EMBANKMENT STABILITY STUDY
QUABBIN RESERVOIR DAMS
WARE, MASSACHUSETTS

(FINAL COPY)

Prepared For:

Commonwealth of Massachusetts
Metropolitan District Commission
Boston, Massachusetts

Prepared By:

Goldberg-Zoino & Associates, Inc.
Newton Upper Falls, Massachusetts

File No. Z-2801
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November 6, 1981
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Commonwealth of Massachusetts
Metropolitan District Commission
20 Somerset Street
Boston, Massachusetts 02108

Attention: Mr. Joel Barry Chase

Re: Embankment Stability Study
Quabbin Reservoir Dams

Gentlemen:

We are pleased to submit this report, which presents the results of a geotechnical engineering study and evaluation of the stability of the Winsor Dam and Goodnough Dike at the Quabbin Reservoir in central Massachusetts. The work was initiated by the MDC in response to recommendations contained in the Phase I report authorized by Public Law 92-367, through the Corps of Engineers. As requested by the MDC in our final review meeting, we have added an executive summary of the purpose, exploration, evaluation, and findings presented in this report. We have also completed all other modifications requested by the MDC at the final review meeting.

We wish to thank those personnel at the MDC, both in Boston and at Quabbin Section, who provided assistance in the research for documents used in preparing this report. Personnel at GZA who also assisted in the preparation of this report include: Dr. Richard Simon, Nicholas Campagna, Dr. Gary Jaworski, William Hadge, and Edward Taylor, Geotechical Engineers; Gardner Hayward, Chief Draftsman, and Donald Schulze, Laboratory Director.

We have enjoyed working on this project with you and trust that this information meets your requirements. If you have any questions or if we can be of further assistance to you on this project, please call.

Very truly yours,

Richard P. Weber
Project Engineer

William S. Zoino

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RPW/dmm

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TABLE OF CONTENTS

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TABLES

FIGURES

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EXECUTIVE SUMMARY

This report summarizes the results of a geotechnical engineering study and evaluation of the stability of the Winsor Dam and Goodnough Dike at the Quabbin Reservoir in Central Massachusetts. Authorization for the project is an agreement dated July 17, 1980, between the Metropolitan District Commission and Goldberg-Zoino & Associates, Inc.

Purpose of Study - In June 1978, a limited visual inspection was performed in conjunction with the National Dam Inspection Program, authorized by Public Law 92-367, and administered by the Secretary of the Army, through the Corps of Engineers. Findings of the inspections were summarized in a Phase I report (Reference 1).

The report indicated that the embankments are generally in good to excellent condition with no obvious signs of failure or conditions that would warrant urgent or remedial treatment. The report also recommended that a detailed study of embankment stability under static and earthquake loading be conducted because of the expected nature of the hydraulic fill embankment material and critical importance of the dams. The work presented in this report summarizes the evaluation of the embankment stability performed in response to recommendations made in the Phase I report.

Subsurface Explorations and Laboratory Testing - A subsurface exploration program was undertaken at the Main Dam and Dike during this study to obtain a measure of embankment density and to obtain representative soil samples for visual classification and laboratory testing.

A total of nine soil test borings were drilled during the explorations at the Main Dam and Dike. Standard split spoon sampling and fixed piston undisturbed sampling were used to obtain representative soil samples. At the completion of each boring, a total of eighteen pneumatic piezometers were installed at selected elevations within the boreholes to measure pore water pressure in the embankment.

A program of laboratory testing was conducted on selected split spoon and undisturbed samples. The purpose of the testing was to provide information for soil classification and to measure engineering parameters to assess shear strength and liquefaction potential of the embankment soils.

Soil Conditions - The Main Dam and Dike were constructed by hydraulic fill methods, although the top 30 feet was constructed as a rolled fill. The interior, less pervious section, or core, of the embankments consist of silty, fine sand or silt. In general, the materal is loose to very dense. The outer areas,

or shell, of the embankment consist of a dense to very dense sand with varying percentages of silt, gravel, and cobbles. The gradation of materials encountered in this exploration compares well with the gradation of materials recorded during construction.

Methods of Analysis - The stability of the Main Dam and Dike embankments was assessed using several analytical methods. First, the stability of the embankment was assessed by calculating factors of safety for a slope stability failure. Both static and pseudo-static analyses were conducted.

The static analysis assumes that only forces of gravity act on the embankment, and that resistance is derived from the shear strength of the soils. The pseudo-static analysis, in addition to the gravity forces, introduces a horizontal force acting outward from the embankment to represent earthquake loads. Resistance is again derived from the soil shear strength.

For this analysis, horizontal earthquake loads were derived based on peak accelerations of 0.12g and 0.18g. A peak acceleration of 0.12g is based on Massachusetts State Building Code requirements, while a peak acceleration of 0.18g is a more conservative maximum probable peak acceleration for the area. The selection of the peak acceleration values and approximate correlation to earthquake intensity level are discussed in the text.

A second analysis evaluated the liquefaction potential of the core material. Liquefaction, as used in this text, refers to a condition of nearly complete loss of strength of a granular soil, turning the soil into a temporary viscous fluid. Liquefaction can result from seismic events and can be triggered by a single large force or a series of smaller transient loads such as vibrations. The consequence of liquefaction at the dams is settlement of the embankment crest.

Findings - The results of the analyses are summarized below. A detailed explanation is presented in the text of the report and should be referred to for more specific information.

The results of both the field exploration and the theoretical calculations conducted for this evaluation, in our opinion, suggest that the embankments are strong and resistant to complete failure. The analyses were conducted for both normal static conditions and conditions where earthquake loads result in an additional applied force. Earthquake loads were based on peak accelerations up to 0.18g. A peak acceleration of 0.18g, which corresponds to a Level VII and Level VIII intensity on the Modified Mercalli Scale, is judged an extreme event for this area.

An analysis to assess the liquefaction potential of the core material was also conducted. Results of the analysis indicate that the core of the embankments exhibits a limited liquefaction potential, meaning that the core is capable of temporarily losing its shear strength during a seismic event. Even if the core

were to liquefy, however, the shell appears sufficiently strong to resist failure of the embankment. Liquefaction of the core is expected to result in settlement of the crest; however, a minimum freeboard of 20 feet exists, and neither a breach nor a complete failure of the embankment is expected.

1.00 INTRODUCTION

This report summarizes the results of a geotechnical engineering study and evaluation of the stability of the Winsor Dam and Goodnough Dike at the Quabbin Reservoir in Central Massachusetts. Authorization for the project is an agreement dated July 17, 1980, between the Metropolitan District Commission and Goldberg-Zoino & Associates, Inc. (GZA).

In June 1978, a limited visual inspection was conducted by others in accordance with guidelines prepared by the U.S. Army Corps of Engineers. The inspection was performed in conjunction with the National Dam Inspection Program, authorized by Public Law 92-367, and administered by the Secretary of the Army, through the Corps of Engineers. Findings of the inspections were summarized in a Phase I report (Reference 1).

The report indicated that the embankments are generally in good to excellent condition with no obvious signs of failure or conditions that would warrant urgent or remedial treatment. The report also recommended that a detailed study of embankment stability under static and earthquake loading be conducted because of the expected nature of the hydraulic fill embankment material and critical importance of the dams. The work presented in this report summarizes the evaluation of the embankment stability performed in response to recommendations made in the Phase I report.

2.00 CONSTRUCTION HISTORY OF THE MAIN DAM AND DIKE

The construction history of the Winsor Dam (Main Dam) and Goodnough Dike (Dike) as described in Phase I report (Reference 1) is summarized below.

2.10 LOCATION OF PROJECT

Winsor Dam is located on the Swift River at the Belchertown/Ware town line. Goodnough Dike is located on Beaver Brook in Ware, Massachusetts. The locations of the Main Dam and Dike are shown on Figure 1, Locus Plan.

2.20 WINSOR DAM

The Winsor Dam (Main Dam) is a zoned earth embankment constructed by hydraulic fill methods. The site chosen for construction of the dam was overlain by deep glacial deposits of pervious sand, gravel, cobbles, and boulders.

The embankment has a maximum height of about 170 feet (crest elevation 550 feet). The crest is about 35 feet wide with a paved roadway across it. The upstream slope is at about 2 horizontal to 1 vertical above a berm at Elevation 535. Light riprap is above Elevation 535. Below the berm, heavy riprap is on a 1-1/2 horizontal to 1 vertical slope which flattens to 3 horizontal to 1 vertical. The grassed downstream slope is 2 horizontal to 1 vertical and 2-1/2 horizontal to 1 vertical, starting from the crest. Berms have been constructed at Elevation 500 and Elevation 460.

Prior to construction of the embankment, an open trench was excavated across the valley floor to a depth of about 30 feet. Rectangular concrete caissons were constructed from the bottom of the trench to rock. The upper 20 feet of bedrock was grouted from the bottom of the caissons. The caissons extended a minimum of 25 feet above the bottom of the trench and were subsequently backfilled with compacted impervious trench backfill.

The embankment was constructed by hydraulic fill methods. Material to construct the embankment was brought from an off-site borrow source to a hog box by conveyor belt where it was mixed with water. The soil-water slurry then flowed to the construction site in a steeply sloped trough. The core was constructed by allowing the slurry to pool near the centerline of the dam where the fines settled out.

The quality of the core material was continually monitored and checked by sounding with a rod. Samples were obtained during construction for inspection and laboratory analysis. The top 30 feet of the embankment was placed by rolled-fill methods.

2.30 GOODNOUGH DIKE

Construction of Goodnough Dike (Dike) was essentially the same as that of the Main Dam. A trench was excavated, caissons constructed to rock, rock grouted, trench backfilled, and the embankment constructed by hydraulic fill methods.

3.00 SUBSURFACE EXPLORATIONS

A subsurface exploration program was undertaken at the Main Dam and Dike during this study to obtain a measure of embankment density and to obtain representative soil samples for visual classification and laboratory testing.

3.10 SOIL TEST BORINGS

A total of nine soil test borings were drilled by Briggs Engineering of Norwell, Massachusetts at the Main Dam and Dike between May 6, 1981, and June 22, 1981. Six borings were taken at the Main Dam along two cross sections perpendicular to the embankment centerline. Three borings were conducted at Centerline Station 15+08; the remaining three borings were conducted at Station 20+00. Three borings were taken along the cross section at Station 21+80 of the Dike. The locations of the borings are shown in the Exploration Location Plans, Figures 2a and 2b.

At each station, one boring was taken on the crest of the embankment through the core material (the central least pervious material. The other two borings were taken along the downstream face at the midslope and toe through the shell material (the outer more pervious granular soils). In some cases, borings were taken into the foundation soils, the soils on which the embankment is constucted.

All holes were advanced using a power-driven rotary bit while circulating drilling fluid. Four-inch flush joint steel casing was used to support the upper 30 to 35 feet of each boring. Below this depth, the holes were advanced uncased and kept open with Revert organic drilling mud. Initially, Revert, an agent added to water, thickens and becomes a viscous fluid. With age, however, it loses its viscosity and becomes water-like again, thereby not affecting the function of the instrument.

Water levels in the boreholes were measured at the completion of the borings and prior to installation of instrumentation. Water level measurements and remarks are presented on the logs. Boring logs prepared by GZA and the driller may be found in Appendix A and Appendix B, respectively.

3.20 SOIL SAMPLING

Representative soil samples were obtained using both split spoon and thin-walled piston samplers. Split spoon samples

were taken at 5-foot intervals using a 24-inch-long, 1-3/8-inch I.D. sampler. The number of blows required to drive the spoon in 6-inch increments with a 140-pound hammer falling 30 inches is recorded on the boring logs. Three-inch-diameter undisturbed samples of the core material were taken in the crest borings at approximately 10 foot intervals. Thirty-inch-long, 3-inch O.D., thin-walled steel tubes were pushed 24 inches using a hydraulic piston sampler (Osterberg Sampler). Sample recovery was measured, after allowing the sample to drain, and is included on the boring logs. The tubes were sealed at each end with wax, stored vertically in the MDC Garage at the Quabbin Administration Building, and then transported to GZA's Newton, Massachusetts laboratory by Briggs Engineering. Undisturbed samples of the shell were not obtained because of its dense nature.

3.30 PIEZOMETER INSTALLATION

A total of 18 pneumatic piezometers were installed at selected locations in the completed boreholes. Piezometers are instruments used to measure water pressure at a point within the embankments. Three piezometers were installed in each crest boring, two in each midslope boring, and one in each toe boring. The piezometers were manufactured by Petur Instrument Company, Inc., of Seattle, Washington, and all but one were Model P-102, which is prepacked in a steel well-screen protective casing. Piezometer (P-12) was a canvas pack Petur Model P-106. All piezometer sensors were Model P-100.

Piezometers were installed in the boreholes using the following general procedure:

1. Upon completion of drilling, a length of 2-1/2-inch casing was suspended inside the 4-inch casing to within several feet of the proposed piezometer tip elevation.

2. The casing was flushed with clean water to displace the drilling fluid.

3. The piezometer was lowered into the hole and isolated within a 3- to 4-foot-long zone of Ottawa sand. The zone of sand was sealed at the top and bottom by a 12-inch layer of compacted dry bentonite clay pellets.

In holes where multiple piezometers were installed, the length of hole between piezometer seals was backfilled with alternating 9-foot layers of pea gravel and 1-foot layers of compacted bentonite pellets. After the uppermost piezometer

was installed, the borehole was backfilled with bentonite grout. Leads for the piezometers are protected by gate valve boxes installed at the surface of the embankment.

Because of the low phreatic surface noted in the embankment, an additional boring (B-8A) was required to install P-16 midslope at Station 21+80 of the Dike. The phreatic surface is the upper water flow line in the embankment, and the planned location would have been above the observed phreatic surface.

4.00 SUBSURFACE SOIL CONDITIONS

Subsurface soil conditions encountered in the 9 borings taken in the core and shell of the Winsor Dam and Dike are described below. The core and much of the shell material, having been hydraulically placed, are expected to exhibit little lateral continuity. Consequently, no interpretation of soil strata between borings has been made. Detailed descriptions of soil conditions are presented in the boring logs.

A graphic presentation of subsurface soil conditions is shown in Figures 3, 4, and 5. Standard penetration resistances (blow counts) shown on the profiles are the number of blows required to drive a standard split spoon sampler with a 140-pound hammer, falling 30 inches between the 6-inch and 18-inch sampling interval. The standard penetration resistance may be used to infer comparative density of cohesionless soils

4.10 WINSOR DAM - CORE

Borings B-1 (Station 15+08) and B-4 (Station 20+00) were taken at the crest of the dam through the core material. In general, the upper 25 feet of soil consists of a granular fill which is, in turn, underlain by over 120 feet of hydraulically placed silt and fine sand which comprise the core material. Underlying the silty core, another fill - - presumably compacted trench backfill - - was encountered. At both stations, the upper stratum of compacted fill consisted of very dense, gravelly, fine to coarse sand with many cobbles. Blow counts in the fill ranged from 22 to 250 blows per foot. The high blow counts are attributed in part to the presence of cobbles.

The sequence of materials with depth in the core was similar at both Borings B-1 and B-4. The upper core material consists of a fine sand and silt of varying densities. At Boring B-1,

penetration resistance measured by blow counts ranged from 5 to 25 blows per foot (loose to medium-dense); while at Boring B-4, penetration resistances of 3 to 9 blows per foot (loose) were encountered.

At midrange depths, the material consists of a sandy or clayey (slightly plastic) silt. Penetration resistance in Boring B-1 ranged from 7 to 59 blows per foot (loose to very dense); in B-4, penetration resistances ranged from 5 to 27 blows per foot (loose to medium-dense).

The lower zone of the core in these two borings consists of dense to very dense, stratified fine sand and silt. Stratification in this zone is significantly more prominent than in the upper and middle zones. Penetration resistance at B-1 ranged from 30 to 81 blows per foot, and at B-4 from 10 to 114 blows per foot.

In each of the two crest borings, a change of strata to a denser, silty fine sand occurred at a depth of about 148 feet below the crest. Penetration resistances as high as 108 blows per foot in B-1 and 143 per foot in B-4 were recorded. According to design drawings, this material corresponds to compacted fill placed prior to hydraulic fill operations.

4.20 WINSOR DAM - SHELL

Four borings (B-2, B-3, B-4, and B-5) were taken through the shell material within the downstream embankment of the dam. In general, the material comprising the shell consists of granular soils, ranging from a very dense, fine sand to gravelly fine to coarse sand, with cobbles and varying percentages of silt.

In Borings B-2 at Station 15+08 and B-5 at Station 20+00, the material consists of a very dense, fine and fine to medium sand beneath a surface layer of fine to coarse sand, gravel, and cobbles which are approximately 30 feet deep. In boring B-2, these fine sands exhibited a slight stratification, indicating hydraulic placement. A transition to a very dense (over 270 blows/foot) sand and gravel stratum was observed at a depth of approximately 77 feet. A review of design drawings and topographic preconstruction contours indicate that original ground occurred about 75 feet below the existing embankment at the borehole location. In Boring B-5, the fine and fine to medium sand was observed to a depth of over 90 feet. Boring B-5 was not advanced into foundation material below the embankment.

In Boring B-3 at Station 15+08 and boring B-6 at Station 20+00, both taken near the toe of the downstream slope, medium-dense to very dense, gravelly sand with cobbles were encountered. Penetration resistances were higher in B-6 than in B-3, suggesting that the percentage of cobbles at Station 20+00 is greater than that at Station 15+08. The transition to original material was estimated to be at a depth of 18 feet in B-3, based on a review of topographic plans showing original ground. At Boring B-6, the transition to natural ground was estimated to be at a depth of 75 feet. Boring B-6 was advanced an additional 37 feet through very dense foundation materials consisting of sand, gravel, and cobbles.

4.30 GOODNOUGH DIKE - CORE

Boring B-7 at Station 21+80 was taken at the crest of the Dike through the core material. The results of the boring indicate that approximately 42 feet of very dense, compacted, granular fill is underlain by over 95 feet of hydraulically placed, stratified, fine sandy silt core material. The zone of compacted fill above the core consists of dense, gravelly sands. The high penetration resistance (over 200 blows per foot) presumably reflects the high percentage of cobbles in the fill.

The core material was primarily stratified, fine sandy silt. Strata thicknesses noted in split spoon samples ranged from 1/32-inch to 1/2-inch and were distinguished by variations in color, grain size, and silt content. Penetration resistance indicates that the core material is generally medium-dense to dense, although the lowest recorded resistance was 8 blows per foot.

A change of soil stratum to a very dense, fine sand (100 to 200 blows per foot) occurred at a depth of approximately 138 feet. Based on a review of design drawings, original topography, and penetration resistances, this material is judged to be compacted fill placed prior to hydraulic filling operations.

4.40 GOODNOUGH DIKE - SHELL

Two borings, B-8 and B-9, were taken through the downstream shell of the embankment at Station 21+80. The material encountered in the borings consists primarily of dense, fine to coarse sand with varying amounts of silt, gravel, and cobbles.

The predominant soil encountered in Boring B-8, taken at midslope on the downstream face, is a dense, fine sand. A transition from fine sand to a gravelly sand with cobbles was noted at a depth of about 74 feet. From a review of design drawings and original topography this material appears to be compacted fill placed on original ground prior to the hydraulic filling operations.

At Boring B-9, taken near the downstream toe, the shell material consists of about 17 feet of medium-dense, fine to coarse sand, underlain by 30 feet of medium- to very dense, gravelly, fine to coarse sand with cobbles. The transition to natural material is estimated to be at a depth of 48 feet below the top of borehole. The natural foundation soils at this depth and location consist of stratified fine sand. At 71 feet below the top of borehole, a gravelly, fine to coarse sand with cobbles was encountered in the boring.

5.00 LABORATORY TESTING PROGRAM

A program of laboratory testing was conducted on selected split spoon and undisturbed thin-walled tube samples. The purpose of the testing was to provide information for soil classification and to provide engineering parameters necessary to assess the shear strength and liquefaction potential of the embankment soils. The results of the laboratory soil testing are presented in Appendix C and are summarized below.

5.10 CLASSIFICATION TESTS

Representative soil samples were selected from both undisturbed tube and split spoon samples. Grain size analyses were conducted on representative samples of the core, shell, and foundation soils from both the Main Dam and the Dike. Atterberg limits and moisture content tests were conducted on soils consisting of fine-grained material found in the core. The purpose of these tests was to assist in the classification of the embankment and foundation materials. Tests for specific gravity were also conducted on representative samples of the core material.

A summary plot showing the limits of all gradation tests performed on the soil samples is presented in Figure 6. These results are in compliance with other gradation analyses from published sources (Reference 9) and MDC records. Results of all classification testing are shown on summary sheets presented in Appendix C.

5.20 STRAIN-CONTROLLED UNDRAINED SHEAR TESTS

Conventional triaxial undrained shear tests with pore pressure measurements were conducted on undisturbed samples from the core of the Main Dam and Dike. Similar tests were conducted on representative samples of the shell material. For the shell material, however, tests were performed on remolded samples that had been compacted to both a relatively loose (100 pcf dry density) and a relatively dense (110 pcf dry density) state. The purpose of the tests was to measure a friction angle and cohesion intercept for the two densities and to provide data as a basis for selecting shear strength parameters for the shell material.

Triaxial test samples were approximately 2.9 inches in diameter and 6.0 inches in length. Water content and sample weights were recorded prior to testing. Samples were back-pressured under a small effective stress to saturate the samples. The chamber pressure was then increased to the desired consolidation pressure and allowed to remain for approximately 12 hours. During consolidation, volume change was recorded. After consolidation of the sample, pore pressure response was checked by increasing the cell pressure and monitoring the corresponding increase in pore pressure. When required, additional back pressure was applied to achieve a pore pressure response equal to or greater than 95 percent.

The samples were loaded under strain-controlled conditions while allowing no drainage during shear. Load application rates were selected using formulas described in Reference 2. The applied load, back pressure, and change in height of the samples were recorded at regular intervals during the test. When 20 percent strain was reached, loading was terminated, and the samples were removed from the loading apparatus. A sketch of the failed sample was made, the weight obtained, and water content determined.

Applied pressures during application of load were corrected for effects of membrane stiffness in accordance with procedures outlined in Reference 3. The results of these tests are presented in Appendix C.

5.30 STRESS-CONTROLLED UNDRAINED SHEAR TESTS

Stress-controlled triaxial undrained shear tests with pore pressure measurements were conducted on representative samples of core material from the Main Dam and Dike to establish their potential for liquefaction. These tests were conducted

in a manner similar to the previously described strain-controlled tests, except that samples were loaded incrementally with a constant stress. The purpose of these tests was to provide data to construct a flow line showing the relationship between the critical void ratio and the effective minor principal stress at failure (σ_{3f}).

Testing for the Main Dam was conducted on representative samples obtained from Boring B-1 at a depth of 64 to 66 feet. The material consisted of a nonplastic grey silt and fine sand. Tests for the Dike were conducted on representative samples obtained from Boring B-7 at a depth of 62 to 64 feet. The material was a slightly plastic, clayey silt with a trace of fine sand. The liquid limit of this sample was 36, and the plasticity index was 2. The liquid limit and plastic limit of a soil give an approximate range of water contents between the soil's solid and liquid state and are used as a measure of the soil's plasticity.

6.00 PIEZOMETRIC CONDITIONS IN THE MAIN DAM AND DIKE

Pneumatic piezometers were installed in the boreholes at the completion of the borings and periodic readings have since been made. The reservoir level varied between elevation 522.2 and 522.9 during this time as measured by MDC personnel. Piezometric levels observed during May and June 1981 in the eighteen piezometers have been tabulated in Table1 . The piezometric levels measured on June 26, 1981, are considered stabilized readings, and were used in the evaluation. Cross sections showing the piezometer locations and piezometric levels on June 26, 1981, are shown in Figures 7, 8, and 9 . The water levels observed in boreholes are also shown on these figures.

Data for piezometers located in Borings B-1, B-4, and B-7 (crest borings at the Main Dam and Dike) suggest that the measured piezometric elevations in the core decrease with depth, indicating dissipation of head in the core and downward flow. This trend is expected. Piezometers located in the shell show little pressure, suggesting that little flow is occurring within the downstream embankment. The estimated phreatic surfaces, or upper flow lines, through the embankment at the three sections are shown on the figures. The phreatic surface estimate was based on a review of piezometric data and on engineering judgment.

7.00 METHODS OF ANALYSIS

The methods of analysis used in the evaluation of embankment stability are described below.

7.10 STABILITY ANALYSIS

The stability of Winsor Dam and Goodnough Dike was evaluated using LEASE II, a computerized slope stability analysis program. LEASE II solves two-dimensional stability problems employing the Simplified Bishop Method of Slices or the Morganstern-Price Method. All stability analyses performed for the dam and dike were made using the Simplified Bishop Method of Slices for circular failure surfaces.

Input data to the program consist of the following:

1. Geometry of the embankment cross section
2. Soil data (unit weight, strength parameters)
3. Pore pressure data
4. Seismic coefficients (if analyzing "psuedo-static" or earthquake condition)
5. Information describing the circle centers and the range of radii to be analyzed.

An example of a typical set of program input is given in Appendix D.

In the analyses completed for this study, three sets of soil parameters were used to describe: (1) the core material, (2) the shell material, and (3) the foundation material. The selection of soil parameters was based on results of laboratory tests and on judgment. A parametric study was also performed by selecting a series of friction angles for the core to evaluate the effect on stability resulting from possibly weaker zones within the core. A friction angle of zero was used to simulate a complete loss of strength in the core material. The soil properties used in the analyses are presented in the table below:

	Saturated Density (psf)	Effective Friction Angle (degrees)	Cohesion Intercept (psf)
Core	124	0, 20, 25, 35	0
Shell	130	37	0
Foundation	135	40	0

The limit of the core for analysis was defined by using the approximate edge of pool as shown in the soil profile figures. The approximate edge of pool was obtained from design drawings. The edge of pool corresponds to the edge of the settling pond maintained during construction of the core and describes the probable maximum extent of the core. Limited data taken from MDC files showing the limits of the core suggest that the actual core extends to the edge of the pool.

Pore pressure data for these analyses was described by the phreatic surface. Pore pressures were internally calculated by multiplying the distance of the point on the failure surface below the phreatic surface by the unit weight of water.

7.20 EARTHQUAKE SELECTION

Earthquake peak accelerations of 0.18g and 0.12g were selected. A peak acceleration of 0.18g was selected based on a review of predicted values suggested by the New England Division, U.S. Corps of Engineers for three Federal dams in central and western Massachusetts, southern New Hampshire, and northern Connecticut. The peak acceleration was determined by increasing recorded Mercalli intensity by one unit for each event and attenuating the value to the site (Reference 7). The Massachusetts State Building Code, on the other hand, requires a peak acceleration of 0.12g. The selected values of peak acceleration 0.12g and 0.18g have been approximately equated to the Modified Mercalli (1931) earthquake intensity level. A peak acceleration of 0.12g and 0.18g correspond approximately to Level VII and Level VIII earthquake intesities.

Data is presented in Appendix F which correlates the Modified Mercalli intensity level and physical description with the peak acceleration of seismic events. The Modified Mercalli scale is an approximate rating of seismic events. Two maps are also presented in the Appendix which show first a compilation of recorded earthquakes in the central New England area and second

a tectonic map of New England. Earthquakes observed within about 50 miles of the Quabbin Reservoir have been intensity V or less. Therefore, the analysis conducted on the basis of a 0.12g or 0.18g peak acceleration is judged conservative.

7.30 EMBANKMENT STRESS ANALYSIS

A finite element analysis was performed to obtain an estimate of the existing state of stress in the embankment. The stresses were used to plot minor principal stress versus void ratio for samples at selected locations within the embankment. The data is used in assessing the potential of the core material to liquefy.

The method used to calculate the static stresses was based on a reasonable representation of the nonlinear stress-strain relationships for the construction material. The analysis follows a step-by-step sequence representative of the construction sequence for the embankment under consideration. The finite element computer program ISBILD, which was developed at the University of California, Berkeley (Reference 4) was used. A total stress plane strain analysis using drained stress-strain parameters was performed.

The computer program ISBILD employs a hyperbolic stress-strain relationship to model several aspects of the stress-strain behavior of soils, including (1) nonlinearity, or decreasing tangent modulus with increasing strain; (2) stress-dependency, or increasing stiffness and strength with increasing confining pressure; and (3) realistic variations of Poisson's ratio with strain and confining pressure. The parameters employed in the hyperbolic stress-strain relationships are listed in Table 2, together with descriptions of their physical significance and explanations of their role in the finite element analyses. A more complete description of these parameters is contained in a report by Wong and Duncan, 1974 (Reference 5). The appropriate nonlinear stress-strain parameters for each soil type in the embankment were selected using the results of consolidated-undrained triaxial tests with pore pressure measurements and published data for similar soils.

The finite element analysis was conducted using the cross section at Station 21+80 of Goodnough Dike. The initial states of stress at Stations 15+08 and 20+00 of Winsor Dam were obtained from the same analysis by scaling the stresses according to the difference in the sizes of the cross sections. This was possible because of the similarities among the three cross sections.

The results of the analyses are shown as contours of major principal stress (σ_1) and minor principal stress (σ_3) through the core and into the shell and are presented in Figures 10 and 11. It can be seen from these results that there is a stress reduction in the core material caused by stresses arching on the stiffer shell material.

7.40 LIQUEFACTION POTENTIAL

The term "liquefaction" as used in this report refers to the nearly complete loss of strength of a granular soil and the attendant onset of flow. Such a condition can be brought about by either static or transient loads, provided that the soil exists at a void ratio at or greater than the critical value (i.e., the soil contracts when sheared). Casagrande (Reference 6) observed that the critical void ratio is proportional to the initial effective confining pressure; i.e., the greater the confining pressure, the denser the soil must be to avoid a flow failure (liquefaction). Although flow can apparently be induced by only a slight change in the loading if the soil exists at or above the critical void ratio, it is also expected that large deformations could develop (roughly in proportion to the magnitude of imposed shear stress) in cases where the void ratio is only slightly less than the critical value.

The evaluation of the potential for liquefaction was based on the critical void ratio established through stress-controlled, static triaxial tests (R-tests). The liquefaction potential, L_p, was defined by Casagrande as:

$$L_p = \frac{\sigma_{3i}}{\sigma_{3f}} - 1$$

Data presented by Casagrande in the form of void ratio, e, versus σ_3 (initial minor principal stress) for a particular kind of sand is shown in Figure 12. The so-called F-line ("F" designating "flow") separates contractive from dilative behavior. For L_p values greater than zero (e greater than the critical value), the soil contracts when sheared, and a flow condition may prevail. For L_p values less than zero, the soil dilates when sheared, and strains are limited by the attendant reduction in pore pressure.

In some actual cases, the critical void ratio may be rather insensitive to the initial confining pressure, and liquefaction potential can be assessed qualititively only according to the proximity of the existing void ratio relative to the critical value.

A similar analysis was conducted for these studies. Representative samples of core material were subjected to stress controlled consolidated undrained shear tests. The results are presented as a plot of void ratio (e) versus σ_3, as shown in Appendix C and summarized in Figure 13. Flow line A was developed with nonplastic silt and fine sand. Flow line B was developed with slightly plastic, clayey silt. Field data that plot above and to the right of the flow line may be susceptible to liquefaction, and data lying below and to the left of the flow line are probably not susceptible to liquefaction.

8.00 DISCUSSION OF RESULTS

In accordance with recommendations contained in the Department of the Army, U.S. Corps of Engineers' Phase I Report (Reference 1), a stability analysis including both static and seismic factors was conducted for the downstream embankment of the Main Dam and Dike. The analysis consisted of: (1) evaluating the penetration resistances recorded in the field during the subsurface explorations; (2) evaluating the laboratory soil testing data, and (3) evaluating the results of slope stability analyses.

8.10 PENETRATION RESISTANCE

Penetration resistances recorded in the field during the subsurface explorations were used in this analysis as one basis of evaluation.

8.11 Embankment Core

Penetration resistance values in the core material, uncorrected for overburden stress, range from 3 to greater than 50 blows per foot. The median of all values is 19. Approximately 50 percent of the values fall between the range of 3 to 15 blows per foot. When corrected for confining pressures caused by the depth of the sample within the embankment, these values are expected to be lower and to fall within the loose range between zero and 10 blows per foot.

Low penetration resistance values are probably indicative of potential liquefaction susceptibility. Generally, values less than 10 blows per foot in saturated, clean, fine to medium sands exhibit a liquefaction potential. Although liquefaction is not well understood in silty soils, it is advisable, nevertheless

to consider that the loose, nonplastic silt encountered in the core material is potentially liquefiable. However, liquefaction would only occur for a seismic event of sufficient magnitude or duration to cause pore pressure increase resulting in a loss of shear strength in the core.

8.12 Shell

Penetration resistance values in the shell material, uncorrected for overburden stress, range from a low of 5 to well over 150 blows per foot. Median values of 77 and 25 blows per foot and mean values of 83 and 31 blows per foot occur in the midslope and toe boreholes, respectively. Even if the field data were corrected for confining pressure, which would lower the values, it is expected that approximately 85 percent of the corrected data points would indicate that liquefaction is improbable.

In addition, the free-water surface flowing within the embankment is, on the average, at a depth of 50 feet or greater below the face of the slope. Capillary rise above the free-water surface in the fine to coarse sand shell is estimated to be limited to about 8 feet. Therefore, the embankment, for all pratical purposes, is not saturated, is dense, and the shell is not expected to liquefy.

The friction angle of the shell material, which is a measure of shear strength, is estimated to be about 37 degrees, based on an assessment of field penetration resistance and laboratory soil testing data. The maximum slope of the downstream embankment is 1 vertical to 2 horizontal, or an angle of 26.5 degrees. Because the angle of internal resistance for the shell material is greater than the slope of the embankment, the face of the embankment is judged to be stable.

8.20 LABORATORY TEST RESULTS

Stress-controlled undrained triaxial shear tests were conducted on selected samples of core material to guide the assessment of liquefaction potential. Details of the tests are presented in Section 5.30. Calculated test sample void-ratio has been plotted versus the effective minor principal stress at failure (σ'_{3f}) to develop a flow line as shown by line A and line B in Figure 13. A flow line separates contractive soils from dilative soils or those soils in where liquefaction is possible from those soils where liquefaction is not possible. As a measure of liquefaction potential in the core material, in situ void ratios of undisturbed

samples from the field were plotted versus calculated effective minor principal stress within the embankment at the sampling depth. These data have also been plotted on Figure 13.

Flow line A was developed using nonplastic soil samples from within the core. Therefore, there appears to be a potential for liquefaction of the nonplastic soils within the core.

Flow line B was developed using slightly plastic soils (plastic index 2) from within the core. The state of two representative field samples of slightly plastic soils was plotted and compared to line B. One sample plots in the contractive zone, while the other plots in the dilative zone. These results suggest that zones of nonliquefiable soils may exist in the core.

One apparent anomaly in the method of liquefaction evaluation was noted. Stress-controlled undrained triaxial shear tests were conducted according to generally accepted engineering methods on remolded samples to test a range of void ratios to produce contractive specimens. One stress-controlled test was conducted on an undisturbed sample of slightly plastic soil consolidated to the estimated effective minor principal stress within the embankment. The test results indicated dilative behavior. The sample was then remolded and tested at the same void ratio and consolidation pressure, but it exhibited contractive behavior. Results of the tests are shown in Figure 14. These limited results suggest that the evaluation of the flow line locus based on tests of remolded samples may be conservative. That is, the flow lines of Figure 13 would be shifted upward if based on tests of undisturbed material, and the measured in situ void ratios and calculated stresses would be less indicative of liquefaction. A program of additional sampling and testing to explore this possibility would be difficult and expensive, however, and is therefore not recommended at this time.

8.30 STABILITY ANALYSIS

Stability analyses of the downstream embankment for both static and seismic conditions were calculated. The calculated factors of safety in the analyses were compared with minimum factors of safety normally used for design. Minimum acceptable factors of safety presented in Reference 3 (Table 1), included herein as Table 3, were used as a guideline in this evaluation.

A series of analyses was conducted for trial-failure circles using selected strength parameters for the core and shell. Results of laboratory shear testing indicate that effective angles of friction (ϕ') for the core and shell are 35 degrees and 37 degrees, respectively.

8.31 Static Case

The initial analysis for static conditions was conducted using strength parameters of 35 degrees and 37 degrees for the core and shell, respectively. To account for potentially weaker zones within the core, the analysis was also conducted using reduced friction angles for the core material of 25 and 20 degrees. For the limiting case of zero shear strength in the core, which represents complete liquefaction, a friction angle of zero was used. Results of the analyses are presented in the table below and indicate that acceptable factors of safety exist in the embankment. The results also show that, even if the core were completely liquefied, the strength of the shell would appear to maintain an acceptable factor of safety. Critical circles which show the potential failure surface with the lowest factor of safety are presented in Appendix E.

Summary of Stability Analyses - Static (Downstream Embankment)

Section	Core (degrees)	Shell (degrees)	Factor of Safety	Remarks
		Winsor Dam		
STA 20+00	35	37	2.39	Core strength based on laboratory test results
	25	37	2.21	Core strength reduced for possibly weaker zones
	20	37	2.12	Core strength reduced for possibly weaker zones
	0	37	1.75	Core assumed to liquefy
STA 15+08	25	37	2.01	Reasonable minimum friction angle for core

Goodnough Dike

STA 21+00	25	37	2.05	Reasonable minimum friction angle for core
Minimum Acceptable	--	--	1.50	Corps of Engineers Design Minimum

8.32 Pseudo-Static Case

A similar stability analysis for a seismic event was conducted for the embankment by applying a static horizontal force to simulate an earthquake. The seismic analysis was conducted using two levels of peak acceleration, 0.12g and 0.18g, selected as described in Section 7.20.

A peak acceleration of 0.12g is based on Massachusetts State Building Code requirements, while the peak acceleration of 0.18g is a more conservative maximum probable peak acceleration for the area. A reasonable minimum friction angle for the core of 25 degrees was selected for analysis. The results of the analysis presented in the table below show that, for both magnitudes of peak acceleration, acceptable minimum factors of safety exist. Critical circles which show the potential failure surface with the lowest factor of safety are present in Appendix E.

An additional conservative analysis was conducted on the embankment. This analysis assumed that the peak acceleration occurs and, at the same time, actual liquefaction of the core occurs. For this analysis, peak accelerations of 0.12g and 0.18g and a core having zero shear strength were assumed. Usually, the pseudo-static analysis is conducted using embankment strengths consistent with the static case. Results of this analysis indicate that acceptable factors of safety exist for a peak acceleration of 0.12g.

Results of the analysis conducted with a peak acceleration of 0.18g indicate a factor of safety slightly less than one. However, because the assumptions made in this analysis were conservative, and because the probability that the event will occur is unlikely, these factors of safety are considered acceptable. In addition, even if the core were to liquefy, total failure of the dam is not expected. Damage to the embankment would probably result from limited sloughing of the downstream slope or subsidence of the crest during short periods of peak shaking, but is is expected that movement would stop within a

day after shaking has subsided. It should be noted that a design freeboard of about 20 feet is expected between the crest of the dam and reservoir level at design pool.

Summary of Stability Analysis -
Pseudo-Static (Downstream Embankment)

Section	Core (degrees)	Shell (degrees)	Predicted Peak Acceleration	Factor of Safety	Remarks
			Winsor Dam		
STA 20+00	25	37	.18g	1.35	*
	0	37	.12g	1.18	**
	0	37	.18g	1.00	**
STA 15+08	25	37	.18g	1.26	*
	0	37	.12g	1.08	**
	0	37	.18g	0.93	**
			Goodnough Dike		
STA 21+80	25	37	.18g	1.28	*
	0	37	.12g	1.12	**
	0	37	.18g	0.96	**
Minimum Acceptable	--	--	--	1.00	Corps of Engineers Design Minimum

NOTES:

* Reasonable minimum friction angle for core
** Assumes liquefaction of core

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9.00 CONCLUSIONS AND RECOMMENDATIONS

Conclusions on the stability of the downstream slope are presented below, subject to the limitations set forth in Appendix G.

1. Factors of safety normally considered acceptable exist in the downstream embankment; therefore, complete failure of the dam is judged to be unlikely.

2. The core exhibits limited liquefaction potential. Results of the stability analyses indicate that, even if the core were to liquefy, an acceptable factor of safety is available.

3. Should the core liquefy during an extreme seismic event (peak acceleration of 0.18g), the crest of the embankment will probably subside. Settlement of the embankment, however, is not expected to precipitate a breach or complete failure of the dam especially since a minimum free-board of 20 feet is expected above the reservoir level.

10.00 REFERENCES

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2. Bishop, A.W., and Henkel, D.J., "The Triaxial Test," Edward Arnold Publisher, 1957, pp. 124-127, 204-206.

3. Seed, H.B., and Duncan, J.M., "Corrections for Strength Test Data", Journal of Soil Mechanics and Foundation Division, ASCE, September 1967.

4. Ozawa, Y. and Duncan, J.M. "Isbild: A computer program for Analysis of Static Stresses and Movements in Embankments", Geotechnical Engineering Report No. TE 73-4, University of California, Berkeley, December 1973.

5. Wong, Kais, and Duncan, J.M., "Hyperbolic Stress-Strain Parameters for Nonlinear Finite Element Analyses of Stresses and Movements in Soil Masses", Report No. TE 74-3 to National Science Foundation, Office of Research Services, University of California, Berkeley, July 1974.

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6. Casagrande, A., "Liquefaction and Cyclic Deformation of Sands - A Critical Review", Harvard Soil Mechanics, Series No. 88, Harvard University, Cambridge, Massachusetts, 1976.

7. Goldberg-Zoino & Associates, Inc., and D'Appolonia Consulting Engineers, Inc., Liquefaction and Cyclic Mobility Potential, Corps of Engineers Completed New England Dams, Phase I Investigation, Department of the Army, New England Division, September 1980.

8. Department of the Army, Corps of Engineers; Engineering Design Stability of Earth and Rock-Fill Dams; EM1110-2-1902, 1, April 1970.

9. Kyrnine and Judd, Principles of Enginering Geology and Geotechnics, McGraw-Hill, 1957, P. 620.

10. Dore, Stanley, M., "Quabbin Dike Building by Hydraulic-Fill Methods", Procedings of the American Society of Civil Engineers, New York, September 1937, pp. 1396-1413.

TABLES

TABLE 1 - SUMMARY OF PIEZOMETRIC LEVELS

PIEZOMETRIC NUMBER	DATE INSTALLED	TIP ELEVATION	PIEZOMETER ELEVATION (NOTE 1), BOSTON CITY BASE															
			MAY 1981						JUNE 1981									
			11	12	14	29	1	3	4	5	9	10	12	16	18	19	23	26
1	6/04/81	475.2							512.2		497.7		497.4			497.4		497.4
2	6/04/81	440.2								480.4	478.1		477.6			477.2		477.6
3	6/04/81	413.0							482.3	479.5	478.4		479.0			479.0		479.0
4	5/11/81	458.5	468.9	458.7	458.9			458.9					459.0			458.9		459.0
5	5/11/81	446.5	466.1	451.1	451.6			451.1					449.3			451.1		451.1
6	6/18/81	391.0														391.0		391.0
7	6/01/81	484.2					501.8	498.9			498.1		498.1			498.5		498.1
8	5/29/81	440.8				470.4	469.0	469.4			469.0		459.4			469.0		469.0
9	5/29/81	403.2				499.6	493.1	452.2			455.4		456.3			491.7		451.7
10	6/03/81	457.0						457.9	457.2				457.5			457.0		457.5
11	6/03/81	436.3						436.8	436.3				436.8			436.3		436.8
12	6/23/81	378.2															445.2	392.9
13	6/19/81	482.4														510.6	502.3	502.3
14	6/19/81	456.0														486.0	487.0	481.9
15	6/19/81	413.5														495.7		Note 2
16	6/16/81	431.0												443.9		437.5		437.0
17	6/09/81	442.0										445.7		445.5		445.7		445.7
18	6/12/81	405.0											425.8	425.1		425.8		425.3

NOTE: (1) Elevations are approximate and based on assumed surface elevations.
(2) Piezometer lines probably plugged, reading unreliable.

TABLE 2 - STRENGTH AND STRESS-STRAIN PARAMETERS USED IN THE FINITE ELEMENT ANALYSIS

PARAMETER	SYMBOL	ROLE OF ANALYSIS	FOUNDATION ALLUVIUM	CONCRETE CORE WALL	SILT CORE	TRANSITION FILTERS	SHELLS	RIPRAP
Moist unit weight	γ_m	Stress values are proportional to unit weight (moist, saturated, or bouyant, depending on zone).	0.135	0.150	0.124	0.127	0.130	0.135
Cohesion intercept	c	Together, determine how strength varies with confining pressure.	0	432	0	0	0	0
Friction angle	ϕ		40	0	35	36	37	37
Modulus number	K	Together, determine how initial tangent modulus varies with confining pressure.	700.0	450,000	125.0	510.0	500.0	500.0
Modulus exponent	n		0.20	0.01	0.20	0.20	0.20	0.20
Failure ratio	R_f	Relates value of hyperbolic asymptote to compressive strength	0.7	1.0	0.7	0.7	0.7	0.7
Poisson's ratio at σ_3 = 1 atmosphere, and zero strain	G		0.35	.1	.40	0.45	0.35	.35
Reduction in Poisson's ration for 10-fold increase in σ_3	F	Together, determine how Poisson's ratio varies with σ_3	0.15	0.01	0.1	0.1	0.1	0.1
Increase in Poisson's ration for 100% strain	d		5.0	1.0	5.0	5.0	5.0	5.0

NOTE: All parameters are dimensionless, with the exception of γ_m and C, which are in units of kips and feet.

Table 3

Minimum Factors of Safety†

Normally Accepted for Earth Embankments

Case No.	Design Condition	Minimum Factor of Safety	Shear Strength	Remarks
I	End of construction	1.3††	Q or S‡	Upstream and downstream slopes
II	Sudden drawdown from maximum pool	1.0‡‡	R, S	Upstream slope only. Use composite envelope. See fig. 4
III	Sudden drawdown from spillway crest or top of gates	1.2‡‡	R, S	Upstream slope only. Use composite envelope. See fig. 4
IV	Partial pool with steady seepage	1.5	$\frac{R+S}{2}$ for R < S, S for R > S	Upstream slope only. Use intermediate envelope. See fig. 5
V	Steady seepage with maximum storage pool	1.5	$\frac{R+S}{2}$ for R < S, S for R > S	Downstream slope only. Use intermediate envelope. See fig. 5
VI	Steady seepage with surcharge pool	1.4		
VII	Earthquake (Cases I, IV, and V with seismic loading)	1.0	§	Upstream and downstream slopes

† Not applicable to embankments on clay shale foundations.

†† For embankments over 50 ft high on relatively weak foundations use minimum factor of safety of 1.4.

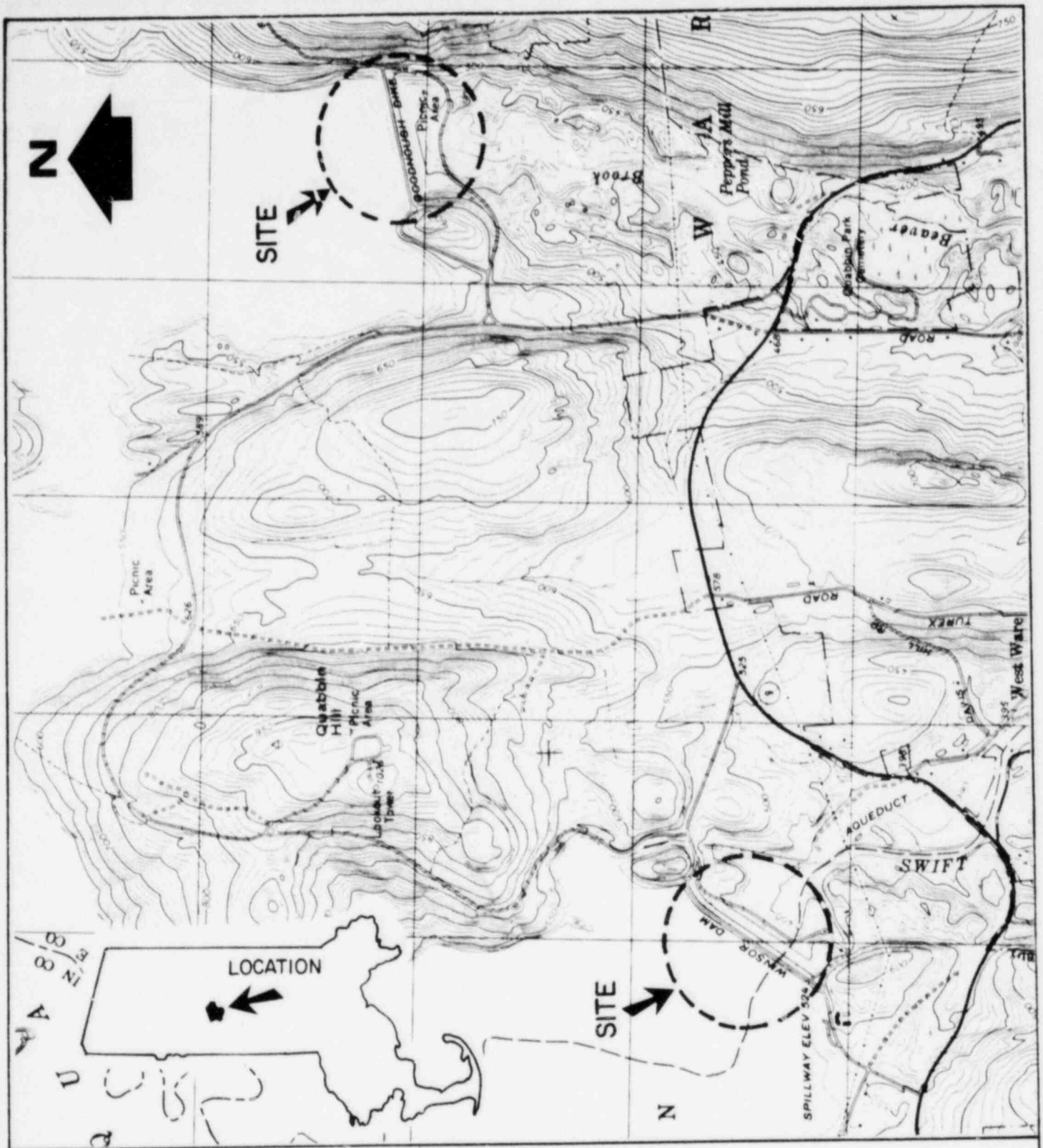
‡ In zones where no excess pore water pressures are anticipated, use S strength.

‡‡ The safety factor should not be less than 1.5 when drawdown rate and pore water pressures developed from flow nets (Appendix III) are used in stability analyses.

§ Use shear strength for case analyzed without earthquake except that it is not necessary to analyze sudden drav down for earthquake effects.

Reference: Department of the Army, Corps of Engineers; Engineering Design Stability of Earth and Rock-Fill Dams, EM 1110-2-1902, April 1970.

FIGURES



FILE No. 2801

FROM USGS WINSOR DAM, MASS. QUADRANGLE MAP (1967)

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METROPOLITAN DISTRICT COMMISION
QUABBIN RESERVOIR DAMS
WARE, MASSACHUSETTS

LOCUS PLAN

JULY 1981

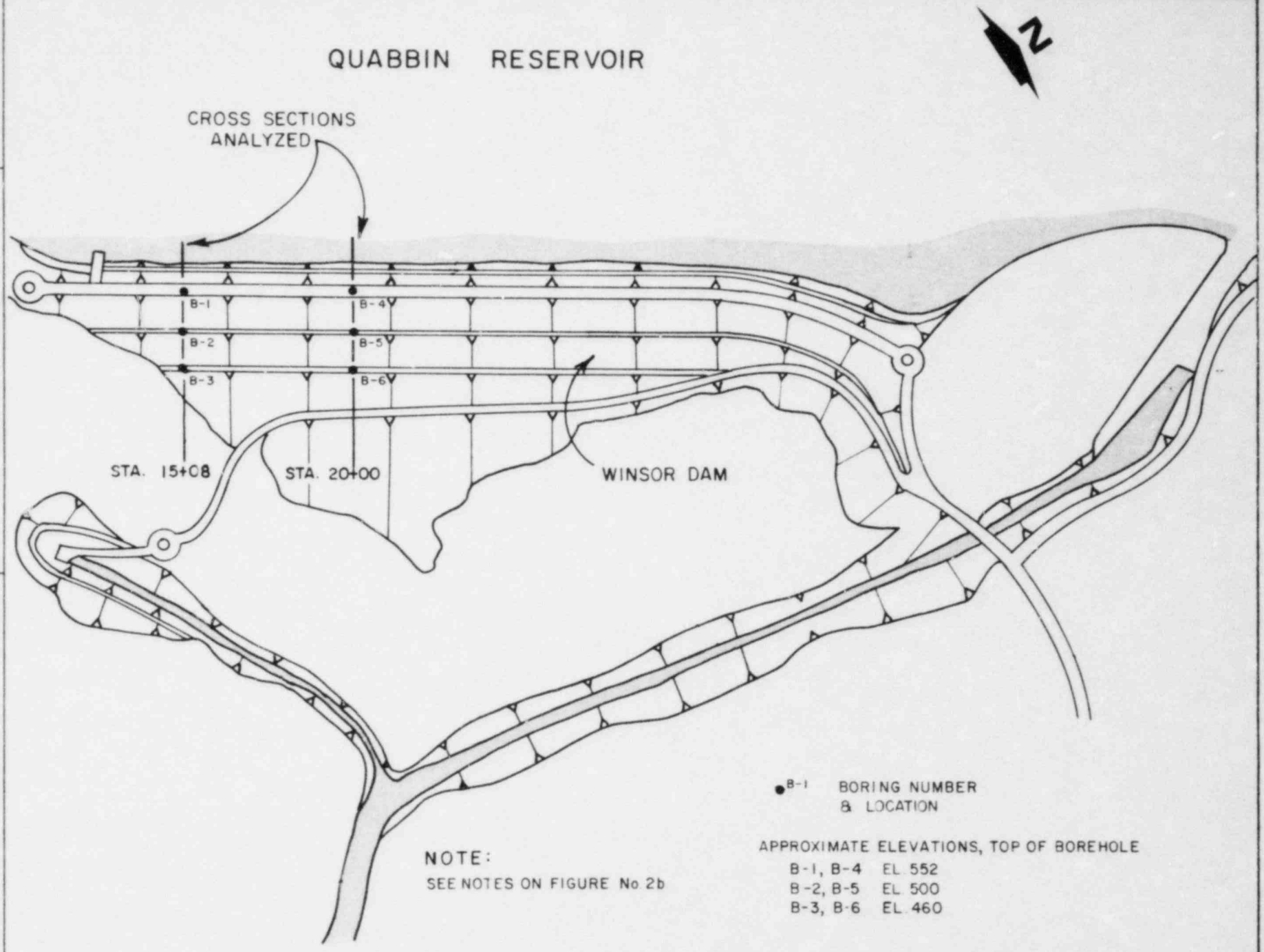
FIGURE No. 1

FILE No. 2801

GZA

METROPOLITAN DISTRICT COMMISION
QUABBIN RESERVOIR DAMS
WARE, MASSACHUSETTS

EXPLORATION LOCATION PLAN
· WINSOR DAM ·
JULY 1981
FIGURE No 2a



FILE No. 2801

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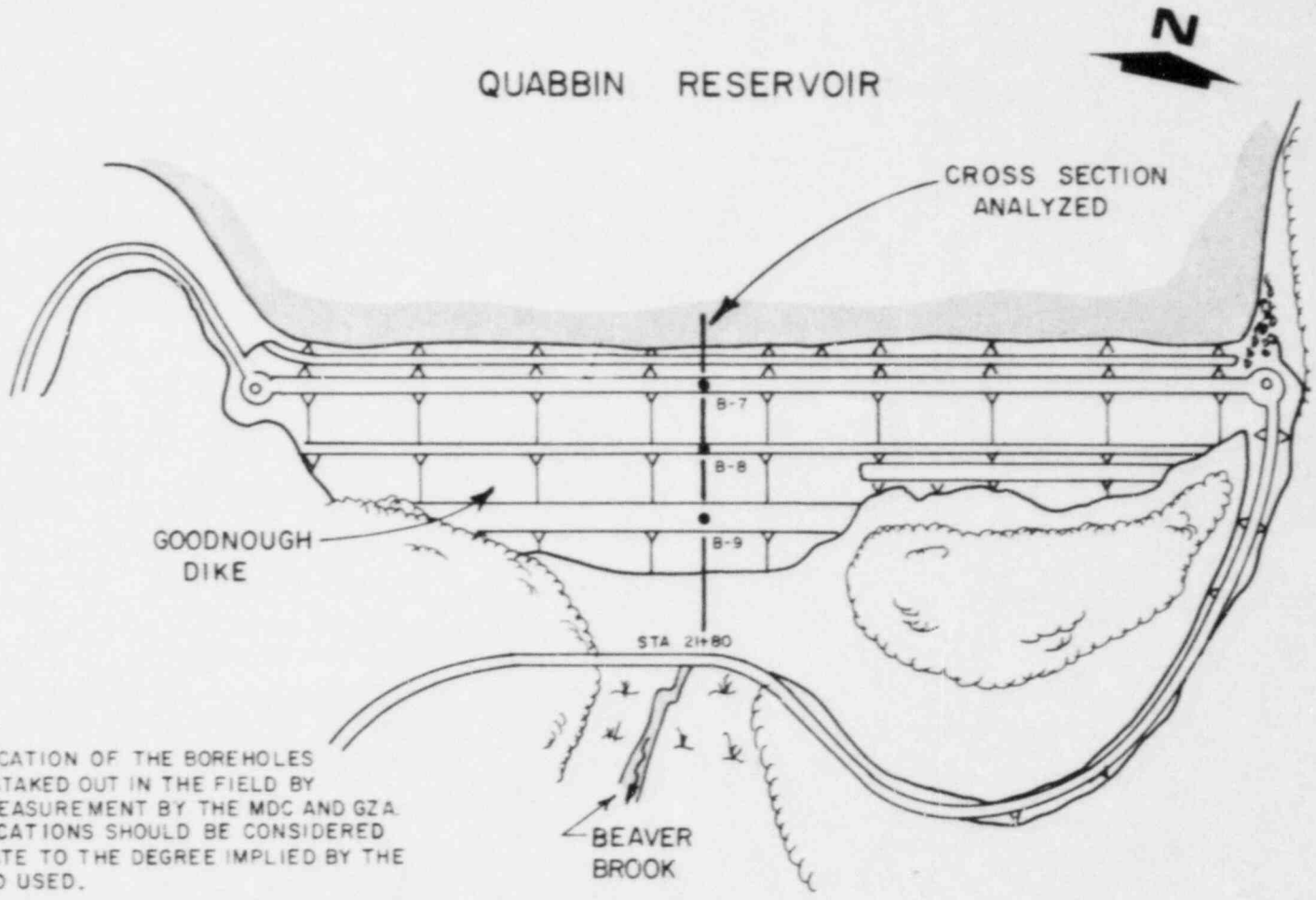
METROPOLITAN DISTRICT COMMISION
QUABBIN RESERVOIR DAMS
WARE, MASSACHUSETTS

EXPLORATION LOCATION PLAN
· GOODNOUGH DIKE ·
JULY 1981
FIGURE No. 2b

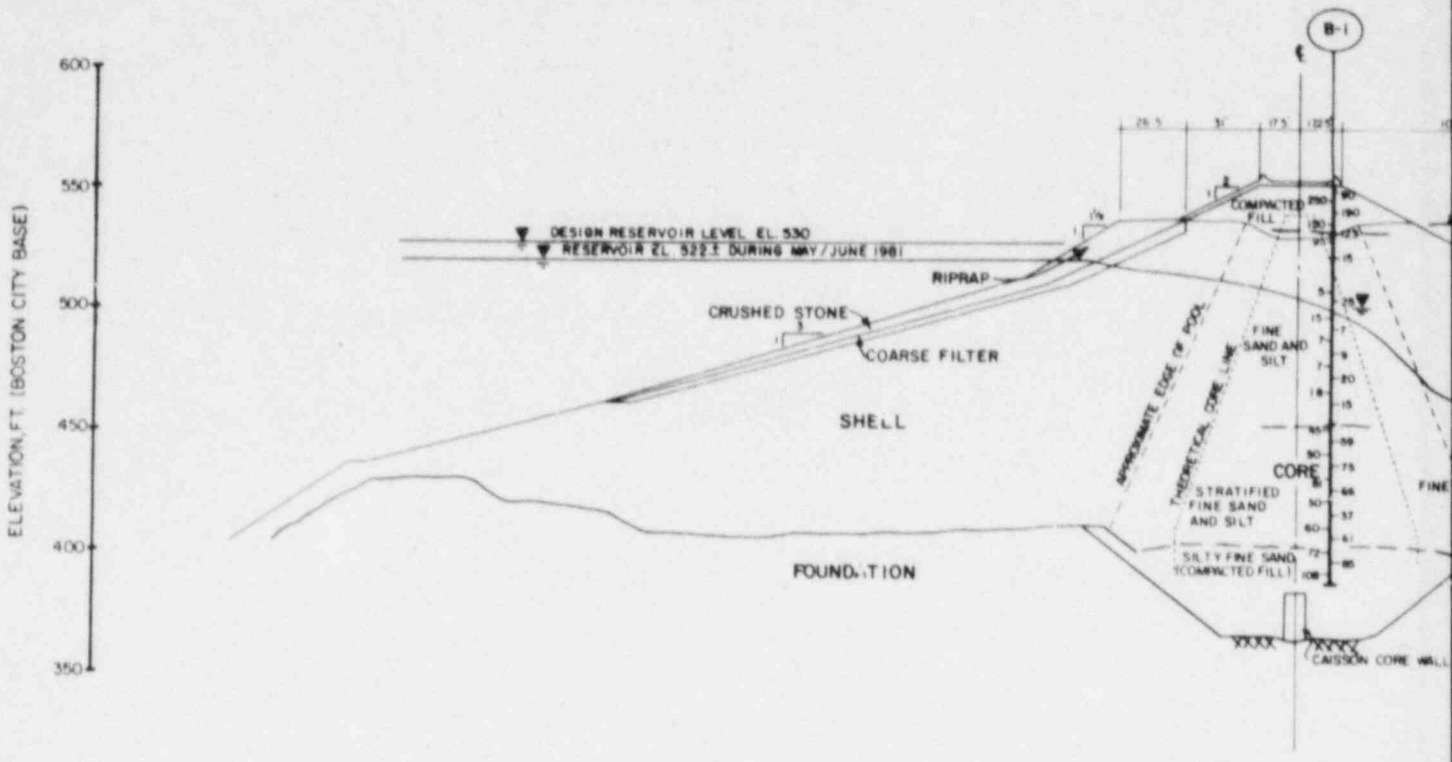


NOTES:

1. THE LOCATION OF THE BOREHOLES WERE STAKED OUT IN THE FIELD BY TAPE MEASUREMENT BY THE MDC AND GZA. THE LOCATIONS SHOULD BE CONSIDERED ACCURATE TO THE DEGREE IMPLIED BY THE METHOD USED.
2. THE BORINGS WERE PERFORMED BY BRIGGS ENGINEERING OF NORWELL, MA.
3. THE ELEVATION OF THE TOP OF BOREHOLES WERE TAKEN FROM DESIGN DRAWING CROSS SECTIONS OF THE DAM AND ARE APPROXIMATE. ELEVATIONS REFER TO BOSTON CITY BASE.

●B-7 BORING NUMBER & LOCATION

APPROXIMATE ELEVATION, TOP OF BOREHOLE
B-7 EL. 552
B-8 EL. 500
B-9 EL. 460



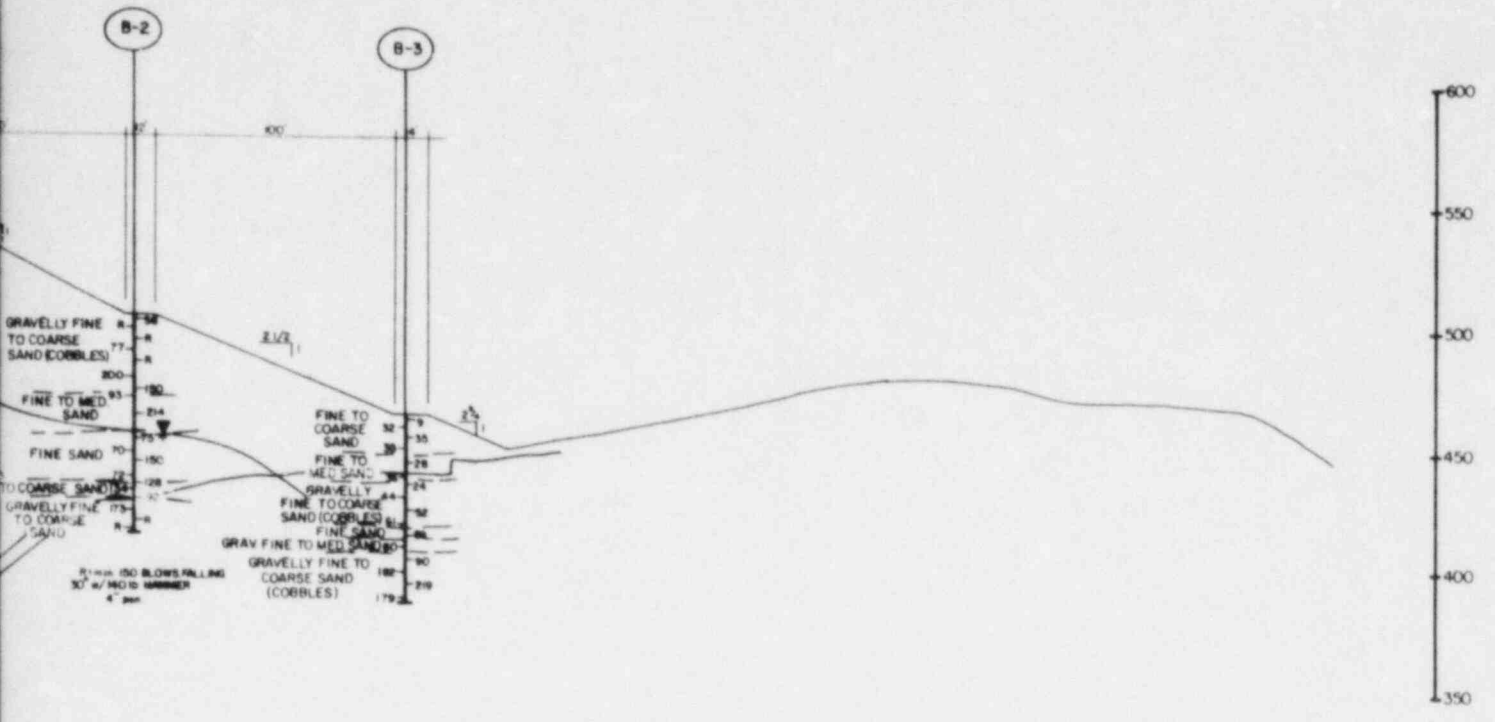
STATION 15+08

NOTES

1. EMBANKMENT GEOMETRY AND DETAILS ARE BASED ON DESIGN DRAWINGS PREPARED FOR METROPOLITAN DISTRICT WATER SUPPLY COMMISSION ENTITLED "MAIN DAM CORE WALL, TRANSVERSE SECTIONS" DATED DECEMBER 21, 1934 (CONTRACT 38, FILE 38-2 32 S) AND "QUABBIN RESERVOIR - MAIN DAM" DATED SEPTEMBER 14, 1932 (FILE 2 32 S).
2. FREE WATER LEVELS ARE BASED ON OBSERVATIONS MADE DURING PIEZOMETER INSTALLATION AND ON PIEZOMETER READINGS.
3. PHREATIC SURFACE SHOWN IS AN APPROXIMATE REPRESENTATION BASED ON OBSERVATIONS IN BOREHOLES AND ON PIEZOMETER READINGS, AND IS ONLY INTENDED TO ILLUSTRATE THE ESTIMATED FREE WATER LEVEL IN THE DAM.
4. STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
5. SOIL PROFILES REPRESENT SOIL CONDITIONS AT BORE HOLES. NO INTERPOLATION BETWEEN BORINGS IS GIVEN OR IMPLIED. FOR SPECIFIC INFORMATION REFER TO BORING LOGS.

FILE NO. 2801

GZA



LEGEND

(B-1) NUMBER OF BORING MADE BY BRIGGS ENGINEERING INC, BETWEEN MAY 6, 1981 AND JUNE 22, 1981

STANDARD PENETRATION RESISTANCE IN BLOWS/FOOT

STRATA CHANGE NOTED IN BORING

GROUNDWATER LEVEL DETERMINED BY OBSERVATION IN BOREHOLES AND PIEZOMETER READINGS

ESTIMATED PHREATIC SURFACE

BOTTOM OF BORING

-VERTICAL-

40 20 0 40 80 120 (FT.)

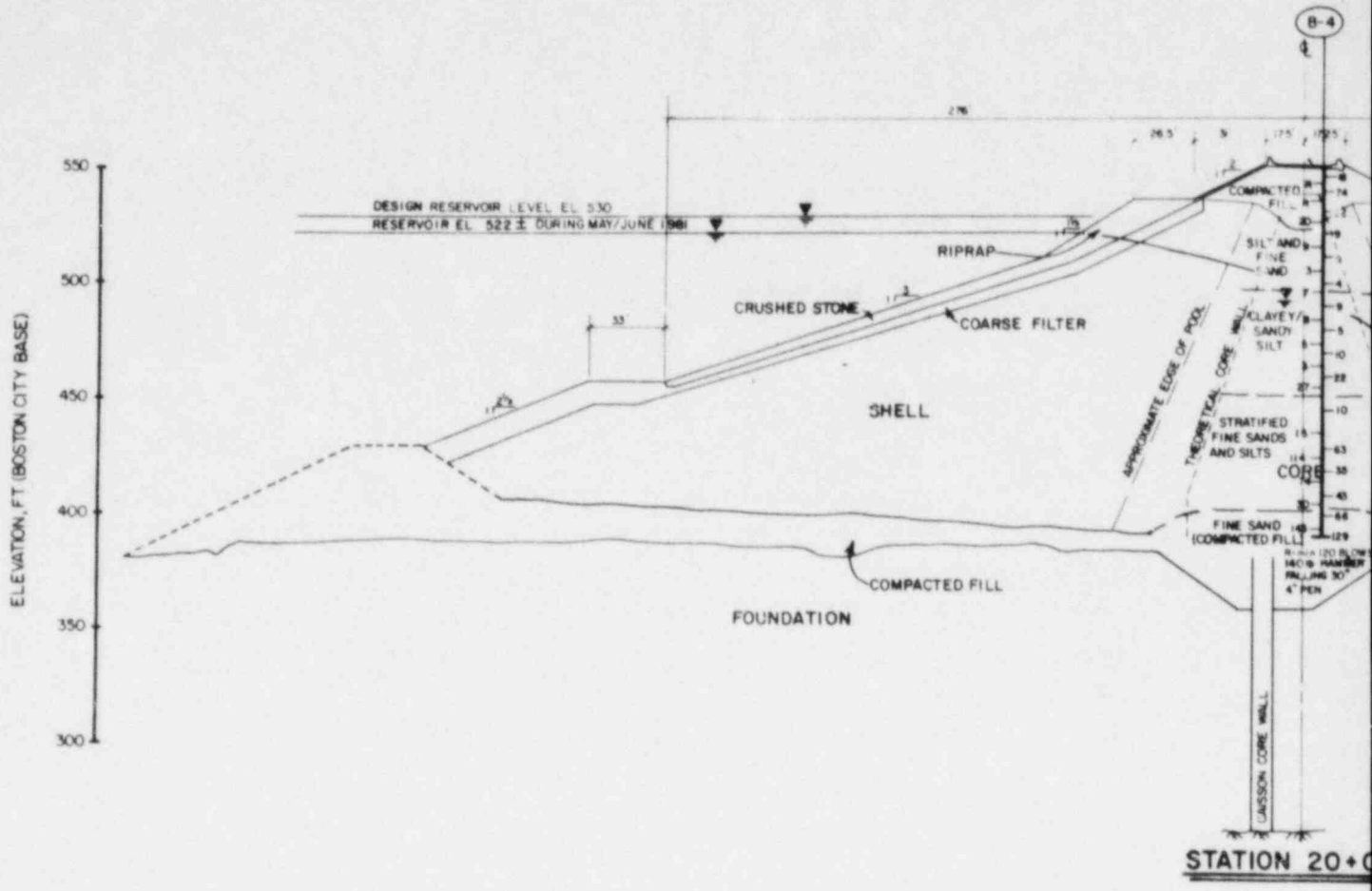
40 20 0 40 80 120 (FT.)

-HORIZONTAL-

QUABBIN RESERVOIR DAMS
WARE, MASSACHUSETTS

CROSS SECTION AT STATION 15+08
WINSOR DAM
JULY 1981

FIGURE No.3

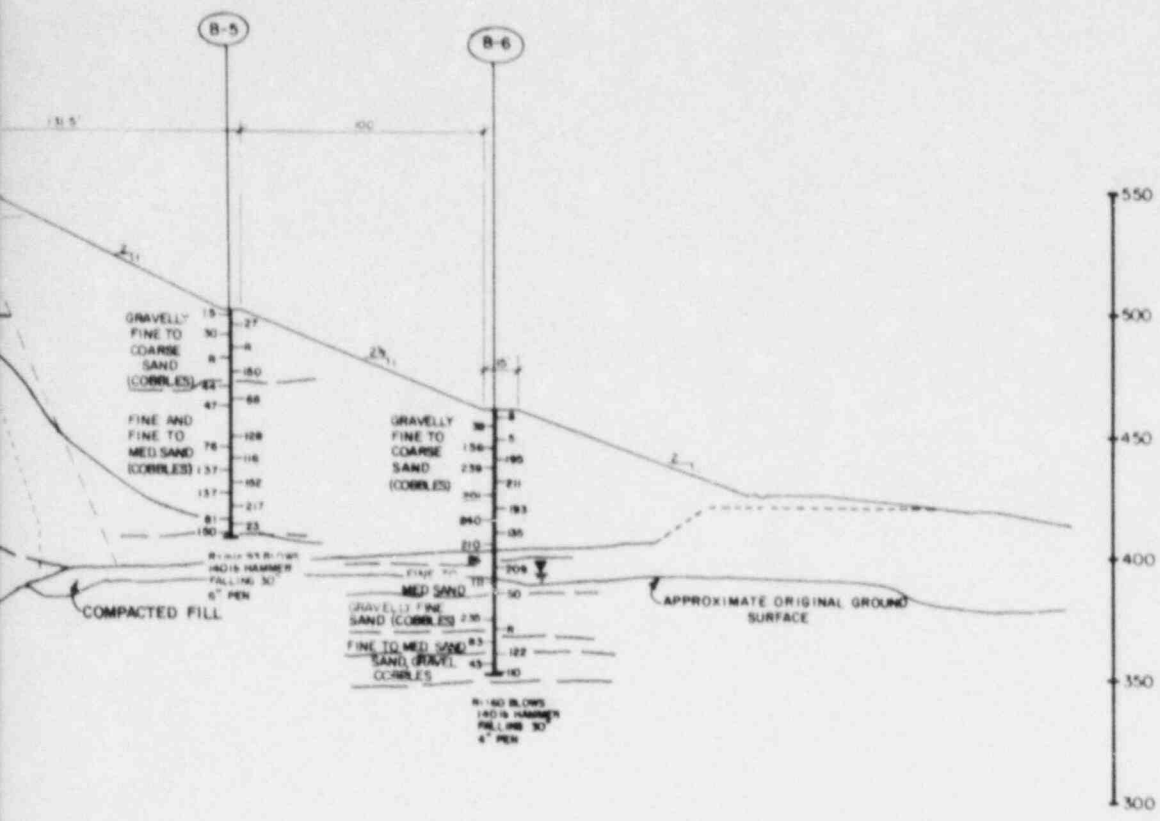


NOTES

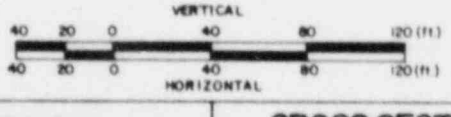
1. EMBANKMENT GEOMETRY AND DETAILS ARE BASED ON DESIGN DRAWINGS PREPARED FOR METROPOLITAN DISTRICT WATER SUPPLY COMMISSION ENTITLED "QUABBIN RESERVOIR - MAIN DAM" DATED SEPTEMBER 14, 1932 (FILE 2.32 S) AND "MAIN DAM CORE WALL, TRANSVERSE SECTIONS" DATED DECEMBER 21, 1934 (CONTRACT 38, FILE 38-2.32 S)
2. FREE WATER LEVELS ARE BASED ON OBSERVATIONS MADE DURING PIEZOMETER INSTALLATION AND ON PIEZOMETER READINGS.
3. PHREATIC SURFACE SHOWN IS AN APPROXIMATE REPRESENTATION BASED ON OBSERVATIONS IN BOREHOLES AND ON PIEZOMETER READINGS, AND IS ONLY INTENDED TO ILLUSTRATE THE ESTIMATED FREE WATER LEVEL IN THE DAM.
4. STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
5. SOIL PROFILES REPRESENT SOIL CONDITIONS AT BORING LOCATIONS ONLY. NO INTERPOLATION BETWEEN BORINGS IS GIVEN OR IMPLIED. FOR SPECIFIC INFORMATION REFER TO BORING LOGS.

