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(formerly 40-8355)

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Wood County Project Near Parkersburg, West Virginia

September 1980

Geotechnical and Consultation Services

Wood County Project
Near Parkersburg, West Virginia

Prepared For

AMAX Environmental
Services, Incorporated
Denver, Colorado

August 1980

Revised Draft September 1980

Woodward-Clyde Consultants

Consulting Engineers, Geologists and Environmental Scientists
2909 West 7th Avenue, Denver, Colorado 80204

Job No. 20052

2909 West 7th Avenue
P.O. Box 4036
Denver, Colorado 80204
303-573-7882

Woodward-Clyde Consultants

August 5, 1980

AMAX Environmental Services, Inc.
4704 Harlan Street
Denver, Colorado 80212

Attention: Mr. James E. Kerrigan
Senior Environmental Engineer

Re: Geotechnical and Consultation Services, Wood County Project, near Parkersburg, West Virginia.
Job No. 20052

Gentlemen:

As requested, we have completed our geotechnical investigations to locate clayey borrow material and recommend placement and compaction procedures for materials to be used in construction at your Wood County project site, as outlined in our letter dated June 6, 1980. In addition, surface soil samples of potential topsoil material were collected for testing, as requested. Data gathered during our investigation, our analysis of these data, and our opinions and conclusions are presented below. Suggested earthwork and seeding specifications are attached.

The project site is located in Wood County about 8 miles southwest of Parkersburg, West Virginia, on the east side of the Ohio River near the intersection of Foster Road and Dupont Road. We understand you plan to collect material that exists on the site from previous operations in a localized area about 10 acres in size on the site, and cover it with compacted clayey soils in order to minimize infiltration of rain water. The compacted clayey soils will consist of a 1-foot thick clay stabilization layer overlying the collected material, covered by a 1-foot thick clay layer having a coefficient of permeability of less than or equal to 1×10^{-7} centimeters per second. The compacted clayey soils will be covered with a "topsoil" layer, and then seeded.

2909 West 7th Avenue
P.O. Box 4036
Denver, Colorado 80204
303-573-7882

Woodward-Clyde Consultants

November 6, 1980

AMAX Environmental Services, Inc.
4704 Harlan Street
Denver, Colorado 80212

Attention: Mr. James E. Kerrigan
Senior Environmental Engineer

Re: Geotechnical and Consultation Services, Wood County Project, near Parkersburg, West Virginia.
Job No. 20052

Gentlemen:

Enclosed please find one copy of our report including suggested earthwork and seeding specifications for the above referenced project.

If you have questions, please call.

Yours truly,

Frank J. Holliday
Vice President

AJB:ba

Enclosure

Our investigations for the project included: (1) research of geologic literature and information pertinent to the study area to assist in locating potential sources of clayey borrow materials in the vicinity of the site; (2) field reconnaissance by one of our geotechnical engineers and an engineering geologist to field check potential sources of clayey borrow materials, including established sources of clayey soils; (3) supervision of excavation of test pits at the most appropriate sites located during our reconnaissance of the area; (4) collecting samples from the test pits on site and from potential off-site borrow sources for laboratory testing in Denver; (5) collecting surface soil samples of potential topsoil material; and (6) analysis of the results of our investigation and preparation of this report and appropriate specifications.

We found ample quantities of suitable clayey materials, both off site in an existing borrow pit and on site, for construction of the stabilization and clay layers. We found an ample quantity of suitable "topsoil" material on site for construction of the topsoil layer.

We believe some of the borrow material will need to be dried and some wetted to achieve the desired designed optimum moisture content. Permanent borrow excavation slopes on site should be flattened to minimize erosion or the risk of slope movement.

Construction operations should be conducted as expeditiously as possible to minimize erosion of the collected materials and fills, and prevent drying and cracking of the clay layer. Fill materials should be placed in loose lifts at or above designed optimum moisture content and compacted to high density or as discussed in the report. The surface of the fill should be sloped to drain.

Seeding preparation and recommendations are discussed in the report.

If you have questions, please call.

Yours truly,

Frank J. Holliday
Vice President

AJB:mr

Geotechnical and Consultation Services

Wood County Project
Near Parkersburg, West Virginia

Prepared For

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TABLE OF CONTENTS

GEOTECHNICAL AND CONSULTATION SERVICES
WOOD COUNTY PROJECT
NEAR PARKERSBURG, WEST VIRGINIA

INTRODUCTION

AMAX Environmental Services, Inc. plans to collect material that exists on the Wood County Project Site and cover the collected layer with a clay layer.

We made our studies to (1) locate clayey borrow material, (2) recommend placement and compaction procedures for materials to be used in construction, (3) recommend surface preparation for seeding and seed, and (4) prepare suggested earthwork specifications for the project. Data gathered during our investigations, our analysis of these data and our opinions and conclusions are presented below. Suggested earthwork and seeding specifications are presented in Appendix A.

PROJECT DESCRIPTION

The project site is located in Wood County about 8 miles southwest of Parkersburg, West Virginia, on the east side of the Ohio River near the intersection of Foster Road and Dupont Road, as shown on Figure 1. We understand you plan to collect material that exists on the site from previous operations in a localized area about 10 acres in size on the site, and cover it with compacted clayey soils in order to minimize infiltration of rain water. The compacted clayey soils will consist of a 1-foot thick clay stabilization layer overlying the collected

material, covered by a 1-foot thick clay layer having a coefficient of permeability of less than or equal to 1×10^{-7} centimeters per second. The compacted clayey soils will be covered with a "topsoil" layer, and then seeded.

INVESTIGATIONS

Our investigations for the project included: (1) research of geologic literature and information pertinent to the study area to assist in locating potential sources of clayey borrow materials in the vicinity of the site; (2) field reconnaissance by one of our geotechnical engineers and an engineering geologist to field check potential sources of clayey borrow materials, including established sources of clayey soils; (3) supervision of excavation of test pits at the most appropriate sites located during our reconnaissance of the area; (4) collecting samples from the test pits on site and from potential off-site borrow sources for laboratory testing in Denver; (5) collecting surface soil samples of potential topsoil material; and (6) analysis of the results of our investigation and preparation of this report and appropriate specifications.

OFF-SITE BORROW SOURCES

We investigated a potential off site clayey borrow area in the existing De Barr borrow pit shown on Figure 1. Mechanical analyses and Atterberg Limit tests on samples of hand excavated claystone bedrock and dozer excavated claystone bedrock stock-

piled in the De Barr borrow pit indicate these materials are medium plasticity clays (CL), according to the Classification of Soils for Engineering Purposes as described in the 1980 Annual Book of ASTM Standards, Part 19, ASTM Designation D2487-69. The materials are also similar to claystone bedrock materials sampled on the project site, discussed below. Permeability test results on samples of excavated bedrock material and stockpiled material compacted to 98% of maximum density in accordance with ASTM Designation D698-78 indicates coefficients of permeability of 0.10 and 0.19 x 10^{-7} centimeters per second, respectively. Moisture-density relations of the soils used to obtain the maximum density were performed in accordance with ASTM Designation D698-78 as described in the 1978 Annual Book of ASTM Standards, Part 19. Gradation analyses were performed according to ASTM Designation D422-72. Permeability testing was perforemd according to the U. S. Department of the Interior, Bureau of Reclamation "Earth Manual" Designation E-13. We believe these materials would prove suitable for use in the stabilization and clay layer. Gradation analysis test results are presented on Figures 4 through 24, compaction test results are presented on Figures 25 through 32, laboratory test results are summarized in Table I and laboratory permeability test results are summarized in Table II.

The needed quantity of borrow for covering the collected material appears to be available in the De Barr borrow pit. We estimate in excess of 20,000 cubic yards of clayey material is likely available from the De Barr borrow pit. Our volume estimates do not include the effect of bulking and shrinking during excavation, hauling, placement and compaction.

ON-SITE BORROW SOURCES

We investigated four potential borrow areas on site, numbered Areas 1, 2, 3 and 4, shown on Figure 2. Areas 1, 2 and 3 are located on relatively flat lying terraces in the Ohio River Valley. Area 4 is in a moderately hilly area abutting the terraces. Area 1 and the northern half of Area 2 appear to be relatively undisturbed ground except for surficial agricultural activities. The southern portion of Area 2 contains remnants of recreational facilities and has recently been used as a pipe storage area. Area 3 appears to have undergone some excavation and contains localized areas of man-made fill. Areas 1 and 3 are generally vegetated with weeds and grasses. Areas 2 and 4 are also vegetated with weeds and grasses, but sections of the southern portion of Area 2 and central and eastern portion of Area 4 are forested. We observed a manhole near Test Pit TP-16 and a pipe outlet near Test Pit TP-17 in Area 1. An old barn is located on the north end of Area 2 and powerlines cross the western portion of Area 4. Area 4 is separated from the plant site by Dupont Road. The Ohio River

borders the west side of Area 1. Area 1 and the northern portion of Area 2 were dry at the time of our investigations but wet swampy areas covered portions of the southwestern section of Area 2 and standing water covered the bottom of the man-made excavation in the east central portion of Area 3. The intermittent stream in Area 4 was dry and water was observed behind an earth dam located northwest of Test Pit TP-35. No bedrock outcrops were observed on the sites.

Test pits in Area 1 showed about 0.5 to 1 foot of clays and silts with roots overlying about 4 to more than 12 feet of silty to very silty, sandy clays and very clayey, sandy silts. Some layers of silty and clayey sands were found below a depth of 5 feet in Test Pits TP-16, TP-18, and TP-19. Generally siltier soils were found in the northeastern portion of Area 1. Test pits in Area 2 showed about 0.5 feet of clays, silts and sands with roots overlying about 3 to 10 feet of very silty, sandy clays and very clayey, sandy silts overlying clean to clayey and silty sands. Test pits in Area 3 showed about 0 to 1.5 feet of man-made fill or 0.5 to 1.5 feet of clays, silts and sands with roots overlying about 1 to 9.5 feet of silty to very silty, sandy clays and very clayey, sandy silts, or clean to silty and clayey sands overlying clean sandy gravels. Test pits in Area 4 showed about 0.5 to 3 feet of clays and silts with roots overlying about 1 to 8.5 feet of silty to very silty, sandy clays overlying claystone bedrock. Clayey, sandy

silts were found to a depth of 3 to 4 feet in Test Pits TP-29, TP-30 and TP-31. Generally clayey soils overlie claystone bedrock in the southwest portion of Area 4.

The test pits in Areas 1 through 4 were dry at the time of excavation. Upon completion of test pit excavation and sampling, the upper pit slopes were flattened to about 1:1 (horizontal to vertical) and the bottom was backfilled to a depth of about 7 feet. Locations and summary logs of test pits are shown on Figures 2 and 3, respectively.

Based on our observations of soils exposed in the test pits and laboratory test results on samples from the test pits, we believe soils suitable for the clayey soil layer can be obtained from the southern portion of Area 1 and the southwestern portion of Area 4 within the recommended limits for impervious borrow material shown on Figure 2. Borrow materials within these limits include the more easily excavated claystone bedrock.

Classification test results indicate that these materials are generally sandy, silty clays (CL) according to the Unified Soil Classification System. Permeability test results on samples of these soils compacted to 98% of maximum density (ASTM D698-78) indicate coefficients of permeability ranging from 0.05 to 0.29 x 10^{-7} centimeters per second. We believe these materials would be suitable for use in the clay layer as well as for the stabilization layer.

We recommend assuming, for cost estimating purposes, removal of existing structures, man-made fill, vegetation, and stripping of about 1 foot of surface soils containing roots in the areas selected for borrow on site.

We estimate about 40,000 cubic yards of clayey soils for the clay and stabilization layers are available within about 5 feet of the ground surface in the southern portion of Area 1 and about 50,000 cubic yards of clayey materials are available within about 10 feet of the ground surface in the southwest portion of area 4. About 40,000 cubic yards of material in the upper 18 inches of natural soil are estimated to be available in Area 1 for the topsoil layer. Our volume estimates do not include the effect of bulking and shrinking during excavation, hauling, placement and compaction. These on-site borrow volume estimates assumed 1-foot of surface soil stripping and removal.

FILL PLACEMENT AND COMPACTION PROCEDURES

We understand the collected materials will be placed in a fill area shown on Figure 2. We recommend the collected materials be placed in 4-inch maximum loose lifts and compacted by four passes with a Caterpillar Model D-8 dozer or equivalent. We recommend clay borrow materials in the stabilization layer be dumped and dozed out over the collected materials without mixing with the underlying earth. The stabilization layer should be placed in 12-inch maximum loose lifts at or above the designed optimum moisture content and

compacted by "smooth" wheel or rubber-tired rollers to at least 95% density (ASTM D698-78). Lift thickness and density may need to be revised during construction to prevent mixing with the collected material. The clay borrow materials for the clay layer should be placed at or above the designed optimum moisture content in 8-inch maximum loose lifts and compacted to a minimum of 98% density (ASTM D698-78). The topsoil layer above the clay layer should be placed in 12-inch maximum loose lifts at the designed optimum moisture content and compacted by 2 passes with a Caterpillar Model D-8 dozer or equivalent. The layer should be 30 inches thick to prevent frost from penetrating the clay layer. This thickness for frost protection is based on discussions with Mr. Elvin Moelldinck of the Code Enforcement Office, City of Parkersburg, West Virginia and Mr. Berl Marks of Berl Marks Excavation Company, a local earthwork contractor in the vicinity of the project site. We believe some of the borrow soils will need to be dried and some wetted to achieve the desired designed optimum moisture content.

Permanent borrow excavation slopes in Area 4 should be no steeper than 5:1 to minimize the risk of slope movements. Permanent borrow excavation slopes in other areas should be 3:1 or flatter to minimize erosion.

Construction operations should be conducted as expeditiously as possible to minimize erosion of the collected

materials and fills, and prevent drying and cracking of the clay layer. The surface of each fill layer should be graded to drain.

SEEDING

Shallow hand dug pits, numbered HP-1 through HP-5, were excavated in Area 1 to collect surface samples in the top 18 inches of soil for potential use in the topsoil layer. The samples were submitted to the Cooperative Extension Service (CES) county extension agent in Parkersburg, West Virginia for analysis. We asked the CES to recommend a hardy grass with a short root system for planting based on the soil samples submitted to them, and they recommended Kentucky 31 Fescue grass. CES also recommended pulverized limestone and fertilizer soil treatment in preparation for seeding. Their test results and recommendations, given verbally to us, are presented in Table III. Location of the surface samples is shown on Figure 2.

The fibrous root system of Kentucky 31 Fescue grass should contain 80 to 90% of the roots by weight within the top 12 inches of soil under optimum growing conditions and root penetration to a depth of 30 inches should be insignificant, based on verbal discussions with Dr. Robert C. Buckner of the United States Department of Agriculture, Science and Education

Administration - Agricultural Research, University of Kentucky, Lexington, Kentucky, and Mr. Orland Parks, State Agronomist, United States Soil Conservation Service, Morgantown, West Virginia.

Based on CES test results and recommendations and our experience with similar soils, we believe common agricultural limestone, the finest ground material available, and fertilizer should be mixed with the topsoil to a depth of 6 inches at the rate of 2 1/2 tons per acre for the limestone and 1000 pounds per acre for the fertilizer at 10-10-10 or similar grade. The soil surface should be reasonably smooth prior to seeding.

We understand the fill area and areas excavated to remove collected materials will be covered with topsoil and seeded. We recommend Kentucky 31 Fescue grass be applied at the rate of 50 pounds seed per acre to the prepared topsoil surface. The seed should be clean, containing no noxious weeds and less than 1% total weed seed, and have no less than 80% germination. The seeds should be lightly covered with a minimum of 1/4 inch to a maximum of 1/2 inch of topsoil, then rolled with an implement suitable for lightly packing the seed bed surface. Recommended planting times are between April 15 and September 15 with a light straw spread on the ground surface for planting between May 15 and August 15. The ground surface should not be excessively wet to cause rutting or frozen during planting.

CONCLUSIONS

(1) We believe ample quantities of clayey borrow materials are available on site and off site to construct the stabilization and clay layer.

(2) We believe ample quantities of surface soil materials are available on site to construct the topsoil layer.

(3) Fill placement and compaction procedures, as well as seed bed preparation and seeding recommendations, are presented in the report.

GENERAL

Professional based judgments on the design alternatives and criteria are presented in this report. They are based partly on evaluation of technical information gathered, partly on our understanding of the planned construction and partly on our general experience. We do not guarantee the performance of the project in any respect; only that our engineering work and judgments rendered meet the standard of care of our profession.

Test pits excavated for this investigation were spaced to obtain a reasonably accurate picture of subsurface conditions for design purposes. Variations from the conditions portrayed which were not indicated by test explorations frequently occur. These variations are sometimes sufficient to necessitate modifications in the design. Earthwork construction involves use of materials which, by their nature, vary so much that it is not possible to cover all eventualities in design. This necessitates guidance in decisions at all stages of construc-

tion which must be made by competent and experienced personnel. We recommend construction be continuously observed by a qualified soils engineer or technician trained and experienced in the field to take advantage of all opportunities to recognize differing conditions and minimize the risk of having undetected conditions that may adversely affect the performance of the project.

CREDITS

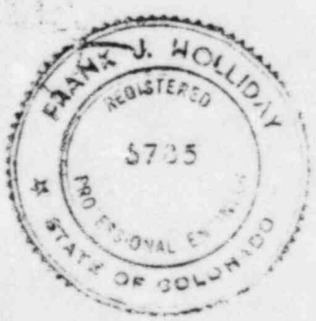
Our explorations and analysis were made under the supervision of Mr. Al Gipson, Assistant Chief of our Earth Dams Division. Mr. Allan Breitenbach analyzed the data and prepared the draft of this report. Mr. Ralph Luebs, Chief of our Land Resources Division analyzed seeding recommendations. Information on the proposed construction was provided by Messrs. Jim Kerrigan and Carl Morris of AMAX Inc. This report has been reviewed and approved by the undersigned Principal of our firm.

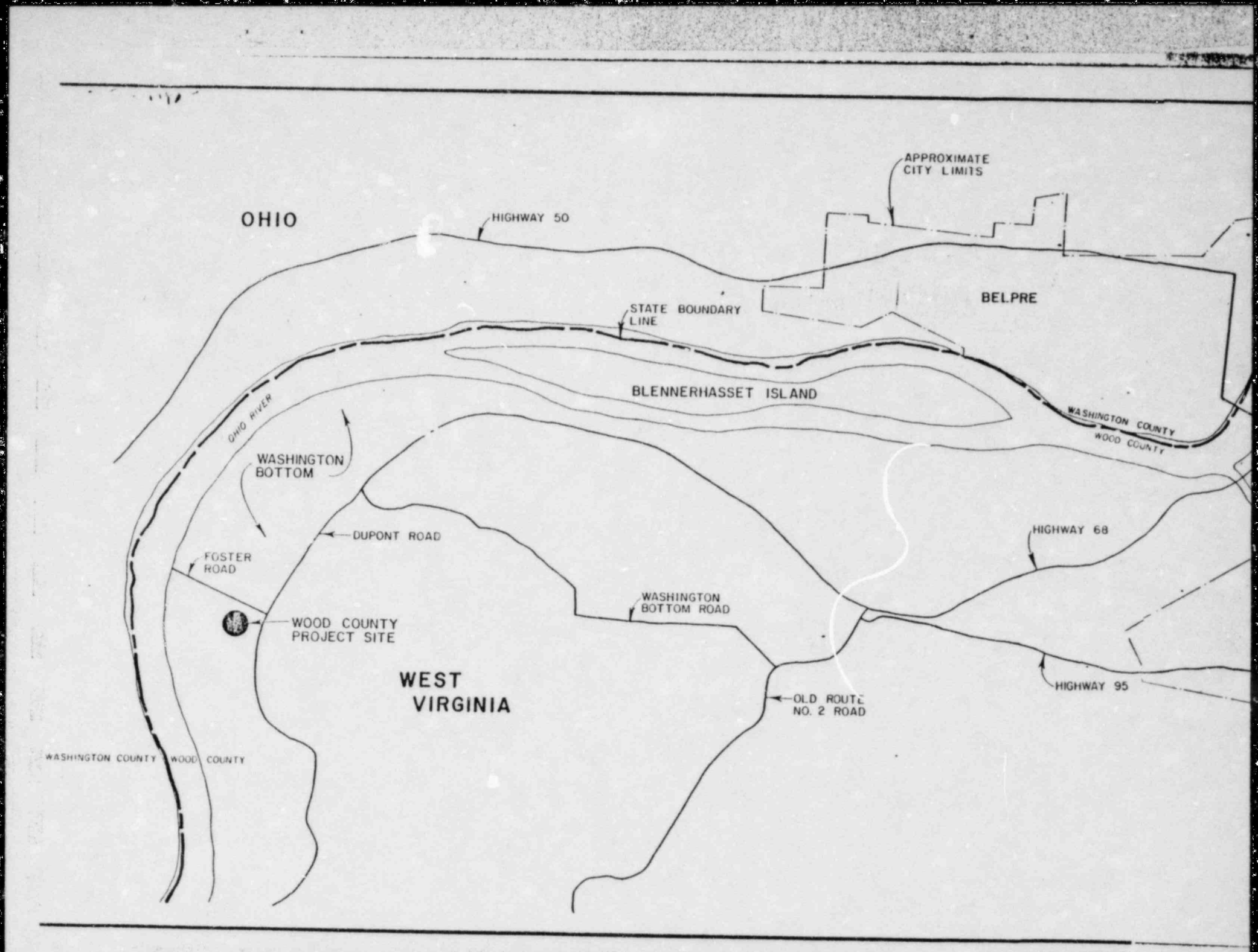
It has been a pleasure to continue working with you on this interesting project.

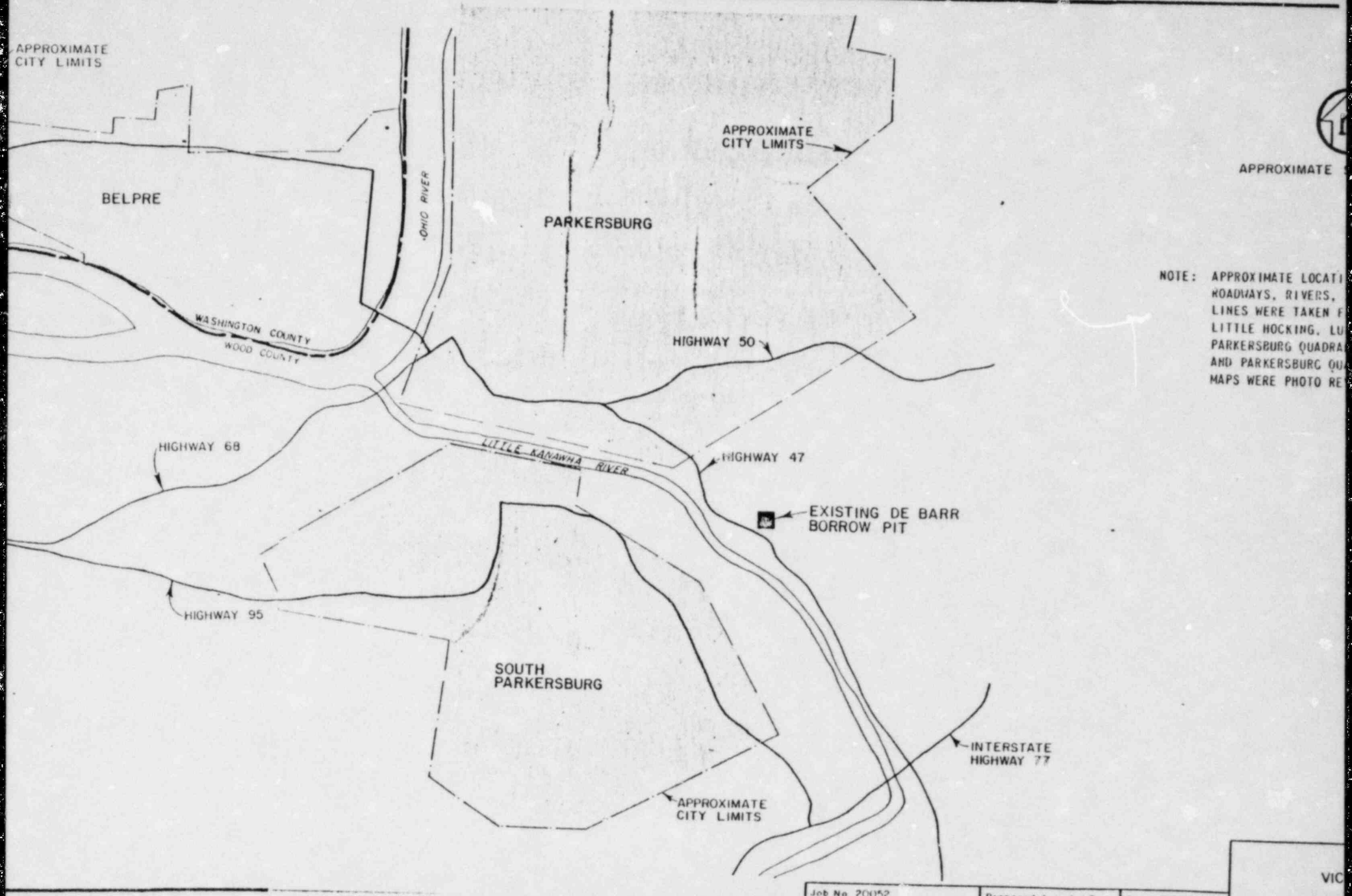
Frank J. Holliday
Vice President

AJB:mr

(1 copy sent)




APPROXIMATE
CITY LIMITS
OHIO
HIGHWAY 50
BELPRE
STATE BOUNDARY
LINE
BLENNERHASSET ISLAND
OHIO RIVER
WASHINGTON COUNTY
WOOD COUNTY
WASHINGTON
BOTTOM
DUPONT ROAD
HIGHWAY 68
FOSTER
ROAD
WASHINGTON
BOTTOM ROAD
WOOD COUNTY
PROJECT SITE
WEST
VIRGINIA
HIGHWAY 95
OLD ROUTE
NO. 2 ROAD
WASHINGTON COUNTY
WOOD COUNTY



NOTE: APPROXIMATE LOCATI
ROADWAYS, RIVERS,
LINES WERE TAKEN F
LITTLE HOCKING, LU
PARKERSBURG QUADRA
AND PARKERSBURG QU
MAPS WERE PHOTO RE

