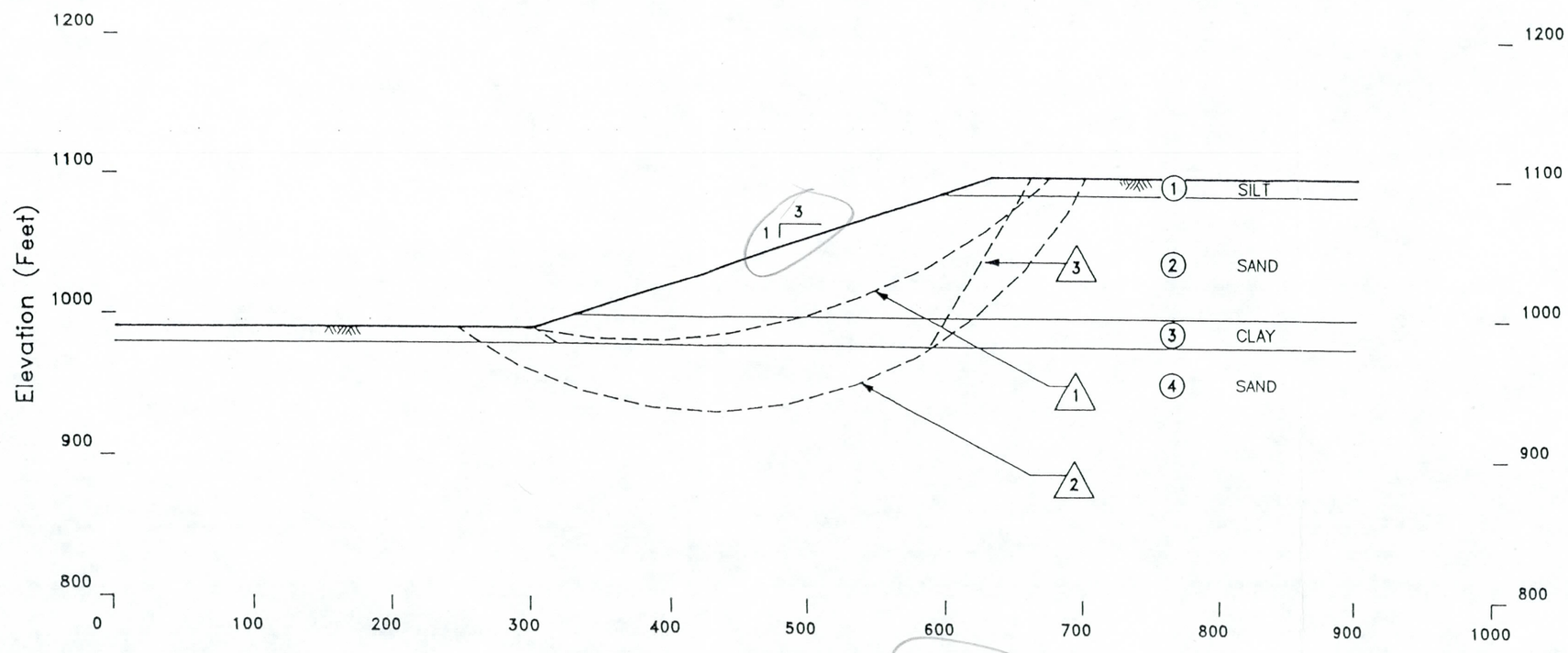
SOURCE: Mathews Kessler & Associates, Inc.

Figure 1

ENGINEERING PROPERTIES				
LAYER	DESCRIPTION	TOTAL UNIT WEIGHT (PCF)	COHESION (PSF)	INTERNAL FRICTION DEGREE
1	Silt	120	400	27.5
2	Sand	120	300	34
3	Clay	120	400	27.5
4	Sand	120	300	34

RESULTS OF SLOPE STABILITY ANALYSIS		
FAILURE SURFACE	MIN. COMPUTED STATIC FACTOR OF SAFETY	REMARKS
1	2.3	Circular failure surface
2	3.2	Circular failure surface
3	2.4	Wedge type failure surface

for 3:1 (pit slope)



EXCAVATION SLOPE (3H:1V)
(Pit)

EMCON Associates

Scale: 1" = 100'

BROWNING FERRIS INDUSTRIES OF ARIZONA, INC.
CHOLLA SANITARY LANDFILL
EL MIRAGE, ARIZONA

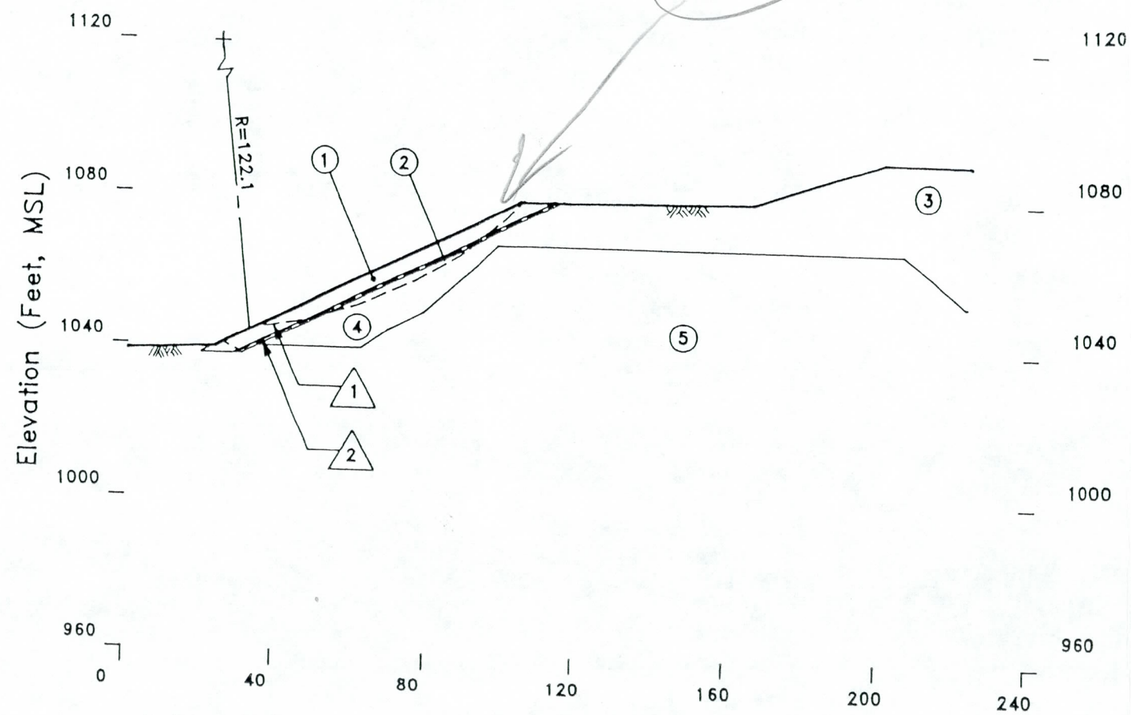
SLOPE STABILITY ANALYSIS

FIGURE 2

PROJECT NO. 372-15.04

ENGINEERING PROPERTIES				
LAYER	DESCRIPTION	TOTAL UNIT WEIGHT (PCF)	Long-term	
			COHESION (PSF)	INTERNAL FRICTION DEGREE
1	Rock rip rap	150	0	40
2	Rip rap bedding	120	0	34
3	Silts and clays	120	400	27.5
4	Compacted sand earthfill	120	0	34
5	In situ sands	120	300	34

