



Defense Special Weapons Agency
Alexandria, VA 22310-3398



DNA-TR-93-133

Underground Technology Program Test Adit Construction

James B. Beck
C. Richard Linamen
Lachel and Associates, Inc.
P.O. Box 10652
McLean, VA 22102-9652

DTIC QUALITY INSPECTED

November 1996

Technical Report

CONTRACT No. DNA 001-92-C-0051

Approved for public release;
distribution is unlimited.

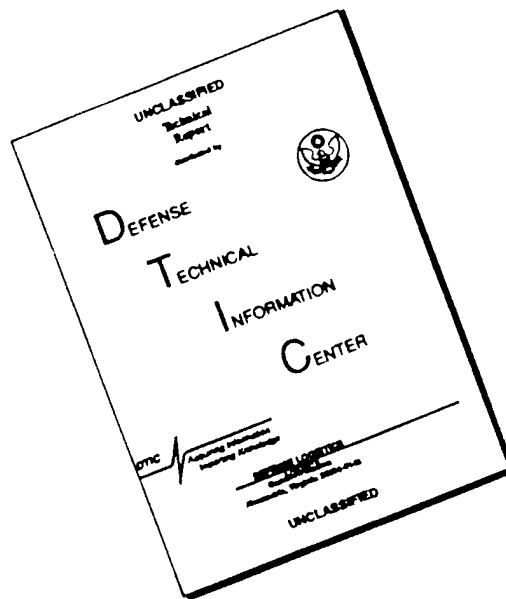
19961216 051

Destroy this report when it is no longer needed. Do not return to sender.

PLEASE NOTIFY THE DEFENSE NUCLEAR AGENCY,
ATTN: CSTI, 6801 TELEGRAPH ROAD, ALEXANDRIA, VA
22310-3398, IF YOUR ADDRESS IS INCORRECT, IF YOU
WISH IT DELETED FROM THE DISTRIBUTION LIST, OR
IF THE ADDRESSEE IS NO LONGER EMPLOYED BY YOUR
ORGANIZATION.



DISCLAIMER NOTICE



THIS DOCUMENT IS BEST QUALITY AVAILABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

DISTRIBUTION LIST UPDATE

This mailer is provided to enable DSWA to maintain current distribution lists for reports. (We would appreciate your providing the requested information.)

- ☐ Add the individual listed to your distribution list.
- ☐ Delete the cited organization/individual.
- ☐ Change of address.

NOTE:

Please return the mailing label from the document so that any additions, changes, corrections or deletions can be made easily. For distribution cancellation or more information call DSWA/IMAS (703) 325-1036.

NAME: _____

ORGANIZATION: _____

OLD ADDRESS

CURRENT ADDRESS

TELEPHONE NUMBER: () _____

DSWA PUBLICATION NUMBER/TITLE

CHANGES/DELETIONS/ADDITIONS, etc.) (Attach Sheet if more Space is Required)

DSWA OR OTHER GOVERNMENT CONTRACT NUMBER: _____

CERTIFICATION OF NEED-TO-KNOW BY GOVERNMENT SPONSOR (if other than DSWA):

SPONSORING ORGANIZATION: _____

CONTRACTING OFFICER OR REPRESENTATIVE: _____

SIGNATURE: _____

CUT HERE AND RETURN



DEFENSE SPECIAL WEAPONS AGENCY
ATTN: IMAS
6801 TELEGRAPH ROAD
ALEXANDRIA, VA 22310-3398

DEFENSE SPECIAL WEAPONS AGENCY
ATTN: IMAS
6801 TELEGRAPH ROAD
ALEXANDRIA, VA 22310-3398

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503

1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE 961101	3. REPORT TYPE AND DATES COVERED Technical 920728 - 940831	
4. TITLE AND SUBTITLE Underground Technology Program: Test Adit Construction			5. FUNDING NUMBERS C - DNA 001-92-C-0051 PE - 62715H PR - AC TA - AB WU - DH322770	
6. AUTHOR(S) James E. Beck and C. Richard Linamen				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Lachel and Associates, Inc. P. O. Box 10652 McLean, VA 22102-9652			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Defense Special Weapons Agency 6801 Telegraph Road Alexandria, VA 22310-3398 PMT/Senseny			10. SPONSORING/MONITORING AGENCY REPORT NUMBER DNA-TR-93-133	
11. SUPPLEMENTARY NOTES This work was sponsored by the Defense Special Weapons Agency under RDT&E RMC Code B 4662 D AC AB 00010 4300 A AC 25904D.				
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) This report describes the geotechnical investigation, design and construction of a test adit which was built to support the Defense Special Weapons Agency's Underground Technology Program experiments for predicting the effects of conventional munitions on tunnels.				
14. SUBJECT TERMS Tunnels Underground Shale Test Sites			15. NUMBER OF PAGES 388	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT SAR	

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

CLASSIFIED BY:

N/A since Unclassified

DECLASSIFY ON:

N/A since Unclassified

SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

SUMMARY

This report describes the geotechnical investigation, design, and construction of a test adit which was built to support the Defense Nuclear Agency's Underground Technology Program experiments for predicting the effects of conventional munitions on tunnels.

The geotechnical investigation includes preconstruction geologic exploration, geologic mapping, gas detection, and soil and rock hydrology. The information provided is also the result of on-site inspection, quality control review, and instrumentation of ground support areas, all performed during the course of construction.

The contractor's methods of construction are also examined, as are the remedial methods taken when methane gas was encountered during the course of construction.

PREFACE

This report documents work performed as part of the DNA Underground Technology Program, and was funded under contract DNA001-92-C-0051. The DNA Project Managers were Major Curt Krieser and Paul Senseny. The Army Corps of Engineers, Louisville District, inspectors were Mr. Tony Hamblin and Mr. Steve Duncan. The Waterways Experiment Station (WES) Site Manager was Mr. David Ward.

For Lachel and Associates: Mr. James E. Beck was in charge of overall project management; Mr. Lawrence Eckert and Mr. Ghailan Alsayab provided the geologic and tunnel engine-ring field work; Mr. Dennis Lachel and Mr. Rich Linamen provided the off-site tunnel engineering support; and Mr. Gunnar J. Radel reviewed and edited the final report.

Detailed information on the preconstruction geologic explorations and investigations can be found in Volumes 2 and 3 of the "Solicitation for Underground Technology Program, Test Adit Construction, 1992" which contains the Geotechnical Design Summary Report prepared by Lachel and Associates.

CONVERSION TABLE

Conversion factors for U.S. Customary to metric (SI) units of measurement.

MULTIPLY → BY → TO GET
TO GET ← BY ← DIVIDE

angstrom	1.000 000 X E -10	meters (m)
atmosphere (normal)	1.013 25 X E +2	kilo pascal (kPa)
bar	1.000 000 X E +2	kilo pascal (kPa)
barn	1.000 000 X E -28	meter ² (m ²)
British thermal unit (thermochemical)	1.054 350 X E +3	joule (J)
calorie (thermochemical)	4.184 000	joule (J)
cal (thermochemical/cm ²)	4.184 000 X E -2	mega joule/m ² (MJ/m ²)
curie	3.700 000 X E +1	*giga becquerel (GBq)
degree (angle)	1.745 329 X E -2	radian (rad)
degree Fahrenheit	$t_F = (t_C + 459.67)/1.8$	degree kelvin (K)
electron volt	1.602 19 X E -19	joule (J)
erg	1.000 000 X E -7	joule (J)
erg/second	1.000 000 X E -7	watt (W)
foot	3.048 000 X E -1	meter (m)
foot-pound-force	1.355 818	joule (J)
gallon (U.S. liquid)	3.785 412 X E -3	meter ³ (m ³)
inch	2.540 000 X E -2	meter (m)
jerk	1.000 000 X E +9	joule (J)
joule/kilogram (J/kg) radiation dose absorbed	1.000 000	Gray (Gy)
kilotons	4.183	terajoules
kip (1000 lbf)	4.448 222 X E +3	newton (N)
kip/inch ² (ksi)	6.894 757 X E +3	kilo pascal (kPa)
ktop	1.000 000 X E +2	newton-second/m ² (N-s/m ²)
micron	1.000 000 X E -6	meter (m)
mil	2.540 000 X E -5	meter (m)
mile (international)	1.609 344 X E +3	meter (m)
ounce	2.834 952 X E -2	kilogram (kg)
pound-force (lbs avoirdupois)	4.448 222	newton (N)
pound-force inch	1.129 848 X E -1	newton-meter (N·m)
pound-force/inch	1.751 268 X E +2	newton/meter (N/m)
pound-force/foot ²	4.788 026 X E -2	kilo pascal (kPa)
pound-force/inch ² (psi)	6.894 757	kilo pascal (kPa)
pound-mass (lbm avoirdupois)	4.535 924 X E -1	kilogram (kg)
pound-mass-foot ² (moment of inertia)	4.214 011 X E -2	kilogram-meter ² (kg·m ²)
pound-mass/foot ³	1.601 846 X E +1	kilogram/meter ³ (kg/m ³)
rad (radiation dose absorbed)	1.000 000 X E -2	**Gray (Gy)
roentgen	2.579 760 X E -4	coulomb/kilogram (C/kg)
shake	1.000 000 X E -8	second (s)
slug	1.459 390 X E +1	kilogram (kg)
torr (mm Hg, 0° C)	1.333 22 X E -1	kilo pascal (kPa)

*The becquerel (Bq) is the SI unit of radioactivity; 1 Bq = 1 event/s.

**The Gray (GY) is the SI unit of absorbed radiation.

TABLE OF CONTENTS

Section	Page
SF298	i
SUMMARY	iii
PREFACE	iv
CONVERSION TABLE	v
FIGURES	x
TABLES	xi
 1 INTRODUCTION	 1
1.1 UNDERGROUND TECHNOLOGY PROGRAM	1
1.2 TEST ADIT CONSTRUCTION	1
1.3 REPORT ORGANIZATION	1
 2 PROJECT DESCRIPTION	 5
2.1 GENERAL	5
2.2 AS-BID PROJECT CONFIGURATION	5
2.2.1 Site Work.	5
2.2.2 Portal Structures	7
2.2.3 Main Adit.	7
2.2.4 Calibration Adit and Drift	11
2.2.5 Ground Support	11
2.2.6 Electrical and Mechanical Systems.	15
2.3 CHANGES DURING CONSTRUCTION	15
2.3.1 Contractor Initiated Changes	15

TABLE OF CONTENTS (Continued)

Section	Page
2.3.2 Owner Initiated Changes	17
2.3.3 Differing Site Condition.	17
3 GEOLOGY	23
3.1 GENERAL SITE AREA	23
3.2 ADIT GEOLOGY.	25
3.3 FIELD EXPLORATION PROGRAM	29
3.3.1 Core Drilling	31
3.3.2 Geologic Discontinuities	31
3.3.3 Hydraulic Testing and Water Sampling.	33
3.3.4 Geophysical Survey.	37
3.3.5 Formation Gas Detection	37
3.4 UNDERGROUND GEOLOGIC MAPPING	39
3.5 SITE HYDROGEOLOGY	41
3.5.1 Soil Water	41
3.5.2 Rock Hydrology	41
3.5.2.1 Shale Hydrology.	43
3.5.2.2 Louisville Carbonate Hydrology.	43
3.5.2.3 Deep (Laurel) Hydrology	43
3.6 HYDROLOGIC MONITORING.	43
4 CONSTRUCTION METHODS	45
4.1 GENERAL	45
4.2 PORTAL CONSTRUCTION	45

TABLE OF CONTENTS (continued)

Section	Page
4.3 ADIT CONSTRUCTION	47
4.4 GROUND SUPPORT	49
4.5 GROUNDWATER CONTROL	51
5 INSTRUMENTATION	
5.1 TAPE EXTENSOMETERS	53
5.2 SINGLE POINT BOREHOLE EXTENSOMETERS	53
6 REFERENCES	55
 APPENDICES	
A GEOLOGIC CORE LOGS	A-1
B ROCK TEST RESULTS	B-1
C GEOLOGIC MAPS	C-1
D PHOTOGRAPHS	D-1

FIGURES

Figure		Page
1-1	Location Map	xi
2-1	Project Site Plan.	3
2-2	Portal Construction	5
2-3	Portal U-Wall	7
2-4	Portal Section.	8
2-5	As-Bid Plan & Profile	9
2-6	Tunnel Supports	11
2-7	Tunnel Supports	13
2-8	Revised Cal Adit Plan & Profile	15
2-9	Revised Cal Adit	17
2-10	Gas Containment Plug.	19
2-11	As-Built Plan & Profile.	20
3-1	Rodgers Hollow Area	21
3-2	Stratigraphic Column of Ft. Knox UTP Area of North Central Kentucky	23
3-3	Maximum Advance of Glaciers In Ft. Knox Region	25
3-4	Geologic Profile Along Adit Centerline.	26
3-5	New Site Plan With All Borings Shown	28
3-6	Formation Gas Log for Boring GTB-1	35
3-7	Typical Profile of Installed Piezometers	38
3-8	Location Map of Installed Piezometers	40
4-1	Tunnel Excavation Weekly Progress	42

TABLES

Table		Page
3-1	Summary of Aquifer Water Quality	31
3-2	Coefficients of Transmissibility and Storage Active Pumping Phase GTB-1	33
3-3	Coefficients of Transmissibility Passive Recovery Phase GTB-1	33
4-1	Summary of Utilized Permanent Support	46

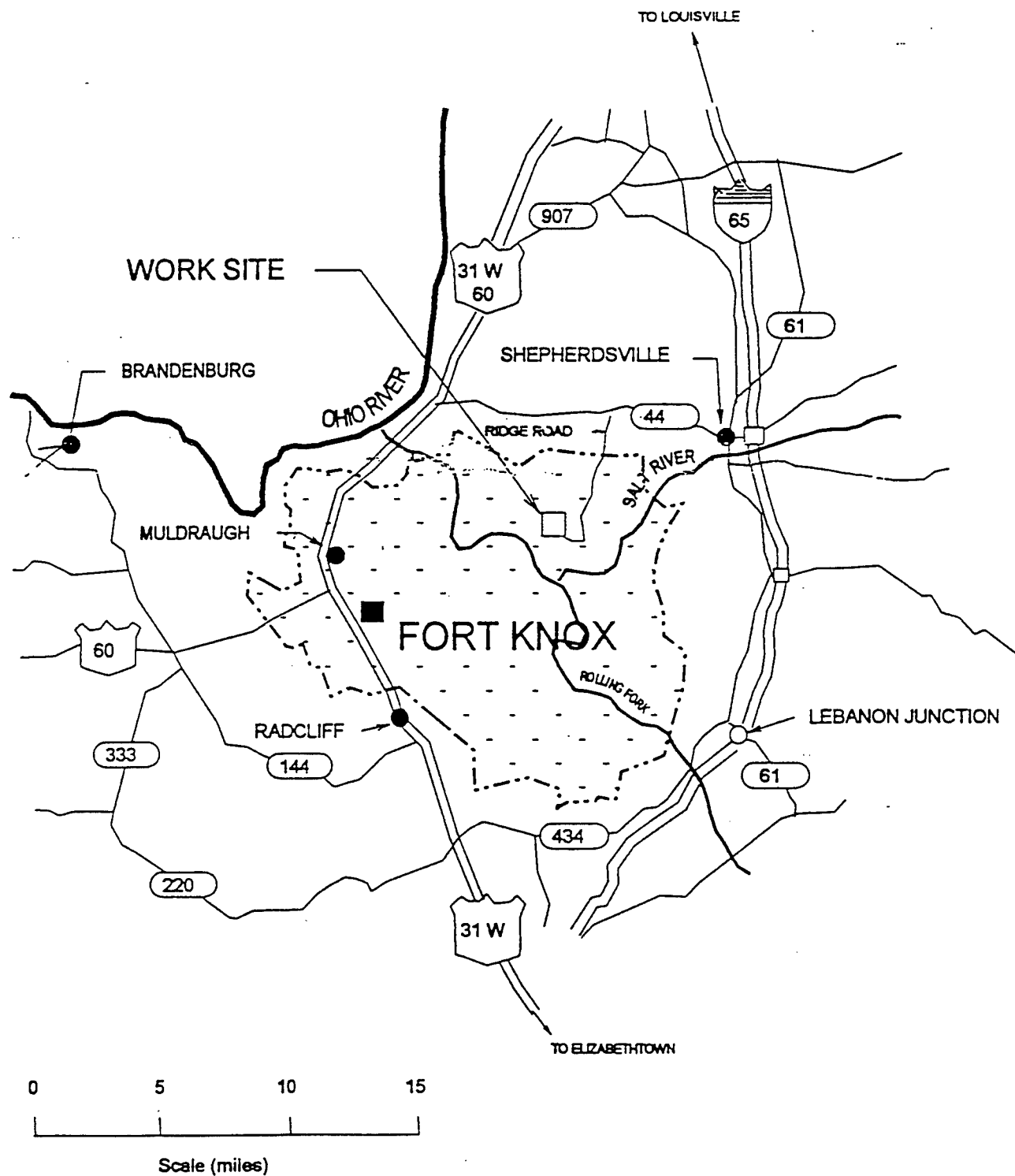


Figure 1-1. Location Map.

SECTION 1

INTRODUCTION

1.1 UNDERGROUND TECHNOLOGY PROGRAM.

The Underground Technology Program (UTP) is a part of the Government's continuing research to evaluate the lethality effects of dynamic loads on underground structures, and to develop a high-confidence method for predicting these effects. This method is being developed through both theoretical and analytical activities, combined with field tests and experimental activities. This research is sponsored by the Defense Nuclear Agency (DNA).

1.2 TEST ADIT CONSTRUCTION.

As part of the overall Underground Technology Program, DNA is developing an underground high explosive test bed at the Rodgers Hollow Area, Fort Knox, Kentucky, to support field tests and experimental activities. The test adit construction contract is the first phase in developing the test bed. Rodgers Hollow is located on the Fort Knox Military Reservation approximately 7.4 miles west-southwest of Shepherdsville, Kentucky, in Bullitt County. The Rodgers Hollow geographic coordinates are 37° 56' 57.40308" North and 85° 50' 34.56814" West at an elevation approximately 490 feet above mean sea level (MSL). The site location plan is shown in Figure 1-1.

The test adit was constructed by W. L. Hailey and Company, Inc. of Nashville, Tennessee under U.S. Army Corps of Engineers contract DACA27-92-R-0003 administered by the U.S. Army Corps of Engineers, Louisville District. LACHEL and Associates, Inc. of Golden, Colorado performed the tunnel design, prepared the contract drawings and specifications, and provided onsite geotechnical assistance during the construction period. The U.S. Army Corps of Engineers Waterways Experimental Station (WES) provided overall program management for the UTP and site management of the Rodgers Hollow test site.

1.3 REPORT ORGANIZATION.

This report is divided into six sections and appendices. This introduction (Section 1) is followed by a description of the test adit construction project (Section 2) and changes to the original adit design. Section 3 describes the geology and hydrology of the Rodgers Hollow site. Section 4 describes construction methods and

production rates. Section 5 describes the tunnel instrumentation, and Section 6 is a list of references. The Appendices A through D contain the geologic core logs, rock test results, geologic maps, and photographs, respectively.

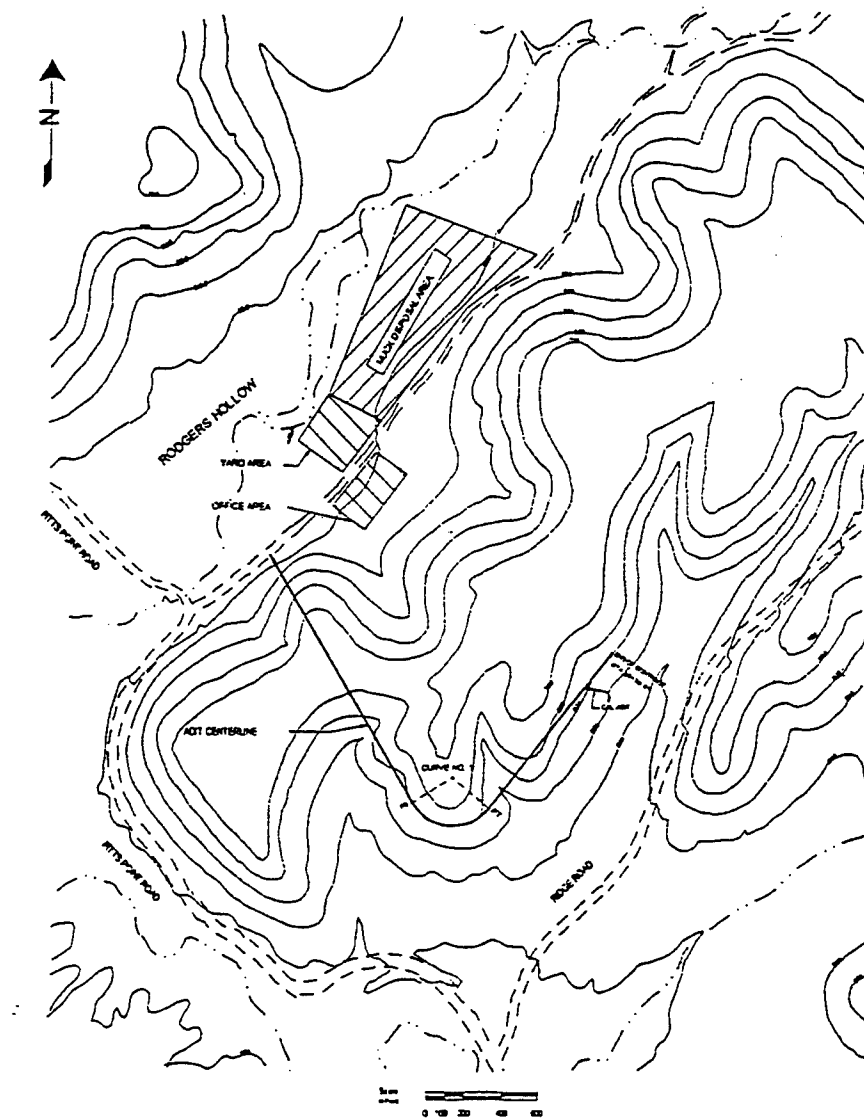


Figure 2-1. Project Site Plan.

SECTION 2

PROJECT DESCRIPTION

2.1 GENERAL.

The UTP Test Adit Construction contract was designed to provide access to the test bed located in the Louisville Formation, approximately 300 feet below the floor of Rodgers Hollow. The major items of work required by the contract included surface site work, one flood protection structure, 36 feet of cut-and-cover portal structure, 3,035 feet of 12 foot by 12 foot adit, 100 feet of 8 foot by 8 foot adit, four enlargements in tunnel cross section, and electrical, ventilation and dewatering systems.

A Request for Proposals (RFP) was issued in May, 1992, which required the submission of a two-part proposal, Technical and Cost, in separate envelopes. The cost proposal was a firm fixed price based on contractor developed unit prices for a schedule of bid items included in the RFP. The proposals were evaluated first on technical merit, and then on cost. A total of ten proposals were received in June, 1992, ranging in value from a low of \$3.8 million to a high of \$8.0 million. After evaluating the Technical Proposals, establishing a competitive range, and determining the most advantageous proposal to the Government, a contract was awarded to W. L. Hailey & Co., Inc. in July 1992, for an approximate value of \$4,665,000.

2.2 AS-BID PROJECT CONFIGURATION.

2.2.1 Site Work.

As part of the test adit construction, the contractor was required to provide and upgrade surface site facilities. Included in this item are the upgrading of the gravel road in Rodgers Hollow, providing office trailers, parking areas, contractor's laydown areas, clearing and grubbing for the portal, muck disposal, the installation of sediment control tanks, and 6,800 feet of surface discharge water line. Figure 2-1 shows the original site layout. Also included in this item of work was the providing of normal site services and maintenance such as furnishing potable water, sewage disposal, trash removal, guard service, the cleaning of offices and yard areas, and the supply and distribution of electrical power on surface.

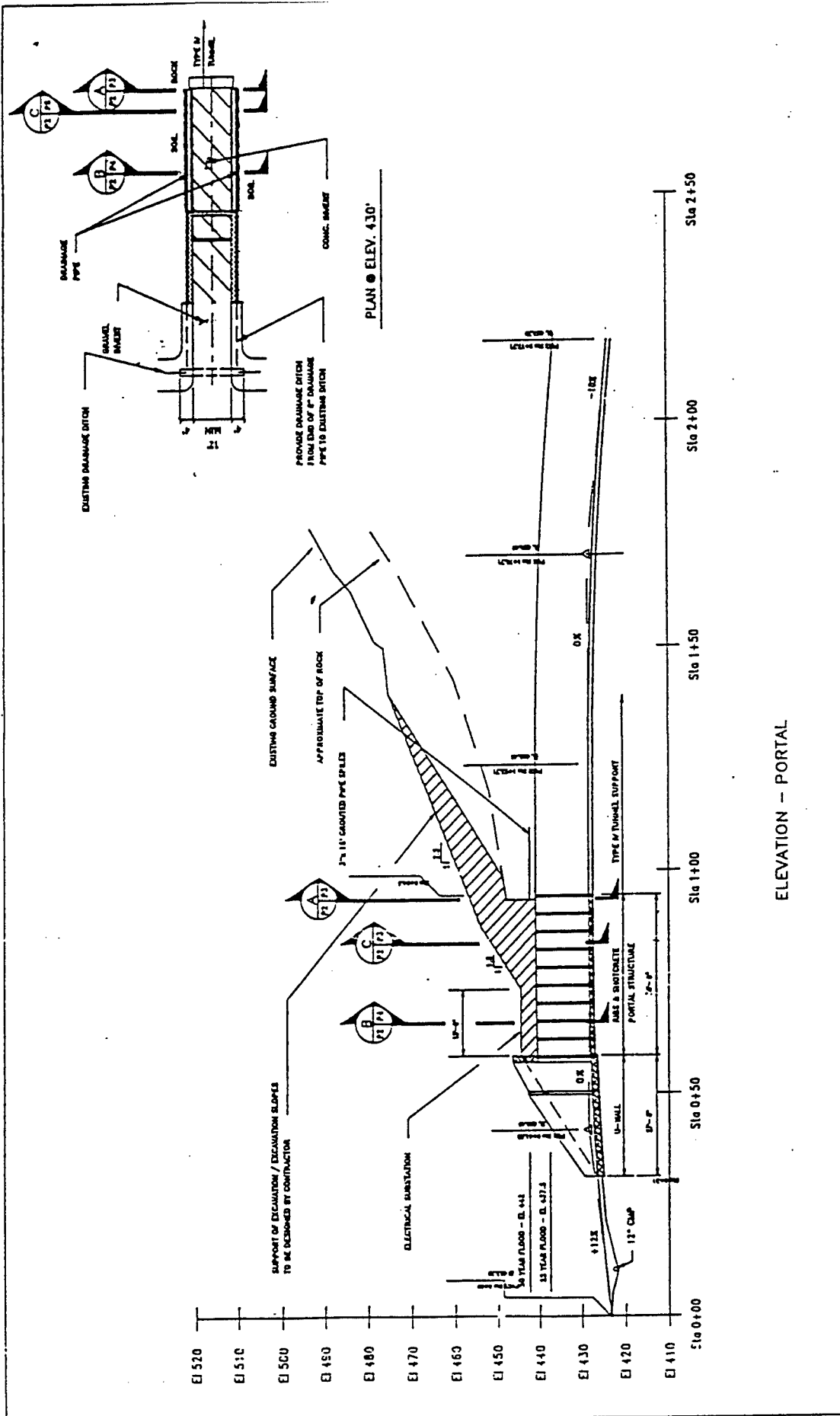


Figure 2-2. Portal Construction.

2.2.2 Portal Structures .

The portal to the test adit is comprised of two sections, a flood protection structure, and a cut-and-cover tunnel section, as shown in Figure 2-2 opposite. The flood protection structure, from Station 0+31 to Station 0+58, is a U-shaped reinforced concrete structure with removable timber stop logs (shown on Figure 2-3 on the next page). During normal operation of the site, the stop logs are removed and the structure provides unimpeded access to the portal. During flood events of the Salt River basin, the stop logs are installed in the cast-in-place guides, and an temporary earth dike is constructed in front of the stop logs to provide flood protection for the tunnel adit for a 50 year flood. When the stop logs are in place, access to the tunnel for both men and tunnel utilities is provided via the open area between the stop logs and the concrete portal at Station 0+58.

The cut-and-cover portal structure, from Station 0+58 to Station 0+94, consists of a 6 inch thick wire reinforced shotcrete with horseshoe shaped, steel arch sections (W6x25s) 4 feet on center and a 1 foot thick reinforced concrete slab at the tunnel invert. The outside of the structure is coated with an asphaltic dampproofing. A 6 inch perforated drain pipe is provided at the base of the wall on either side to prevent surface water from entering the tunnel. Figure 2-4, which follows, provides details of the structure. The portal was constructed in an open cut in the side of the hill and backfilled with structural material prior to commencing tunneling operations.

2.2.3. MAIN ADIT .

The main adit consists of 2,935 feet of 12 foot wide by 13 foot high, straight legged, horseshoe-shaped tunnel which commences at Station 0+94 and progresses downgrade on a 10 per cent slope to Station 30+29. It penetrates completely through the New Providence and New Albany Shales and terminates in the middle of the Louisville Formation, 286 feet below the portal elevation and approximately 458 feet below the top of the hill (see Figure 2-5 on page 9). The main adit alignment consists of two tangent sections, at bearings S31°06'53"E and N39°18'46"E, and a 250 foot radius curve.

A total of four widened areas or bays were required to be excavated within the main adit. The tunnel width increased to 17 feet in the bay areas to accommodate permanent electrical and mechanical equipment. Two of these bays were for electrical transformers and circuit panels, which are located at Station 15+00 and Station 29+73, and offset to the right of tunnel centerline. The other two bays contain dewatering sump boxes and pumps and are located at Station 14+56 and Station 30+17, and are offset to the left of the

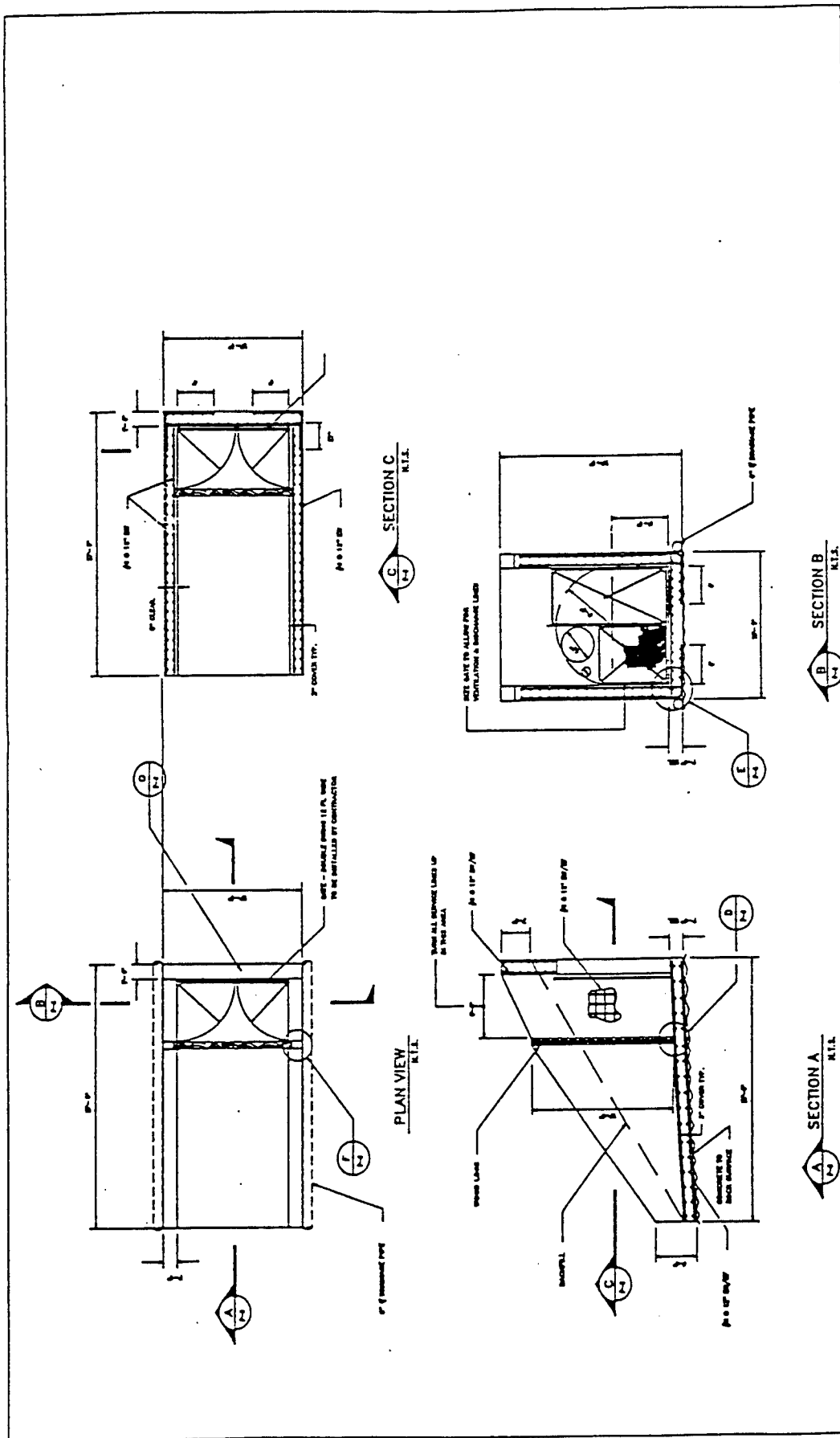


Figure 2-3. Portal U-Wall.

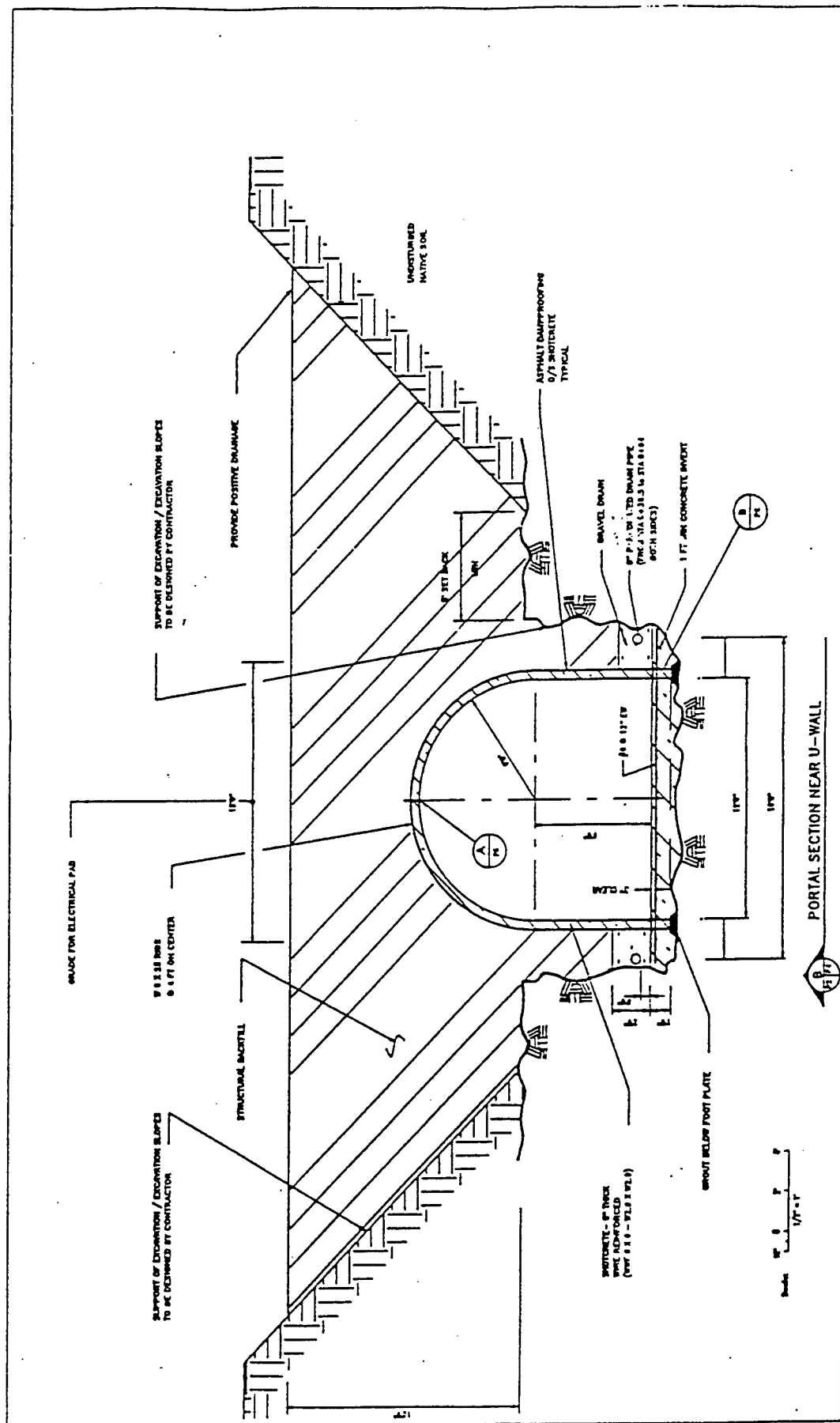


Figure 2-4. Portal Section.

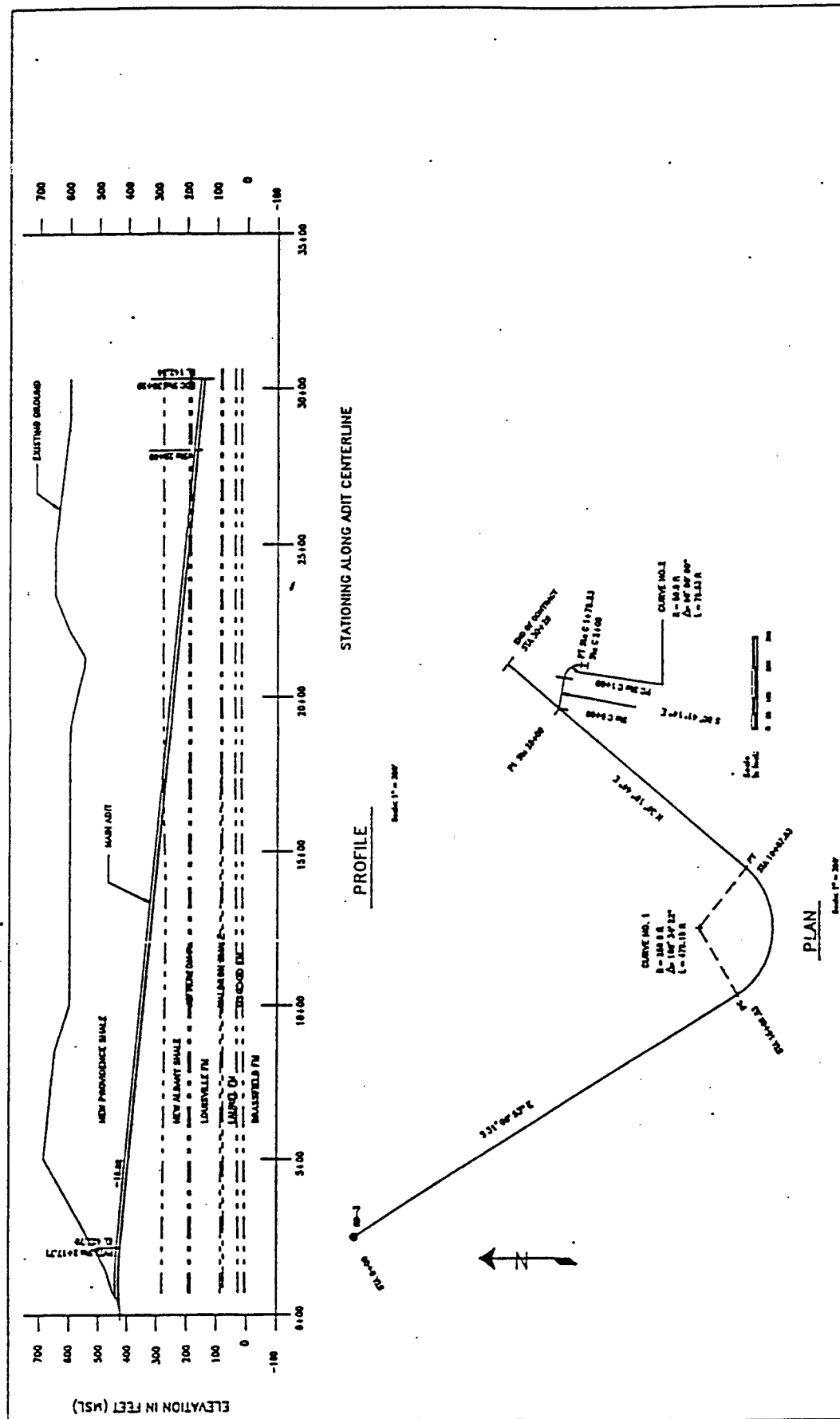


Figure 2-5. As-Bid Plan & Profile.

tunnel centerline. The design configuration of the main adit included a 12 inch thick gravel invert and a permanent lining of 2 inches of shotcrete in the shale formations, and chain link fabric in the top 120° of the crown in the limestone formations.

2.2.4 Calibration Adit and Drift.

The calibration adit forms a Y-intersection with the main adit at Station 28+00 and progresses on a S80°41'14"E bearing away from the main adit. This adit is a 12 foot wide by 13 foot high tunnel similar in cross section and configuration to the main adit and extends from Station C 0+00 to C 1+00. At Station C 1+00, the cross section reduces to an 8 foot wide by 8 foot high drift which continues to the termination of the drift at Station C 2+00. The drift is not lined with shotcrete or chain link fabric, nor does it have a gravel invert.

2.2.5 Ground Support .

The design of the permanent tunnel support was based on data obtained through the geotechnical explorations conducted at the site as detailed in Section II of the GEOTECHNICAL DESIGN SUMMARY REPORT (Reference 2) included in Vol. 2 of the "Solicitation for the Underground Technology Program Test Adit Construction", and summarized in Section 3 of this report. The primary basis for the design of tunnel support was the Norwegian Geotechnical Institute (NGI) Q-system which is a quantitative design method based on the evaluation of hundreds of tunnels. The method considers a variety of parameters that are known to affect tunnel stability.

The initial ground support calculations, based on the data obtained during the geotechnical investigation, indicated that the formations to be excavated (the New Providence Shale, the New Albany Shale, and the Louisville Carbonate) required only minimal support, for example, spot bolting in localized areas. However, it is recognized that even the best geotechnical investigation can only identify those features which are intersected by the borings, and that subsurface conditions between borings may vary considerably. Therefore, it was decided to provide four tunnel support designs in the contract to accommodate the likely variations in ground conditions which might be encountered during construction. As the tunnel was excavated, the actual ground conditions encountered were evaluated by a geotechnical engineer familiar with the design requirements, and the most appropriate tunnel support design was selected for each region. This approach allows the contractor the greatest flexibility in constructing the tunnel while affording the owner the lowest cost alternative based on the actual conditions encountered.

In determining the permanent ground support requirements, the rock mass characteristics developed during the geotechnical investigation were the primary factors considered in the design. However, additional factors such as extent of weathering, proximity to the surface, material durability, and dynamic loading from the future test events were also considered in determining the final support requirements. Based on the evaluation of rock mass characteristics and future use of the site, four types of tunnel support were selected for use in the contract. The support methods included: Type I Support, spot rock bolts (Number 8 by 8 foot long) with a 2 inch minimum thickness of non-reinforced shotcrete; Type II Support, pattern rock dowels (No. 8 by 8 foot long) with a 2 inch minimum thickness of non-reinforced shotcrete; Type III Support, pattern rock dowels (No. 8 by 8 foot long at 4 foot on center) with chain link fabric in the top 120° of crown; and Type IV Support, W6x25 steel sets at 4 foot center-to-center spacing. While the exact locations for each type of support were not determined at the time of bid, the contract provided an estimate of the quantity of each type for bidding purposes. These ground support methods are depicted in Figure 2-6, (Type I and II) and Figure 2-7 on the following page, (Type III and IV).

In addition to the main adit support designs detailed above, permanent ground support designs for the two transformer bays, two sump bays and the Calibration Adit intersection were specified in the contract. This consisted of pattern rock bolts (No. 8 by 10-foot long 4 foot on center) and a 2 inch thickness of non-reinforced shotcrete for the four bays, and a 4 inch thickness of wire reinforced shotcrete for the Calibration Adit intersection.

In the shale formations, the anticipated primary failure mode was the deterioration of the rock surface due to moisture loss, commonly referred to as air slaking, which causes the rock to ravel (disintegrate into pieces). To prevent this deterioration, a 2 inch minimum thickness of shotcrete was specified throughout the shale formations, and it was necessary to seal the shale with shotcrete within 24 hours of exposure to the atmosphere. In order to facilitate the tunnel advance and reduce the cost of the project, the specifications allowed the shale to be covered with a air-excluding sealant within the first 24 hours of exposure to temporarily protect the rock surface from deterioration or air slaking. The permanent shotcrete lining was then applied some distance behind the advancing face, effectively removing it from the daily mining cycle and allowing the contractor to utilize a separate and more efficient operation.

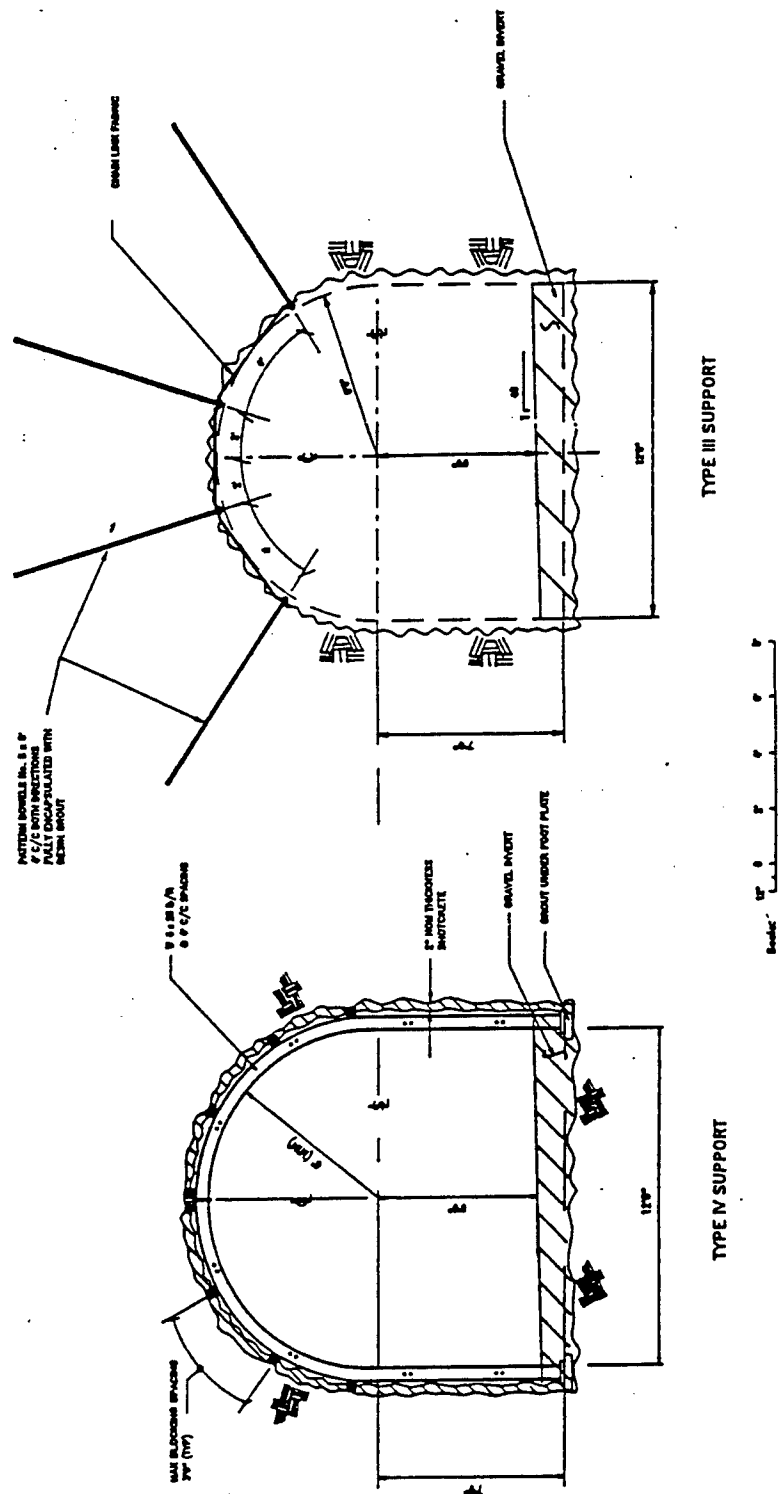


Figure 2-7. Tunnel Supports.

2.2.6. Electrical and Mechanical Systems .

The contract included a permanent electrical power distribution and lighting system for both the surface and underground work areas. This system included the 1,000 kVA main substation located above the adit portal. The system also included transformers and distribution systems for the contractor's yard area and the tunnel services. The tunnel system consisted of three substations each comprised of a transformer and power distribution panels. One substation was located together with the main substation on surface, and the other two substations were installed in enlargements in the main adit at Station 15+00 and Station 29+73.

The permanent mechanical systems included a tunnel ventilation system, and a dewatering collection and discharge system. The tunnel ventilation system included two 42-inch diameter, 75 horsepower axial vane fans and approximately 3,100 linear feet of 42 inch diameter steel vent line. The dewatering system included: four 2,800 gallon sumps, two located at the portal, and two located in the tunnel at Stations 14+56 and 30+17; six submersible pumps, and approximately 3,100 linear feet of 6 inch diameter steel discharge line.

2.3 CHANGES DURING CONSTRUCTION .

While there were a number of minor changes during the course of the contract, there were only four substantial changes which affected the final configuration of the project. Of these four significant changes, two were contractor initiated, one was Owner initiated, and one was due to differing site conditions.

2.3.1 Contractor Initiated Changes .

The first contractor initiated change dealt with the 6 inch discharge line from the adit portal to the Salt River. The contract required that a 6 inch spiral weld steel pipe with Victaulic couplings be installed on the ground surface from the portal to a discharge point in the Salt River, which the contractor was required to maintain during the life of the contract. The contractor proposed changing this to a buried 6 inch PVC pipe in place of the above ground steel pipe. While the installation cost to bury the line was higher than the above ground installation cost, there were savings in material and line maintenance expenditures realized for the duration of the contract, and for future contracts as well. This made the revision virtually a no-cost change for the Government and it was accepted on that basis.

The second contractor initiated change involved substituting a 6 inch thick wire reinforced concrete invert in the shale formations for the 1 foot thick gravel invert specified. The contractor proposed this revision as a no-cost change, noting that the increased cost for the concrete invert would be offset by a savings in increased mining production and reduced maintenance of the tunnel invert. The change to a concrete invert in the shale formations was accepted by the Government.

2.3.2 Owner Initiated Change .

As plans for the overall test configuration for the UTP test bed were developed further, the Government found it necessary to relocate the Calibration Adit to accommodate the overall test objectives for the UTP. The Government initiated a design change which relocated the Calibration Adit from Station 28+00 with a bearing of S80°41'14"E to Station 24+64 with a bearing of N35°41'14"W. The change also eliminated the 100 feet of 8 foot by 8 foot drift and replaced it with a additional 100 feet of 12 foot by 13 foot drift and 10 feet of 10 foot diameter shaft. Figure 2-8 shows the alignment changes and Figure 2-9 on the next page depicts the Calibration Adit and Charge Shaft details.

This change was negotiated with the contractor, but it was never implemented due to the more sweeping changes in the scope of the project necessitated by the differing site condition at Station 18+54.

2.3.3 Differing Site Condition .

On June 25, 1993, when the tunnel heading was at Station 18+54, detectable levels of methane gas were encountered. The contractor immediately ceased mining operations, withdrew the roadheader from the face, and instituted a gas monitoring program to determine the extent of the gas inflow. Over the course of the next several days, the gas monitoring program indicated that while the flow of explosive gas was sporadic, varying from zero to greater than 20 percent of the Lower Explosive Limit (LEL) of methane, it was continuing, and exceeded the OSHA limits. This necessitated a change in classification of the tunnel from "non-gassy" to "gassy". The revision in tunnel classification required that the mining equipment, ventilation equipment, and electrical equipment be changed to comply with the more stringent requirements for gassy tunnels. Over the next several months, various alternate plans to continue the project were evaluated on the basis of UTP requirements, safety compliance, constructibility, and cost and schedule impacts.

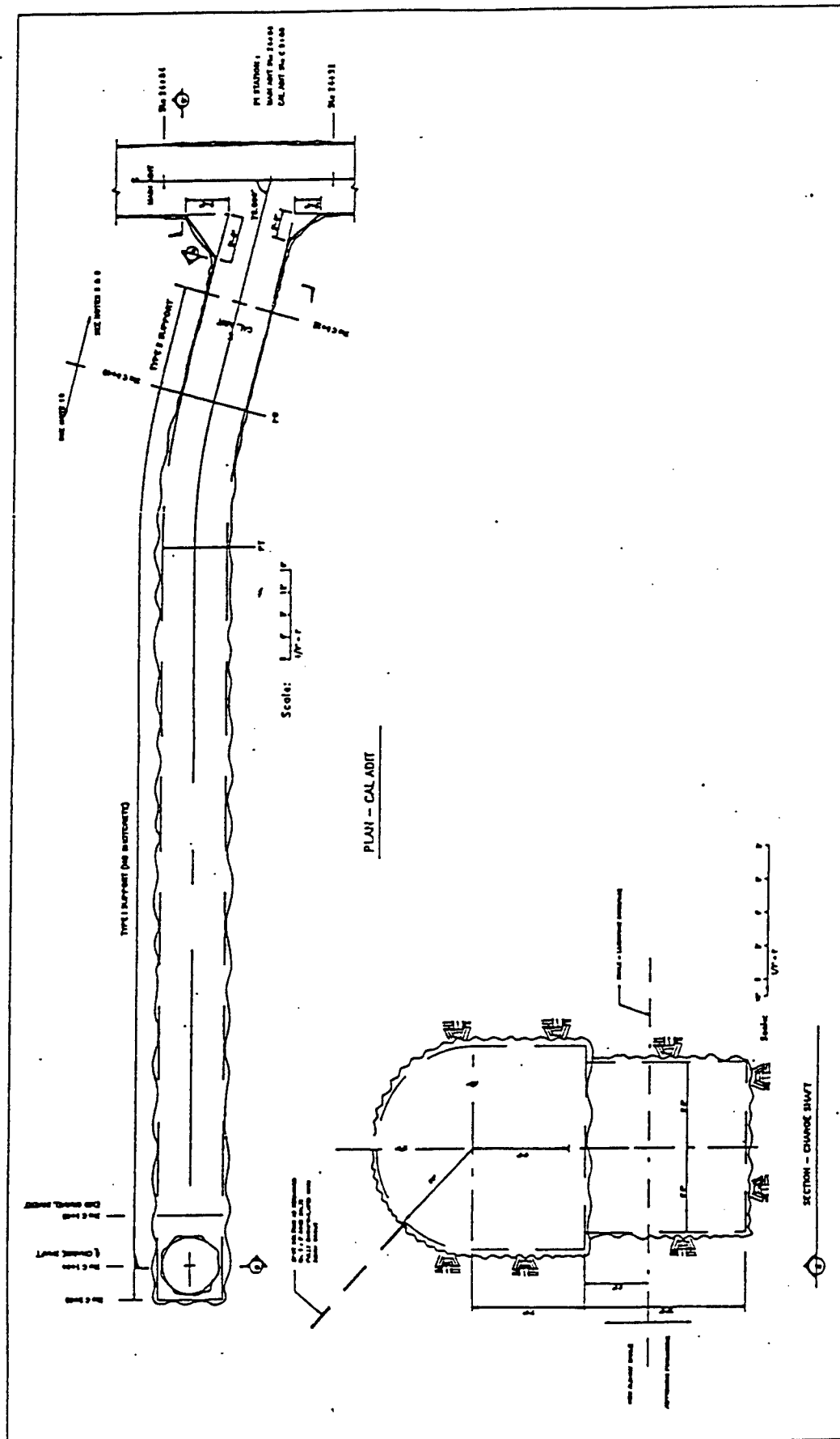


Figure 2-9. Revised Cal Adit.

A ventilation expert from the Bureau of Mines, and additional safety personnel from the DNA Field Command, Las Vegas, were brought in to assist in the development of the alternate plans for the completion of the test adit construction contract. Based on an evaluation of the alternate plans available, and an extensive review of the overall UTP requirements, DNA directed that the adit construction be terminated at Station 18+54. DNA also directed that the gas producing portion of the tunnel had to be sealed with a containment plug and pressure grouting, similar to that utilized at the Nevada Test Site (NTS), and that a 12 foot wide by 13 foot high test adit be constructed parallel to and below the existing main adit. As a result of this determination, the following changes were implemented:

1. The existing ventilation system was upgraded by replacing the non-explosion-proof fan with an explosion-proof fan.
2. A continuous gas monitoring system with remote sensors was installed and interlocked to the tunnel lighting and mine power feed systems.
3. The gas inflow was isolated from the work area with concrete slab and vent pipes connected to a main vent line. Figure 2-10 on the next page shows this arrangement.
4. A containment plug was installed from Station 17+70 to Station 18+00 utilizing the NTS grout mix and a pressure grout containment plug (see Figure 2-10).
5. 524 feet of a 12 foot wide by 13 foot high test adit was constructed starting at the main adit Station 16+00 and progressed on a 0.5 percent slope up and back toward the portal on a parallel heading, 100 feet north of the main adit. Figure 2-11, which follows, provides an as-built plan and profile for this revision.
6. The main adit from Station 18+54 to Station 30+29 was deleted.
7. The electrical substation at Station 29+73 was deleted and the permanent electrical distribution in the tunnel was revised.
8. The dewatering sump at Station 30+17 was eliminated and the 6-inch tunnel discharge line was terminated at the dewatering sump at Station 15+00.
9. The Revised Calibration Adit at Station 24+54 and charge shaft was deleted.

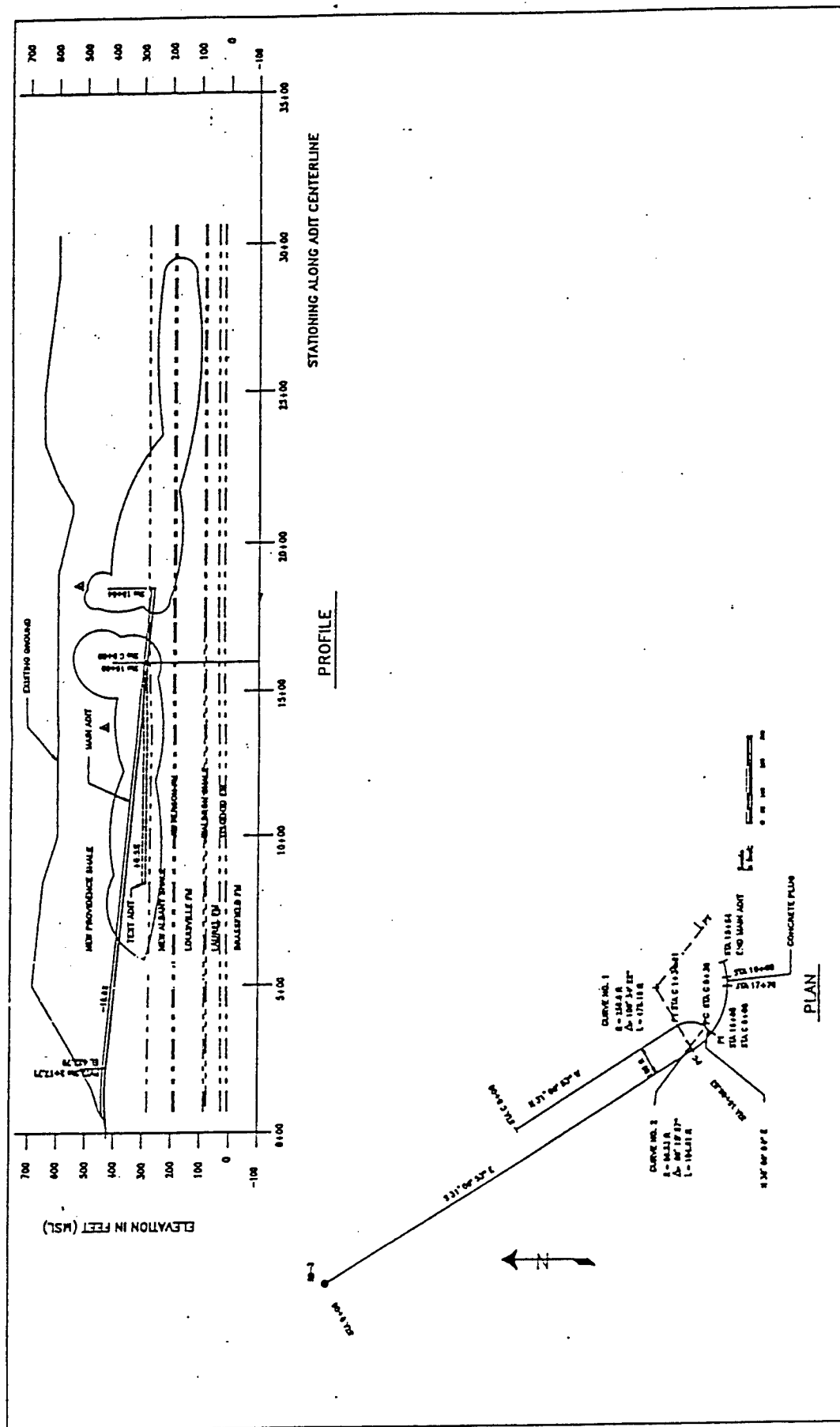


Figure 2-11. As-Built Plan & Profile.

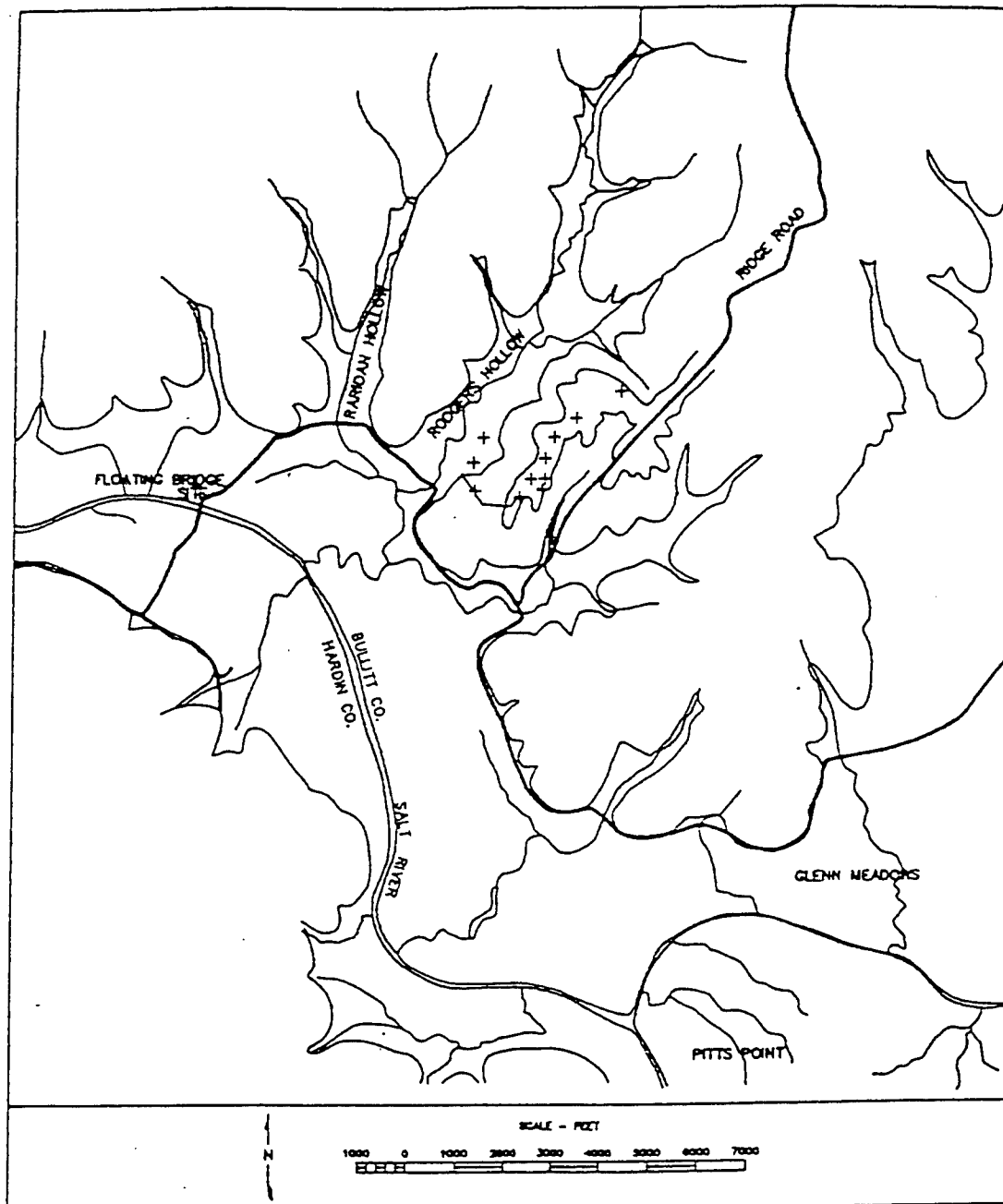


Figure 3-1. Rodgers Hollow Area.

SECTION 3

GEOLOGY

3.1 GENERAL SITE AREA .

The UTP project area lies beneath a ridgeline and immediately east of a small tributary valley to the Salt River on the northern end of Ft. Knox. A map is provided in Figure 3-1, as well as earlier in Figure 1-1. The portal for the adit was excavated on the lower hillslope of the ridgeline, just above the slope break to the valley, which is called Rodgers Hollow. The Rodgers Hollow area is characterized by a relatively flat valley floor surrounded by hills on three sides. The area is drained by a small unnamed creek that branches into two forks in the northern portion of the hollow. This creek flows into the Salt River approximately 0.6 miles southwest of the entrance of Rodgers Hollow.

The overburden material in Rodgers Hollow consists of quaternary alluvium and lacustrine deposits; generally light-tan to dark-brown silts and clays with varying amounts of sand, gravel, and rock fragments. Zones of gray to olive-gray silty clays are commonly encountered in an intermix with the brownish material. The overburden slopes toward the drainageway in the hollow and nominally parallels the ground surface contours. In many areas of Rodgers Hollow, the water table is 2 to 6 feet below the ground surface.

The bedrock at the portal elevation is shale that is a part of the Mississippian-age Borden formation. The portal was constructed at the boundary between the upper shale member of the Borden Formation, the Nancy Member, and the underlying New Providence Shale Member (see Figure 3-2 on the next page). At this site, the Nancy and New Providence Members are essentially indistinguishable, although the silt content of the Nancy Shale is known to be slightly higher than that of the finer grained, underlying New Providence Shale. The general hillslope, above the slope break to the valley, has a minimal soil profile and a weathered zone approximately 20 to 30 feet thick. Because the New Providence and Nancy Members of the Borden Formation are so impervious to water, the depth of weathering usually does not exceed 30 feet below the ground surface.

The Nancy Member Shale base lies at the portal elevation and is approximately 150 feet thick, so that under the main portion of the ridgeline, the Nancy Shale overlies the adit for a considerable thickness. The New Providence Member Shale continues 180 feet beneath the portal. Another 80 feet of shale thickness, the New Albany Shale, exists below the New Providence, making the total

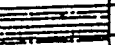
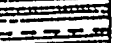
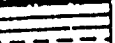
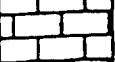
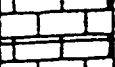
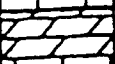
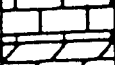
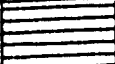
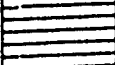
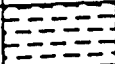
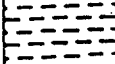
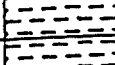
SYSTEM	SERIES	GLACIATION	FORMATION, MEMBER, AND BED	LITHOLOGY	THICKNESS (FT)	
QUATERNARY	HOLOCENE		YOUNGER ALLUVIUM		0-20	
	PLEISTOCENE	ILLINOISIAN	LACUSTRINE, LOESS & OLDER ALLUVIUM		0-85	
TERTIARY ? & QUATERNARY	PLIOCENE ? & PLEISTOCENE		TERRACE DEPOSITS		0-90	
MISSISSIPPIAN	MERAMECIAN		ST. LOUIS LIMESTONE			
			SALEM LIMESTONE		ONLY LOWER PART PRESENT	
			HARRODSBURG LIMESTONE		40	
	OSAGEAN		BORDEN FORMATION	MULDRAUGH MEMBER		60-70
				NANCY MEMBER		150
				NEW PROVIDENCE SHALE MEMBER		180
				KINDERHOOKIAN		
DEVONIAN	MIDDLE & UPPER DEVONIAN		NEW ALBANY SHALE		75	
			JEFFERSONVILLE		7-9	
SILURIAN	NIAGARAN		LOUISVILLE		102	
			WALDRON		15-20	
			LAUREL		45	

Figure 3-2. Stratigraphic Column of Ft. Knox UTP Area of North Central Kentucky.

aggregate thickness of shale above and below the portal elevation greater than 300 feet. Beneath the New Albany are the initial test target carbonates of the Louisville Formation.

The uppermost hillslopes, just below the ridge line, are also predominantly shale, yet they actually classified as shaley siltstone with minor beds of limestones, dolomitic siltstones, shales, and sandstones. The materials are of the Upper Borden Formation (Muldraugh Member). The ridge-capping materials consist of the Harrodsburg and the overlying Salem Formations. All the hillslope and ridgeline materials are of Mississippian age. The stratigraphic relationship and thicknesses of the rocks of this area of Ft. Knox are shown in the stratigraphic column on Figure 3-2 opposite.

The valleys bordering the test site ridge have been formed by erosional processes of the tributary streams; however, the valleys in the vicinity of the test site have also been affected by a major glacier advance during the Illinoian Ice Age which occurred approximately 200,000 years ago. Glaciers advanced to within 50 miles of the site area. The advance, along with the climate effects associated with the glacial period, caused substantial erosion and alteration to the existing drainage of the area, including the rerouting of the ancestral Ohio River from a more northerly position to the one now currently occupied (Reference 1) as shown in Figure 3-3 on the next page.

The ice advance caused the pooling of water in many very large areas, including a huge temporary lake in the vicinity of Louisville, which encompassed Rodgers Hollow and the nearby valleys. This led to the deposition of some very low-strength lacustrine (lake bed) silty clay units in the valleys. The weak lacustrine deposits associated with the valleys were not a factor in the adit design and construction because they exist at elevations below the portal, and are present only within the valley boundaries.

3.2 ADIT GEOLOGY .

A geologic profile along the adit centerline is shown in Figure 3-4 which follows. The adit portal materials consist of the basal Nancy Member Shales and upper New Providence Shales of the Borden Formation. As the adit penetrates deeper, the New Providence Shale, while appearing lithologically quite consistent, has a gradual decrease in the fine-grained, granular quartz content with increasing depth. The contact with the underlying New Albany Shale is obvious, as it is where the dark gray shales of the New Providence give way abruptly to the dark brown shales of the New Albany. The New Albany is a more competent shale than the New Providence, although it is less dense because of the high

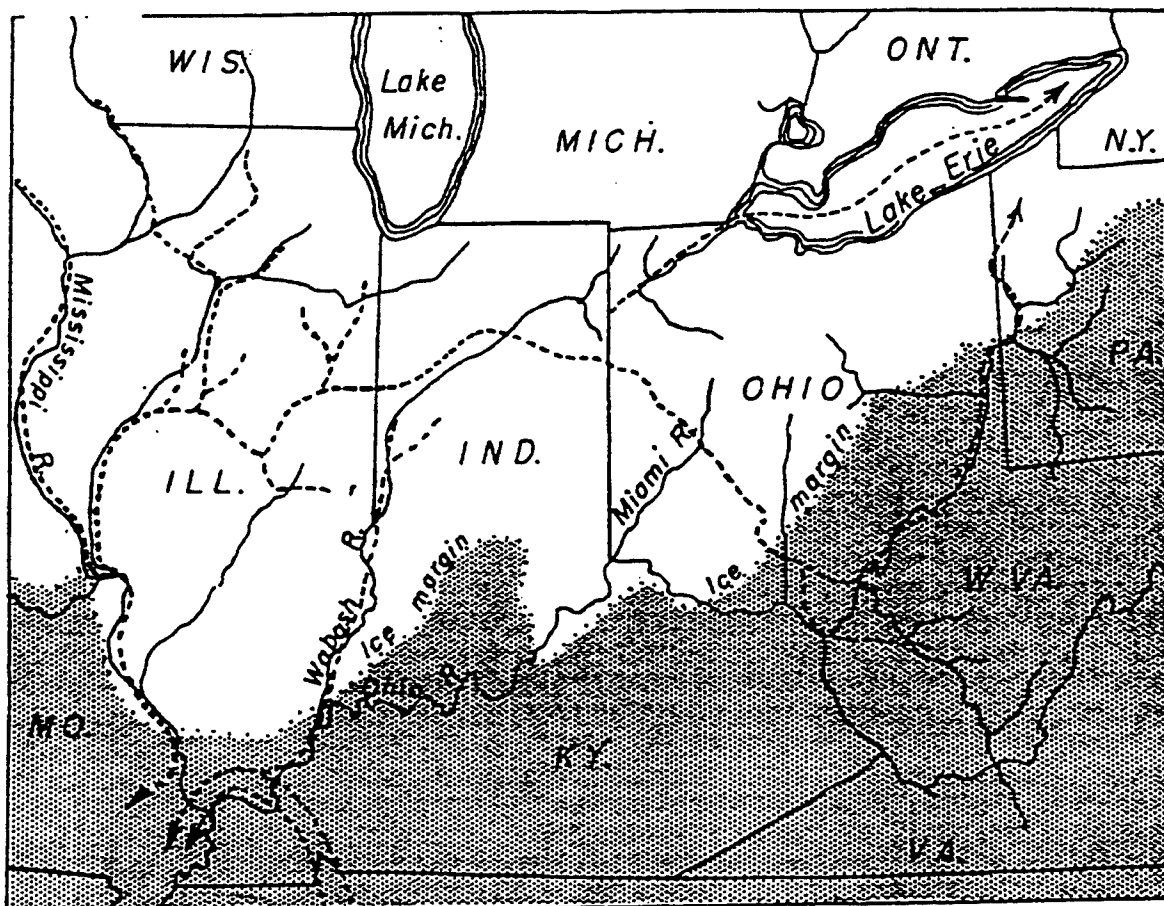


Figure 3-3. Maximum Advance of Glaciers In
Ft. Knox Region.

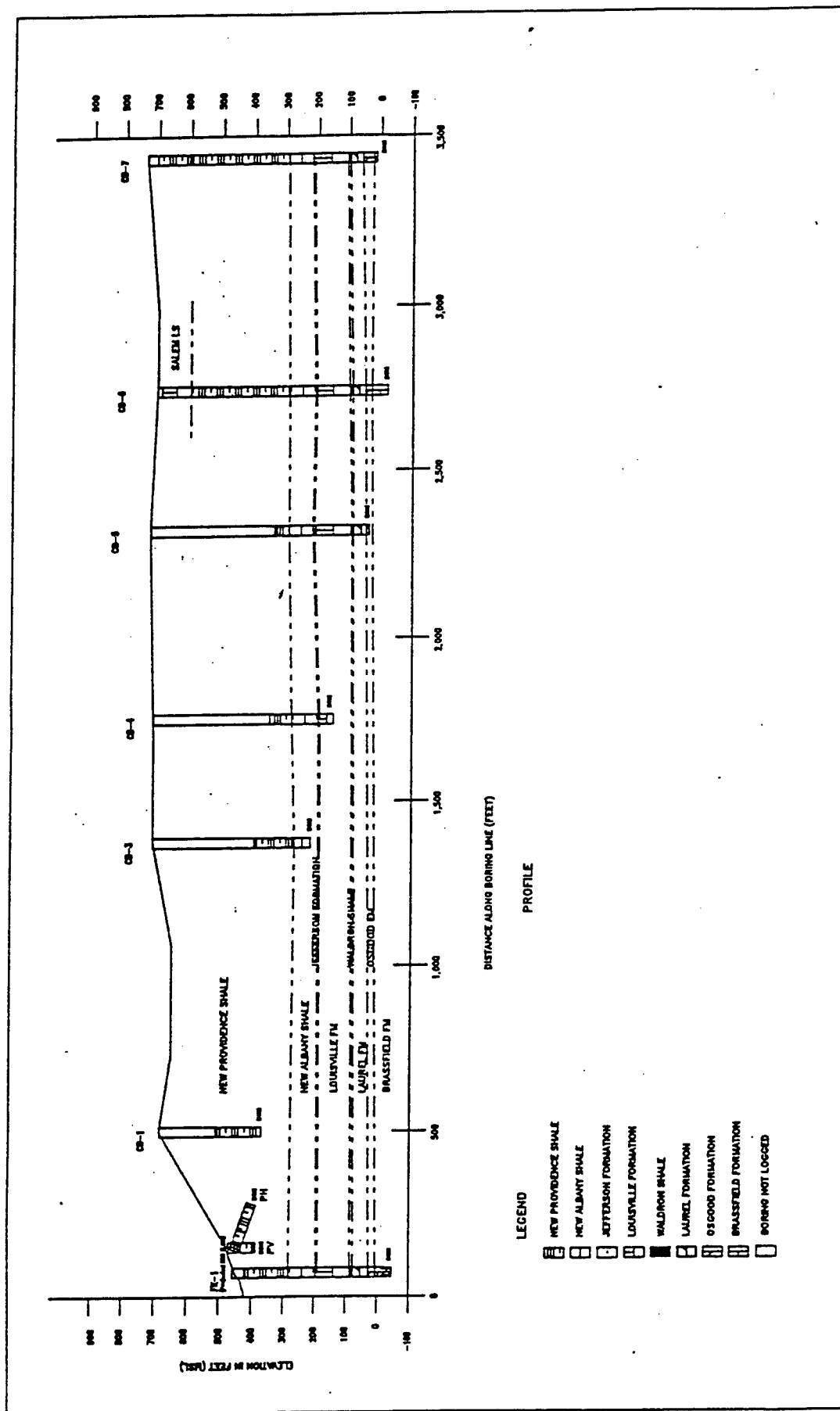


Figure 3-4. Geologic Profile Along Adit Centerline.

percentage of kerogen (organic material) it contains.

Below the New Albany there is an equally recognizable transition to the important carbonate (limestones and dolomites) section of the test horizon. The uppermost carbonate formation is the Jeffersonville limestone which varies in thickness through the test area from 6 to 9 feet. Beneath the Jeffersonville is the 100 feet thick Louisville Carbonate Formation. The Louisville is difficult to distinguish from the overlying Jeffersonville, unless it is tested by applying hydrochloric acid. The Jeffersonville is mostly limestone (calcite (CaCO_3)) while the Louisville is predominately dolomite (Ca, MgCO_3). However, there are zones within the Louisville which are rich in calcite and can be classified as limestone, hence, the term Louisville Carbonate was chosen.

Since the adit was never intended to penetrate below the Louisville Formation, the deeper formations (Laurel, Osgood, and Brassfield), which were penetrated by the exploratory borings, are not described herein.

3.3 FIELD EXPLORATION PROGRAM .

The geotechnical characterization of the UTP project site consisted of field explorations and testing. The purpose of the explorations was to provide the factual data to characterize the site for testing purposes, and to identify the geotechnical conditions expected during excavation of the portal and adit, including the geologic formations, rock type and condition, and the anticipated ground water conditions which had to be addressed. To accomplish this task, four geologic exploration techniques were used: core drilling; hydrologic testing and water sampling; geophysical logging; and formation gas detection.

The exploration activity was chronologically subdivided into four different phases. These were: 1) site-selection, 2) adit lay-out, 3) groundwater monitoring and testing, and 4) formation gas detection. Ft. Knox was only one of a number of sites considered during Phase 1, site selection, and the last of this work was accomplished during calendar year 1990. Phases 2, 3 and 4 were accomplished only for the Rodgers Hollow site, and were conducted concurrently during the calendar year 1991. Additional exploration activities classified under phases 2 and 3 were conducted during the construction of the test adit in the calendar years 1992 and 1993.

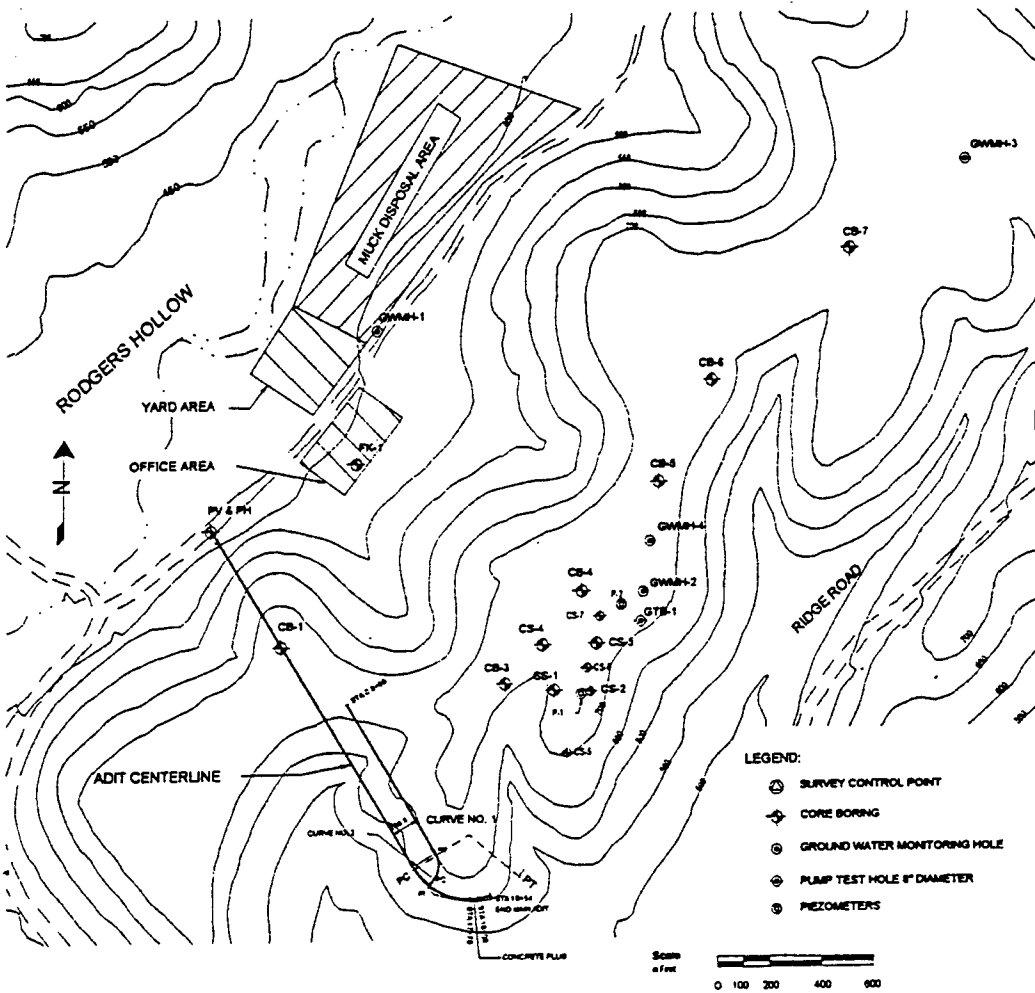


Figure 3-5. New Site Plan With All Borings Shown.

3.3.1 Core Drilling .

A total of 15 NQ and NX core borings were drilled and logged as part of the preconstruction exploratory program developed for the UTP. During the site selection (Phase 1) of this project, two borings, FK-1 and FK-2 were cored with NQ wireline equipment, each to a depth of 500 feet. This work was performed under contract for WES using a Failing 500 drill rig. Site-specific explorations (Phase 2) to lay out the adit and define the anticipated tunneling conditions included borings CB-1, CB-3, CB-4, CB-5, CB-6, and CB-7 (boring CB-2 was not drilled). Explorations conducted to define the conditions at the portal location included one vertical and one angle boring, designated PV and PH respectively. All of the Phase 2 drilling was performed by U.S. Army Corps of Engineers drill crews. Five additional borings, GWMH-1, GWMH-2, GWMH-3, GWMH-3A, and GWMH-4 were cored as part of Phase 3 groundwater monitoring program. All of these holes were drilled by the Corps of Engineers using HQ wireline equipment. Boring GWMH-3A was logged only by the geophysical surveys, and GWMH-4 was not logged at all.

During the Test Adit Construction phase of the UTP, an additional exploratory program was carried out in December 1992, and in May 1993, in which a total of 9 additional borings were drilled and logged. Piezometers were later installed in five of these borings (P-1, P-2, CS-5, CS-6, and CS-7) and in two of the previous borings (GWMH-2 and GWMH-4). The boring locations are shown on Figure 3-5 on the opposite page and the logs of the borings are presented in Appendix A.

3.3.2 Geologic Discontinuities .

Based on data obtained from the preconstruction exploratory borings and other available geologic data available, it was concluded that no faults or shears would be encountered. It was also concluded that bedding plane joints, which are horizontal to moderately inclined, would comprise the majority of joints encountered.

Discontinuities in the New Providence Shale are typically planar, tight to moderately tight, horizontally oriented (0° to 10°) with smooth to slightly rough surfaces and with a few occurrences of soft clay fillings. The discontinuities are mostly unweathered. The New Albany Shale, on the other hand, has steeper discontinuities (0° to 40°), with occasional calcite and pyrite fillings. The joints are planar, slightly rough to rough-surfaced, moderately tight to tight, and unweathered. The Louisville Carbonate Formation typically has a higher frequency of discontinuities than both the New Providence and New Albany Shales. Discontinuities here are steeper (0° to 50°), and are open. Calcite fillings are frequent along the joints. Weathering of discontinuities in the Louisville Carbonate Formation is more

evident.

Geologic mapping of main and test adits confirmed the exploratory data obtained for the New Providence Shale. In accordance with the exploratory data, no shears or faults were encountered and only five open and bentonite-filled joints were encountered. All of these were encountered in the first 141 feet of main adit, close to portal (Station 0+94 to Station 2+34). Every one of these discontinuities were transverse and vertically oriented (252° to 263° Azimuth strike and 75° to 85° NW dip direction).

There were four bedding planes encountered in the main adit at Station 4+55, Station 16+07, Station 16+55, and Station 17+62. Their measured Azimuth strikes ranged from 305° to 335° , except for the bedding plane at Station 17+65 which had a 285° Azimuth strike. Dip angles for these planes were 6.5° to 9° NW direction except for the plane at Station 17+65 which had a SW dip direction.

Since all of the explorations, other than portal boring PH, were drilled vertically, exploratory data would be biased against high-angle fractures, and the exploratory borings data for the New Albany Shale and the Louisville Carbonate Formation may not be representative of what might be encountered in the adit when tunneling into these strata.

3.3.3 Hydraulic Testing and Water Sampling .

The UTP site-selection criteria required that the final experimental test bed be located in a water-saturated, carbonate rock. The hydrologic properties of the Louisville Formation are important characteristics, not only for test bed predictions, but also for anticipating ground water conditions during construction. To that end, a program to establish and define the hydrologic nature of the site was developed and consisted of:

1. Constant head tests using downhole packer injection to establish rates of flow and hydraulic conductivity by depth interval.
2. Water sampling to determine water quality.
3. A long-term (25-hour) pump test to determine the ability to draw down the primary aquifer at the site (Louisville Carbonate Formation).

The injection (pump in) tests were conducted in seven of the NQ boreholes to determine the volume of water required to maintain a constant head.

Table 3-1. Summary of Aquifer Water Quality .