Job No. 20052

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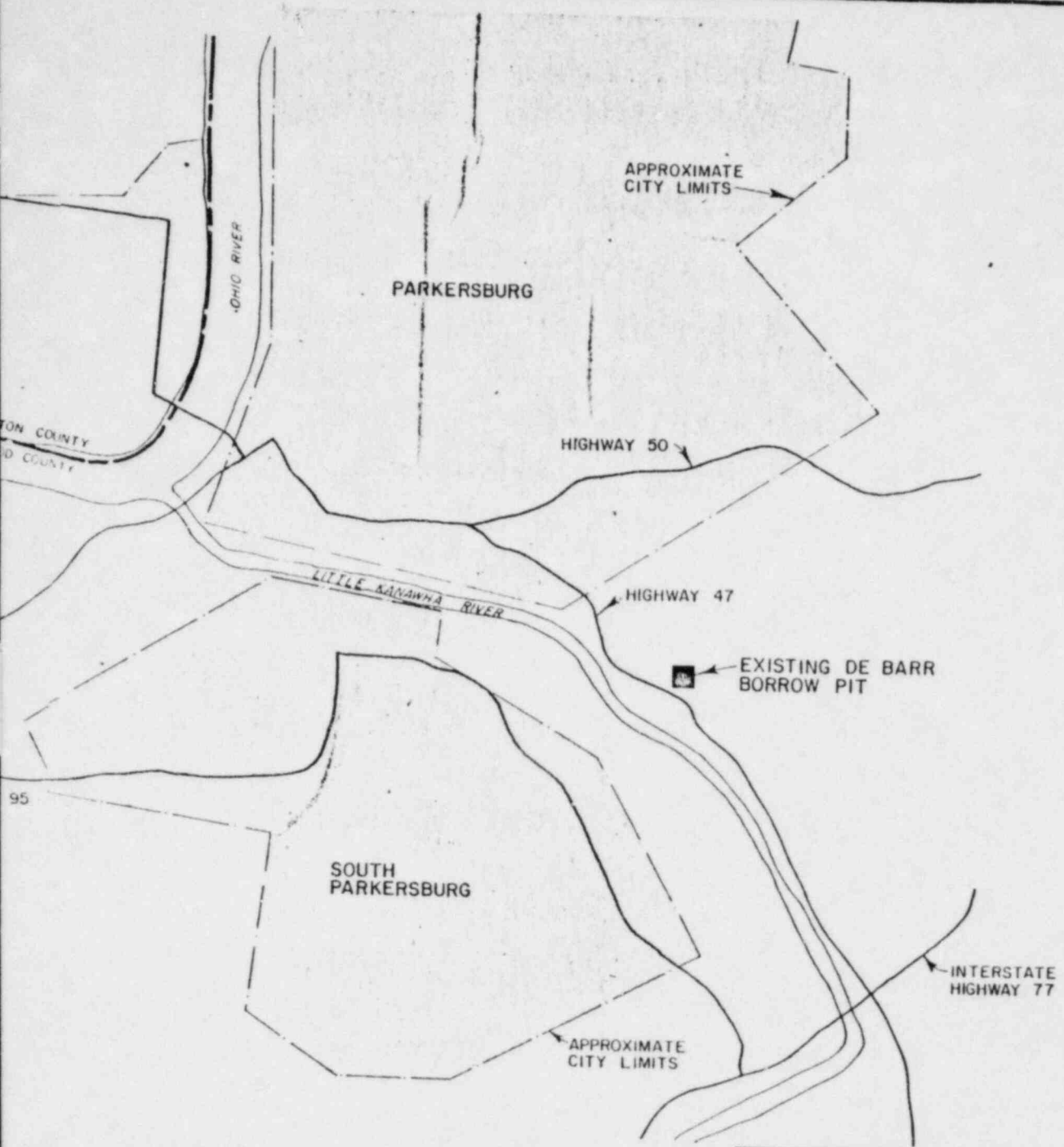


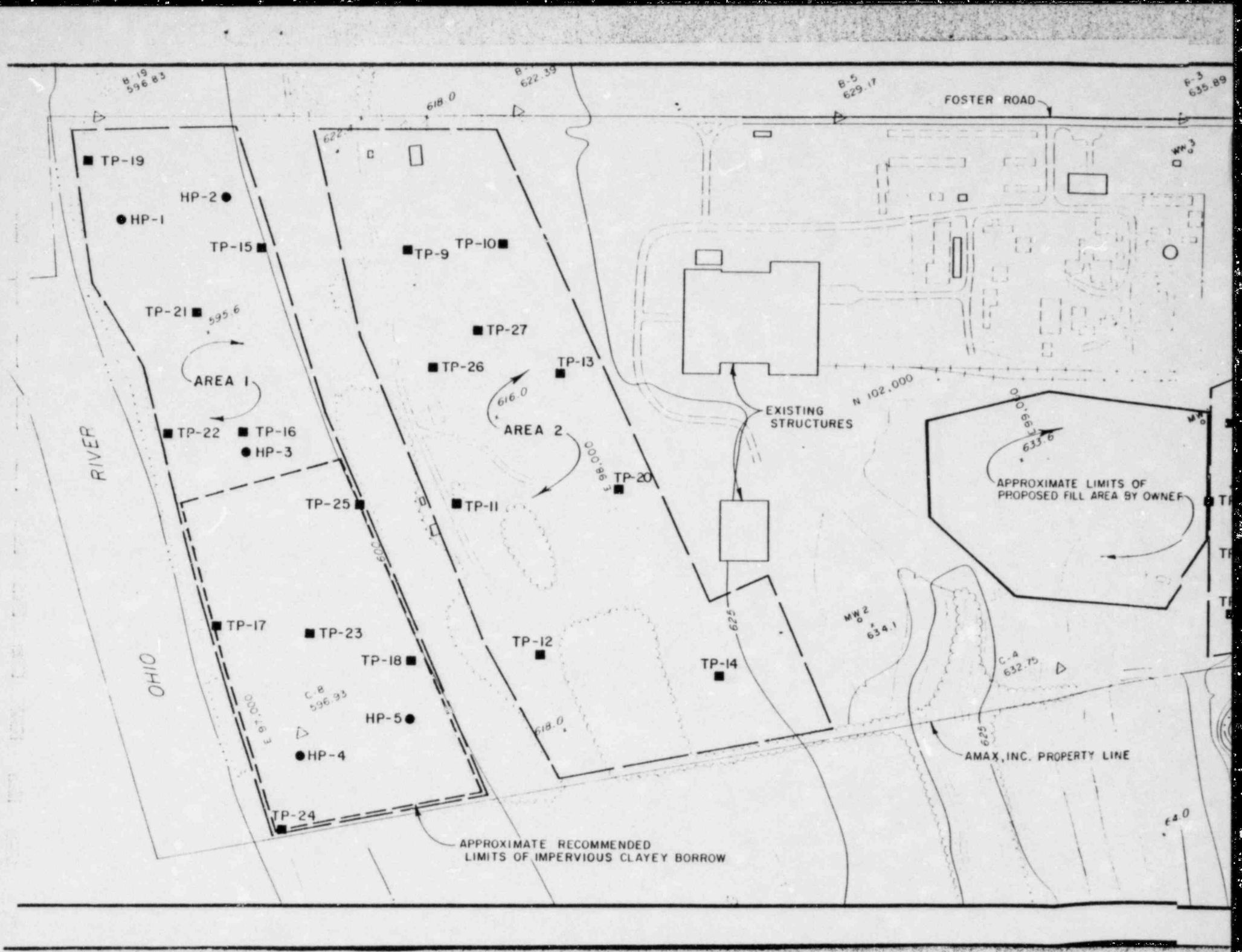
N

APPROXIMATE SCALE: 1" = 1/2 MILE

NOTE: APPROXIMATE LOCATIONS OF CITY LIMITS, ROADWAYS, RIVERS, AND STATE AND COUNTY LINES WERE TAKEN FROM U.S.G.S. MAPS OF LITTLE HOCKING, LUBECK, AND SOUTH PARKERSBURG QUADRANGLES, DATED 1961, AND PARKERSBURG QUADRANGLE, DATED 1969. MAPS WERE PHOTO REVISED IN 1975.

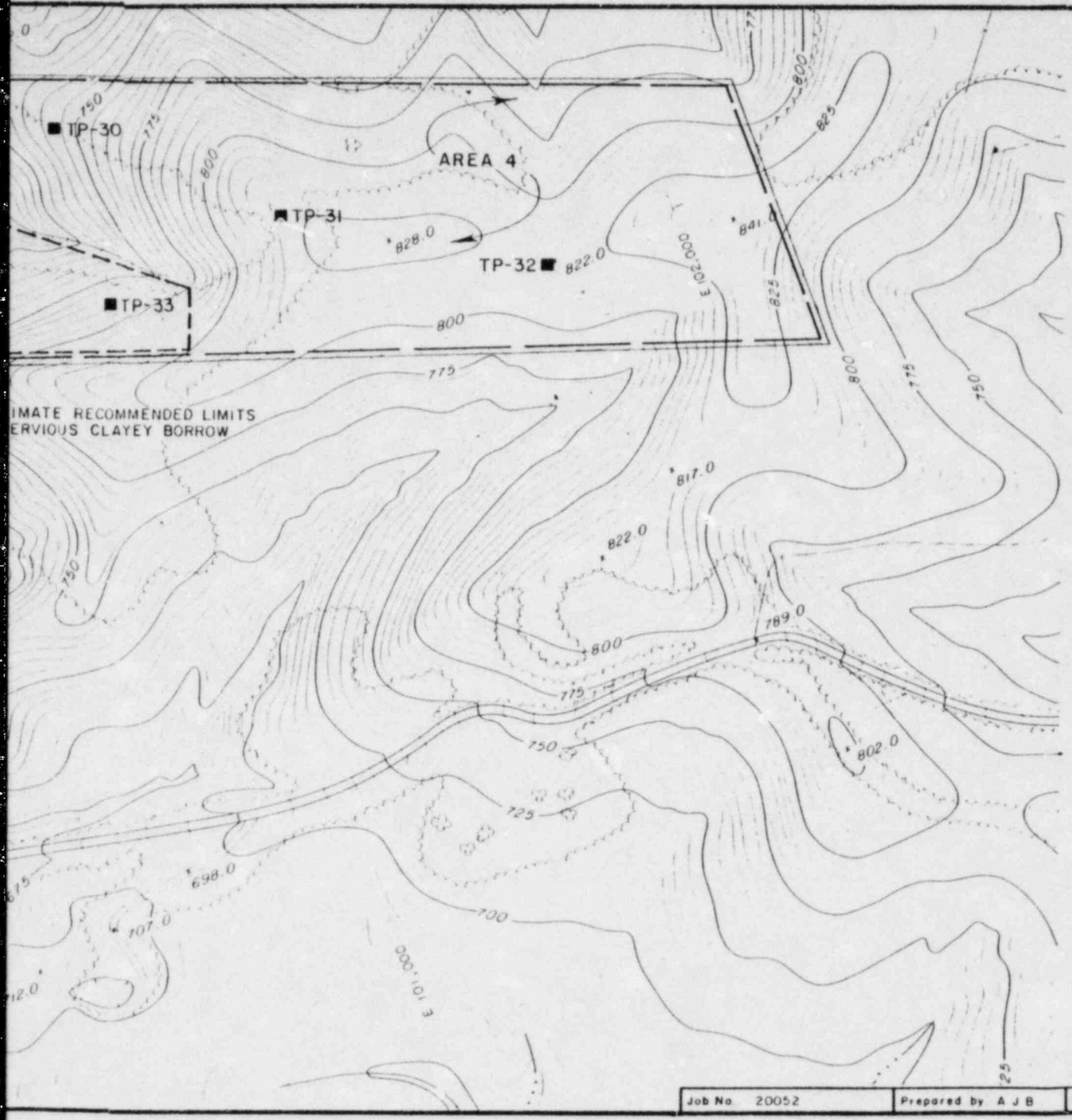
Job No. 20052

VICINITY MAP


FOSTER ROAD
TP-19
HP-2
HP-1
TP-15
TP-9
TP-10
TP-21
595.6
TP-27
TP-26
TP-13
AREA 1
AREA 2
616.0
TP-22
TP-16
HP-3
TP-20
TP-25
TP-11
RIVER
OHIO
TP-17
TP-23
TP-18
TP-12
TP-14
HP-5
HP-4
TP-24
618.0
625
EXISTING STRUCTURES
N 102,000
APPROXIMATE LIMITS OF PROPOSED FILL AREA BY OWNER
633.6
MW 2
634.1
C-4
632.75
AMAX, INC. PROPERTY LINE
APPROXIMATE RECOMMENDED LIMITS OF IMPERVIOUS CLAYEY BORROW


DUPONT ROAD
AREA 3
AREA 4
TP-1
TP-2
TP-3
TP-4
TP-5
TP-6
TP-7
TP-8
TP-28
TP-29
TP-30
TP-31
TP-32
TP-33
TP-34
TP-35
TP-36
APPROXIMATE RECOMMENDED LIMITS
OF IMPERVIOUS CLAYEY BORROW
Job No. 20052

Woodward-Clyde Consultants



N

SCALE: 1" = 200'

LEGEND

■ LOCATION OF TEST PIT

● LOCATION OF SURFACE SOIL SAMPLE

NOTES:

1. TOPOGRAPHIC MAP SHOWN IS A PORTION OF A MAP COMPILED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY TAKEN FEBRUARY 13, 1980 BY BELL MAPPING COMPANY, DENVER, COLORADO.

2. TEST PIT AND SURFACE SOIL SAMPLE LOCATIONS WERE PROVIDED BY BELL MAPPING COMPANY, DENVER, COLORADO.

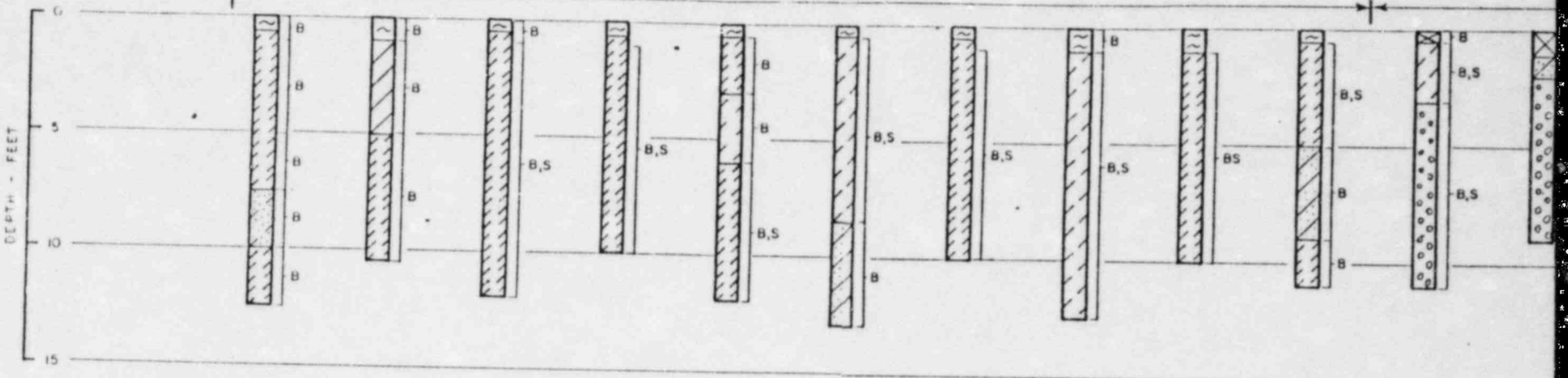
Job No. 20052	Prepared by A J B	Date 7/18/80

LOCATION OF TEST PITS AND SURFACE SOIL SAMPLES

FIG. 2

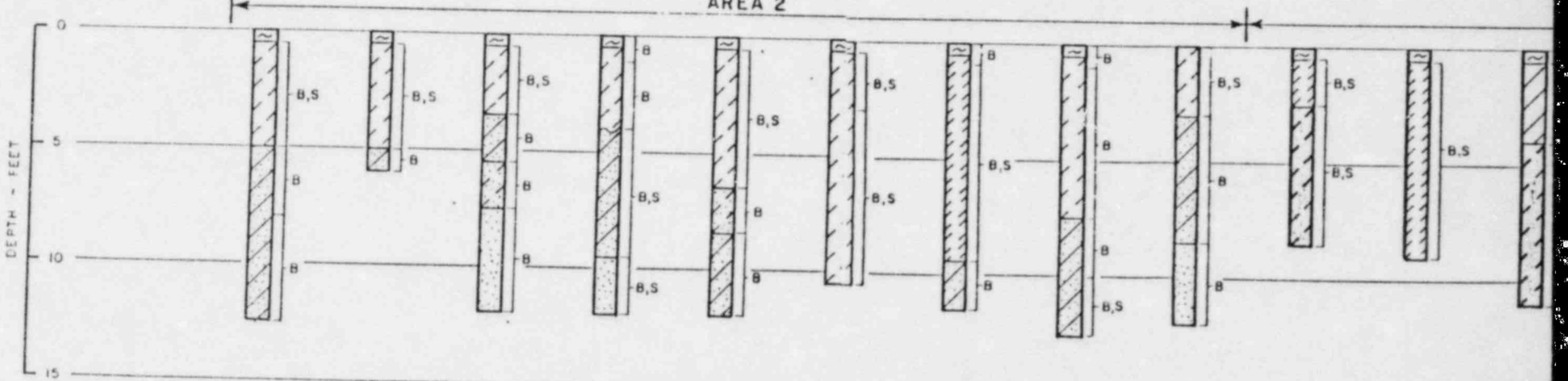
TEST PIT	TP-19	TP-22	TP-17	TP-24	TP-21	TP-16	TP-23	TP-15	TP-25	TP-18	TP-1	TP-
ELEVATION	598	598	599	599	595	595	595	599	599	599	633	63
COORDINATE N	103,301	102,611	102,134	101,619	102,855	102,540	102,025	102,935	102,259	101,868	101,578	101,4
COORDINATE E	97,169	97,073	97,000	96,946	97,252	97,244	97,197	97,465	97,463	97,393	99,473	99,3

AREA 1



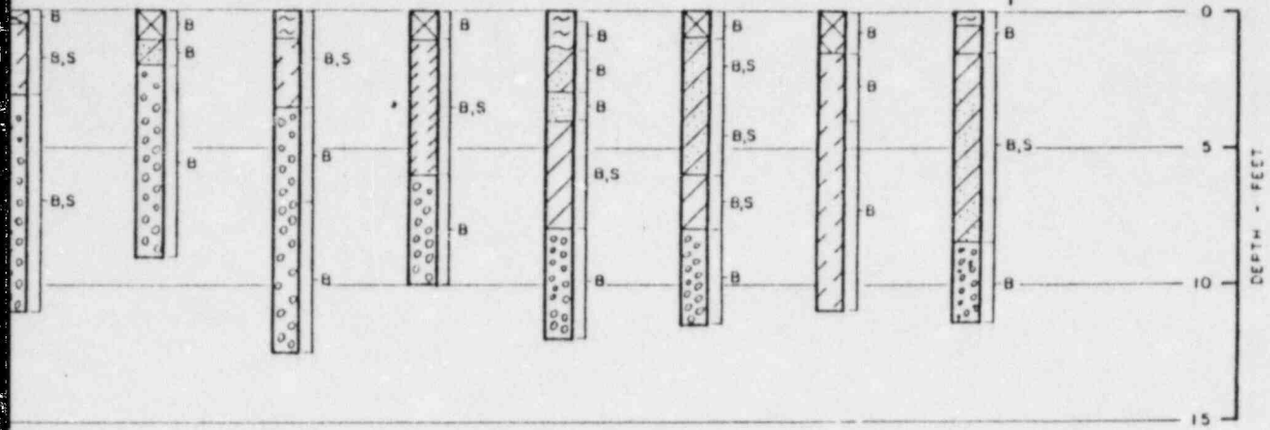
TEST PIT	TP-9	TP-26	TP-11	TP-12	TP-10	TP-27	TP-13	TP-20	TP-14	TP-28	TP-35	TP-2
ELEVATION	620	618	619	618	619	616	620	621	623	674	672	692
COORDINATES N	102,784	102,496	102,168	101,749	102,703	102,538	102,354	102,039	101,523	101,513	101,464	101,64
COORDINATES E	97,790	97,730	97,646	97,683	98,005	97,866	98,008	98,002	98,065	100,258	100,433	100,5

AREA 2



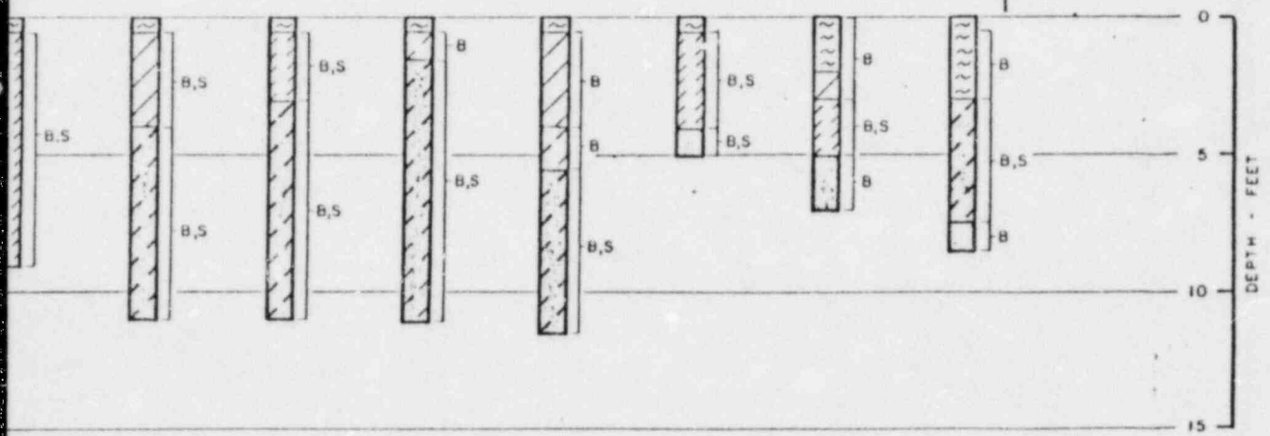
-1	TP-7	TP-5	TP-3	TP-4	TP-2	TP-8	TP-6	
33	63*	633	631	634	631	631	632	TEST PIT / ELEVATION
578	101,419	101,149	101,410	101,251	101,490	101,268	101,090	N
473	99,353	99,295	99,499	99,421	99,633	99,542	99,404	E — COORDINATES

AREA 3



-35	TP-29	TP-36	TP-34	TP-30	TP-33	TP-31	TP-32	
72	692	712	737	741	764	819	820	TEST PIT / ELEVATION
464	101,648	101,441	101,289	101,591	101,252	101,275	100,994	N
433	100,597	100,717	100,642	101,005	100,973	101,332	101,747	E — COORDINATES

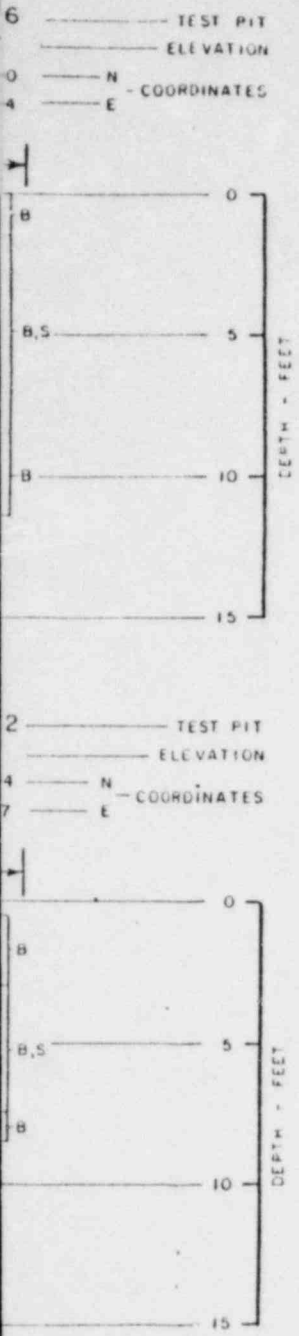
AREA 4



LEGEND

- MAN-MADE FILL, SAND, SILT, CLAY, GRAVELLY, SOME ORGANICS, ASH CINDERS, DRY TO MOIST, GRAY (SM, ML, CL).
- SAND, SILT, CLAY, NUMEROUS ROOTS, SOME ORGA MOIST TO VERY MOIST, BROWN (SM, SC, CL, ML
- CLAY, MEDIUM STIFF TO VERY STIFF, SILTY TO SILTY, SANDY TO VERY SANDY, LOW PLASTICITY, TO VERY MOIST, BROWN, GRAY (CL, CL-ML).
- CLAY, STIFF TO VERY STIFF, SLIGHTLY SANDY SANDY, SILTY, MODERATE TO HIGH PLASTICITY, TO VERY MOIST, BROWN, RED, TAN (CL).
- SILT, MEDIUM DENSE, CLAYEY TO VERY CLAYEY, SANDY TO VERY SANDY, MOIST TO VERY MOIST, (ML).
- SAND, MEDIUM DENSE, CLAYEY TO VERY CLAYEY, MOIST TO VERY MOIST, BROWN (SC).
- SAND, MEDIUM DENSE, SILTY TO VERY SILTY, CL SAND LAYERS, MOIST TO VERY MOIST, BROWN (SM
- SAND, MEDIUM DENSE, CLEAN TO SLIGHTLY SILTY BROWN (SP, SP-SM).
- GRAVEL, MEDIUM DENSE TO DENSE, SANDY TO VER CLEAN TO SLIGHTLY SILTY, MOIST, BROWN (GP,
- CLAYSTONE, MEDIUM HARD TO VERY HARD, THIN S STONE LAYERS, MODERATE TO DIFFICULT TO EXCA WITH BACKHOE, BREAKS DOWN TO SAND, SILT AND SIZED PIECES DUPING EXCAVATION WITH BACKHOE MODERATE TO HIGH PLASTICITY, MOIST TO VERY RED, TAN (BEDROCK).
- CLAYSTONE, HARD TO VERY HARD, VERY SILTY TO SANDY, DIFFICULT TO EXCAVATE WITH BACKHOE. DOWN TO COBBLE, GRAVEL AND SAND SIZED PIECE EXCAVATION WITH BACKHOE, MODERATE PLASTICIT TAN, BROWN (BEDROCK).

Job No. 20052



LEGEND

MAN-MADE FILL, SAND, SILT, CLAY, GRAVELLY, ROOTS, SOME ORGANICS, ASH CINDERS, DRY TO MOIST, BROWN, GRAY (SM, ML, CL).

SAND, SILT, CLAY, NUMEROUS ROOTS, SOME ORGANICS, MOIST TO VERY MOIST, BROWN (SM, SC, CL, ML).

CLAY, MEDIUM STIFF TO VERY STIFF, SILTY TO VERY SILTY, SANDY TO VERY SANDY, LOW PLASTICITY, MOIST TO VERY MOIST, BROWN, GRAY (CL, CL-ML).

CLAY, STIFF TO VERY STIFF, SLIGHTLY SANDY TO VERY SANDY, SILTY, MODERATE TO HIGH PLASTICITY, MOIST TO VERY MOIST, BROWN, RED, TAN (CL).

SILT, MEDIUM DENSE, CLAYEY TO VERY CLAYEY, SLIGHTLY SANDY TO VERY SANDY, MOIST TO VERY MOIST, BROWN (ML).

SAND, MEDIUM DENSE, CLAYEY TO VERY CLAYEY, SILTY, MOIST TO VERY MOIST, BROWN (SC).

SAND, MEDIUM DENSE, SILTY TO VERY SILTY, CLAYEY SAND LAYERS, MOIST TO VERY MOIST, BROWN (SM).

SAND, MEDIUM DENSE, CLEAN TO SLIGHTLY SILTY, MOIST, BROWN (SP, SP-SM).

GRAVEL, MEDIUM DENSE TO DENSE, SANDY TO VERY SANDY, CLEAN TO SLIGHTLY SILTY, MOIST, BROWN (GP, GP-GM).

CLAYSTONE, MEDIUM HARD TO VERY HARD, THIN SILTSTONE LAYERS, MODERATE TO DIFFICULT TO EXCAVATE WITH BACKHOE, BREAKS DOWN TO SAND, SILT AND CLAY SIZED PIECES DUPING EXCAVATION WITH BACKHOE, MODERATE TO HIGH PLASTICITY, MOIST TO VERY MOIST, RED, TAN (BEDROCK).