FILE NO. 2801

GZA



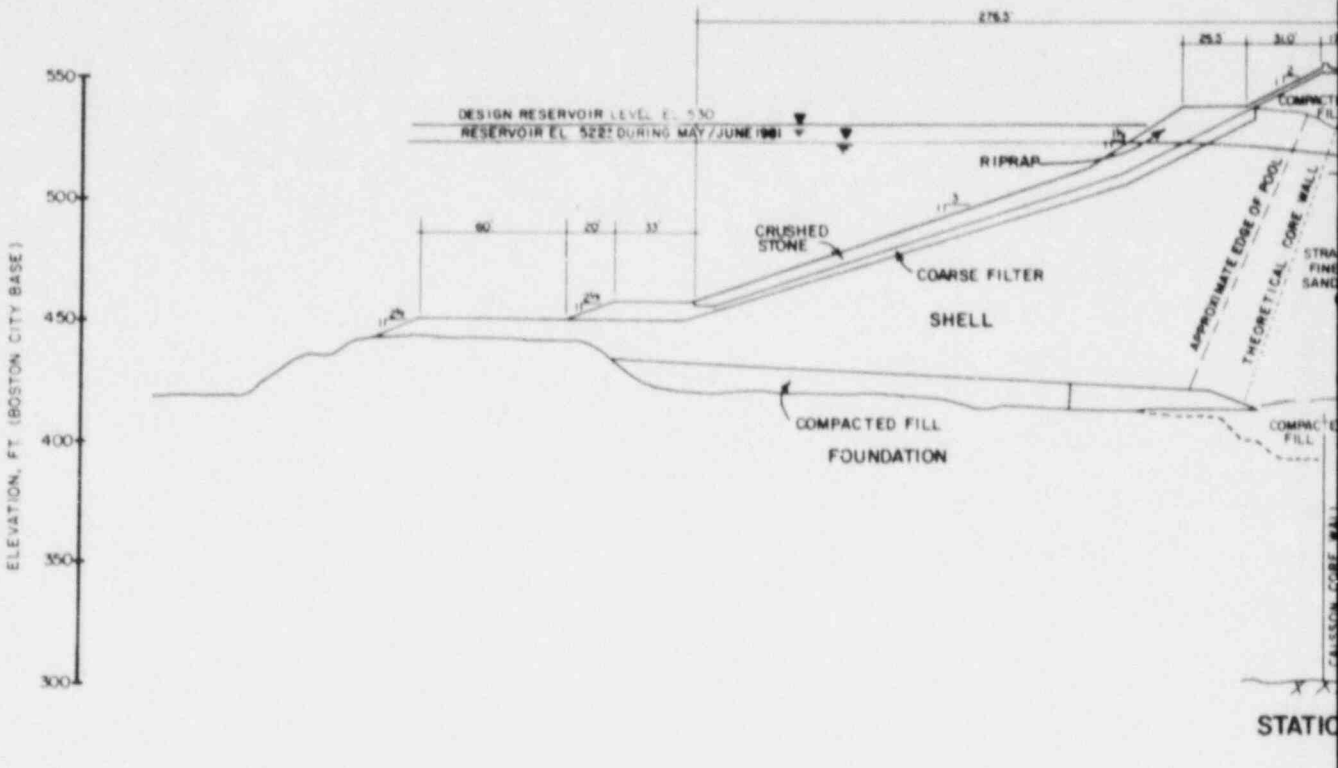
LEGEND



QUABBIN RESERVOIR DAMS
WARE, MASSACHUSETTS

CROSS SECTION AT STATION 20+00
WINSOR DAM
JULY 1981

FIGURE No. 4

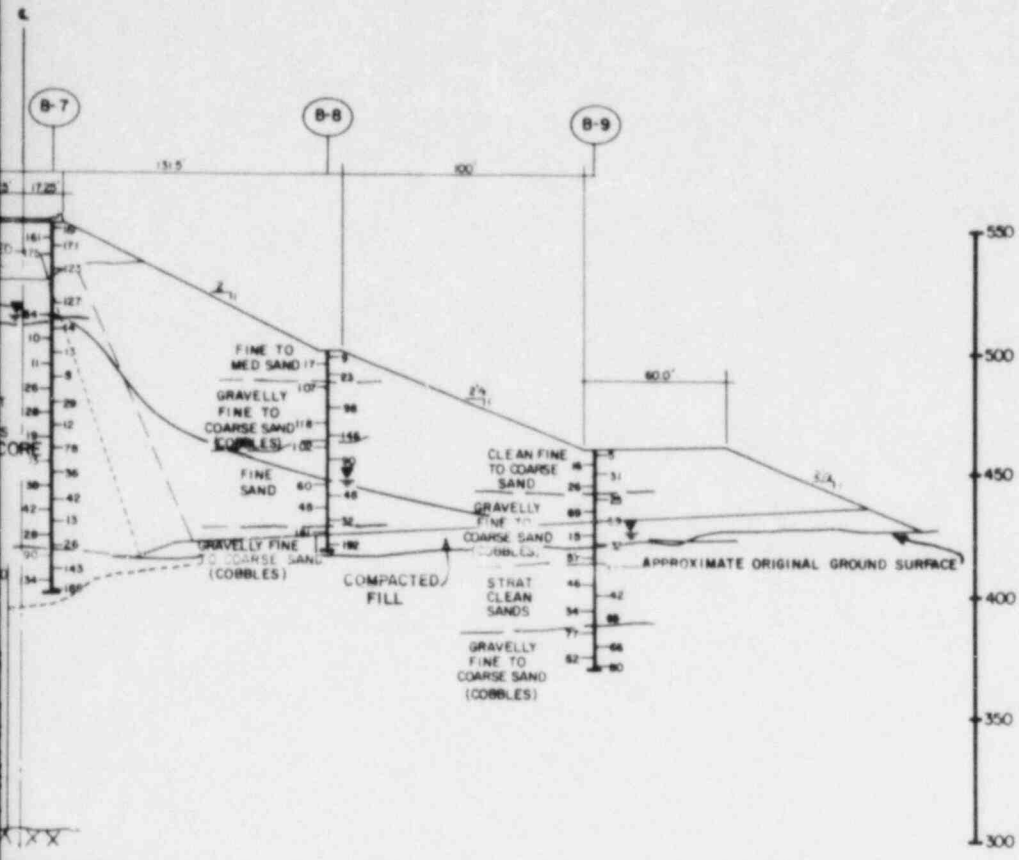


NOTES

1. EMBANKMENT GEOMETRY AND DETAILS ARE BASED ON A DESIGN DRAWING PREPARED FOR METROPOLITAN DISTRICT WATER SUPPLY COMMISSION ENTITLED "DIKE EMBANKMENT, TYPICAL CROSS SECTIONS" DATED OCTOBER 1, 1934 (CONTRACT 50, FILE 50.2.32.S).
2. FREE WATER LEVELS ARE BASED ON OBSERVATIONS MADE DURING PIEZOMETER INSTALLATION AND ON PIEZOMETER READINGS.
3. PHREATIC SURFACE SHOWN IS AN APPROXIMATE REPRESENTATION BASED ON OBSERVATION IN BOREHOLES AND ON PIEZOMETER READINGS, AND IS ONLY INTENDED TO ILLUSTRATE THE ESTIMATED FREE WATER LEVEL IN THE DAM.
4. STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
5. SOIL PROFILES REPRESENT SOIL CONDITIONS AT BORING LOCATIONS ONLY. NO INTERPOLATION BETWEEN BORINGS IS GIVEN OR IMPLIED. FOR SPECIFIC INFORMATION REFER TO BORING LOGS.

FILE NO. 2801

GZA



N 21+80

LEGEND

B-7 — NUMBER OF BORING MADE BY BRIGGS ENGINEERING INC, BETWEEN MAY 6,1981 AND JUNE 22, 1981.

STANDARD PENETRATION RESISTANCE IN BLOWS/FOOT

STRATA CHANGE NOTED IN BORING LOGS

GROUNDWATER LEVEL DETERMINED BY OBSERVATION IN BOREHOLE AND PIEZOMETER READINGS

ESTIMATED PHREATIC SURFACE

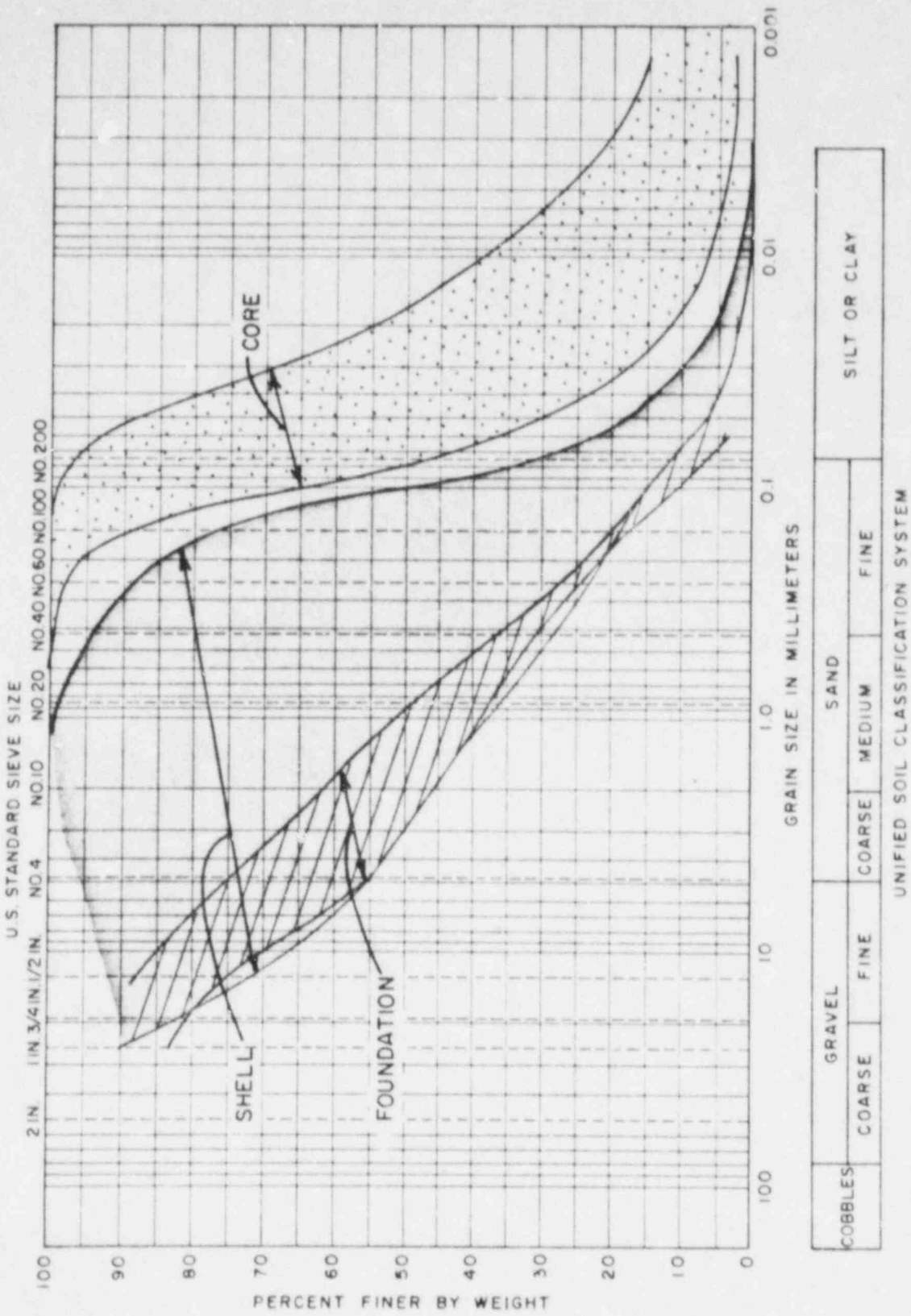
BOTTOM OF BORING

-VERTICAL-
40 20 0 40 80 120 (ft.)
40 20 0 40 80 120 (ft.)
-HORIZONTAL-

QUABBIN RESERVOIR DAMS
WARE, MASSACHUSETTS

CROSS SECTION AT STATION 21+80
GOODNOUGH DIKE
JULY 1981

FIGURE No. 5



FILE No. 2801

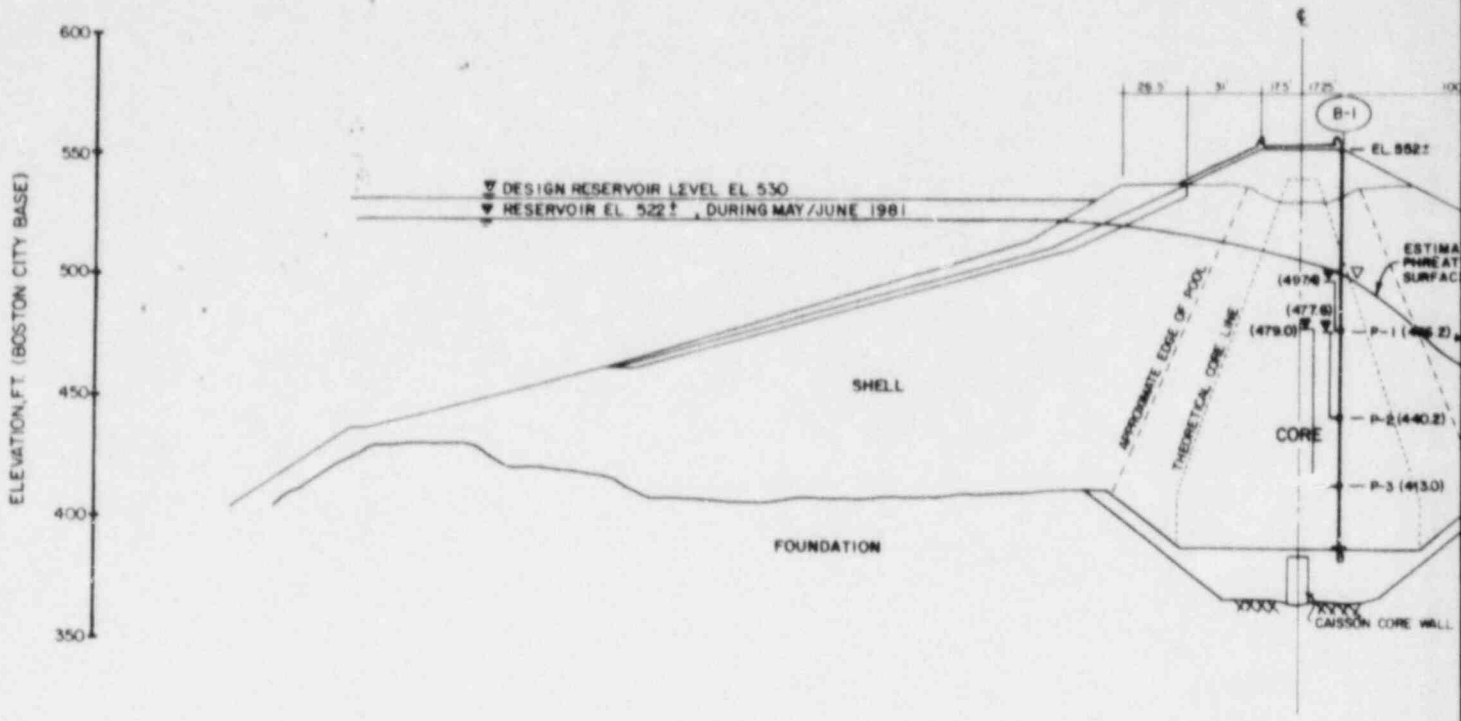
GZA

METROPOLITAN DISTRICT
COMMISION
QUABBIN RESERVOIR DAMS
WARE, MASSACHUSETTS

SUMMARY PLOT
GRADATION TESTS

JULY 1981

FIGURE No. 6



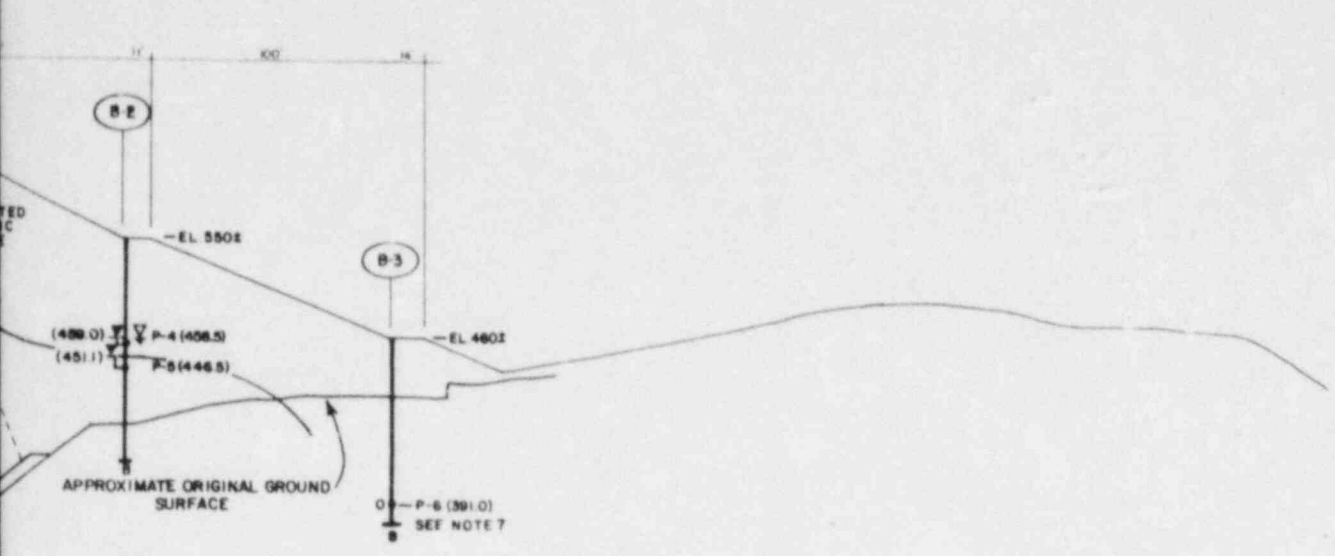
STATION 15+08

NOTES

1. EMBANKMENT GEOMETRY AND DETAILS ARE BASED ON DESIGN DRAWINGS PREPARED FOR METROPOLITAN DISTRICT WATER SUPPLY COMMISSION ENTITLED "MAIN DAM CORE WALL, TRANSVERSE SECTIONS" DATED DECEMBER 21, 1934 (CONTRACT 38, FILE 38-2.32 S) AND "QUABBIN RESERVOIR - MAIN DAM" DATED SEPTEMBER 14, 1932 (FILE 2.32 S)
2. FREE WATER LEVELS ARE BASED ON OBSERVATIONS MADE DURING PIEZOMETER INSTALLATION AND ON PIEZOMETER READINGS.
3. PHREATIC SURFACE SHOWN IS AN APPROXIMATE REPRESENTATION BASED ON OBSERVATIONS IN BOREHOLES AND ON PIEZOMETER READINGS, AND IS ONLY INTENDED TO ILLUSTRATE THE ESTIMATED FREE WATER LEVEL IN THE DAM
4. ELEVATIONS SHOWN ARE APPROXIMATE AND ARE BASED ON GROUND SURFACE ELEVATIONS GIVEN ON THE DESIGN DRAWINGS LISTED ABOVE. ELEVATIONS SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED TO DETERMINE THEM.
5. PIEZOMETERS WERE MODEL P-102 PNEUMATIC PIEZOMETERS MANUFACTURED BY PETUR INSTRUMENT COMPANY, INC., SEATTLE, WAS
6. WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. F IN THE LEVEL OF THE PHREATIC SURFACE WILL OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS W PARTICULARLY AS THE RESERVOIR LEVEL CHANGES.
7. DURING INSTALLATION OF P-7, WATER IN BOREHOLE WAS NEAR GROUND SURFACE AFTER INSTALLATION WAS COMPLETED. NO WAS REGISTERED.

FILE NO. 2801

GZA



LEGEND

B-1 NUMBER OF BORING IN WHICH PIEZOMETER WAS INSTALLED

(497.4) PIEZOMETRIC ELEVATION RECORDED BY PNEUMATIC PIEZOMETER ON JUNE 26, 1981

P-1 PIEZOMETER NUMBER

(478.2) ELEVATION OF PIEZOMETER TIP

PHREATIC SURFACE DETERMINED BY OBSERVATION IN BOREHOLES AT TIME OF SUBSURFACE EXPLORATIONS

B BOTTOM OF BORING

HINGTON

LUCTUATIONS
ERE MADE.

PRESSURE

- VERTICAL -

40 80 0 40 80 120(ft.)

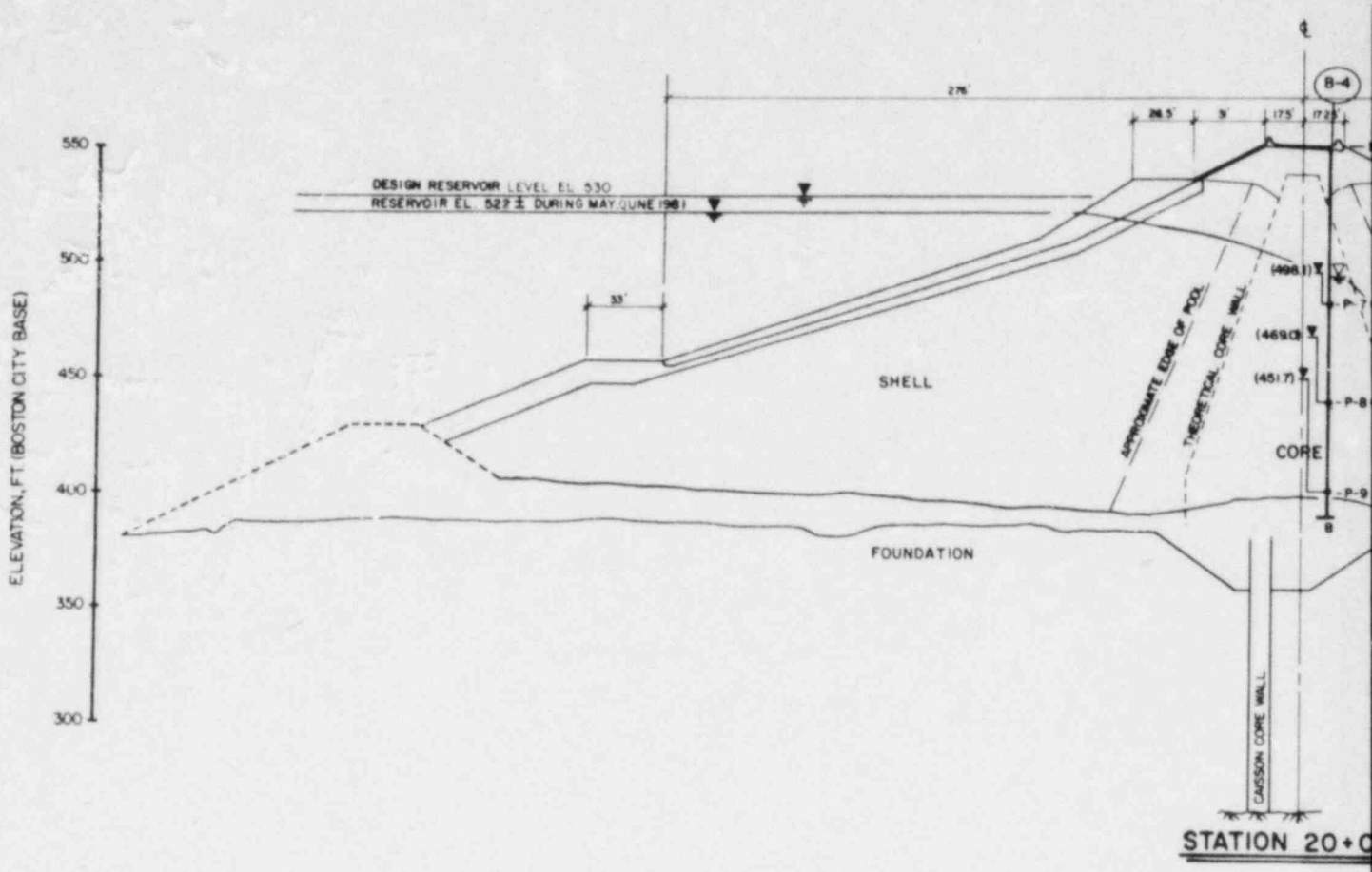
40 20 0 40 80 120(ft.)

- HORIZONTAL -

QUABBIN RESERVOIR DAMS
WARE, MASSACHUSETTS

OBSERVED PIEZOMETER LEVELS
AT STATION 15+08
JULY 1981 WINSOR DAM

FIGURE No. 7



NOTES

1. EMBANKMENT GEOMETRY AND DETAILS ARE BASED ON DESIGN DRAWINGS PREPARED FOR METROPOLITAN DRISTRICT WATER SUPPLY COMMISSION ENTITLED "QUABBIN RESERVOIR - MAIN DAM" DATED SEPTEMBER 14, 1932 (FILE 2.32 S) AND "MAIN DAM CORE WALL, TRANSVERSE SECTIONS" DATED DECEMBER 21, 1934 (CONTRACT 38, FILE 38-2.32 S)
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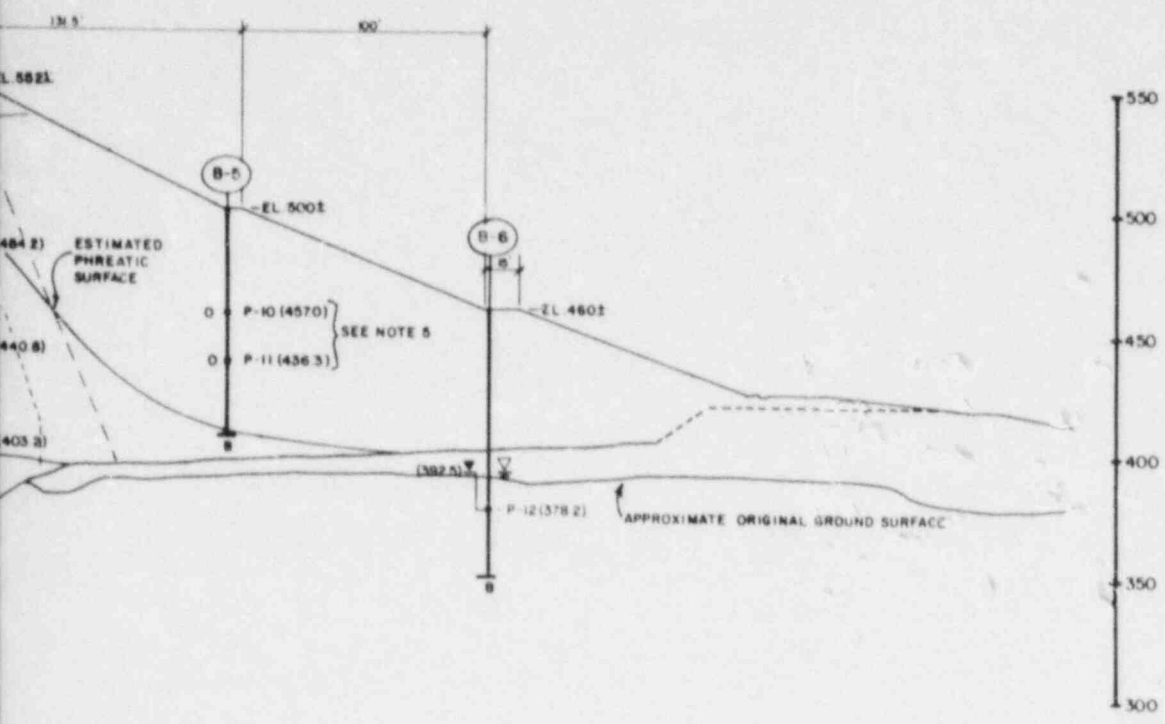
4. SEE NOTES 4-6 ON FIGURE No. 7
5. DURING INSTALLATION OF P-10 AND P-11 WATER IN BOREHOLE WAS AT EL. 462± AFTER INSTALLATION WAS COMPLETED NEITHER PIEZOMETER REGISTERED ANY PRESSURE.

FILE NO. 2801

GZA



LEGEND

B-4 NUMBER OF BORING IN WHICH PIEZOMETER WAS INSTALLED

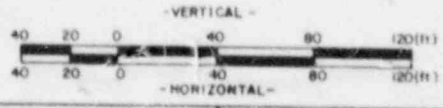
(498.1) PIEZOMETRIC ELEVATION RECORDED BY PNEUMATIC PIEZOMETER ON JUNE 26, 1981

P-7 PIEZOMETER NUMBER

(484.2) ELEVATION OF PIEZOMETER TIP

PHREATIC SURFACE DETERMINED BY OBSERVATION IN BOREHOLES AT TIME OF SUBSURFACE EXPLORATIONS

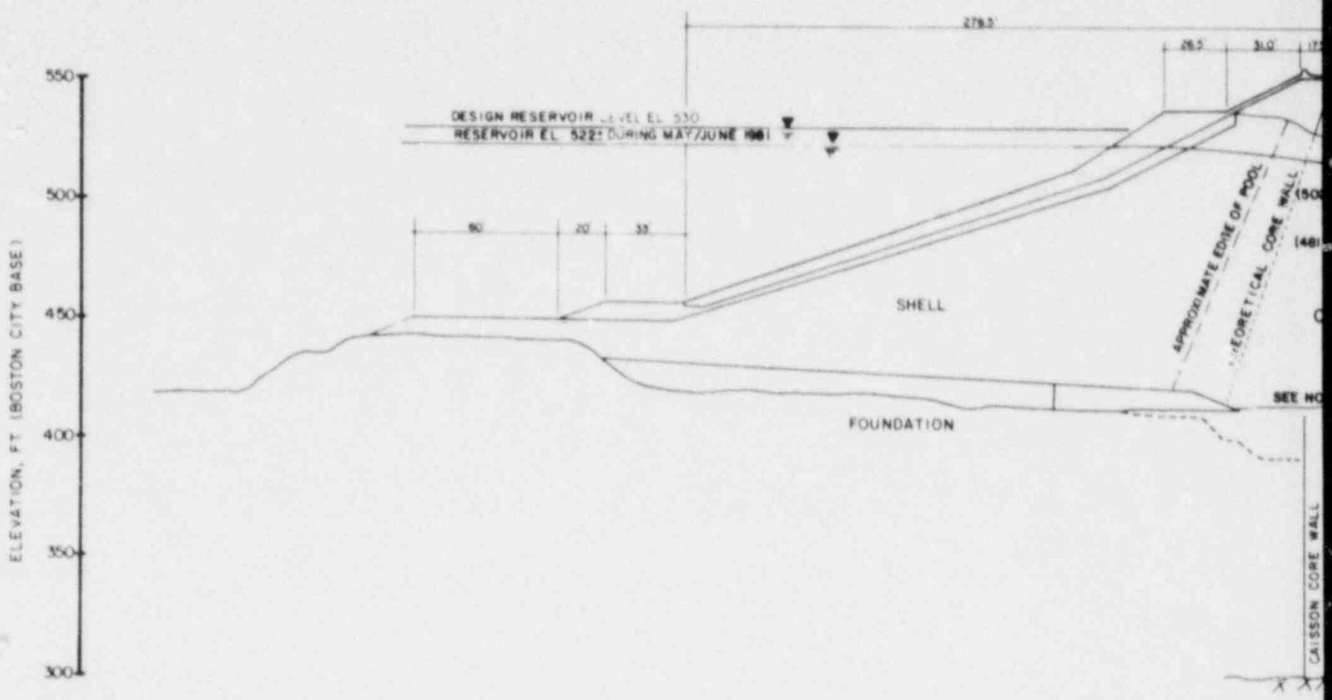
B BOTTOM OF BORING



QUABBIN RESERVOIR DAMS
WARE, MASSACHUSETTS

OBSERVED PIEZOMETER LEVELS AT STATION 20+00
WINSOR DAM
JULY 1981

FIGURE No. 8



NOTES

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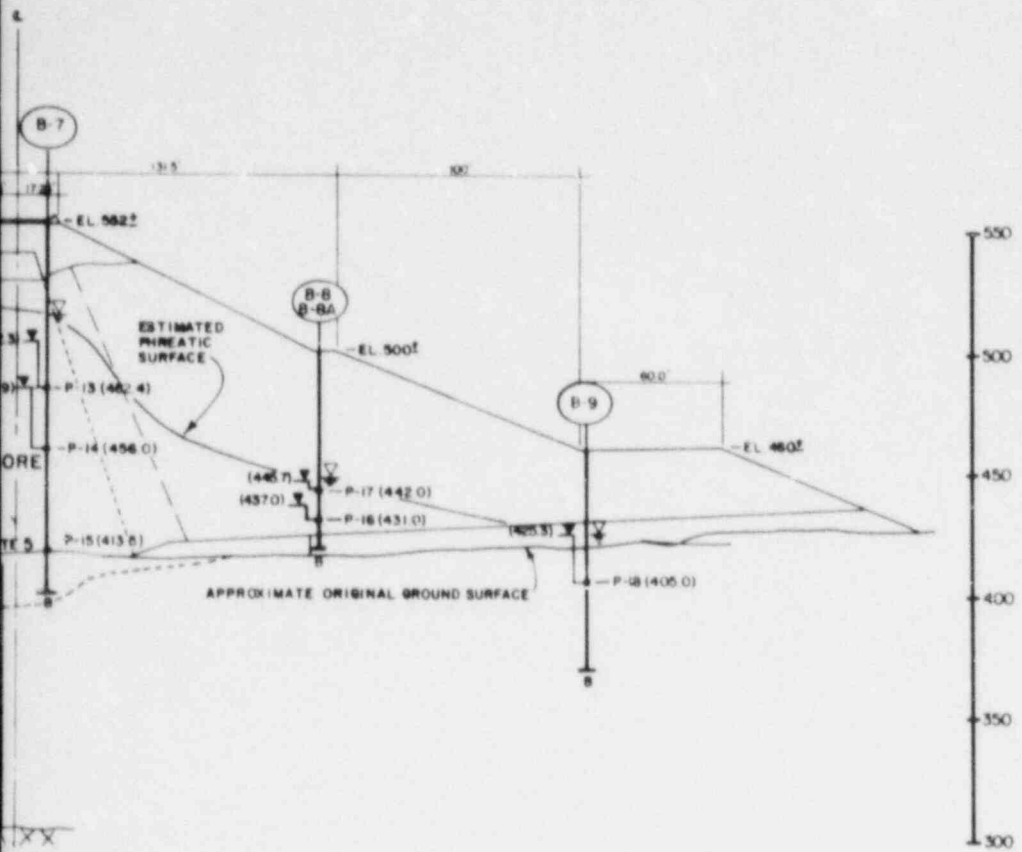
3 PHREATIC SURFACE SHOWN IS AN APPROXIMATE REPRESENTATION BASED ON OBSERVATIONS IN BOREHOLES AND ON PIEZOMETER READINGS, AND IS ONLY INTENDED TO ILLUSTRATE THE ESTIMATED FREE WATER LEVEL IN THE DAM

4 SEE NOTES 4-6 ON FIGURE No. 7

5 PIEZOMETER P-15 INSTALLED ON 6/19/81, DOES NOT FUNCTION.

FILE NO 2807



N 21+80

LEGEND

- (B-7) NUMBER OF BORING IN WHICH PIEZOMETER WAS INSTALLED
- (508.3) PIEZOMETRIC ELEVATION RECORDED BY PNEUMATIC PIEZOMETER ON JUNE 26, 1981
- P-13 PIEZOMETER NUMBER
- (462) ELEVATION OF PIEZOMETER TIP
- PHREATIC SURFACE DETERMINED BY OBSERVATION IN BOREHOLES AT TIME OF SUBSURFACE EXPLORATIONS
- B BOTTOM OF BORING

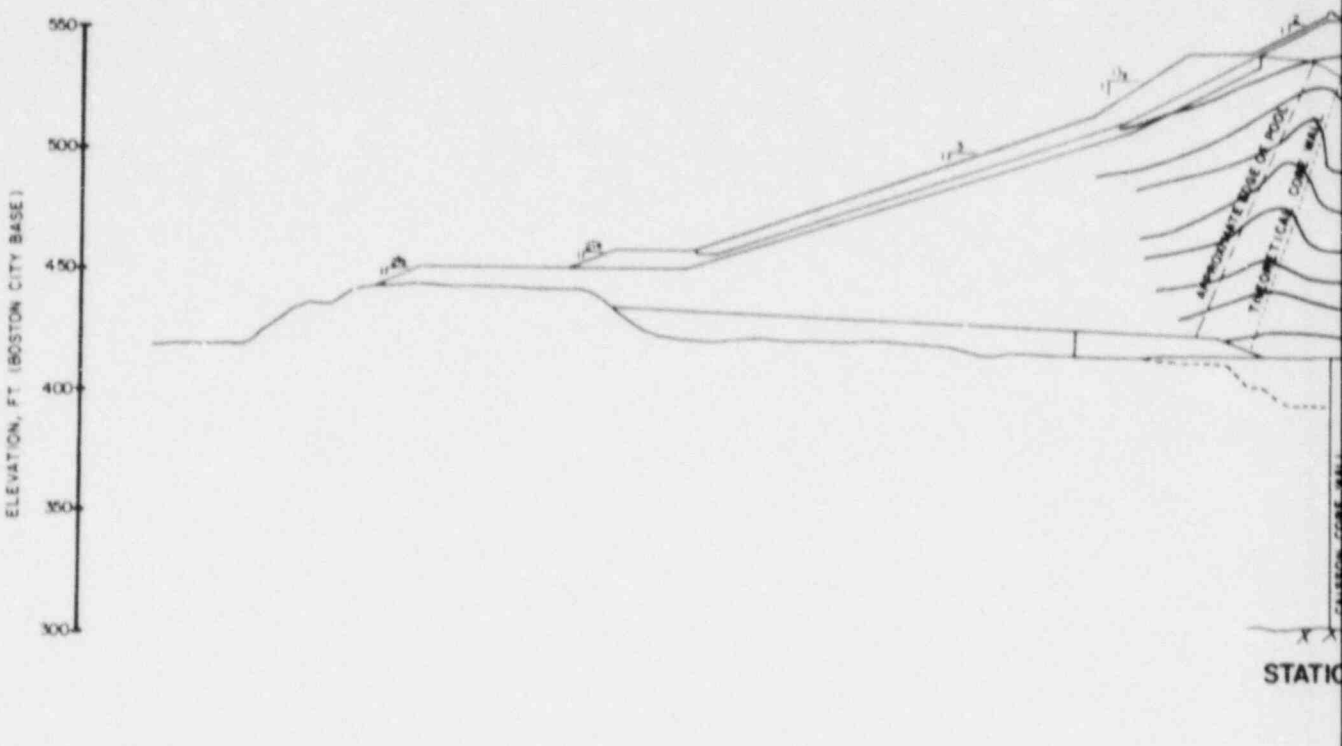
-VERTICAL-
40 20 0 40 80 120 (ft.)
40 20 0 40 80 120 (ft.)
-HORIZONTAL-

QUABBIN RESERVOIR DAMS
WARE, MASSACHUSETTS

OBSERVED PIEZOMETER LEVELS AT STATION 21+80
GOODNOUGH DIKE

JULY 1981

FIGURE No. 9



NOTES

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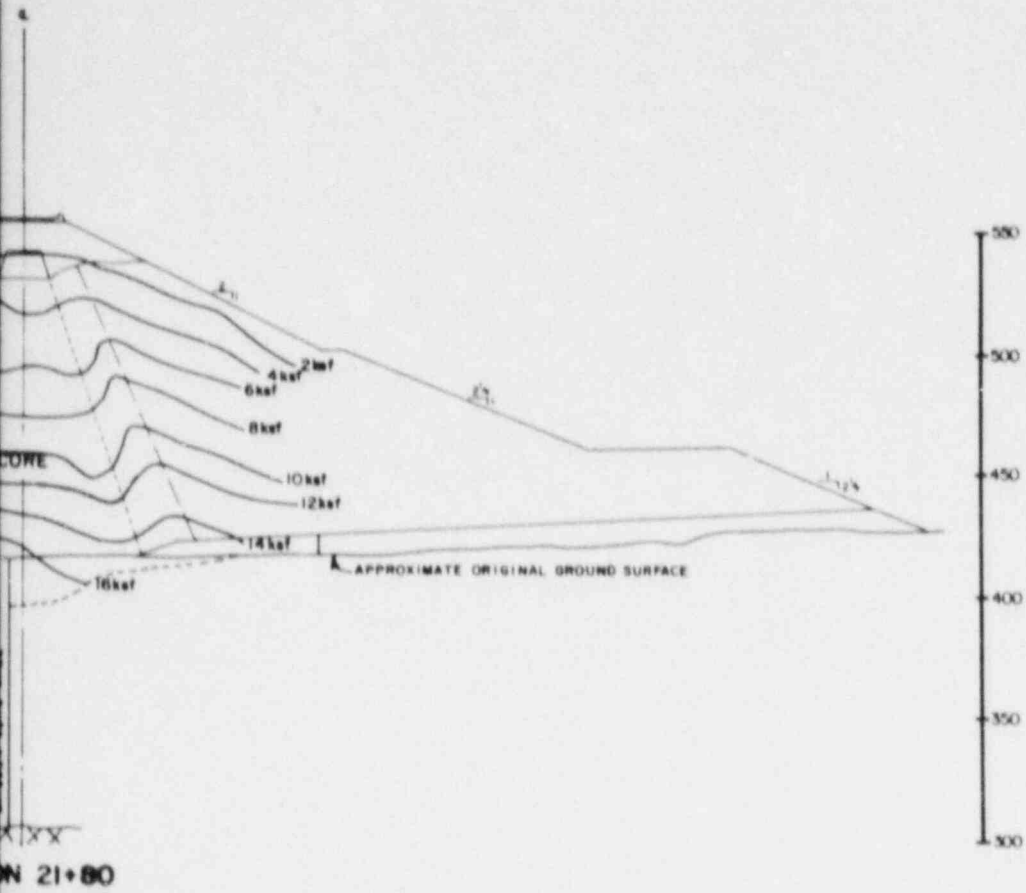
2. CONTOURS OF MAJOR PRINCIPAL STRESS COMPUTED BY FINITE ELEMENT OF ANALYSIS.

LEGEND

10 ksf ~ CONTOURS OF EQUAL MAJOR PRINCIPAL STRESS

FILE NO. 2801

GZA



N 21+80

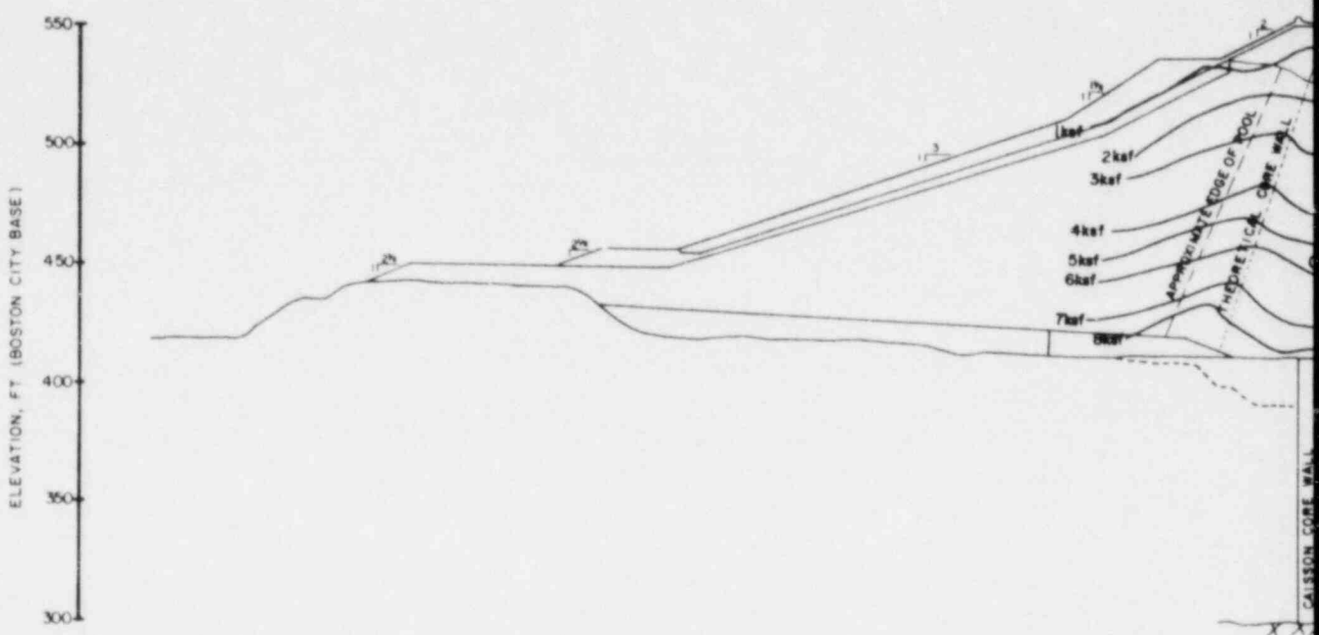
VERTICAL
40 20 0 40 80 120 (ft)
40 20 0 40 80 120 (ft)
HORIZONTAL

QUABBIN RESERVOIR DAMS
WARE, MASSACHUSETTS

CONTOURS OF MAJOR PRINCIPAL STRESS (σ_1)
THROUGH CORE OF DIKE

JULY 1981

FIGURE No. 10



STATIO

NOTES

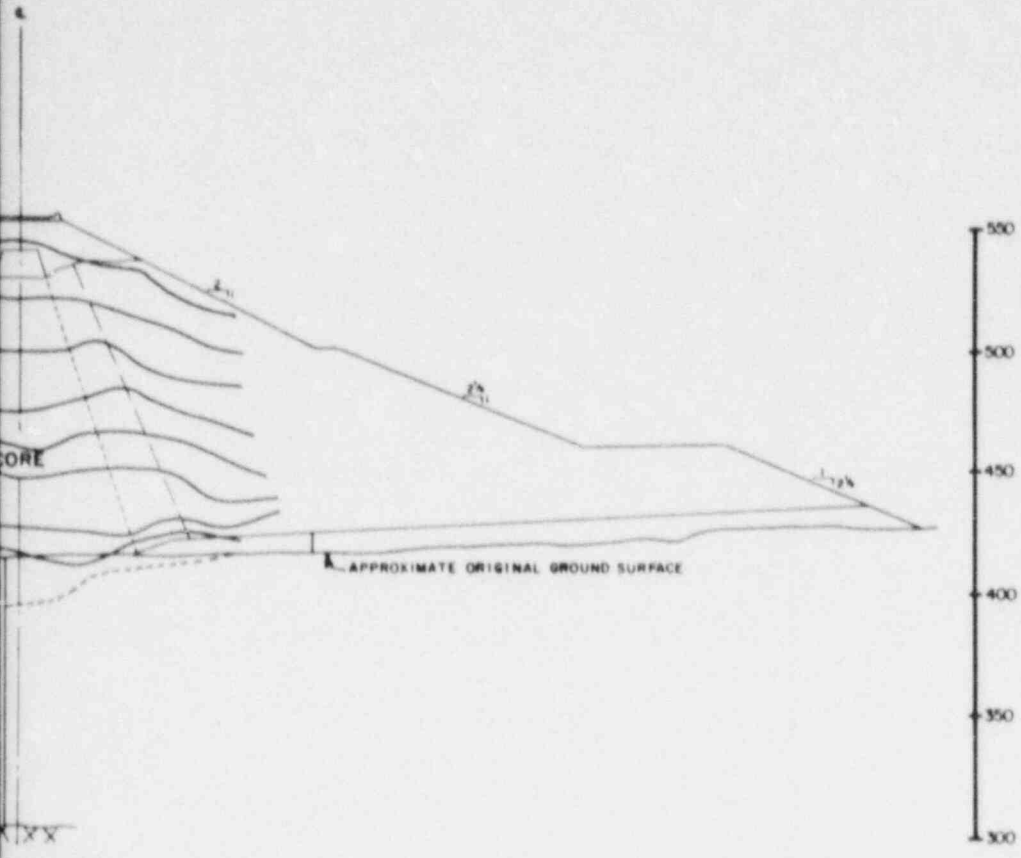
1. EMBANKMENT GEOMETRY AND DETAILS ARE BASED ON A DESIGN DRAWING PREPARED FOR METROPOLITAN DISTRICT WATER SUPPLY COMMISION ENTITLED "DIKE EMBANKMENT, TYPICAL CROSS SECTIONS" DATED OCTOBER 1, 1934 (CONTRACT 50, FILE 50-2 32 S1)
2. CONTOURS OF MINOR PRINCIPAL STRESS COMPUTED BY FINITE ELEMENT OF ANALYSIS

LEGEND

7 ksf — CONTOURS OF MINOR PRINCIPAL STRESS

FILE NO. 2801

GZA



VERTICAL

40 20 0 40 80 120 (ft)

40 20 0 40 80 120 (ft)

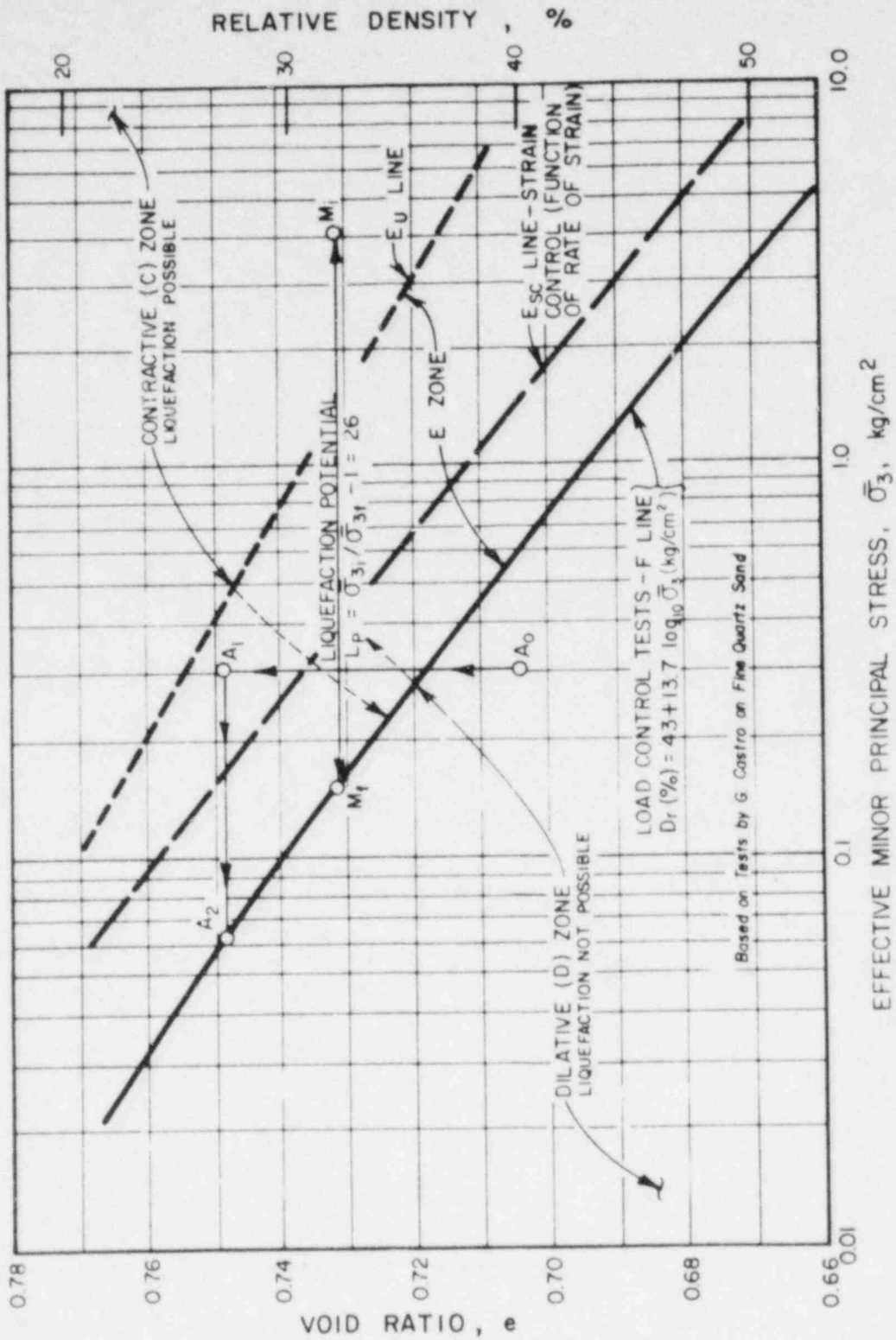
HORIZONTAL

QUABBIN RESERVOIR DAMS
WARE, MASSACHUSETTS

CONTOURS OF MINOR PRINCIPAL STRESS (σ_3) THROUGH CORE OF DIKE

JULY 1981

FIGURE No. 11



FILE No. 2801

GZA

METROPOLITAN DISTRICT COMMISSION
QUABBIN RESERVOIR DAMS
WARE, MASSACHUSETTS

LIQUEFACTION POTENTIAL

JULY 1981

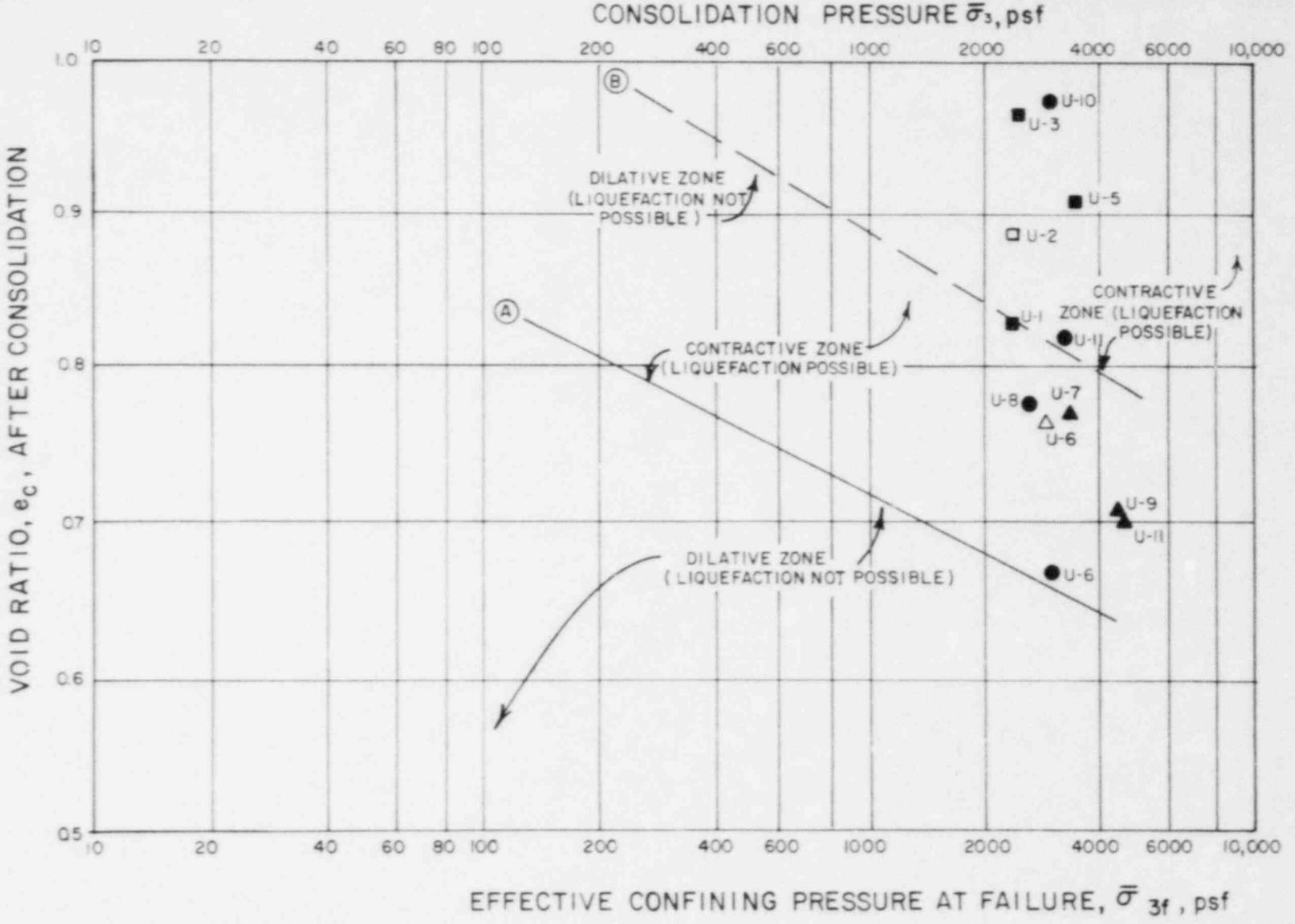
FIGURE No. 12

FILE No. 2801

GZA

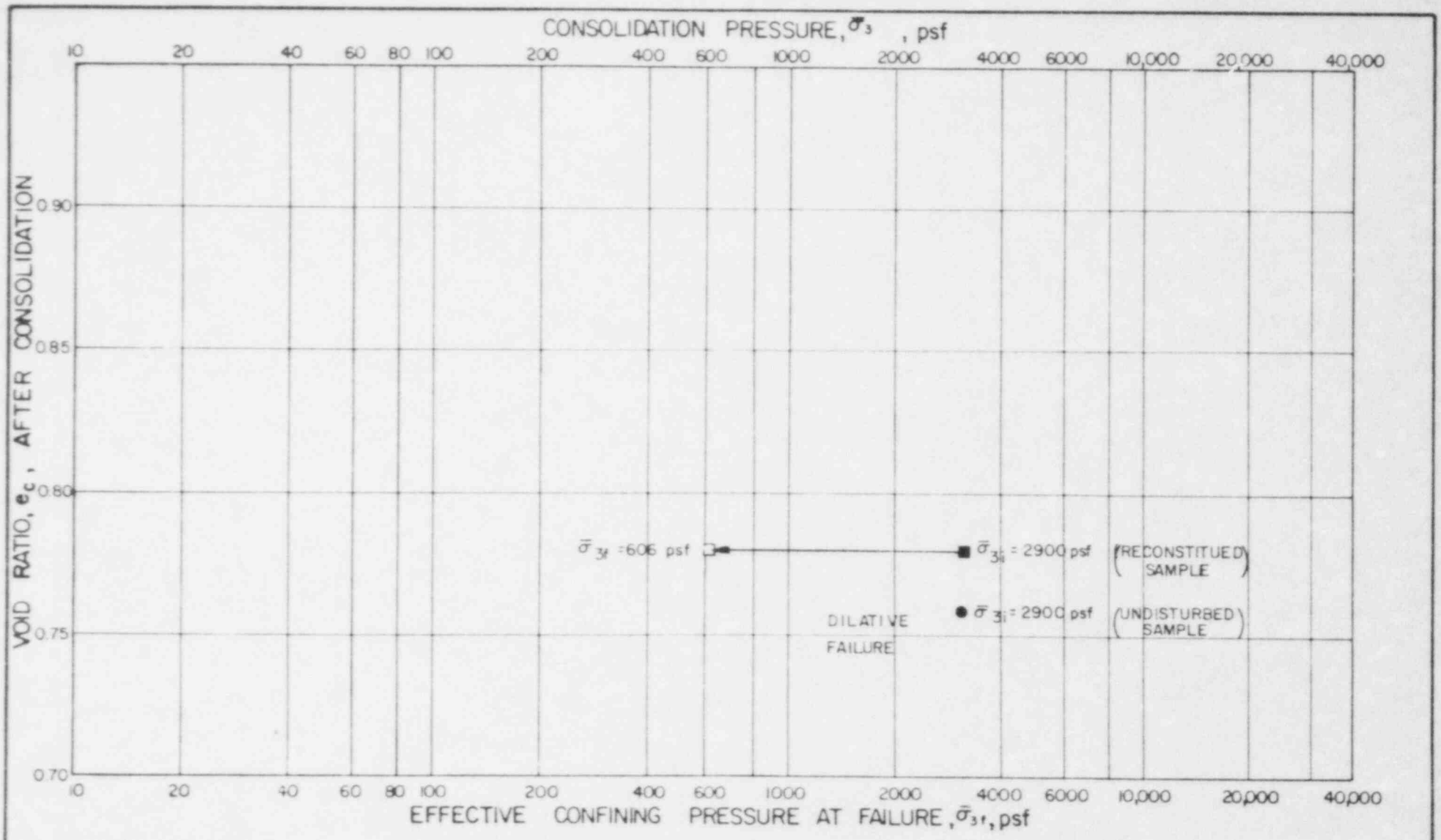
METROPOLITAN DISTRICT COMMISION
QUABBIN RESERVOIR DAMS
WARE, MASSACHUSETTS

SUMMARY PLOT
LIQUEFACTION POTENTIAL
F-LINE VS FIELD DATA
JULY 1981
FIGURE No. 13



● DATA POINTS, BORING B-1
▲ DATA POINTS, BORING B-4
■ DATA POINTS, BORING B-7
U-8 SAMPLE NUMBER
□ INDICATES SLIGHT PLASTICITY (OPEN SYMBOL)
■ INDICATES NON PLASTIC (CLOSED SYMBOL)

——— FLOW LINE (A), CORE MATERIAL BORING B-1 (NON PLASTIC)
— — — FLOW LINE (B), CORE MATERIAL BORING B-7 (SLIGHTLY PLASTIC) SEE DATA APPENDIX C FOR DEVELOPMENT OF FLOW LINE



TEST No.	SYM.	BORING No.	DEPTH (ft)	INITIAL CONDITIONS			CONDITIONS BEFORE LOADING					FINAL CONDITIONS	
				ω_N (%)	γ_d pcf	HT / DIA	$\bar{\sigma}_1 - \bar{\sigma}_3$ psf	u_b psf	ϵ_v (%)	β (%)	e_c	ω_N (%)	γ_d pcf
T143.1	●	B4	78.9 - 79.4	29.5	94.2	6.00 / 2.87	2900	10080	3.09	96	.76	29.5	97.2
T143.2	■	B4	78.9 - 79.9	7.5	93.8	6.00 / 2.90	2900	11520	2.46	95	.78	26.5	96.1

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASS

SUMMARY PLOT
MONOTONIC TRIAXIAL TESTS

DATE JULY 1981 FILE 2729

FIGURE No. 14

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS

APPENDIX A

BORING LOGS BY GZA

GOLDBERG · ZOINO & ASSOC., INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
QUABBIN RESERVOIR DAM
WARE, MASSACHUSETTS

REPORT OF BORING NO. B-1
SHEET 1 OF 5
DATE MAY 1981 FILE 2801

BORING CO. NEW ENGLAND BORING CONTR.
FOREMAN RON STAVINSKI/T. CARPENTIER
G-Z-A ENGINEER W. HADGE, D. CARDINALE

BORING LOCATION WINSOR DAM, STA 15+08
GROUND ELEV. CREST; EL ±552'
DATE START 5/12/81 DATE END 5/21/81

CASING
SIZE: 4" F.J.
HAMMER: 300 lb.
FALL: 24"

SAMPLER
TYPE: Split Spoon (24")
HAMMER 140 lb.
FALL: 30"
OTHER: 3" thin-walled tube (Osterberg Sampler)

GROUNDWATER READINGS

DATE	DEPTH	CASING AT	STABILIZATION TIME
5/14	29.8'	29'	0830 Hours
5/19	29'	29'	0930 Hours
5/20	29'	29'	0845 Hours
5/22	34'	30'	1000 Hours

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHG. and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
							ASPHALT PAVEMENT. 4 inches.	
		S-1	18"/12"	0.5-2'	20-		Brown, fine SAND, little+ fine Gravel,	,
					25-65		trace fractured Stone, trace Silt,	
							trace dark brown Loam.	
5						Gravelly fine to coarse SAND		
		S-2	12"/8"	5-6'	80-170		Brown, fine SAND, trace+ fine Gravel,	
							trace Silt, trace coarse Sand, trace	
							fractured Stone.	
						(ROLLED FILL)		
10	166							(1)
		S-3	18"/10"	10-11.5'	80-85		Brown, fine to coarse SAND, little-	
					105		fine Gravel, trace Silt.	
	80							(2)
15	100							
	31	S-4	18"/7"	15-16.5'	33-117		Brown, fine to coarse SAND, little	
	28				22 (300#)		Silt, trace fine Gravel. Fractured	(3)
	27					18'	Cobble.	
	53							
	85					Gravelly fine SAND (ROLLED FILL) 24'		
20	32	S-5	18"/8"	20-21.5'	49-58-		Gray-green fine SAND, some- Silt,	
	37				65		trace fine Gravel, trace medium to	
	34						coarse Sand. One-inch plug of dark	
	81						brown, fine SAND and SILT in end of	
	95						Spoon.	(4)
25	80	S-6	18"/4"	25-26.5'	49-50		Green, fine SAND, trace Silt.	(5)
	80				45	Fine SAND and SILT (HYDRAU-LIC FILL		
	85							
								(6)
30		U-1	24"/23"	30-32'			(Top sample 3-3/4" from top of tube;	(7)
							fixed piston sampler used.)	
		S-7		32-33.5'	10-7		Brown, fine SAND and SILT.	
					8			

REMARKS: (1) 166 blows/foot typical for 5-10 feet. (2) Driller drilled ahead of casing with rotary bit from 10 to 20 feet to break cobbles. (3) From 16' to 16.5', used 300 lb. hammer falling 24". [NOTES CONTINUE ON NEXT PAGE.]

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF THE GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

GOLDBERG · ZOINO & ASSOC., INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
QUABBIN RESERVOIR DAM
WARE, MASSACHUSETTS

REPORT OF BORING NO. B-1
SHEET 2 OF 5
DATE MAY 1981 FILE 2801

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHNG and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
35								
40		U-2	24"/0	39-41'			No recovery. (Hydraulic sampler)	(8)
		U-3	24"/0	41-43'			No recovery. (Fixed-piston sampler)	(9)
45		S-8	24"/10"	44-46'	5-2	Fine	Brownish-green, fine SAND and SILT.	
					3-2			
		U-4	24"/24"	46-48'		SAND	(Hydraulic sampler) (Jar sample taken of soil at tip of tube.)	(10)
		S-9	18"/13"	49-49.5'	12-13	and	Brownish-green, fine SAND and SILT.	
50					12	SILT		
								(11)
						(HYDRAU-		
						LIC		
55		U-5	24"/24"	54-56'		FILL)		
		S-10	18"/16"	56-57.5'	5-8		Brownish-green, fine SAND and SILT.	
					7			
60		S-11	18"/17"	60-61.5'	4-3		Brownish-green, fine SAND and SILT.	
					4			
		U-6	24"/23-3/4"	64-66'			(Jar sample taken of soil at tip of tube.)	(12)
65								
		S-12	18"/12"	66-67.5'	9-4		Brownish-green, fine SAND, some Silt, trace Root Matter.	
					3			
70		S-13	18"/18"	70-71.5'	4-4		Brownish-green, Clayey SILT and fine SAND; slight plasticity.	
					5			

REMARKS: (4) Noted change in color of wash from brown to dark brown; also, wood in wash at 24 feet. (5) Lost sample; redrove spoon from 21.5' to 23.5' using 300 lb. hammer to obtain sample. (6) 4-inch casing to 29 feet. Using drilling mud to keep hole open below 29 feet. (7) Sample U-1 subjected to significant disturbance when driller removed piston and sample placed horizontally, jolted, and shaken during efforts to remove piston. Sample is split horizontally in tube. (8) Lost sample using Osterberg (hydraulic) sampler. (9) Pushed sampler 2 feet; piston moved with tube; no sample. [NOTES CONTINUE ON NEXT PAGE.]

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF THE GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

GOLDBERG · ZOINO & ASSOC., INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
QUABBIN RESERVOIR DAM
WARE, MASSACHUSETTS

REPORT OF BORING NO. B-1
SHEET 3 OF 5
DATE MAY 1981 FILE 2801

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHNG and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
75		U-7	24"/21"	74-76'				
		S-14	18"/18"	76-77.5'	4-4		Brownish-green SILT, little fine Sand, pockets of brownish-gray Silt.	
					3			
80		S-15	18"/12"	80-81.5'	6-12		Brownish-green SILT, little fine Sand, trace Root Matter.	
					8			
85		U-8	24"/Note 13	84-86'				(13)
		S-16	18"/9"	86-87.5'	2-10	Fine and Silty Fine SAND (HYDRAULIC FILL)	Brownish-green SILT, little fine Sand; Clayey SILT (slight to low plasticity), trace Root Matter in top 3 inches of Spoon.	
					8			
90		S-17	18"/9"	90-91.5'	13-7		Brown SILT, some fine Sand; Clayey SILT (slight plasticity) in top 2 inches of Spoon.	
					8			
95		U-9	24"/2"	94-96'				(14)
		U-10	24"/15-3/4"	97-99'				(15)
100		S-18	18"/14"	99'-	10-18		Brownish-green SILT, some fine Sand, trace Root Matter, trace Wood; thin lenses of brown and gray Silt.	
				100.5'	27			
105		S-19	18"/9"	104'-	10-27		Brownish-green SILT and fine SAND, trace Root Matter.	
				105.5'	32			
		U-11	24"/24"	107-109'			Brownish-green, fine SAND and SILT, trace Root Matter.	
110		S-20	18"/15"	109'-	12-26			
				110.5'	24		Gray, fine SAND, trace Silt.	

REMARKS: (10) All undisturbed samples from U-4 on taken with hydraulic sampler. Samples U-1 and U-3 made with conventional push-type stationary piston sampler. (11) The fine sand below 25 feet is very fine. (12) Sample split horizontally in the tube during removal of piston. (13) Sample split horizontally in tube during removal of piston. From top tube to top sample = 4 inches; bottom sample is flush with bottom tube; must be at least a 2-inch gap in sample. (14) Poor recovery; sample lost during raising of rods. (15) Six inches from top tube to sample; 8-1/4 inches from bottom tube to bottom sample.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF THE GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

GOLDBERG · ZOINO & ASSOC., INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
QUABBIN RESERVOIR DAM
WARE, MASSACHUSETTS

REPORT OF BORING NO. B-1
SHEET 4 OF 5
DATE MAY 1981 FILE 2801

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHNG and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
115							Gray-brown SILT, some fine Sand with	
		S-21	18"/12"	115'-	17-35		lenses, up to 1/2", of brown Silt,	
				116.5'	40		trace Root Matter.	
		S-22	18"/6"	117'-	20-33		Stratified fine SAND, trace Silt,	
				118.5'	48		color varies from rust to brown to	
120						Strati-	gray; layers 1/16" to 1/8"; Silt	
						fied	content varies in strata; trace Root	
							Matter.	
						Fine		
		S-23	18"/6"	123'-	21-28		Gray, fine SAND, trace Silt, with	
125				124.5'	38	SAND	1/2" layers of brown SILT.	
						and		
						SILT		
130		S-24	18"/16"	129'-	11-8	(HYDRAU-	Brown SILT, trace fine Sand; visible	
				130.5'	22	LIC	stratification, indicated by differ-	
							ent shades of brown.	
						FILL)		
		S-25	18"/18"	133'-	9-12		Brownish-green SILT, trace fine Sand,	
135				134.5'	25		trace Root Matter. Lenses of gray,	
							fine Sand, trace Silt.	
		S-26	18"/13"	138'-	9-21		Stratified brown and gray, fine SAND	
140				139.5'	39		trace Silt; strata approximately	
							1/8" thick.	
		S-27	18"/12"	143'-	16-27		Stratified fine SAND, trace to little	
145				144.5'	34		Silt (varies from strata to strata),	
							trace Root matter. Strata from	
							1/32" to 1/8" thick. Color varies	
							from brownish-gray to gray.	
		S-28	18"/12"	148'-	18-28		Dark brown, fine SAND and SILT,	(16)
150				149.5'	44		trace Root Matter. 1" piece of	(17)
							Quartz lodged in end of Spoon.	
				153'-			Brown to gray-brown, fine SAND, lit-	
		S-29	18"/9"	154.5'	35-45		tle Silt, trace Root Matter. 1" piece	
							of fractured Gravel. Sand is finely	
							bonded, indicating stratification	
							(<1/32").	

REMARKS:

(16) Material has appearance of topsoil.
(17) Foundation material appears to start at 148 feet.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF THE GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

GOLDBERG · ZOINO & ASSOC., INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
QUABBIN RESERVOIR DAM
WARE, MASSACHUSETTS

REPORT OF BORING NO. B-1
SHEET 5 OF 5
DATE MAY 1981 FILE 2801

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHNG and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
155					40			
						Silty Fine SAND (FOUNDA-TION)		
		S-30	18"/14"	158'-	23-41		Dark brown, fine SAND and SILT, trace Root Matter, fractured Cobble.	(18)
160				159.5'	67			
		S-31	18"/12"	163'-	40-36		Dark brown and yellow-brown, fine SAND, little Silt, trace fine Gravel.	
165				164.5'	38		Bottom of hole at 164.5 feet.	

REMARKS:

(18) Few grains of medium to coarse SAND observed in Spoon.

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GOLDBERG · ZOINO & ASSOC., INC. GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS	PROJECT QUABBIN RESERVOIR DAM WARE, MASSACHUSETTS	REPORT OF BORING NO. B-2 SHEET 1 OF 3 DATE MAY 1981 FILE 2801

BORING CO. NEW ENGLAND BORING CONTR. — BORING LOCATION WINSOR DAM, STA 15+08.5
FOREMAN RON STAVINSKY — GROUND ELEV. MIDDLE BERM, EL ±500'
G-Z-A ENGINEER W. HADGE — DATE START 5/6/81 — DATE END 5/11/81

CASING
SIZE: 4" F.J.
HAMMER: 300 lb
FALL: 24"

SAMPLER (1-3/8" ID)
TYPE Split Spoon OTHER:
HAMMER 140 lb
FALL: 30"

GROUNDWATER READINGS

DATE	DEPTH	CASING AT	~~STABILIZATION~~ TIME
5/06	17.5'	29.0'	1645 Hours
5/07	26.0'	29.0'	0900 Hours
5/11	41.5'	35.0'	1020 Hours
5/11	35.6'	30.0'	1500 Hours

DEPTH	CAS. BL./FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHG. and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
		S-1	24"/16"	0-2'	4-13	LOAM	Dark brown, fine SAND, some Silt, trace Roots. (LOAM)	
					26-32		Brown, fine to coarse SAND, little fine Gravel, trace Silt (Gravel fractured). Cobbles.	
5		S-2	8"/4"	5-5'8"	40/105-2"		Brown, fine to coarse SAND, trace fine Gravel, trace Silt (Gravel fractured, angular). Cobbles.	(1)
	125							(2)
	233					Gravelly		
	215							
	142					Fine to		
10		S-3	4"/0"	10-10'4"	150-4"	Coarse		(3)
	50							
	80					SAND		
	70							
15	60					with		
		S-4	24"/6"	15-17'	24-20	Cobbles	Green-brown, fine to coarse SAND, little fine Gravel, trace+ Silt (Gravel angular, fractured).	
	50				22-55			
	82							
	60							
20		S-5	8"/3"	19-19'8"	65/130-2"		Brown, fine to coarse SAND and fine Gravel, trace+ Silt. Cobbles.	(4)
	34							
	39							
	100							
25		S-6	18"/4"	24-25.5'	145-25		Orange-white-brown, fine+ to coarse SAND and fine GRAVEL, trace+ Silt (Gravel angular, fractured). Cobbles.	(5)
	230				32			(6)
	130							
	125							
	220							
0		S-7	18"/3"	29-30.5'	50-87		Gray-green, fine to coarse SAND, some fine Gravel, trace+ Silt (Gravel angular, fractured). Cobbles.	
					63			

REMARKS: (1) Driller advancing hole using rotary bit. Progress slowed by cobbles and tones. (2) Sampler on cobble; terminated sample at 5'7". (3) Refusal; sample terminated. 4) Drove 20 feet of 4" casing; drilling mud used [NOTES CONTINUED NEXT PAGE.]

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF THE GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

GOLDBERG · ZOINO & ASSOC., INC. GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS	PROJECT QUABBIN RESERVOIR DAM WARE, MASSACHUSETTS	REPORT OF BORING NO. B-2 SHEET 2 OF 3 DATE MAY 1981 FILE 2801

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHNG and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
30		S-7	18"/3"	29-30.5'	50-87 63		Gray-green, fine to coarse SAND, some fine Gravel, trace+ Silt (Gravel angular, fractured). Cobbles.	
35		S-8	18"/8"	34-35.5'	44-46 47	Fine to Medium SAND	Brown, fine to medium SAND, trace+ coarse Sand, trace Silt.	
40		S-9	18"/7"	39-40.5'	87-104 110		Brown, fine to medium SAND, trace+ coarse Sand, trace Silt.	
45		S-10	18"/10"	44-45.5'	41-42 33		Brown, fine to medium SAND, trace coarse Sand, little Silt.	
50		S-11	18"/8"	49-50.5'	38-35 35		Brown, fine to medium SAND, trace coarse Sand, trace Silt. Brown, fine SAND, trace Silt.	
55		S-12	18"/11"	54-55.5'	57-67 83	Fine SAND	Brown, fine SAND, trace Silt; grading to brown, fine to medium SAND, trace Silt, in bottom of tube. One 2" thick layer of black, fine SAND in top of sample.	
60		S-13	18"/10"	59-60.5'	27-32 40		Brown, fine SAND, some Silt.	
65		S-14	18"/8"	64-65.5'	53-68 60		Brown, fine SAND, trace Silt. Trace of stratification indicated by lighter and darker shades of brown.	

REMARKS: (4) Continued...below 20 feet in uncased hole. (5) Last foot driven with 300 lb. hammer falling 24". (6) Added 10 feet of 4" casing to 30 feet; could not maintain drilling mud in hole.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
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GOLDBERG · ZOINO & ASSOC., INC. GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS	PROJECT QUABBIN RESERVOIR DAM WARE, MASSACHUSETTS	REPORT OF BORING NO. B-2 SHEET 3 OF 3 DATE MAY 1981 FILE 2801

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHNG and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
65		S-14	18"/8"	64-65.5'	53-68		Brown, fine SAND, trace Silt. Trace of stratification, indicated by lighter and darker shades of brown.	
					60	Fine SAND		
							Alternate layers of brown, very fine SAND, trace Silt; and SILT, some fine Sand (layers 1/8"-3/8").	
70		S-15	18"/11"	69-70.5'	26-52			
					82	Fine to Coarse SAND	Brown, fine to coarse SAND, trace+ fine Gravel, trace Silt.	(7)
75		S-16	18"/7"	74-75.5'	20-26		Dark brown, fine to coarse SAND, little- fine Gravel, trace Silt. 2" of dark brown SILT and fine SAND, trace Wood, trace Root Matter.	(7A)
					67			
80		S-17	18"/8"	79-80.5'	76-85		Orange-gray-brown, fine to coarse SAND and fine GRAVEL, little decomposed, green-black Rock, little Silt.	(8)
					88	Gravelly Fine to Coarse SAND		
85		S-18	18"/10"	84-85.5'	70-164		Orange-gray-brown, fine to coarse SAND and weathered ROCK, little+ fine Gravel, trace Silt.	(9)
					46 (300#)			
							Orange-gray-brown, fine to coarse SAND, little+ fine Gravel, little- weathered Rock, trace Silt.	
90		S-19	24"/9"	89-91'	119-160			(10)
					37-49(300#)			
							Bottom of hole at 91.0 feet.	(11)
95								
00								

REMARKS: (7) 1" piece of fractured, white quartz lodged in end of spoon. (7A) Original ground appears to start at approximately 75', possibly several feet higher, due to topsoil material found in Sample S-16. (8) 1" piece of granite lodged in end of spoon. (9) From 12" to 18", used 300 lb. hammer falling 24". (10) From 12" to 24", used 300 lb. hammer falling 24". (11) At completion of drilling, 5 additional feet of 4" casing driven to 35', and 55' of 2.5" O.D. casing dropped in hole in preparation for piezometer installation.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
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GOLDBERG · ZOINO & ASSOC., INC. GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS	PROJECT QUABBIN RESERVOIR DAM WARE, MASSACHUSETTS	REPORT OF BORING NO. B-3 SHEET 1 OF 3 DATE JUNE 1981 FILE 2801

BORING CO. NEW ENGLAND BORING CONTR. BORING LOCATION WINSOR DAM, STA 15+08
FOREMAN STEVE RAMSDELL GROUND ELEV. LOWER BERM; EL ±460'
G-Z-A ENGINEER W. HADGE, N. CARDINALE DATE START 6/16/81 DATE END 6/18/81

CASING
SIZE: 4" F.J.
HAMMER: 300 lb.
FALL: 24"

SAMPLER
TYPE: Split Spoon OTHER:
HAMMER: 140 lb.
FALL: 30"

GROUNDWATER READINGS			
DATE	DEPTH	CASING AT	STABILIZATION TIME
	NOTE 1		

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHG. and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
		S-1	18"/10"	0-1.5'	2-4	TOPSOIL	TOPSOIL, 6".	
					5	Fine to Coarse SAND	Brown, fine to coarse SAND, trace fine Gravel, trace Cobble, trace Silt.	
5		S-2	18"/11"	5-6.5'	14-15		Light brown, fine to coarse SAND, trace fine Gravel, trace Silt.	
					17			
10		S-3	18"/9"	10-11.5'	16-17		Light brown, medium to coarse SAND, little fine Gravel, trace Silt.	
					18			
15		S-4	18"/12"	15-16.5'	12-16		Brown, fine to coarse SAND, trace fine Gravel, trace Silt.	
					19			
20		S-5	18"/10"	20-21.5'	12-14	Fine to Medium SAND	Brown, fine to medium SAND, little fine Gravel, trace Silt.	
					14			
25		S-6	18"/10"	25-26.5'	13-16		Brown, fine to medium SAND, little fine Gravel, trace Silt.	
					20			
30		S-7	18"/8"	30-31.5'	14-15		Brown, fine to coarse SAND, trace fine Gravel, trace Silt.	(2)
					9			

REMARKS: (1) Driller advanced hole using drilling mud. After flushing hole with clean water, groundwater level remained near top of casing and did not stabilize prior to piezometer installation and grouting. Therefore, no groundwater reading. (2) [SEE NEXT PAGE FOR NOTE 2]

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF THE GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

GOLDBERG · ZOINO & ASSOC., INC. GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS	PROJECT QUABBIN RESERVOIR DAM WARE, MASSACHUSETTS	REPORT OF BORING NO. B-3 SHEET 2 OF 3 DATE JUNE 1981 FILE 2801

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHNG and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
35		S-8	18"/8"	35-36.5'	15-20 24	Gravelly, Fine to Coarse SAND	Brown, fine to medium SAND, little fine Gravel, trace Silt.	
40		S-9	18"/10"	40-41.5'	27-23 20		Brown, fine to coarse SAND, little fine Gravel, trace Silt. Fractured Cobble.	
45		S-10	18"/11"	45-46.5'	26-30 31		Brown, fine to coarse SAND, little fine Gravel, trace Silt. Fractured Cobble.	
50		S-11	18"/9"	50-51.5'	19-29 40	Fine SAND	Stratified, brown, fine SAND, trace Silt; coarseness of Sand varies; several 1/8" to 1/4" layers of fine to medium Sand; fine Sand strata vary from 1/8"-1".Fractured Cobble.	
55		S-12	18"/7"	55-56.5'	36-39 41	Fine to Medium SAND	Brown, fine to medium SAND, trace fine Gravel, trace Silt. Fractured Cobble.	
60		S-13	18"/10"	60-61.5'	43-49 41	Gravelly, Fine to Coarse SAND	Clean, light brown, fine to coarse SAND, little fine Gravel, trace Silt. Fractured Cobble.	
65		S-14	18"/14"	65-66.5'	81-103 79		Brown, fine to coarse SAND, some fine Gravel, trace Silt. Fractured Cobble.	
70		S-15	12"/9"	70-71'	92-127		Brown, fine to coarse SAND, some fine Gravel, trace Silt. Fractured Cobble.	