<u>ANALYSIS</u>	<u>RESULTS</u>
Conductivity	27,000 micro-ohms
ph	7.01
Total Alkalinity	456
Chloride	11,535 mg/l
Calcium	588 mg/l
Magnesium	336 mg/l
Sodium	5,620 mg/l
Hardness (CaCO ₃)	2,820 mg/l
Total Dissolved Solids	16,500 mg/l

Determining the quality of the groundwater present in the Louisville Formation was an important consideration in the planning of the UTP Test Adit Project. An uncontaminated water sample was obtained from boring CB-6 and chemically tested. The results of the laboratory test are reported in Appendix B.3 of the GEOTECHNICAL DESIGN SUMMARY REPORT (Reference 2) and are provided in Table 3-1. Due to the high chloride content of the groundwater, it was necessary to make special provisions in the contract to pipe the tunnel discharge water to the Salt River and to specify minimum dilution factors for its discharge into the river.

The long term pump test was performed using a large diameter boring, denoted as borehole GTB-1. An 8-1/2 inch diameter hole was drilled with an air hammer to a depth of 102 feet, and a 6 inch diameter PVC pipe was set in place and sealed with Bentonite. The remainder of the hole was then drilled with a 6 inch diameter air hammer button bit to a total depth of 640 feet. Detailed results of this test were reported in Appendix B.2, Volume 4 of the "Solicitation For Underground Technology Program Test Adit Construction" (Reference 3) Tables 3-2 and 3-3 on the following page summarize the results from the active and passive pumping phases of the pump test performed at boring GTB-1.

Based on the data obtained through the hydraulic testing program conducted at the site, it was established that the porosity in the carbonate material, known in many situations to be laterally variable, exists only on a minor scale in the immediate vicinity of the Louisville Carbonate Formation of interest. Furthermore, the Louisville Formation water reservoir could be considered isotropic in properties and in extent. The two distinct porosity zones of the Louisville Carbonate Formation, the upper and the lower porosity zone, appear to be both laterally continuous (at least in the area of the program borings), as suggested by their presence in each well of the pump test program. Also, only partial water level recovery was achieved in a 24 hour period after pumping. This suggests that the extent of the aquifer is limited.

Using the characterized coefficient of transmissibility in the vicinity of borings GTB-1 and GWMH-2 as 750 to 1120 gpd/ft (100 to 150 ft³/day/foot), as reported in Appendix B.2, Volume 4 of the "Solicitation For Underground Technology Program Test Adit Construction" (Reference 3) and using 74 feet as the nominal aquifer thickness, the equivalent hydraulic conductivity would be 1.35 to 2.03 ft/day. Assuming a steady-state drainage for both the borehole and the adit under a constant water head of 270 ft, the tunnel was estimated to produce about 510 to 766 Ft³ of water per day per foot of length in the aquifer (see Appendix B.2). This translates to approximately 2.6 to 4.0 gpd per foot of adit. Since the adit was designed to have a 10 percent downward grade, the 74 feet of aquifer translates to approximately 740 feet of aquifer zone penetration. The resulting total flow within the Louisville

Table 3-2. Coefficients of transmissibility and storage,
Active Pumping Phase GTB-1.

<u>WELL TEST</u>	<u>RANGE FROM GTB-1 (FT)</u>	<u>COEF TRANS (T) GPD/FT</u>	<u>COEF STORAGE (S)</u>
GWMH-2	121	676	3.60
GWMH-4	320	1650	1.34
CB-5	540	663	1.75
CB-6	960	539	1.90
FK-1	1250	499	1.53
GWMH-1	1520	580	0.92
CB-7	1590	434	0.61
GWMH-3A	2090	868	0.48

Table 3-3. Coefficients of transmissibility and storage,
Passive Recovery Phase GTB-1.

<u>WELL/TEST</u>	<u>COEF TRANS (T), GPD/FT</u>
GWMH-2	729
GWMH-4	1600
CB-5	1422
CB-6	1307
FK-1	937
GWMH-1	904
CB-7	1114

aquifer was calculated to be 1,925 to 2,960 gallons per day.

3.3.4 Geophysical Surveys .

Geophysical wireline logging was conducted in each of the core borings drilled at the site in the preconstruction exploration phase, except for the portal area borings (PV and PH) and the air drilled boring (GTB-1). Various types of geophysical logs were performed during this program. All logs were run in the open hole within several months of the completion of the drilling of each hole. The types of log runs, the principle of measurement, the recorded parameters of each log type, and the results of the logging are summarized in Section V of the GEOTECHNICAL DESIGN SUMMARY REPORT (Reference 2).

3.3.5 Formation Gas Detection .

In an attempt to detect the possible presence of formation hydrocarbon and/or hydrogen sulfide (H_2S) gases, a "mud logging" unit was employed during the air drilling of boring GTB-1 in July, 1991, to monitor the returning air stream in order to determine the presence and concentration of either or both of the gases.

The hydrocarbon gas detection involved the use of two instruments, a total hydrocarbon gas detector, and a gas chromatograph unit. The total hydrocarbon gas detector that was utilized on the UTP logging is commonly referred to as a thermal conductivity detector (TCD). This unit provides a continuous measurement of the presence and level of total combustible gases either within the flow stream, as in the case of air drilling, or emanating out of solution from the recirculating mud stream. The gas chromatograph, uses discrete samples, separating the mixture into its component gases, and then samples each component. In this way the device can determine the type, such as methane (CH_4), ethane (C_2H_6), propane (C_3H_8), butane and/or isobutane (C_4H_{10}), and pentane (C_5H_{12}), and concentration of each component gas within. Methane (CH_4) gas was detected in borehole GTB-1. The total hydrocarbon gas concentration was measured and recorded, as well as an independent methane concentration level. The results are presented in Figure 3-6 on the following page.

Figure 3-6 also shows the data recorded from the hydrocarbon gas detectors adjacent to the lithologic log and stratigraphic column. There was no gas was detected through the entire Borden Shale section of the hole. The first detection of gas corresponds with the drill bit penetration into the top of the organically rich New Albany Shale, and the sustained high readings matched almost perfectly with the interval within the New Albany Shale which has the highest natural gamma ray activity on the geophysical log. In

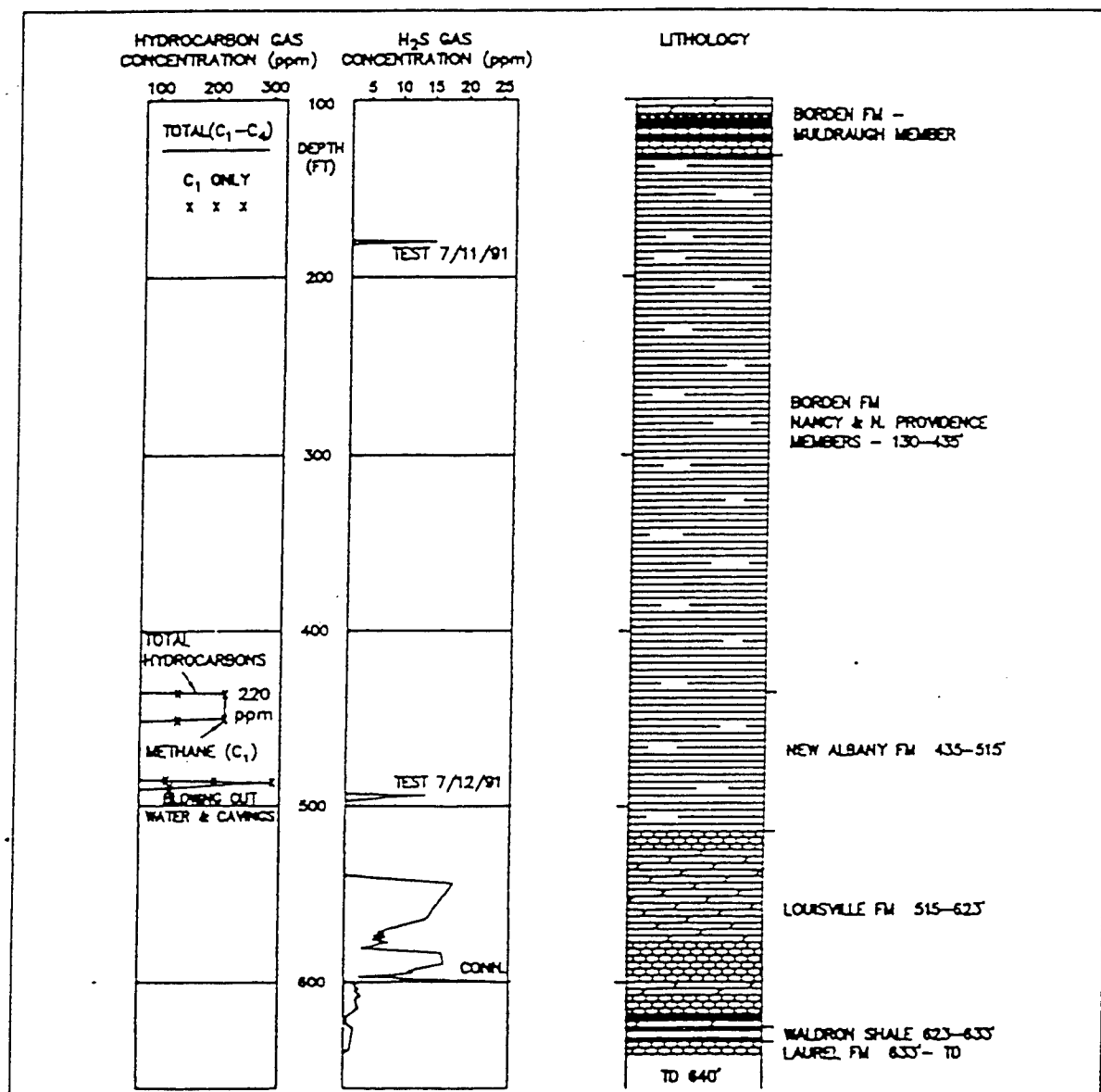


Figure 3-6. Formation Gas Log for Boring GTB-1.

previous studies, this interval has been shown to possess the highest organic material content in the form of kerogen as well (Reference 7.2 in GEOTECH REPORT). Samples of this material have been triaxially tested in the laboratory and have been observed to release hydrocarbon gas after testing. Based on the formation gas detection operation, it was determined that small quantities of methane (CH_4) gas may be encountered as the adit is driven through the upper portion of the New Albany Shale.

The presence of hydrogen sulfide (H_2S) gas in the UTP adit was another concern since it could represent a serious hazard to personnel. In an attempt to detect the presence and measure levels of hydrogen sulfide gas, two types of sensors, one active (Metal Oxide Detector) and one passive (Lead Acetate Paper), were employed to monitor the exit air stream while drilling borehole GTB-1. The data obtained from that monitoring program is displayed adjacent to the lithologic log and stratigraphic column in Figure 3-6. It can be clearly seen that the occurrence of H_2S corresponds to the upper porosity zone in the Louisville Formation.

The formation gas monitoring project resulted in the detection of both hydrocarbon and hydrogen sulfide gases. Each was identified in distinct and isolated intervals.

During construction of main adit, methane (CH_4) gas was encountered in the top 2 to 3 feet of the New Albany Shale, as gas percolated from two 0.1-inch wide, calcite filled, open vertical joints in the New Albany Shale in the adit invert at approximate station 18+50. Analysis of the air/gas samples taken revealed that the emitted gas was 98 percent methane (CH_4) with the remainder being primarily carbon dioxide (CO_2) and ethane (C_2H_6). Concentrations for samples taken at adit face were 24 ppm of CH_4 on the left side, 463 and 155 ppm CH_4 at center (2 samples), and 64 ppm CH_4 at right side. Hydrogen sulfide gas was not encountered, since no tunneling in the Louisville Carbonate Formation was performed.

3.4 UNDERGROUND GEOLOGIC MAPPING .

The Full Periphery Method (developed by the U.S. Corps of Engineers) was adopted for mapping the underground geology encountered in the excavation of the adit. The mapping indicated that the New Providence Shale was massive with few discontinuities. Five vertically oriented, bentonite filled joints were encountered in the first 50 feet of the main adit excavation. Another set of tight, mostly vertical joints was encountered between Station 2+29 and Station 2+35. As noted in Section 3.3.2, There were four bedding planes encountered in the main adit at Station 4+55, Station 16+07, Station 16+55, and Station 17+62.

Cobble-size siderite intrusions occurred frequently throughout the New Providence Shale and one 8 inch thick siderite dike was encountered in the main adit from Station 15+64 to Station 16+54 and continued on in the test adit to Station C 3+10. The New Providence Shale started displaying organic laminar deposition patterns at about Station 15+00, where shale started to have horizontal bands of olive-green to grayish green coloration that became increasingly dominating and distinct as excavation advanced deeper into the New Providence Shale towards interface with the dark brown colored New Albany Shale (encountered at Station 15+34). Detailed geologic maps are presented in Appendix C.

3.5 SITE HYDROGEOLOGY .

The test site selection criteria required a saturated carbonate section at the test depth, therefore, a discussion of the hydrology of area becomes necessary to complete the description of the geology of site area. Two hydrologic regimes are discussed, the soil water, and the water within the rock units. Please refer to Section 3.3.3, Hydraulic Testing and Water Sampling, for details of hydrological testing performed for the UTP.

3.5.1 Soil Water .

The valleys contain a shallow perched water table. Boreholes drilled at various locations within the Rodgers Hollow area, below the grade change controlled by the weathering of the rock slopes, all indicated the presence of the shallow water table. The recorded piezometric levels showed a remarkable seasonal dependence. For example, the water table at a site a small distance up the valley from the portal area had been observed at a depth of 2 to 4 feet below the surface in February to April, and as deep as 9 or 10 feet in August through early November. This perched aquifer exists only at elevations within the valley proper and below the portal elevation, so that it should not be a factor in either portal construction or within the adit.

3.5.2 Rock Hydrology .

The hydrology of the rock materials affects the design parameters of the adit construction. For the purposes of this discussion, the rock hydrology will be divided into three zones: the Shale Zone; the Louisville Carbonate Zone; and the Deep Zone, i.e. the Waldron Formation into the Laurel Dolomite (Laurel Zone).

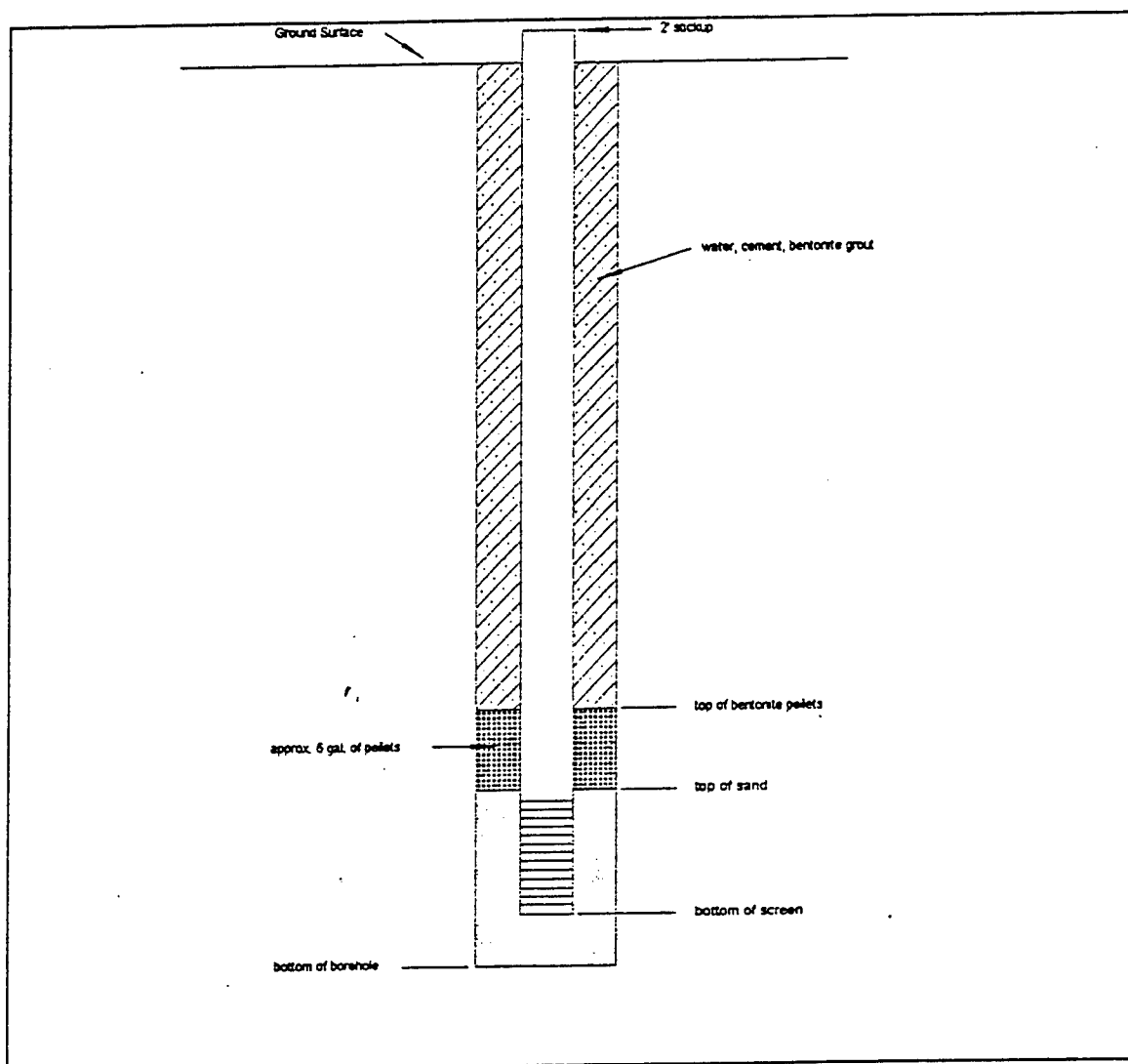


Figure 3-7. Typical Profile of Installed Piezometers.

3.5.2.1 Shale Hydrology. All of the shale units encountered above the Louisville Carbonate give evidence of 100 percent water saturation. However, no noticeable water flow has been encountered while drilling within the Borden or New Albany Shales. Thus, from a hydrologic engineering standpoint, only minor water seepage would be expected while tunneling through the shales.

3.5.2.2 Louisville Carbonate Hydrology. Two zones of water flow within the Louisville Carbonate have been detected and hydrologically tested. The upper zone is variable in thickness, but the base of the zone lies 35 to 40 feet below the base of the New Albany Shale. This zone is identified as the major water producing zone of the site. The lower water-bearing zone of the Louisville lies approximately 20 feet above the underlying Waldron Shale. This zone is also variable in thickness and permeability, but can generally be classified as less water-productive than the upper zone.

3.5.2.3 Deep (Laurel) Hydrology. The only recognized potential water zone below the Louisville Carbonate at the site is a zone within the Laurel Dolomite. There is relatively little known about this zone since it lies below the depth of interest for testing. Where this formation was penetrated by boreholes, it was found that it is located about 15 feet below the base of the Waldron Shale at approximately the 650 feet depth (as encountered in boreholes CB-5 and CB-6). The fluid conductivity/temperature geophysical logs do not demonstrate significant fluid entry from this zone, although the reservoir properties suggest it could be a water-bearing strata of minor to intermediate importance.

3.6 HYDROLOGIC MONITORING .

A total of seven piezometers were installed in 1993 during construction of the test adit by the WES crew at boreholes GWMH-4, GTB-1, P-1, P-2, CS-5, CS-6, and CS-7 to monitor the water table in the Louisville Formation Reservoir, prior to and during the penetration of the main adit. The data collected provided quick and accurate feedback on depletability, drainage profiles, and the pressure drop of the reservoir as the main adit was constructed, and also provided the means necessary to determine if remedial steps were needed to be implimented so that the saturation of the Carbonate Formation could be maintained as required by the test parameters. A profile of a typical piezometer installation is shown in Figure 3-7 at left, and the locations of the piezometers are shown in Figure 3-8 on the next page.

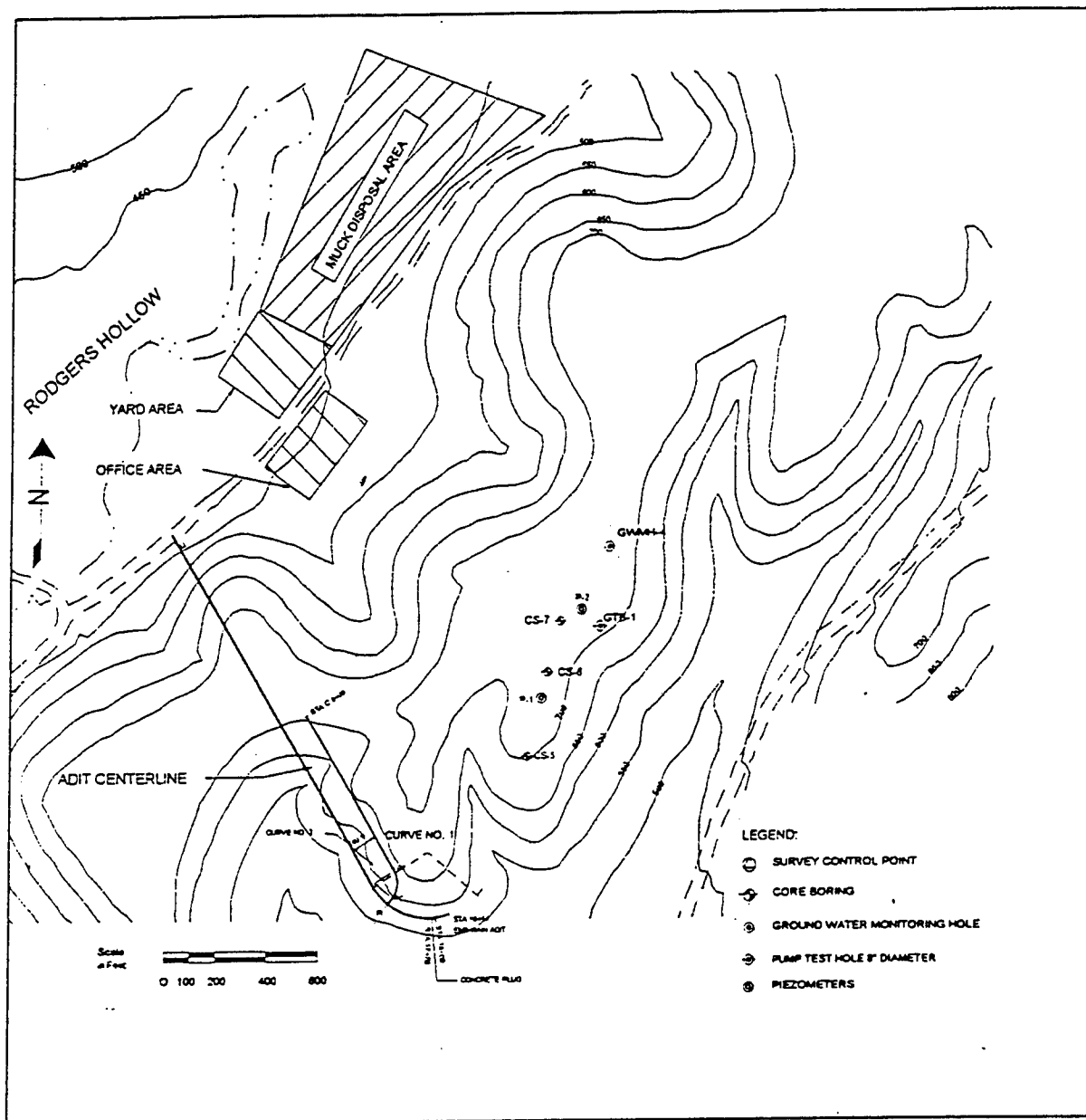


Figure 3-8. Location Map of Installed Piezometers.

SECTION 4

CONSTRUCTION METHODS

4.1 GENERAL .

A Request for Proposals (RFP), Solicitation No. DACA27-92-R-003 Underground Technology Program, Test Adit Construction, was issued in May, 1992 by the U.S. Army Engineer District, Louisville. A total of ten proposals were received in June, 1992 and, after evaluation of the proposals, a contract was awarded in July, 1992 to W.L. Hailey & Co., Inc. of Nashville, Tennessee. The contract provided for a one year construction period for the completion of the test adit and all appurtenant features of the permanent work.

The contractor began mobilization at the site in early August, 1992 and completed the initial site work, office set up, and site preparation, on October 20, 1992. Portal construction commenced on October 13, 1992, with the clearing of the portal area and the backfill of the structure was completed on December 23, 1992. Tunnel excavation commenced on December 28, 1992, and progressed to Station 18+54 on June 25, 1993, at which time methane gas was encountered in the heading and the tunnel excavation was halted. Work in the tunnel resumed on November 8, 1993, with the installation of vent line hangers in the main adit. The gas collection system was installed between November 15 to November 18, 1993 and the containment plug was constructed between November 22, 1993 and February 28, 1994. The test adit was excavated concurrently with the containment plug construction between November 22, 1993, and February 11, 1994. The balance of the contract work, electrical, mechanical, invert placement, shotcrete lining and final tunnel clean up was performed from March 1, 1994 through May 7, 1994.

4.2 PORTAL CONSTRUCTION .

The portal construction involved an open cut excavation of both overburden and shale. The overburden material was excavated using a dozer, loader, and dump trucks. The side slopes of the overburden excavation were laid back, thereby eliminating the need for the support of excavation structure. The shale cut was excavated utilizing drill and blast methods to break the rock, and a loader and dump trucks to excavate the shot rock. The side slopes of the rock cut were excavated with a slight outward batter to eliminate the need for any rock support.

UTP TUNNEL EXCAVATION WEEKLY PROGRESS

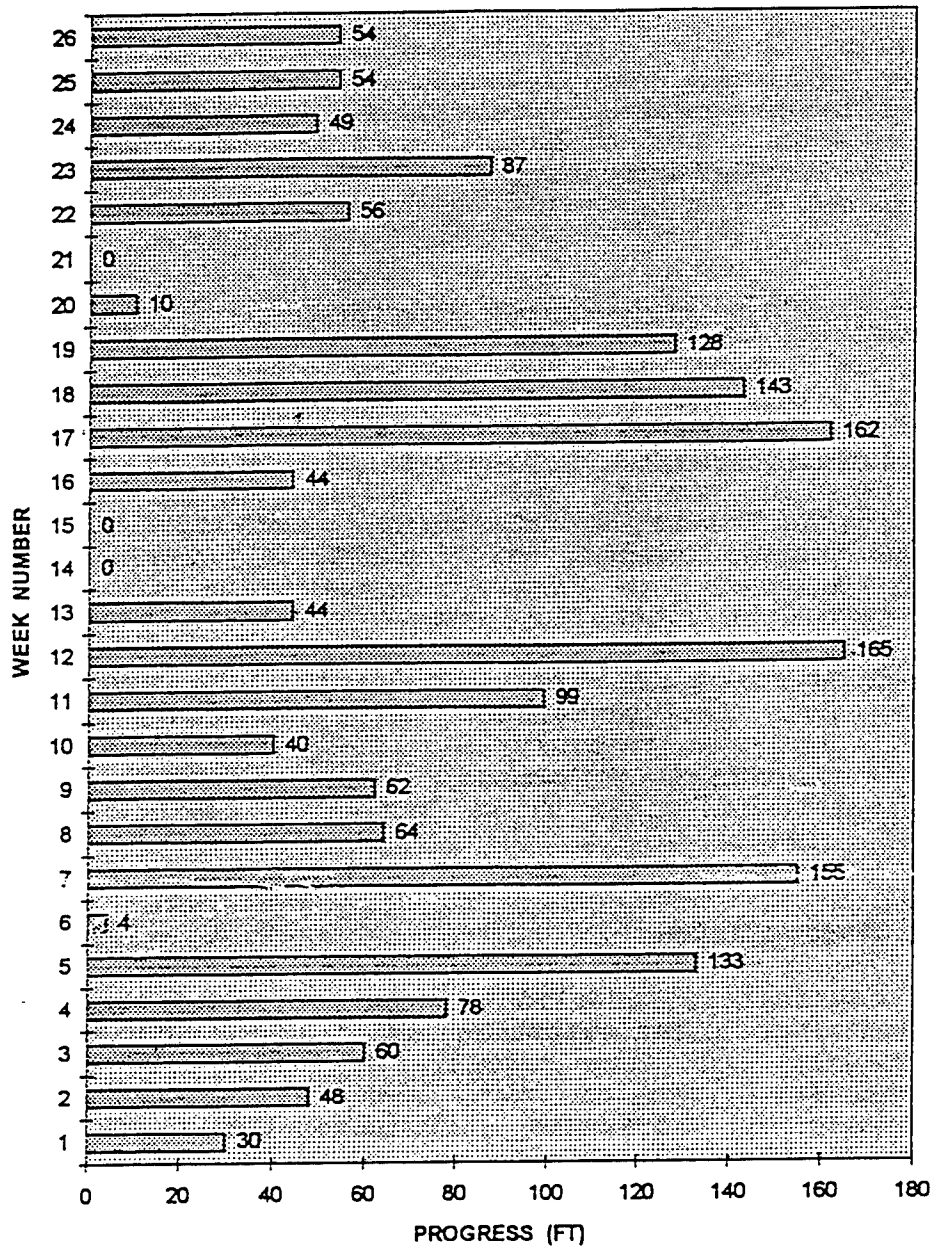


Figure 4-1. Tunnel Progress Summary,
(Chart 1 of 2).

After completion of the excavation, the steel ribs (W6x25s) were installed and the concrete invert poured. The 6 inch thick wire reinforced shotcrete was then placed between the ribs and the structure was backfilled. The reinforced concrete U-Wall structure was built by normal cast-in-place methods with wood forms.

4.3 ADIT EXCAVATION .

Tunneling operations commenced on December 28, 1992, at Station 0+94 using a Voest-Alpine Roadheader to mine the shale, and a pair of 5 cubic yard Eimco low profile mine trucks were used for muck removal. The contractor selected this type of equipment for excavating the shales because it provided a more continuous mining operation. This method significantly reduced overexcavation, and eliminated many of the safety hazards that are inherent in a drill and blast operation.

Throughout the tunnel excavation, the contractor mined the required cross section with minimal variance, and maintained line and grade well within tolerances. The roadheader and heading crews limited overexcavation and minimized the disturbance to the rock beyond design line. However, the actual advance rates for the roadheader operation never approached the anticipated rates. The estimated production rates for the roadheader excavation were an average of 15 linear feet of advance per 8 hour shift after an initial startup period. The contractor was prepared to mine two shifts per day and use a third shift to install ground support and tunnel utilities, as well as maintain the mining equipment. In this way, he had planned to mine and support an average of 30 linear feet per day, or 150 linear feet of tunnel per five day work week.

In the period from December 28, 1992 to June 25, 1993, the contractor worked a total of 141 days and mined 1,760 linear feet of adit. The overall average for this period was 12.5 feet per day and 67.7 feet per week. There were only six weeks in which production levels exceeded 100 feet per week, and the best weekly production was 165 feet. At left, Figure 4-1, provides the weekly advance rates for the first twenty-six weeks. The rates for the remainder of the project may be found on the following page. Of the total 141 day project duration, the contractor was able to mine on 89 days, and lost a total of 52 days for the following reasons: 13 days were spent on ground support installation; 12 days due to equipment breakdowns; 12 days for concrete operations on the invert; 8 days for ventilation system installation; and 7 days due to inclement weather.

On June 25, 1993, methane gas was detected in the tunnel at Station 18+54. The quantity and duration of the gas entering the

UTP TUNNEL EXCAVATION WEEKLY PROGRESS

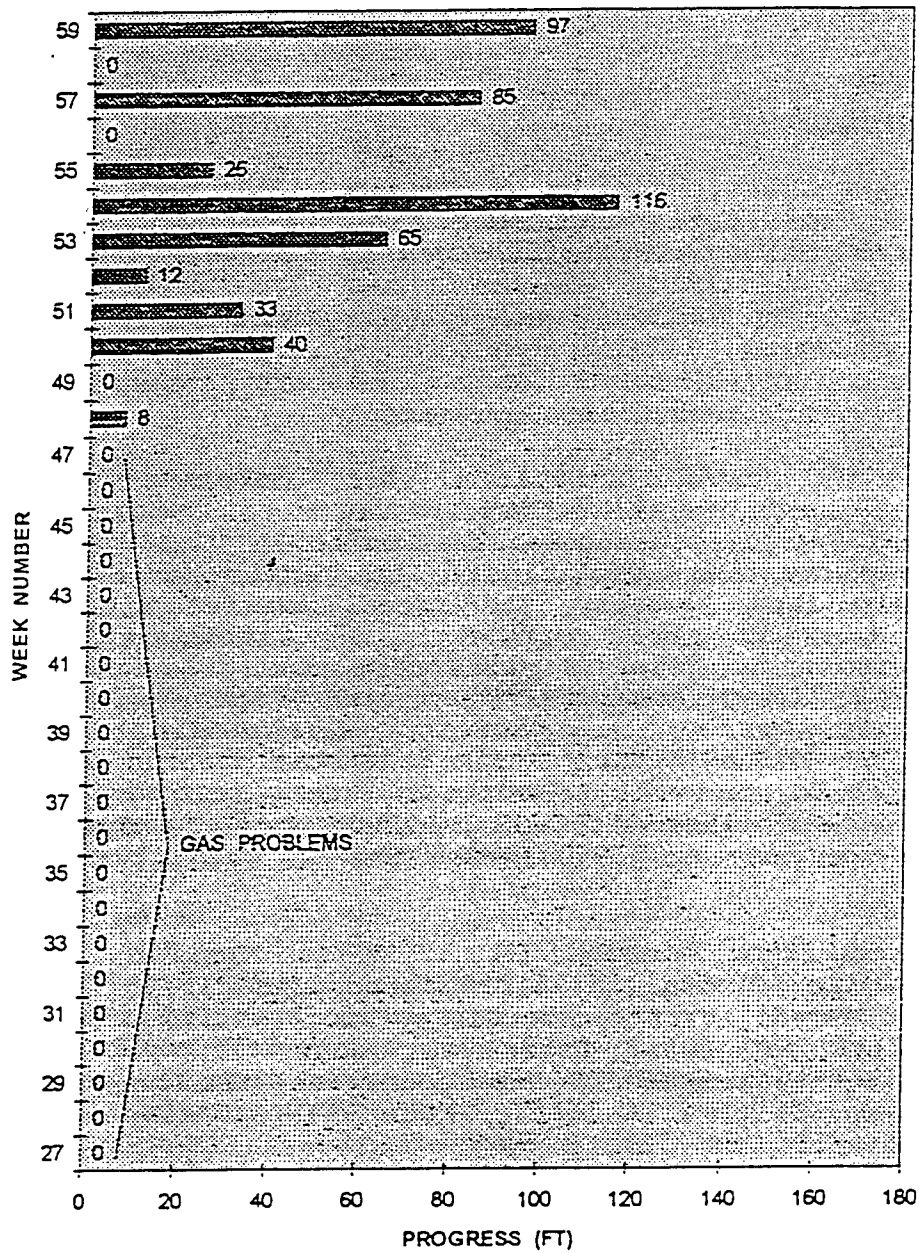


Figure 4-1. Tunnel Progress Summary (Chart 2 of 2),
(Continued).

tunnel was sufficient to require that the tunnel be re-classified as a "gassy" tunnel. Mining operations were discontinued for a period of 23 weeks while alternate plans were developed to deal with the gassy conditions. As noted in Section 2.3.3, Differing Site Condition, the decision was made to terminate the main adit at Station 18+54, seal the tunnel with a gas containment plug from Station 17+70 to Station 18+00, and to realign the test adit to remain totally within the New Providence Shale.

The test adit was excavated from Station C 0+06 to C 5+24 during the period of November 22, 1993 to February 11, 1994 and utilized the same equipment and methods as the main adit. Unlike the main adit, the test adit was excavated essentially on a single shift basis, four days per week. The average production rate for the 518 linear feet of tunnel was 13 feet per day on a single shift basis, which is more than twice the advance rate achieved in the main adit. Figure 4-1, Chart 2 of 2, at left shows the weekly advance rates in the test adit.

4.4 GROUND SUPPORT .

As discussed in Section 2.2.5, Ground Support, there were four types of ground support provided for the contract, with the determination of which type to employ, made in the field as the excavation progressed. As anticipated, the New Providence Shale was massive and competent, and required very little direct ground support. A total of six steel sets were installed at the beginning of the adit from Station 0+94 to Station 1+18. A total of twenty-two rock bolts and twelve rock dowels were installed in the main adit from Station 1+22 to Station 2+36. The permanent support for the sump bay (Station 14+54) and transformer bay (Station 15+16) consisted of a total of 101 rock bolts, and the support of the adit intersection (Station 16+00) consisted of seventy-two rock dowels.

The only area of the main adit which required a substantial number of rock dowels was from Station 16+56 to Station 18+46. In this reach of the tunnel, the New Providence Shale had a tendency to spall and ravel at crown of tunnel when the heading face advanced two tunnel diameters further. As the excavation progressed, the New Providence Shale became more organic and displayed planar, thin, lamination layers at crown, beginning at Station 15+02. At approximately Station 16+60, spalling of rock from crown started occurring more frequently, and the size of the spalled rock fragments increased to approximately 1 foot wide by 2 foot long and 2 to 3 inches thick. Even though the shale formation was still massive and structurally self-supporting, the spalling posed a safety hazard to the workmen in the heading, and the contractor was directed to install rock dowels from Station 16+56 to the

Table 4-1. Summary of UTP-Permanent Support Utilized.

ADIT STATION	TYPE OF SUPPORT INSTALLED
0+94 to 1+18	Steel ribs (6 ea)
1+22 to 1+33	Spot rock dowels (16 ea)
1+45 to 1+51	Spot rock bolts (12 ea)
2+32 to 2+36	Spot rock bolts (6 ea)
5+68 to 5+80	Spot rock bolts
14+35 to 15+38 (Sump Bay)	Patterned rock bolts (47 ea)
14+93 to 15+38 (Transformer Bay)	Patterned rock bolts (57 ea)
15+80 to 16+20 and C 0+12 to C 0+21 (Intersection)	Patterned rock bolts (72 ea)
16+56 to 18+46	Patterned rock bolts (212 ea) (with wire mesh from 17+58 to 18+44)

face, located at Station 17+35, before any further advance of the heading. The contractor was also directed to have rock dowels installed within 15 feet of the face at all times. Therefore, patterned rock dowels were installed from Station 16+56 to Station 18+46. Table 4-1 lists the different support systems used and their location in test adit.

All rock bolts and rock dowels were fully resin-encapsulated Number 8 threaded rebar, Grade 60 steel. The typical bolt/dowel length was 8 feet except for a number of 10 foot long bolts which were used at the sump and transformer bays and at the adit intersection.

While the adits required only minimal direct ground support for safety and stability, the New Providence Shale did require a shotcrete lining to permanently seal the excavated surface to prevent long-term deterioration of the shale due to air slaking. A nominal 2-inch thickness of shotcrete was applied throughout the entire length of both the main and test adits, and a 4 inch thickness was applied to the intersection area of the two adits.

4.5 GROUNDWATER OCCURRENCES .

The only measurable water inflow encountered during tunneling was at the top of the New Albany Shale at Station 18+50. While the water inflow, estimated at less than 5 gpm, presented no problem to the excavation, the water was accompanied by methane gas. The impact of the methane gas is discussed in detail in Section 2.3.3, Differing Site Condition.

SECTION 5

TUNNEL INSTRUMENTATION

5.1 TAPE EXTENSOMETERS .

A total of six sets (four points each) of convergence points were provided in the bid schedule. These convergence points were to be installed as needed in the main and calibration adits to monitor movements of the tunnel lining in areas where the geological conditions warranted. Due to the massive nature of the New Providence Shale, only one set was required, and the instrument was installed in the main adit at Station 1+20 to monitor any movement close to the portal. A total of four readings were taken in the period from February 3, to February 8, 1993. The data obtained from these readings indicated that the movements were negligible and stabilized quickly.

5.2 SINGLE POINT BOREHOLE EXTENSOMETERS .

None of the six sets of Single Point Borehole Extensometers (SPBXs) that were provided for in the contract were required in the New Providence Shale, and none were installed.

SECTION 6

REFERENCES

- 1 Pitts Point Geologic Quadrangle Map, USGS Publication, 1976.
- 2 UNDERGROUND TECHNOLOGY PROGRAM, Geotechnical Design Summary Report, Volume 1.
- 3 UNDERGROUND TECHNOLOGY PROGRAM, Geotechnical Design Summary Report, Volume 2.
- 4 "Petrophysical Analysis - US Army Corps of Engineers Hole FK-1, Bullitt County, Kentucky", Restech Inc., Houston Report, April 1990, Houston, Texas.
- 5 Underground Technology Program, Test Adit Construction, Solicitation No. DACA27-92-R-003, US Army Engineer District, Louisville, Kentucky, May, 1992.
- 6 Rock Engineering, J.A. Franklin and M.B. Dusseault, McGraw-Hill, New York, 1989.

Appendix A

Geologic Core Logs

DRILLING LOG		DIVISION		INSTALLATION		SHEET 1 OF 7 SHEETS	
1. PROJECT UTP				10. SIZE AND TYPE OF BIT N _Q wire line			
2. LOCATION (Coordinates or Section) Fr. Knox, KY				11. DATUM FOR ELEVATION BROWN (FSM - MSL)			
3. DRILLING AGENCY FMSM				12. MANUFACTURER'S DESIGNATION OF DRILL B-61			
4. HOLE NO. (As shown on drawing title and file number) CS-1				13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN		13. DISTURBED UNDISTURBED	
5. NAME OF DRILLER John Surber				14. TOTAL NUMBER CORE BOXES			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				15. ELEVATION GROUND WATER		15. DATE HOLE STARTED Dec. 10, 92 COMPLETED	
7. THICKNESS OF OVERBURDEN				16. ELEVATION TOP OF HOLE			
8. DEPTH DRILLED INTO ROCK 140				17. TOTAL CORE RECOVERY FOR BORING			
9. TOTAL DEPTH OF HOLE 630.5				18. SIGNATURE OF INSPECTOR Shailan Alsayab			
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
			Hole was pre drilled to 490.6' depth & cased to a depth of 100' with metal casing				
490.6			Run ① 490.6 - 496.3				
			Run was cut short due to mechanical problems with core barrel. Dark brown, unweath. fine grained New Albany shale. Thinly laminated & finely grained, with pyrite lenses.			Recovery = 4.8' Preserved core: 492.15 - 494.05	
496.3			Run ② 496.3 - 506.3				
			Same shale as in previous run. bottom of core 505.25'			Recovered 9.5' Preserved: 496.4 - 497.4 498.3 - 499.9 499.9 - 501 503.95 - 505 Water Loss = 100% Drilling time = 45 min	
506.3							

A-3

DRILLING LOG (Cont Sheet)			ELEVATION TOP OF HOLE		Hole No. CS-1	
PROJECT			INSTALLATION		SHEET 2 OF SHEETS	
ELEVATION a	DEPTH b	LOGNO c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV. e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	506.3		RUN B 506.3 - 516 Dark brown shale changing @ 508 to light gray hard un- weathered Lime stone. L.S. slightly porous & vuggy @ 509.5-506.15 with very thin soft gray shale interbeds (1-2 mm) plenty of pyrite horiz. interbeds (lenses) in the shale.			Recovery 9.35' <u>Preserved core:</u> 505.25 - 506.72 WL = 100%. DT = 50 min
	516		RUN A 516 - 526 Light gray, mod. hard shaly L.S. non porous & unweathered with 1 inch interbed of shale (mod. soft, gray) at 516.			WL = 100% DT = 50 min Recovery = ~~10.1~~ 10.1
	526		RUN C 526 - 536 Light gray shaly L.S. mod. hard (scraped by knife easily), thinly laminated, unweathered			WL = 100% Recovery 10.25' DT = 30 min.

A-4

DRILLING LOG (Cont Sheet)		ELEVATION TOP OF HOLE		Hole No. CS-1		
PROJECT		INSTALLATION		SHEET 3 OF 3		
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	536		Run (C) 536-546			
			536-536.45 light gray shaly L.S. changing to pure L.S. that is light gray with hues of darker gray color. mod. porous & vuggy especially @ 538.7-539.2 & 542.8-543.8 with some deep vugs. @ 543.8 core gets better in quality - non porous - and it has gray shale lenses.			DT = 25 min WL = 100 % Recovery 10.1
	546		Run (A) 546-556			
			Light gray L.S. w/ darker gray hues & horizontal soft gray shale seams. Changing @ 548 to tannish or pinkish gray L.S. (with quartz) slightly porous & shly. Weathered, coarse grained then changing again @ 554 back to light gray L.S. as at top. Some vugs: A-5 rock.			Recovery 10.05 WL = 100 %

DRILLING LOG (Cont Sheet)			ELEVATION TOP OF HOLE		Hole No. CS-1	
PROJECT			DESCRIPTION		SHEET 41 OF SHEETS	
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	SOI OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Core breaks easily upon handling at gray shale seams.			
	556		RUN (8) 556 - 566			
			Pinkish to tannish gray L.S., shly. porous w/ dark gray hues and gray shale seams changing @ 564.5 to light gray non-porous L.S. The pinkish gray L.S. is coarser in grain than the lt. gray L.S. which is med. coarse grained.			Recovery = 10' WL = 50% DT = 30 min.
	566		RUN (9) 566 - 574			
			Pinkish to tannish gray L.S. with darker gray hues & gray shale seams. Underneath & hard.			Recov. 9' Water Loss = 50% D.T. = 1 hr
	574		RUN (10) 574 - 584			
			Same L.S. as in previous run, with soft gray shale lenses.			D.T. = 110 min WL = 50% Recovery 10'

A-6

DRILLING LOG (Cont Sheet)			ELEVATION TOP OF HOLE		Hole No. CS-1	
PROJECT			INSTALLATION		SHEET 5 OF 5 SHEETS	
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV. ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	584		Run (11) 584-594			
			Same L.S. as in previous run with vertical fractures and two broken rock zones @ 588.3-588.6 & 593-593.6 where drilling rod dropped.			D.T. = 80 min. W.L. = 50 % Recov. 9.3'
			Top 2 feet non porous, fine grained getting porous & broken @ 587.5-589 w/ plenty of pyrite veins.			* plenty of pyrite at broken rock zones.
			Rest of core is mod. porous.			* A vertical pyrite seam @ 587.7-590.0
			.3' thick quartz interbed @ 586.1-586.4			
	594		Run (12) 594-604			
			Light gray porous L.S. w/ plenty of quartz getting less porous @ 598 to bottom.			D.T. = 40 min W.L. = 100 % Recov. 9.9'
			Core has a weak putrid odor.			

A-7

DRILLING LOG (Cont Sheet)			ELEVATION TOP OF HOLE		Hole No. CS-1	
PROJECT			INSTALLATION		SHEET 6 OF 6	
ELEVATION a	DEPTH b	LOGNO c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV. e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	604		Run (13) 604-609			
			604-605 tannish gray L.S. changing to darker greenish gray L.S., fine grained, unweathered. Plenty of soft gray horiz. lenses. Core is nonporous			WL = 100 % DT = 40 min Recov. = 4.4
	609		Run (14) 609-615.5			
			609-612.5 light gray L.S., non porous, mod. fine grained changing to tannish gray L.S. w/ qtz. to bottom of core.			WL = 100 % DT = ? Recov. 7.2
	615.5		Run (15) 615.5-625.5			
			615.5-617 L.S. as in previous run changing to shaly L.S. 617-619 (darker gray) then to greenish gray thinly laminated shale.			Recov. 10' WL = 100 % D.T. = 60 min Pres. Core: 618-619.3 621.75-623.55 623.55-624.6
	619					

A-8

DRILLING LOG (Cont Sheet)			ELEVATION TOP OF HOLE		Hole No. CS-1	
PROJECT			INSTALLATION		SHEET 7 OF SHEETS	
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV- ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	625.5		Run (16) 625.5 - 630.5			
	627		625.5 - 627 dark greenish gray shale changing to tanish gray L.S. to bottom			Recov. 5' WL = 100% Pres. Core: 625.5 - 626.4
	630.5		Bottom			

A-9

Hole No. CS-2

DRILLING LOG		DIVISION	INSTALLATION		SHEET 1 OF 7 SHEETS	
1. PROJECT <u>UTP</u>			10. SIZE AND TYPE OF BIT <u>NQ wire line</u>			
2. LOCATION (Coordinates or Section) <u>Ft. Knox, KY</u>			11. DAY FOR ELEVATION SHOWN (FPM or MSL)			
3. DRILLING AGENCY <u>FMSH</u>			12. MANUFACTURER'S DESIGNATION OF DRILL <u>B-61</u>			
4. HOLE NO. (As shown on drawing title and file number) <u>CS-2</u>			13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN		DISTURBED	UNDISTURBED
5. NAME OF DRILLER <u>John Serber</u>			14. TOTAL NUMBER CORE BOXES			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.			15. DATE HOLE		STARTED	COMPLETED
7. THICKNESS OF OVERBURDEN			16. DATE HOLE		<u>Dec. 16 92</u>	
8. DEPTH DRILLED INTO ROCK <u>142.4</u>			17. ELEVATION TOP OF HOLE			
9. TOTAL DEPTH OF HOLE <u>642.4</u>			18. TOTAL CORE RECOVERY FOR BORING <u>1</u>			
			19. SIGNATURE OF INSPECTOR <u>G. Alsayab</u>			
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVER- ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Hole pie drilled to 500' depth & cased for 95'			
502			Run (1) 500 - 505.4 Dark brown unweath. New Albany shale with some gray colored banding at top 2.5' of core. Thinly laminated, fine textured.			Water Loss = 0 D.T. = ? Pres. 500 - 500.8 501.3 - 502.1 503.85 - 504.85 Recov. 5.3'
505.4			Run (2) 505.4 - 515.5 Same shale with more discontinuities. - some vertical - Frequent pyrite lenses & one pyrite & L.S. lens @ 505.65 - 505.9			D.T. = 65 min. W.L. = 0 Preserved: 507.4 - 508.55 508.55 - 509.3 509.85 - 510.6 510.6 - 511.35 514.4 - 515.15 Recov. 10.2'
515.5						

A-11

DRILLING LOG (Cont Sheet)			ELEVATION TOP OF HOLE		Hole No. CS-2	
PROJECT			DESCRIPTION		SHEET 2 OF SHEETS	
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
515.5			Run (3) 515.5 - 525.5			
			Same shale to 519.3 where core changes to vuggy, porous tannish gray L.S.			Recon. 9.95' D.T. = 35 min W.L. = ϕ Preserved Core: 515.5 - 516.6 516.6 - 517.65 518.25 - 519.3
519.3			At 521.5 rock change to finer grained, light gray to tannish gray non porous L.S.			
525.5			Run (4) 525.5 - 535.8			
			Same L.S. as at bottom of previous run changing to darker gray shaly L.S. @ 527.6 which is unweathered, fine textured with some qtz.			Recon. 10.25 D.T. = 30 min. W.L. = ϕ Pres. Core 528.2 - 529.1 529.1 - 529.4 532.6 - 534 534 - 535.8
527.6						
535.8			Run (5) 535.8 - 545.8			
			shaly L.S. as above changing @ 544.3 to porous dark gray L.S.			D.T. = 30 min W.L. = ϕ Recon. = 10'

A-12

DRILLING LOG (Cont Sheet)			ELEVATION TOP OF HOLE		Hole No. CS-2	
PROJECT			INSTALLATION		SHEET 3 OF 3	
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			L.S. gets less shaly @ 537.3 to bottom.			<u>Pres. Core:</u>
	544.3					
	545.8		Run (6) 545.8 - 556			
			L.S. porous, tannish gray, vuggy, slightly weathered & odorous Rock improves in quality at bottom 1' (i.e. 555-556) Some gray shale Veins.			Recov. 10.2 D.T. = 25 min W.L. = ∅
	556		Run (7) 556 - ~~556~~ 566			
			Same light gray non porous L.S. as at bottom of last run changing @ 599.5 to tannish gray, porous silly. weather. L.S. w/ vuggs. Some gray shale veins. Smells like H ₂ S.			Recov. 10' D.T. = ? W.L. = ∅

A-13

DRILLING LOG (Cont Sheet)			ELEVATION TOP OF HOLE		Hole No. C5-2		
PROJECT			INSTALLATION		SHEET 4 OF 5 SHEETS		
ELEVATION a	DEPTH b	LOGNO c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV. BY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
	566		Run (8) 566 - 576 Tannish gray L.S. slly. weathered & frequently jointed at 568.5 - 574.6 w/ some porosity. Some gray shale veins. Odorous.			Recov. 10' D.T. = 40 min. W.L. = 9	
	576		Run (9) 576 - 586.2 SW tannish gray L.S. as above. Non-porous, coarse grained with shale lenses & veins.			W.L. = 7 D.T. = ? Recov. 10.2	
	586.2						

A-14

DRILLING LOG (Cont Sheet)			ELEVATION TOP OF HOLE		Hole No. C5-2		
PROJECT			INSTALLATION			SHEET 5 OF 5	
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV. ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
	586.2		Run (10) 586.2 - 596.4				
			Same L.S. as in previous run			Recov. 10.2' D.T. = 50 min. W.L. = ∅	
	596.4		Run (11) 596.4 - 606.3				
			Same L.S. as above changing @ 602 to pinkish gray, porous & vuggy L.S. with fatted odor.			Recov. 9.9' D.T. = 50 min W.L. = ∅	
	606.3		Run (12) 606.3 - 616.3				
			Porous pinkish gray vuggy L.S. with frequent discontinuities changing @ 613.8 to darker 'A-15'			Recov. 9.8'	

DRILLING LOG (Cont Sheet)			ELEVATION TOP OF HOLE		Hole No. CS-2	
PROJECT			DESCRIPTION		SHEET 6 OF 6	
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			gray L.S. with plenty of qtz mixed with the L.S. Non porous to slily. porous			
	616.3		Run (13) 616.3 - 626.3			
			Sam as above to 624.8 where it gets tannish-gray and coarser grained			Recov. 9.7' D.T. = 30 min W.L. = ø
	626.3		Run (14) 626.3 - 636.3			
			Tannish gray L.S. as above changing @ 628.8 to shaly L.S. down to 630.6 & grading again to dark gray limy shale down to 632. 632-636.2 gray Waldron shale unweath, mod. soft			D.T. = 30 min. W.L. = ø Pres. Core: 632.7 - 634 634.2 - 635.55 Recov. 9.9'

A-16

DRILLING LOG (Cont Sheet)		ELEVATION TOP OF HOLE		Hole No. CS-2		
PROJECT		INSTALLATION		SHEET 7 OF 7 SHEETS		
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV. e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	634.3		Run (15) 636.3-642.4			
	638		Top to 638' pure Waldron shale, gray unweathered.			Pres. Core: 636.6 - 637.6 637.6 - 639.1
	639.8		638-639.8 limy shale.			
			639.8 - BOH tannish gray L.S. slightly porous.			Recov. 6.2'
	642.4		--642.4 BOH			

A-17

Hole No. CS-3

DRILLING LOG		DIVISION		INSTALLATION		SHEET 1 OF 7 SHEETS	
1. PROJECT UTP				10. SIZE AND TYPE OF BIT 1 1/2" wire line			
2. LOCATION (Coordinate or Station) Fl. Knox, KY				11. DAYUM FOR ELEVATION BROWN (TBM or MSL)			
3. DRILLING AGENCY FMSM				12. MANUFACTURER'S DESIGNATION OF DRILL B-61			
4. HOLE NO. (As shown on drawing title and file number) CS-3				13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN		13. DISTURBED UNDISTURBED	
5. NAME OF DRILLER John Serber				14. TOTAL NUMBER CORE BOXES			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				15. ELEVATION GROUND WATER			
7. THICKNESS OF OVERBURDEN				16. DATE HOLE Dec. 29			
8. DEPTH DRILLED INTO ROCK 139.6				16. STARTED COMPLETED Dec. 29 Jan. 4, 93			
9. TOTAL DEPTH OF HOLE 639.45				17. ELEVATION TOP OF HOLE			
				18. TOTAL CORE RECOVERY FOR BORING 1			
				19. SIGNATURE OF INSPECTOR Ghailan Alsayab			
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
			Hole pre drilled to 499.8' & cased down to 95'				
	499.8		Run (1) 499.8 - 505				
			Dark brown shale (New Albany) unweath, frequently jointed, with some pyrite lenses			D.T. = W.L. = ϕ Recov. 5' Pres. Core: 502.53 - 503.15 503.15 - 503.75	
	505		Run (2) 505 - 514				
			shale - same as above.			Recov. 8.6' D.T. = 40 min W.L. = ϕ Pres core: 505.35 - 506.01 507.7 - 508.55 508.55 - 509.4 509.4 - 510.45 511.2 - 511.95 511.45 - 513.55	
	514		Run (3) 514 - 524				
			514 - 517.5 New Albany shale as above changing at 517.5 to tannish gray L.S., porous.			Recov. 10.2' D.T. = 90 min. W.L. = ϕ	

A-19

DRILLING LOG (Cont Sheet)			ELEVATION TOP OF HOLE		Hole No. C-5-3	
PROJECT			INSTALLATION		SHEET 2 OF 2	
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV. e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			At 520 L.S. gets non porous & shaly. L.S. has plenty of mixed qtz.			Pres. Core: 515.5 - 517.05
	524		Run (4) 524 - 534.3			
			524 - 525.8 light gray non porous L.S. 525.8 - 526.2 L.S. gets mixed w/ gray shale getting shaly L.S. 526.2 - bottom. Fine grained, nonporous, and unweathered.			Recov. 10.3 D.T. = 90 min W.L. = x Pres. Core: 526.2 - 527.3 528.65 - 529.82 531 - 532.5 532.5 - 533.7
	534.3		Run (5) 534.3 - 544.3			
			shaly L.S., same as above with blended quartz. L.S. gets less shaly & coarser grained @ 541.5 to bottom. 544 - 544.3 cement- gray L.S.			Recov. 10' D.T. = ? W.L. = x Pres. Core: 534.3 - 535.7 536.8 - 537.68 538.2 - 539.45 540.3 - 541.65 541.65 - 543.2

A-20

DRILLING LOG (Cont Sheet)			ELEVATION TOP OF HOLE		Hole No. C 5-3	
PROJECT			INSTALLATION		SHEET 5 OF SHEETS	
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV- ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	544.3		Run (6) 544.3 - 554.6			
			Light gray L.S. with plenty of qtz, porous, unweathered, with fetted odor. Frequently jointed			Recov. 10.3' D.T. = 60 min W.L. = 0
	564.4		Run (7) 554.6 - 564.4			
			554.6 - 555.1 light tannish gray mostly non porous L.S., frequently jointed changing @ 555.1 to 559.4 to light gray slightly porous L.S. Frequent discontin. plenty of qtz. 559.4 - 564.4 tannish gray L.S. again. Fetted odor.			Recov. 9.8' D.T. = ? W.L. = 0

A-21

DRILLING LOG (Cont Sheet)			ELEVATION TOP OF HOLE		Hole No. C S - 3	
PROJECT			PRELIMINARY		SHEET 4 OF SHEETS	
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV. e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	564.4		Run (8) 564.4 - 573.75			Dec. 31, 92
			Same tan.-gray L.S. as above w/ fetted odor. mod. porous.			Recov. = 9.35' D.T. = ? W.L. = 0
	573.75		Run (9) 573.75 - 582.1			Recov. = 8.35' D.T. = 60 min W.L. = 1/2
			Top .25 same tan.- gray L.S. changing to light gray fine grained unweath. L.S. at 574 - 576 with few vugs with gray soft shale lenses .5 - 1" thick at top & bottom of that zone then at 576 - 582.1 back to tannish gray porous, sw, L.S.			
	582.1		Run (10) 582.1 - 583.9			Run was cut short due to blockage of water circuit. Need to replace bit.
	583.9		Same tannish gray L.S., less porous than before			Recov. 1.8'

A-22

DRILLING LOG (Cont Sheet)			ELEVATION TOP OF HOLE		Hole No. CS-3	
PROJECT			INSTALLATION		SHEET OF SHEETS 5	
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV. e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	583.9		Run (11) 583.9 - 594 Tannish gray L.S. Nonporous, hard, unweath. w/ plenty of quartz at bottom 2' especially. Also freq. shale lenses. Top .5' porous.			Recov. 10.2' D.T. = 60 min W.L. = 0
	594		Run (12) 594 - 604.2 Same as above getting sw & porous and silty vuggy at 600.4 to 604.2 with weak fetid odor.			Recov. 10.2' D.T. = 30 min. W.L. = 0
	604.2		Run (13) 604.2 - 614.3 Same as above. porous to 610.3 then less weath. & non porous to end of core. A-23			Recov. 10.1 D.T. = 30 min W.L. = 0

DRILLING LOG (Cont Sheet)			ELEVATION TOP OF HOLE		Hole No. CS-3	
PROJECT			INSTALLATION		SHEET 7 OF 7	
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVER- ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	636.3		Run (17) 636.3 - 639.45			
	639.45		Dark greenish gray shale (limy) at top - 4 grading to shaly L.S. & to tannish gray L.S. @ 638.1 - bottom			Pres. Core: 636.3 - 638.1
			BoH 639.45			

A-25

DRILLING LOG		DIVISION		INSTALLATION		SHEET 1 OF 7 SHEETS	
1. PROJECT UTP				10. SIZE AND TYPE OF BIT NQ wire line			
2. LOCATION (Coordinates or Section) Fl. Knox, KY				11. DAY ON FOR ELEVATION KNOWN (YES - NO)			
3. DRILLING AGENCY FMSM				12. MANUFACTURER'S DESIGNATION OF DRILL B-61			
4. HOLE NO. (As shown on drilling site and file number) CS-4				13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN		DISTURBED - UNDISTURBED	
5. NAME OF DRILLER John Serber				14. TOTAL NUMBER CORE BOXES			
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.				15. DATE HOLE STARTED Dec. 16, 92		COMPLETED	
7. THICKNESS OF OVERBURDEN				16. ELEVATION GROUND WATER			
8. DEPTH DRILLED INTO ROCK 144.65'				17. ELEVATION TOP OF HOLE			
9. TOTAL DEPTH OF HOLE 643.85'				18. TOTAL CORE RECOVERY FOR BORING			
				19. SIGNATURE OF INSPECTOR Ghailan Alsagab			
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
			Hole pre drilled to 499.2' & cased to 95' depth				
499.2			Run (1) 499.2 - 505.3			Recov. 6.1' D.T. = 35 min W.L. = 100 % Pres. Core: 501.45 - 502.2 502.2 - 503.05 503.8 - 504.6	
505.3			Run (2) 505.3 - 515.3			Recov. 10' W.L. = 50 % D.T. = 60 min Started losing water at 510' depth. Pres. core: 507.5 - 508.45 509.4 - 510.3 511.15 - 512.4 512.7 - 513.3 514.1 - 514.7	
515.3			New Albany shale w/ pyrite lenses & 1" thick pyrite interbed @ 506.6				

A-27

DRILLING LOG (Cont Sheet)			ELEVATION TOP OF HOLE		Hole No. CS-4	
PROJECT			INSTALLATION		SHEET 2 OF SHEETS	
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV. EFT e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	515.3		Run (3) 515.3 - 525.3			
	520		515.3 - 520 New Albany shale. Dark brown, thinly laminated, unweathered. with pyrite lenses. 520 - 525.3: L.S. light gray, unweathered. with pitted odor. L.S. is porous @ 520-522.			Recov. 9.9' Pres. Core: 516.25 - 517.45 518.3 - 518.9 518.11 - 519.8 519.8 - 520.8 D.T. = 40 min W.L. = 100%
	525.3		Run (4) 525.3 - 535.5			
			525.3 - 527.9 light gray L.S., non porous, mod. coarse grained. changing to darker gray shaly L.S., unweathered, mod. hard, to bottom of core.			Pres. Core: 530.55 - 531.4 532.8 - 534.6 534.6 - 535.5 D.T. = 30 min W.L. = 100% Recovery = 10.2'
	535.3		Run (5) 535.5 - 545.5			
			Same L.S. as at bottom of last run, shaly.			D.T. = 50 min W.L. = 100% Recov. 10'

A-28

DRILLING LOG (Cont Sheet)			ELEVATION TOP OF HOLE		Hole No. C3-4	
PROJECT			INSTALLATION		SHEET 5 OF 5 SHEETS	
ELEVATION a	DEPTH b	LOGNO c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV. e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						<u>Pres. core:</u> 535.85 - 537.05 537.05 - 538 538 - 539.2 542.9 - 544.1
	545.5		Run (6) 545.5 - 555.7 Top foot gray shaly L.S. grading to lt. gray porous L.S. with felted odor. Vuggy & silty weath. More vuggy @ 551.6 - 552			Recov. 10.2' D.T. = 20 min W.L. = 100 % <u>Pres. core:</u> 545.5 - 547
	555.7		Run (7) 555.7 - 565.8 555.7 - 557 light gray porous, vuggy L.S. with felted odor getting more shaly & less to non porous - with darker gray color 557 - 562. At 562 L.S. gets silty weath, tannish gray & porous with strong odor.			Recov 10.1' D.T. = 20 min W.L. = 100 %

A-29

DRILLING LOG (Cont Sheet)			ELEVATION TOP OF HOLE		Hole No. C5-4	
PROJECT			INSTALLATION		SHEET 9 OF 9	
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV. e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	565.8		Run (8) 565.8 - 576			
			565.8 - 567.4 porous tannish gray L.S., sw, getting unweather. to 570.2 then sw again to bottom of core Oderous.			D.T. = 5 min W.L. = 100 % Recov. 10.2'
	576		Run (9) 576 - 586			
			Top .6' tannish gray porous L.S., sw, getting darker gray, shaly & mod. coarse grained 576.5 - 578.7 where it has 1' thick shale bed @ 578.7 and 576.5 (both ends of that shaly zone) then back to tannish gray porous L.S.			D.T. = 20 min. W.L. = 100 % Recov. 10'
	586		A-30			* Next day, rods where hung up ~~at~~ @ 486' and could not be moved up or down. Flushed hole by inserting water hose all way down, used soap & bentonite, Took 2 days.

DRILLING LOG (Cont Sheet)			ELEVATION TOP OF HOLE		Hole No. C5-4	
PROJECT			INSTALLATION		SHEET 5 OF 5	
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV. e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	586		Run (10) 586 - 596.2 gray to tannish gray L.S. with lenses of soft gray shale. Non porous, unweather. with quartz. Smooth texture.			Dec 21, 92 stuck on wed. Freed on Fri Resumed coring on Mon. Dec. 21, 92 Using Revert mud. D-T. = 45 min. W.L. = 100 % Recov. 10.2'
	596.2		Run (11) 596.2 - 606.4 596.2 - 602.5 Same L.S. as above, smooth textured. At 602.5 core gets tannish gray. Rock gets vuggy @ 603.5 - 605 & porous 605 - bottom. 2 broken rock zones where rod dropped while coring at 604.8 - 605 & 605.3 - 605.5 where vuggs caused rock to break.			D-T. = 50 min. W.L. = 100 % Recov. 9.95' on 10.2' run
	606.4					

A-31

DRILLING LOG (Cont Sheet)			ELEVATION TOP OF HOLE		Hole No. CS-4		
PROJECT			DESCRIPTION			DEPTH OF SHOTS	
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV. e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
	606.4		Run (12) 606.4 - 616.7				
			Light tannish gray L.S., weath., porous & vuggy with fettered odor. Changing color @ 614 to cement gray, more porous & coarser grained. Deteriorated rock Zone @ 612.6 - 612.8			D.T. = 50 min W.L. = 100 % Recov. 10.2	
	616.7		Run (13) 616.7 - 626.85				
			616.7 - 624.3 Same L.S. as at bottom of previous run (cement gray, porous) 624.3 - bottom: gets shaly, with thin lamination, tannish gray L.S. plenty of gray shale lenses.			Recov. 10.2 W.L. = 100 % D.T. = 35 min	
	626.85		Run (14) 626.85 - 636.85				
			626.85 - 650 tannish gray, non porous L.S. grading to darker gray shaly L.S. to 632			D.T. = 95 min W.L. = 100 % Recov. 9.9	

A-32

DRILLING LOG (Cont Sheet)			ELEVATION TOP OF HOLE		Hole No. CS-4	
PROJECT			INSTALLATION		SHEET 7 OF 7 SHEETS	
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	632		Then grades to greenish gray shale (Waldron), thinly laminated & fine textured to end of core (i.e. 632' where shale starts)			<u>Pres. Core:</u>
	636.85		Run (15) 636.85 - 643.85			
	641.5		Shale (Waldron) as in bottom of previous run changing to tannish gray L.S. at 641.5			Recov. = 7' W.L. = 100 % D.T. = ? <u>Pres. Core:</u>
	643.85		639 - 640.5 shale & L.S. mix.			
			BOH			

A-33

BORING NO. 15-5

Project WTP
 Date: Start 5/19/93 Complete 6/18/93
 Location N. Boggs' Hollow E. Ft. Knox, Ky
 Drilling Agency Gayles Bros
 Driller Joe Stivers Inspector Parsons
 Drill Type Fulling Hole Master CF-15
 Drill Method 9 7/8" bit, 4 3/4" bit, 2 1/2" core
 Thickness of Overburden 35.8'
 Depth Drilled into Rock 609.7'
 Total Depth of Boring 645.5'
 Dir. of Boring X Vert. Inclined Deg

Instrumentation Installed _____
 Surface Elevation 7061' ±
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
701.12		SURFACE COVER								
	1	Brown, <u>CLAYEY SILT</u> , Moist, Soft to Medium Stiff (0'-3')	ML							9 7/8" Tricone Roller Bit to a depth of 49.5'
	2									Installed 6" Sch 80 P.V.C. to a depth of 47ft, The casing fell 2.5' when started to use 4 3/4" Hammer Drill. Glued an extension on to P.V.C. Casing
696.12	3	Reddish Brown to Brownish Red, <u>CLAY</u> , Moist to Damp, Medium Stiff (3'-5')	CH							Depth of 6" P.V.C. Casing 49.5' w/ 1' stickup
696.12	4									
	5	Red to Reddish Brown, Cherty <u>CLAY</u> , Damp to Dry, Med Stiff to Medium Stiff (5'-24.8')	CH							
	6									
	7									
	8									
	9									
	10									
	11									2 1/2" Core
	12									Christson NG-SWL Core Barrel
	13									Using a surface set 25/CT
	14									SN 35 Ø 38649
	15									Type Ø 2 Ø 406676
	16									
	17									
	18									
	19									
	20									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-5

Project H.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency
 Driller Inspector
 Drill Type
 Drill Method
 Thickness of Overburden
 Depth Drilled into Rock
 Total Depth of Boring
 Dir. of Boring Vert. Inclined Deg

Instrumentation Installed
 Surface Elevation
 Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
68.11		SURFACE COVER								
20										
21										
22										
23										
24										
67.3	25	Light Red, Fine SANDY CLAY								
	26	w/ Lenses of CLAYEY Fine SAND								
	27	Damp to Moist Soft to Med Stiff								
	28	(24.8' - 35.8')								
	29									
	30									
	31									
	32									
	33									
	34									
66.3	35	Top of Rock								
	36	SHALE, Light Brown to Lt Gray, Soft to Mod. Hard,								
	37	Weathered, Damp w/ CLAY								
	38	Seams								
		(35.8 to 62')								
SH	39	New Providence Shale								
40										

water encountered at top of Rock

SYMBOLS: ∇ - WATER LEVEL AT COMPLETION
 ∇ - WATER LEVEL HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
 1 June 1988

SHEET 2 OF 33 A-36

BORING NO. CS-5

BORING NO. CS-5

Project U. T. P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
661.12		SURFACE COVER								
	40									
	41									
	42									
	43									
SH	44									
	45									
	46									
4 3/4"	47									
bit	48									
6"	49									
Casing	50									
6566	51									
4 3/4"	52									
bit	53									
SH	54									
	55									
	56									
	57									
	58									
	59									
	60									

Bottom of 6" P.V.C. 5119
 Sch 80 Casing 5120
 Elev 656.6'
 at 49.5' changed to
 4 3/4" air hammer
 drill bit

5120

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-5

Instrumentation Installed _____

Project U. T. P.

Surface Elevation _____

Date: Start 1/1 Complete 1/1

Datum for Surface El. _____

Location N E

Drilling Agency _____

Driller _____ Inspector _____

Drill Type _____

Drill Method _____

Thickness of Overburden _____

Depth Drilled into Rock _____

Total Depth of Boring _____

Dir. of Boring Vert. _____ Inclined _____ Deg _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
671.12		SURFACE COVER								
SH	60									5/21
	61									
639.12	62	Top of Unweathered Rock								
SH	63	SHALE, Lt Gray, Mod Hard, Unweathered, Dip.								
	64	(62' - 439')								
	65	New Providence Shale								
	66									
	67									
	68									
	69									
	70									
	71									
	72									
	73									
	74									
	75									
	76									
	77									
	78									
	79									
	80									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-5

Instrumentation Installed _____

Project U. T. P.

Surface Elevation _____

Date: Start 1/1 Complete 1/1

Datum for Surface El. _____

Location N _____ E _____

Drilling Agency _____

Driller _____ Inspector _____

Drill Type _____

Drill Method _____

Thickness of Overburden _____

Depth Drilled into Rock _____

Total Depth of Boring _____

Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
626.1	80	SURFACE COVER								
	81									
SH	82									
	83									
	84									
	85									
	86									
	87									
	88									
	89									
	90									
	91									
	92									
	93									
	94									
	95									
	96									
	97									
	98									
	99									
	100									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▽ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-5Project U.T.P.Date: Start 1/1 Complete 1/1Location N EDrilling Agency Driller Inspector Drill Type Drill Method Thickness of Overburden Depth Drilled into Rock Total Depth of Boring Dir. of Boring Vert. Inclined DegInstrumentation Installed Surface Elevation Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
100.1		SURFACE COVER								
100.2										
100.3										
100.4										
100.5										
100.6										
100.7										
100.8										
100.9										
101.0										
101.1										
101.2										
101.3										
101.4										
101.5										
101.6										
101.7										
101.8										
101.9										
102.0										
102.1										
102.2										
102.3										
102.4										
102.5										
102.6										
102.7										
102.8										
102.9										
103.0										
103.1										
103.2										
103.3										
103.4										
103.5										
103.6										
103.7										
103.8										
103.9										
104.0										
104.1										
104.2										
104.3										
104.4										
104.5										
104.6										
104.7										
104.8										
104.9										
105.0										
105.1										
105.2										
105.3										
105.4										
105.5										
105.6										
105.7										
105.8										
105.9										
106.0										
106.1										
106.2										
106.3										
106.4										
106.5										
106.6										
106.7										
106.8										
106.9										
107.0										
107.1										
107.2										
107.3										
107.4										
107.5										
107.6										
107.7										
107.8										
107.9										
108.0										
108.1										
108.2										
108.3										
108.4										
108.5										
108.6										
108.7										
108.8										
108.9										
109.0										
109.1										
109.2										
109.3										
109.4										
109.5										
109.6										
109.7										
109.8										
109.9										
110.0										
110.1										
110.2										
110.3										
110.4										
110.5										
110.6										
110.7										
110.8										
110.9										
111.0										
111.1										
111.2										
111.3										
111.4										
111.5										
111.6										
111.7										
111.8										
111.9										
112.0										
112.1										
112.2										
112.3										
112.4										
112.5										
112.6										
112.7										
112.8										
112.9										
113.0										
113.1										
113.2										
113.3										
113.4										
113.5										
113.6										
113.7										
113.8										
113.9										
114.0										
114.1										
114.2										
114.3										
114.4										
114.5										
114.6										
114.7										
114.8										
114.9										
115.0										
115.1										
115.2										
115.3										
115.4										
115.5										
115.6										
115.7										
115.8										
115.9										
116.0										
116.1										
116.2										
116.3										
116.4										
116.5										
116.6										
116.7										
116.8										
116.9										
117.0										
117.1										
117.2										
117.3										
117.4										
117.5										
117.6										
117.7										
117.8										
117.9										
118.0										
118.1										
118.2										
118.3										
118.4										
118.5										
118.6										
118.7										
118.8										
118.9										
119.0										
119.1										
119.2										
119.3										
119.4										
119.5										
119.6										
119.7										
119.8										
119.9										
120.0										

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. 15-5

Instrumentation Installed _____

Project H. T. P.

Surface Elevation _____

Date: Start 1/1 Complete 1/1

Datum for Surface El. _____

Location N E

Drilling Agency _____

Driller _____ Inspector _____

Drill Type _____

Drill Method _____

Thickness of Overburden _____

Depth Drilled into Rock _____

Total Depth of Boring _____

Dir. of Boring _____ Vert. _____ Inclined _____ Deg

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
54.1		SURFACE COVER								
	120									
	121									
	122									
	123									
	124									
	125									
54	126									
	127									
	128									
	129									
	130									
	131									
	132									
	133									
	134									
	135									
	136									
	137									
	138									
	139									
	140									

SYMBOLS: ☒ WATER LEVEL AT COMPLETION
☐ WATER LEVEL _____ HOURS AFTER COMPLETION> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUIDORL FORM 1202
1 June 1988SHEET 2 OF 33 **A-41****BORING NO.** 15-5

BORING NO. CS-5

Project U.T.P.
Date: Start 1/1 Complete 1/1
Location N E
Drilling Agency _____
Driller _____ Inspector _____
Drill Type _____
Drill Method _____
Thickness of Overburden _____
Depth Drilled into Rock _____
Total Depth of Boring _____
Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
Surface Elevation _____
Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
561.12		SURFACE COVER								
	140									
	141									
5H	142									
	143									
	144									
	145									
	146									
	147									
	148									
	149									
	150									
	151									
	152									
	153									
	154									
	155									
	156									
	157									
	158									
	159									
	160									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

BORING NO. _____

Instrumentation Installed _____

Project _____

Surface Elevation _____

Date: Start ____/____/____ Complete ____/____/____

Datum for Surface El. _____

Location N _____ E _____

Drilling Agency _____

Driller _____ Inspector _____

Drill Type _____

Drill Method _____

Thickness of Overburden _____

Depth Drilled into Rock _____

Total Depth of Boring _____

Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
846.15		SURFACE COVER								
	160									
	161									
	162									
	163									
	164									
	165									
	166									
	167									
	168									
	169									
	170									
	171									
	172									
	173									
	174									
	175									
	176									
	177									
	178									178'± Elev a 3' Comp From
	179									
	180									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL ____ HOURS AFTER COMPLETION> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-5

Project H. T. P.
Date: Start 1/1 Complete 1/1
Location N E
Drilling Agency _____
Driller _____ Inspector _____
Drill Type _____
Drill Method _____
Thickness of Overburden _____
Depth Drilled into Rock _____
Total Depth of Boring _____
Dir. of Boring Vert. Inclined _____ Deg _____

Instrumentation Installed _____
Surface Elevation _____
Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
521.1		SURFACE COVER								
54	170									
	181									
	172									
	173									
	174									
	175									
	176									
	177									
	178									
	179									
	180									
	181									
	182									
	183									
	184									
	185									
	186									
	187									
	188									
	189									
	190									
	191									
	192									
	193									
	194									
	195									
	196									
	197									
	198									
	199									
	200									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▽ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-5

Project H. T. P.
Date: Start 1/1 Complete 1/1
Location N E
Drilling Agency _____
Driller _____ Inspector _____
Drill Type _____
Drill Method _____
Thickness of Overburden _____
Depth Drilled into Rock _____
Total Depth of Boring _____
Dir. of Boring Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
Surface Elevation _____
Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
506.1		SURFACE COVER								
	200									
	201									
	202									
5H	203									
	204									
	205									
	206									
	207									
	208									
	209									
	210									
	211									
	212									
	213									
	214									
	215									
	216									
	217									
	218									
	219									
	220									

SYMBOLS: WATER LEVEL AT COMPLETION
 WATER LEVEL ____ HOURS AFTER COMPLETION
ORL FORM 1202
1 June 1988

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

SHEET 11 OF 33: A-45

BORING NO. CS-5

BORING NO. _____

Instrumentation Installed _____

Project _____

Surface Elevation _____

Date: Start _____ Complete _____

Datum for Surface El. _____

Location N _____ E _____

Drilling Agency _____

Driller _____ Inspector _____

Drill Type _____

Drill Method _____

Thickness of Overburden _____

Depth Drilled into Rock _____

Total Depth of Boring _____

Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
491.12		SURFACE COVER								
220										
221										
222										
223										
224										
225										
226										
227										
228										
229										
230										
231										
232										
233										
234										
235										
236										
237										
238										
239										
240										

SYMBOLS: ☒ WATER LEVEL AT COMPLETION
☐ WATER LEVEL _____ HOURS AFTER COMPLETION> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUIDORL FORM 1202
1 June 1988

SHEET 12 OF 33 SHI A-46

BORING NO. CS-5

BORING NO. CS-5

Project U.T.P.
 Date: Start 11 Complete 11
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
461.1		SURFACE COVER								
240										
241										
242										
243										
244										
245										
246										
247										
248										
249										
250										
251										
252										
253										
254										
255										
256										
257										
258										
259										
260										

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL ____ HOURS AFTER COMPLETION
 ORL FORM 1202
 1 June 1988

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

SHEET 12 OF 33 : **A-47**

BORING NO. CS-5

BORING NO. CS-5

Instrumentation Installed _____

Project W. T. P.

Surface Elevation _____

Date: Start 1/1 Complete 1/1

Datum for Surface El. _____

Location N E

Drilling Agency _____

Driller _____ Inspector _____

Drill Type _____

Drill Method _____

Thickness of Overburden _____

Depth Drilled into Rock _____

Total Depth of Boring _____

Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
441.1		SURFACE COVER								
	260									
	261									
	262									
	263									
	264									
54	265									
	266									
	267									
	268									
	269									
	270									
	271									
	272									
	273									
	274									
	275									
	276									
	277									
	278									
	279									
	280									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL _____ HOURS AFTER COMPLETION> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-5

Project H. T. P.
Date: Start 1/1 Complete 1/1
Location N E
Drilling Agency _____
Driller _____ Inspector _____
Drill Type _____
Drill Method _____
Thickness of Overburden _____
Depth Drilled into Rock _____
Total Depth of Boring _____
Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
Surface Elevation _____
Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
421.1		SURFACE COVER								
280										
281										
282										
283										
284										
285										
286										
287										
288										
289										
290										
291										
292										
293										
294										
295										
296										
297										
298										
299										
300										

SYMBOLS: WATER LEVEL AT COMPLETION
 WATER LEVEL _____ HOURS AFTER COMPLETION
ORL FORM 1202
1 June 1988

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

SHEET 15 OF 23 s. A-49

BORING NO. CS-5

BORING NO. CS-5

Project U. T. P.
Date: Start 1/1 Complete 1/1
Location N E
Drilling Agency _____
Driller _____ Inspector _____
Drill Type _____
Drill Method _____
Thickness of Overburden _____
Depth Drilled into Rock _____
Total Depth of Boring _____
Dir. of Boring Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
Surface Elevation _____
Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
401.12		SURFACE COVER								
300										
301										
302										
303										
304										
305										
306										
307										
308										
309										
310										
311										
312										
313										
314										
315										
316										
317										
318										
319										
320										

SYMBOLS: ∇ WATER LEVEL AT COMPLETION
 ∇ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

BORING NO. 15-5

Project U. T. P.
Date: Start 1/1 Complete 1/1
Location N E
Drilling Agency _____
Driller _____ Inspector _____
Drill Type _____
Drill Method _____
Thickness of Overburden _____
Depth Drilled into Rock _____
Total Depth of Boring _____
Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
Surface Elevation _____
Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
381.12		SURFACE COVER								
320										
321										
322										
323										
324										
325										
326										
327										
328										
329										
330										
331										
332										
333										
334										
335										
336										
337										
338										
339										
340										

SYMBOLS: ∇ WATER LEVEL AT COMPLETION
 ∇ - WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-5

Instrumentation Installed _____

Project H. T. P.

Surface Elevation _____

Date: Start 1/1 Complete 1/1

Datum for Surface El. _____

Location N E

Drilling Agency _____

Driller _____ Inspector _____

Drill Type _____

Drill Method _____

Thickness of Overburden _____

Depth Drilled into Rock _____

Total Depth of Boring _____

Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
366.1	0.0	SURFACE COVER								
377	10									
376	20									
375	30									
374	40									
373	50									
372	60									
371	70									
370	80									
369	90									
368	100									
367	110									
366	120									
365	130									
364	140									
363	150									
362	160									
361	170									
360	180									
359	190									
358	200									
357	210									
356	220									
355	230									
354	240									
353	250									
352	260									
351	270									
350	280									
349	290									
348	300									
347	310									
346	320									
345	330									
344	340									
343	350									
342	360									
341	370									
340	380									
339	390									
338	400									
337	410									
336	420									
335	430									
334	440									
333	450									
332	460									
331	470									
330	480									
329	490									
328	500									
327	510									
326	520									
325	530									
324	540									
323	550									
322	560									
321	570									
320	580									
319	590									
318	600									
317	610									
316	620									
315	630									
314	640									
313	650									
312	660									
311	670									
310	680									
309	690									
308	700									
307	710									
306	720									
305	730									
304	740									
303	750									
302	760									
301	770									
300	780									
299	790									
298	800									
297	810									
296	820									
295	830									
294	840									
293	850									
292	860									
291	870									
290	880									
289	890									
288	900									
287	910									
286	920									
285	930									
284	940									
283	950									
282	960									
281	970									
280	980									
279	990									
278	1000									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. 15-5Project U. T. P.Date: Start 1/1 Complete 1/1Location N EDrilling Agency Driller Inspector Drill Type Drill Method Thickness of Overburden Depth Drilled into Rock Total Depth of Boring Dir. of Boring Vert. Inclined Deg Instrumentation Installed Surface Elevation Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
371.1		SURFACE COVER								
	360									
	361									
	362									
SH	363									
	364									
	365									
	366									
	367									
	368									
	369									
	370									
	371									
	372									
	373									
	374									
	375									
	376									
	377									
	378									
	379									
	380									

SYMBOLS: ☒ WATER LEVEL AT COMPLETION
☐ WATER LEVEL HOURS AFTER COMPLETION> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUIDORL FORM 1202
1 June 1988SHEET 19 OF 33 S. A-53**BORING NO.** 15-5

BORING NO. CS-5

BORING NO. CS-5

BORING NO. CS-5

Instrumentation Installed _____

Project 4. T.P.

Surface Elevation _____

Date: Start 1/1 Complete 1/1

Datum for Surface El. _____

Location N _____ E _____

Drilling Agency _____

Driller _____ Inspector _____

Drill Type _____

Drill Method _____

Thickness of Overburden _____

Depth Drilled into Rock _____

Total Depth of Boring _____

Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
701.1		SURFACE COVER								
	700									
	701									
	702									
	703									
	704									
	705									
	706									
	707									
	708									
	709									
	710									
	711									
	712									
	713									
	714									
	715									
	716									
	717									
	718									
	719									
	720									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▽ WATER LEVEL _____ HOURS AFTER COMPLETION> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-5

Project H.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
261.1		SURFACE COVER								
	720									
	721									
	722									
	723									
	724									
	725									
	726									
	727									
	728									
	729									
	730									
5H	731									
	732									
	733									
	734									
	735									
	736									
	737									
	738									
262.1	739									
5H	740	New Albany Shale (Black to Dark Brown Dust)								

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-5

Instrumentation Installed _____

Project H. T. P.

Surface Elevation _____

Date: Start 1/1 Complete 1/1

Datum for Surface El. _____

Location N E

Drilling Agency _____

Driller _____ Inspector _____

Drill Type _____

Drill Method _____

Thickness of Overburden _____

Depth Drilled into Rock _____

Total Depth of Boring _____

Dir. of Boring Vert. _____ Inclined _____ Deg _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
261.1		SURFACE COVER								
	440									
	441									
	442									
	443									
	444									
	445									
	446									
	447									
	448									
	449									
	450									
	451									
	452									
	453									
	454									
	455									
	456									
	457									
	458									
	459									
	460									

SYMBOLS: ∇ - WATER LEVEL AT COMPLETION
 ∇ - WATER LEVEL _____ HOURS AFTER COMPLETION> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-5

Instrumentation Installed _____

Project U.T.P.