CLAYSTONE, HARD TO VERY HARD, VERY SILTY TO SILTY, SANDY, DIFFICULT TO EXCAVATE WITH BACKHOE, BREAKS DOWN TO COBBLE, GRAVEL AND SAND SIZED PIECES DURING EXCAVATION WITH BACKHOE, MODERATE PLASTICITY, MOIST, TAN, BROWN (BEDROCK).

B — INDICATES SMALL BAG SAMPLE TAKEN FROM DEPTH INTERVAL SHOWN.

S — INDICATES LARGE SACK SAMPLE TAKEN FROM DEPTH INTERVAL SHOWN.

NOTES:

1. TEST PITS WERE EXCAVATED BETWEEN JUNE 24 AND JULY 3, 1980 WITH A MODEL 3500A INTERNATIONAL HARVESTER BACKHOE EQUIPPED WITH A 30-INCH WIDE BUCKET.
2. SURVEYED TEST PIT LOCATIONS AND ELEVATIONS WERE PROVIDED BY BELL MAPPING COMPANY, DENVER, COLORADO.
3. TEST PITS WERE DRY AT THE TIME OF EXCAVATION.
4. TEST PIT LOGS IN THIS REPORT ARE SUBJECT TO LIMITATIONS, EXPLANATIONS AND CONCLUSIONS OF THIS REPORT.
5. THESE TEST PIT LOGS SUMMARIZE FINDINGS RELIED ON IN FORMULATING THE DESIGN CRITERIA PRESENTED IN THIS REPORT. THE EXPLORATIONS WERE NOT MADE TO DEFINE CONDITIONS FOR CONSTRUCTION NOR IS THE INFORMATION PRESENTED HEREIN FOR THAT PURPOSE.

Job No. 20052	Prepared by: A J B	Date: 7/7/80

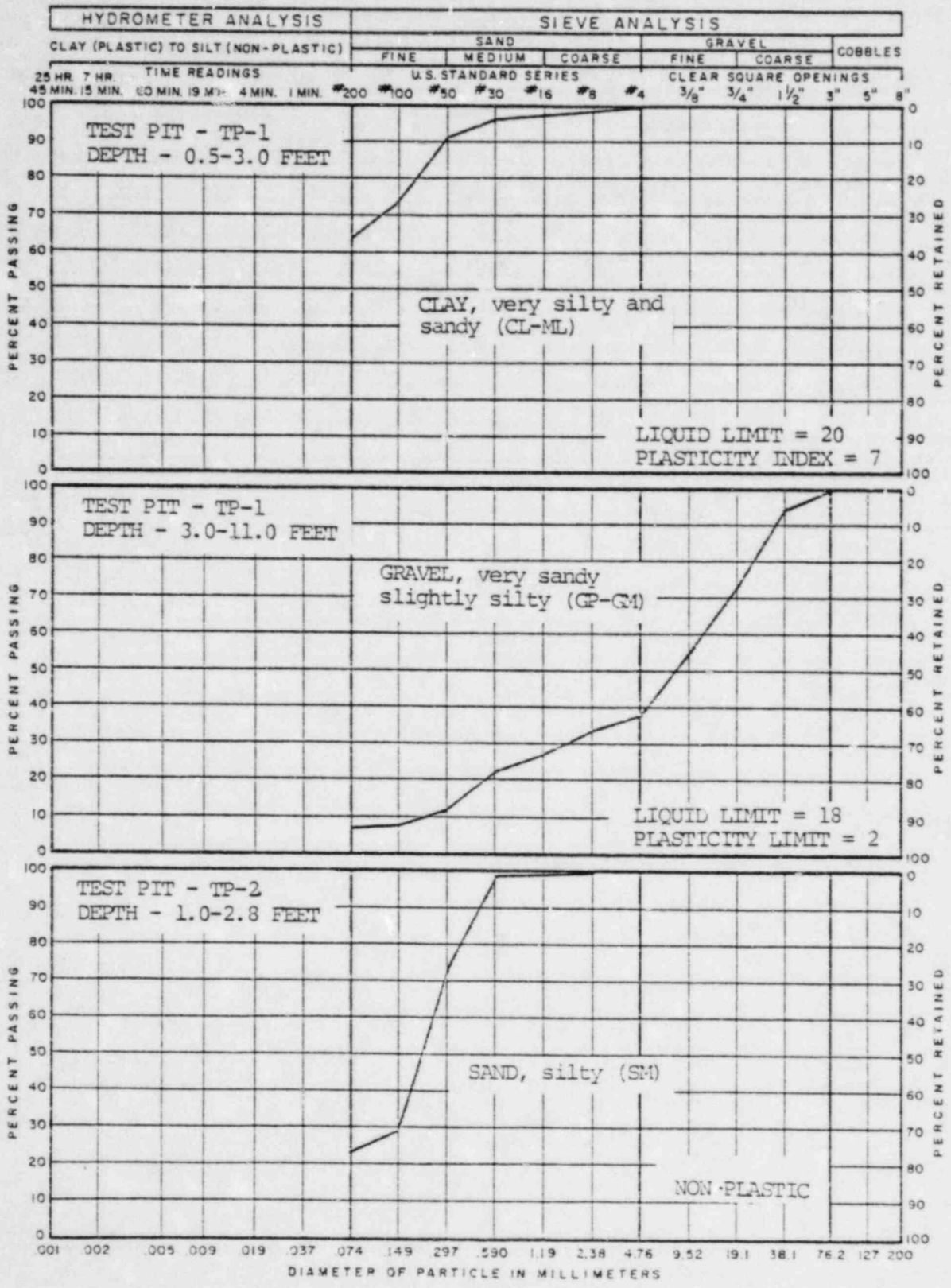
SUMMARY LOGS OF TEST PITS

FIG. 3

WOODWARD - CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

ROCKY MOUNTAIN REGION



GRADATION ANALYSIS

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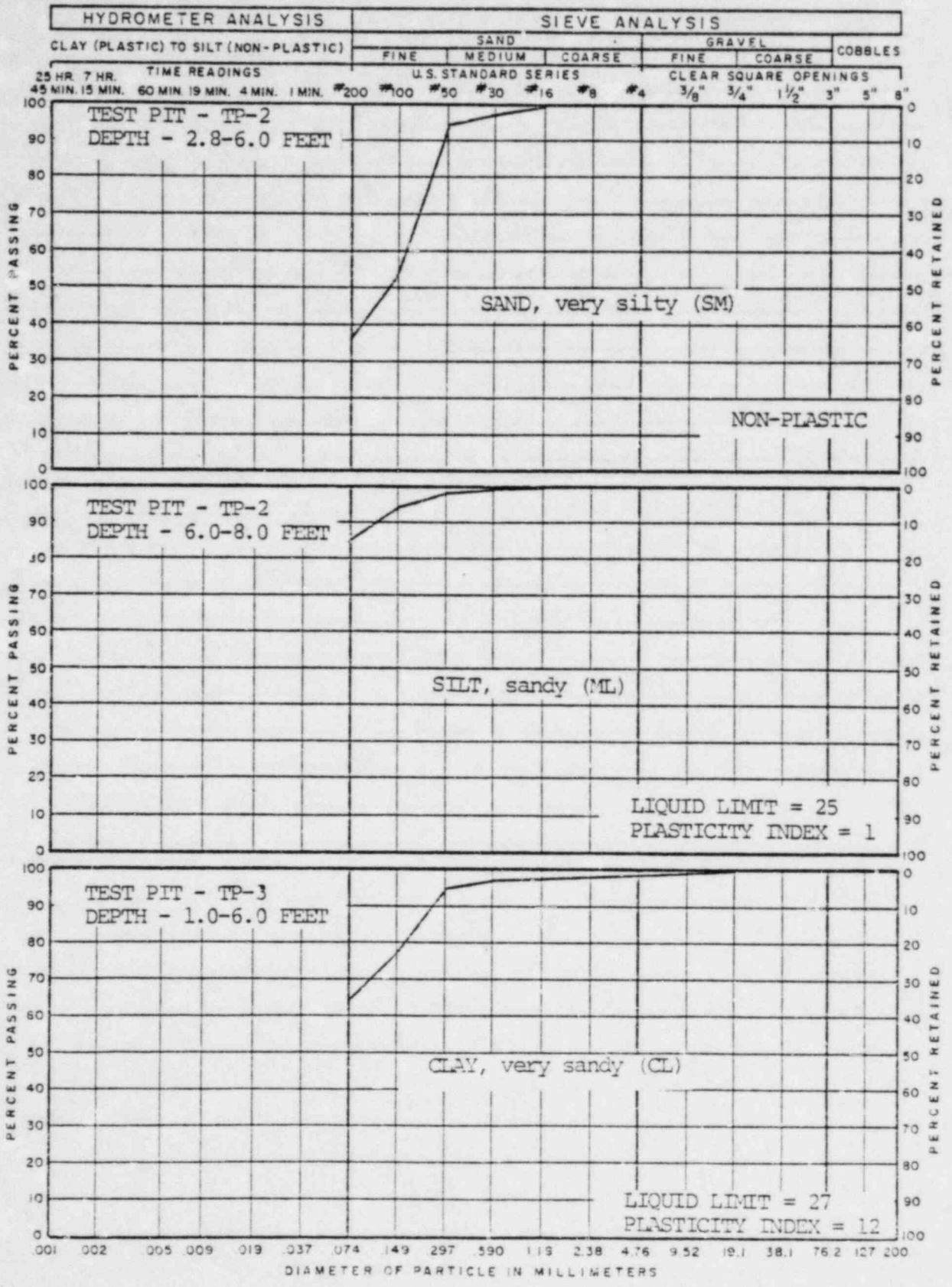
FIG. 4

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

ROCKY MOUNTAIN REGION



GRADATION ANALYSIS

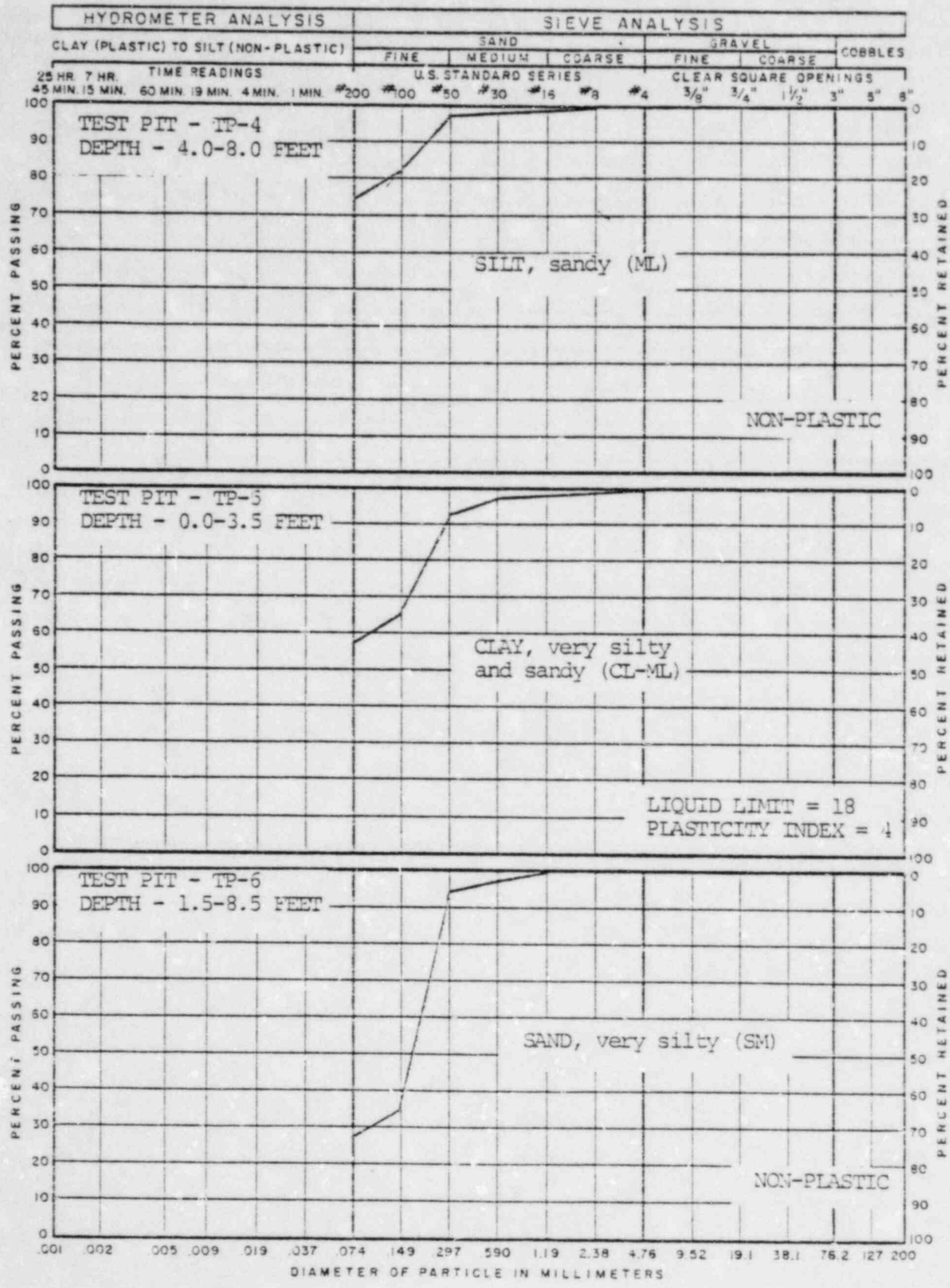
JOB NO. 20052

FIG. 5

WOODWARD - CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

ROCKY MOUNTAIN REGION



GRADATION ANALYSIS

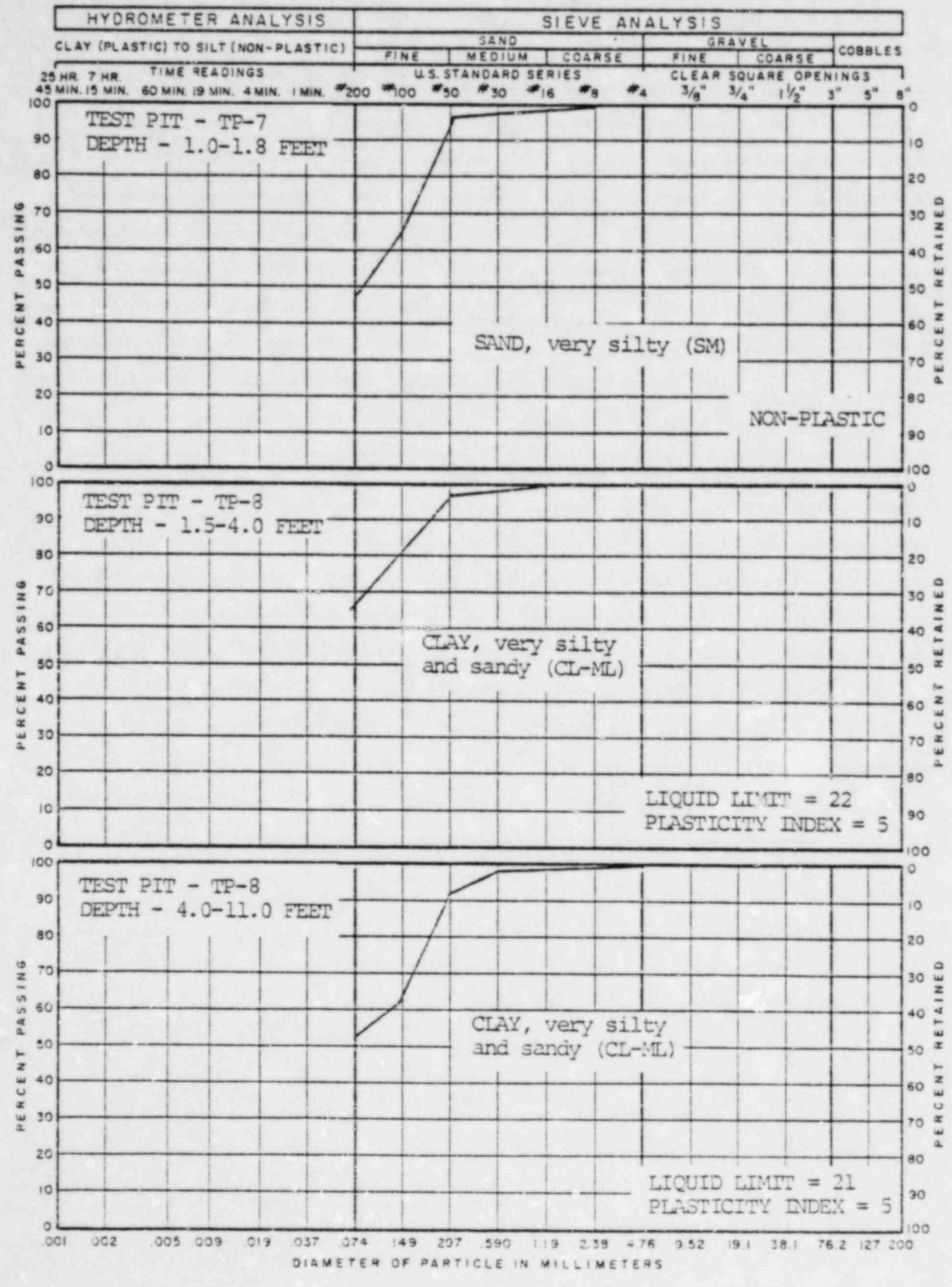
JOB NO. 20052

FIG. 6

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

ROCKY MOUNTAIN REGION



GRADATION ANALYSIS

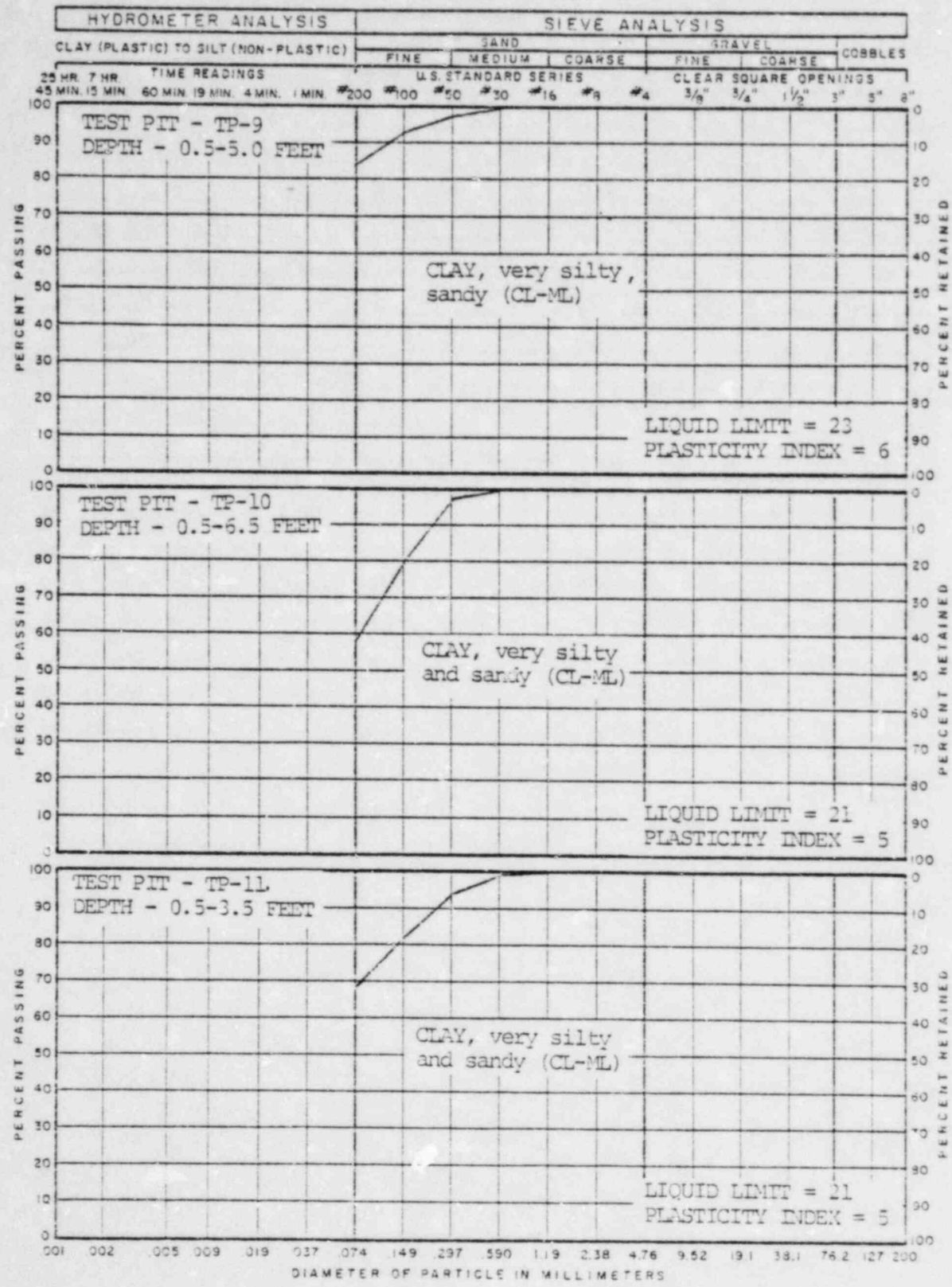
JOB NO. 20052

FIG. 7

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

ROCKY MOUNTAIN REGION



GRADATION ANALYSIS

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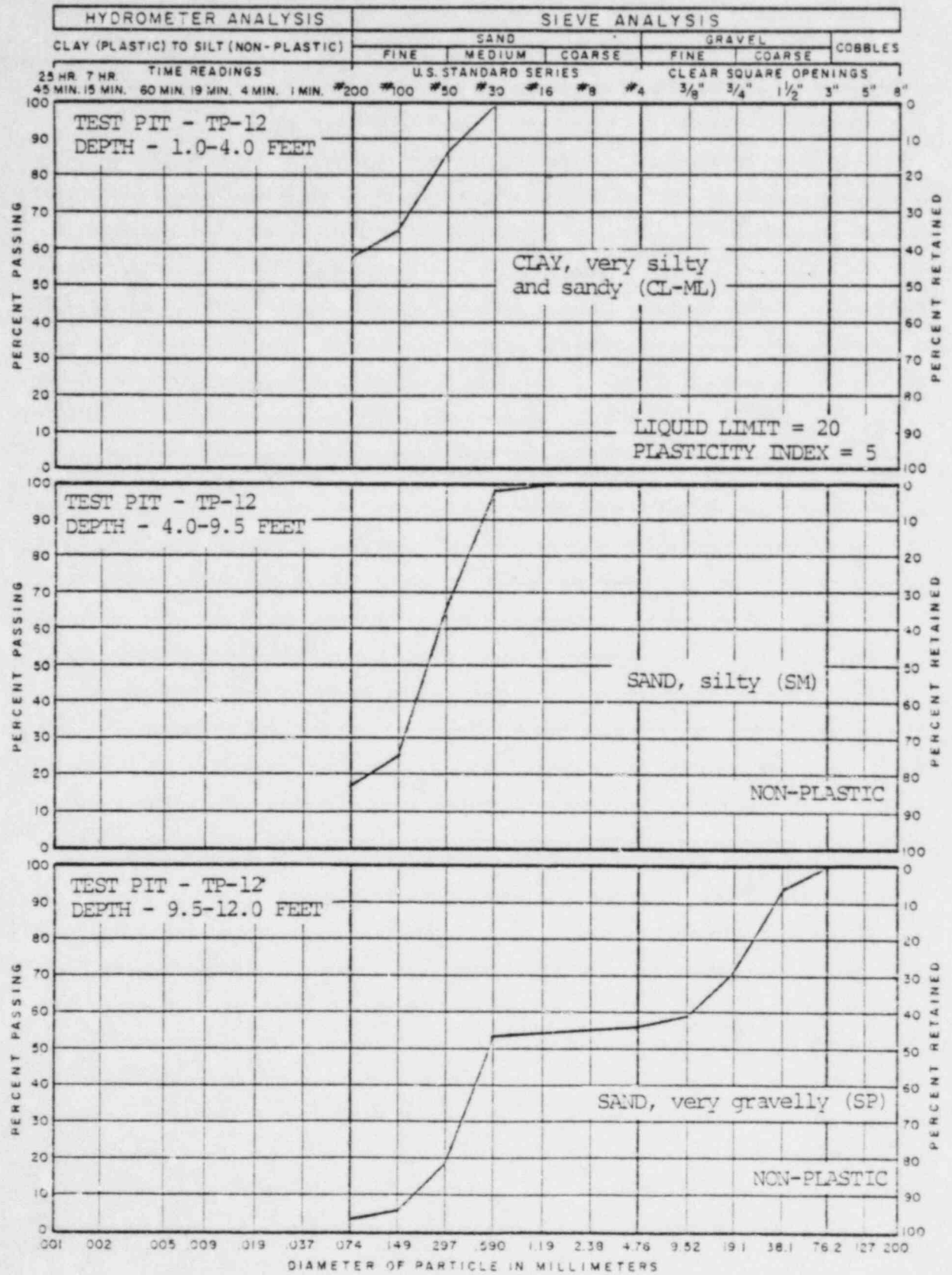
FIG. 8