REMARKS: (2) Foundation material appears to begin at 29 feet.

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GOLDBERG · ZOINO & ASSOC., INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
QUABBIN RESERVOIR DAM
WARE, MASSACHUSETTS

REPORT OF BORING NO. B-3
SHEET 3 OF 3
DATE JUNE 1981 FILE 2801

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHNG and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
75		S-16	18"/12"	75-76.5'	69-88 91		Brown, fine to coarse SAND, little fine Gravel, trace Silt. Fractured Cobbles.	
							Bottom of hole at 76.5'.	
80								
85								
90								
95								
100								
105								
110								

REMARKS:

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
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GOLDBERG · ZOINO & ASSOC., INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
QUABBIN RESERVOIR DAM
WARE, MASSACHUSETTS

REPORT OF BORING NO. B-4
SHEET 1 OF 5
DATE MAY 1981 FILE 2801

BORING CO. NEW ENGLAND BORING CONTR. BORING LOCATION WINSOR DAM, STA 20+00
FOREMAN STEVE RAMSDELL/TIM CARPENTIER GROUND ELEV. CREST; EL ±552'
G-Z-A ENGINEER W. HADGE, D. CARDINALE DATE START 5/14/81 DATE END 5/27/81

CASING
SIZE: 4" F.J.
HAMMER: 300 lb
FALL: 24"

SAMPLER
TYPE Split Spoon
HAMMER 140 lb
FALL: 30"
OTHER: 3" thin-walled tube (Osterberg Sampler)

GROUNDWATER READINGS

DATE	DEPTH	CASING AT	~~STABILIZATION~~ TIME
5/18	24.5'	24'	0930 Hours
5/19	33.0'	24'	0830 Hours
5/21	33.0'	24'	0850 Hours

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHG. and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
							ASPHALT PAVEMENT	
		S-1	18"/10"	0.5-2'	2		Fine to coarse GRAVEL and fine to coarse SAND, trace Silt. Fractured Cobbles. Gravel angular, fractured.	
					6-12			
5		S-2	18"/4"	5-5'4"	120-4"	Gravelly, Fine to Coarse SAND (ROLLED FILL)	Brown, fine to coarse SAND, some fine Gravel, trace+ Silt. Gravel angular, fractured.	(1)
10		S-3	18"/12"	10-11.5'	20-24		Brown, fine to coarse SAND, little- fine Gravel, trace Silt.	
					50			
15		S-4	1"/0"	15-15'1"	100-1"		COBBLE	
20		S-5	18"/4"	20-21.5'	6-8		Orange-white-brown, fine to coarse+ SAND, some fine Gravel, trace Silt.	
					14			
25		S-6	18"/11"	25-26.5'	6-10		Dark brown, fine SAND and SILT, Cobble, in top of tube.	(2)
					10	Fine SAND and SILT (HYDRAULIC FILL)	Grayish-green, fine SAND, trace Silt in bottom of tube.	
30		S-7	18"/12"	30-31.5'	4-4		Brown, fine SAND and SILT.	(3)
		U-1	24"/13"	31.5'-33.5'	5			

REMARKS: (1) Sample terminated after 4 inches. (2) Driller drove 24 feet of 4-inch casing; drilled ahead of casing with rotary bit due to presence of gravel and cobbles. (3) Sample slid 11 inches in tube while draining.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
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GOLDBERG · ZOINO & ASSOC., INC. GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS	PROJECT QUABBIN RESERVOIR DAM WARE, MASSACHUSETTS	REPORT OF BORING NO. B-4 SHEET 2 OF 5 DATE MAY 1981 FILE 2801

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHNG and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
35								
		S-8	18"/12"	35-36.5'	4-4		Brown, fine SAND and SILT.	
					5			
						SILT		
		U-2	24"/20"	38-40'		and		
40						Fine		
		S-9	18"/10"	40-41.5'	3-4		Brownish-green, fine SAND and SILT,	
					5	SAND	trace Wood, trace Root Matter.	
						(HYDRAU-		
						LIC FILL)		
45		S-10	18"/11"	44.5-46'	3-2		Brown, fine SAND and SILT, trace	
					1		Root Matter. Brownish-green SILT	
							in top 2" of spoon.	
		U-3	24"/23"	48-50'				
50								
		S-11	18"/13"	50-51.5'	2-2		Brownish-green SILT, little fine	
					2		Sand, trace Root Matter.	
55		S-12	18"/11"	55-56.5'	3-3		Brownish-green, Clayey SILT (slight	
					4		plasticity), trace Roots, trace fine	
		U-4	24"/19"	58-60			Sand with lenses of brown, fine SAND,	
							trace Silt.	
60		S-13	18"/16"	60-61.5'	3-4	Clayey/	Brownish-green, Clayey SILT (slight	
					5	Sandy	plasticity), trace Roots, trace Wood,	
						SILT	with lenses of brown, fine SAND.	
65						(HYDRAU-		
		S-14	18"/13"	65-66.5'	3-3	LIC FILL)	Brownish-green, Clayey SILT, some	
					5		fine Sand, trace Roots, trace Wood	
		U-5	24"/23½"	68-70			with lenses of brownish-green, fine	
70							SAND, trace Silt, trace Roots, trace	
		S-15	18"/16"	70-71.5'	2-2		Wood.	
					3		Brownish-green, Clayey SILT, little	
							fine Sand, trace Roots (slight plas-	
							ticity).	

REMARKS:

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF THE GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

GOLDBERG · ZOINO & ASSOC., INC. GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS	PROJECT QUABBIN RESERVOIR DAM WARE, MASSACHUSETTS	REPORT OF BORING NO. B-4 SHEET 3 OF 5 DATE MAY 1981 FILE 2801

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHNG and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
75		S-16	18"/17"	75-76.5'	3-2 2		Brownish-green SILT, some fine Sand, trace Root Matter, spotted with gray-green Silt (nonplastic).	
		U-6	24"/23-3/4"	78-80'				
80		S-17	18"/18"	80-81.5'	5-5 5	Clayey/ Sandy SILT (HYDRAU-LIC FILL)	Brownish-green SILT, some fine Sand, spotted with gray-green Silt.	
85		S-18	18"/18"	85-86.5'	1-2 3		Gray-green, Clayey SILT, trace Root Matter, trace fine Sand (top 14"); slight plasticity. Dark brown, Clayey SILT (bottom 4"); slight plasticity.	
		U-7	24"/23"	88-90'				
90		S-19	18"/16"	90-91.5'	9-12 10		Brownish-green SILT, some fine Sand, trace Roots.	
95		S-20	18"/12"	95-96.5'	4-13 14		Brownish-green SILT, trace fine Sand, trace Root Matter (nonplastic).	
		U-8	24"/15"	98-100'				
100		S-21	36"/	100-103'	Note(4)	Fine SAND (HYDRAU-LIC FILL)	Stratified, gray, fine SAND and brown SILT; strata 1/4" to 1/2" thick.	(4)
105		S-22	18"/18"	105'-106.5'	5-3 7		Brownish-green to gray, fine SAND, little Silt, trace Root Matter.	
110		U-9	24"/16"	110-112'				
		S-23	18"/10"	112-113'	5-8		Gray, fine SAND, trace Silt; lenses	

REMARKS:

(4) No blows; rods dropped by driller; penetrated 3 feet.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
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GOLDBERG · ZOINO & ASSOC., INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
QUABBIN RESERVOIR DAM
WARE, MASSACHUSETTS

REPORT OF BORING NO. B-4
SHEET 4 OF 5
DATE MAY 1981 FILE 2801

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHNG and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
115					7		1/8" thick of brownish-green, Clayey Silt (slight plasticity). Brownish-green, Clayey Silt, top 3" of spoon (slight plasticity).	
		U-10	24"/0"	118-120'				(5)
120		U-11	24"/14½"	120-122'				(6)
		S-24	18"/13"	122'-123.5'	8-23 40		Green-brown-gray SILT, with lenses of fine Sand 1/32" to 1/8" thick, trace Root Matter.	
125		S-25	18"/11"	125'-126.5'	38-56 58	Stratified Fine SANDS and SILTS (HYDRAULIC FILL)	Brown, fine SAND, trace Silt.	
130		S-26	18"/18"	130'-131.5'	10-7 28		Brownish-green SILT, lenses of gray, fine SAND 1/32" to 1/8" thick, trace Root Matter.	
135		S-27	18"/14"	135'-136.5'	22-36 38		Light brown, fine SAND, trace Silt, trace Root Matter (top 4" of spoon). Brownish-green, fine SAND, trace Silt; lenses of gray, fine Sand 1/32" to 1/8" thick, bottom 10".	
140		S-28	18"/10"	140'-141.5'	22-19 24		Brownish-green SILT; thin lenses of gray, fine Sand; 1/2" layer of black Silt.	
145		S-29	18"/18"	145'-146.5'	7-10 20		Stratified, brown SILT and gray, fine SAND; strata vary in thickness from 1/16" to 1/4"; trace Root Matter.	(7)
150		S-30	18"/14"	150'-151.5'	16-28 38	Fine SAND (FOUNDATION)	Dark brown, fine SAND, little Silt, trace Root Matter, trace Organic Matter.	

REMARKS: (5) No recovery. (6) 5.5 inches from top tube to top sample; 10 inches from bottom sample to bottom tube. (7) Foundation material appears to start at 148 feet.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
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GOLDBERG · ZOINO & ASSOC., INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
QUABBIN RESERVOIR DAM
WARE, MASSACHUSETTS

REPORT OF BORING NO. B-4
SHEET 5 OF 5
DATE MAY 1981 FILE 2801

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHNG and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
155						Fine SAND (FOUNDATION)	Brown, fine SAND, trace Silt, trace medium to coarse Sand, trace Root Matter.	
		S-31	18"/16"	155'- 156.5'	86-79 67			
160		S-32	18"/12"	160'- 161.5'	49-56 73		Brown, fine SAND, trace Silt; color varies from tan to dark brown in lenses from 1/16" to 1/4" thick; several thin lenses of black, fine SAND and SILT, trace coarse Gravel.	
165							Bottom of hole at 161.5 feet.	

REMARKS:

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GOLDBERG · ZOINO & ASSOC., INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
QUABBIN RESERVOIR DAM
WARE, MASSACHUSETTS

REPORT OF BORING NO. B-5
SHEET 1 OF 3
DATE MAY 1981 FILE 2801

BORING CO. NEW ENGLAND BORING CONTR.
FOREMAN STEVE RAMSDELL
G-Z-A ENGINEER W. HADGE, D. CARDINALE

BORING LOCATION WINSOR DAM, STA 20+00
GROUND ELEV. MIDDLE BERM; EL ±500'
DATE START 5/27/81 DATE END 6/03/81

CASING
SIZE: 4" F.J.
HAMMER: 300 lb.
FALL: 24"

SAMPLER
TYPE: Split Spoon
HAMMER 140 lb.
FALL: 30"
OTHER: 5-foot Spoon; 3-inch Tube.

GROUNDWATER READINGS

DATE	DEPTH	CASING AT	~~STABILIZATION~~ TIME
6/03	35.5'	60'	0900 Hours
6/03	38.5'	60'	1030 Hours
6/03	40.0'	35'	1500 Hours

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHG. and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
		S-1	18"/16"	0-1.5'	2-5	LOAM	Dark brown, fine SAND, some Silt, trace Roots (LOAM).	
					10			
						Gravelly Fine to Coarse SAND	Brown, fine to coarse SAND, little fine Gravel, trace Silt. Cobbles.	
5		S-2	18"/12"	5-6.5'	18-13		Gray-brown, fine to coarse SAND, little fine Gravel, trace Silt. Cobbles.	
					14			
10		S-3	18"/14"	10-11.5'	10-13		Brown, fine to coarse SAND, little fine Gravel, trace Silt. Cobbles	
					17			
15		S-4	6"/0"	15-15.5'	43-6"			(1)
20		S-5	9"/2"	20-20'9"	10/140(3")		Brown, fine to coarse SAND, little fine Gravel, trace Silt. Cobbles.	
25		S-6	18"/12"	25-26.5'	40-96		Gray-brown, fine to coarse SAND, some fine Gravel, trace Silt. Cobbles.	
					54			
30		S-7	18"/10"	30-31.5'	17-21	Fine to Medium SAND	Brown, fine to medium SAND, trace fine Gravel, trace Silt. Cobbles, trace coarse Sand.	
					23			

REMARKS: (1) Advanced hole to 15 feet using 4-inch hollow stem auger due to presence of cobbles.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
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GOLDBERG · ZOINO & ASSOC., INC. GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS	PROJECT QUABBIN RESERVOIR DAM WARE, MASSACHUSETTS	REPORT OF BORING NO. B-5 SHEET 2 OF 3 DATE JUNE 1981 FILE 2801

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHNG and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
35						Fine to Medium SAND		
		S-8	18"/6"	35-36.5'	23-30		Brown, fine to medium SAND, trace fine Gravel, trace Silt, trace coarse Sand.	
					38			
40		S-9	18"/10"	40-41.5'	11-19	Fine SAND	Brown, fine SAND, trace Silt, trace Root Matter.	
		S-10	42"/12"	41.5-45'	28		Brown, fine SAND, trace medium to coarse Sand, trace Silt.	(2)
					NOTE (2)			
45								
50		U-1	20"/14"	50-51.7	NOTE (3)			(3)
		S-11	18"/16"	52-53.5'	32-66	Fine to Medium SAND	Brown, fine to medium SAND, trace coarse Sand, trace fine Gravel, trace Silt.	(4)
					62			
55		S-12	18"/7"	55-56.5'	30-36		Brown, fine to medium SAND, trace coarse Sand, trace fine Gravel, trace Silt.	
					40			
60		S-13	18"/7"	60-61.5'	34-60		Brown, fine to medium SAND, trace coarse Sand, trace Silt.	
					56			
65		S-14	18"/9"	65-66.5'	25-48	Stratified Fine and Fine to Medium SAND	Brown, fine SAND, trace Silt. Alternate layers, ±2" thick, of very fine Sand and coarser, fine Sand.	
					89			
70		S-15	18"/10"	70-71.5'	38-62		Brown, fine SAND, trace Silt in top 2"; brown, fine to medium SAND, trace coarse Sand, trace Silt, bottom 7"; 1" stratified, fine SAND and SILT in between (strata 1/8"-1/4" thick).	
					90			

REMARKS: (2) Drove 5-foot-long, 2-inch I.D. sampler 3.5 feet. (3) Drove 3-inch tube 20 inches, using 300-lb. hammer. Hit cobble at 20 inches. (4) Driller noted occasional cobbles below 50 feet.

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GOLDBERG · ZOINO & ASSOC., INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
QUABBIN RESERVOIR DAM
WARE, MASSACHUSETTS

REPORT OF BORING NO. B-5
SHEET 3 OF 3
DATE JUNE 1981 FILE 2801

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHNG and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
75		S-16	18"/9"	75-76.5'	17-59 78	Stratified Fine and Fine to Medium SAND	Brown, fine SAND, trace Silt with strata of brown SILT (1/16" to 1/4" thick); also layer of fine to medium SAND, trace coarse Sand, trace Silt (2" to 3").	
80		S-17	18"/7"	80-81.5'	44-105 112		Brown, fine SAND, trace Silt with very thin Silt lenses in top 3"; brown, fine to medium SAND, trace coarse Sand, trace fine Gravel, trace Silt in bottom 4".	
85		S-18	18"/9"	85-86.5'	23-36 45		Brown, fine SAND, trace Silt; 1/2" layer of brown SILT; 1" layer of fine to medium SAND, trace Silt.	
90		S-19	18"/0"	90-91.5'	23-21			(5)
		S-20	18"/13"	91.5-93'	12-25 50-100		Brown, fine SAND, trace Silt top 8" of spoon; stratified, brown and dark brown SILT, trace fine Sand, trace Root Matter (1/8" to 1/4" strata) middle 3"; brown, fine to medium SAND, trace fine Gravel, trace Silt bottom 2".	(6)
95							Bottom of hole at 93 feet.	
100								
105								
110								

REMARKS: (5) Lost sample while rasing rods; redrove spoon. (6) Foundation material appears to start at 92 feet. Boring terminated at 93 feet.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
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GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
QUABBIN RESERVOIR DAM
WARE, MASSACHUSETTS

REPORT OF BORING NO. B-6
SHEET 1 OF 3
DATE JUNE 1981 FILE 2801

BORING CO. NEW ENGLAND BORING CONTR.
FOREMAN STEVE RAMSDELL
G-Z-A ENGINEER W. HADGE, N. CARDINALE

BORING LOCATION WINSOR DAM, STA 20+00
GROUND ELEV. LOWER BERM, EL ±460'
DATE START 6/18/81 DATE END 6/23/81

CASING
SIZE: 4" F.J.
HAMMER: 300 lb
FALL: 24"

SAMPLER
TYPE Split Spoon OTHER:
HAMMER 140 lb
FALL: 30"

GROUNDWATER READINGS

DATE	DEPTH	CASING AT	~~STABILIZATION~~ TIME
	NOTE (1)		

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHG. and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
						TOPSOIL	TOPSOIL, 6"	
		S-1	18"/8"	0-1.5'	1-3		Brown to light brown, fine to medium SAND.	
					5			
5		S-2	18"/10"	5-6.5'	16-18		Light brown, fine to medium SAND, trace fine Gravel, trace Silt. Fractured Cobble.	
					20			
10		S-3	18"/10"	10-11.5'	1-2		Light brown, fine to medium SAND, little fine to coarse Gravel, trace Silt. Fractured Cobble.	
					3	Gravelly, Fine to Coarse SAND (COBBLES)		
15		S-4	18"/14"	15-16.5'	82-71		Light brown, fine to coarse SAND, some fine to coarse Gravel, trace Silt. Fractured Cobble.	
					85			
20		S-5	18"/6"	20-21.5'	52-89		Light brown to gray, medium to coarse SAND, little fine to coarse Gravel, trace Silt. Fractured Cobble.	
					66			
25		S-6	18"/12"	25-26.5'	47-121		Light gray, fine to coarse SAND, little fine Gravel, trace Silt. Fractured Cobble.	
					118			
30		S-7	18"/8"	30-31.5'	92-111		Brown, fine to coarse SAND, trace fine to coarse Gravel, trace Silt. Fractured Cobble.	
					100			

REMARKS: (1) Drilling mud used to advance hole. Water level did not stabilize after hole was flushed or during piezometer installation, remaining several feet below ground surface.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
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GOLDBERG · ZOINO & ASSOC., INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
QUABBIN RESERVOIR DAM
WARE, MASSACHUSETTS

REPORT OF BORING NO. B-6
SHEET 2 OF 3
DATE JUNE 1981 FILE 2801

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHNG and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
35								
		S-8	18"/10"	35-36.5'	65-80	Gravelly Fine to Coarse SAND (COBBLES)	Brown, fine to coarse SAND, little fine to coarse Gravel, trace Silt. Fractured Cobble.	
					121			
40		S-9	18"/10"	40-41.5	60-83		Brown, fine to coarse SAND, trace fine to coarse Gravel, trace Silt. Fractured Cobble.	
					110			
45		S-10	18"/8"	45-46.5'	30-90		Light brown, fine to medium SAND, little fine to coarse Gravel, trace Silt, trace Root Matter. Fractured Cobble.	
					150			
50		S-11	18"/10"	50-51.5'	32-42		Light brown, fine to coarse SAND, trace fine Gravel, trace Silt, trace Root Matter. Fractured Cobble.	
					93			
55		S-12	18"/7"	55-56'	45-165		Brown, fine to coarse SAND, trace fine Gravel, trace Silt. Fractured Cobble.	
60		S-13	18"/6"	60-61.5'	28-35		Brown, fine to coarse SAND, trace fine Gravel, trace Silt. Fractured Cobble.	
					51			
65		S-14	18"/9"	65-66.5'	46-61	Fine to Medium SAND	Light brown, fine to medium SAND, little fine Gravel, trace Silt, trace Root Matter. Fractured Cobble.	
					144			
70		S-15	18"/10"	70-71.5'	81-71		Light brown, fine to medium SAND, trace Silt.	
					40			

REMARKS:

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GOLDBERG · ZOINO & ASSOC., INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
QUABBIN RESERVOIR DAM
WARE, MASSACHUSETTS

REPORT OF BORING NO. B-6
SHEET 3 OF 3
DATE JUNE 1981 FILE 2801

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHNG and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
75		S-16	18"/13"	75-76.5'	30-30 20	Gravelly fine SAND with COBBLES	Dark brown, streaked with light brown, fine to medium SAND, trace fine to coarse Gravel, trace Silt, trace Root Matter (top 10" of spoon); Gray to brown, fine to medium SAND, trace Silt (bottom 3" of spoon).	
80		S-17	18"/20"	80-81.5'	42-72 55		S-17: Yellow-gray, fine SAND, some fine Gravel, little Silt.	
85		S-18	12"/6"	85-86'	128-107		Fractured, coarse GRAVEL and COBBLE, some fine Sand, trace Silt.	
90		S-19	18"/0"	90-90.4'	106-5"		No sample.	
95		S-20	18"/12"	95-96.5'	39-40 43	Fine to Medium SAND	Orange-brown, fine to medium SAND, trace Silt.	
100		S-21	18"/11"	100'-101.5'	32-58 64	SAND, GRAVEL, COBBLES	Fractured, coarse GRAVEL and COBBLE, some fine Sand, little fine Gravel, trace Silt.	
105		S-22	18"/12"	105'-106.5'	29-21 22		Gray-brown, fine to coarse SAND, little fine to coarse Gravel, trace Silt. Fractured Cobble.	
110		S-23	18"/7"	110'-111.5'	35-62 48		S-23: Gray-brown, fine SAND, some fractured, coarse Gravel, trace fine Gravel, trace Silt. Fractured Cobble.	
							Bottom of hole at 111.5 feet.	

REMARKS:

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GOLDBERG · ZOINO & ASSOC., INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
QUABBIN RESERVOIR DAM
WARE, MASSACHUSETTS

REPORT OF BORING NO. B-7
SHEET 1 OF 5
DATE JUNE 1981 FILE 2801

BORING CO. NEW ENGLAND BORING CONTR.
FOREMAN TIM CARPENTER
G-Z-A ENGINEER W. HADGE, N. CARDINALE

BORING LOCATION GOODNOUGH DIKE, STA 21+80
GROUND ELEV. CREST, EL ±552'
DATE START 6/08/81 DATE END 6/17/81

CASING
SIZE: 4" F.J.
HAMMER: 300 lb.
FALL: 24"

SAMPLER
TYPE: Split Spoon
HAMMER 140 lb.
FALL: 30"
OTHER: Piston Sampler--3" tubes (Osterberg)

GROUNDWATER READINGS

DATE	DEPTH	CASING AT	~~STABILIZATION~~ TIME
6/19	38'	140'	0900 Hours

DEPTH	CAS. BL./FT.	SAMPLE NO.	PEN./REC.	SAMPLE DEPTH	BLOWS/6"	STRTA CHG and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
		S-1	18"/10"	0.5-2'	10-53	ASPHALT	BLACKTOP, 6"	
					66		Brown, fine to medium SAND and fractured COBBLES, little fine Gravel, trace coarse Sand, trace Silt.	
5		S-2	18"/14"	5-6.5'	56-73	Gravelly Fine to Coarse SAND	Light brown, fine to coarse SAND, little fine Gravel, trace Silt.	
					88			
10		S-3	18"/8"	10-11.5'	79-120	(ROLLED FILL)	Light brown, fine to coarse SAND, trace fine Gravel, trace fractured Cobbles, trace Silt.	
					51			
15		S-4	18"/7"	15-16.5'	139-116	Gravelly Fine and Fine to Medium SAND (COBBLES)	Gray, fine to medium SAND, little fine Gravel, trace fractured Cobbles, trace coarse Sand, trace Silt.	
					59			
20		S-5	18"/12"	20-21.5'	159-43		Gray, fine to coarse SAND, little fine Gravel, little fractured Cobbles, trace Silt.	(1)
					80			
25		S-6	12"/10"	25-26.5'	210-112		Greenish-brown, fine to medium SAND, some fractured Cobbles, little fine Gravel, trace coarse Sand, trace Silt.	(2)
					NOTE (2)			
30		S-7	18"/12"	30-31.5'	150-37		Gray and gray-brown, fine to medium SAND, little fractured Cobble, trace fine Gravel, trace coarse Sand, trace Silt, with lenses of brown and rust, fine Sand.	(3)
					45			
					NOTE (3)			

REMARKS: (1) 1"-2" cobble of quartz. (2) Second 6" of spoon driven with 300-lb. hammer; gneiss and quartz, cobble in bottom of spoon. (3) Last 12" of spoon driven with 300-lb hammer.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF THE GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

GOLDBERG · ZOINO & ASSOC., INC. GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS	PROJECT QUABBIN RESERVOIR DAM WARE, MASSACHUSETTS	REPORT OF BORING NO. B-7 SHEET 2 OF 5 DATE JUNE 1981 FILE 2801

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHNG and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
35								
		S-8	18"/12"	35-36.5'	38-56		Gray, fine SAND, little fractured Cobbles, trace fine Gravel, trace medium to coarse Sand, trace Silt.	
					71			
40		S-9	18"/14"	40-41.5'	29-29		Gray, fine SAND, trace fine Gravel, trace medium to coarse Sand,,trace Silt. Thin lenses of rust-colored, fine Sand.	
					35			
45		S-10	18"/16"	45-46.5'	5-6		Very fine, brown SAND, little Silt, trace Root Matter. Lense of rust-colored, fine Sand, 1/4" thick.	
					8			
						Strati-fied		
50		S-11	18"/16"	50-51.5'	7-5		Brown, fine SAND, trace Silt, with lenses of brown Silt (1/16"-1/4").	
					5	Fine		
		U-1	24"/12"	52-54'	NOTE (4)	SAND		(4)
55		S-12	18"/12"	54-55.5'	7-6		Top 6" brown, fine SAND, trace Silt. Bottom 6" brown, fine SAND with very thin lenses of brown Silt (1/32" to 1/16" thick).	
					7	(HYDRAU-LIC FILL)		
60		S-13	18"/18"	60-61.5'	8-4		Stratified, gray and brown, fine SAND, Silt content varies from trace to little; strata vary from 1/32" to 1/2"; also several lenses of rust-colored, fine Sand.	
					7			
		U-2	24"/24"	62-64'				
65		S-14	18"/16"	64-65.5'	8-4		Stratified, gray and brown, fine SAND, Silt content varies from trace to little; strata vary from 1/32" to 1/2" thick.	
					4			
70		S-15	18"/14"	70-71.5'	8-10		Brown-gray, fine SAND, trace Silt; (bottom 10" of spoon) greenish-brown, fine SAND.	
					16			
		U-3	24"/20.5"	72-74'				(5)

REMARKS: (4) 7" from top tube to top sample; 11" from bottom tube to bottom sample.
(5) 2" from top tube to top sample; 7-1/2" from bottom tube to bottom sample.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
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GOLDBERG · ZOINO & ASSOC., INC. GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS	PROJECT QUABBIN RESERVOIR DAM WARE, MASSACHUSETTS	REPORT OF BORING NO. B-7 SHEET 3 OF 5 DATE JUNE 1981 FILE 2801

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHNG and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
75		S-16	18"/18"	74-75.5'	9-13 16		Stratified, greenish-brown, fine SAND, little Silt; 1/32" to 1/4" layers of gray and rust-colored, fine Sand, trace Silt; trace Root Matter.	
80		S-17	18"/18"	80-81.5'	7-11 17		Stratified, gray to greenish-brown, fine SAND, little Silt.	
		U-4	24"/0"	82-84'				(6)
85		S-18	18"/18"	84-85.5'	8-4 8	Stratified Fine SAND	Greenish-brown, fine SAND; Silt content varies from trace to some; 1/8" layers of rust colored, fine Sand.	
90		S-19	18"/14"	89-90.5'	4-6 13	(HYDRAULIC FILL)	Gray, fine SAND, trace Silt, trace Wood (top 8" of spoon); greenish-brown, fine SAND, trace Silt (bottom 8" of spoon).	
		U-5	24"/16"	92-94'				(7)
95		S-20	18"/18"	94-95.5'	27-36 42		Stratified, greenish-brown, fine SAND; Silt content varies from trace to some; trace Root Matter. Strata from 1/32" to 1/8" thick.	
100		S-21	18"/18"	99'- 100.5'	4-4 9		Stratified, greenish-brown, fine SAND; Silt content varies from trace to some; trace Root Matter. Strata from 1/32" to 1/8" thick.	
		U-6	24"/17"	102-104'				
105		S-22	18"/18"	104'- 105.5'	14-15 21		Stratified, greenish-brown, fine SAND, trace Silt; 1/32" to 1/8" layers of brown, gray, rust-colored, fine Sand, trace Silt.	
110		S-23	18"/16"	109'- 110.5'	5-11 27		Greenish-brown to gray, fine SAND, little Silt, trace Root Matter.	
		U-7	24"/23"	112-114'				

REMARKS: (6) No recovery. (7) 8" from top of tube to top of sample; 6" from bottom of tube to bottom of sample.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
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GOLDBERG · ZOINO & ASSOC., INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
QUABBIN RESERVOIR DAM
WARE, MASSACHUSETTS

REPORT OF BORING NO. B-7
SHEET 4 OF 5
DATE JUNE 1981 FILE 2801

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHNG and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
115		S-24	18"/18"	114'- 115.5'	7-19 23	Stratified Fine SAND (HYDRAULIC FILL)	Stratified, greenish-brown and brown, fine SAND, little Silt, trace Root Matter. Strata 1/32" to 1/8" thick.	
120		S-25	18"/13"	119'- 120.5'	17-19 23		Stratified, greenish-brown to gray, fine SAND, little Silt, trace Root Matter. Strata 1/32" to 1/4" thick. Rust-colored lenses, top 1" of spoon.	
		U-8	24"/17"	122-124'				(8)
125		S-26	18"/18"	124'- 125.5'	5-5 8		Stratified, greenish-brown and brown, fine SAND; Silt content varies from trace to some; trace Root Matter. Strata 1/16" thick, average.	
130		S-27	18"/	129'- 130.5'	5-7 21		Stratified, gray and brownish-green, fine SAND of varying coarseness; lenses of Silt from 1/32" to 1/4"; trace Root Matter. Middle 3" of sample was brownish-green Silt.	
		U-9	24"/22"	132-134'				
135		S-28	18"/18"	134'- 135.5'	11-9 19		Stratified, gray and brownish-green, fine SAND of varying coarseness. Silt content varies from trace to some; trace Root Matter.	(9)
140		S-29	18"/18"	139'- 140.5'	31-37 53	Fine SAND (FOUNDATION MATERIAL)	Dark brown, fine SAND, little Silt, trace fine Gravel, trace Root Matter, trace Cobble.	
145		S-30	18"/8"	144'- 145.5'	56-60 83		Stratified, brown and yellow-brown, fine SAND, little Silt, trace fine Gravel, trace Root Matter. Strata/lenses 1/32" to 1/8".	
150		S-31	18"/13"	149'- 150.5'	51-57 77		Brown, fine SAND, little fine Gravel, trace Silt, trace Root Matter, with lenses of yellow-brown, fine Sand.	

REMARKS: (8) 3" from top of sample to top of tube; 10" from bottom of sample to bottom of tube. (9) Foundation material appears to start at 137.5 feet.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
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GOLDBERG · ZOINO & ASSOC., INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
QUABBIN RESERVOIR DAM
WARE, MASSACHUSETTS

REPORT OF BORING NO. B-7
SHEET 5 OF 5
DATE JUNE 1981 FILE 2801

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHNG and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
155		S-32	18"/	154'-	28-73		Yellow-brown, fine SAND, trace fine Gravel, trace Root Matter, fractured Cobble. Lenses of dark brown, fine Sand, 1/8" to 3/8" thick. 1" layer of dark brown, fine Sand, little Silt, trace Roots, trace Leaves, trace Organic Matter (typical of Topsoil).	
				155.5'	115		Bottom of hole at 155.5 feet.	
160								

REMARKS:

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
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GOLDBERG · ZOINO & ASSOC., INC. GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS	PROJECT QUABBIN RESERVOIR DAM WARE, MASSACHUSETTS	REPORT OF BORING NO. B-8 SHEET 1 OF 3 DATE JUNE 1981 FILE 2801

BORING CO. NEW ENGLAND BORING CONTR. BORING LOCATION GOODNOUGH DIKE, STA 21+80
FOREMAN STEVE RAMSDELL GROUND ELEV. MIDDLE BERM, EL ±500'
G-Z-A ENGINEER W. HADGE, N. CARDINALE DATE START 6/04/81 DATE END 6/09/81

CASING
SIZE: 4" F.J.
HAMMER: 300 lb.
FALL: 24"

SAMPLER
TYPE Split Spoon
HAMMER 140 lb.
FALL: 30"
OTHER: 5-foot, 2-inch I.D. Spoon

GROUNDWATER READINGS

DATE	DEPTH	CASING AT	~~STABILIZATION~~ TIME
6/09	46'	55'	1600 Hours
6/10	52	55'	0900 Hours

DEPTH	CAS. BL./FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHG and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
							TOPSOIL, 3"	
		S-1	18"/8"	0-1.5'	2-4	LOAM	Brown, fine to medium SAND, trace Silt, trace Root Matter, trace Cobble.	
					5			
5		S-2	18"/12"	5-6.5'	17-9	Fine to Medium SAND	Light brown, fine to medium SAND, little fine Gravel, trace coarse Sand, trace Silt.	
					8			
10		S-3	18"/10"	10-11.5'	11-13		Light brown, fine SAND, trace medium to coarse Sand, trace fine Gravel, trace Silt. Fractured Cobble.	
					10			
15		S-4	18"/8"	15-16.5'	28-32		Gray-brown, fine to coarse SAND and fractured COBBLES, little fine Gravel, trace Silt.	
					75			
20		S-5	18"/0"	20-21.5'		Gravelly Fine to Coarse SAND (COBBLES)		
25		S-6	18"/10"	25-26.5'	31-50		Gray-brown, fine to coarse SAND, little fractured Cobbles, little fine Gravel, trace Silt.	
					48			
30		S-7	18"/8"	30-31.5'	39-58		Gray-brown, fine to coarse SAND, little fractured Cobbles, little fine Gravel, trace Silt.	
					60			

REMARKS:

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
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GOLDBERG · ZOINO & ASSOC., INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
QUABBIN RESERVOIR DAM
WARE, MASSACHUSETTS

REPORT OF BORING NO. B-8
SHEET 2 OF 3
DATE JUNE 1981 FILE 2801

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHNG and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
35		S-8	18"/8"	35-36.5'	53-71 75		Gray-brown, fine to coarse SAND, little fractured Cobbles, little fine Gravel, trace Silt.	
40		S-9	18"/9"	40-41.5'	26-50 52		Brown, fine SAND, trace fine Gravel, trace Silt.	
45		S-10	18"/9"	45-46.5'	25-35 55		Light brown to brown, fine SAND, trace fine Gravel, trace Silt.	
50		S-11	60"/20"	50-55'	NOTE (1)	Fine SAND	Light gray-brown, fine SAND, trace fine Gravel, trace Silt.	(1)
55		S-12	18"/9"	55-56.5'	14-26 34		Gray-brown, fine to medium SAND, trace fine Gravel, trace Silt.	
60		S-13	18"/9"	60-61.5'	21-26 22		Gray-brown, fine SAND, trace fine Gravel, trace Silt. Fractured Cobble.	
65		S-14	18"/11"	65-66.5'	11-22 26		Gray-brown, fine SAND, trace fine Gravel, trace Silt.	
70		S-15	18"/11"	70-71.5'	20-13 19		Gray-brown, fine SAND, trace fine Gravel, trace Silt.	

REMARKS: (1) Drove 5-foot spoon with 300-lb. hammer.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
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GOLDBERG · ZOINO & ASSOC., INC. GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS	PROJECT QUABBIN RESERVOIR DAM WARE, MASSACHUSETTS	REPORT OF BORING NO. B-8 SHEET 3 OF 3 DATE JUNE 1981 FILE 2801

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHNG and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
75		S-16	18"/11"	76-77.5'	30-108 73	Gravelly Fine to Coarse SAND	Brown to dark brown, fine to coarse SAND, trace fine Gravel, trace Silt, trace Wood (top 3" of spoon); Gray, fine to coarse SAND, trace fine Gravel, trace fractured Cobble, trace Silt (bottom 8" of spoon).	(2)
80		S-17	18"/	80-81.5'	76-86 106	(COBBLES)	Gray, fine to coarse SAND, little fine Gravel, trace Silt. Fractured Cobbles.	
85							Bottom of hole at 83.7 feet.	(3)
90								
95								
100								
105								
110								

REMARKS: (2) Driller noted change in strata at ±74 feet. Natural material appears to start at 74 feet. (3) Roller bit refusal at 83.7 feet. Drilled through boulder last 8 inches.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
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GOLDBERG · ZOINO & ASSOC., INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
QUABBIN RESERVOIR DAM
WARE, MASSACHUSETTS

REPORT OF BORING NO. B-9
SHEET 1 OF 3
DATE JUNE 1981 FILE 2801

BORING CO. NEW ENGLAND BORING CONTR.
FOREMAN STEVE RAMSDELL
G-Z-A ENGINEER W. HADGE, N. CARDINALE

BORING LOCATION GOODNOUGH DIKE, STA 21+80
GROUND ELEV. LOWER BERM, EL ±460'
DATE START 6/09/81 DATE END 6/12/81

CASING
SIZE: 4" F.J.
HAMMER: 300 lb
FALL: 24"

SAMPLER
TYPE Split Spoon OTHER:
HAMMER 140 lb
FALL: 30"

GROUNDWATER READINGS

DATE	DEPTH	CASING AT	STABILIZATION TIME
6/12	25'	55'	0900 Hours
6/12	34'	50'	1200 Hours
SEE NOTE (1)			

DEPTH	CAS. BL./FT.	SAMPLE NO.	PEN./REC.	SAMPLE DEPTH	BLOWS/6"	STRTA CHG. and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
							TOPSOIL, 7"	
		S-1	18"/8"	0-1.5'	2-2		Brown, fine to coarse SAND, trace fine Gravel, trace Silt.	
					3			
5		S-2	18"/12"	5-6.5'	6-6		Light brown, clean, fine to coarse SAND, trace fine Gravel, trace Silt.	
					10	Clean Fine to Coarse SAND		
10		S-3	18"/16"	10-11.5'	16-15		Light brown, clean, fine to medium SAND, some fractured Cobble, trace fine Gravel, trace coarse Sand, trace Silt.	(2)
					16			
15		S-4	18"/9"	15-16.5'	10-12		Light brown, clean, fine to medium SAND, trace fine Gravel, trace coarse Sand, trace Silt.	
					14			
20		S-5	18"/7"	20-21.5'	17-17		Brown, fine to coarse SAND, little fine Gravel, trace fractured Cobble, trace Silt.	
					8	Gravelly Fine to Coarse SAND (COBBLES)		
25		S-6	18"/7"	25-26.5'	21-33		Gray-brown, fine to coarse SAND, little fine Gravel, trace fractured Cobble, trace Silt.	
					36			
30		S-7	18"/6"	30-31.5'	55-38		Gray-brown, fine to coarse SAND, little fine Gravel, trace fractured Cobble, trace Silt.	
					21			

REMARKS: (1) First reading prior to flushing with water; second reading 2.5 hours after flushing hole with water. (2) 3" cobble of quartz, 8" from bottom of spoon.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
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GOLDBERG · ZOINO & ASSOC., INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
QUABBIN RESERVOIR DAM
WARE, MASSACHUSETTS

REPORT OF BORING NO. B-9
SHEET 2 OF 3
DATE JUNE 1981 FILE 2801

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHNG and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
35		S-8	18"/4"	35-36.5'	7-7 8	Gravelly, Fine to Coarse SAND	Gray, fine to coarse SAND, trace fine Gravel, trace Silt.	
40		S-9	18"/0"	40-41.5'	19-17 15			
45		S-10	18"/12"	45-46.5	48-33 24		Gray, fine to coarse SAND, little fine Gravel, trace Silt.	(3)
50		S-11	18"/12"	50-51.5'	21-19 18	Stratified Clean SAND (ALLUVIAL DEPOSITS)	Light gray-brown, fine to medium SAND, trace Silt (top 4" of spoon). Light brown, fine to coarse SAND, trace Silt (middle 3" of spoon). Light brown to gray, fine to medium SAND, trace Silt (bottom 5" of spoon).	
55		S-12	18"/10"	55-56.5'	15-14 32		Gray, fine SAND, trace Silt; light brown, fine to medium SAND, trace Silt (in middle 2" of spoon). Lenses of rust-colored, fine to medium Sand.	
60		S-13	18"/10"	60-61.5'	17-20 22		Gray, fine SAND, trace Silt; streaked with light brown, fine SAND (middle 2" of spoon).	
65		S-14	18"/11"	65-66.5'	24-18 16		Light brown, fine SAND, trace Silt; 1/32" to 1/4" lenses of rust and gray, fine Sand.	
70		S-15	18"/15"	70-71.5'	14-21 34		Greenish-brown, fine SAND, some Silt (top 5" of spoon). Rust to green, fine SAND, little to trace Silt (middle 6" of spoon). Gray, fine to coarse Sand, trace Silt, trace fine Gravel (bottom 4" of spoon).	

REMARKS:
(3) Natural material appears to start at 47 feet.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
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GOLDBERG · ZOINO & ASSOC., INC. GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS	PROJECT QUABBIN RESERVOIR DAM WARE, MASSACHUSETTS	REPORT OF BORING NO. B-9 SHEET 3 OF 3 DATE JUNE 1981 FILE 2801

DEPTH	CAS. BL. /FT.	SAMPLE NO.	SAMPLE PEN./REC.	SAMPLE DEPTH	SAMPLE BLOWS/6"	STRTA CHNG and GEN. DESC.	SAMPLE DESCRIPTION	NOTE
75		S-16	18"/0"	75-76.5'	15-44 33	Gravelly Fine to Coarse SAND (COBBLES)		(4) (5)
80		S-17	18"/9"	80-81.5'	25-34 32		Gray, fine to coarse SAND, little fine to coarse Gravel, fractured Cobble, trace Silt.	
85		S-18	18"/8"	85-86.5'	27-30 32		Gray, black, and light brown, fine to coarse SAND, little fine to coarse Gravel, fractured Cobble, trace Silt.	
90		S-19	18"/7"	90-91.5'	69-37 43		Gray-brown, fine to coarse SAND, little fine to coarse Gravel, fractured Cobble, trace Silt.	
95							Bottom of hole at 91.5 feet.	
100								
105								
110								

REMARKS: (4) No recovery. (5) Driller noted frequent cobbles below 75 feet.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF THE GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

APPENDIX B

BORING LOGS BY BRIGGS ENGINEERING

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12,092

SHEET 1 OF 5
LOCATION Winsor Dam
HOLE NO. B-1
LINE & STA. 15 + 10
OFFSET

GROUND WATER OBSERVATIONS

At 29' ft. after ____ Hours
At ____ ft. after ____ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300 lb	140 lb	BIT
Hammer Fall	24"	30"	

SURFACE ELEV. 550
DATE START: 5-12-81
DATE FINISH 5-22-81
BORING FOREMAN Tim Carpent
INSPECTOR Bill Hadge

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From To 0-6	6-12	12-18	18-24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	Re
	6"-2'	SS	20	25	66		3"	Blacktop	1	18	1
								GRAY, brown fine to coarse sand, little trace silt (fill) fine to coarse gravel.			
	5'-6'	SS	80	170					2	12	8
	10'-11'6"	SS	80	85	105				3	18	1(
	15'-16'6"	SS	33	117	22/3	00#			4	18	7'
	20'-21'6"	SS	49	58	65				5	18	8"
							24'				
	25'-26'6"	SS	49	50	45			GRAY fine sand, and silt	6	18	4'
	30'-32'	UP1								24	2
	32'-33'6"	SS	10	7	8				7	18	1
	39'-41'	UP2								24	0

Blow Counts for Clay

0 - 2 Very soft
2 - 4 Soft
5 - 8 Medium
9 - 15 Stiff
15 - 30 Very stiff
30 - Hard

Proportion used: trace = 0 - 10%

Granular Materials

0 - 4 Very loose
4 - 10 Loose
10 - 30 Medium or Firm
30 - 50 Compact
50 - Very compact

some = 20 - 35%
and = 35 - 50%

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12,092

SHEET 2 OF 5
LOCATION Winsor Dam
HOLE NO. B-1
LINE & STA.
OFFSET

GROUND WATER OBSERVATIONS

At 29' ft. after ____ Hours
At ____ ft. after ____ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300 lb	140 lb	BIT
Hammer Fall	24"	30"	

SURFACE ELEV.
DATE START: 5-12-81
DATE FINISH 5-22-81
BORING FOREMAN Tim Carpente
INSPECTOR Bill Hadge

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From To 0-6	6-12	12-18	18-24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	Rec.
	41'-43'	UP3						GRAY fine sand, and silt		24	0
	44'-46'	SS	5	2	3				8	24	10
	46'-48'	UP4								24	24
	48'-49'6"	SS	12	13	12				9	18	13
	54'-56'	UP5								24	24
	56'-57'6"	SS	5	8	7				10	18	16
	60'-61'6"	SS	4	3	4				11	18	17
	64'-66'	UP6								24	23
	66'-67'6"	SS	9	4	3				12	18	12
	70'-71'6"	SS	4	4	5				13	18	18
	74'-76'	UP7								24	21
	76'-77'6"	SS	4	4	3				14	18	18
	80'-81'6"	SS	6	12	8				15	18	12

Blow Counts for Clay

0 - 2 Very soft
2 - 4 Soft
5 - 8 Medium
9 - 15 Stiff
15 - 30 Very stiff
30 - Hard

Proportion used: trace = 0 - 10%

Granular Materials

0 - 4 Very loose
4 - 10 Loose
10 - 30 Medium or Firm
30 - 50 Compact
50 - Very compact

some = 20 - 35%
and = 35 - 50%

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12,092

SHEET 3 OF 5
LOCATION Winsor Dam
HOLE NO. B-1
LINE & STA.
OFFSET

GROUND WATER OBSERVATIONS

At 29' ft. after ____ Hours
At ____ ft. after ____ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300 lb	140 lb	BIT
Hammer Fall	24"	30"	

SURFACE ELEV.
DATE START: 5-12-81
DATE FINISH 5-22-81
BORING FOREMAN Tim Carpente
INSPECTOR Bill Hadge

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From To 0-6	6-12	12-18	18-24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	Rec
								GRAY fine sand, and silt			
	84'-86'	UP8								24	24
	86'-87'6"	SS	2	10	8				16	18	9"
	90'-91'6"	SS	13	7	8				17	18	9"
	94'-96'	UP9 No tube- jar sample								24	2"
	97'-99'	UP10								24	16"
	99'-100'6"	SS	10	18	27				18	18	13"
	104'-105'6"	SS	10	27	32				19	18	9"
	107'-109'	UP11								24	24"
	109'-110'6"	SS	12	26	24				20	18	15"
	115'-116'6"	SS	17	35	40				21	18	12"
	117'-118'6"	SS	20	33	48				22	18	6"

Blow Counts for Clay

0 - 2 Very soft
2 - 4 Soft
5 - 8 Medium
9 - 15 Stiff
15 - 30 Very stiff
30 - Hard

Proportion used: trace = 0 - 10%

Granular Materials

0 - 4 Very loose
4 - 10 Loose
10 - 30 Medium or Firm
30 - 50 Compact
50 - Very compact

some = 20 - 35%
and = 35 - 50%

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12,092

SHEET 4 OF 5
LOCATION Winsor Dam
HOLE NO. B-1
LINE & STA.
OFFSET

GROUND WATER OBSERVATIONS

At 29' ft. after ____ Hours
At ____ ft. after ____ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300 lb	140 lb	BIT
Hammer Fall	24"	30"	

SURFACE ELEV.
DATE START: 5-12-81
DATE FINISH 5-22-81
BORING FOREMAN Tim Carpente
INSPECTOR Bill Hadge

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From / To 0-6	6-12	12-18	18-24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	Rec
								GRAY fine sand, and silt			
	123'-124'6"	SS	21	28	38				23	18	6"
	128'-129'6"	SS	11	8	22				24	18	16"
	133'-134'6"	SS	9	12	25				25	18	18
	138'-139'6"	SS	9	21	39				26	18	13
	143'-144'6"	SS	16	27	34				27	18	12
							148'				
	148'-149'6"	SS	18	28	44			BLACK SILT, little fine sand.	28	18	12
							151'	GRAY brown fine to medium sand, some silt (cobbles)			
	153'-154'6"	SS	35	45	40				29	18	9"
	158'-159'6"	SS	23	41	67				30	18	12

Blow Counts for Clay

0 - 2 Very soft
2 - 4 Soft
5 - 8 Medium
9 - 15 Stiff
15 - 30 Very stiff
30 - Hard

Proportion used: trace = 0 - 10%

Granular Materials

0 - 4 Very loose
4 - 10 Loose
10 - 30 Medium or Firm
30 - 50 Compact
50 - Very compact

some = 20 - 35%
and = 35 - 50%

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12,092

SHEET 5 OF 5
LOCATION Winsor Dam
HOLE NO. B-1
LINE & STA.
OFFSET

GROUND WATER OBSERVATIONS

At 29' ft. after ____ Hours
At ____ ft. after ____ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300 lb	140 lb	BIT
Hammer Fall	24"	30"	

SURFACE ELEV.
DATE START: 5-12-81
DATE FINISH 5-22-81
BORING FOREMAN Tim Carpente
INSPECTOR Bill Hadge

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From To 0-6	6-12	12-18	18-24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	Re
								GRAY fine sand, and silt			
	163'-164'6"	SS	40	36	38		164'6"		31	18	12
								EOB 164' 6"			
								Water at 29'			

Blow Counts for Clay

0 - 2 Very soft	9 - 15 Stiff
2 - 4 Soft	15 - 30 Very stiff
5 - 8 Medium	30 - Hard

Proportion used: trace = 0 - 10%

Granular Materials

0 - 4 Very loose	30 - 50 Compact
4 - 10 Loose	50 - Very compact
10 - 30 Medium or Firm	

some = 20 - 35% and = 35 - 50%

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12.092

SHEET 1 OF 3
LOCATION Winsor Dam
HOLE NO. B-2
LINE & STA. 15 + 10
OFFSET 1'-1"

GROUND WATER OBSERVATIONS

At 41 ft. after ____ Hours
At ____ ft. after ____ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300 lb	140 lb	BIT
Hammer Fall	24"	30"	

SURFACE ELEV. 493
DATE START: 5-6-81
DATE FINISH 5-11-81
BORING FOREMAN Tim Carpent
INSPECTOR Bill Hadge

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From 0-6	6-12	12-18	18-24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	R
	0'-2'	SS	4	13	26	32		TOPSOIL, brown fine to coarse sand, little fine gravel, little silt.	1	24	1
	5'-5'8"	SS	40	105/2"					2	8	
225											
200	10'-10'4"	SS	150/4"						3	4	
21											
50											
80							13'				
70											
60	15'-16'6"	SS	24	20	22			GRAY brown fine coarse sand, and gravel, some silt.	4	18	
19											
50											
82											
60											
	20'-20'8"	SS	65	130/2"					5	8	
	24'-25'6"	SS	145 w/140	25 w/300	32 w/300				6	18	
230											
130											
125											
220	29'-30'6"	SS	50	87	63				7	18	
	34'-35'6"	SS	44	46	47		34'		8	18	
								GRAY fine to coarse sand, some silt, trace fine gravel.			
	39'-40'6"	SS	87	104	110				9	18	

Blow Counts for Clay

0 - 2 Very soft	9 - 15 Stiff
2 - 4 Soft	15 - 30 Very stiff
5 - 8 Medium	30 - Hard

Proportion used: trace = 0 - 10% some = 20 - 35% and = 35 - 50%

Granular Materials

0 - 4 Very loose	30 - 50 Compact
4 - 10 Loose	50 - Very compact
10 - 30 Medium or Firm	

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12,092

SHEET 2 OF 3
LOCATION Winsor Dam
HOLE NO. B-2
LINE & STA.
OFFSET

GROUND WATER OBSERVATIONS
At ___ ft. after ___ Hours
At ___ ft. after ___ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300 lb	140 lb	BIT
Hammer Fall	24"	30"	

SURFACE ELEV. 493
DATE START: 5-6-81
DATE FINISH 5-11-81
BORING FOREMAN Tim Carpent
INSPECTOR Bill Hadge

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From / To 0-6	6-12	12-18	18-24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	Re
	44'-45'6"	SS	41	42	33				10	18	1
	49'-50'6"	SS	38	35	35		50'		11	18	
	54'-55'6"	SS	57	67	83			GRAY brown, fine to medium sand, some silt.	12	18	1
	59'-60'6"	SS	27	32	40				13	18	1
	64'-65'6"	SS	53	68	60		65'		14	18	
	69'-70'6"	SS	26	56	82			GRAY brown, fine to coarse sand, trace silt.	15	18	1
	74'-75'6"	SS	20	26	67		75'		16	18	7
	79'-80'6"	SS	76	85	88			GRAY brown fine to coarse sand, some fine gravel, trace of silt.	17	18	8

Blow Counts for Clay

0 - 2 Very soft	9 - 15 Stiff
2 - 4 Soft	15 - 30 Very stiff
5 - 8 Medium	30 - Hard

Proportion used: trace = 0 - 10%

Granular Materials

0 - 4 Very loose	30 - 50 Compact
4 - 10 Loose	50 - Very compact
10 - 30 Medium or Firm	

some = 20 - 35% and = 35 - 50%

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12,092

SHEET 3 OF 3
LOCATION Winsor Dam
HOLE NO. B-2
LINE & STA.
OFFSET

GROUND WATER OBSERVATIONS

At ___ ft. after ___ Hours

At ___ ft. after ___ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300 lb	140 lb	BIT
Hammer Fall	24"	30"	

SURFACE ELEV. 493
DATE START: 5-6-81
DATE FINISH 5-11-81
BORING FOREMAN Tim Carpent
INSPECTOR Bill Hadge

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From - To 0-6	6-12	12-18	18-24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	R
	84'-85'6"	SS	70 w/140	164 w/140	46 w/300				15	18	
	89'-91'	SS	119 w/140	160 w/300	37 w/300	49 w/300		91'	16	24	
								EOB @ 91.0'			

Blow Counts for Clay

0 - 2 Very soft	9 - 15 Stiff
2 - 4 Soft	15 - 30 Very stiff
5 - 8 Medium	30 - Hard

Proportion used: trace = 0 - 10%

Granular Materials

0 - 4 Very lo[illegible]	30 - 50 Compact
4 - 10 Loose	50 - Very compact
10 - 30 Medium or Firm	

some = 20 - 35% and = 35 - 50%

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12,092

SHEET 1 OF 2
LOCATION Winsor Dam
HOLE NO. B-3
LINE & STA. 15 + 00
OFFSET

GROUND WATER OBSERVATIONS
At ___ ft. after ___ Hours
At ___ ft. after ___ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300 lb	140 lb	BIT
Hammer Fall	24"	30"	

SURFACE ELEV. 453
DATE START: 6-16-81
DATE FINISH 6-17-81
BORING FOREMAN S. Ramsdell
INSPECTOR B. Hadge

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From 0-6	6-12	12-18	To 18-24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	Rec
	0-1'6"	SS	2	4	5		6"	Top Soil	1	18"	10"
							1'6"	Brown fine sand, some silt, little medium to coarse sand occ. cobbles, little fine to coarse gravel.			
	5'-6'6"	SS	14	15	17				2	18"	11"
								Gray-brown fine to coarse sand and fine to coarse gravel, occ. cobbles.			
	10'-11'6"	SS	16	17	18				3	18"	9"
	15'-16'6"	SS	12	16	19				4	18"	12"
							17'6"				
	20'-21'6"	SS	12	14	14			Brown fine sand, some medium to coarse sand, some fine to coarse gravel, trace silt, occ. cobbles.	5	18"	10"
	25'-26'6"	SS	13	16	20				6	18"	10"
							29'				
	30'-31'6"	SS	14	15	9			Light brown fine to coarse sand, trace fine to coarse gravel, trace silt, trace of cobbles.	7	18"	8"
	35'-36'6"	SS	15	20	24				8	18"	8"
	40'-41'6"	SS	27	23	20				9	18"	10"

Blow Counts for Clay

0 - 2 Very soft	9 - 15 Stiff
2 - 4 Soft	15 - 30 Very stiff
5 - 8 Medium	30 - Hard

Proportion used: trace = 0 - 10%

Granular Materials

0 - 4 Very loose	30 - 50 Compact
4 - 10 Loose	50 - Very compact
10 - 30 Medium or Firm	

some = 20 - 35% and = 35 - 50%

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12,092

SHEET 2 OF 2
LOCATION Winsor Dam
HOLE NO. B-3
LINE & STA. 15 + 00
OFFSET

GROUND WATER OBSERVATIONS

At ___ ft. after ___ Hours

At ___ ft. after ___ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300 lb	140 lb	BIT
Hammer Fall	24"	30"	

SURFACE ELEV. 453
DATE START: 6-16-81
DATE FINISH 6-17-81
BORING FOREMAN S. Ramsdell
INSPECTOR B. Hadge

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From 0-6	6-12	To 12-18	18-24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	Rec.
	45'-46'6"	SS	26	30	31				10	18"	11"
							47'6"				
	50'-51'6"	SS	19	29	40			Gray brown fine sand, little medium to coarse sand, little gravel, trace silt, occ. cobbles.	11	18"	9"
	55'-56'6"	SS	36	39	41				12	18"	7"
							56'6"				
	60'-61'6"	SS	43	49	41			Gray brown fine to coarse sand fine to coarse gravel, few cobbles, trace of silt.	13	18"	10"
	65'-66'6"	SS	81	103	79				14	18"	14"
	70'-71'	SS	92	127					15	12"	9"
	75'-76'6"	SS	69	88	91				16	18"	12"
							76'6"				
								EOB 76'6"			

Blow Counts for Clay

0 - 2 Very soft	9 - 15 Stiff
2 - 4 Soft	15 - 30 Very stiff
5 - 8 Medium	30 - Hard

Proportion used: trace = 0 - 10%

Granular Materials

0 - 4 Very loose	30 - 50 Compact
4 - 10 Loose	50 - Very compact
10 - 30 Medium or Firm	

some = 20 - 35% and = 35 - 50%

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12,092

SHEET 1 OF 5
LOCATION Winsor Dam
HOLE NO. B-4
LINE & STA. 20 + 00
OFFSET

GROUND WATER OBSERVATIONS

At 54 ft. after ____ Hours
At ____ ft. after ____ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

SURFACE ELEV. 550.0'
DATE START: 5-14-81
DATE FINISH 6-03-81
BORING FOREMAN S. Ramsdill
INSPECTOR Bill Hadge

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From 0-6	6-12	To 12-18	18-24	Strata Change Depth / Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	Rec.
	6"-2'	SS	2	6	12		6"	BLACK TOP-road base	1	18"	10
							3'	BROWN fine to coarse sand and fine to coarse gravel, little silt.			
	5'-5'4"	SS	120/4"					BROWN fine to coarse sand, some fine to coarse gravel, occ. cobbles.	2	4"	4
	10'-11'6"	SS	20	21	50				3	18"	12
	15'-15'1"	SS	100/1"						4	1"	0
	20'-21'6"	SS	6	8	14				5	18"	4
	21'6"-23'	UP1								18"	13
	25'-26'6"	SS	6	10	10		25'6"		6	18"	11
								GRAY fine sand & silt.			
							28'				
	30'-31'6"	SS	4	4	5			GRAY brown fine sand & silt.	7	18"	12
	35'-36'6"	SS	4	5	4				8	18"	12
	38'-40'	UP2								24"	20
	40'-41'6"	SS	3	4	5				9	18"	10

Blow Counts for Clay

0 - 2 Very soft
2 - 4 Soft
5 - 8 Medium
9 - 15 Stiff
15 - 30 Very stiff
30 - Hard

Proportion used: trace = 0 - 10%

Granular Materials

0 - 4 Very loose
4 - 10 Loose
10 - 30 Medium or Firm
30 - 50 Compact
50 - Very compact

some = 20 - 35%
and = 35 - 50%

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12,092

SHEET 2 OF 5
LOCATION Winsor Dam
HOLE NO. B-4
LINE & STA. 20 + 00
OFFSET

GROUND WATER OBSERVATIONS

At ___ ft. after ___ Hours

At ___ ft. after ___ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

SURFACE ELEV. 550.0'
DATE START: 5-14-81
DATE FINISH 6-03-81
BORING FOREMAN S. Ramsdill
INSPECTOR Bill Hadge

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From To 0-6	6-12	12-18	18-24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	Rec.
								GRAY brown fine sand and silt			
	44'6"-46'	SS	3	2	1				10	18"	18
	48'-50'	UP3								24"	23
	50'-51'6"	SS	2	2	2				11	18"	12
	55'-56'6"	SS	3	3	4				12	18"	12
	58'-60'	UP4								24"	19
	60'-61'6"	SS	3	4	5				13	18"	16
	65'-66'6"	SS	3	3	5				14	18"	13
	68'-70'	UP5								24"	23
	70'-71'6"	SS	2	2	3				15	18"	16
	75'-76'6"	SS	3	2	3				16	18"	17
	78'-80'	UP6								24"	24
	80'-81'6"	SS	5	5	5				17	18"	18

Blow Counts for Clay

0 - 2 Very soft
2 - 4 Soft
5 - 8 Medium
9 - 15 Stiff
15 - 30 Very stiff
30 - Hard

Proportion used: trace = 0 - 10%

Granular Materials

0 - 4 Very loose
4 - 10 Loose
10 - 30 Medium or Firm
30 - 50 Compact
50 - Very compact

some = 20 - 35%
and = 35 - 50%

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12,092

SHEET 3 OF 5
LOCATION Winsor Dam
HOLE NO. B-4
LINE & STA. 20 + 00
OFFSET

GROUND WATER OBSERVATIONS

At ___ ft. after ___ Hours
At ___ ft. after ___ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

SURFACE ELEV. 550.0'
DATE START: 5-14-81
DATE FINISH 6-03-81
BORING FOREMAN S. Ramsdill
INSPECTOR Bill Hadge

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From 0-6	6-12	To 12-18	18-24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	Rec.
								GRAY brown fine sand and silt.			
	85'-86'6"	SS	1	2	3				18	18"	18
	88'-90'	UP7								12"	23
	90'-91'6"	SS	9	12	10				19	18"	17
	95'-96'6"	SS	4	13	14				20	18"	13
	98'-100'	UP8								24"	15
	100'-103'	SS	dropped		rods				21	36"	20
	105'-106'6"	SS	5	3	7				22	18"	18
	108'-110'	UP9								24"	16
	112'-113'6"	SS	5	8	7				23	18"	10
	118'-120'	UP10								24"	0"

Blow Counts for Clay

0 - 2 Very soft
2 - 4 Soft
5 - 8 Medium
9 - 15 Stiff
15 - 30 Very stiff
30 - Hard

Proportion used: trace = 0 - 10%

Granular Materials

0 - 4 Very loose
4 - 10 Loose
10 - 30 Medium or Firm
30 - 50 Compact
50 - Very compact

some = 20 - 35%
and = 35 - 50%

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12,092

SHEET 4 OF 5
LOCATION Winsor Dam
HOLE NO. B-4
LINE & STA. 20 + 00
OFFSET

GROUND WATER OBSERVATIONS

At ___ ft. after ___ Hours
At ___ ft. after ___ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

SURFACE ELEV. 550.0'
DATE START: 5-14-81
DATE FINISH 6-03-81
BORING FOREMAN S. Ramsdill
INSPECTOR Bill Hadge

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From 0-6	6-12	To 12-18	18-24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	Rec
	120'-122'	UP11						GRAY brown fine sand and silt.		24"	13
	122'-123'6"	SS	8	23	40				24	18"	13
	125'-126'6"	SS	38	56	58				25	18"	11
	130'-131'6"	SS	10	7	28				26	18"	18
	135'-136'6"	SS	22	36	38				27	18"	14
	140'-141'6"	SS	22	19	24				28	18"	10
	145'-146'6"	SS	7	10	20				29	18"	18
							148'				
	150'-151'6"	SS	16	28	38			GRAY-brown fine sand, little silt, (cobbles)	30	18"	14
	155'-156'6"	SS	86	79	67				31	18"	16
	160'-161'6"	SS	49	56	73				32	18"	12

Blow Counts for Clay

0 - 2 Very soft
2 - 4 Soft
5 - 8 Medium
9 - 15 Stiff
15 - 30 Very stiff
30 - Hard

Proportion used: trace = 0 - 10%

Granular Materials

0 - 4 Very loose
4 - 10 Loose
10 - 30 Medium or Firm
30 - 50 Compact
50 - Very compact

some = 20 - 35%
and = 35 - 50%

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12,092

SHEET 5 OF 5
LOCATION Winsor Dam
HOLE NO. B-4
LINE & STA. 20 + 00
OFFSET

GROUND WATER OBSERVATIONS

At ___ ft. after ___ Hours

At ___ ft. after ___ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

SURFACE ELEV. 550.0'
DATE START: 5-14-81
DATE FINISH 6-03-81
BORING FOREMAN S. Ramsdill
INSPECTOR Bill Hadge

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From To 0 - 6	6 - 12	12 - 18	18 - 24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	Rec
							161'6"	EOB 161'6" Water at 54', installed piezometers at P-7 68', installed 2nd piezometer at P-8 111.0', installed 3rd piezometer at P-9 149'.			

Blow Counts for Clay

0 - 2	Very soft	9 - 15	Stiff
2 - 4	Soft	15 - 30	Very stiff
5 - 8	Medium	30 -	Hard

Proportion used: trace = 0 - 10%

Granular Materials

0 - 4	Very loose	30 - 50	Compact
4 - 10	Loose	50 -	Very compact
10 - 30	Medium or Firm		

some = 20 - 35% and = 35 - 50%

BRIGGS

TOWN Ware, MA
PROJECT NAME Windsor Dam-Quabbin
PROJECT NO. 12,092

SHEET 1 OF 3
LOCATION
HOLE NO. B-5
LINE & STA. 20 + 00
OFFSET

GROUND WATER OBSERVATIONS

At 38 ft. after ____ Hours
At ____ ft. after ____ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

SURFACE ELEV. 493
DATE START: 5-27-81
DATE FINISH 6-04-81
BORING FOREMAN S. Ramsdell
INSPECTOR B. Hadge

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From / To 0-6	6-12	12-18	18-24	Strata Change Depth / Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	Rec.
	0-1'6"	SS	2	5	10		8"	Topsoil	1	18"	14"
								Gray br. fine to coarse sand some fine to coarse gravel. Few cobbles.			
	5'-6'6"	SS	18	13	14				2	18"	12"
	10'-11'6"	SS	10	13	17				3	18"	14'
	15'-15'6"	SS	93/6"						4	6"	0
							18'				
	20'-20'9"	SS	10	140/3"				Gray-br. fine to coarse sand, and fine to coarse gravel, few cobbles, little silt.	5	9"	2'
	25'-26'6"	SS	40	96	54				6	18'	12
							28'6"				
	30'-31'6"	SS	17	21	23			Gray br. fine sand, little medium to coarse sand, little fine to coarse gravel, trace of silt, occ. cobbles	7	18"	10"
	35'-36'6"	SS	23	30	38				8	18"	6"
	40'-41'6"	SS	11	19	28				9	18"	10"

Blow Counts for Clay

0 - 2 Very soft
2 - 4 Soft
5 - 8 Medium
9 - 15 Stiff
15 - 30 Very stiff
30 - Hard

Proportion used: trace = 0 - 10%

Granular Materials

0 - 4 Very loose
4 - 10 Loose
10 - 30 Medium or Firm
30 - 50 Compact
50 - Very compact

some = 20 - 35%
and = 35 - 50%

BRIGGS

TOWN Ware, MA
PROJECT NAME Windsor Dam Quabbin Res.
PROJECT NO. 12,092

SHEET 2 OF 3
LOCATION
HOLE NO. B-3
LINE & STA. 20 + 00
OFFSET

GROUND WATER OBSERVATIONS

At ___ ft. after ___ Hours

At ___ ft. after ___ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

SURFACE ELEV. 493
DATE START: 5-27-81
DATE FINISH 6-04-81
BORING FOREMAN S. Ramsdell
INSPECTOR B. Hadge

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From / To 0-6	6-12	12-18	18-24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	Rec
							43'				
	41'6"-45'	SS	NO BLOWS					Gray br. fine to medium sand, little coarse sand, little fine to coarse gravel, occ. cobbles. Trace of silt.	10	42"	12"
	50'-52'	UPI	DROVE							24"	14"
	52'-53'6"	SS	32	66	62				11	18"	16"
	55'-56'6"	SS	30	36	40				12	18"	7"
							57'6"				
	60'-61'6"	SS	34	60	56			Gray br. fine sand, little medium to coarse sand, trace of silt, occ. cobbles.	13	18"	7"
	65'-66'6"	SS	25	48	89				14	18"	9"
	70'-71'6"	SS	38	62	90				15	18"	10"
	75'-76'6"	SS	17	59	78				16	18"	9"
	80'-81'6"	SS	44	105	112				17	18"	7"

Blow Counts for Clay

0 - 2	Very soft	9 - 15	Stiff
2 - 4	Soft	15 - 30	Very stiff
5 - 8	Medium	30 -	Hard

Proportion used: trace = 0 - 10%

Granular Materials

0 - 4	Very loose	30 - 50	Compact
4 - 10	Loose	50 -	Very compact
10 - 30	Medium or Firm		

some = 20 - 35% and = 35 - 50%

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin REservoir Dam
PROJECT NO. 12,092

SHEET 3 OF 3
LOCATION
HOLE NO. B-5
LINE & STA. 20 + 00
OFFSET

GROUND WATER OBSERVATIONS

At ___ ft. after ___ Hours

At ___ ft. after ___ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

SURFACE ELEV. 493
DATE START: 5-27-81
DATE FINISH 6-04-81
BORING FOREMAN S. Ramsdell
INSPECTOR B. Hadge

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From To 0-6	6-12	12-18	18-24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	Rec
	85'-86'6"	SS	23	36	45				18	18"	9'
	90'-91'6"	SS	23	21	12				19	18"	0
	91'-6"-93'	SS	25	50	100		92'		20	18"	13'
							92'3"	Dark br. silt, little fine sand			
							93'	Gray br. fine to medium sand, trace of coarse sand, trace of fine gravel, trace of silt.			