RESULTS OF SLOPE STABILITY ANALYSIS		
FAILURE SURFACE	STATIC FACTOR OF SAFETY	REMARKS
1	1.50	Circular failure surface
2	1.52	Wedge type failure surface



STABILIZED RIVER BANK - DRY

EMCON Associates

Scale: 1" = 40'

BROWNING FERRIS INDUSTRIES OF ARIZONA, INC.
CHOLLA SANITARY LANDFILL
EL MIRAGE, ARIZONA

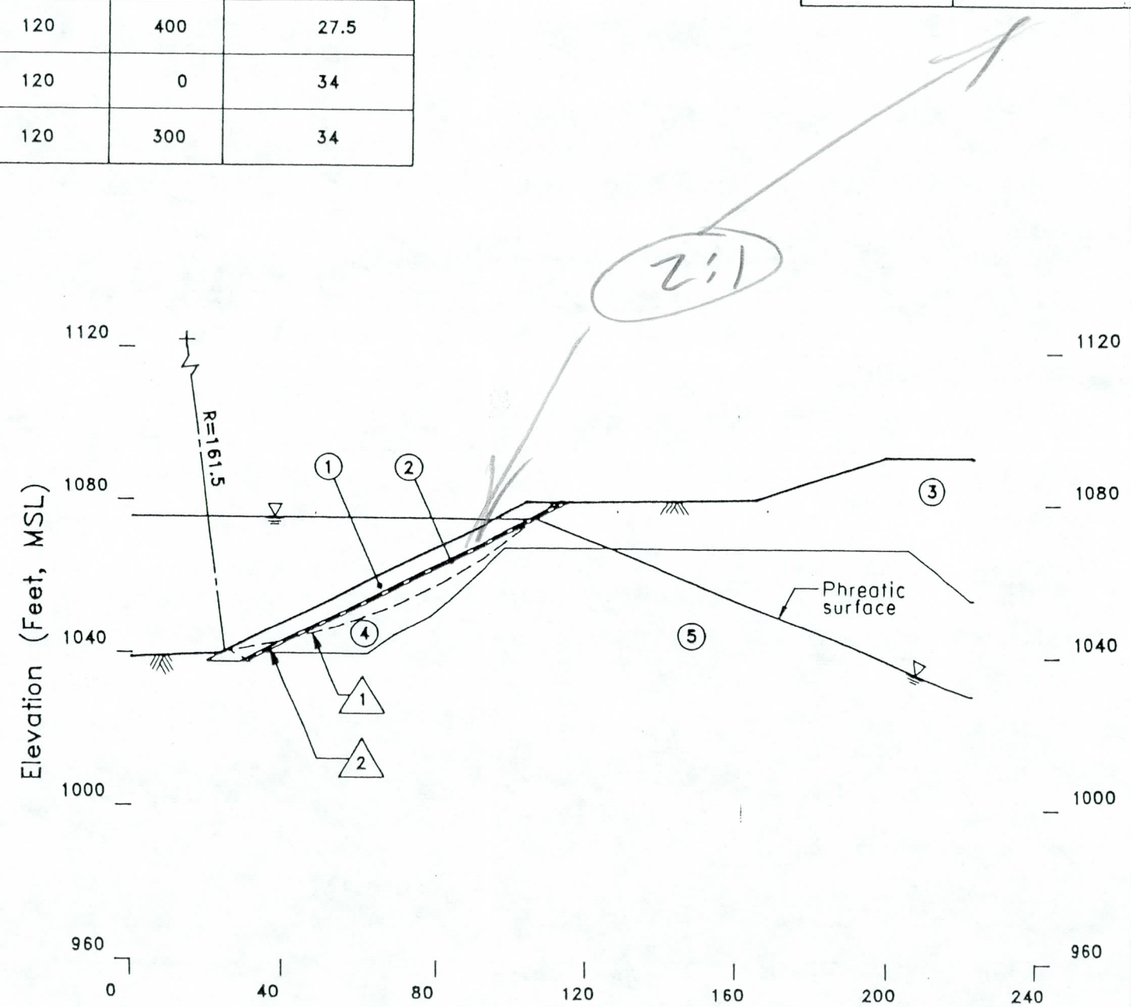
SLOPE STABILITY ANALYSIS

FIGURE 3

PROJECT NO. 372-15.04

ENGINEERING PROPERTIES				
LAYER	DESCRIPTION	TOTAL UNIT WEIGHT (PCF)	Long-term	
			COHESION (PSF)	INTERNAL FRICTION DEGREE
1	Rock rip rap	150	0	40
2	Rip rap bedding	120	0	34
3	Silts and clays	120	400	27.5
4	Compacted sand earthfill	120	0	34
5	In situ sands	120	300	34

RESULTS OF SLOPE STABILITY ANALYSIS		
FAILURE SURFACE	STATIC FACTOR OF SAFETY	REMARKS
1	1.48	Circular Failure surface
2	1.51	Wedge type failure surface



STABILIZED RIVER BANK - 100 YEAR FLOOD LEVEL

EMCON Associates

Scale: 1" = 40'