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

ROCKY MOUNTAIN REGION



GRADATION ANALYSIS

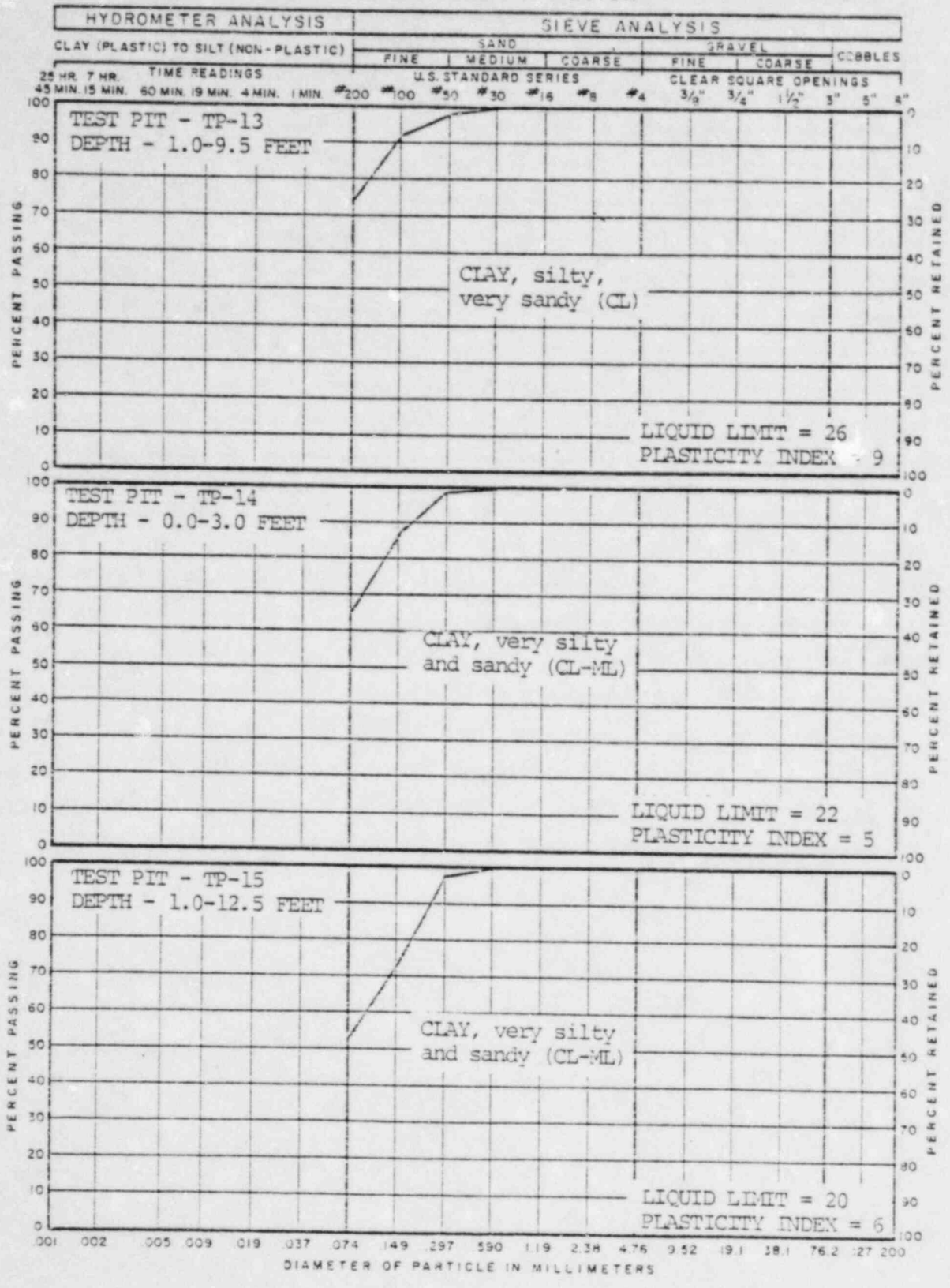
JOB NO. 20052

FIG. 9

WOODWARD - CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

ROCKY MOUNTAIN REGION



GRADATION ANALYSIS

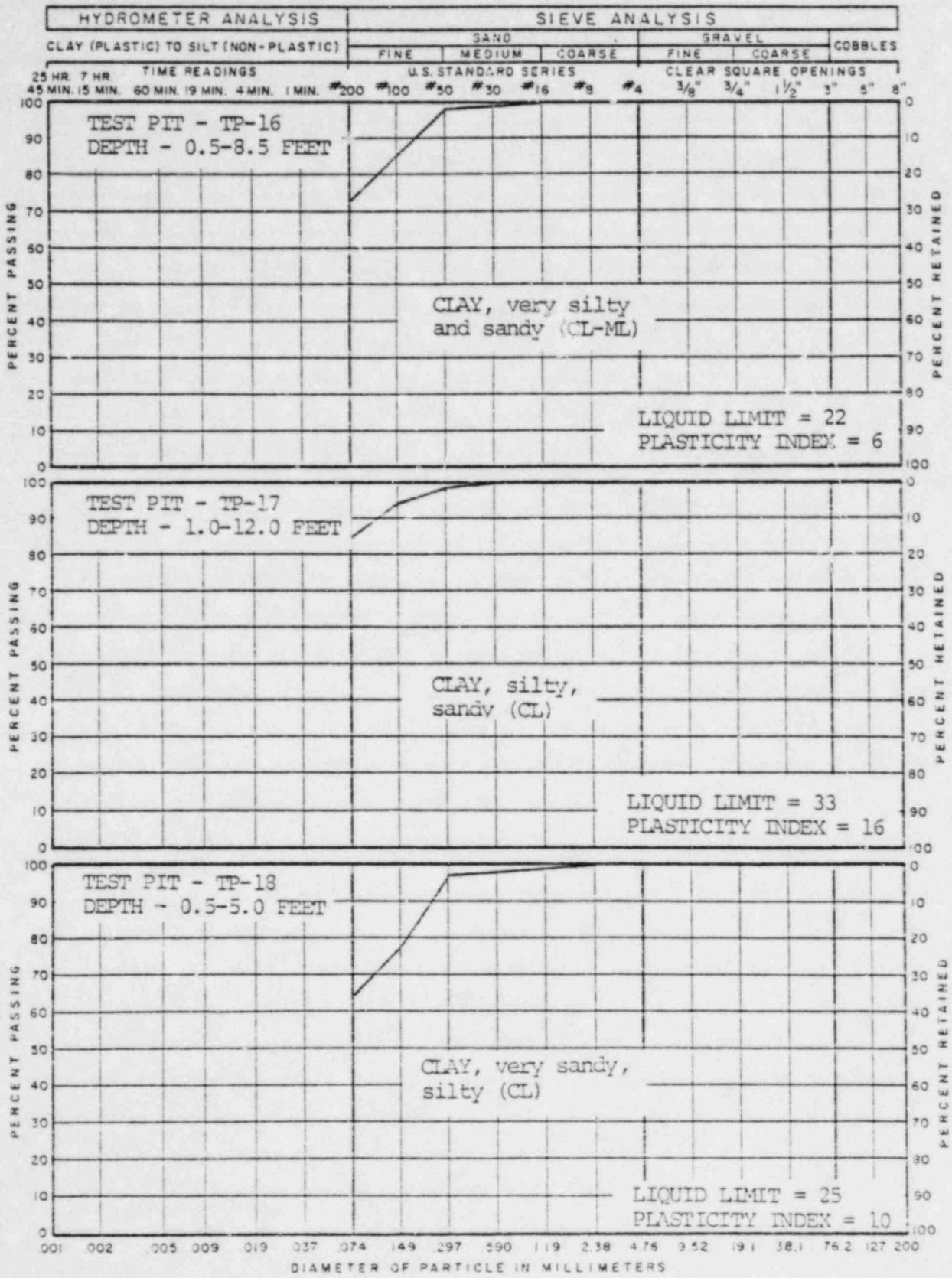
JOB NO. 20052

FIG. 10

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

ROCKY MOUNTAIN REGION



GRADATION ANALYSIS

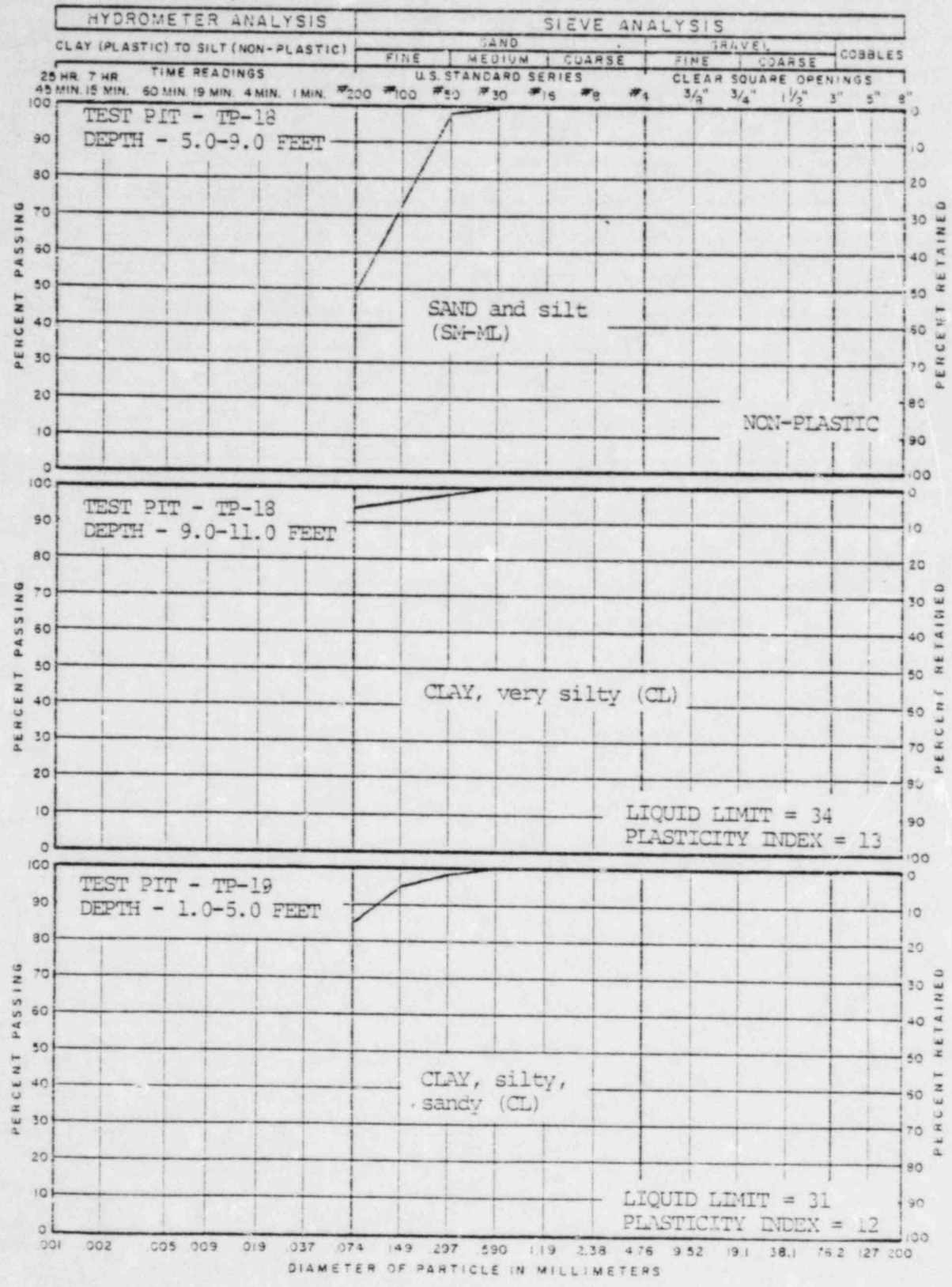
JOB NO. 20052

FIG. 11

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

ROCKY MOUNTAIN REGION



GRADATION ANALYSIS

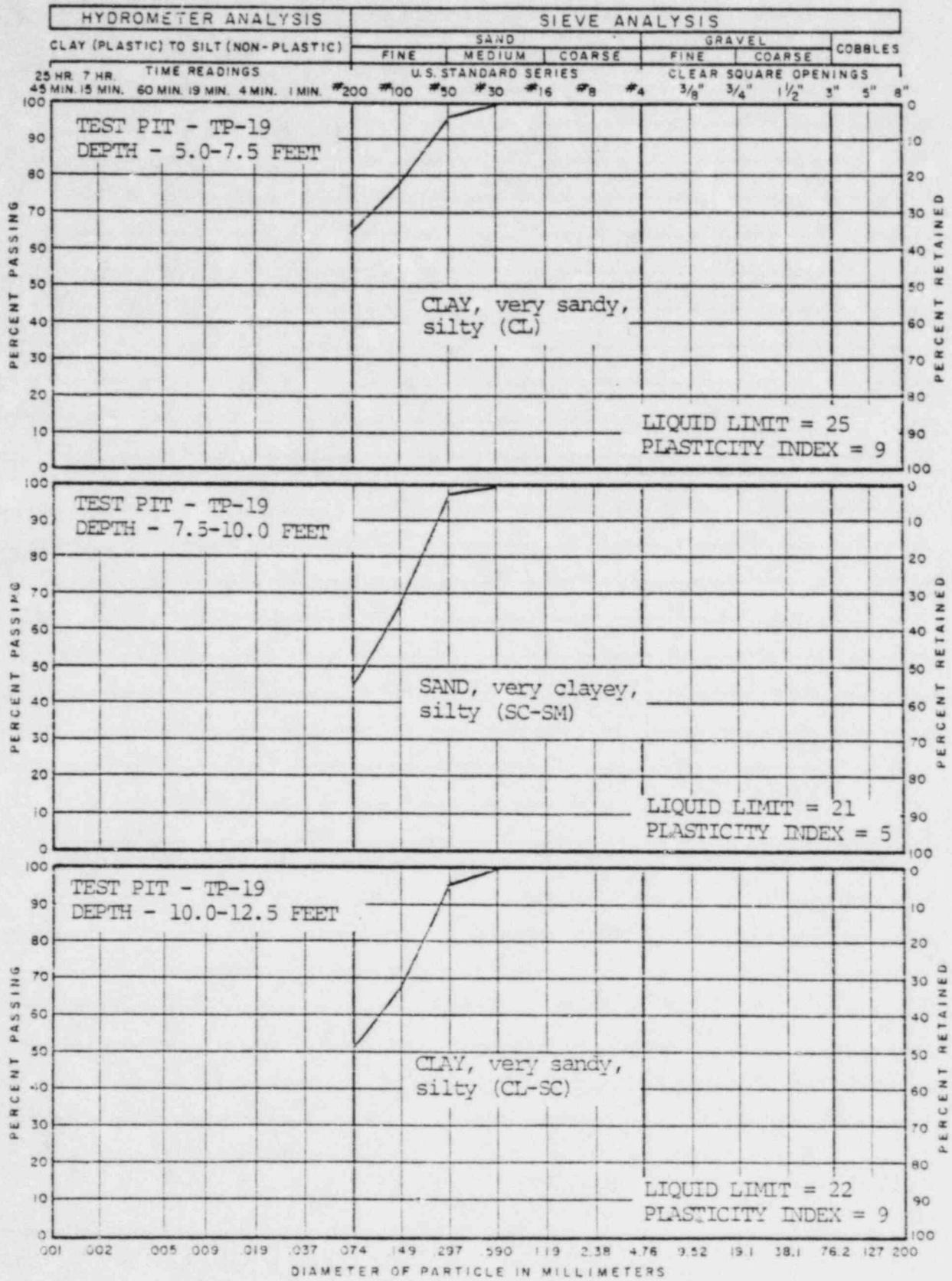
JOB NO. 20052

FIG. 12

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

ROCKY MOUNTAIN REGION



GRADATION ANALYSIS

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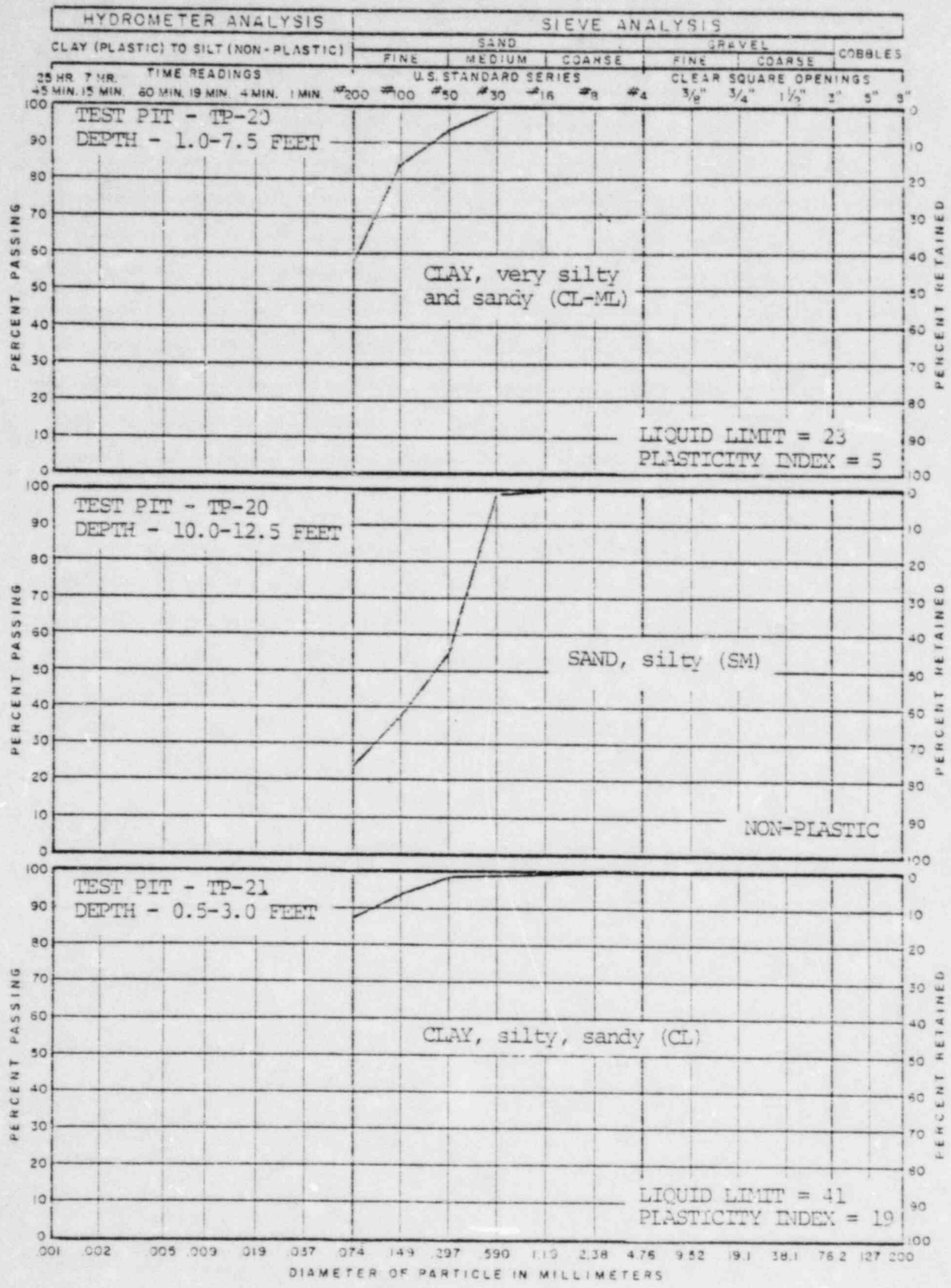
FIG. 13