End of Boring 93'
P-10 Top at 43'
P-11 Top at 63'8"

Blow Counts for Clay

0 - 2	Very soft	9 - 15	Stiff
2 - 4	Soft	15 - 30	Very stiff
5 - 8	Medium	30 -	Hard

Proportion used: trace = 0 - 10%

Granular Materials

0 - 4	Very loose	30 - 50	Compact
4 - 10	Loose	50 -	Very compact
10 - 30	Medium or Firm		

some = 20 - 35% and = 35 - 50%

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12,092

SHEET 1 OF 3
LOCATION
HOLE NO. B-6
LINE & STA. 20 + 00
OFFSET

GROUND WATER OBSERVATIONS

At ___ ft. after ___ Hours

At ___ ft. after ___ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300 lb	140 lb	BIT
Hammer Fall	24"	30"	

SURFACE ELEV. 453
DATE START: 6-17-81
DATE FINISH 6-17-81
BORING FOREMAN S. Ramsdell
INSPECTOR B. Hadge

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From 0-6	6-12	To 12-18	18-24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	Rec
	0-1'6"	SS	1	3	5		6"	Top Soil	1	18"	8"
							2'6"	Brown fine sand, little silt few cobbles, little gravel.			
	5'-6'6"	SS	16	18	20			Gray brown fine to coarse sand some fine to coarse gravel, few cobbles, trace silt.	2	18"	10
	10'-11'6"	SS	1	2	3				3	18"	10"
							12'				
	15'-16'6"	SS	82	71	85			Gray brown fine to coarse sand and fine to coarse gravel, few cobbles.	4	18"	14"
	20'-21'6"	SS	57	89	66				5	18"	6"
	25'-26'6"	SS	47	121	118				6	18"	12"
	30'-31'6"	SS	92	111	100				7	18"	8"
	35'-36'6"	SS	65	80	121				8	18"	13"
	40'-41'6"	SS	60	83	110				9	18"	10"

Blow Counts for Clay

0 - 2 Very soft	9 - 15 Stiff
2 - 4 Soft	15 - 30 Very stiff
5 - 8 Medium	30 - Hard

Proportion used: trace = 0 - 10% some = 20 - 35% and = 35 - 50%

Granular Materials

0 - 4 Very loose	30 - 50 Compact
4 - 10 Loose	50 - Very compact
10 - 30 Medium or Firm	

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12,092

SHEET 2 OF 3
LOCATION
HOLE NO. B-6
LINE & STA. 20 + 00
OFFSET

GROUND WATER OBSERVATIONS

At ___ ft. after ___ Hours

At ___ ft. after ___ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300 lb	140 lb	BIT
Hammer Fall	24"	30"	

SURFACE ELEV. 453
DATE START: 6-17-81
DATE FINISH 6-17-81
BORING FOREMAN S. Ramsdell
INSPECTOR B. Hadge

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From / To 0-6	6-12	12-18	18-24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	Rec
							42'				
	45'-46'6"	SS	30	90	150			Brown fine to medium, sand little coarse sand, little gravel, occ. cobbles, trace silt	10	18"	8"
	50'-50'6"	SS	32	42	93				11	18"	10'
	55'-56'	SS	45	165					12	12"	7"
	60'-61'6"	SS	28	35	51				13	18"	6"
	65'-66'6"	SS	46	61	144				14	18"	9"
	70'-71'6"	SS	81	71	40				15	18"	10"
							74'				
	75'-76'6"	SS	30	30	20			Brown fine sand, some silt, trace medium to coarse sand	16A	18"	13"
							76'		16B		
							77'	Gray Brown fine sand, some silt.			
	80'-81'6"	SS	42	72	55				17	18"	10"

Blow Counts for Clay

0 - 2	Very soft	9 - 15	Stiff
2 - 4	Soft	15 - 30	Very stiff
5 - 8	Medium	30 -	Hard

Proportion used: trace = 0 - 10%

Granular Materials

0 - 4	Very loose	30 - 50	Compact
4 - 10	Loose	50 -	Very compact
10 - 30	Medium or Firm		

some = 20 - 35% and = 35 - 50%

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12,092

SHEET 3 OF 3
LOCATION
HOLE NO. B-6
LINE & STA. 20 + 00
OFFSET

GROUND WATER OBSERVATIONS

At ___ ft. after ___ Hours

At ___ ft. after ___ Hours

	CASING	SAMPLER	CORE BAR.
Type			
Size I.D.			
Hammer Wt.			BIT
Hammer Fall			

SURFACE ELEV. 453
DATE START: 6-17-81
DATE FINISH 6-17-81
BORING FOREMAN S. Ramsdell
INSPECTOR B. Hadge

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From - To 0-6	6-12	12-18	18-24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	Re
								Gray very fine sand, little gravel, little silt, occ. cobbles.			
							84'				
	85'-86'	SS	128	107				Gray fine sand, some fine to coarse gravel, few cobbles, trace silt.	18	12"	6'
	90'-90'5"	SS	160/5"						19	5"	0
							93'6"				
	95'-96'6"	SS	39	40	43			Brown fine to coarse sand, trace of silt.	20	18"	12'
							98'				
	100'-101'6"	SS	32	58	64			Gray brown fine to coarse sand and fine to coarse gravel, occ. cobbles, trace of silt.	21	18"	1'
	105'-106'6"	SS	29	21	22				22	18"	1'
	110'-111'6"	SS	36	62	48				23	18"	7'
							111'6"				
								EOB 111'6" Piezometer #12 at 81'10"			

Blow Counts for Clay

0 - 2 Very soft	9 - 15 Stiff
2 - 4 Soft	15 - 30 Very stiff
5 - 8 Medium	30 - Hard

Proportion used: trace = 0 - 10%

Granular Materials

0 - 4 Very loose	30 - 50 Compact
4 - 10 Loose	50 - Very compact
10 - 30 Medium or Firm	

some = 20 - 35% and = 35 - 50%

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12,092

SHEET 1 OF 4
LOCATION Goodnough Dike
HOLE NO. B-7
LINE & STA. 21 + 80
OFFSET

GROUND WATER OBSERVATIONS

At ___ ft. after ___ Hours

At ___ ft. after ___ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300 lb	140 lb	BIT
Hammer Fall	24"	30"	

SURFACE ELEV. 550
DATE START: 6-8-81
DATE FINISH 6-17-81
BORING FOREMAN T. Carpenter
INSPECTOR B. Hadge

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From To 0-6	6-12	12-18	18-24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	Re
	6"-2'	SS	10	53	66		6"	Blacktop	1	18"	10"
								Brown fine to coarse sand and gravel.			
	5'-6'6"	SS	56	73	88				2	18"	14"
	10'-11'6"	SS	79	120	51				3	18"	8"
							12'				
	15'-16'6"	SS	139	116	59			Gray brown fine to medium sand, little gravel, trace of silt.	4	18"	9"
	20'-21'6"	SS	159	43	80				5	18"	12"
							24'				
	25'-26'	SS	210	112/300				Gray fine to coarse sand, little gravel, some silt.	6	12"	10"
	30'-31'6"	SS	150/300	37	45/300				7	18"	12"
	35'-36'6"	SS	38	56	71				8	18"	12"
	40'-41'6"	SS	29	29	35				9	18"	14"

Blow Counts for Clay

0 - 2 Very soft
2 - 4 Soft
5 - 8 Medium
9 - 15 Stiff
15 - 30 Very stiff
30 - Hard

Proportion used: trace = 0 - 10%

Granular Materials

0 - 4 Very loose
4 - 10 Loose
10 - 30 Medium or Firm
30 - 50 Compact
50 - Very compact

some = 20 - 35%
and = 35 - 50%

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12,092

SHEET 2 OF 4
LOCATION Goodnough Dike
HOLE NO. B-7
LINE & STA. 21 + 80
OFFSET

GROUND WATER OBSERVATIONS

At ___ ft. after ___ Hours

At ___ ft. after ___ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300 lb	140 lb	BIT
Hammer Fall	24"	30"	

SURFACE ELEV. 550
DATE START: 6-8-81
DATE FINISH 6-17-81
BORING FOREMAN T. Carpenter
INSPECTOR B. Hadge

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From 0-6	6-12	12-18	To 18-24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	Rec
							42'				
	45'-46'6"	SS	5	6	8			Brown Silt, and fine sand,	10	18"	16"
	50'-51'6"	SS	7	5	5				11	18"	16"
	52'-54'	UP-1								24"	12"
	54'-55'6"	SS	7	6	7				12	18"	12"
	60'-61'6"	SS	8	4	7				13	18"	18"
	62'-64'	UP-2								24"	24"
	64'-65'6"	SS	8	4	4				14	18"	16"
	70'-71'6"	SS	8	10	16				15	18"	14"
	72'-74'	UP-3								24"	21"
	74'-75'6"	SS	9	13	16				16	18"	18"
	80'-81'6"	SS	7	11	17				17	18"	18"

Blow Counts for Clay

0 - 2 Very soft
2 - 4 Soft
5 - 8 Medium
9 - 15 Stiff
15 - 30 Very stiff
30 - Hard

Proportion used: trace = 0 - 10%

Granular Materials

0 - 4 Very loose
4 - 10 Loose
10 - 30 Medium or Firm
30 - 50 Compact
50 - Very compact

some = 20 - 35%
and = 35 - 50%

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12,092

SHEET 3 OF 4
LOCATION Goodnough Dike
HOLE NO. B-7
LINE & STA. 21 + 80
OFFSET

GROUND WATER OBSERVATIONS
At ___ ft. after ___ Hours
At ___ ft. after ___ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300 lb	140 lb	BIT
Hammer Fall	24"	30"	

SURFACE ELEV. 550
DATE START: 6-8-81
DATE FINISH 6-17-81
BORING FOREMAN T. Carpenter
INSPECTOR B. Hadge

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From - To 0-6	6-12	12-18	18-24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	Rec
	82'-84'	UP-4						Brown Silt, and fine sand.		24"	0
	84'-85'6"	SS	8	4	8				18	18"	18'
	89'-90'6"	SS	4	6	13				19	18"	14
	92'-94'	UP-5								24"	16
	94'-95'6"	SS	27	36	42				20	18"	18
	99'-100'6"	SS	4	4	9				21	18"	18
	102'-104'	UP-6								24"	
	104'-105'6"	SS	14	15	21				22	18"	18
	109'-110'6"	SS	5	11	27				23	18"	16
	112'-114'	UP-7								24"	23
	114'-115'6"	SS	7	19	23				24	18"	18
	119'-120'6"	SS	17	19	23				25	18"	13

Blow Counts for Clay

0 - 2 Very soft	9 - 15 Stiff
2 - 4 Soft	15 - 30 Very stiff
5 - 8 Medium	30 - Hard

Proportion used: trace = 0 - 10% some = 20 - 35% and = 35 - 50%

Granular Materials

0 - 4 Very loose	30 - 50 Compact
4 - 10 Loose	50 - Very compact
10 - 30 Medium or Firm	

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12,092

SHEET 4 OF 4
LOCATION Goodnough Dike
HOLE NO. B-7
LINE & STA. 21 + 80
OFFSET

GROUND WATER OBSERVATIONS

At ___ ft. after ___ Hours

At ___ ft. after ___ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300 lb	140 lb	BIT
Hammer Fall	24"	30"	

SURFACE ELEV. 550
DATE START: 6-8-81
DATE FINISH 6-17-81
BORING FOREMAN T. Carpenter
INSPECTOR B. Hadge

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From To 0-6	6-12	12-18	18-24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen.	Rec.
	122'-124'	UP-8								24"	17"
	124'-125'6"	SS	5	5	8				26	18"	18"
	129'- 130'6"	SS	5	7	21				27	18"	18"
	132'-134'	UP-9								24"	22"
	134'-135'6"	SS	11	9	19				28	18"	18"
							137'				
	139'-140'6"	SS	31	37	53			Brown fine sand, little silt trace of cobbles.	29	18"	18"
	144'-145'6"	SS	56	60	83				30	18"	12"
	149'-150'6"	SS	51	57	77				31	18"	14
	154'-155'6"	SS	28	73	115				32	18"	
								EOB at 155'6" 1st Piezometer 138'6"-140'6" 2nd Piezometer 96'-98' 3rd Piezometer 69'6"-71'6"			

Blow Counts for Clay

0 - 2 Very soft	9 - 15 Stiff
2 - 4 Soft	15 - 30 Very stiff
5 - 8 Medium	30 - Hard

Proportion used: trace = 0 - 10%

Granular Materials

0 - 4 Very loose	30 - 50 Compact
4 - 10 Loose	50 - Very compact
10 - 30 Medium or Firm	

some = 20 - 35% and = 35 - 50%

BRIGGS

TOWN Ware, Ma
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12,092

SHEET 1 OF 3
LOCATION Goodnough Dike
HOLE NO. B-8
LINE & STA. 21 + 80
OFFSET

GROUND WATER OBSERVATIONS
At 29' ft. after ____ Hours
At ____ ft. after ____ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

SURFACE ELEV. 493
DATE START: 6-4-81
DATE FINISH 6-10-81
BORING FOREMAN S. Ramsdell
INSPECTOR

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From - To 0-6	6-12	12-18	18-24	Strata Change Depth / Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	Re
	0'-1'6"	SS	2	4	5		3" / 1'6	Topsoil Br. silt, some fine to coarse sand, little fine gravel.	1	18"	8
	5'-6'6"	SS	17	9	8		6'	Gray br. sand, some medium to coarse sand, some fine gravel, little medium to coarse gravel little silt, few cobbles.	2	18"	12
	10'-11'6"	SS	13	11	13		11'	Br. fine to medium sand, little coarse sand.	3	18"	10
	15'-16'6"	SS	28	32	75			Gray br. fine to coarse sand and fine to coarse gravel, trace silt, many cobbles.	4	18"	8
	20'-21'6"	SS							5	18"	
	25'-26'6"	SS	31	50	48				6	18"	1(
	30'-31'6"	SS	39	58	60				7	18"	
	35'36'6"	SS	53	71	75				8	18"	
	40'-41'6"	SS	26	50	52		38'	Gray br. fine sand, trace medium sand, little fine to coarse gravel, trace of silt.	9	18"	

Blow Counts for Clay

0 - 2 Very soft	9 - 15 Stiff
2 - 4 Soft	15 - 30 Very stiff
5 - 8 Medium	30 - Hard

Proportion used: trace = 0 - 10%

Granular Materials

0 - 4 Very loose	30 - 50 Compact
4 - 10 Loose	50 - Very compact
10 - 30 Medium or Firm	

some = 20 - 35% and = 35 - 50%

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12,092

SHEET 2 OF 3
LOCATION Goodnough Dike
HOLE NO. B-8
LINE & STA. 21 + 80
OFFSET

GROUND WATER OBSERVATIONS

At ___ ft. after ___ Hours

At ___ ft. after ___ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

SURFACE ELEV. 493
DATE START: 6-4-81
DATE FINISH 6-10-81
BORING FOREMAN S. Ramsdell
INSPECTOR

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From To 0-6	6-12	12-18	18-24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	R
	45'-46'6"	SS	25	35	55				10	18"	9
	50'-55'	SS	5' Spoon						11	60"	20
							53'				
	55'-56'6"	SS	14	26	34			Gray br. fine to medium sand, trace coarse sand, little gra- trace silt.	12	18"	9
							59'				
	60'-61'6"	SS	21	26	22			Gray br. fine sand, trace medium to coarse sand, trace silt, little gravel.	13	18"	9
	65'-66'6"	SS	11	22	26				14	18"	11
	70'-71'6"	SS	20	13	19				15	18"	1
							74'				
							74'3"	Br. fine sand, little medium to coarse sand, little gravel, little silt, some cobbles.			
	76'-77'6"	SS	30	108	73				16A	18"	1
									16B		
								Gray fine to coarse sand, some fine to coarse gravel few cobbles, trace of silt.			

Blow Counts for Clay

0 - 2 Very soft	9 - 15 Stiff
2 - 4 Soft	15 - 30 Very stiff
5 - 8 Medium	30 - Hard

Proportion used: trace = 0 - 10%

Granular Materials

0 - 4 Very loose	30 - 50 Compact
4 - 10 Loose	50 - Very compact
10 - 30 Medium or Firm	

some = 20 - 35% and = 35 - 50%

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12,092

SHEET 3 OF 3
LOCATION Goodnough Dike
HOLE NO. B-8
LINE & STA. 21 + 80
OFFSET

GROUND WATER OBSERVATIONS

At ___ ft. after ___ Hours

At ___ ft. after ___ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

SURFACE ELEV. 493
DATE START: 6-4-81
DATE FINISH 6-10-81
BORING FOREMAN S. Ramsdell
INSPECTOR

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From To 0 - 6	6 - 12	12 - 18	18 - 24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	Re
	80'-81'6"	SS	76	56	105				17	18"	9"
							83'8"	Roller bit refusal at 83'8"			
								Piezometer set at 80'			

Blow Counts for Clay

0 - 2 Very soft	9 - 15 Stiff
2 - 4 Soft	15 - 30 Very stiff
5 - 8 Medium	30 - Hard

Proportion used: trace = 0 - 10%

Granular Materials

0 - 4 Very loose	30 - 50 Compact
4 - 10 Loose	50 - Very compact
10 - 30 Medium or Firm	

some = 20 - 35% and = 35 - 50%

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12,092

SHEET 1 OF 3
LOCATION Goodnough Dike
HOLE NO. B-9
LINE & STA. 21 + 80
OFFSET

GROUND WATER OBSERVATIONS

At ___ ft. after ___ Hours

At ___ ft. after ___ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

SURFACE ELEV. 453
DATE START: 6-8-81
DATE FINISH 6-12-81
BORING FOREMAN S. Ramsdell
INSPECTOR

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From To 0-6	6-12	12-18	18-24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	Rec
	0'-1'6"	SS	2	2	3		7"	Topsoil	1	18"	8"
							1'2"	Light br. silt, little fine to coarse sand.			
	5'-6'6"	SS	6	6	10			Gray fine to coarse sand, little fine to coarse gravel, occ. cobbles.	2	18"	12"
	10'-11'6"	SS	16	15	16				3	18"	16"
	15'-16'6"	SS	10	12	14				4	18"	9"
							17'				
	20'-21'6"	SS	17	17	8			Gray fine to coarse sand, some fine to coarse gravel, occ. cobbles. Trace of silt.	5	18"	7"
	25'-26'6"	SS	21	33	36				6	18"	7"
	30'-31'6"	SS	55	38	21				7	18"	7"
	35'-36'6"	SS	7	7	8				8	18"	4"
	40'-41'6"	SS	19	17	15				9	18"	0

Blow Counts for Clay

0 - 2 Very soft
2 - 4 Soft
5 - 8 Medium
9 - 15 Stiff
15 - 30 Very stiff
30 - Hard

Proportion used: trace = 0 - 10%

Granular Materials

0 - 4 Very loose
4 - 10 Loose
10 - 30 Medium or Firm
30 - 50 Compact
50 - Very compact

some = 20 - 35%
and = 35 - 50%

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12,092

SHEET 2 OF 3
LOCATION Goodnough Dike
HOLE NO. B-9
LINE & STA. 21 + 80
OFFSET

GROUND WATER OBSERVATIONS
At ___ ft. after ___ Hours
At ___ ft. after ___ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

SURFACE ELEV. 453
DATE START: 6-8-81
DATE FINISH 6-12-81
BORING FOREMAN S. Ramsdell
INSPECTOR

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From - To 0-6	6-12	12-18	18-24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	Rec
	45'-46'6"	SS	48	33	24				10	18"	12
							48'				
	50'-51'6"	SS	21	19	18			Gray fine to coarse sand, trace gravel, trace silt.	11	18"	11
							51'6"				
	55'-56'6"	SS	15	14	32			Gray br. fine sand, little medium to coarse sand in layers, trace silt.	12	18"	10
							57'6"				
	60'-61'6"	SS	17	20	22			Gray br. fine sand, tr. silt	13	18"	10
							62'				
	65'-66'6"	SS	24	18	16			Gray br. very fine sand, trace silt.	14	18"	11
							67'6"				
	70'-71'6"	SS	14	21	34			Gray br. silt, trace fine sand	15	18"	15
							71'				
	75'-76'6"	SS	15	24	33			Gray fine to coarse sand, little fine to coarse gravel, trace silt, occ. cobbles.	16	18"	(
	80'-81'6"	SS	25	34	32				17	18"	

Blow Counts for Clay

0 - 2 Very soft	9 - 15 Stiff
2 - 4 Soft	15 - 30 Very stiff
5 - 8 Medium	30 - Hard

Proportion used: trace = 0 - 10% some = 20 - 35% and = 35 - 50%

Granular Materials

0 - 4 Very loose	30 - 50 Compact
4 - 10 Loose	50 - Very compact
10 - 30 Medium or Firm	

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12,092

SHEET 3 OF 3
LOCATION Goodnough Dike
HOLE NO. B-9
LINE & STA. 21 + 80
OFFSET

GROUND WATER OBSERVATIONS

At ___ ft. after ___ Hours

At ___ ft. after ___ Hours

	CASING	SAMPLER	CORE BAR.
Type	HW	SS	
Size I.D.	4"	1 3/8"	
Hammer Wt.	300#	140#	BIT
Hammer Fall	24"	30"	

SURFACE ELEV. 453
DATE START: 6-8-81
DATE FINISH 6-12-81
BORING FOREMAN S. Ramsdell
INSPECTOR

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From To 0 - 6	6 - 12	12 - 18	18 - 24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	Rec
	85'-86'6"	SS	27	30	32				18	18"	8"
	90'-91'6"	SS	69	57	43				19	18"	8"
							91'6"	EOB 91'6" Piezometer #18 set at 57'			

Blow Counts for Clay

0 - 2 Very soft	9 - 15 Stiff
2 - 4 Soft	15 - 30 Very stiff
5 - 8 Medium	30 - Hard

Proportion used: trace = 0 - 10%

Granular Materials

0 - 4 Very loose	30 - 50 Compact
4 - 10 Loose	50 - Very compact
10 - 30 Medium or Firm	

some = 20 - 35% and = 35 - 50%

BRIGGS

TOWN Ware, MA
PROJECT NAME Quabbin Reservoir Dam
PROJECT NO. 12,092

SHEET 1 OF 1
LOCATION
HOLE NO. B-8-A
LINE & STA.
OFFSET 10' East of B-8

GROUND WATER OBSERVATIONS

At ___ ft. after ___ Hours

At ___ ft. after ___ Hours

	CASING	SAMPLER	CORE BAR.
Type			
Size I.D.			
Hammer Wt.			BIT
Hammer Fall			

SURFACE ELEV.
DATE START: 6-11-81
DATE FINISH 6-11-81
BORING FOREMAN
INSPECTOR

LOCATION OF BORING:

Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From To 0 - 6	6 - 12	12 - 18	18 - 24	Strata Change Depth Elev.	Field Identification of Soil. Remarks (incl. color, loss of wash water, seams in rock, etc.)	SAMPLE No.	Pen	Rec
								No samples taken 4" casing to 30' Revert mud hole to 75'			
							75.0'	Piezometer @ 73.0'			
								End of Boring @ 75.0'			

Blow Counts for Clay

0 - 2 Very soft	9 - 15 Stiff
2 - 4 Soft	15 - 30 Very stiff
5 - 8 Medium	30 - Hard

Proportion used: trace = 0 - 10%

Granular Materials

0 - 4 Very loose	30 - 50 Compact
4 - 10 Loose	50 - Very compact
10 - 30 Medium or Firm	

some = 20 - 35% and = 35 - 50%

APPENDIX C

LABORATORY TEST RESULTS

BELCHERTOWN, MASSACHUSETTS

LABORATORY TESTING DATA SUMMARY

Reviewed by _____
Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date Assigned _____ Required _____

Boring No.	Sample No.	Depth ft.	Laboratory or Test No.	IDENTIFICATION TESTS: Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf	Permeability	STRENGTH TESTS: Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	CONSOL. C_c / e_o	Laboratory Log and Soil Description
B1	U1	30.0-32.0	1	Average Total Unit Weight (30.0-31.1') = 124.5 pcf														
		30.0-31.1		26.9						98.1								Yellow-brown and grey fine SAND, little Silt trace organics. Few layers 1/2-1" thick of yellow brown Clayey Silt or Silt of non to slight plasticity, comprising 10%± of total sample.
																		[e ∿ 0.74 Used G_s=2.74]
	SS7	32.0-33.5	18		Non-Plastic		56	3										Grey SILT and fine SAND (non-plastic)

SUMMARY OF LAB TESTS
TABLE NUMBER

BELCHERTOWN, MASSACHUSETTS

LABORATORY TESTING DATA SUMMARY

Reviewed by _____
Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date Assigned _____ Required _____

Boring No.	Sample No.	Depth ft.	Laboratory or Test No.	IDENTIFICATION TESTS: Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf	Permeability	STRENGTH TESTS: Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	CONSOL. C_c / e_o	Laboratory Log and Soil Description
B1	U4	46.0-48.0	2	Average Total Unit Weight (46.0-47.8')=123.5 pcf														Yellow-brown, fine SAND, little Silt, trace organics. Few layers 1/2"-1 1/2" thick of yellow-brown Silt & Clay of low plasticity comprising 15%± of total sample
		46.7-46.8		31.1	30	24												
		47.0-47.1							2.76									
		46.0-47.8		28.0						96.5								
																		[e ≈ 0.78]
	SS10	56.0-57.5	19				46	3										Grey fine SAND and SILT (non-plastic)

SUMMARY OF LAB TESTS
TABLE NUMBER ____

BELCHERTOWN, MASSACHUSETTS

LABORATORY TESTING DATA SUMMARY

Reviewed by _____
Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date Assigned _____ Required _____

Boring No.	Sample No.	Depth ft.	Laboratory or Test No.	IDENTIFICATION TESTS: Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf	Permeability	STRENGTH TESTS: Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	CONSOL. C_c / e_o	Laboratory Log and Soil Description
B1	UP6	64.0-66.0	4	Average Total Unit Weight (64.0-65.8')=128.8 pcf														
		64.0-65.1		25.6														Grey SILT and fine Sand, (non-plastic)
		64.6		26.4														
		65.1-65.3			Non Plastic		55	3	2.74									
		65.3		23.7														
		65.3-65.8		23.9						105.0	$\overline{CIU}$	$\bar{\sigma}$ = 3989	(Stress controlled triaxial Test)					
		64.0-65.8		5.7						93.5	$\overline{CIU}$	$\bar{\sigma}$ = 3989	(Reconstituted Stress Controlled Triaxial Test)					
		64.0-65.8		6.7						97.7	$\overline{CIU}$	$\bar{\sigma}$ = 3989	"	"	"	"		
		64.0-65.8		7.5						100.9	$\overline{CIU}$	$\bar{\sigma}$ = 6005	"	"	"	"		

SUMMARY OF LAB TESTS
TABLE NUMBER _____

BELCHERTOWN, MASSACHUSETTS

LABORATORY TESTING DATA SUMMARY

Reviewed by _____
Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date Assigned _____ Required _____

Boring No.	Sample No.	Depth ft.	Laboratory or Test No.	IDENTIFICATION TESTS							Permeability	STRENGTH TESTS					CONSOL.	Laboratory Log and Soil Description
				Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf		Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	C_c / e_o	
B1	UP7	74.0-76.0	5	Average Total Unit Weight (74.0-75.6') = 123.6 pcf														
		74.0-75.6		25.7														Brown Clayey SILT, trace fine Sand, overall slight plasticity
		74.1		22.1														
		74.6		27.2														
		74.6-74.9		Save														
		74.9-75.1			28	25	93	16										
		75.1		26.3														
		75.1-75.6		25.2						97.8		$\overline{CIU}$	$\bar{\sigma}_c$ = 8000	$\Phi\bar{\sigma}/\bar{\sigma}_3$ max	10050	6.9		
	SS14	76.0-77.5	20		Non-Plastic		84	11										Grey SILT, little fine Sand, (non-plastic)

SUMMARY OF LAB TESTS
TABLE NUMBER

BELCHERTOWN, MASSACHUSETTS

LABORATORY TESTING DATA SUMMARY

Reviewed by _____
Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date Assigned _____ Required _____

Boring No.	Sample No.	Depth ft.	Laboratory or Test No.	IDENTIFICATION TESTS: Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf	Permeability	STRENGTH TESTS: Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	CONSOL. C_c / e_o	Laboratory Log and Soil Description
B1	UP8	84.0-86.0	6															Yellow-brown SILT, little fine Sand
		85.0-85.5		26.7						96.5		(e ≈ 0.78',	used G_s=2.75)					@ 84.3' change to-
																		Yellow-brown SILT or Clayey SILT of non to slight plasticity
																		@ 84.6' change to-
																		Grey fine SAND, some Silt, trace Organics
																		@ 85.0' change to-
																		Grey SILT, little (+) fine Sand, trace Organics
																		@ 85.5' change to-
																		Yellow-brown SILT, little fine Sand
																		Note: Void in sample
																		@ 84.5' depth
	SS17	90.0-91.5	21		Non-Plastic		74	6	2.76									Grey SILT, some fine Sand, non-plastic

SUMMARY OF LAB TESTS
TABLE NUMBER _____

BELCHERTOWN, MASSACHUSETTS

LABORATORY TESTING DATA SUMMARY

Reviewed by _____
Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date Assigned _____ Required _____

Boring No.	Sample No.	Depth ft.	Laboratory or Test No.	IDENTIFICATION TESTS: Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf	Permeability	STRENGTH TESTS: Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	CONSOL. C_c / e_o	Laboratory Log and Soil Description
B1	UP10	97.0-99.0	7	Average Total Unit Weight (97.0-98.3')=117.3 pcf														Grey SILT, trace fine Sand (non-plastic)
		97.1		31.3														
		97.2-98.0		35.5	34	34	96	8										
		97.2-98.0		Save														
		97.6		34.0														
		98.1		41.4														
	SS18	99.0-100.5	22				77	4	2.77									Grey SILT, some fine Sand, (non-plastic)

$e \sim 0.98$
used $G_s = 2.74$
W_N (AVG)= 35.5%

SUMMARY OF LAB TESTS
TABLE NUMBER

BELCHERTOWN, MASSACHUSETTS

LABORATORY TESTING DATA SUMMARY

Reviewed by _____
Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date Assigned _____ Required _____

Boring No.	Sample No.	Depth ft.	Laboratory or Test No.	IDENTIFICATION TESTS							Permeability	STRENGTH TESTS					CONSOL.	Laboratory Log and Soil Description
				Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf		Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	C_c / e_o	
B1	UP11	107.0-109.0	8		Average Total Unit Weight (107.0-108.4')=122.7 pcf													Grey brown SILT, trace fine Sand, trace Organics
		107.0-108.9		30.6						94.0								
		107.9-108.0							2.74									[e ~ 0.82]
	SS21	115.0-116.5	23		Non-Plastic		70	3										Grey SILT, some fine Sand, (non-plastic)
	SS25	134.0-134.5	24		Non-Plastic		94	8										Grey SILT, trace fine Sand, (non-plastic)
	SS30	156.0-159.5	25				47											Grey fine to medium SAND and SILT, trace fine Gravel

SUMMARY OF LAB TESTS
TABLE NUMBER

BELCHERTOWN, MASSACHUSETTS

JAKS

LABORATORY TESTING DATA SUMMARY

Reviewed by _____

Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date Assigned _____ Required _____

Boring No.	Sample No.	Depth ft.	Laboratory or Test No.	IDENTIFICATION TESTS: Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf	Permeability	STRENGTH TESTS: Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	CONSOL. C_c / e_o	Laboratory Log and Soil Description
B2	SS2	5.0-5.7	26				13											Grey fine to coarse SAND and fine to coarse Gravel, little SILT
	SS6	24.0-25.5	27				17											Grey fractured GRAVEL, and fine to coarse Sand, little Silt
	SS10	44.0-45.5	28				14											Grey fine to medium SAND, little Silt
	SS13	59.0-60.5	29				22											Grey fine SAND, some (-) Silt
	SS17	79.0-80.5	30				12											Grey fine to coarse SAND and fine GRAVEL, little (-) Silt

SUMMARY OF LAB TESTS
TABLE NUMBER _____

GOLDBERG-ZOINO & ASSOCIATES, INC.

BELCHERTOWN, MASSACHUSETTS

LABORATORY TESTING DATA SUMMARY

Reviewed by _____
Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date Assigned _____ Required _____

Boring No.	Sample No.	Depth ft.	Laboratory or Test No.	IDENTIFICATION TESTS							Permeability	STRENGTH TESTS					CONSOL.	Laboratory Log and Soil Description
				Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf		Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	C_c / e_o	
B3	S7	30.0-31.5	52	11.2			9											Light brown fine to coarse SAND, some fine Gravel, trace (+) Silt
	S14	65.0-66.5	53	7.7			12											Brown, fine to coarse SAND and GRAVEL, little Silt

SUMMARY OF LAB TESTS
TABLE NUMBER _____

BELCHERTOWN, MASSACHUSETTS

LABORATORY TESTING DATA SUMMARY

Reviewed by _____
Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date Assigned _____ Required _____

Boring No.	Sample No.	Depth ft.	Laboratory or Test No.	IDENTIFICATION TESTS: Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf	Permeability	STRENGTH TESTS: Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	CONSOL. C_c / e_o	Laboratory Log and Soil Description
B4	UP1	31.5-33.5	9	Average Total Unit Weight (31.5-32.5')=124.0 pcf														
		31.5-32.5		20.4						103.0								Yellow-brown, fine SAND, little (+) Silt
																		[e ∿ 0.66 used G_s= 2.74]
	SS7	30.0-31.6	32		Non-Plastic		45	2										Brown, fine SAND and SILT (non-plastic)

SUMMARY OF LAB TESTS
TABLE NUMBER _____

BELCHERTOWN, MASSACHUSETTS

LABORATORY TESTING DATA SUMMARY

Reviewed by _____
Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date Assigned _____ Required _____

Boring No.	Sample No.	Depth ft.	Laboratory or Test No.	IDENTIFICATION TESTS: Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf	Perme-ability	STRENGTH TESTS: Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	CONSOL. C_c / e_o	Laboratory Log and Soil Description
B4	UP3	48.0-50.0	11	Average Total Unit Weight (48.0-49.8')=125.0 pcf														Yellow-brown SILT, some fine Sand with layers 1/4-1 1/2" thick of yellow-brown CLAY & SILT of medium plasticity comprising 10%± of sample
		48.0-49.8		21.6						102.8								
		48.6		42.1	40	28												
																		e ∿ =0.66 used G_s = 2.74
	SS11	50.0-51.6	33		Non-Plastic		88	7										Grey SILT, little (-) fine Sand (non-plastic)

SUMMARY OF LAB TESTS
TABLE NUMBER

BELCHERTOWN, MASSACHUSETTS

LABORATORY TESTING DATA SUMMARY

Reviewed by _____
Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date Assigned _____ Required _____

Boring No.	Sample No.	Depth ft.	Laboratory or Test No.	IDENTIFICATION TESTS: Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf	Permeability	STRENGTH TESTS: Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	CONSOL. C_c / e_o	Laboratory Log and Soil Description
B4	UP4	58.0-60.0	12	Average Total Unit Weight (58.0-59.4')=128.5 pcf														Yellow-brown SILT, some (-) fine Sand, trace Organics.
		58.0-59.4		21.1						106.1								
		58.9-59.0							2.76									

[e ≈ .62]

SUMMARY OF LAB TESTS
TABLE NUMBER

GOLDBERG-ZOINO & ASSOCIATES, INC.

BELCHERTOWN, MASSACHUSETTS

LABORATORY TESTING DATA SUMMARY

Reviewed by _____
Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date Assigned _____ Required _____

Boring No.	Sample No.	Depth ft.	Laboratory or Test No.	IDENTIFICATION TESTS							Permeability	STRENGTH TESTS					CONSOL.	Laboratory Log and Soil Description
				Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf		Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	C_c / e_o	
B4	UP6	78.0-80.0	14	Averate Total Unit Weight (78.0-79.9') = 124.2 pcf														
		78.1		20.1														Brown Clayey SILT, trace fine Sand, slight plasticity
		78.1-78.6		26.3						97.7		$\overline{CIU}$	$\bar{\sigma}_c$ = 4000	$\bar{\sigma}/\bar{\sigma}_3$ max	5492	6.2		
		78.6-78.8			27	25	92	14										
		78.9-79.4		29.5						94.2		$\overline{CIU}$	$\bar{\sigma}_c$ = 2900	Stress Controlled Triaxial Test				
		78.9-79.9		7.5						93.8		$\overline{CIU}$	$\bar{\sigma}_c$ = 2900	Reconstituted Stress Controlled Triaxial Test				
		79.4-79.9		23.8														
	SS18	85.0-86.6	34		29	28	91	8										Grey Clayey SILT, trace fine Sand, overall slight plasticity.

SUMMARY OF LAB TESTS
TABLE NUMBER ____

BELCHERTOWN, MASSACHUSETTS

LABORATORY TESTING DATA SUMMARY

Reviewed by _____

Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date Assigned _____ Required _____

Boring No.	Sample No.	Depth ft.	Laboratory or Test No.	IDENTIFICATION TESTS							Perme-ability	STRENGTH TESTS					CONSOL.	Laboratory Log and Soil Description
				Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf		Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	C_c / e_o	
B4	UP7	88.0-90.0	15	Average Total Unit Weight (88.0-89.8')=124.0 pcf														Yellow-grey SILT, little fine Sand, trace Organics. One pocket of grey fine Sand, trace SILT noted @88.9' depth comprising <5% of total sample
				28.4						96.6								
																		e ~ 0.77 used G_s = 2.74

SUMMARY OF LAB TESTS
TABLE NUMBER

BELCHERTOWN, MASSACHUSETTS

LABORATORY TESTING DATA SUMMARY

Reviewed by _____
Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date Assigned _____ Required _____

Boring No.	Sample No.	Depth ft.	Laboratory or Test No.	IDENTIFICATION TESTS: Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf	Permeability	STRENGTH TESTS: Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	CONSOL. C_c / e_o	Laboratory Log and Soil Description
B4	UP9	110.0-112.0	17	Average Total Unit Weight (110.0-111.3')=122.3 pcf														
		110.0-111.3		22.4						99.9								Yellow-brown SILT, trace fine Sand, trace Organics @ 110.5' change to- Yellow-brown and grey SILT and fine Sand, trace Organics @ 110.0' change to- Yellow-brown SILT, trace fine Sand [e ∿ 0.71 used G_s = 2.74]

SUMMARY OF LAB TESTS
TABLE NUMBER

BELCHERTOWN, MASSACHUSETTS

LABORATORY TESTING DATA SUMMARY

Reviewed by _____
Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date Assigned _____ Required _____

Boring No.	Sample No.	Depth ft.	Laboratory or Test No.	IDENTIFICATION TESTS: Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf	Permeability	STRENGTH TESTS: Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	CONSOL. C_c / e_o	Laboratory Log and Soil Description
B4	UP11	120.0-122.0	31	Average Total Unit Weight (120.0-121.1')=120.2 pcf														Yellow-brown SILT, trace fine Sand with two 1 1/2" thick layers of grey fine Sand, little Silt comprising 35-40% of sample
		120.0-121.1		19.6						100.5								@ 120.7' change to-
																		Yellow-brown SILT with thin layers of (1/32 - 1/4") of grey fine Sand comprising 15-20% of total
																		[e ∿ = 0.70 used G_s= 2.74]

SUMMARY OF LAB TESTS
TABLE NUMBER ____

QUABBIN RESERVOIR
BELCHERTOWN, MASSACHUSETTS

LABORATORY TESTING DATA SUMMARY

Reviewed by _____
Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date Assigned _____ Required _____

Boring No.	Sample No.	Depth ft.	Laboratory or Test No.	IDENTIFICATION TESTS							Permeability	STRENGTH TESTS					CONSOL.	Laboratory Log and Soil Description
				Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf		Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	C_c / e_o	
B4	SS27	135.0-136.5	39		Non-Plastic		81	6										Yellow-brown SILT, little (+) fine Sand
	SS31	155.0-156.5	40				41											Yellow-brown, fine to medium SAND and SILT (non-plastic)

SUMMARY OF LAB TESTS
TABLE NUMBER _____

QUABBIN RESERVOIR
BELCHERTOWN, MASSACHUSETTS

LABORATORY TESTING DATA SUMMARY

Reviewed by _____
Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date Assigned _____ Required _____

Boring No.	Sample No.	Depth ft.	Laboratory or Test No.	IDENTIFICATION TESTS							Perme-ability	STRENGTH TESTS					CONSOL.	Laboratory Log and Soil Description
				Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf		Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	C_c / e_o	
B5	SS7	30.0-31.5	35				33	1										Brown, fine SAND, some (+) Silt
B5	SS10	41.5-45.0	42	12.9			19											Grey fine to medium SAND, little (+) Silt
				6.6						109.3		$\overline{CIU}$	$\bar{\sigma}_c$ = 2002	$\bar{\sigma}_1/\bar{\sigma}_3$ max	7331	1.2		
				6.3						109.7		$\overline{CIU}$	$\bar{\sigma}_c$ = 6005	$\bar{\sigma}_1/\bar{\sigma}_3$ max	14995	2.4		
				6.6						99.4		$\overline{CIU}$	$\bar{\sigma}_c$ = 2002	$\sigma_1 - \sigma_3$ max	1030	0.5		
				6.6						99.4		$\overline{CIU}$	$\bar{\sigma}_c$ = 6005	$\sigma_1 - \sigma_3$ max	3142	2.2		

SUMMARY OF LAB TESTS
TABLE NUMBER _____

BELCHERTOWN, MASSACHUSETTS

LABORATORY TESTING DATA SUMMARY

Reviewed by _____
Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date Assigned _____ Required _____

Boring No.	Sample No.	Depth ft.	Laboratory or Test No.	IDENTIFICATION TESTS							Perme-ability	STRENGTH TESTS					CONSOL.	Laboratory Log and Soil Description
				Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf		Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	C_c / e_o	
B5	UP1	50.0-52.0	43	Average Total Unit Weight (50.0-51.1')-123.0 pcf														
		50.0-51.1		17.9			22			104.3								Yellow-brown fine SAND, some (-) Silt [e ∿ 0.64 used G_s = 2.74]
	SS11	32.0-53.5	36				11	<1										Brown fine to medium SAND, little fine Gravel, little (-) Silt
	SS15	70.0-71.5	37				28	<1										Brown, fine to medium SAND, some Silt
	S18	85.0-86.6	38				22	<1										Brown fine to medium SAND, some (-) Silt, little fine Gravel

SUMMARY OF LAB TESTS
TABLE NUMBER _____

QUABBIN RESERVOIR
BELCHERTOWN, MASSACHUSETTS

LABORATORY TESTING DATA SUMMARY

Reviewed by _____
Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date Assigned _____ Required _____

Boring No.	Sample No.	Depth ft.	Laboratory or Test No.	IDENTIFICATION TESTS: Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf	Permeability	STRENGTH TESTS: Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	CONSOL. C_c / e_o	Laboratory Log and Soil Description
B7	UP1	52.0-54.0	44	Average Total Unit Weight (52.0-52.9')=121.4 pcf														Yellow-brown SILT or Clayey SILT of non to slight plasticity with few pockets of grey fine Sand, trace Silt comprising 15-20% of sample
		52.0-52.9		29.6						93.7								
		52.5 52.6							2.75									[e ∿ = 0.83]

SUMMARY OF LAB TESTS
TABLE NUMBER _____

QUABBIN RESERVOIR
BELCHERTOWN, MASSACHUSETTS

LABORATORY TESTING DATA SUMMARY

Reviewed by _____
Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date Assigned _____ Required _____

Boring No.	Sample No.	Depth	Laboratory or Test No.	IDENTIFICATION TESTS: Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf	Permeability	STRENGTH TESTS: Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	CONSOL. C_c / e_o	Laboratory Log and Soil Description
B7	UP2	62.0-64.0	45		Average Total Unit Weight (62.0-63.9')=115.1 pcf													
		62.1-62.6		32.8						89.3		$\overline{CIU}$	$\bar{\sigma}_c$= 4003	(Stress controlled Triaxial Test)				Grey-brown Clayey SILT of slight plasticity, with dark grey color banding, trace fine Sand
		62.6-62.8		38.1	36	34	94	5	2.69									
		62.8-63.9		35.2										Reconstituted				
		62.0-63.9		7.3					2.70	82.8		$\overline{CIU}$	$\bar{\sigma}_c$= 4003	Stress controlled Triaxial Test				
		62.0-63.9		7.8						85.4		$\overline{CIU}$	$\bar{\sigma}_c$= 4003	"	"	"		
		62.0-63.9		7.5						83.5		$\overline{CIU}$	$\bar{\sigma}_c$= 4003	"	"	"		
B7	S14	64.0-65.5	55				91	9										Grey SILT, trace fine Sand

SUMMARY OF LAB TESTS
TABLE NUMBER _____

QUABBIN RESERVOIR
BELCHERTOWN, MASSACHUSETTS

LABORATORY TESTING DATA SUMMARY

Reviewed by _____
Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date Assigned _____ Required _____

Boring No.	Sample No.	Depth ft.	Laboratory or Test No.	IDENTIFICATION TESTS							Permeability	STRENGTH TESTS					CONSOL.	Laboratory Log and Soil Description
				Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf		Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	C_c / e_o	
B7	UP3	72.0-74.0	46	Average Total Unit Weight (72.0-73.6')=118.1 pcf														Yellow-brown and grey SILT, little fine Sand with layers (1/2-2 3/4") of grey fine Sand, little Silt comprising 25%± of total sample [e ~ 0.97]
		72.0-73.6		36.0	Non-Plastic		86	4	2.74	86.8								

SUMMARY OF LAB TESTS
TABLE NUMBER _____

BELCHERTOWN, MASSACHUSETTS

LABORATORY TESTING DATA SUMMARY

Reviewed by _____
Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date Assigned _____ Required _____

Boring No.	Sample No.	Depth ft.	Laboratory or Test No.	IDENTIFICATION TESTS: Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf	Permeability	STRENGTH TESTS: Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	CONSOL. C_c / e_o	Laboratory Log and Soil Description
B7	UP5	92.0-94.0	47	Average Total Unit Weight (92.0-93.3')=119.4 pcf														Grey brown SILT, trace fine Sand, trace Organics. Few thin layers (1/8-1" thick) of grey fine Sand comprising 10-15% of total sample
		92.0-93.3		33.6						89.4								
																		$e \sim 0.91$ used $G_s = 2.74$

SUMMARY OF LAB TESTS
TABLE NUMBER _____

GOLDBERG-ZOINO & ASSOCIATES, INC.

APPENDIX E-2

QUABBIN RESERVOIR
BELCHERTOWN, MASSACHUSETTS **LABORATORY TESTING DATA SUMMARY**

Reviewed by _____
Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date Assigned _____ Required _____

Boring No.	Sample No.	Depth ft.	Laboratory or Test No.	IDENTIFICATION TESTS: Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf	Permeability	STRENGTH TESTS: Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	CONSOL. C_c / e_o	Laboratory Log and Soil Description
B7	UP6	102.0-104.0	48	Average Total Unit Weight (102.0-103.1')=121.8 pcf														Grey SILT, little fine Sand
		102.1-102.5		29.9			88	4		93.9		$\overline{CIU}$	$\bar{\sigma}_c$ 4003	$\bar{\sigma}_1/\bar{\sigma}_3$ max	8114	7.6		
		102.5		28.1														@ 102.5' change to-
		102.6-103.1		31.9	29	27	88	7		89.9		$\overline{CIU}$	$\bar{\sigma}_0$ 8007	$\bar{\sigma}_1/\bar{\sigma}_3$ max	9800	7.4		Grey Clayey SILT of slight plasticity, little fine Sand

SUMMARY OF LAB TESTS
TABLE NUMBER _____

QUABBIN RESERVOIR
BELCHERTOWN, MASSACHUSETTS

LABORATORY TESTING DATA SUMMARY

Reviewed by _____
Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date Assigned _____ Required _____

Boring No.	Sample No.	Depth ft.	Laboratory or Test No.	IDENTIFICATION TESTS: Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf	Permeability	STRENGTH TESTS: Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	CONSOL. C_c / e_o	Laboratory Log and Soil Description
B"	UP8	122.0-124.0	50															Grey brown SILT, little fine Sand, trace Organics. Few thin layers (1/32-1/4") of grey fine Sand throughout comprising <10% of total sample
		122.2-122.5		32.6						90.6		(e ∿	0.90)					
		122.7-123.0		33.0						89.5		(e ∿	0.92)					
		123.0-123.1							2.76									

SUMMARY OF LAB TESTS
TABLE NUMBER _____

GOLDBERG-ZOINO & ASSOCIATES, INC.

QUABBIN RESERVOIR
BELCHERTOWN, MASSACHUSETTS

LABORATORY TESTING DATA SUMMARY

Reviewed by _____
Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date Assigned _____ Required _____

Boring No.	Sample No.	Depth ft.	Laboratory or Test No.	IDENTIFICATION TESTS: Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf	Permeability	STRENGTH TESTS: Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	CONSOL. C_c / e_o	Laboratory Log and Soil Description
B7	UP9	132.0-134.0	51															Grey fine SAND, little Silt, trace organics with few thin layers (1/32-1/8") of yellow brown Silt, comprising <5% of total
		133.3 133.5		33.9						87.5		e ∿ 0.95 (used G_s = 2.74)						
		133.5-133.7		33.9						78.4		e ∿ 1.18 (used G_s = 2.74)						
																		@ 133.5' change to-
																		Yellow brown SILT, little fine Sand
																		Note: from 132.0 to 133.2', sample disturbed

SUMMARY OF LAB TESTS
TABLE NUMBER _____

BELCHERTOWN, MASSACHUSETTS

LABORATORY TESTING DATA SUMMARY

Reviewed by _____
Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date Assigned _____ Required _____

Boring No.	Sample No.	Depth ft.	Laboratory or Test No.	IDENTIFICATION TESTS							Permeability	STRENGTH TESTS					CONSOL.	Laboratory Log and Soil Description
				Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf		Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	C_c / e_o	
B7	S28	134.0-135.5	56				92	9										Grey SILT, trace fine Sand
	S29B	139.0-140.5	57	26.3	Non-Plastic		47											Dark brown fine SAND and SILT, trace Organics

SUMMARY OF LAB TESTS
TABLE NUMBER _____

QUABBIN RESERVOIR
BELCHERTOWN, MASSACHUSETTS

LABORATORY TESTING DATA SUMMARY

Reviewed by _____
Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date Assigned _____ Required _____

Boring No.	Sample No.	Depth ft.	Laboratory or Test No.	IDENTIFICATION TESTS							Permeability	STRENGTH TESTS					CONSOL.	Laboratory Log and Soil Description
				Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf		Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	C_c / e_o	
B8	SS11	50.0-55.0	41	14.9			6											Grey fine to medium SAND, trace Silt
				5.6						109.6		$\overline{CIU}$	$\bar{\sigma}_c$ = 2002	$\bar{q}/\bar{\sigma}_3$ max	7899	1.4		
				5.9						110.1		$\overline{CIU}$	$\bar{\sigma}_c$ = 6000	$\bar{\sigma}_1/\bar{\sigma}_3$ max	20933	2.0		
				6.8						99.1		$\overline{CIU}$	$\bar{\sigma}_c$ = 2002	$\sigma_1-\sigma_3$ max	1778	1.4		
				6.7						99.3		$\overline{CIU}$	$\bar{\sigma}_c$ = 6000	$\sigma_1-\sigma_3$ max	4801	1.6		

SUMMARY OF LAB TESTS
TABLE NUMBER _____

QUABBIN RESERVOIR
BELCHERTOWN, MASSACHUSETTS

LABORATORY TESTING DATA SUMMARY

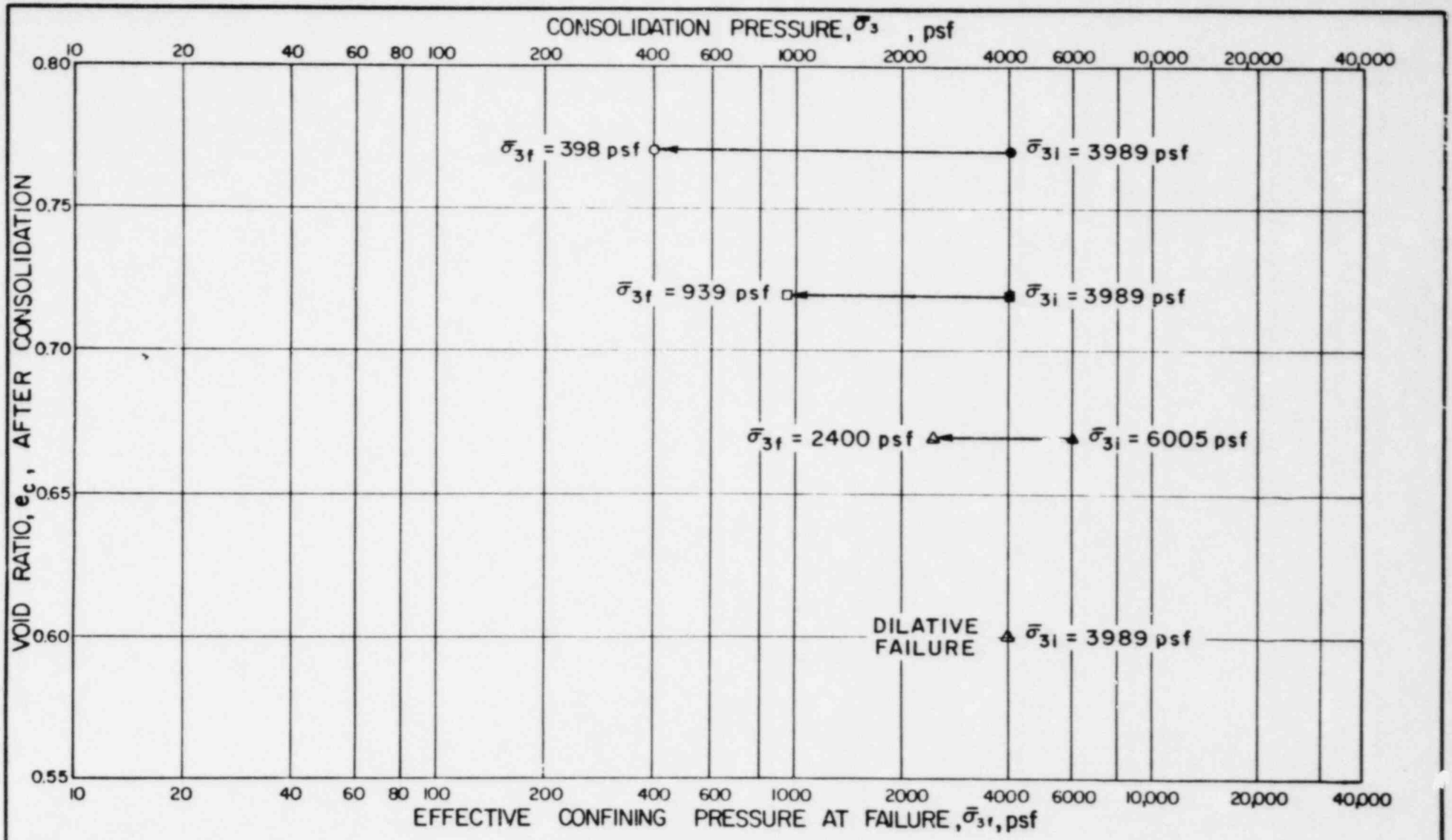
Reviewed by _____
Date _____

Project No. 2801 Project Engr. RW Assigned By RW Date: Assigned _____ Required _____

Boring No.	Sample No.	Depth ft.	Laboratory or Test No.	IDENTIFICATION TESTS							Permeability	STRENGTH TESTS					CONSOL.	Laboratory Log and Soil Description
				Water Content %	LL %	PL %	Sieve -200 %	Hyd -2μ %	G_s	γ_d pcf		Torvane or Type Test	σ_c or $\bar{\sigma}_c$ or σ psf	Failure Criteria	$\sigma_1 - \sigma_3$ or τ psf	Strain %	$C_c / 1+e_o$	
B9	S18	85.0-86.5	54	7.4			9											Grey brown, fine to coarse SAND and GRAVEL, trace (+) Silt

GOLDBERG, ZOINO, DUNNICLIFF & ASSOCIATES, INC.
CONSULTANTS IN GEOTECHNICAL ENGINEERING

SUMMARY OF LAB TESTS
TABLE NUMBER _____



TEST No.	SYM.	BORING No.	DEPTH (ft.)	INITIAL CONDITIONS			CONDITIONS BEFORE LOADING					FINAL CONDITIONS	
				ω_N (%)	γ_d pcf	HT. / DIA	$\bar{\sigma}_1 - \bar{\sigma}_3$ psf	u_b psf	ϵ_v (%)	B (%)	e_c	ω_N (%)	γ_d pcf
T4.3.1	△	B1	65.3-65.8	23.9	105.0	6.00 / 2.87	3989	10080	1.54	96	.60	20.5	106.6
T4.3.2	●	B1	64.0-65.8	5.7	93.5	6.00 / 2.90	3989	10080	3.11	95	.77	25.7	96.5
T4.3.3	■	B1	64.0-65.8	6.7	97.7	6.13 / 2.90	3989	7200	1.66	95	.72	25.5	99.4
T4.3.4	▲	B1	64.0-65.8	7.5	100.9	6.00 / 2.90	6005	7200	1.74	95	.67	25.6	102.7

QUABBIN RESERVOIR DAMS

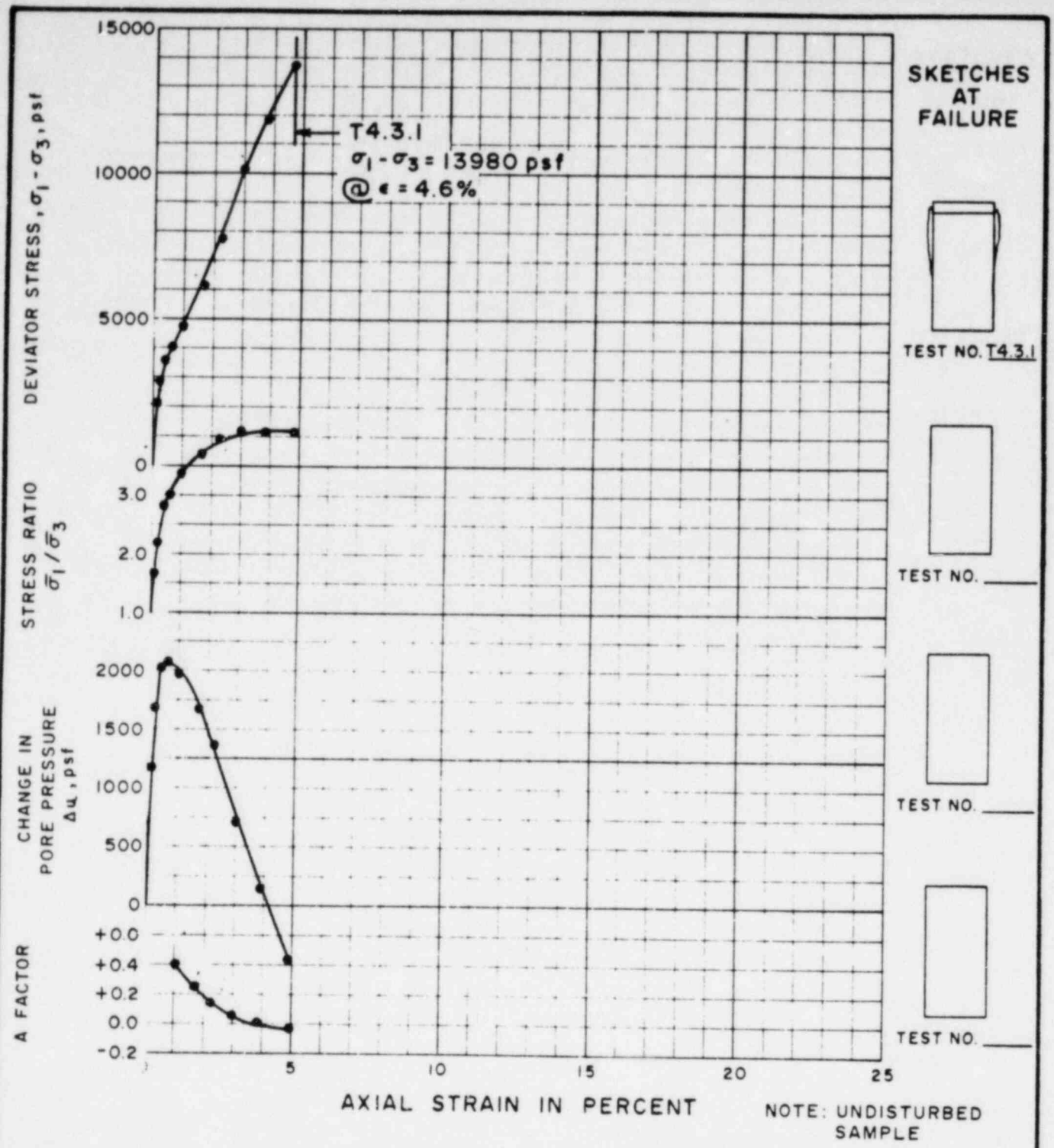
BELCHERTOWN, MASSACHUSETTS

SUMMARY PLOT

MONOTONIC TRIAXIAL TESTS

DATE JUNE 1981 FILE 2801

GOLDBERG-ZOINO & ASSOCIATES, INC.



NOTE: UNDISTURBED SAMPLE

TEST NO./SYMBOL	INITIAL CONDITIONS: INITIAL WATER CONTENT, %	INITIAL DRY UNIT WEIGHT, pcf	SAMPLE HEIGHT & DIAMETER, in.	CONDITIONS BEFORE SHEAR: INITIAL STRESSES $\bar{\sigma}_1 = \bar{\sigma}_3$ psf	FINAL BACK PRESSURE, psf	VOLUMETRIC STRAIN, %	PORE PRESSURE RESPONSE, %	FINAL CONDITIONS: FINAL WATER CONTENT, %	FINAL DRY UNIT WEIGHT, pcf	RATE OF STRAIN, PERCENT PER MINUTE
T4.3.1	23.9	105.0	6.00 / 2.87	3989	10080	1.54	96	20.5	106.6	-

SOIL DESCRIPTION: GREY SILT AND FINE SAND

LIQUID LIMIT NP % PLASTIC LIMIT NP % SPECIFIC GRAVITY 2.74

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

TRIAXIAL COMPRESSION TESTS (MONOTONIC)

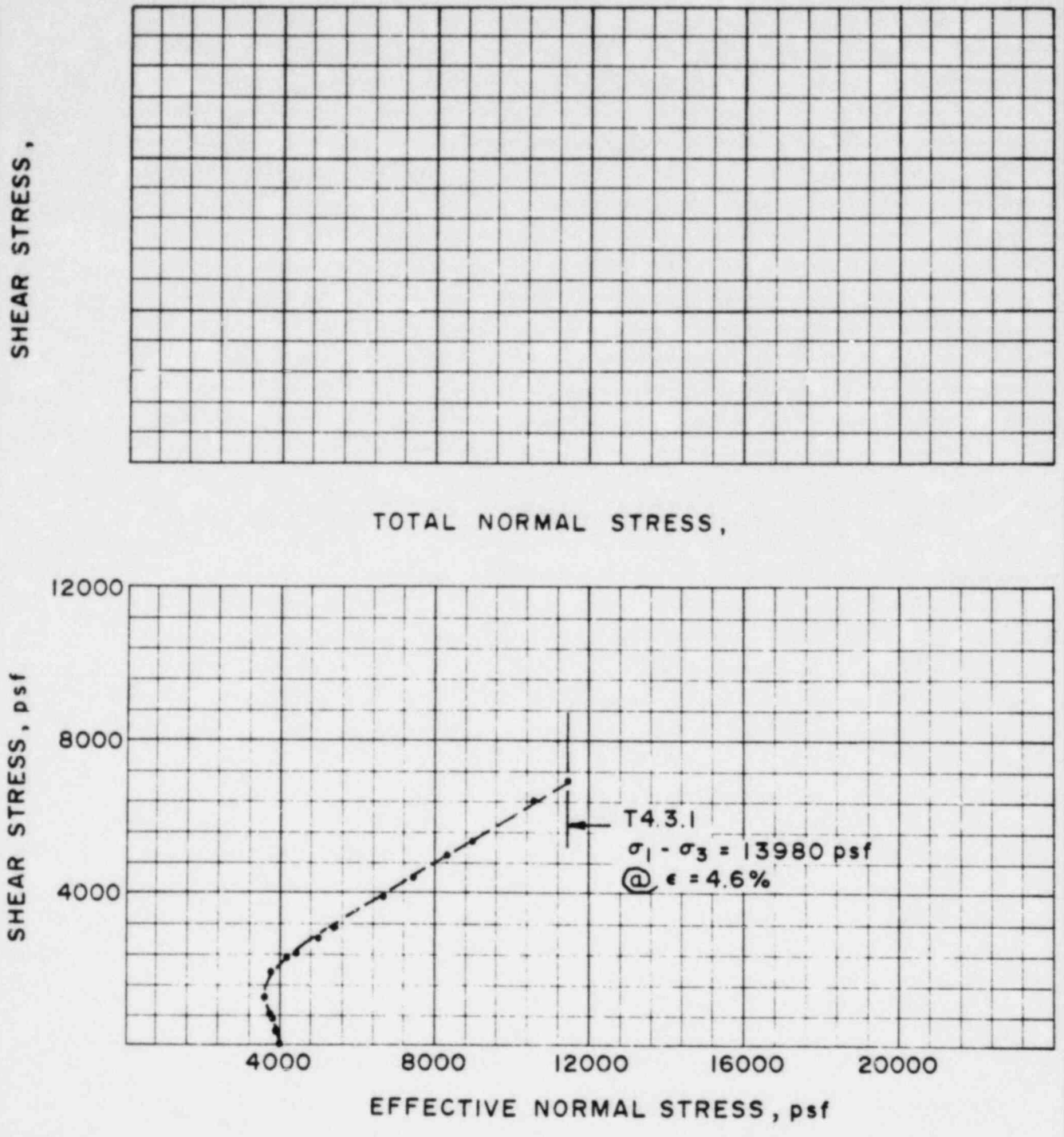
BORING NO. B1
SAMPLE UP6
DEPTH 65.3'-65.8'
TECH. ____
REVIEWER ____

TEST SERIES NO. 4
DATE JUNE 1981

FILE 2801

FIGURE T.9

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



SOIL DESCRIPTION: GREY SILT AND FINE SAND
LIQUID LIMIT NP % PLASTIC LIMIT NP % SPECIFIC GRAVITY 2.74

FAILURE CRITERIA _____

REMARKS FINAL DATA POINT IS MAXIMUM OF LOADING DEVICE

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

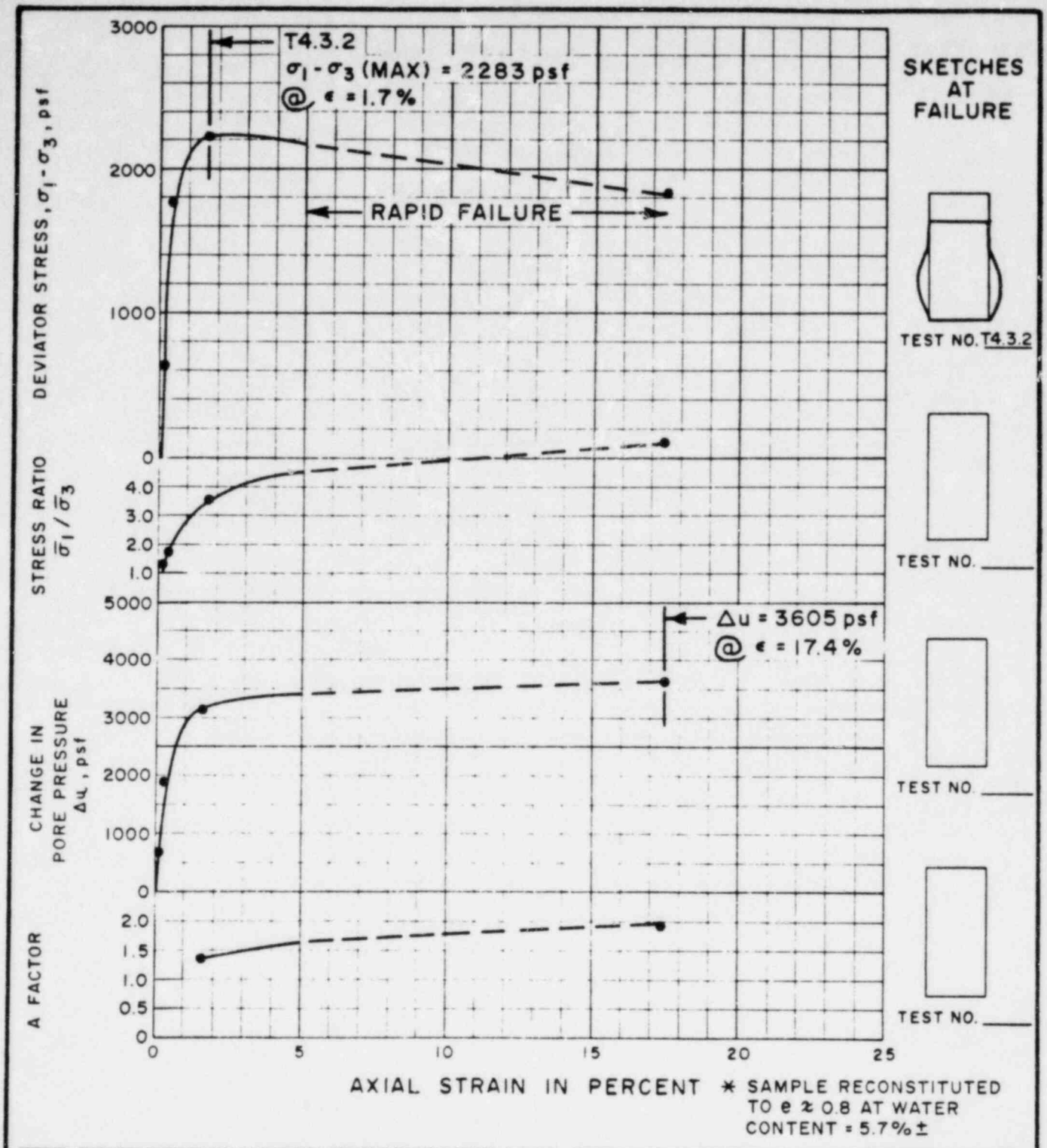
MOHR STRENGTH ENVELOPE
TRIAXIAL COMPRESSION TESTS (MONOTONIC)

BORING NO. B1
SAMPLE UP6
DEPTH 65.3'-65.8'
TECH. _____
REVIEWER _____

TEST SERIES NO. 4
DATE JUNE 1981
FILE 2801

FIGURE

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



* SAMPLE RECONSTITUTED TO e ≈ 0.8 AT WATER CONTENT = 5.7% ±

TEST NO./SYMBOL	INITIAL CONDITIONS: INITIAL WATER CONTENT, %	INITIAL DRY UNIT WEIGHT, pcf	SAMPLE HEIGHT & DIAMETER, in.	CONDITIONS BEFORE SHEAR: INITIAL STRESSES $\sigma_1 = \sigma_3$, psf	FINAL BACK PRESSURE, psf	VOLUMETRIC STRAIN, %	PORE PRESSURE RESPONSE, %	FINAL CONDITIONS: FINAL WATER CONTENT, %	FINAL DRY UNIT WEIGHT, pcf	RATE OF STRAIN, PERCENT PER MINUTE
T4 3.2 ●	5.7	93.5	2.00 2.90	3989	10080	3.11	95	25.7	96.5	-

SOIL DESCRIPTION: GREY SILT AND FINE SAND *

LIQUID LIMIT - % PLASTIC LIMIT - % SPECIFIC GRAVITY 2.74

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

TRIAXIAL COMPRESSION TESTS (MONOTONIC)

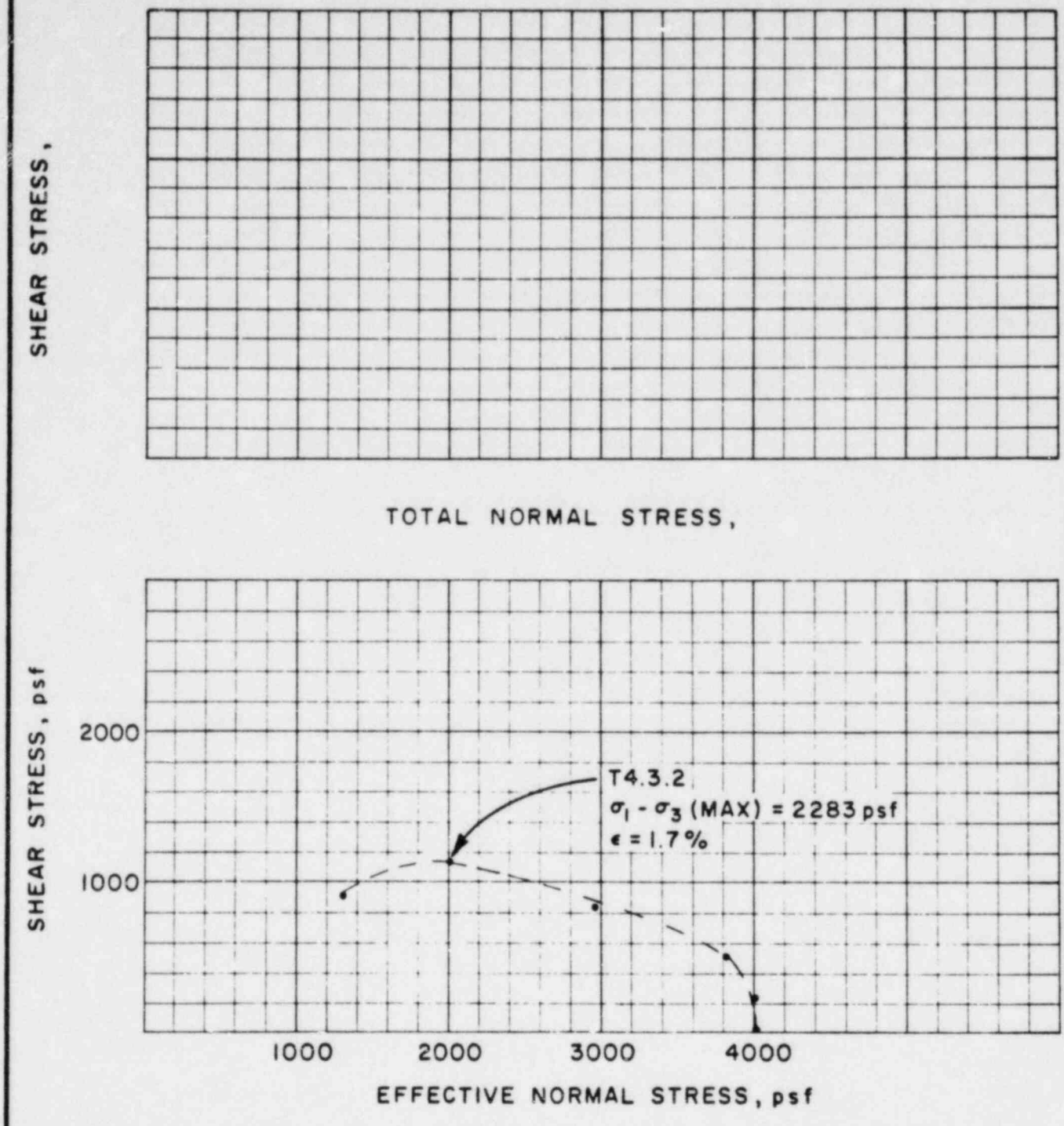
BORING NO. B1
SAMPLE UP6
DEPTH 64.0'-65.8'
TECH. ____
REVIEWER ____

TEST SERIES NO. 4
DATE JUNE 1981

FILE 2801

FIGURE T.9

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



SOIL DESCRIPTION: GREY SILT AND FINE SAND

LIQUID LIMIT - % PLASTIC LIMIT - % SPECIFIC GRAVITY 2.74

FAILURE CRITERIA $\sigma_1 - \sigma_3$ (MAX)

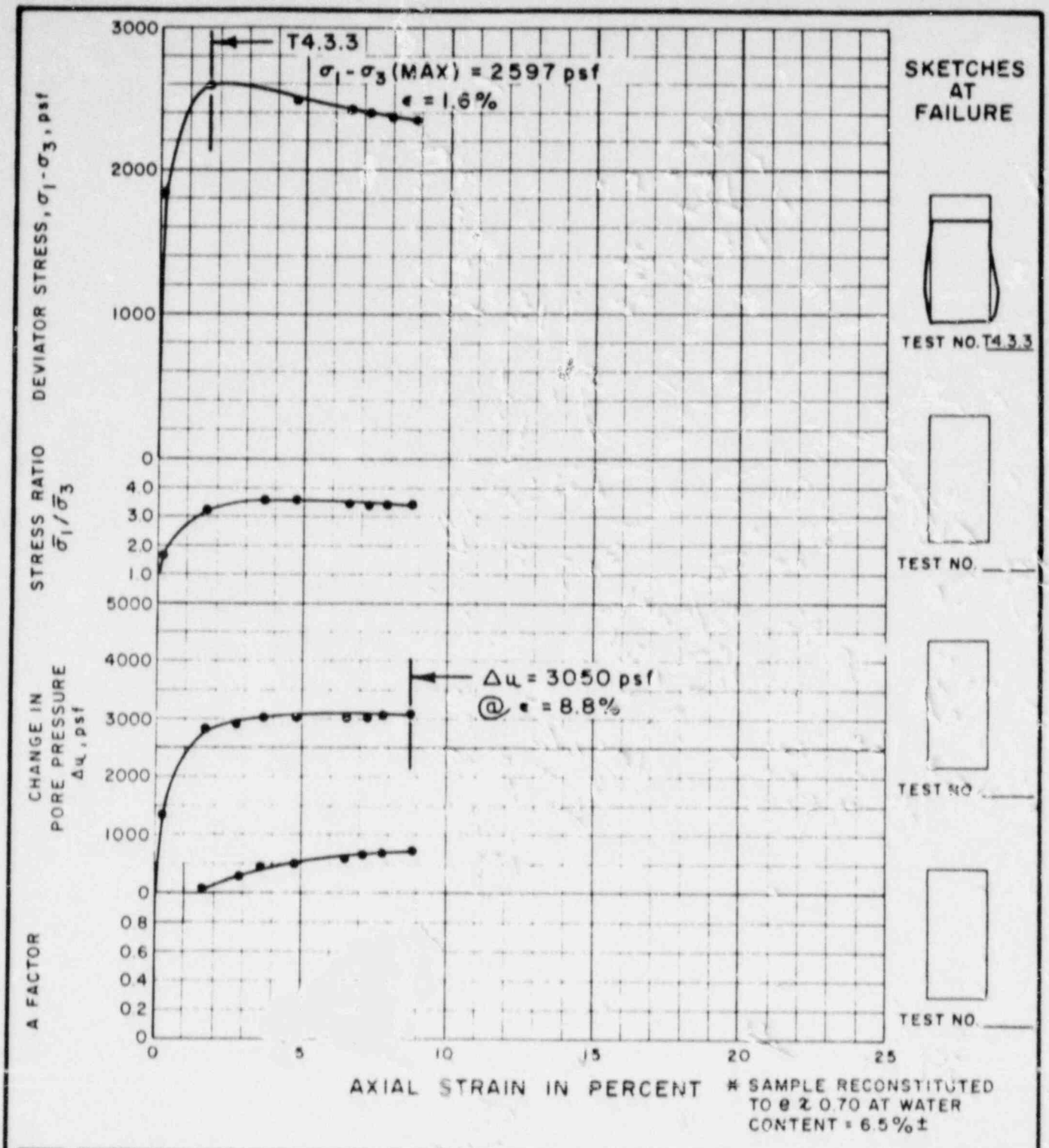
REMARKS SAMPLE RECONSTITUTED TO $e \approx 0.8$ @ WATER CONTENT = 5.7% ±

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS
MOHR STRENGTH ENVELOPE
TRIAXIAL COMPRESSION TESTS (MONOTONIC)

FIGURE

BORING NO. B1 TEST SERIES NO. 4
SAMPLE UP6
DEPTH 64.0'-65.8' DATE JUNE 1981
TECH.
REVIEWER FILE 2801

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



* SAMPLE RECONSTITUTED TO e ≈ 0.70 AT WATER CONTENT = 6.5% ±

TEST NO./SYMBOL	INITIAL CONDITIONS: INITIAL WATER CONTENT, %	INITIAL DRY UNIT WEIGHT, pcf	SAMPLE HEIGHT & DIAMETER, in.	CONDITIONS BEFORE SHEAR: INITIAL STRESSES $\bar{\sigma}_1 = \bar{\sigma}_3$, psf	FINAL BACK PRESSURE, psf	VOLUMETRIC STRAIN, %	PORE PRESSURE RESPONSE, %	FINAL CONDITIONS: FINAL WATER CONTENT, %	FINAL DRY UNIT WEIGHT, pcf	RATE OF STRAIN, PERCENT PER MINUTE
•	6.7	97.7		3989	7200	1.66	95	25.5	99.4	-

SOIL DESCRIPTION: GREY SILT AND FINE SAND *

LIQUID LIMIT - % PLASTIC LIMIT - % SPECIFIC GRAVITY 2.74

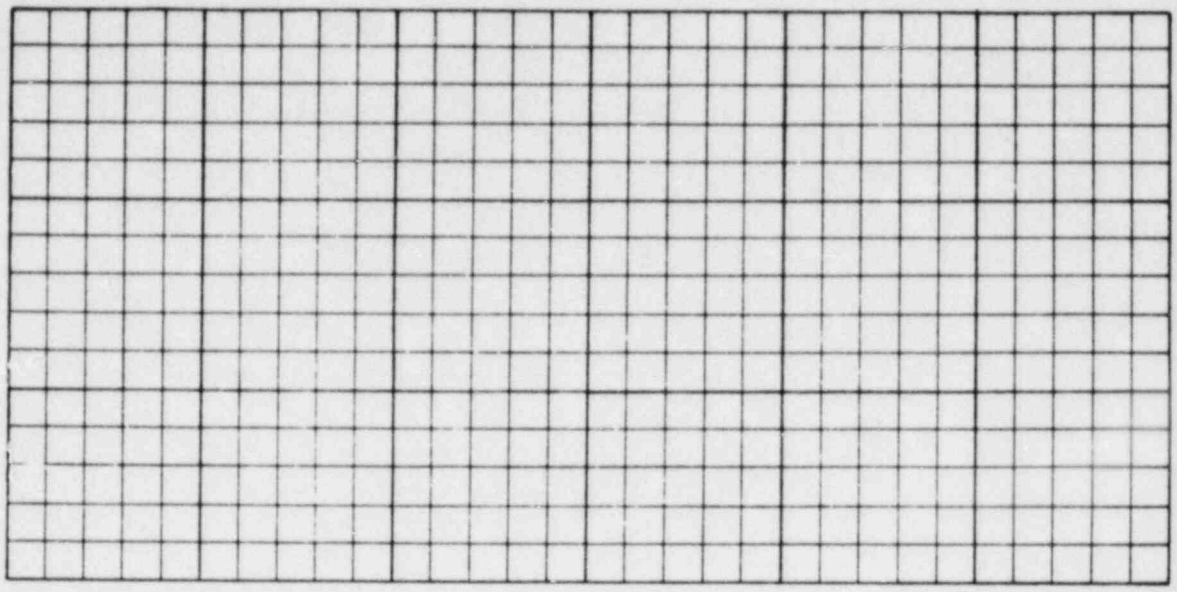
QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