BROWNING FERRIS INDUSTRIES OF ARIZONA, INC.
CHOLLA SANITARY LANDFILL
EL MIRAGE, ARIZONA

SLOPE STABILITY ANALYSIS

FIGURE 4

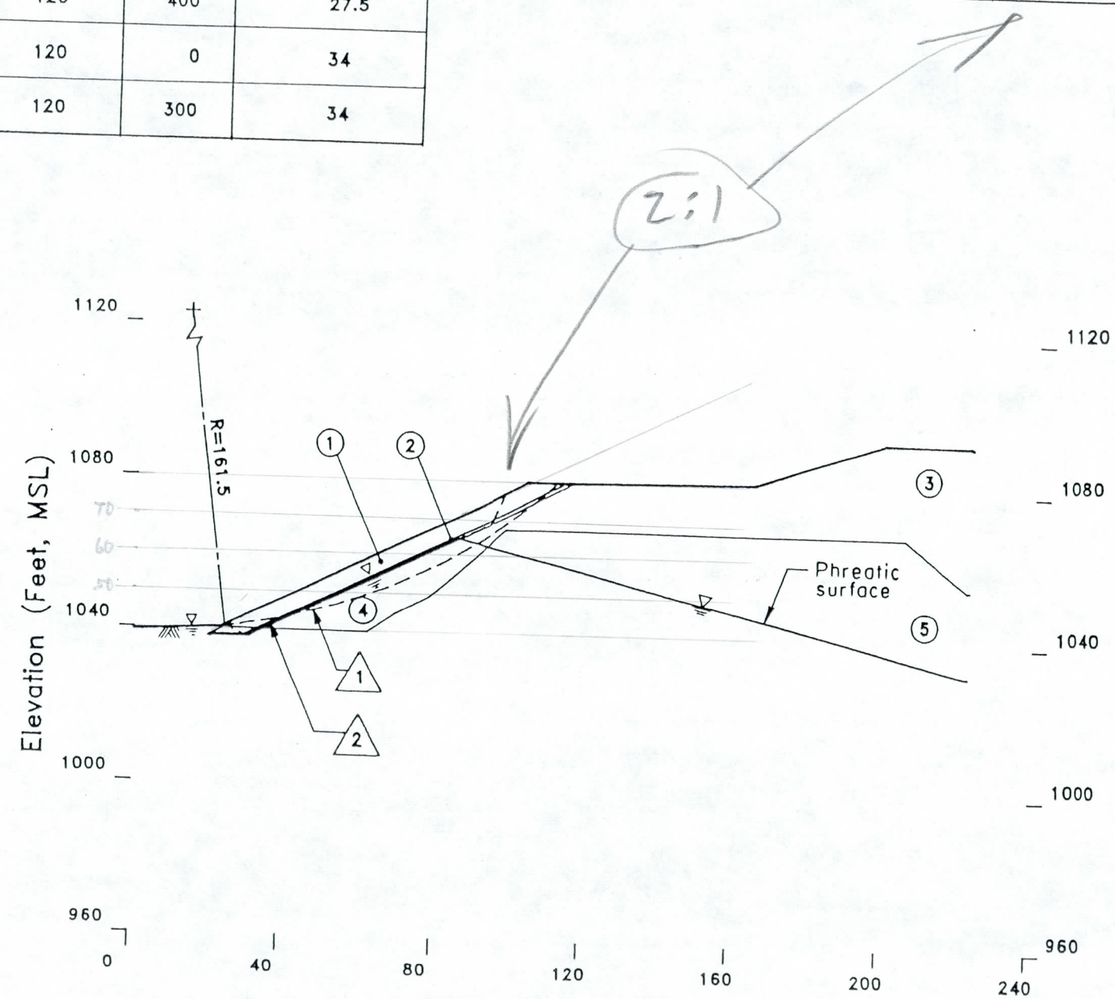
PROJECT NO. 372-15.04

ENGINEERING PROPERTIES

LAYER	DESCRIPTION	TOTAL UNIT WEIGHT (PCF)	Long-term COHESION (PSF)	Long-term INTERNAL FRICTION DEGREE
1	Rock rip rap	150	0	40
2	Rip rap bedding	120	0	34
3	Silts and clays	120	400	27.5
4	Compacted sand earthfill	120	0	34
5	In situ sands	120	300	34

RESULTS OF SLOPE STABILITY ANALYSIS

FAILURE SURFACE	STATIC FACTOR OF SAFETY	REMARKS
1	1.34	Circular failure surface
2	1.48	Wedge type failure surface



STABILIZED RIVER BANK - POST **100** YEAR FLOOD

EMCON Associates

Scale: 1" = 40'

BROWNING FERRIS INDUSTRIES OF ARIZONA, INC.
CHOLLA SANITARY LANDFILL
EL MIRAGE, ARIZONA

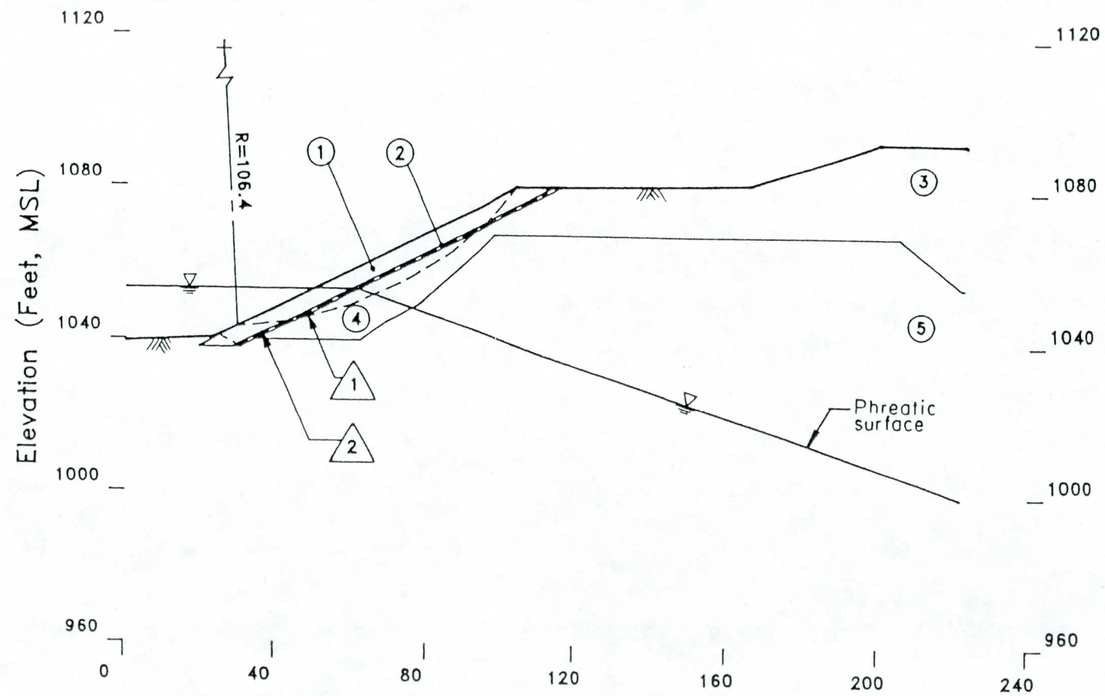
SLOPE STABILITY ANALYSIS

FIGURE 5

PROJECT NO. 372-15.04

ENGINEERING PROPERTIES				
LAYER	DESCRIPTION	TOTAL UNIT WEIGHT (PCF)	Long-term	
			COHESION (PSF)	INTERNAL FRICTION DEGREE
1	Rock rip rap	150	0	40
2	Rip rap bedding	120	0	34
3	Silts and clays	120	400	27.5
4	Compacted sand earthfill	120	0	34
5	In situ sands	120	300	34

RESULTS OF SLOPE STABILITY ANALYSIS		
FAILURE SURFACE	STATIC FACTOR OF SAFETY	REMARKS
1	1.41	Circular failure surface
2	1.43	Wedge type failure surface



STABILIZED RIVER BANK - PARTIALLY FULL CHANNEL

EMCON Associates

Scale: 1" = 40'