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

ROCKY MOUNTAIN REGION



GRADATION ANALYSIS

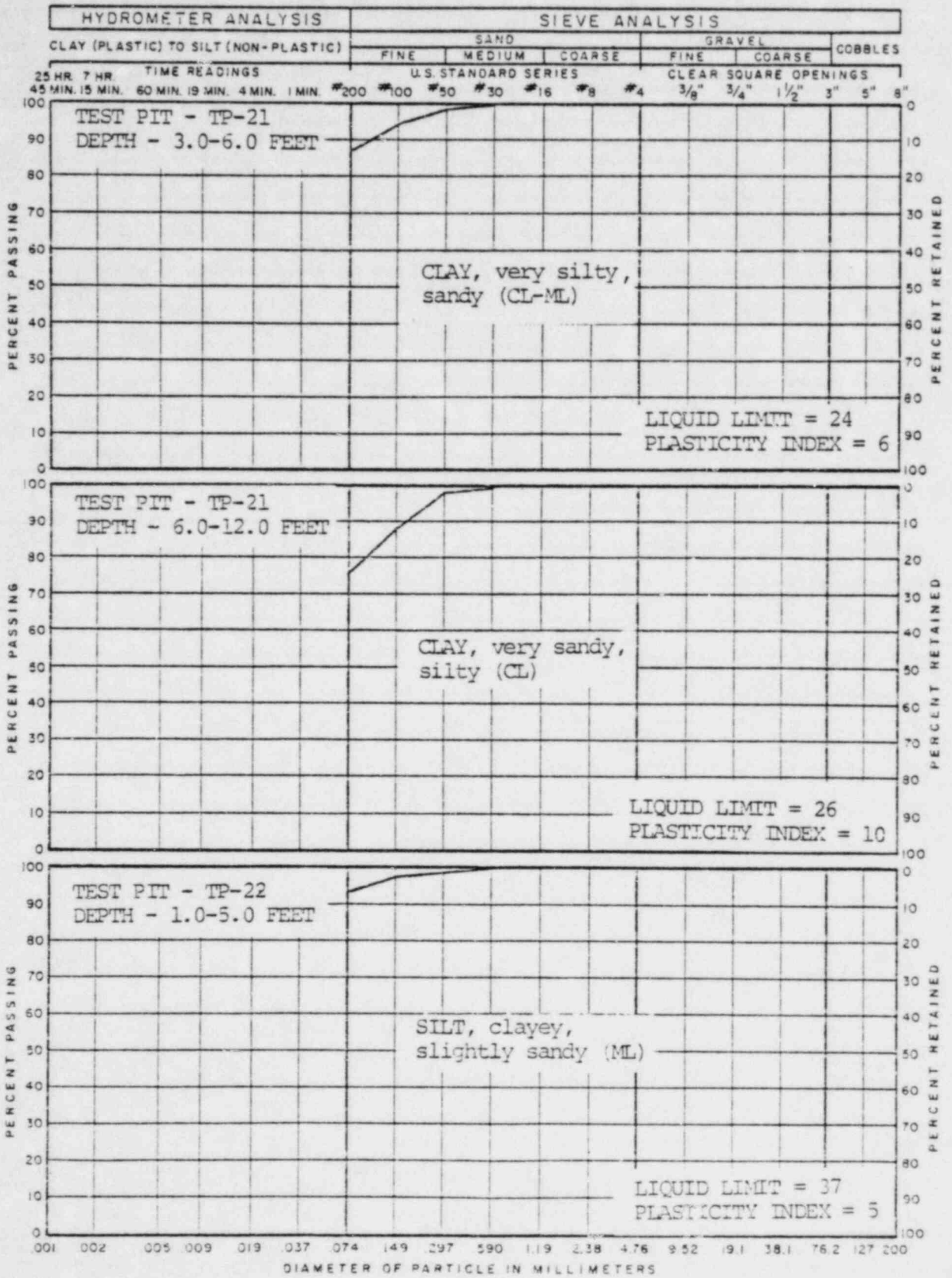
JOB NO. 20052

FIG. 14

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

ROCKY MOUNTAIN REGION



GRADATION ANALYSIS

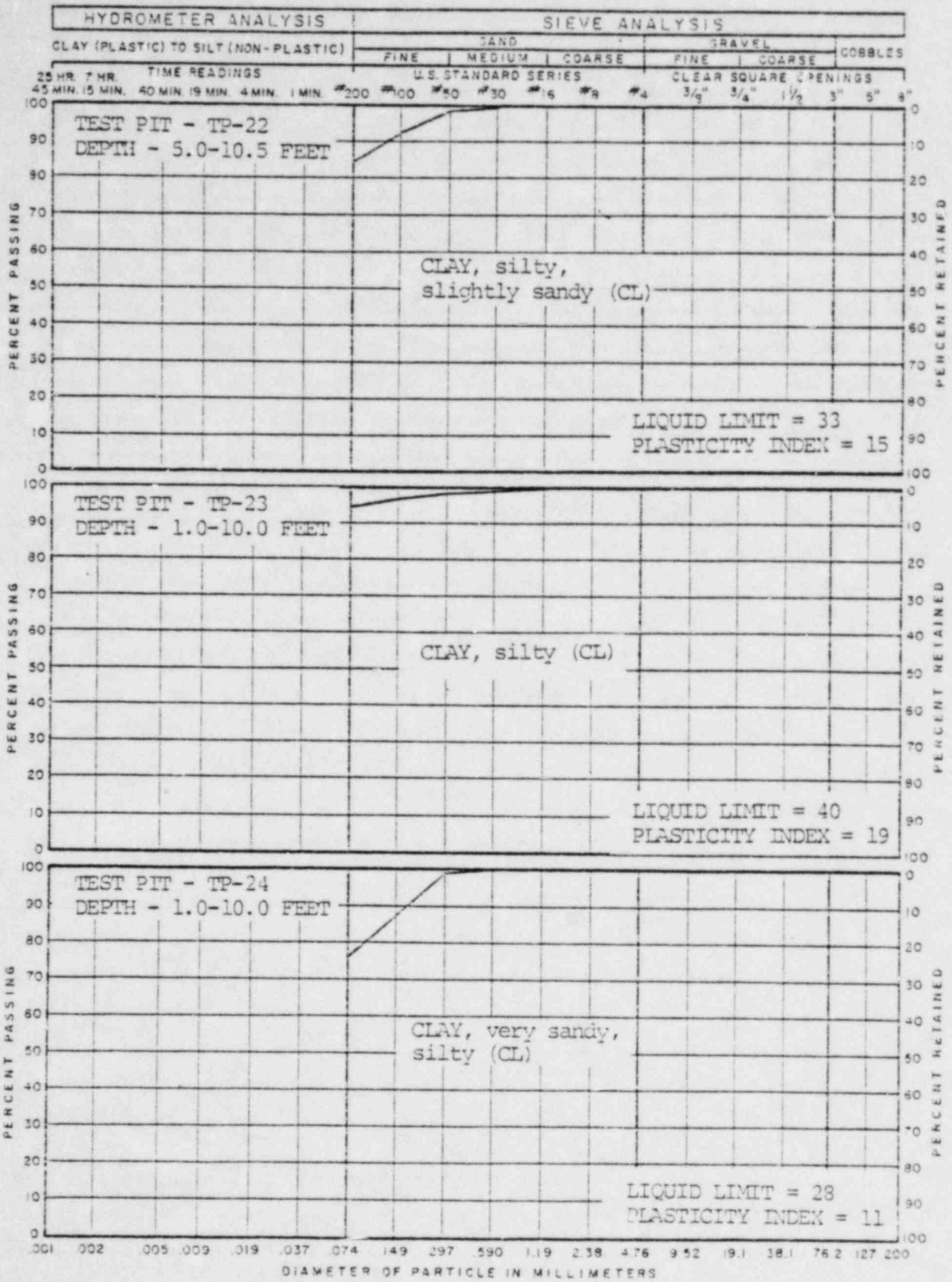
JOB NO. 20052

FIG. 15

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

ROCKY MOUNTAIN REGION



GRADATION ANALYSIS

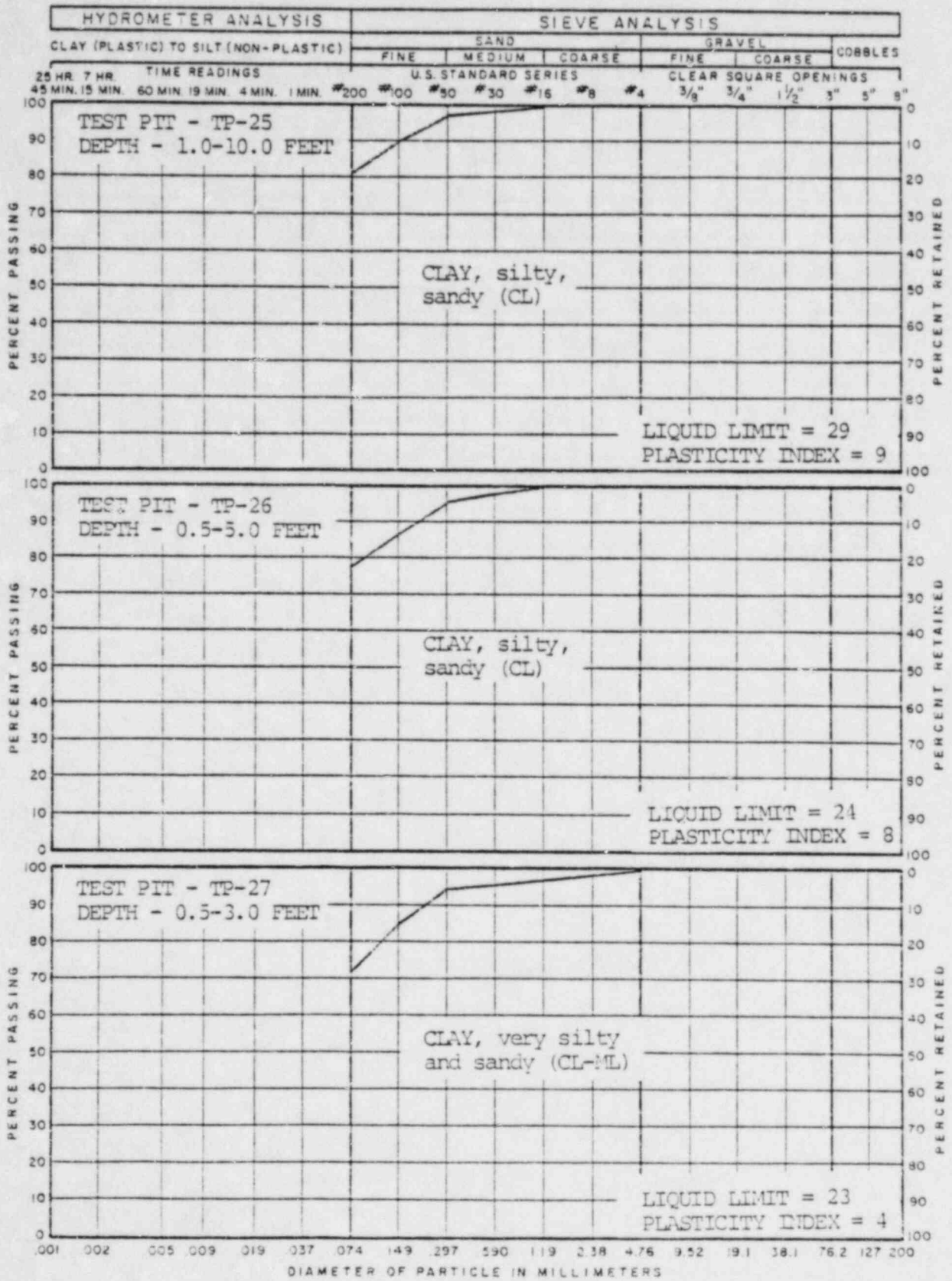
JOB NO. 20052

FIG. 16

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

ROCKY MOUNTAIN REGION



GRADATION ANALYSIS

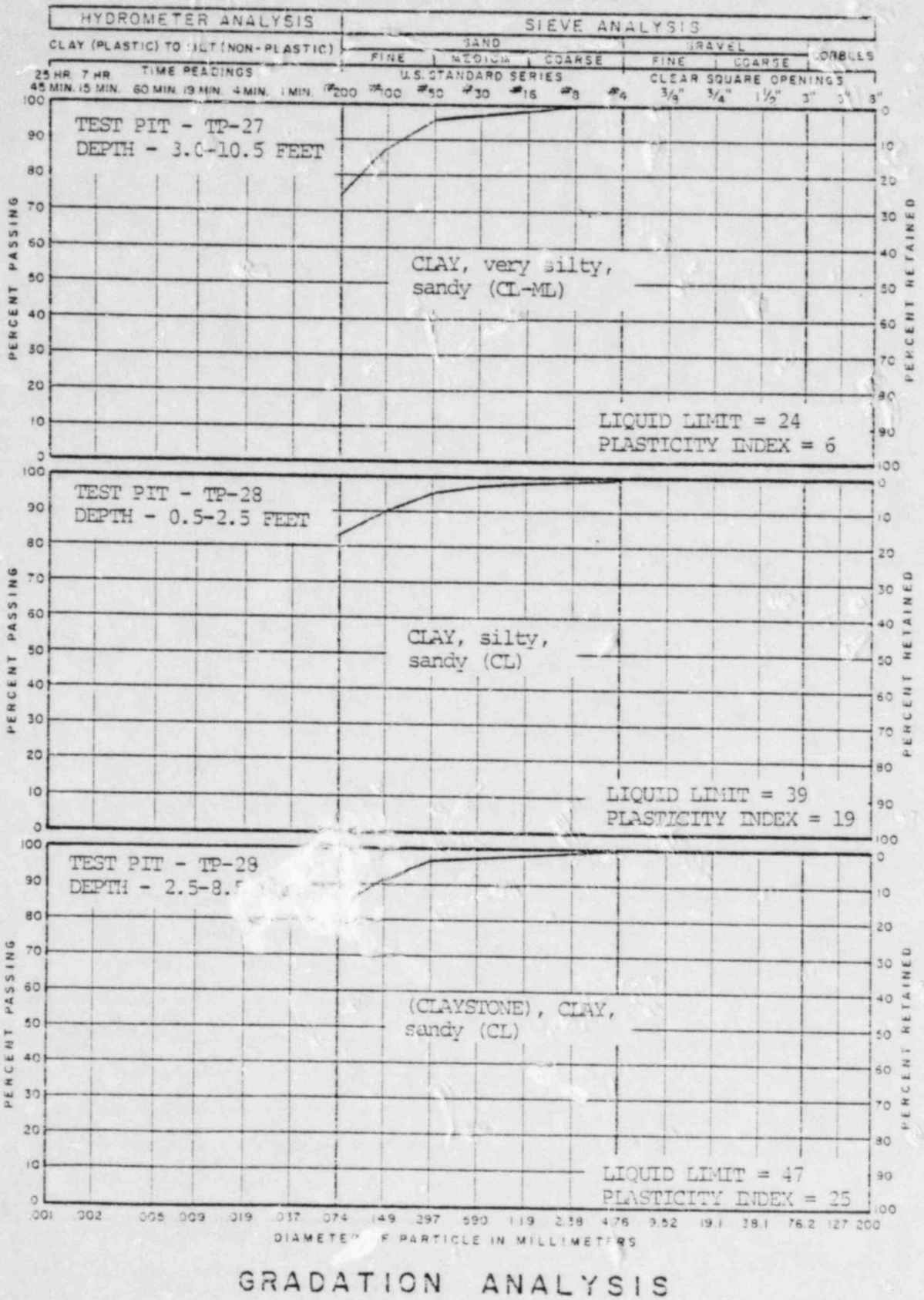
JOB NO. 20052

FIG. 17

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

ROCKY MOUNTAIN REGION



GRADATION ANALYSIS

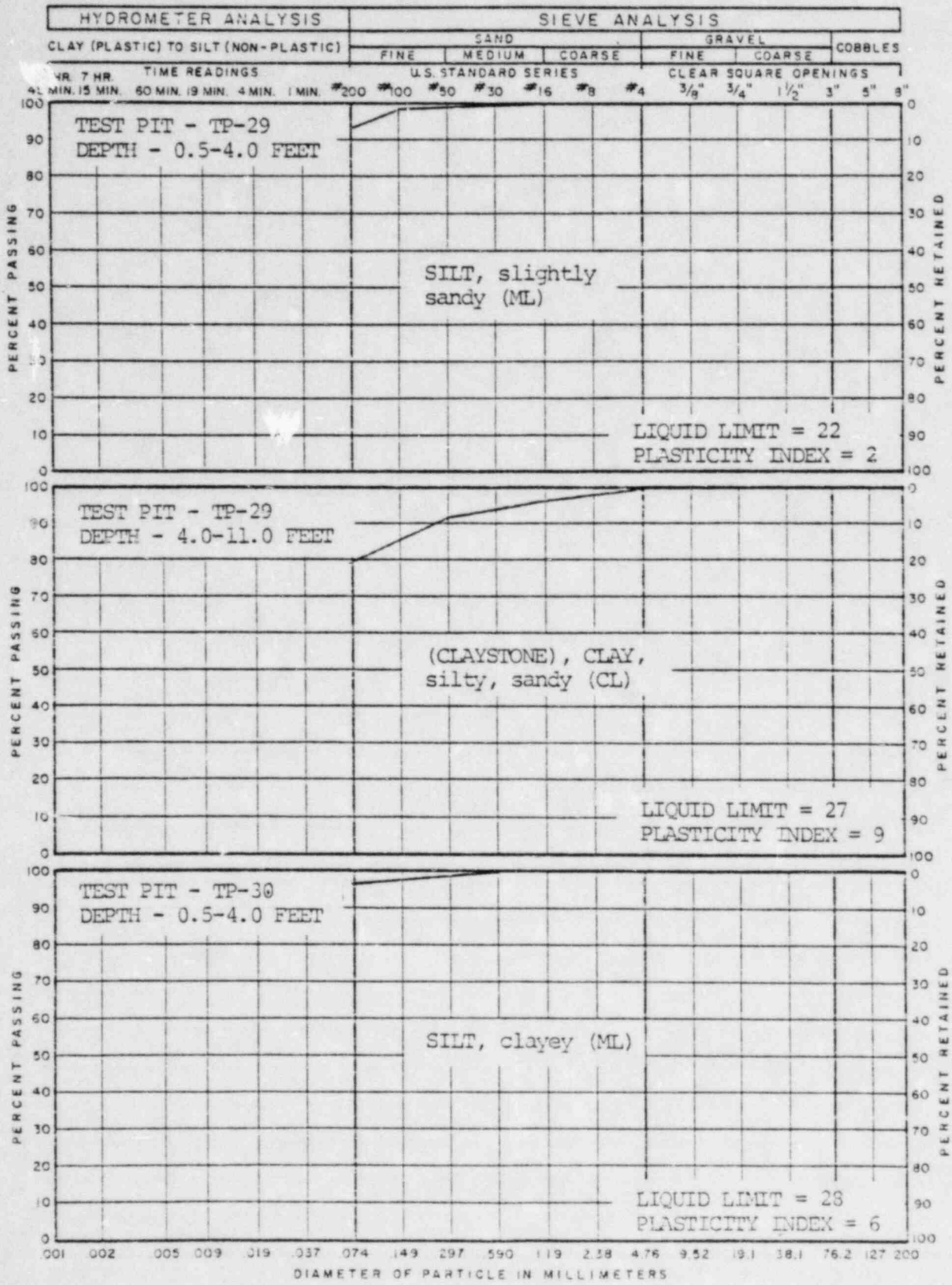
JOB NO. 20052

FIG. 18

WOODWARD - CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

ROCKY MOUNTAIN REGION



GRADATION ANALYSIS

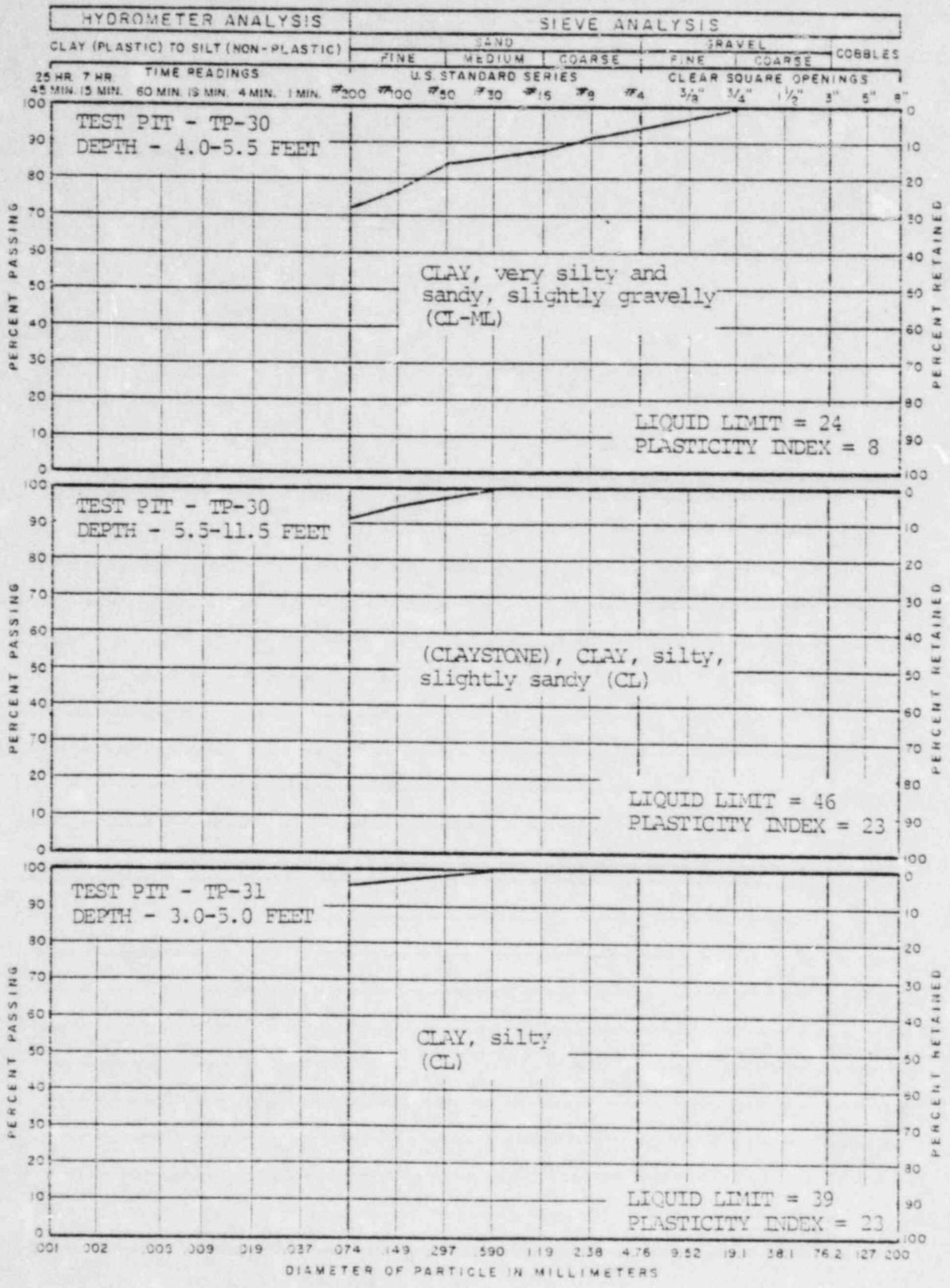
JOB NO. 20052

FIG. 19

WOODWARD - CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

ROCKY MOUNTAIN REGION



GRADATION ANALYSIS

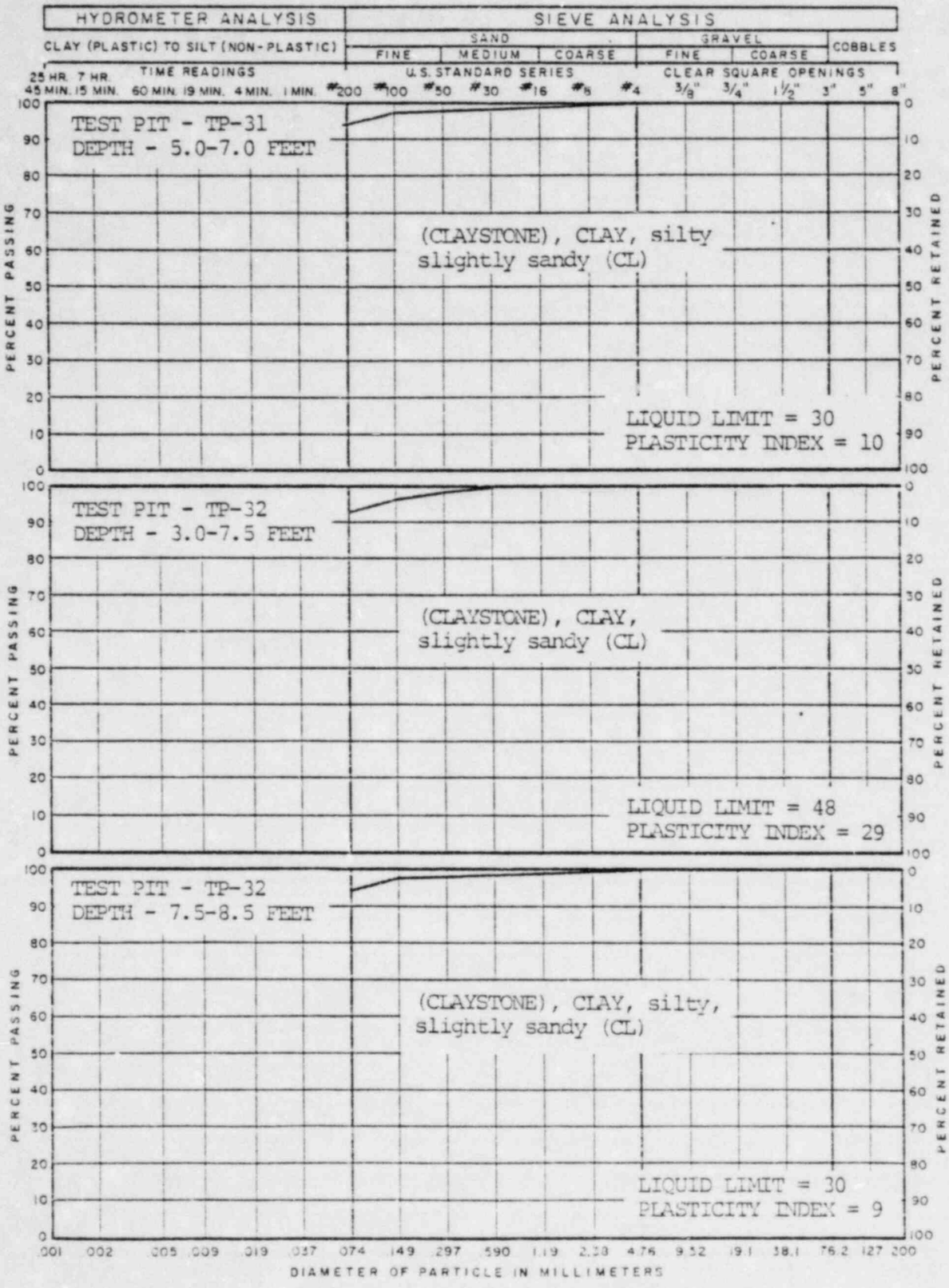
JOB NO. 20052

FIG. 20

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

ROCKY MOUNTAIN REGION



GRADATION ANALYSIS

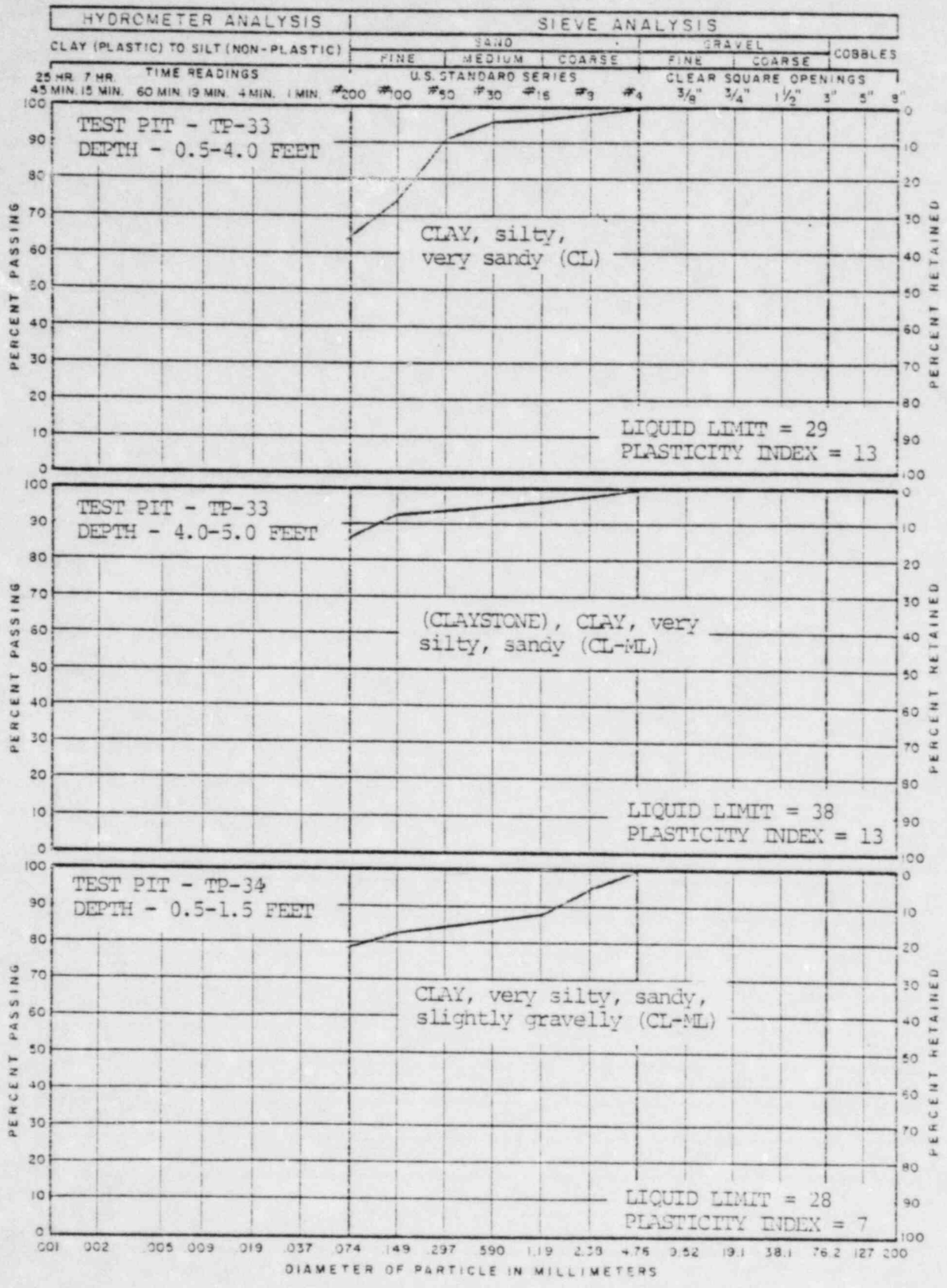
JOB NO. 20052

FIG. 21

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

ROCKY MOUNTAIN REGION



GRADATION ANALYSIS

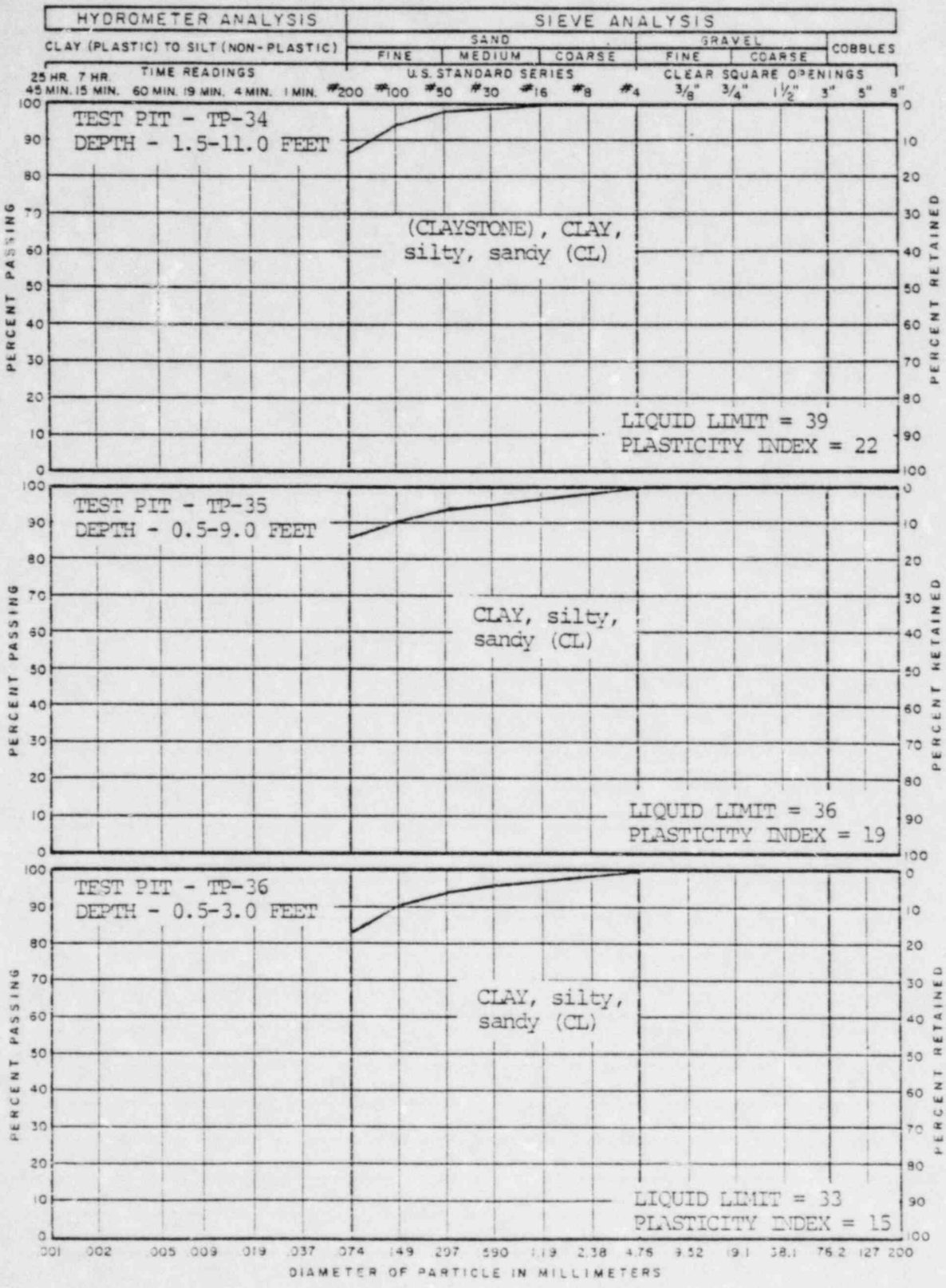
JOB NO. 20052

FIG. 22

WOODWARD - CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

ROCKY MOUNTAIN REGION



GRADATION ANALYSIS

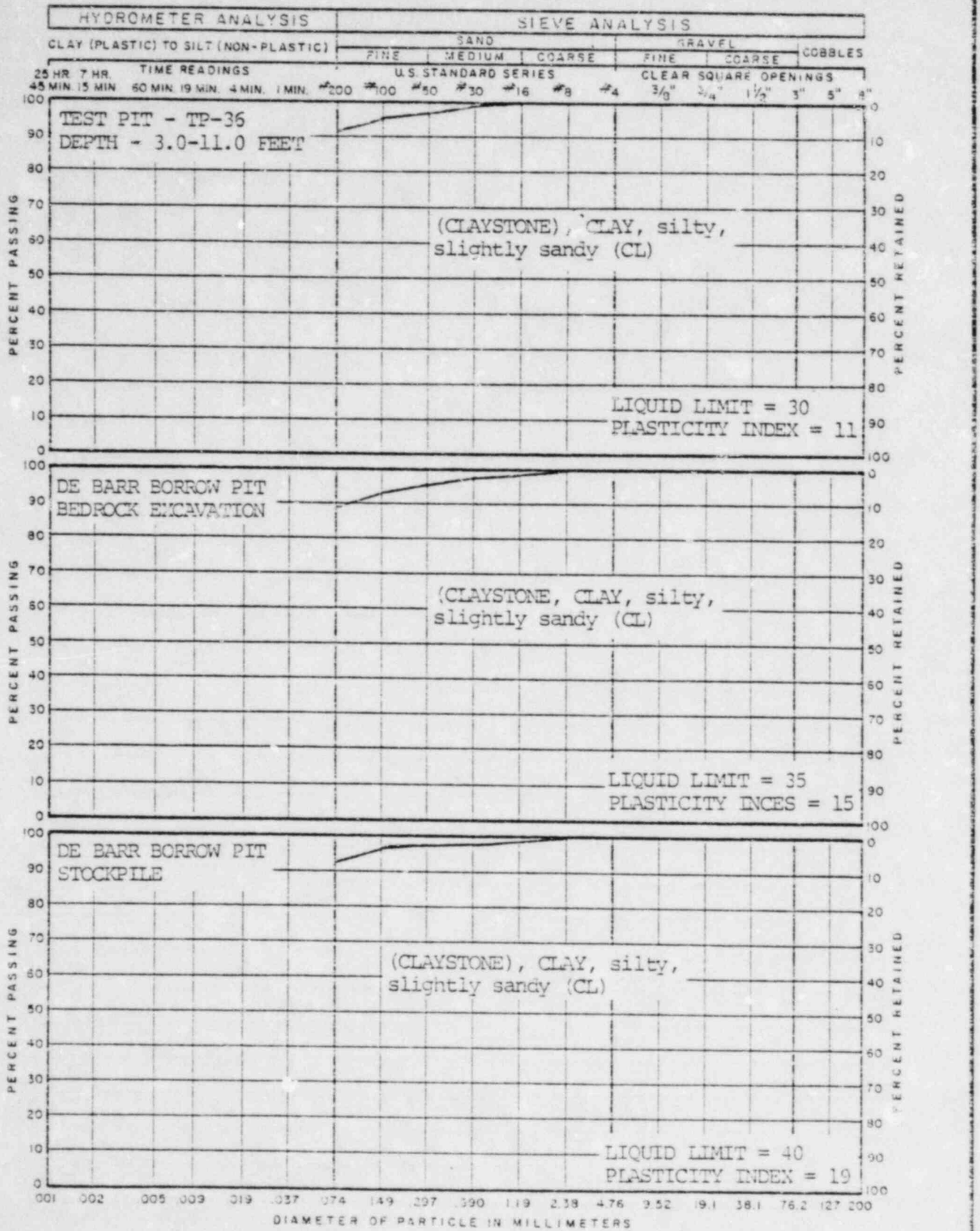
JOB NO. 20052

FIG. 23

WOODWARD - CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

ROCKY MOUNTAIN REGION



GRADATION ANALYSIS

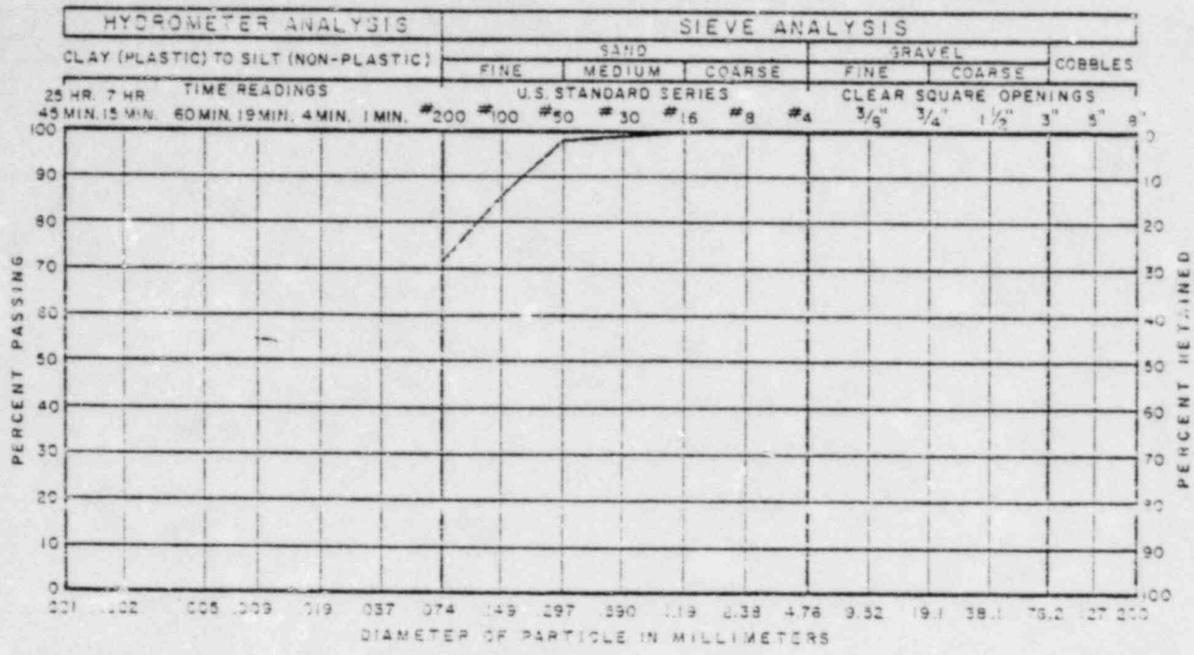