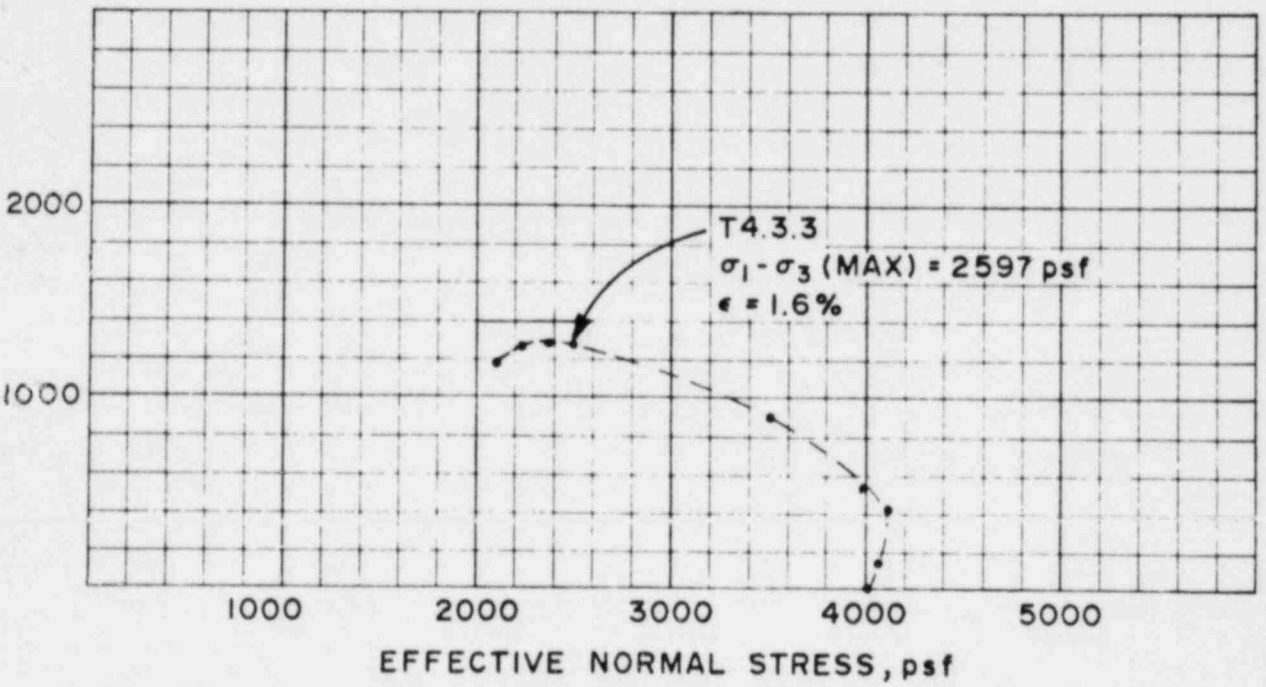
TRIAXIAL COMPRESSION TESTS (MONOTONIC)

BORING NO. B1 TEST SERIES NO. 4
SAMPLE UP6
DEPTH 64.0'-65.8' DATE JUNE 1981
TECH. ___
REVIEWER ___ FILE 2801

FIGURE T.9

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS





SOIL DESCRIPTION GREY SILT AND FINE SAND

LIQUID LIMIT ____ % PLASTIC LIMIT ____ % SPECIFIC GRAVITY 2.74

FAILURE CRITERIA $\sigma_1 - \sigma_3$ (psf)

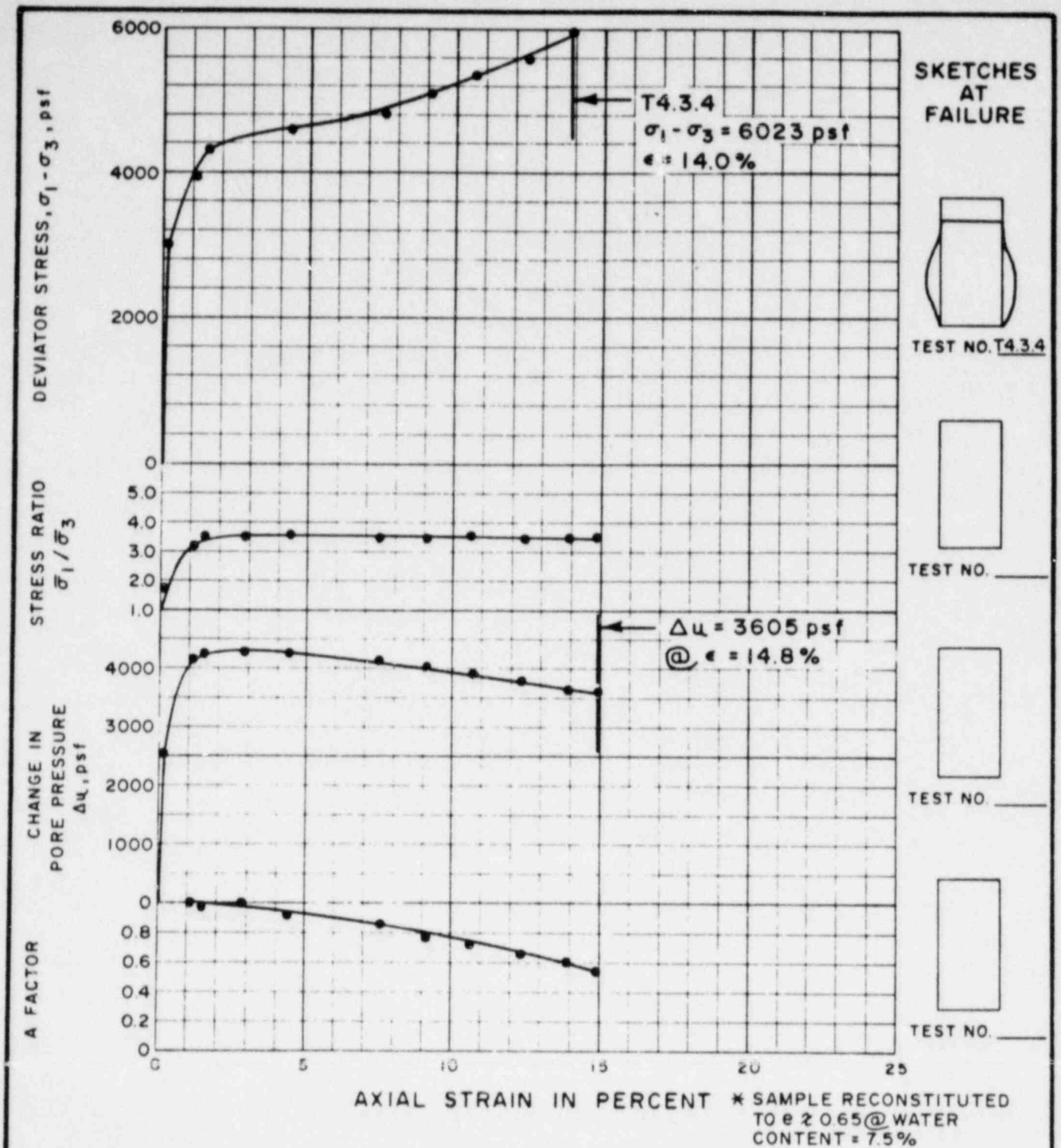
REMARKS SAMPLE RECONSTITUTED TO $e \approx 0.70$ @ WATER CONTENT = 6.5% ±

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS
MOHR STRENGTH ENVELOPE
TRIAXIAL COMPRESSION TESTS (MONOTONIC)

BORING NO. B1 TEST SERIES NO. 4
SAMPLE UP6
DEPTH 64.0'-65.8' DATE JUNE 1981
TECH. ____
REVIEWER ____ FILE 2801

FIGURE

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



* SAMPLE RECONSTITUTED TO e ≈ 0.65 @ WATER CONTENT = 7.5%

TEST NO./SYMBOL	INITIAL CONDITIONS: INITIAL WATER CONTENT, %	INITIAL CONDITIONS: INITIAL DRY UNIT WEIGHT, pcf	INITIAL CONDITIONS: SAMPLE HEIGHT & DIAMETER, in.	CONDITIONS BEFORE SHEAR: INITIAL STRESSES $\bar{\sigma}_1 = \bar{\sigma}_3$, psf	CONDITIONS BEFORE SHEAR: FINAL BACK PRESSURE, psf	CONDITIONS BEFORE SHEAR: VOLUMETRIC STRAIN, %	CONDITIONS BEFORE SHEAR: PORE PRESSURE RESPONSE, %	FINAL CONDITIONS: FINAL WATER CONTENT, %	FINAL CONDITIONS: FINAL DRY UNIT WEIGHT, pcf	RATE OF STRAIN, PERCENT PER MINUTE
T4 3.4	7.5	100.9	2.00 2.90	6005	7200	1.74	95	25.6	102.7	-

SOIL DESCRIPTION: GREY SILT AND FINE SAND *

LIQUID LIMIT ___ - % PLASTIC LIMIT ___ - % SPECIFIC GRAVITY 2.74

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

TRIAXIAL COMPRESSION TESTS (MONOTONIC)

FIGURE

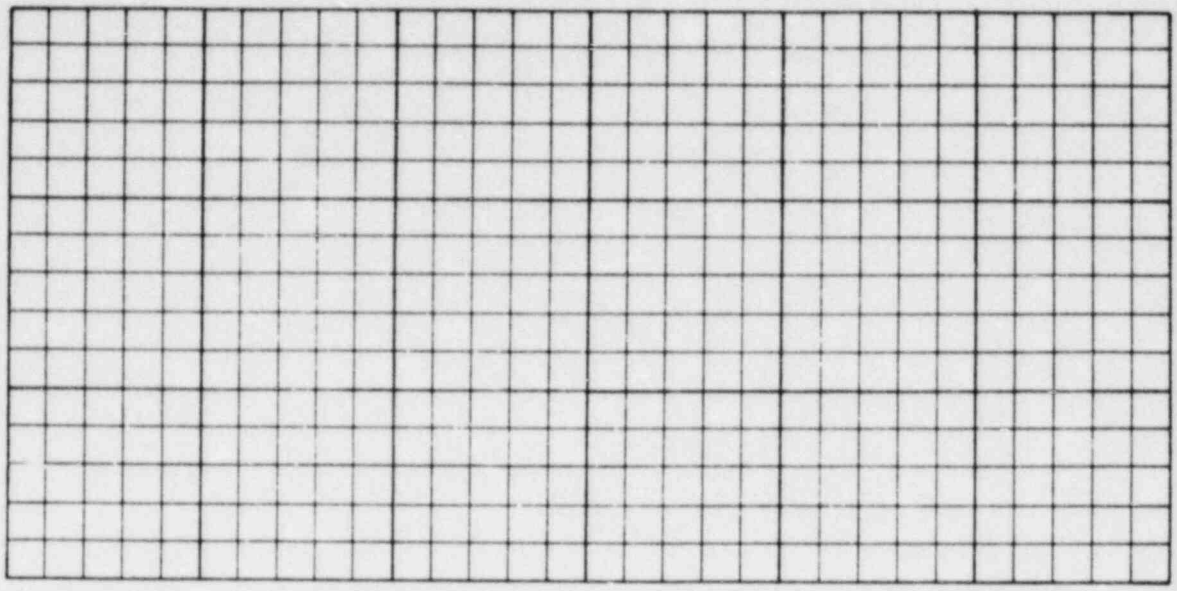
BORING NO. B1
SAMPLE UP6
DEPTH 64.0' - 65.8'
TECH. ____
REVIEWER ____

TEST SERIES NO. 4
DATE JUNE 1981

FILE 2801

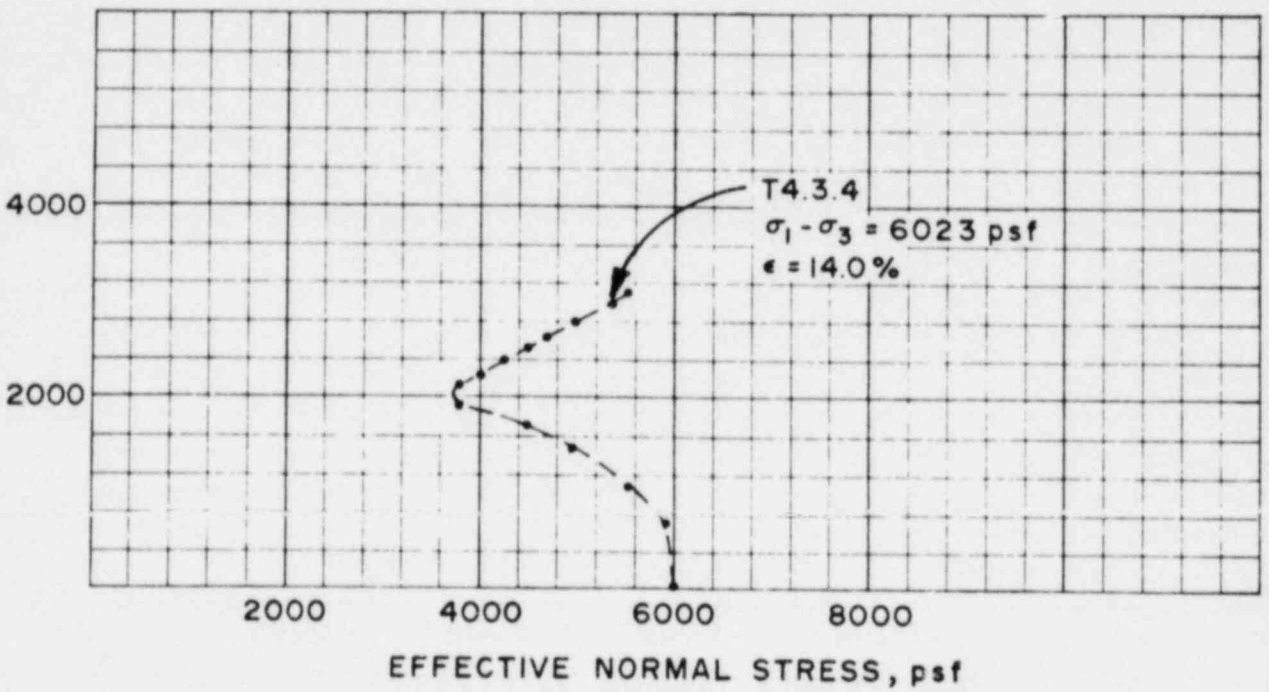
T.9

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



SHEAR STRESS,

TOTAL NORMAL STRESS,



SOIL DESCRIPTION: GREY SILT AND FINE SAND
LIQUID LIMIT - % PLASTIC LIMIT - % SPECIFIC GRAVITY 2.74

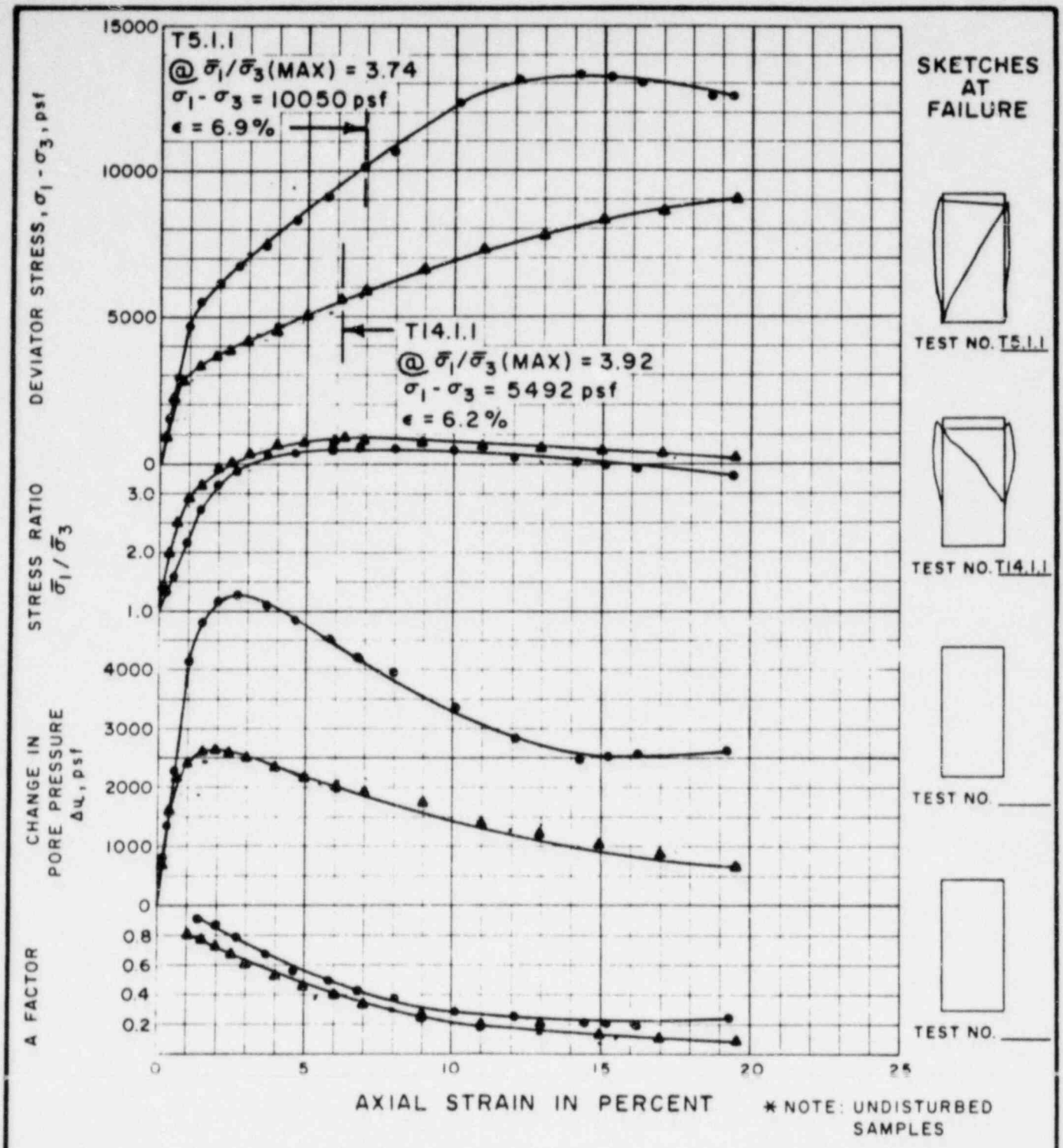
FAILURE CRITERIA

REMARKS SAMPLE RECONSTITUTED TO e ≈ .65 @ WATER CONTENT = 7.5%

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS
MOHR STRENGTH ENVELOPE
TRIAXIAL COMPRESSION TESTS (MONOTONIC)

BORING NO. B1
SAMPLE UP6
DEPTH 64.0'-65.8'
TECH.
REVIEWER
TEST SERIES NO. 4
DATE JUNE 1981
FILE 2801

FIGURE



TEST NO./SYMBOL	INITIAL CONDITIONS: INITIAL WATER CONTENT, %	INITIAL DRY UNIT WEIGHT, pcf	SAMPLE HEIGHT & DIAMETER, in.	CONDITIONS BEFORE SHEAR: INITIAL STRESSES σ̄1 = σ̄3, psf	FINAL BACK PRESSURE, psf	VOLUMETRIC STRAIN, %	PORE PRESSURE RESPONSE, %	FINAL CONDITIONS: FINAL WATER CONTENT, %	FINAL DRY UNIT WEIGHT, pcf	RATE OF STRAIN, PERCENT PER MINUTE
T5.1 ●	25.2	97.8	2.87	8000	8640	4.1	95	21.2	102.0	0.1
T14.1 ▲	26.3	97.7	2.87	4000	11520	3.2	95	23.6	100.9	0.1

SOIL DESCRIPTION: BROWN CLAYEY SILT, TRACE FINE SAND

LIQUID LIMIT 28 % PLASTIC LIMIT 25 % SPECIFIC GRAVITY ____

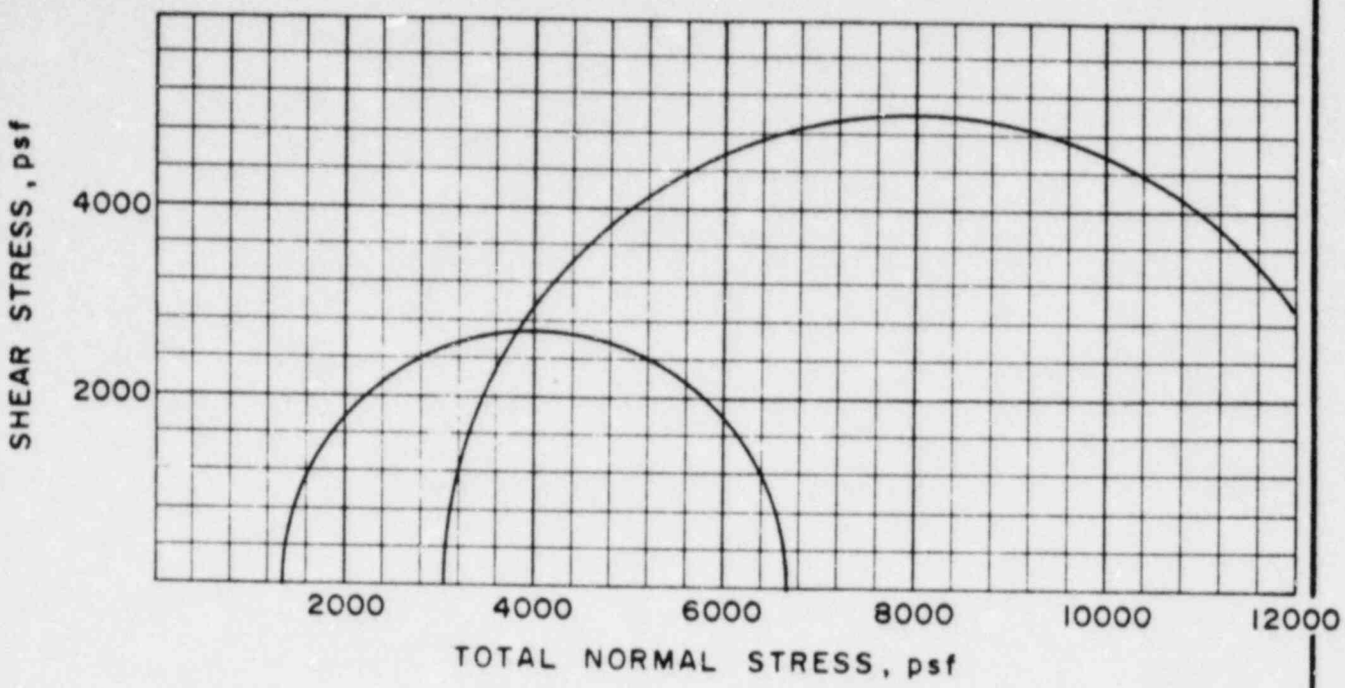
QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

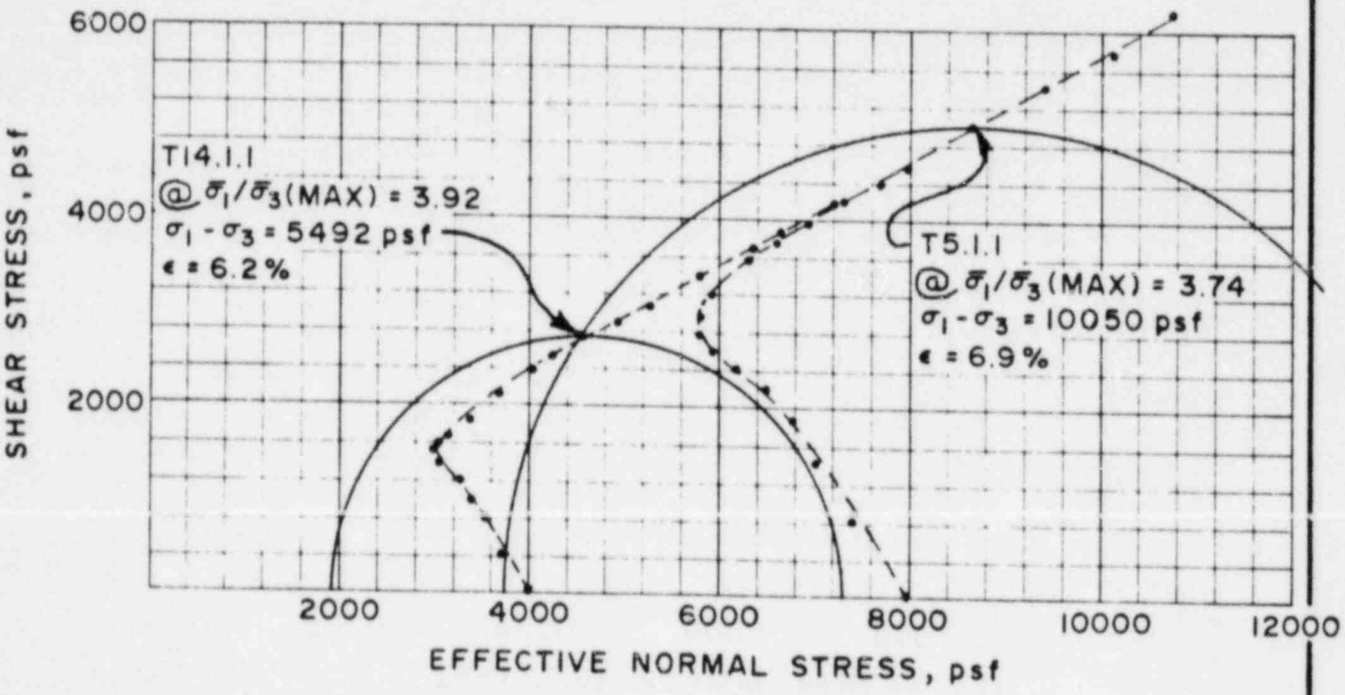
TRIAXIAL COMPRESSION TESTS ($\overline{CIU}$)

BORING NO. B1 B4 TEST SERIES
SAMPLE UP7 UP6 NO. 5, 14
DEPTH 75.1'-75.6', 78.1'-78.6' DATE JUNE 1981
TECH. ____
REVIEWER ____ FILE 2801

FIGURE

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS





SOIL DESCRIPTION: BROWN CLAYEY SILT, TRACE FINE SAND

LIQUID LIMIT 28 % PLASTIC LIMIT 25 % SPECIFIC GRAVITY ____

FAILURE CRITERIA @ $\bar{\sigma}_1/\bar{\sigma}_3$ (MAX)

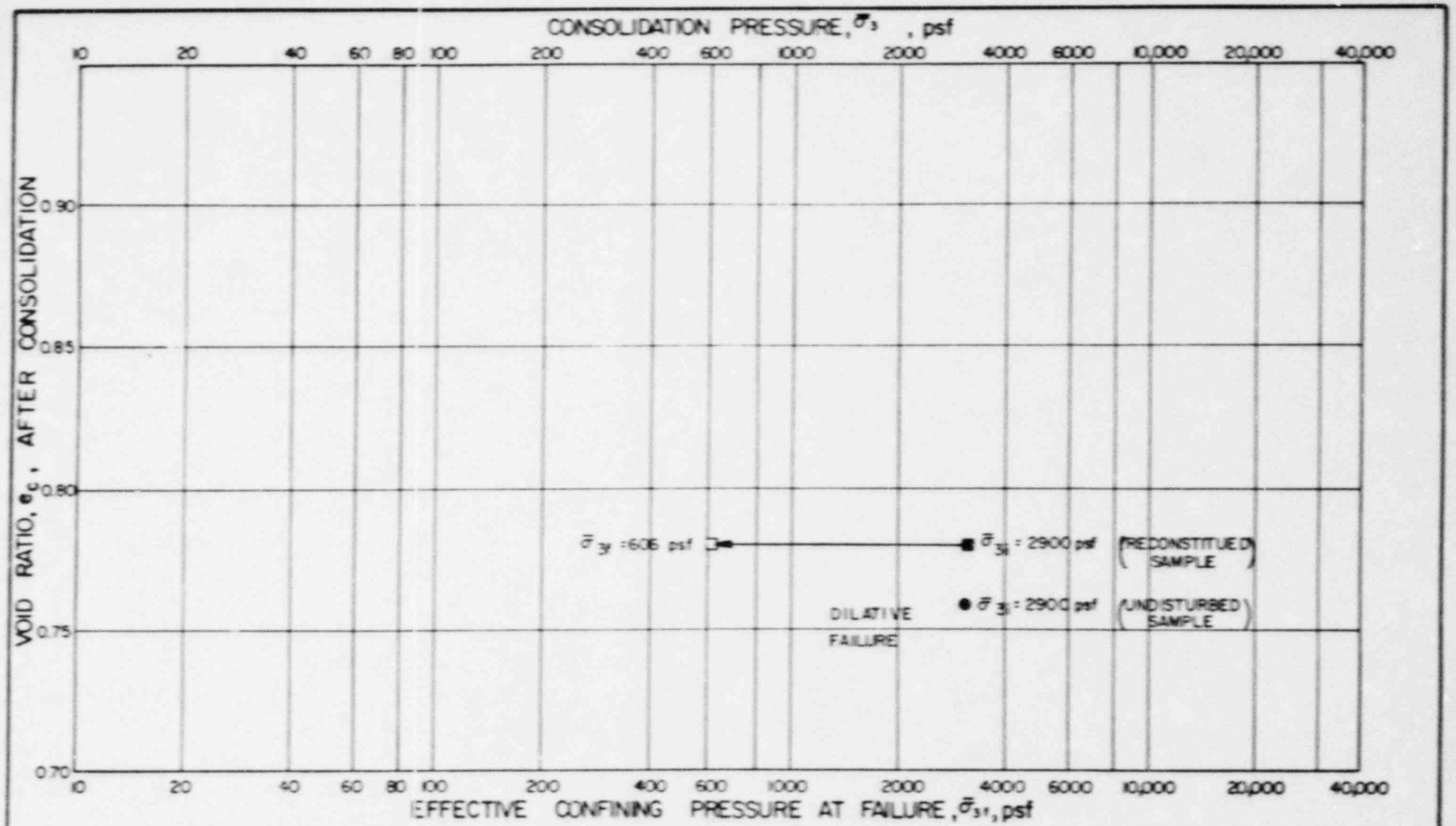
REMARKS ____

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS
MOHR STRENGTH ENVELOPE
TRIAXIAL COMPRESSION TESTS ($\overline{CIU}$)

BORING NO. B1 B4 TEST SERIES
SAMPLE UP7 UP6 NO. 5,14
DEPTH 75.1'-75.6', 78.1'-78.6' DATE JUNE 1981
TECH. ____
REVIEWER ____ FILE 2801

FIGURE

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



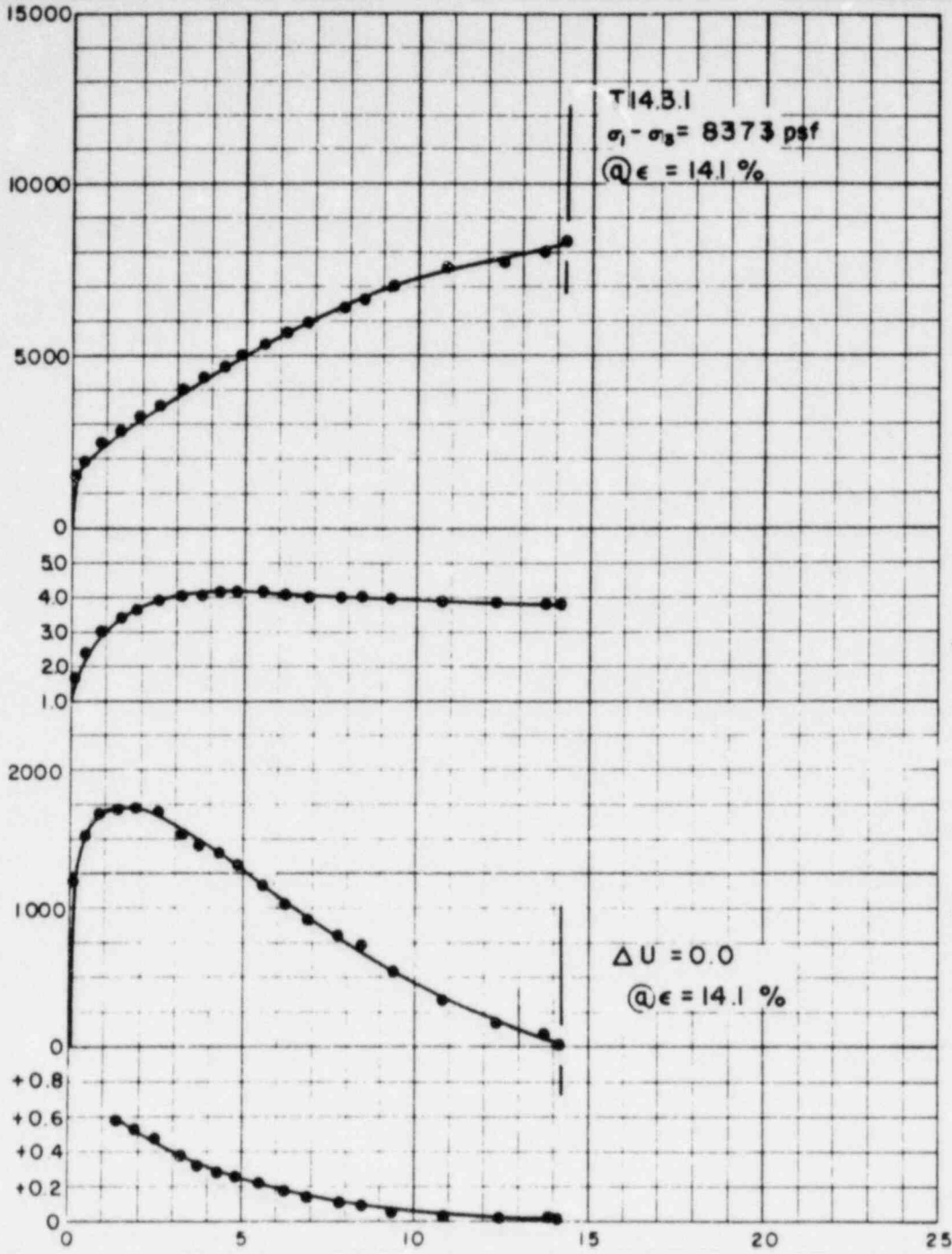
TEST No.	SYM.	BORING No.	DEPTH (ft)	INITIAL CONDITIONS			CONDITIONS BEFORE LOADING					FINAL CONDITIONS	
				w_o (%)	γ_d pcf	HT / DIA.	$\bar{\sigma}_3$, $\bar{\sigma}_3$ psf	u_i psf	ϵ_v (%)	β (%)	e_c	w_f (%)	γ_d pcf
T14.3.1	●	B4	78.9-79.4	29.5	94.2	6.00 / 2.87	2900	10080	3.09	96	.76	29.5	97.2
T14.3.2	■	B4	78.9-79.9	7.5	93.8	6.00 / 2.90	2900	11520	2.46	95	.78	26.5	96.1

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASS

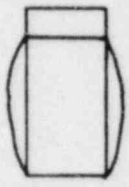
SUMMARY PLOT
MONOTONIC TRIAXIAL TESTS

DATE JULY 1981 FILE 2729

GOLDBERG-ZOINO & ASSOCIATES, INC.



SKETCHES AT FAILURE



TEST NO. T14.3.1

TEST NO. ____

TEST NO. ____

TEST NO. ____

* UNDISTURBED SAMPLE

TEST NO./SYMBOL	INITIAL CONDITIONS: INITIAL WATER CONTENT, %	INITIAL CONDITIONS: INITIAL DRY UNIT WEIGHT, pcf	INITIAL CONDITIONS: SAMPLE HEIGHT & DIAMETER, in	CONDITIONS BEFORE SHEAR: INITIAL STRESSES $\bar{\sigma}_1 = \bar{\sigma}_3$, psf	CONDITIONS BEFORE SHEAR: FINAL BACK PRESSURE, psf	CONDITIONS BEFORE SHEAR: VOLUMETRIC STRAIN, %	CONDITIONS BEFORE SHEAR: PORE PRESSURE RESPONSE, %	FINAL CONDITIONS: FINAL WATER CONTENT, %	FINAL CONDITIONS: FINAL DRY UNIT WEIGHT, pcf	RATE OF STRAIN, PERCENT PER MINUTE
T14 3.1 ●	26.8	94.2	2.80 2.87	2900	10080	3.09	96	29.5	97.2	1

SOIL DESCRIPTION: BROWN CLAYEY SILT *

LIQUID LIMIT 27 % PLASTIC LIMIT 25 % SPECIFIC GRAVITY ____

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

TRIAXIAL COMPRESSION TESTS (MONOTONIC)

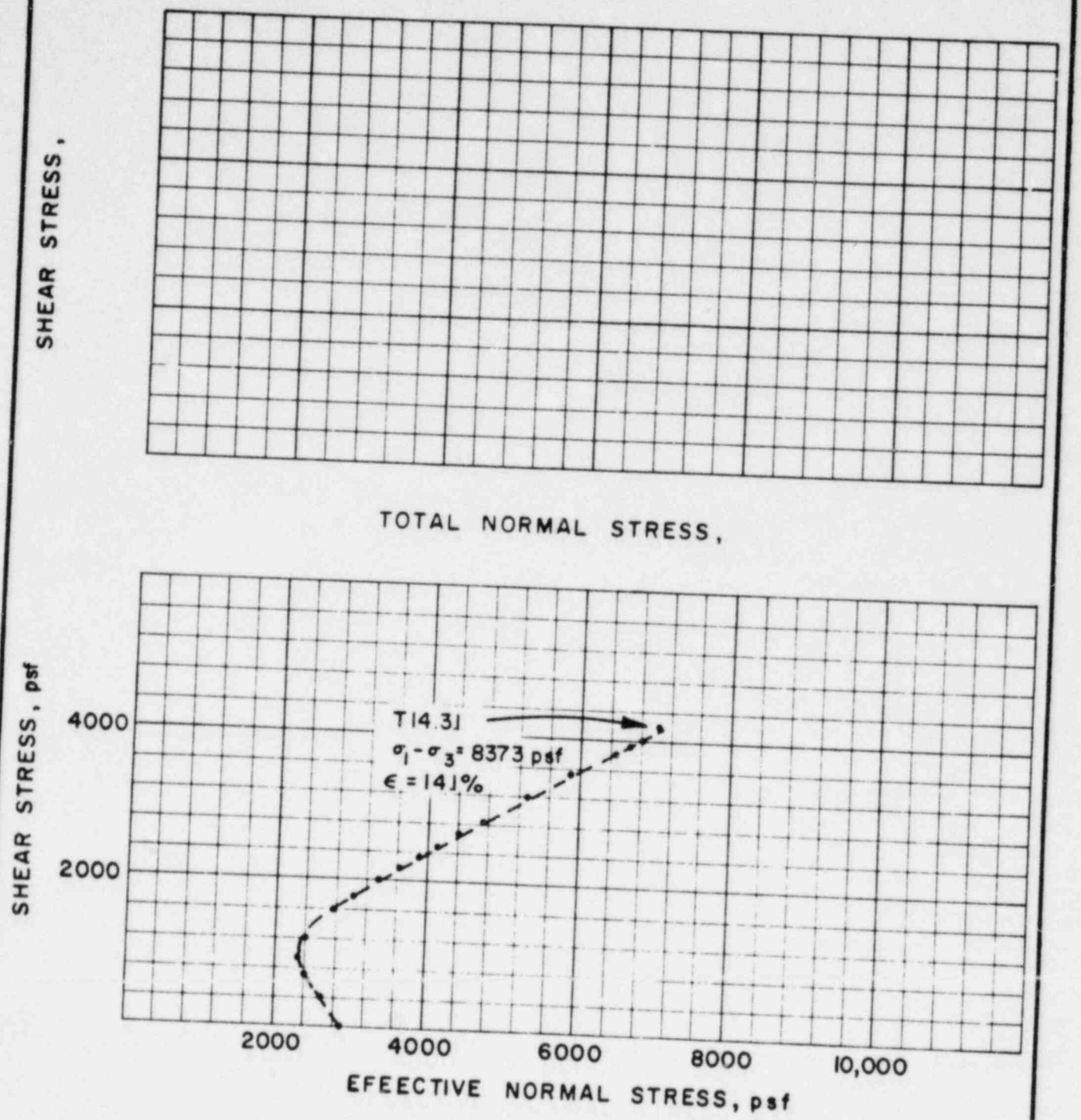
BORING NO. B4
SAMPLE UP6
DEPTH 79.0 - 79.5
TECH ____
REVIEWER ____

TEST SERIES NO. 14
DATE JULY 1981

FILE 2801

FIGURE T.9

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



SOIL DESCRIPTION: BROWN CLAYEY SILT

LIQUID LIMIT 27 % PLASTIC LIMIT 25 % SPECIFIC GRAVITY ____

FAILURE CRITERIA ____

REMARKS UNDISTURBED SAMPLE

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASS.

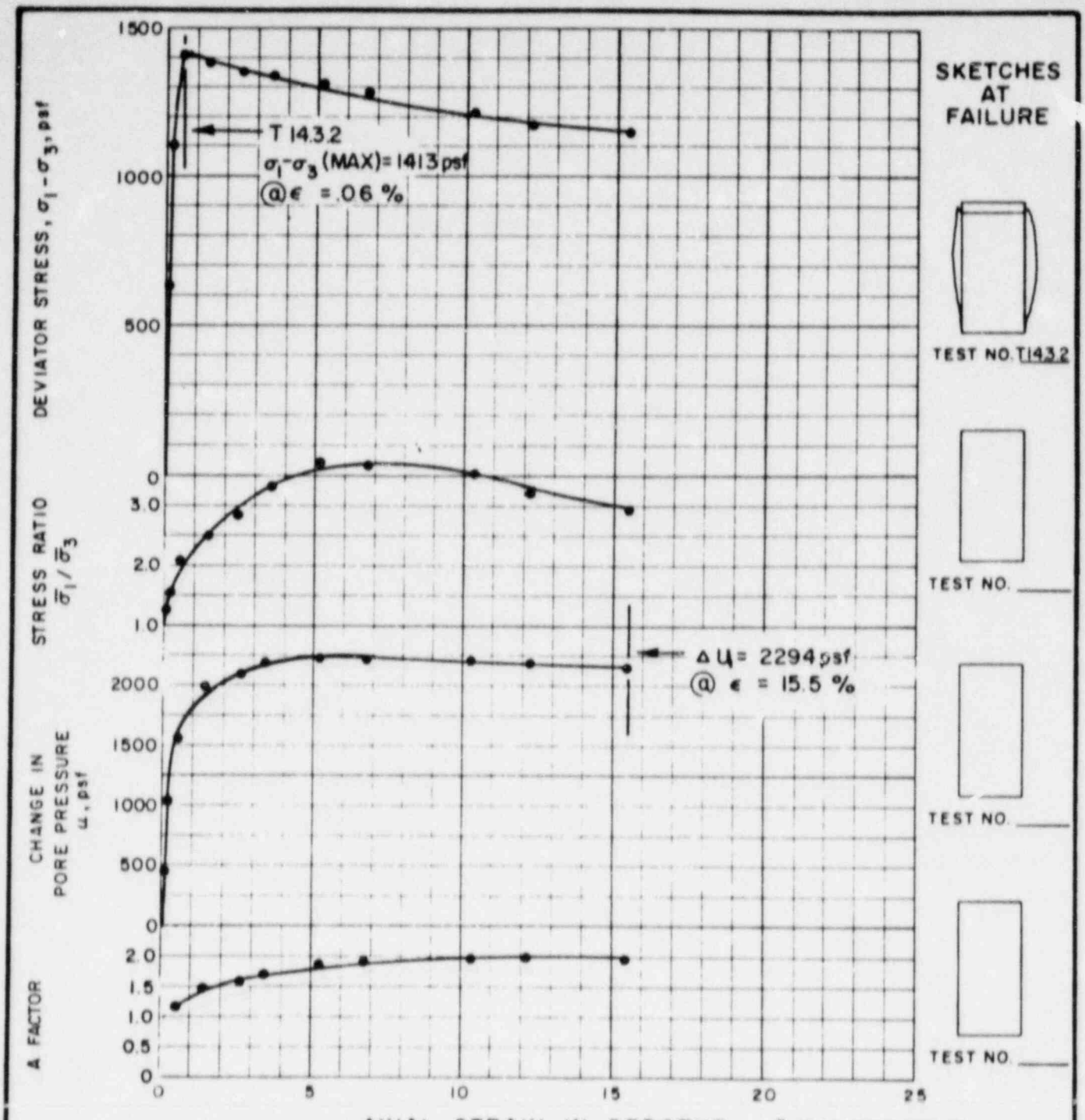
MOHR STRENGTH ENVELOPE
TRIAXIAL COMPRESSION TESTS (MONOTONIC)

BORING NO. B4
SAMPLE UP6
DEPTH 79.0' - 79.5'
TECH. ____
REVIEWER ____

TEST SERIES NO. 14
DATE JULY 1981
FILE 2801

FIGURE

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



* RECONSTITUTED TO e ~ 0.76 @ WATER CONTENT = 7.0 % *

TEST NO./SYMBOL	INITIAL CONDITIONS: INITIAL WATER CONTENT, %	INITIAL CONDITIONS: INITIAL DRY UNIT WEIGHT, pcf	INITIAL CONDITIONS: SAMPLE HEIGHT & DIAMETER, in	CONDITIONS BEFORE SHEAR: INITIAL STRESSES $\bar{\sigma}_1 = \bar{\sigma}_3$, psf	CONDITIONS BEFORE SHEAR: FINAL BACK PRESSURE, psf	CONDITIONS BEFORE SHEAR: VOLUMETRIC STRAIN, %	CONDITIONS BEFORE SHEAR: PORE PRESSURE RESPONSE, %	FINAL CONDITIONS: FINAL WATER CONTENT, %	FINAL CONDITIONS: FINAL DRY UNIT WEIGHT, pcf	RATE OF STRAIN, PERCENT PER MINUTE
T143	7.5	93.8	2.80	2900	11520	2.46	95	26.5	96.1	-

SOIL DESCRIPTION BROWN CLAYEY SILT

LIQUID LIMIT 27 % PLASTIC LIMIT 25 % SPECIFIC GRAVITY ____

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

TRIAXIAL COMPRESSION TESTS (MONOTONIC)

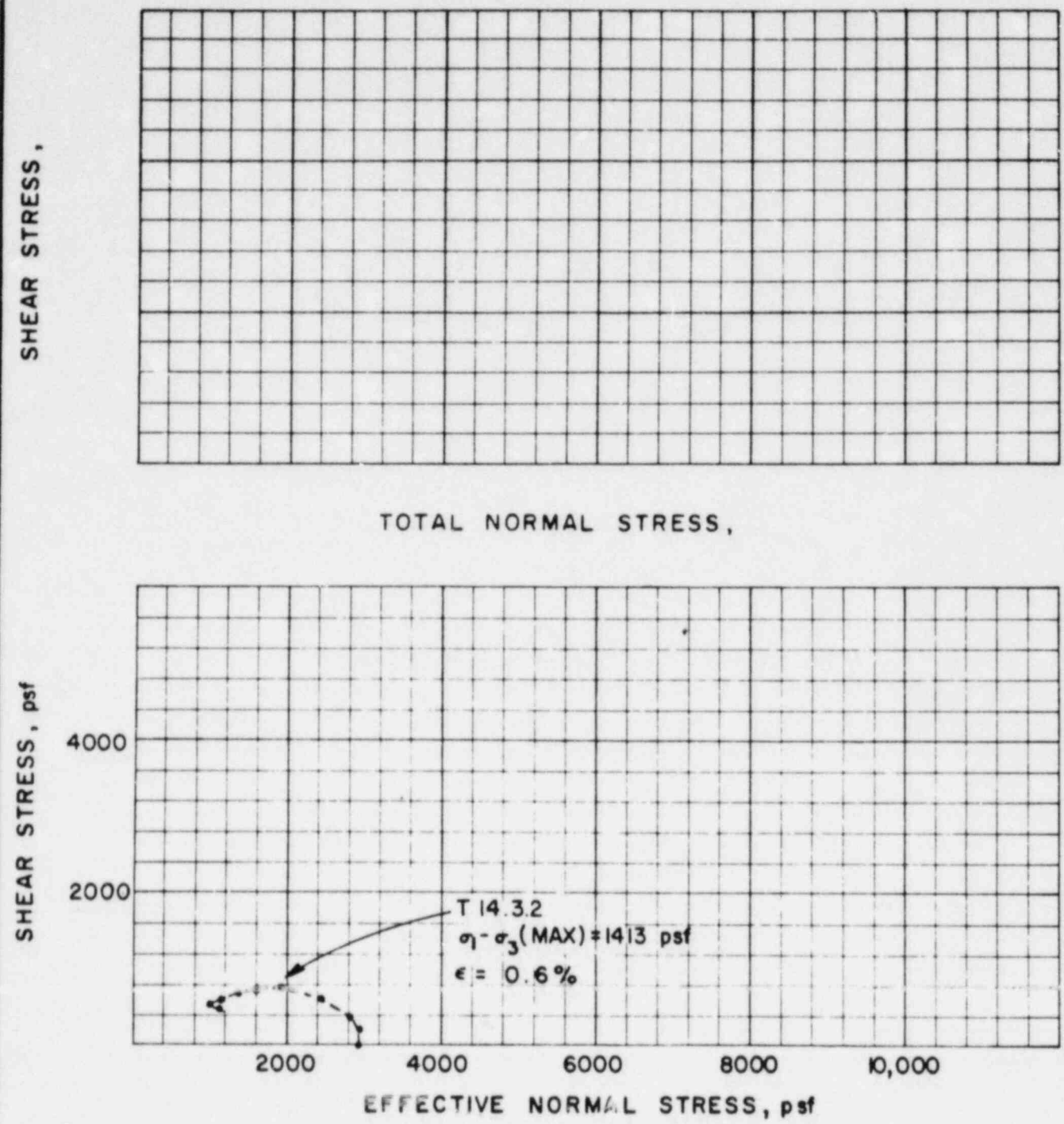
BORING NO. B4
SAMPLE UP6
DEPTH 78.9'-79.9'
TECH ____
REVIEWER ____

TEST SERIES NO. 14
DATE JUNE 1981

FILE 2801

FIGURE T.9

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



SOIL DESCRIPTION: BROWN CLAYEY SILT

LIQUID LIMIT 27 % PLASTIC LIMIT 25 % SPECIFIC GRAVITY ____

FAILURE CRITERIA ____

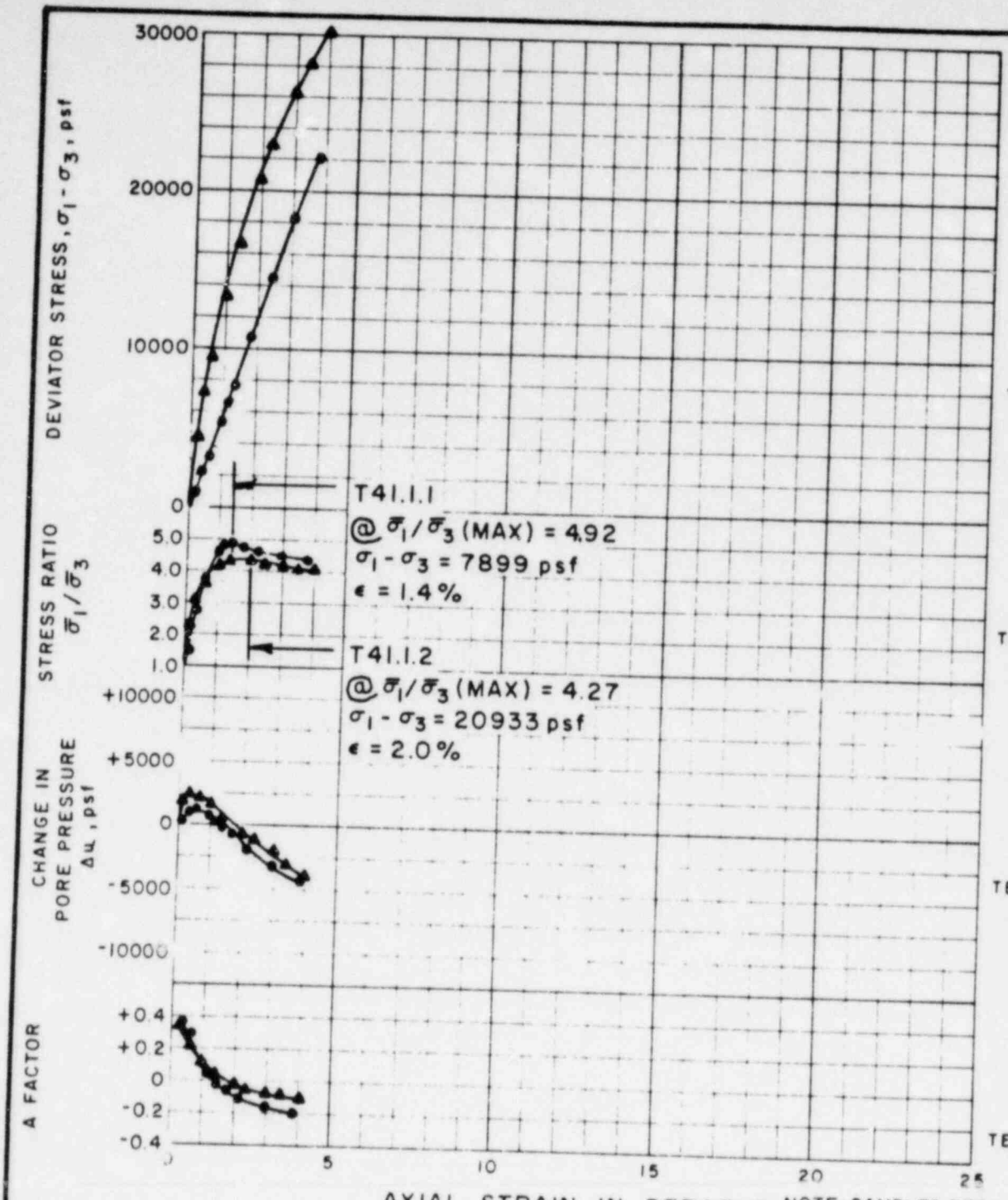
REMARKS RECONSTITUTED TO e~0.76 @ WATER CONTENT = 7.0%±

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASS

MOHR STRENGTH ENVELOPE
TRIAXIAL COMPRESSION TESTS (MONOTONIC)

BORING NO. B4 TEST SERIES NO. 14
SAMPLE UP6
DEPTH 78.9'-79.9' DATE JULY 1981
TECH. ____
REVIEWER ____ FILE 2801

FIGURE



SKETCHES AT FAILURE

TEST NO. T41.1.1

TEST NO. T41.1.2

TEST NO. ____

TEST NO. ____

NOTE: SAMPLES RECONSTITUTED TO γ_d = 110 pcf AT WATER CONTENT = 6% ±

TEST NO./SYMBOL	INITIAL CONDITIONS: INITIAL WATER CONTENT, %	INITIAL DRY UNIT WEIGHT, pcf	SAMPLE HEIGHT & DIAMETER, in.	CONDITIONS BEFORE SHEAR: INITIAL STRESSES $\bar{\sigma}_1 = \bar{\sigma}_3$ psf	FINAL BACK PRESSURE, psf	VOLUMETRIC STRAIN, %	PORE PRESSURE RESPONSE, %	FINAL CONDITIONS: FINAL WATER CONTENT, %	FINAL DRY UNIT WEIGHT, pcf	RATE OF STRAIN, PERCENT PER MINUTE
T41.1.1 ●	5.6	109.6	4.00 2.00	2002	11520	0.45	99	20.6	110.9	0.15
T41.1.2 ▲	5.9	110.1	4.00 2.00	6000	10080	0.95	96	20.0	111.1	0.15

SOIL DESCRIPTION: GREY FINE TO MEDIUM SAND TRACE SILT

LIQUID LIMIT ____ % PLASTIC LIMIT ____ % SPECIFIC GRAVITY ____

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

TRIAXIAL COMPRESSION TESTS ($\overline{CIU}$)

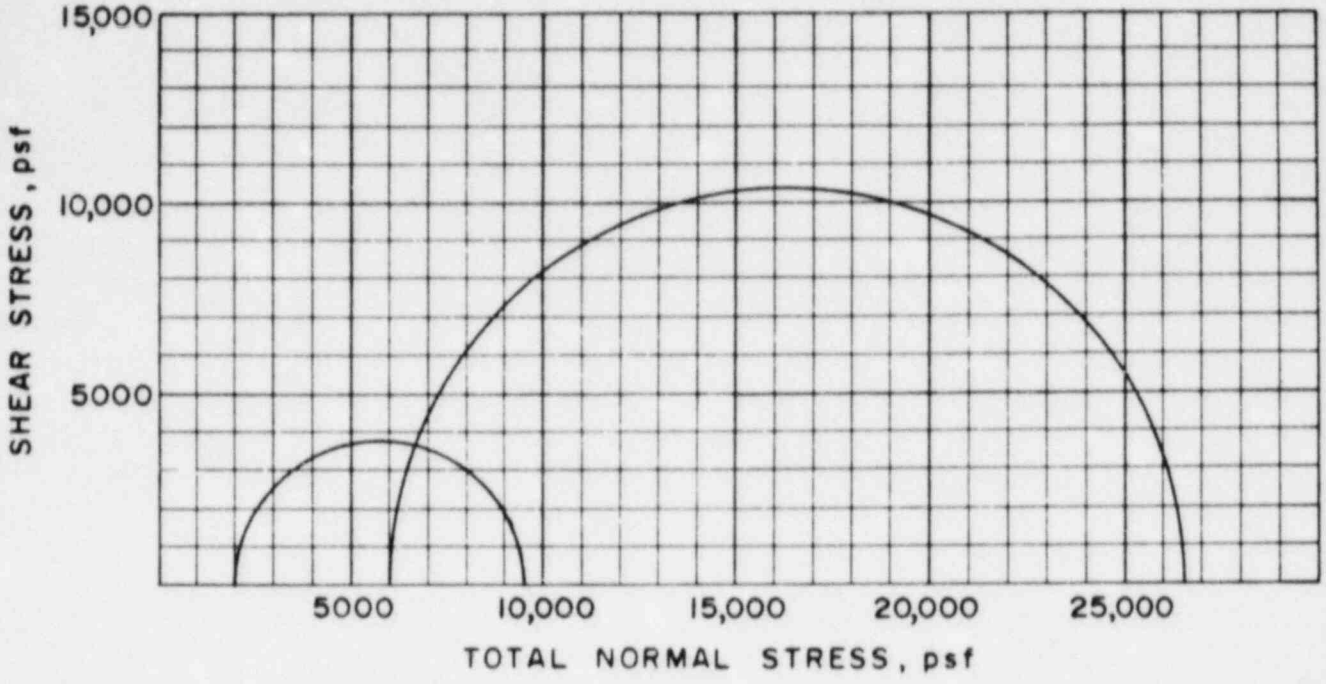
BORING NO. B8
SAMPLE SS11
DEPTH 50.0'-55.0'
TECH ____
REVIEWER ____

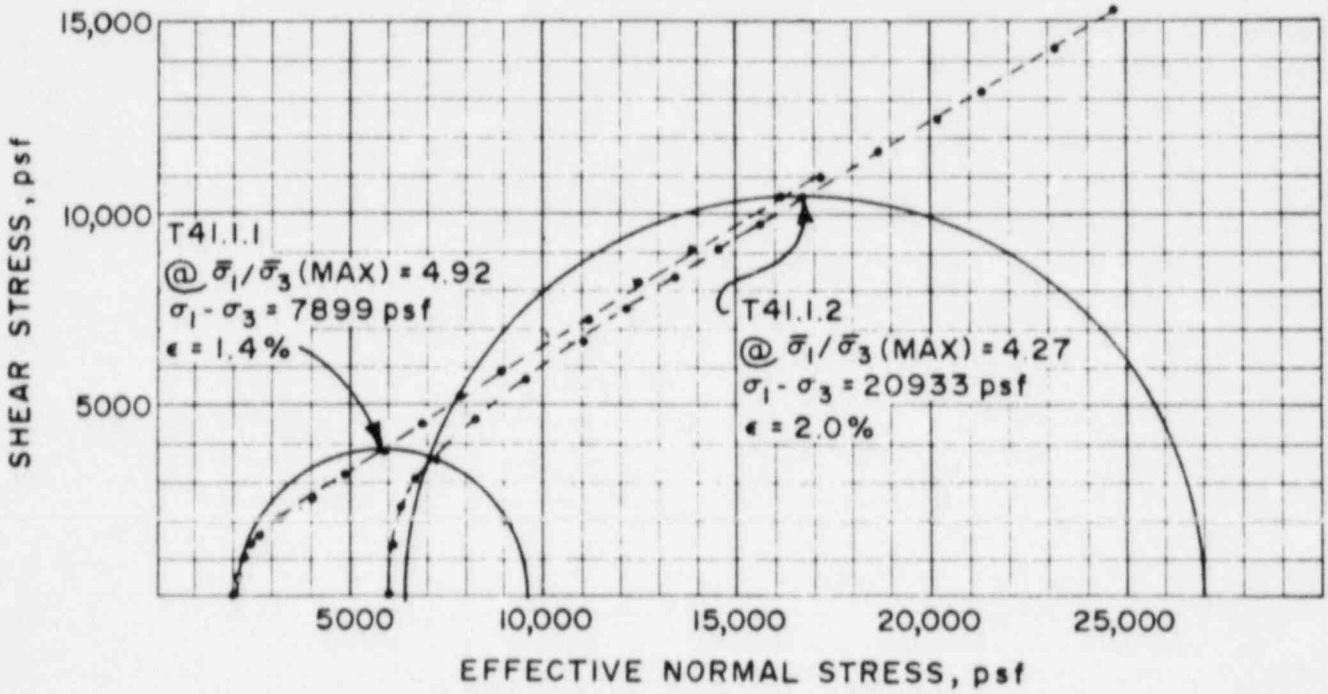
TEST SERIES NO. 41
DATE JUNE 1981

FILE 2801

FIGURE

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS





SOIL DESCRIPTION GREY FINE TO MEDIUM SAND, TRACE SILT

LIQUID LIMIT ____ % PLASTIC LIMIT ____ % SPECIFIC GRAVITY ____

FAILURE CRITERIA $\bar{\sigma}_1/\bar{\sigma}_3$ (MAX)

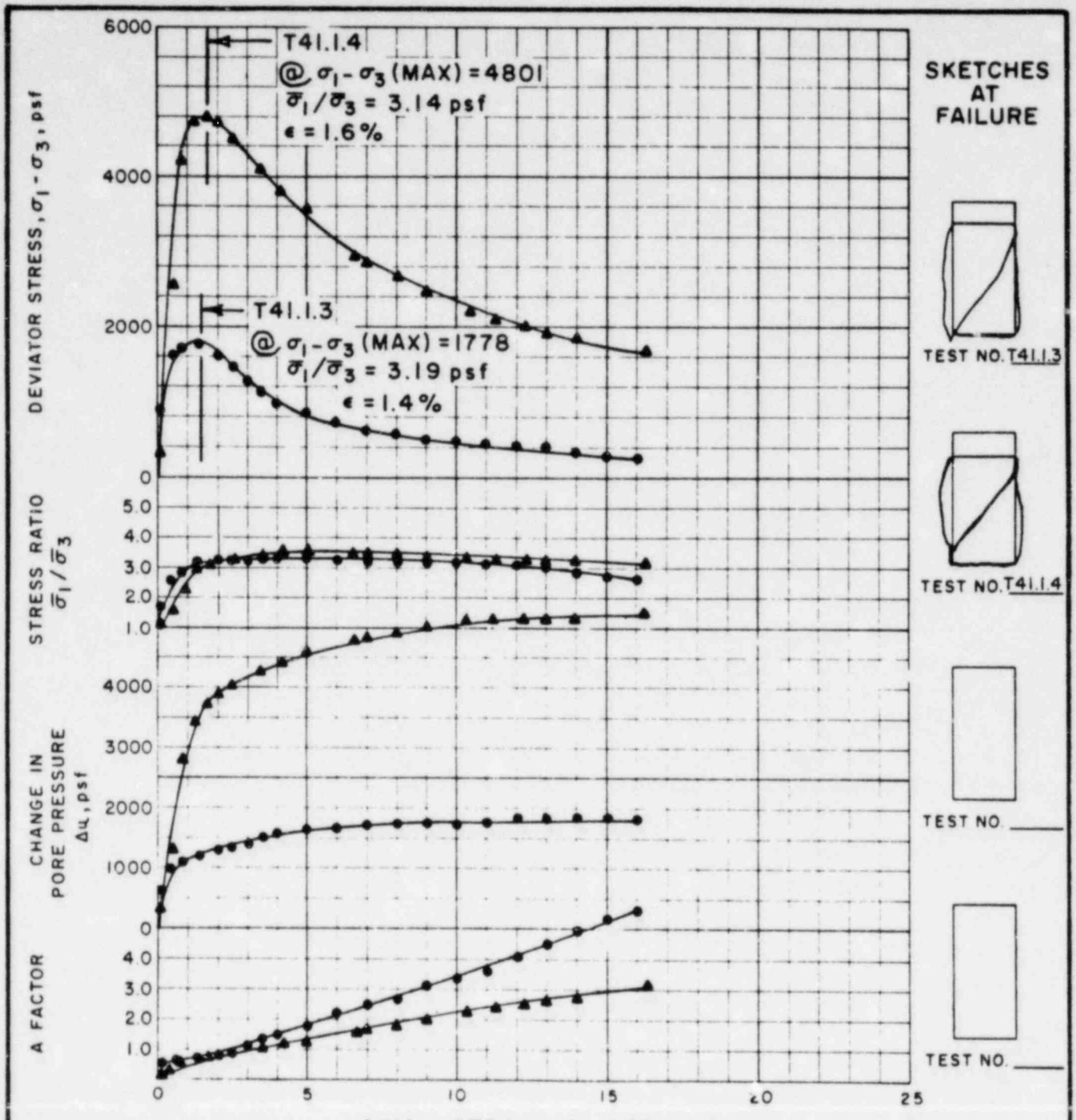
REMARKS SAMPLES RECONSTITUTED TO γ_d = 110 pcf @ WATER CONTENT = 6%±

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS
MOHR STRENGTH ENVELOPE
TRIAXIAL COMPRESSION TESTS (CIU)

BORING NO. 88 TEST SERIES NO. 41
SAMPLE SS11
DEPTH 50.0'-55.0' DATE JUNE 1981
TECH. ____
REVIEWER ____ FILE 2801

FIGURE

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



NOTE: SAMPLE RECONSTITUTED TO γ_d = 100 pcf @ WATER CONTENT = 6.5%

TEST NO./SYMBOL	INITIAL CONDITIONS: INITIAL WATER CONTENT, %	INITIAL DRY UNIT WEIGHT, pcf	SAMPLE HEIGHT & DIAMETER, in.	CONDITIONS BEFORE SHEAR: INITIAL STRESSES $\bar{\sigma}_1 = \bar{\sigma}_3$, psf	FINAL BACK PRESSURE, psf	VOLUMETRIC STRAIN, %	PORE PRESSURE RESPONSE, %	FINAL CONDITIONS: FINAL WATER CONTENT, %	FINAL DRY UNIT WEIGHT, pcf	RATE OF STRAIN, PERCENT PER MINUTE
T41.1.4 ●	6.8	99.1	2.8 DIA. 5.6	2002	10080	0.69	94	24.9	99.8	0.15
T41.1.3 ▲	6.7	99.3	2.8 DIA. 5.6	6000	10080	1.3	99	23.9	100.7	0.15

SOIL DESCRIPTION: GREY FINE TO MEDIUM SAND, TRACE SILT

LIQUID LIMIT ___ - ___ % PLASTIC LIMIT ___ - ___ % SPECIFIC GRAVITY ____

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

TRIAXIAL COMPRESSION TESTS ($\overline{CIU}$)

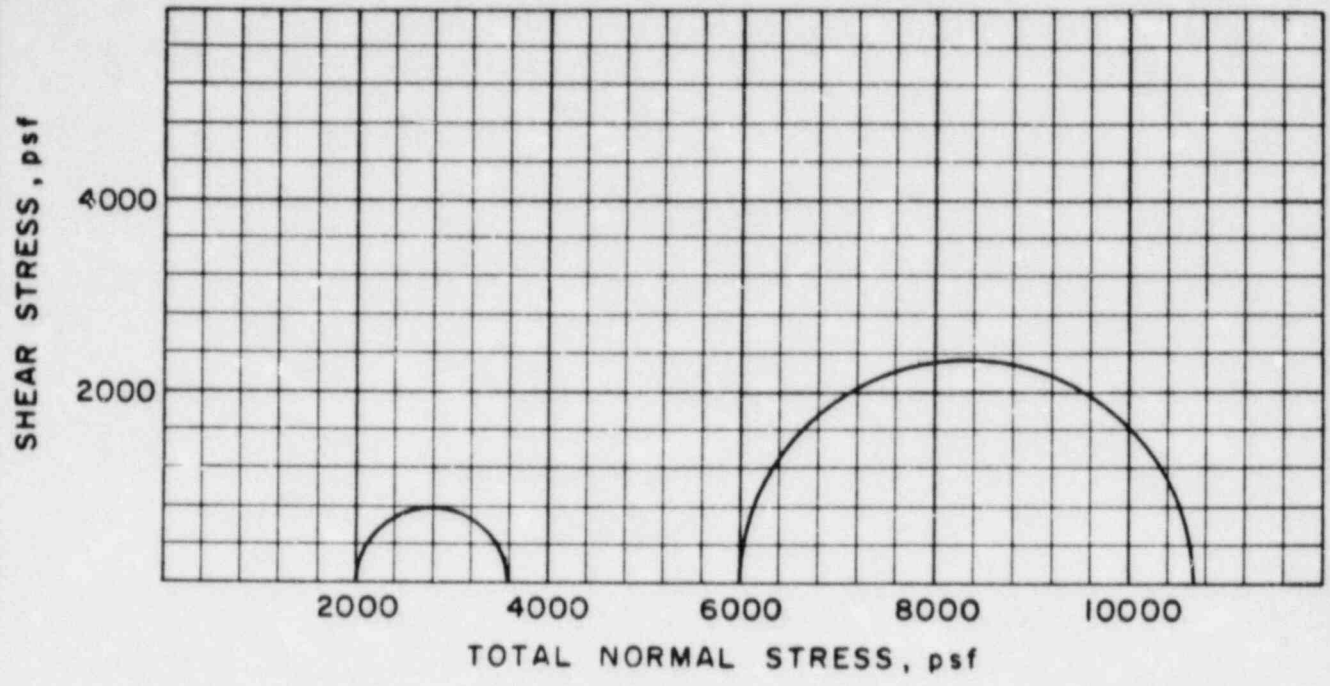
BORING NO. B8
SAMPLE SS11
DEPTH 50.0'-55.0'
TECH. ____
REVIEWER ____

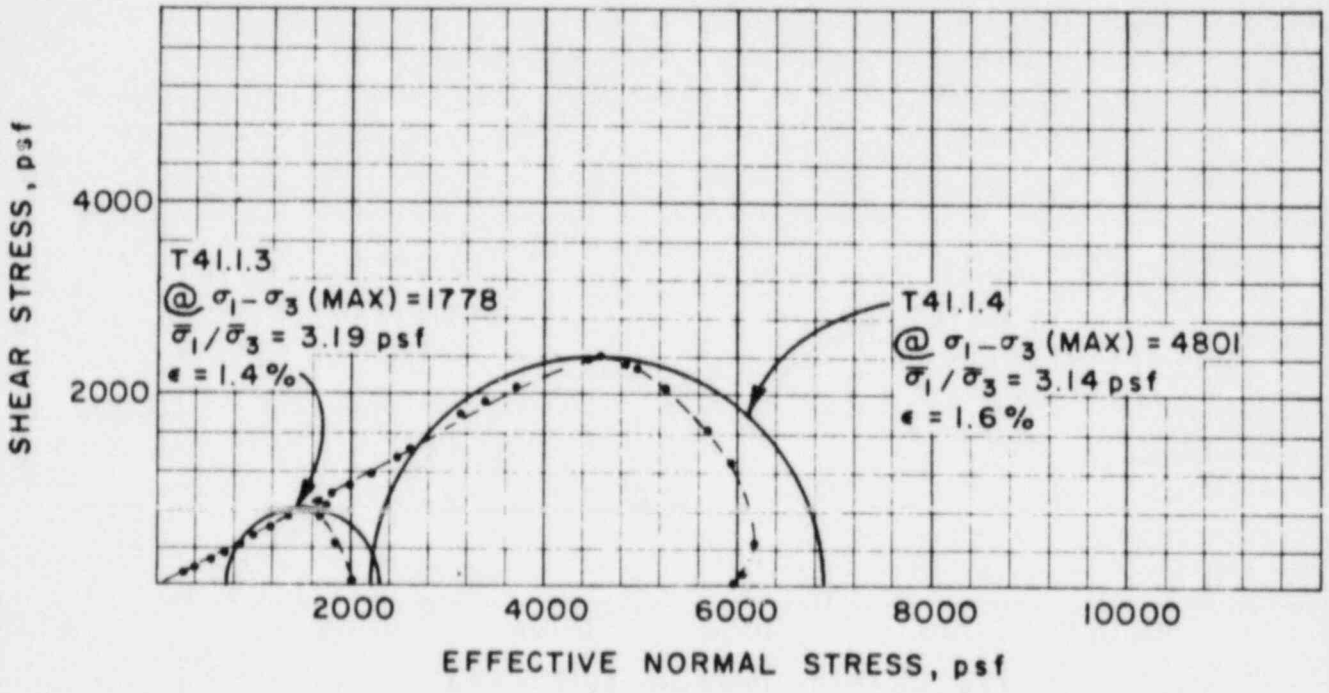
TEST SERIES NO. 41
DATE JUNE 1981

FILE 2801

FIGURE T.9

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS





SOIL DESCRIPTION: GREY FINE TO MEDIUM SAND, TRACE SILT

LIQUID LIMIT ____ % PLASTIC LIMIT ____ % SPECIFIC GRAVITY ____

FAILURE CRITERIA $\sigma_1 - \sigma_3$ (MAX)

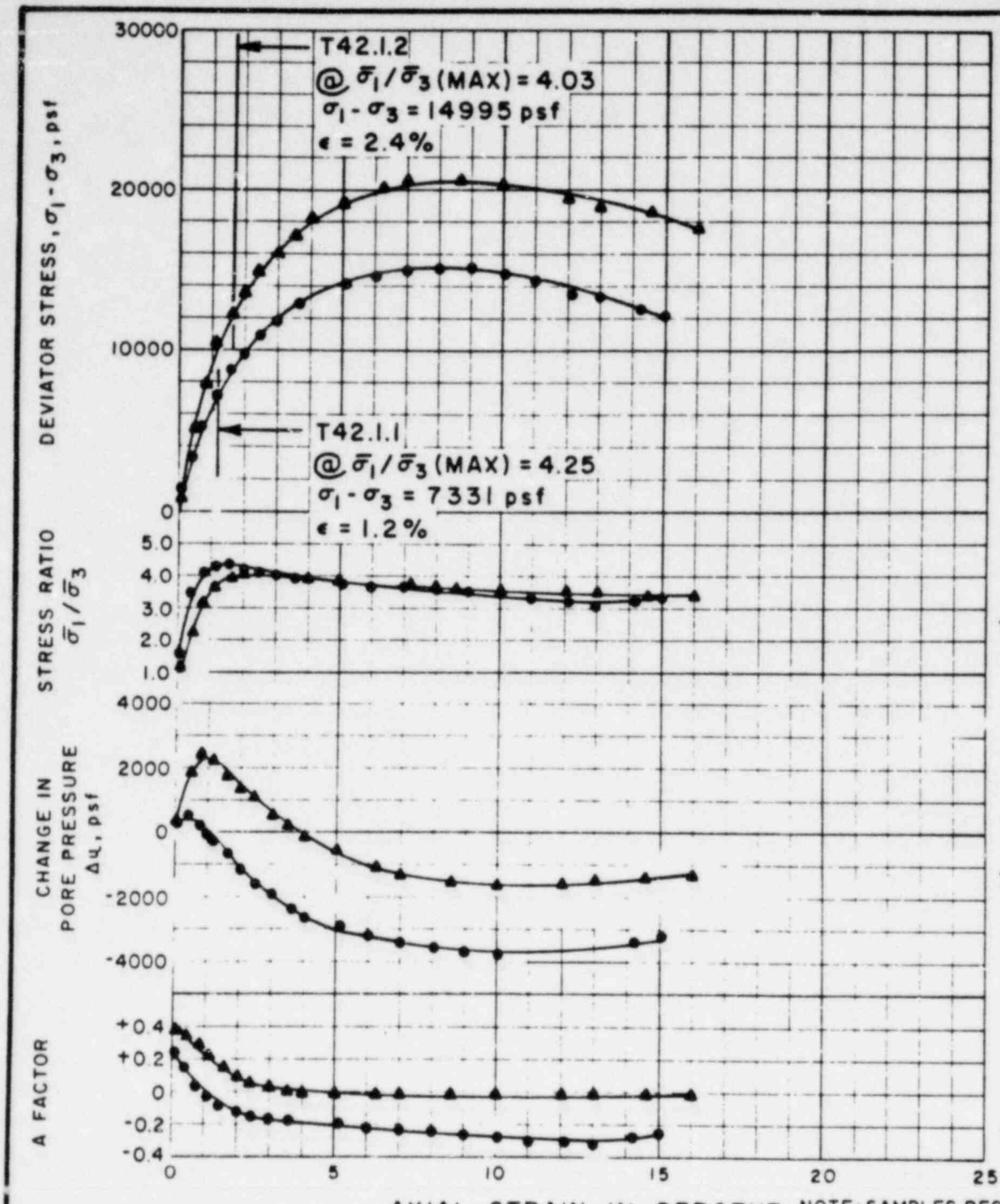
REMARKS SAMPLE RECONSTITUTED TO γ_d = 100 pcf @ WATER CONTENT = 6.5%

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS
MOHR STRENGTH ENVELOPE
TRIAXIAL COMPRESSION TESTS ($\overline{CIU}$)

BORING NO. B8
SAMPLE SS11
DEPTH 50.0'-55.0'
TECH. ____
REVIEWER ____

TEST SERIES NO. 41
DATE JUNE 1981
FILE 2801

FIGURE



SKETCHES AT FAILURE

TEST NO. T42.1.1

TEST NO. T42.1.2

TEST NO. ____

TEST NO. ____

NOTE: SAMPLES RECONSTITUTED TO γ_d = 110 pcf @ WATER CONTENT = 6.5%

TEST NO./SYMBOL	INITIAL CONDITIONS: INITIAL WATER CONTENT, %	INITIAL CONDITIONS: INITIAL DRY UNIT WEIGHT, pcf	INITIAL CONDITIONS: SAMPLE HEIGHT & DIAMETER, in.	CONDITIONS BEFORE SHEAR: INITIAL STRESSES $\bar{\sigma}_3$, psf	CONDITIONS BEFORE SHEAR: FINAL BACK PRESSURE, psf	CONDITIONS BEFORE SHEAR: VOLUMETRIC STRAIN, %	CONDITIONS BEFORE SHEAR: PORE PRESSURE RESPONSE, %	FINAL CONDITIONS: FINAL WATER CONTENT, %	FINAL CONDITIONS: FINAL DRY UNIT WEIGHT, pcf	RATE OF STRAIN, PERCENT PER MINUTE
T42 1-●	6.6	109.3	2.00 4.00	2002	10080	0.33	95	19.6	109.7	0.15
T42 2-▲	6.3	109.7	2.00 4.00	6005	15840	0.99	94	20.0	110.8	0.15

SOIL DESCRIPTION: * GREY FINE TO MEDIUM SAND, LITTLE (†) SILT

LIQUID LIMIT ___ - ___ % PLASTIC LIMIT ___ - ___ % SPECIFIC GRAVITY ___

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

TRIAXIAL COMPRESSION TESTS ($\overline{CIU}$)