BROWNING FERRIS INDUSTRIES OF ARIZONA, INC.
CHOLLA SANITARY LANDFILL
EL MIRAGE, ARIZONA

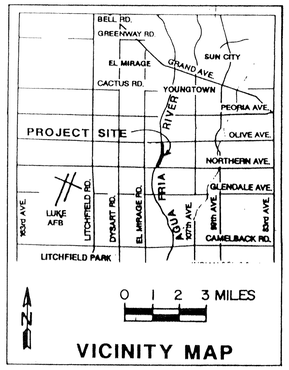
SLOPE STABILITY ANALYSIS

FIGURE 6

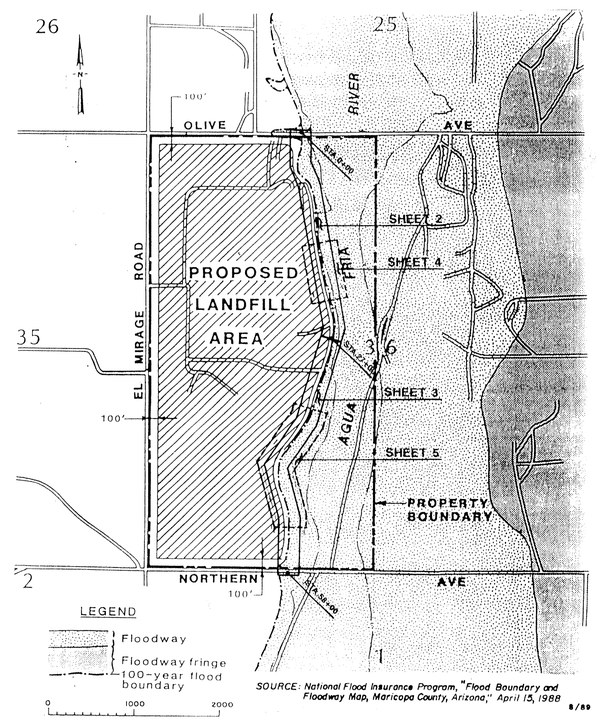
PROJECT NO. 372-15.04

CHOLLA LANDFILL SITE - EL MIRAGE, ARIZONA

PROPOSED RIP-RAP BANK STABILIZATION & LEVEE REPAIR



VICINITY MAP



SOURCE: National Flood Insurance Program, "Flood Boundary and Floodway Map, Maricopa County, Arizona," April 15, 1988

8/89

SHEET INDEX MAP

PROJECT:	
CHOLLA LANDFILL SITE - EL MIRAGE, ARIZONA PROPOSED RIP-RAP BANK STABILIZATION & LEVEE REPAIR	
TITLE: COVER SHEET	DRWG. NO. 1 of 6
MATHEWS KESSLER & ASSOCIATES, INC. architecture · engineering · planning 4646 E. McDOWELL ROAD, PHOENIX, ARIZONA 85008-4400 602/244-2044	Registered Professional Engineer (Civil) WILLIAM D. MATHEWS Arizona U.S.A.
PROJECT NO. 8017	
SCALE: AS SHOWN DATE: 12/89	
DRAWN BY WB CHECKED BY RLS	

NOTE: DATUM ADJUSTMENT

Due to datum differences between the flood insurance study from which water surface profiles were taken and the topography from which all other elevations were taken, an equation has been applied to the water surface elevations. For purposes of this design, 1.7 ft. has been subtracted from all water surface profile elevations to provide compatibility with the corresponding topography.

NOTE:

Topography used to prepare all design drawings for this project was provided to Mathews Kessler & Associates (MKA) by others and is assumed to be correct.

LEGEND

- 24 25 — CONTROL LINE (STATIONING)
- EXISTING GROUND
- WATER SURFACE 100 YEAR FLOOD
- TOE OF SLOPE
- CHANNEL THALWEG
- RECOMMENDED TOEDOWN ELEVATION FOR BANK PROTECTION-UPSTREAM, DOWNSTREAM & THROUGH THE GRAVEL PIT.
- ESTIMATED HEADCUT PROFILE UPSTREAM OF GRAVEL PIT / ESTIMATED DEGRADATION PROFILE DOWNSTREAM OF GRAVEL PIT (CALLED OUT ON PROFILE).
- NATIVE MATERIAL ELEVATION BASED ON BORINGS. ACTUAL LIMITS OF EXCAVATION AND ENGINEERED BACKFILL TO BE DETERMINED BY A GEOTECHNICAL ENGINEER DURING CONSTRUCTION.
- EB-6 — TEST BORING LOCATION

SHEET INDEX

SHT.#	SHEET DESCRIPTION
1	COVER SHEET
2	PLAN & PROFILE (STA. 0+00 TO STA. 27+00)
3	PLAN & PROFILE (STA. 27+00 TO STA. 58 +00)
4.	LEVEE REPAIR (STA. 14+00± TO STA. 24+00±) UPSTREAM
5.	LEVEE REPAIR & ALTERNATIVE LEVEE (STA. 35+00± TO STA. 51+00±) DOWNSTREAM
6.	BANK CROSS - SECTION

PROJECT:

CHOLLA LANDFILL SITE - EL MIRAGE, ARIZONA

PROPOSED RIP-RAP BANK STABILIZATION & LEVEE REPAIR

TITLE: PLAN & PROFILE

STA.0+00 TO STA.27+00

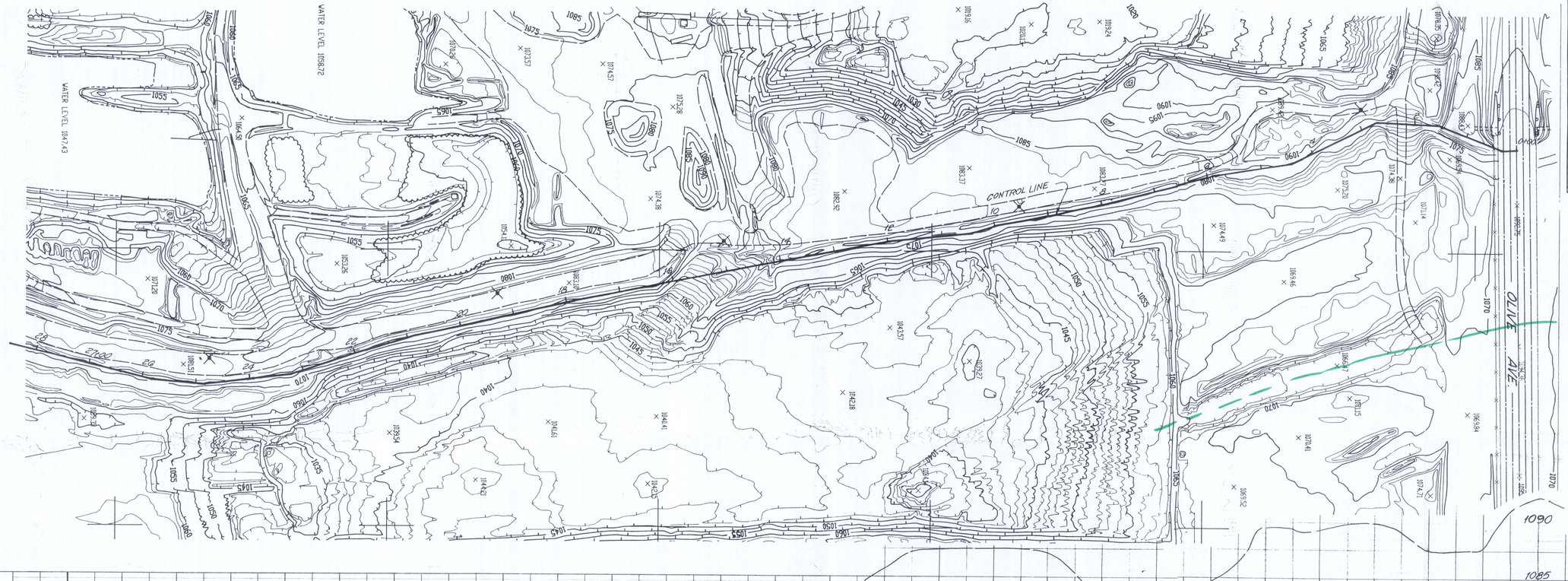
DRWG. NO. 2 of 6

MATHEWS KESSLER & ASSOCIATES, INC.
architecture · engineering · planning
4045 E. McDOWELL ROAD, PHOENIX, ARIZONA 85008-4405
602/244-2684

PROJECT NO. 8017

SCALE: AS SHOWN DATE: 12/89

DRAWN BY WG CHECKED BY RK



NOTE: DATUM ADJUSTMENT

Due to datum differences between the flood insurance study from which water surface profiles were taken and the topography from which all other elevations were taken, an equation has been applied to the water surface elevations. For purposes of this design, 1.7 ft. has been subtracted from all water surface profile elevations to provide compatibility with the corresponding topography.