JOB NO. 20052

FIG. 24

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

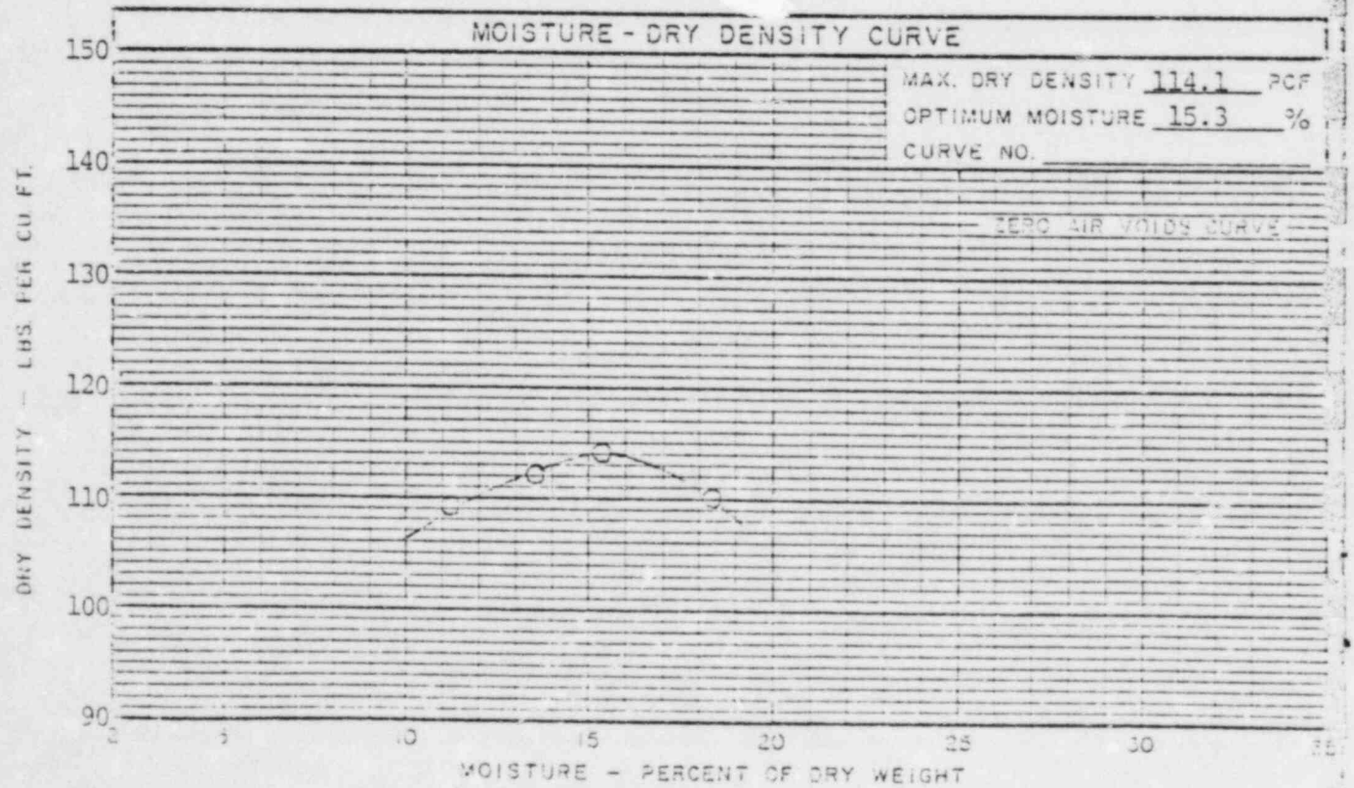
ROCKY MOUNTAIN REGION



GRAVEL 0 % SAND 27.5 % SILT AND CLAY 72.5 %

LIQUID LIMIT 22 % PLASTICITY INDEX 6 %

GRADATION TEST RESULTS



COMPACTION TEST PROCEDURE ASTM-D-698-78 METHOD A

JOB NO. 20052

COMPACTION TEST RESULTS

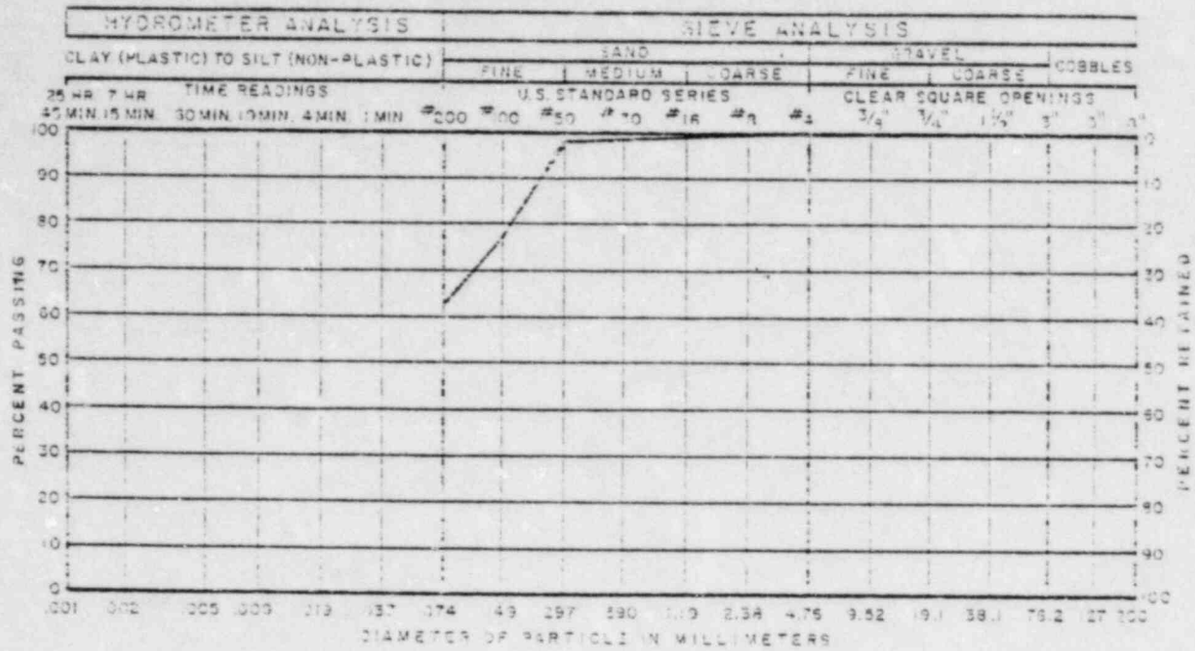
SAMPLE OF CLAY, very silty and sandy (CL-ML) FROM TEST PIT - TP-16 DEPTH 0.5-8.5 FEET

FIG. 25

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

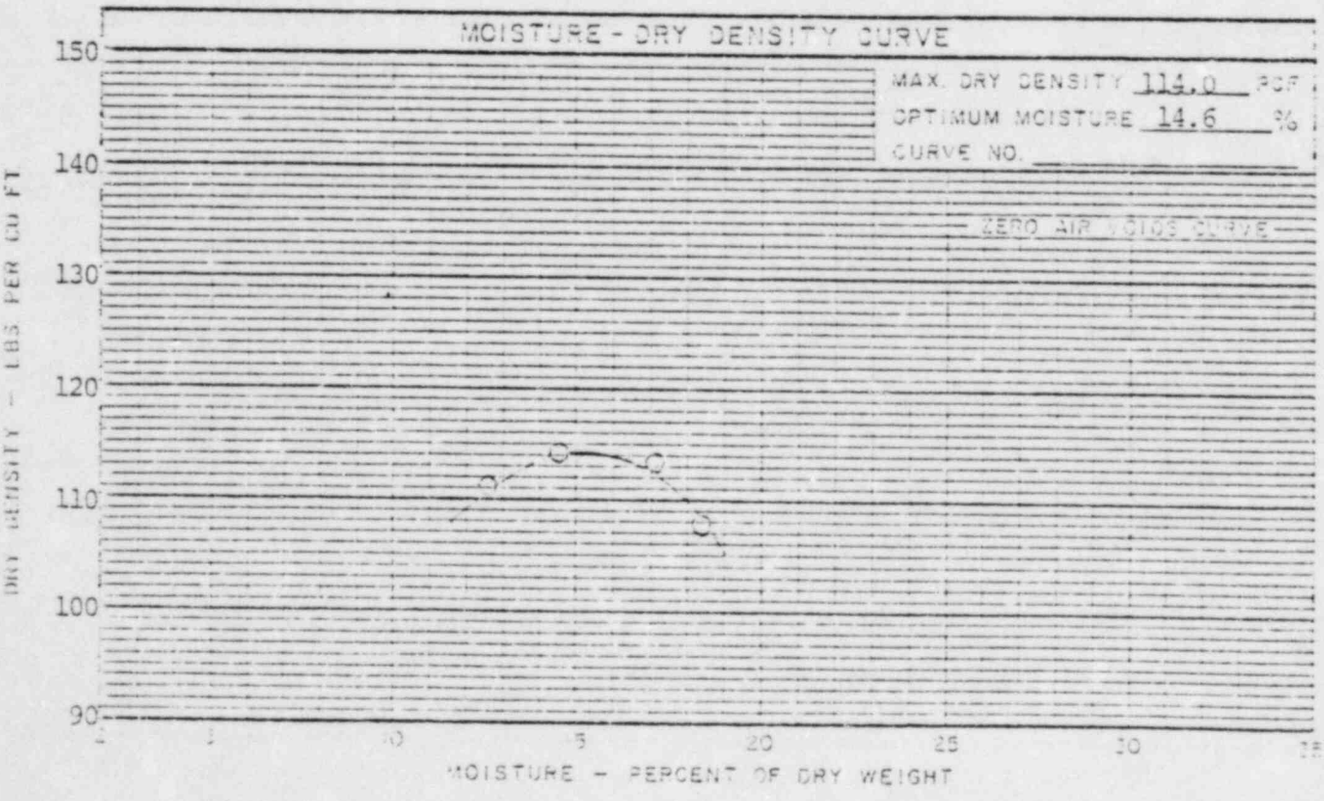
ROCKY MOUNTAIN REGION



GRAVEL 0 % SAND 36.3 % SILT AND CLAY 63.7 %

LIQUID LIMIT 25 % PLASTICITY INDEX 10 %

GRADATION TEST RESULTS



COMPACTION TEST PROCEDURE ASTM-D-698-78 METHOD A

COMPACTION TEST RESULTS

JOB NO. 20052

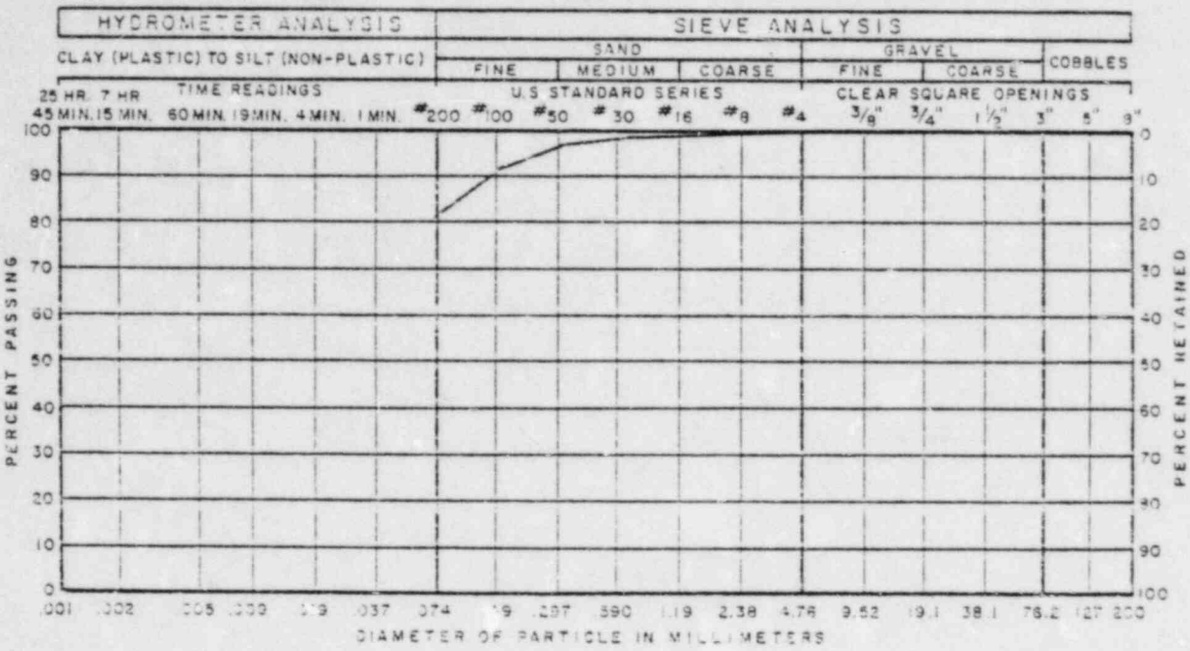
SAMPLE OF CLAY, very sandy, silty, (CL) FROM TEST PIT - TP-18 DEPTH 0.5-5.0 FEET

FIG. 26

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

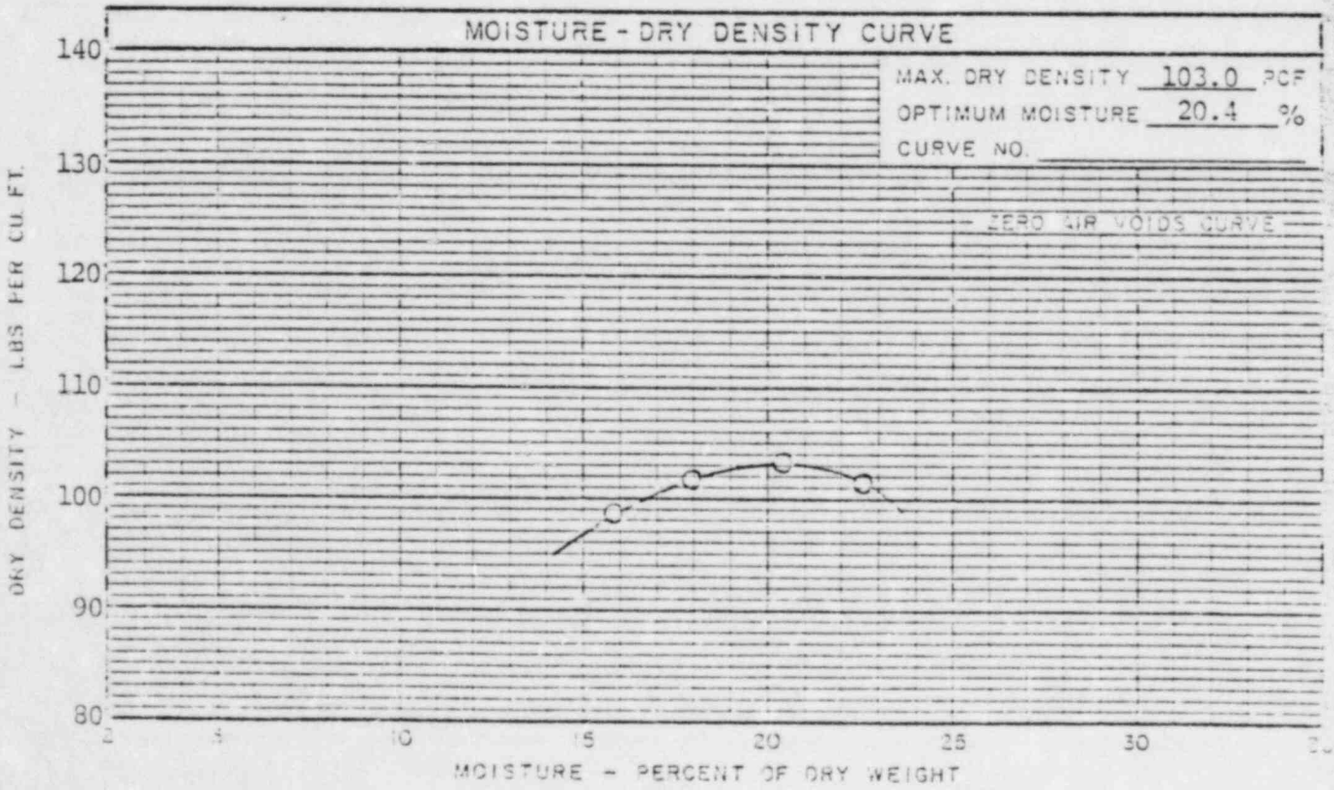
ROCKY MOUNTAIN REGION



GRAVEL 0 % SAND 17.1 % SILT AND CLAY 82.9 %

LIQUID LIMIT 47 % PLASTICITY INDEX 25 %

GRADATION TEST RESULTS



COMPACTION TEST PROCEDURE ASTM-D-698-78 METHOD A

JOB NO. 20052

COMPACTION TEST RESULTS

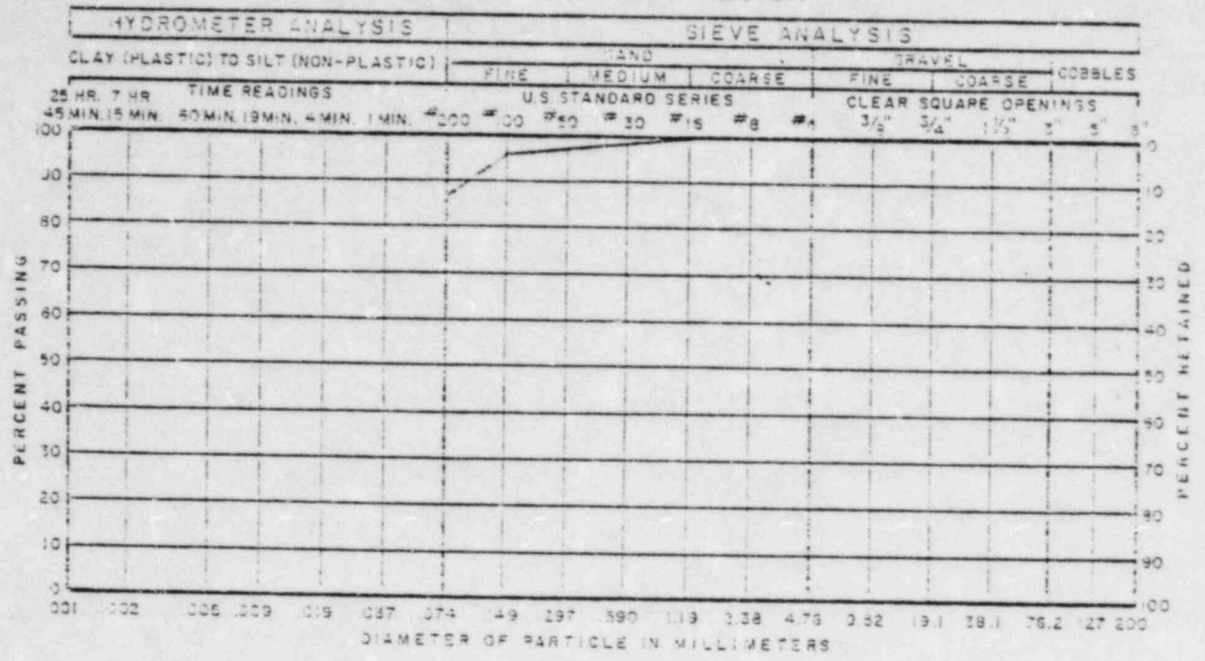
SAMPLE OF (CLAYSTONE), CLAY sandy (CL) FROM TEST PIT - TP-28 DEPTH 2.5-8.5 FEET

FIG. 27

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

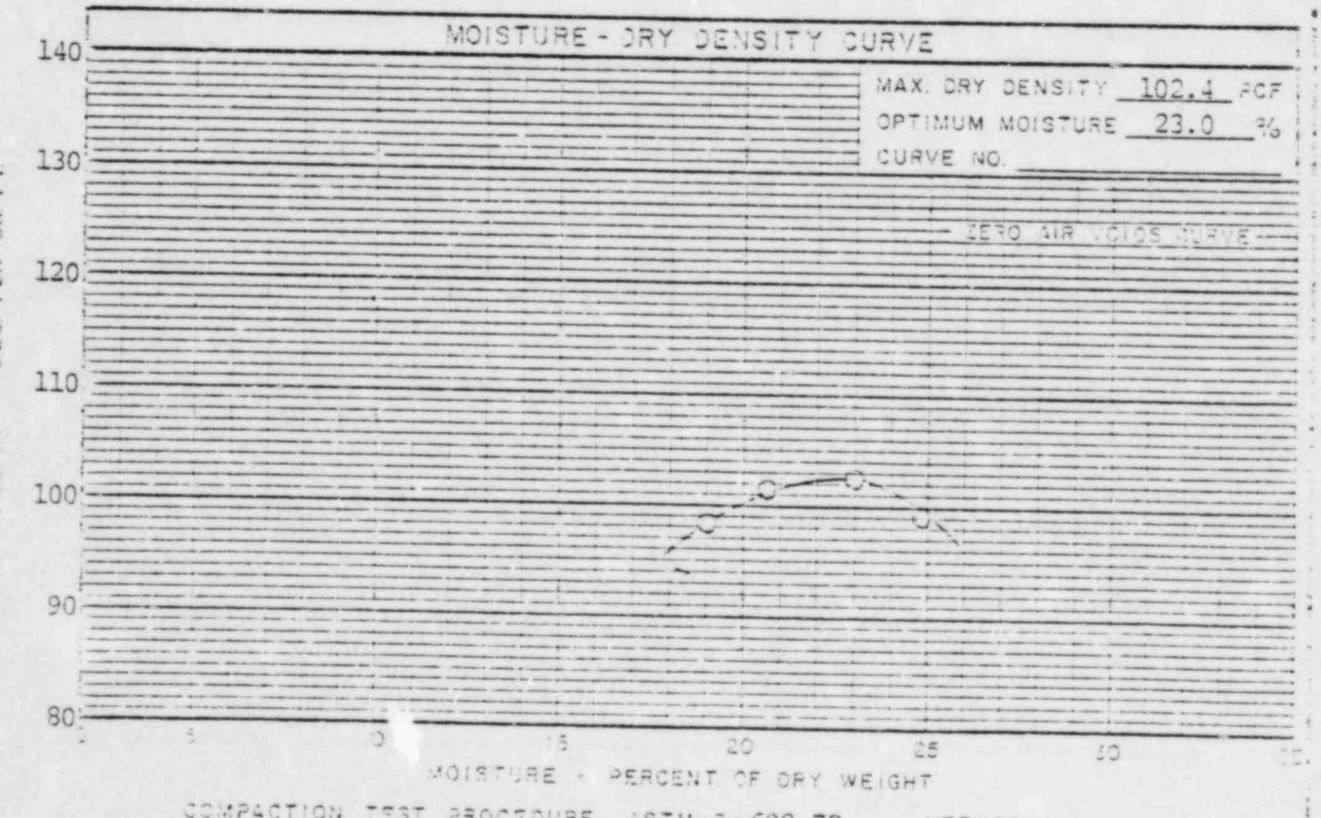
ROCKY MOUNTAIN REGION



GRAVEL 0 % SAND 12.5 % SILT AND CLAY 87.5 %

LIQUID LIMIT 39 % PLASTICITY INDEX 22 %

GRADATION TEST RESULTS



COMPACTION TEST PROCEDURE ASTM-D-698-78 METHOD A

JOB NO. 20052

COMPACTION TEST RESULTS

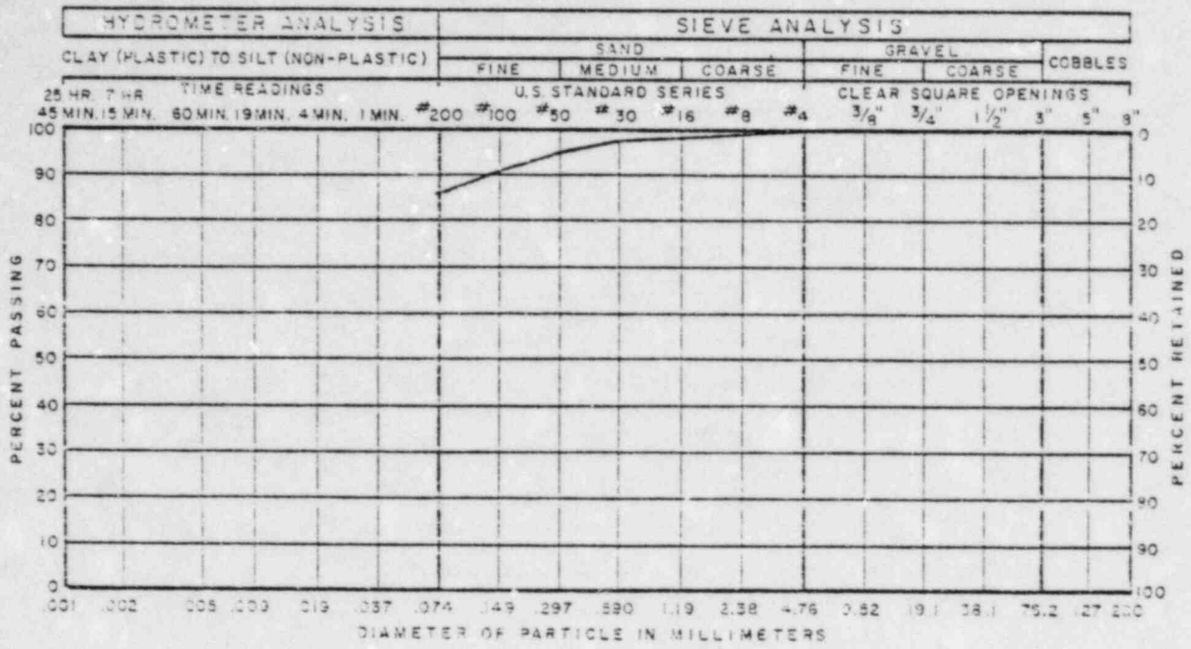
SAMPLE OF (CLAYSTONE), CLAY, silty, sandy (CL) FROM TEST PIT - TP-34 DEPTH 1.5-11.0 FEET