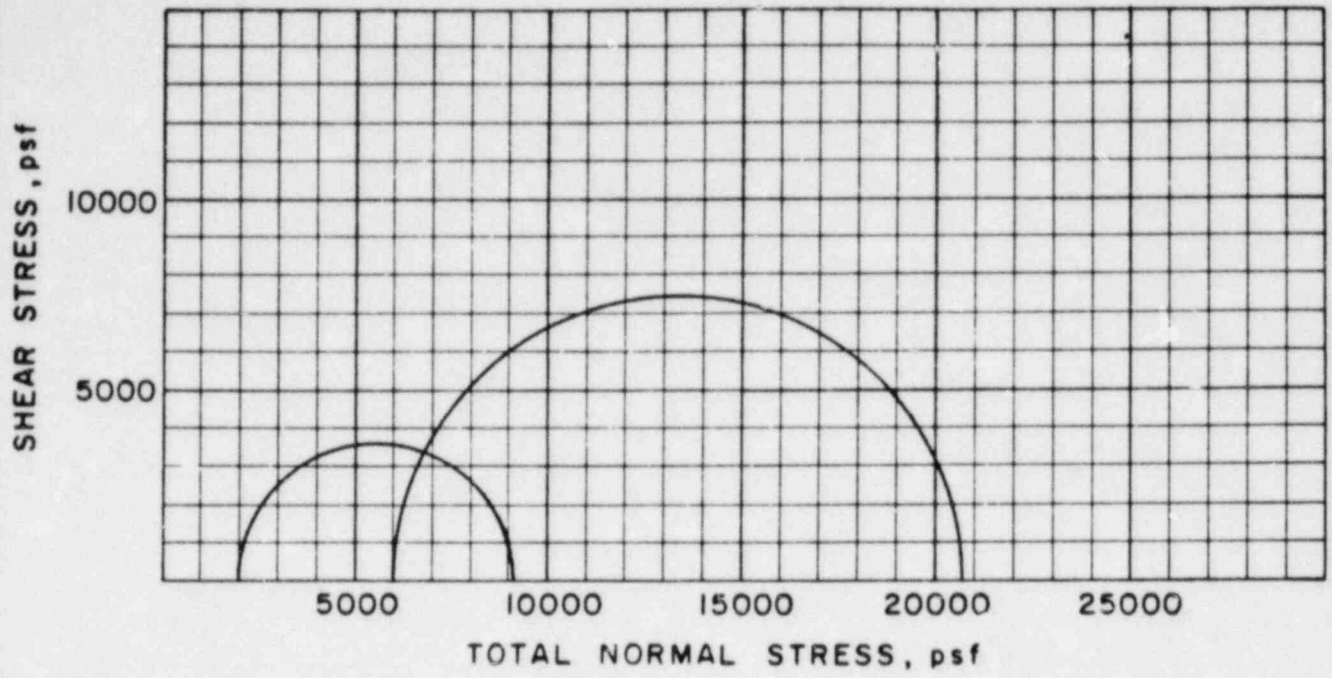
BORING NO. B5
SAMPLE SS10
DEPTH 41.5'-45.0'
TECH. ____
REVIEWER ____

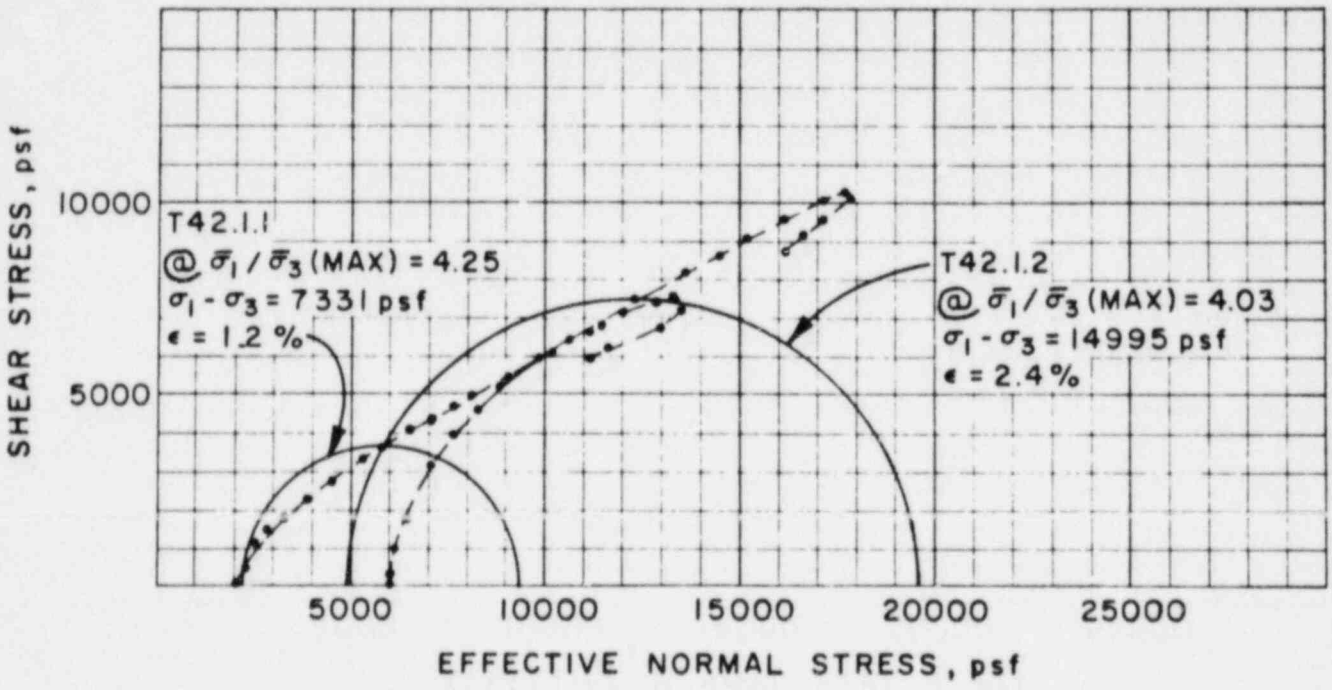
TEST SERIES NO. 42
DATE JUNE 1981

FILE 2801

FIGURE T.9

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS





SOIL DESCRIPTION: GREY FINE TO MEDIUM SAND, LITTLE SILT

LIQUID LIMIT - % PLASTIC LIMIT - % SPECIFIC GRAVITY -

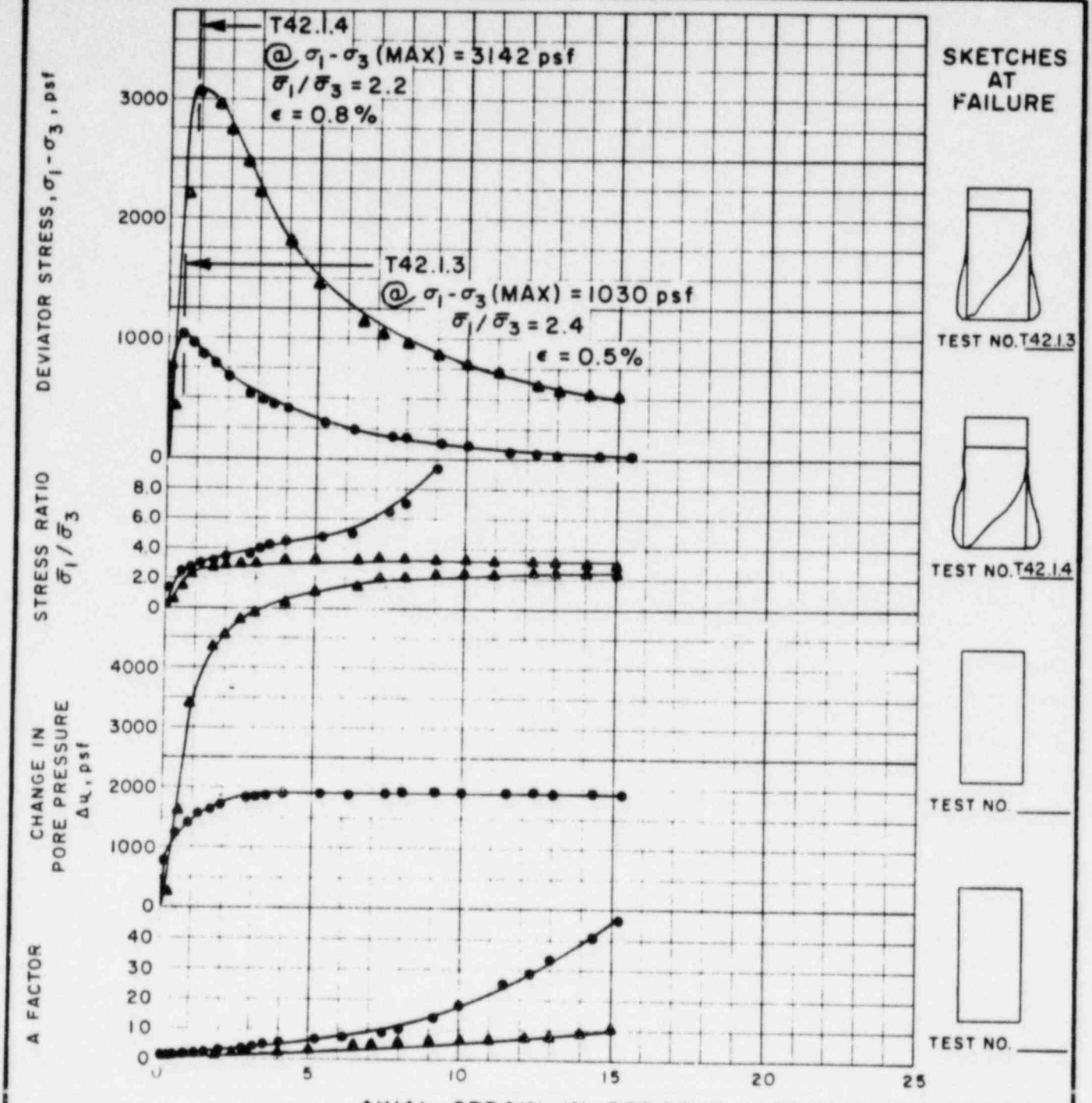
FAILURE CRITERIA @ $\bar{\sigma}_1 / \bar{\sigma}_3$ (MAX)

REMARKS SAMPLE RECONSTITUTED TO γ_d = 110 pcf @ WATER CONTENT = 6.5%

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS
MOHR STRENGTH ENVELOPE
TRIAXIAL COMPRESSION TESTS ($\overline{CIU}$)

BORING NO. B5 TEST SERIES NO. 42
SAMPLE SS10 DATE JUNE 1981
DEPTH 41.5'-45.0'
TECH.
REVIEWER FILE 2801

FIGURE



NOTE: SAMPLE RECONSTITUTED TO γ_d = 100 pcf @ WATER CONTENT = 6.5%

TEST NO./SYMBOL	INITIAL CONDITIONS: INITIAL WATER CONTENT, %	INITIAL DRY UNIT WEIGHT, pcf	SAMPLE HEIGHT & DIAMETER, in.	CONDITIONS BEFORE SHEAR: INITIAL STRESSES $\bar{\sigma}_1 = \bar{\sigma}_3$, psf	FINAL BACK PRESSURE, psf	VOLUMETRIC STRAIN, %	PORE PRESSURE RESPONSE, %	FINAL CONDITIONS: FINAL WATER CONTENT, %	FINAL DRY UNIT WEIGHT, pcf	RATE OF STRAIN, PERCENT PER MINUTE
T42.1.3 ●	6.6	99.4	2.8 x 1.4	2002	10080	0.80	99	22.9	100.3	0.15
T42.1.4 ▲	6.6	99.4	2.8 x 1.4	6005	10080	2.35	98	22.2	101.8	0.15

SOIL DESCRIPTION: GREY FINE TO MEDIUM SAND, LITTLE (f) SILT

LIQUID LIMIT ___ % PLASTIC LIMIT ___ % SPECIFIC GRAVITY ___

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

TRIAXIAL COMPRESSION TESTS ($\overline{CIU}$)

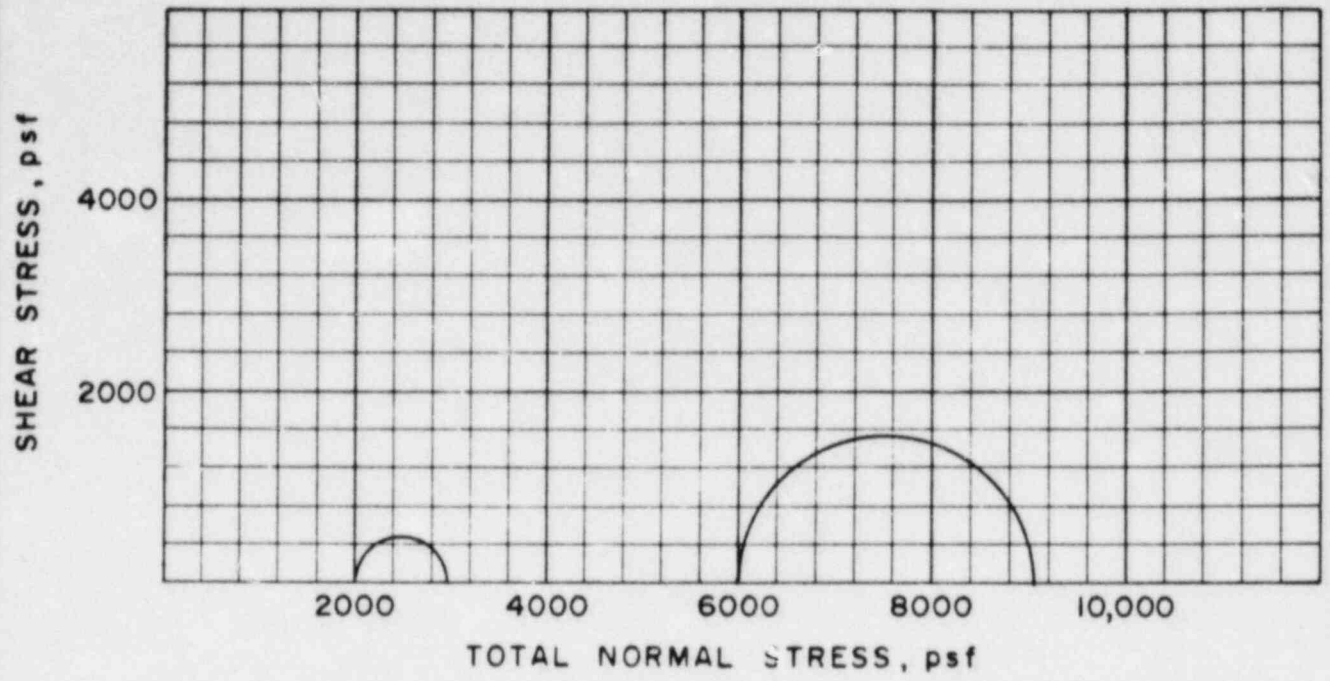
BORING NO. B5
SAMPLE SS10
DEPTH 41.5'-45.0'
TECH. ____
REVIEWER ____

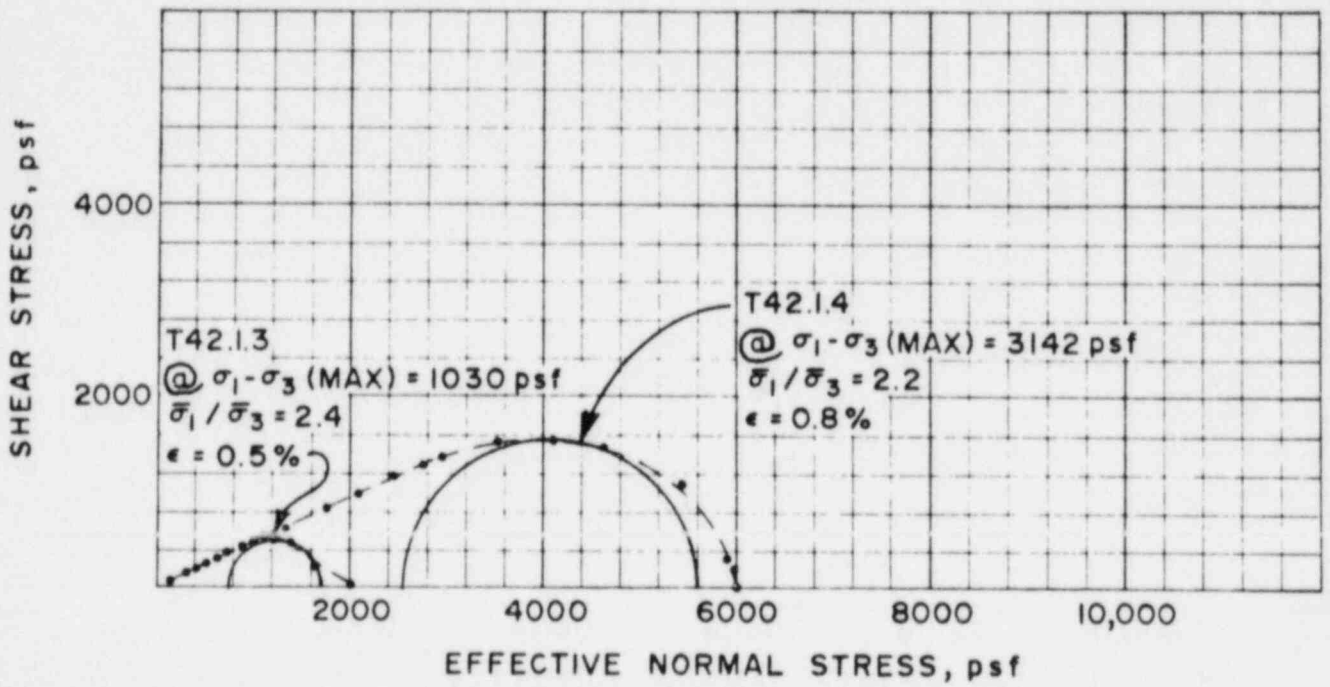
TEST SERIES NO. 42
DATE JUNE 1981

FILE 2801

FIGURE T.9

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS





SOIL DESCRIPTION: GREY FINE TO MEDIUM SAND, LITTLE SILT

LIQUID LIMIT - % PLASTIC LIMIT - % SPECIFIC GRAVITY -

FAILURE CRITERIA $\sigma_1 - \sigma_3$ (MAX)

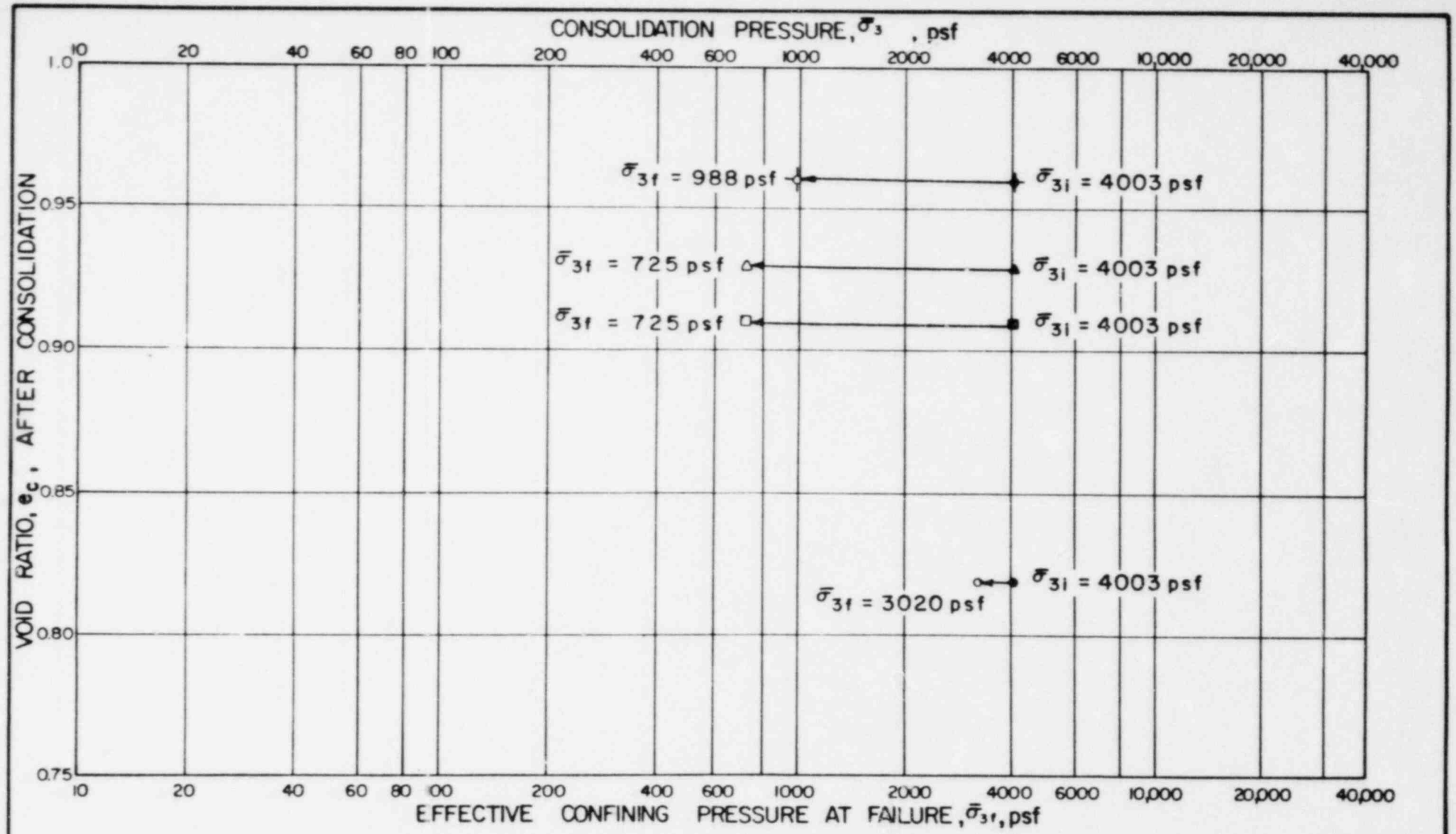
REMARKS SAMPLE RECONSTITUTED TO γ_d = 100 pcf @ WATER CONTENT = 6.5%±

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS
MOHR STRENGTH ENVELOPE
TRIAXIAL COMPRESSION TESTS ($\overline{CIU}$)

BORING NO. B5
SAMPLE S10
DEPTH 41.5' - 45.0'
TECH.
REVIEWER

TEST SERIES NO. 42
DATE JUNE 1981
FILE 2801

FIGURE



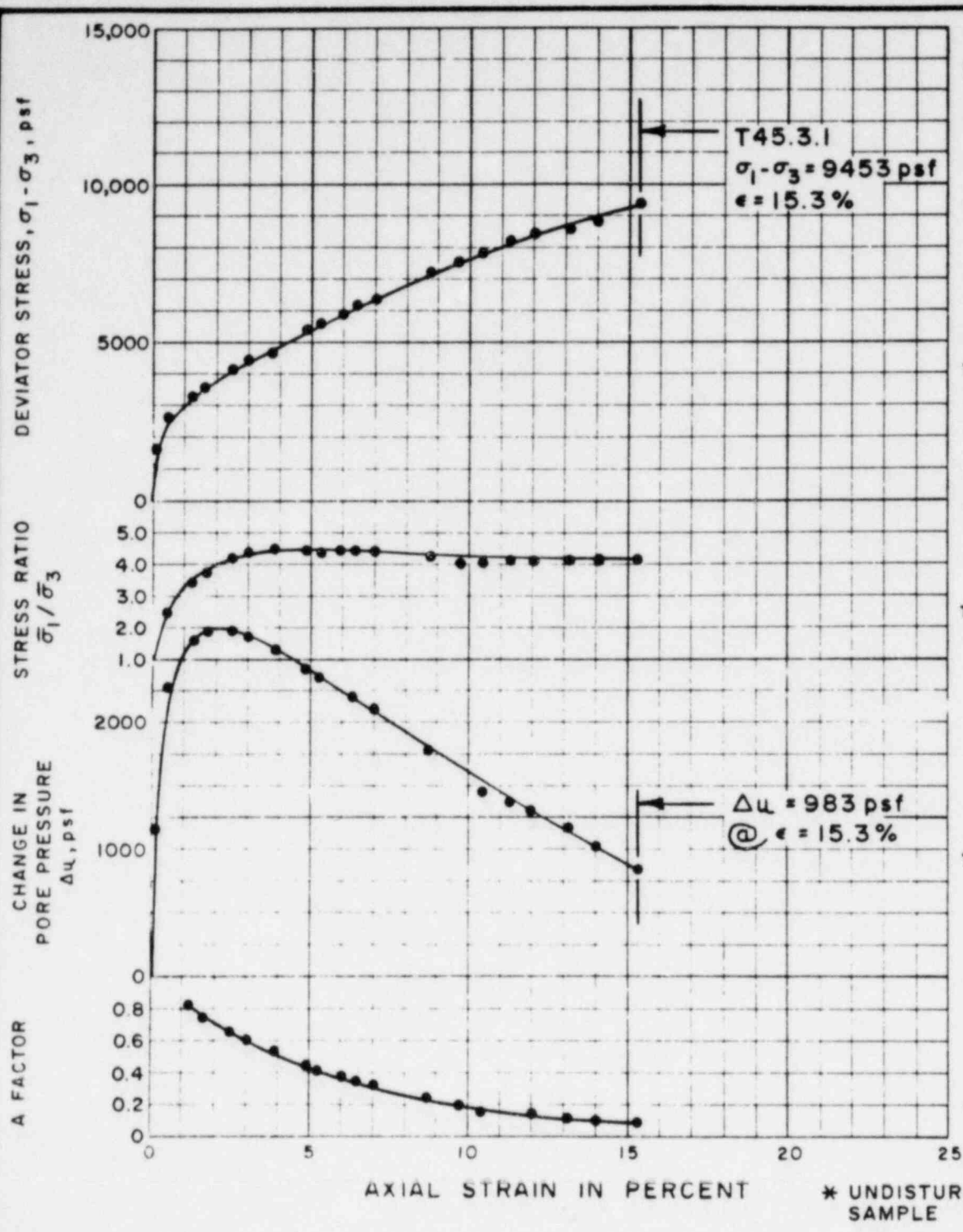
TEST No.	SYM.	BORING No.	DEPTH (ft.)	INITIAL CONDITIONS			CONDITIONS BEFORE LOADING					FINAL CONDITIONS	
				w_N (%)	γ_d pcf	HT / DIA.	$\bar{\sigma}_1 - \bar{\sigma}_3$ psf	u_b psf	ϵ_v (%)	B (%)	e_c	w_N (%)	γ_d pcf
T45.3.1	●	B7	62.1-62.6	32.8	89.3	6.00 / 2.87	4003	7200	2.94	96	.82	29.2	92.0
T45.3.2	✦	B7	62.0-63.9	7.3	82.8	6.00 / 2.90	4003	10080	3.50	94	.96	31.3	85.7
T45.3.3	■	B7	62.0-63.9	7.8	85.4	6.00 / 2.90	4003	12240	3.02	95	.91	30.4	88.0
T45.3.4	▲	B7	62.0-63.9	7.6	83.5	6.00 / 2.90	4003	7200	3.18	95	.93	31.9	86.8

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASS.

SUMMARY PLOT
MONOTONIC TRIAXIAL TESTS

DATE JULY 1981 FILE 2801

GOLDBERG-ZOINO & ASSOCIATES, INC.



* UNDISTURBED SAMPLE

TEST NO./SYMBOL	INITIAL CONDITIONS: INITIAL WATER CONTENT, %	INITIAL CONDITIONS: INITIAL DRY UNIT WEIGHT, pcf	INITIAL CONDITIONS: SAMPLE HEIGHT & DIAMETER, in.	CONDITIONS BEFORE SHEAR: INITIAL STRESSES $\bar{\sigma}_1=\bar{\sigma}_3$, psf	CONDITIONS BEFORE SHEAR: FINAL BACK PRESSURE, psf	CONDITIONS BEFORE SHEAR: VOLUMETRIC STRAIN, %	CONDITIONS BEFORE SHEAR: PORE PRESSURE RESPONSE, %	FINAL CONDITIONS: FINAL WATER CONTENT, %	FINAL CONDITIONS: FINAL DRY UNIT WEIGHT, pcf	RATE OF STRAIN, PERCENT PER MINUTE
T45 3.1 ●	32.8	89.3	6.00 2.87	4003	7200	2.94	96	29.2	92.0	·

SOIL DESCRIPTION: GREY BROWN CLAYEY SILT *

LIQUID LIMIT 36 % PLASTIC LIMIT 34 % SPECIFIC GRAVITY 2.69

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASS.

TRIAXIAL COMPRESSION TESTS (MONOTONIC)

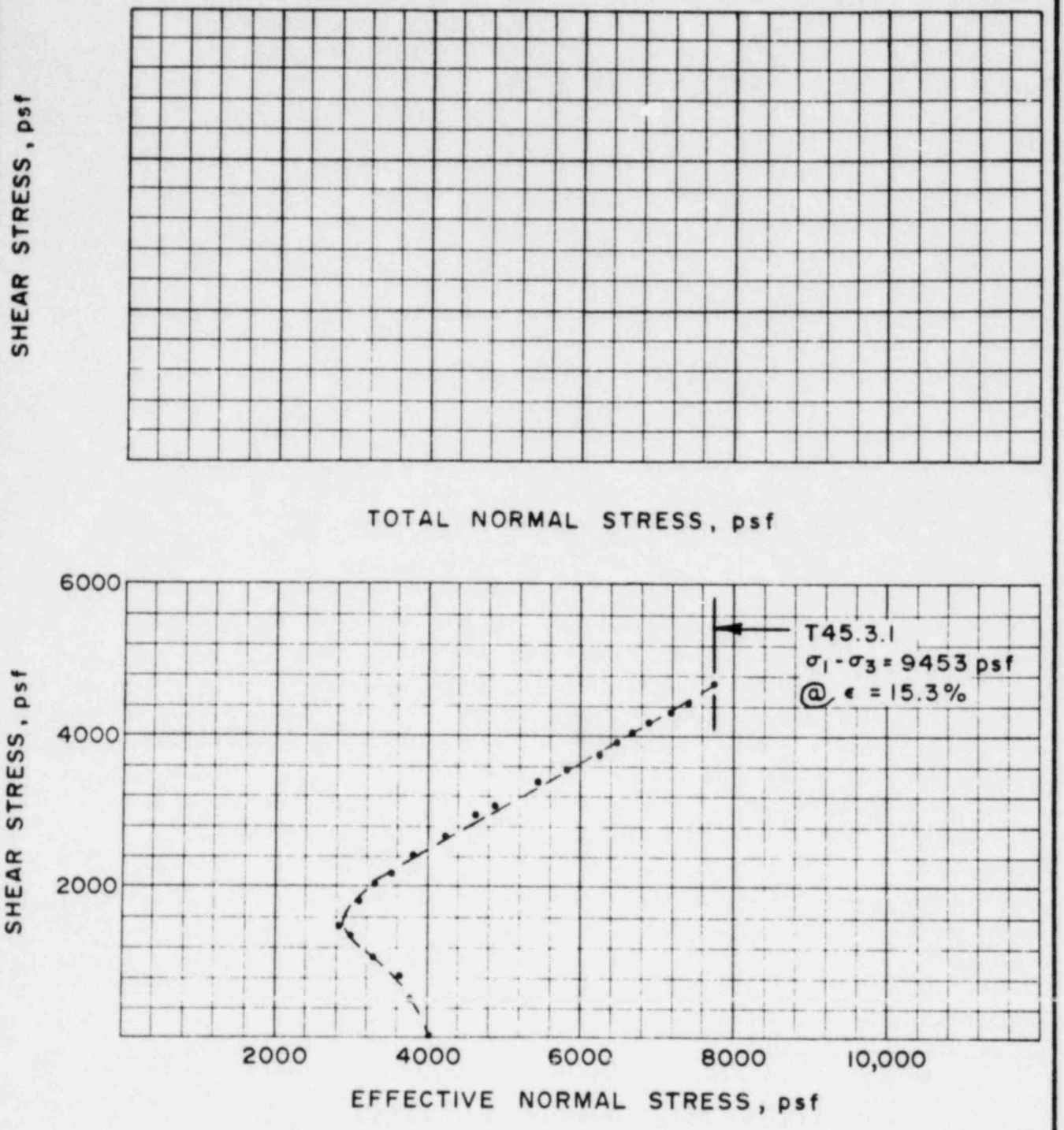
BORING NO. B7
SAMPLE UP2
DEPTH 62.1' - 62.6'
TECH. ____
REVIEWER ____

TEST SERIES NO. 45
DATE JUNE 1981

FILE 2801

FIGURE T.9

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



SOIL DESCRIPTION: GREY BROWN CLAYEY SILT

LIQUID LIMIT 36 % PLASTIC LIMIT 34 % SPECIFIC GRAVITY 2.69

FAILURE CRITERIA _____

REMARKS UNDISTURBED SAMPLE

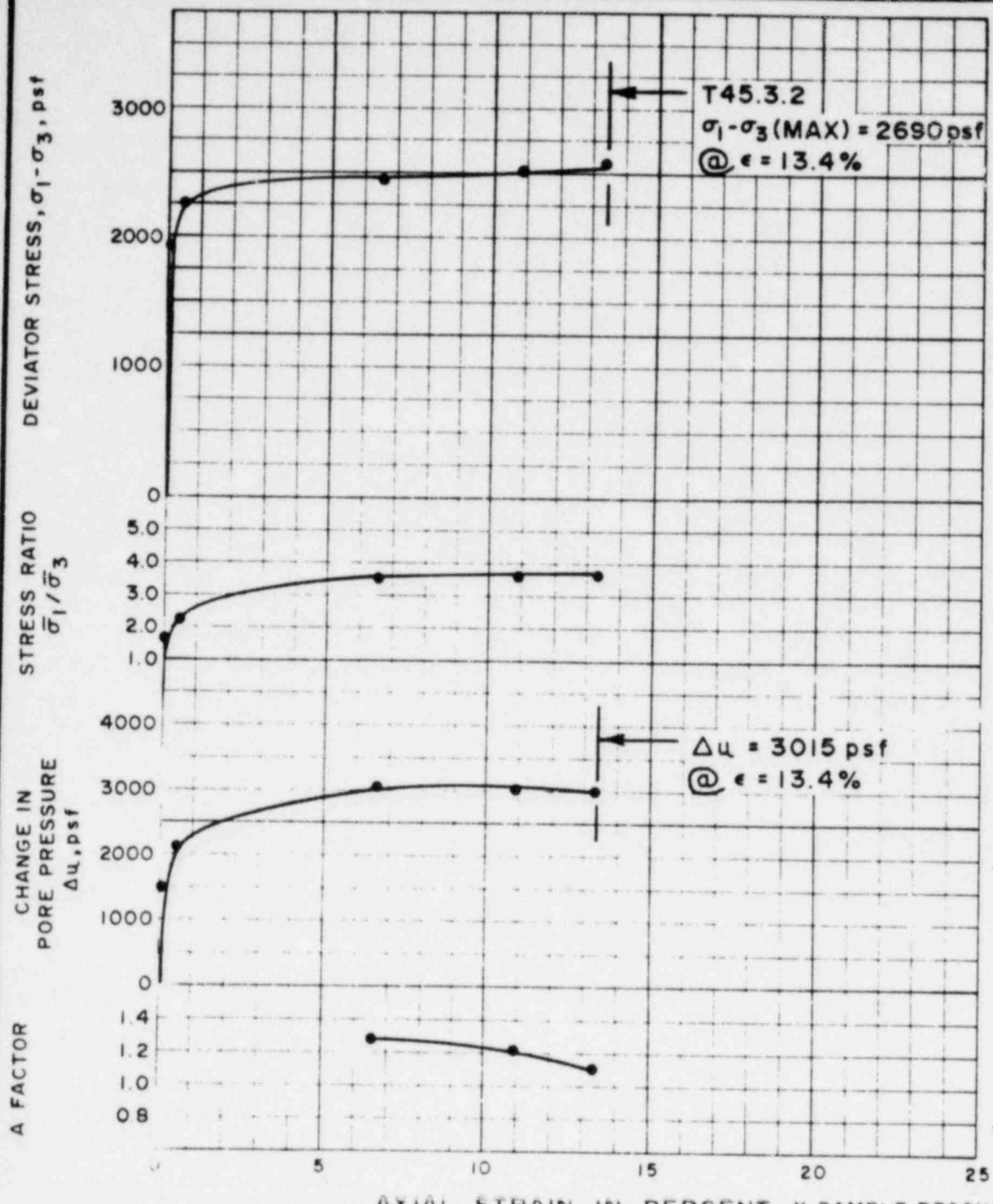
QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASS.

MOHR STRENGTH ENVELOPE
TRIAXIAL COMPRESSION TESTS (MONOTONIC)

BORING NO. B7 TEST SERIES NO. 45
SAMPLE UP2
DEPTH 62.1'-62.6' DATE JUNE 1981
TECH. _____
REVIEWER _____ FILE 2801

FIGURE

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



* SAMPLE RECONSTITUTED TO $e \approx 0.95$ AT WATER CONTENT = 7.0% ±

TEST NO./SYMBOL	INITIAL CONDITIONS: INITIAL WATER CONTENT, %	INITIAL DRY UNIT WEIGHT, pcf	SAMPLE HEIGHT & DIAMETER, in.	CONDITIONS BEFORE SHEAR: INITIAL STRESSES $\bar{\sigma}_1 = \bar{\sigma}_3$, psf	FINAL BACK PRESSURE, psf	VOLUMETRIC STRAIN, %	PORE PRESSURE RESPONSE, %	FINAL CONDITIONS: FINAL WATER CONTENT, %	FINAL DRY UNIT WEIGHT, pcf	RATE OF STRAIN, PERCENT PER MINUTE
T45 3.2 ●	7.3	82.8	6.00 2.90	4003	10,080	3.50	94	31.3	85.7	-

SOIL DESCRIPTION: GREY BROWN CLAYEY SILT *

LIQUID LIMIT 36 % PLASTIC LIMIT 34 % SPECIFIC GRAVITY 2.69

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASS.

TRIAXIAL COMPRESSION TESTS (MONOTONIC)

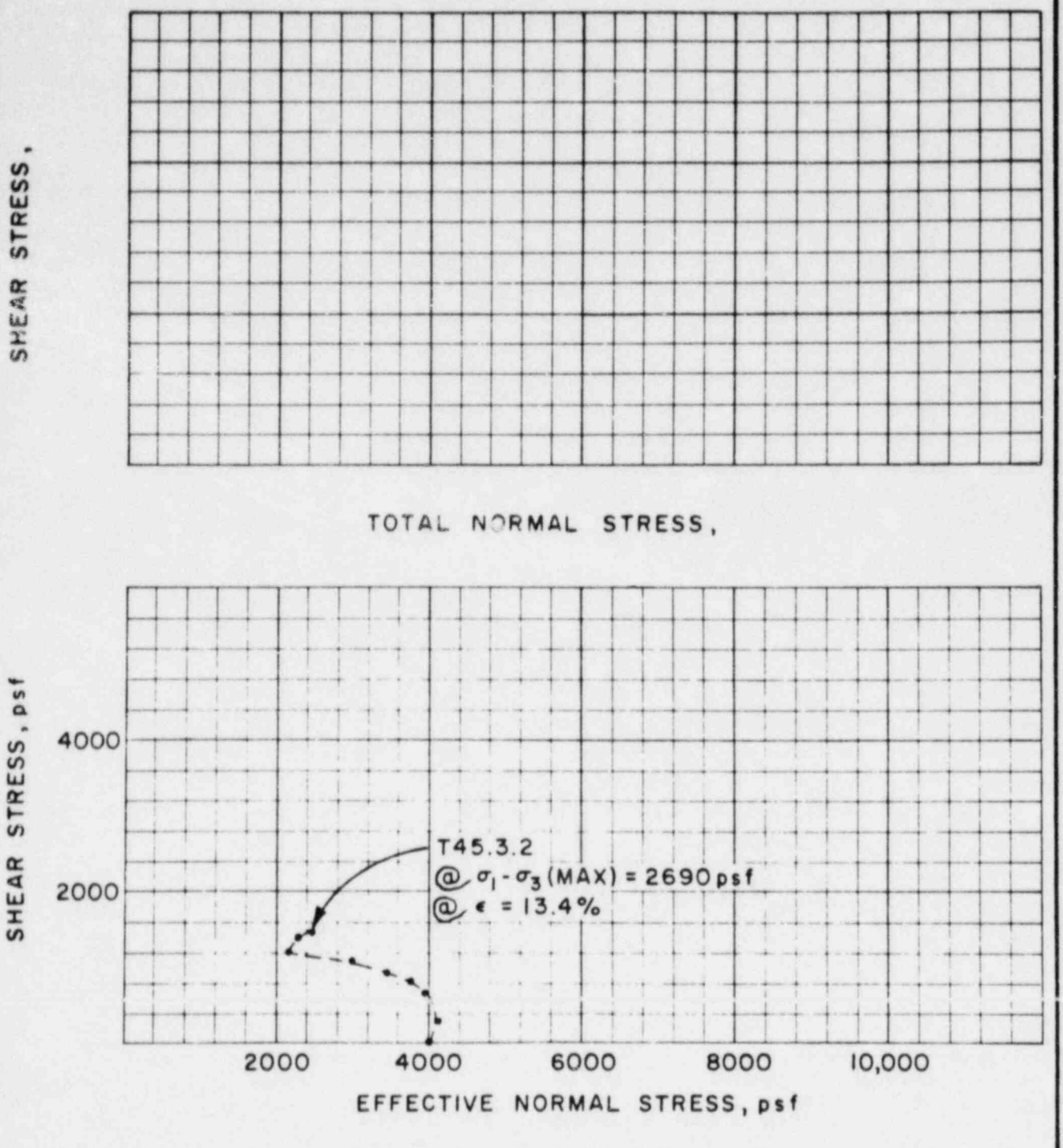
BORING NO. B7
SAMPLE UP2
DEPTH 62.0'-63.9'
TECH. ____
REVIEWER ____

TEST SERIES NO. 45
DATE JULY 1981

FILE 2801

FIGURE T.9

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



SOIL DESCRIPTION: GREY BROWN CLAYEY SILT

LIQUID LIMIT 36 % PLASTIC LIMIT 34 % SPECIFIC GRAVITY 2.69

FAILURE CRITERIA $\sigma_1 - \sigma_3$ (MAX)

REMARKS SAMPLE RECONSTITUTED TO $e \approx 0.95$ @ WATER CONTENT = 7.0% ±

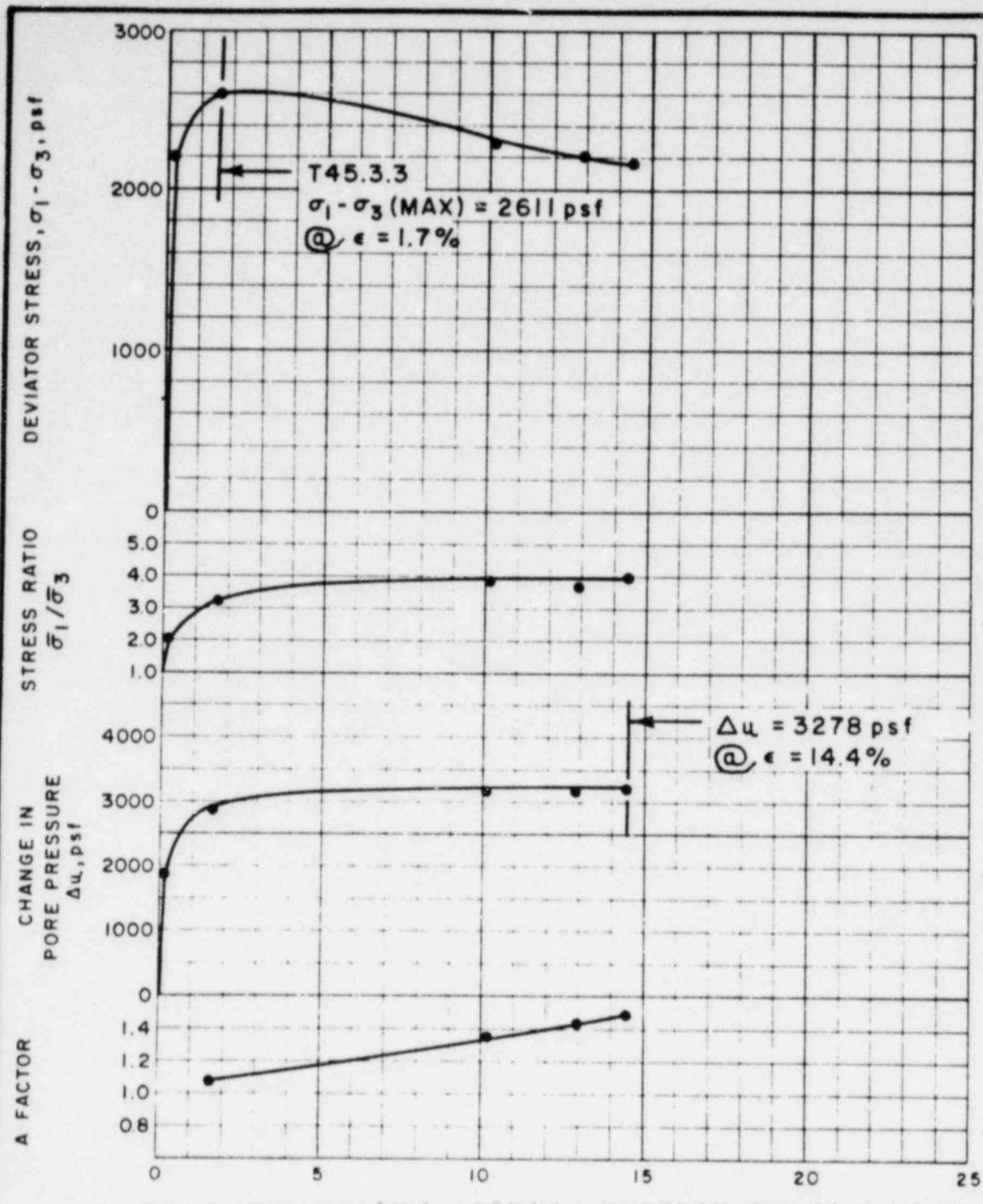
QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASS.

MOHR STRENGTH ENVELOPE
TRIAXIAL COMPRESSION TESTS (MONOTONIC)

BORING NO. B7
SAMPLE UP2
DEPTH 62.0'-63.9'
TECH.
REVIEWER

TEST SERIES NO. 45
DATE JULY 1981
FILE 2801

FIGURE



* SAMPLE RECONSTITUTED TO $e \approx 0.90$ AT WATER CONTENT = 7.0% ±

TEST NO./SYMBOL	INITIAL CONDITIONS: INITIAL WATER CONTENT, %	INITIAL CONDITIONS: INITIAL DRY UNIT WEIGHT, pcf	INITIAL CONDITIONS: SAMPLE HEIGHT & DIAMETER, in.	CONDITIONS BEFORE SHEAR: INITIAL STRESSES $\bar{\sigma}_1 = \bar{\sigma}_3$, psf	CONDITIONS BEFORE SHEAR: FINAL BACK PRESSURE, psf	CONDITIONS BEFORE SHEAR: VOLUMETRIC STRAIN, %	CONDITIONS BEFORE SHEAR: PORE PRESSURE RESPONSE, %	FINAL CONDITIONS: FINAL WATER CONTENT, %	FINAL CONDITIONS: FINAL DRY UNIT WEIGHT, pcf	RATE OF STRAIN, PERCENT PER MINUTE
T45.3.3 ●	7.8	85.4	6.00 × 2.90	4003	12,240	3.02	95	30.4	88.0	1

SOIL DESCRIPTION: GREY BROWN CLAYEY SILT *

LIQUID LIMIT 36 % PLASTIC LIMIT 34 % SPECIFIC GRAVITY 2.69

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASS.

TRIAXIAL COMPRESSION TESTS (MONOTONIC)

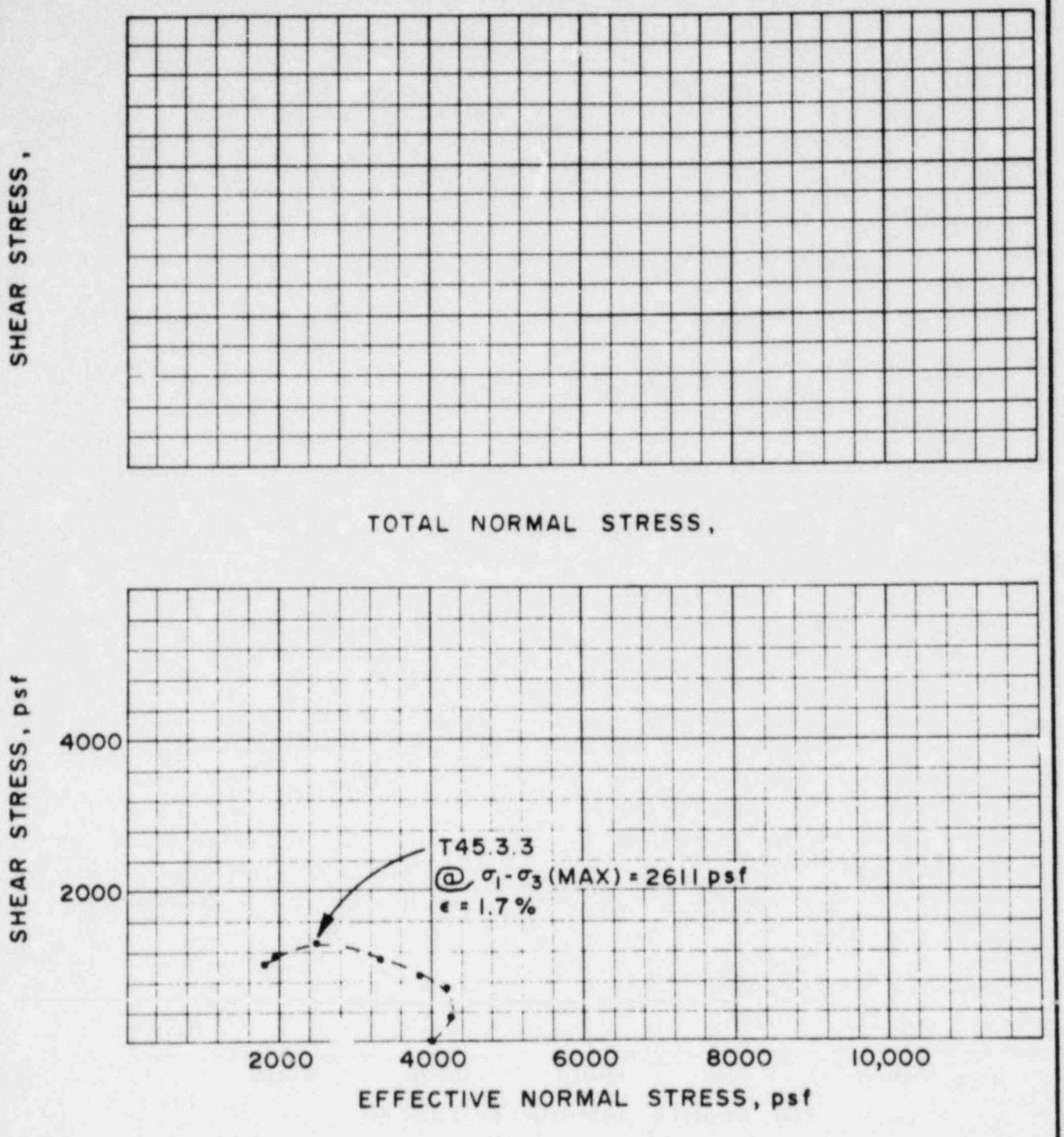
BORING NO. B7
SAMPLE UP2
DEPTH 62.0'-63.9'
TECH. ____
REVIEWER ____

TEST SERIES NO. 45
DATE JULY 1981

FILE 2801

FIGURE T.9

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



SOIL DESCRIPTION: GREY BROWN CLAYEY SILT
LIQUID LIMIT 36 % PLASTIC LIMIT 34 % SPECIFIC GRAVITY 2.69

FAILURE CRITERIA $\sigma_1 - \sigma_3$ (MAX)

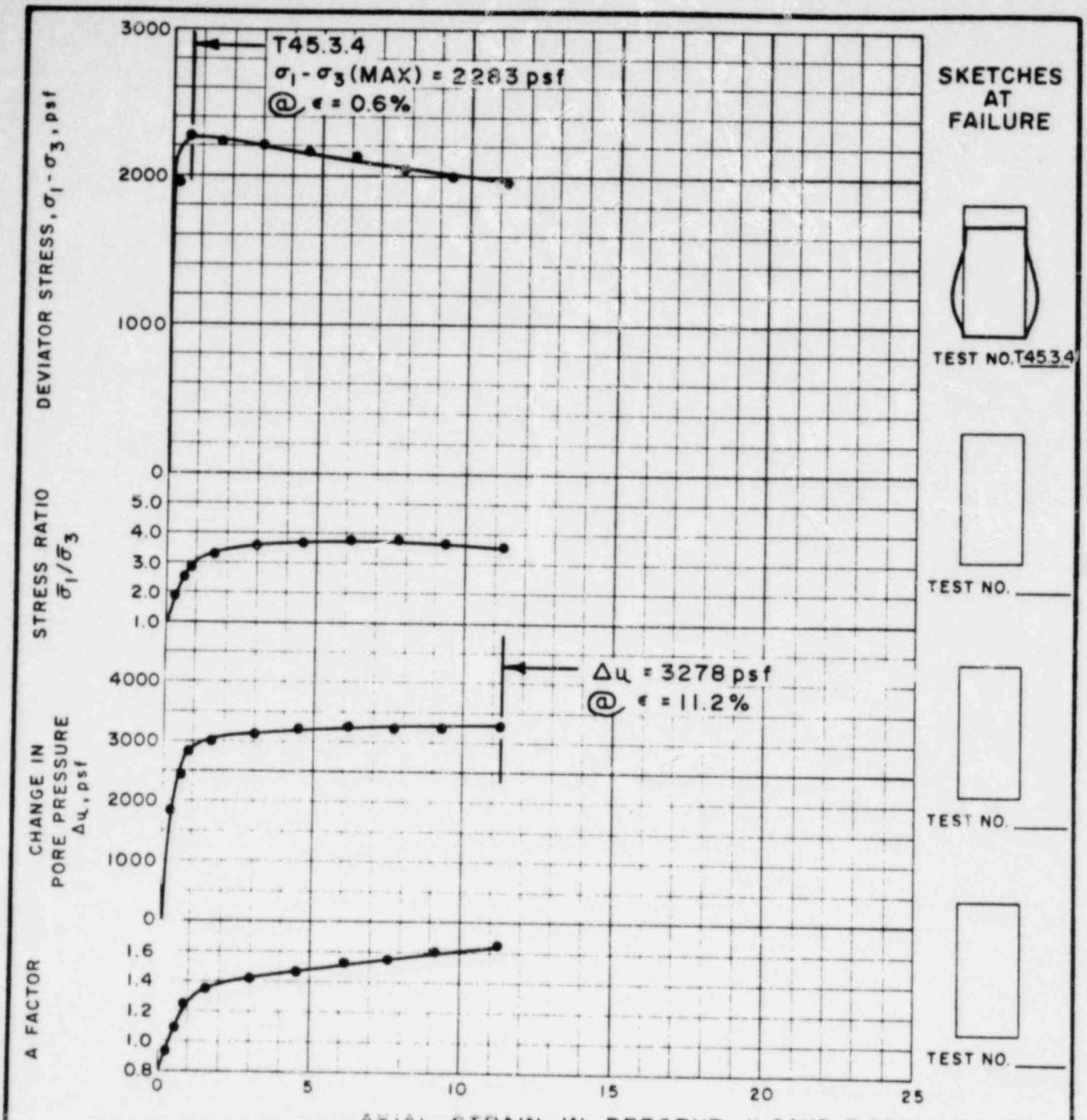
REMARKS SAMPLE RECONSTITUTED TO $e \approx 0.90$ AT WATER CONTENT = 7.0 % ±

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASS.

MOHR STRENGTH ENVELOPE
TRIAXIAL COMPRESSION TESTS (MONOTONIC)

BORING NO. B7 TEST SERIES NO. 45
SAMPLE UP2
DEPTH 62.0' - 63.9' DATE JULY 1981
TECH.
REVIEWER FILE 2801

FIGURE



* SAMPLE RECONSTITUTED TO $e \approx 0.95$ @ WATER CONTENT = 7.5% ±

TEST NO./SYMBOL	INITIAL CONDITIONS: INITIAL WATER CONTENT, %	INITIAL CONDITIONS: INITIAL DRY UNIT WEIGHT, pcf	INITIAL CONDITIONS: SAMPLE HEIGHT & DIAMETER, in.	CONDITIONS BEFORE SHEAR: INITIAL STRESSES $\bar{\sigma}_1 = \bar{\sigma}_3$, psf	CONDITIONS BEFORE SHEAR: FINAL BACK PRESSURE, psf	CONDITIONS BEFORE SHEAR: VOLUMETRIC STRAIN, %	CONDITIONS BEFORE SHEAR: PORE PRESSURE RESPONSE, %	FINAL CONDITIONS: FINAL WATER CONTENT, %	FINAL CONDITIONS: FINAL DRY UNIT WEIGHT, pcf	RATE OF STRAIN, PERCENT PER MINUTE
T45.3.4 ●	7.6	83.5	6.00 / 2.90	4003	7200	3.18	95	31.9	86.8	-

SOIL DESCRIPTION: GREY BROWN CLAYEY SILT *

LIQUID LIMIT 36 % PLASTIC LIMIT 34 % SPECIFIC GRAVITY 2.70

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASS.

TRIAXIAL COMPRESSION TESTS (MONOTONIC)

BORING NO. B7
SAMPLE UP2
DEPTH 62.0'-63.9'
TECH. ____
REVIEWER ____

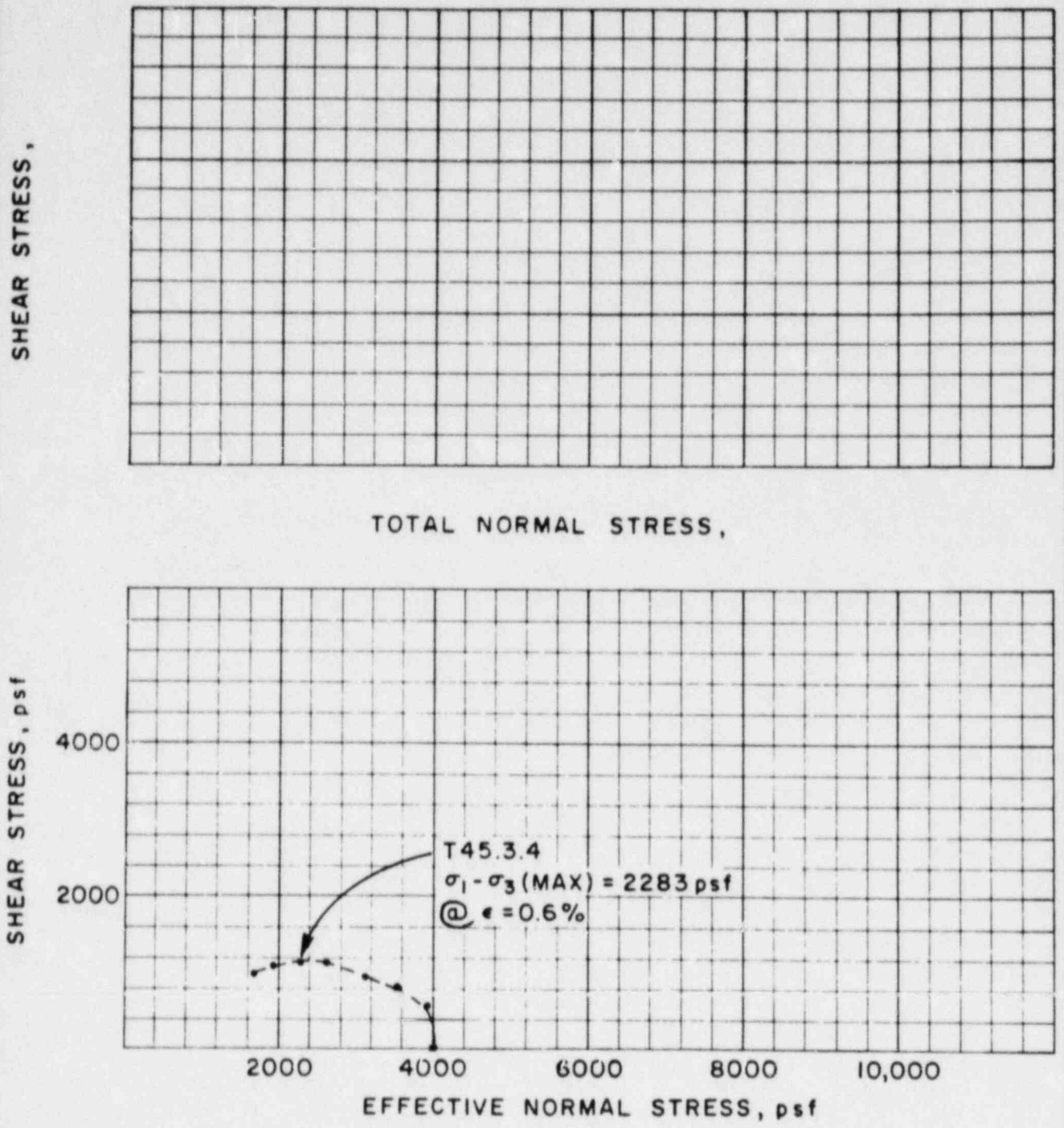
TEST SERIES NO. 45
DATE JULY 1981

FILE 2801

FIGURE

T.9

GOLDBERG-ZOINO & ASSOCIATES, INC
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



SOIL DESCRIPTION: GREY BROWN CLAYEY SILT
LIQUID LIMIT 36 % PLASTIC LIMIT 34 % SPECIFIC GRAVITY 2.70

FAILURE CRITERIA $\sigma_1 - \sigma_3$ (MAX)

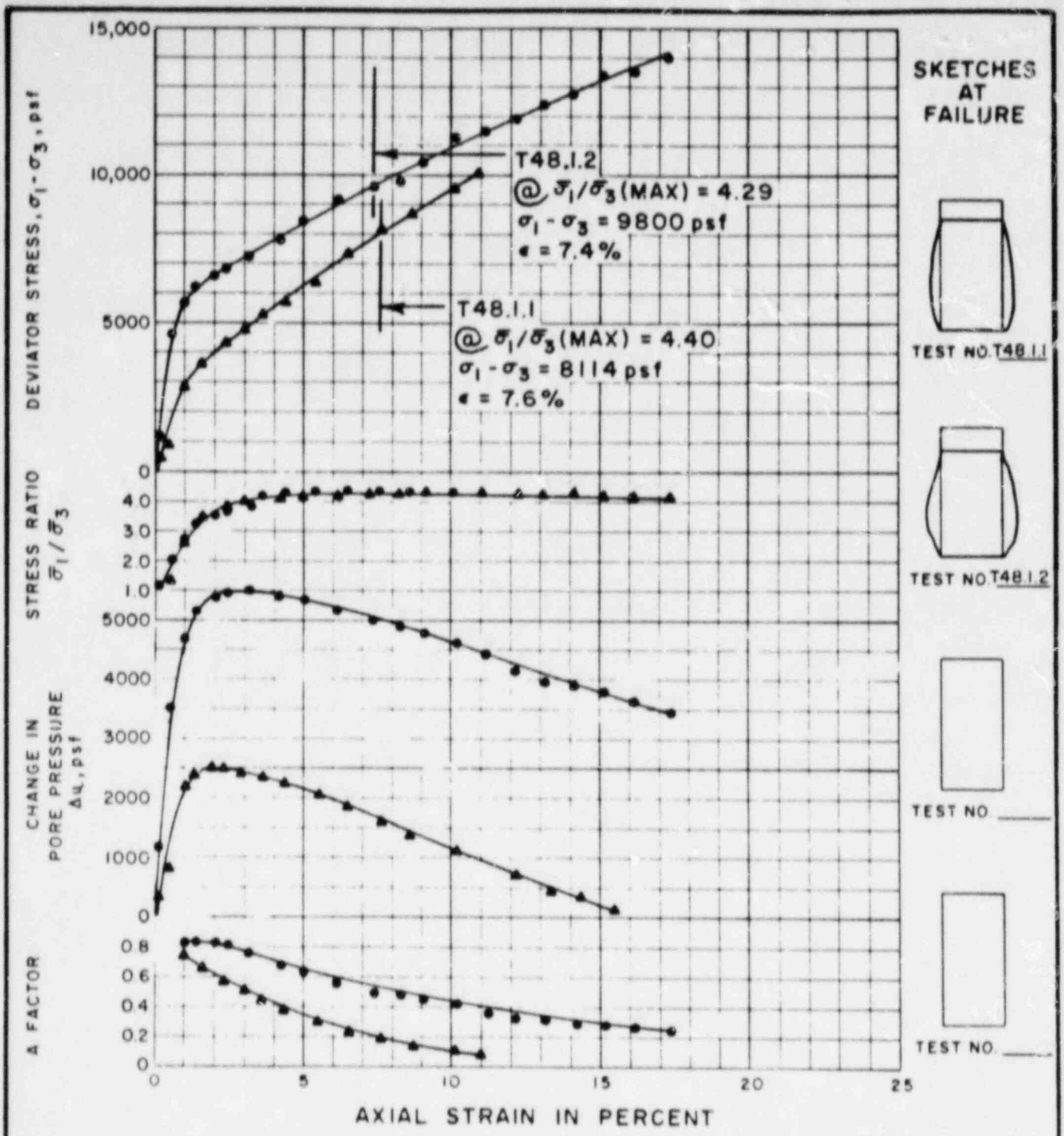
REMARKS SAMPLE RECONSTITUTED TO
e ≈ 0.95 @ WATER CONTENT = 7.5% ±

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASS.

MOHR STRENGTH ENVELOPE
TRIAXIAL COMPRESSION TESTS (MONOTONIC)

BORING NO. B7 TEST SERIES NO. 45
SAMPLE UP2
DEPTH 62.0'-63.9' DATE JULY 1981
TECH.
REVIEWER FILE 2801

FIGURE



TEST NO./SYMBOL	INITIAL CONDITIONS: INITIAL WATER CONTENT, %	INITIAL CONDITIONS: INITIAL DRY UNIT WEIGHT, pcf	INITIAL CONDITIONS: SAMPLE HEIGHT & DIAMETER, in.	CONDITIONS BEFORE SHEAR: INITIAL STRESSES $\bar{\sigma}_1 = \bar{\sigma}_3$, psf	CONDITIONS BEFORE SHEAR: FINAL BACK PRESSURE, psf	CONDITIONS BEFORE SHEAR: VOLUMETRIC STRAIN, %	CONDITIONS BEFORE SHEAR: PORE PRESSURE RESPONSE, %	FINAL CONDITIONS: FINAL WATER CONTENT, %	FINAL CONDITIONS: FINAL DRY UNIT WEIGHT, pcf	RATE OF STRAIN, PERCENT PER MINUTE
T48.1.1 ▲	29.9	93.9	2.87	4003	7,280	2.48	95	27.9	96.3	0.15
T48.1.2 ●	31.9	89.9	2.87	8007	11,520	3.21	95	28.5	92.9	0.15

SOIL DESCRIPTION GREY SILT OR CLAYEY SILT

LIQUID LIMIT 29 % PLASTIC LIMIT 27 % SPECIFIC GRAVITY -

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASS.

TRIAXIAL COMPRESSION TESTS ($\overline{CIU}$)

BORING NO. B7
SAMPLE UP6
DEPTH 102.1'-103.1'
TECH
REVIEWER

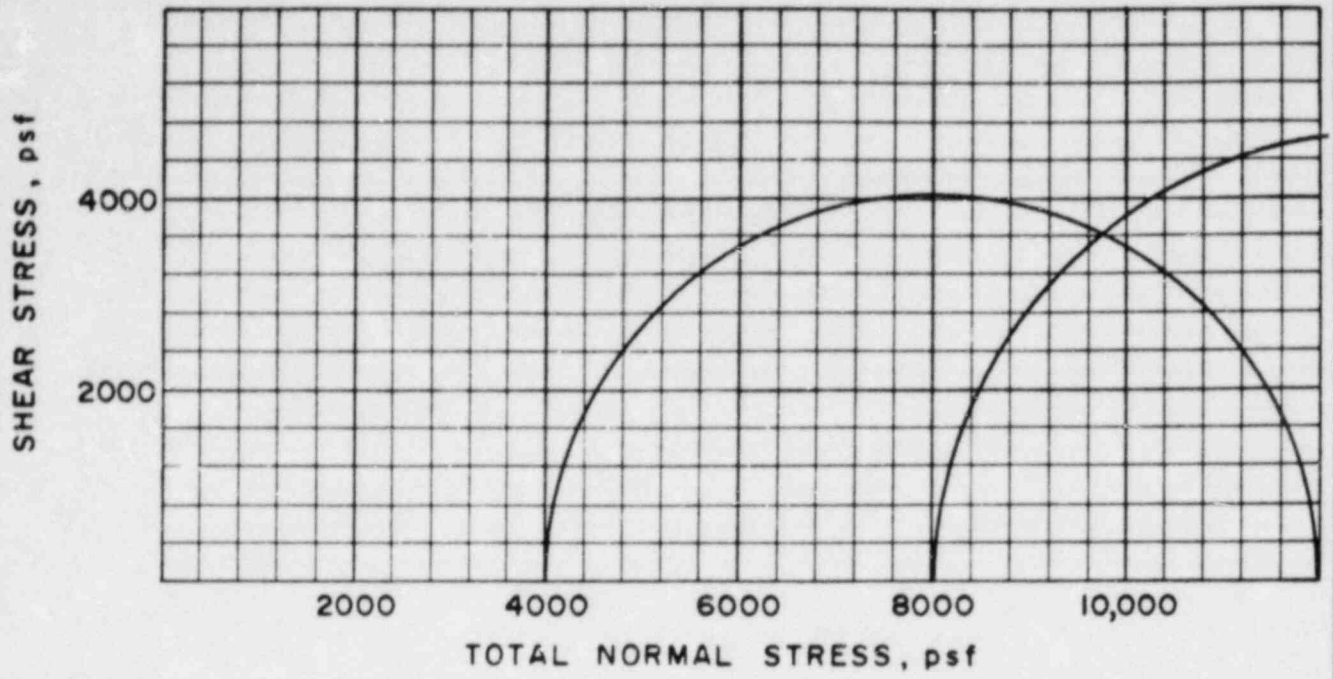
TEST SERIES NO. 48
DATE JUNE 1981

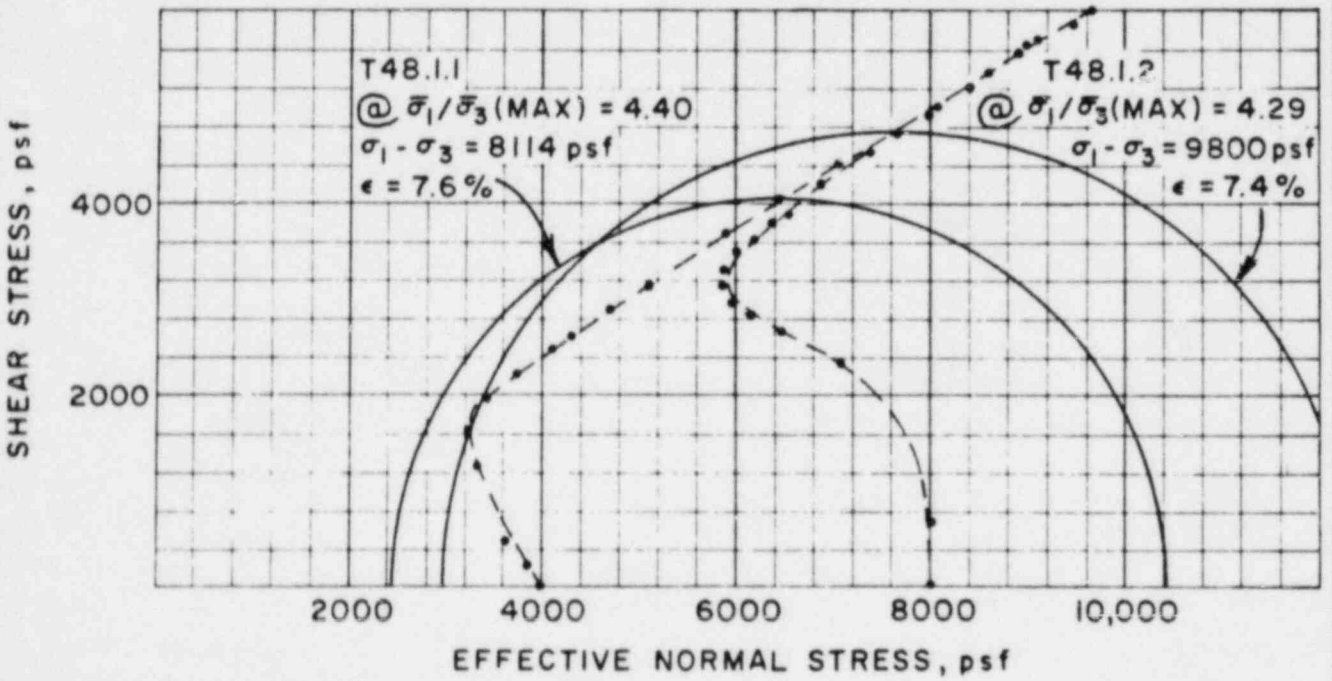
FILE 2801

T.9

FIGURE

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS





SOIL DESCRIPTION GRAY SILT OR CLAYEY SILT

LIQUID LIMIT 29 % PLASTIC LIMIT 27 % SPECIFIC GRAVITY ____

FAILURE CRITERIA $\bar{\sigma}_1/\bar{\sigma}_3$ (MAX)

REMARKS ____

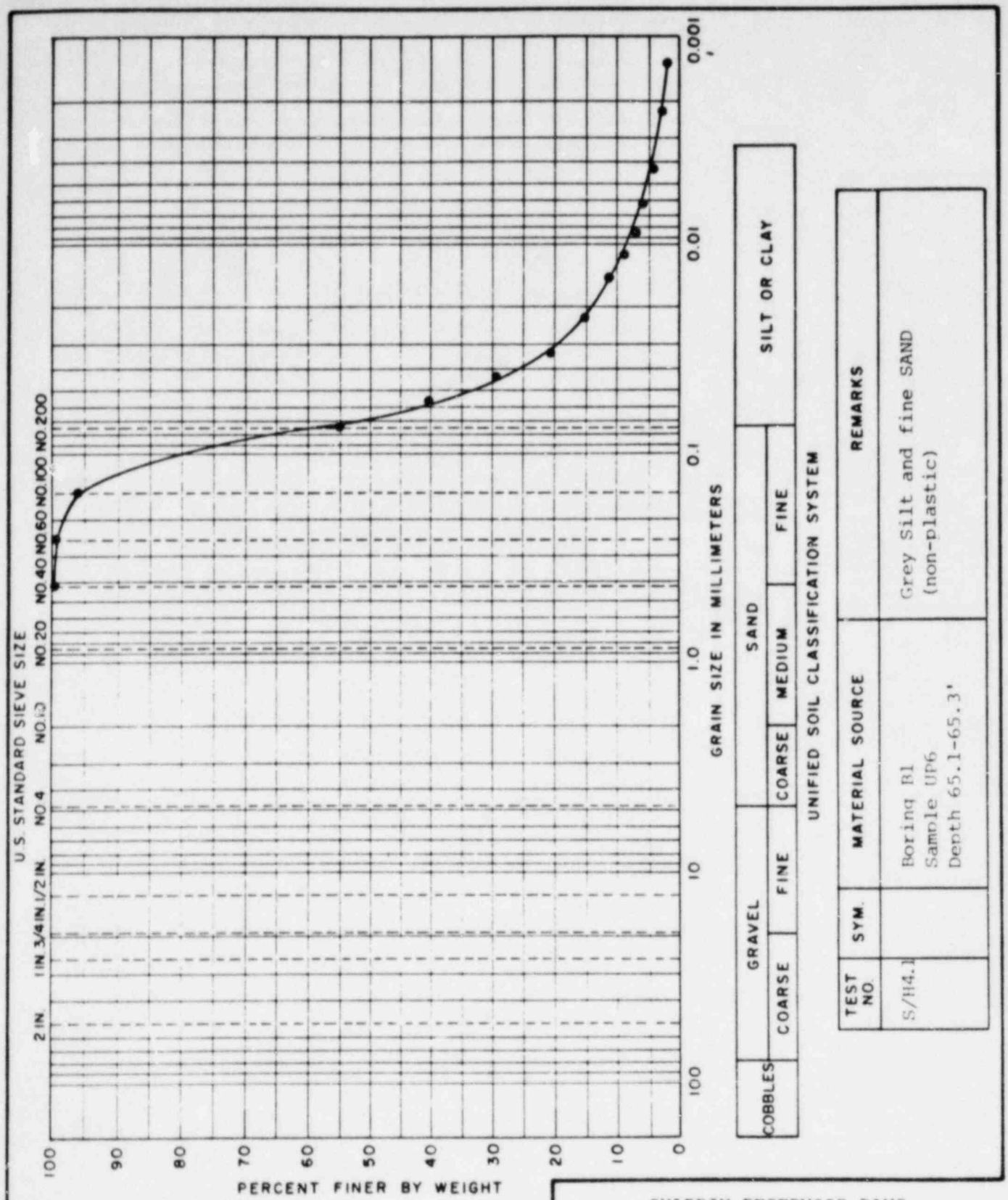
QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASS.