SCALE: HORIZ. 1" = 100'
VERT. 1" = 5'

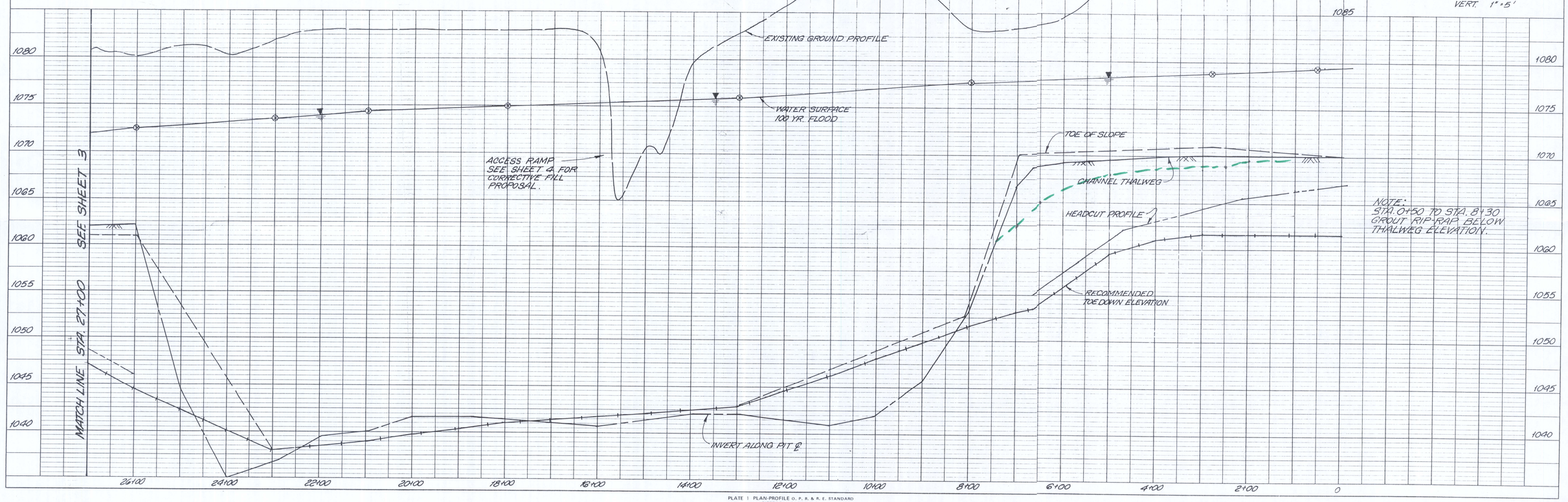
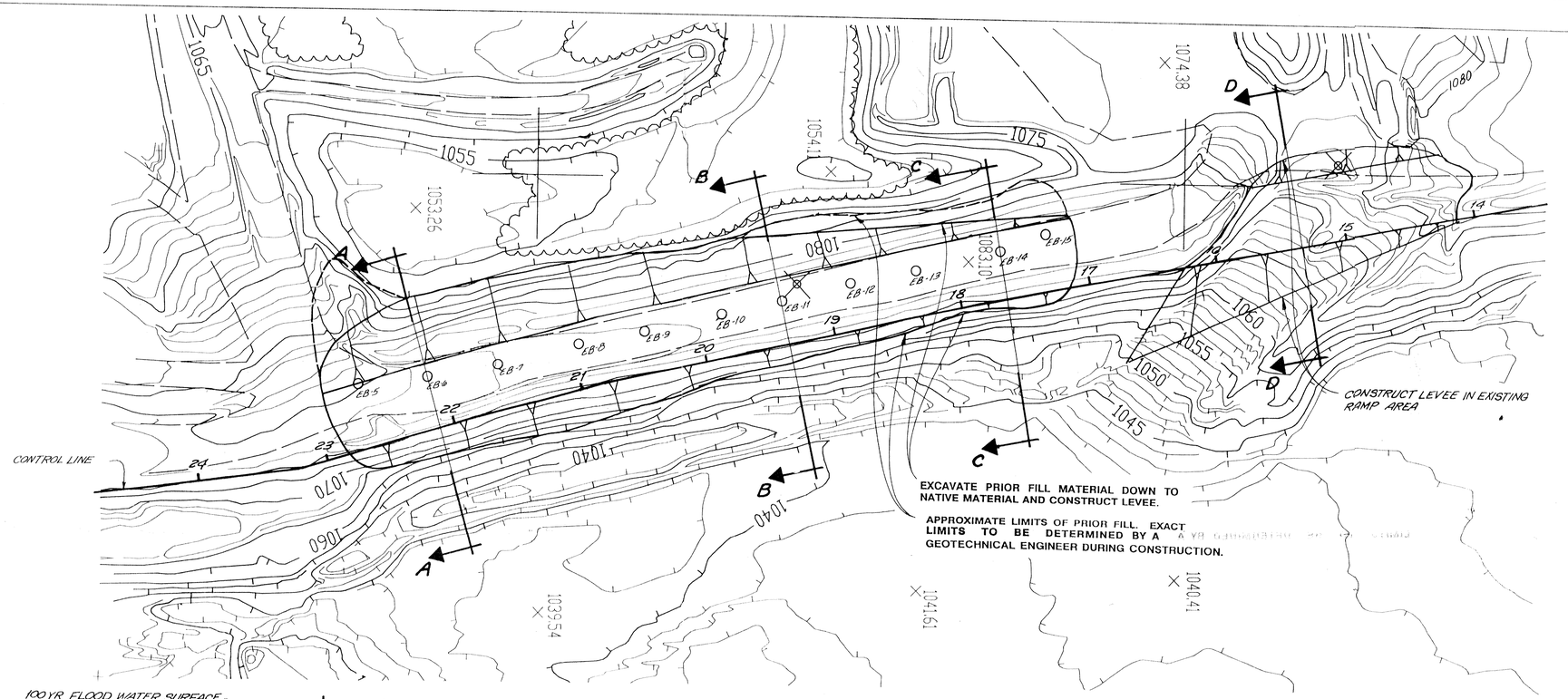


PLATE 1 PLAN-PROFILE O. P. R. & R. E. STANDARD
DIETZGEN CORPORATION
PRINTED IN U.S.A.