Surface Elevation _____

Date: Start 1/1 Complete 1/1

Datum for Surface El. _____

Location N E

Drilling Agency _____

Driller _____ Inspector _____

Drill Type _____

Drill Method _____

Thickness of Overburden _____

Depth Drilled into Rock _____

Total Depth of Boring _____

Dir. of Boring Vert. _____ Inclined _____ Deg _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
746.13		SURFACE COVER								
746.0										
746.1										
746.2										
746.3										
746.4										
746.5										
746.6										
746.7										
746.8										
746.9										
747.0										
747.1										
747.2										
747.3										
747.4										
747.5										
747.6										
747.7										
747.8										
747.9										
748.0										

Jt - Joint
Sty - Styrofoam
Xyln - Crystalline

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-5

Project U.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
2261.2		SURFACE COVER								
5 ft	480									SH - Shale Ls - Limestone Dol - Dolomite BIP - Bedding Plane Mech - Mechanical Break Geo - Geologist 526
	481									
	482	Start of 2 1/2" Core								
5 ft	483					8				Run 1 512.7
	484	pyrite				2 1/4				Cored 9.8'
	485	Bedding Plane				1 1/4				Rec 9.8'
	486	pyrite								Loss 0.0'
	487									Time 16:30 - 17:00
	488	Mech. Geo.								Waxed Depth Elev Sample
	489									1 482.5 218.6
	490									487.4 213.7
	491	Silty Vug								2 487.4 213.7
	492	pyrite								489.9 211.2
	493	Mech								Water Return 1570
	494	Mech Break								Run 1 to Run 6
	495	Core Spin								Water Loss at Weathered SH at Top of Rock
	496	Mech								512.7
	497	Broken Mech								Run 2 512.5
	498	CLAY								Cored 10.3
	499	BIP CLAY								Rec 10.3
	500	Mech								Loss 0.0
	501	(New Albany Shale)								Time 9:20 - 10:00
	502	SHALE, Brown Black to Black								Waxed Depth Elev Sample
	503	Thinly Laminated, soft to								3 493.7 207.4
	504	Medium Hard, w/ Occ								496.3 204.8
	505	Siltstone Lenses and								4 496.3 204.8
	506	Pyrite nodules.								499.4 201.7
	507	Broken								
	508	Siltstone								

SYMBOLS: ∇ WATER LEVEL AT COMPLETION
 ∇ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-5

Instrumentation Installed _____

Project U.T.P.

Surface Elevation _____

Date: Start 1/1 Complete 1/1

Datum for Surface El. _____

Location N E

Drilling Agency _____

Driller _____ Inspector _____

Drill Type _____

Drill Method _____

Thickness of Overburden _____

Depth Drilled Into Rock _____

Total Depth of Boring _____

Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
201.1		SURFACE COVER								
	500	JT								
	501	Broken Arches								
	502									
	503	Mech								
	504	Bedding Plane								
	505									Run 3 Cored 10.3 Rec 10.3 Loss 0.0 Time 10:50-11:20
5 ft	506	Mech								
	507	Sls Mech JT								
	508	Broken Mech								
	509	Mech								
	510									
	511	Mech								
	512	Mech Siltystone								
	513	Mech Vertical JT								
187.5'	514	Archie								
L5	515	Mech Geo (Jeffersonville Limestone)								
	516	Sty Porous Zone								
	517	Sty Limestone, Tan Brown to Lt Grey, Hard, Fossiliferous, Pervious								
	518	Sty Limestone BIP								
182.1'	519	Sty Limestone BIP								
	520	Mech (Louisville Limestone)								
L5	521	Mech Geo								

SYMBOLS: ∇ - WATER LEVEL AT COMPLETION
 ∇ - WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
 1 June 1988

SHEET 26 OF 33 SI A-60

BORING NO. CS-5

BORING NO. CS-5

Project U. T. P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
520.2		SURFACE COVER								
520						8				
521						0				
522						3				
523		Shale Laminar B/P				2				
524		Meek Geo				1/8				Run 5 Cored 10.3 Rec 10.3 Loss 0.0 Time 12:35-13:10
525		Limestone, Light Gray to Gray, Medium Hard to Hard, Slightly Vuggy to Vuggy, w/ Porous Zones, Stylolites,								
526		w/ Occ Shale Laminar or Bed.								
527		LS								
528		Meek Geo								
529										
530										
531										
532		Meek								
533		LS								
534		Meek Geo								Run 6 Cored 10.2 Rec 10.2 Loss 0.0 Time 12:55-13:20
535										
536										
537										
538		SH Laminar B/P Meek SH Bedding Plane								
539		SH Laminar B/P Meek Geo								
540		SH Laminar Zone B/P								
540		Cemented JT								

SYMBOLS: ∇ WATER LEVEL AT COMPLETION
 ∇ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. 15-5

Project H. T. P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring Vert. Inclined Deg

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
161.1'		SURFACE COVER								
160.6'	540	Gravelly JT								Run 6 out of spec for core size
	541	Porous Elev 160.6-159.6								
159.5'	542	Vug								
	543	Solution Mech								
	544	Mech								
	545	Solution								
	546	BIP Open Broken								
	547	Solution								Run 7
	548	Sty Vertical Fracture								Cored 10.3'
155.6'	549	BIP Open								Rec 10.3'
	550	Solution Sty								Loss 0.0'
	551	BIP Open								Time 13:40-14:45
	552	V. Porous Elev								Water Return 3 To
	553	BIP Open 155.6'-152.8'								
	554	BIP Open								
152.8'	555	Mech								
	556	BIP Open Solution								
	557	BIP Open								
	558	60° JT								
	559	SH Laminar 0.05' apart BIP								Out of Spec Core Size
	560	BIP Mech								
	561	SH Laminar BIP								
	562	Open Vugs Solution								
	563	SH Laminar BIP								
	564	SH Laminar BIP								
148.3'	565	SH								
	566	Sty V. Porous Elev								
147.3'	567	SH Laminar BIP 148.3'-147.3'								Run 8
	568	BIP Mech								Cored 10.0'
	569	SH Laminar BIP								Rec 10.0'
	570	Sty								Loss 0.0'
	571	SH Laminar BIP								Time 15:05-15:42
	572	Open Vug w/ Xstol								Out of Spec Core Size
	573	Sty Cemented BIP								
	574	Solution BIP Mech Geo								
	575	Vug								Lost all drill water for rest of Boring
	576	SH Laminar BIP								
	577	Sty Mech Geo								
	578	SH Laminar BIP								
	579	Sty								

SYMBOLS: ▽ WATER LEVEL AT COMPLETION > - PARTIAL LOSS OF DRILL FLUID
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION >> - TOTAL LOSS OF DRILL FLUID

BORING NO. LS-5

Project U. T. P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
141.12		SURFACE COVER								
137.8'	560	SH Laminar BIP								
	561	SH 0.02								
	562	SH Laminar BIP								
	563	SH 0.05								
	564	SH Laminar BIP								
136.8'	565	Fracture Cemented								Run 9 Cored 10.3' Rec 10.3 Loss 0.0 Time 16:05-16:43 Detected H ₂ S Elev 132.1'
	566	SH 0.02' Mech								
	567	SH Laminar BIP								
	568	SH Laminar BIP								
	569	Core spin SH 0.01'								
	570	Core spin								
	571	60° Cemented Jt								
	572	SH BIP Open Solution								
	573	Core spin								
	574	Mech 6-10								
127.0'	575	BIP Open Solution								
	576	SH Laminar BIP								
	577	BIP								
	578	SH Laminar BIP								
	579	SH 0.01								
122.9'	580	SH 0.02								
	581	Mech 6-10								
	582	Mech 6-10								
	583	SH 0.01								

SYMBOLS: ∇ WATER LEVEL AT COMPLETION
 ∇ WATER LEVEL _____ HOURS AFTER COMPLETION
 ORL FORM 1202
 1 June 1988

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

SHEET 29 OF 33 : **A-63**

BORING NO. LS-5

Instrumentation Installed _____
Surface Elevation _____
Datum for Surface El. _____

[illegible]

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▴ WATER LEVEL ____ HOURS AFTER COMPLETION

- > - PARTIAL LOSS OF DRILL FLUID
- >> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 30 OF 33 ST. A-64

BORING NO. 65-5

BORING NO. CS-5

Instrumentation Installed _____

Project H. T. P.

Surface Elevation _____

Date: Start 1/1 Complete 1/1

Datum for Surface El. _____

Location N E

Drilling Agency _____

Driller _____ Inspector _____

Drill Type _____

Drill Method _____

Thickness of Overburden _____

Depth Drilled into Rock _____

Total Depth of Boring _____

Dir. of Boring Vert. Inclined Deg

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
101.1'		SURFACE COVER								
100.8'	600	SH BIP								
	601	Vug								
98.8'	602	Mech Geo								
	603	BIP Open Porous to V. Porous								
	604	Mech Vug								
	605	Mech Vug								
	606	BIP Open								
LS	607	Vug								
	608	BIP Open								
92.3'	609	SH 0.01'								
	610	SH Laminar BIP								
	611	Mech SH Laminar BIP								
	612	Mech Geo								
	613	SH Laminar BIP								
LS	614	SH 0.03' SH 0.01'								
	615	SH Laminar BIP								
	616	SH 0.01'								
	617	Mech Geo SH Laminar								
	618	SH 0.01'								
	619	SH Laminar BIP								
	620	SH 0.01 to 0.03								

SYMBOLS: ∇ WATER LEVEL AT COMPLETION
 ∇ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
 1 June 1988

SHEET 31 OF 33 **A-65**

BORING NO. CS-5

Run 13
 Cored 10.1
 Rec 10.1
 Loss 0.0
 Time
 14:20 - 16:05
 Some Testable 4" Sections

Run 14
 Cored 10.3
 Rec 10.3
 Loss 0.0
 Time 8:47 - 11:30
 Some Testable Sections

BORING NO. CS-5

Project U. T. P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring Vert. Inclined Deg

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
81.1'		SURFACE COVER								
80.7'	120	Mech Cemented Jt Elev 80.7'-79.7'								
79.7'	121	Vug Xstol SH Laminar RNP Mech Geo								
	122	Vug, Xstol, Mech								
	123									
	124	Cemented Jt								
	125	Xstol Filled Vug SH								
75.9'	126	Transition Zone w/ Mech SH Elev 75.9'-74.3'								61.3 61.4
74.3'	127	Mech Geo								Run 15 Cored 7.8 Rec 7.8 Loss 0.0 Time 11:48-14:05
	128	Mech (Waldron Shale)								Wared Depth Elev Sample
	129	Mech SHALE, Dark Green, Medium Hard, Dolomitic.								9 <u>627.1</u> <u>74.0</u> <u>627.8</u> <u>72.3</u>
	130	Mech								10 <u>627.8</u> <u>73.8</u> <u>628.8</u> <u>72.8</u>
	131									11 <u>628.8</u> <u>72.8</u> <u>630.0</u> <u>71.1</u>
	132									12 <u>630.0</u> <u>71.1</u> <u>631.6</u> <u>69.5</u>
	133									13 <u>632.5</u> <u>68.6</u> <u>634.0</u> <u>67.1</u>
66.9'	134	Mech								
	135	SH Laminar (Laural Dolomite)								
	136	Mech								
	137	Dolomite, Light Gray to White, Hard w/ Shale								Run 16 Cored 10.1 Rec 10.1 Loss 0.0 Time 9:30-11:05
	138	SH 0.02' Laminar and layers.								
	139									
	140	Mech Geo								
	141	Mech								
	142									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▴ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-5

Project U.P.T.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
61.12		SURFACE COVER								
	640	sty								
	641									
	642									
	643	Mech Geo								
	644	Mech Geo								
	645	sty								
	646	Mech								
	647	B.D.H.								
	648									
	649									
	650									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION
 ORL FORM 1202
 1 June 1988

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

SHEET 33 OF 33 **A-67**

BORING NO. CS-5

BORING NO. 15-6

Project H.T.P.
 Date: Start 6/18/93 Complete 1/1
 Location N. Rogers' Hollow E. Ft. Knox, Ky.
 Drilling Agency Reynolds Bros
 Driller Joe Stiller Inspector Reynolds
 Drill Type Fulling Hole Master CF-15
 Drill Method 9 7/8" bit, 4 3/4" bit, 2 1/8" core
 Thickness of Overburden 44.0'
 Depth Drilled into Rock 602.8'
 Total Depth of Boring 646.8'
 Dir. of Boring ☒ Vert ☐ Inclined ☐ Deg

Instrumentation Installed _____
 Surface Elevation 712.8'
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
712.8'		SURFACE COVER								
712.4'		Crushed Gravel (0-0.4')								
	1	Reddish Brown, SILTY CLAY								9 7/8" Tricone Roller Bit to a depth of 49ft
	2	Moist, Soft to Medium Stiff								Installed 6" Sch 80 P.I.L. to a depth of 49ft, 1ft stickup
	3									
	4									
708.3'		(0.4' - 4.5')								
	5	Brownish Red to Red, SILTY CLAY, Moist to								Changed to 4 3/4" air hammer bit at 44'
	6	Damp, Medium Stiff to Stiff								
	7	(4.5 - 44.0')								
	8									
	9									
	10									2 1/8" Core
	11									Christen NG-5WL
	12									Core Barrel
	13									Using a surface set 25ct
	14									SN 35 38649
	15									Type 2 406676
	16									Changed Drill rig to Core Toy 22B
	17									
	18									Set NX casing to a depth of 500' Elev 712.8'
	19									
	20									

SYMBOLS: ☒ WATER LEVEL AT COMPLETION
☐ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-6

Project UTP
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
692.8'		SURFACE COVER								
	20									
	21									
	22									
	23									
	24									
	25									
	26									
	27									
	28									
	29									
	30									
	31									
	32									
	33									
	34									
	35									
	36									
	37									
	38									
	39									
	40									

SYMBOLS: ☒ WATER LEVEL AT COMPLETION ☐ - PARTIAL LOSS OF DRILL FLUID
☐ WATER LEVEL _____ HOURS AFTER COMPLETION ☐ - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-6

Project U.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
672.8	40	SURFACE COVER								
	41									
	42									
	43									
668.8	44	T.O.R.								
54	45	SHALE, Light Gray, Soft to Med Hard								
	46									
	47									
	48									
	49									
	50									
	51									
	52									
	53									
	54									
	55									
	56									
	57									
	58									
652.8	60									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
 1 June 1988

SHEET 3 OF 33 S. A-71

BORING NO. CS-6

BORING NO. CS-6

Project U.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
652.8		SURFACE COVER								
	60	LIMESTONE, Light Brown to								
	61	Light Gray, Medium Hard								
	62									
649.8	63	SHALE, Light Brown to Light Gray,								
648.3		Medium Hard								
55	64	SANDSTONE, Light Brown.								
	65									
647.3	66	SHALE, Lt Gray, Medium								
5H	67	Hard								
	68									
	69									
	70									
	71									
	72									
	73									
	74									
	75									
	76									
	77									
	78									
	79									
	80	Good Solid Shale 0.50'								

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-6

Instrumentation Installed _____

Project U.T.P.

Surface Elevation _____

Date: Start 1/1 Complete 1/1

Datum for Surface El. _____

Location N E

Drilling Agency _____

Driller _____ Inspector _____

Drill Type _____

Drill Method _____

Thickness of Overburden _____

Depth Drilled into Rock _____

Total Depth of Boring _____

Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
632.8'		SURFACE COVER								
	70									
	81									
	82									
	83									
	84									
	85									
	86									
	87									
	88									
	89									
	90									
	91									
	92									
	93									
	94									
	95									
	96									
	97									
	98									
	99									
632.8'	100									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION

▼ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID

>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988SHEET 5 OF 33 SI **A-73****BORING NO.** CS-6

BORING NO. CS-6

Instrumentation Installed _____

Project U.T.P.

Surface Elevation _____

Date: Start 1/1 Complete 1/1

Datum for Surface El _____

Location N _____ E _____

Drilling Agency _____

Driller _____ Inspector _____

Drill Type _____

Drill Method _____

Thickness of Overburden _____

Depth Drilled into Rock _____

Total Depth of Boring _____

Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
612.8		SURFACE COVER								
	100									
	101									
	102									
	103									
	104									
	105									
	106									
	107									
	108									
	109									
	110									
	111									
	112									
	113									
	114									
	115									
	116									
	117									
	118									
	119									
	120									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL _____ HOURS AFTER COMPLETION> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUIDORL FORM 1202
1 June 1988SHEET 6 OF 33 SHL A-74**BORING NO.** CS-6

BORING NO. CS-6

Project UTP
Date: Start 1/1 Complete 1/1
Location N E
Drilling Agency _____
Driller _____ Inspector _____
Drill Type _____
Drill Method _____
Thickness of Overburden _____
Depth Drilled into Rock _____
Total Depth of Boring _____
Dir. of Boring Vert. _____ Inclined _____ Deg

Instrumentation Installed _____
Surface Elevation _____
Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
592.8'		SURFACE COVER								
	120									
	121									
	122									
	123									
	124									
	125									
	126									
	127									
	128									
	129									
	130									
	131									
	132									
	133									
	134									
	135									
	136									
	137									
	138									
	139									
	140									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 2 OF 33 S **A-75**

BORING NO. CS-6

BORING NO. 15-6

Project U. T. P.
Date: Start 1/1 Complete 1/1
Location N E
Drilling Agency _____
Driller _____ Inspector _____
Drill Type _____
Drill Method _____
Thickness of Overburden _____
Depth Drilled into Rock _____
Total Depth of Boring _____
Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
Surface Elevation _____
Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
572.8		SURFACE COVER								
	140									
	141									
	142									
	143									
	144									
	145									
	146									
	147									
	148									
	149									
	150									
	151									
	152									
	153									
	154									
	155									
	156									
	157									
	158									
	159									
	160									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▽ WATER LEVEL _____ HOURS AFTER COMPLETION
ORL FORM 1202
1 June 1988

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

SHEET 8 OF 33 SHI **A-76**

BORING NO. 15-6

BORING NO. CS-6

Project H. T. P.
Date: Start 1/1 Complete 1/1
Location N E
Drilling Agency _____
Driller _____ Inspector _____
Drill Type _____
Drill Method _____
Thickness of Overburden _____
Depth Drilled into Rock _____
Total Depth of Boring _____
Dir. of Boring Vert. _____ Inclined _____ Deg

Instrumentation Installed _____

Surface Elevation _____

Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
552.8		SURFACE COVER								
	160									
	161									
	162									
	163									
	164									
	165									
	166									
	167									
	168									
	169									
	170									
	171									
	172									
	173									
	174									
	175									
	176									
	177									
	178									
	179									
	180									

SYMBOLS: ☒ WATER LEVEL AT COMPLETION
☐ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-6

Project H.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.		DEPTH		SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
SURFACE COVER												
5128		188										
		189										
		190										
		191										
		192										
		193										
		194										
		195										
		196										
		197										
		198										
		199										
		200										

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▼ WATER LEVEL _____ HOURS AFTER COMPLETION
 ORL FORM 1202
 1 June 1988

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

SHEET 10 OF 33 SHI A-78

BORING NO. CS-6

BORING NO. CS-6

Project U.T.P.
Date: Start 1/1 Complete 1/1
Location N E
Drilling Agency _____
Driller _____ Inspector _____
Drill Type _____
Drill Method _____
Thickness of Overburden _____
Depth Drilled into Rock _____
Total Depth of Boring _____
Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
Surface Elevation _____
Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
572.8		SURFACE COVER								
200										
201										
202										
203										
204										
205										
206										
207										
208										
209										
210										
211										
212										
213										
214										
215										
216										
217										
218										
219										
220										

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-6

Project U. T. P.
Date: Start 1/1 Complete 1/1
Location N E
Drilling Agency _____
Driller _____ Inspector _____
Drill Type _____
Drill Method _____
Thickness of Overburden _____
Depth Drilled into Rock _____
Total Depth of Boring _____
Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
Surface Elevation _____
Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
492.5		SURFACE COVER								
220										
221										
222										
223										
224										
225										
226										
227										
228										
229										
230										
231										
232										
233										
234										
235										
236										
237										
238										
239										
240										

SYMBOLS: ∇ WATER LEVEL AT COMPLETION
 $\blacktriangledown$ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-6

Instrumentation Installed _____

Project U.T.P.

Surface Elevation _____

Date: Start 1/1 Complete 1/1

Datum for Surface El. _____

Location N E

Drilling Agency _____

Driller _____ Inspector _____

Drill Type _____

Drill Method _____

Thickness of Overburden _____

Depth Drilled into Rock _____

Total Depth of Boring _____

Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
472.8		SURFACE COVER								
470										
471										
472										
473										
474										
475										
476										
477										
478										
479										
480										
481										
482										
483										
484										
485										
486										
487										
488										
489										
490										
491										
492										
493										
494										
495										
496										
497										
498										
499										
500										
501										
502										
503										
504										
505										
506										
507										
508										
509										
510										
511										
512										
513										
514										
515										
516										
517										
518										
519										
520										
521										
522										
523										
524										
525										
526										
527										
528										
529										
530										
531										
532										
533										
534										
535										
536										
537										
538										
539										
540										

SYMBOLS: ∇ - WATER LEVEL AT COMPLETION
 ∇ - WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-6

Project U.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
252.8		SURFACE COVER								
260										
261										
262										
263										
264										
265										
266										
267										
268										
269										
270										
271										
272										
273										
274										
275										
276										
277										
278										
279										
280										

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION
 ORL FORM 1202
 1 June 1988

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

SHEET 14 OF 33 SHE A-82

BORING NO. CS-6

BORING NO. CS-6

Project U.T.P.
Date: Start 1/1 Complete 1/1
Location N E
Drilling Agency _____
Driller _____ Inspector _____
Drill Type _____
Drill Method _____
Thickness of Overburden _____
Depth Drilled into Rock _____
Total Depth of Boring _____
Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
Surface Elevation _____
Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
432.8		SURFACE COVER								
	290									
	291									
	292									
	293									
	294									
	295									
	296									
	297									
	298									
	299									
	300									
	301									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-6

Project A.T.P.

Date: Start 1/1 Complete 1/1

Location N E

Drilling Agency

Driller Inspector

Drill Type

Drill Method

Thickness of Overburden

Depth Drilled into Rock

Total Depth of Boring

Dir. of Boring Vert. Inclined Deg

Instrumentation Installed

Surface Elevation

Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
412.8		SURFACE COVER								
300										
301										
302										
303										
304										
305										
306										
307										
308										
309										
310										
311										
312										
313										
314										
315										
316										
317										
318										
319										
320										

SYMBOLS: ☒ WATER LEVEL AT COMPLETION
☒ WATER LEVEL HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
 1 June 1988

SHEET 16 OF 33 SHE. A-84

BORING NO. CS-6

BORING NO. CS-6

Instrumentation Installed _____

Project U. T. P.

Surface Elevation _____

Date: Start 1/1 Complete 1/1

Datum for Surface El. _____

Location N E

Drilling Agency _____

Driller _____ Inspector _____

Drill Type _____

Drill Method _____

Thickness of Overburden _____

Depth Drilled into Rock _____

Total Depth of Boring _____

Dir. of Boring _____ Vert. _____ Inclined _____ Deg.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
392.8'		SURFACE COVER								
	320									
	321									
	322									
	323									
	324									
	325									
	326									
	327									
	328									
	329									
	330									
	331									
	332									
	333									
	334									
	335									
	336									
	337									
	338									
	339									
	340									

SYMBOLS:  WATER LEVEL AT COMPLETION
 WATER LEVEL _____ HOURS AFTER COMPLETION> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUIDORL FORM 1202
1 June 1988SHEET 17 OF 37 S. **A-85****BORING NO.** CS-6

BORING NO. CS-6

Instrumentation Installed _____

Project H. T. P.

Surface Elevation _____

Date: Start 1/1 Complete 1/1

Datum for Surface El. _____

Location N _____ E _____

Drilling Agency _____

Driller _____ Inspector _____

Drill Type _____

Drill Method _____

Thickness of Overburden _____

Depth Drilled into Rock _____

Total Depth of Boring _____

Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
172.8		SURFACE COVER								
	370									
	371									
	372									
	373									
	374									
	375									
	376									
	377									
	378									
	379									
	380									
	381									
	382									
	383									
	384									
	385									
	386									
	387									
	388									
	389									
	390									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-6

Project U.T.P.
Date: Start 1/1 Complete 1/1
Location N E
Drilling Agency _____
Driller _____ Inspector _____
Drill Type _____
Drill Method _____
Thickness of Overburden _____
Depth Drilled into Rock _____
Total Depth of Boring _____
Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
Surface Elevation _____
Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
352.8		SURFACE COVER								
360										
361										
362										
363										
364										
365										
366										
367										
368										
369										
370										
371										
372										
373										
374										
375										
376										
377										
378										
379										
380										

SYMBOLS: WATER LEVEL AT COMPLETION
 WATER LEVEL _____ HOURS AFTER COMPLETION
ORL FORM 1202
1 June 1988

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

SHEET 19 OF 33 S. A-87

BORING NO. CS-6

BORING NO. CS-6

Project U.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
272.8		SURFACE COVER								
372										
381										
382										
383										
384										
385										
386										
387										
388										
389										
390										
391										
392										
393										
394										
395										
396										
397										
398										
399										
400										

SYMBOLS: ☒ WATER LEVEL AT COMPLETION
☐ WATER LEVEL _____ HOURS AFTER COMPLETION
 ORL FORM 1202
 1 June 1988

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

SHEET 20 OF 23 St. A-88

BORING NO. CS-6

BORING NO. CS-6

Project H.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.		DEPTH		SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
312.8				SURFACE COVER								
		400										
		401										
		402										
		403										
		404										
		405										
		406										
		407										
		408										
		409										
		410										
		411										
		412										
		413										
		414										
		415										
		416										
		417										
		418										
		419										
		420										

SYMBOLS: ☒ WATER LEVEL AT COMPLETION
☐ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
 1 June 1988

SHEET 21 OF 33 SI **A-89**

BORING NO. CS-6

BORING NO. CS-6

Project U. T. P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
722.8		SURFACE COVER								
720										
721										
722										
723										
724										
725										
726										
727										
728										
729										
730										
731										
732										
733										
734										
735										
736										
737										
738										
739										
740										

SYMBOLS: ▽ WATER LEVEL AT COMPLETION > - PARTIAL LOSS OF DRILL FLUID
 ▴ WATER LEVEL _____ HOURS AFTER COMPLETION >> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-6

Project H.T.P.
Date: Start 1/1 Complete 1/1
Location N E
Drilling Agency _____
Driller _____ Inspector _____
Drill Type _____
Drill Method _____
Thickness of Overburden _____
Depth Drilled into Rock _____
Total Depth of Boring _____
Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
Surface Elevation _____
Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
272.8'		SURFACE COVER								
	790									
	441									
	442									
	443									
	444									
	445									
	446									
	447									
	448									
	449									
	450									
	451									
	452									
	453									
	454									
	455									
	456									
	457									
	458									
	459									
	460									

SYMBOLS:  WATER LEVEL AT COMPLETION
 WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988

SHEET 23 OF 33 **A-91**

BORING NO. CS-6

BORING NO. CS-6

Instrumentation Installed _____

Project U.T.P.

Surface Elevation _____

Date: Start 1/1 Complete 1/1

Datum for Surface El. _____

Location N _____ E _____

Drilling Agency _____

Driller _____ Inspector _____

Drill Type _____

Drill Method _____

Thickness of Overburden _____

Depth Drilled into Rock _____

Total Depth of Boring _____

Dir. of Boring Vert. _____ Inclined _____ Deg _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
252.8		SURFACE COVER								
461										
461										
462										
463										
464										
465										
466										
467										
468										
469										
470										
471										
472										
473										
474										
475										
476										
477										
478										
479										
480										

SYMBOLS: ☒ WATER LEVEL AT COMPLETION
☒ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-6

Instrumentation Installed _____

Project U.T.P.

Surface Elevation _____

Date: Start 1/1 Complete 1/1

Datum for Surface El. _____

Location N _____ E _____

Drilling Agency _____

Driller _____ Inspector _____

Drill Type _____

Drill Method _____

Thickness of Overburden _____

Depth Drilled into Rock _____

Total Depth of Boring _____

Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
232.8		SURFACE COVER								
	470									
	481									
	482									
	483									
	484									
	485									
	486									
	487									
	488									
	489									
	490									
	491									
	492									
	493									
	494									
	495									
	496									
	497									
	498									
	499									
	500									

Sty - Stylolite
 Jt - Joint
 Xyn - Crystalline
 SH - Shale
 Ls - Limestone
 Dol - Dolomite
 BIP - Bedding Plane
 Mech - Mechanical Break
 Geo - Geologist
 SLs - Siltstone

SYMBOLS: ☒ WATER LEVEL AT COMPLETION
☐ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
 1 June 1988

SHEET 25 OF 33 **A-93**

BORING NO. CS-6

BORING NO. CS-6

Project U.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring Vert Inclined Deg

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
212.8'		SURFACE COVER								
500		Mech								Start 2 nd Core with
501		Light Gray								Jay 22 B
502		Mech								Depth 500.1'
503		Light Gray								Elev 212.7'
504		Mech								Run 1
505		Core spin pyrite								Cored 9.9 Rec 9.9
506		Mech								Loss 0.0'
507		pyrite								Time 8:35-9:30
508		SLS 0.01								Waved
509		SLS 0.02								Sample Depth Elev
510		Mech								No 502.8 210.0
511		SLS Mech								1 503.9 208.9
512		SLS Laminar								2 505.0 207.8
513		SLS Laminar								3 507.1 205.7
514		SLS Laminar								4 507.7 205.1
515		SLS Laminar								5 508.8 204.0
516		SLS Laminar								6 508.8 204.0
517		SLS Laminar								7 509.6 203.2
518		SLS Laminar								100% Water Return
519		SLS Laminar								Run 2 Cored 4.8'
520		SLS Laminar								Rec 4.8 Loss 0.0'
521		SLS Laminar								Time 11:20-14:30
522		SLS Laminar								Waved
523		SLS Laminar								Sample Depth Elev
524		SLS Laminar								No 511.1 201.7
525		SLS Laminar								5 514.7 198.1
526		SLS Laminar								100% Water Return
527		SLS Laminar								Run 3 Cored 5.0
528		SLS Laminar								Rec 5.0 Loss 0.0
529		SLS Laminar								Time 15:30-16:00
530		SLS Laminar								Waved
531		SLS Laminar								Sample Depth Elev
532		SLS Laminar								No 518.0 194.8
533		SLS Laminar								6 521.4 191.4
534		SLS Laminar								
535		SLS Laminar								
536		SLS Laminar								
537		SLS Laminar								
538		SLS Laminar								
539		SLS Laminar								
540		SLS Laminar								

SYMBOLS: ☒ WATER LEVEL AT COMPLETION
☐ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-6

Project W. T. P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER/FLUID LOSS	LABORATORY RESULTS AND REMARKS
192.8'		SURFACE COVER								
191.5'	520	SLs 0.04								
	521	SLs Laminar								
	522	SLs 0.04								
	522	(Jeffersonville Limestone)								
	523	Limestone, Tan Brown to								
	523	LT Gray, Hard, Fossiliferous,								
	524	Mech Porous								
	524	SLs								
188.3'	525	Mech								
	525	Mech Shaly Limestone								
	526	Shale								
	526	Mech								
	527	SLs								
	528	BIP Open								
	528	SL Laminar								
	529	BIP Open								
	529	SL 0.02								
	530	Aggillous Porous Limestone								
	530	Vert Fracture								
	531	BIP								
	531	SL Laminar								
	532									
	533	Mech Geo								
	534	SL Laminar								
	535	SL Laminar								
	536	Mech								
	537	Mech Very Aggillous Limestone								
	538									
	539	Mech Geo								
	540	Mech Geo								

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION
 ORL FORM 1202
 1 June 1988

SHEET 27 OF 33 **A-95****BORING NO.** CS-6

Trace of Hydrocarbons
 in Jeffersonville
 Limestone
 Some sections will
 not pass wire test
 for Jeffersonville
 Limestone

Run 4
 Cored 10.1'
 Rec 10.1'
 Loss 0.0
 Time 16:30-17:30

100% Water Return

Run 5
 Cored 10.1
 Rec 10.1
 Loss 0.0
 Time 8:30-9:00
 5% Drill return at the
 start of run
 80% return at end of
 run

BORING NO. 156

Project H. T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
172.8		SURFACE COVER								
	540	(Louisville Limestone)								
	541	Limestone, Light Gray to Gray, Medium Hard to Hard, Slightly Vuggy to Vuggy				2				
	542	Mech w/ Porous Zones, Stylolites, w/ Occ Shale Laminar				1/8				
	543	Mech Red w/ Occasional Chert nodules								
	544									
	545	Mech								
	546	Sh. Laminar Zone								
	547	Mech Shale Laminar 0.01' to 0.05' apart								
165.3	548	Mech Porous to Very Porous								
	549	B/P Open								
	550	Depth 547.5 Elev 165.3								
	551	B/P Open								
	552	Mech								
	553	B/P Open Sol.								
	554	Sh Laminar Sh. 0.01'								
	555	Solution								
	556	Mech								
	557	Sty								
	558	B/P Solution								
	559	Sty								
	560	Sty B/P								
	561	Sty								
	562	Mech								
	563	Mech								
	564	Mech								
	565	A/P Open Solution								
154.6	566	A/P Open Solution								
	567	Sh Laminar Sty								
	568	Con Spn								
	569	Sh Laminar								
	570	Sty								

SYMBOLS: ∇ - WATER LEVEL AT COMPLETION
 ∇ - WATER LEVEL _____ HOURS AFTER COMPLETION

ORL FORM 1202
 1 June 1988

SHEET 28 OF 33 SH A-96

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. 156

Run 6
 Cored 10.4 Ft. Bottom
 Rec 10.4
 Loss 0.0
 Time 9:30 - 10:00

Some sections of
 core will not pass
 70 To Water Return
 for rest of Boring

Run 7
 Cored 10.4
 Rec 10.4
 Loss 0.0
 Time 10:05 - 10:35
 Core out of spec
 for some sections

BORING NO. CS-6

Project U.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
152.8'		SURFACE COVER								
LS	561	Sh Laminar Sty								
		Sh Laminar								
151.8'	561	Vag Mecl Sol								
		Sh Laminar								
	562	Mecl								
		Sh Laminar								
		Sh 0.03' Depth Elev								
	563	Sh 0.01' 561.0 151.8'								
		Sh Laminar 577.5 135.3'								
	564	Sh Laminar								
		Vag								
	565	Vag								
		Sty								
	566	Sty								
		Sty								
	567	BIP Sol Core Spin								Run 8 Cored 10.0 Rec 10.0 Loss 0.0 Time 12:30 - 13:30 Core out of spec
LS	568	Vag BIP Solution								
		Sh 0.03								
	569	Sh 0.01 Sty								
		Sh Laminar								
	570	Core Spin								
		Sh Laminar								
	571	Vag BIP Solution								
		Sh Laminar 0.02 - 0.05 apart								
	572	BIP								
	573	Sty Sol								
		Sh Laminar								
	574	Sh 0.03								
		BIP Sh Laminar								
	575	BIP Open Solution								
		Sty								
	576	Mecl								
		Sh Laminar								
	577	Sty								
		Sh 0.05'								
	578	Sty								
	579									
		Sh								
	580	Sh Laminar								

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
 1 June 1988

SHEET 27 OF 33 SI **A-97**

BORING NO. CS-6

BORING NO. CS-6

Instrumentation Installed _____

Project U.T.P.

Surface Elevation _____

Date: Start 1/1 Complete 1/1

Datum for Surface El. _____

Location N E

Drilling Agency _____

Driller _____ Inspector _____

Drill Type _____

Drill Method _____

Thickness of Overburden _____

Depth Drilled Into Rock _____

Total Depth of Boring _____

Dir. of Boring Vert. Inclined Deg

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
132.8		SURFACE COVER								
	590	Mech								Some of core out of Sprc
	591	Mech								
	592	0.05' Chert Sh Laminar								Core in Run 9 is: Occasional small voids
	593	Chert								
	594	Sh Laminar								
	595	Sh 0.01' Laminar								
	596	Sty								
	597	Sh 0.01' Laminar								
	598	Sty								
	599	0.05' Loss Loss 0.1' Sh Core Spin								Run 10 Cored 4.5' Rec 4.75' Loss 0.15' Time 9:45-10:35 Core out of Sprc
	600	Sty								
	601	Sh 0.01' Laminar								
	602	Mech								
	603	Sh 0.02' Laminar								Run 11 Cored 5.7' Rec 5.7' Loss 0.0' Time 11:10-11:40
	604	Chert								
	605	Sty								
	606	Sh 0.01' Mech								
	607	Sh 0.02' Laminar								
	608	Chert Mech								
	609	Mech								
	610	Sh 0.01' Laminar								
	611	Mech Sty								
	612	Sh 0.01' Laminar								
	613	Sty								
	614	Sh Laminar								Run 12 Cored 10.2' Rec 10.2' Loss 0.0' Time 12:05-12:30
	615	Sh 0.01' w/ chert between								
	616	Chert								
	617	Sty								
	618	Sh 0.01' Laminar								

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▴ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
 1 June 1988

SHEET 30 OF 33 SH A-98

BORING NO. CS-6

BORING NO. CS-6

Project U.P.T.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
112.8		SURFACE COVER								
600		Mech								
601		Sh BIP Core Spin								
602		Sh Laminar								
603		Sh Laminar								
604		Sh Laminar								
605		Sh Laminar								
606		Sh Laminar								
607		Sh Laminar								
608		Sh Laminar								
609		Sh Laminar								
610		Sh Laminar								
611		Sh Laminar								
612		Sh Laminar								
613		Sh Laminar								
614		Sh Laminar								
615		Sh Laminar								
616		Sh Laminar								
617		Sh Laminar								
618		Sh Laminar								
619		Sh Laminar								
620		Sh Laminar								
621		Sh Laminar								
622		Sh Laminar								
623		Sh Laminar								
624		Sh Laminar								
625		Sh Laminar								
626		Sh Laminar								
627		Sh Laminar								
628		Sh Laminar								
629		Sh Laminar								
630		Sh Laminar								
631		Sh Laminar								
632		Sh Laminar								
633		Sh Laminar								
634		Sh Laminar								
635		Sh Laminar								
636		Sh Laminar								
637		Sh Laminar								
638		Sh Laminar								
639		Sh Laminar								
640		Sh Laminar								
641		Sh Laminar								
642		Sh Laminar								
643		Sh Laminar								
644		Sh Laminar								
645		Sh Laminar								
646		Sh Laminar								
647		Sh Laminar								
648		Sh Laminar								
649		Sh Laminar								
650		Sh Laminar								
651		Sh Laminar								
652		Sh Laminar								
653		Sh Laminar								
654		Sh Laminar								
655		Sh Laminar								
656		Sh Laminar								
657		Sh Laminar								
658		Sh Laminar								
659		Sh Laminar								
660		Sh Laminar								
661		Sh Laminar								
662		Sh Laminar								
663		Sh Laminar								
664		Sh Laminar								
665		Sh Laminar								
666		Sh Laminar								
667		Sh Laminar								
668		Sh Laminar								
669		Sh Laminar								
670		Sh Laminar								
671		Sh Laminar								
672		Sh Laminar								
673		Sh Laminar								
674		Sh Laminar								
675		Sh Laminar								
676		Sh Laminar								
677		Sh Laminar								
678		Sh Laminar								
679		Sh Laminar								
680		Sh Laminar								
681		Sh Laminar								
682		Sh Laminar								
683		Sh Laminar								
684		Sh Laminar								
685		Sh Laminar								
686		Sh Laminar								
687		Sh Laminar								
688		Sh Laminar								
689		Sh Laminar								
690		Sh Laminar								
691		Sh Laminar								
692		Sh Laminar								
693		Sh Laminar								
694		Sh Laminar								
695		Sh Laminar								
696		Sh Laminar								
697		Sh Laminar								
698		Sh Laminar								
699		Sh Laminar								
700		Sh Laminar								

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▴ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
 1 June 1988

SHEET 31 OF 35 A-99

BORING NO. CS-6

BORING NO. CS-6

Project U.P.T.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

Date: Start _____ Stop _____			USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
Location N _____ E _____										
Drilling Agency _____										
Driller _____ Inspector _____										
Drill Type _____										
Drill Method _____										
Thickness of Overburden _____										
Depth Drilled into Rock _____										
Total Depth of Boring _____										
Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____										
ELEV.	DEPTH	SOIL CLASSIFICATION								
92.8'		SURFACE COVER								
	620	STY								NQ Found to be hung on 6/28 Removed NX casing and over drilled NX casing w/ 3 1/2" QD, casing to a depth of 616' Elev 96.8'
	621	Sh Laminar Sh 0.01 to 0.03								
	622	Cone Spin Sh 0.01								
	623	Sh 0.02								
	624	Sh Laminar Mech Mech Geo								
	625	Mech Sh Laminar								
	626	STY Sh Laminar 0.01 to 0.07' 0.01 to 0.05 apart								
	627	Mech Sh Laminar Mech								
	628	Usg BIP Mech AIP								
	629	Mech								
	630	Sh Mech								
	631	Sh Zone 0.01 - 0.03'								
	632	Mech								
	633	(Waldron Shale)								
	634	Mech								
	635	AIP								
	636									
	637									
	638	Mech								
	639									
	640									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. 656

Project U.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
72.8'		SURFACE COVER								
SH	640									
71.4'	641	(Laurel Dolomite)				2				Waxed Sample
	642					1/8				No Depth Elev
	643	Mech Sty								9 636.2 76.6
	644	Dolomite, Light Gray to								638.3 74.5
	645	White, Hard w/ Shale								10 638.3 74.5
	646	Laminae and layers w/								642.9 69.9
	647	Occasional Stylolite								
	648	and Dark Bands								
66.0'	649	sty SHA0.03'								
	650	B.O.H.								
	651									
	652									
	653									
	654									
	655									
	656									
	657									
	658									
	659									
	660									
	661									
	662									
	663									
	664									
	665									
	666									
	667									
	668									
	669									
	670									
	671									
	672									
	673									
	674									
	675									
	676									
	677									
	678									
	679									
	680									
	681									
	682									
	683									
	684									
	685									
	686									
	687									
	688									
	689									
	690									
	691									
	692									
	693									
	694									
	695									
	696									
	697									
	698									
	699									
	700									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-7

Project U. T. P.
 Date: Start 6/15/93 Complete 7/12/93
 Location N Recess Hollow E. Ft. Knox, Ky
 Drilling Agency Bailey Bros
 Driller Joe Stillwell Inspector Parsons
 Drill Type Fuller Link Master CF-15
 Drill Method 9 7/8" Bit, 4 1/2" bit, 2 1/2" bit
 Thickness of Overburden 39.0'
 Depth Drilled into Rock 557.7'
 Total Depth of Boring 636.7'
 Dir. of Boring X Vert. Inclined Deg

Instrumentation Installed
 Surface Elevation 706.4
 Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
706.9		SURFACE COVER								
	1	Lt Brown, <u>SILTY CLAY</u> , Wet, Soft to Medium Stiff (0-4')								9 7/8" Tricone Roller Bit to a depth of 43'
	2									
	3									Installed 6" Sch 40 P.V.C. to a depth of 43 ft.
702.9	4	<u>Limestone Boulder</u> (4-5')								
701.9	5	Reddish Brown to Dark Red, <u>SILTY CLAY w/ Chert</u> Fragments, Damp to Moist, Stiff to Very Stiff								
	6									
	7									
	8									
	9									
	10									2 1/8" Core drilled using a Jay 22B and 3 1/2" Casing from 495 to Surface
	11									
	12									
	13									2 1/8" Core (495'-535') Christensen Impregnated bit
	14									Type Ø 204 Ø 5132
691.9'	15	(5-15')								C' Bit N6SWL 2.985 RSG Green SN 35-037574 (535'-636.7') Impregnated Bit C' Bit N6SWL 2.985 RSG Green SN 35 Ø 386 Ø 4
	16	Reddish Brown, Fine <u>SANDY SILTY CLAY</u> , Moist, Stiff								
	17	(15-39')								
	18									
	19									
	20									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION
 ORL FORM 1202
 1 June 1988

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

SHEET 1 OF 32 SI A-103BORING NO. CS-7

BORING NO. _____

Project U.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring Vert. Inclined Deg

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
667.9		SURFACE COVER								
	20									
	21									
	22									
	23									
	24									
	25									
	26									
	27									
	28									
	29									
	30									
	31									
	32									
	33									
	34									
	35									
	36									
	37									
	38									
667.9	39	T.O.P.								
SH	40	SHALE, Lt Gray to Tan, Soft, w/ Occasional Clay Seams								

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▼ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. _____

Project U.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
666.9		SURFACE COVER								
	40									
	41									
	42									
	43									
	44									
	45									
	46									
54	47									
	48									
	49									
	50									
	51									
	52									
	53									
652.9	54	CLAY Seam 4"								
651.9	55	CLAY Seam 3"								
	56									
	57									
	58	(39-58)								
	59	Lt Gray, 5 Holes, Unweathered Medium Hard to Soft.								
	60	(58-60)								

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. _____

Project U.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
646.9	60	SURFACE COVER								
55	61	Lt Brown to Brown, Sandstone								
	62									
643.9	63	(60-63)								
54	64	Lt Gray, Shale, Medium Hard, w/ Occasional Joint and Chert nodules, (63'-474')								
	65									
	66	New Providence Shale								
	67									
	68									
	69									
	70									
	71									
	72									
	73									
	74									
	75									
	76									
	77									
	78									
	79									
	80									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO.

Project A.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring _____ Vert. _____ Inclined _____ Deg

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
626.9		SURFACE COVER								
	80									
	81									
	82									
	83									
	84									
	85									
	86									
	87									
	88									
	89									
	90									
	91									
	92									
	93									
	94									
	95									
	96									
	97									
	98									
	99									
	100									

SYMBOLS: ☒ WATER LEVEL AT COMPLETION
☐ WATER LEVEL _____ HOURS AFTER COMPLETION
 ORL FORM 1202
 1 June 1988

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

SHEET 5 OF 32 **A-107**

BORING NO. CS-7

BORING NO. 65-7

Project U.T.P.
Date: Start 1/1 Complete 1/1
Location N E
Drilling Agency _____
Driller _____ Inspector _____
Drill Type _____
Drill Method _____
Thickness of Overburden _____
Depth Drilled into Rock _____
Total Depth of Boring _____
Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
Surface Elevation _____
Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
606.9		SURFACE COVER								
	100									
	101									
	102									
	103									
	104									
	105									
	106									
	107									
	108									
	109									
	110									
	111									
	112									
	113									
	114									
	115									
	116									
	117									
	118									
	119									
	120									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▽ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

BORING NO. 65-7

Instrumentation Installed _____

Project U.T.P.

Surface Elevation _____

Date: Start 1/1 Complete 1/1

Datum for Surface El. _____

Location N E

Drilling Agency _____

Driller _____ Inspector _____

Drill Type _____

Drill Method _____

Thickness of Overburden _____

Depth Drilled into Rock _____

Total Depth of Boring _____

Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
586.9		SURFACE COVER								
	120									
	121									
	122									
	123									
	124									
	125									
	126									
	127									
	128									
	129									
	130									
	131									
	132									
	133									
	134									
	135									
	136									
	137									
	138									
	139									
	140									

SYMBOLS: ∇ WATER LEVEL AT COMPLETION
 ∇ WATER LEVEL _____ HOURS AFTER COMPLETION> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUIDORL FORM 1202
1 June 1988SHEET 7 OF 32 SI **A-109****BORING NO.** 65-7

BORING NO. CS-7

Project U.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
566.9		SURFACE COVER								
567										
568										
569										
570										
571										
572										
573										
574										
575										
576										
577										
578										
579										
580										
581										
582										
583										
584										
585										
586										
587										
588										
589										
590										

SYMBOLS: ▽ WATER LEVEL AT COMPLETION > - PARTIAL LOSS OF DRILL FLUID
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION >> - TOTAL LOSS OF DRILL FLUID
 ORL FORM 1202
 1 June 1988 SHEET 7 OF 32 ST. **A-110** **BORING NO.** CS-7

BORING NO. CS-1

Project U.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
546.9		SURFACE COVER								
160										
161										
162										
163										
164										
165										
166										
167										
168										
169										
170										
171										
172										
173										
174										
175										
176										
177										
178										
179										
180										

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. 15-7

Project U.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.		DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
526.9			SURFACE COVER								
		170									
		171									
		172									
		173									
		174									
		175									
		176									
		177									
		178									
		179									
		180									
		181									
		182									
		183									
		184									
		185									
		186									
		187									
		188									
		189									
		190									
		191									
		192									
		193									
		194									
		195									
		196									
		197									
		198									
		199									
		200									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-7Project U.T.P.Date: Start 1/1 Complete 1/1Location N E

Drilling Agency _____

Driller _____ Inspector _____

Drill Type _____

Drill Method _____

Thickness of Overburden _____

Depth Drilled into Rock _____

Total Depth of Boring _____

Dir. of Boring _____ Vert. _____ Incline 1 Deg

Instrumentation Installed _____

Surface Elevation _____

Datum for Surface El _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
5106.9		SURFACE COVER								
	200									
	201									
	202									
	203									
	204									
	205									
	206									
	207									
	208									
	209									
	210									
	211									
	212									
	213									
	214									
	215									
	216									
	217									
	218									
	219									
	220									

SYMBOLS: ∇ WATER LEVEL AT COMPLETION
 ∇ WATER LEVEL _____ HOURS AFTER COMPLETION> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUIDORL FORM 1202
1 June 1988SHEET 11 OF 32 S A-113**BORING NO.** CS-7

BORING NO. 15-1Project U. T. P.Date: Start 1/1 Complete 1/1Location N E

Drilling Agency _____

Driller _____ Inspector _____

Drill Type _____

Drill Method _____

Thickness of Overburden _____

Depth Drilled into Rock _____

Total Depth of Boring _____

Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____

Surface Elevation _____

Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
4861.9		SURFACE COVER								
223										
222										
222										
223										
224										
225										
226										
227										
228										
229										
230										
231										
232										
233										
234										
235										
236										
237										
238										
239										
240										

SYMBOLS: ∇ - WATER LEVEL AT COMPLETION
 $\blacktriangledown$ - WATER LEVEL _____ HOURS AFTER COMPLETION> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUIDORL FORM 1202
1 June 1988SHEET 12 OF 32 SHEETS **A-114****BORING NO.** 15-1

BORING NO. 15-1

Project H.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
466.9		SURFACE COVER								
	240									
	241									
	242									
	243									
	244									
	245									
	246									
	247									
	248									
	249									
	250									
	251									
	252									
	253									
	254									
	255									
	256									
	257									
	258									
	259									
	260									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▼ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-7Project H.T.P.Date: Start 1/1 Complete 1/1Location N EDrilling Agency Driller Inspector Drill Type Drill Method Thickness of Overburden Depth Drilled into Rock Total Depth of Boring Dir. of Boring Vert. Inclined Deg Instrumentation Installed Surface Elevation Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
446.9		SURFACE COVER								
260										
261										
262										
263										
264										
265										
266										
267										
268										
269										
270										
271										
272										
273										
274										
275										
276										
277										
278										
279										
280										

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-7Project H.T.P.Date: Start 1/1 Complete 1/1Location N E

Drilling Agency _____

Driller _____ Inspector _____

Drill Type _____

Drill Method _____

Thickness of Overburden _____

Depth Drilled into Rock _____

Total Depth of Boring _____

Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____

Surface Elevation _____

Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
426.9		SURFACE COVER								
	250									
	251									
	252									
	253									
	254									
	255									
	256									
	257									
	258									
	259									
	260									
	261									
	262									
	263									
	264									
	265									
	266									
	267									
	268									
	269									
	270									
	271									
	272									
	273									
	274									
	275									
	276									
	277									
	278									
	279									
	280									
	281									
	282									
	283									
	284									
	285									
	286									
	287									
	288									
	289									
	290									
	291									
	292									
	293									
	294									
	295									
	296									
	297									
	298									
	299									
	300									

SYMBOLS: ∇ - WATER LEVEL AT COMPLETION
 ∇ - WATER LEVEL _____ HOURS AFTER COMPLETION> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

BORING NO. 65-7Project U.T.P.Date: Start 1/1 Complete 1/1Location N E

Drilling Agency _____

Driller _____ Inspector _____

Drill Type _____

Drill Method _____

Thickness of Overburden _____

Depth Drilled into Rock _____

Total Depth of Boring _____

Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____

Surface Elevation _____

Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER FT-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
4116.9		SURFACE COVER								
310										
311										
312										
313										
314										
315										
316										
317										
318										
319										
320										

SYMBOLS: ☒ WATER LEVEL AT COMPLETION
☐ WATER LEVEL _____ HOURS AFTER COMPLETION> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUIDORL FORM 1202
1 June 1988SHEET 16 OF 32 SHEETS **A-118****BORING NO.** 65-7

BORING NO. 65-7

Project U.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
386.4		SURFACE COVER								
320										
321										
322										
323										
324										
325										
326										
327										
328										
329										
330										
331										
332										
333										
334										
335										
336										
337										
338										
339										
340										

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. 15-7

Project W.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller Inspector
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring Vert. Inclined _____ Deg

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
366.9		SURFACE COVER								
367										
367.1										
367.2										
367.3										
367.4										
367.5										
367.6										
367.7										
367.8										
367.9										
368										
368.1										
368.2										
368.3										
368.4										
368.5										
368.6										
368.7										
368.8										
368.9										
369										
369.1										
369.2										
369.3										
369.4										
369.5										
369.6										
369.7										
369.8										
369.9										
370										

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION
 ORL FORM 1202
 1 June 1988

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

SHEET 18 OF 32 SHI A-120

BORING NO. 15-7

BORING NO. 15-7

Project U.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____

Surface Elevation _____

Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
376.9		SURFACE COVER								
	360									
	361									
	362									
	363									
	364									
	365									
	366									
	367									
	368									
	369									
	370									
	371									
	372									
	373									
	374									
	375									
	376									
	377									
	378									
	379									
	380									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
 1 June 1988

SHEET 14 OF 32 **A-121**

BORING NO. 15-7

BORING NO. 65-7Project U. T. P.Date: Start 1/1 Complete 1/1Location N EDrilling Agency Driller InspectorDrill Type Drill Method Thickness of Overburden Depth Drilled into Rock Total Depth of Boring Dir. of Boring Vert. Inclined DegInstrumentation Installed Surface Elevation Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
326.4		SURFACE COVER								
	310									
	311									
	312									
	313									
	314									
	315									
	316									
	317									
	318									
	319									
	320									
	321									
	322									
	323									
	324									
	325									
	326									
	327									
	328									
	329									
	330									
	331									
	332									
	333									
	334									
	335									
	336									
	337									
	338									
	339									
	340									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
▼ WATER LEVEL _____ HOURS AFTER COMPLETION> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUIDORL FORM 1202
1 June 1988SHEET 22 OF 32 SHE. A-122**BORING NO.** 65-7

BORING NO. 65-7

Instrumentation Installed _____

Project U. T. P.

Surface Elevation _____

Date: Start 1/1 Complete 1/1

Datum for Surface El. _____

Location N _____ E _____

Drilling Agency _____

Driller _____ Inspector _____

Drill Type _____

Drill Method _____

Thickness of Overburden _____

Depth Drilled into Rock _____

Total Depth of Boring _____

Dir. of Boring _____ Vert. _____ Inclined _____ Deg. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
		SURFACE COVER								
706.4	0									
	1									
	2									
	3									
	4									
	5									
	6									
	7									
	8									
	9									
	10									
	11									
	12									
	13									
	14									
	15									
	16									
	17									
	18									
	19									
	20									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. 65-7

Instrumentation Installed _____

Project U. T. P.

Surface Elevation _____

Date: Start 1/1 Complete 1/1

Datum for Surface El. _____

Location N E

Drilling Agency _____

Driller _____ Inspector _____

Drill Type _____

Drill Method _____

Thickness of Overburden _____

Depth Drilled into Rock _____

Total Depth of Boring _____

Dir. of Boring Vert. _____ Inclined _____ Deg

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
296.9		SURFACE COVER								
	420									
	421									
	422									
	423									
	424									
	425									
	426									
	427									
	428									
	429									
	430									
5H	431									
	432									
	433									
272.9	434									
5H	435	New Albany Shale, SHALE, Brown-Black to Black, Thinly Laminated, Soft to Medium Hard, w/ Occ Siltstone Lenses and pyrite nodules								
	436									
	437									
	438									
	439									
	440									

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-7

Project U.T.P.
Date: Start 1/1 Complete 1/1
Location N E
Drilling Agency _____
Driller _____ Inspector _____
Drill Type _____
Drill Method _____
Thickness of Overburden _____
Depth Drilled into Rock _____
Total Depth of Boring _____
Dir. of Boring _____ Vert. _____ Inclined _____ Deg

Instrumentation Installed _____

Surface Elevation _____

Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
266.9		SURFACE COVER								
440										
441										
442										
443										
444										
445										
446										
447										
448										
449										
450										
451										
452										
453										
454										
455										
456										
457										
458										
459										
460										

SYMBOLS: ∇ - WATER LEVEL AT COMPLETION
 ∇ - WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-7

Project U.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring _____ Vert. _____ Inclined _____ Deg

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
246.4		SURFACE COVER								
460										
461										
462										
463										
464										
465										
466										
467										
468										
469										
470										
471										
472										
473										
474										
475										
476										
477										
478										
479										
480										

Ls = Limestone
 Dol = Dolomite
 Sh = Shale
 Sty = Stylolite
 Xst = Crystalline
 BIP = Bedding Plane
 Mech = Mechanical
 Break
 Geo = Geologist

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION
 ORL FORM 1202
 1 June 1988

SHEET 24 OF 32 SHEET A-126

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID
 BORING NO. CS-7

BORING NO. CS-7

Project U.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
276.9		SURFACE COVER								
490										Core is Very Bad
491										From 495 to 509.5
492										due to bent Core
493										Barrel. The inner barrel
494										would not last for
495										Washed
496										Sample
497										No Depth Elev
498										1 497.3 209.6
499										497.9 209.0
500										2 500.9 206.0
501										501.7 205.2
502										3 501.9 205.0
503										503.1 209.8
504										4 505.4 201.5
505										506.8 200.1
506										5 507.3 199.6
507										508.4 199.5
508										6 508.6 198.3
509										509.5 197.9
510										7 509.9 197.0
511										511.5 195.4
512										8 511.5 193.7
513										512.3 194.6
514										9 512.3 194.6
515										513.2 193.7
211.9'		Start 2 1/2" Core								Run 1
496		Broken Mech								Cored 4.9
497		mech (New Albany Shale)								Rec 2.9
498		mech SHALE, Brown Black to								Loss 0.0
499		mech Black, Thinly Laminated								Time
500		mech Soft to Medium Hard,								11:10 - 12:30
501		mech Siltstone w/ Occ Siltstone Lenses								Left 2' of core in
502		mech Broken Mech and pyrite nodules								Bottom of hole
503		mech (core splinters)								100% Drill Water Returned
504		mech Pyrite								
505		mech Broken Mech								

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

Instrumentation Installed _____
Surface Elevation _____
Datum for Surface El. _____

[illegible]

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL ____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
>> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-7

Project U.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
		SURFACE COVER								
520		Limestone, Tan Brown to Lt Gray, Hard, Fossiferous								
521		BIP Porous w/ Hydrocarbons								
522		BIP Sh. BIP Sh. Laminar								
523		Very argillaceous Black porous								
524		Louisville Limestone								
525		BIP								
526		Mech								
527		Mech Geo								
528		Mech								
529		Mech								
530		Mech Geo								
531		Mech Geo								
532		Limestone, Light Gray to Gray, Medium Hard to Hard, Slightly Vuggy to Vuggy w/ Porous Zones, stylolites, w/ oolite								
533		Laminar or Bed w/ Occ Stringer of								
534		Mech Dolomite								
535		Mech								
536		Mech								
537		BIP								
538		Mech								
539		Sh Laminar with 0.03 apart								

Res 5000

↓

Run 6
 Cored 10.2
 Rec 10.2
 Loss 0.0
 Time
 14:00 - 14:35

20% Drill water
 Return

Run 7
 Cored 10.0
 Rec 10.0
 Loss 0.0
 Time
 14:45 - 15:20
 H₂S Odor
 Changed Bit

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-7

Project U.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
166.9		SURFACE COVER								
	540	Mesh Sh Laminar 0.01 to 0.05' apart								
		Mesh								
	541	Mesh								
Ls										
	542	AIP Open								
164.3										
	543	Perous to Very Perous Zone								
		AIP Open								
Ls		Solution								
	544	Vag								
		542.6 164.3								
	545	sty								
		552.6 154.3								
	546	BIP Solution								
		AIP Open w/ X-stall								
		AIP Open								
	547	Vertical Fracture								
		AIP Sh Laminar								
	548	AIP								
		Vertical Fracture								
	549	AIP Open								
		Sh Laminar								
	550	AIP Open Solution								
		sty								
	551	Core Spin								
		BIP Open								
	552	BIP Open								
		BIP w/ Weathered Sh								
	553	sty								
		Sh Laminar								
154.3		sty								
		Sh 0.01' Sh Laminar								
	554	Sh Laminar								
		Sh Laminar								
	555	Vag								
Ls		Mesh								
	556	Mesh Sh Laminar								
		Sh Laminar								
	557	Sh Laminar								
		Sh Laminar								
	558	Sh Laminar								
		Sh Laminar								
	559	Sh Laminar								
		Sh Laminar								
	560	Sh Laminar								
		Sh Laminar								
	561	Sh Laminar								
		Sh Laminar								
	562	Sh Laminar								
		Sh Laminar								
	563	Sh Laminar								
		Sh Laminar								
	564	Sh Laminar								
		Sh Laminar								
	565	Sh Laminar								
		Sh Laminar								
	566	Sh Laminar								
		Sh Laminar								
	567	Sh Laminar								
		Sh Laminar								
	568	Sh Laminar								
		Sh Laminar								
	569	Sh Laminar								
		Sh Laminar								
	570	Sh Laminar								
		Sh Laminar								
	571	Sh Laminar								
		Sh Laminar								
	572	Sh Laminar								
		Sh Laminar								
	573	Sh Laminar								
		Sh Laminar								
	574	Sh Laminar								
		Sh Laminar								
	575	Sh Laminar								
		Sh Laminar								
	576	Sh Laminar								
		Sh Laminar								
	577	Sh Laminar								
		Sh Laminar								
	578	Sh Laminar								
		Sh Laminar								
	579	Sh Laminar								
		Sh Laminar								
	580	Sh Laminar								
		Sh Laminar								
	581	Sh Laminar								
		Sh Laminar								
	582	Sh Laminar								
		Sh Laminar								
	583	Sh Laminar								
		Sh Laminar								
	584	Sh Laminar								
		Sh Laminar								
	585	Sh Laminar								
		Sh Laminar								
	586	Sh Laminar								
		Sh Laminar								
	587	Sh Laminar								
		Sh Laminar								
	588	Sh Laminar								
		Sh Laminar								
	589	Sh Laminar								
		Sh Laminar								
	590	Sh Laminar								
		Sh Laminar								
	591	Sh Laminar								
		Sh Laminar								
	592	Sh Laminar								
		Sh Laminar								
	593	Sh Laminar								
		Sh Laminar								
	594	Sh Laminar								
		Sh Laminar								
	595	Sh Laminar								
		Sh Laminar								
	596	Sh Laminar								
		Sh Laminar								
	597	Sh Laminar								
		Sh Laminar								
	598	Sh Laminar								
		Sh Laminar								
	599	Sh Laminar								
		Sh Laminar								
	600	Sh Laminar								
		Sh Laminar								

SYMBOLS: ∇ WATER LEVEL AT COMPLETION
 ∇ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

BORING NO. CS-7

Project U.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring Vert. Inclined _____ Deg

Instrumentation Installed _____

Surface Elevation _____

Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
146.4		SURFACE COVER								
	560	BIP Open Solution								
Ls	561	BIP Open Solution								
	561	Sty Fracture 80°								
145.0	562	Core Spin 5' 0.03'								
	562	Sh Laminar								
	563	Sh Laminar Mech								
	563	Sty 5' 0.01'								
Ls	564	Sh Laminar								
	564	Sh Laminar Mech								
	565	Sty 5' 0.03' apart								
	565	Sh Laminar								
140.9	566	Sty Mech								
	566	Vug Xs tall								
	567	BIP Open								
	567	Sty 5' 0.04'								
	568	Sty Open Vertical Fracture Open								
	568	Sty Open								
	569	Core Spin Open								
	570	BIP Open								
	570	Core Spin 5' 0.04'								
	571	Vug Core Loss 0.2'								
	572	Vertical Fracture Open								
Ls	573	Sh Core Spin Old Core Loss								
	574	Porous Zone								
	574	BIP Open								
	575	Sty Open								
	576	Sty Mech								
	576	Sh Laminar 0.01 to 0.03' apart								
	577	Sh Laminar								
	578	Vug								
	579	Sty								
	580	BIP Open Solution								

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
 1 June 1988

SHEET 29 OF 32 A-131BORING NO. CS-7

Run 10
 Cored 10.3
 Rec 10.0
 Loss 0.3
 Time 4:55 - 10:35

Some sections of
 core will not pass
 specs.

No Drill water
 Return for the
 rest of bore.

Run 11
 Cored 10.1
 Rec 10.1
 Loss 0.0
 Time 10:45 - 11:40

BORING NO. CS-7Project U. T. P.Date: Start 1/1 Complete 1/1Location N EDrilling Agency Driller Inspector Drill Type Drill Method Thickness of Overburden Depth Drilled into Rock Total Depth of Boring Dir. of Boring Vert. Inclined DegInstrumentation Installed Surface Elevation Datum for Surface El.

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
126.4		SURFACE COVER								
	580	Sty								
126.0	581	Sh 0.1' w/ Core Spin								
	582									
	583	Sty Sh 0.02'								
	584	pyritz Mech								
	585	Core Spin Sh 0.05'								
	586	Sty Sh Laminar Sty 0.03' Sh								
65	587	Sh Laminar Mech								Run 12
	588	Chert Sh Laminar								Corrd 10.3
	589	Chert								Rec 0.0
	590	Mech Sty								Loss 0.0
	591	Sh 0.01' Mech								Time 13:20-14:35
	592	Sh Laminar								
	593	Sh 0.07 w/ Core Spin								
	594	Sty w/ Core Spin								
	595	Sh 0.02' Mech								
	596	BIP w/ Core Spin								
	597	Mech Sh 0.01' Sh Laminar Mech								
	598	Sty								
	599	Sty								
	600	Mech Sh Laminar								
	601	Sty								
	602	Mech								
	603	Sty								
	604	Mech								
	605	Sty Sh Laminar								
107.4	606	Sty								
107.4	607	Sty								

SYMBOLS: ▽ WATER LEVEL AT COMPLETION

▽ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID

>> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
1 June 1988SHEET 30 OF 32 S A-132BORING NO. CS-7

BORING NO. CS-7

Project U. T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/RQD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
106.4		SURFACE COVER								
	600	BIP Open Solution								
	601	Solutioning Broken								
	602	BIP Solutioning								
	603	BIP Solutioning w/ Core Spn								
	604	BIP Solutioning								
	605	BIP Solutioning Mech								
	606	Solutioning								
	607	BIP Open w/ Xstall								
	608	BIP Open Solution								
	609	Mech								
	610	Mech								
	611	Sty Sh 0.01' Weathered								
	612	Sh Laminar								
	613	Sty Mech								
	614	BIP Open								
	615	Sty Sh 0.01'								
	616	Sty								
	617	Sty								
	618	Sty								
	619	Sty								
	620	Sty								
	621	Sty								
	622	Sty								
	623	Sty								
	624	Sty								
	625	Sty								
	626	Sty								
	627	Sty								
	628	Sty								
	629	Sty								
	630	Sty								
	631	Sty								
	632	Sty								
	633	Sty								
	634	Sty								
	635	Sty								
	636	Sty								
	637	Sty								
	638	Sty								
	639	Sty								
	640	Sty								
	641	Sty								
	642	Sty								
	643	Sty								
	644	Sty								
	645	Sty								
	646	Sty								
	647	Sty								
	648	Sty								
	649	Sty								
	650	Sty								
	651	Sty								
	652	Sty								
	653	Sty								
	654	Sty								
	655	Sty								
	656	Sty								
	657	Sty								
	658	Sty								
	659	Sty								
	660	Sty								
	661	Sty								
	662	Sty								
	663	Sty								
	664	Sty								
	665	Sty								
	666	Sty								
	667	Sty								
	668	Sty								
	669	Sty								
	670	Sty								
	671	Sty								
	672	Sty								
	673	Sty								
	674	Sty								
	675	Sty								
	676	Sty								
	677	Sty								
	678	Sty								
	679	Sty								
	680	Sty								
	681	Sty								
	682	Sty								
	683	Sty								
	684	Sty								
	685	Sty								
	686	Sty								
	687	Sty								
	688	Sty								
	689	Sty								
	690	Sty								
	691	Sty								
	692	Sty								
	693	Sty								
	694	Sty								
	695	Sty								
	696	Sty								
	697	Sty								
	698	Sty								
	699	Sty								
	700	Sty								

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▽ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

ORL FORM 1202
 1 June 1988

SHEET 31 OF 32 A-133

BORING NO. CS-7

BORING NO. CS-7

Project U.T.P.
 Date: Start 1/1 Complete 1/1
 Location N E
 Drilling Agency _____
 Driller _____ Inspector _____
 Drill Type _____
 Drill Method _____
 Thickness of Overburden _____
 Depth Drilled into Rock _____
 Total Depth of Boring _____
 Dir. of Boring _____ Vert. _____ Inclined _____ Deg _____

Instrumentation Installed _____
 Surface Elevation _____
 Datum for Surface El. _____

ELEV.	DEPTH	SOIL CLASSIFICATION	USCS CLASSIFICATION	BLOWS PER 6-INCH	RECOVERY/ROD	SAMPLE NUMBER	SAMPLE TYPE	MOISTURE CONTENT (%)	GROUNDWATER-FLUID LOSS	LABORATORY RESULTS AND REMARKS
86.9		SURFACE COVER								
	620	Veg, Xstall								
	621	01P Open								
	622	Mesh								
	623	Mesh 5h 0.03'								
	624	5h 0.01' Xstall								
82.1'	624	Transition Zone Very Aggrillcons								
	625	Waldron Shale								
	626	SHALE, Dark Green, Medium Hard, Dolomitic								
5H	627	Mesh								
	628	Mesh								
	629	Mesh and OFF size core								
	630	Mesh								
	631	OFF size Core								
	632	Mesh								
	633	OFF size Core								
72.7'	634	Mesh								
	635	Laurel Dolomite								
Dol	636	SH 0.015' Dolomite, Light Gray to White, Hard w/ Shale								
70.7'	637	Mesh								
	638	Laminar and Stylolites								
	639	B.O.H.								
	640									
	641									

Run 14 Pulled
 Cored 10.4 Bottom
 Rec 10.4 of Core
 Loss 0.0

Time
 9:50 - 10:30

Weighted
 Sample No Depth Elev
 11 628.1 78.8
 628.7 78.2
 12 629.7 78.2
 630.5 76.7
 13 630.9 76.0
 633.6 77.3

SYMBOLS: ▽ WATER LEVEL AT COMPLETION
 ▴ WATER LEVEL _____ HOURS AFTER COMPLETION

> - PARTIAL LOSS OF DRILL FLUID
 >> - TOTAL LOSS OF DRILL FLUID

DATE: Dec. 10, 92

JOINT CLASSIFICATION LOG

ELEV. TOP OF HOLE

PROJECT NAME

CORE BORING NO. C5-1

PAGE 1

JOINT NO.	DEPTH	ELEV.	JOINT PER FT.	TYPE	DIRECTION	ASPECT	TIGHTNESS	OXIDATION	MINERALIZATION	WEATHERING	REMARKS
RUN 1	491.6 - 496.3										
1	492.15			P	0°	Polished	mt	No	No	Un	
2	494.05			P	0°	sm	mt	=	=	SW	
3	494.5			P	0°	pl	mt	=	=	Un	
4	494.55			P	0°	pl	mt	=	=	=	
5	494.6			P	0°	pl	=	=	=	=	
6	495			P	10°	sm	=	=	=	SW	
RUN 2	496.3 - 506.3										
1	496.1			P	0°	sm	mt	No	No	Un	
2	496.4			P	0°	=	=	=	=	=	
3	497.4			P	5°	=	=	=	=	=	
4	498.3			P	0°	SR	=	=	=	=	SR: slightly rough
5	499.9			U	0°	sm	=	=	=	=	
6	501			P	0°	sm	=	=	=	=	
7	501.55			U	10°	SR	=	=	=	=	
8	502.7			P	10°	sm	=	=	=	=	MB ?
9	503.95			P	0°	pl	=	=	=	=	
10	505			P	0°	pl	=	=	=	=	
RUN 3	506.3 - 516										
1	506.72			P	0°	sm	Open	No	No	Un	
2	506.72 - 508										MB (vertical break)
3	508.4			P	15°	SR	0	=	=	=	
4	509 - 510			P	90°	R	0	=	=	SW	Vertical jt.

DATE: Dec. 12, 92
CORE BORING NO. CS-1
PAGE 2

JOINT CLASSIFICATION LOG

ELEV. TOP OF HOLE

PROJECT NAME

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPECT	TIGHTNESS	OXIDATION	MINERALIZATION	WEATHERING	REMARKS
5	511.7			P	0°	SR	mt	No	No	Un.	
	514.4										MB
RUN 4	516 - 526										
1	515.22										
2	516			P	0°	R	Open	No	calcite	Un	
3	520.65			P	0°	SR	=	=	No	=	thin shale lens
				P	0°	sm	mt	=	=	=	
RUN 5	526 - 536										
1	526.7			P	0°	polished	mt	No	No	Un	shale lens
2	531.85			P	5°	sm	=	=	=	=	
RUN 6	536 - 546										
1	538			S	15°	R	open	No	calcite	Un	v. thin calcite flakes
2	539.7			S	15°	R	=	=	quartz	Un	
3	540			U	10°	R	mt	=	No	SW	fossils
4	540.35			U	5°	R	=	=	calc.	Un	
5	540.75			P	10°	silly R	=	=	=	=	shale
6	541			P	5°	R	open	=	qtz	=	very coarse surface
7	543			P	0°	R	mt	=	calc.	=	
8	543.85			U	0°	SR	Open	=	=	SW	
9	543.9			P	0°	SR	Open	=	=	=	

DATE: Dec. 10, 92

CORE BORING NO. CS-1
PAGE 3

JOINT CLASSIFICATION LOG

PROJECT NAME

ELEV. TOP OF HOLE

JOINT NO.	DEPTH	ELEV.	JOINT PER FT.	TYPE	ORIENTATION	ASPECT	THICKNESS	DURATION	MINERALIZATION	WEATHERING	REMARKS
Run 7	546 - 556										
1	545.55			S	0°	R	mt	No	No	SW	
2	545.75										mB
3	547										mB
4	547.65			P	0°	SR	mt	No	No	SW	shale seam
5	547.75			P	10°	"	"	"	"	SW	
6	547.8			P	"	sm	"	"	"	SW	shale seam
7	548.45			U	"	SR	"	"	"	SW	
8	548.75			S	5°	"	"	"	"	SW	shale seam
9	549			S	10°	R	open	"	Calc.	W	
10	549.9			S	10°	R	"	"	No	SW	
11	550.8			U	15°	R	mt	"	"	UN	
12	551.4			P	5°	SR	mt	"	"	W	calcite nodule
13	552										mB
14	552.45			S	15°	R	mt	No	No	SW	
15	553.3			S	15°	R	mt	"	"	"	
16	553.7			S	0°	Very R	open	"	"	"	
17	553.95			U	0°	SR	mt	"	"	UN	
18	554.45										mB
Run 8	556 - 566										
1	556.05			U	0°	SR	mt	No	No	UN	shale lens
2	557			U	"	"	"	"	"	SW	"
3	558			U	"	"	"	"	"	"	"

DATE: Dec. 92

JOINT CLASSIFICATION LOG

PROJECT NAME

ELEV. TOP OF HOLE

CORE BORING NO. CS-1

PAGE

4

JOINT NO.	DEPTH	ELEV.	JOINT PERL FT	TYPE	DIRECTION	ASPECT	THICKNESS	ORIENTATION	MINERALIZATION	WEATHERING	REMARKS
4	558.7			U	0°	SR	mt	No	No	SW	shale lens
5	559			U	5°	SW	=	=	=	UN	= (2mm)
6	560.85			S	10°	R	=	=	Calc.	SW	=
7	562.5			S	=	=	=	=	=	=	=
8	563			S	0°	=	open	=	=	=	=
9	564.85			S	0°	=	mt	=	=	UN	calcite & qtz with vugs
RUN 9	566	574									
1	565.14			P	0°	SR	mt	No	No	UN	
2	565.5			U	5°	=	O	=	=	=	shale lens 1" thick
3	565.6			U	0°	=	mt	=	=	SW	= (2mm)
4	565.95			P	=	R	O	=	Calc.	=	
5	566.2			S	10°	=	O	=	No	=	
6	567			U	5°	=	mt	=	=	=	
7	567.7			S	0°	=	O	=	=	=	shale lens
8	568.3			S	=	=	mt	=	=	=	
9	568.6			U	=	=	=	=	=	=	
10	569.35			U	=	=	=	=	=	=	
11	569.7			U	5°	=	=	=	=	=	shale lens
12	570.3			P	0°	=	=	=	=	=	
13	571.4			U	10°	=	=	=	=	=	shale lens
14	572.4			U	5°	=	=	=	=	=	
15	573.1			S	0°	=	=	=	=	=	
16	573.4			U	=	=	=	=	=	=	shale lens

DATE: Dec 14, 92

JOINT CLASSIFICATION LOG

CORE BORING NO. C5-1

PAGE 5

PROJECT NAME

ELEV. TOP OF HOLE

JOINT NO.	DEPTH	ELEV.	JOINT PER FT.	TYPE	ORIENTATION	ASPECT	TIGHTNESS	ORIENTATION	MINERALIZATION	WEATHERING	REMARKS
Run 10	574 - 584										
1	574.95			S	0°	R	T	No	No	Un	Joint @ shale - L.S. interface
2	576.3			U	°	SR	T	°	°	°	Shale lens
3	577.7			°	5°	°	mt	°	°	°	°
4	579.2			°	0°	°	°	°	°	°	°
5	579.3			°	5°	°	°	°	°	°	°
6	582.4			°	0°	°	°	°	°	°	thin shale lens
7	583.35			°	5°	°	°	°	°	°	quartz lens (3/4" thick)
8	583.6			P	0°	°	Open	°	calcite	SW	calcite film
Run 11	584 - 594										
1	584.2			P	0°	SR	mt	No	No	SW	
2	585.8			S	30°	R	°	°	°	Un	shale lens
3	586.2			S	45°	°	°	°	°	°	°
4	587			P	55°	°	°	°	calcite	SW	shale & calcite
5	587 - 587.8			U	80°	°	°	°	°	Un	shale lens, vertical w/ pyrite
6	588.4			S	30°	°	Open	°	pyrite	SW	Broken - crushed rock & pyrite
7	589			U	10°	°	mt	°	No	Un	shale lens
8	589.4			S	5°	R	O	°	°	°	°
9	590			S	15°	°	O	°	pyrite	°	°
10	590.6			U	10°	°	mt	°	No	°	°
11	591.5										MB
12	592			S	10°	°	°	°	°	°	°
13	592.7			S	10°	°	Open	°	°	SW	°
14	592.95			U	0°	SR	°	°	°	°	calcite film

DATE: Dec. 92

PROJECT NAME

COPE BORING NO. CS-1

PAGE 6

[illegible]

JOINT CLASSIFICATION LOG

DATE: Dec. 92

CORE BORING NO. C5-1
PAGE 7

PROJECT NAME _____

ELEV. TOP OF HOLE _____

JOINT NO.	DEPTH	ELEV.	JOINT PER FT.	TYPE	ORIENTATION	ASPECT	TIGHTNESS	OXIDATION	MINERALIZATION	WEATHERING	REMARKS
RUN 13	604 -	609		U	0°	sm	mt	No	No	Un	2mm shale lens
1	605.55			P	"	"	O	"	"	"	crushed shale
2	605.65			P	10°	SR	"	"	"	"	"
3	605.75			U	15°	"	mt	"	"	"	shale lens
4	606.4			U	"	R	"	"	"	"	"
5	607.3			U	"	"	"	"	"	"	"
6	607.45			U	"	"	"	"	"	"	"
7	608			S	50°	"	O	"	"	"	"
RUN 14	609 -	615.5		S	15°	R	mt	No	No	Un	
1	609.7			S	"	"	"	"	"	"	
2	611.2			P	0°	sm	O	"	"	"	
3	611.8			"	"	"	"	"	"	"	
4	611.9			"	"	"	"	"	"	"	
5	612.45			"	"	SR	mt	"	"	SW	
6	612.95			"	"	"	"	"	"	"	
7	613.3			"	"	"	O	"	"	"	
8	613.75			"	5°	"	mt	"	"	"	
9	614.2			S	40°	"	O	"	"	"	
10	614.3			P	0°	"	"	"	"	"	
11	614.55			"	"	"	"	"	"	"	
12	614.7			"	"	"	"	"	"	"	
13	614.8			U	5°	"	mt	"	"	UN	MB ?
14	614.9			P	"	"	"	"	"	"	
15	615.25			P	"	"	O	"	"	SW	

DATE: Dec- 72

ELZY. TOP OF BOILER

PROJECT NAME

CORE BORING NO. CS - 1

PAGE

3/3

[illegible]

DATE: Dec. 2, 192
 CCRE BORING NO. C5-2
 PAGE 1

JOINT CLASSIFICATION LOG

PROJECT NAME UTP

ELEV. TOP OF HOLE

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPECT	TIGHTNESS	ORIENTATION	MINERALIZATION	WEATHERING	REMARKS
Run 1	500 - 505.4			P	0°	pl	mt	No	No	un	* un: unweathered
	500.8			"	"	"	"	"	"	"	
	501.3			"	"	"	"	"	"	"	
	502.1			"	"	"	"	"	"	"	Top wall gray shale
	502.75			"	"	"	"	"	"	"	"
	503.3			"	"	"	"	"	"	"	"
	503.85			"	"	"	"	"	"	"	"
	504.85			"	"	"	"	"	"	"	"
Run 2	505.4 - 515.5			P	0°	sm	0	No	No	un	
	505.55			"	"	"	"	"	"	sw	
	505.9			"	"	pl	"	"	"	un	
	506.25			"	"	sm	"	"	"	"	
	506.6			"	"	pl	"	"	"	"	
	507			"	"	pl	mt	"	"	"	
	507.3			"	"	sm	"	"	"	"	
	507.9			"	"	"	"	"	"	"	
	508.55	MB		"	"	"	"	"	"	"	MB
	509.25			"	"	pl	mt	"	"	"	
	510.0			"	"	pl	"	"	"	"	
	511.35			"	"	pl	"	"	"	"	
	511.0 - 514.2			U	90°	sr	"	"	Calc.	"	Vertical jt. healed @
	511.9			S	0°	sm	0	"	No	"	511 - 511.9 w/ calcite cementing
	512.1			P	"	sr	mt	"	Calc.	sw	then broken w/ calc. residue

JOINT CLASSIFICATION LOG

DATE: _____

CORE BORING NO. C5-2
PAGE 2

PROJECT NAME _____

ELEV. TOP OF HOLE _____

JOINT NO.	DEPTH	ELEV.	JOINT PER FT.	TYPE	ORIENTATION	ASPECT	TIGHTNESS	ORIENTATION	MINERALIZATION	WEATHERING	REMARKS
	512.65			S	15°	sm	0	No	No	un	Broken rock
	513.2			P	0°	pl	mt	"	"	"	
	513.4			"	"	sm	"	"	"	"	
	513.5			"	"	"	"	"	"	"	
	514.4			"	"	"	"	"	"	"	
	515.15			"	"	"	"	"	"	"	
	515.45			"	"	"	"	"	"	"	
Run 3	515.5	525.5									
	516.6			P	0°	sm	mt	No	pyrite	un	
	517.65			P	"	"	"	"	No	"	
	518.3			U	5°	"	"	"	"	"	
	519.3			P	0°	SR	"	"	pyrite	sw	contact w/ L.S.
	520.5			U	5°	"	"	"	pyrite	"	
	521-3			U	15°	R	"	"	No	"	
	522.2			S	"	"	"	yes	pyrite	"	
	522.45			S	0°	"	"	"	"	"	
	523.6			U	"	"	"	No	No	"	
	524.35			S	15°	"	"	"	pyrite	un	V. thin shale vein
Run 4	525.5	535.2									
	526.1			U	0°	R	mt	No	No	sw	shale seam
	526.9			P	"	"	"	"	"	un	
	527.45			"	10°	sm	"	"	"	"	
	527.55			U	"	"	"	"	"	"	shale seam

A-144

JOINT CLASSIFICATION LOG

DATE: _____

CORE BORING NO. C-5-2 PAGE 3

PROJECT NAME _____

ELEV. TOP OF HOLE _____

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPECT	TIGHTNESS	ORIENTATION	MINERALIZATION	WEATHERING	REMARKS
Run 5	535.8 - 545.8			P	0°	SW	mt	No	No	un	mt?
	537.3			U	5°	"	"	"	"	"	
	544.15			U	"	SR	"	"	"	"	
	544.65			S	25°	R	0	"	qtz	sw	unq.
	545.4										
Run 6	545.8 - 556			U	0°	SR	mt	No	No	Un	
	546.5			S	15°	R	0	"	"	"	
	547			U	10°	SR	mt	"	"	"	
	547.3			U	"	"	"	"	"	"	
	547.35			U	"	"	"	"	"	"	
A-145	547.85			P	"	"	0	"	"	"	
	548.55			U	"	"	0	"	"	sw	
	548.75			U	"	"	0	"	"	"	
	548.9			U	0°	R	0	"	"	"	Very vuggy - eroded
	549.6			P	5°	"	mt	"	"	sw	
	550.1			U	10°	"	0	"	qtz	"	fossils
	550.7			U	"	"	0	"	No	"	
	551			S	15°	"	0	"	"	sw	
	551.1			U	0°	"	"	"	"	"	
	551.7			"	"	"	"	"	"	un	
	552.25			"	"	"	mt	"	"	sw	
	552.55			"	5°	"	"	"	"	un	
	552.7			"	10°	SR	"	"	Calc	sw	
	553			S	"	R	"	"	"	un	

DATE:

CORE BORING NO. CS-2 PAGE 4

4
PAGE

PROJECT NAME

FILED. TOP OF EOLE

Joint No.	Depth	Elev.	Joint per ft	Type	Dip Direction	Asperity	Tightness	Oxidation	Mineralization	Weathering	Remarks
	553.4			S	20°	R	0	No	No	w	eroded
	554			U	10°	s	mt	'	"	un	
	554.85			U	15°	s	s	=	s	s	
	554.9			U	"	s	s	s	s	s	
	555.3			P	0°	SR	s	s	Calc.	sw	
	555.85			S	15°	R	s	s	No	un	
Run 7	556 - 566										
	556.4			S	0°	R	mt	No	No	un	
	556.9			U	"	sm	s	s	"	s	shale seam
	558.8			U	"	s	s	s	"	"	
	559.5			U	15°	"	s	s	"	"	
	560.1			U	0°	SR	s	s	"	w	
	560.55			S	15°	R	s	s	"	w	
	561.55			U	0°	s	0	s	"	sw	
	561.8			U	15°	"	mt	s	"	s	
	562.25			U	0°	SR	s	s	"	s	
	562.9			S	15°	R	s	s	"	s	vuggy bottom wall
	563.35			S	"	s	s	s	"	s	
	563.5			U	"	"	s	s	"	"	
	564.15			U	0°	SR	s	s	"	Un	
	564.6			P	"	"	0	s	Calc.	sw	
	564.8			S	"	R	mt	s	"	s	
	565.15			P	5°	sm	s	s	"	s	shale seam
	565.7			U	"	s	s	s	"	UN	