MOHR STRENGTH ENVELOPE

TRIAXIAL COMPRESSION TESTS ($\overline{CIU}$)

BORING NO. B7 TEST SERIES NO. 48
SAMPLE UP6
DEPTH 102.1'-103.1' DATE JUNE 1981
TECH. ____
REVIEWER ____ FILE 2801

FIGURE



QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B1
SAMPLE UP6
DEPTH 65.1-65.3
TECH.
REVIEWER

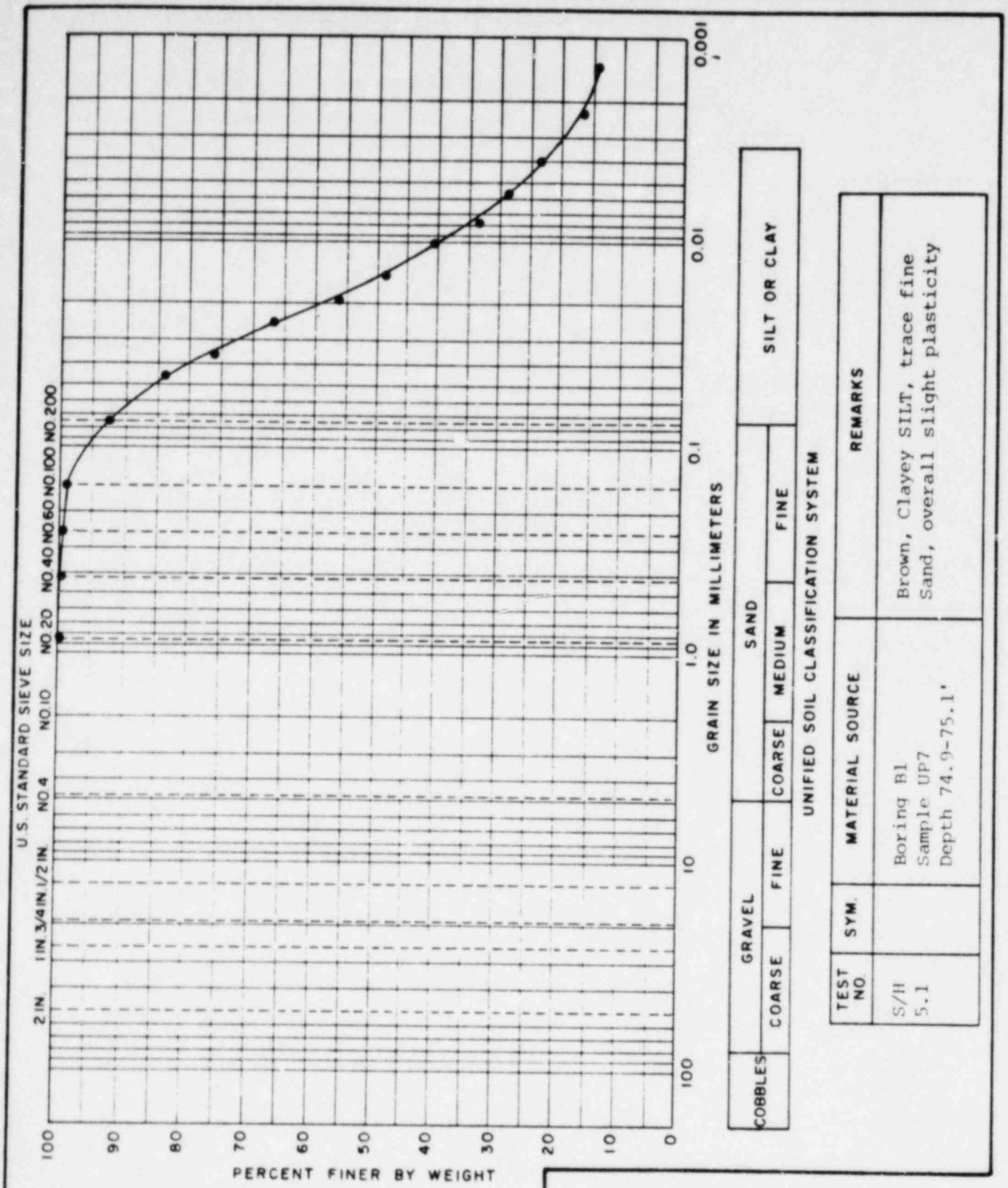
TEST SERIES NO. 4
DATE June 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



TEST NO.	SYM.	MATERIAL SOURCE	REMARKS
S/H 5.1		Boring B1 Sample UP7 Depth 74.9-75.1'	Brown, Clayey SILT, trace fine Sand, overall slight plasticity

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B1
SAMPLE UP7
DEPTH 74.9-75.1'
TECH. _____
REVIEWER _____

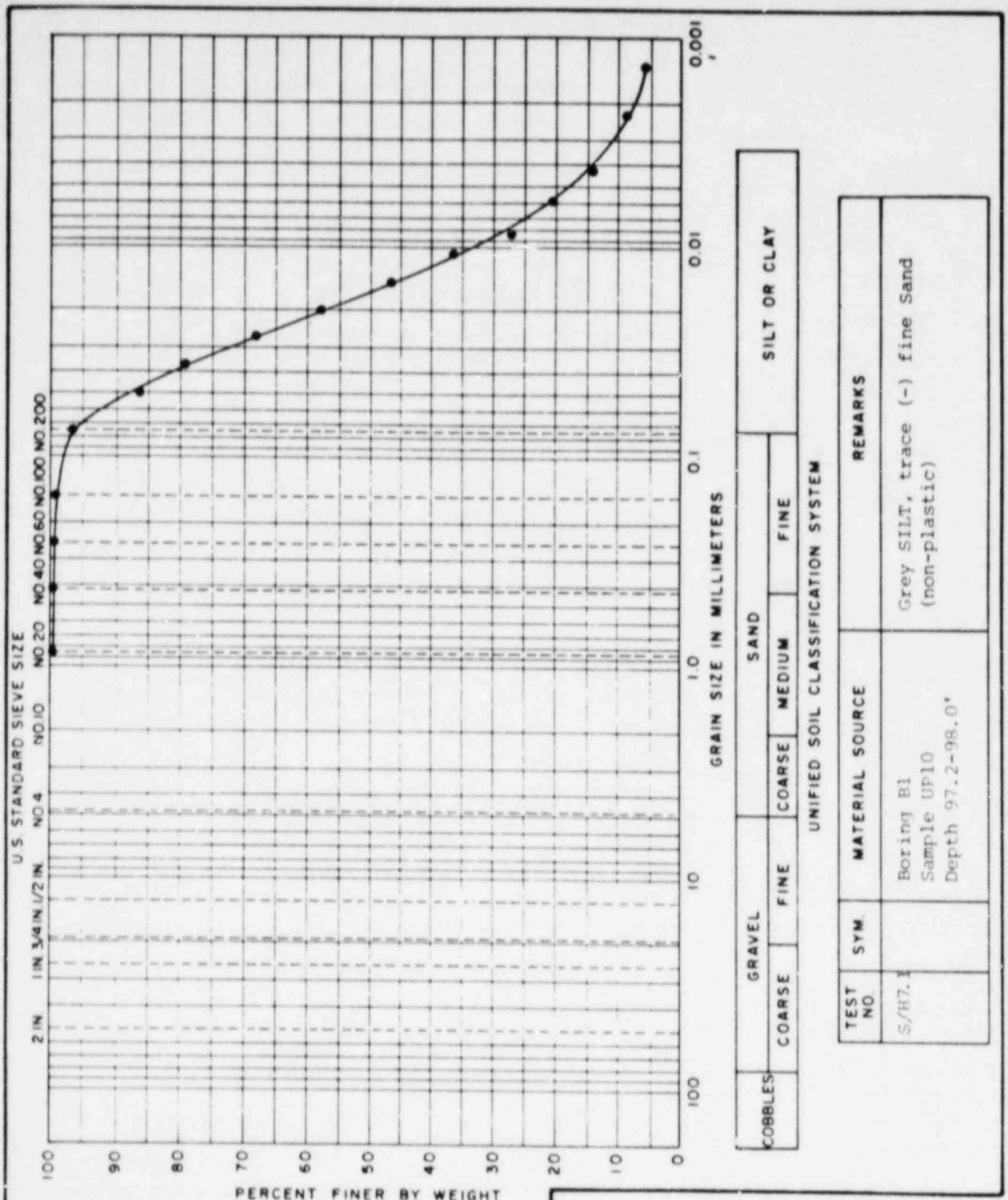
TEST SERIES NO. 5
DATE June 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



TEST NO	SYM.	MATERIAL SOURCE	REMARKS
S/H7.1		Boring B1 Sample UP10 Depth 97.2-98.0'	Grey SILT, trace (-) fine Sand (non-plastic)

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B1
SAMPLE UP10
DEPTH 97.2-98.0
TECH.
REVIEWER

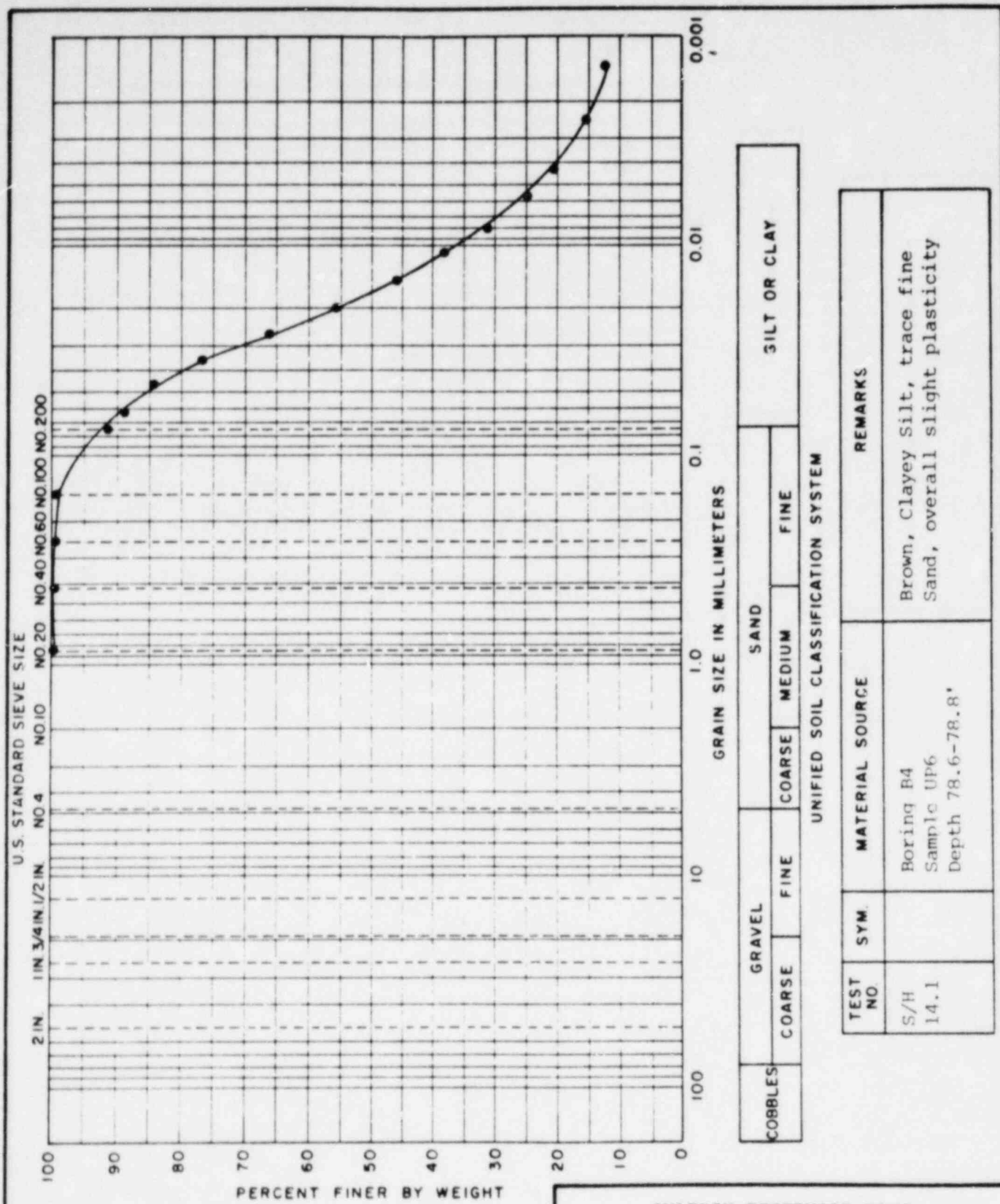
TEST SERIES NO. 7
DATE June 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B4
SAMPLE UP6
DEPTH 78.6-78.8
TECH.
REVIEWER

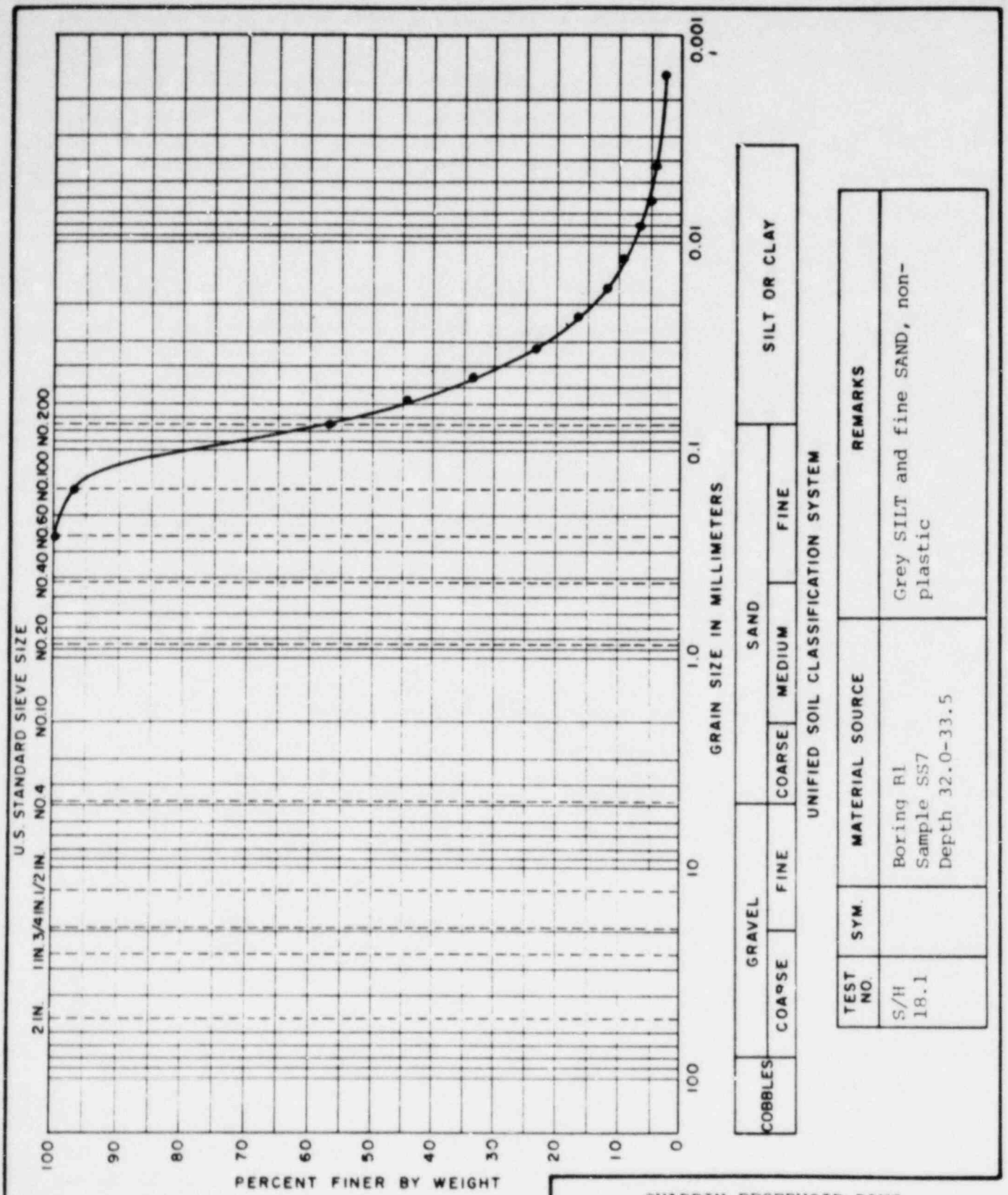
TEST SERIES NO. 14
DATE June 1961

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B1
SAMPLE SS7
DEPTH 32.0-33.5
TECH.
REVIEWER

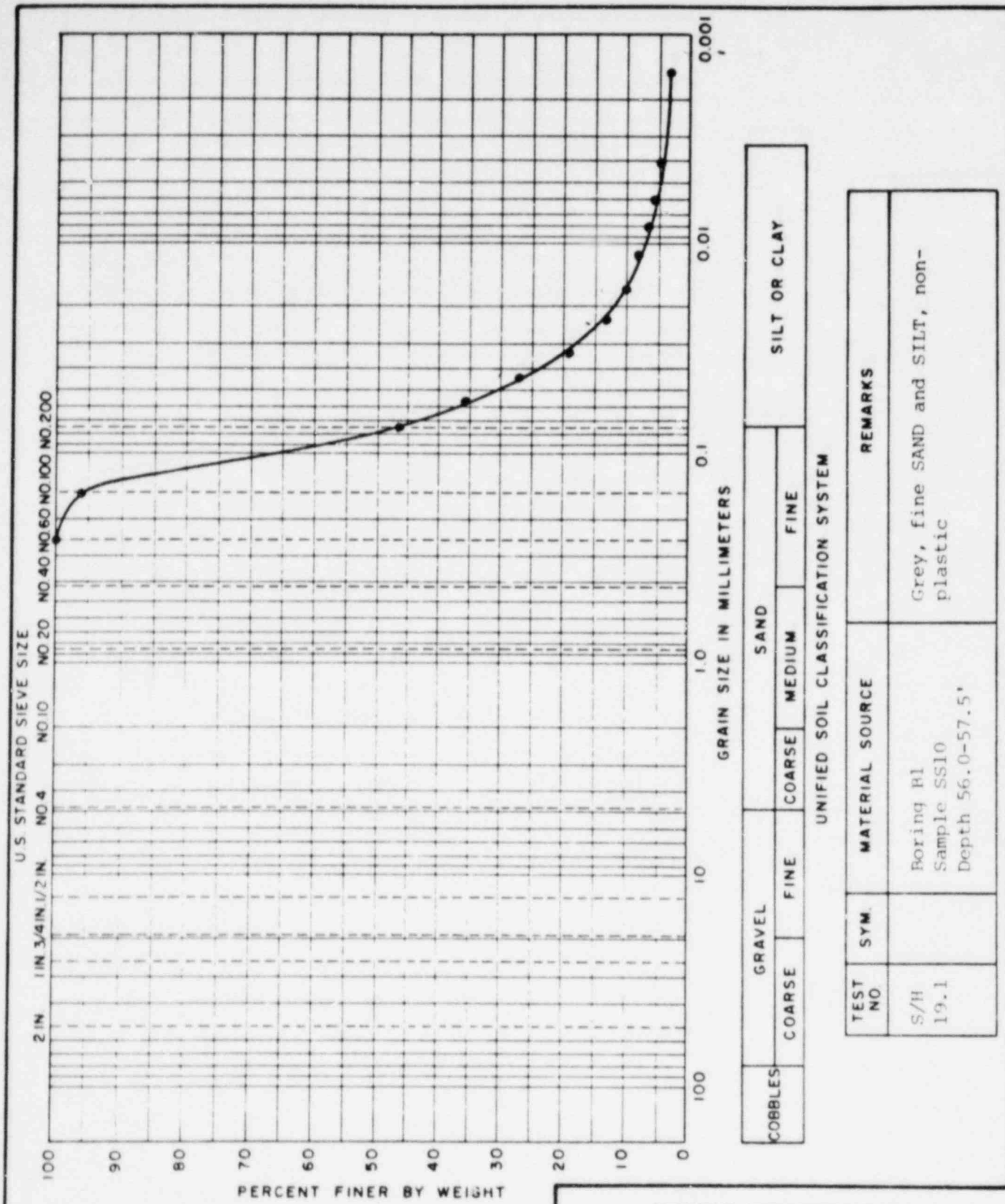
TEST SERIES NO. 18
DATE June 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B1
SAMPLE SS10
DEPTH 56.0-57.5
TECH.
REVIEWER

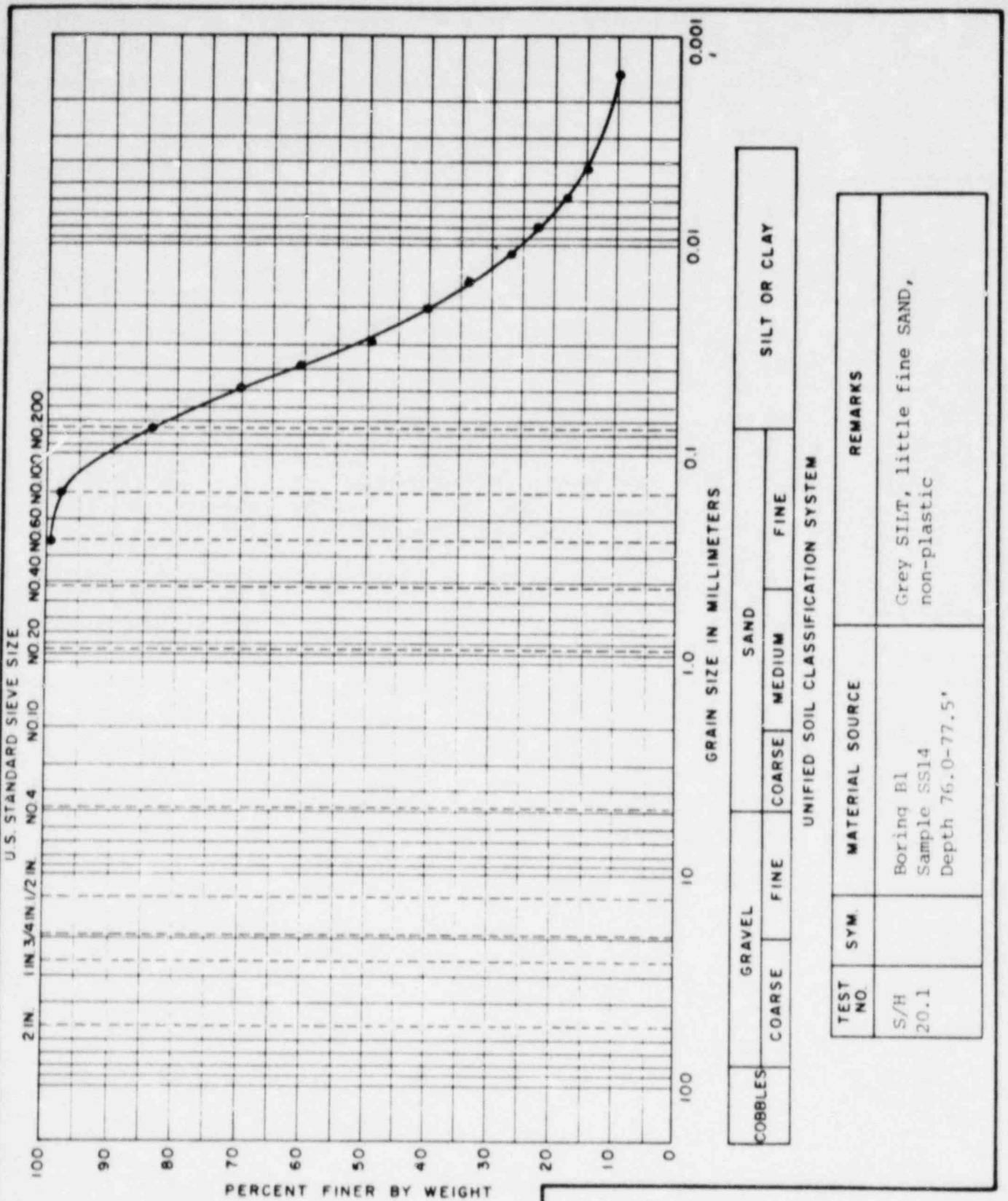
TEST SERIES NO. 19
DATE June 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B1
SAMPLE SS14
DEPTH 76.0-77.5
TECH.
REVIEWER

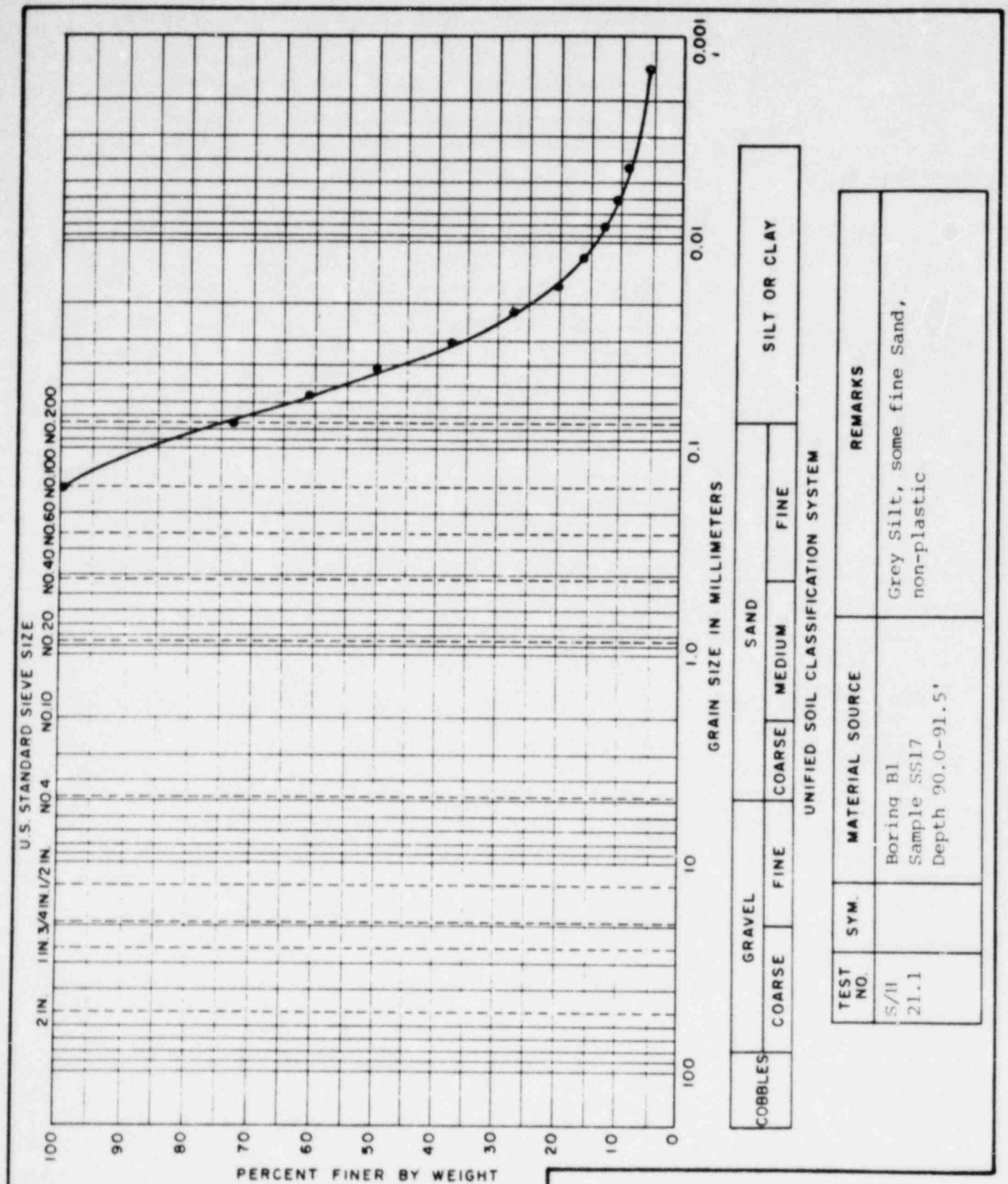
TEST SERIES NO. 20
DATE June 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



TEST NO.	SYM.	MATERIAL SOURCE	REMARKS
S/H 21.1		Boring B1 Sample SS17 Depth 90.0-91.5'	Grey Silt, some fine Sand, non-plastic

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B1
SAMPLE SS17
DEPTH 90.0-91.5
TECH.
REVIEWER

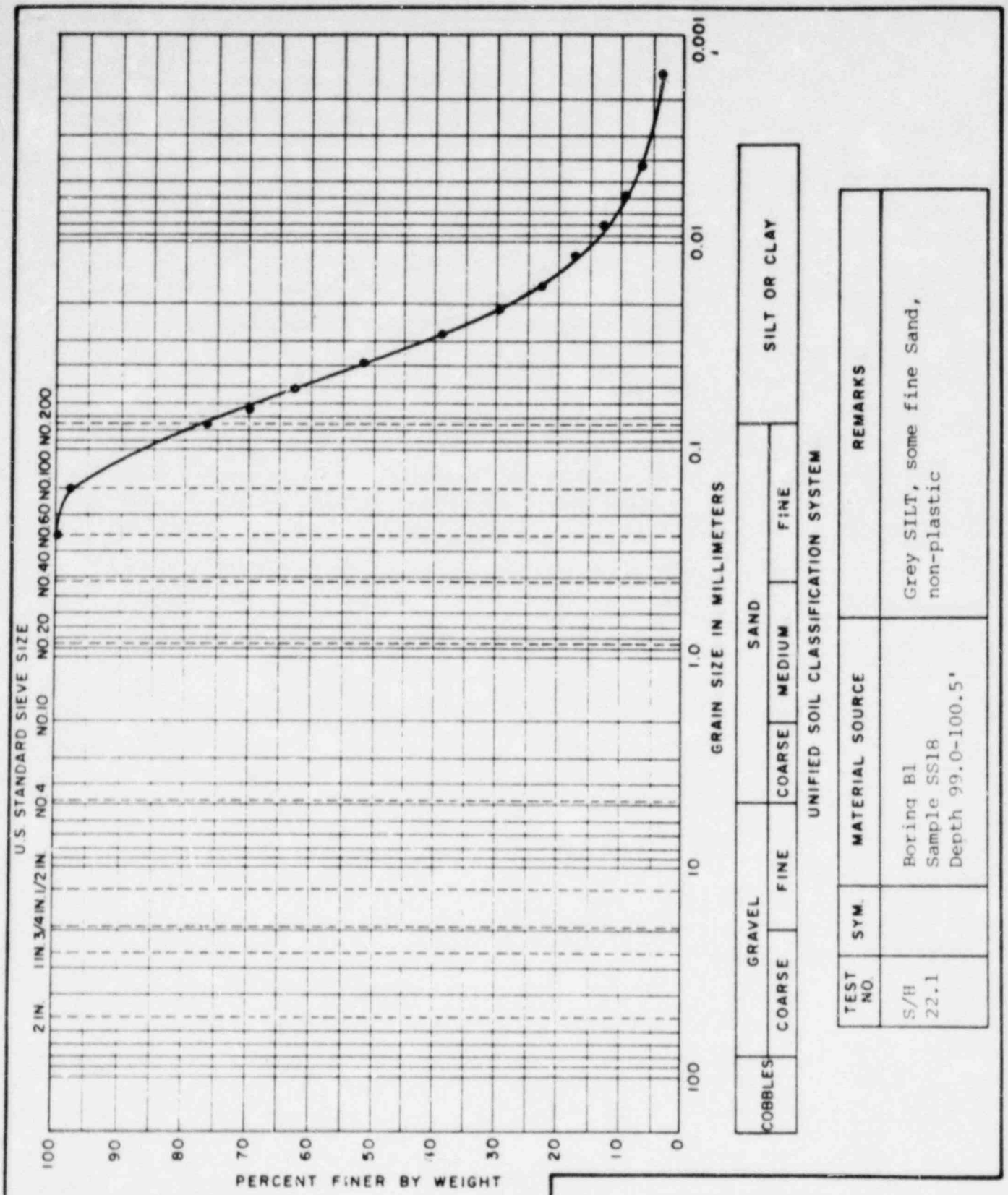
TEST SERIES NO. 21
DATE June 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B1
SAMPLE SS18
DEPTH 99.0-100.5
TECH.
REVIEWER

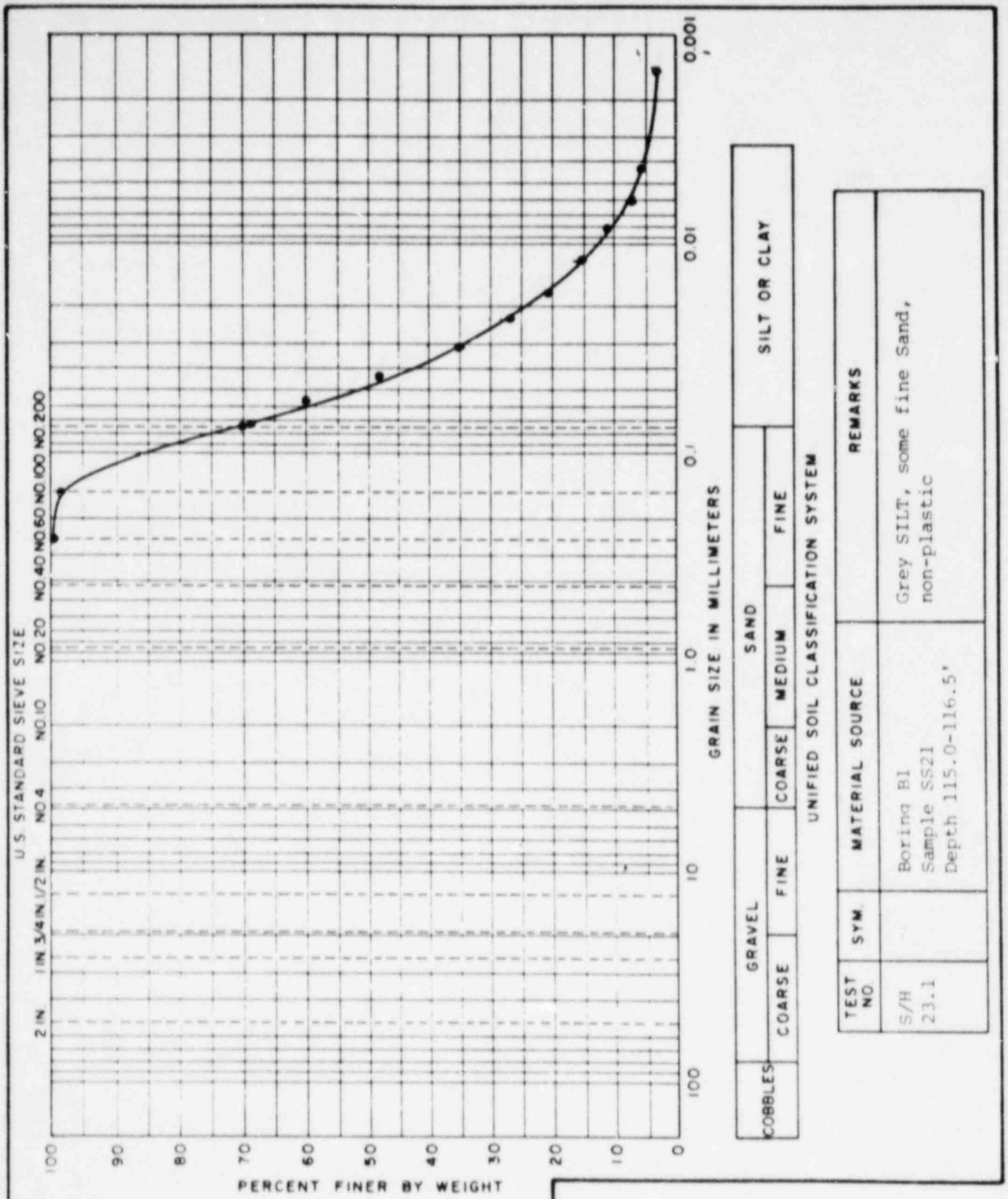
TEST SERIES NO. 22
DATE June 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B1
SAMPLE SS21
DEPTH 115.0-116.5
TECH.
REVIEWER

TEST SERIES NO. 23
DATE June 1981

FILE 2801

APPENDIX E-9

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS

GRADATION TESTS

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

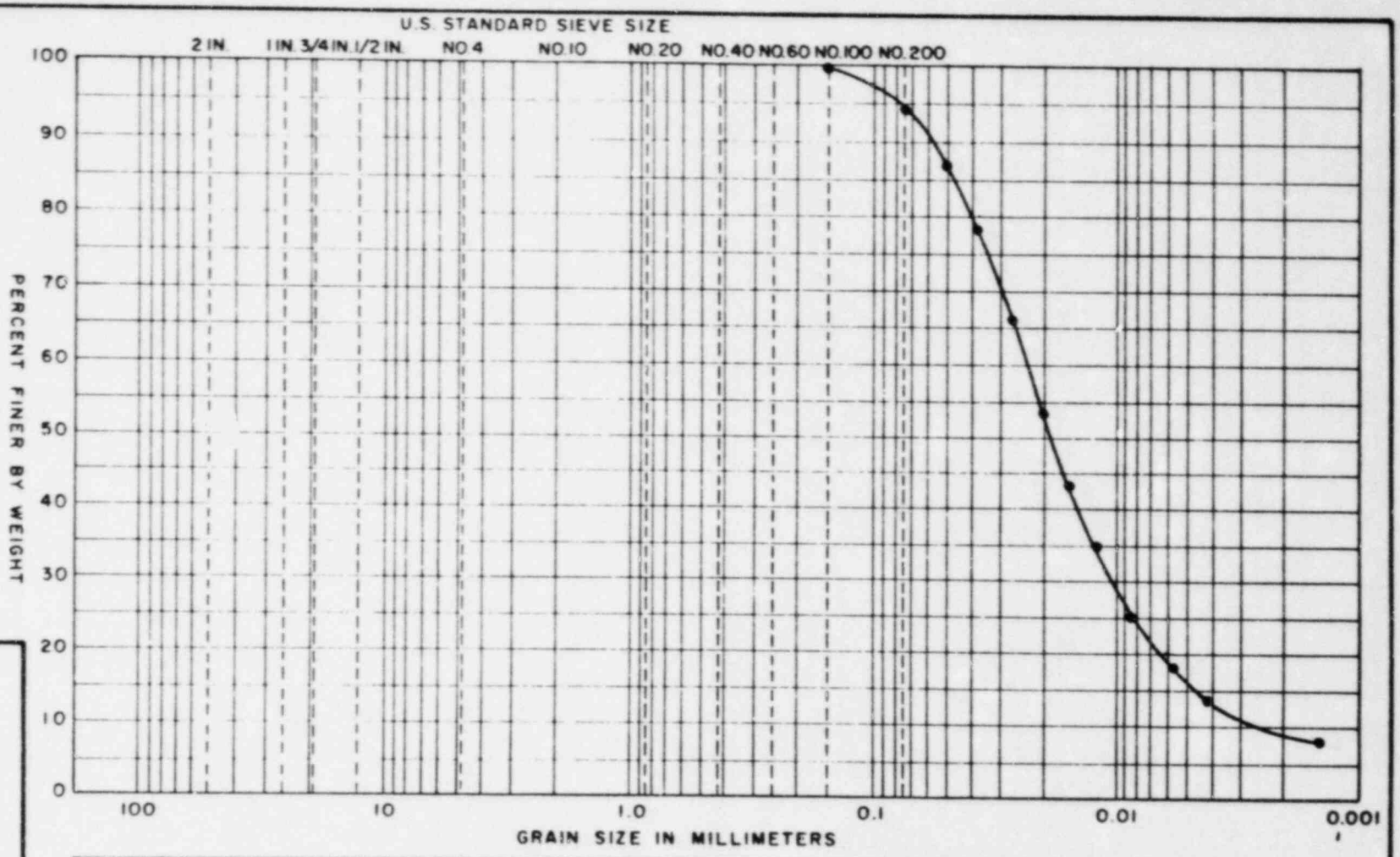
BORING NO. B1
SAMPLE SS25
DEPTH 134.0-134.5
TECH.
REVIEWER

TEST SERIES NO. 24
DATE June 1991

APPENDIX E-9

FILE 2801

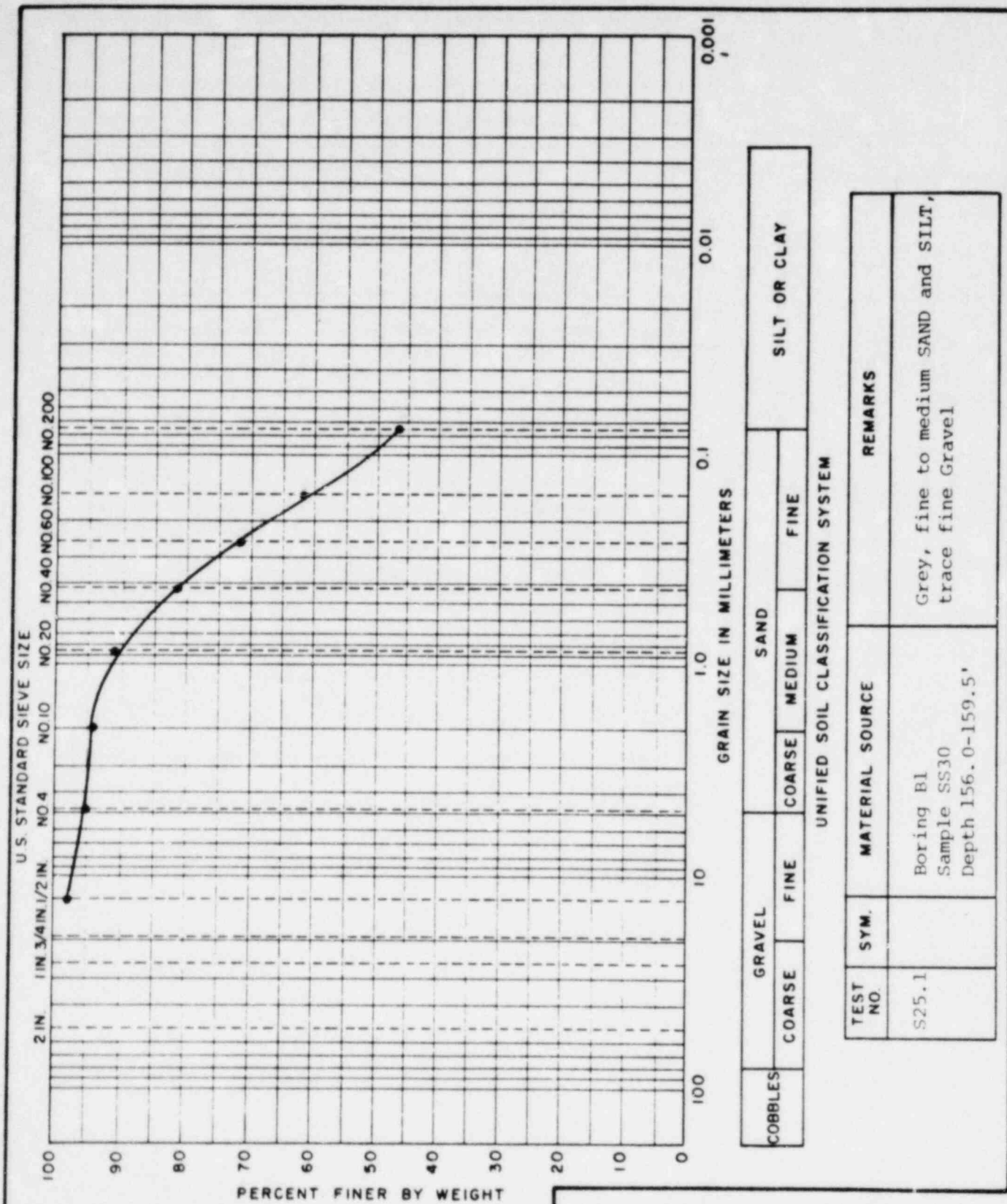
S.3



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

UNIFIED SOIL CLASSIFICATION SYSTEM

TEST NO.	SYM.	MATERIAL SOURCE	REMARKS
S/H 24.1		Boring B1 Sample SS25 Depth 134.0-134.5'	Grey SILT, trace fine Sand, non-plastic



QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B1
SAMPLE SS30
DEPTH 156.0-159.5
TECH. _____
REVIEWER _____

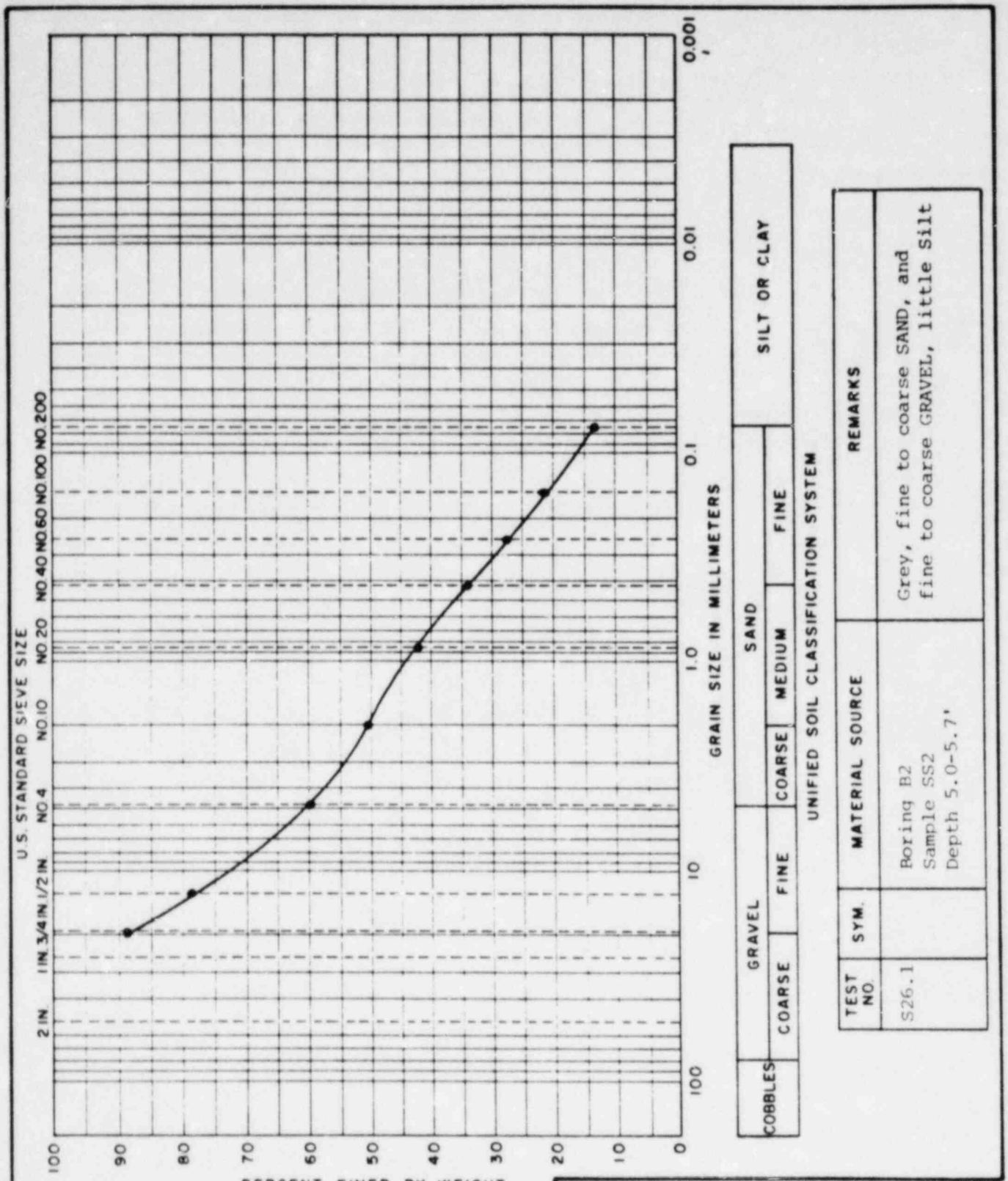
TEST SERIES NO. 25
DATE June 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B2
SAMPLE SS2
DEPTH 5.0-5.7'
TECH. _____
REVIEWER _____

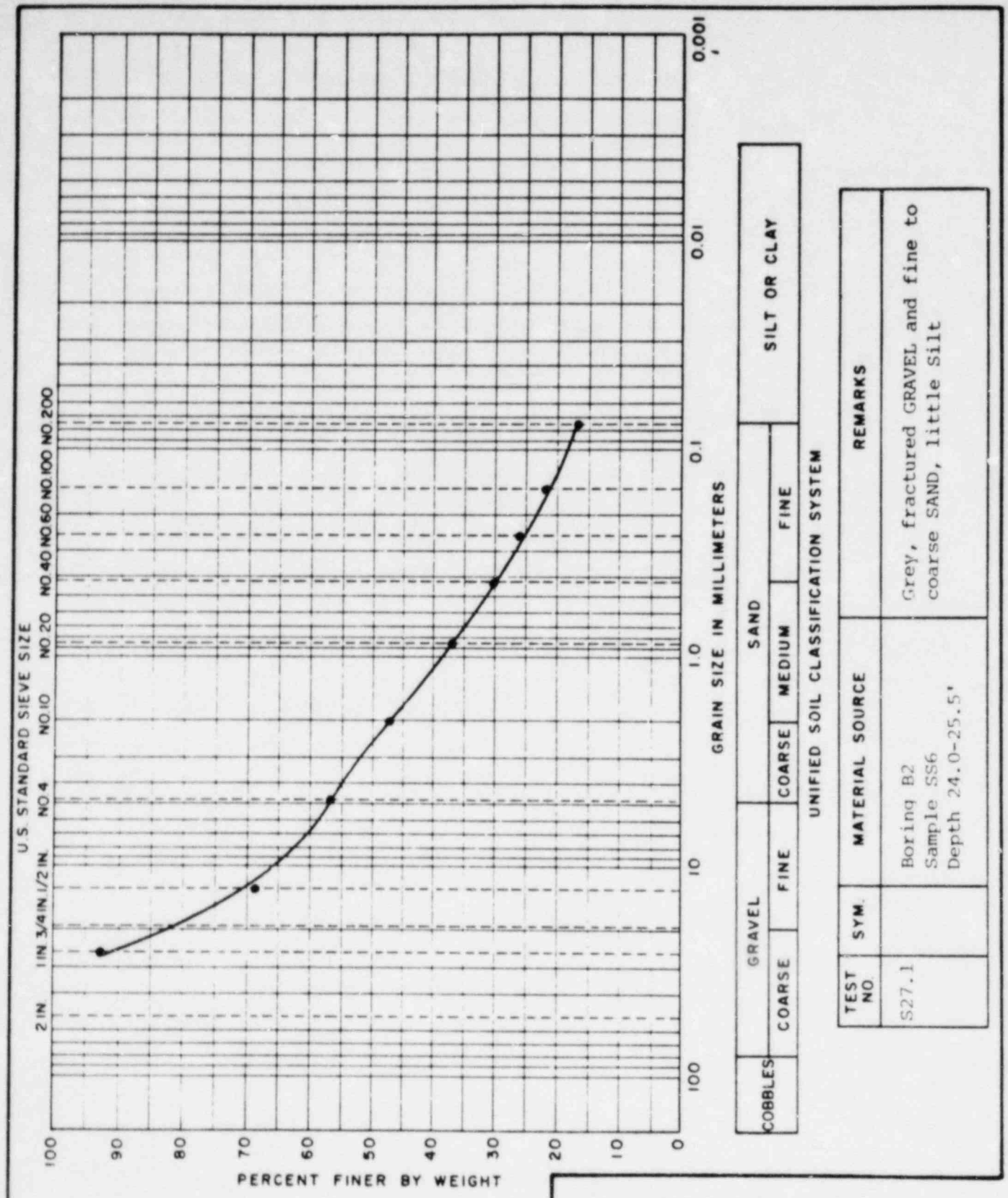
TEST SERIES NO. 26
DATE June 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B2
SAMPLE SS6
DEPTH 24.0-25.5'
TECH. _____
REVIEWER _____

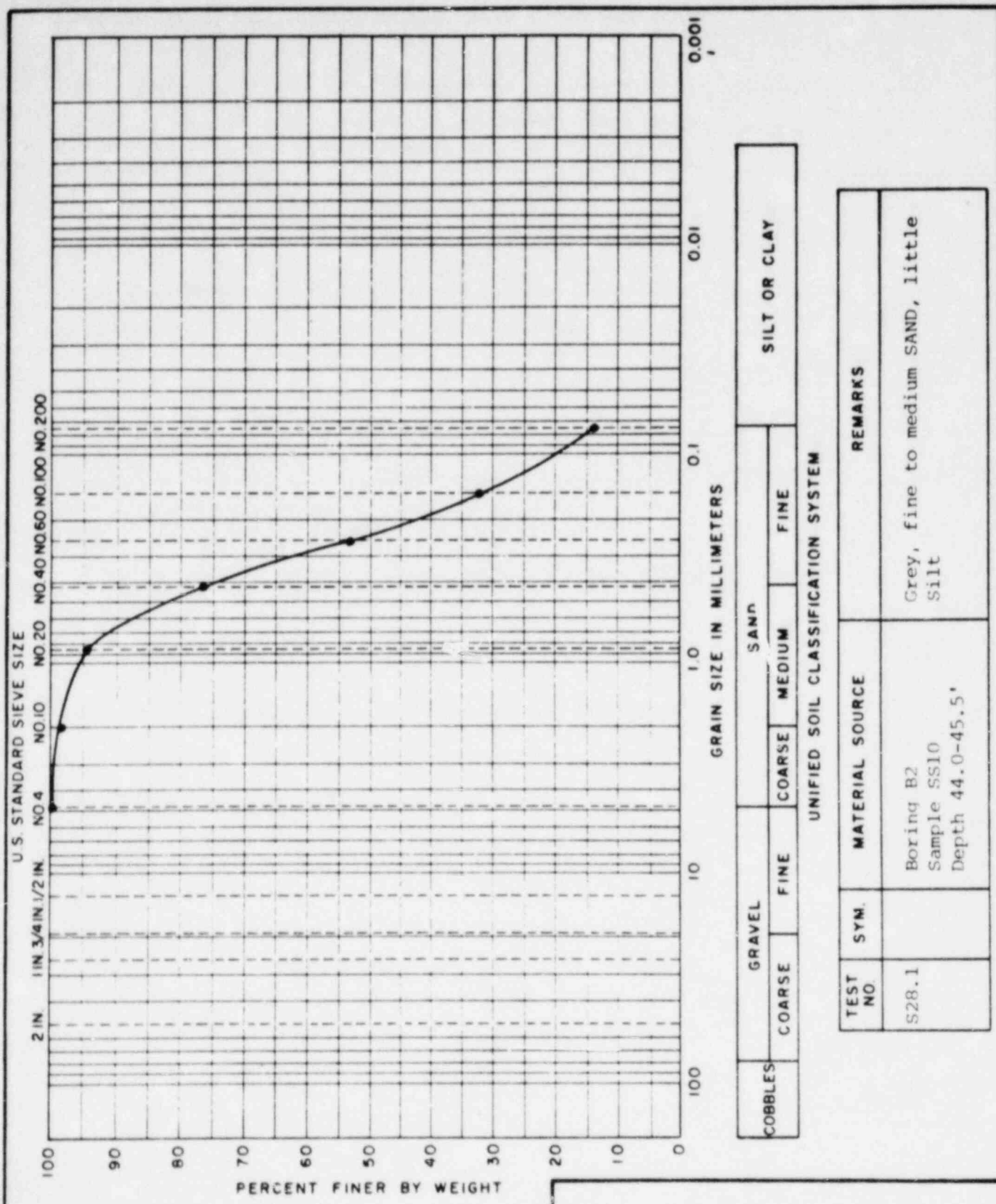
TEST SERIES NO. 27
DATE June 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B2
SAMPLE SS10
DEPTH 44.0-45.5'
TECH.
REVIEWER

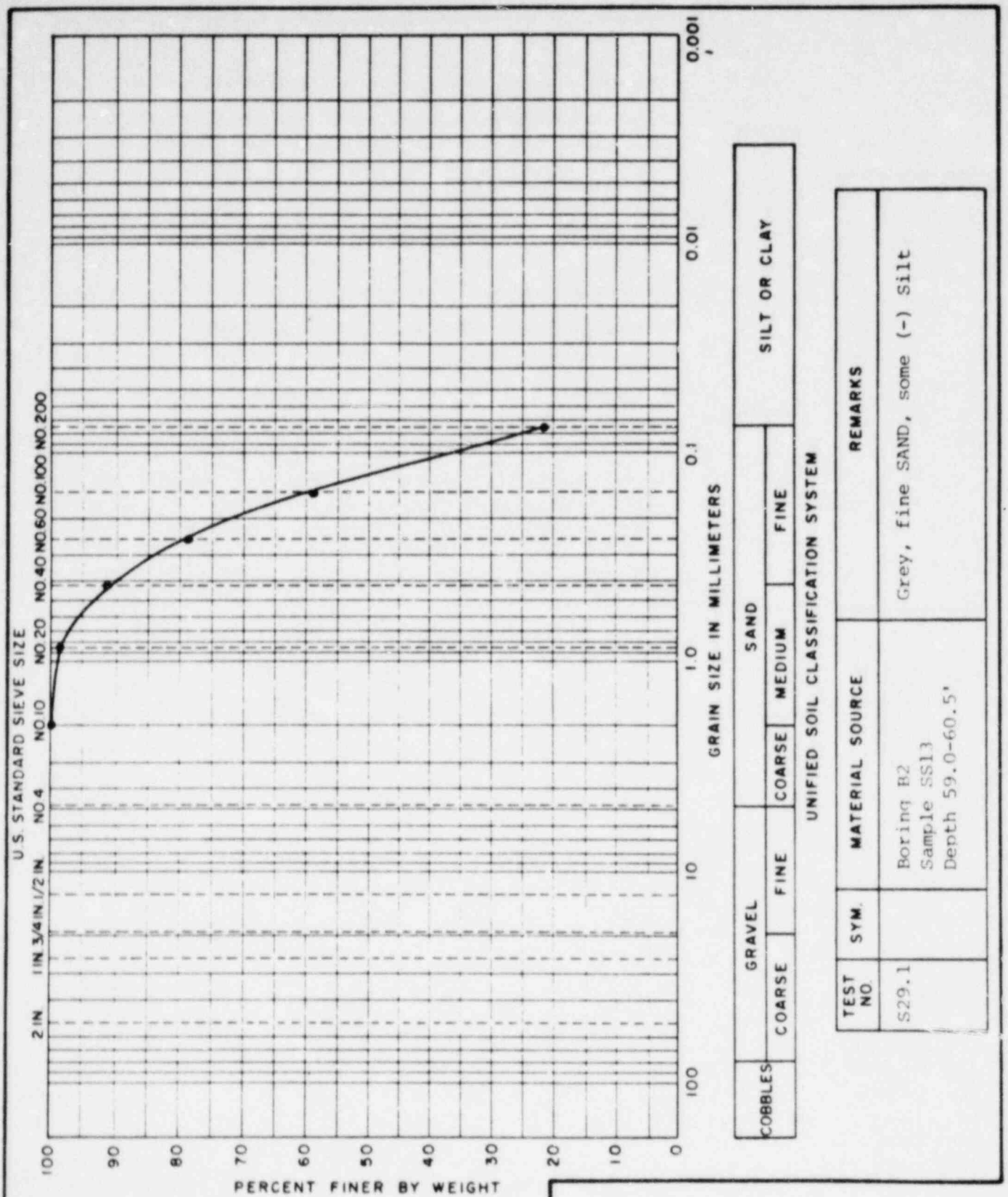
TEST SERIES NO. 28
DATE June 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B2
SAMPLE SS13
DEPTH 59.0-60.5'
TECH. _____
REVIEWER _____

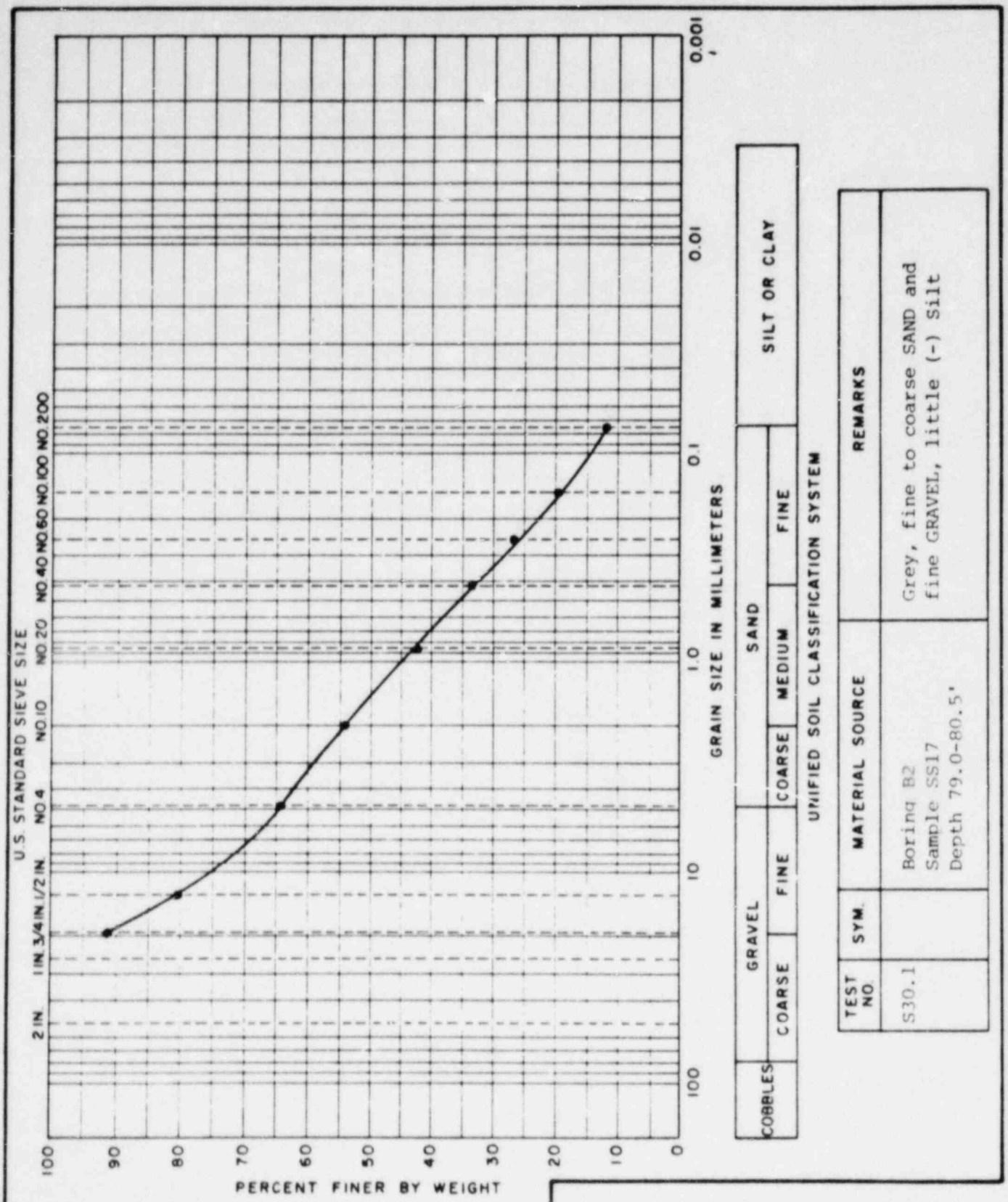
TEST SERIES NO. 29
DATE June 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



TEST NO.	SYM.	MATERIAL SOURCE	REMARKS
S30.1		Boring B2 Sample SS17 Depth 79.0-80.5'	Grey, fine to coarse SAND and fine GRAVEL, little (-) Silt

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B2
SAMPLE SS17
DEPTH 79.0-80.5'
TECH. _____
REVIEWER _____

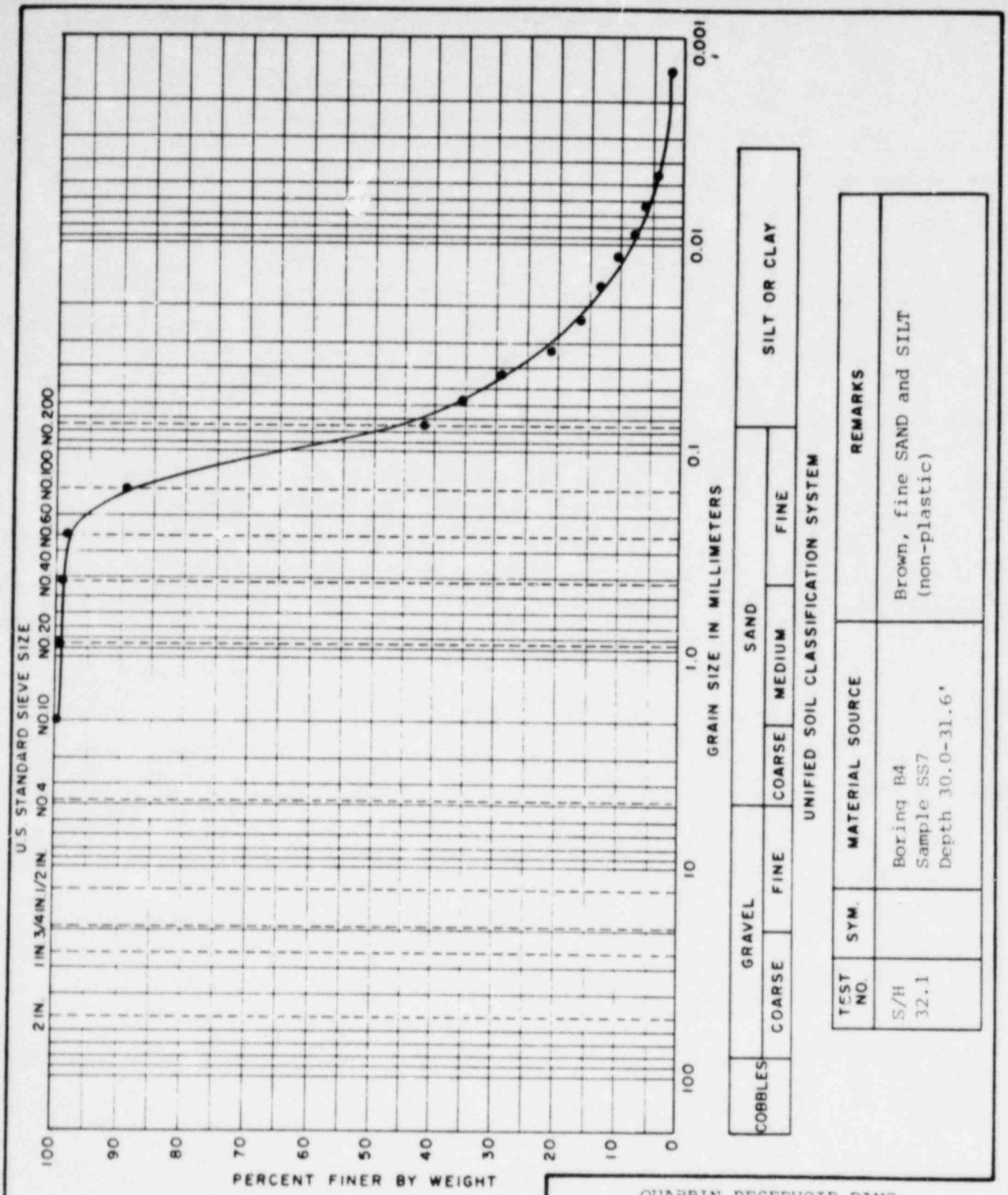
TEST SERIES NO. 30
DATE June 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B4
SAMPLE SS7
DEPTH 30.0-31.6
TECH.
REVIEWER

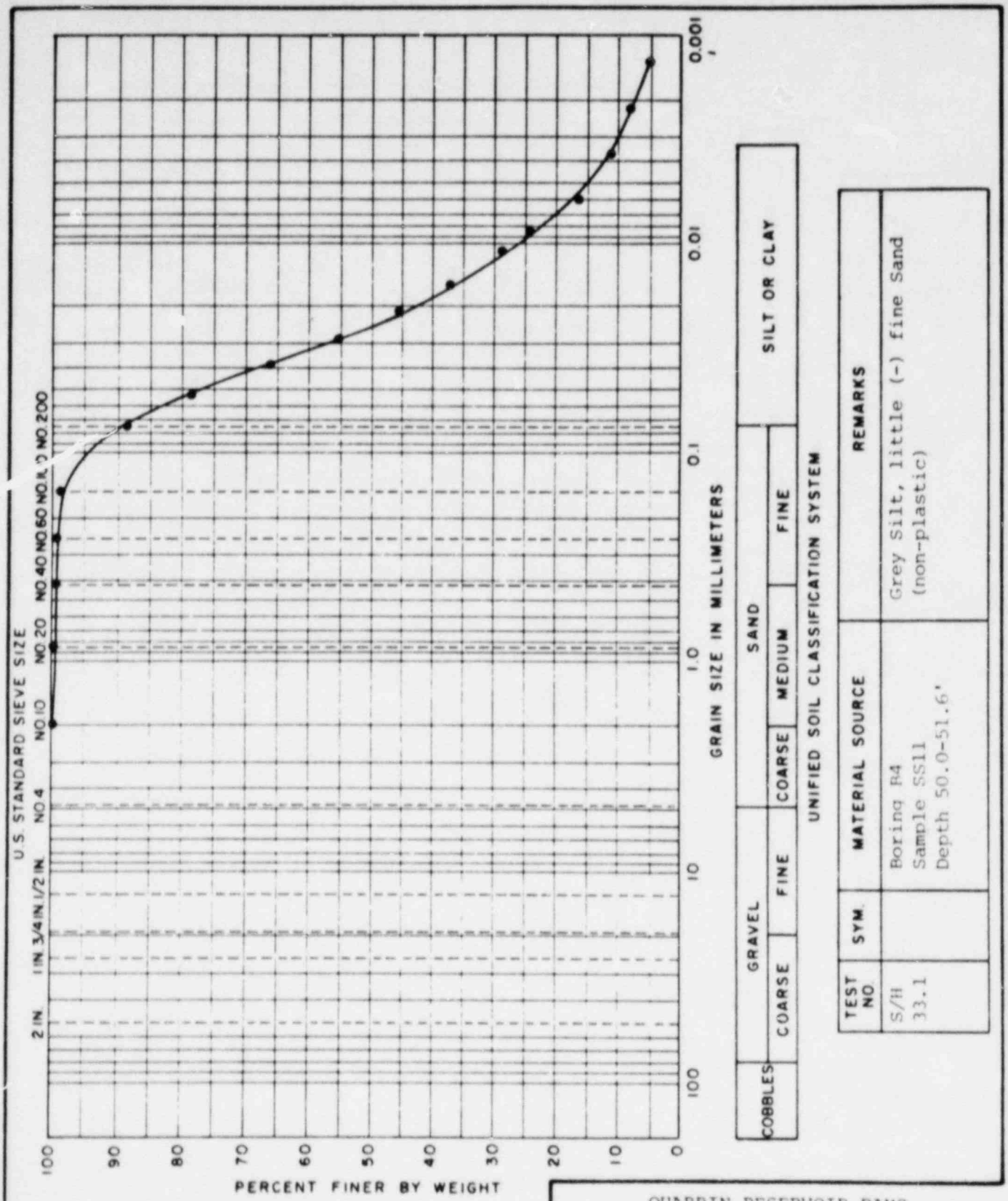
TEST SERIES NO. 32
DATE June 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



TEST NO	SYM.	MATERIAL SOURCE	REMARKS
S/H 33.1		Boring B4 Sample SS11 Depth 50.0-51.6'	Grey Silt, little (-) fine Sand (non-plastic)

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B4
SAMPLE SS11
DEPTH 50.0-51.6
TECH. _____
REVIEWER _____

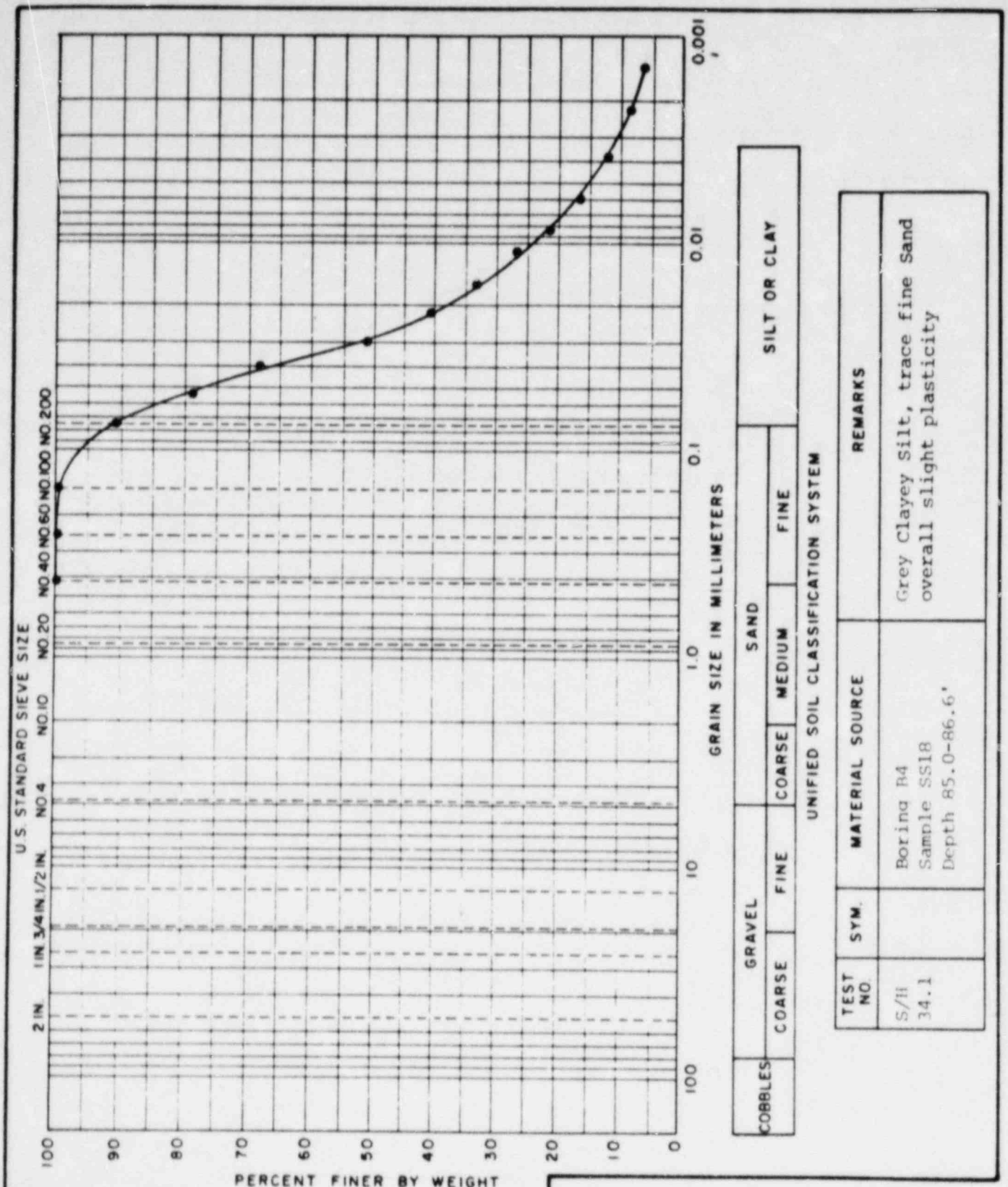
TEST SERIES NO. 33
DATE June 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B4
SAMPLE SS18
DEPTH 85.0-86.6
TECH.
REVIEWER

TEST SERIES NO. 34
DATE June 1981

FILE 2801

APPENDIX E-9

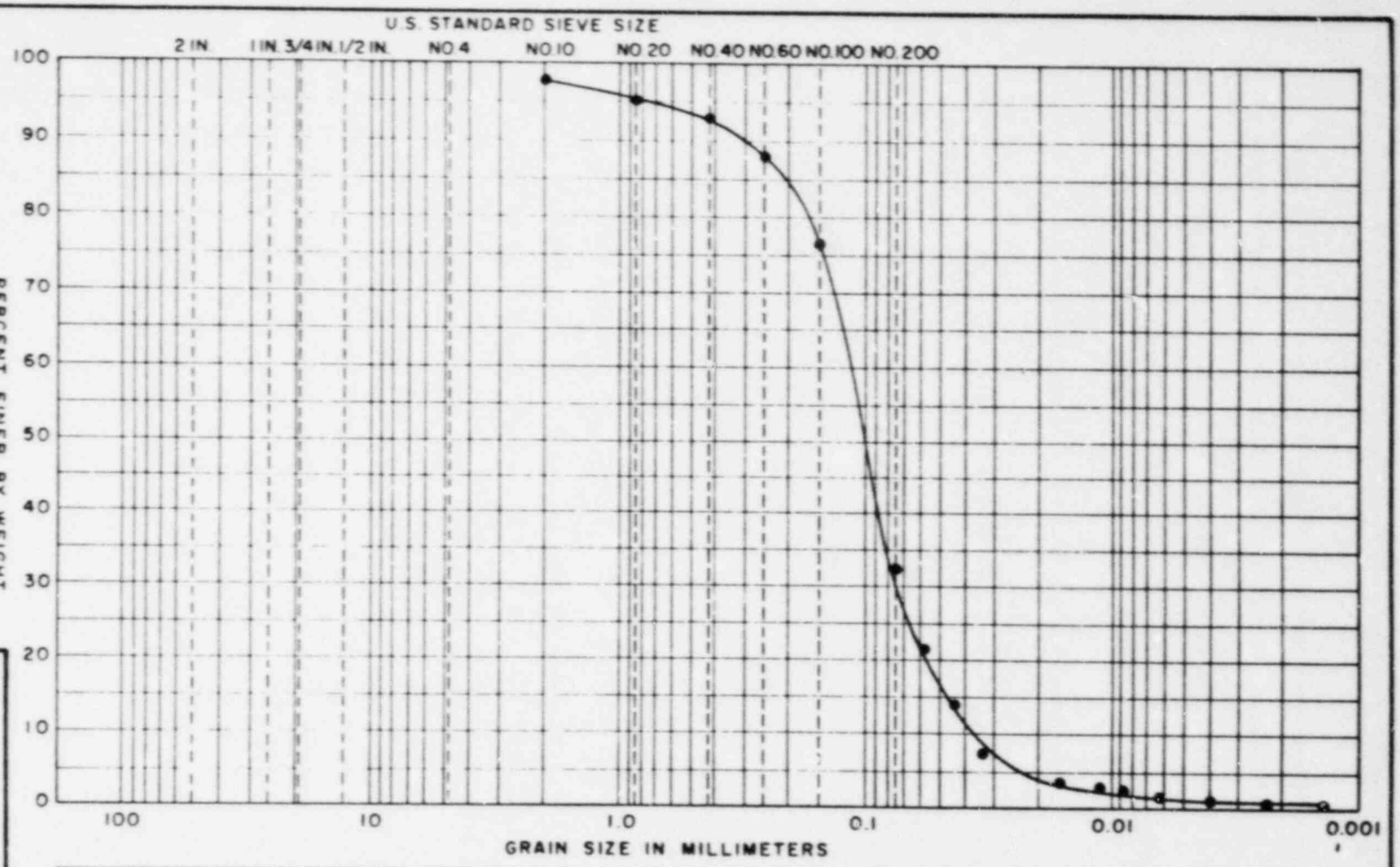
S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS

GRADATION TESTS

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

UNIFIED SOIL CLASSIFICATION SYSTEM

TEST NO.	SYM.	MATERIAL SOURCE	REMARKS
S/H 35.1		Boring B5 Sample SS7 Depth 30.0-31.5'	Brown, fine SAND, some (+) Silt