FIG. 28

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

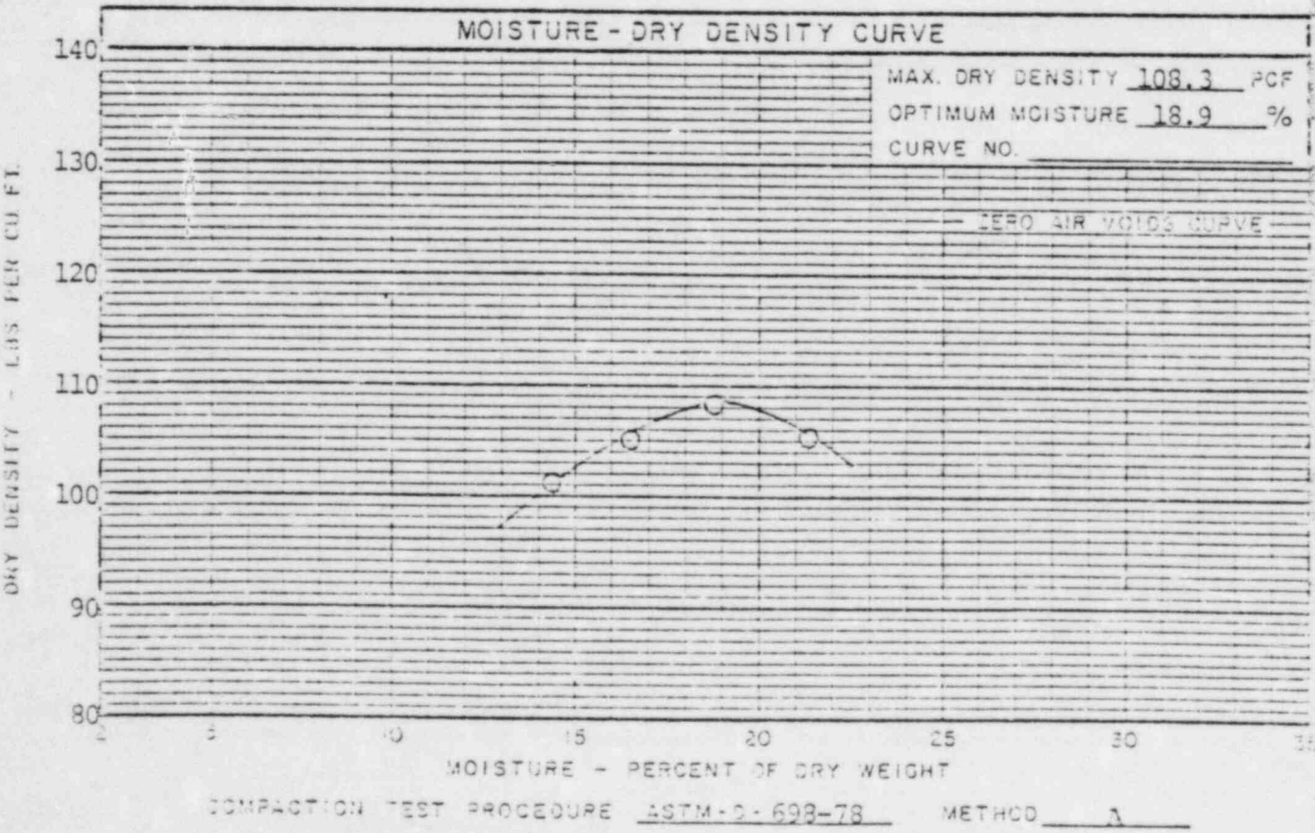
ROCKY MOUNTAIN REGION



GRAVEL 0 % SAND 13.6 % SILT AND CLAY 86.4 %

LIQUID LIMIT 36 % PLASTICITY INDEX 19 %

GRADATION TEST RESULTS



COMPACTION TEST PROCEDURE ASTM-D-698-78 METHOD A

JOB NO. 20052

SAMPLE OF CLAY, silty, sandy (CL)

COMPACTION TEST RESULTS

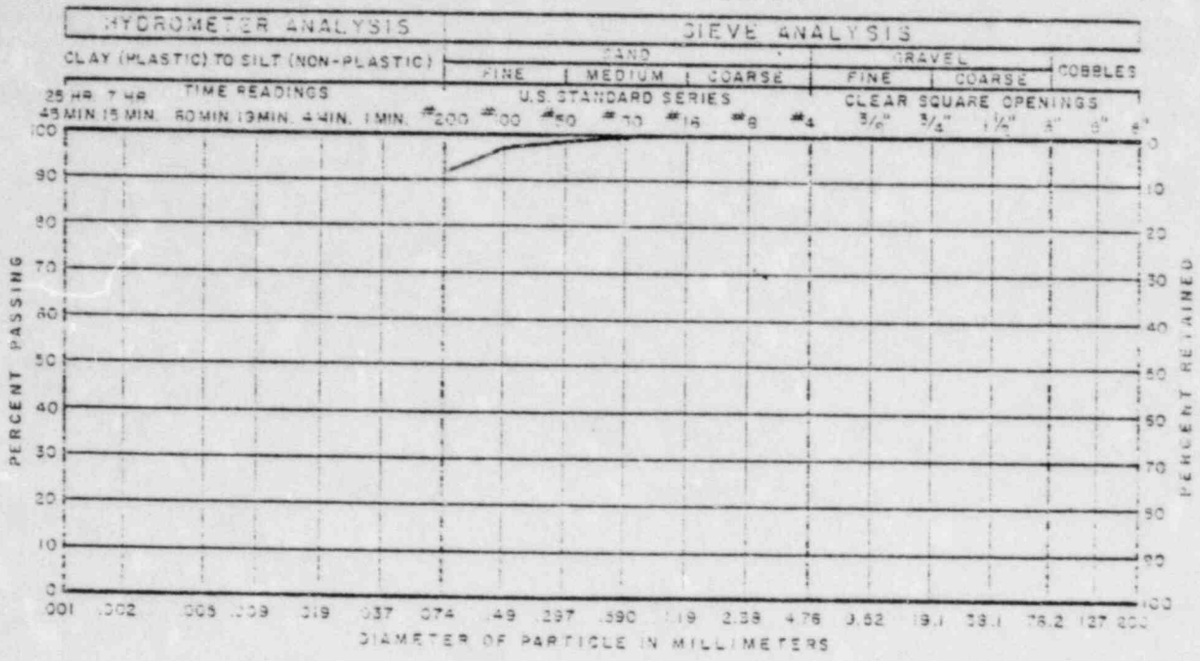
FROM TEST PIT - TP-35 DEPTH 0.5-9.0 FEET

FIG. 29

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

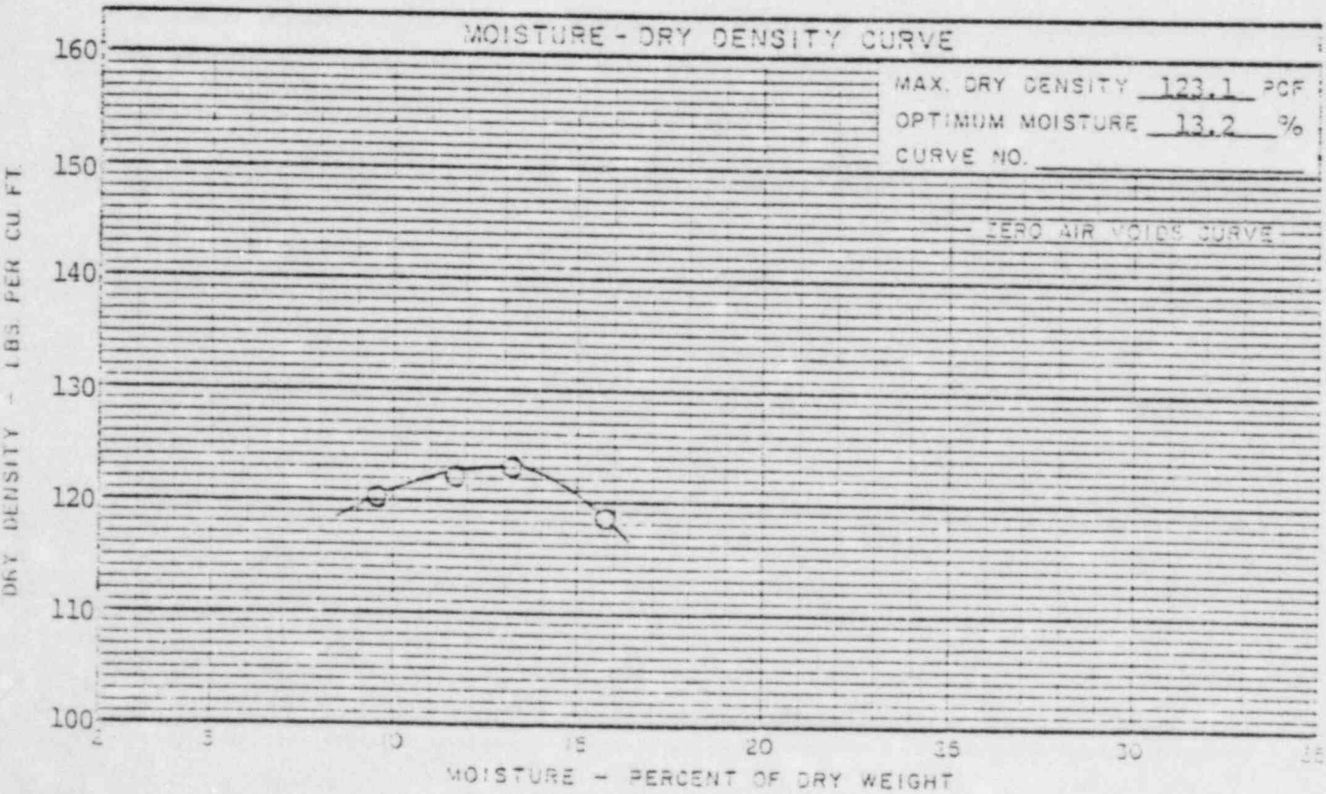
ROCKY MOUNTAIN REGION



GRAVEL 0 % SAND 8.7 % SILT AND CLAY 91.3 %

LIQUID LIMIT 30 % PLASTICITY INDEX 11 %

GRADATION TEST RESULTS



COMPACTION TEST PROCEDURE ASTM-D-698-78 METHOD A

COMPACTION TEST RESULTS

JOB NO. 20052

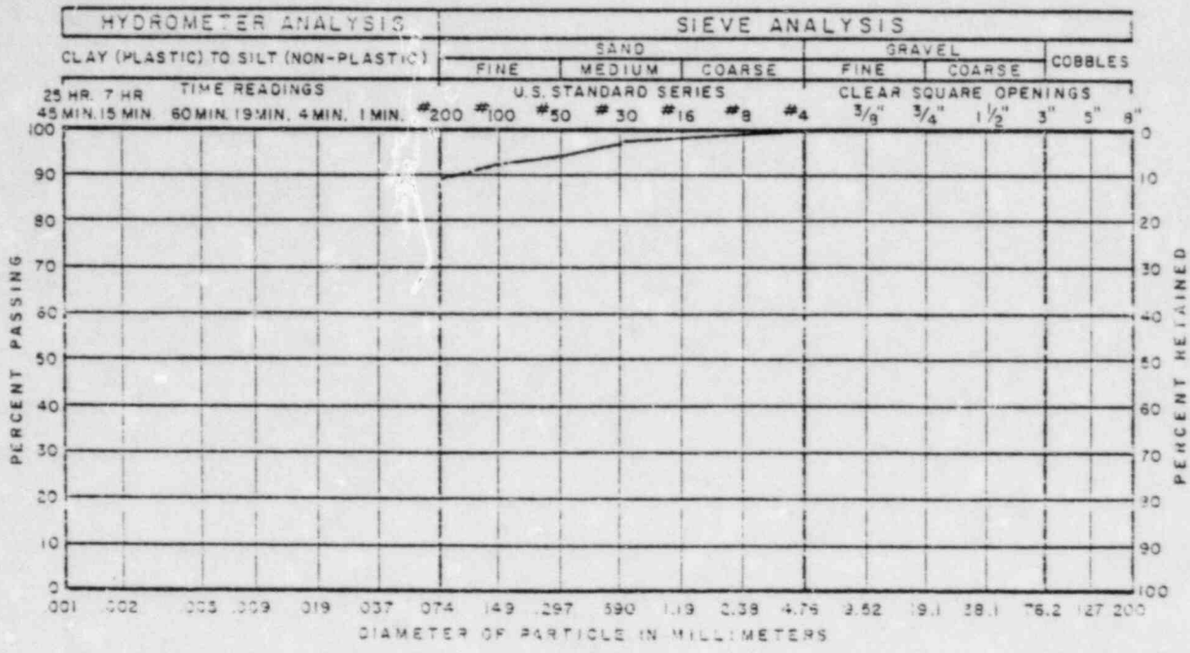
SAMPLE OF (CLAYSTONE), CLAY, silty, slightly sandy (CL) FROM TEST PIT - TP-36 DEPTH 3.0-11.0 FEET

FIG. 30

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

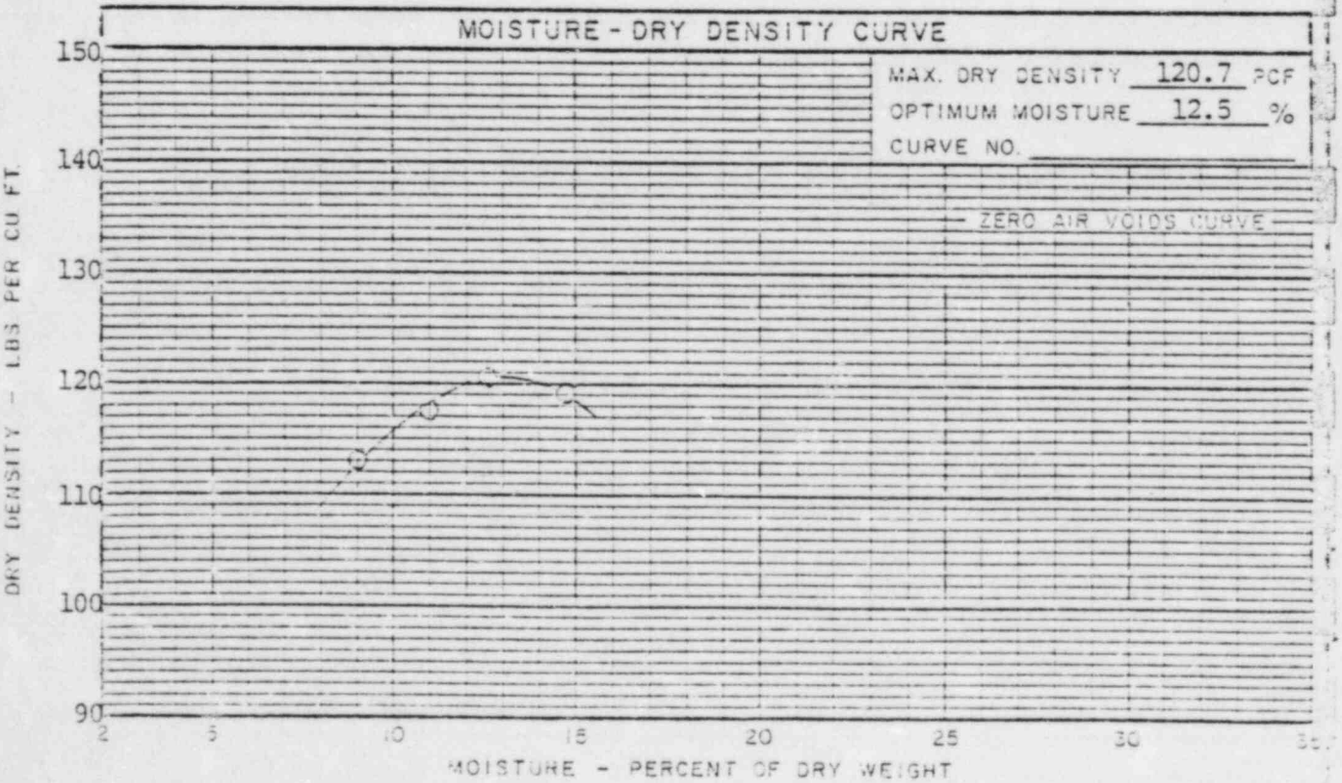
ROCKY MOUNTAIN REGION



GRAVEL 0.0 % SAND 10.4 % SILT AND CLAY 89.6 %

LIQUID LIMIT 35 % PLASTICITY INDEX 15 %

GRADATION TEST RESULTS



COMPACTION TEST PROCEDURE ASTM-D-698-78 METHOD A

JOB NO. 20052

COMPACTION TEST RESULTS

SAMPLE OF (CLAYSTONE) CLAY (CL) silty, slightly sandy FROM De Barr Borrow Pit Bedrock Excavation DEPTH 0-1 Feet

FIG. 31

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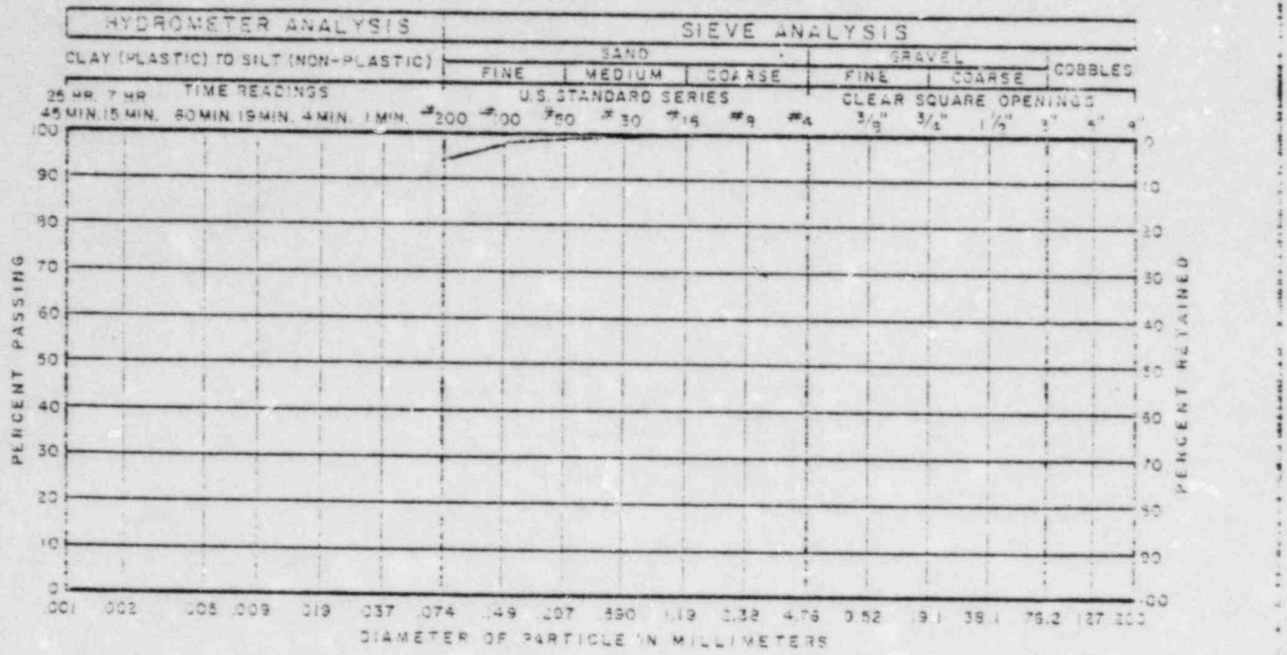
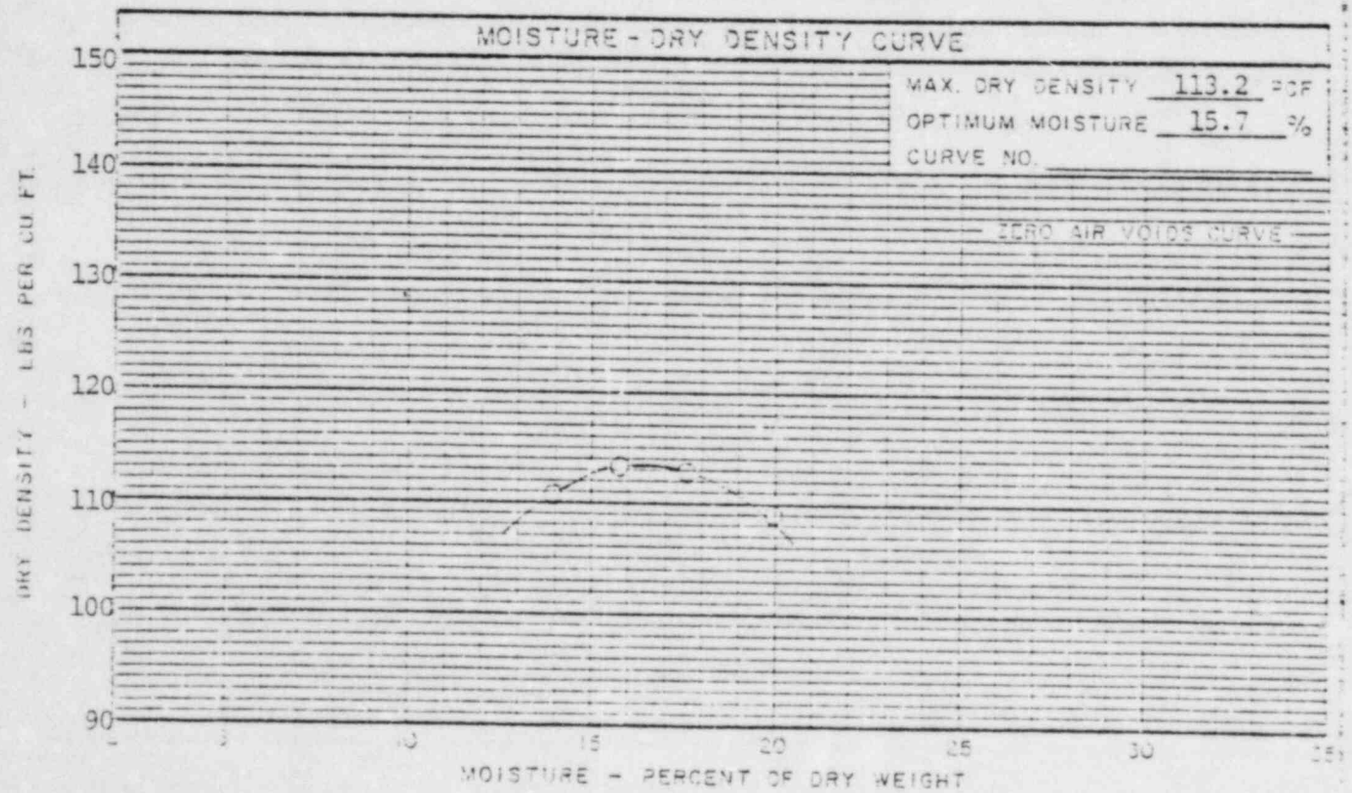
ROCKY MOUNTAIN REGION



GRAVEL 0.0 % SAND 6.0 % SILT AND CLAY 94.0 %

LIQUID LIMIT 40 % PLASTICITY INDEX 19 %

GRADATION TEST RESULTS



COMPACTION TEST PROCEDURE ASTM-D-698-78 METHOD A

JOB NO. 20052

COMPACTION TEST RESULTS

SAMPLE OF (CLAYSTONE), CLAY, silty, slightly sandy (CL) FROM De Barr Borrow Pit Stockpile DEPTH 0-1 Feet

FIG. 32

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TABLE I
SUMMARY OF LABORATORY TEST RESULTS

TEST PIT	DEPTH (FEET)	NATURAL MOISTURE (%)	NATURAL DRY DENSITY (PCF)	ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH (PSF)	TRIAXIAL SHEAR TESTS			SOIL TYPE
				LIQUID LIMIT (%)	PLASTICITY INDEX (%)		DEVIATOR STRESS (PSF)	CONFINING PRESSURE (PSF)		
TP-1	0.0-0.5	14.7								(FILL) SILT, very sandy, slightly clayey, very calcareous, gray (ML)
TP-1	0.5-3.0	12.3		20	7					CLAY, very silty and sandy, brown (CL-ML)
TP-1	3.0-11.0	9.4		18	2					GRAVEL, very sandy, slightly silty, brown (GP-GM)
TP-2	0.0-1.0	7.9								(FILL) SAND, very gravelly, slightly silty, brown (SP-SM)
TP-2	1.0-2.8	13.0		NON-PLASTIC						SAND, silty, roots, brown (SM)
TP-2	2.8-6.0	23.4		NON-PLASTIC						SAND, very silty, brown (SM)
TP-2	6.0-8.0	27.0		25	1					SILT, sandy, roots, brown (ML)
TP-2	8.0-11.5	7.3								GRAVEL, very sandy, brown (GP)