PLAN		BY	DATE
NOTE BOOK No.	SURVEYED		
	PLOTTED		
	ALIGNMENT CHECKED		
	RT. OF WAY CHECKED		

PROFILE		BY	DATE
NOTE BOOK No.	SURVEYED		
	PLOTTED		
	GRADES CHECKED		
	BLUE TOPED		
	STRUCTURE NOTATIONS CHECKED		



PROJECT:

CHOLLA LANDFILL SITE - EL MIRAGE, ARIZONA

PROPOSED RIP-RAP BANK STABILIZATION & LEVEE REPAIR

TITLE: UPSTREAM LEVEE REPAIR

STA. 14+00± TO STA. 24+00±

DRWG. NO. 4 of 6

MATHEWS KESSLER & ASSOCIATES, INC.
architecture engineering planning
4801 E. McDOWELL ROAD, PHOENIX, ARIZONA 85008-4405
602/244-2684

PROJECT NO. 8017

SCALE: AS SHOWN DATE: 12/89

DRAWN BY WB CHECKED BY RLS

NOTE: DATUM ADJUSTMENT

Due to datum differences between the flood insurance study from which water surface profiles were taken and the topography from which all other elevations were taken, an equation has been applied to the water surface elevations. For purposes of this design, 1.7 ft. has been subtracted from all water surface profile elevations to provide compatibility with the corresponding topography.

LEGEND

NATIVE MATERIAL ELEVATION BASED ON BORINGS. ACTUAL LIMITS OF EXCAVATION AND ENGINEERED BACKFILL TO BE DETERMINED BY A GEOTECHNICAL ENGINEER DURING CONSTRUCTION.

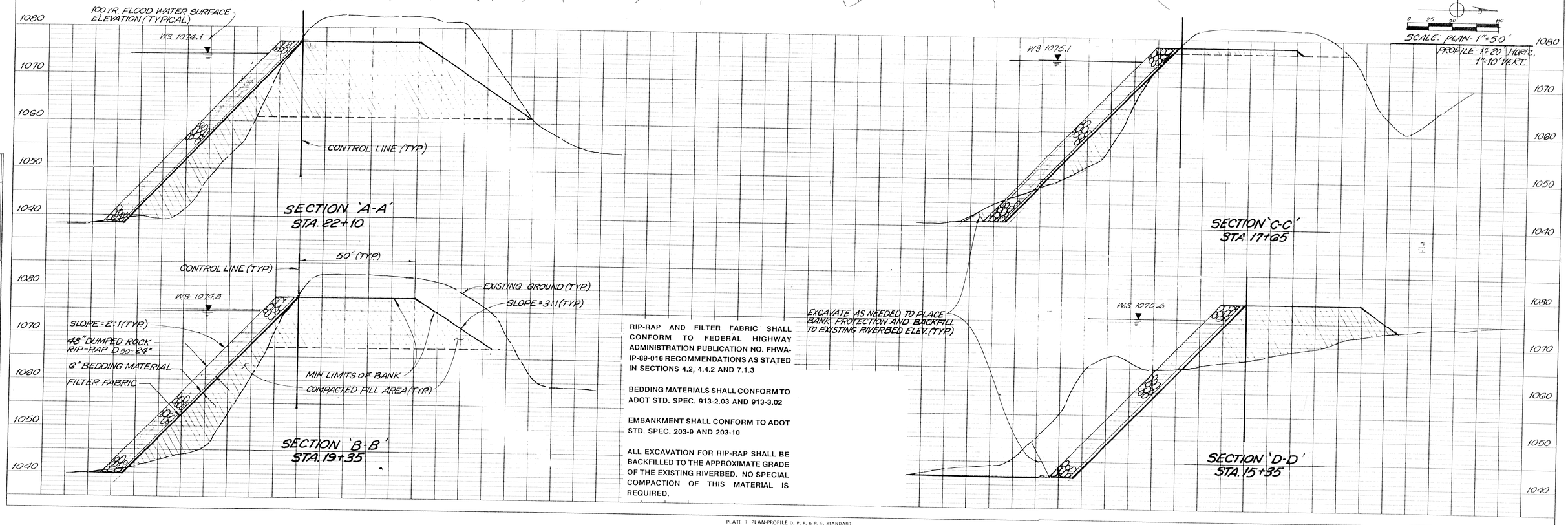
WATER SURFACE 100 YEAR FLOODPLAIN

EXISTING GROUND

22 21 CONTROL LINE (STATIONING)

EB-Q TEST BORING LOCATION

SCALE: PLAN- 1"=50'
PROFILE- 1"=20' HORIZ., 1"=10' VERT.



RIP-RAP AND FILTER FABRIC SHALL CONFORM TO FEDERAL HIGHWAY ADMINISTRATION PUBLICATION NO. FHWA-IP-89-016 RECOMMENDATIONS AS STATED IN SECTIONS 4.2, 4.4.2 AND 7.1.3

BEDDING MATERIALS SHALL CONFORM TO ADOT STD. SPEC. 913-2.03 AND 913-3.02

EMBANKMENT SHALL CONFORM TO ADOT STD. SPEC. 203-9 AND 203-10

ALL EXCAVATION FOR RIP-RAP SHALL BE BACKFILLED TO THE APPROXIMATE GRADE OF THE EXISTING RIVERBED. NO SPECIAL COMPACTION OF THIS MATERIAL IS REQUIRED.

PLATE 1 PLAN-PROFILE O., P., R. & R. E. STANDARD
DIETZGEN CORPORATION
PRINTED IN U.S.A.

PROJECT:

CHOLLA LANDFILL SITE - EL MIRAGE, ARIZONA

PROPOSED RIP-RAP BANK STABILIZATION & LEVEE REPAIR

TITLE: DOWNSTREAM LEVEE REPAIR & ALTERNATIVE LEVEE (STA.35+00± TO STA.51+00±)