JOINT CLASSIFICATION LOG

DATE: _____

CORE BORING NO. CS-2 PAGE 5

ELEV. TOP OF HOLE _____

PROJECT NAME _____

JOINT NO.	DEPTH	ELEV.	JOINT PER. FT.	TYPE	ORIENTATION	ASPECT	TIGHTNESS	OXIDATION	MINERALIZATION	WEATHERING	REMARKS
B-13	566 - 576										
	566.34			U	15°	SM	mt	No	No	Un	2mm thick shale seam
	566.5			"	"	"	"	"	"	"	1mm " "
	567.5			"	10°	"	"	"	"	"	"
	567.9			"	"	SR	"	"	"	SW	
	568.4			"	15°	R	O	"	"	"	shale seam
	568.85			"	10°	"	"	"	qtz	"	
	569.1			"	0°	"	"	"	calc.	W	eroded & broken to flakes
	569.4			S	25°	"	"	"	No	"	eroded
	569.9			S	10°	"	mt	"	"	SW	
	569.9 - 570.15			P	90°	SR	"	"	calc.	"	
	570.55			U	10°	SM	"	"	No	Un	4mm shale seam
	570.8			"	"	SR	"	"	"	"	
	571.35			"	0°	"	"	"	"	"	
	571.8			"	5°	"	"	"	"	SW	
	572.5			S	0°	R	"	"	"	"	
	573			P	"	"	"	"	"	"	
	573.5			U	5°	"	O	"	calc.	W	
	574			S	15°	"	mt	"	No	Un	
	574.6			U	5°	SR	O	"	"	"	
B-14	576 - 586.2			P	0°	SM	mt	No	No	Un	shale bed
	576.45			"	"	"	"	"	"	SW	
	576.55			S	10°	R	"	"	"	"	
	576.75										

A-147

JOINT CLASSIFICATION LOG

DATE: _____

ELEV. TOP OF HOLE _____

PROJECT NAME _____

CORE BORING NO. C5-2PAGE 6

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	DIP ORIENTATION	ASPECT	TIGHTNESS	OXIDATION	MINERALIZATION	WEATHERING	REMARKS
	577.25			P	10°	SR	mt	No	No	SW	
	577.65			"	0°	"	"	"	"	"	
	578.1			S	20°	"	"	"	"	"	
	578.3			"	15°	"	"	"	"	Un	
	578.6			U	10°	"	"	"	"	SW	
	578.9			S	5°	R	"	"	"	"	
	579.4			U	0°	SR	0	"	"	"	
	579.8			"	20°	"	0	"	"	"	
	580.2			"	10°	"	mt	"	"	"	
	580.6			"	"	"	"	"	"	"	
	580.7			S	0°	R	"	"	"	"	
	580.85			U	"	SR	"	"	"	"	
	590.85			P	"	"	"	"	"	"	
	591.4			"	10°	"	"	"	"	"	
	591.8			U	20°	sm	"	"	"	"	
	592.8			"	0°	SR	"	"	"	Un	
	593.45			"	10°	sm	"	"	"	SW	
	593.9			"	"	"	"	"	"	Un	shale seam
	594.3			"	0°	"	"	"	"	SW	"
Run 10	586.2 - 596.4										
	597.3			S	20°	R	mt	No	No	Un	
	597.6			U	10°	sm	"	"	"	"	
	598.3			P	20°	"	"	"	"	"	4 mm shale seam
	599.2			"	"	"	"	"	"	"	

A-148

DATE:

CORE BORING NO. C5-2 PAGE 7

ELEV. TOP OF HOLE

PROJECT NAME

[illegible]

JOINT CLASSIFICATION LOG

DATE: _____

ELEV. TOP OF HOLE _____

PROJECT NAME _____

CORE BORING NO. C5-2

PAGE 2

JOINT NO.	DEPTH	ELEV.	JOINT PER. FT	TYPE	ORIENTATION	ASPECT	THICKNESS	ORIENTATION	MINERALIZATION	WEATHERING	REMARKS
R.012	606.3 - 616.3			U	15°	SR	mt	No	qtz.	SW	
	606.0			P	"	"	"	"	"	"	
	607			"	0°	"	"	"	"	"	
	607.45			S	90°	"	"	"	"	Un	
	608			P	0°	SM	mt	"	No	"	
	608.15			U	"	SR	"	"	qtz.	"	
	608.25			P	15°	"	"	"	"	SW	
	608.6			"	"	R	"	"	"	"	Un
	609			S	0°	R	"	"	No	"	shale seam (1mm)
	609.45			P	90°	SR	"	"	"	Un	
	610.2	610		U	15°	"	"	"	"	"	
	610.8			"	0°	"	"	"	"	"	shale seam (1mm)
	611.2			S	15°	R	"	"	"	"	
	611.4			U	0°	SM	"	"	"	"	
	611.55			P	15°	SR	"	"	"	"	
	612.3			"	"	"	"	"	"	"	
	612.5			U	15°	"	"	"	"	"	shale seam (2mm)
	612.8			P	0°	"	"	"	"	"	
	613.4			"	0°	"	0	"	"	"	
	613.85			"	5°	SM	mt	"	"	"	shale seam (1mm)
	614.2			U	15°	SR	"	"	"	"	"
	614.9			"	5°	SM	"	"	"	"	"

A-150

JOINT CLASSIFICATION LOG

DATE: _____

CCRE BORING NO. C.S-2 PAGE 9

PROJECT NAME _____

ELEV. TOP OF BOLT _____

JOINT NO.	DEPTH	ELEV.	JOINT PER. FT.	TYPE	ORIENTATION	ASPECT	TIGHTNESS	ORIENTATION	MINERALIZATION	WEATHERING	REMARKS
Run 13	616.3 - 626.3			U	45°	pl ~~km~~	mt	No	No	Un	2 mm shale vein
	617.45			"	15°	"	"	"	"	"	6 mm "
	618.1			"	40°	SR	"	"	"	"	
	620.4			S	"	R	"	"	"	"	shale vein
	621.2			S	"	"	"	"	"	"	
	621.5			P	0°	SR	"	yes	"	"	green colorization
	621.9			"	5°	"	"	"	"	"	
	622.35			S	"	R	"	"	"	"	
	622.7			U	45°	SR	"	"	"	"	
	623.1			"	30°	sm	"	"	"	"	shale seam
	624			S	"	SR	"	"	"	"	
	624.6			U	10°	"	0	"	"	"	shale seam
	624.75			P	0°	"	mt	"	"	SW	
	625.7										
Run 14	626.3 - 636.3			P	0°	SR	0	No	No	Un	
	626.15			U	15°	"	mt	"	"	"	
	626.45			P	5°	"	"	"	"	"	
	627.4			"	0°	"	"	"	"	"	
	627.85			"	0°	sm	"	"	"	"	shale seam
	627.75										
Run 15	636.3 - 642.4			P	0°	sm	mt	No	No	Un	
	639.1			S	25°	R	"	"	"	"	
	640.9			P	15°	SR	"	"	"	"	
	641.7										

A-151

JOINT CLASSIFICATION LOG

DATE: Dec. 29, 92

ELEV. TOP OF HOLE

PROJECT NAME

UTP

CORE BORING NO. CS-3

PAGE 1

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPECT	TIGHTNESS	ORIENTATION	MINERALIZATION	WEATHERING	REMARKS
Run 1	499.9 - 505			P	0	pl	mt	No	No	UN	
	500.05			P	0	pl	=	=	=	=	
	500.4			P	0	sm	=	=	=	=	
	500.63			=	=	pl	=	=	=	=	
	500.9			=	=	=	=	=	=	=	
	501.18			=	=	=	=	=	=	=	
	501.43			=	=	=	=	=	=	=	
	501.7			=	=	=	=	=	=	=	
	502			=	=	=	=	=	=	=	
	502.2			=	=	=	=	=	=	=	
	502.53			=	=	=	=	=	=	=	
	503.15			=	=	=	=	=	=	=	
	504.75			=	=	=	=	=	=	=	
	504.05			=	=	=	=	=	=	=	
	504.1			=	=	=	=	=	=	=	
	504.3			=	=	=	=	=	pyrite	SW	
	504.7			P	0	SR	=	=	calcite	"	L.S.
	505			P	0	pl	0	=	=	SW	
Run 2	505 - 514			P	0	pl	OP	No	No	UN	
	505.35			P	0	=	OP	=	=	=	
	506.07			=	=	=	=	=	=	=	
	506.5			=	=	=	=	=	=	=	
	507.2			=	=	=	=	=	=	=	
	507.7			=	=	=	=	=	=	=	

A-152

JOINT CLASSIFICATION LOG

FILED. TOP OF FOLE

PROJECT NAME

CCRE BORING NO. CS-3
PAGE

PAGE 2

[illegible]

DATE:

ELEV. TOP OF HOLE

PROJECT NAME

CCRE BORING NO. CS-3

PAGE _____ **3**

[illegible]

JOINT CLASSIFICATION LOG

DATE: _____

BL37. TOP OF HOLE _____

PROJECT NAME _____

CORE BORING NO. C.S-3PAGE 4

JOINT NO.	DEPTH	ELEV.	JOINT PER. FT.	TYPE	ORIENTATION	ASPECT	TIGHTNESS	ORIENTATION	MINERALIZATION	WEATHERING	REMARKS
Run 6	544.3 - 554.5										
	544.5			P	10°	R	mt	No	No	UN	
	544.9			U	0°	"	0	"	"	SW	Vugged
	545.2			U	"	"	"	"	"	"	
	545.3			U	"	SR	"	"	"	"	next 0.1 broken rounded rock.
	545.4			S	20°	R	"	"	No	"	Vugged
	545.9			U	10°	SR	mt	"	"	UN	
	546.2			U	"	"	0	"	"	UN	
	546.63			P	0°	"	0	"	"	"	Vugged
	546.9			U	15°	"	mt	No	"	UN	1 mm shale vein
	547.12			U	0°	"	0	"	"	"	2 mm "
	547.6			U	"	R	0	"	"	SW	Vugged
	548.15			P	15°	"	mt	"	"	UN	fossils
	549.15			U	10°	"	"	"	"	SW	
	549.5			P	0°	SR	"	No	"	"	
	550.05			U	30°	SR	"	"	"	UN	
	550.3			U	"	"	0	"	Yes	SW	Green coloring / shale
	550.75										mB
	551.1			P	0°	R	mt	No	No	UN	very porous (vugged)
	551.7										mB
	552.35			P	0°	sm	mt	No	No	UN	
	552.65			P	"	"	"	"	"	"	
	553.17			P	"	"	"	"	"	"	
	553.45			U	"	SR	"	"	"	"	

A-155

DATE:

CORE BORING NO. CS-3

PAGE 5

PROJECT NAME

ELEV. TOP OF HOLE

[illegible]

A-156

DATE:

CCRE BORING NO. CS-3 PAGE 6

PROJECT NAME

ELEV. TOP OF EOLE

[illegible]

DATE:

PROJECT NAME

CCRE BORING NO. CS-3 PAGE 1

PAGE 7

[illegible]

DATE: _____
CORE BORING NO. C5-3
PAGE 8

JOINT CLASSIFICATION LOG

PROJECT NAME _____

ELEV. TOP OF HOLE _____

JOINT NO.	DEPTH	ELEV.	JOINT PER FT.	TYPE	ORIENTATION	ASPECT	TIGHTNESS	OXIDATION	MINERALIZATION	WEATHERING	REMARKS
Run 9	573.75 - 582.1			P	0°	SR	mt	No	No	SW	Left wall L.S., Right is shale
	574			P	"	"	"	"	"	Un	
	574.37			U	"	"	"	"	"	"	
	575.4			S	15°	R	O	"	"	SW	left wall shale, Right L.S.
	576			P	5°	SR	mt	"	"	"	
	576.35			P	15°	"	"	"	"	"	
	577.2			U	25°	"	"	"	"	"	
	577.72			U	15°	"	O	"	"	W	some shale
	578.1			P	0°	"	O	"	"	"	
	578.4			U	0°	R	O	"	"	"	
	578.55			U	10°	SR	mt	"	"	"	
	579.05			S	20°	R	"	"	"	"	
	579.5			S	5°	"	"	"	"	"	
	579.9			S	5°	"	"	"	"	"	
	580.05			U	5°	"	"	"	"	SW	2 mm shale vein
	580.5			P	0°	"	"	"	"	"	
	580.8			U	10°	"	"	"	"	"	
	581.35			U	30°	"	"	"	"	"	
	581.5			U	0°	"	O	"	"	Un	quartz lens jointed at its middle
	581.85										
Run 10	582.1 - 583.9			U	10°	SR	mt	No	No	Un	
	582.4			U	15°	"	"	"	"	"	
	582.95			S	"	R	"	"	"	SW	
	583.55			U	20°	"	"	"	"	"	
	583.8										

A-159

DATE:

ELEV. TOP OF BOIL

PROJECT NAME

CORE BORING NO. CS-3

PAGE 9

Joint No.	Depth	Elev.	Joint per ft	Type	Orientation	Asperity	Tightness	Oxidation	Mineralization	Weathering	Remarks
R-11	583.9 - 594			U	0°	sm	o	No	No	SW	
	584.45			U	20°	"	mt			"	2 mm shale vein
	586.5			"	"	"	"				
	586.75			"	0°	"	"			UN	2 mm shale vein
	588.25			"	10°	"	"			"	1/2' thick shale lens
	589.7			S	40°	R	"			"	2 mm shale vein
	591.35			U	0°	"	"			W	
	592.2			U	10°	"	"			UN	" "
	592.7										
A-160 A12	594 - 604.2			S	5°	R	mt	No	No	UN	
	594.6			P	15°	sm	"	"	"	UN	3 mm thick shale vein
	595.75			U	"	SR	"	"	"	"	2 mm " " "
	596.85			S	0°	R	"	"	"	"	
	597.3			U	"	SR	"	"	"	SW	
	597.65			S	30°	R	"	"	"	UN	
	598			P	15°	sm	"	"	"	"	
	598.55			U	0°	R	o	"	"	"	shale lens w/ fine fragments
	599			U	30°	sm	mt	"	"	"	2 mm thick shale vein
	599.65							"	"	"	
	600.02			S	20°	R	mt	"	"	"	1 mm " " "
	600.4			U	15°	R	"	"	"	"	
	601 - 601.5			U	90°	R	mt	No	No	UN	
	601.5			S	0°	VR	"	"	"	SW	

JOINT CLASSIFICATION LOG

DATE: _____

CORE BORING NO. C S-3
PAGE 10

PROJECT NAME _____

ELEV. TOP OF HOLE _____

JOINT NO.	DEPTH	ELEV.	JOINT PER. FT.	TYPE	ORIENTATION	ASPECT	TIGHTNESS	OXIDATION	MINERALIZATION	WEATHERING	REMARKS
	601.85			S	40°	R	mt	No	No	SW	
	602.45			S	0°	"	O	"	"	"	
	602.55 - 602.6										Crushed Rock
	602.6			S	25°	R	O	"	"	W	
	602.7			P	45°	"	O	"	"	UN	
	603.4			P	"	"	mt	"	"	SW	
	603.5			S	15°	"	O	"	"	"	
	603.9			S	40°	"	O	"	qtz	"	eroded (Vug)
				U	40°	R	mt	No	No	UN	eroded
				P	30°	"	"			"	
				P	0°	"	"			"	
				U	"	"	"			"	
				P	"	"	"			"	
				U	"	"	"			"	
				P	15°	"	"			"	
				U	0°	"	"			"	
				S	"	SR	O			"	
				U	"	"	mt			"	
				P	15°	SR	O			"	
				U	"	R	mt			"	
				P	5°	R	"			"	
				S	0°	R	mt	No	No	UN	
				S	0°	VR	"	"	"	"	2 mm shade vein

R. 1113 604.2 - 614.3

A-161

JOINT CLASSIFICATION LOG

DATE: _____

ELEV. TOP OF HOLE _____

PROJECT NAME _____

CORE BORING NO. C5-3

PAGE 11

JOINT NO.	DEPTH	ELEV.	JOINT PER FT.	TYPE	ORIENTATION	ASPECT	TIGHTNESS	ORIENTATION	MINERALIZATION	WEATHERING	REMARKS
Run 14	614.3 - 616										
	614.3 - 614.6										
	614.6			P	0°	R	O	No	No	Un	Broken by drilling
	614.8			P	20°	SR	mt	"	"	"	shale lens
	615.05										MB
	615.5			P	5°	SM	O	"	"	"	shale lens separated on both faces
	615.55			P	25°	SM	O	No	No	Un	
	615.7			U	35°	PI	"	"	"	"	
	615.75			"	25°	SM	"	"	"	"	
				P	5°	SM	mt	No	No	Un	2mm shale seam
	616.55			U	25°	SR	"	"	"	"	"
	618.9			"	20°	SM	"	"	"	"	"
	620.55			"	15°	SR	"	"	"	"	"
	622.65			P	5°	"	"	"	"	"	
	624.5			U	15°	SM	"	"	"	"	2mm shale seam
	625.3										
				P	0°	SM	mt	No	No	Un	
				"	"	"	"	"	"	"	
				"	5°	"	"	"	"	"	
Run 14	626.1 - 636.3										
	629.2										
	630.72										
	631.42										

A-162

CORE BORING NO. CS-3

PAGE

12

[illegible]

DATE: Dec. 15, 92

JOINT CLASSIFICATION LOG

ELEV. TOP OF HOLE

PROJECT NAME

UTP

CORE BORING NO. CS-4

PAGE 1

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPECT	TIGHTNESS	OXIDATION	MINERALIZATION	WEATHERING	REMARKS
R.W. 1	499.2 - 505.3										
	499.5 - 499.6										clay bed
	499.7 - 499.9										clay bed
1	499.4			P	0°	Sm	open	No	No	SW	clay filling w/ fine crushed rock
2	500			"	7.5°	"	=	"	"	SW	mB?
3	500.4			"	0°	"	mt	"	"	UN	mB?
4	500.95			"	"	"	"	"	"	"	mB?
5	501.4			"	"	"	"	"	"	"	mB?
6	502.25			"	"	"	"	"	"	"	
7	503.05			"	"	"	"	"	"	"	
8	503.4			"	"	"	"	"	"	"	
9	503.7			"	"	"	"	"	"	"	
10	503.85			"	0°	"	"	"	"	SW	
11	504.6			"	0°	"	"	"	"	UN	
R.W. 2	505.3 - 515.3										
1	505.33			U	0°	Sm	open	No	No	UN	
2	505.35			U	"	"	O	"	"	"	
3	505.9			P	"	polished	mt	"	"	"	
4	506.25			P	"	SW	open	"	"	"	
5	506.3			"	"	polished	mt	"	"	"	
6	506.7			"	"	SR	open	"	"	SW	Pyrite lens at one sidewall
7	506.85			"	"	Sm	mt	"	"	"	
8	507.3			"	"	"	open	"	"	"	
9	507.5			"	"	"	open	"	"	"	

JOINT CLASSIFICATION LOG

DATE: _____

ELEV. TOP OF HOLE _____

PROJECT NAME _____

CORE BORING NO. C5-APAGE 2

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	DIRECTION	ASPECT	THICKNESS	DIRECTION	MINERALIZATION	WEATHERING	REMARKS
10	509.35			P	5°	sm	mt	No	No	Un	
11	510.3			U	15°	=	=	=	=	=	
12	510.8			P	0°	=	0	=	=	=	
13	511.2			U	=	SR	0	=	=	=	
14	512.4			P	=	sm	0	=	=	=	
15	512.7			P	=	=	0	=	=	=	Pyrite lens at top wall
	513.4										mB
16	513.9			U	0°	sm	0	=	=	=	
	514										mB
17	514.1			P	0°	sm	0	=	=	=	
	514.85										mB
A-165											
Run 3	515.3-525.3										
1	515.3			P	0°	Pl	mt	No	No	Un	
2	516.2			U	10°	sm	0	=	=	=	Trace of pyrite
3	517.5			P	0°	Pl	mt	=	=	=	
4	518.2			=	=	sm	mt	=	=	=	=
5	518.9			U	=	=	0	=	=	=	
6	519.8			P	=	=	mt	=	=	=	
											L.S. stratum starts at 520.2 with 105 pyrite lens between shale & L.S.
7	520.85			P	5°	SR	mt	No	No	SW	
8	521.3			S	=	R	=	=	=	=	shale seam

JOINT CLASSIFICATION LOG

DATE: _____

ELEV. TOP OF HOLE _____

PROJECT NAME _____

CORE BORING NO. C5-4PAGE 3

JOINT NO.	DEPTH	ELEV.	JOINT PER FT.	TYPE	ORIENTATION	ASPECT	THICKNESS	OXIDATION	MINERALIZATION	WEATHERING	REMARKS
9	523.3			S	25°	R	0	Yes	pyrite	sw	green coloring
10	524.1			=	0°	'	0	No	No	'	shale lens / seam
Run 4	525.3 - 535.3										
1	525.25			U	0°	SR	mt	No	No	sw	
2	526.15			S	'	R	'	'	'	Un	thin shale lens
3	526.6			P	15°	sm	'	'	'	'	'
4	527.8			P	0°	SR	0	'	'	'	changing from L.S. to
5	530.55			P	0°	SR	mt	'	'	'	shaly L.S. w/ 1" lens of shale (gr.)
A-166	535.3 - 545.5										
1	539.15			P	0°	pl	mt	No	No	Un	
2	544.1			'	'	sm	'	'	'	'	
3	544.95			'	'	'	'	'	'	sw	
Run 6	545.5 - 555.7										
1	547			U	30°	SR	mt	No	No	Un	shale seam
2	548.6			U	15°	'	0	'	'	'	
3	549.4			U	'	'	mt	'	'	'	
4	550			S	0°	R	0	No	qtz.	'	Etched w/ qtz. crystals
5	550.5			U	30°	SR	mt	'	No	Un	
6	551.2			U	15°	'	'	'	calcite	sw	calcite film
7	551.3			U	'	'	0	'	'	sw	'
8	551.65			P	5°	'	0	'	No	sw	

JOINT CLASSIFICATION LOG

DATE: _____

ELEV. TOP OF HOLE _____

PROJECT NAME _____

CORE BORING NO. CS-4PAGE 4

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPECT	TIGHTNESS	ORIENTATION	MINERALIZATION	WEATHERING	REMARKS
9	551.75			P	0°	SR	O	No	No	SW	
10	552.4			S	30°	R	:	:	:	Un	
11	552.9			S	15°	R	:	:	:	:	
12	553.5			P	0°	SR	:	:	:	:	
13	553.7			U	15°	:	:	:	:	:	shale lens
14	554			S	:	R	:	:	:	SW	
15	554.4			U	5°	SR	:	:	:	Un	
16	555			U	15°	:	:	:	:	:	
17	555.3			P	5°	:	:	:	:	:	
P.n 7 555.7-565.8											
A-167											
1	555.75			P	0°	SR	O	No	No	Un	
2	555.8			P	:	:	O	:	:	:	
3	556.9			P	5°	:	mt	:	:	:	
4	557			P	0°	:	O	:	:	:	
5	557.4			U	5°	sm	mt	:	:	:	shale seam
6	558.3			S	:	R	:	:	:	:	v. thin shale seam
7	558.6			S	15°	:	:	:	:	:	:
8	560.85			U	0°	sm	:	:	:	:	shale seam
9	561.6			U	15°	:	:	:	:	:	:
10	561.95			U	5°	:	O	:	:	:	shale lens .5' thick
11	562			U	:	:	O	:	:	:	
12	562.7			S	:	R	O	:	:	SW	
13	562.4			S	15°	R	t	:	:	SW	
14	564.05			S	:	R	mt	:	calcite	SW	

JOINT CLASSIFICATION LOG

DATE: _____

ELEV. TOP OF HOLE _____

PROJECT NAME _____

CORE BORING NO. CS-4PAGE 5

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPECT	THICKNESS	ORIENTATION	MINERALIZATION	WEATHERING	REMARKS
15	565.2			P	15°	SR	mt	No	No	SW	shale seam
Run 8 565.8 - 574											
1	566.35			U	0°	R	mt	No	No	Un	shale seam
2	566.8			U	:	SR	mt	:	:	:	:
3	567.45			P	:	:	:	:	:	SW	:
4	568.7			U	:	SM	:	:	:	:	:
5	570.35			S	40°	R	:	:	:	Un	:
6	572.15			U	30°	SR	:	:	:	SW	:
7	572.4			U	0°	:	:	:	:	Un	:
8	573			U	:	:	:	:	:	:	:
9	573.95			S	:	R	:	:	:	:	:
10	574.75			U	:	:	:	:	:	:	:
11	575.5			U	5°	:	:	:	:	SW	shale seam
Run 9 576 - 586											
1	576.15			P	0°	SR	mt	No	No	SW	shale lens at bottom
2	576.5			P	:	:	:	:	:	:	shale lens at top of bill.
3	578.7			U	:	:	0	:	:	Un	:
4	578.75			U	15°	:	:	:	:	SW	:
5	580.1			P	0°	:	:	:	:	:	:
6	580.8			S	15°	R	mt	:	:	Un	shale seam
7	581.3			U	5°	SR	0	:	:	:	:
8	582.6			S	:	12	mt	:	:	:	:
9	582.85			S	:	:	:	:	:	:	:

DATE:

DATE: _____

CCRE BORING NO. C5-4 PAGE 6

PROJECT NAME

ELEV. TOP OF HOLT

[illegible]

JOINT CLASSIFICATION LOG

DATE:

ELEV. TOP OF HOLE

PROJECT NAME

CORE BORING NO. C5-4

PAGE

7

JOINT NO.	DEPTH	ELEV.	JOINT PER FT	TYPE	ORIENTATION	ASPECT	TIGHTNESS	ORIENTATION	MINERALIZATION	WEATHERING	REMARKS
Row 12	606.4 - 616.7										
1	606.5			P	0°	SR	0	N2	No	UN	
2	607.3			P	'	'	mt	'	'	'	
3	608.05			U	'	R	0	'	qtz	SW	Vuggy.
4	608.4			P	'	SR	0	'	N2	UN	Flaked
5	608.42			S	'	R	mt	'	'	UN	
6	608.8			P	'	'	'	'	'	'	
7	609.4			P	'	'	'	'	'	SW	
8	609.8			S	'	'	'	'	'	'	
9	610.1			S	10°	'	'	'	'	'	vuggy @ bottom wall
10	610.7			S	10°	'	0	'	qtz	'	vuggy walls
A-170											
11	611.1			P	0°	Polished	mt	N2	No	UN	* Core breaks upon handling 608.4 - 608.8
12	611.2			P	'	R	0	'	'	SW	Crushed rock at bott. wall
13	611.55 - 612.65			P	'	SR	0	'	'	'	deteriorated flakes
14	611.8			P	'	'	mt	'	'	UN	
15	612.35			U	'	'	'	'	'	'	
16	612.65			P	'	'	'	'	'	'	
17	613.25			P	'	'	'	'	'	'	
18	613.8			P	'	'	'	'	'	'	
19	614.65			U	'	'	'	'	'	'	
20	615.15			U	10°	'	'	'	'	'	
21	615.65			P	0°	R	'	'	'	'	

PAGE 8

A-171

Appendix B

Rock Test Results

Table 4.1a

Summary of Laboratory Test Results for
Borehole PV at the UTP Portal Area

FORT KNOX, KENTUCKY - ROCK TEST RESULTS
JULY 30, 1991

SAMPLE NUMBER (UTP)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY* (%)	POROSITY (%)	SPEC GRAV	PERM (md)	ROCK TYPE	SONIC VELOCITIES (FT/SEC)		
													AXIAL	AVERAGE	DIAMETER
													1/4	1/2	3/4
													LATERAL		
PV17	17.8- 18.2		1100	3.10	0.03	153.4	5.8	12.8				SHALE	7600	8200	8300 8300 8200 8200
PV26	26.8- 27.1		1000	3.93	0.02	155.9	5.9	12.7				SHALE	7600	8100	8000 8300 8200 8100
PV36	37.0- 37.3		600	3.93	0.02	155.7	6.2	13.0				SHALE	7600	8200	8300 8000 8200 8200
PV45	45.2- 45.5		500	4.12	0.01	154.8	7.2	14.3				SHALE	7300	7800	7800 7800 7700 7800
PV56	56.0- 56.3		500	4.00	0.01	153.8	6.6	13.3				SHALE	7400	7900	7900 7900 7800 7800
PV67	67.1- 67.4		500	3.24	0.01	157.0	5.7	11.9				SHALE	7600	8600	8700 8600 8500 8400
PV74	75.0- 75.3		1000	2.98	0.03	158.6	5.2	10.5				SHALE	8100	8900	9300 9000 8800 8600

* ASSUMED VALUES OF SPECIFIC GRAVITY WERE: SHALE = 2.70 (2.60 FOR NEW ALBANY); LIMESTONE = 2.71; DOLOMITE = 2.82; SANDSTONE = 2.65.

Table 4.1b

Summary of Laboratory Test Results for
Borehole PH at the UTP Portal Area

FORT KNOX, KENTUCKY - ROCK TEST RESULTS
JULY 30, 1991

SONIC VELOCITIES (FT/SEC)																		
SAMPLE NUMBER (UTP)	REACH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X EOG (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY* (%)	MEASURED			ROCK TYPE	LATERAL					
									POROSITY (%)	SPEC GRAV	PERM (md)		AXIAL AVERAGE	DIAMETER				
														1/4	1/2	3/4		
PH17	17.5- 17.8		900	1.61	0.05	158.3	5.4	10.9				SHALE	8500	8300	8400	8500	8500	7900
PH26	26.7- 27.0		1100	1.70	0.07	158.0	4.9	10.6				SHALE	8600	8600	8300	8400	8200	8200
PH32	32.3- 32.5		1100	1.33	0.08	159.8	4.9	9.6				SHALE	8600	8600	8500	8700	8200	8800
PH44	44.4- 44.7		1200	1.43	0.09	158.7	4.9	10.2				SHALE	6500	8700	8500	8500	8500	9000
PH66	66.1- 66.4		1200	1.20	0.10	158.8	4.5	9.8				SHALE	6800	8900	8800	8900	8900	9000
PH69	69.2- 69.5		800	1.45	0.06	158.4	5.1	10.5				SHALE	6400	8700	8200	8100	8300	9300
PH101	101.9- 102.2		1000	1.55	0.06	159.5	4.5	9.4				SHALE	9000	9000	8500	8600	8500	9500
PH121	121.7- 122.0		600	2.62	0.06	159.0	5.1	10.2				SHALE	8700	8900	8500	8700	8700	9200
PH145	146.2		1000	0.80	0.14	161.5	4.3	8.1				SHALE	9500	9500	9700	9200	9600	9400
PH160	160.0- 160.3		800	1.36	0.09	159.6	4.5	9.3				SHALE	8800	9700	9800	9600	10000	9700

* ASSUMED VALUES OF SPECIFIC GRAVITY WERE: SHALE = 2.70 (2.60 FOR NEW ALBANY); LIMESTONE = 2.71; DOLOMITE = 2.82; SANDSTONE = 2.65.

Table 4.2a

FORT KNOX, KENTUCKY - ROCK TEST RESULTS
MAY 6, 1991

SONIC VELOCITIES (FT/SEC)

MEASURED

POSSIB

SPEC GRAV (md)

ROCK TYPE

AXIAL AVERAGE

LATERAL

1/4

1/2

3/4

YOUNG'S MODULUS X 10⁶ (PSI)

WET DENSITY (PCF)

WATER CONTENT (%)

CALCULATED POROSITY^a (%)

UC STRENGTH (PSI)

AXIAL STRAIN AT FAILURE (%)

DEPTH (FT)

ELV (FT)

SAMPLE NUMBER (CS-1)

1	175.1 175.6	510.8 510.3	7000	1.73	0.35	159.3	4.0	9.1			SHALE	10500	11800	11700	11900	11600
18	178.9	507.0							9.7	2.76						
20	189.5	494.4							9.1	2.77						
2	195.1 195.6	499.8 499.3	5000	1.67	0.43	160.4	3.8	8.3			SHALE	10400	11800	11800	12000	11500
30	196.6	487.3							10.1	2.77						
40	206.9	477.0							9.2	2.79						
3	215.0 215.5	470.9 470.4	4500	1.95	0.29	160.4	4.0	8.5			SHALE	10300	11400	11200	11400	11500
50	218.9	467.0							9.0	2.76						
60	228.0	457.9							8.8	2.75						
4	235.4 236.1	450.3 449.8	4600	1.70	0.30	163.8	3.9	6.5			SHALE	10500	11800	12400	11400	12500
70	237.4	448.3							8.4	2.75						
80	240.4	437.5							8.7	2.76						
5	252.8 254.3	430.1 429.6	2800	1.86	0.14	161.0	4.0	8.2			SHALE	10000	11800	11400	11200	11300
90	258.6	427.3							9.0	2.78						
100	260.1	417.8							8.3	2.76						
6	274.8 274.5	411.9 411.4	3400	2.10	0.13	161.0	4.0	8.2			SHALE	9900	11300	11200	11400	11500
110	278.8	407.1							8.5	2.77						
120	289.2	396.7							8.5	2.76						
7	295.3 295.8	390.4 390.1	4100	1.74	0.19	161.6	3.7	7.6			SHALE	10600	12000	12000	12100	12000
130	298.9	387.0							8.6	2.77						
140	308.9	377.0							8.2	2.76						
8	316.1 316.5	369.8 369.4	4100	1.70	2.31	161.0	3.9	8.1			SHALE	10300	11900	11900	12000	11800
150	318.9	367.0							10.5	2.68						

10.5

2.68

BOULDER = 2.62; SANDSTONE = 2.65.

MAY 6, 1991

^a ASSUMED VALUES OF SPECIFIC GRAVITY WERE: SHALE = 2.70 (2.60 FOR NEW ALBANY); LIMESTONE = 2.71; DOLOMITE = 2.82; SANDSTONE = 2.65.

Table 4.2b (page 1 of 2)

PORT KNOX, KENTUCKY - ROCK TEST RESULTS
MAY 6, 1991

SONIC VELOCITIES (FT/SEC)																
SAMPLE NUMBER (CH-3)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X 10 ⁶ (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POISSON'S RATIO (%)	MEASURED			ROCK TYPE	LATERAL			
									POISSON'S RATIO (%)	SPEC GRAV (pcf)	PBH (in)		AXIAL AVERAGE	DIAMETER		
														1/4	1/2	3/4
1B	314.6	394.7						9.0	2.80							
2B	325.0	384.3						8.9	2.78							
1	329.8 - 330.4	379.3 - 378.9	4400	1.99	0.22	160.6	3.9	8.3			SHALE	5400	12000	12000	11900	
3B	334.0	373.3						7.4	2.74						11900	
4B	344.0	343.3						9.3	2.78						12000	
2	348.1 - 348.6	341.8 - 340.7	4300	2.04	0.19	161.5	4.0	7.9			SHALE	10200	12100	11900	12400	
5B	355.0	334.3						9.9	2.81						12500	
6B	364.3	343.0						9.7	2.79						12500	
3	368.4 - 368.9	340.9 - 340.4	3800	2.08	0.19	161.6	4.3	8.1			SHALE	9500	12300	12200	12500	
7B	373.0	334.3						10.1	2.81							
8B	384.6	324.7						8.1	2.75							
4	388.4 - 388.8	320.9 - 320.5	4300	1.96	0.21	161.7	3.9	7.7			SHALE	10100	12800	12800	12800	
4A	394.1	319.2						7.5	2.77							
4B	394.4	314.9						7.8	2.75							
4C	404.1	305.2						7.9	2.73							
4D	405.1	304.2						8.1	2.77							
5	409.3 - 409.8	300.0 - 299.5	1000	0.75	0.21	161.8	3.9	7.6			SHALE	9300	12700	12800	12500	
5A	415.1	294.2						6.5	2.77							
5B	424.1	285.2						7.2	2.74							
5C	425.6	283.7						7.6	2.77							
6 +	428.4 - 428.8	280.9 - 280.5						8.8			SHALE					
6A	434.1	273.2						5.9	2.72							
6B	435.8	273.5						7.5	2.76							
6C	442.8	266.5							2.38							

Table 4.2b (page 2 of 2)

PORT KNOX, KENTUCKY - ROCK TEST RESULTS
MAY 6, 1991
(continued)

SAMPLE NUMBER (CH-3)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X 10 ⁶ (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY* (%)	MEASURED POROSITY (%)	SPEC GRAV (gd)	ROCK TYPE	SONIC VELOCITIES (FT/SEC)			
												AXIAL	AVERAGE	1/4	3/4
60	445.4	243.9													
7	450.2 - 456.7	259.1 - 258.6	13900	1.49	1.28	139.2	1.2	10.4	2.18		CARBON SHALE	9700	12700	12900	12700
7A	455.1	254.2							2.25						
7B	444.1	245.2							2.43						
8	470.1 - 470.6	239.2 - 238.7	6700	0.90	0.86	145.1	1.7	15.4			CARBON SHALE	9900	13400	14100	12800
8A	475.0	234.3							2.43						
8B	484.6	224.7							2.57						
8C	485.1	224.2							2.53						
9	489.4 - 489.8	219.9 - 219.3	10700	1.40	0.96	147.3	2.0	14.3			CARBON SHALE	10400	13700	13400	13600

* SPECIMEN WAS TOO BROKEN TO TEST.
* ASSUMED VALUES OF SPECIFIC GRAVITY WERE: SHALE = 2.70 (2.60 FOR NEW ALBANY); Limestone = 2.71; Dolomite = 2.82; Sandstone = 2.65.

Table 4.2c (page 1 of 2)

PORT ENOX, KENTUCKY - ROCK TEST RESULTS
MAY 6, 1991

SAMPLE NUMBER (CS-4)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X 10 ⁶ (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY* (%)	SPEC GRAV (G)	PERM** (MD)	ROCK TYPE	SONIC VELOCITIES (FT/SEC)			
												LATERAL			
												AXIAL	AVERAGE	1/4	3/4
1	343.8 - 344.3	344.9 - 344.6	1400	2.85	0.04	161.1	5.5	9.4			SHALE	9200	11600	11500	11700
10	344.3	344.6							8.1	2.77				11500	11500
20	379.4	335.3							8.6	2.79					
2	343.7 - 344.2	327.0 - 326.5	2600	1.80	0.13	161.7	4.3	8.0			SHALE	9400	11800	11700	11800
30	344.4	324.3							7.0	2.75				11700	11500
40	394.3	314.4							6.4	2.78					
3	404.4 - 405.2	304.1 - 303.5	1400	0.31	0.40	199.6	1.2	17.0			SHALE	14400	16400	16100	17200
50	404.4	304.3							7.4	2.75				15100	17700
60	416.3	294.4							6.7	2.76				17700	16700
4	424.1 - 424.6	284.6 - 284.1	1800	1.49	0.23	142.0	4.4	7.9			SHALE	9900	13000	12900	12900
70	424.2	284.5							5.8	2.76				13000	13000
80	434.2	274.5							2.17						
5	444.2 - 444.7	244.5 - 244.0	15300	2.50	0.95	137.3	1.2	16.4			CARBON SHALE	9600	15000	13000	13400
90	444.7	244.0							2.24						
100	454.8	233.9							2.49						
110	457.0	233.7							2.39						
6	444.2 - 444.7	244.5 - 244.0	7700	1.88	0.57	143.3	1.8	13.3			CARBON SHALE	9500	14200	14400	14000
120	476.7	234.0							2.45					13700	13700
7	483.5 - 484.0	227.2 - 226.7	10800	1.38	1.05	151.2	2.2	8.9			CARBON SHALE	11100	14400	14500	14400
130	487.0	223.7							2.38					14400	14500
140	494.8	213.9							2.74					14400	14800
8	503.9 - 504.4	204.8 - 204.3	6600	1.24	0.84	154.7	1.7	6.3			CARBON SHALE	10900	15200	14700	14700
150	507.2	203.5							2.50					14700	14700

Table 4.2c (page 2 of 2)

FORT KNOX, KENTUCKY - ROCK TEST RESULTS
MAY 6, 1991
(continued)

SAMPLE NUMBER (CB-4)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X 10 ⁶ (PSI)	NET DENSITY (G/CC)	WATER CONTENT (%)	CALCULATED POROSITY ^{..} (%)	POROSI- TY (%)	SPEC GRAV (G/CC)	PGR ^{..} (in)	ROCK TYPE	SONIC VELOCITIES (FT/SEC)			
													AXIAL	AVERAGE	LATERAL	DIAMETER
146	317.2	191.5							1.9	2.83	0.02 - 0.02		15900	16200	16300	16000
9	323.1 - 323.6	187.6 - 187.1	13500	0.85	2.01	143.9	3.2	6.1				LNST	16300	16300	16500	16400
178	327.2	183.5							5.8	2.81	0.01 - 0.01					
188	338.6	172.1							5.0	2.84	0.04 - 0.04					
10	341.9 - 342.4	168.6 - 168.3	2700	0.54	0.64	158.0	5.0	11.1				LNST	17500	16700	15300	14000
198	348.3	163.4							17.8	2.87	311.00 - 297.00				14400	18000
208	356.7	154.0							12.8	2.87	94.19 - 30.33					
11	344.8 - 345.1	145.9 - 145.6	12400	0.72	2.05	168.0	2.6	3.2				LNST	17000	17100	17300	16900
218	347.3	143.4							9.4	2.86	1.43 - 1.35				17100	17500

* ASSUMED VALUES OF SPECIFIC GRAVITY WERE: SHALE = 2.78 (2.60 FOR NEW ALBANY); LIMESTONE = 2.71; DOLOMITE = 2.82; SANDSTONE = 2.65.
.. HORIZONTAL (CROSS-AXIS) VALUES; FIRST VALUE IS THE MAXIMUM FOR THE PLUG; SECOND VALUE OBTAINED PERPENDICULAR TO THE FIRST.

Table 4.2d (page 1 of 3)

PORT KONG, KENTUCKY - ROCK TEST RESULTS
MAY 7, 1971

SONIC VELOCITIES (FT/SEC)																		
SAMPLE NUMBER (CD-5)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X 10 ⁶ (PSI)	UNIT WEIGHT (PCF)	WATER CONTENT (%)	CALCULATED POROSITY ^a (%)	MEASURED			ROCK TYPE	LATERAL					
									POROSITY (%)	SPEC GRAV (G/CM ³)	PEN ^b (mm)		AXIAL	AVERAGE	DIAMETER 1/4	DIAMETER 1/2	DIAMETER 3/4	
1A	404.2	316.8							8.0	2.74								
1	407.5 - 407.9	313.5 - 313.1	2900	1.36	0.36	161.6	4.1	7.9				SAND	9100	12700	12600	12800	12500	12600
1B	416.7	306.3							4.7	2.76								
1C	425.5	299.5							7.3	2.74								
2	427.5 - 428.8	293.5 - 291.8	1700	1.40	0.26	178.3	4.6	3.4				SAND	4100	11700	11800	11600	11900	11800
2A	434.9	286.1							8.0	2.73								
2B	445.1	275.9								2.25								
3	444.9 - 447.3	274.1 - 273.7	10700	0.96	1.18	136.5	1.2	15.6				CARBON SAND	9700	13300	13900	13700	13200	13100
3A	455.2	265.8								2.31								
3B	446.1	255.9								2.44								
4	447.3 - 447.9	253.7 - 253.1	7800	0.82	1.20	149.6	1.6	9.2				CARBON SAND	9900	14000	14100	14000	14300	14300
4A	476.5	244.5								2.48								
5	486.2 - 486.6	234.8 - 234.4	10200	0.89	1.33	151.6	2.0	8.4				CARBON SAND	10900	14000	14100	14000	14300	14100
5A	486.8	234.2								2.44								
5B	496.6	224.6								2.58								
5C	505.9	215.1								2.30								
6	506.4 - 506.8	214.6 - 214.2	9400	0.91	1.47	149.9	1.6	9.1				CARBON SAND	10400	13100	14100	17900	14300	14300
6A	514.6	206.4								2.45								
6B	523.8	198.8							0.9	2.72	0.26 - 0.16							
7	527.6 - 528.1	193.4 - 192.9	15100	0.57	2.77	167.4	2.6	7.3				DOL	16100	16500	14500	14300	14400	14400
7A	535.2	185.8							5.2	2.81	0.14 - 0.07							
7B	544.6	176.4							17.6	2.84	2088 - 2037							

Table 4.2d (page 3 of 3)

PORT ROCK, KENTUCKY - ROCK TEST RESULTS
MAY 7, 1991
(continued)

SAMPLE NUMBER (CB-5)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X 10 ⁶ (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY* (%)	MEASURED			ROCK TYPE	SONIC VELOCITIES (FT/SEC)				
									POROSITY (%)	SPEC GRAV	PERM** (MD)		AXIAL	AVERAGE	LATERAL		
															1/4	3/4	DIAMETER
14	446.6 - 447.0	54.4 - 54.0	18300	0.38	5.76	172.1	1.6	--- +				LHST	19700	19300	19100	19400	18700 19200
14A	474.6	46.6						8.8	2.81	0.61 - 0.51							
15	481.0 - 481.4	48.0 - 39.6	8100	0.48	1.00	167.2	3.1	7.8				DOL	14400	14400	14900 14100	14700 15100	13800 15000
15A	481.7	39.3						9.1	2.82	0.01 - 0.01							

* A NEGATIVE VALUE WAS CALCULATED (-0.2).
 * ASSUMED VALUES OF SPECIFIC GRAVITY WERE: SHALE = 2.70 (2.60 FOR NEW ALBANY); LIMESTONE = 2.71; DOLOMITE = 2.82; SANDSTONE = 2.65.
 ** HORIZONTAL (CROSS-AXIS) VALUES; FIRST VALUE IS THE MAXIMUM FOR THE PLUG; SECOND VALUE OBTAINED PERPENDICULAR TO THE FIRST.

Table 4.2e (page 1 of 3)

PORT DOCK, KENTUCKY - ROCK TEST RESULTS
MAY 7, 1991

SONIC VELOCITIES (FT/SEC)																	
SAMPLE NUMBER (CS-6)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X 10 ⁶ (PSI)	NET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY ^a (%)	MEASURED			ROCK TYPE	LATERAL				
									POROSITY (%)	SPEC GRAV	PDM ^b (ms)		AXIAL	AVERAGE	DIAMETER		
															1/4	1/2	3/4
1	401.5 - 402.0	331.6 - 321.0	2400	1.01	0.37	163.5	3.6	6.4				SHALE					
2	421.2 - 421.8	301.9 - 301.3	1700	1.28	0.18	160.0	4.3	9.0				SHALE					
18	430.2	292.9							6.4	2.75							
3	440.0 - 440.5	283.1 - 282.6	12100	1.72	0.98	138.3	1.3	15.9				CARBON SHALE	9300	12400	12400 12500 12500 12200		
28	440.7	282.4								2.26							
38	449.8	273.3								2.26							
4	439.4 - 440.1	243.5 - 243.0	8700	0.85	1.29	153.2	2.1	7.6				CARBON SHALE	10900	13900	14000 14200 13400 13200		
48	440.2	242.9								2.26							
58	471.0	232.1								2.45							
5	478.5 - 479.1	244.6 - 244.0	10100	0.95	1.37	148.4	2.0	10.4				CARBON SHALE	10400	13900	13900 14000 13900 13700		
68	480.0	243.1								2.42							
78	489.3	233.8								2.38							
88	497.8	225.3								2.51							
6	496.7 - 499.1	224.4 - 224.0	7700	0.77	1.30	152.7	2.2	8.0				CARBON SHALE	10300	14400	14400 14400 14300 14300		
98	509.0	216.1								2.32							
7	521.0 - 521.5	202.1 - 201.6	9500	0.42	5.89	169.3	0.3	0.2				LMT	19900	19000	18900 19100 19400 19400		
108	521.7	201.4							0.1	2.74	0.06 - 0.06						
76	523.1 - 523.6	200.0 - 199.5	9000	0.60	2.50	171.9	1.5	0.1				LMT					
118	532.0	191.1							5.7	2.81	1332.00 - 305.00						
8	540.8 - 540.8	183.1 - 182.5	4000	0.30	3.07	153.6	5.1	17.0				DOL	17100	14800	17900 16000 16000 15200		
128	541.3	181.8							2.9	2.81	2.57 - 2.35						

Table 4.2e (page 2 of 3)

PORT KNOX, KENTUCKY - ROCK TEST RESULTS
MAY 7, 1991
(continued)

SAMPLE NUMBER (CS-6)	DEPTH (FT)	SLV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X 10 ⁶ (PSI)	UNIT WEIGHT (PCF)	WATER CONTENT (%)	CALCULATED POROSITY (%)	MEASURED POROSITY (%)	SPEC GRAV (IND)	ROCK TYPE	SONIC VELOCITIES (FT/SEC)			
												LATERAL			
												AXIAL	AVERAGE	1/4	3/4
138	553.7	169.4							8.4	2.84	7.35 - 3.23				
148	540.8	142.3							9.9	2.84	17.20 - 11.09				
9	541.3 - 541.8	161.8 - 161.3	10200	0.41	2.59	145.4	3.5	9.1			DOL	17000	17200	17200	16500
158	570.7	192.4							8.4	2.84	18.08 - 8.09				
168	540.8	143.1							11.4	2.85	5.44 - 1.48				
10	540.2 - 540.7	143.9 - 142.4	13100	0.75	6.67	169.6	2.1	5.7			DOL	19500	18400	18500	18900
178	549.1	154.8							3.2	2.83	6.11 - 0.04				
11	600.4 - 601.1	122.5 - 122.8	4700	0.75	6.97	163.8	4.0	10.5			DOL	17200	18100	17400	18700
188	601.4	121.7							10.9	2.85	1515.80 - 422.00				
111	602.9 - 603.4	128.2 - 119.7	8400	0.80	2.88	162.7	2.0	9.4			DOL				
199	608.6	114.5							4.8	2.85	0.17 - 0.15				
12	620.7 - 621.2	102.4 - 101.9	9900	0.59	4.00	168.7	2.3	6.3			DOL	16900	17800	18500	17400
208	622.4	100.7							8.8	2.85	13.77 - 12.87				
218	629.2	95.9							2.7	2.71					
228	639.2	83.9							4.4	2.84	1.42 - 0.09				
13	639.4 - 640.8	83.7 - 83.1	18900	0.54	6.74	171.4	1.3	3.9			DOL	20100	19800	19200	19700
13L	648.9 - 641.5	82.2 - 81.6	19500	0.87	2.04	169.9	1.1	4.5			DOL				
238	658.5	72.4							7.1	2.85	0.10 - 0.04				

Table 4.2f (page 1 of 6)

PORT KNOX, KENTUCKY - ROCK TEST RESULTS
MAY 7, 1991

SONIC VELOCITIES (FT/SEC)																	
SAMPLE NUMBER (72-1)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X 10 ⁶ (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY** (%)	MEASURED			ROCK TYPE	LATERAL				
									POROSITY (%)	SPEC GRAV	PDM (md)		AXIAL	AVERAGE	DIAMETER		
															1/4	1/2	3/4
1	48.7 - 41.1	416.2 - 415.8	1000 +	2.00 +	-----	137.5	4.9	10.9				SHALE	8400	9100	9100 8300 9200		
2	43.4 - 43.9	373.5 - 373.0	2200	1.88	-----	139.8	4.6	9.3				SHALE	9000	9900	9700 9100 9900 10400		
3	81.3 - 81.7	373.4 - 373.2	2400	1.86	-----	140.0	4.4	9.0				SHALE	8400	10000	10300 9400 9700 10700		
4	101.3 - 101.7	355.4 - 355.2	2700	1.96	-----	161.5	3.9	7.8				SHALE	8400	10400	10700 9700 10100 11300 10700		
5	121.4 - 121.8	335.5 - 335.1	2000	1.84	-----	161.4	4.2	8.1				SHALE	4300	11200	10800 10900 10700 11400 11500		
6	141.3 - 141.7	315.4 - 315.2	2000	1.27	-----	161.7	4.4	8.1				SHALE	9000	10900	10400 11500 10200 10300		
8	178.4 - 178.8	278.5 - 278.1	1600	1.48	0.18	161.0	4.7	8.7				SHALE	8700	11100	10700 10400 10100 12100 11900		
9	185.2 - 185.6	271.7 - 271.3	7300	0.83	1.11	134.8	2.0	18.5				CARBON SHALE	9000	12000	11700 11900 12500 12800		
10	200.4 - 200.8	254.5 - 254.1	11500	1.27	1.48	142.5	1.3	13.3				CARBON SHALE	6900	12300	12300 12300 12300		
11	224.1 - 224.5	232.8 - 232.4	6500	0.55	1.48	147.0	1.9	11.1				CARBON SHALE	10200	12700	13200 12400 13400 13000 10200		
39	249.4 - 241.0	216.3 - 215.9	3500	0.73	11.96	162.7	3.0	2.6				CAL SHALE					
40	241.1 - 241.5	215.8 - 215.4	3000	0.59	10.95	155.6	2.3	6.3				CARBON SHALE					
12	241.6 - 242.8	215.3 - 216.9	5200	0.76	0.78	163.6	2.9	2.0				CAL SHALE	11200	15100	13900 12900 11000 14400 11400		
13	242.3 - 242.7	194.6 - 194.2	7400	0.44	1.91	145.5	1.1	11.3				SHALE	8300	13900	13900 13900 13900 13900		
16	263.2	193.7							2.7	2.86	< 0.01						
14	243.2 - 243.6	193.7 - 193.3	12000	0.24	6.86	170.4	2.7	5.7				COL	19300	12100	12000 12500 11900 10700		
18	267.8	189.9							1.0	2.82	< 0.01						
28	268.7	188.2							0.8	2.72	< 0.01						
38	272.3	184.6							8.6	2.82	< 0.01						
48	274.7	182.2							6.8	2.82	< 0.01						

Table 4.2f (page 2 of 6)

PORT KNOX, KENTUCKY - ROCK TEST RESULTS
MAY 7, 1991
(continued)

SAMPLE NUMBER (FC-1)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X 10 ⁶ (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY (%)	MEASURED			ROCK TYPE	SONIC VELOCITIES (FT/SEC)			
									POSSIB. (%)	SPEC GRAV (g/d)	P/M (%)		AXIAL	AVERAGE	LATERAL	DIAMETER
15	279.4	178.5							4.6	2.79	< 0.01		-16300	16500	16400	17100
15	278.5 - 278.9	178.4 - 178.0	14600	0.44	3.40	168.0	2.1	6.4				DOL			16400	17100
58	279.8	177.9							5.6	2.81	< 0.01					
60	282.5	174.4							5.3	2.80	< 0.01					
78	284.8	172.1							5.8	2.82	< 0.01					
88	287.1	169.8							6.1	2.83	< 0.01					
98	288.9	168.0							8.9	2.81	0.27					
108	290.5	166.4							2.4	2.83	< 0.01					
16	292.2 - 292.6	164.7 - 164.3	7400	0.24	4.07	170.8	1.3	4.7				DOL	19500	14500	18100	14900
16A *	292.6 - 293.8	164.3 - 163.9	3900	0.76	1.40	165.3	2.1	8.0				DOL	2600	13600	17500	14700
118	292.9	164.0							7.5	2.82	99.36					
16	293.1	163.8							6.0	2.82	21.64					
30	296.8 - 297.2	160.1 - 159.7	5800	0.24	4.33	163.8	3.7	10.2				DOL	19000	13700	18700	17200
30	297.2	159.7							6.6	2.81	53.70					
33	297.3 - 297.7	159.4 - 159.2	9700	0.15	10.09	162.8	3.2	10.4				DOL				
34	297.7 - 298.1	159.2 - 158.8	7700	0.18	6.76	163.8	3.5	10.1				M.L.				
128	298.2	158.7							12.3	2.82	322.00					
136	300.0	154.9							14.2	2.83	126.00					
140	302.0	154.9							7.5	2.83	0.40					
158	305.0	151.9							6.7	2.82	0.02					
168	306.5	150.4							6.1	2.84	6.72					
178	310.0	146.9							5.2	2.84	0.03					
188	311.7	145.2							8.3	2.85	0.05					
198	313.7	143.2							16.2	2.83	57.40					

Table 4.2f (page 3 of 6)

PORT KNOX, KENTUCKY - ROCK TEST RESULTS
MAY 7, 1991
(cont.)

SONIC VELOCITIES (FT/SEC)																
SAMPLE NUMBER (PK-1)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (IN)	YOUNG'S MODULUS X 10 ⁶ (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY (%)	MEASURED			ROCK TYPE	LATERAL			
									POROSITY (%)	SPEC GRAV (MG)	PEN (MG)		AXIAL AVERAGE	1/4	1/2	3/4
206	316.5	140.4						16.6	2.77	152.00						
216	318.7	138.2						9.2	2.84	0.06						
17	321.4	135.5						10.3	2.82	0.02						
17	321.5 - 321.9	135.4 - 135.0	9900	0.32	3.80	163.3	4.2	10.9			DOL	12300	12300	13000	12200	13200
226	322.0	134.9						10.9	2.83	0.02						
236	324.6	132.3						7.7	2.84	0.11						
246	326.0	130.9						6.3	2.84	0.95						
256	329.6	127.3						3.7	2.85	0.02						
266	331.2	125.7						2.9	2.84	< 0.01						
276	333.6	123.3						3.7	2.83	< 0.01						
286	336.6	120.3						2.0	2.83	0.01						
18A	340.6	116.3						2.2	2.82	< 0.01						
18	340.7	116.2						2.5	2.82	0.01						
18	341.7 - 342.2	115.2 - 114.7	20700	0.32	6.96	172.3	0.9	2.9			LIST/ DOL	20000	18700	17400	19700	19000
37	342.2 - 342.5	114.7 - 114.4	9400	0.14	10.46	173.2	0.6	2.2			LIST/ DOL					
36	342.5 - 342.9	114.4 - 114.0	13600	0.36	6.25	172.5	0.6	2.6			LIST/ DOL					
298	343.3	113.6							2.6	2.82	0.02					
308	344.7	112.2							2.0	2.81	< 0.01					
318	347.2	109.7							6.1	2.85	1.03					
31	351.6	105.3							4.4	2.85	1.47					
31	351.8 - 352.2	105.1 - 104.7	6700	0.22	9.61	164.9	3.7	9.6			DOL	18500	13400	14200	19400	14100
35	352.3 - 352.7	104.6 - 104.2	5200	0.17	6.54	159.7	4.6	13.3			DOL			17400	13600	
328	352.9	104.0							12.9	2.84	167.00					

PORT LOCK, KENTUCKY - ROCK TEST RESULTS
MAY 7, 1991
(continued)

B-19

Table 4.2f (page 5 of 6)

PORT ROCK, KENTUCKY -- ROCK TEST RESULTS
MAY 7, 1991
(continued)

SAMPLE NUMBER (FIC-1)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X 10 ⁶ (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY-- (%)	MEASURED			ROCK TYPE	SONIC VELOCITIES (FT/SEC)				
									POROSITY (%)	SPEC GRAV (md)	PERM (md)		AXIAL	AVERAGE	LATERAL		DIAMETER
															1/4	1/2	
408	412.6	44.3						8.1	2.86	11.76							
498	417.7	39.2						7.3	2.85	< 0.01							
508	419.9	37.0						6.1	2.84	0.01							
518	422.0	34.9						5.1	2.84	0.02							
23	425.7	31.2						7.4	2.82	0.01							
23	425.8 - 426.2	31.1 - 30.7	8000	0.36	3.12	167.9	2.9	7.2				SHALEY DOL	15200	13000	10900	11900 14100	15000
538	426.4	30.5						7.7	2.83	0.02							
24	430.9 - 431.3	26.0 - 25.6	5400	0.33	1.94	164.7	3.0	8.0				DOL	14300	15400		15300 15400	
24	431.5	25.4						8.7	2.81	< 0.01							
528	431.8	25.1						6.2	2.79	0.10							
548	434.2	22.7						8.0	2.82	< 0.01							
558	440.5	16.4						7.3	2.83	< 0.01							
548	443.0	13.9						1.7	2.73	0.02							
578	446.7	10.2						3.6	2.73	0.02							
588	447.8	9.1						1.9	2.74	0.01							
25	448.3 - 448.7	8.6 - 8.2	10000	0.25	6.25	167.2	0.3	1.4				SHALEY LIMST	19600	13800	14400	10400 12700	18000 13200
25	448.8	8.1						0.8	2.71	< 0.01							
608	452.2	4.7						1.5	2.74	< 0.01							
618	454.5	2.4						2.6	2.76	0.03							
628	456.7	0.2						4.6	2.82	< 0.01							
26	458.7 - 459.1	-1.8 - -2.2	7200	0.34	3.11	168.9	1.2	1.3				LIMST/ SHALE	16100	13200	14100	14400 13700	16400
26	459.2	-2.3						1.8	2.75	< 0.01							
638	459.4	-2.5						2.7	2.77	< 0.01							
648	461.6	-4.7						3.4	2.79	< 0.01							

Table 4.2f (page 6 of 6)

FORT KNOX, KENTUCKY - ROCK TEST RESULTS
MAY 7, 1991
(continued)

SONIC VELOCITIES (FT/SEC)																
SAMPLE NUMBER (K-1)	DEPTH (FT)	ELEV (FT)	UC STRENGTH (PSI)	AXIAL STRAIN AT FAILURE (%)	YOUNG'S MODULUS X 10 ⁶ (PSI)	WET DENSITY (PCF)	WATER CONTENT (%)	CALCULATED POROSITY (%)	MEASURED			ROCK TYPE	LATERAL			
									POROSITY (%)	SPEC GRAV	PEM (md)		AXIAL	AVERAGE	DIAMETER 1/4 1/2 3/4	
659	445.0	-8.1							3.4	2.78	0.04					
27	448.0	-11.1	8000	0.30	3.36	167.6	2.5	2.9				SHALE	15400	13500	14400	13500
	448.4	-11.5														12800
27	448.5	-11.6							5.7	2.80	< 0.01					
668	473.2	-16.3							3.3	2.78	< 0.01					
678	476.1	-19.2							2.8	2.73	0.03					
688	479.0	-22.1							2.3	2.75	< 0.01					
28	480.4	-23.5							3.5	2.79	0.02					
28	480.5	-23.6	11700	0.32	4.57	169.2	0.9	0.8				LMST/ SHALE	17700	12800	13400	10200
	480.9	-24.0											13800	10500	12200	16400
698	482.4	-25.5							3.6	2.79	< 0.01					
708	485.0	-28.1							1.6	2.72	< 0.01					
718	488.4	-31.5							4.3	2.82	< 0.01					
728	490.7	-33.8							3.4	2.79	< 0.01					
738	493.0	-36.1							2.0	2.74	< 0.01					
748	496.5	-39.6							1.9	2.74	< 0.01					
758	498.2	-41.3							3.1	2.77	< 0.01					
768	499.5	-42.6							3.5	2.78	< 0.01					
29	499.7	-42.8	8000	0.32	3.09	168.7	1.2	1.5				LMST	16200	13800	12000	15400
	500.1	-43.2													13700	
29	500.2	-43.3							1.1	2.73	0.01					
778	502.0	-45.1							3.0	2.77	< 0.01					
788	504.5	-47.6							1.5	2.74	< 0.01					

* SPECIMEN WAS NOT TAKEN TO FAILURE.

* SPECIMEN HAD PREEXISTING HORIZONTAL FRACTURE.

** ASSUMED VALUES OF SPECIFIC GRAVITY WERE: SHALE = 2.70 (2.60 FOR NEW ALBANY); Limestone = 2.71; Dolomite = 2.82; Sandstone = 2.65.

Figure 4.1
 Summary of Laboratory Test Results for Rock Cores
 from Boring CB-1, Ft. Knox, KY

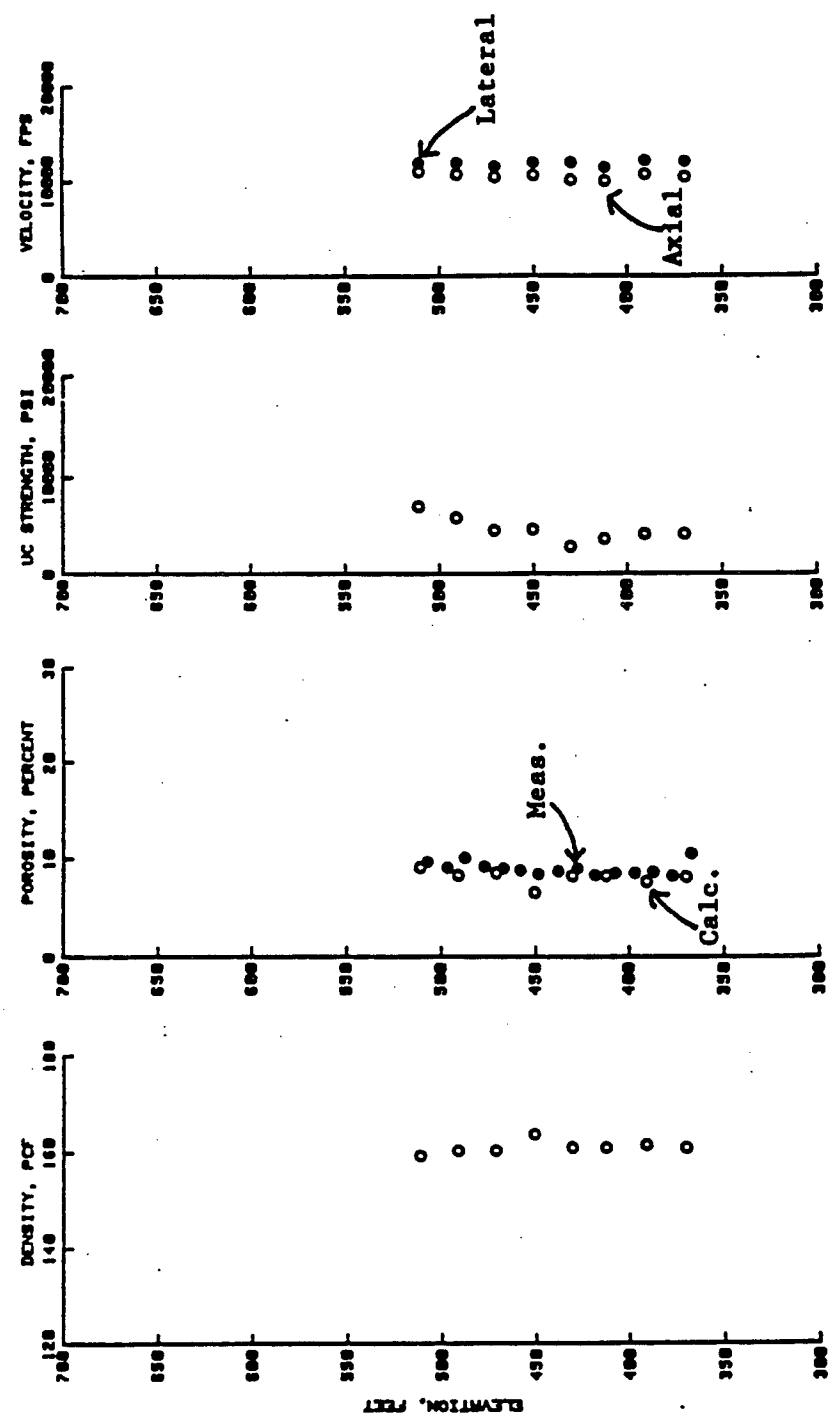


Figure 4.2
Summary of Laboratory Test Results for Rock Cores
from Boring CB-3, Ft. Knox, KY

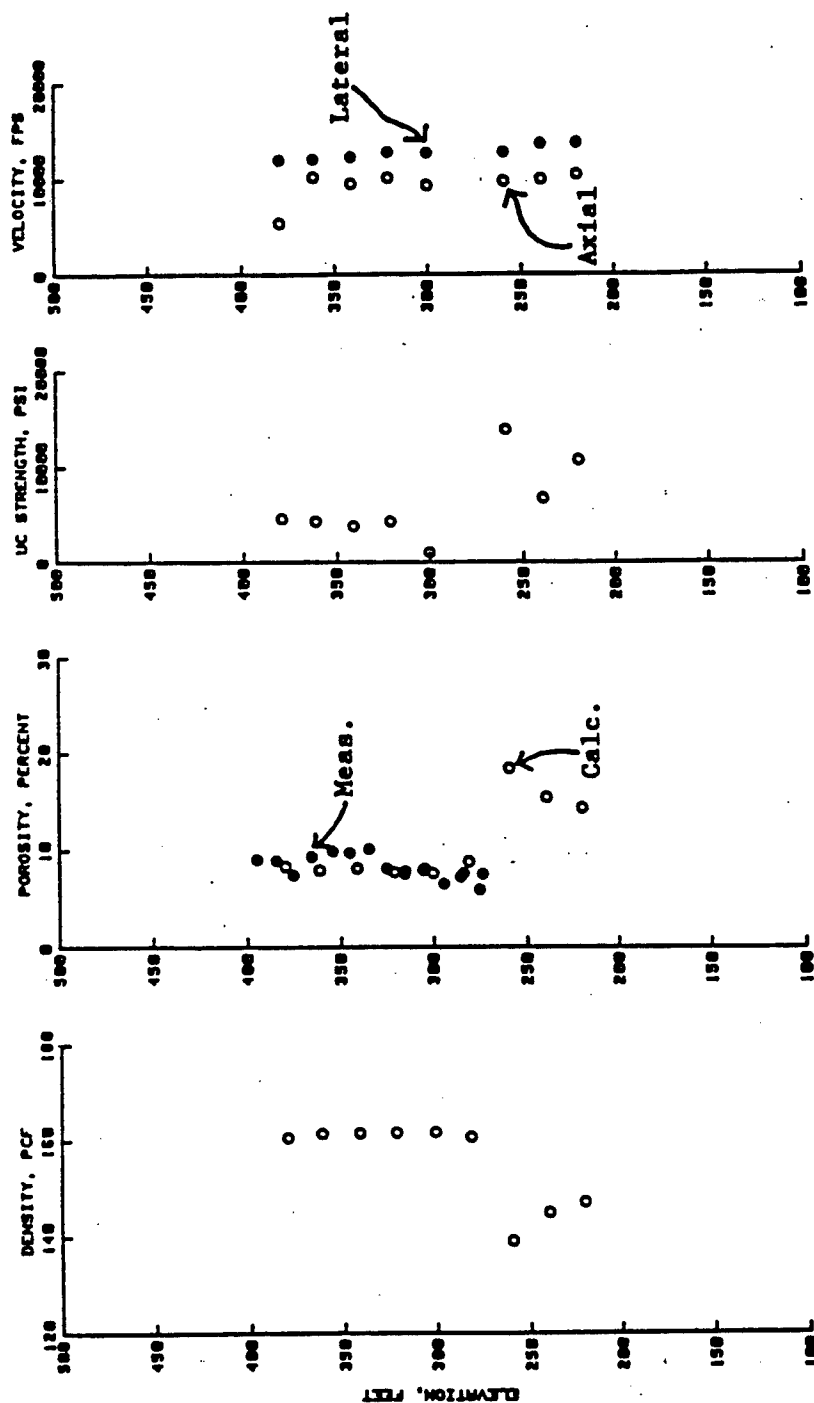


Figure 4.3
Summary of Laboratory Test Results for Rock Cores
from Boring CB-4, Ft. Knox, KY

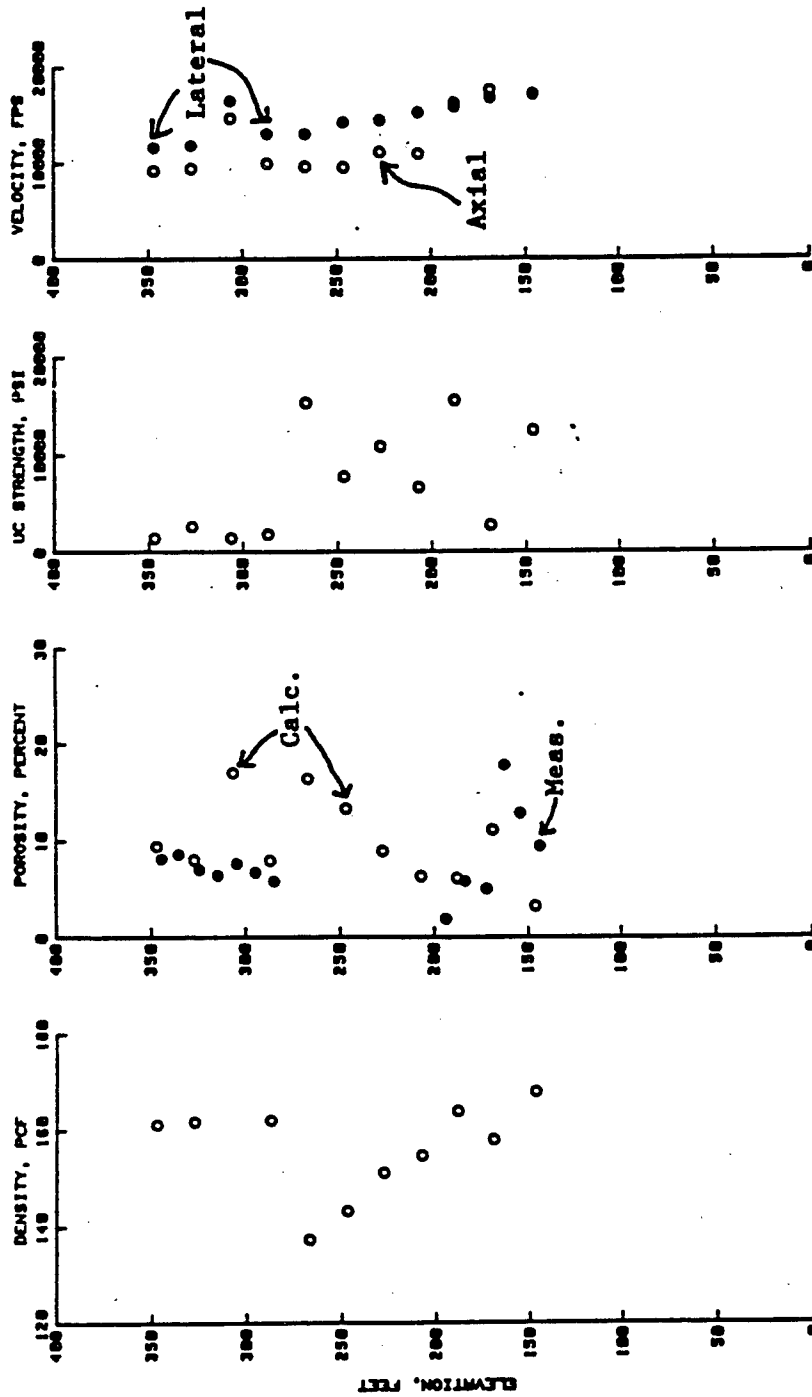


Figure 4.4
Summary of Laboratory Test Results for Rock Cores
from Boring CB-5, Ft. Knox, KY

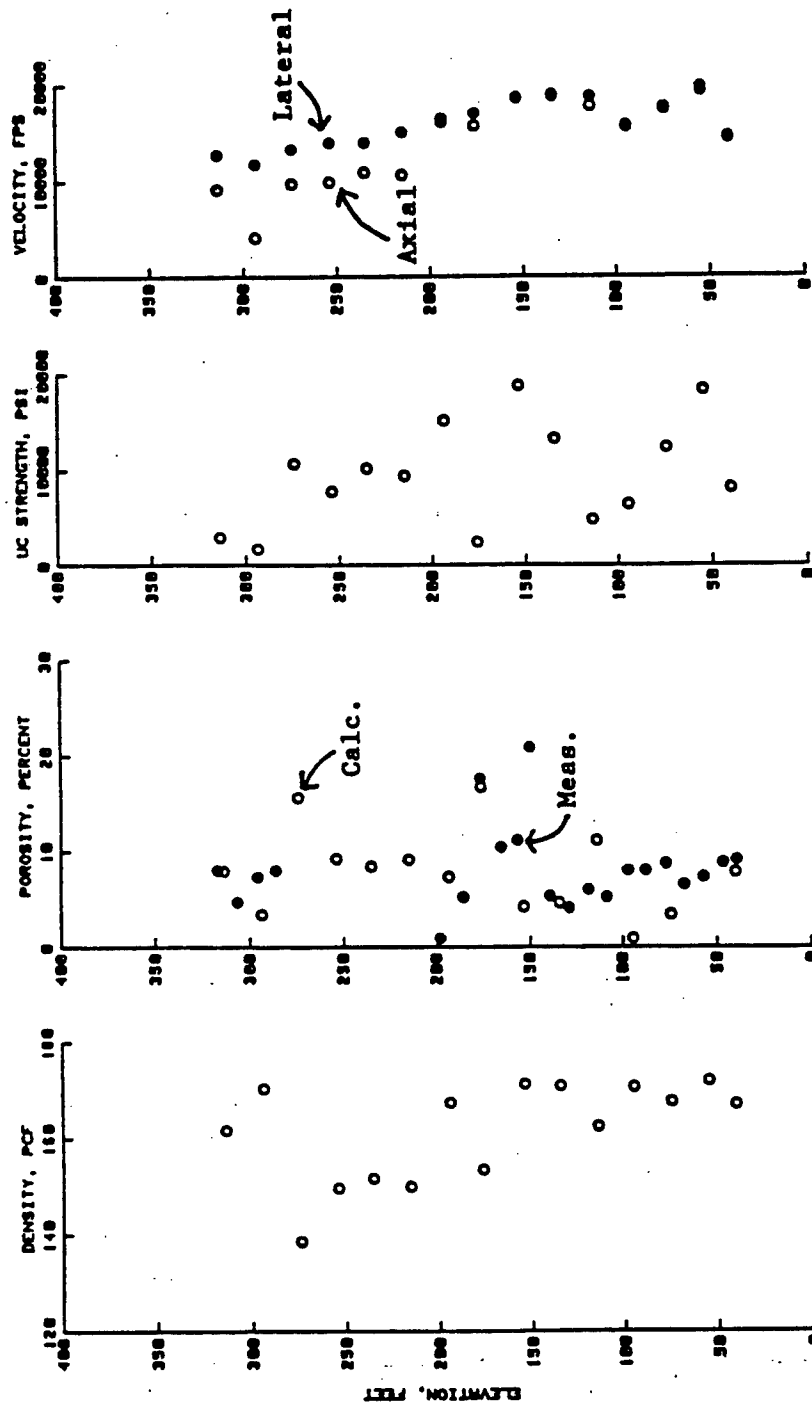


Figure 4.5
Summary of Laboratory Test Results for Rock Cores
from Boring CB-6, Ft. Knox, KY

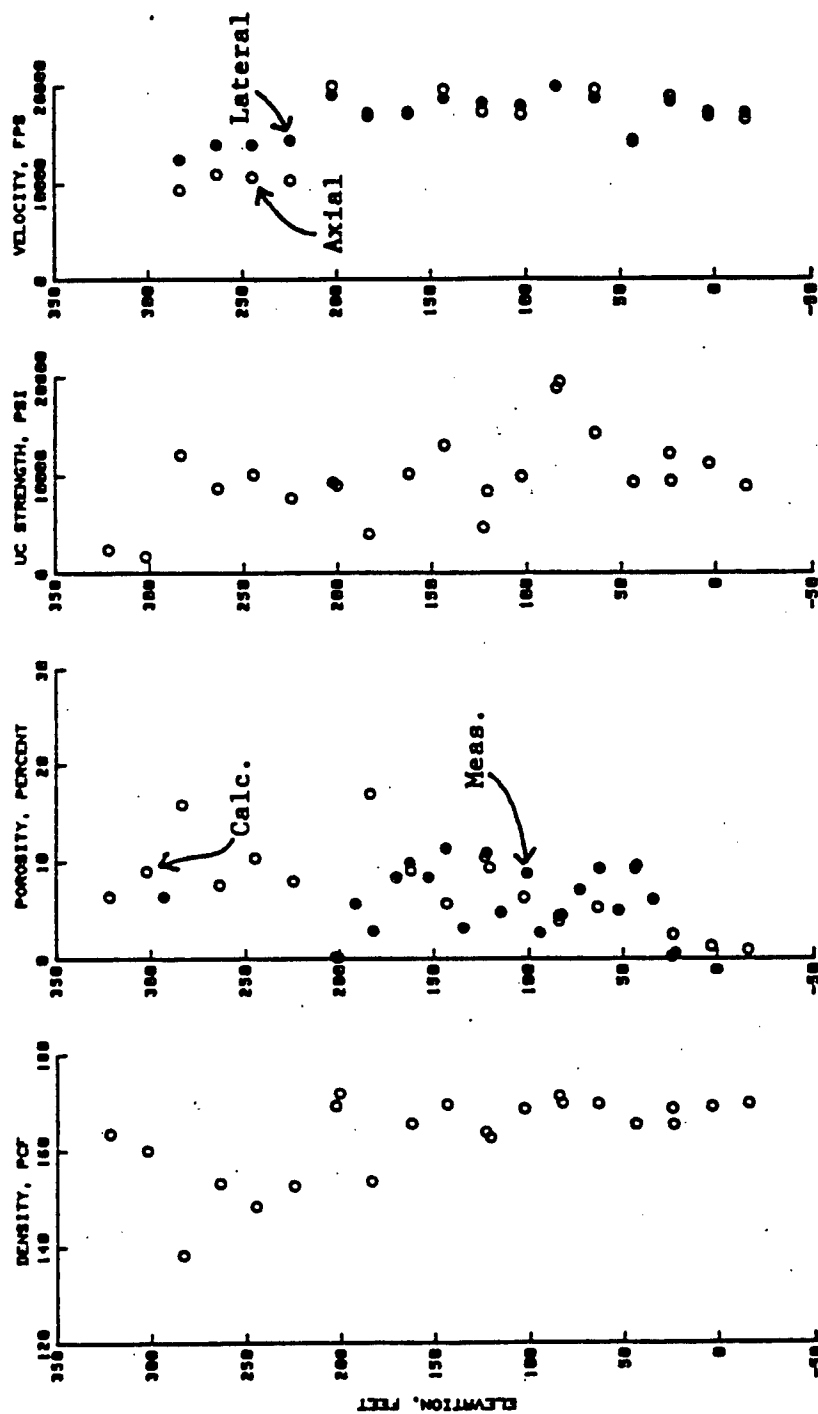


Figure 4.6
Summary of Laboratory Test Results for Rock Cores
from Boring FK-1, Ft. Knox, KY

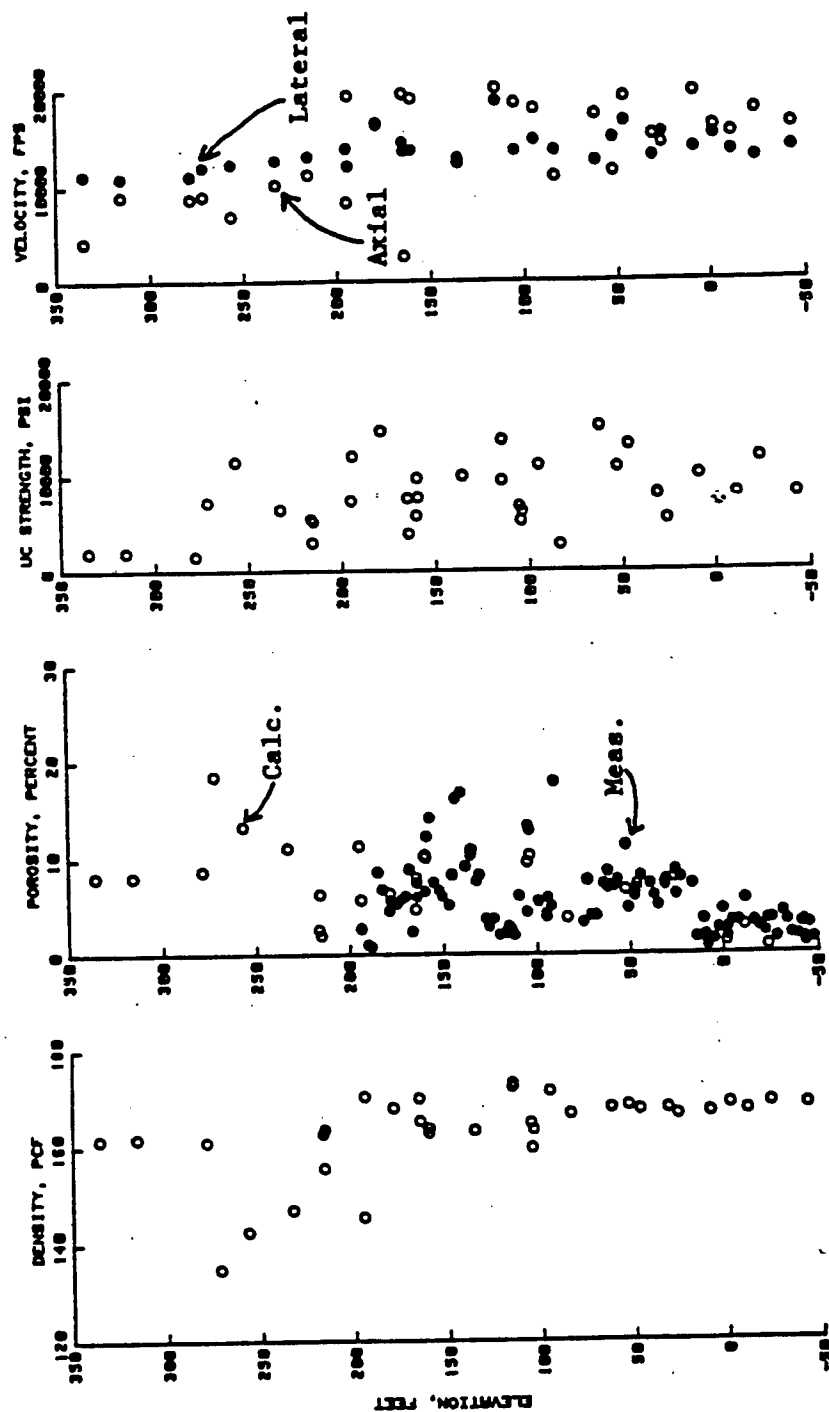


Table 4.3

SUMMARY OF RESULTS OF TENSILE TESTS ON SHALE CORES
FROM UTP BORINGS CB-1, CB-3, AND CB-4 (UPDATED 6/17/91)

Boring No.	Depth (feet)	Dia. (in.)	Ht (in.)	Load (lbs)	Weight (grams)	Wet Density (pcf)	Water Content (%)	Dry Density (pcf)	Indirect Tensile Strength (psi)	Direct Tensile Strength (psi)
CB-1	175.65	1.762	0.964	1506	97.42	157.9	4.23	151.5	564.4	-
	190.80	1.763	0.961	1007	96.91	157.4	4.15	151.1	378.4	-
	206.00	1.760	1.028	980	104.53	159.2	4.23	152.8	344.8	-
	220.35	1.759	0.967	908	96.97	157.2	4.05	151.1	339.8	-
	265.45	1.760	0.959	608	96.71	157.9	4.54	151.1	229.3	-
	279.85	1.762	1.000	599	102.05	159.4	4.67	152.3	216.4	-
	279.95	1.757	0.982	808	100.19	160.3	4.24	153.8	298.1	-
	285.50	1.757	0.933	880	95.63	161.0	3.59	155.5	341.8	-
	291.55	1.756	0.989	735	100.68	160.1	3.75	154.3	269.4	-
	294.10	1.761	0.938	653	95.43	159.1	3.85	153.2	251.7	-
	295.25	1.751	0.942	762	95.41	160.2	4.11	153.9	294.1	-
	299.65	1.757	0.977	626	99.22	159.6	4.12	153.3	232.2	-
	304.70	1.759	0.978	494	103.39	165.7	3.68	159.8	182.8	-
	309.50	1.763	0.887	662	89.99	158.3	4.39	151.7	269.5	-
	309.60	1.759	1.000	708	101.58	159.2	3.78	153.4	256.2	-
CB-3	330.40	1.748	0.941	1134	94.22	158.9	4.22	152.5	438.9	-
	345.05	1.762	1.005	1171	102.31	159.0	4.30	152.5	421.0	-
	360.00	1.763	0.969	1180	97.66	157.3	4.62	150.3	439.7	-
	374.85	1.759	0.992	1370	100.73	159.2	4.48	152.4	499.8	-
	390.10	1.759	1.002	1624	102.58	160.5	4.34	153.8	586.6	-
	405.05	1.762	0.956	726	96.39	157.5	4.38	150.9	274.4	-
	411.50	1.728	0.901	563	89.19	160.8	4.28	154.2	230.2	-
	414.80	1.758	0.989	1071	101.14	160.5	4.32	153.9	392.2	-
	420.25	1.761	1.062	1271	109.65	161.5	3.91	155.4	432.7	-
	425.50	1.761	0.953	1162	97.83	160.6	4.58	153.5	440.8	-
	430.40	1.759	1.035	1198	106.18	160.8	4.42	154.0	418.9	-
	435.50	1.760	1.070	1316	108.72	159.1	4.30	152.5	444.9	-
	440.60	1.762	0.979	2949	82.56	131.8	1.99	129.2	1088.3	-
	445.10	1.763	1.005	2931	93.67	145.5	1.30	143.6	1053.1	-
	450.70	1.765	1.056	3866	95.18	140.3	1.10	138.8	1320.5	-
	465.05	1.763	1.003	2078	97.63	151.9	2.01	148.9	748.1	-
	479.40	1.762	0.961	2514	88.37	143.7	2.12	140.7	945.2	-
CB-4	366.60	1.865	1.000	944	114.27	159.4	4.26	152.8	322.2	-
	380.15	1.864	0.998	1125	114.29	159.9	3.99	153.7	385.0	-
	395.20	1.768	1.005	898	110.07	170.0	3.36	164.4	321.7	-
	409.45	1.762	0.972	1343	99.19	159.4	4.41	152.7	499.2	-
	424.10	1.767	0.994	1143	102.72	160.5	4.61	153.5	414.3	-
	435.00	1.776	4.346	24	453.53	160.5	3.05	155.7	-	1.0
	439.90	1.773	0.993	3394	89.42	138.9	1.40	137.0	1227.3	-
	443.52	1.773	4.305	279.4	373.31	133.8	1.00	132.5	-	113.2
	456.25	1.772	4.232	153.7	393.13	143.5	1.16	141.9	-	62.3
	456.70	1.771	0.957	1815	91.86	148.4	1.75	145.9	681.8	-
	461.70	1.770	1.010	2042	96.83	148.4	1.47	146.3	727.2	-
	466.10	1.774	0.989	2006	94.45	147.2	1.40	145.2	727.9	-
	470.50	1.773	1.014	2504	99.78	151.8	2.21	148.6	886.7	-
	475.30	1.769	4.210	257.2	401.06	147.7	1.87	144.9	-	104.6
	475.60	1.770	1.022	2441	97.01	147.0	1.84	144.3	859.1	-
	480.60	1.758	0.987	2405	101.21	160.9	2.61	156.8	882.4	-
	486.00	1.770	0.940	1815	89.03	146.6	1.83	144.0	694.5	-
	486.30	1.769	4.139	235.6	396.44	148.5	1.85	145.8	-	95.9
	491.10	1.770	0.968	2296	97.02	155.2	2.45	151.5	853.1	-
	495.85	1.767	4.235	261.7	440.13	161.5	2.70	157.2	-	106.7
	500.00	1.771	1.016	2568	94.29	146.5	2.23	143.3	908.6	-