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TABLE I

SUMMARY OF LABORATORY TEST RESULTS

TEST PIT	DEPTH (FEET)	NATURAL MOISTURE (%)	NATURAL DRY DENSITY (PCF)	ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH (PSF)	TRIAXIAL SHEAR TESTS			SOIL TYPE
				LIQUID LIMIT (%)	PLASTICITY INDEX (%)		DEVIATOR STRESS (PSF)	CONFINING PRESSURE (PSF)		
TP-3	0.0-1.0	8.0								(FILL) SAND, very gravelly, slightly silty, brown (SP-SM)
TP-3	1.0-6.0	26.0		27	12					CLAY, very sandy, brown (CL)
TP-3	6.0-10.0	10.0								GRAVEL, very sandy, brown (GP)
TP-4	0.0-1.5	13.9								SILT, very sandy, slightly clayey, roots, brown (ML)
TP-4	1.5-3.0	11.4								SAND, silty, brown (SM)
TP-4	3.0-4.0	5.4								SAND, slightly silty, brown, (SP-SM)
TP-4	4.0-8.0	26.9		NON-PLASTIC						SILT, sandy, brown (ML)
TP-4	8.0-12.0	6.5								GRAVEL, very sandy, brown (GP)

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TABLE I

SUMMARY OF LABORATORY TEST RESULTS

TEST PIT	DEPTH (FEET)	NATURAL MOISTURE (%)	NATURAL DRY DENSITY (PCF)	ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH (PSF)	TRIAXIAL SHEAR TESTS			SOIL TYPE
				LIQUID LIMIT (%)	PLASTICITY INDEX (%)		DEVIATOR STRESS (PSF)	CONFINING PRESSURE (PSF)		
TP-5	0.0-3.5	14.9		18	4					CLAY, very silty and sandy, brown (CL-ML)
TP-5	3.5-7.0	7.9								SAND, very gravelly, slightly silty, brown (SP-SM)
TP-5	7.0-12.5	9.9								SAND, very gravelly, slightly silty, brown (SP-SM)
TP-6	0.0-1.5	13.1								CLAY, very silty and sandy, roots, brown (CL-ML)
TP-6	1.5-8.5	13.8		NON-PLASTIC						SAND, very silty, roots, brown (SM)
TP-6	8.5-11.5	8.6								GRAVEL, very sandy, brown (GP)
TP-7	0.0-1.0	7.4								(FILL) SILT, very sandy, slightly clayey brown (ML)
TP-7	1.0-1.8	13.9		NON-PLASTIC						SAND, very silty, brown (SM)

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TABLE I

SUMMARY OF LABORATORY TEST RESULTS

TEST PIT	DEPTH (FEET)	NATURAL MOISTURE (%)	NATURAL DRY DENSITY (PCF)	ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH (PSF)	TRIAXIAL SHEAR TESTS			SOIL TYPE
				LIQUID LIMIT (%)	PLASTICITY INDEX (%)		DEVIATOR STRESS (PSF)	CONFINING PRESSURE (PSF)		
TP-7	1.8-9.0	6.9								SAND, very gravelly, slightly silty, brown (SP-SM)
TP-8	0.0-1.5	16.4								(FILL) CLAY, very silty, sandy, roots, brown (CL-ML)
TP-8	1.5-4.0	18.8		22	5					CLAY, very silty and sandy, brown (CL-ML)
TP-8	4.0-11.0	21.8		21	5					CLAY, very silty and sandy, brown (CL-ML)
TP-9	0.5-5.0	19.6		23	6					CLAY, very silty, sandy, brown (CL-ML)
TP-9	5.0-8.0	11.0								SAND, silty, brown(SM)
TP-9	8.0-12.5	18.0								SAND, silty, brown(SM)
TP-10	0.5-6.5	17.4		21	5					CLAY, very silty and sandy, brown (CL-ML)
TP-10	6.5-8.5	19.5								SILT, very sandy, slightly clayey,brown (ML)
TP-10	8.5-12.0	15.2								SAND, silty, brown(SM)

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TABLE I
SUMMARY OF LABORATORY TEST RESULTS

TEST PIT	DEPTH (FEET)	NATURAL MOISTURE (%)	NATURAL DRY DENSITY (PCF)	ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH (PSF)	TRIAXIAL SHEAR TESTS			SOIL TYPE
				LIQUID LIMIT (%)	PLASTICITY INDEX (%)		DEVIATOR STRESS (PSF)	CONFINING PRESSURE (PSF)		
TP-11	0.5-3.5	17.0		21	5					CLAY, very silty and sandy, brown (CL-ML)
TP-11	3.5-5.5	11.1								SAND, slightly silty, brown (SP-SM)
TP-11	5.5-7.5	17.1								SILT, very sandy, slightly clayey, brown (ML)
TP-11	7.5-12.0	7.8								SAND, slightly silty, brown (SP-SM)
TP-12	0.0-1.0	21.5								CLAY, very silty, sandy, roots, brown (CL)
TP-12	1.0-4.0	17.2		20	5					CLAY, very silty and sandy, brown (CL-ML)
TP-12	4.0-9.5	14.8		NON-PLASTIC						SAND, silty, brown (SM)
TP-12	9.5-12.0	7.5		NON-PLASTIC						SAND, very gravelly, brown (SP)
TP-13	0.0-1.0	19.8								CLAY, very silty and sandy, roots, brown (CL-ML)

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TABLE I

SUMMARY OF LABORATORY TEST RESULTS

TEST PIT	DEPTH (FEET)	NATURAL MOISTURE (%)	NATURAL DRY DENSITY (PCF)	ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH (PSF)	TRIAXIAL SHEAR TESTS			SOIL TYPE
				LIQUID LIMIT (%)	PLASTICITY INDEX (%)		DEVIATOR STRESS (PSF)	CONFINING PRESSURE (PSF)		
TP-13	1.0-9.5	22.5		26	9					CLAY, very sandy, silty, brown (CL)
TP-13	9.5-11.5	21.7								SILT, very sandy, slightly clayey, brown (ML)
TP-14	0.0-3.0	18.2		22	5					CLAY, very silty and sandy, brown (CL-ML)
TP-14	3.0-8.5	19.8								SILT, very sandy, slightly clayey, brown (ML)
TP-14	8.5-12.0	8.0								SAND, slightly silty, brown (SP-SM)
TP-15	0.0-1.0	16.6								CLAY, very silty, sandy, roots, brown (CL-ML)
TP-15	1.0-12.5	22.1		20	6					CLAY, very silty and sandy, brown (CL-ML)
TP-16	0.5-8.5	19.9		22	6					CLAY, very silty and sandy, brown (CL-ML)
TP-16	8.5-13.0	24.6								SAND, silty, brown (SM)

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TABLE I

SUMMARY OF LABORATORY TEST RESULTS

TEST PIT	DEPTH (FEET)	NATURAL MOISTURE (%)	NATURAL DRY DENSITY (PCF)	ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH (PSF)	TRIAXIAL SHEAR TESTS			SOIL TYPE
				LIQUID LIMIT (%)	PLASTICITY INDEX (%)		DEVIATOR STRESS (PSF)	CONFINING PRESSURE (PSF)		
TP-17	0.0-1.0	16.7								CLAY, very silty and sandy, roots, brown (CL-ML)
TP-17	1.0-12.0	20.7		33	16					CLAY, silty, sandy, brown (CL)
TP-18	0.5-5.0	16.2		25	10					CLAY, very sandy, silty, brown (CL)
TP-18	5.0-9.0	21.4		NON-PLASTIC						SAND AND SILT, brown (SM-ML)
TP-18	9.0-11.0	22.3		34	13					CLAY, very silty, brown (CL)
TP-19	0.0-1.0	16.2								CLAY, silty, sandy, roots, brown (CL)
TP-19	1.0-5.0	18.6		31	12					CLAY, silty, sandy, brown (CL)
TP-19	5.0-7.5	18.4		25	9					CLAY, very sandy, silty, brown (CL)
TP-19	7.5-10.0	19.3		21	5					SAND, very clayey, silty, brown (SC-SM)
TP-19	10.0-12.5	18.5		22	9					CLAY, very sandy, silty, brown (CL-SC)

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TABLE I
SUMMARY OF LABORATORY TEST RESULTS

TEST PIT	DEPTH (FEET)	NATURAL MOISTURE (%)	NATURAL DRY DENSITY (PCF)	ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH (PSF)	TRIAXIAL SHEAR TESTS			SOIL TYPE
				LIQUID LIMIT (%)	PLASTICITY INDEX (%)		DEVIATOR STRESS (PSF)	CONFINING PRESSURE (PSF)		
TP-20	0.0-1.0	10.7								SILT, very sandy, slightly clayey, roots, brown (ML)
TP-20	1.0-7.5	18.8		23	5					CLAY, very silty and sandy, brown (CL-ML)
TP-20	7.5-10.0	17.2								SILT, very sandy, slightly clayey, brown (ML)
TP-20	10.0-12.5	10.5		NON-PLASTIC						SAND, silty, brown (SM)
TP-21	0.5-3.0	23.8		41	19					CLAY, silty, sandy, brown (CL)
TP-21	3.0-6.0	21.0		24	6					CLAY, very silty, sandy, brown (CL-ML)
TP-21	6.0-12.0	21.6		26	10					CLAY, very sandy, silty, brown (CL)
TP-22	0.0-1.0	17.2								CLAY, very silty, sandy, roots, brown (CL-ML)
TP-22	1.0-5.0	22.6		37	5					SILT, clayey, slightly sandy, brown (ML)

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TABLE I

SUMMARY OF LABORATORY TEST RESULTS

TEST PIT	DEPTH (FEET)	NATURAL MOISTURE (%)	NATURAL DRY DENSITY (PCF)	ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH (PSF)	TRIAXIAL SHEAR TESTS			SOIL TYPE
				LIQUID LIMIT (%)	PLASTICITY INDEX (%)		DEVIATOR STRESS (PSF)	CONFINING PRESSURE (PSF)		
TP-22	5.0-10.5	23.1		33	15					CLAY, silty, slightly sandy, brown (CL)
TP-23	1.0-10.0	22.5		40	19					CLAY, silty, brown(CL)
TP-24	1.0-10.0	18.8		28	11					CLAY, very sandy, silty, brown (CL)
TP-25	1.0-10.0	21.2		29	9					CLAY, silty, sandy, brown (CL)
TP-26	0.5-5.0	19.6		24	8					CLAY, silty, sandy, brown (CL)
TP-26	5.0-6.0	9.2								SAND, silty,brown (SM)
TP-27	0.5-3.0	21.9		23	4					CLAY, very silty and sandy, brown (CL-ML)
TP-27	3.0-10.5	21.0		24	6					CLAY, very silty, sandy, brown (CL-ML)
TP-28	0.5-2.5	21.3		39	19					CLAY, silty, sandy, brown (CL)
TP-28	2.5-8.5	16.4		47	25					(CLAYSTONE) CLAY, sandy, brown (CL)
TP-29	0.5-4.0	20.6		22	2					SILT, slightly sandy, brown (ML)

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TABLE I

SUMMARY OF LABORATORY TEST RESULTS

TEST PIT	DEPTH (FEET)	NATURAL MOISTURE (%)	NATURAL DRY DENSITY (PCF)	ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH (PSF)	TRIAXIAL SHEAR TESTS			SOIL TYPE
				LIQUID LIMIT (%)	PLASTICITY INDEX (%)		DEVIATOR STRESS (PSF)	CONFINING PRESSURE (PSF)		
TP-29	4.0-11.0	18.6		27	9					(CLAYSTONE) CLAY, silty, sandy, red (CL)
TP-30	0.5-4.0	24.9		28	6					SILT, clayey, brown (ML)
TP-30	4.0-5.5	16.0		24	8					CLAY, very silty and sandy, slightly gravelly, brown (CL-ML)
TP-30	5.5-11.5	47.3		46	23					(CLAYSTONE) CLAY, silty, slightly sandy, brown (CL)
TP-31	0.0-3.0	21.8								CLAY, very silty, sandy, roots, brown (CL-ML)
TP-31	3.0-5.0	21.1		39	23					CLAY, silty, brown (CL)
TP-31	5.0-7.0	11.6		30	10					(CLAYSTONE) CLAY, silty, slightly sandy, brown (CL)
TP-32	0.5-3.0									CLAY, very silty, sandy, brown (CL-ML)
TP-32	3.0-7.5	19.8		48	29					(CLAYSTONE) CLAY, slightly sandy, brown (CL)

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TABLE I

SUMMARY OF LABORATORY TEST RESULTS

TEST PIT	DEPTH (FEET)	NATURAL MOISTURE (%)	NATURAL DRY DENSITY (PCF)	ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH (PSF)	TRIAXIAL SHEAR TESTS			SOIL TYPE
				LIQUID LIMIT (%)	PLASTICITY INDEX (%)		DEVIATOR STRESS (PSF)	CONFINING PRESSURE (PSF)		
TP-32	7.5-8.5	7.6		30	9					(CLAYSTONE) CLAY, silty, slightly sandy, brown (CL)
TP-33	0.5-4.0	16.8		29	13					CLAY, very sandy, silty, brown (CL)
TP-33	4.0-5.0	7.1		38	13					(CLAYSTONE) CLAY, very silty, sandy, brown (CL-ML)
TP-34	0.5-1.5	17.4		28	7					CLAY, very silty, sandy, slightly gravelly, roots, brown (CL-ML)
TP-34	1.5-11.0	23.7		39	22					(CLAYSTONE) CLAY, silty, sandy, red (CL)
TP-35	0.5-9.0	24.4		36	19					CLAY, silty, sandy, red (CL)
TP-36	0.5-3.0	15.8		33	15					CLAY, silty, sandy, brown (CL)
TP-36	3.0-11.0	12.9		30	11					(CLAYSTONE) CLAY, silty, slightly sandy, red (CL)

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TABLE I

SUMMARY OF LABORATORY TEST RESULTS

HOLE	DEPTH (FEET)	NATURAL MOISTURE (%)	NATURAL DRY DENSITY (PCF)	ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH (PSF)	TRIAXIAL SHEAR TESTS			SOIL TYPE
				LIQUID LIMIT (%)	PLASTICITY INDEX (%)		DEVIATOR STRESS (PSF)	CONFINING PRESSURE (PSF)		
DE BARR GORDON PIT BEDROCK EXCAVATION				35	15					(CLAYSTONE) CLAY, silty, slightly sandy, red (CL)
DE BARR GORDON PIT STOCKPILE				40	19					(CLAYSTONE) CLAY, silty, slightly sandy, red (CL)

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TABLE II

LABORATORY PERMEABILITY TEST RESULTS

TEST PITS	DEPTH (FEET)	PLACEMENT DATA					APPLIED LOAD (PSF)	SETTLEMENT OR EXPANSION (PERCENT)	PERMEABILITY X 10^{-7} (CM/SEC)	SOIL TYPE
		COMPACTION STANDARD	DRY DENSITY		MOISTURE					
			% MAX	PCF	OPT ± %	ACT.%				
TP-16	0.5-8.5	ASTM D-698-78	98	111.8	OPT	15.3	300	+0.34	0.97	CLAY, very silty and sandy (CL-ML)
TP-18	0.5-5.0	ASTM D-698-78	98	111.7	OPT	14.6	300	+0.40	0.29	CLAY, very sandy, silty (CL)
TP-28	2.5-8.5	ASTM D-698-78	98	100.9	OPT	20.4	300	-0.06	0.05	(CLAYSTONE), CLAY, sandy (CL)
TP-34	1.5-11.0	ASTM D-698-78	98	100.4	OPT	23.0	300	-0.06	0.16	(CLAYSTONE), CLAY, silty, sandy (CL)
TP-35	0.5-9.0	ASTM D-698-78	98	106.1	OPT	18.9	300	-0.43	0.27	CLAY, silty, sandy (CL)
TP-36	3.0-11.0	ASTM D-698-78	95	116.9	OPT	13.2	300	-0.50	0.46	(CLAYSTONE), CLAY, silty, slightly sandy (CL)
TP-36	3.0-11.0	ASTM D-698-78	98	120.6	OPT	13.2	300	-0.40	0.23	(CLAYSTONE), CLAY, silty, slightly sandy (CL)
DE BARR BORROW PIT BEDROCK EXCAVATION		ASTM D-698-78	98	118.3	OPT	12.5	300	+0.48	0.10	(CLAYSTONE), CLAY, silty, slightly sandy (CL)
DE BARR BORROW PIT STOCKPILE		ASTM D-698-78	98	110.9	OPT	15.7	300	+0.95	0.19	(CLAYSTONE), CLAY, silty, slightly sandy (CL)

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TABLE III
SURFACE SAMPLE TEST RESULTS AND RECOMMENDATIONS

SURFACE SAMPLE NO.	pH	AGRICULTURAL GROUND LIMESTONE TREATMENT (lbs./1000 sq. ft.)	QUANTITY FERTILIZER (lbs./1000 sq. ft.)	TYPE OF FERTILIZER IN PARTS NITROGEN-PHOSPHOROUS-POT ASH
HP-1	5.7	100	15	10-10-10
HP-2	5.8	100	35	5-10-10
HP-3	5.9	100	35	5-10-10
HP-4	6.5	0	20	10-10-20
HP-5	5.5	100	35	5-10-5

NOTE: Test results and recommendations for topsoil material were provided by the Cooperative Extension Service in Parkersburg, West Virginia.

APPENDIX A

SUGGESTED EARTHWORK AND SEEDING SPECIFICATIONS

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SUGGESTED EARTHWORK AND SEEDING SPECIFICATIONS

SECTION I

SITE PREPARATION

SUGGESTED EARTHWORK AND SEEDING SPECIFICATIONS

I SITE PREPARATION

A. General

Site preparation includes all work and equipment necessary to construct access roads to the work areas and haul roads for equipment; clearing, grubbing and stripping in the borrow areas including stockpiling processing and hauling materials to the point of disposal or final use; and maintaining drainage in excavations and fills. The contractor shall submit a plan for site preparation to the Owner for approval.

B. Clearing, Grubbing and Stripping

Clearing of trees will be required in portions of the borrow areas. Trees shall be cut or dozed and hauled to an area designated by the Owner.

Grubbing in the borrow areas shall include removal of all stumps, roots, and other organic matter unsuitable for incorporation within the compacted fill. All waste materials removed shall be taken to an area designated by the Owner.

Stripping shall include excavation of soil selected by the Owner to be suitable for use as topsoil. It shall be segregated and placed in an area designated by the Owner for later use in reclamation.

C. Drainage

Borrow and fill areas shall be free from water as required for excavating and constructing each part of the work. Drainage shall be maintained during borrow excavation and fill placement by construction of drainage ditches, sloping the excavation or fill surface, or by other methods, suitable for maintaining dry working conditions.

SECTION II

EXCAVATION

II EXCAVATION

A. General

Excavation includes providing all work and equipment necessary to make excavations in accordance with these plans and specifications. Excavation shall be made to the lines, grades, and dimensions shown on the drawings or as directed by the Owner.

During progress of the work, it may be found necessary or desirable to vary the slopes, grades, or the dimensions of the excavations from those specified herein.

There shall be no excess excavation for the convenience of the Contractor or overexcavation by the Contractor except as ordered in writing by the Owner. Where required to complete the work, such excess excavation and overexcavation shall be refilled as directed by the Owner.

Excavation for borrow and removal of collected material beyond the limits of the compacted fill area shall be accomplished in the dry. No excavation shall be made in frozen materials without written approval.

B. Borrow Excavation

Materials required for fill which are not available

from required excavations shall be taken from the borrow area within the limits designated on the drawings or as designated by the Owner. Borrow excavation work includes excavation in the borrow area, processing, stockpiling, and hauling to the point of final use.

Moisture may be added in the borrow area by methods approved by the Owner. If borrow area moisture conditions are too high, moisture content may be reduced by selective excavation to secure the driest materials by grading, by excavating drainage ditches, or other methods, approved by the Owner.

Drainage from the borrow area to the nearest outlet shall be provided by and maintained by the Contractor. The final borrow area bottom level will be defined by securing sufficient material for the fill.

Final borrow area side slopes shall be no steeper than shown on the drawings and shall be left in reasonably smooth and even condition.

C. Collected Material Excavation

Collected material excavation shall be required on site beyond the limits of the compacted fill area to remove collected material for placement in the compacted

fill foundation area. The limits of areas requiring excavation and the depth of excavation required shall be as directed by the Owner. Materials from excavation not determined by the Owner to be suitable for placement in the collected material fill shall be disposed of in an area designated by the Owner.

D. Disposal of Excavated Material

So far as practicable, all suitable materials from excavation required under these specifications shall be used in the permanent construction. Excavated materials that are in excess of permanent construction requirements shall be wasted. The Owner shall select suitable materials.

The disposal of all excavated materials that are to be wasted shall be by approval of the Owner. Waste piles shall be located where they will not interfere harmfully with construction operations in the borrow areas, and where they will not detract from the appearance of the completed project. Waste piles shall be leveled and trimmed to reasonably regular lines.

SECTION III

COMPACTED FILL

III COMPACTED FILL

A. General

Compacted fill includes all work and equipment necessary to place compacted fill, including the collected material layer, stabilization layer, clay layer and topsoil layer, acccrding to these specifications. No fill shall be placed on frozen ground.

Fill operations to cover the collected material layer, stabilization layer and clay layer shall be continuous and expeditious, maintaining proper placement and compaction. The Contractor shall submit a plan to the Owner for placement and compaction of fill material.

The Owner shall observe or have observed fill placement and compaction procedures and take or have taken samples from the compacted fill for field and laboratory testing to confirm that the compacted fill meets requirements of the specifications. Tests may not be the sole basis for determination of compliance with specifications. The Contractor shall aid the Owner in testing.

All areas on the site which are to be graded shall be brought to grade at the indicated elevations, slopes and contours prior to completion of the work. Graders or other power equipment will be permitted for final grading

and dressing of slopes, provided the result is uniform and acceptable for seeding.

All slopes shall be graded to drain. Unless otherwise shown, a slope of at least 1% shall be provided.

Grading and surfacing shall be completed to the satisfaction of the Owner.

B. Collected Material Layer

The collected material layer will consist of all materials on site, beyond the limits of the compacted fill area, designated by the Owner for excavation and placement in the compacted fill area, as shown on the drawings or as directed by the Owner. The collected material will be placed in 4-inch maximum loose lifts and compacted by a minimum of 4 passes of a Caterpillar Model D-8 dozer or equivalent. Care shall be taken during hauling, placement and compaction of collected materials to confine these materials within the limits of the compacted fill area.

C. Stabilization Layer

The stabilization layer will consist of inorganic clay, classified (CL) according to the American Society for Testing and Materials (ASTM) Designation D2487-69, smaller

than 4 inches in size and taken from the borrow area designated by the Owner for covering the collected material layer. The stabilization layer shall be a minimum of 1-foot thick, compacted. Clay borrow materials shall be placed and dozed over the collected material in a manner that will prevent mixing of materials in the stabilization layer with materials in the collected material layer being covered. The fill material shall be placed in 12-inch maximum loose lifts at or above the designed optimum moisture content and compacted to at least 95% of maximum density in accordance with ASTM Designation D698-78 and the moisture content shall be uniform throughout each lift. Lift thickness and density requirements may be varied by the Owner in the field to achieve the desired result of the stabilization layer in separation of the collected material and overlying materials.

If the moisture content is less than specified for compaction moistening of the material will be permitted during excavation or stockpiling. If moisture is added, sufficient mixing shall be done for uniform moisture. No mixing shall be allowed on the compacted fill area unless approved by the Owner.

If the moisture content is greater than specified for compaction, the placing and compaction operations shall be

delayed until the material has dried to the moisture content optimum for compaction. Dry materials may be mixed with the wet material prior to fill placement to reduce the moisture content.

Each compacted lift shall be scarified, if necessary, prior to placement of the next lift to provide a uniform blend and bonding between each successive lift. Water would be placed on the top lift, if necessary, to effect bonding between successive lifts.

The stabilization layer shall be maintained to provide drainage at all times.

D. Clay Layer

The clay layer will consist of inorganic clay, classified (CL) in accordance with ASTM Designation D2487-69, smaller than 4 inches in size taken from the borrow area shown on the drawings or as designated by the Owner for covering the stabilization layer. The clay layer shall be a minimum of 1-foot thick, compacted, and shall have a coefficient of permeability of less than or equal to 1×10^{-7} centimeters per second in accordance with United States Bureau of Reclamation "Earth Manual" Designation E-13. The soils shall be placed in 8-inch maximum loose lifts at or above the designed optimum moisture content and compacted by a

smooth wheel or rubber-tired compactor to at least 98% of maximum density in accordance with ASTM D698-78, and the moisture content shall be uniform throughout each lift.

If the moisture content is less than specified for compaction, moistening of the material will be permitted during excavation or during placement and compaction. If moisture is added, sufficient mixing shall be done for uniform moisture. Mixing on the fill shall not be performed without the Owner's approval.

If the moisture content is greater than specified for compaction, the placing and compaction operations shall be delayed until the material has dried to the moisture content specified for compaction. Dry materials may be mixed with the wet material to reduce the moisture content.

The excavating and placing operations shall be such that the materials when compacted will be blended sufficiently to achieve the specified compaction. Each compacted lift shall be wetted, if necessary, and scarified prior to placement of the next lift to provide a uniform blend and bonding between each successive lift.

The clay layer shall be constructed to provide drainage at all times, and constructed to a final minimum grade of 1%.

E. Topsoil Layer

The topsoil layer shall be constructed to the lines and grades shown on the drawings or as directed by the Owner and will consist of topsoils excavated from designated borrow areas or taken from topsoil stockpiled during construction, as directed by the Owner, for covering the clay layer and providing suitable material for supporting grass cover. The topsoil shall be placed in 12-inch maximum loose lifts at a moisture content optimum for compaction and compacted by 2 passes of a Caterpillar Model D-8 dozer or equivalent. No compaction will be required in the top 6 inches of the topsoil layer.

The topsoil layer shall be constructed to provide drainage at all times.

SECTION IV

SEEDING

IV. SEEDING

A. Seed Bed Preparation

Lime and fertilizer shall be applied to the surface of the topsoil layer after placement of the topsoil layer and final grading of the fill surface. Common agricultural limestone, the finest ground material available, shall be spread and mixed with the topsoil to a depth of 6 inches at the rate of 2 1/2 tons per acre. Fertilizer of 10-10-10 or similar grade shall be spread and mixed to a depth of 6 inches at the rate of 1000 pounds per acre.

A disc or other suitable farm implement approved by the Owner shall be used for mixing the pulverized limestone and fertilizer with topsoil. Spreading and mixing when soil is excessively wet to cause rutting or when frozen shall be avoided. The soil surface shall be reasonably smooth prior to seeding.

B. Seeding

The areas covered by a topsoil layer shall be seeded with Kentucky 31 Fescue at the rate of 50 pounds seed per acre. The seed shall be clean, containing no noxious weeds and less than 1% total weed seed, and have no less than 80% germination. Broadcast

seeding, or other suitable methods approved by the Owner shall be used to spread seed. The seeds shall be lightly covered with a minimum of 1/4 inch to a maximum of 1/2 inch of topsoil, then rolled with a cultipacker or equivalent implement suitable for lightly packing the seed bed surface.

Seeding shall be performed between April 15 and September 15. Two tons of well spread straw per acre shall be added on the packed seed bed surface for planting seed between May 15 and August 15. Seeding, when the soil is excessively wet to cause rutting or when frozen, shall be avoided. The Owner shall determine within 6 months after seeding whether any seeded areas require reseeding at the Contractor's expense.