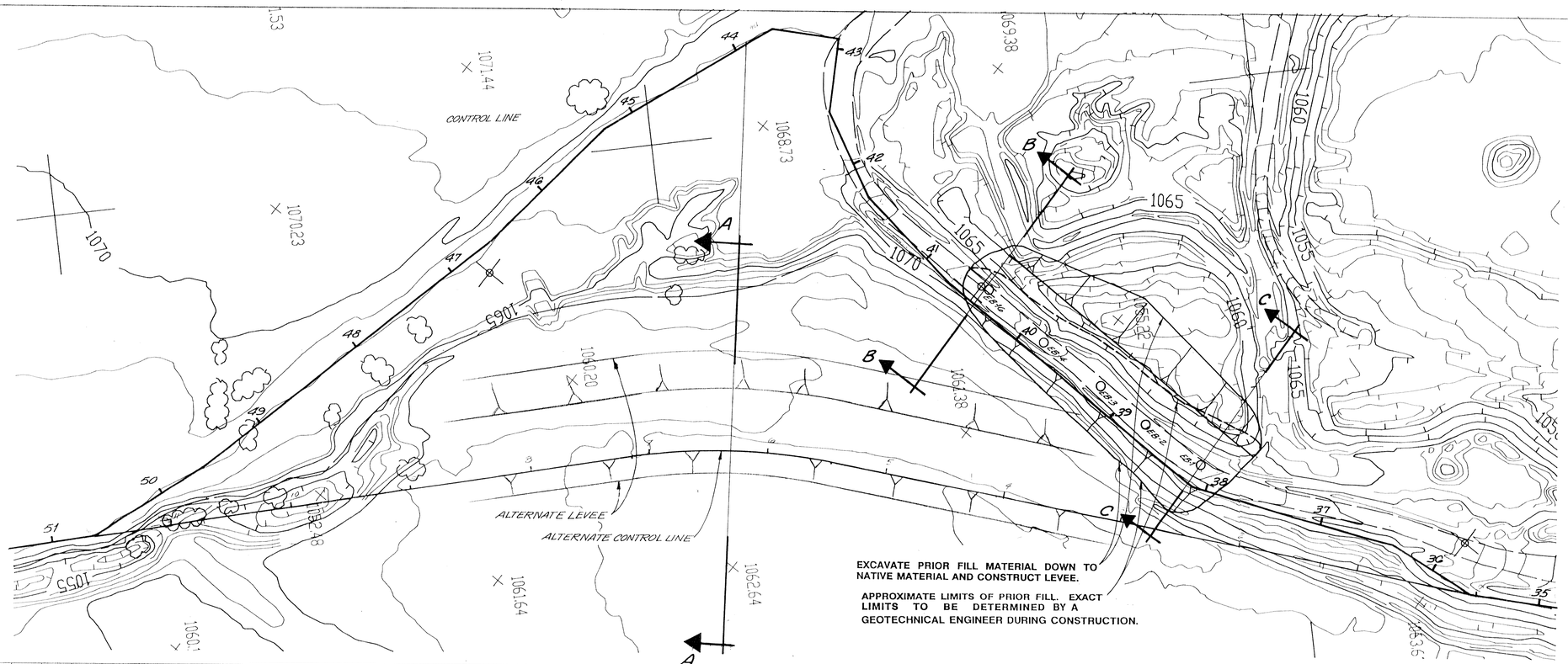
DRWG. NO. 5 of 6

MATHEWS KESSLER & ASSOCIATES, INC.
architecture · engineering · planning
4045 E. McDOWELL ROAD, PHOENIX, ARIZONA 85008-4405
602/241-2684

PROJECT NO. 8017

SCALE: AS SHOWN DATE: 12/89

DRAWN BY WB CHECKED BY RLS



NOTE: DATUM ADJUSTMENT

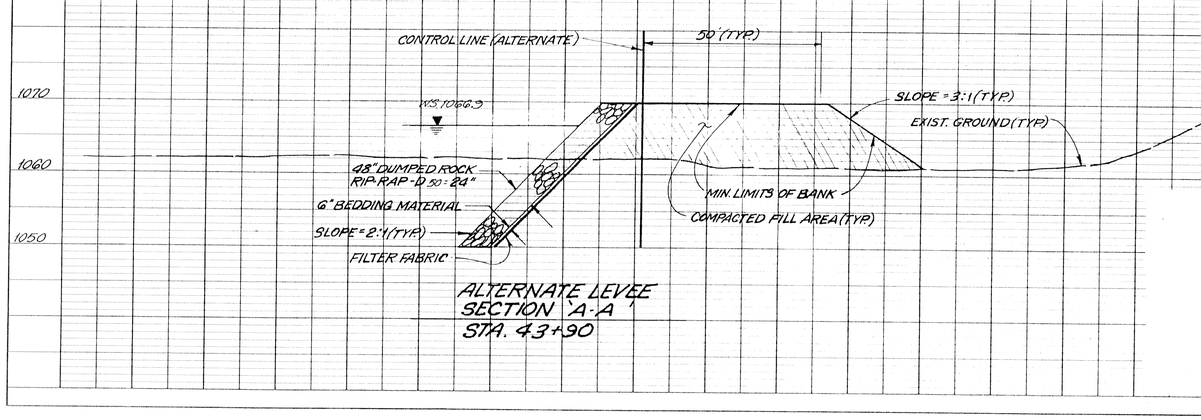
Due to datum differences between the flood insurance study from which water surface profiles were taken and the topography from which all other elevations were taken, an equation has been applied to the water surface elevations. For purposes of this design, 1.7 ft. has been subtracted from all water surface profile elevations to provide compatibility with the corresponding topography.

LEGEND

- NATIVE MATERIAL ELEVATION BASED ON BORINGS. ACTUAL LIMITS OF EXCAVATION AND ENGINEERED BACKFILL TO BE DETERMINED BY A GEOTECHNICAL ENGINEER DURING CONSTRUCTION.
- WATER SURFACE 100 YEAR FLOODPLAIN
- EXISTING GROUND
- 38 37 CONTROL LINE (STATIONING)
- EB-2 TEST BORING LOCATION

SCALE: PLAN 1"=50'

PROFILE 1"=20' HORIZ. 1"=10' VERT.



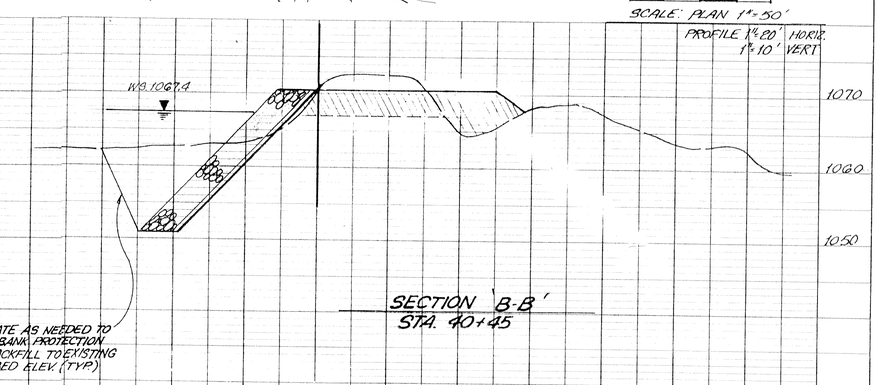
ALTERNATE LEVEE
SECTION 'A-A'
STA. 43+90

RIP-RAP AND FILTER FABRIC SHALL CONFORM TO FEDERAL HIGHWAY ADMINISTRATION PUBLICATION NO. FHWA-IP-89-016 RECOMMENDATIONS AS STATED IN SECTIONS 4.2, 4.4.2 AND 7.1.3

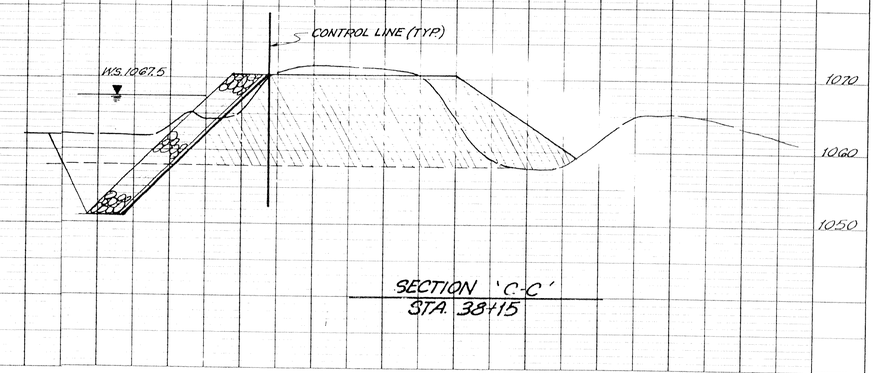
BEDDING MATERIALS SHALL CONFORM TO ADOT STD. SPEC. 913-2.03 AND 913-3.02

EMBANKMENT SHALL CONFORM TO ADOT STD. SPEC. 203-9 AND 203-10

ALL EXCAVATION FOR RIP-RAP SHALL BE BACKFILLED TO THE APPROXIMATE GRADE OF THE EXISTING RIVERBED. NO SPECIAL COMPACTION OF THIS MATERIAL IS REQUIRED.