Figure 4.7
Tensile Strength Tests, Boring CB-1
BORING: CB-1

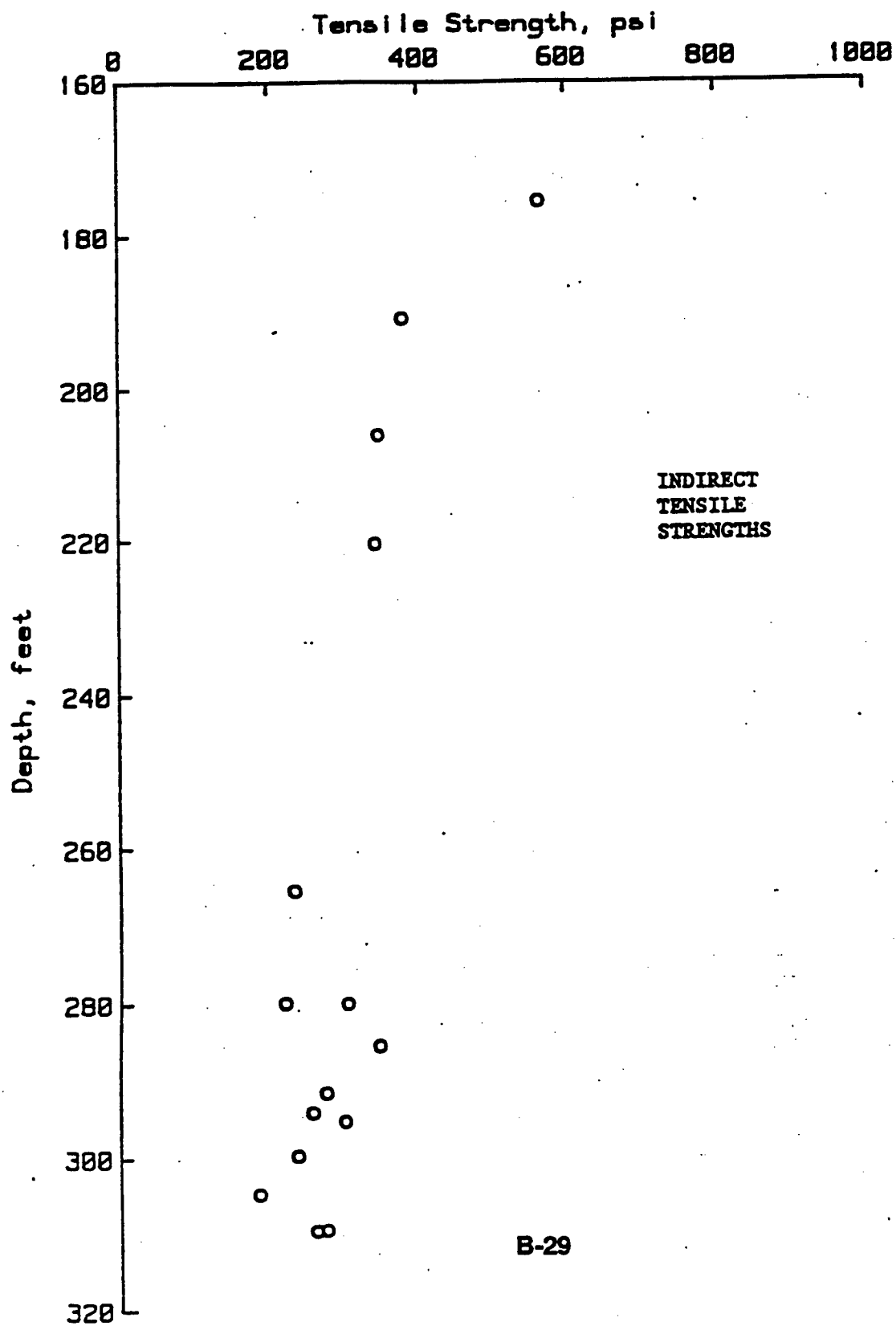
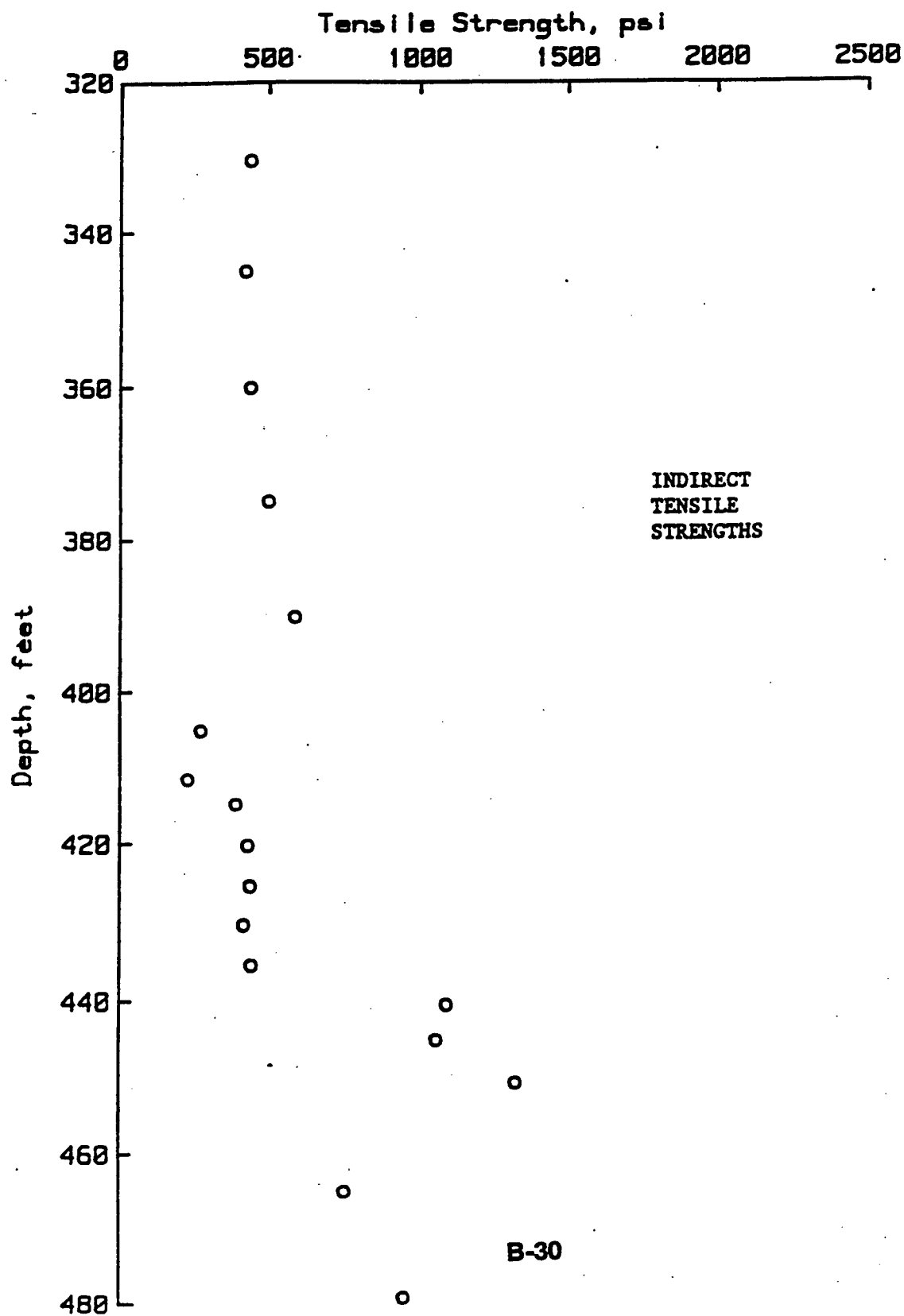


Figure 4.8
Tensile Strength Tests, Boring CB-3
BORING: CB-3



Tensile Strength Tests, Boring CB-4

BORING: CB-4

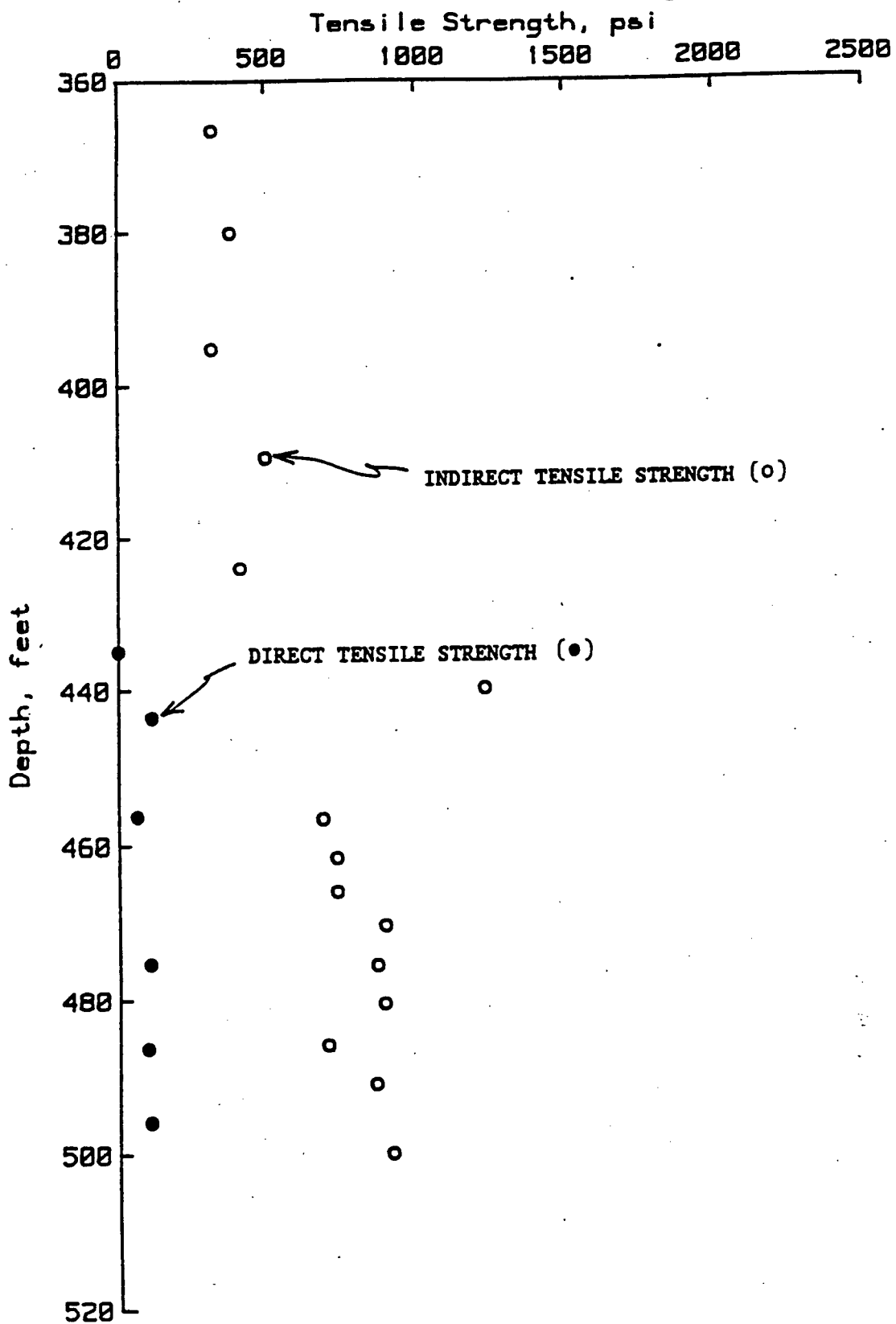


Figure 4.10

Composite Plot of Strength Test Data for CB-1, CB-2, and CB-4

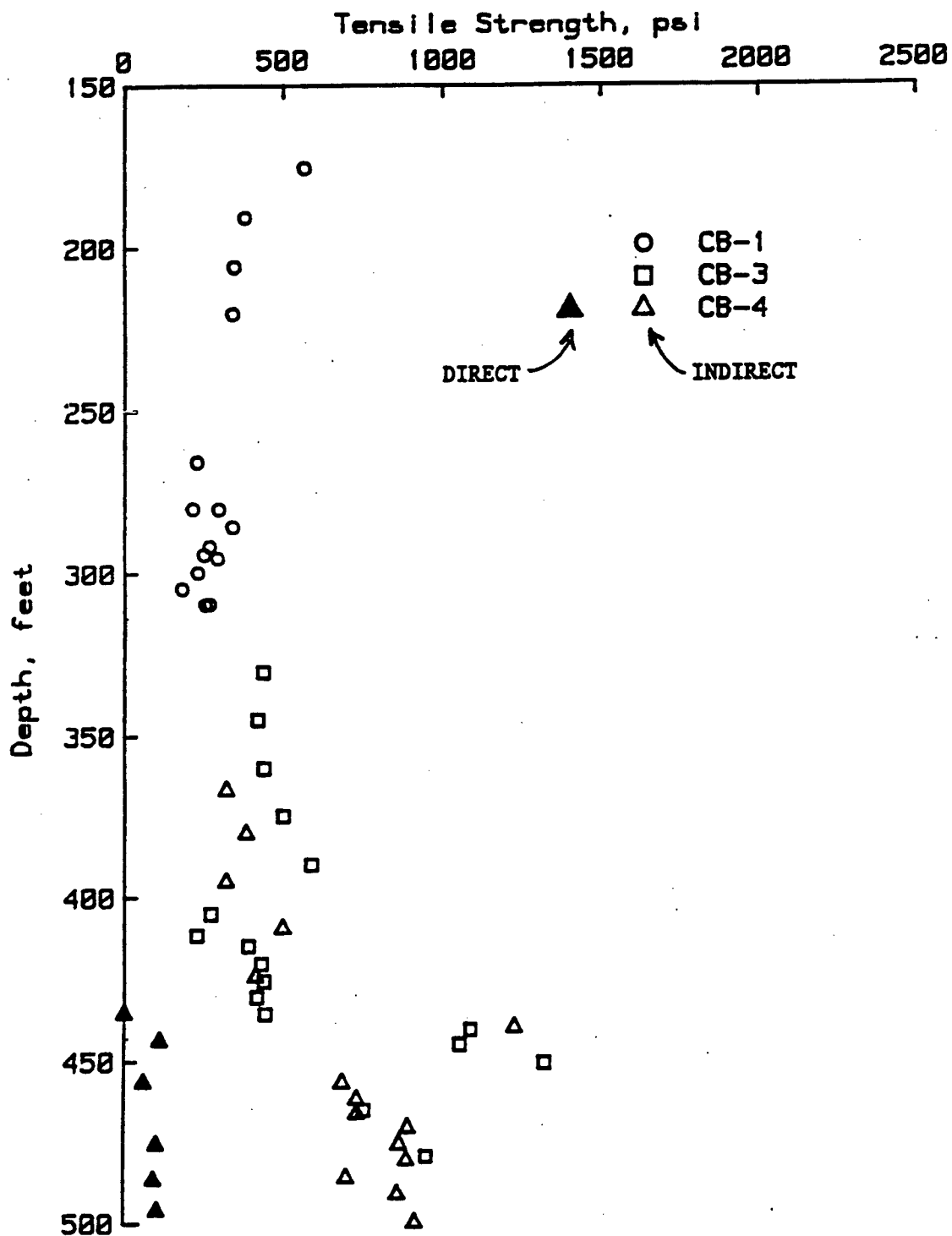


TABLE 4.4
QUANTITATIVE X-RAY DIFFRACTION ANALYSIS

Hole #	Depth (ft)	Formation	Clay-%	Qrtz-%	Fldspr-%	Calc-%	Dolo-%	Other-% ⁺
CB-6	429.9	N. Prov.	5	23	3	<1	5	68
CB-6	453.2	N. Albany	12	19	7	<1	<1	72
CB-6	536.0	Louisville	1	1	-	-	98	1
CB-4	426.0	N. Prov.	12	23	7	<1	<1	68
CB-4	460.2	N. Albany	9	28	7	<1	1	62
CB-4	521.8	Jfsrvi	1	1	-	78	20	1
CB-4	555.5	Louisville	1	2	-	<1	97	1

* Other represents all "other" material not detected by X-ray diffraction analysis, e.g. organics and amorphous material such as glass

Appendix C

Geologic Maps

LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP - Ft. Knox, KY	Computed	G. Alsayeb	Date
Subject	Geological Mapping of Tunnel	Checked		Date
Task		Sheet	1	Of 72

- * Geological Mapping was done according to the "Full Periphery Method" which is explained in the Engineer Technical Letter No. 1110 - 1 - 37, published by Dept. of the Army - Office of the Chief of Engineers - Washington, D.C. 2031 and dated 18 Sept. 1970
- * In this specific mapping of the UTP tunnel, the assumption that Magnetic Declination @ Ft. Knox, KY is zero, was utilized and orientation of geologic discontinuities & bedding planes encountered was measured in Magnetic Azimuth using a Brunton Compass.
- * Main Tunnel orientation, prior to curve = 335° Az
- * Contractor did not maintain station marking along tunnel during excavation. Stations were marked every 100' over shotcrete liner later on.
- * Whole tunnel is lined with shotcrete of 2" thickness minimum.

Scale: 1" = 6' horizontal
1" = 5' Along Tunnel Axis

Legend:

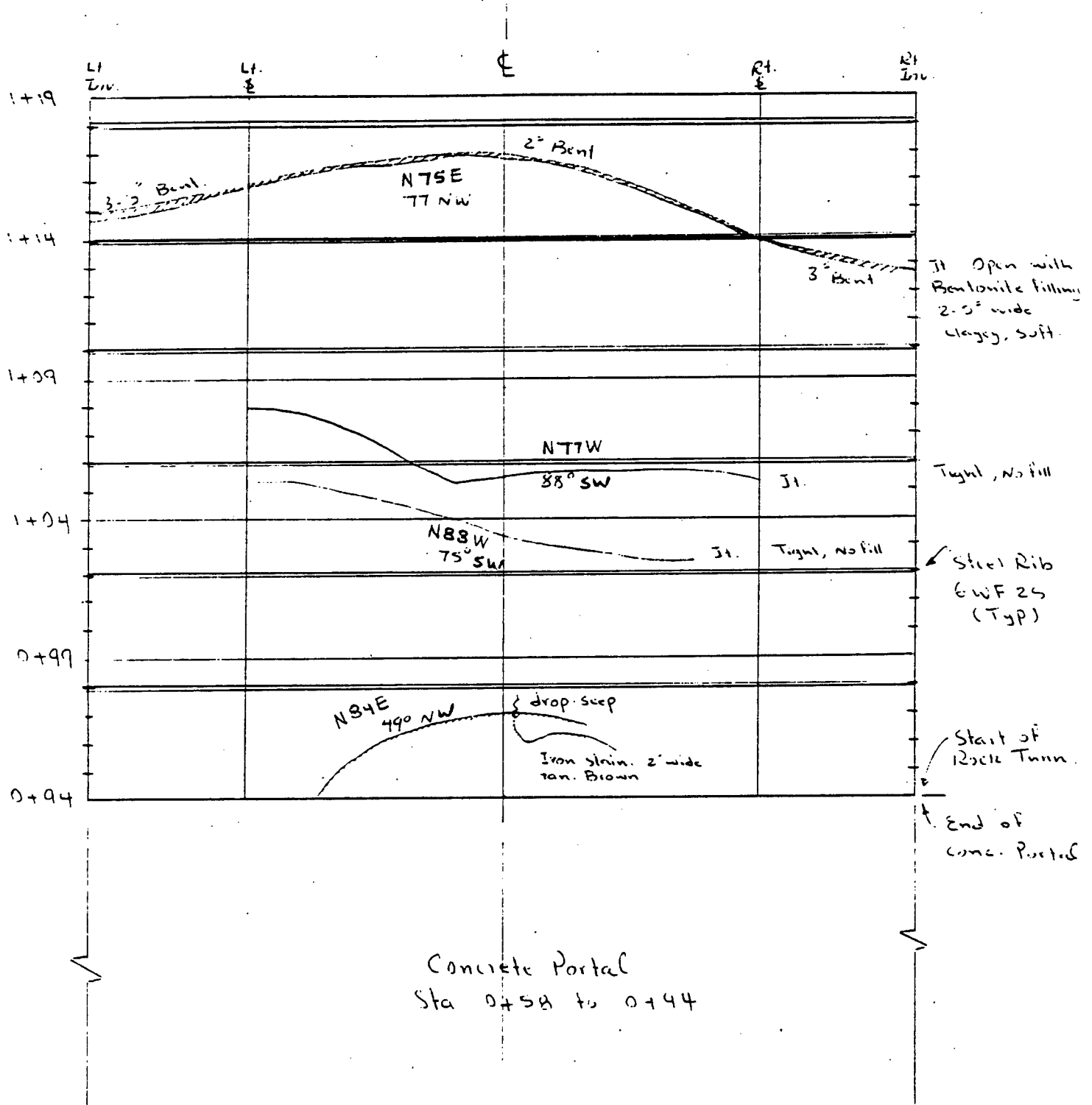
- ? : Estimated
-  : Cave in cast (fall-out)
-  : Siderite Nodule or cast
- ⊙ or ⊠ : Rock dowel
- ⊗ : Tensioned Rock Bolt
- δ : Seepage

: Staining

 : Filling Material

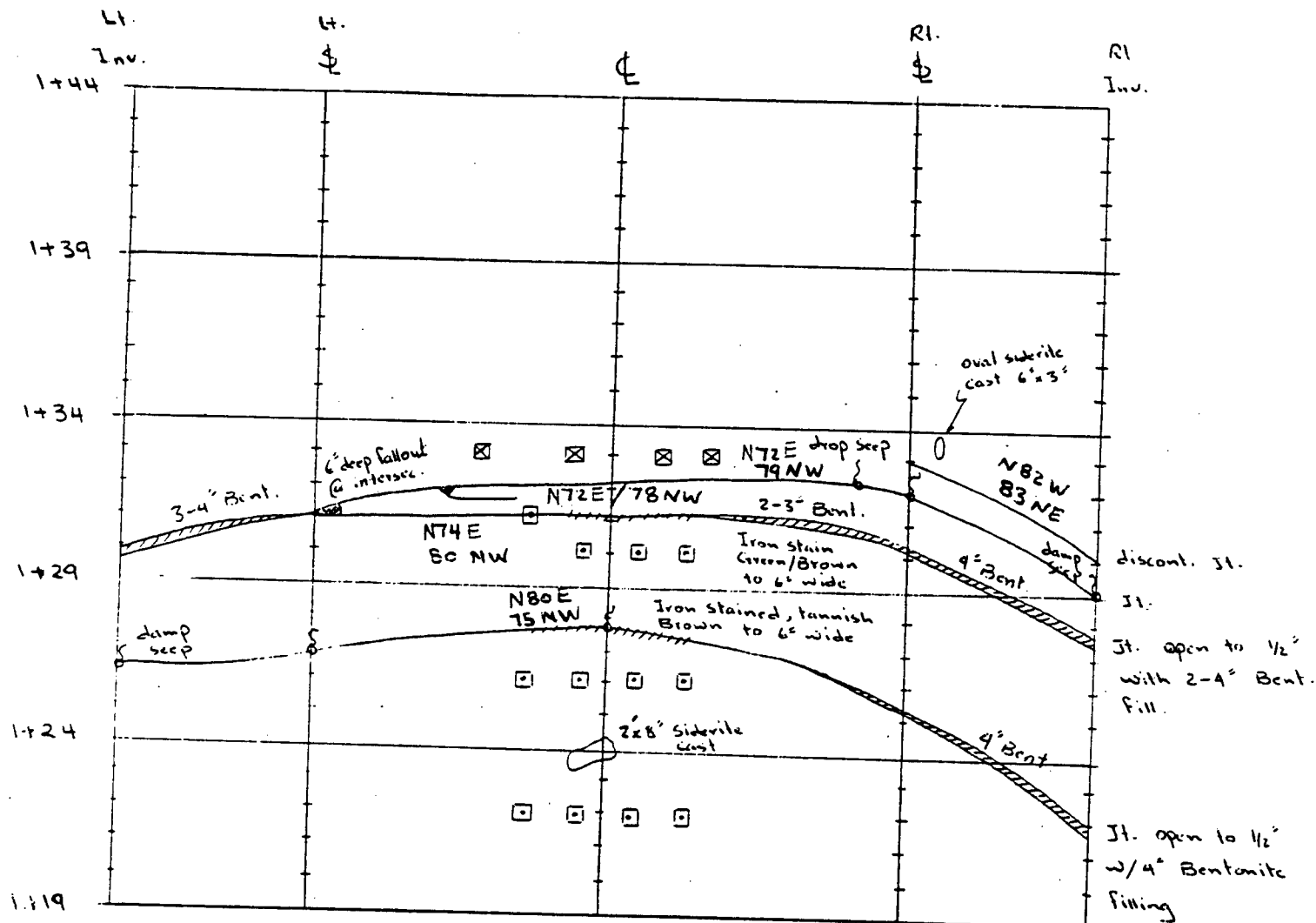
LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject	Geologic Mapping	Checked	Date
Task	Rock: New Providence Shale	Sheet 2	Of 72



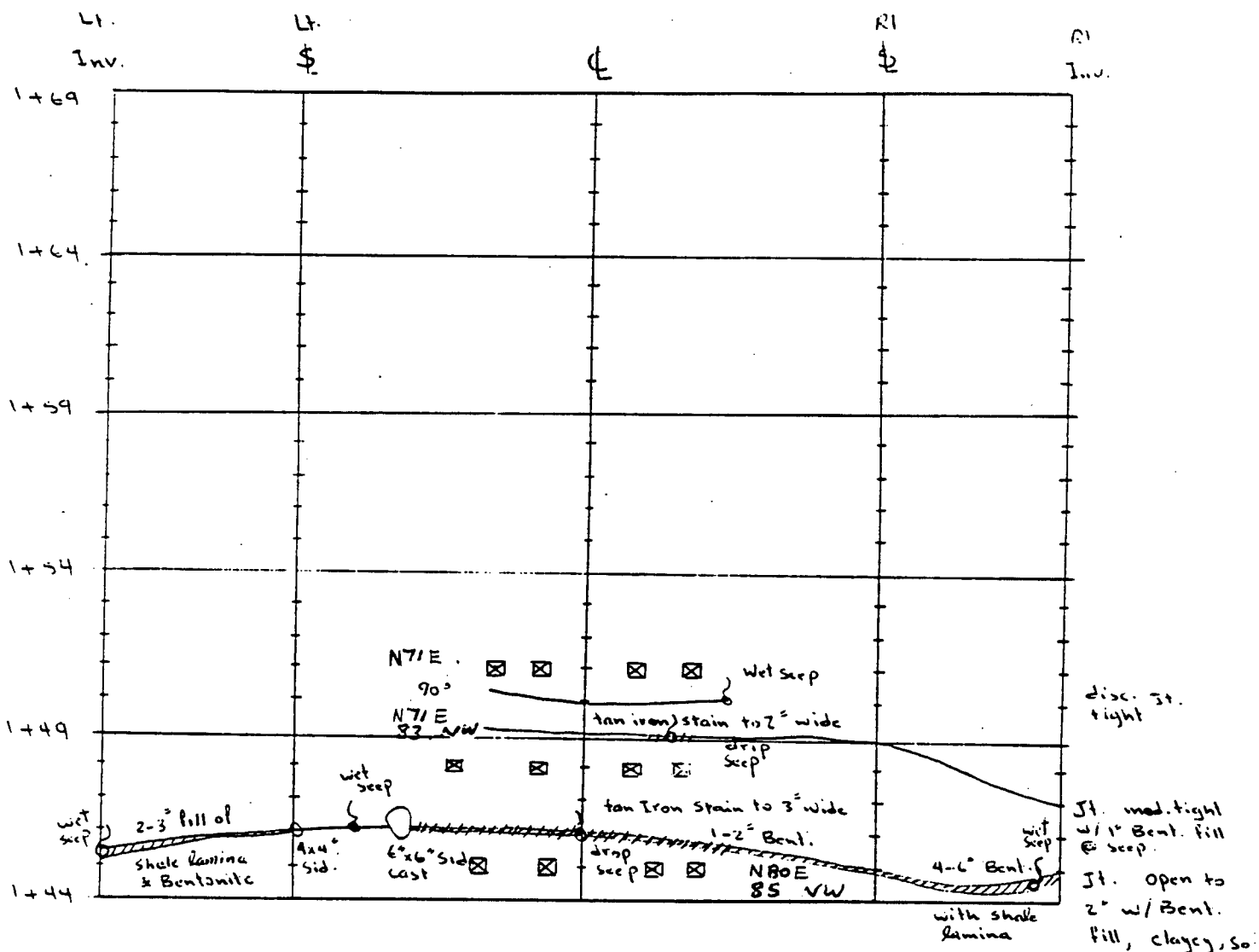
LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject	Geologic Mapping	Checked	Date
Task	Rock : N.P. Shale	Sheet 3	Of 72



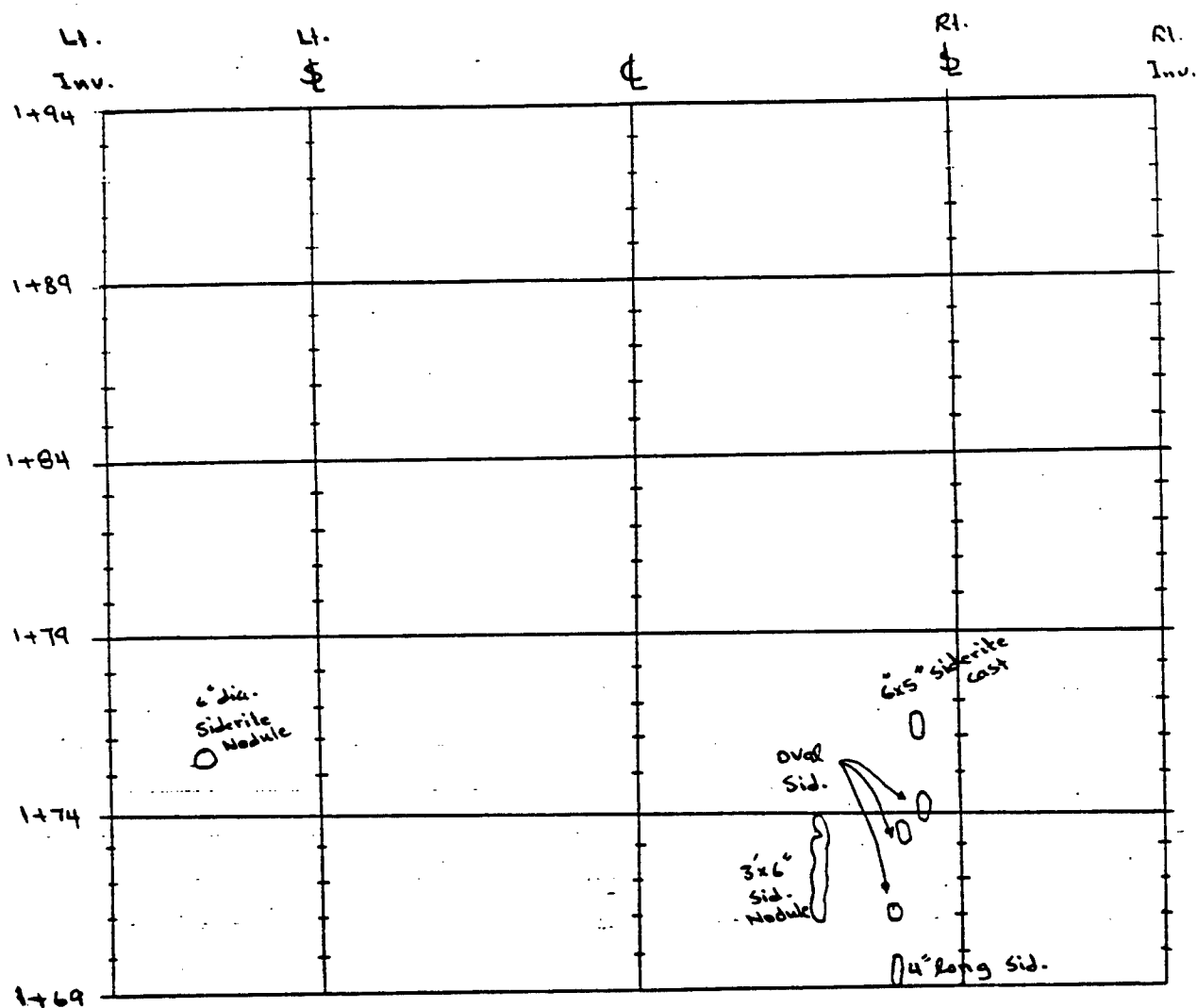
LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject	Geologic Mapping	Checked	Date
Task	Rock: New Providence Shale	Sheet 4	Of 72



LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject	Geologic Mapping	Checked	Date
Task	Rock: N.P. shale	Sheet 5	Of 72



Massive Rock
No Joints

LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed		Date	
Subject	Geologic Mapping	Checked		Date	
Task	Rock : New Providence Shale	Sheet	6	Of	72

Lt. Inv.	Lt. \$	€	Rt. \$	Rt. Inv.
2+29			--	
2+24				
2+19				
2+14				
2+09				
1+94		1 dia. sid. cast ○		

Massive Rock
No discontinuities

LACHEL & Associates, Inc.
Geologists, Engineers

Project

UTP

Computed

Date

Subject

Checked

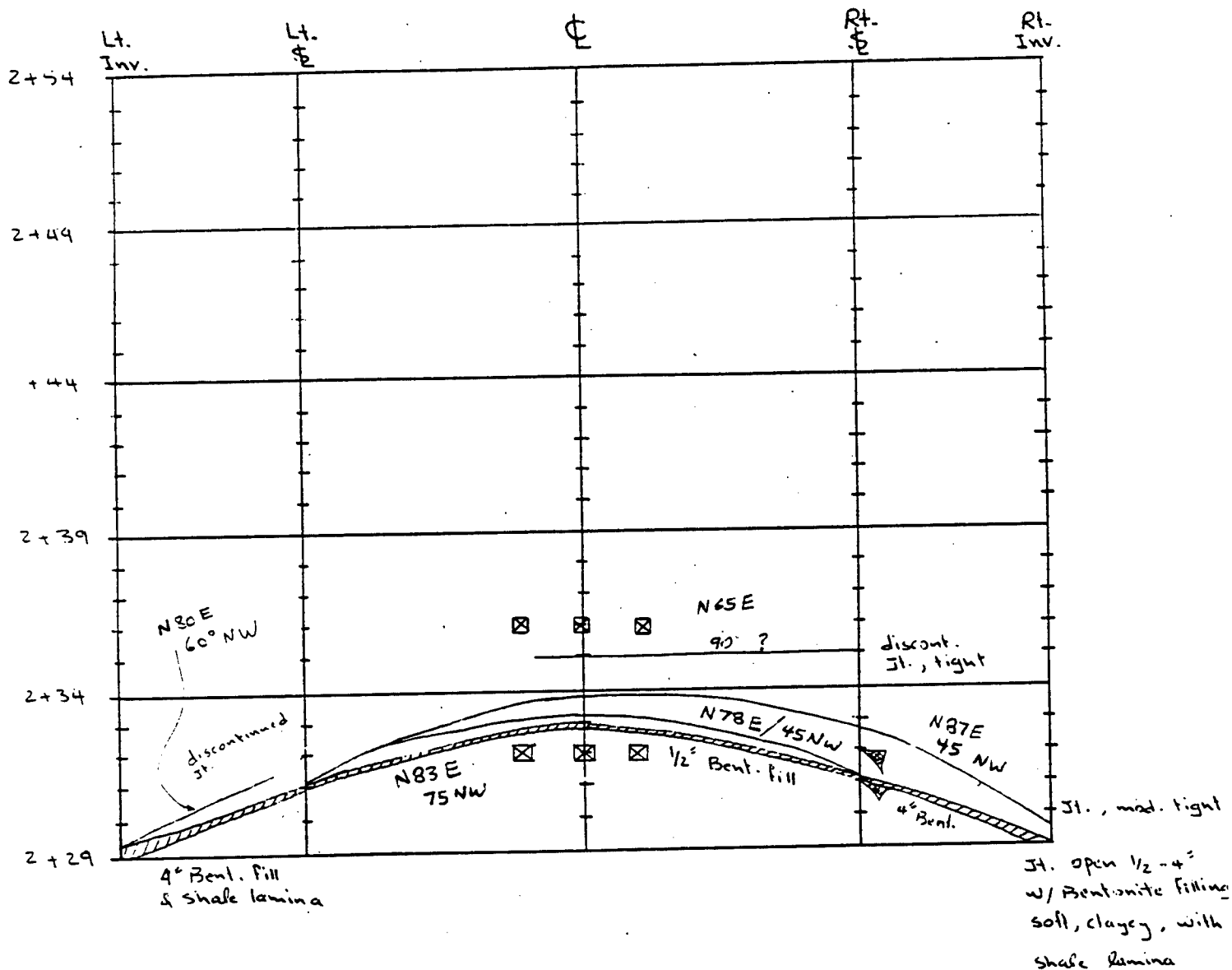
Date

Task

Rock: N.P. shale

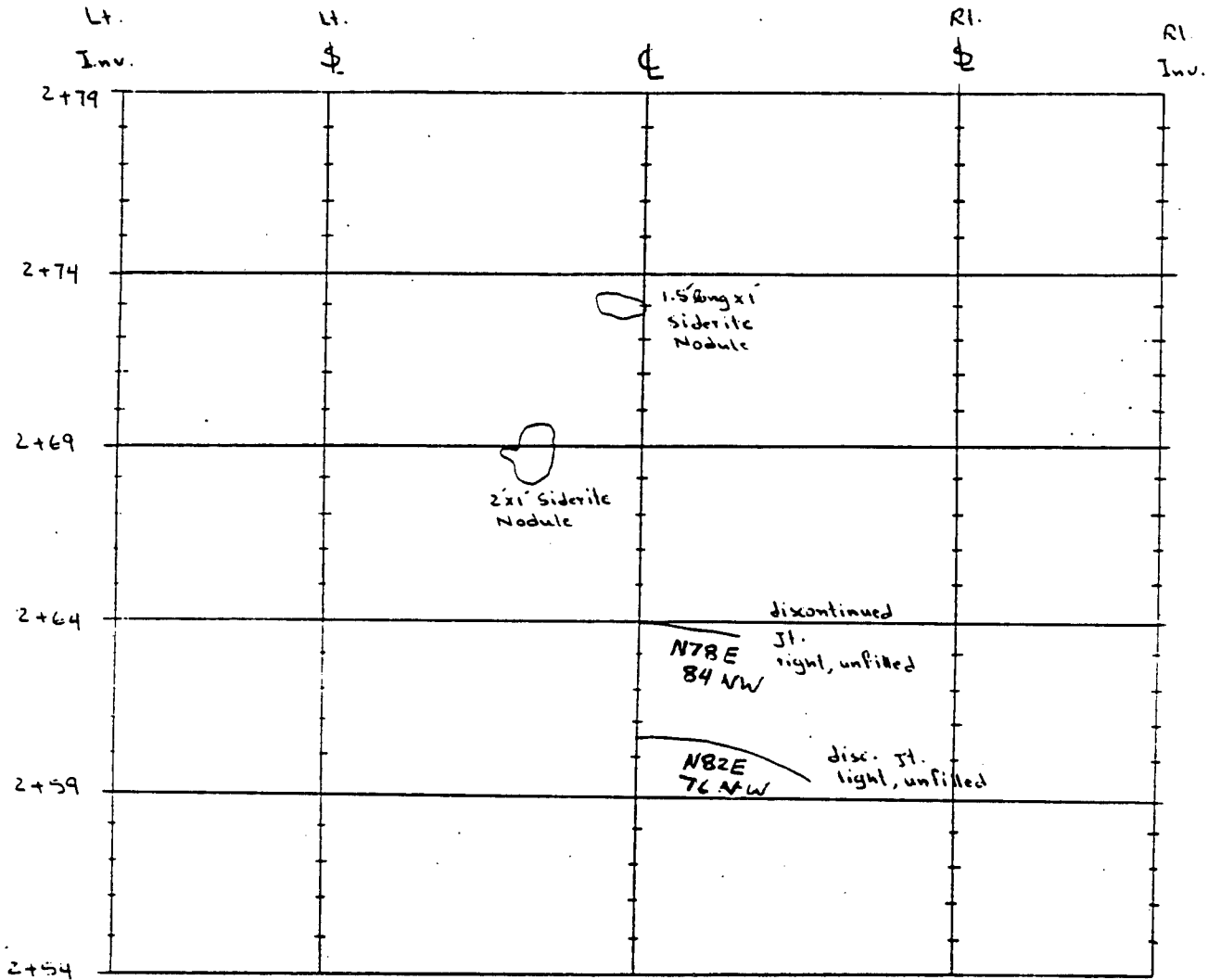
Sheet 7

of 72



LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject		Checked	Date
Task	Rock : N.P. shale	Sheet 8	Of 72



LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject		Checked	Date
Task	Rock: N.P. Shale	Sheet 9	Of 72

	Lt. Inv.	Lt. E	¢	Rt. E	Rt. Inv.
3+09					
3+04					
2+99					
2+94					
2+89					
2+84					

Massive Rock
No discontinuities

LACHEL & Associates, Inc.
Geologists, Engineers

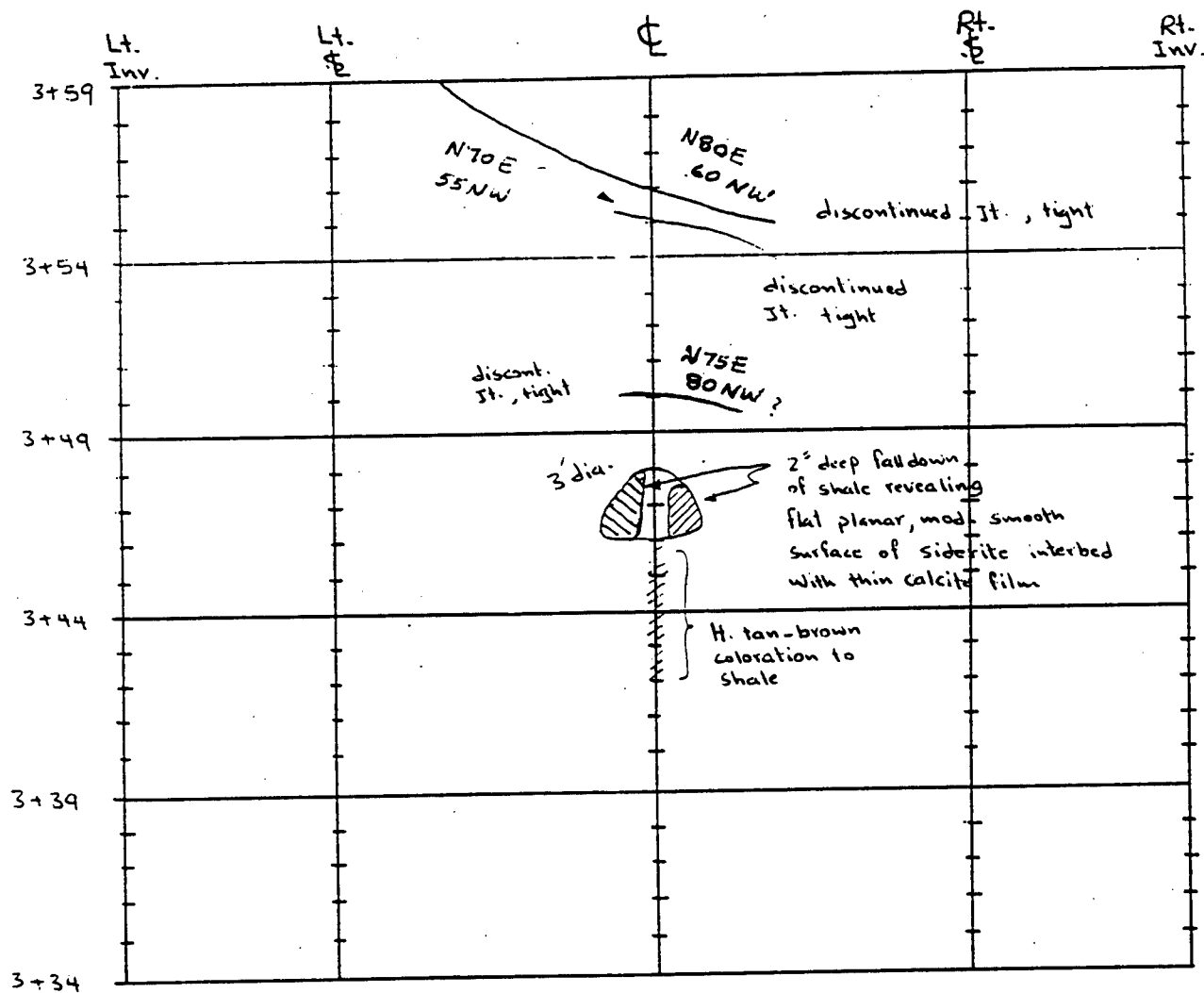
Project <u>UTP</u>	Computed	Date
Subject	Checked	Date
Task <u>Rock: New Providence Shale / embankment</u>	Sheet <u>10</u>	Of <u>72</u>

	Lt. Inv.	Lt. S	¢	Rt. S	Rt. Inv.
3+34					
3+29					
3+24					
3+19					
3+14					
3+09					

Massive New Providence Shale
formation with no discontin.

LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject		Checked	Date
Task	Rock: New Providence shale / calcareous	Sheet 11	Of 72



LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject		Checked	Date
Task	Rock: New Providence shale / ~~conglomerate~~	Sheet 12	Of 72

	Lt. Inv.	Lt. %	¢	Rt. %	Rt. Inv.
3+84					
3+79					
3+74					
3+69					
3+64					
3+59	on damp seep				

Massive Rock w/ no joints

LACHEL & Associates, Inc.
Geologists, Engineers

Project <u>UTP</u>	Computed	Date
Subject	Checked	Date
Task <u>Rock : New Providence shale / ~~cutters~~</u>	Sheet <u>13</u>	Of <u>72</u>

	Lt. Inv.	Lt. £	£	Rt. £	Rt. Inv.
4+09					
4+04					
3+99					
3+94					
3+89					
3+84					

Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

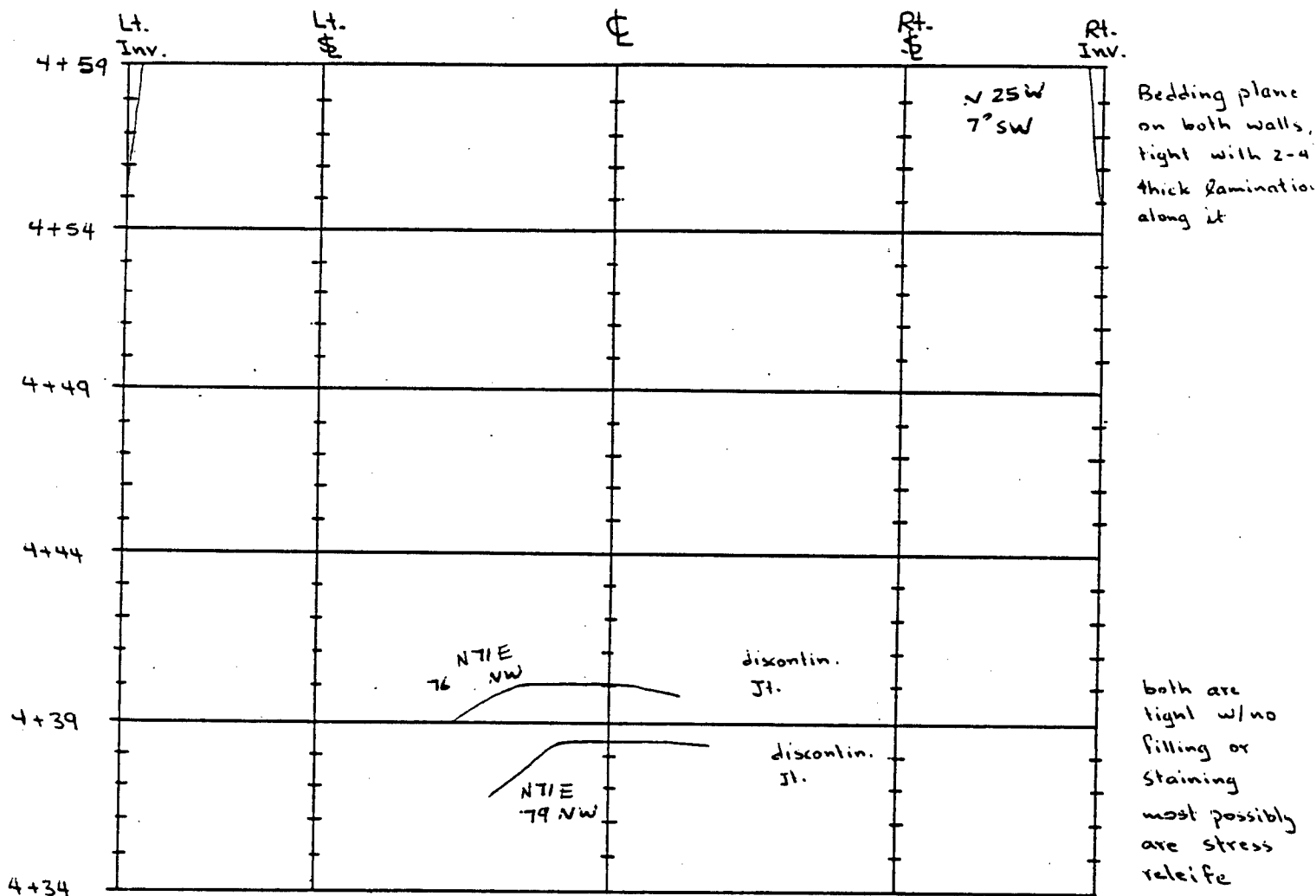
Project	UTP	Computed	Date
Subject		Checked	Date
Task	Rock: New Providence shale /	Sheet 14	Of 72

	Lt. Inv.	Lt. Σ	Σ	Rt. Σ	Rt. Inv.
4+34					
4+29					
4+24					
4+19					
4+14					
4+09					

Massive Rock

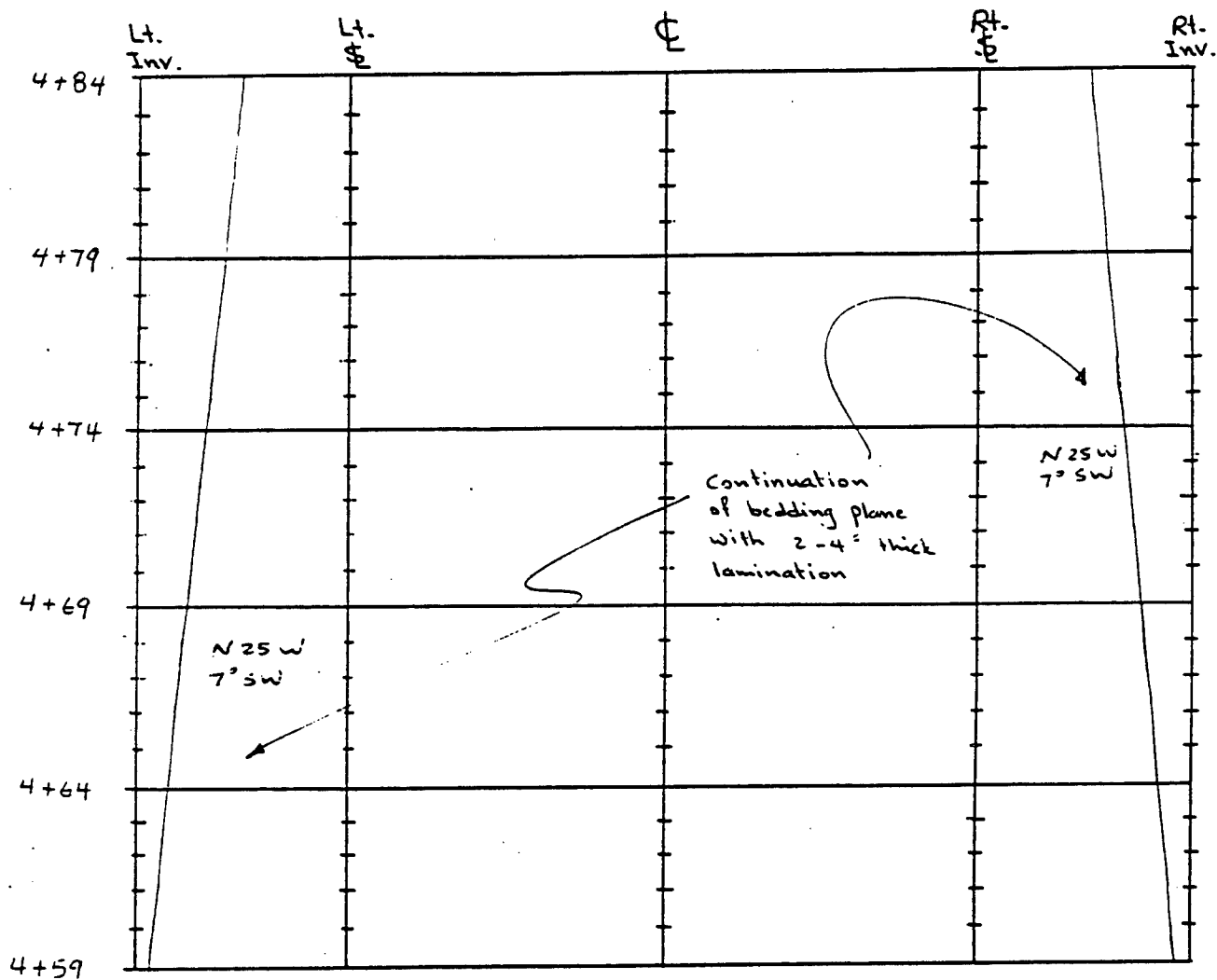
LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject		Checked	Date
Task	Rock : New Providence Shale /	Sheet 15	Of 72



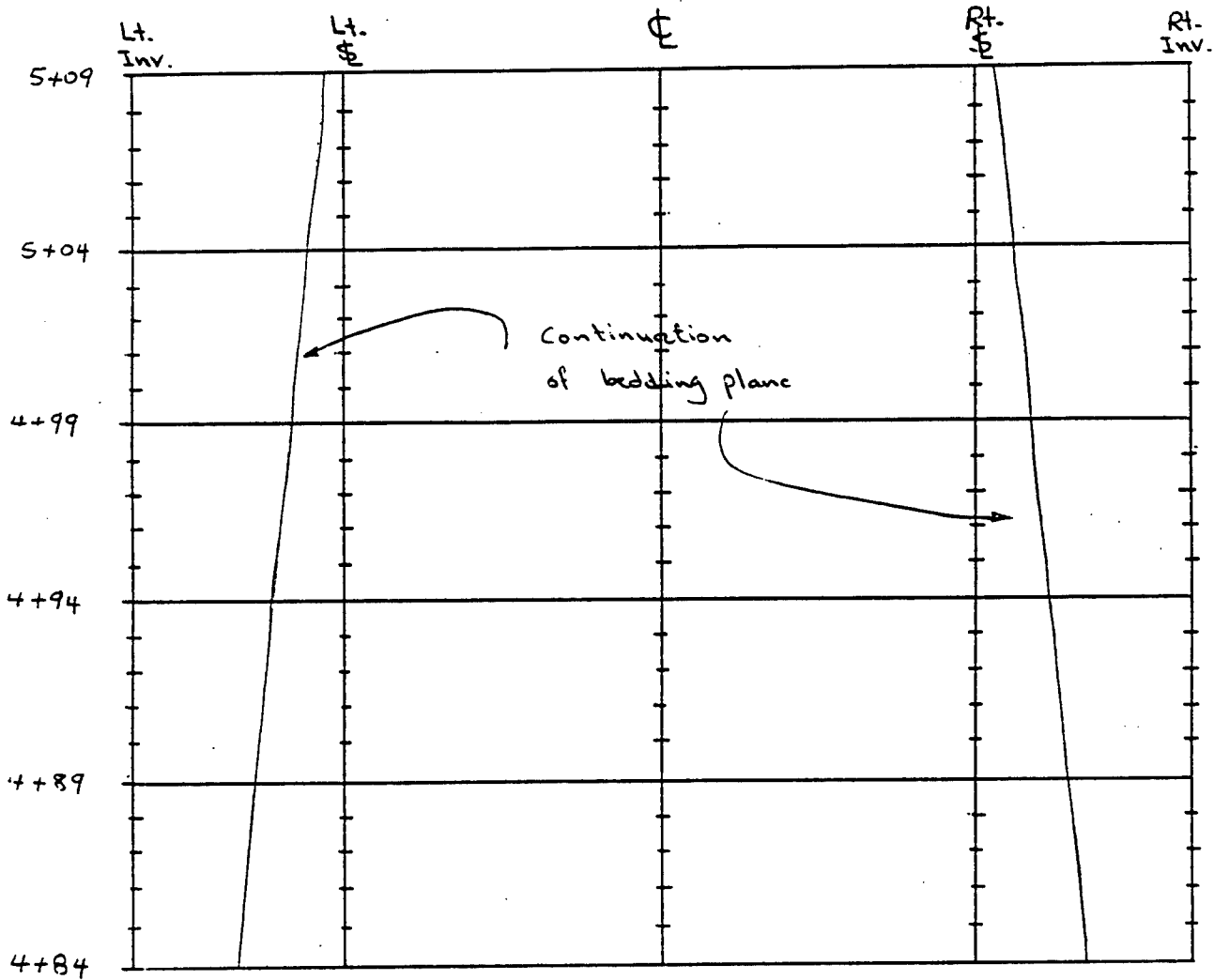
LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed		Date	
Subject		Checked		Date	
Task	Rock: New Providence Shale / ~~carbonaceous~~	Sheet	16	Of	72



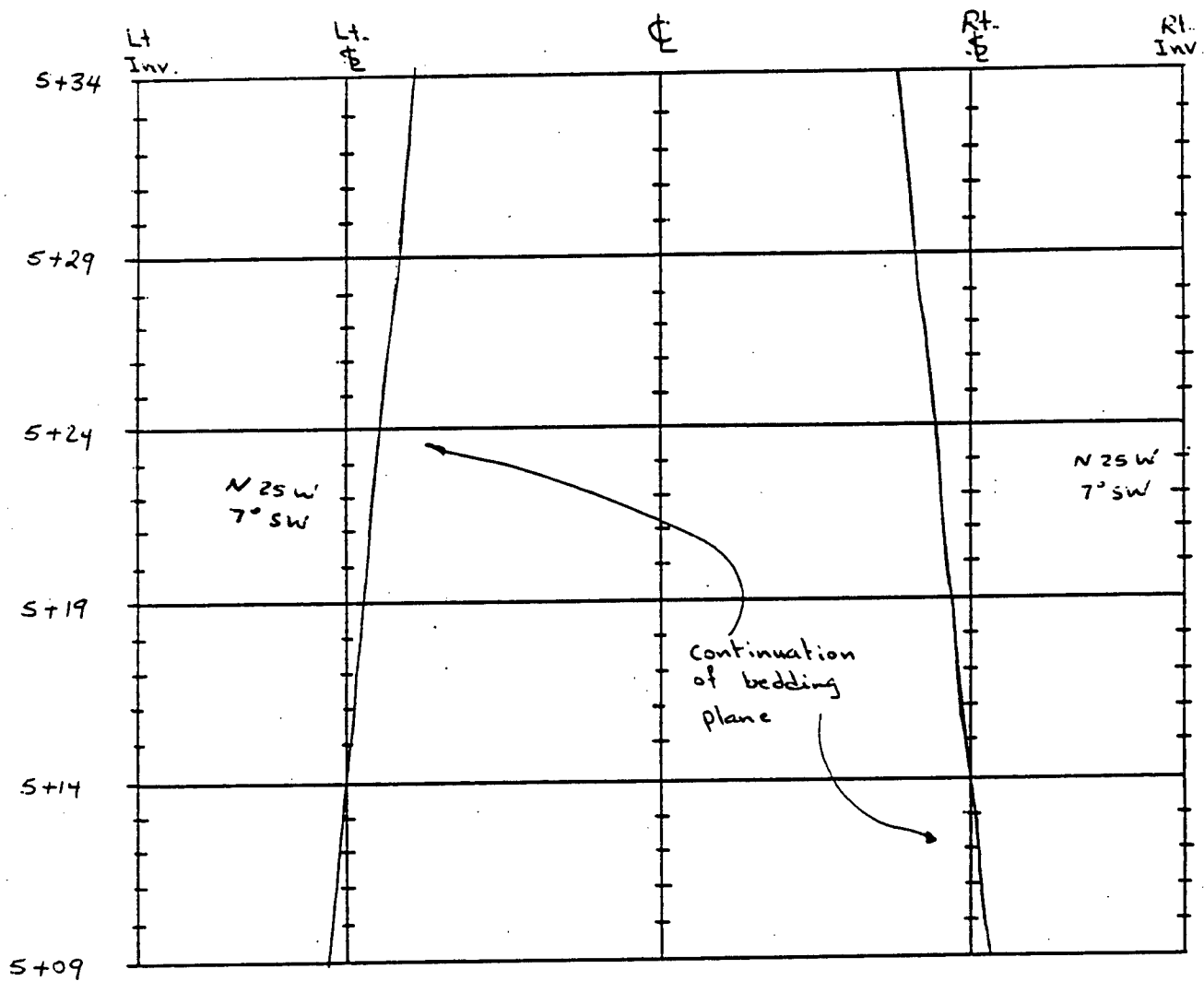
LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject		Checked	Date
Task	Rock: New Providence Shale / carbonaceous	Sheet 17	Of 72



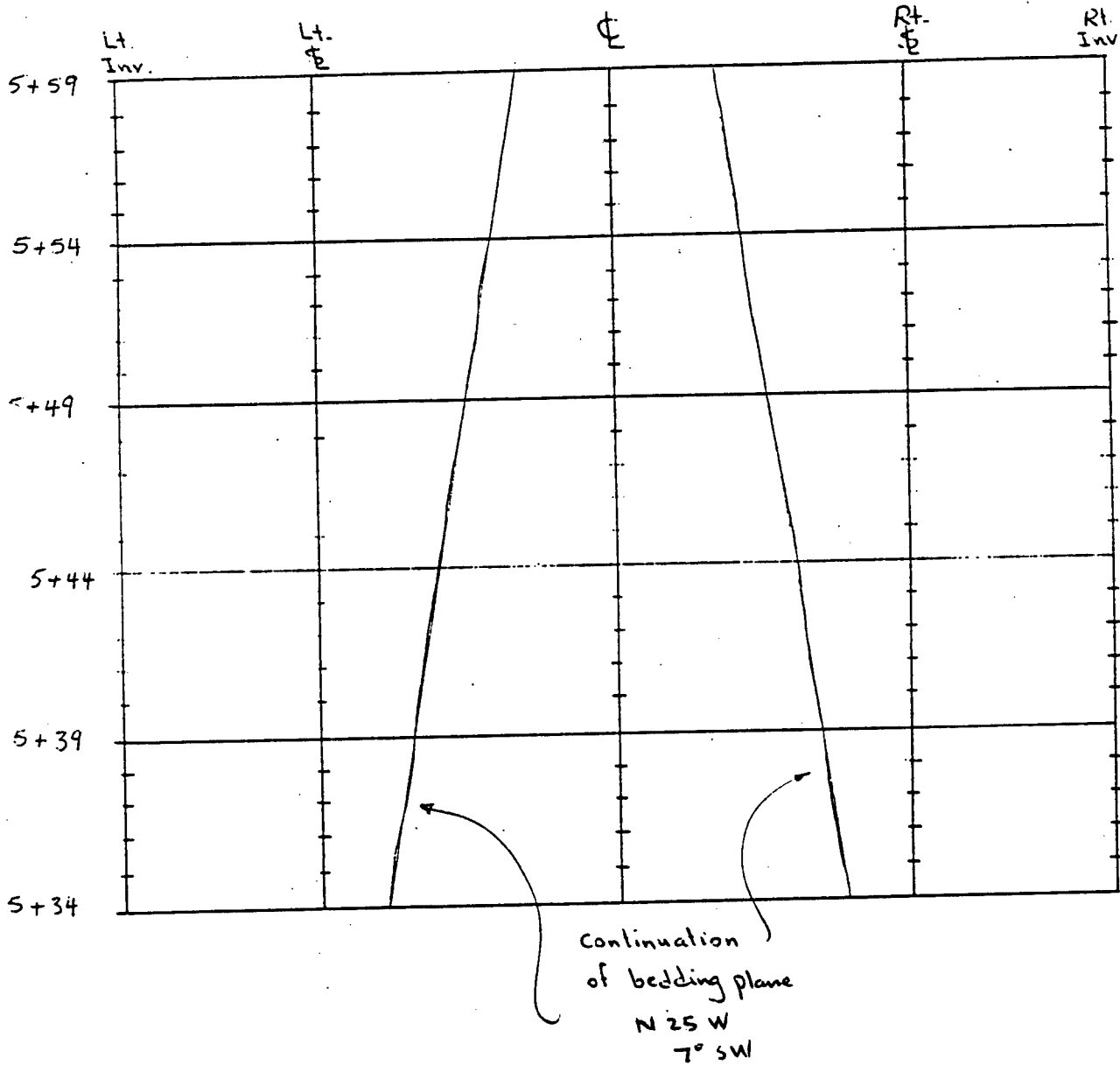
LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject	Geologic Mapping	Checked	Date
Task	Rock: New Providence shale / calcareous	Sheet 18	Of 72



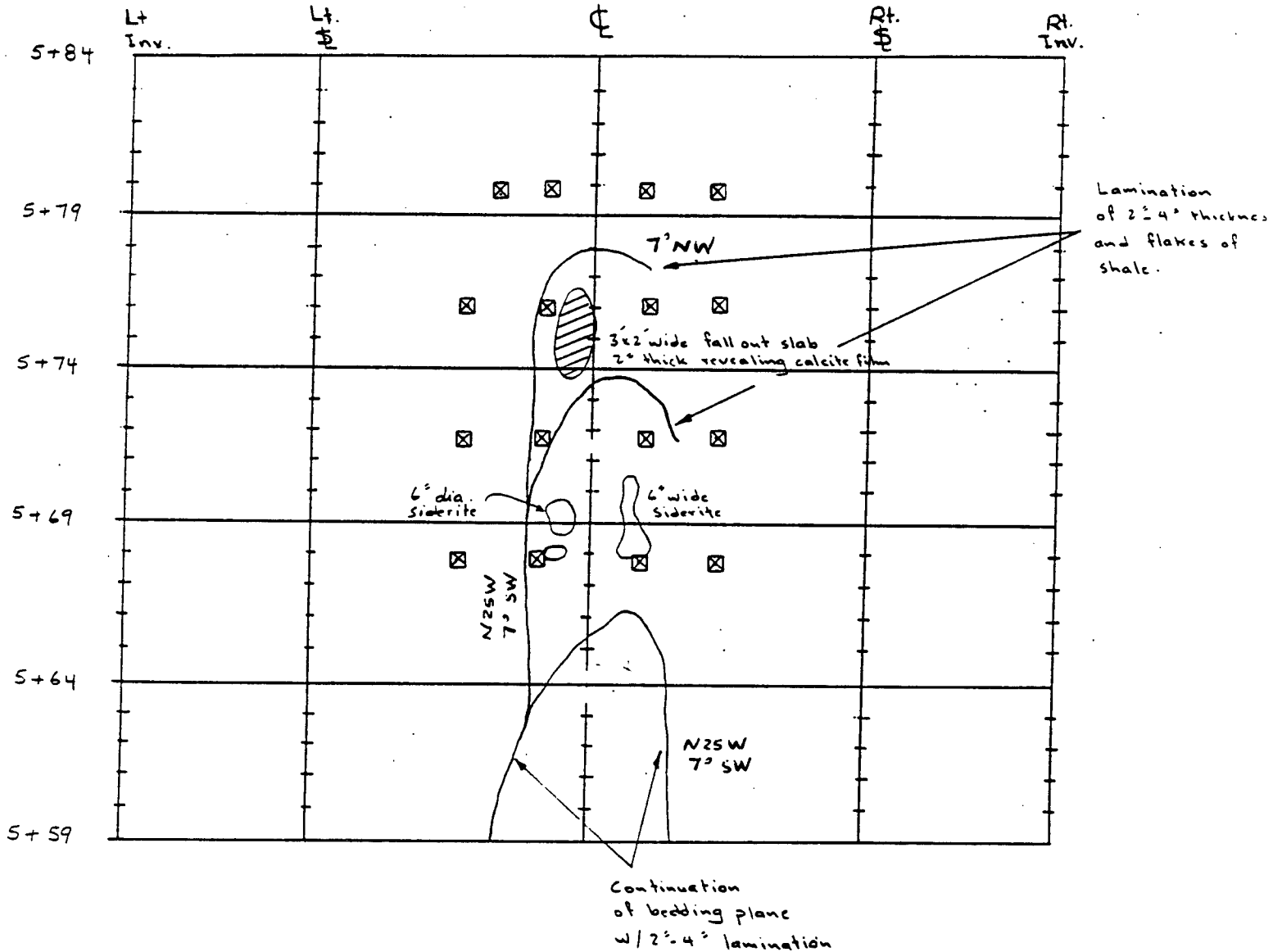
LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject	Geologic Mapping	Checked	Date
Task	Rock: New Providence shale / ~~shale~~	Sheet 19	Of 72



LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject	Geologic Mapping	Checked	Date
Task Rock:	New Providence Shale	Sheet 20	Of 71



LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject	Geologic Mapping	Checked	Date
Task	Rock: New Providence shale / calcareous	Sheet 21	Of 72

	Lt. Inv.	Lt. %	¢	Rt. %	Rt. Inv.
6+09					
6+04					
5+99					
5+94					
5+89					
5+84					

Massive Rock
w/ no joints

LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject		Checked	Date
Task	Rock : New Providence shale / carbonaceous	Sheet 22	Of 72

	Lt. Inv.	Lt. £	£	Rt. £	Rt. Inv.
6+34					
6+29					
6+24					
6+19					
6+14					
6+09					

Massive Rock
No discontinuities

LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject		Checked	Date
Test	Rock : New Providence Shale / ~~interstratified~~	Sheet 23	Of 72

	Lt. Inv.	Lt. \$	¢	Rt. \$	Rt. Inv.
6+59					
6+54					
6+49					
6+44					
6+39					
6+34					

Massive Rock
No Joints

LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject		Checked	Date
Task	Rock: New Providence Shale / ~~conglomerates~~	Sheet 24	Of 72

	Lt. Inv.	Lt. \$	¢	Rt. \$	Rt. Inv.
6+84					
6+79					
6+74					
6+69					
6+64					
6+59					

Massive Rock
No Joints

LACHEL & Associates, Inc.
Geologists, Engineers

Project <u>UTP</u>	Computed	Date
Subject	Checked	Date
Task <u>New Providence Shale / Outcrops</u>	Sheet <u>25</u>	Of <u>72</u>

	Lt. Inv.	Lt. £	£	Rt. £	Rt. Inv.
7+09					
7+04					
6+99					
6+94					
6+89					
6+84					

Massive Rock
No Joints

LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject		Checked	Date
Task	Rock: New Providence shale / ~~arenaceous~~	Sheet 26	Of 72

	Lt. Inv.	Lt. E	¢	Rt. E	Rt. Inv.
7+34					
7+29					
7+24					
7+19					
7+14					
7+09					

Massive Rock
No Joints

LACHEL & Associates, Inc.
Geologists, Engineers

Project <u>UTP</u>	Computed _____	Date _____
Subject _____	Checked _____	Date _____
Task <u>Rock: New Providence shale / ~~oath~~</u>	Sheet <u>27</u>	Of <u>72</u>

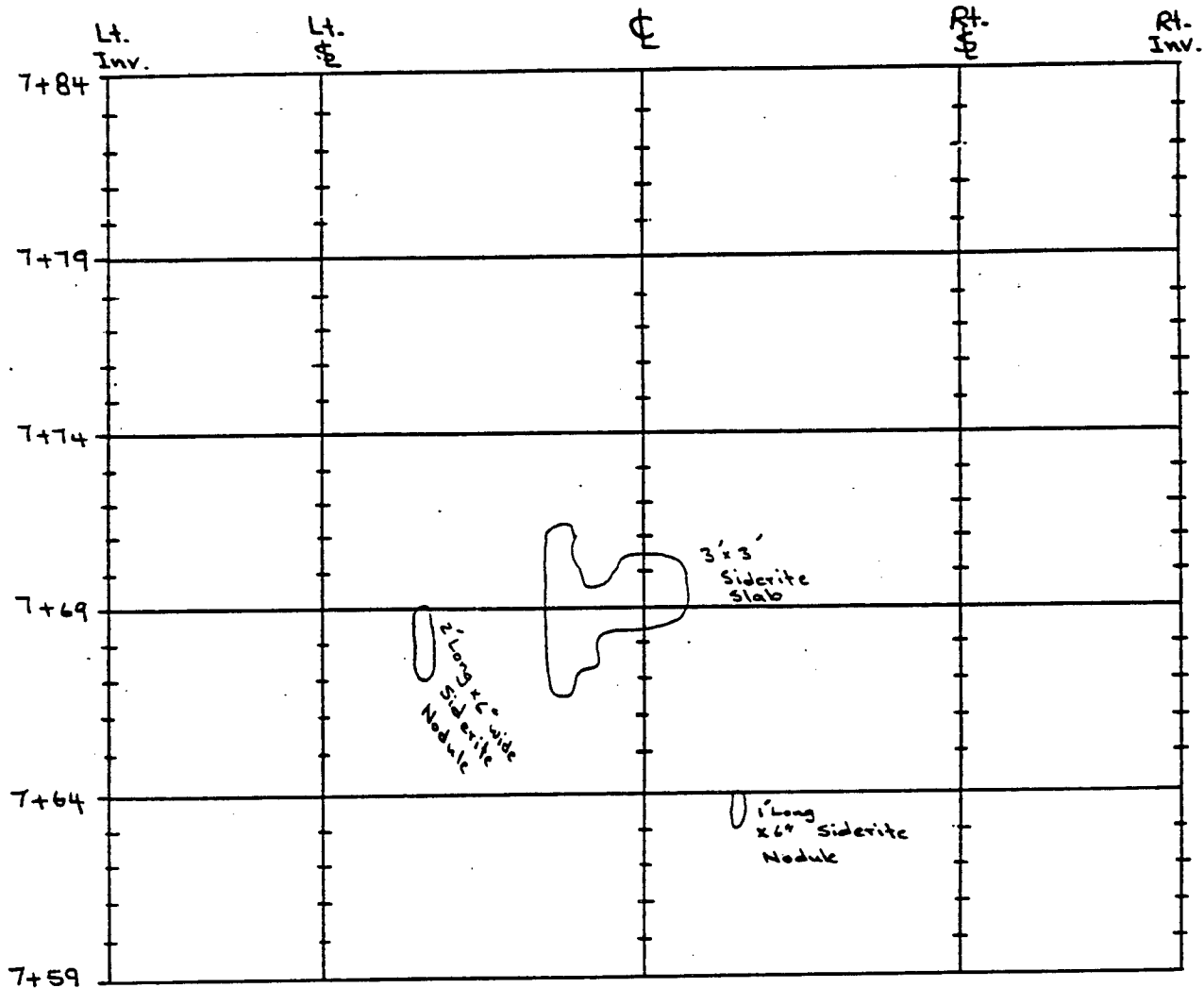
	Lt. Inv.	Lt. \$	¢	Rt. \$	Rt. Inv.
7+59					
7+54					
7+49					
7+44					
7+39					
7+34					

0 1/2" wide
Siderite
Nodule

Massive Rock
No joints

LACHEL & Associates, Inc.
Geologists, Engineers

Project <u>UTP</u>	Computed	Date
Subject	Checked	Date
Task <u>Rock: New Providence Shale</u>	Sheet <u>28</u>	Of <u>72</u>



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject		Checked	Date
Test Rock: New Providence shale		Sheet 29	Of 72

	Lt. Inv.	Lt. E	C	Rt. E	Rt. Inv.
8+09					
8+04					
7+99					
7+94					
7+89					
7+84					

Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject		Checked	Date
Top Rock: New Providence Shale		Sheet 30	Of 72

	Lt. Inv.	Lt. E	C	Rt. E	Rt. Inv.
8+34					
8+29					
8+24					
8+19					
8+14					
8+09					

Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed		Date	
Subject		Checked		Date	
Task	Rock: New Providence shale	Sheet	31	Of	72

	Lt. Inv.	Lt. E	C	Rt. E	Rt. Inv.
8+59					
8+54					
8+49					
8+44					
8+39					
8+34					

Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

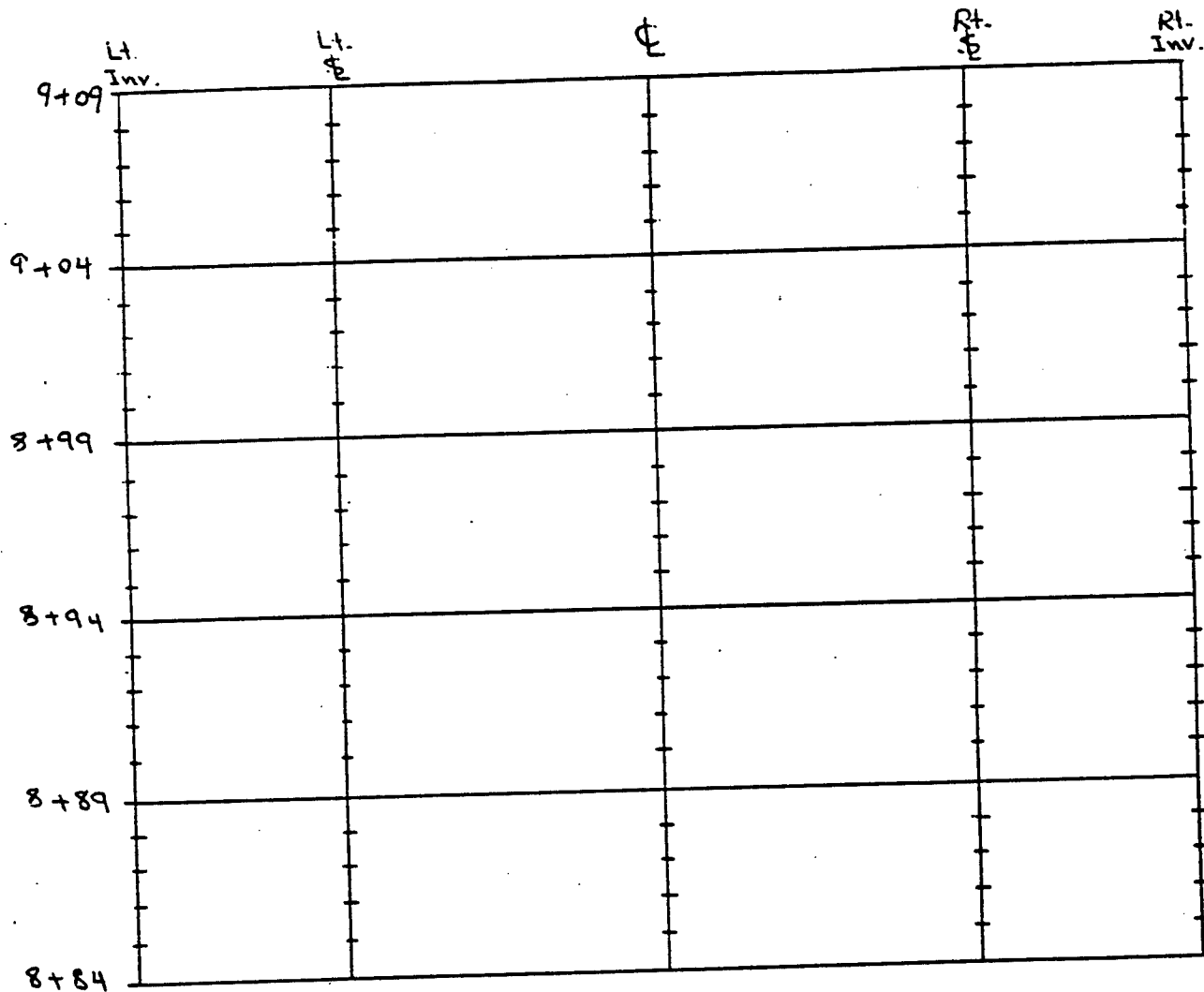
Project <u>UTP</u>	Computed	Date
Subject	Checked	Date
☒ Rock: <u>New Providence shale</u>	Sheet <u>32</u>	Of <u>72</u>

	Lt. Inv.	Lt. \$	¢	Rt. \$	Rt. Inv.
8+84					
8+79					
8+74					
8+69					
8+64					
8+59					

Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project <u>UTP</u>	Computed	Date
Subject	Checked	Date
Task <u>Rock: New Providence shale</u>	Sheet <u>33</u>	Of <u>72</u>



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject		Checked	Date
Task	Rock: New Providence Shale	Sheet 34	of 72

	Lt Inv.	Lt. E	☉	Rt. E	Rt. Inv.
9+34					
9+29					
9+24					
9+19					
9+14					
9+09					

Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project <u>UTP</u>	Computed _____	Date _____
Subject _____	Checked _____	Date _____
Task <u>Rock: New Providence Shale</u>	Sheet <u>35</u>	Of <u>72</u>

	Lt. Inv.	Lt. E	☉	Rt. E	Rt. Inv.
9+59					
9+54					
9+49					
9+44					
9+39					
9+34					

Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

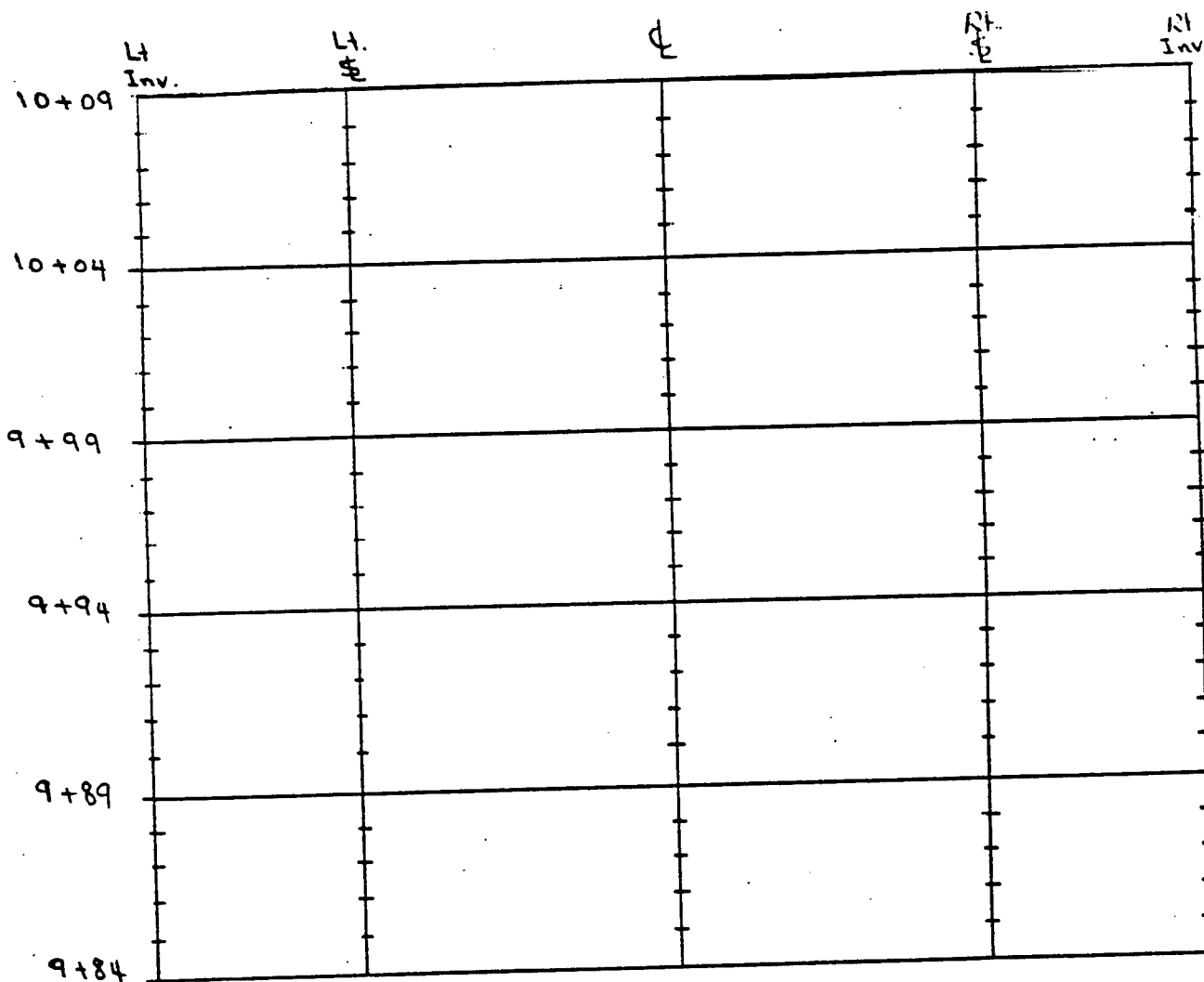
Project <u>UTP</u>	Computed _____	Date _____
Subject _____	Checked _____	Date _____
Task <u>Rock: New Providence Shale</u>	Sheet <u>36</u>	Of <u>72</u>

	Lt. Inv.	Lt. E	E	Rt. E	Rt. Inv.
9+84					
9+79					
9+74					
9+69					
9+64					
9+59					

Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project <u>UTP</u>	Computed	Date
Subject	Checked	Date
Task <u>Rock : New Providence shale</u>	Sheet <u>37</u>	Of <u>72</u>



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject		Checked	Date
Task	Rock: New Providence Shale	Sheet 38	Of 72

	Lt. Inv.	Lt. E	☉	Rt. E	Rt. Inv.
10+34					
10+29					
10+24					
10+19					
10+14					
10+09					

Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project <u>UTP</u>	Computed _____	Date _____
Subject _____	Checked _____	Date _____
Task <u>Rock : New Providence shale</u>	Sheet <u>39</u>	Of <u>72</u>

	Lt. Inv.	Lt. E	Q	Rt. E	Rt. Inv.
10+59					
10+54					
10+49					
10+44					
10+39					
10+34					

Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

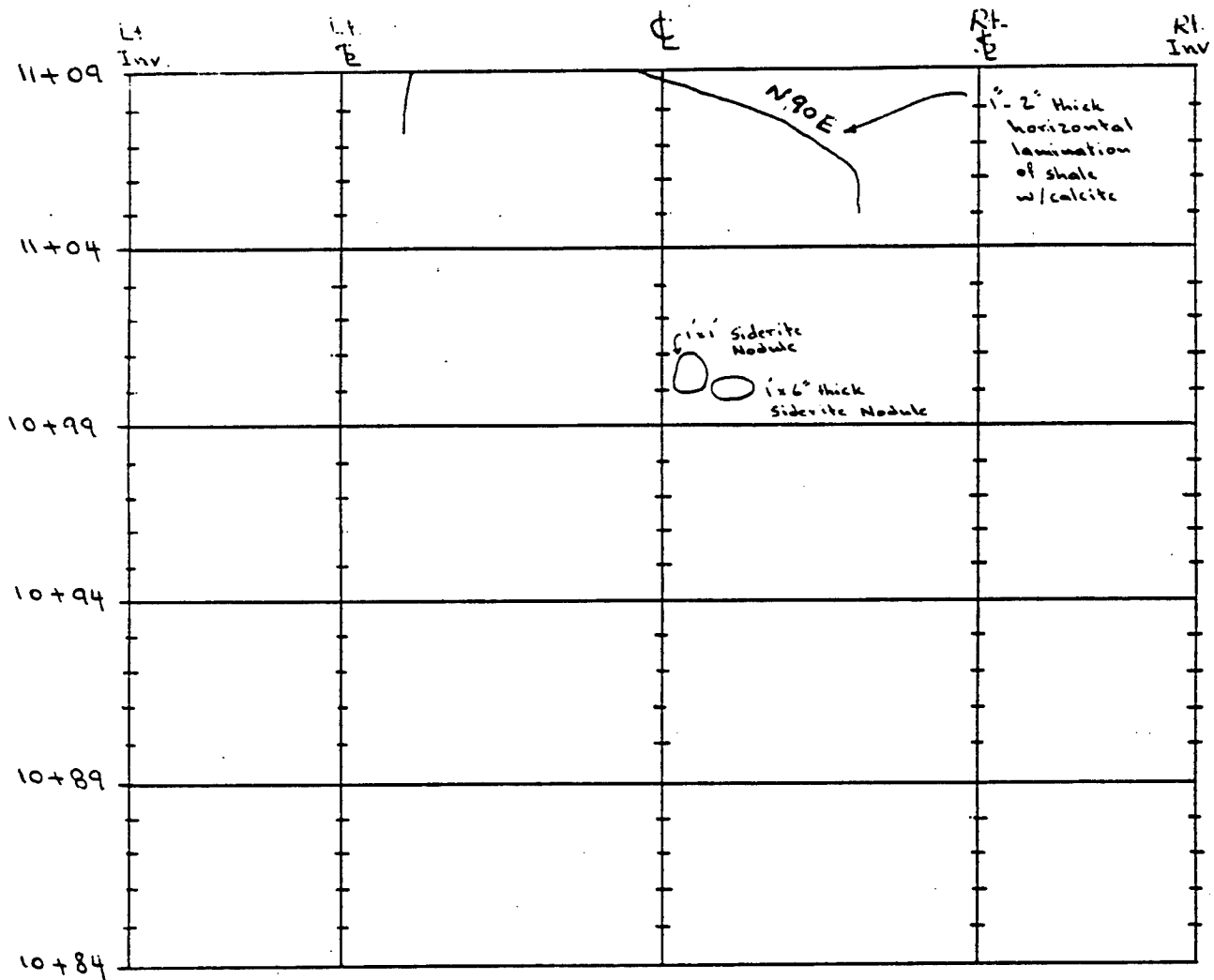
Project	UTP	Computed	Date
Subject		Checked	Date
Task	Rock: New Providence Shale	Sheet 40	Of 72

	Lt. Inv.	Lt. E	E	Rt. E	Rt. Inv.
10+84					
10+79					
10+74					
10+69					
10+64					
10+59					

Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

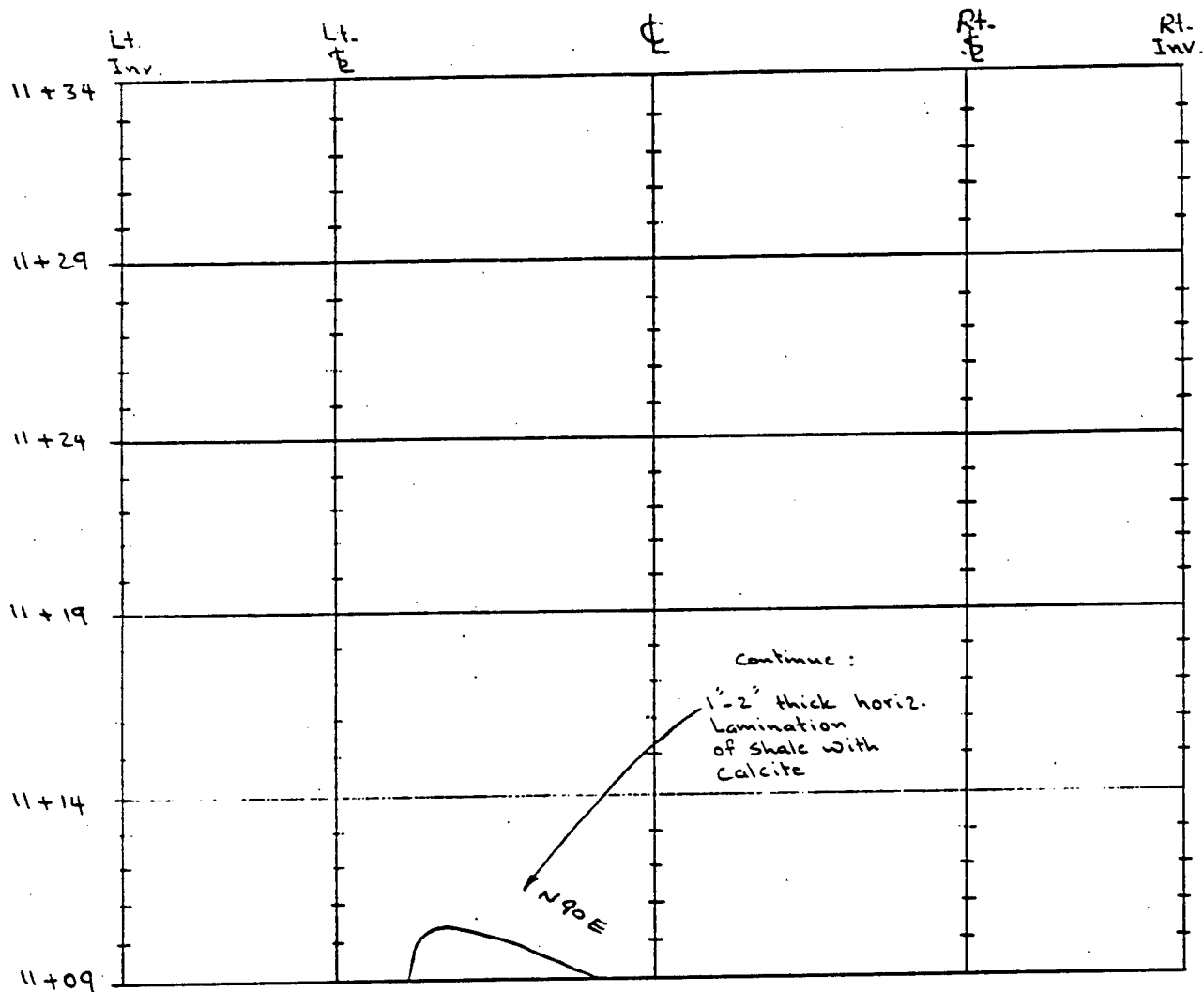
Project	UTP	Computed		Date	
Subject		Checked		Date	
Task	Rock New Providence Shale	Sheet	41	Of	72



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject		Checked	Date
Task	Rock: N. P. shale	Sheet 42	Of 72



LACHEL & Associates, Inc.
Geologists, Engineers

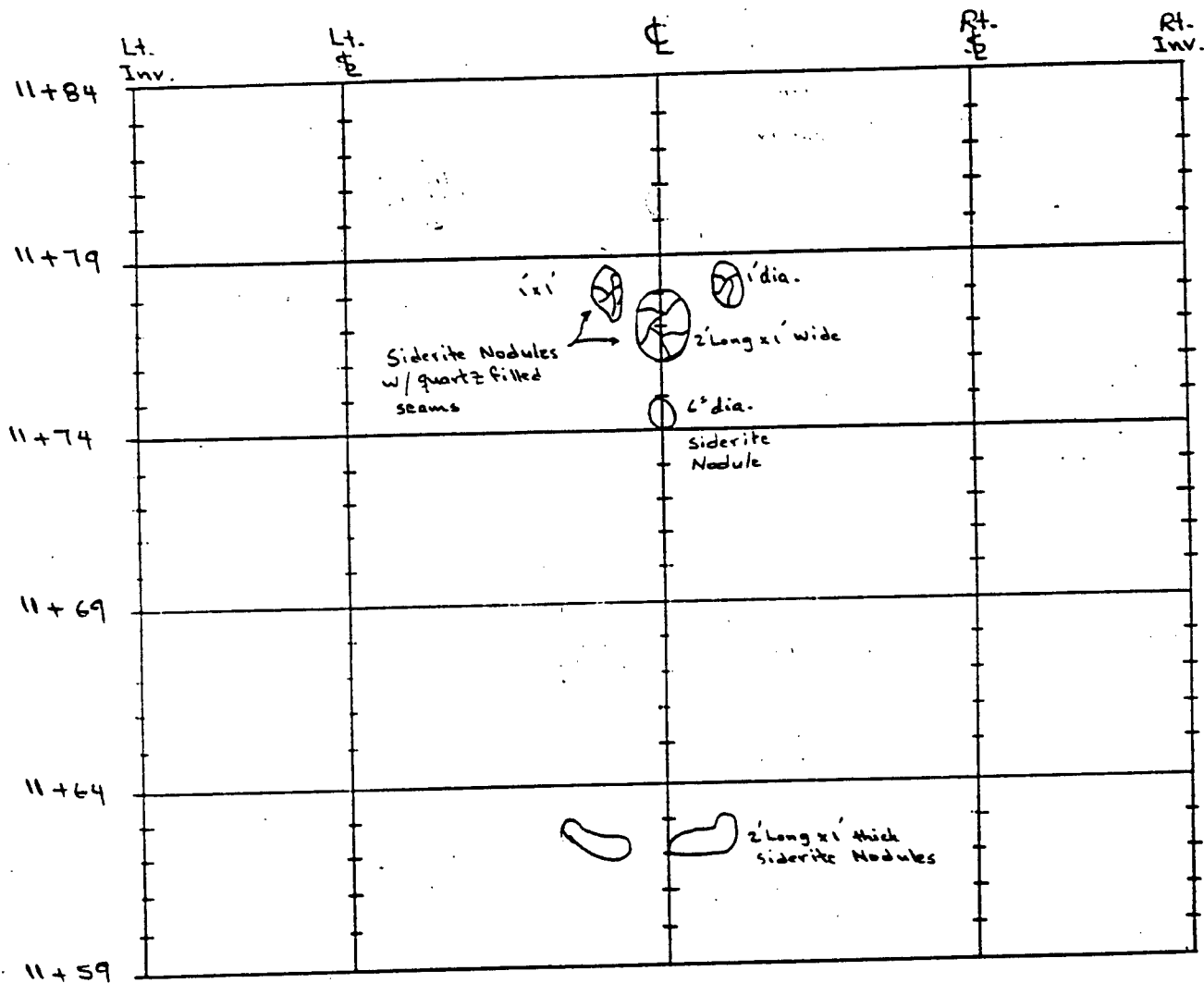
Project <u>UTP</u>	Computed _____	Date _____
Subject _____	Checked _____	Date _____
Task <u>Rock: N.P. shale</u>	Sheet <u>43</u>	Of <u>72</u>

	Lt Inv.	Lt E	Q	Rt E	Rt Inv.
11+59					
11+54					
11+49					
11+44					
11+39					
11+34					

Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

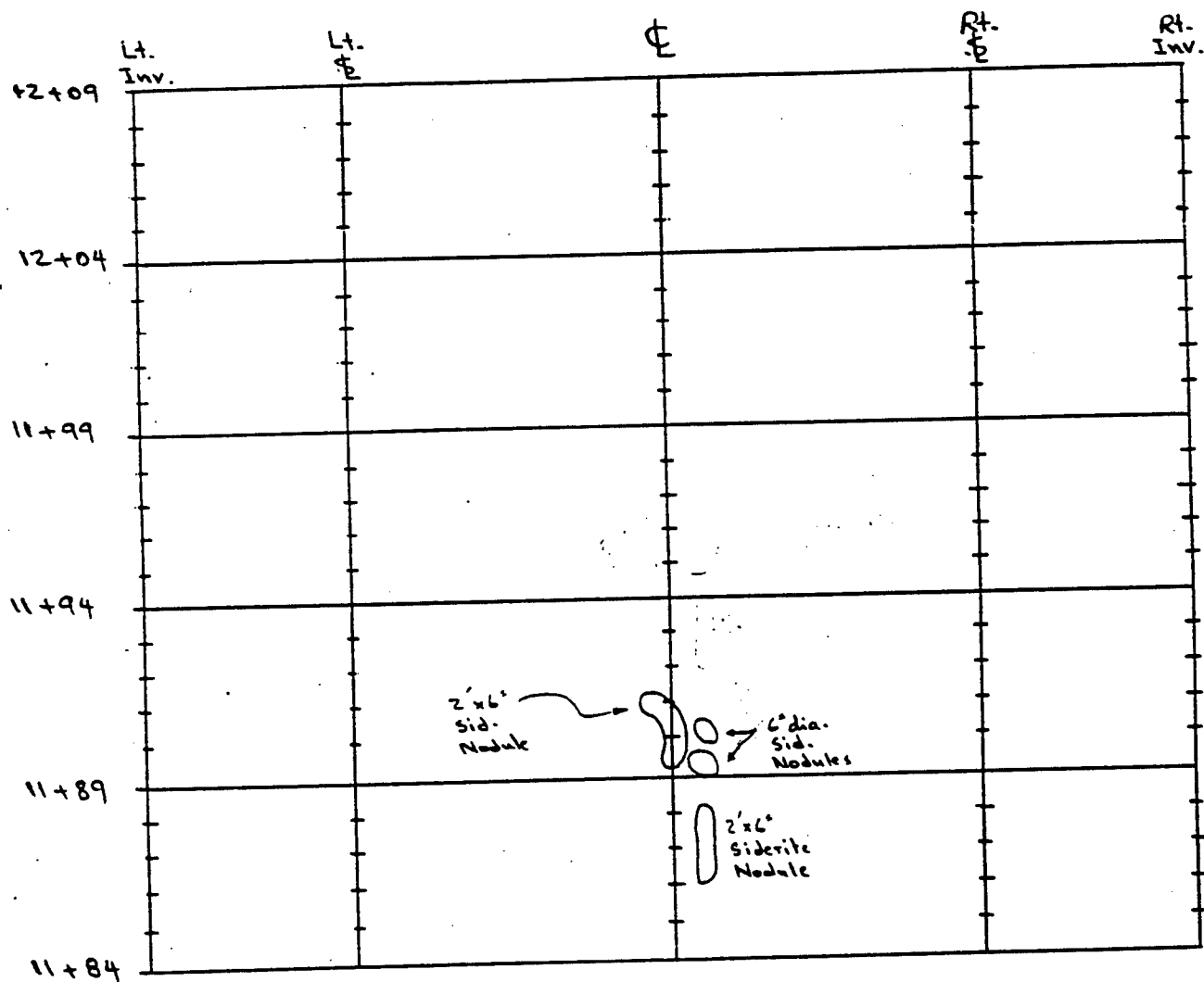
Project	UTP	Computed	Date
Subject		Checked	Date
Task	N. P. shale	Sheet 44	Of 72



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

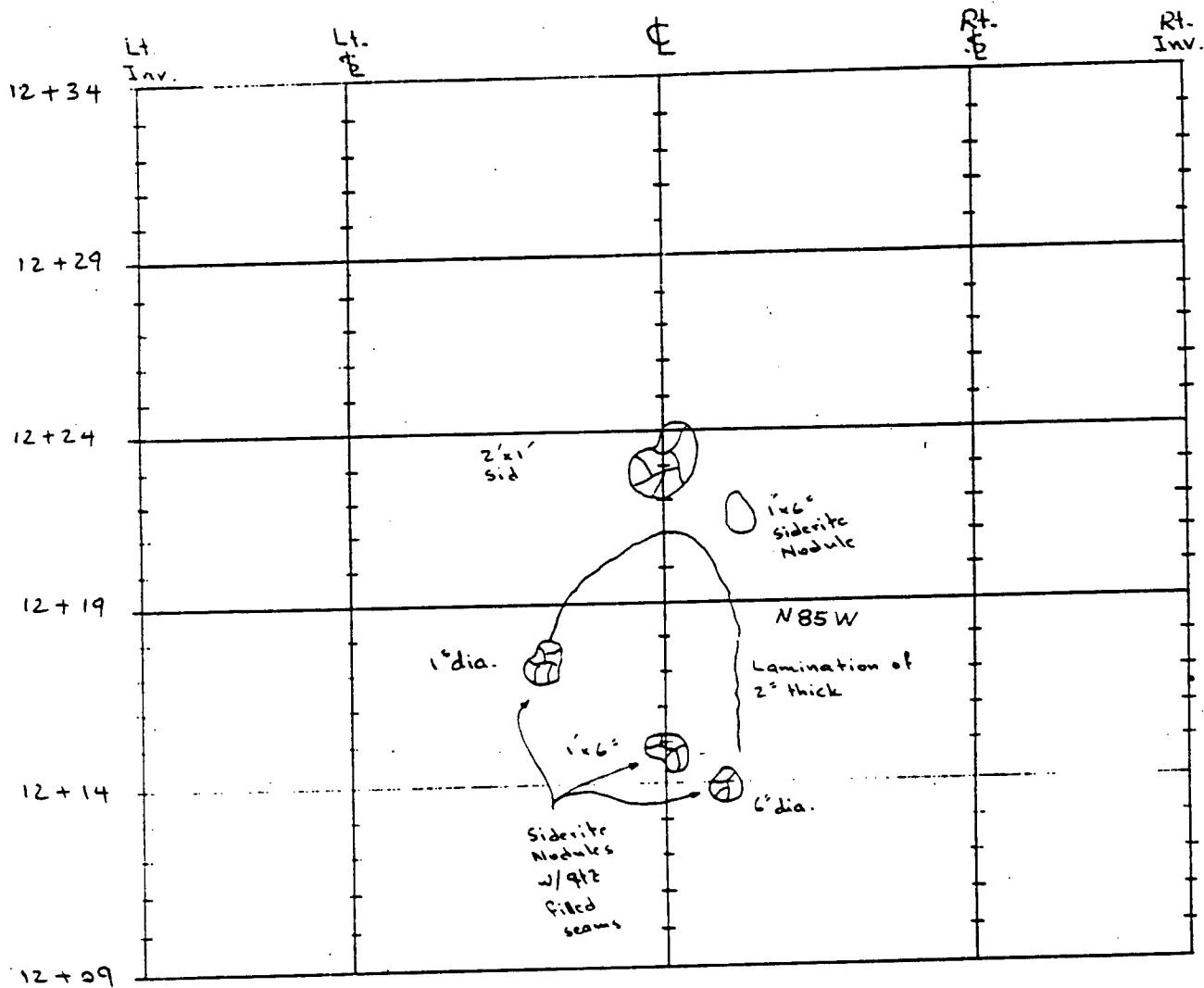
Project	UTP	Computed	Date
Subject		Checked	Date
Task	Rock: N. P. shale	Sheet 45	Of 72



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject		Checked	Date
Task	Rock: N.P. shale	Sheet 46	of 72



LACHEL & Associates, Inc.
Geologists, Engineers

Project <u>UTP</u>	Computed	Date
Subject	Checked	Date
Task <u>Rock: New Providence Shale</u>	Sheet <u>47</u>	Of <u>72</u>

	Lt. Inv.	Lt. E	C	Rt. E	Rt. Inv.
12+59					
12+54					
12+49					
12+44					
12+39					
12+34					

Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

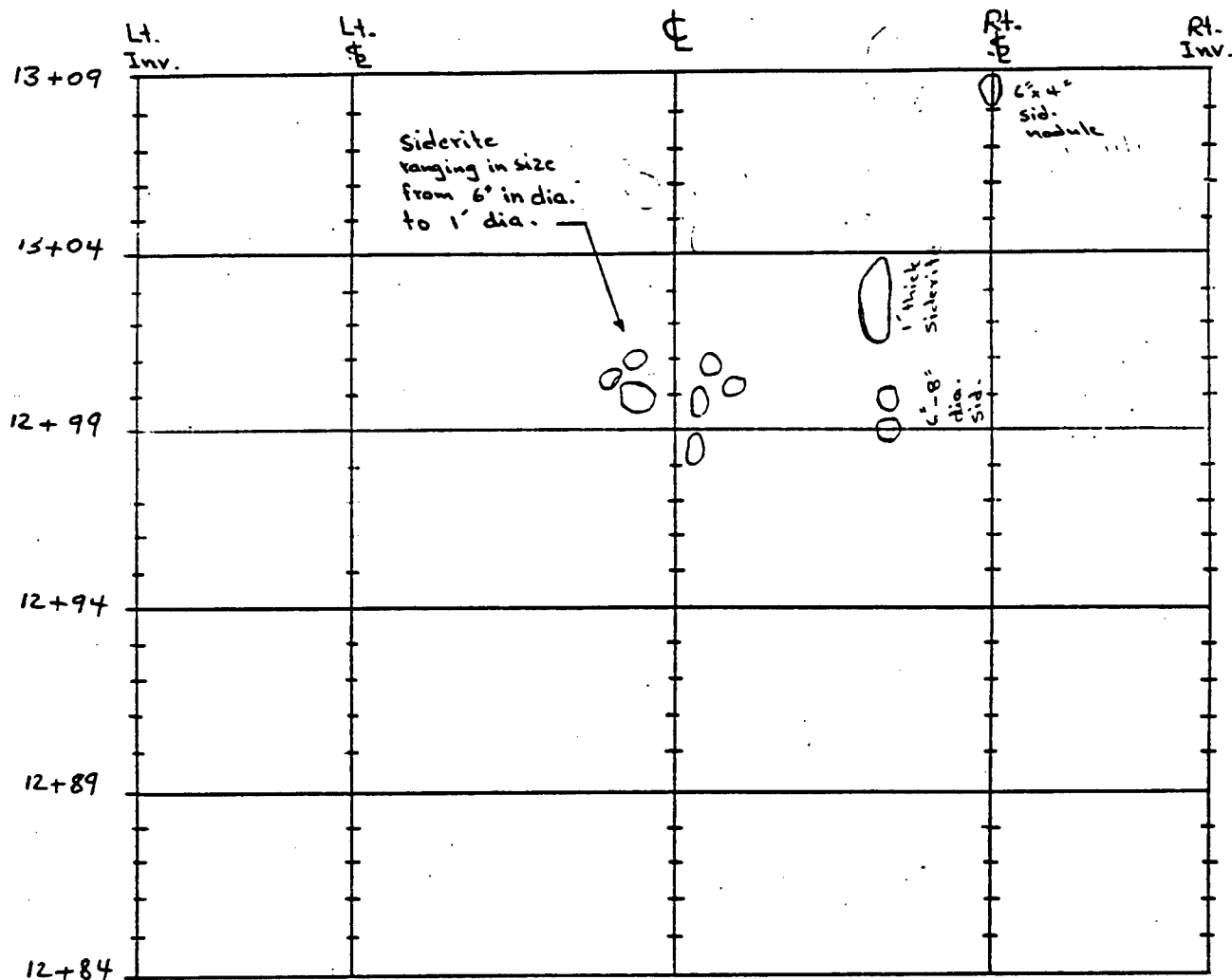
Project <u>UTP</u>	Computed	Date
Subject	Checked	Date
Task <u>Rock: New Prov. Shale</u>	Sheet <u>48</u>	Of <u>72</u>

	Lt. Inv.	Lt. E	¢	Rt. E	Rt. Inv.
12+84					
12+79					
12+74					
12+69					
12+64					
12+59					

Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

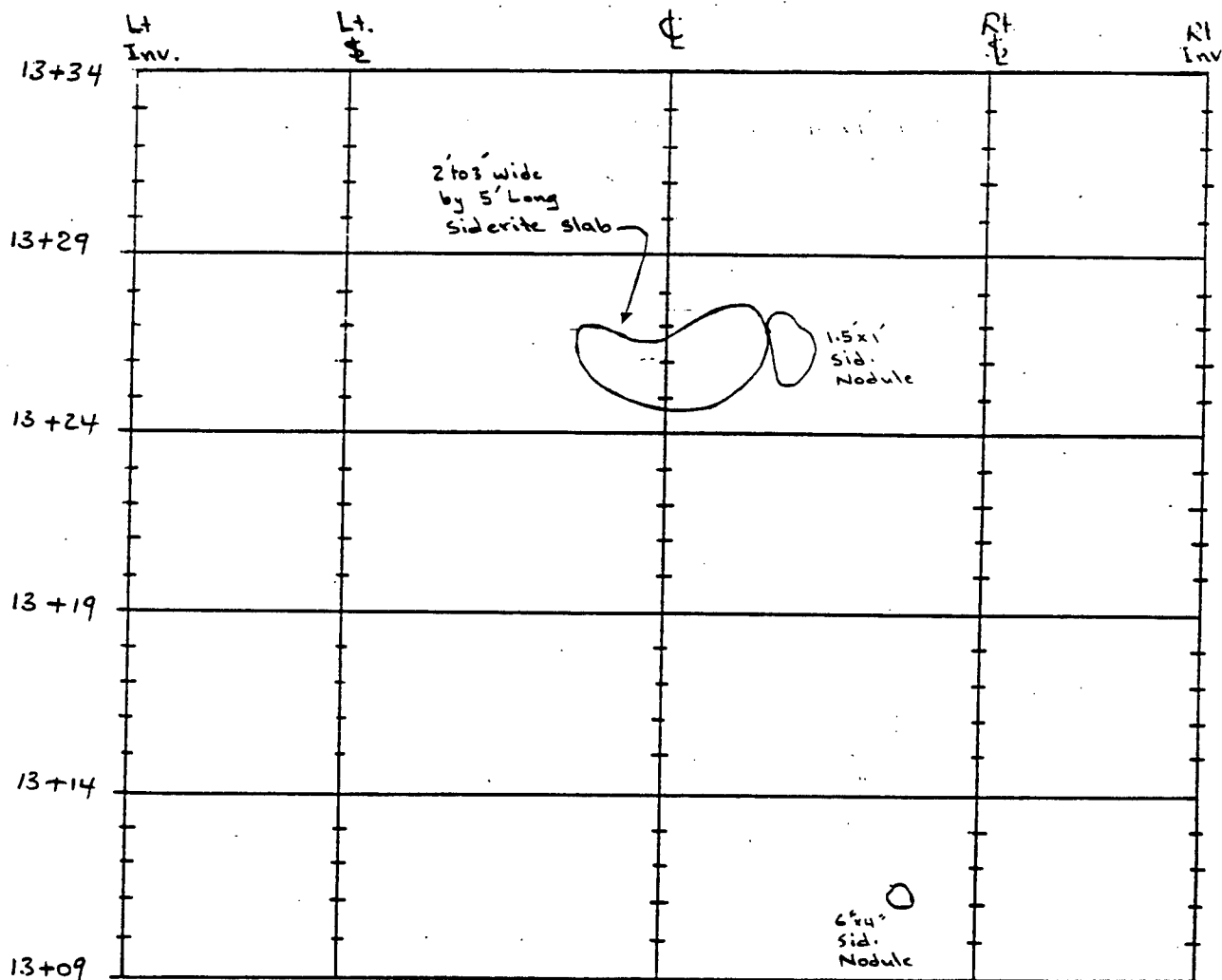
Project <u>UTP</u>	Computed	Date
Subject	Checked	Date
Test Rock: <u>New Provid. shale</u>	Sheet <u>49</u>	Of <u>72</u>



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project <u>UTP</u>	Computed	Date
Subject	Checked	Date
Task <u>Rock: New Providence shale</u>	Sheet <u>50</u>	Of <u>72</u>



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project <u>UTP</u>	Computed	Date
Subject	Checked	Date
Task <u>Rock: New Prov. shale</u>	Sheet <u>51</u>	Of <u>72</u>

	Lt. Inv.	Lt. E	☉	Rt. E	Rt. Inv.
13+59					
13+54					
13+49					
13+44					
13+39					
13+34					

Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

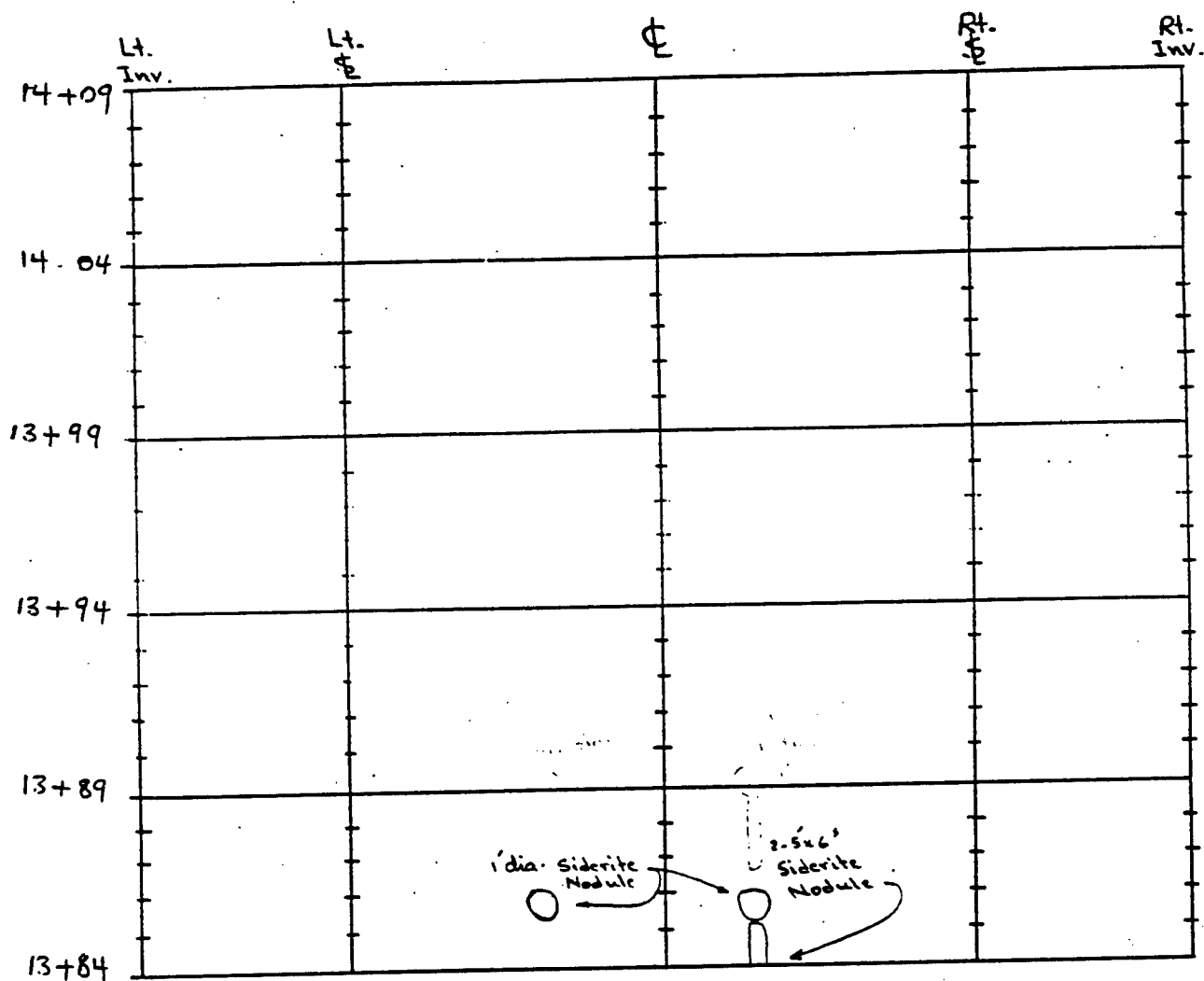
Project <u>UTP</u>	Computed	Date
Subject	Checked	Date
Task <u>Rock: New Prov. shale</u>	Sheet <u>52</u>	Of <u>72</u>

	Lt. Inv.	Lt. \$	¢	Rt. \$	Rt. Inv.
13+84			U		
13+79					
13+74					
13+69					
13+64					
13+59					

Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

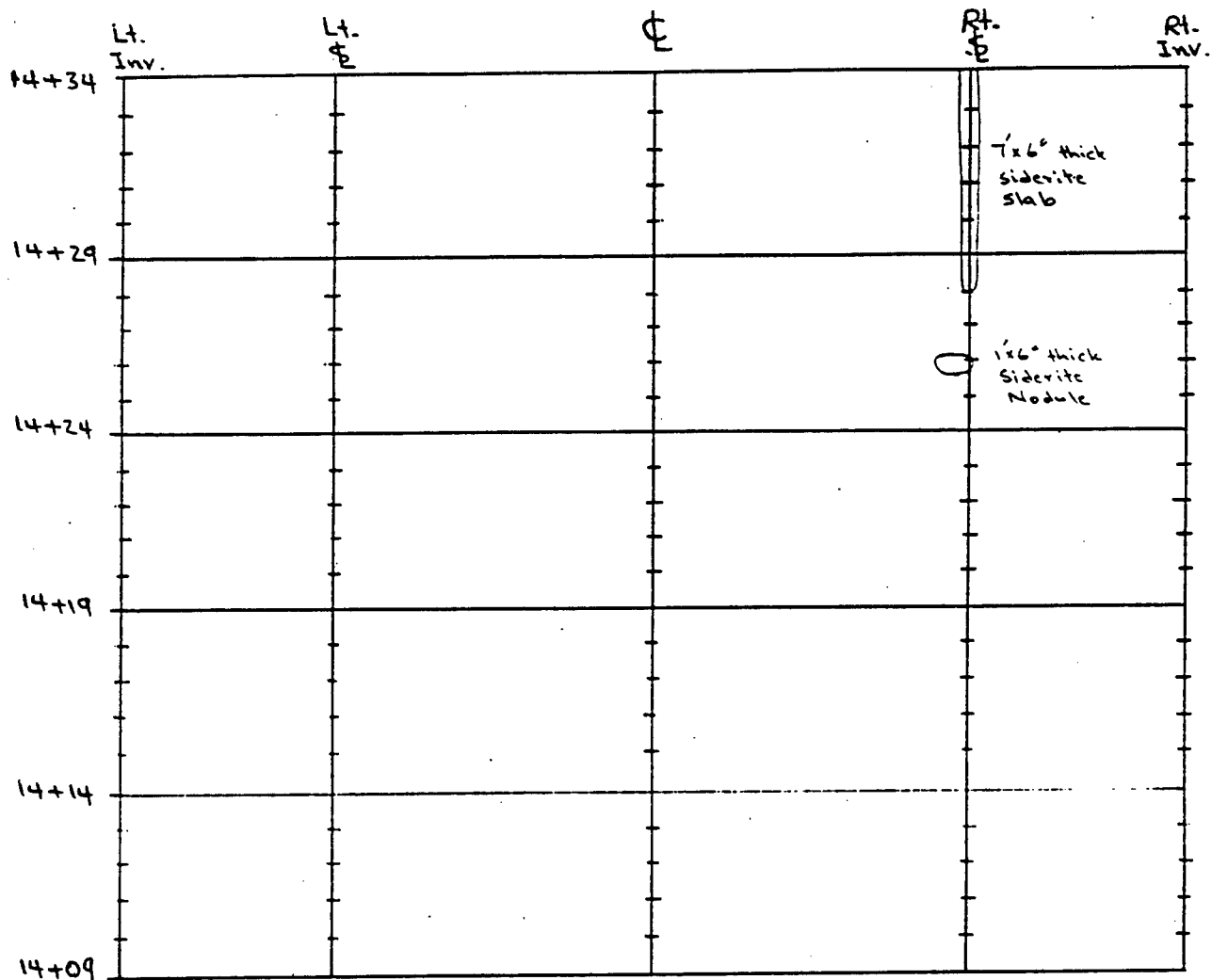
Project <u>UTP</u>	Computed	Date
Subject	Checked	Date
Test <u>Rock: New Providence shale</u>	Sheet <u>53</u>	Of <u>72</u>



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project <u>UTP</u>	Computed _____	Date _____
Subject _____	Checked _____	Date _____
Task <u>Rock: New Providence shale</u>	Sheet <u>54</u>	Of <u>72</u>



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP

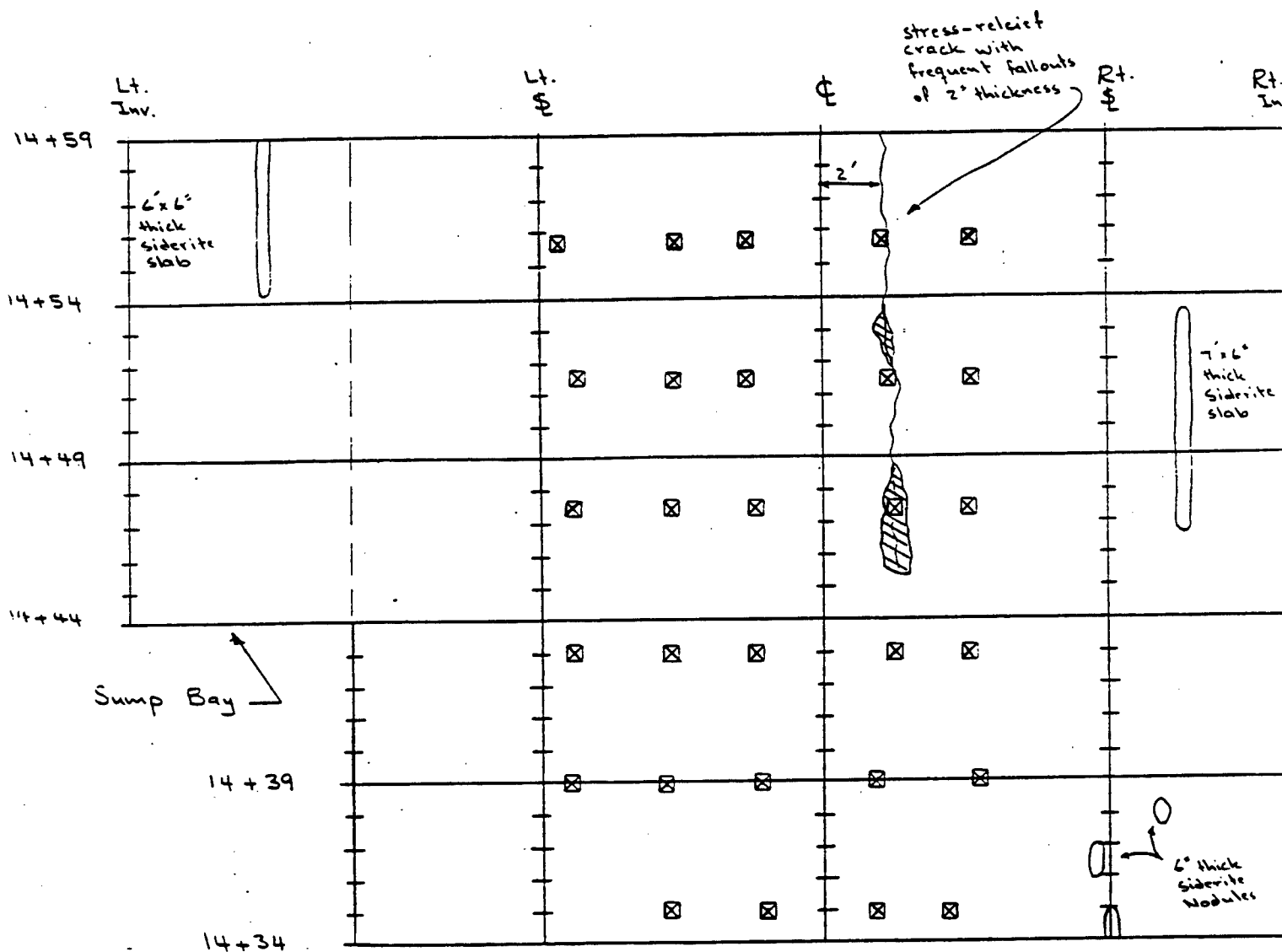
Computed

Date

Subject Sump Bay - Geologic Mapping

Checked

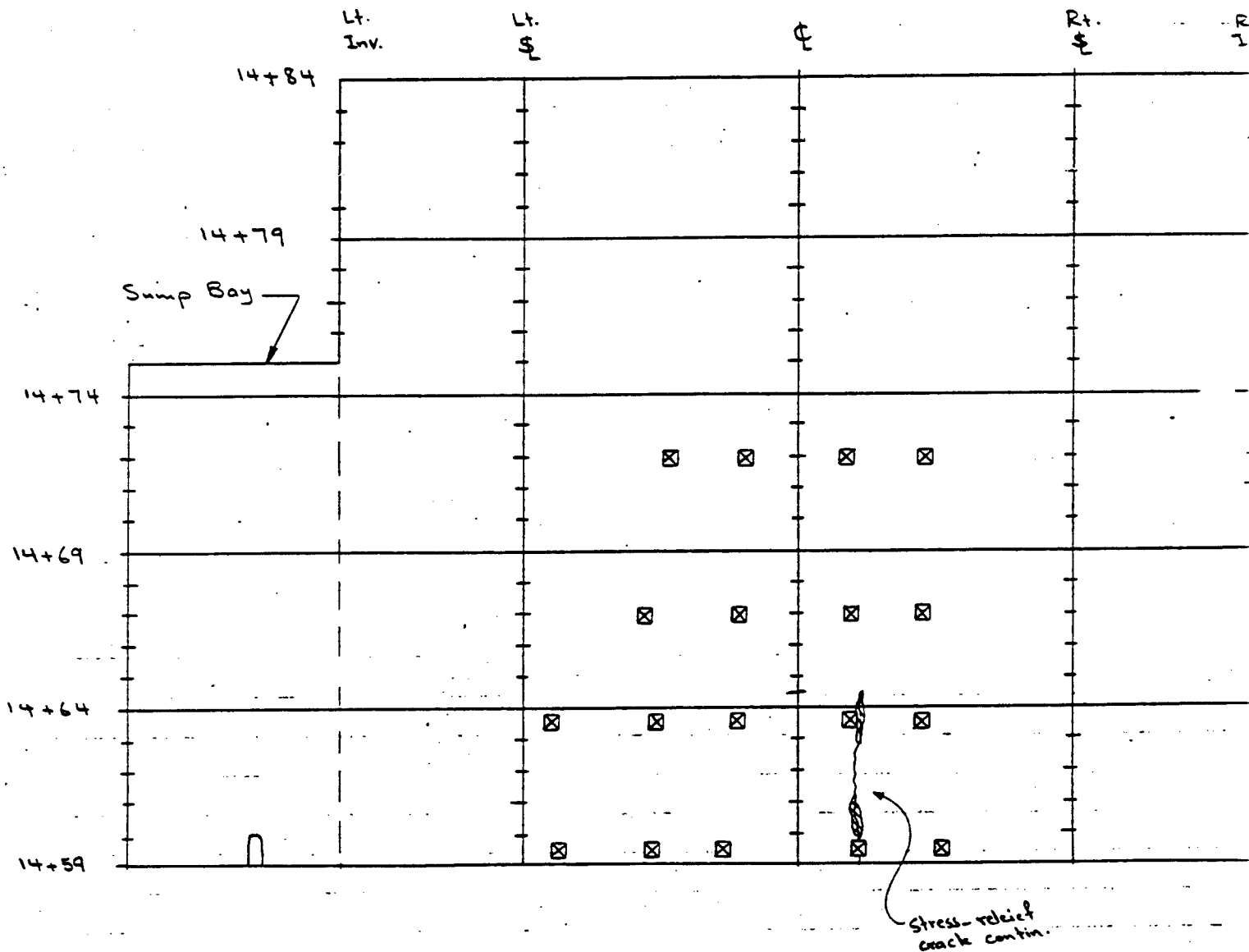
Date

Type Rock: New Providence ShaleSheet 55Of 72

Massive Rock

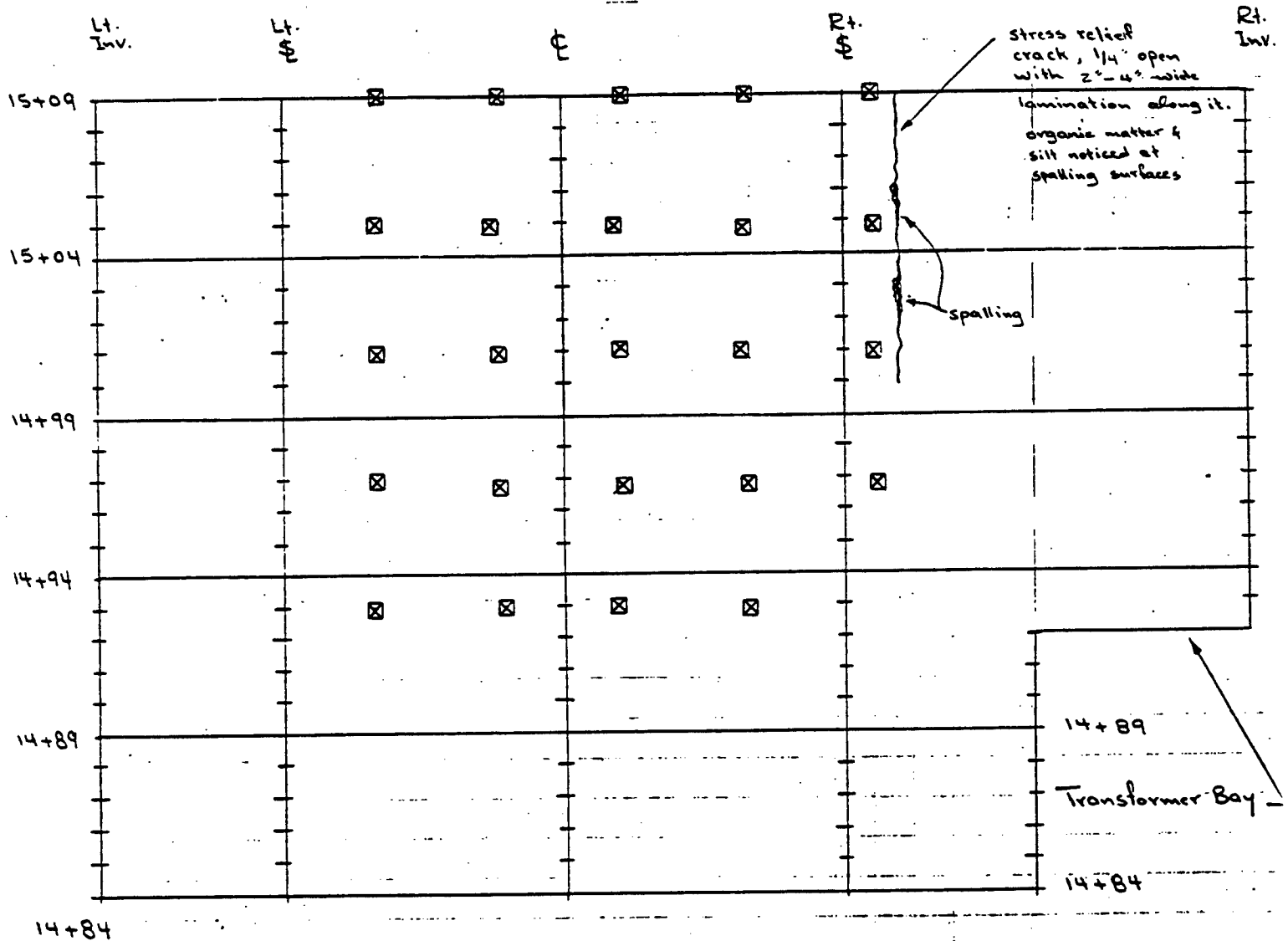
LACHEL & Associates, Inc.
Geologists, Engineers

Project <u>UTP</u>	Computed	Date
Subject	Checked	Date
Task	Sheet <u>56</u>	of <u>72</u>



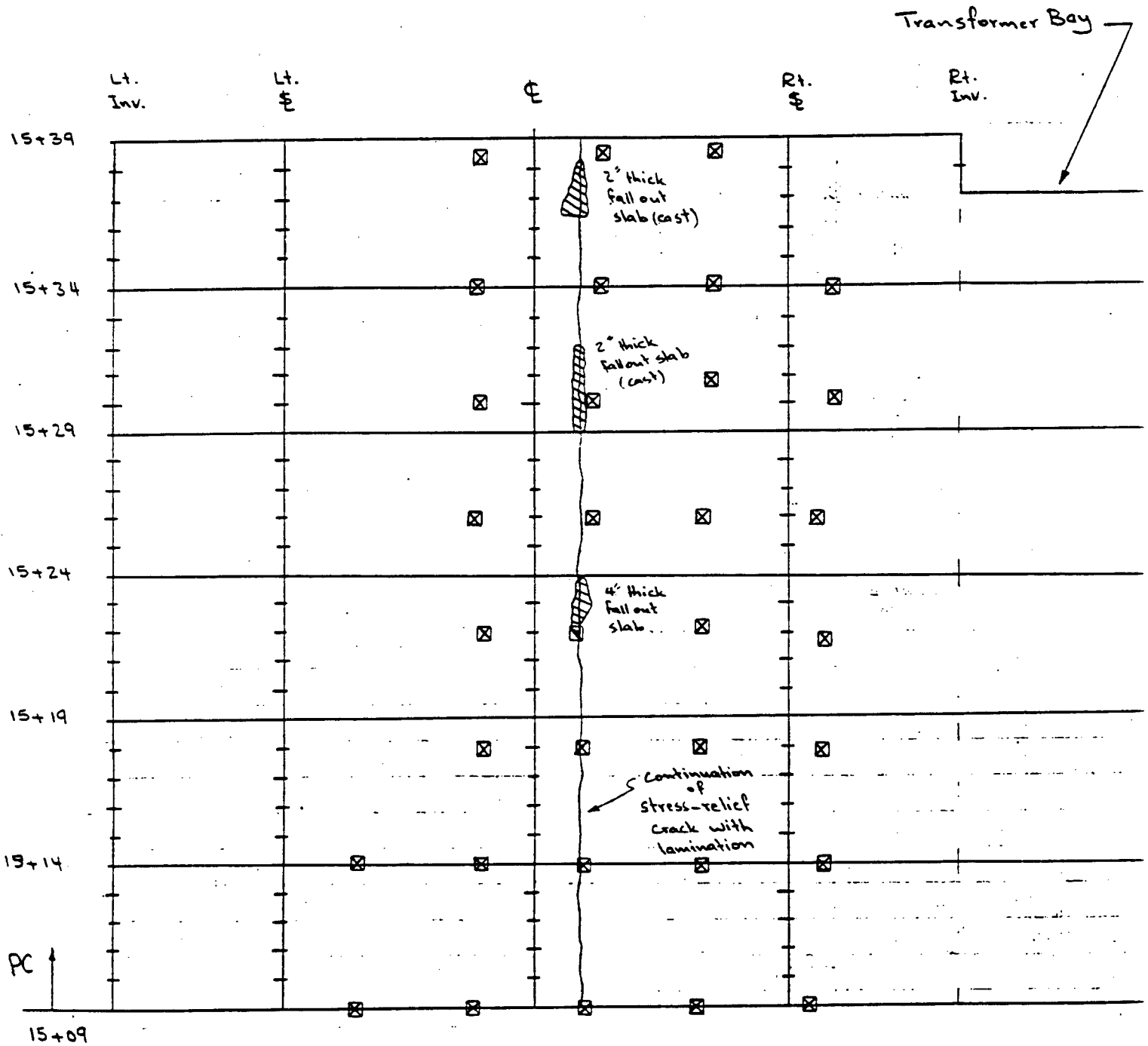
LACHEL & Associates, Inc.
Geologists, Engineers

Project <u>UTP</u>	Computed _____	Date _____
Subject <u>Transformer Bay - Geologic Mapping</u>	Checked _____	Date _____
Task <u>Rock: New Providence Shale</u>	Sheet <u>57</u>	of <u>72</u>



LACHEL & Associates, Inc.
Geologists, Engineers

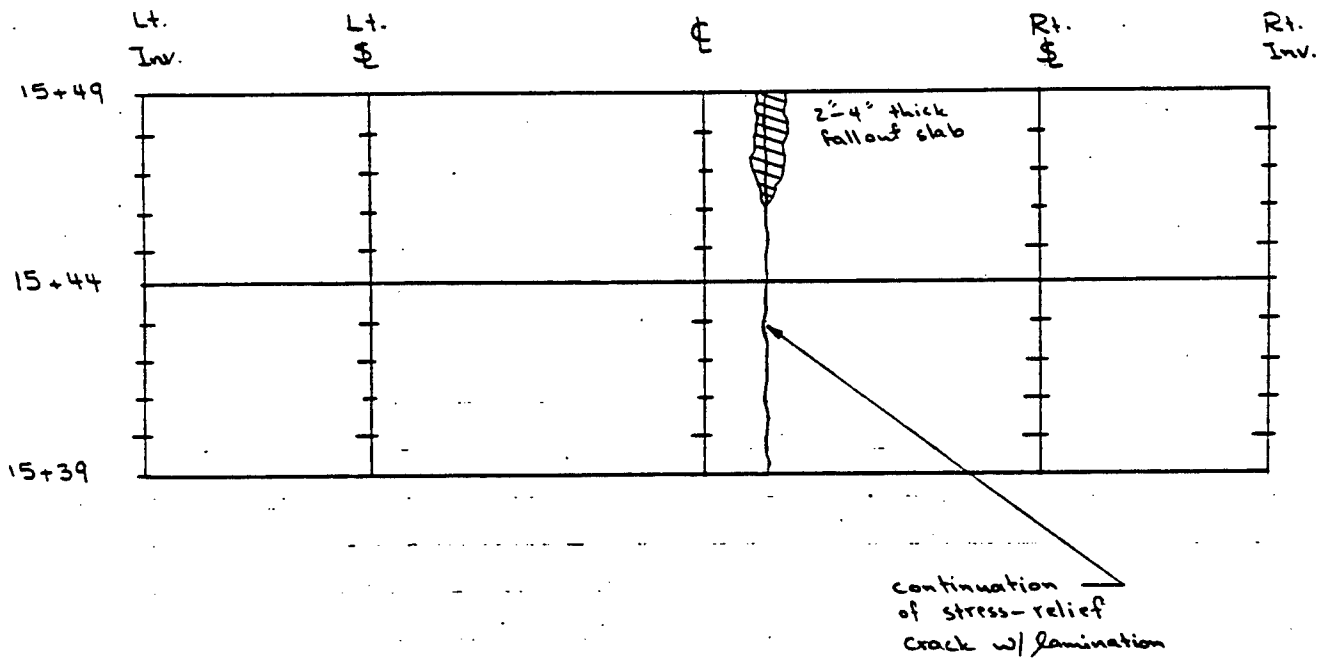
Project <u>UTP</u>	Computed _____	Date _____
Subject _____	Checked _____	Date _____
Task _____	Sheet <u>58</u>	of <u>72</u>



* Tunnel starts to curve to the left @ Sta. 15+09 (PC)
but curve is not shown here for ease.

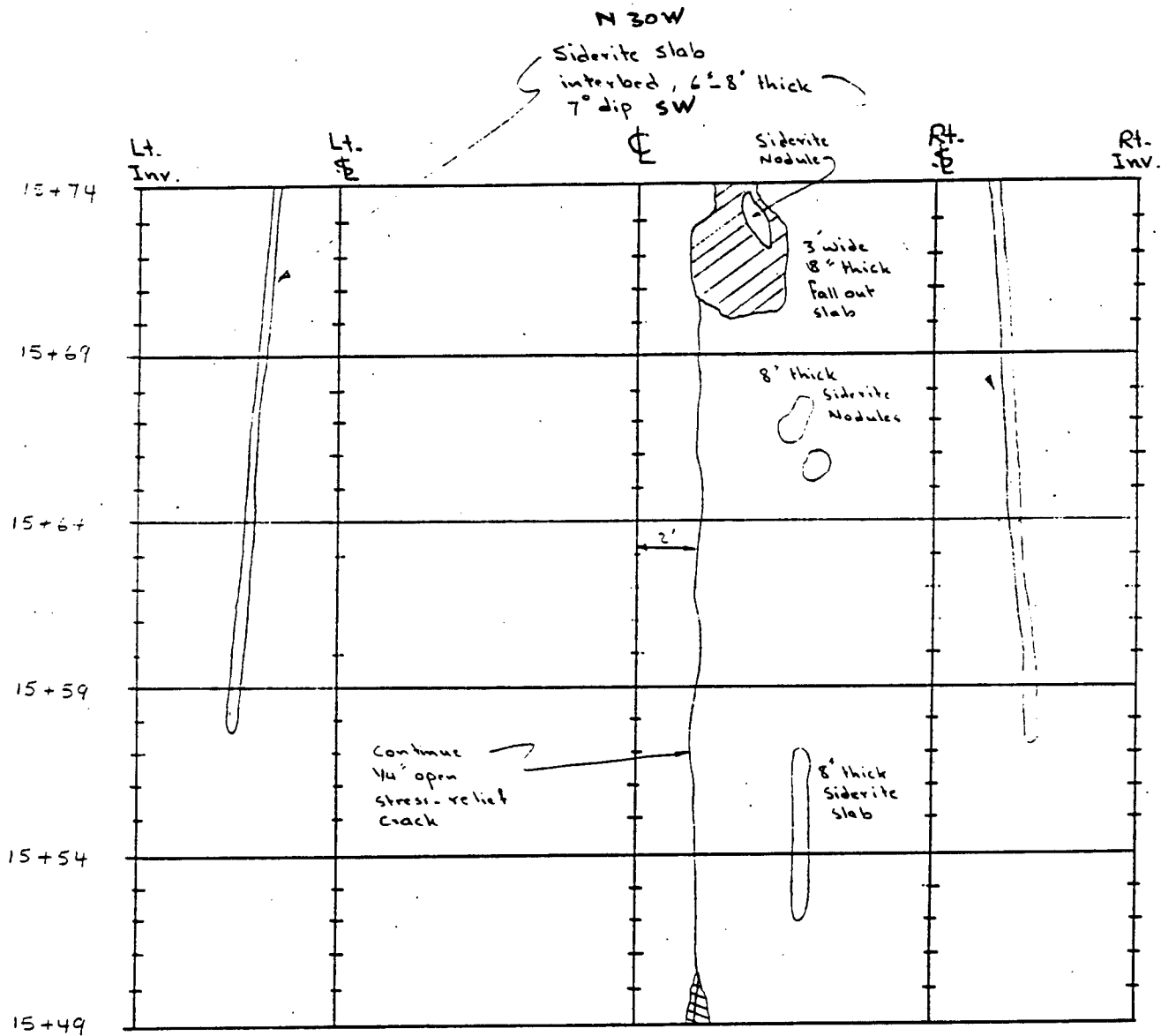
LACHEL & Associates, Inc.
Geologists, Engineers

Project <u>UTP</u>	Computed	Date
Subject	Checked	Date
Task	Sheet <u>59</u>	of <u>72</u>



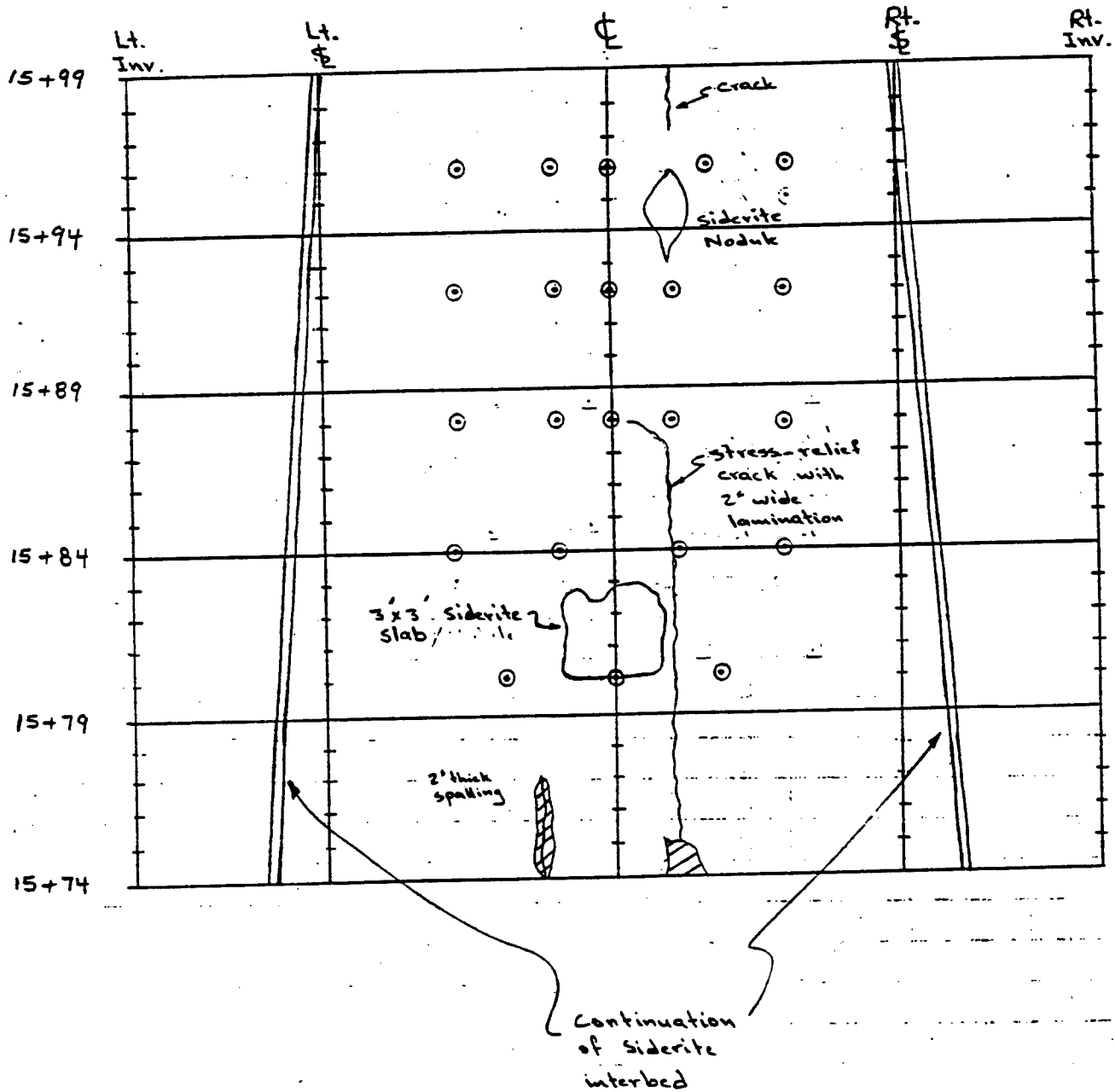
LACHEL & Associates, Inc.
Geologists, Engineers

Project <u>UTP</u>	Computed	Date
Subject	Checked	Date
Task	Sheet <u>60</u>	Of <u>72</u>



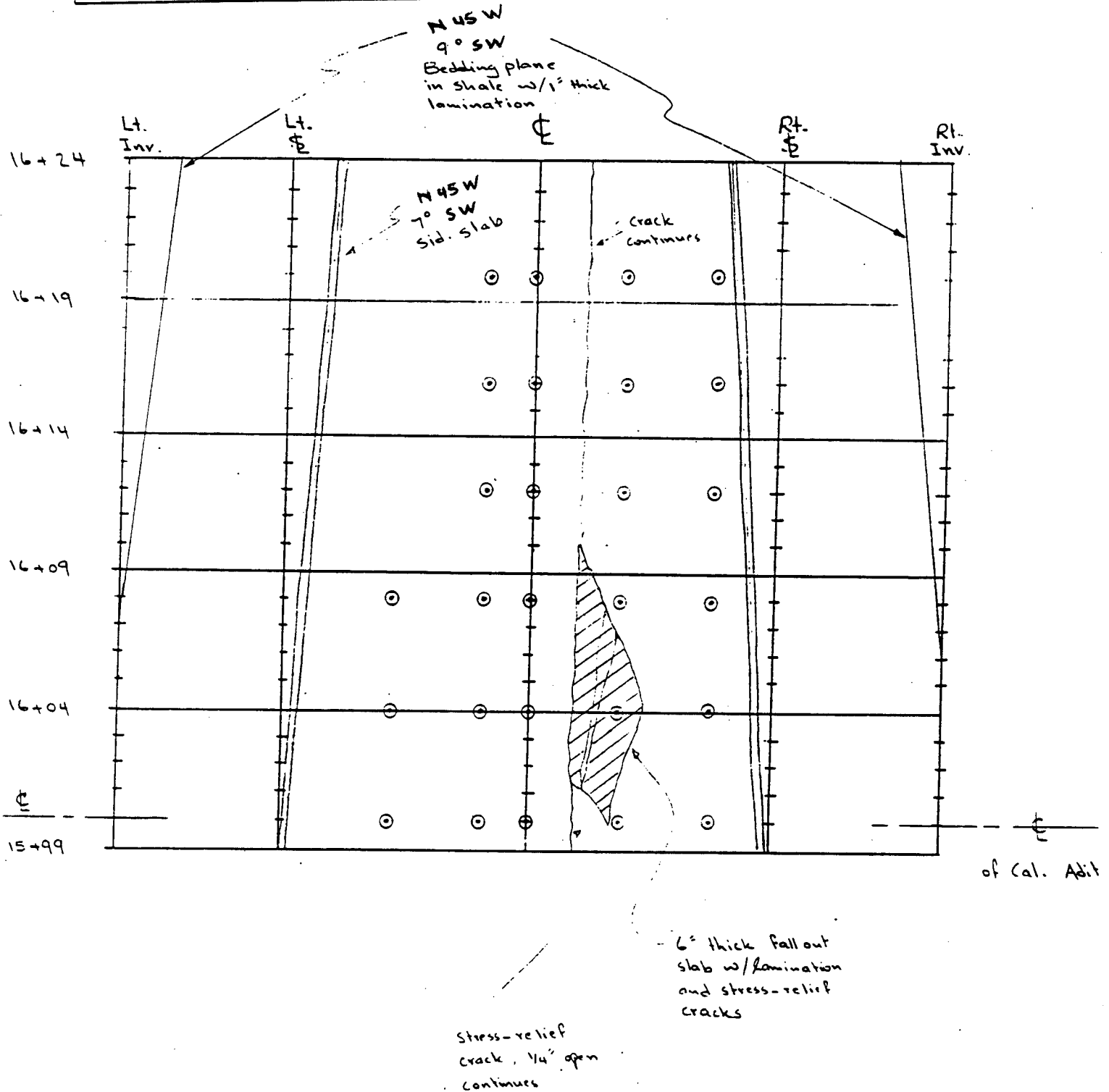
LACHEL & Associates, Inc.
Geologists, Engineers

Project <u>UTP</u>	Computed _____	Date _____
Subject _____	Checked _____	Date _____
Task _____	Sheet <u>61</u>	Of <u>72</u>



LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject		Checked	Date
Task		Sheet 62	of 72



LACHEL & Associates, Inc.
Geologists, Engineers

Project UTP

Computed

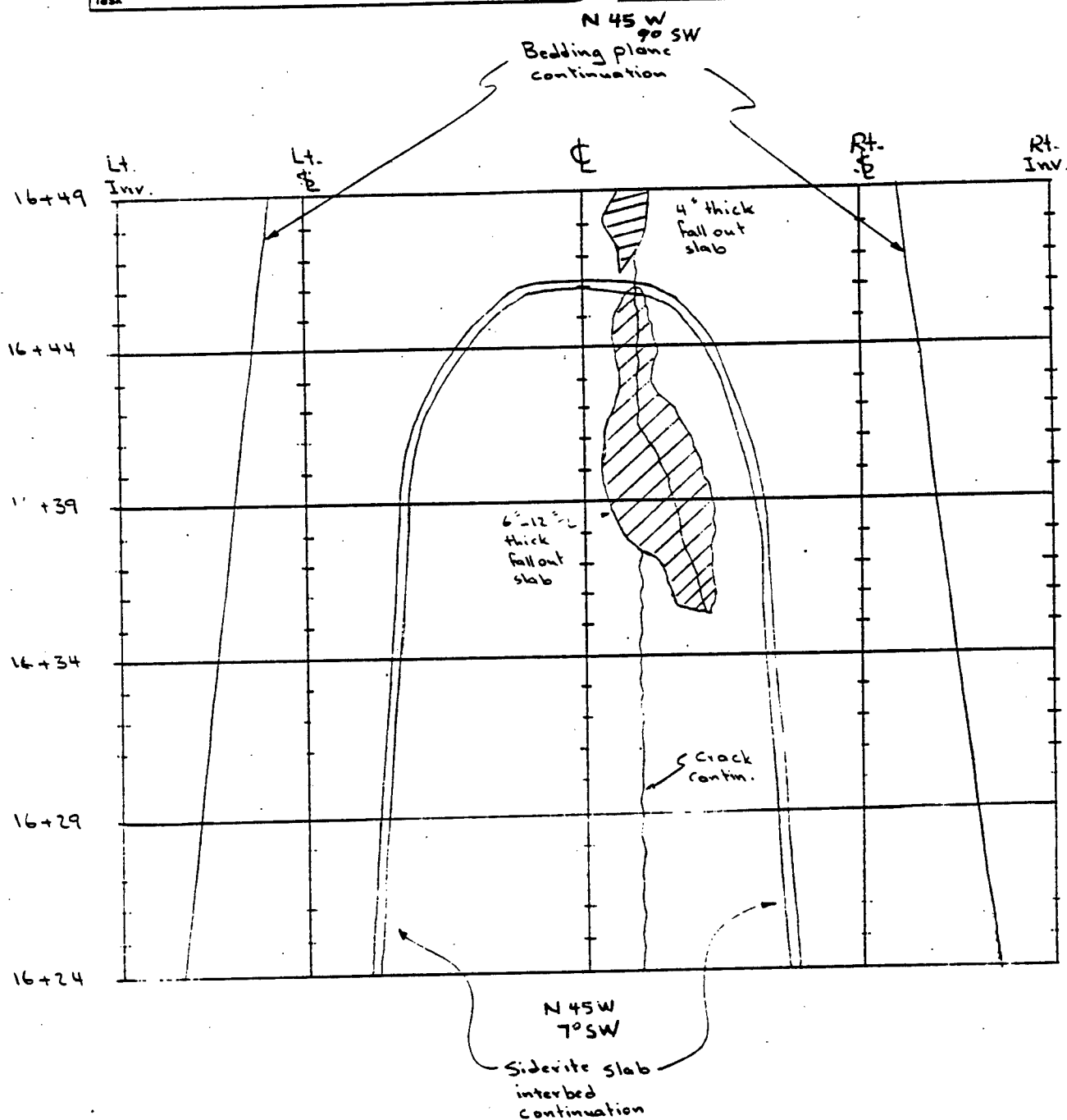
Date

Subject

Checked

Date

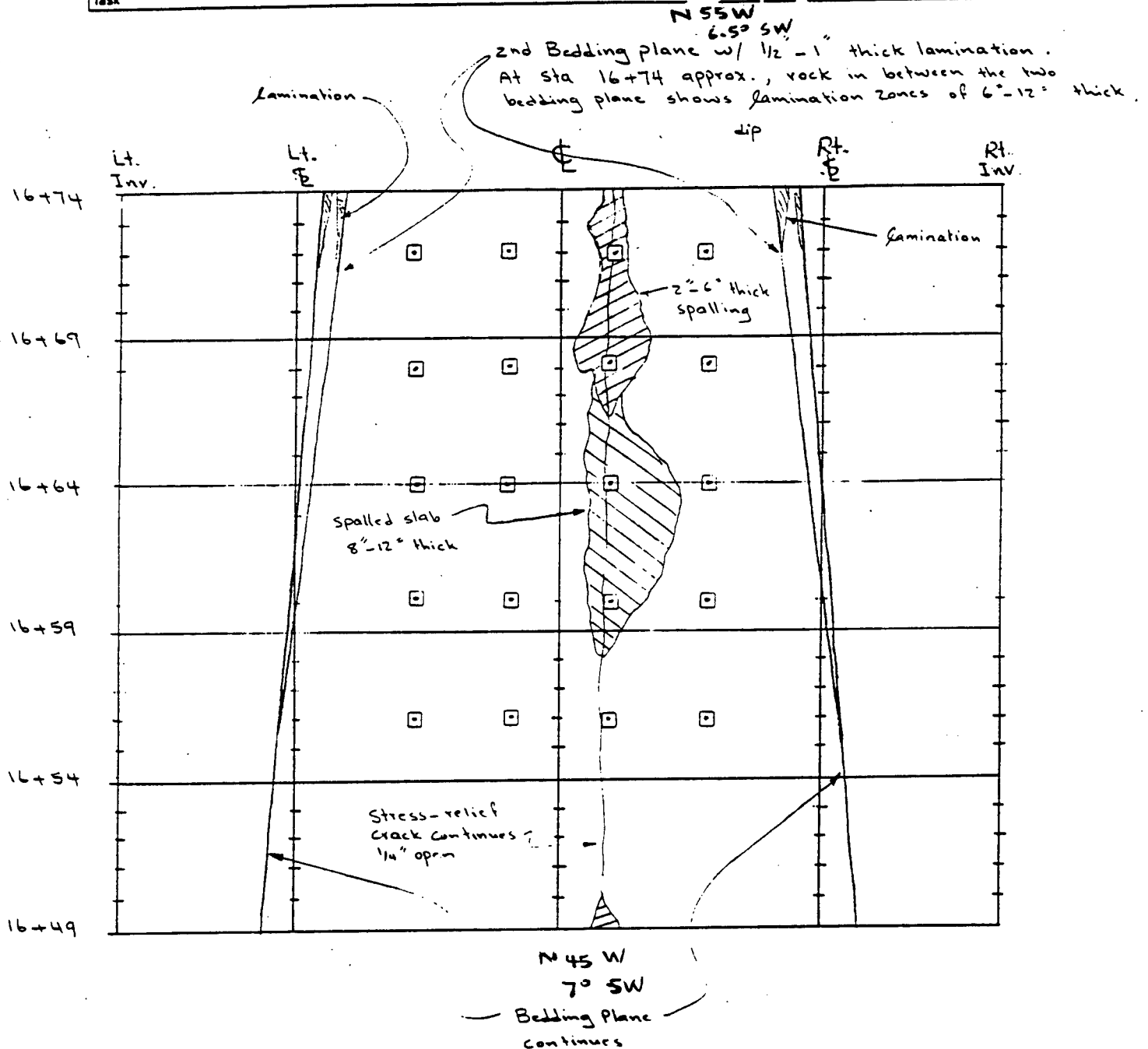
Task

Sheet 63of 72

Notice: Stress relief crack starts developing at 15-20 ft from heading as excavation progresses. Most falling rock start coming down in big chunks at about 20 ft from heading & only after 12 to 18 hours of exposure of newly excavated shale.