SECTION 'B-B'
STA. 40+45



SECTION 'C-C'
STA. 38+15

PLATE 1 PLAN-PROFILE O. P. B. & R. E. STANDARD
DIETZGEN CORPORATION
PRINTED IN U.S.A.

CHOLLA LANDFILL SITE - EL MIRAGE, ARIZONA
PROPOSED RIP-RAP BANK STABILIZATION & LEVEE REPAIR

SHEET 5

PROJECT:
CHOLLA LANDFILL SITE - EL MIRAGE, ARIZONA
PROPOSED RIP-RAP BANK STABILIZATION & LEVEE REPAIR

TITLE: PLAN & PROFILE
STA.27+00 TO STA.50+00

DRWG. NO. 2 of 6

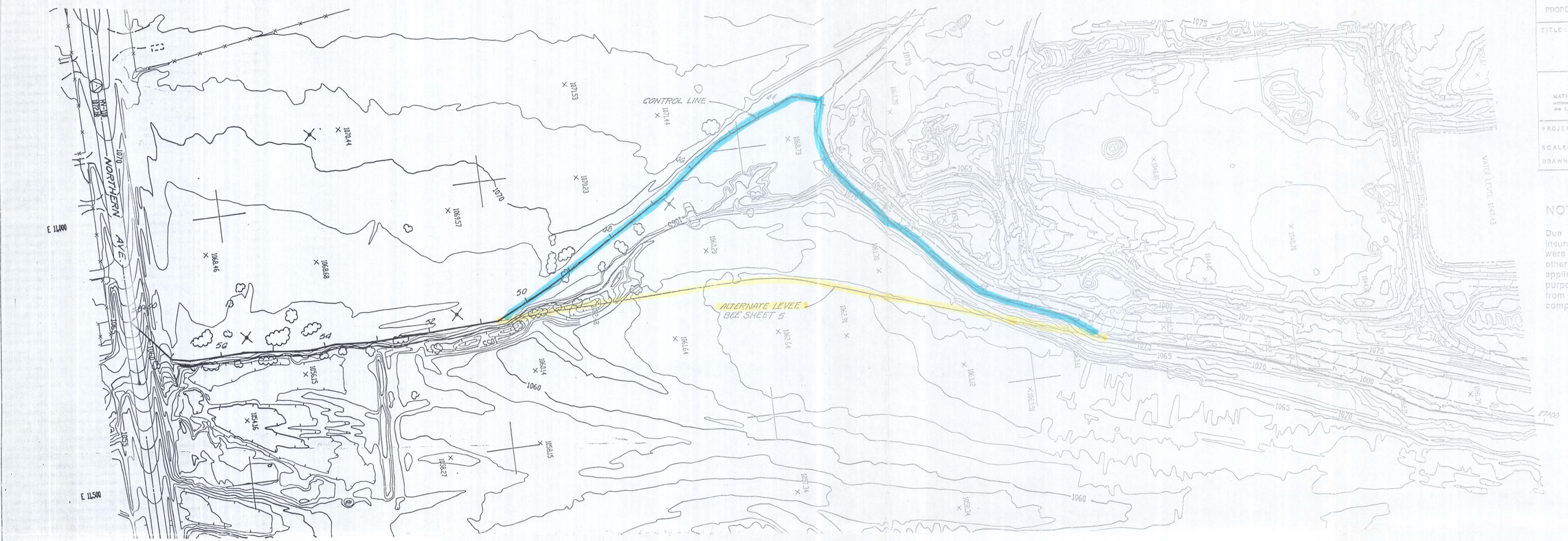
MATHEWS KESSLER & ASSOCIATES, INC.
ENGINEERING — PLANNING
1836 E. INDIANOLA ROAD, PHOENIX, ARIZONA 85006-4401
602/264-2064

PROJECT NO. 3017
SCALE: AS SHOWN DATE: 12/89
DRAWN BY WB CHECKED BY MK

Exhibit 5

NOTE: DATUM ADJUSTMENT

Due to datum differences between the flood insurance study from which water surface profiles were taken and the topography from which all other elevations were taken, an equation has been applied to the water surface elevations. For purposes of this design, 1.7 ft. has been subtracted from all water surface profile elevations to provide compatibility with the corresponding topography.



SCALE: HORIZ. 1"=100'
VERT. 1"=5'

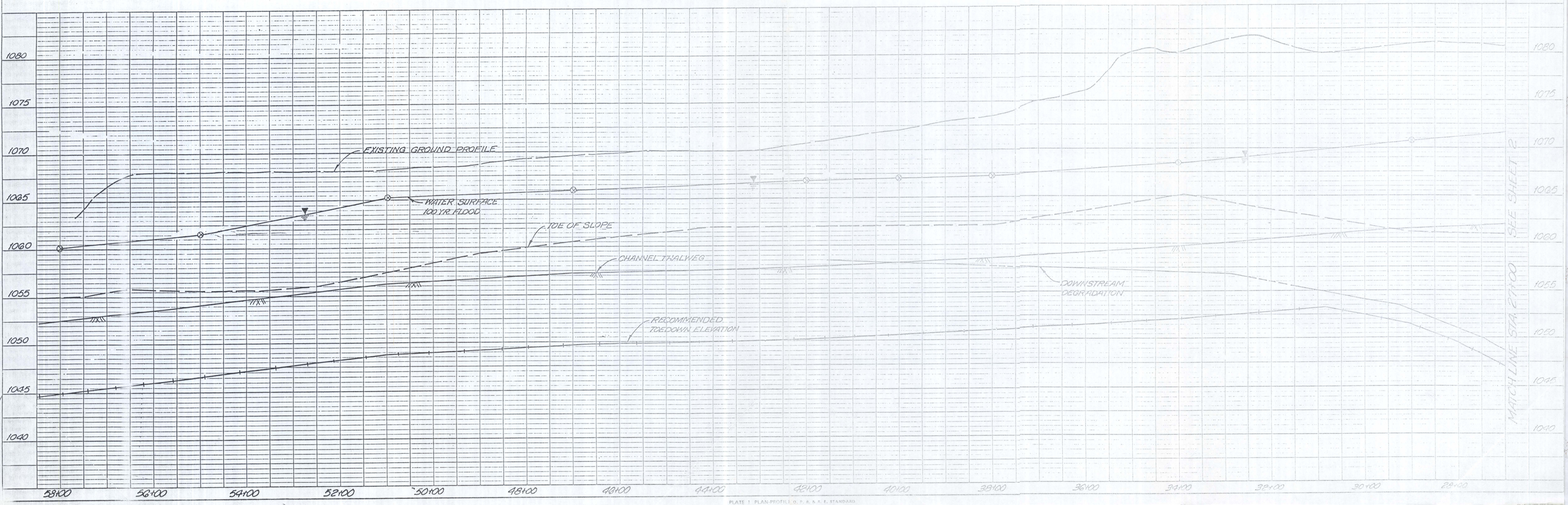


PLATE 1 PLAN-PROFILE O. P. & N. R. R. STANDARD
INSTITUTE CORPORATION