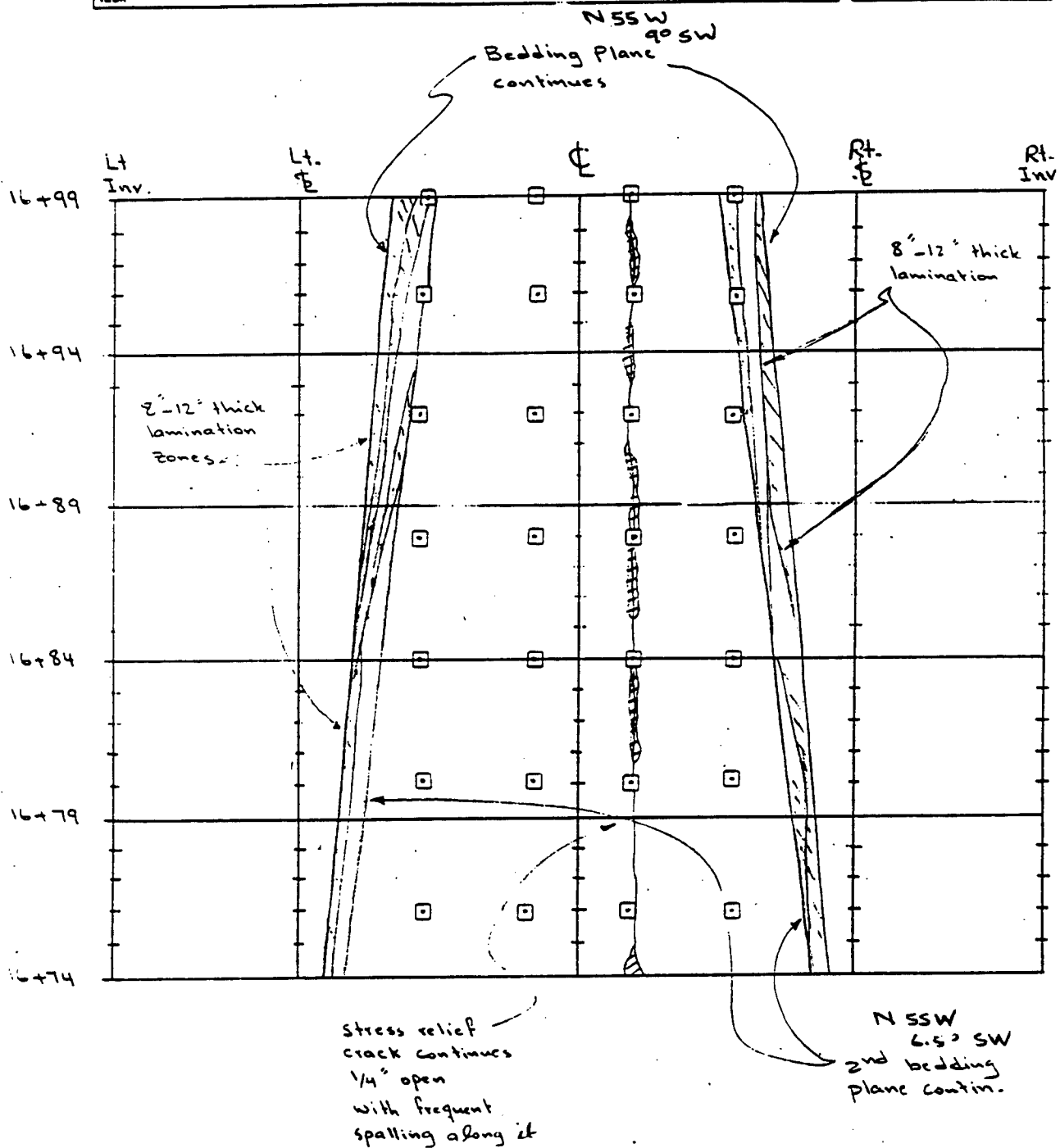
LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject		Checked	Date
Task		Sheet 64	Of 72



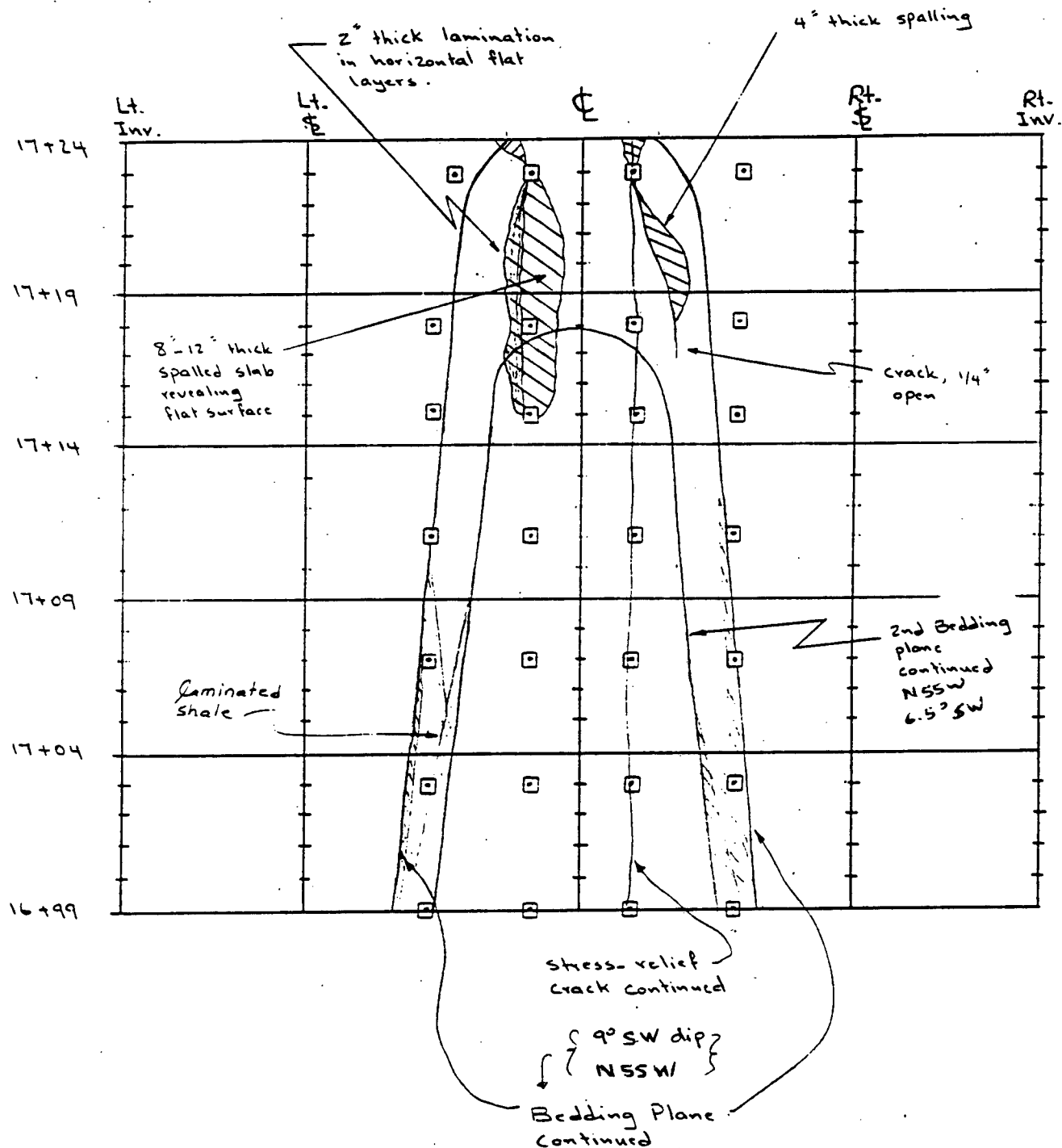
LACHEL & Associates, Inc.
Geologists, Engineers

Project <u>UTP</u>	Computed	Date
Subject	Checked	Date
Task	Sheet <u>65</u>	of <u>72</u>



LACHEL & Associates, Inc.
Geologists, Engineers

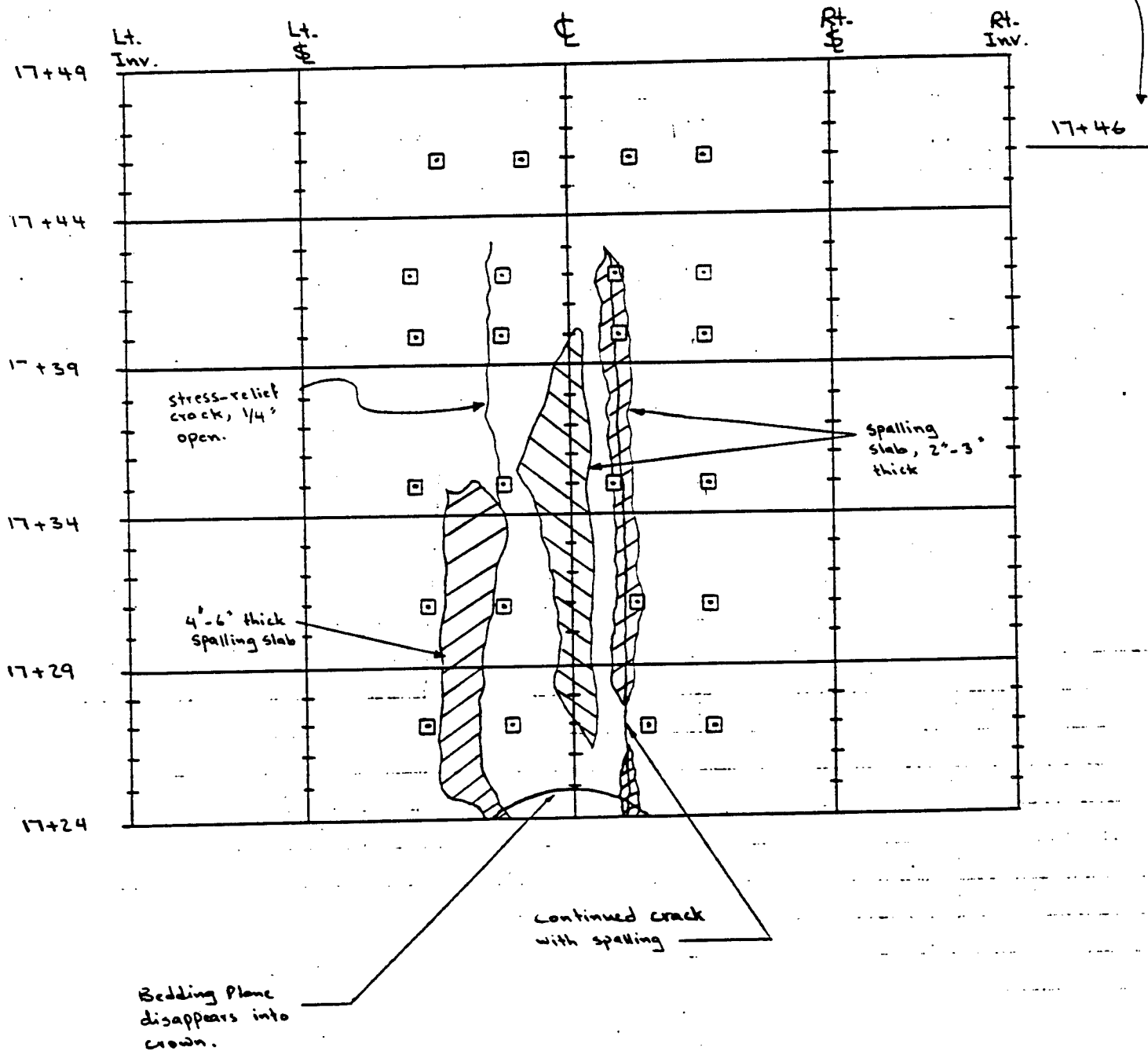
Project <u>UTP</u>	Computed	Date
Subject	Checked	Date
Task	Sheet <u>66</u>	Of <u>72</u>



LACHEL & Associates, Inc.
Geologists, Engineers

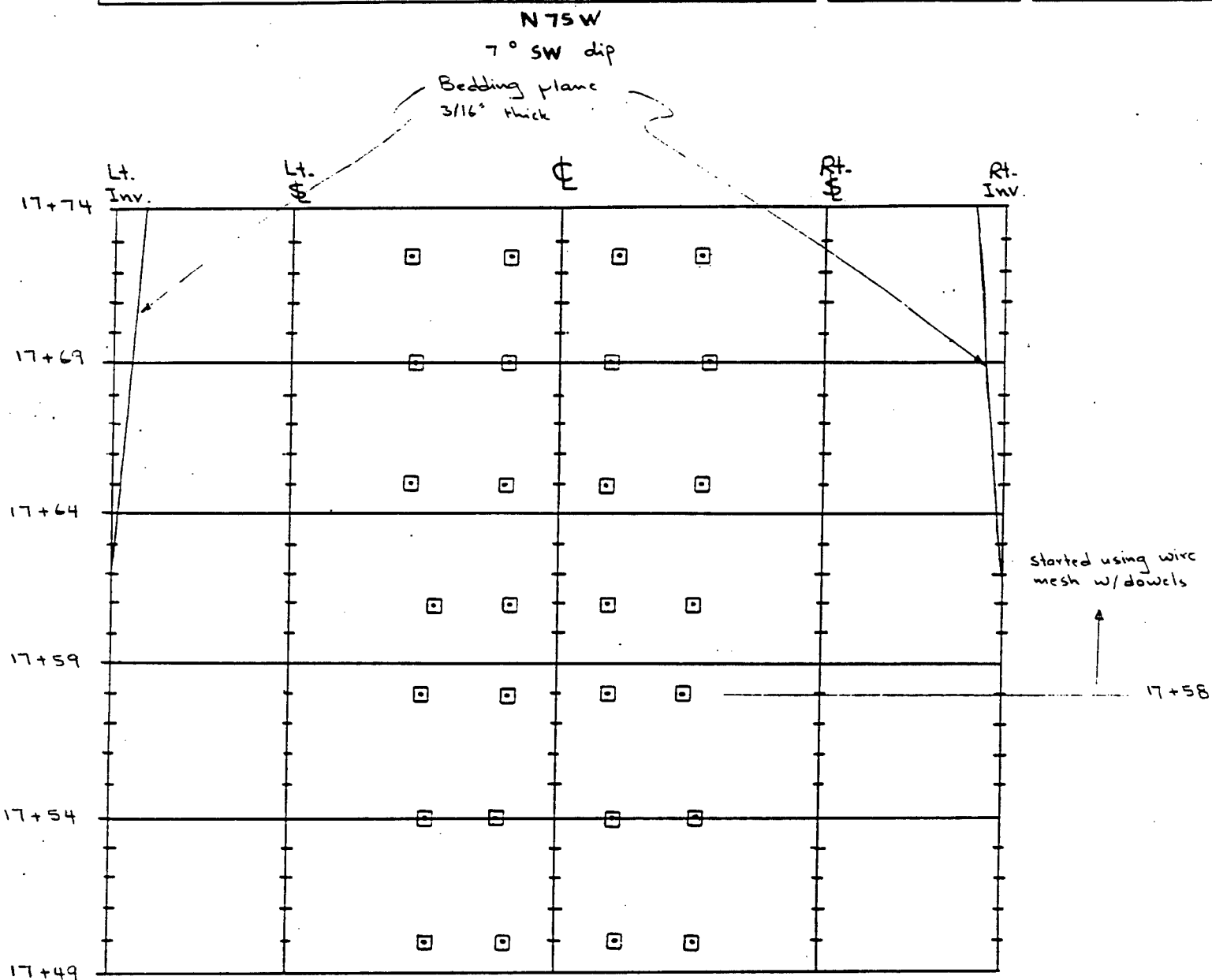
Project <u>UTP</u>	Computed	Date
Subject	Checked	Date
Task	Sheet <u>67</u>	of <u>72</u>

* New Providence Shale started to change color from dark gray to greenish gray with hues of green & silt-brown banding (layers of coloration)



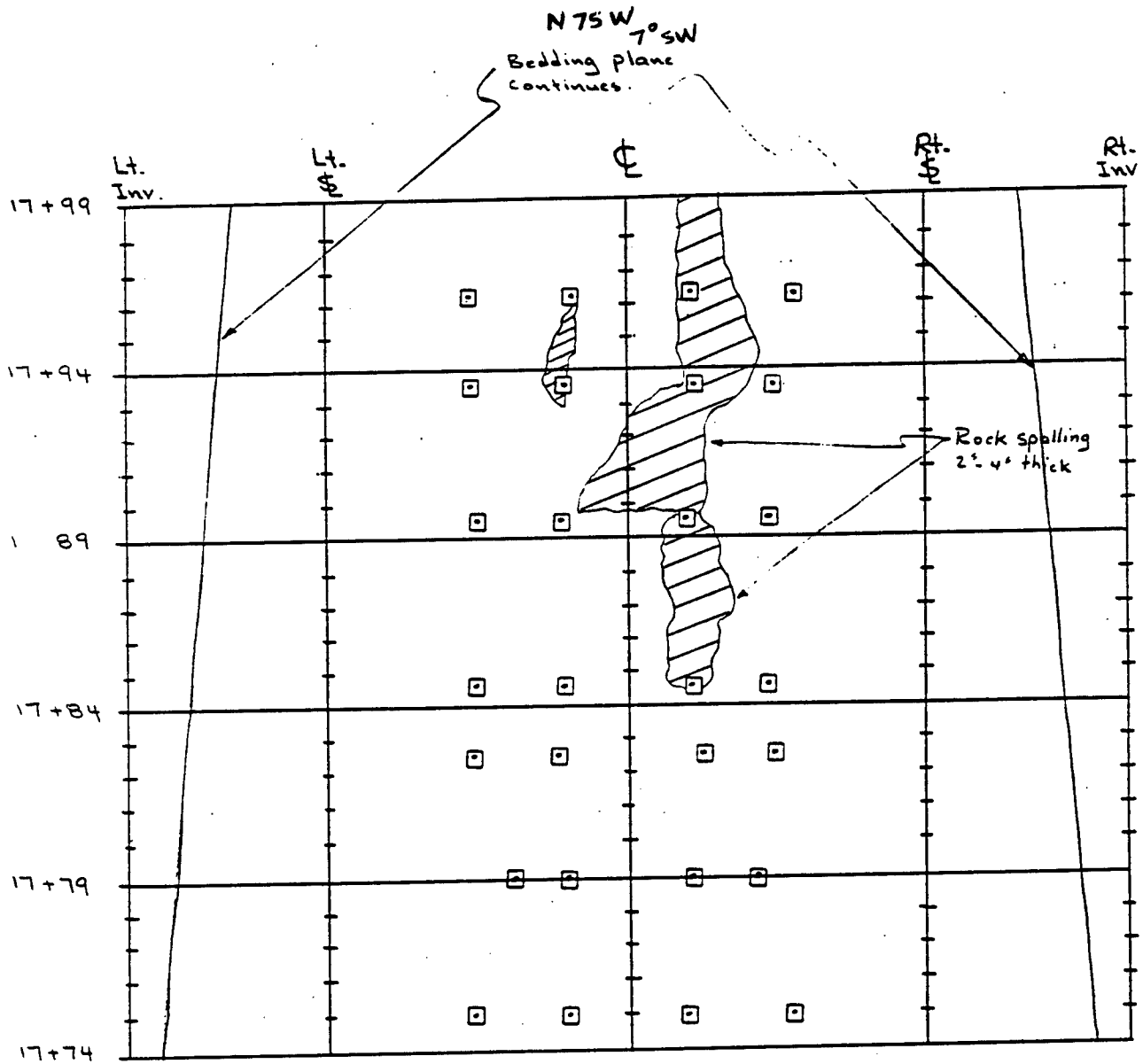
LACHEL & Associates, Inc.
Geologists, Engineers

Project <u>UTP</u>	Computed	Date
Subject	Checked	Date
Task	Sheet <u>68</u>	Of <u>72</u>



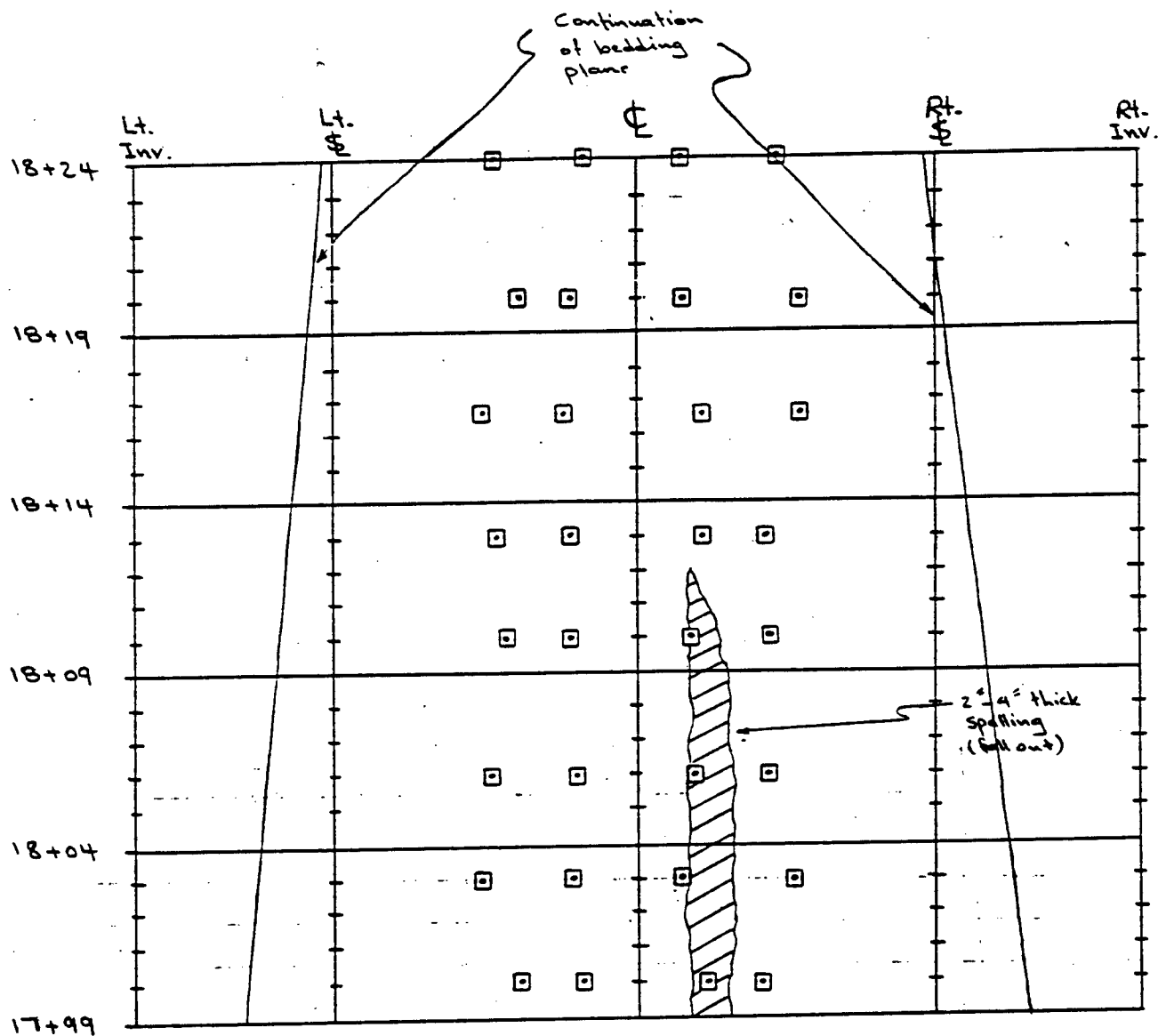
LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject		Checked	Date
Task		Sheet 69	Of 72



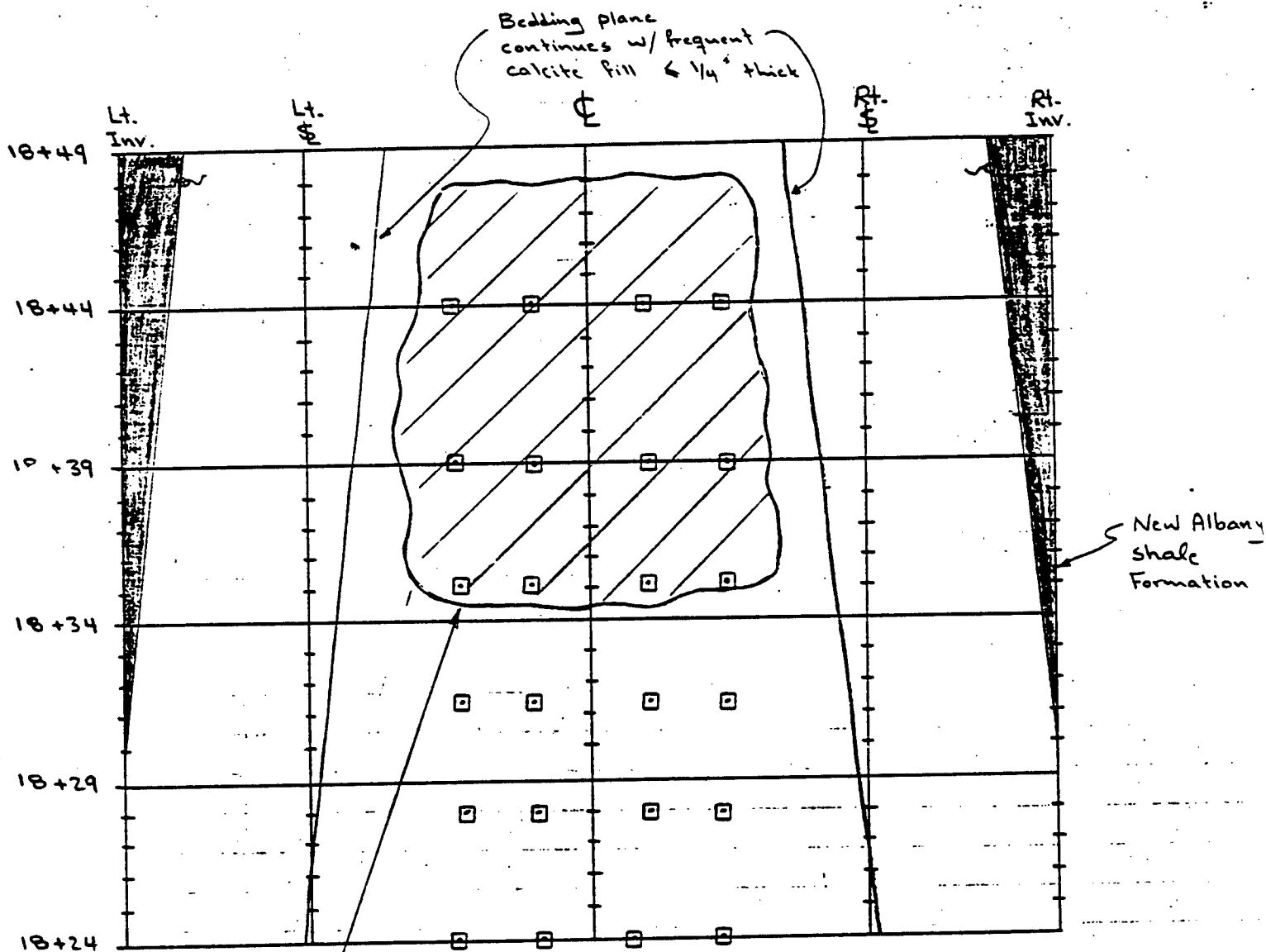
LACHEL & Associates, Inc.
Geologists, Engineers

Project <u>UTP</u>	Computed	Date
Subject	Checked	Date
Task	Sheet <u>70</u>	Of <u>72</u>



LACHEL & Associates, Inc.
Geologists, Engineers

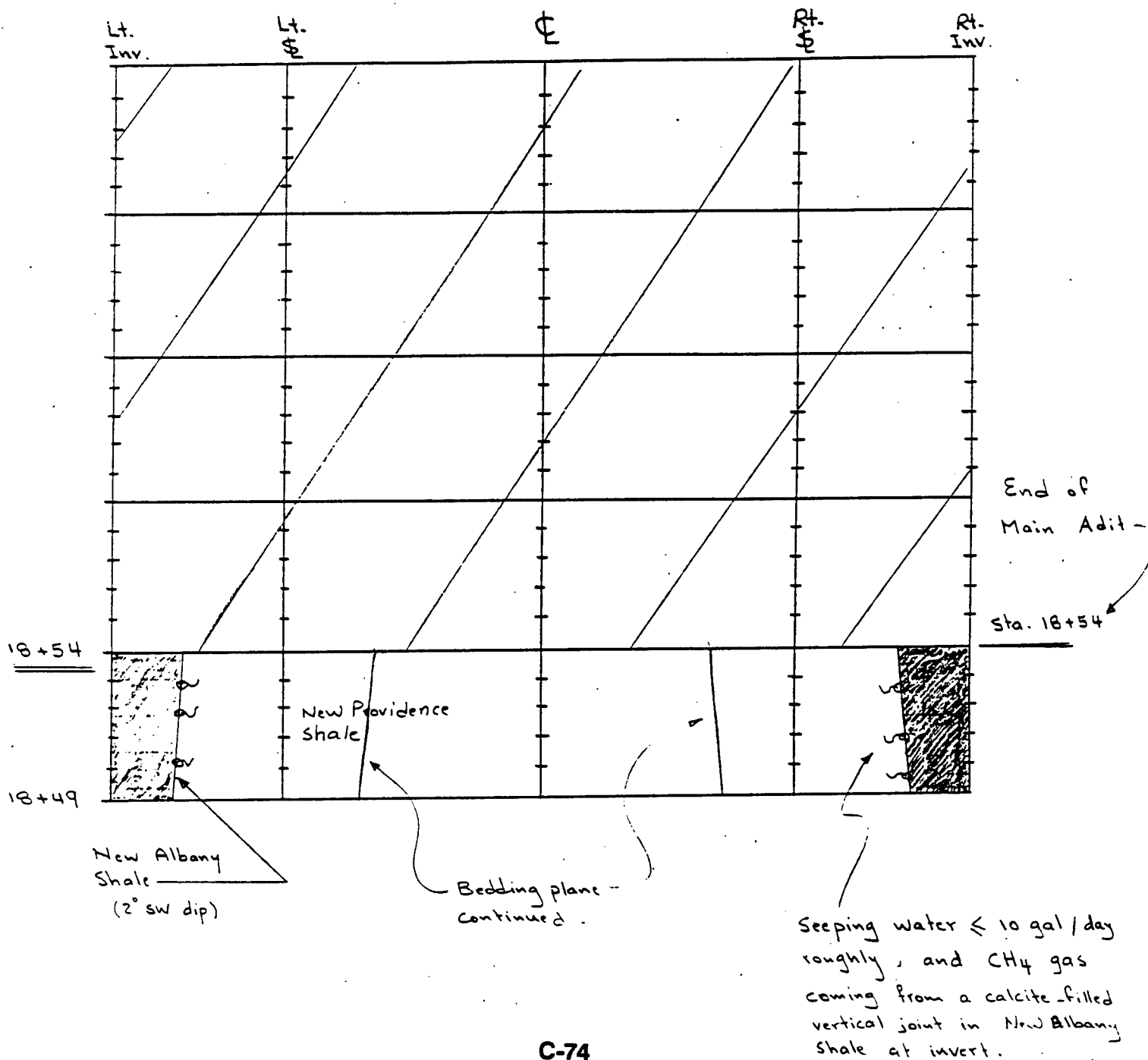
Project <u>UTP</u>	Computed	Date
Subject	Checked	Date
Task	Sheet <u>71</u>	Of <u>72</u>



Spalling rock slab, 4'-8" thick
fell due to long period of shale
exposure to air (> 7 days) without
shotcreting, Resulted in flat crown.

LACHEL & Associates, Inc.
Geologists, Engineers

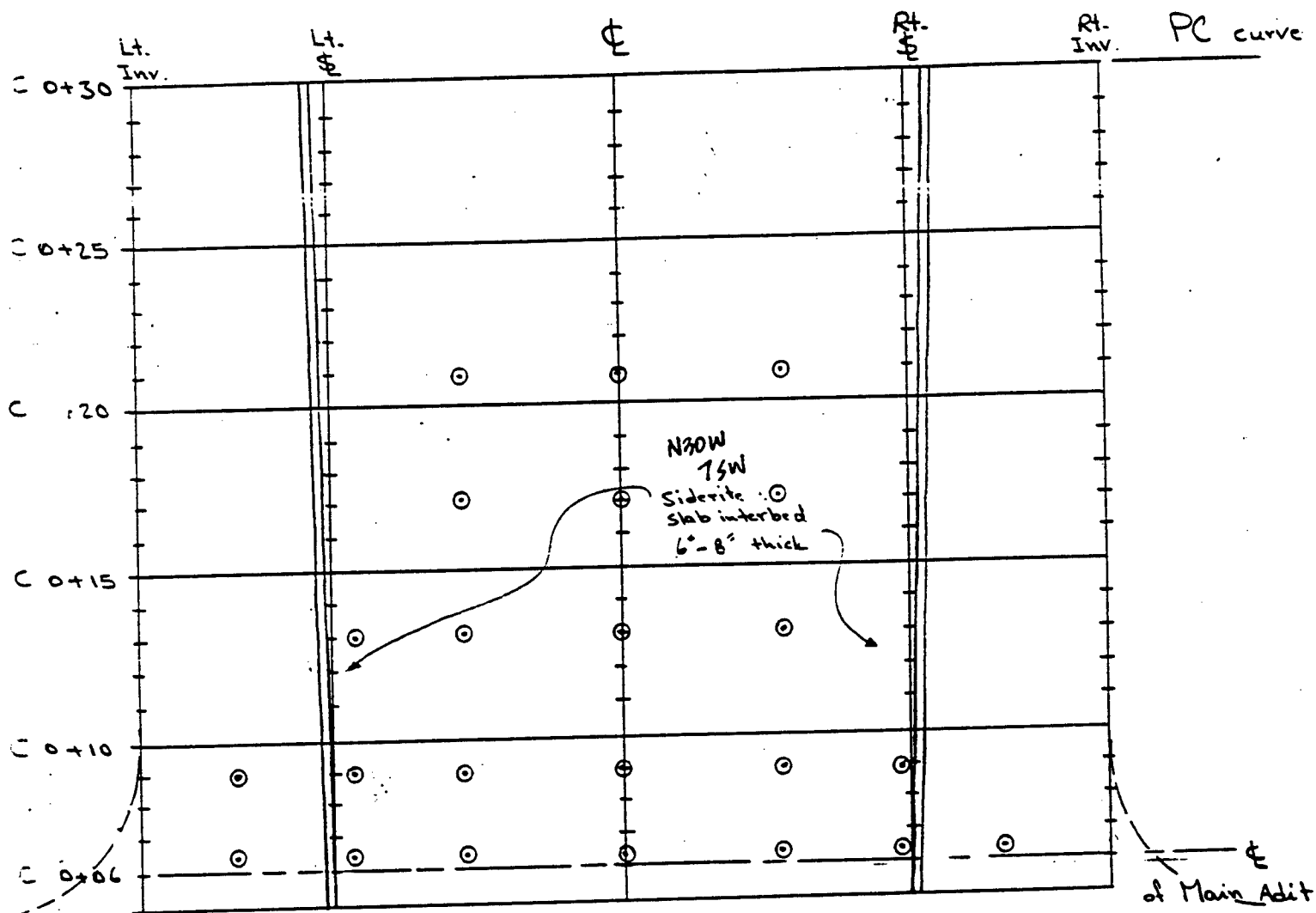
Project <u>UTP</u>	Computed	Date
Subject	Checked	Date
Task	Sheet <u>72</u>	Of <u>72</u>



LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed		Date	
Subject	Geological Mapping of Calib. Adit	Checked		Date	
Task	Rock Type: New Providence shale	Sheet	1	Of	21

Massive Rock

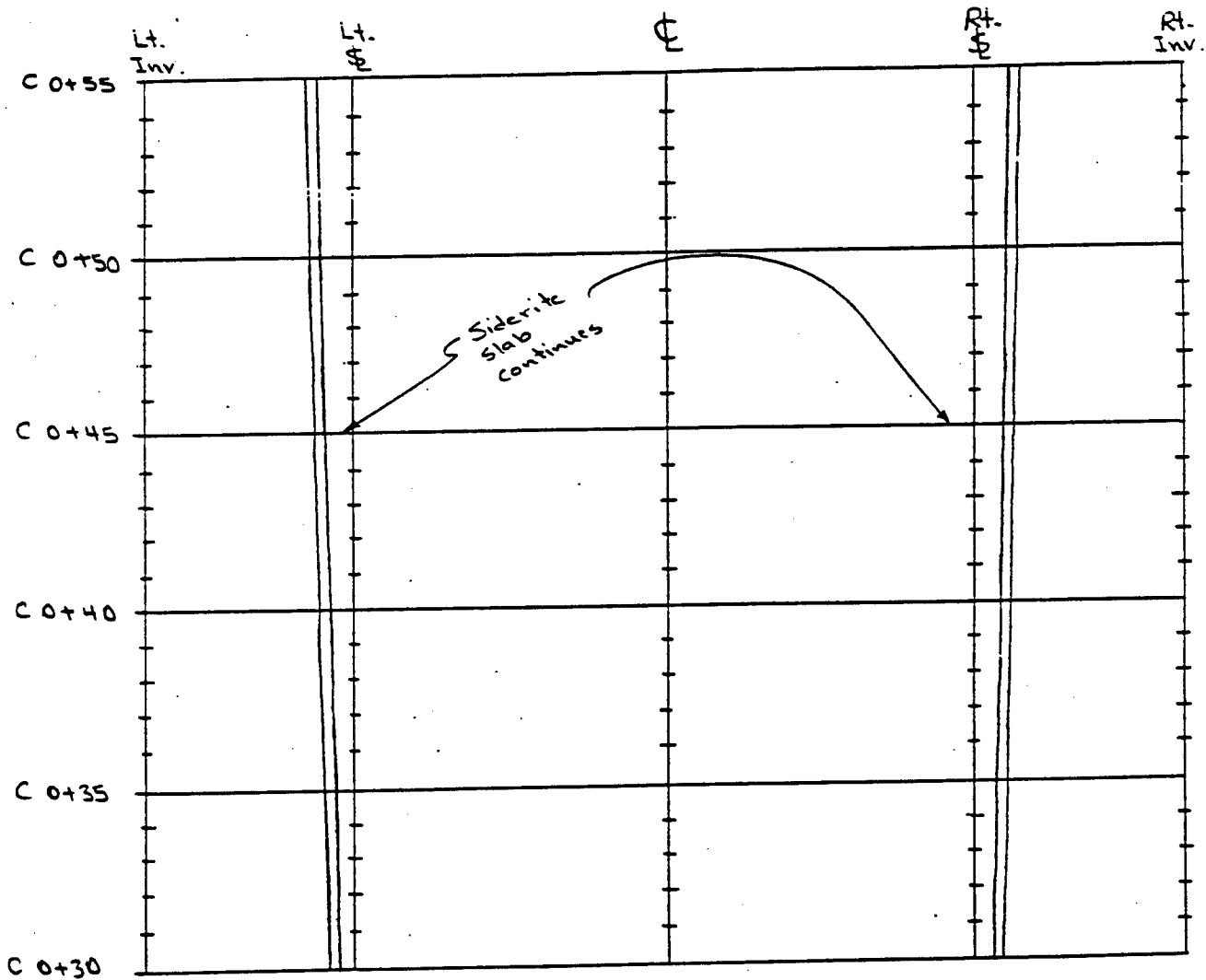


* Start station of Calibration Adit is C 0+00 @ center of Main Adit @ Sta. 16+00

* Cal. Adit has a curve ; Curve #2 PC Sta. C 0+30
PT Sta. C 1+34.61

LACHEL & Associates, Inc.
Geologists, Engineers

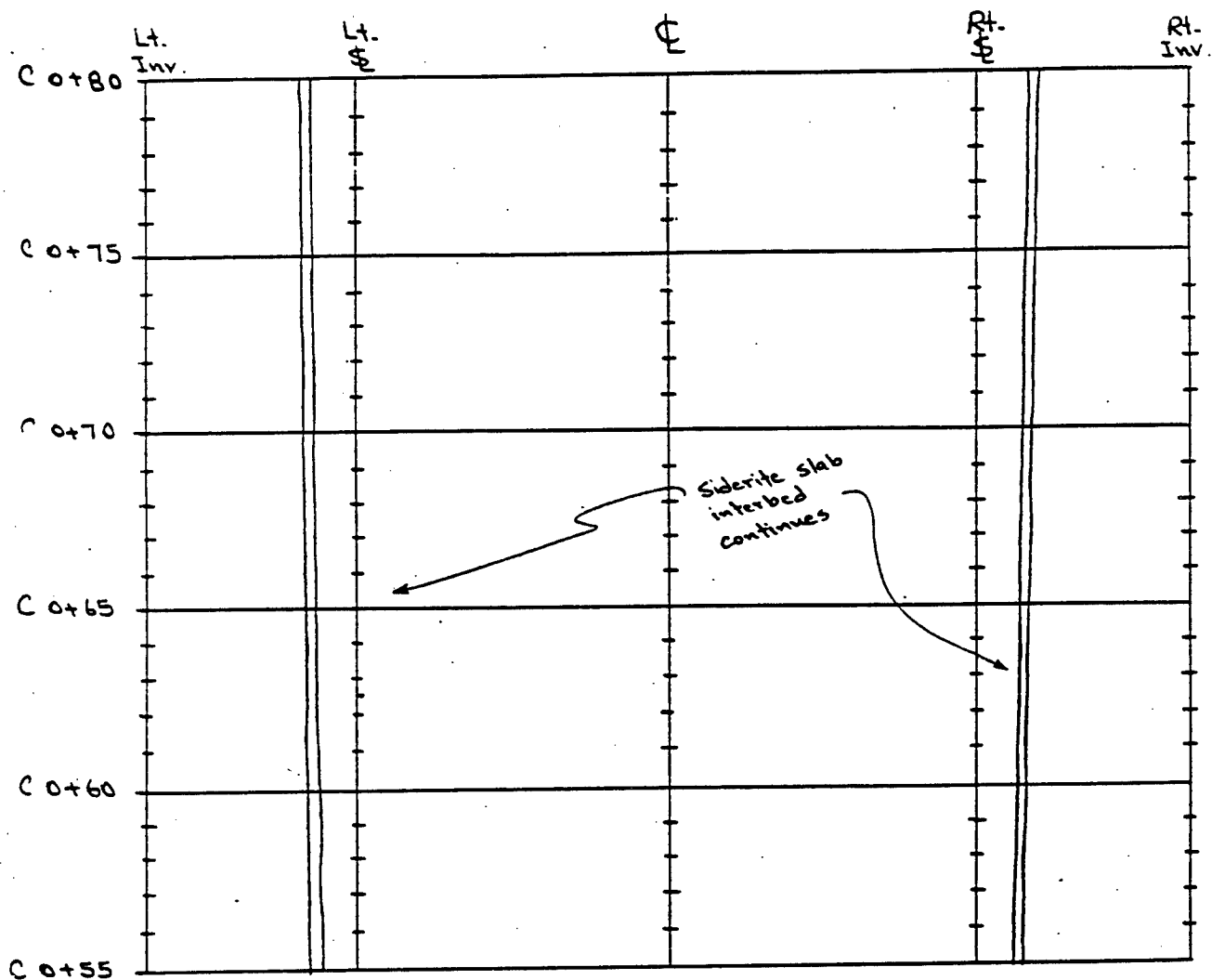
Project	UTP	Computed	Date
Subject	Geo. Mapping - Cal. Adit	Checked	Date
Task		Sheet 2	Of 21



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

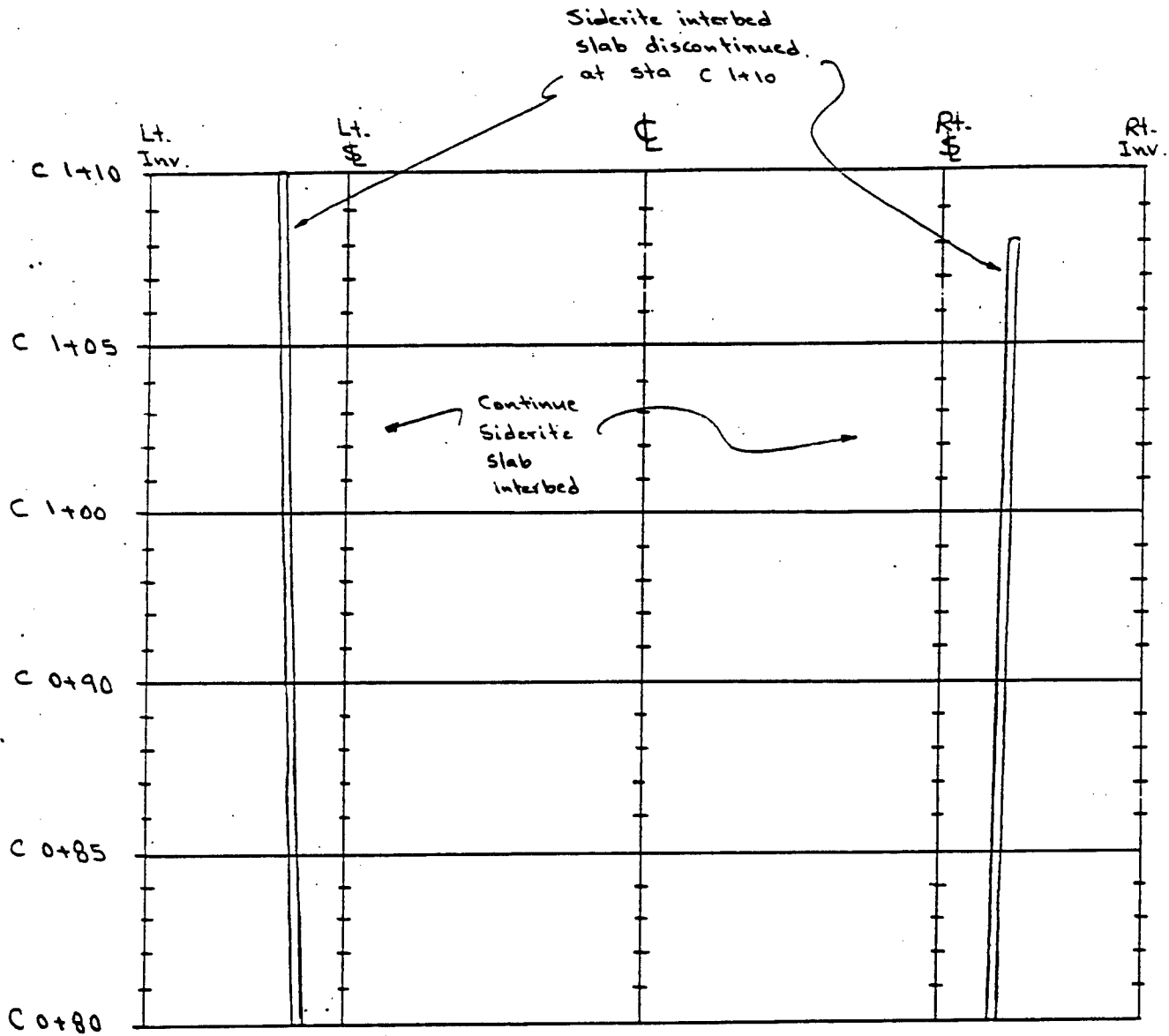
Project <u>UTP</u>	Computed	Date
Subject <u>Cal. Adit</u>	Checked	Date
Task	Sheet <u>3</u>	Of <u>21</u>



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject	Cal. Adit	Checked	Date
Task		Sheet 4	Of 21



LACHEL & Associates, Inc.
Geologists, Engineers

Project <u>UTP</u>	Computed _____	Date _____
Subject <u>Cal. Adit</u>	Checked _____	Date _____
Test Rock: <u>New Providence Shale</u>	Sheet <u>5</u>	Of <u>21</u>

PT of curve @
Sta. C 1+34.62

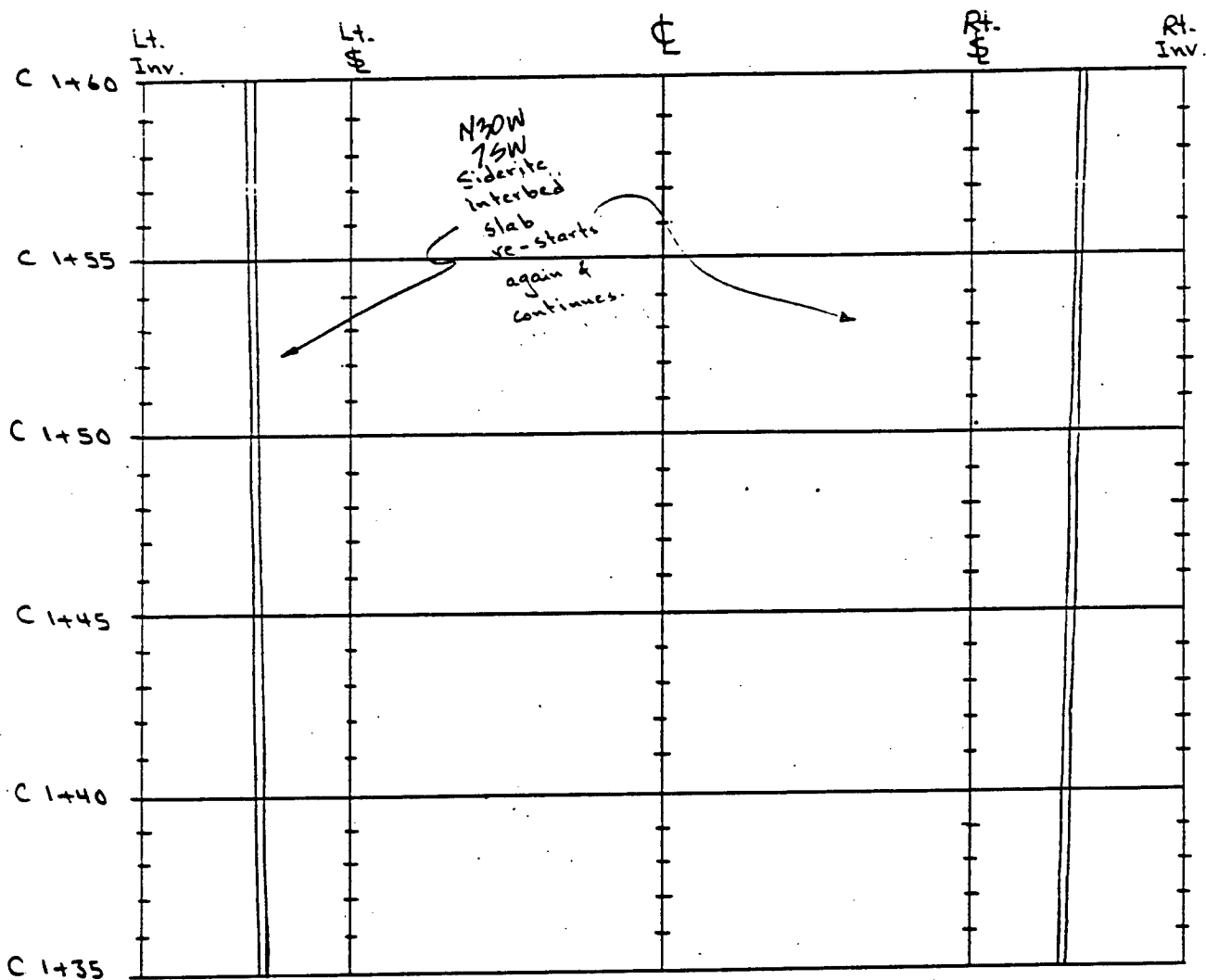
	Lt. Inv.	Lt. §	¢	Rt. §	Rt. Inv.
C 1+35					
C 1+30					
C 1+25					
C 1+20					
C 1+15					
C 1+10					

PT c

Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed		Date	
Subject	Cal. Adit	Checked		Date	
Task		Sheet	6	Of	21

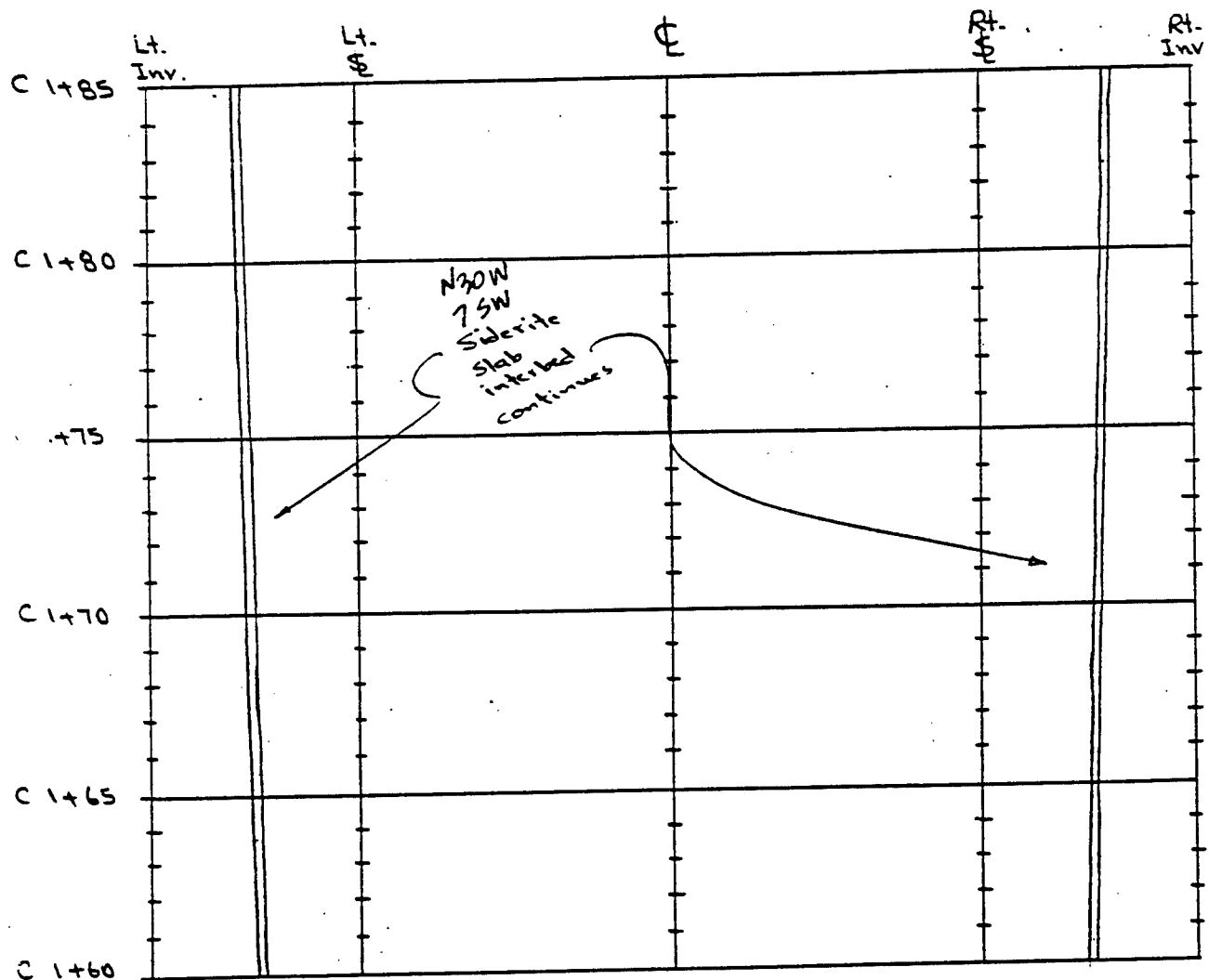


Massive Rock

* Sta. C 1+34.62 - Sta. C 5+24 (End of Cal. Adit)
Orientation of Cal. Adit = 335° (Running Parallel
to Main Adit)

LACHEL & Associates, Inc.
Geologists, Engineers

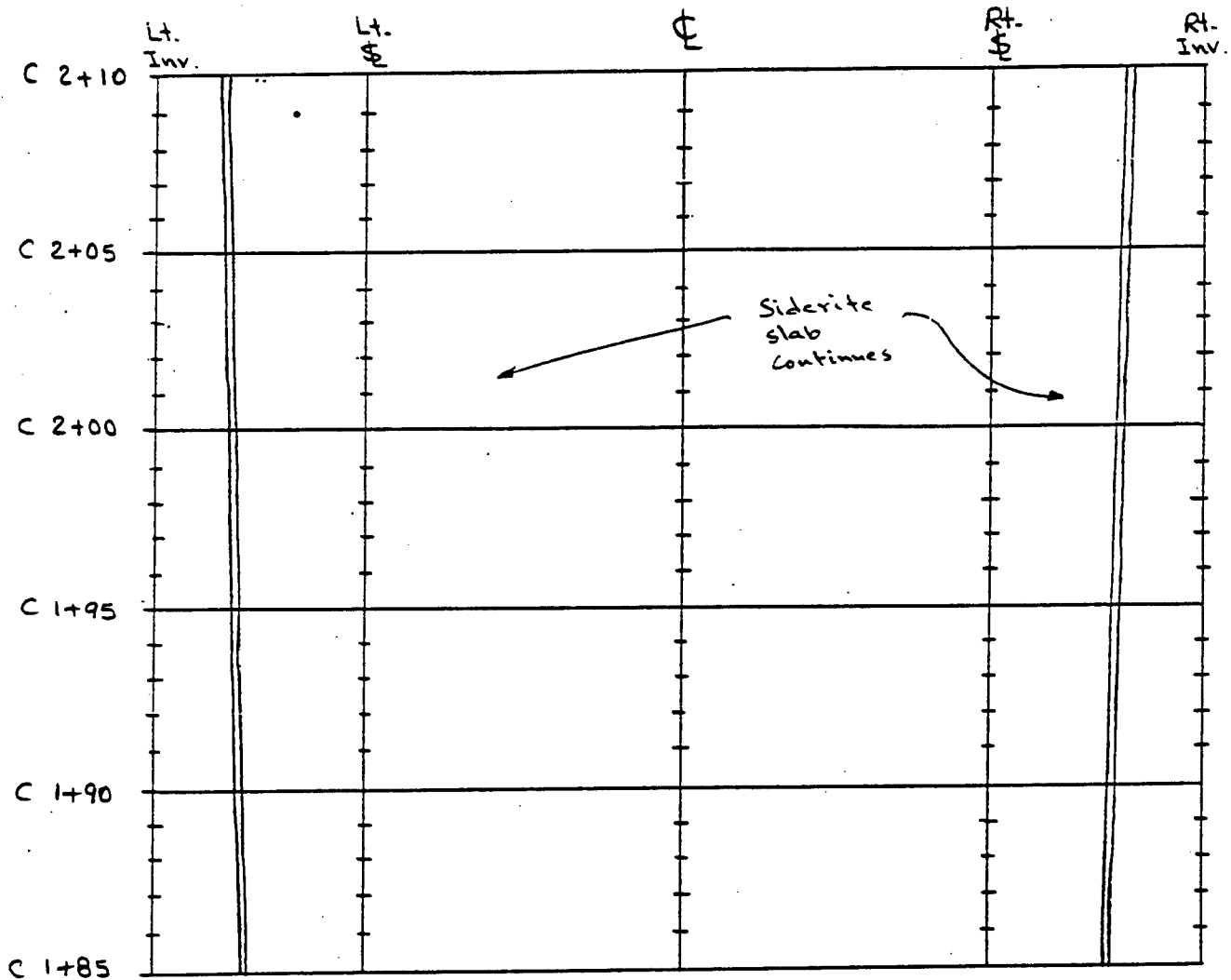
Project <u>UTP</u>	Computed	Date
Subject <u>Cal. Adit</u>	Checked	Date
Task	Sheet <u>7</u>	Of <u>21</u>



Massive Rock

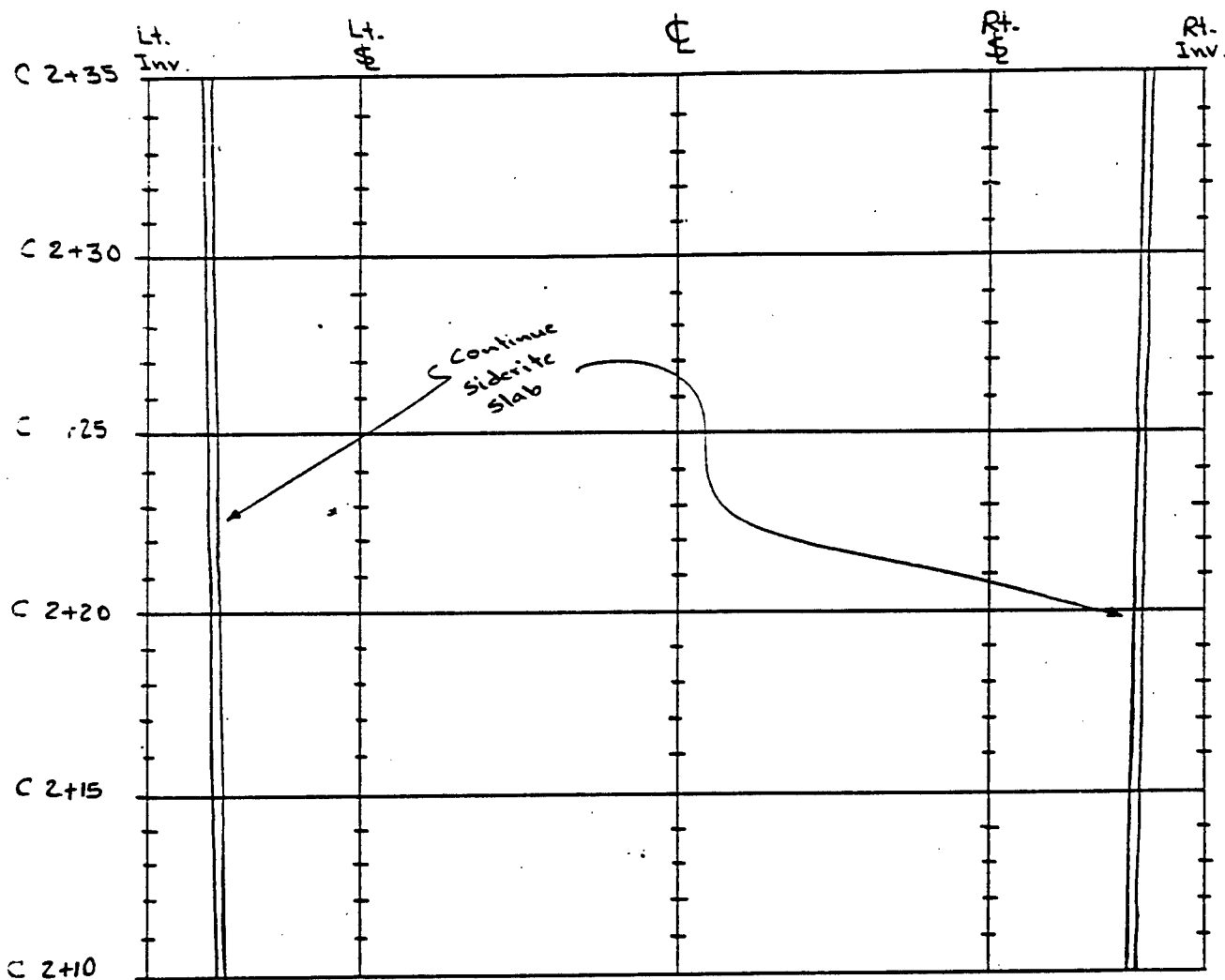
LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject	Cal. Adit	Checked	Date
Task		Sheet 8	Of 21



LACHEL & Associates, Inc.
Geologists, Engineers

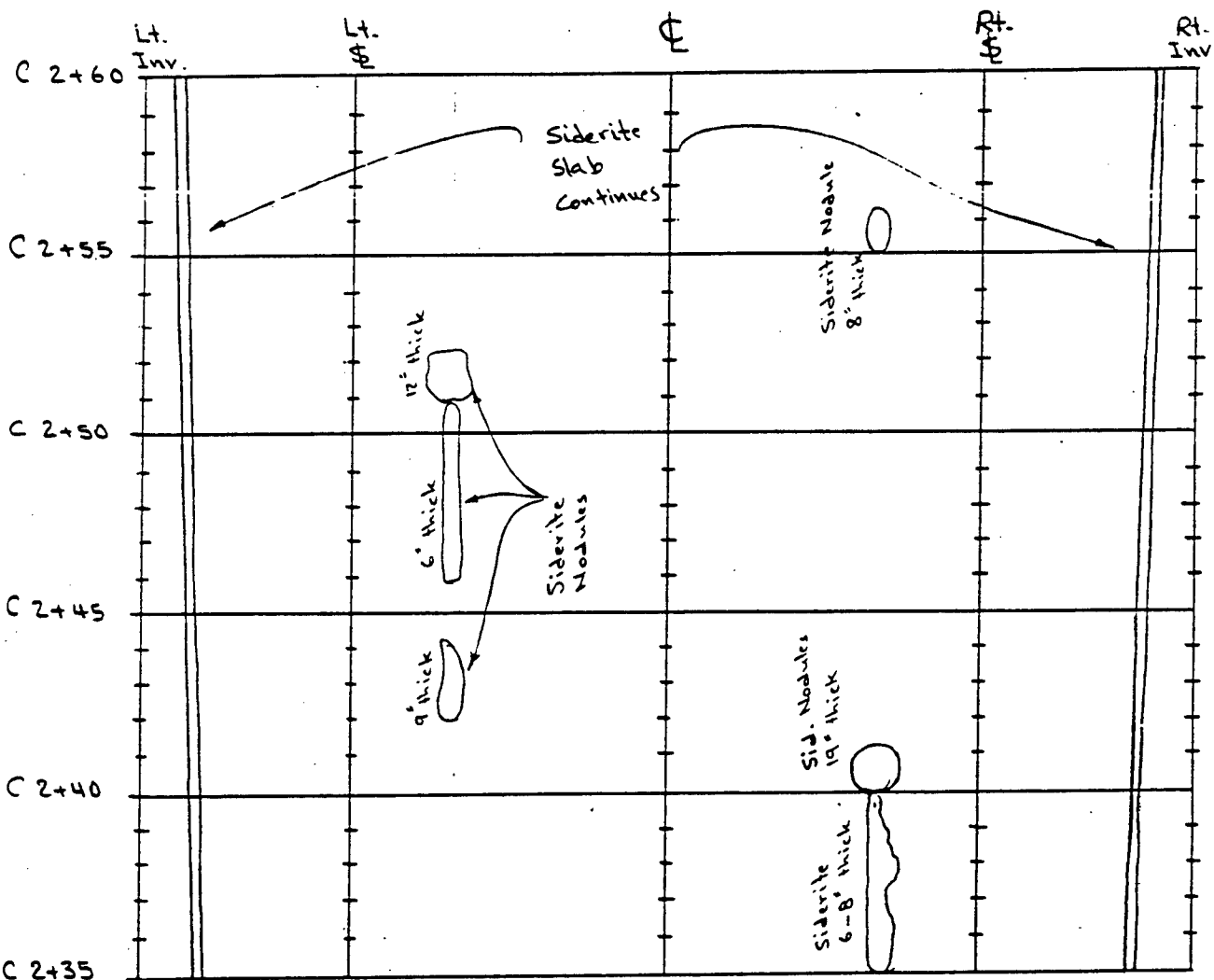
Project	UTP	Computed	Date
Subject	Cal. Adit	Checked	Date
Task		Sheet 9	Of 21



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

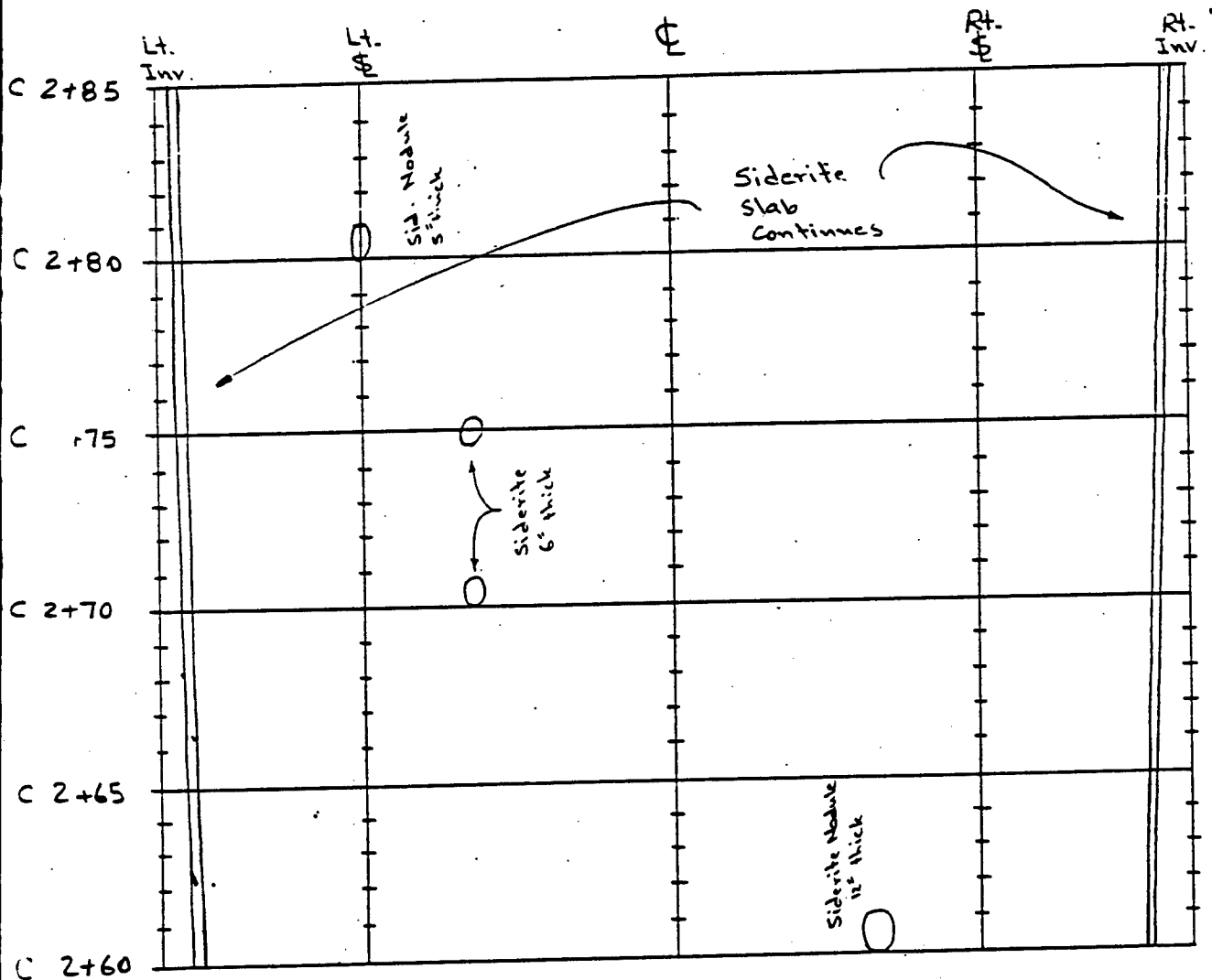
Project	UTP	Computed		Date	
Subject	Cal. Adit	Checked		Date	
Task		Sheet	10	Of	21



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

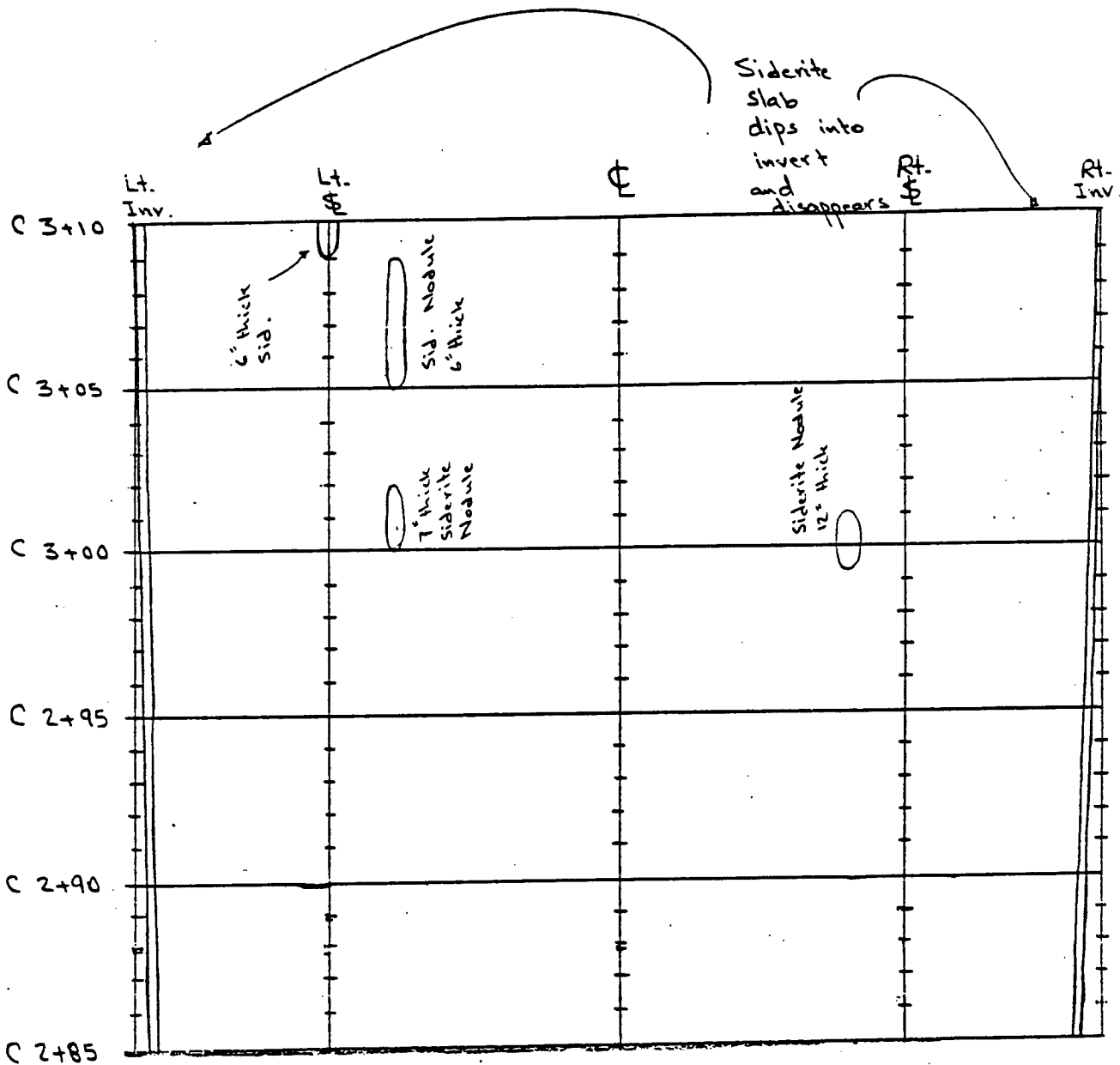
Project <u>UTP</u>	Computed _____	Date _____
Subject _____	Checked _____	Date _____
Task _____	Sheet <u>11</u>	Of <u>21</u>



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

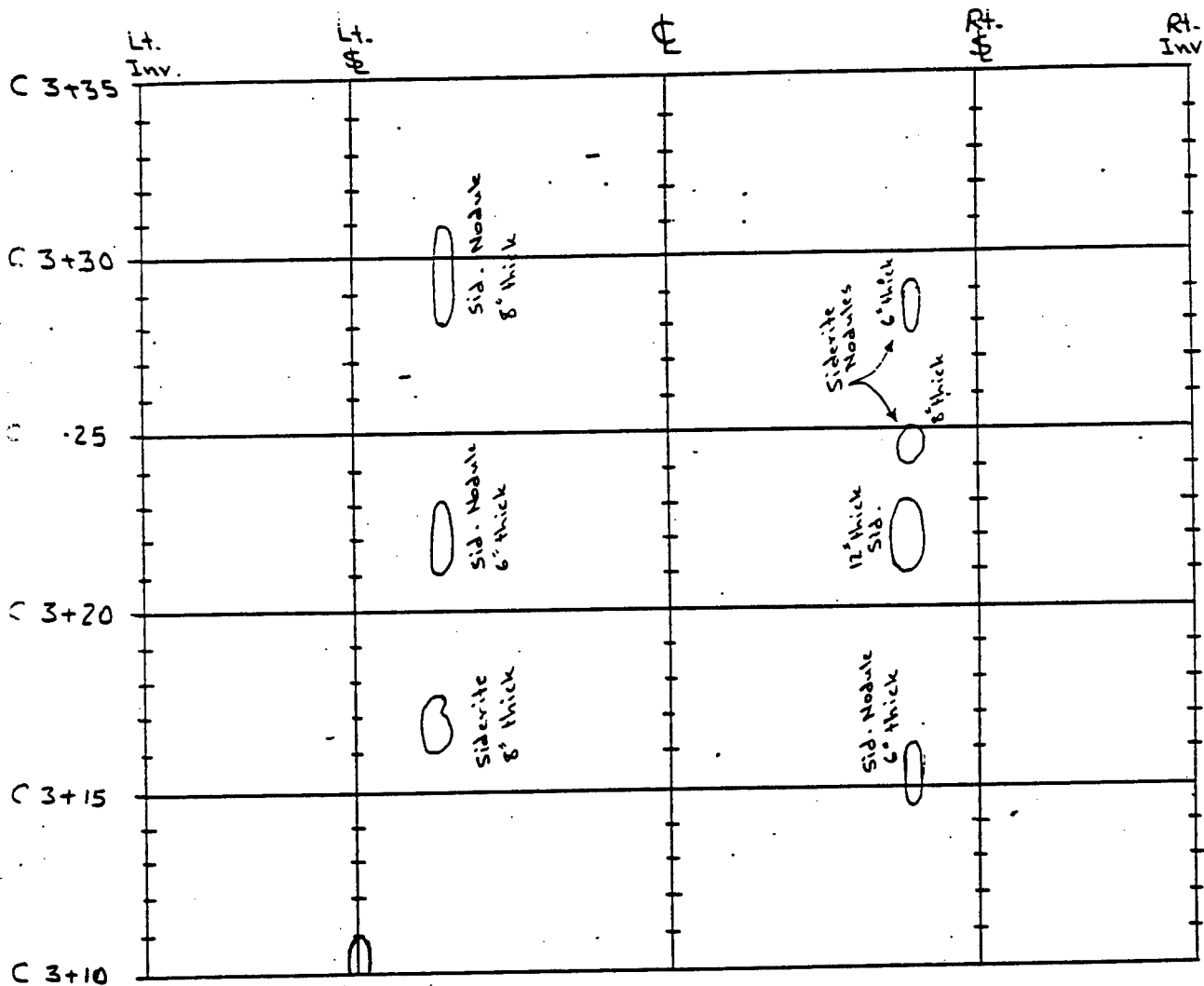
Project <u>UTP</u>	Computed _____	Date _____
Subject <u>Cal. Adit</u>	Checked _____	Date _____
Task _____	Sheet <u>12</u>	Of <u>21</u>



Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project <u>UTP</u>	Computed _____	Date _____
Subject _____	Checked _____	Date _____
Task _____	Sheet <u>13</u>	Of <u>21</u>



Continue
6" Sid.

Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

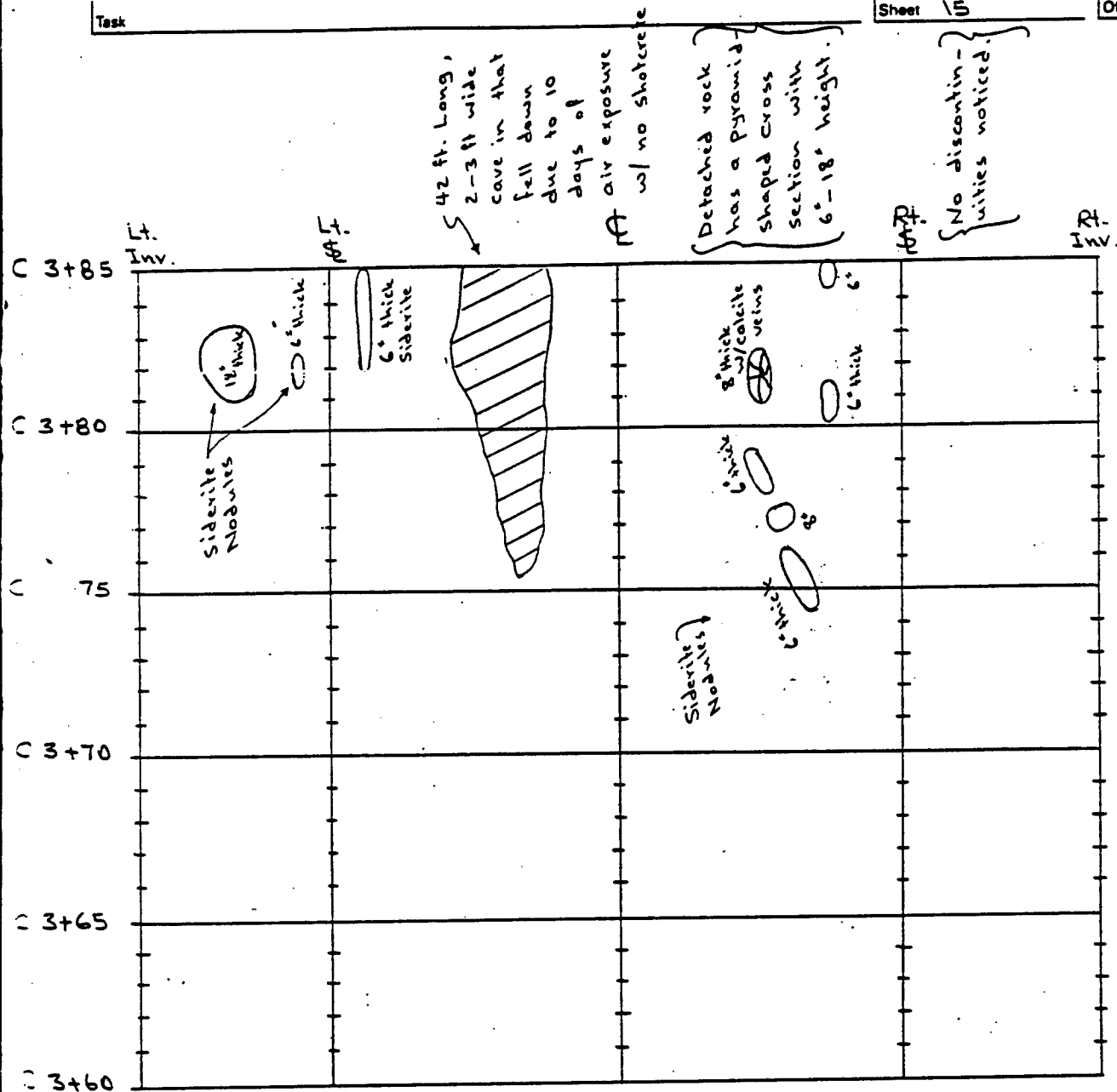
Project <u>UTP</u>	Computed	Date
Subject <u>Cal Adit</u>	Checked	Date
Task	Sheet <u>14</u>	Of <u>21</u>

	Lt. Inv.	Lt. S	C	Rt. S	Rt. Inv.
C 3+60					
C 3+55					
C 3+50					
C 3+45					
C 3+40					
C 3+35					

Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

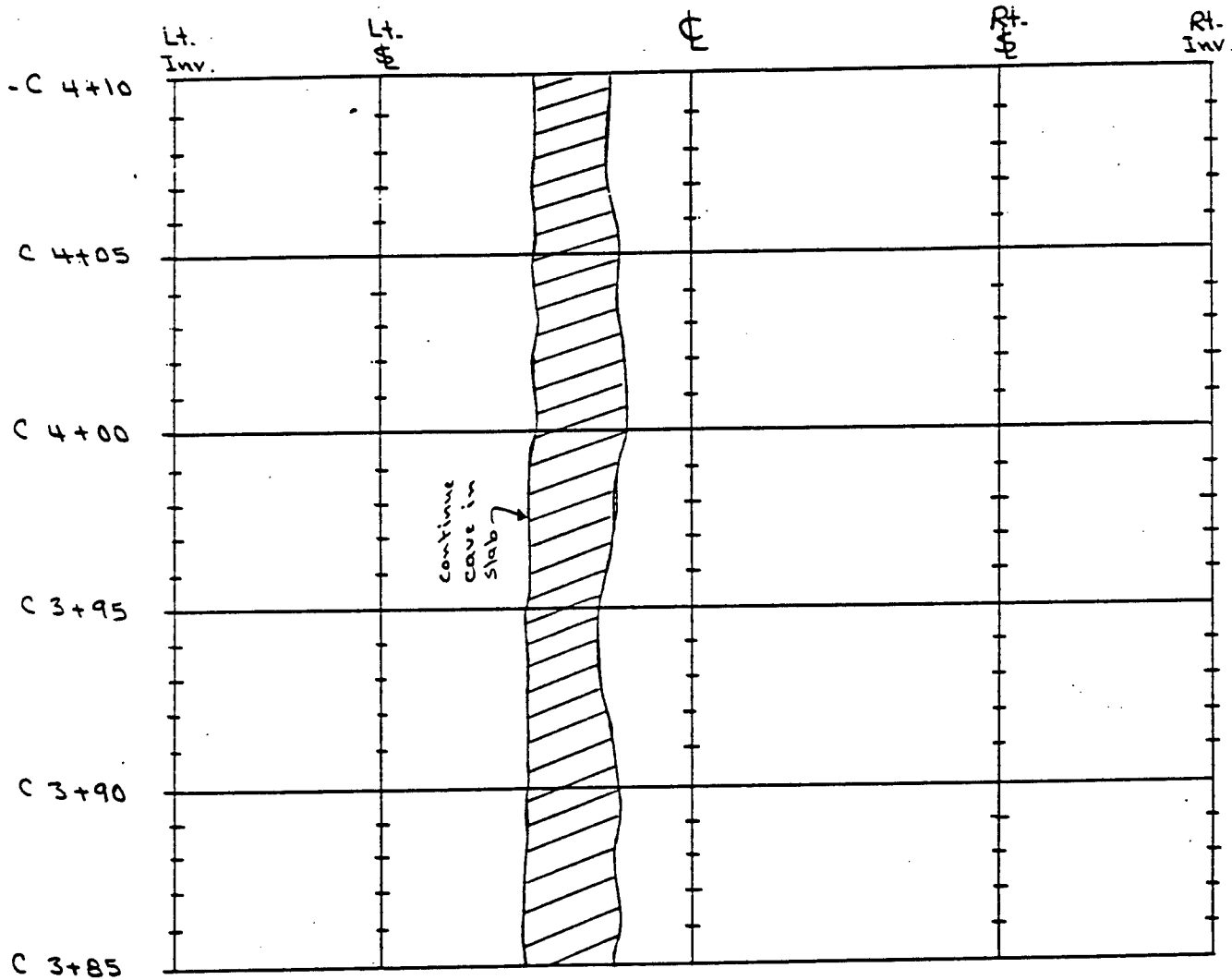
Project	UTP	Computed	Date
Subject	Cal. Adit	Checked	Date
Task		Sheet 15	Of 21



* This cave-in occurred @ one time. Shotcrete liner was @ Sta. C 3+75 and Face @ Sta. C 4+27 when cave-in occurred.

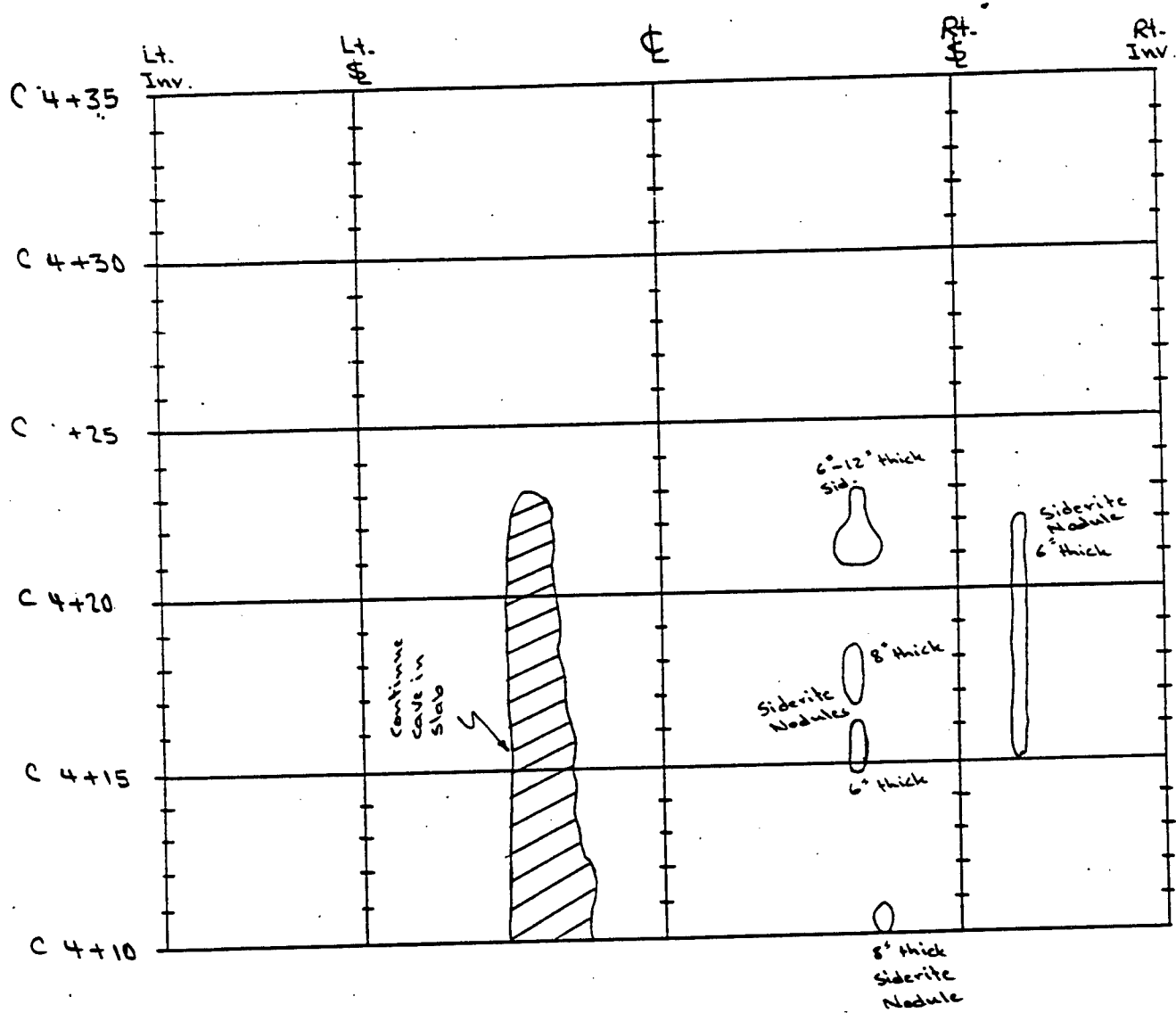
LACHEL & Associates, Inc.
Geologists, Engineers

Project <u>UTP</u>	Computed _____	Date _____
Subject <u>Cal. Adit Geo. Mapping</u>	Checked _____	Date _____
Task _____	Sheet <u>16</u>	Of <u>21</u>



LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject	Cal. Adit	Checked	Date
Task		Sheet 17	Of 21



LACHEL & Associates, Inc.
Geologists, Engineers

Project <u>UTP</u>	Computed	Date
Subject <u>Cal. Adit</u>	Checked	Date
Task	Sheet <u>18</u>	Of <u>21</u>

	Lt. Inv.	Lt. E	E	Rt. E	Rt. Inv.
C 4+60					
C 4+55					
C 4+50					
C 4+45					
C 4+40					
C 4+35					

Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project <u>UTP</u>	Computed _____	Date _____
Subject <u>Cal. Adit</u>	Checked _____	Date _____
Task _____	Sheet <u>19</u>	Of <u>21</u>

	Lt. Inv.	Lt. \$	¢	Rt. \$	Rt. Inv.
C 4+85					
C 4+80					
C 4+75					
C 4+70					
C 4+65					
C 4+60					

Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project <u>UTP</u>	Computed	Date
Subject <u>Cal. Adit</u>	Checked	Date
Task	Sheet <u>20</u>	Of <u>21</u>

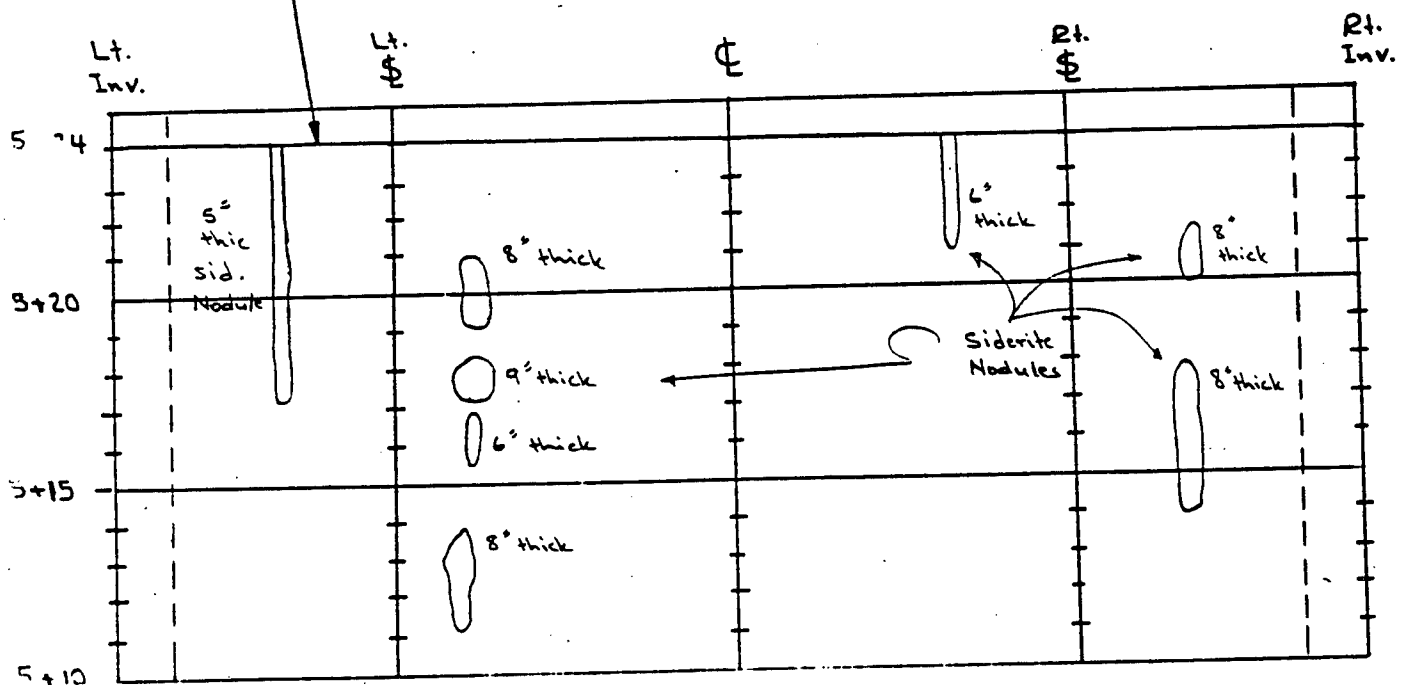
	Lt. Inv.	Lt. Σ	℄	Rt. Σ	Rt. Inv.
C 5+10					
C 5+05					
C 5+00					
C 4+95					
C 4+90					
C 4+85					

Massive Rock

LACHEL & Associates, Inc.
Geologists, Engineers

Project	UTP	Computed	Date
Subject	Cal. Adit - Geological Mapping	Checked	Date
Task	Rock: New Providence Shale	Sheet 21	01 21

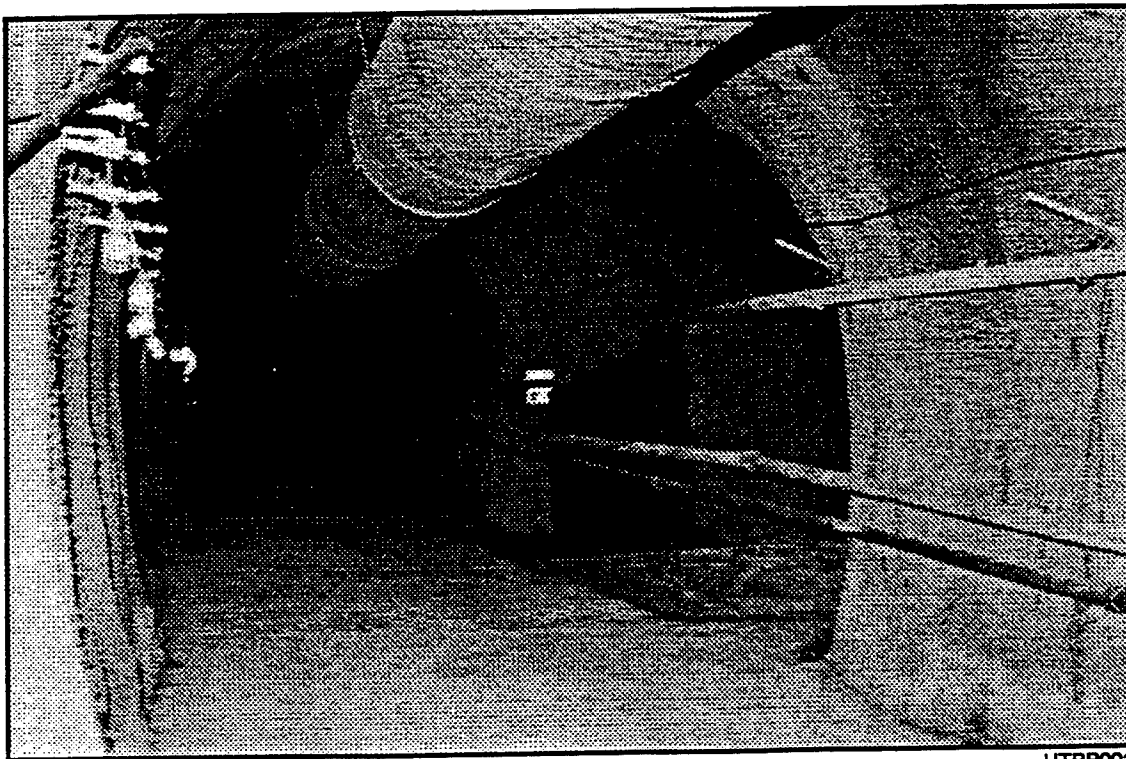
Cal. Adit final heading Sta. @ C 5+24



* Tunnel is wider by 3' from Sta. C5+10 to C5+24

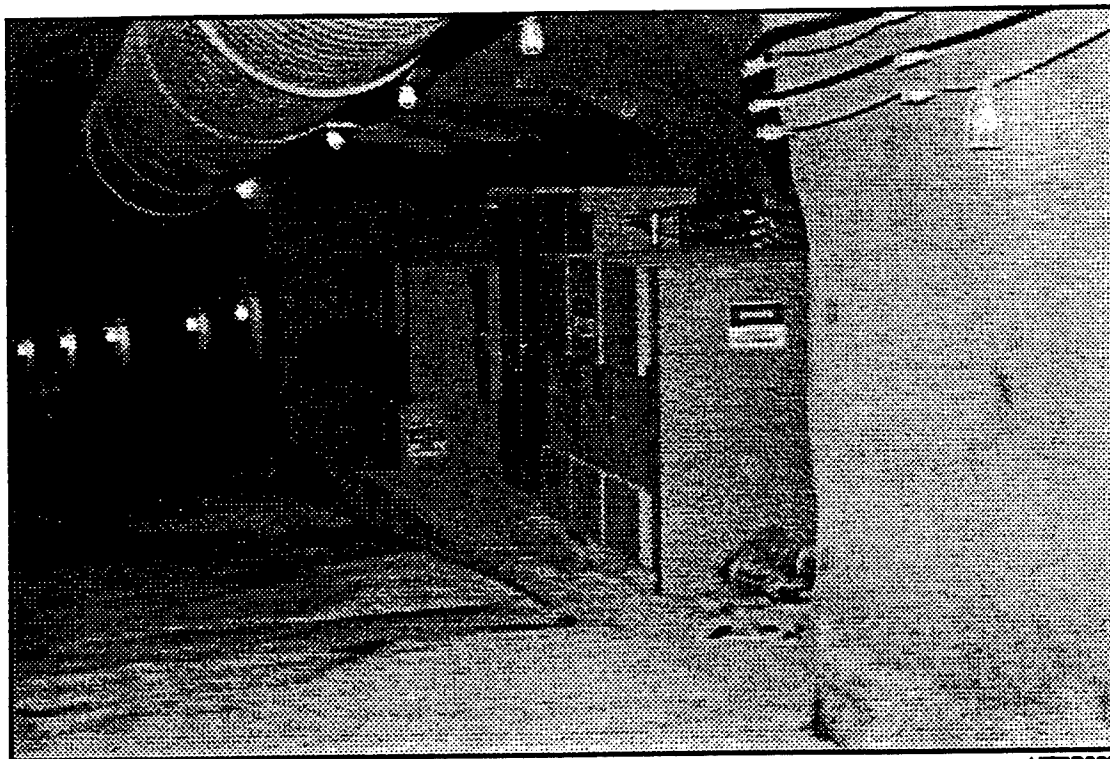
Appendix D

Photographs



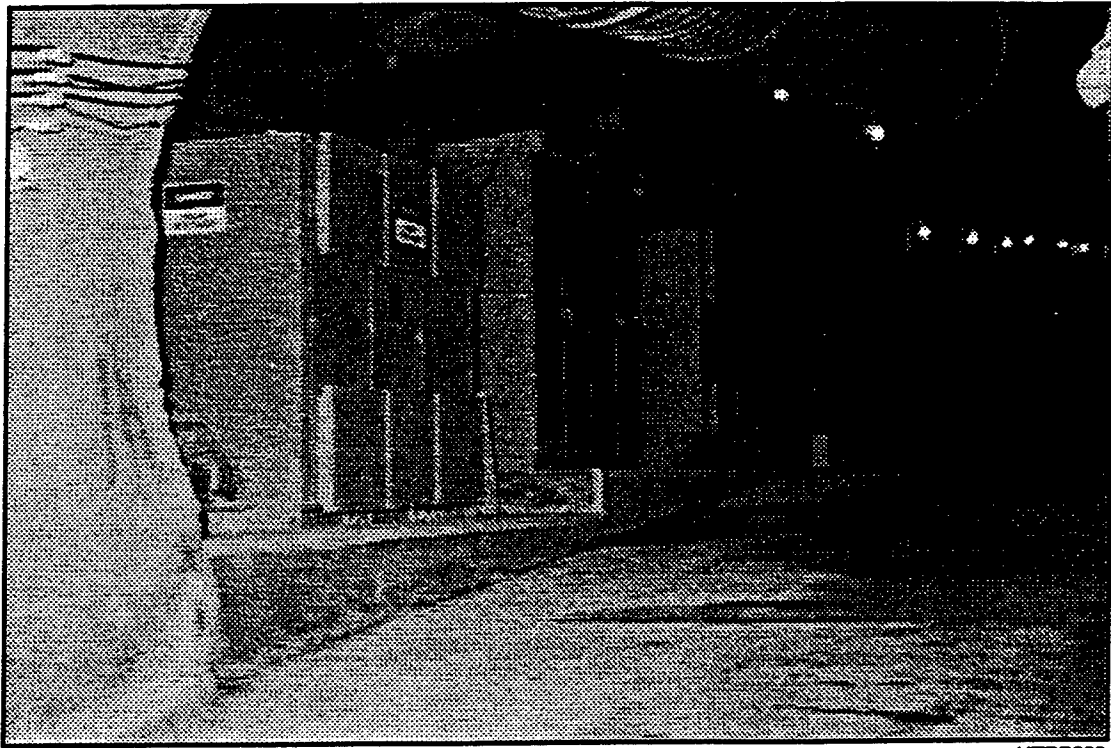
UTPP001

Figure D-1. Sump Bay.



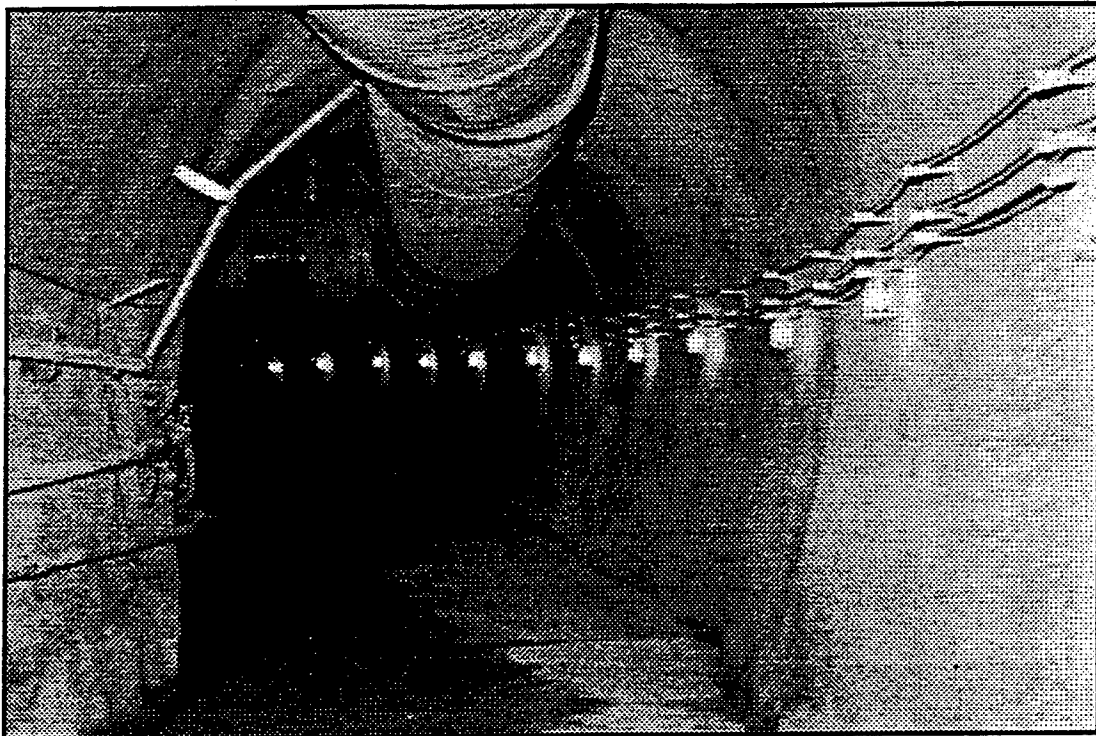
UTPP002

Figure D-2. Transformer bay (looking in).



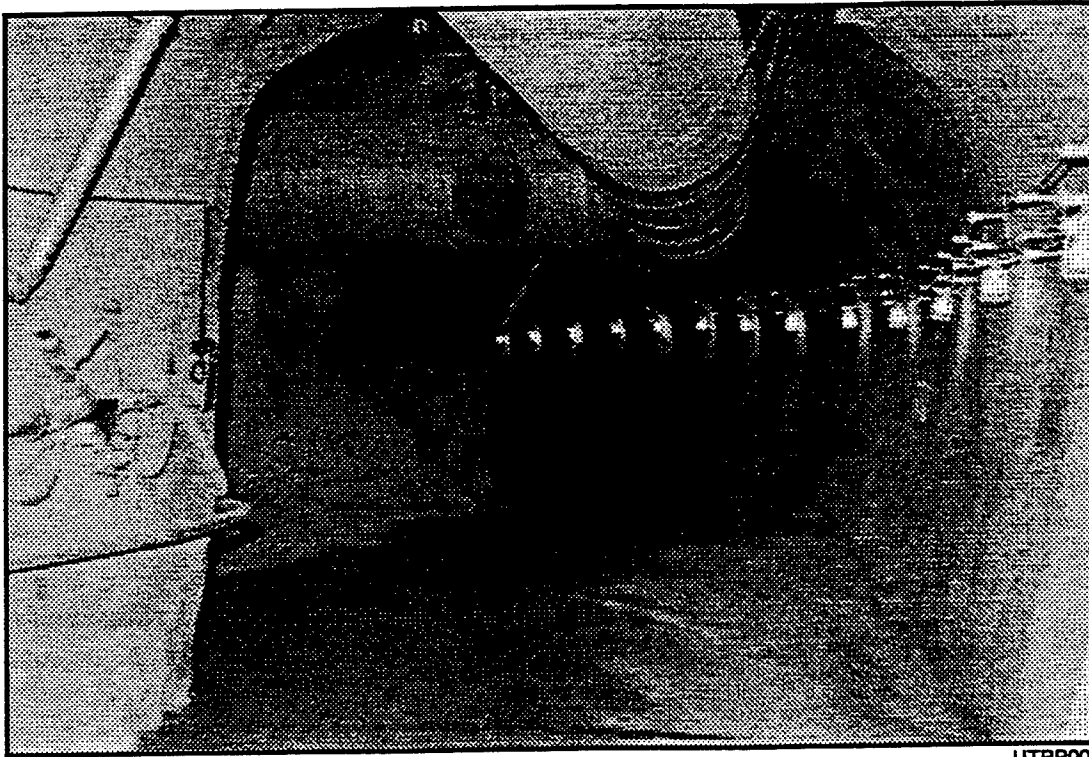
UTPP003

Figure D-3. Transformer Bay.



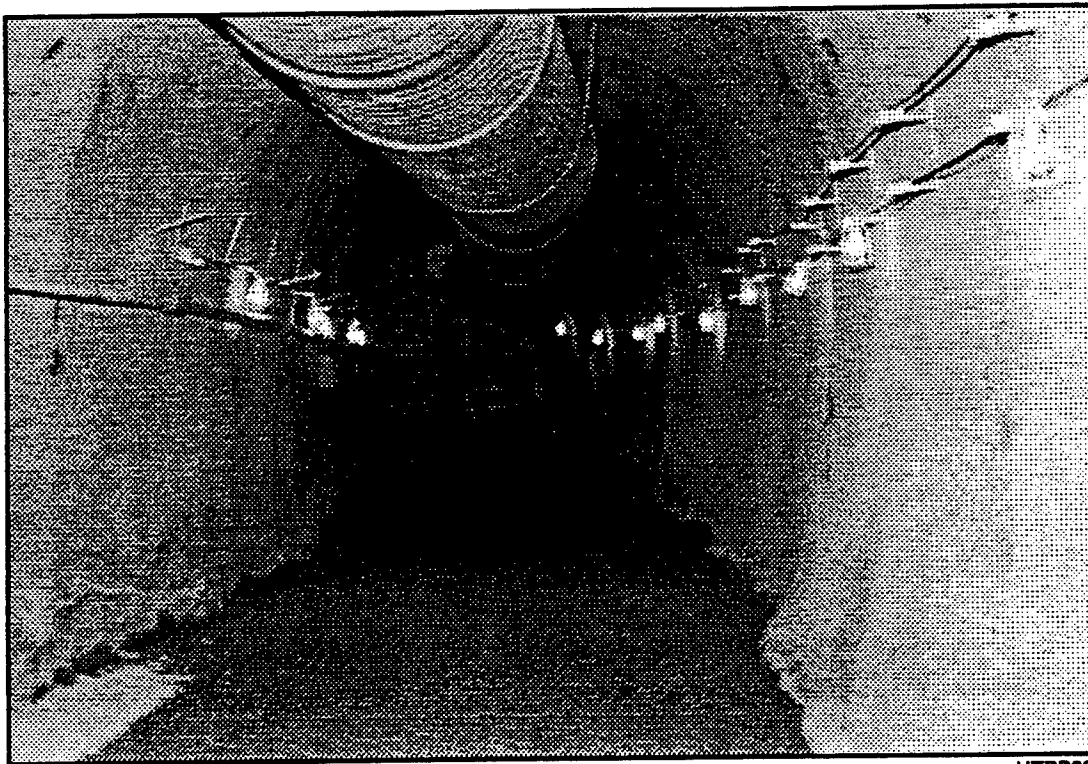
UTPP004

Figure D-4. Intersection (Cal. Adit to Left).



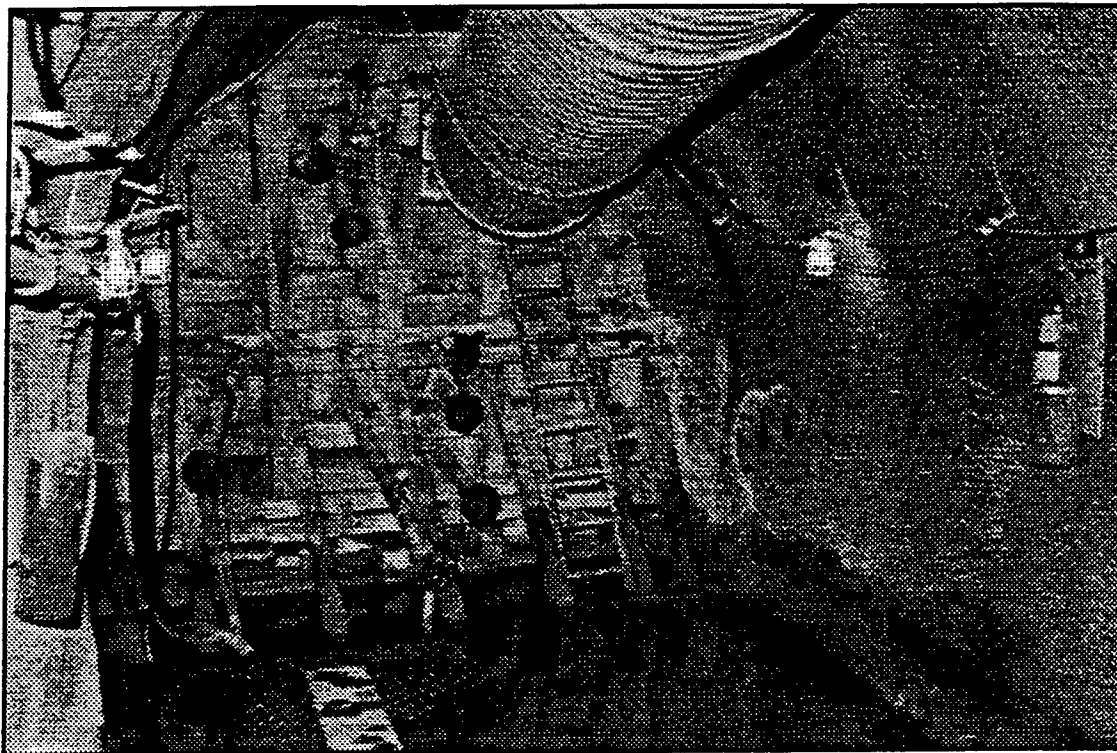
UTPP005

Figure D-5 Intersection (Cal. Adit to Left)



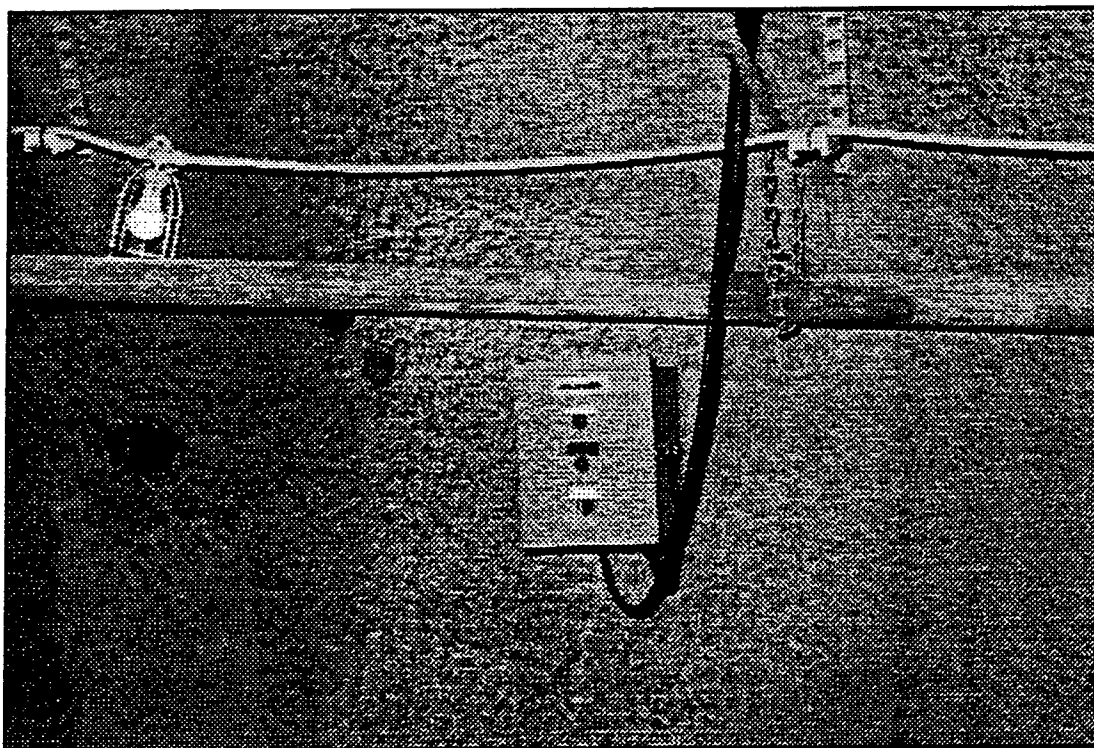
UTPP006

Figure D-6 Test Adit Looking Towards Plug



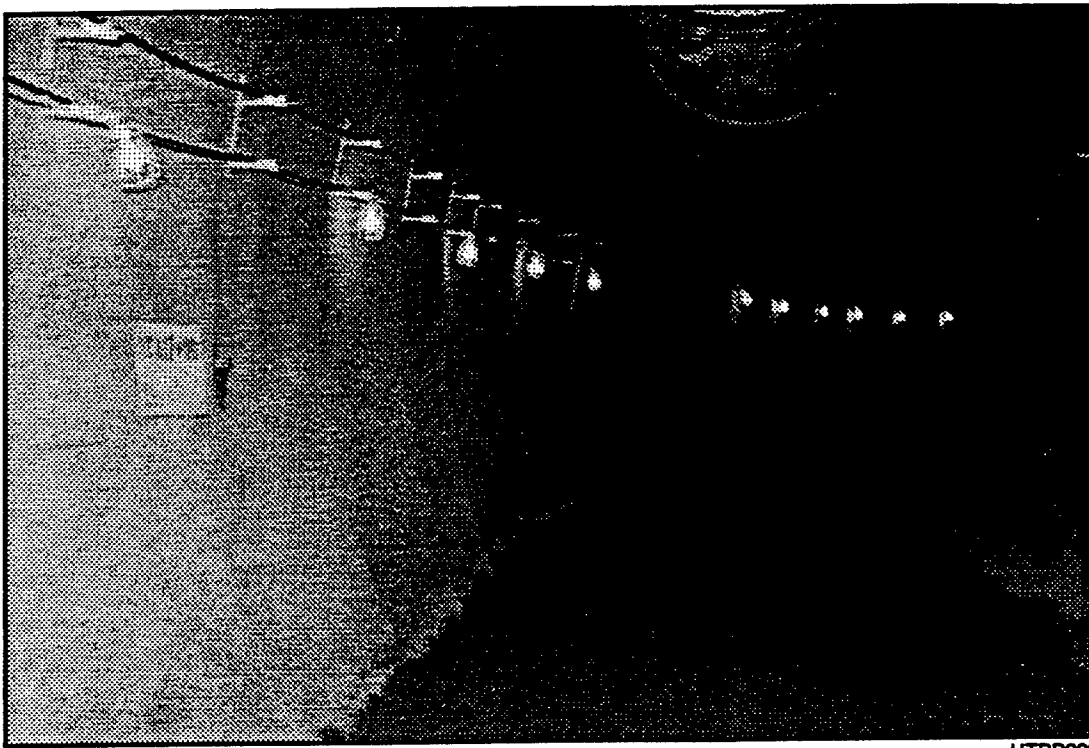
UTPP007

Figure D-7 Plug's Upper Face



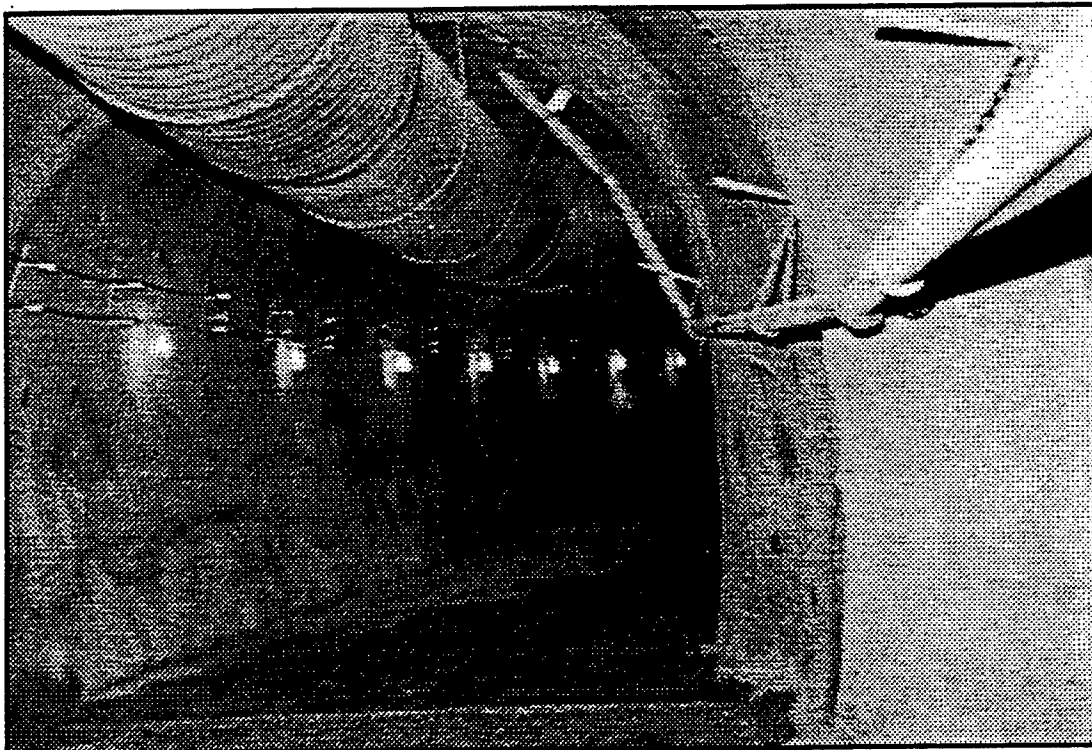
UTPP008

Figure D-8 Typical Electric Switch for Water
Pump at Bulkhead



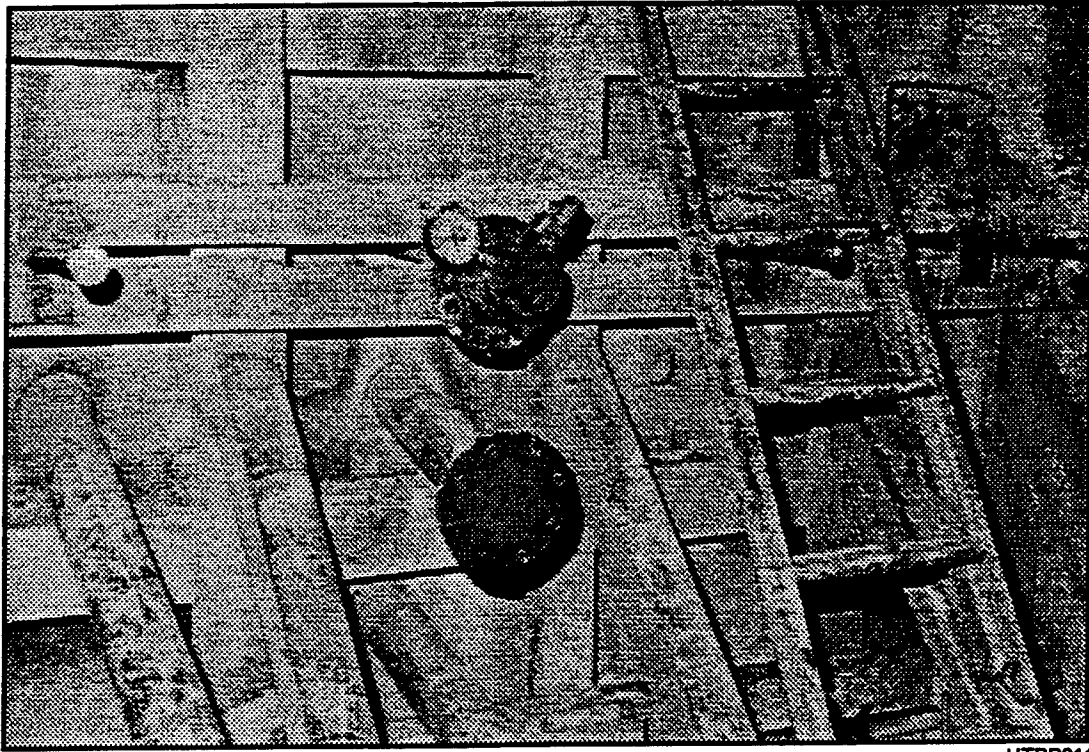
UTPP009

Figure D-9 Test Adit at Sta. 17+00



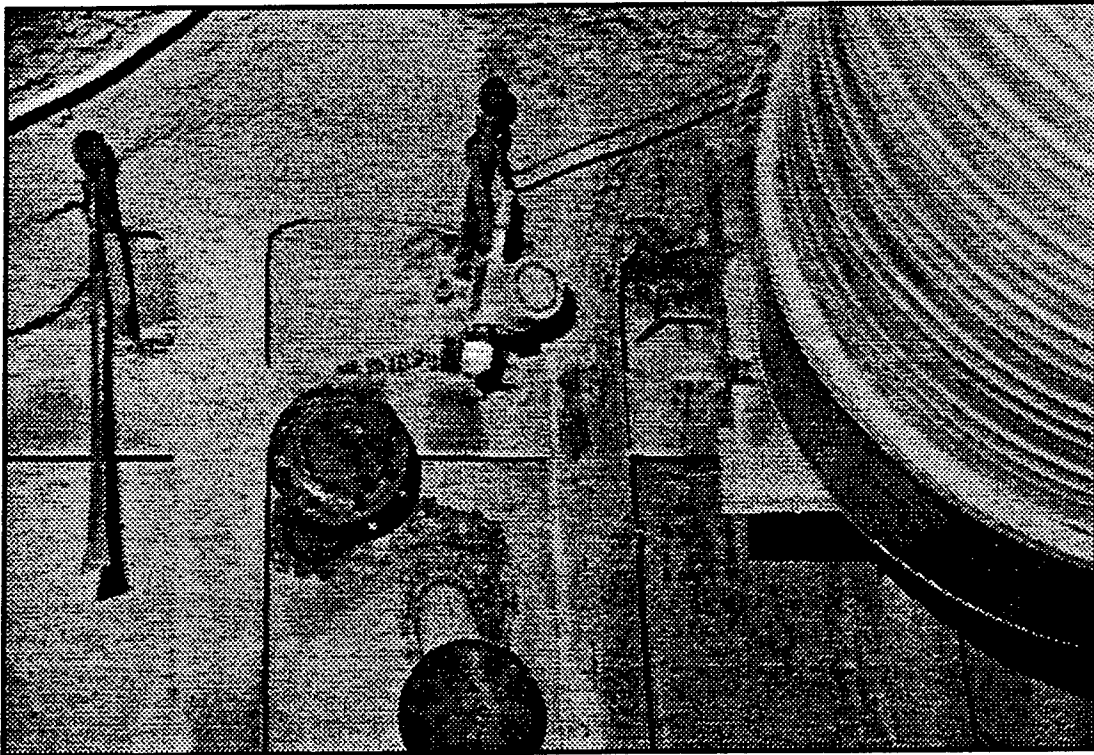
UTPP010

Figure D-10 Test Adit Intersection with Cal. Adit



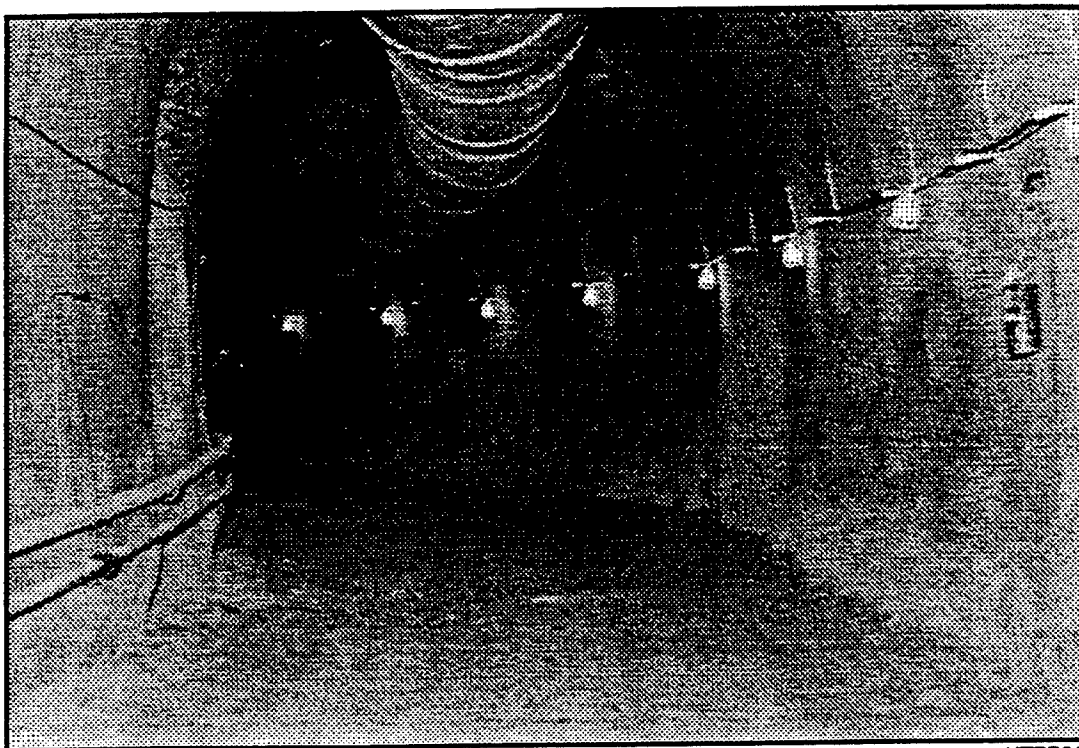
UTPP011

Figure D-11 Plug (Upper Bulkhead with Fill-Bleed Lines Shown)



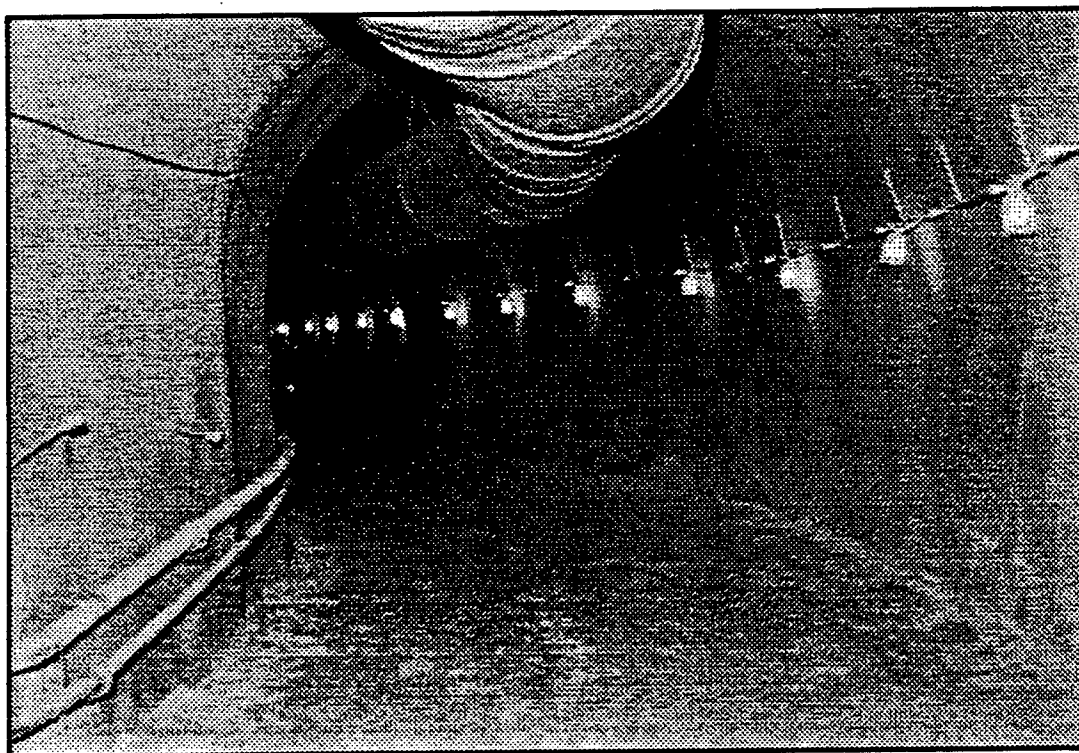
UTPP012

Figure D-12 Gas Monitor at Plug



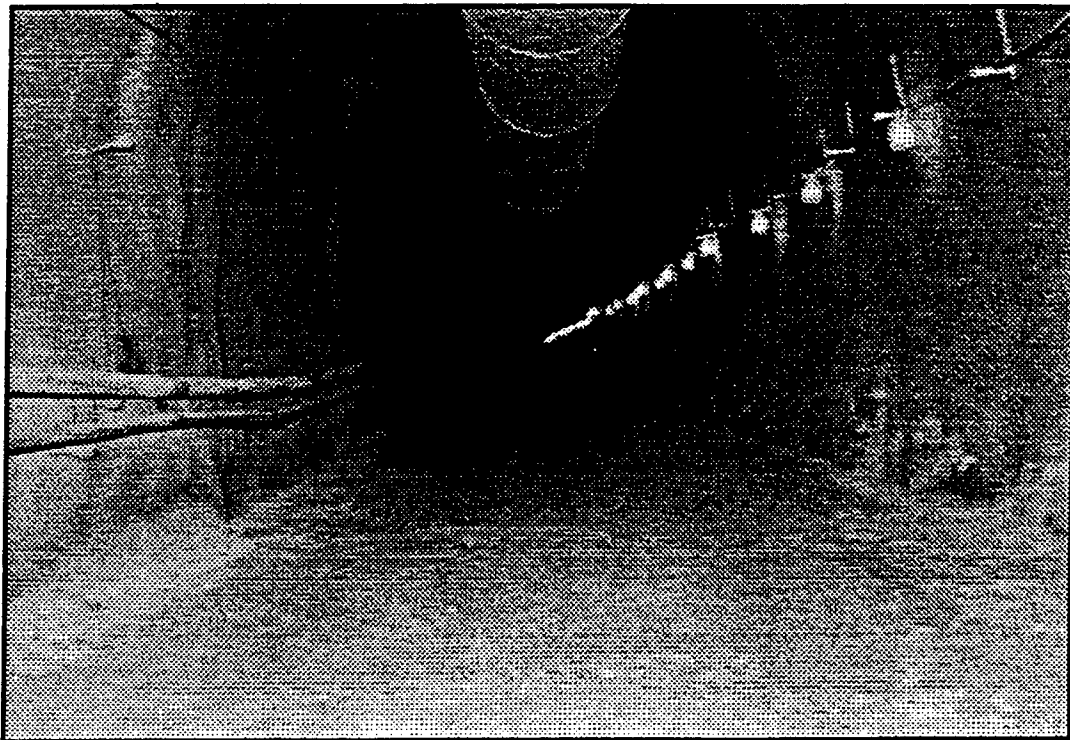
UTPP013

Figure D-13 Cal. Adit (Looking from Intersection)



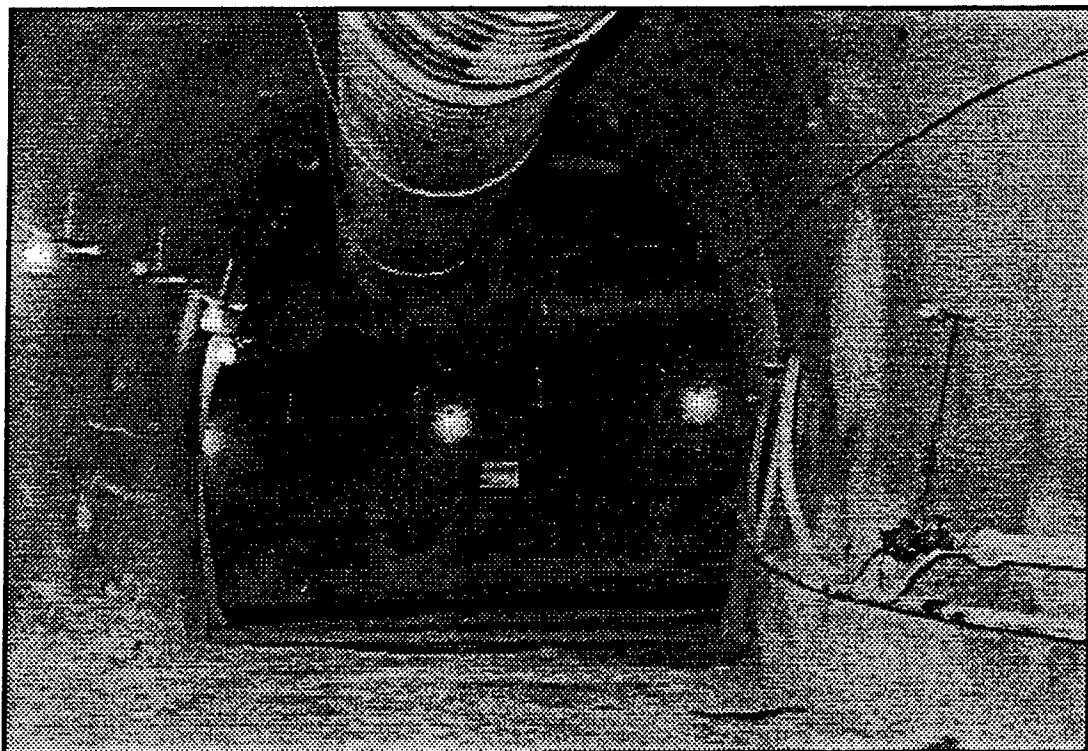
UTPP014

Figure D-14 Cal. Adit



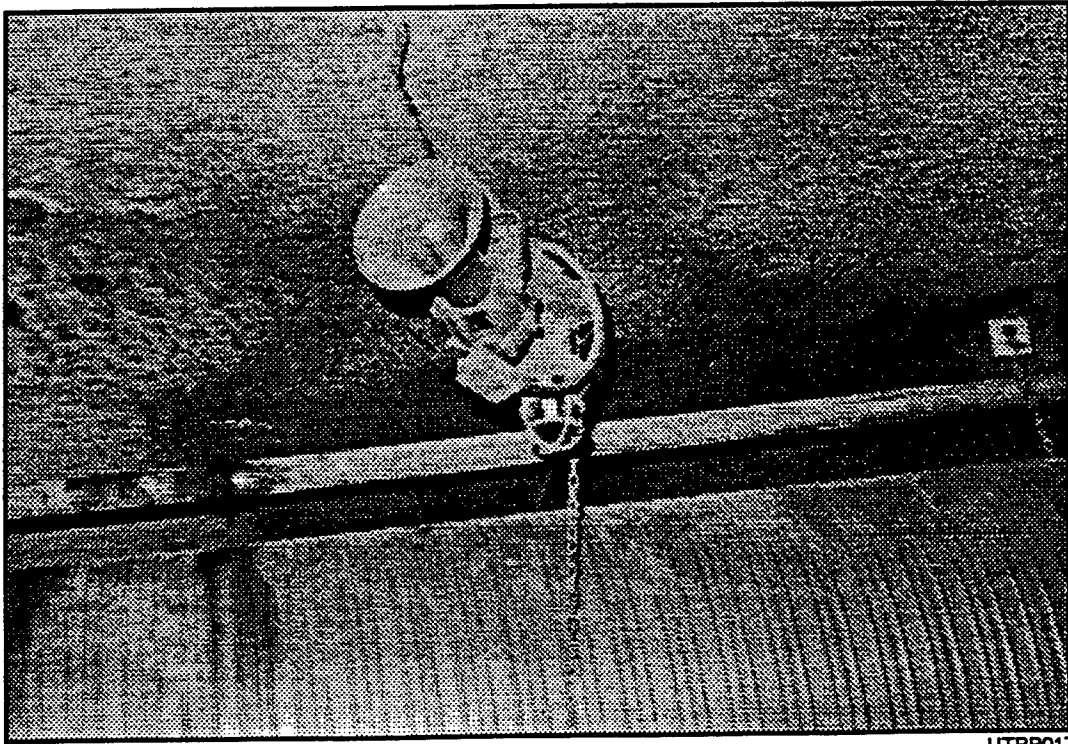
UTPP015

Figure D-15 Cal. Adit (Looking towards its
Terminal Station)



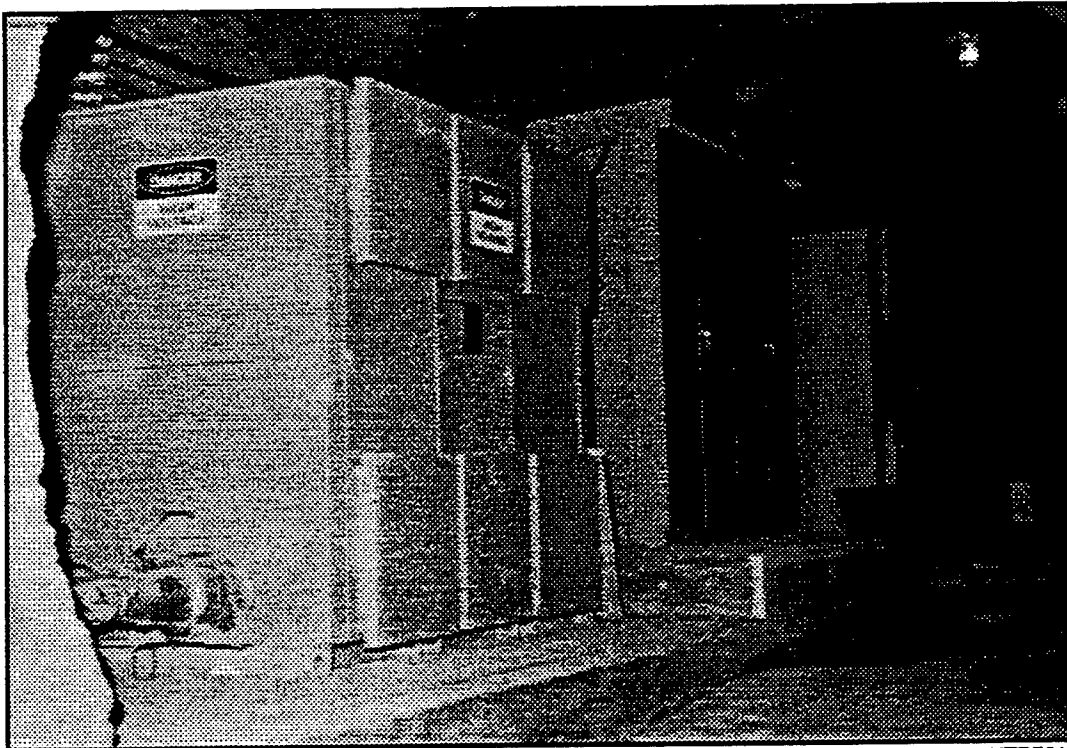
UTPP016

Figure D-16 Intersection (Looking from Cal. Adit)



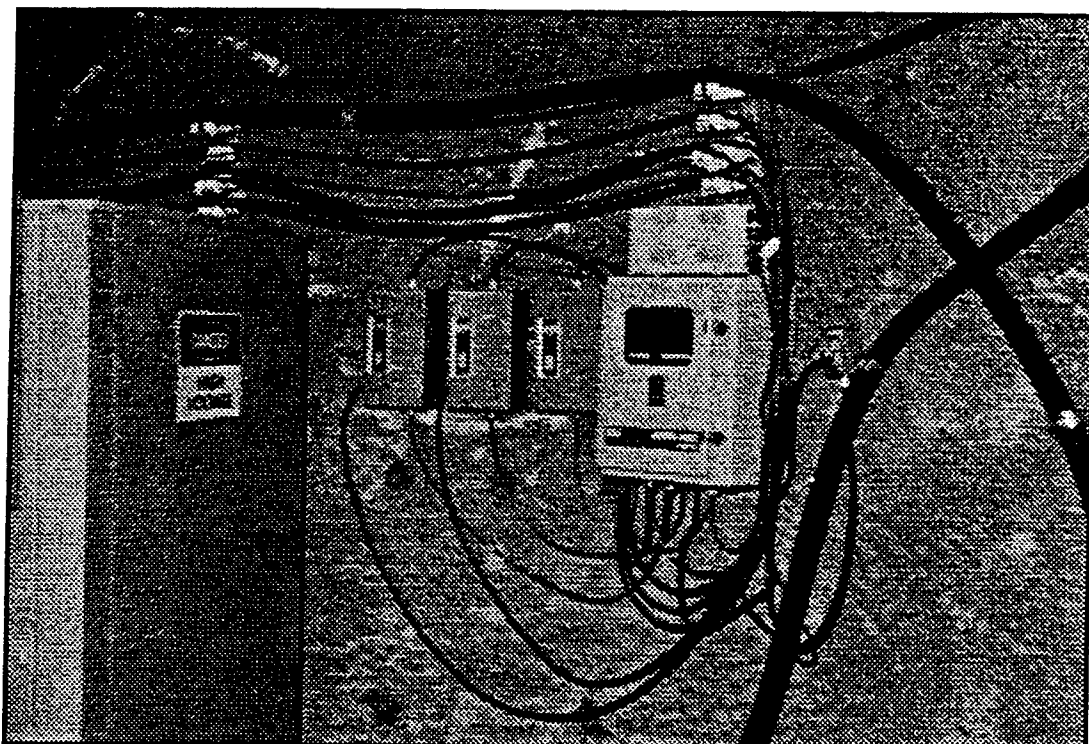
UTPP017

Figure D-17 Gas Warning/Monitor Siren and Light



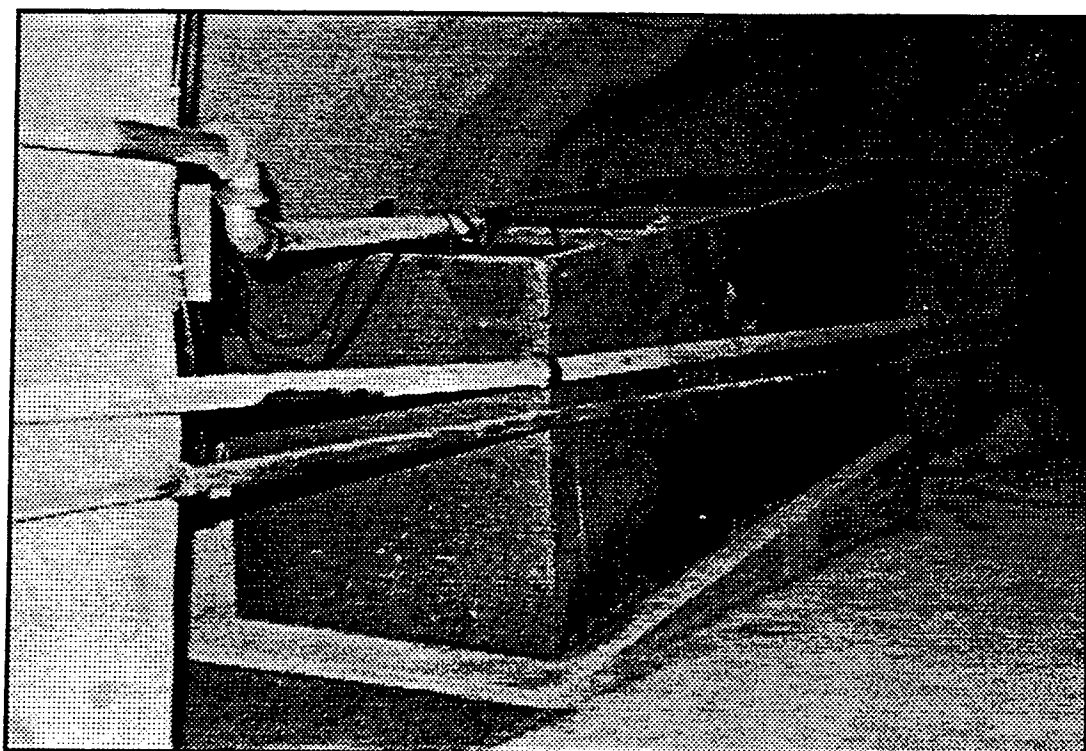
UTPP018

Figure D-18 Transfer Bay



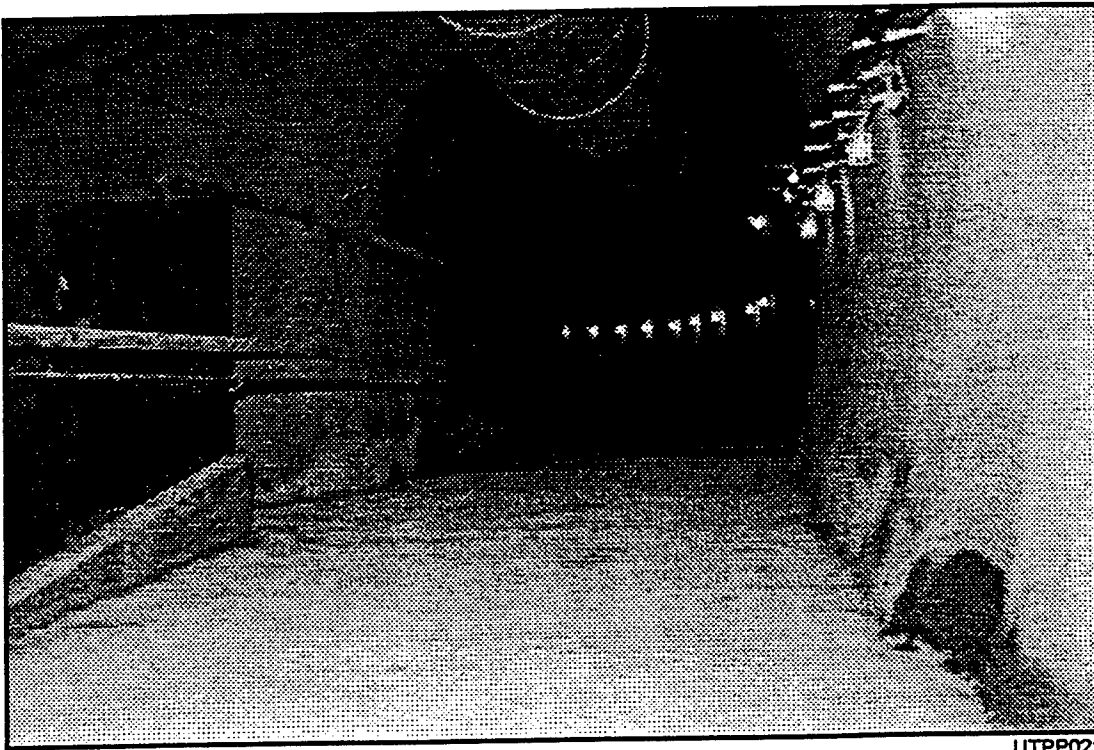
UTPP019

Figure D-19 Electric Controls and Gas Monitor Box



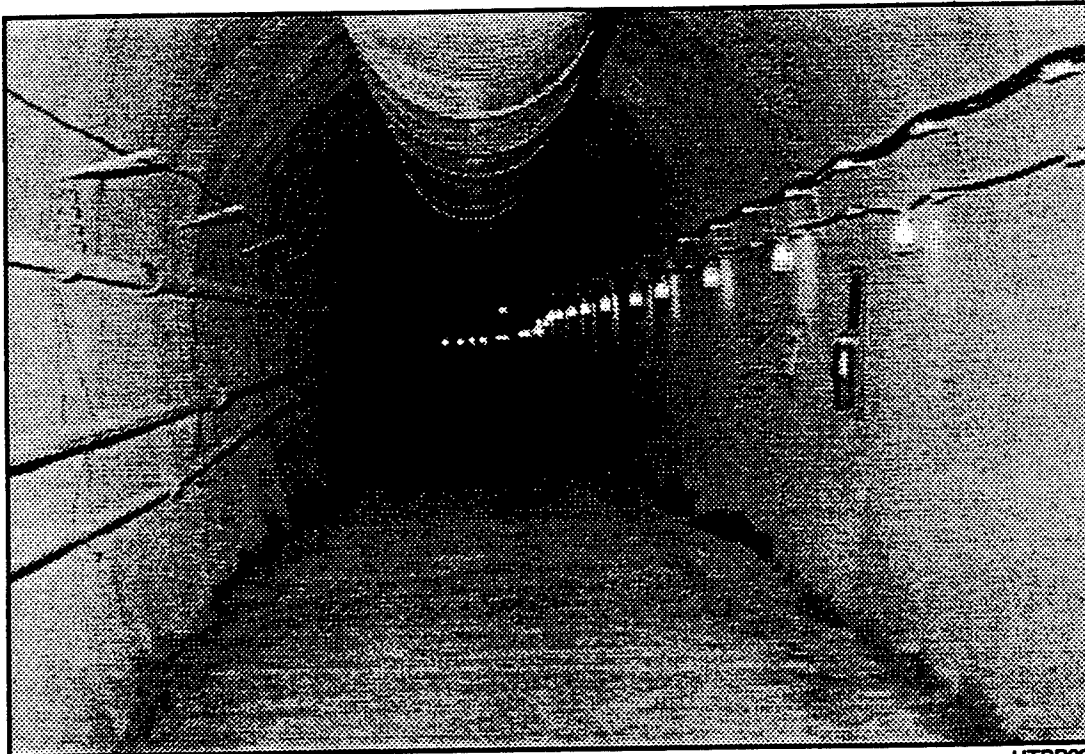
UTPP020

Figure D-20 Sump Tank at Sump Bay



UTPP021

Figure D-21 Sump Bay



UTPP022

Figure D-22 Test Adit



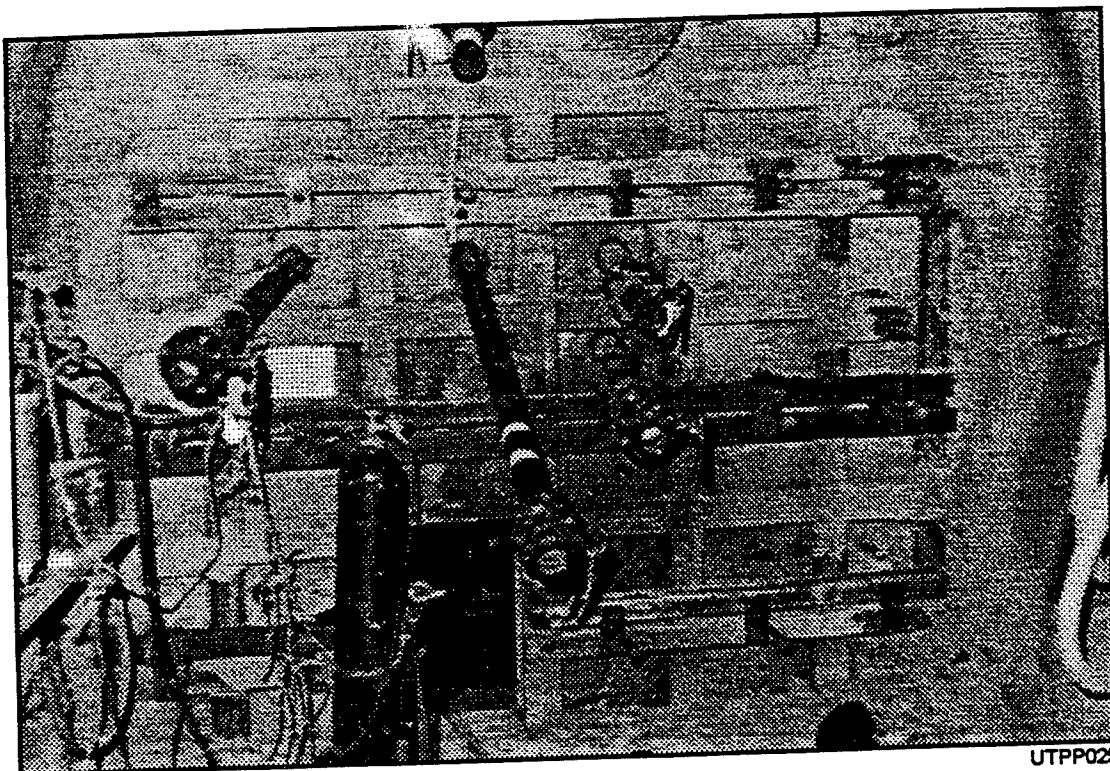
UTPP023

Figure D-23 Access Road to Rodgers Hollow
(Portal on Left)



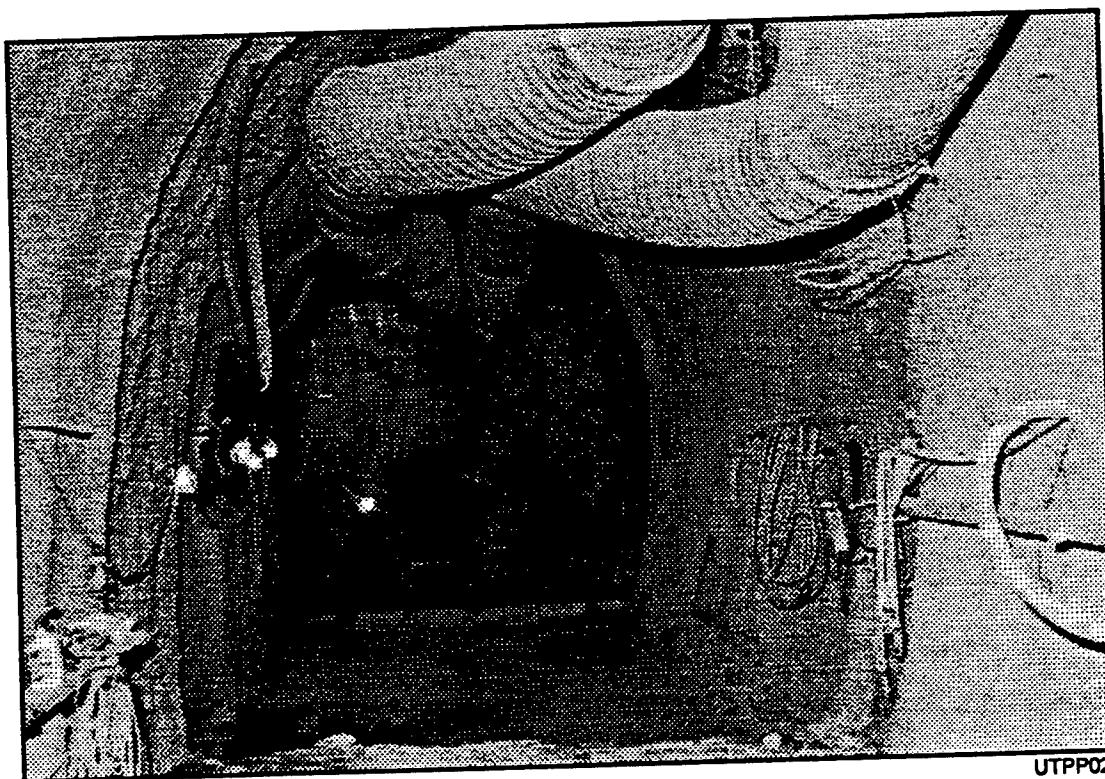
UTPP024

Figure D-24 Plug During Construction. Shown are Pressure
Grout Pipes with Gas Checks (Plates) and
4" Dia. Bleed Lines



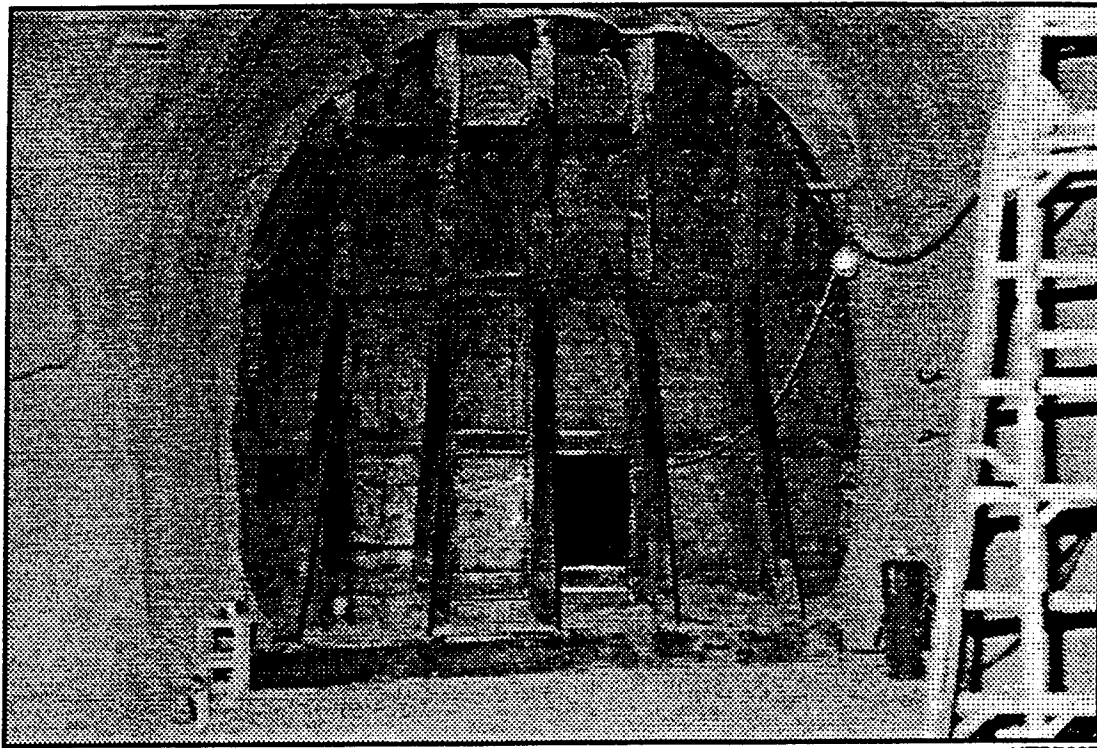
UTPP025

Figure D-25 Front (Upper) Bulkhead with Fill
and Bleed Line Penetrations



UTPP026

Figure D-26 Finished Rear (Lower) Bulkhead from
Inside Plug



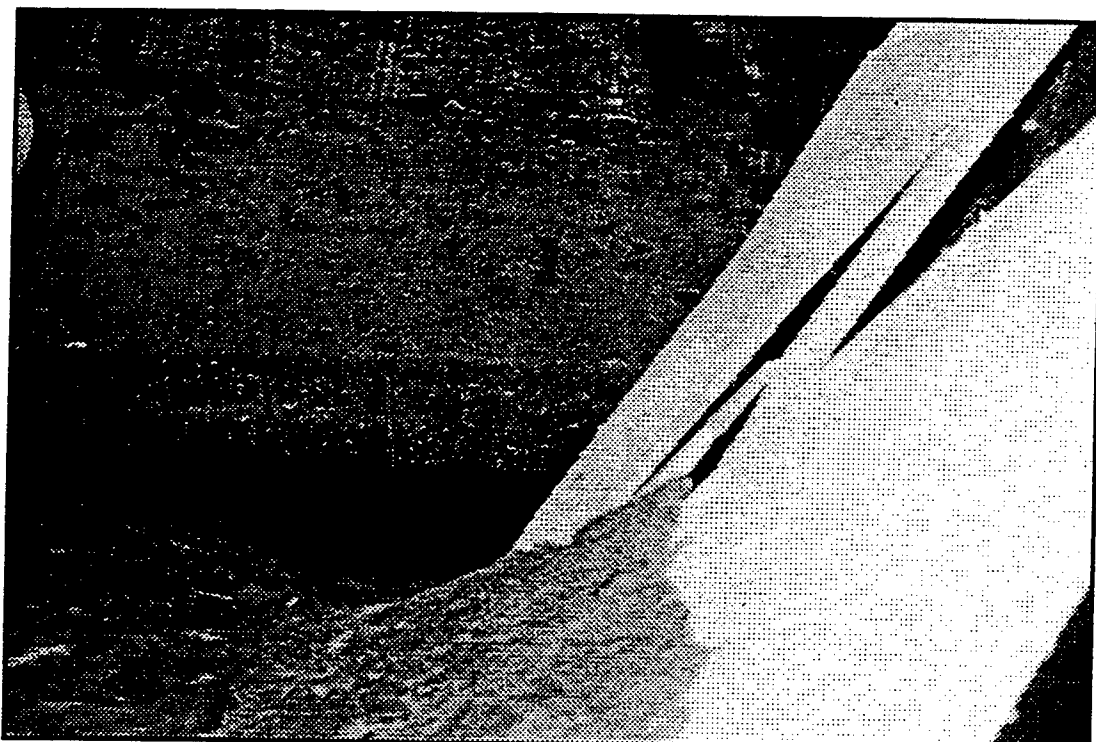
UTPP027

Figure D-27 Back of Lower Bulkhead Prior to completion.
Shown are Supports and Access Opening



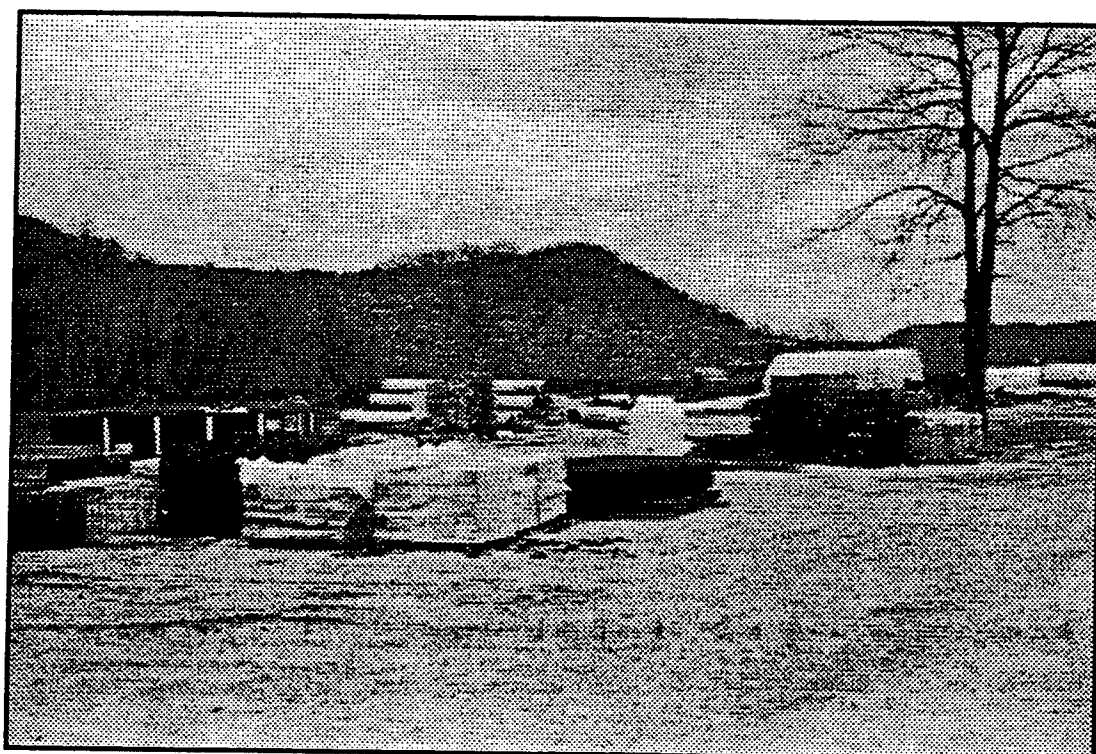
UTPP028

Figure D-28 Gas (Methane) Seepage at Sta. 18+50



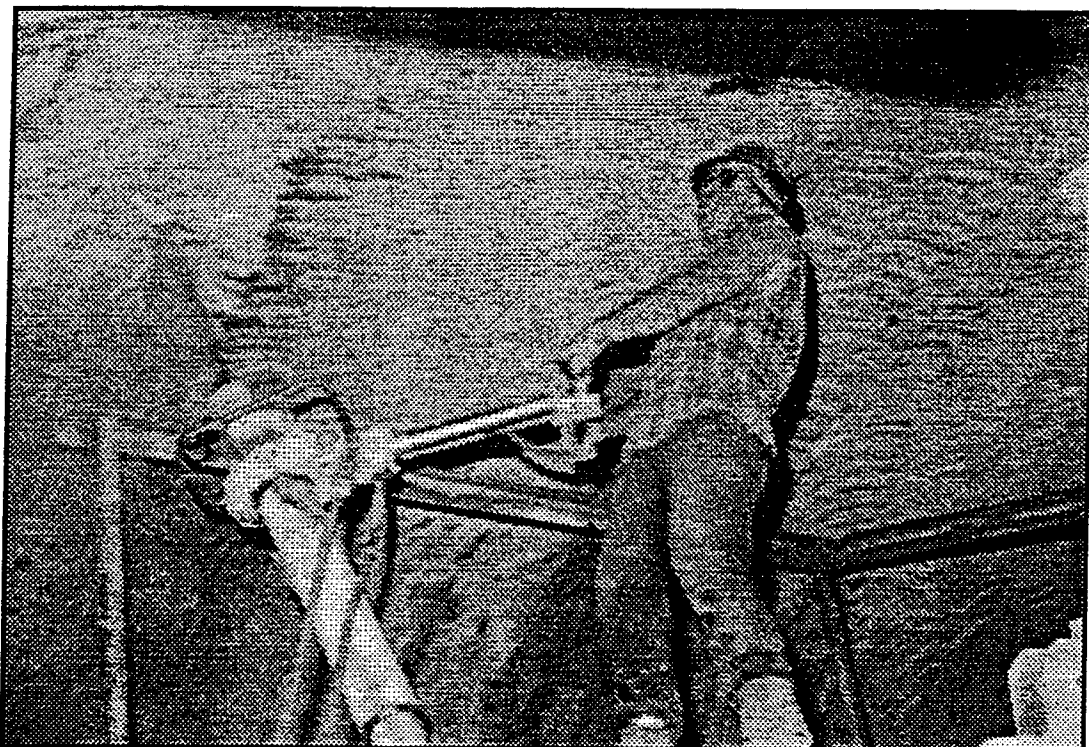
UTPP029

Figure D-29 Interface Between New Providence Shale
(Top) and New Albany Shale (Bottom)
at Sta. 18+54



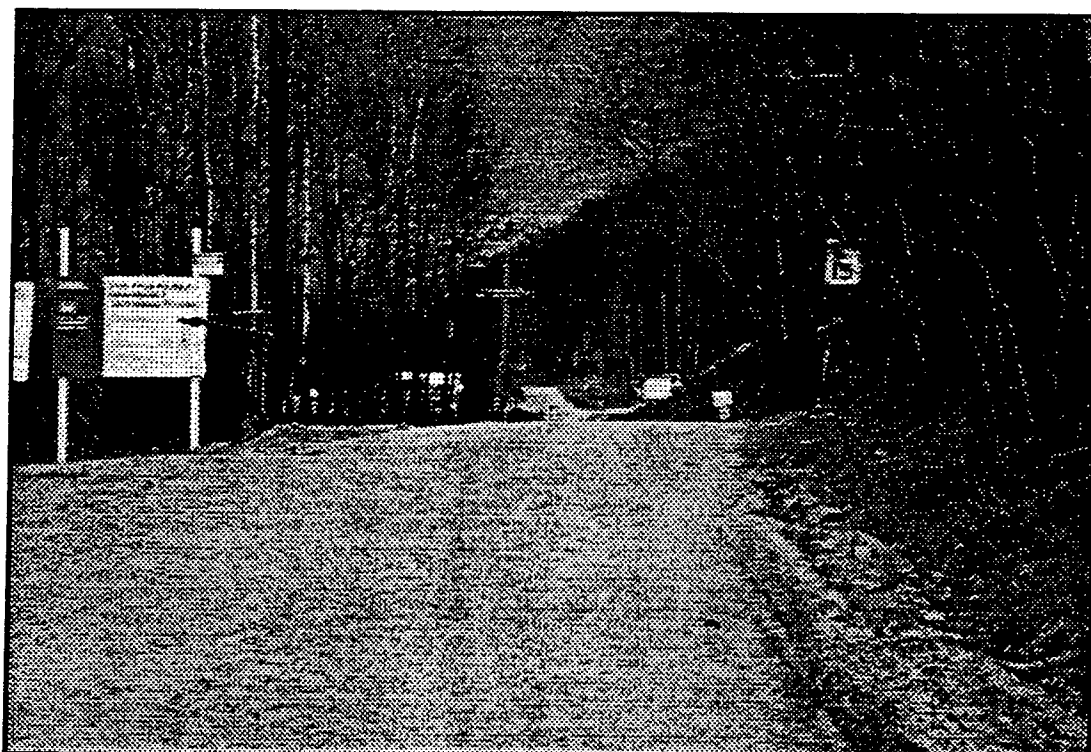
UTPP030

Figure D-30 Yard (Storage) Area on Site



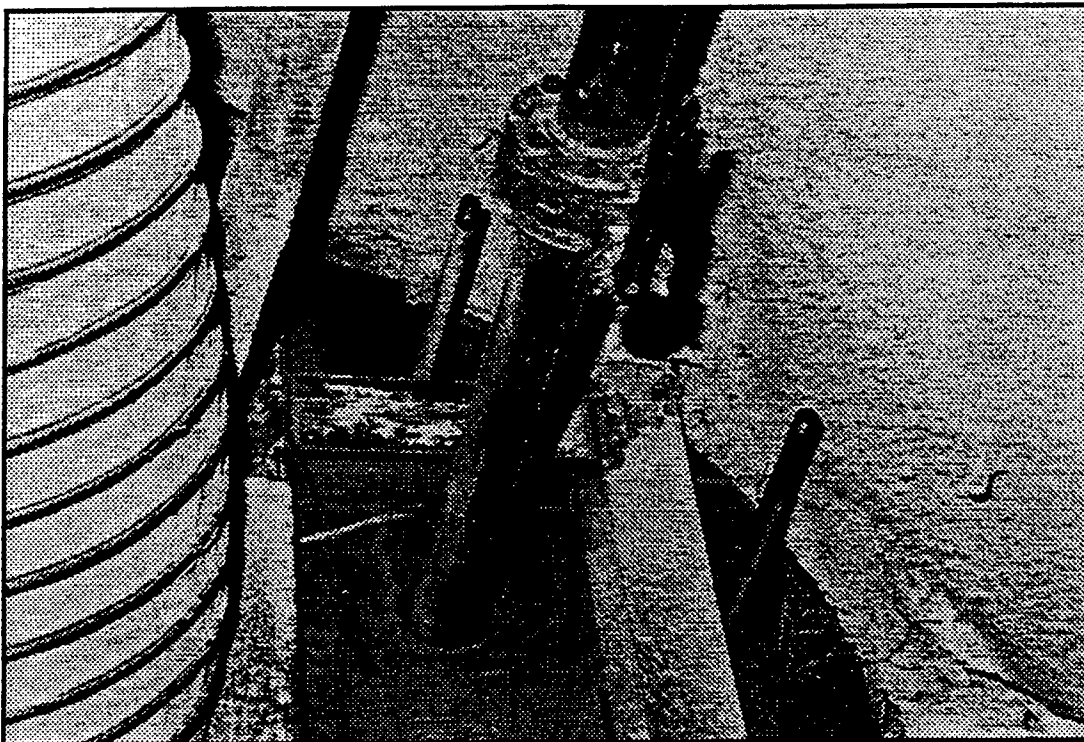
UTPP031

Figure D-31 Rock Bolt Installation



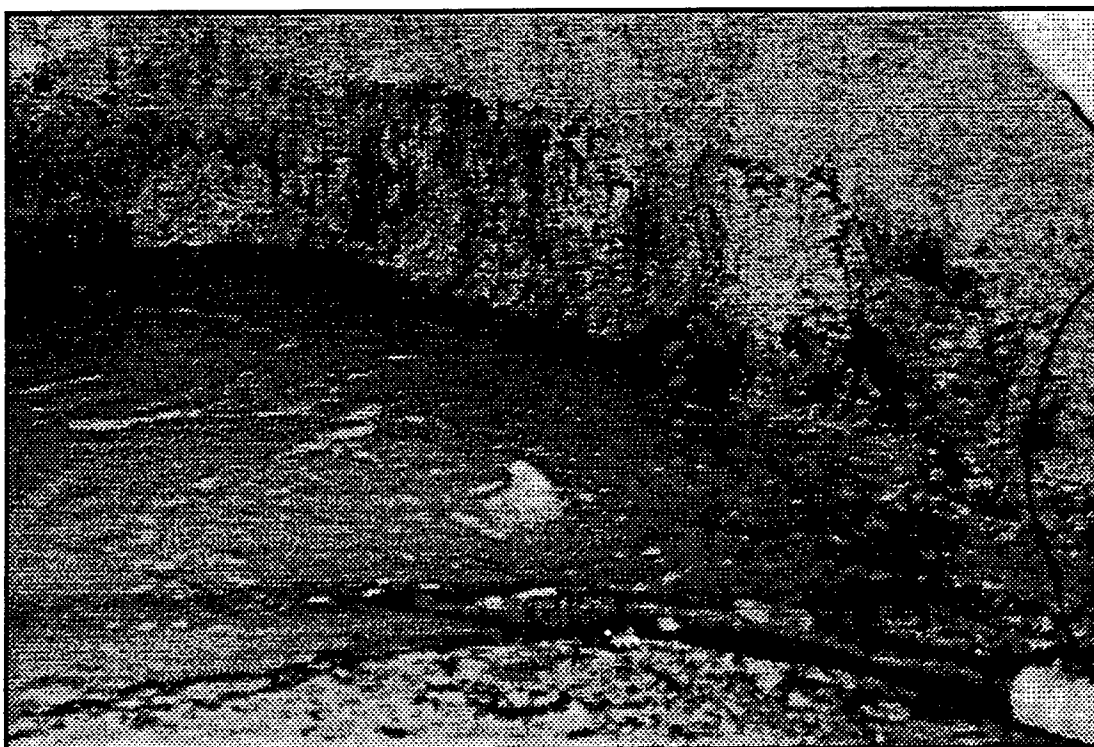
UTPP032

Figure D-32 Access Road to Site (Portal on Right)



UTPP033

Figure D-33 Gas Bleed Line with Valve Penetrating
Upper (Front) Bulkhead



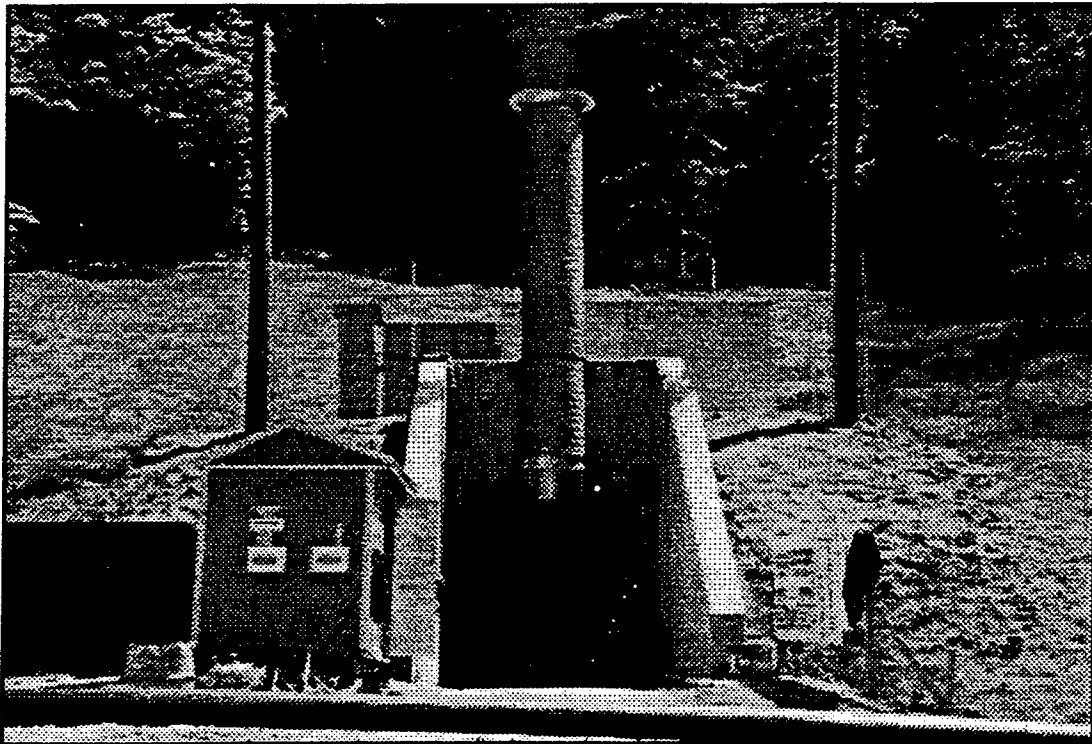
UTPP034

Figure D-34 Gas Seepage at Sta. 18+50



UTPP035

Figure D-35 Piezometer Monitoring Assembly P-1



UTPP036

Figure D-36 Portal Showing Final Vent Exhaust and Electrical Substation on Top (Stack Removed Recently for Safety Reasons)

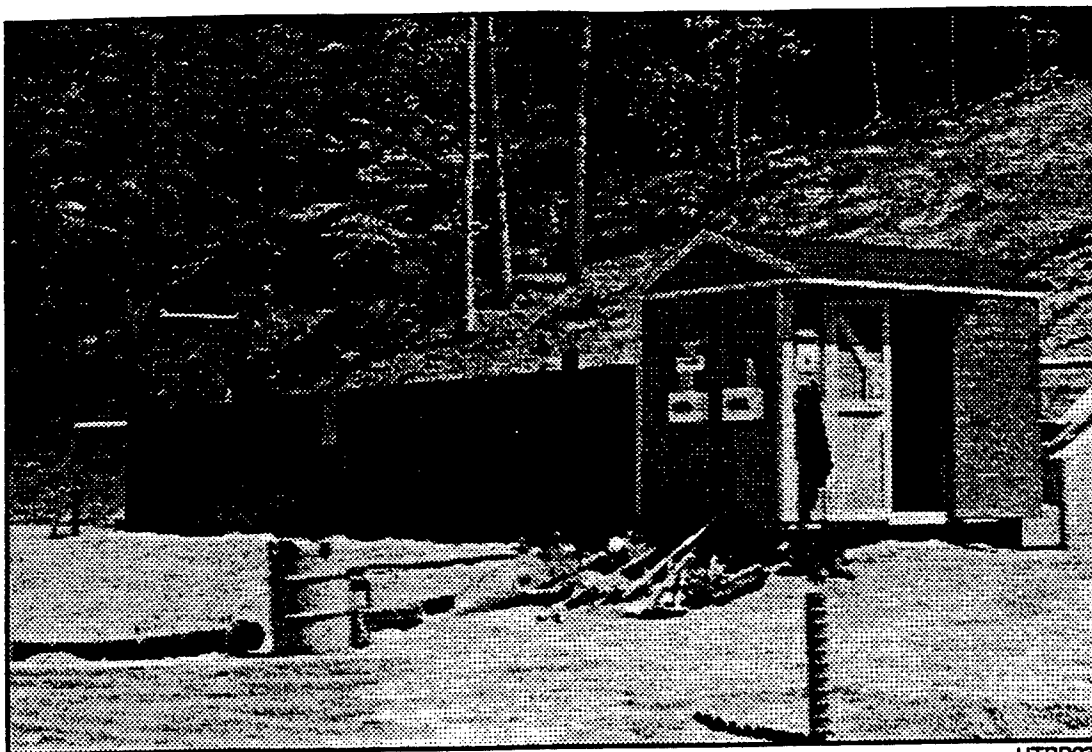
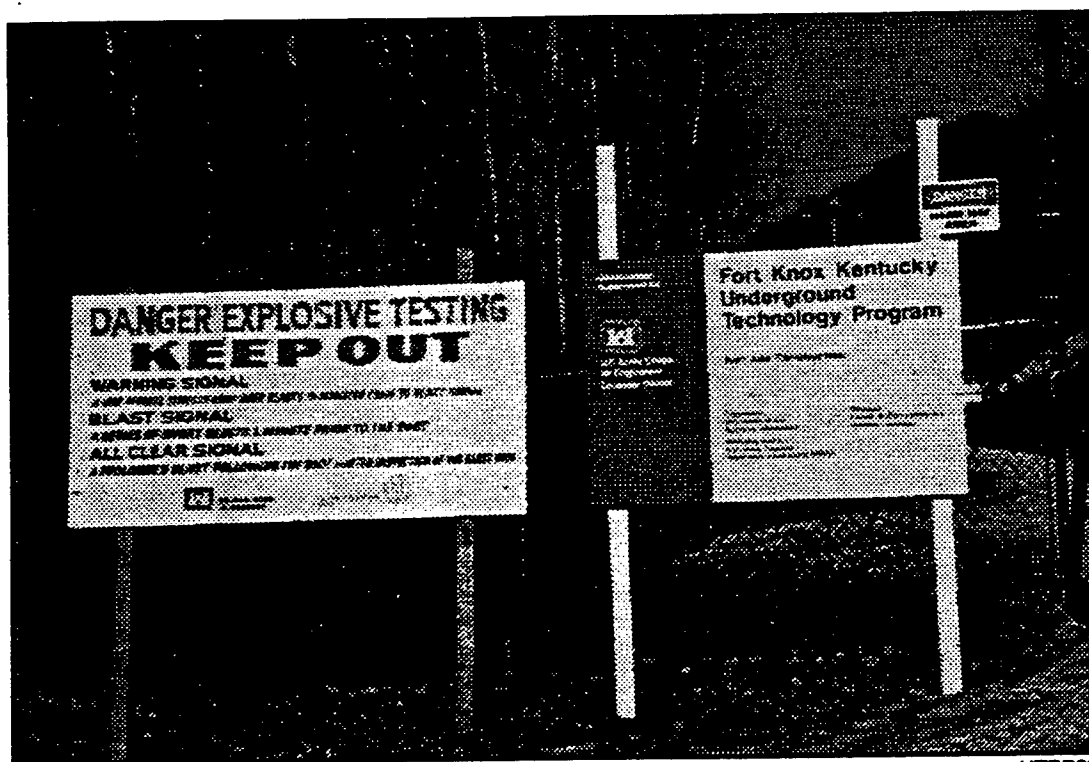


Figure D-37 Sump Tanks Outside Tunnel Delivering Water Pumped Out of Tunnel to Dewatering Line Going to Salt River



Jobsite Entrance Signs

DISTRIBUTION LIST

DSWA-TR-93-133

DEPARTMENT OF DEFENSE

DEFENSE INTELLIGENCE AGENCY
ATTN: DIW-4

DEFENSE SPECIAL WEAPONS AGENCY
2 CY ATTN: ISST
ATTN: OPS
ATTN: P SENSENY
ATTN: D RICE
ATTN: W ULLRICH

DEFENSE TECHNICAL INFORMATION CENTER
2 CY ATTN: DTIC/OCF

FIELD COMMAND DEFENSE SPECIAL WEAPONS AGENCY
ATTN: FCTO
ATTN: FCTOS
ATTN: DR BALADI

DEPARTMENT OF THE ARMY

U S ARMY CORPS OF ENGINEERS
ATTN: CERD-L

U S ARMY ENGINEER DIST OMAHA
ATTN: GAUBE

U S ARMY ENGR WATERWAYS EXPER STATION
ATTN: C D NORMAN
ATTN: CEWES-SD
ATTN: L K DAVIS
ATTN: DR BALSARA
ATTN: DR D BANKS
ATTN: J WARRINER
ATTN: TECHNICAL LIBRARY
ATTN: W MCMAHON
ATTN: W MILLER

DEPARTMENT OF ENERGY

LOS ALAMOS NATIONAL LABORATORY
ATTN: REPORT LIBRARY

SANDIA NATIONAL LABORATORIES
ATTN: A F FOSSUM
ATTN: J D ROGERS
ATTN: T BERGSTRESSER
ATTN: TECH LIB

OTHER GOVERNMENT

CENTRAL INTELLIGENCE AGENCY
ATTN: OSWR/NED

DEPARTMENT OF DEFENSE CONTRACTORS

APPLIED RESEARCH ASSOCIATES INC
ATTN: C J HIGGINS

APPLIED RESEARCH ASSOCIATES INC
ATTN: S BLOUIN

APPLIED RESEARCH ASSOCIATES INC
ATTN: R FRANK

KAMAN SCIENCES CORPORATION
ATTN: DASAC

LACHEL AND ASSOCIATES INC
2 CY ATTN: C LINAMEN
2 CY ATTN: J BECK

SOUTHWEST RESEARCH INSTITUTE
ATTN: B THACKER

SRI INTERNATIONAL
ATTN: DR JIM GRAN

TITAN CORPORATION
ATTN: J THOMSEN