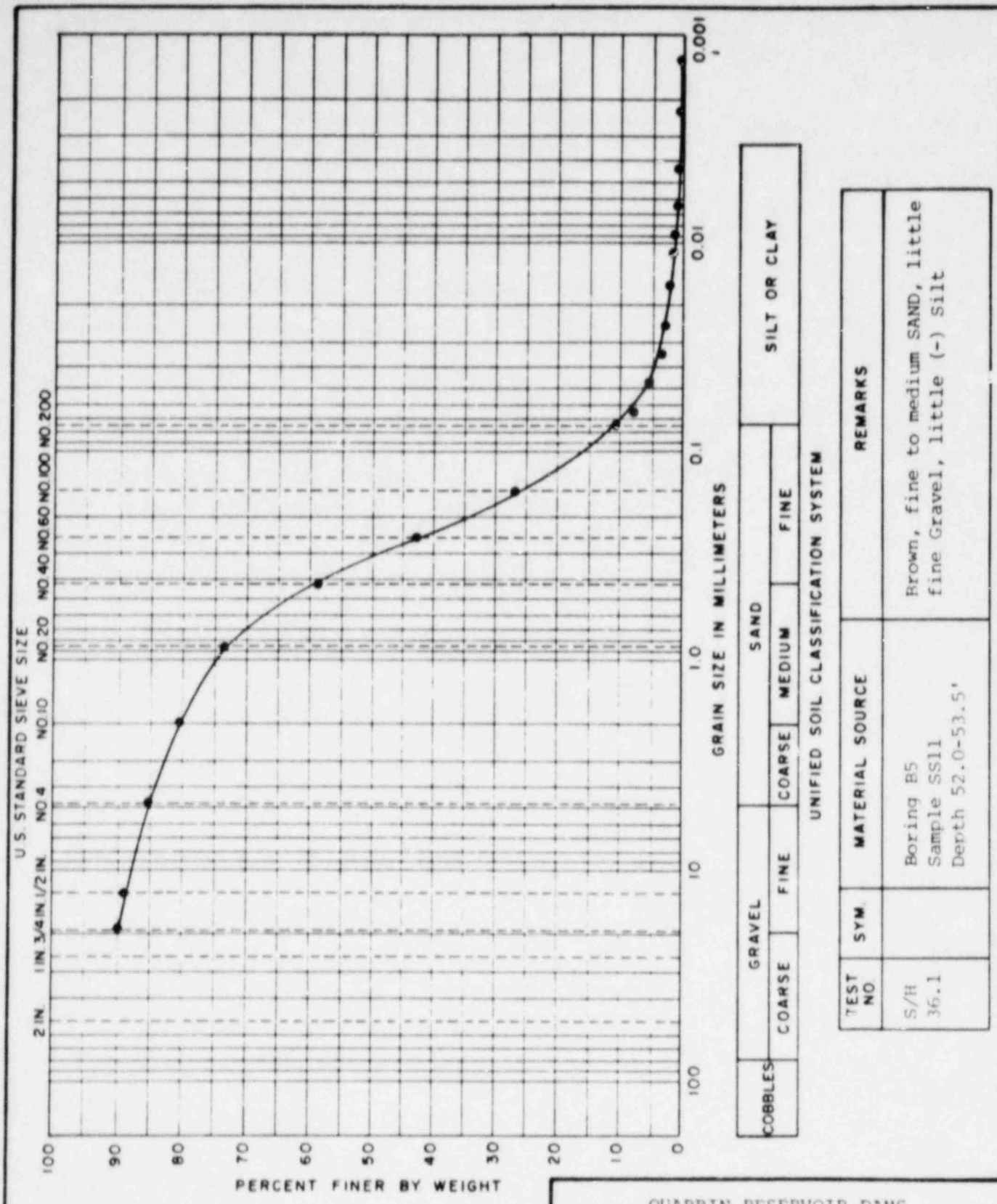
BORING NO. B5
SAMPLE SS7
DEPTH 30.0-31.5'
TECH.
REVIEWER

TEST SERIES NO. 35
DATE June 1981

FILE 2801

APPENDIX E-9

S3



QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

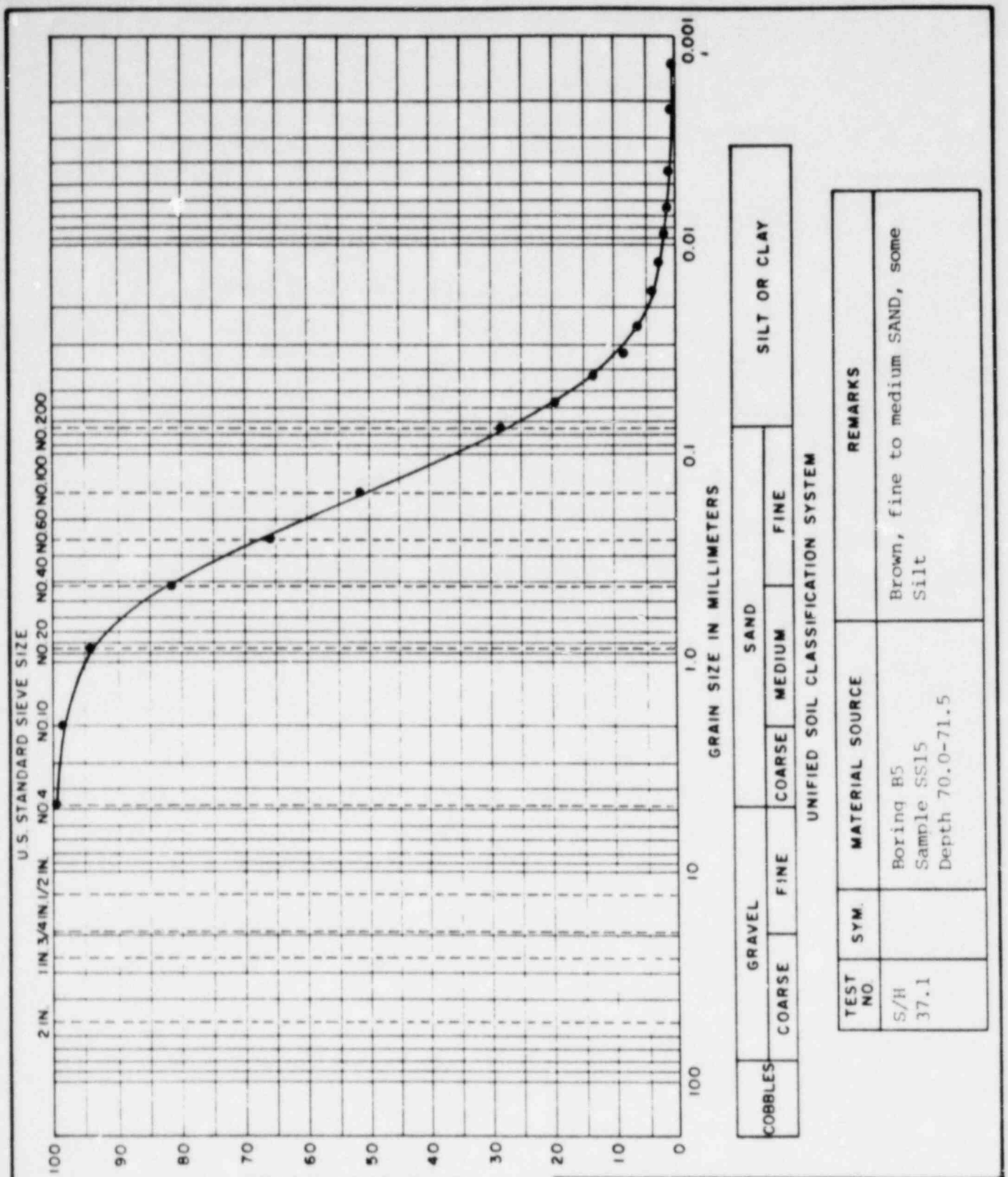
BORING NO. B5
SAMPLE SS11
DEPTH 52.0-53.5
TECH.
REVIEWER

TEST SERIES NO. 36
DATE June 1981

FILE 2801 S.3

APPENDIX E-9

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B5
SAMPLE SS15
DEPTH 70.0-71.5
TECH.
REVIEWER

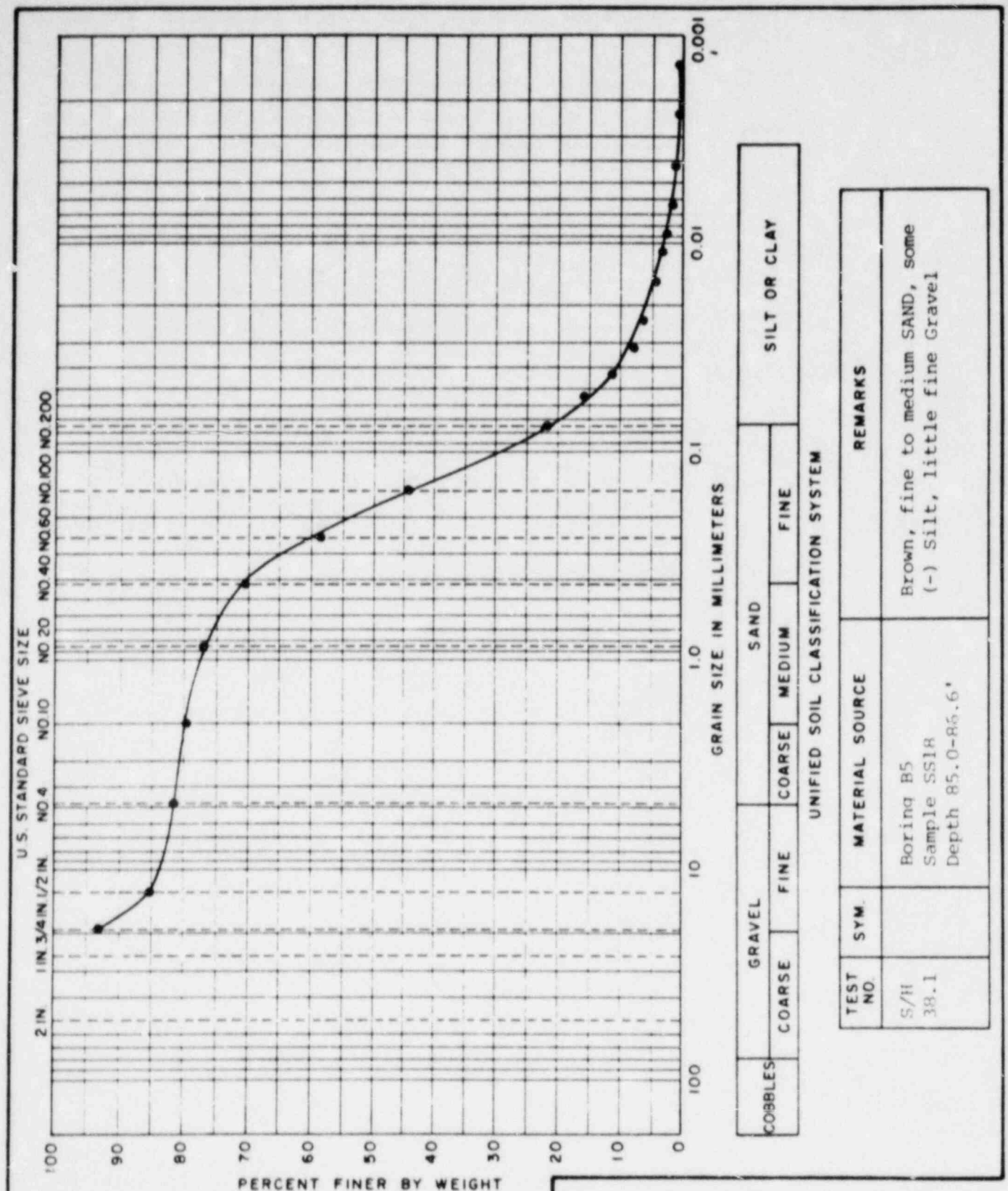
TEST SERIES NO. 37
DATE June 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



TEST NO.	SYM.	MATERIAL SOURCE	REMARKS
S/H 38.1		Boring B5 Sample SS18 Depth 85.0-86.6'	Brown, fine to medium SAND, some (-) Silt, little fine Gravel

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B5
SAMPLE SS18
DEPTH 85.0-86.6
TECH.
REVIEWER

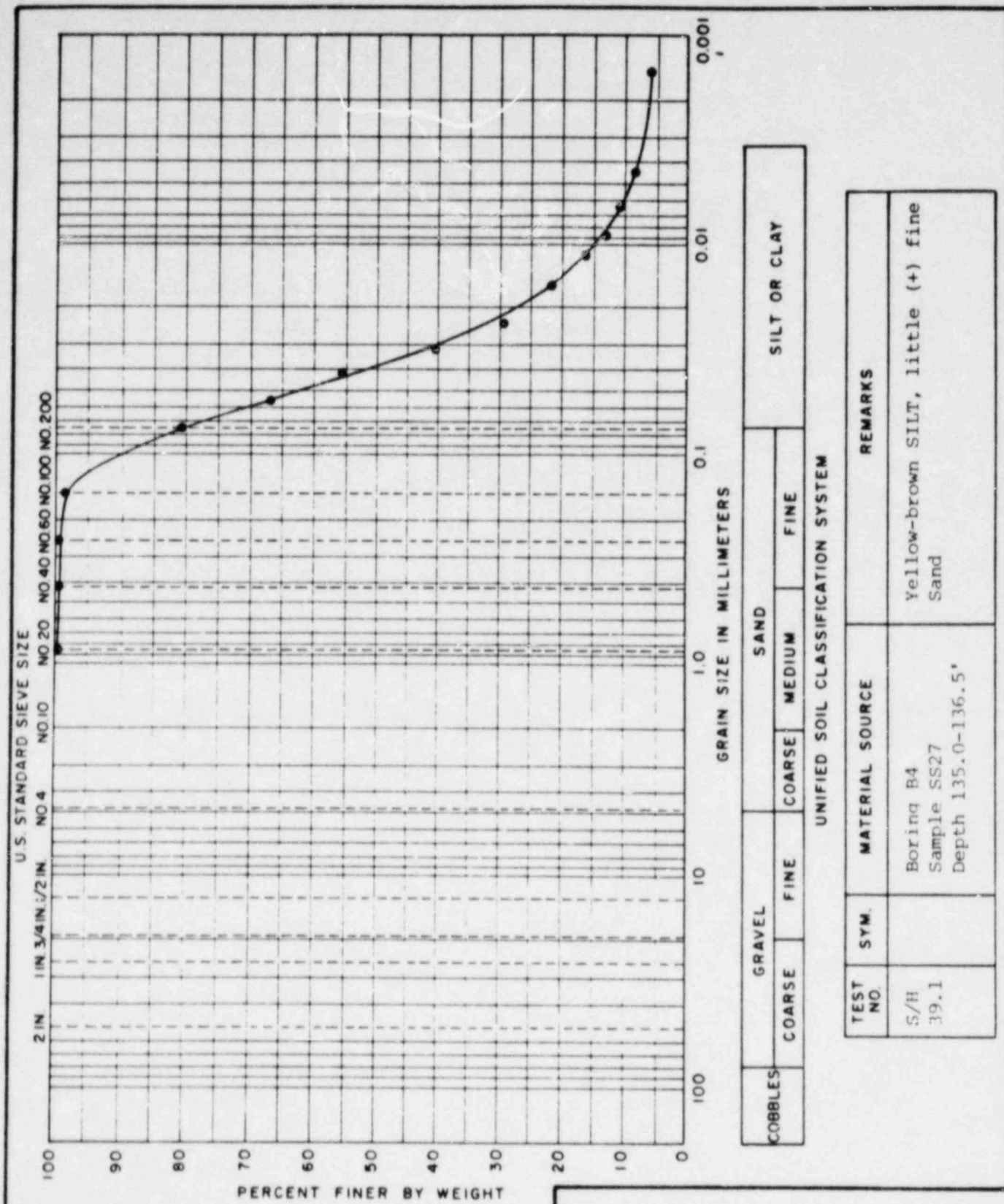
TEST SERIES NO. 38
DATE June 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



TEST NO.	SYM.	MATERIAL SOURCE	REMARKS
S/H 39.1		Boring B4 Sample SS27 Depth 135.0-136.5'	Yellow-brown SILT, little (+) fine Sand

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B4
SAMPLE SS27
DEPTH 135.0-136.5'
TECH.
REVIEWER

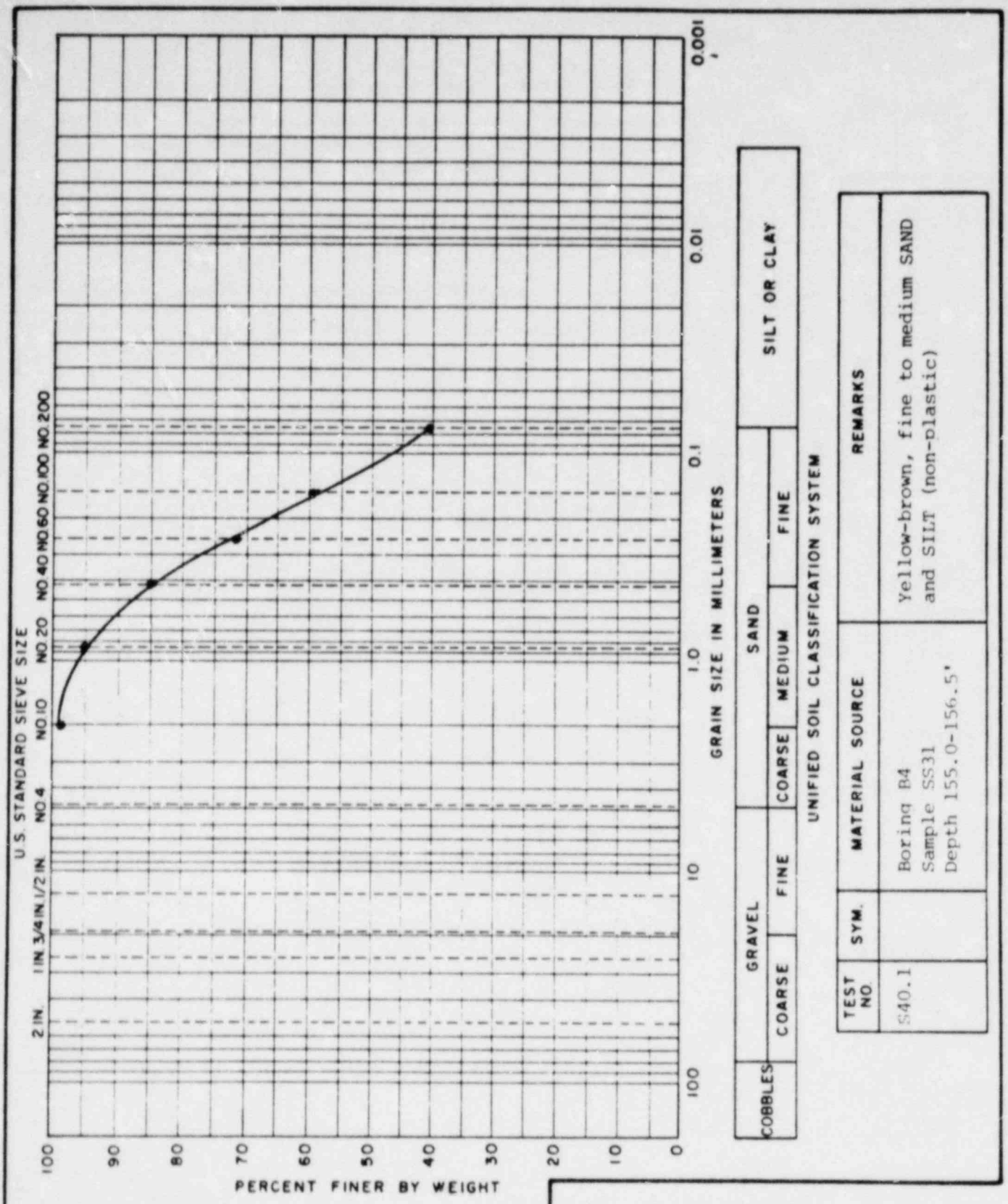
TEST SERIES NO. 39
DATE June 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B4
SAMPLE SS31
DEPTH 155.0-156.5
TECH.
REVIEWER

TEST SERIES NO. 40
DATE June 1981

FILE 2801

APPENDX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

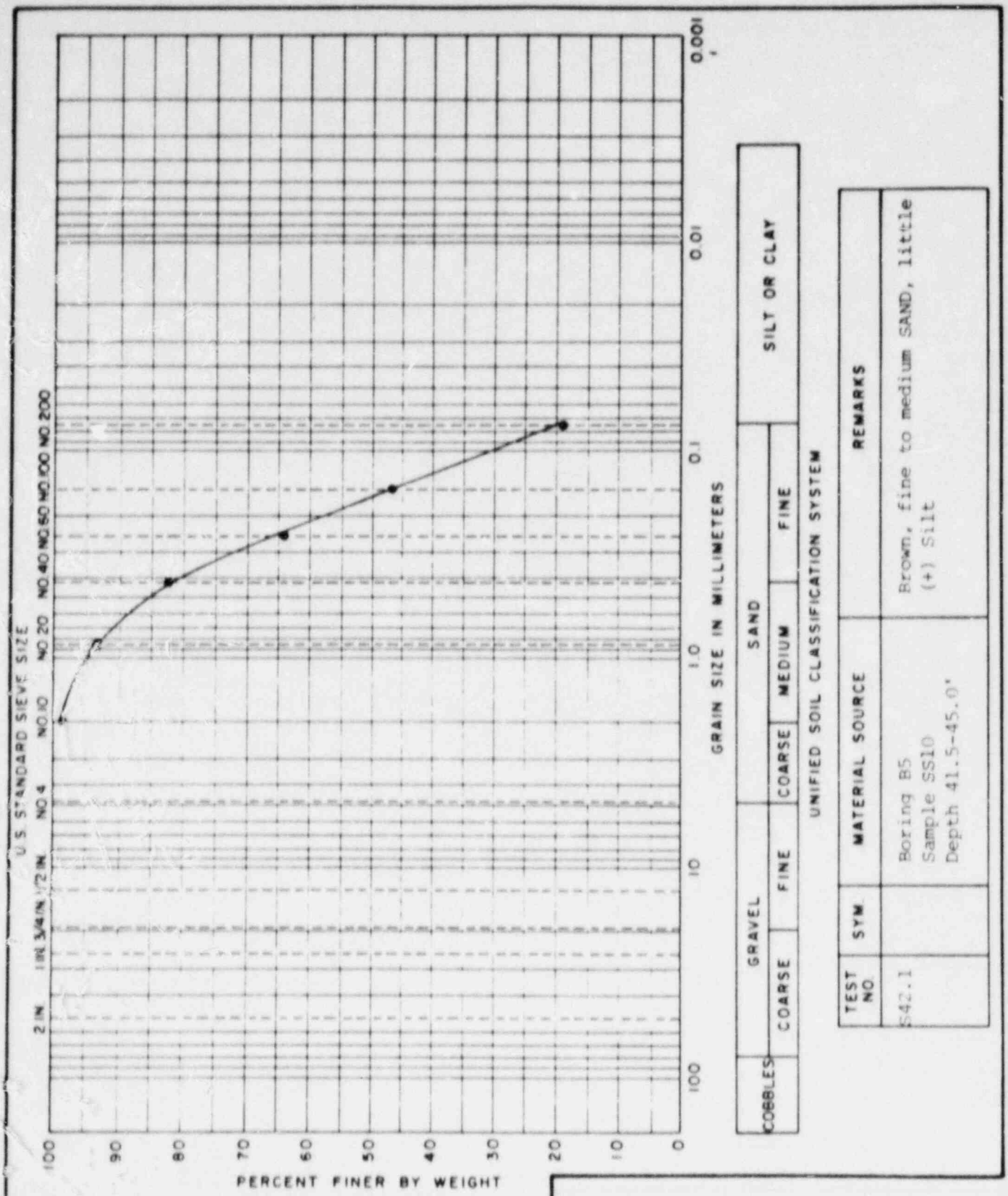
GRADATION TESTS

BORING NO. B8 TEST SERIES
SAMPLE SS11 NO. 41
DEPTH 50.0-55.0' DATE June 1981
TECH. _____
REVIEWER _____ FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B5
SAMPLE SS10
DEPTH 41.5-45.0'
TECH.
REVIEWER

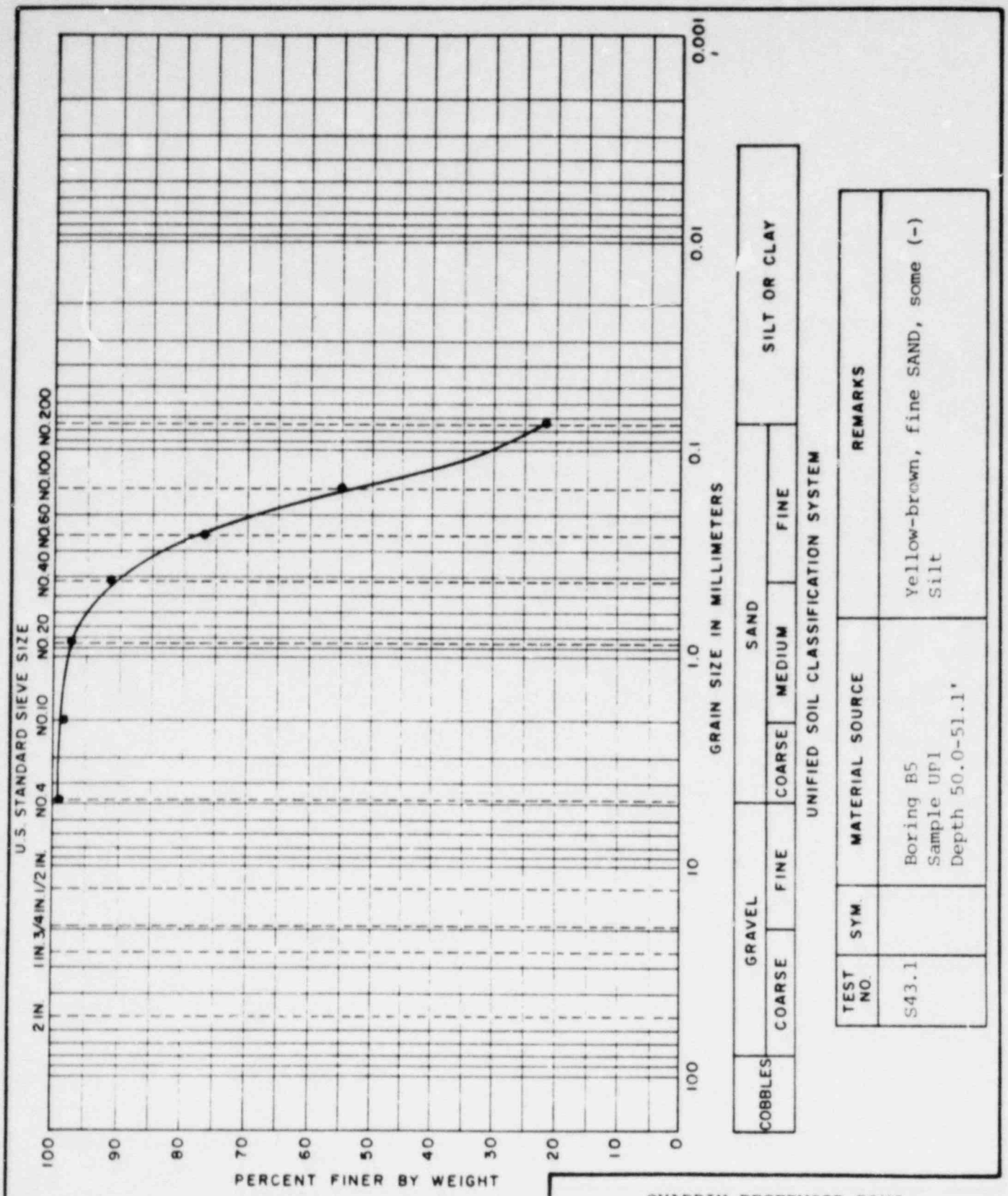
TEST SERIES NO. 42
DATE June 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL GEOHYDROLOGICAL CONSULTANTS



QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B5
SAMPLE UP1
DEPTH 50.0-51.1
TECH. _____
REVIEWER _____

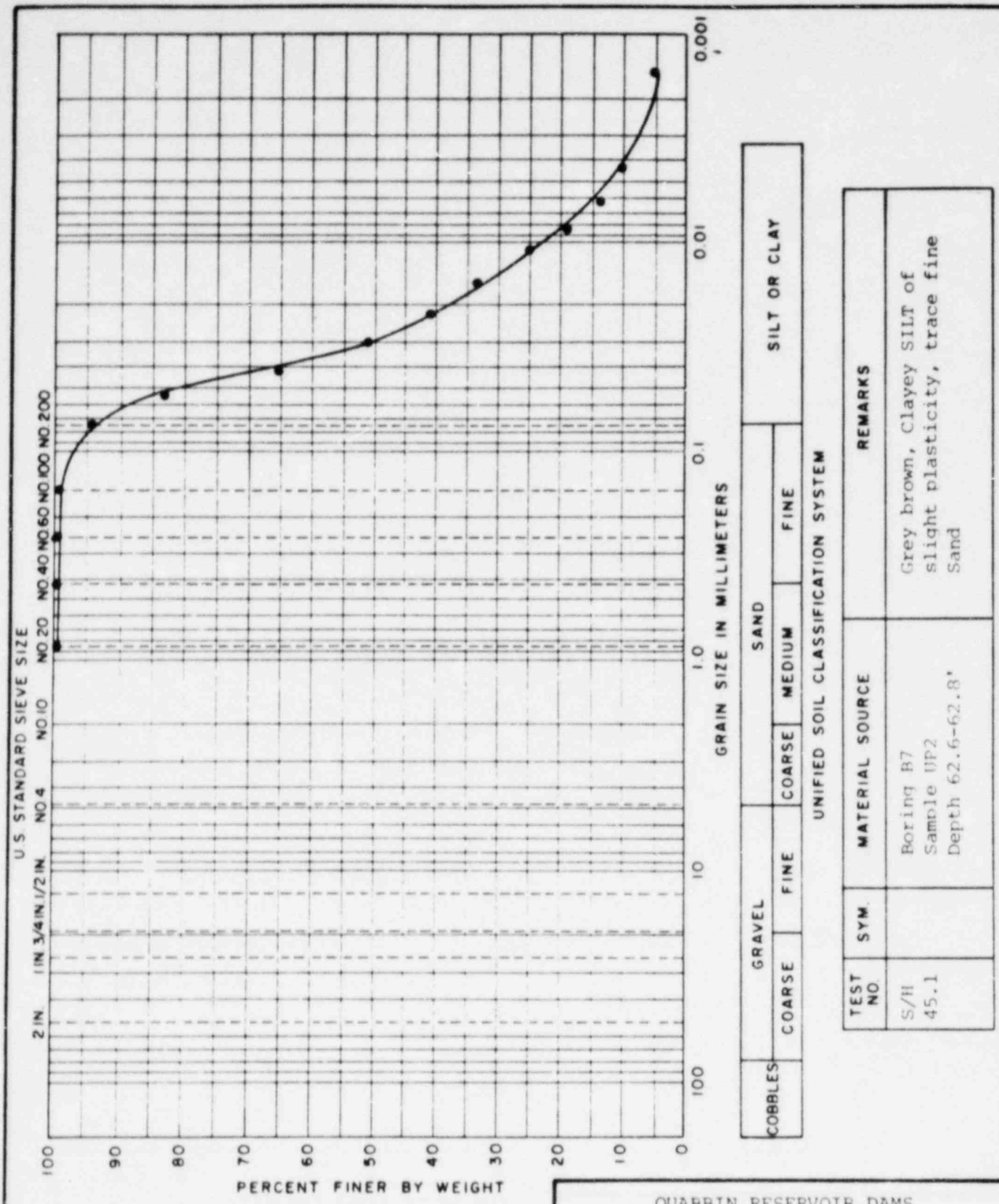
TEST SERIES NO. 43
DATE June 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B7
SAMPLE UP2
DEPTH 62.6-62.8'
TECH. _____
REVIEWER _____

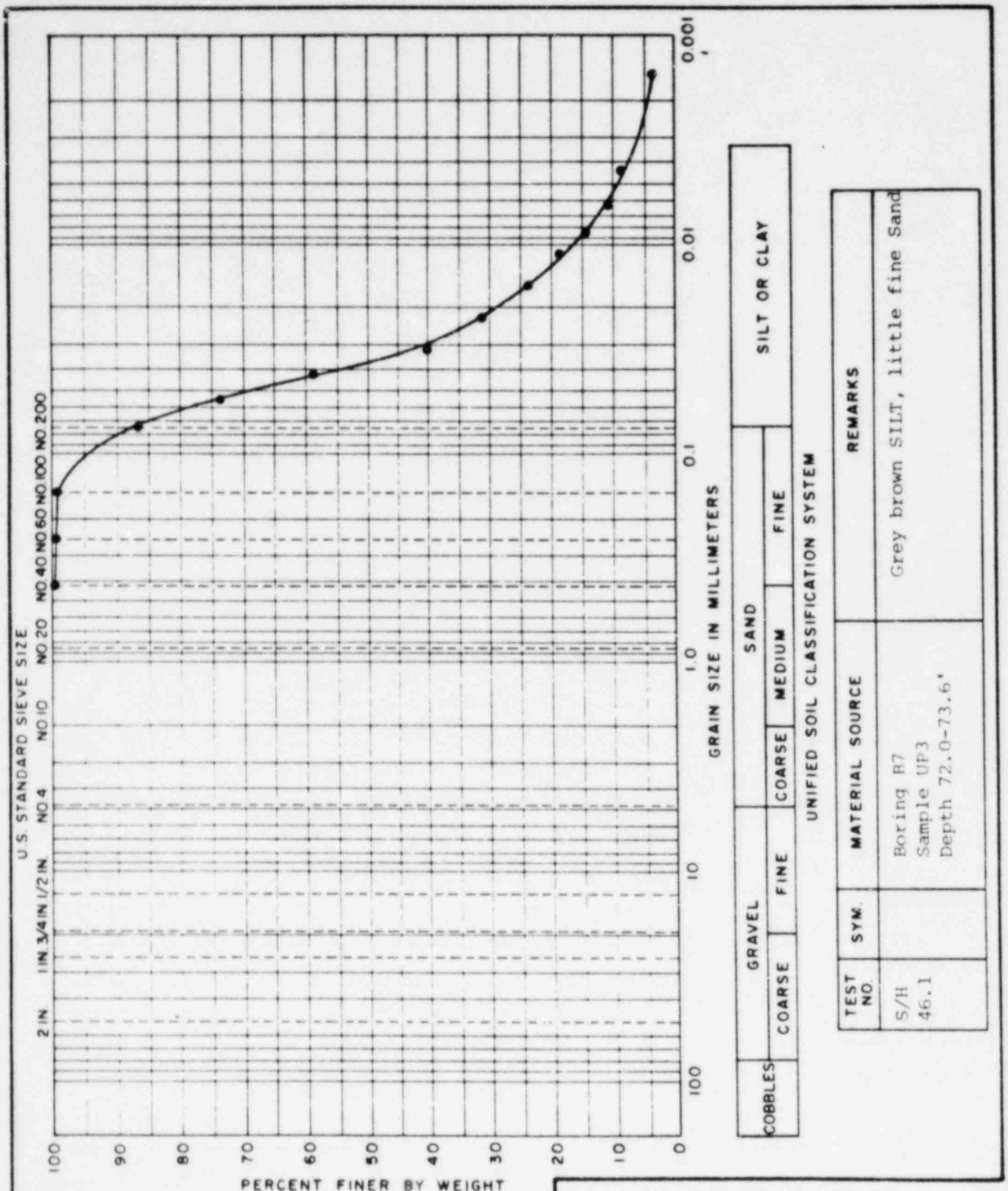
TEST SERIES NO. 45
DATE July 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B7
SAMPLE UP3
DEPTH 72.0-73.6'
TECH.
REVIEWER

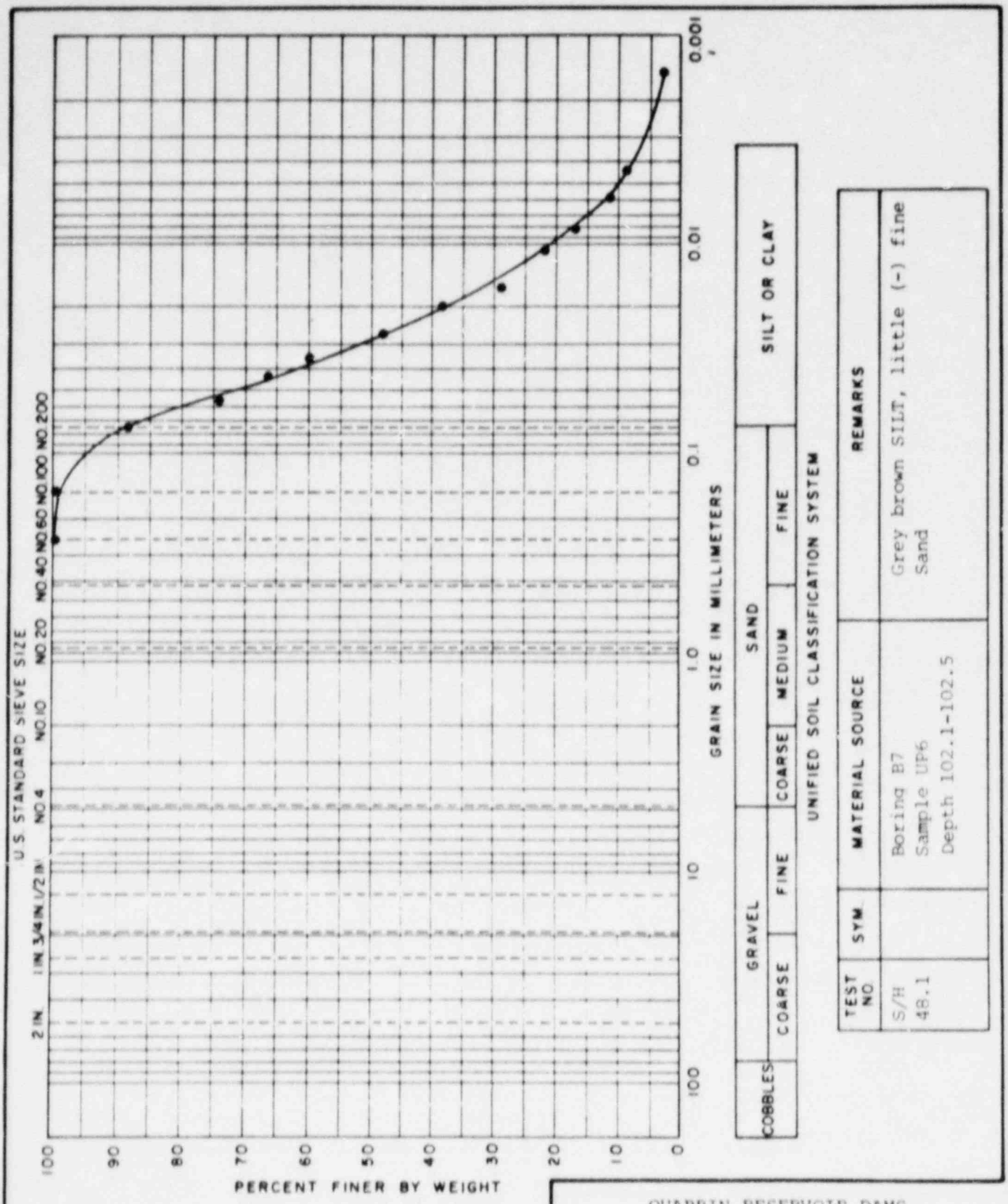
TEST SERIES NO. 46
DATE July 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

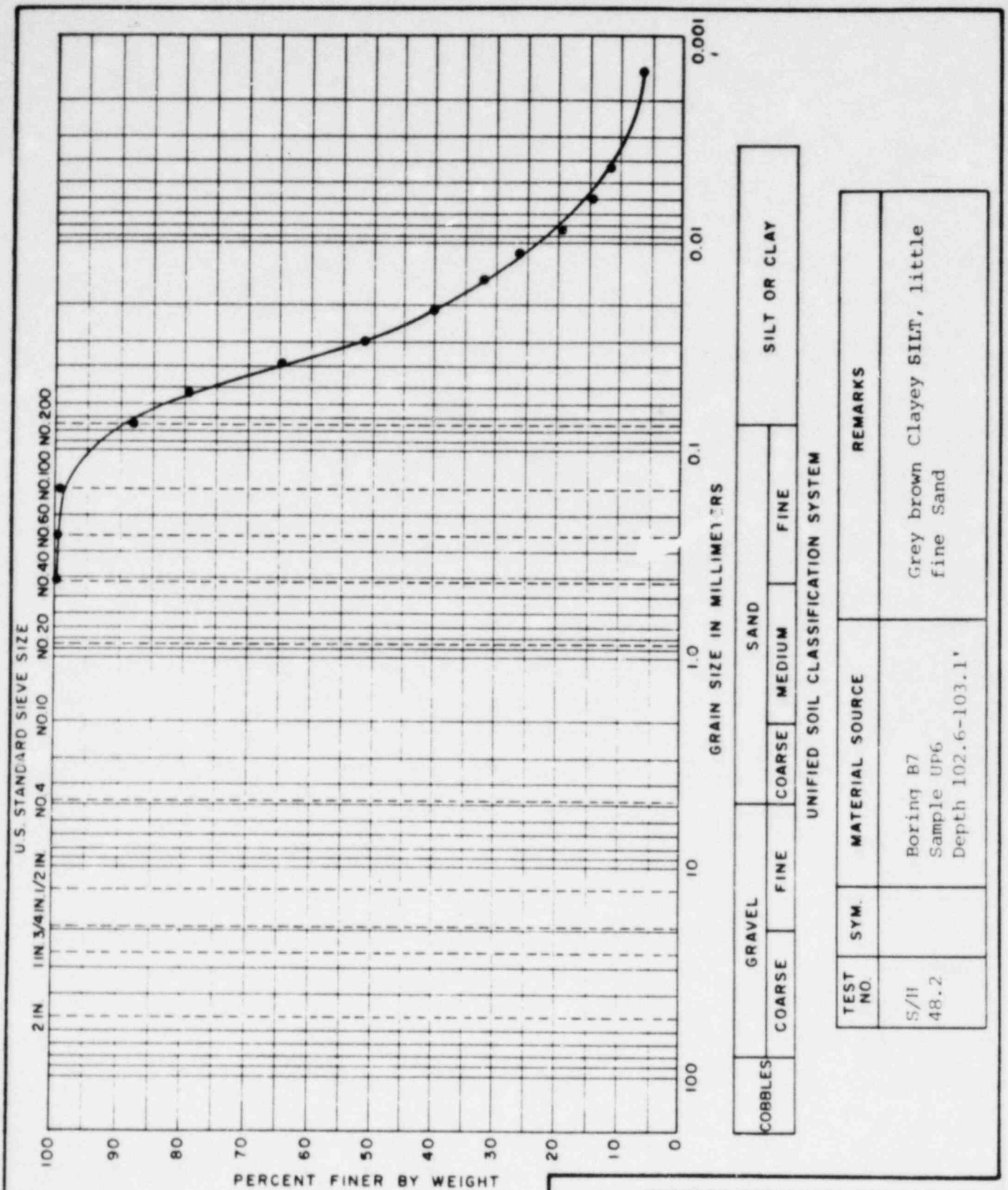
BORING NO. B7
SAMPLE UP6
DEPTH 102.1-102.5'
TECH.
REVIEWER

TEST SERIES NO. 48
DATE July 1981

FILE 2801

APPENDIX E-9

S.3



QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B7
SAMPLE UP6
DEPTH 102.6-103.1'
TECH.
REVIEWER

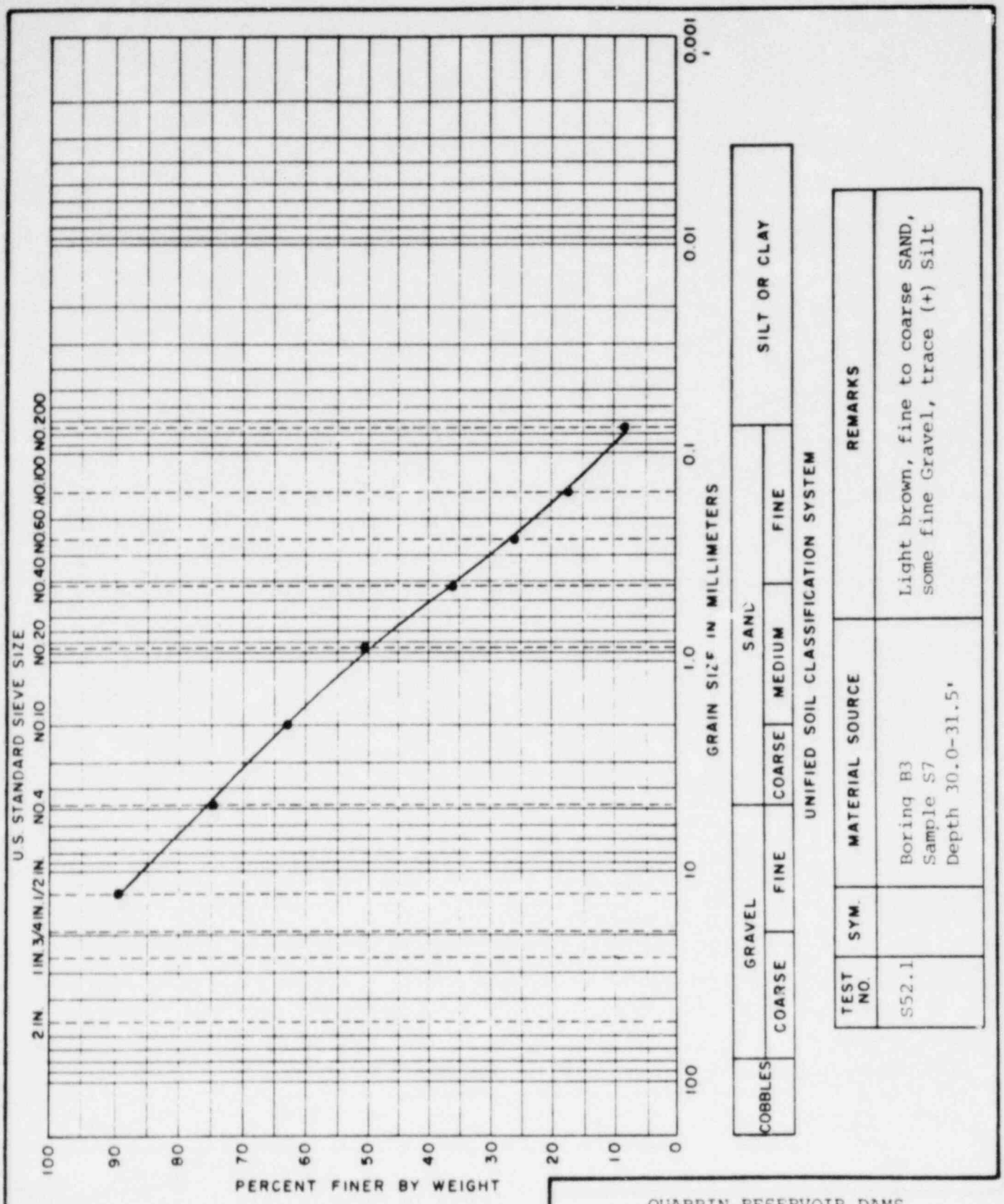
TEST SERIES NO. 48
DATE July 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B3
SAMPLE S7
DEPTH 30.0-31.5'
TECH. _____
REVIEWER _____

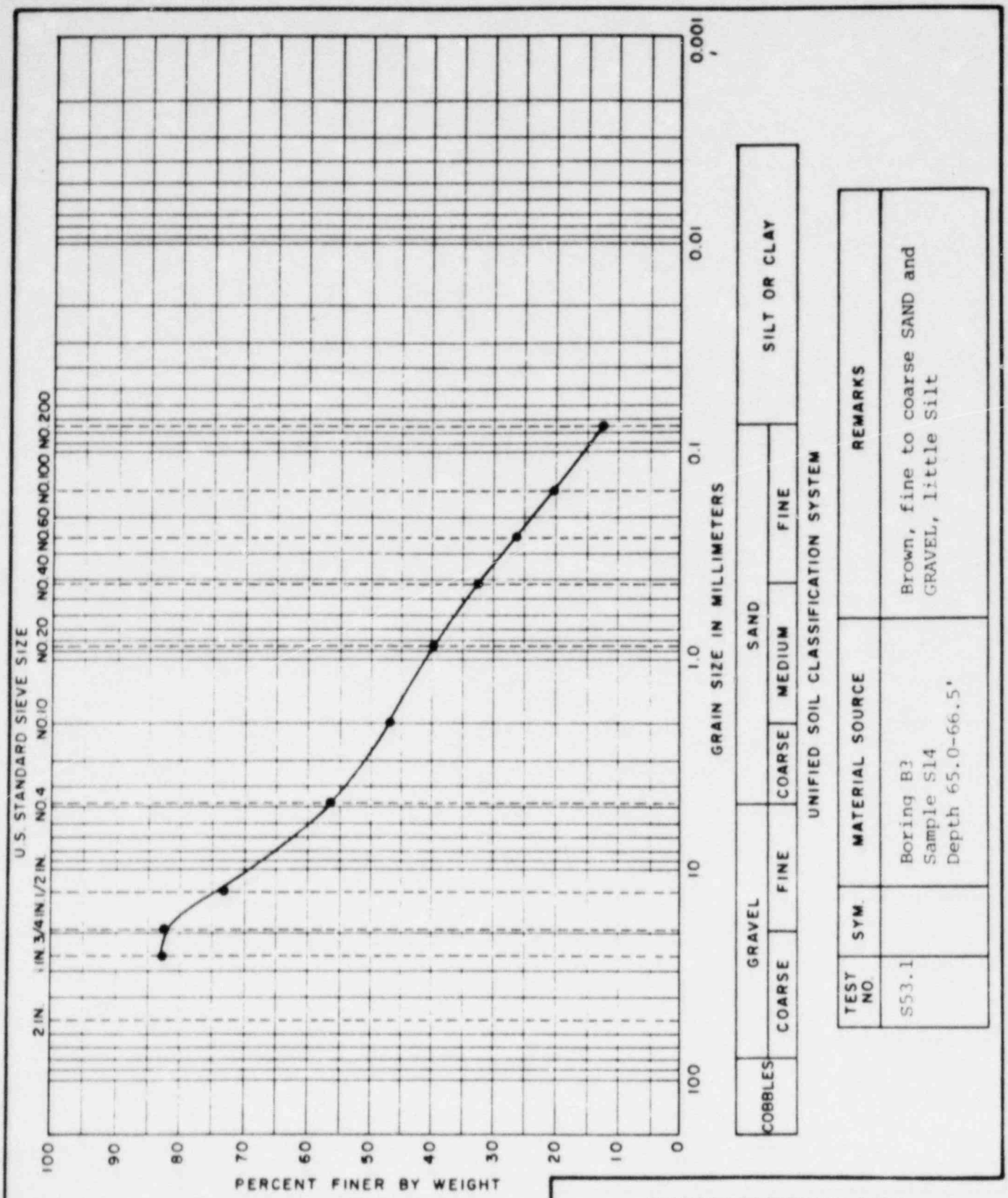
TEST SERIES NO. 52
DATE June 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B3
SAMPLE S14
DEPTH 65.0-66.5'
TECH. _____
REVIEWER _____

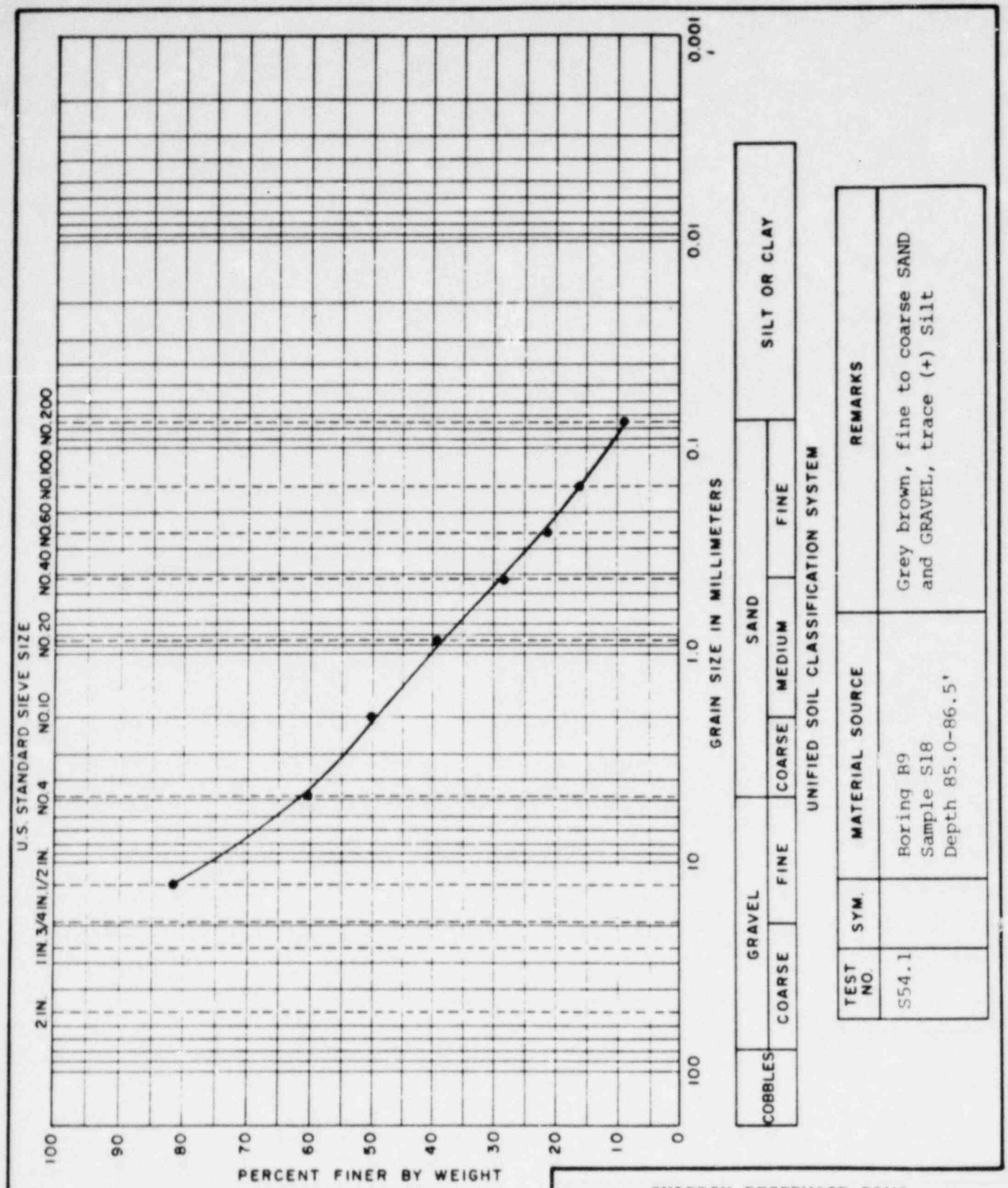
TEST SERIES NO. 53
DATE June 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B9
SAMPLE S18
DEPTH 85.0-86.5'
TECH. _____
REVIEWER _____

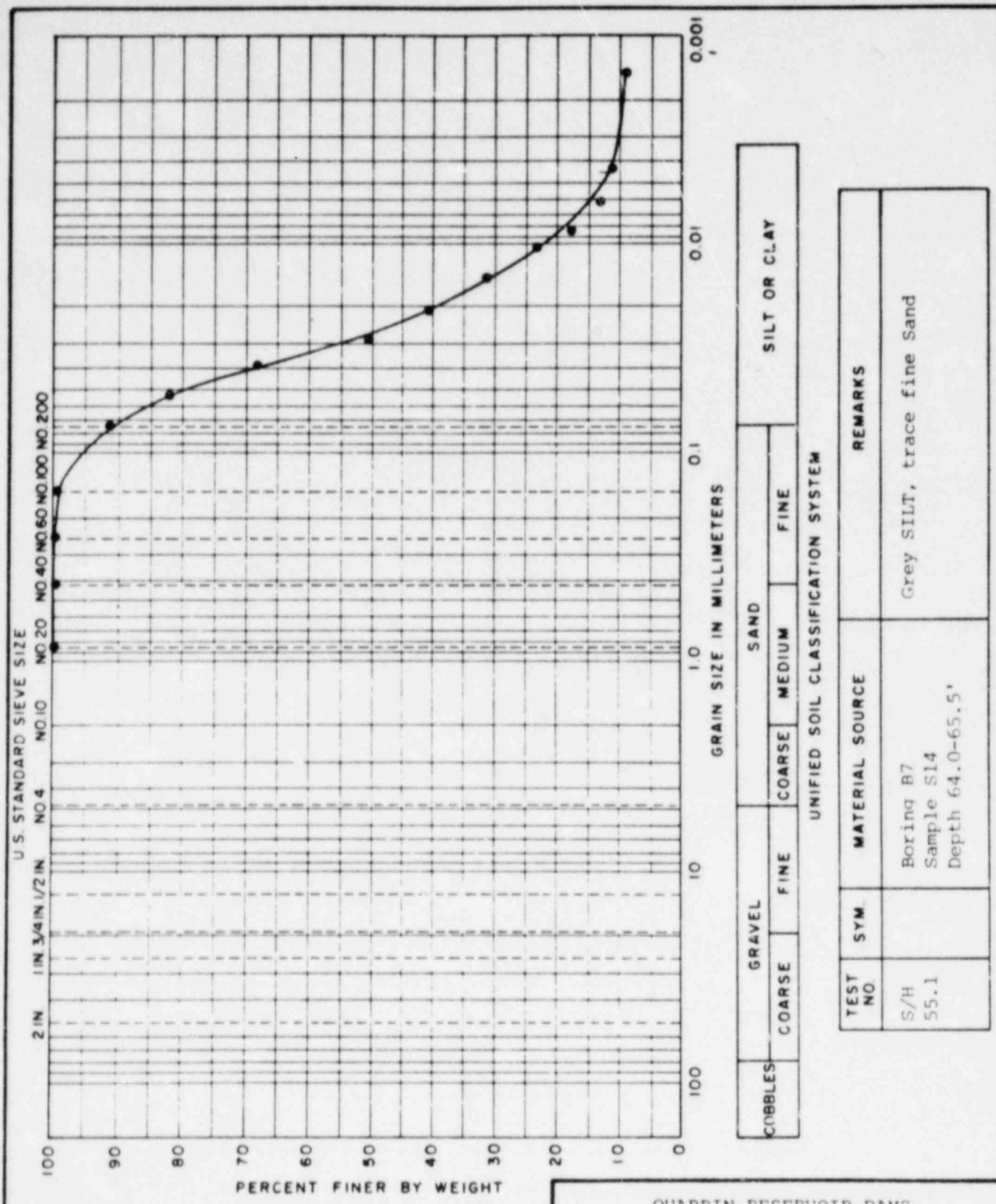
TEST SERIES NO. 54
DATE June 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B7
SAMPLE S14
DEPTH 64.0-65.5'
TECH. _____
REVIEWER _____

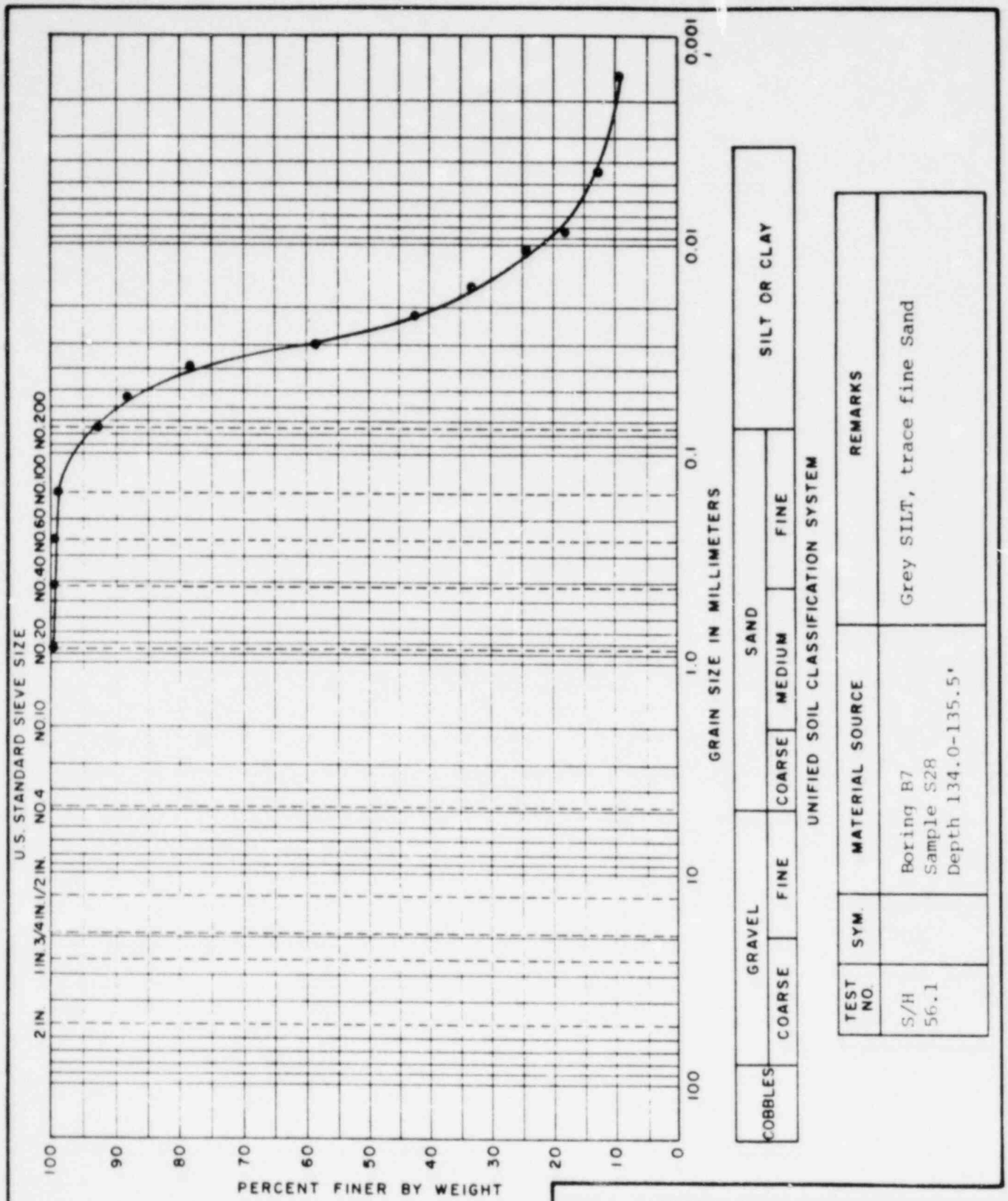
TEST SERIES NO. 55
DATE June 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



TEST NO.	SYM.	MATERIAL SOURCE	REMARKS
S/H 56.1		Boring B7 Sample S28 Depth 134.0-135.5'	Grey SILT, trace fine Sand

QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B7
SAMPLE S28
DEPTH 134.0-135.5'
TECH. _____
REVIEWER _____

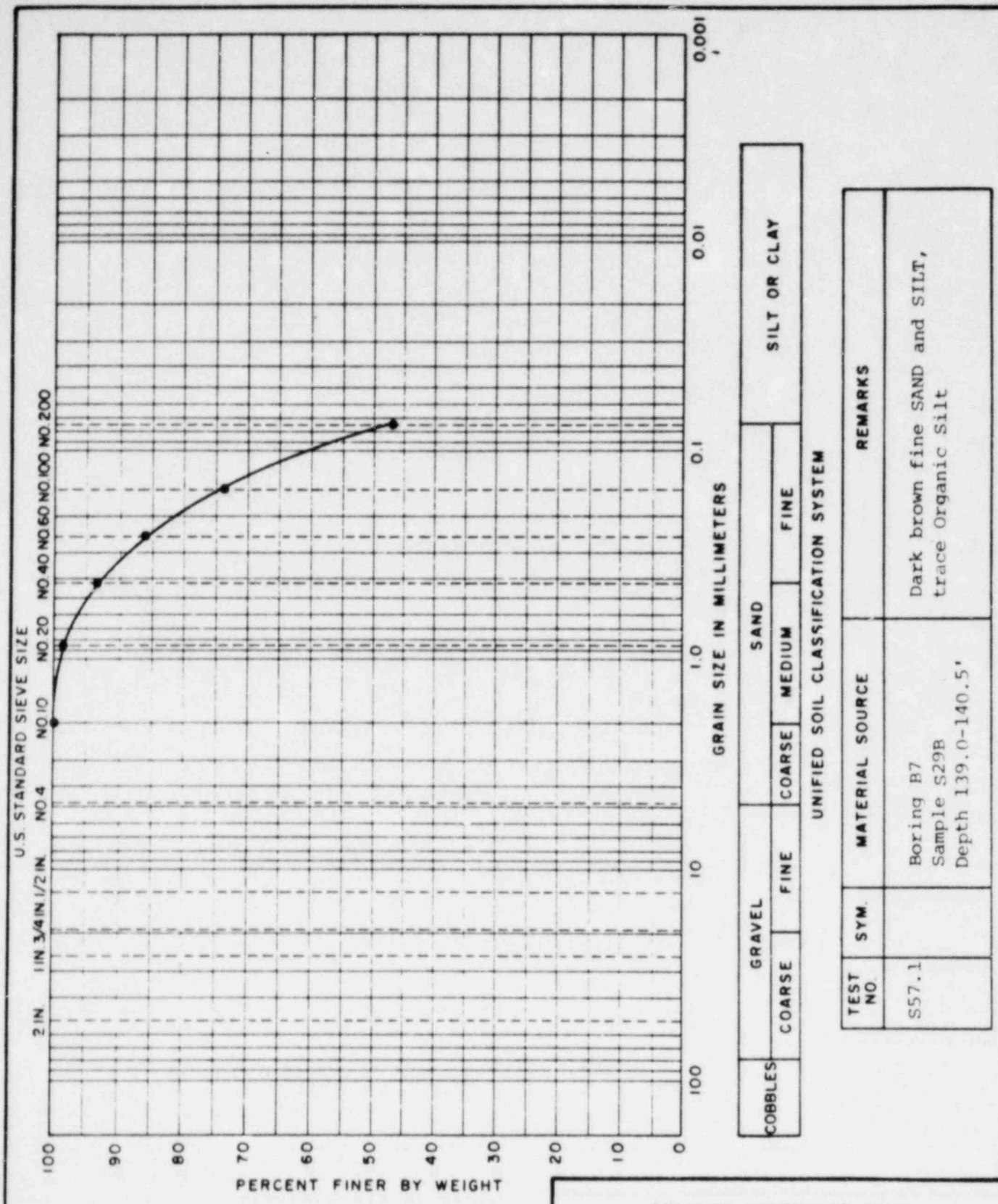
TEST SERIES NO. 56
DATE June 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS



QUABBIN RESERVOIR DAMS
BELCHERTOWN, MASSACHUSETTS

GRADATION TESTS

BORING NO. B7
SAMPLE S29B
DEPTH 139.0-140.5'
TECH. _____
REVIEWER _____

TEST SERIES NO. 57
DATE June 1981

FILE 2801

APPENDIX E-9

S.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS

APPENDIX D

TYPICAL DATA FOR COMPUTER STABILITY ANALYSIS

```
'winsor'
 87.     $ WINSOR DAM, QUABBIN RESERVOIR    DSN = WIN205
1 88/150
 88.     $ STA 20+00, FULL STRENGTH CORE, BEST EST PIEZO, STATIC
 89.     $ W HADGE
 90.     $ ESA
 91.     POINT DATA
 92.     $ POINT X Y
 93.     1 925 120
 94.     2 615 210
 95.     3 525 252
 96.     4 490 252
 97.     5 385 200
 98.     6 165 120
 99.     7 0 120
100.     8 925 85
101.     9 595 85
102.     10 535 230
103.     11 385 230
104.     12 430 85
105.     13 0 85
106.     14 541.21 215
107.     100 925 230
108.     101 571.44 230
109.     $
110.     LINE DATA
111.     $ LINE I J SOIL
112.     1 1 2 2
113.     2 2 101 2
114.     3 3 4 2
115.     4 4 5 2
116.     5 5 6 2
117.     6 6 7 2
118.     7 8 9 3
119.     8 9 10 1
120.     9 10 11 1
121.     10 11 12 1
122.     11 12 13 2
123.     12 9 12 3
124.     100 100 101 4
125.     103 101 3 2
126.     EJECT
127.
128.     SOIL DATA
129.     1 124 0 25 10
130.     2 130 0 37 10
131.     3 135 0 40 10
132.     4 62.4 0 .01 10
133.     $
134.     PIEZOMETRIC DATA
135.     10 1 925 230
136.     10 2 560 230
137.     10 3 490 200
138.     10 4 385 105
139.     10 5 0 100
140.     $
141.     NUMBER OF SLICES 25
142.     $
143.     RMIN THROUGH POINT 14
144.     RMAX TANGENT LINE 11
145.     $
146.     EJECT
147.
148.     GRID 1,300,850 2,300,650 3,100,650 4,4
```

```
149.
150.
l 'minimum'
446.     THE MINIMUM FACTOR OF SAFETY IS  2.206 FOR X=  200.00  Y=  800.00  R=  677.24
l 'lowest'
184.     THE LOWEST FACTOR OF SAFETY FOUND WAS 2.316 AT R=  497.40
196.     THE LOWEST FACTOR OF SAFETY FOUND WAS 2.368 AT R=  541.67
208.     THE LOWEST FACTOR OF SAFETY FOUND WAS 2.434 AT R=  586.86
231.     THE LOWEST FACTOR OF SAFETY FOUND WAS 2.514 AT R=  634.00
254.     THE LOWEST FACTOR OF SAFETY FOUND WAS 2.596 AT R=  679.27
267.     THE LOWEST FACTOR OF SAFETY FOUND WAS 2.215 AT R=  523.48
281.     THE LOWEST FACTOR OF SAFETY FOUND WAS 2.232 AT R=  565.71
296.     THE LOWEST FACTOR OF SAFETY FOUND WAS 2.262 AT R=  609.12
311.     THE LOWEST FACTOR OF SAFETY FOUND WAS 2.299 AT R=  653.47
327.     THE LOWEST FACTOR OF SAFETY FOUND WAS 2.346 AT R=  698.59
336.     THE LOWEST FACTOR OF SAFETY FOUND WAS 2.356 AT R=  552.86
347.     THE LOWEST FACTOR OF SAFETY FOUND WAS 2.270 AT R=  593.00
359.     THE LOWEST FACTOR OF SAFETY FOUND WAS 2.206 AT R=  634.55
371.     THE LOWEST FACTOR OF SAFETY FOUND WAS 2.206 AT R=  677.24
384.     THE LOWEST FACTOR OF SAFETY FOUND WAS 2.228 AT R=  720.87
390.     THE LOWEST FACTOR OF SAFETY FOUND WAS 2.481 AT R=  550.82
396.     THE LOWEST FACTOR OF SAFETY FOUND WAS 2.433 AT R=  599.08
402.     THE LOWEST FACTOR OF SAFETY FOUND WAS 2.418 AT R=  647.61
408.     THE LOWEST FACTOR OF SAFETY FOUND WAS 2.427 AT R=  696.35
414.     THE LOWEST FACTOR OF SAFETY FOUND WAS 2.440 AT R=  745.25
420.     THE LOWEST FACTOR OF SAFETY FOUND WAS 2.881 AT R=  539.35
426.     THE LOWEST FACTOR OF SAFETY FOUND WAS 2.571 AT R=  588.56
432.     THE LOWEST FACTOR OF SAFETY FOUND WAS 2.353 AT R=  637.89
438.     THE LOWEST FACTOR OF SAFETY FOUND WAS 2.271 AT R=  687.31
444.     THE LOWEST FACTOR OF SAFETY FOUND WAS 2.219 AT R=  736.82
 'Fsbshp'
451.     FSBSHP FSNRML FSRANK RADIUS NO.SLCS.    X=  300.00,  Y=  650.00
467.     FSBSHP FSNRML FSRANK RADIUS NO.SLCS.    X=  300.00,  Y=  700.00
489.     FSBSHP FSNRML FSRANK RADIUS NO.SLCS.    X=  300.00,  Y=  750.00
511.     FSBSHP FSNRML FSRANK RADIUS NO.SLCS.    X=  300.00,  Y=  800.00
534.     FSBSHP FSNRML FSRANK RADIUS NO.SLCS.    X=  300.00,  Y=  850.00
557.     FSBSHP FSNRML FSRANK RADIUS NO.SLCS.    X=  250.00,  Y=  650.00
570.     FSBSHP FSNRML FSRANK RADIUS NO.SLCS.    X=  250.00,  Y=  700.00
584.     FSBSHP FSNRML FSRANK RADIUS NO.SLCS.    X=  250.00,  Y=  750.00
599.     FSBSHP FSNRML FSRANK RADIUS NO.SLCS.    X=  250.00,  Y=  800.00
614.     FSBSHP FSNRML FSRANK RADIUS NO.SLCS.    X=  250.00,  Y=  850.00
630.     FSBSHP FSNRML FSRANK RADIUS NO.SLCS.    X=  200.00,  Y=  650.00
639.     FSBSHP FSNRML FSRANK RADIUS NO.SLCS.    X=  200.00,  Y=  700.00
650.     FSBSHP FSNRML FSRANK RADIUS NO.SLCS.    X=  200.00,  Y=  750.00
662.     FSBSHP FSNRML FSRANK RADIUS NO.SLCS.    X=  200.00,  Y=  800.00
674.     FSBSHP FSNRML FSRANK RADIUS NO.SLCS.    X=  200.00,  Y=  850.00
687.     FSBSHP FSNRML FSRANK RADIUS NO.SLCS.    X=  150.00,  Y=  650.00
693.     FSBSHP FSNRML FSRANK RADIUS NO.SLCS.    X=  150.00,  Y=  700.00
699.     FSBSHP FSNRML FSRANK RADIUS NO.SLCS.    X=  150.00,  Y=  750.00
705.     FSBSHP FSNRML FSRANK RADIUS NO.SLCS.    X=  150.00,  Y=  800.00
711.     FSBSHP FSNRML FSRANK RADIUS NO.SLCS.    X=  150.00,  Y=  850.00
717.     FSBSHP FSNRML FSRANK RADIUS NO.SLCS.    X=  100.00,  Y=  650.00
723.     FSBSHP FSNRML FSRANK RADIUS NO.SLCS.    X=  100.00,  Y=  700.00
729.     FSBSHP FSNRML FSRANK RADIUS NO.SLCS.    X=  100.00,  Y=  750.00
735.     FSBSHP FSNRML FSRANK RADIUS NO.SLCS.    X=  100.00,  Y=  800.00
741.     FSBSHP FSNRML FSRANK RADIUS NO.SLCS.    X=  100.00,  Y=  850.00
le act
```

```
 362.     FSBSHP FSNRML FSRANK RADIUS NO.SLCS.    X=  200.00,  Y=  800.00
 363.
 364.      2.532  2.472  2.306  708.80   19
 365.      2.493  2.440  2.279  703.46   18
 366.      2.438  2.392  2.237  698.12   17
 367.      2.352  2.312  2.159  692.78   16
 368.      2.277  2.243  2.088  687.44   15
 369.      2.216  2.185  2.026  682.09   13
 370.      2.206  2.173  2.008  677.24   13
 371.     THE LOWEST FACTOR OF SAFETY FOUND WAS 2.206 AT R=  677.24
```

APPENDIX E

SLOPE STABILITY RESULTS

FILE No 2801

GZA

METROPOLITAN DISTRICT COMMISSION
QUABBIN RESEVOIR DAMS
WARE, MASSACHUSETTS

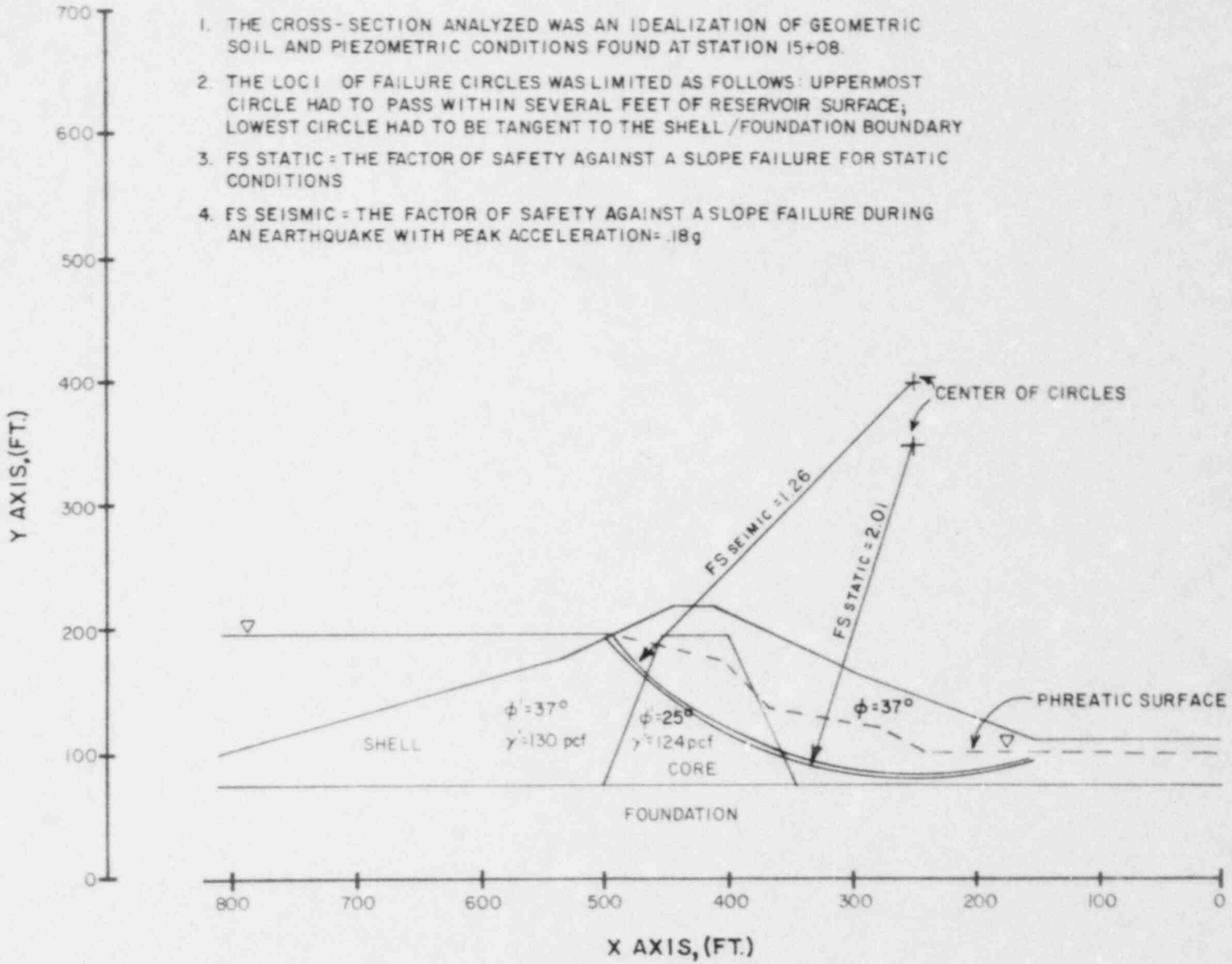
SLOPE STABILITY RESULTS
STATION 15+08
WINSOR DAM

JULY 1981

FIGURE No E-1

NOTES:

1. THE CROSS-SECTION ANALYZED WAS AN IDEALIZATION OF GEOMETRIC SOIL AND PIEZOMETRIC CONDITIONS FOUND AT STATION 15+08.
2. THE LOCI OF FAILURE CIRCLES WAS LIMITED AS FOLLOWS: UPPERMOST CIRCLE HAD TO PASS WITHIN SEVERAL FEET OF RESERVOIR SURFACE; LOWEST CIRCLE HAD TO BE TANGENT TO THE SHELL/FOUNDATION BOUNDARY
3. FS STATIC = THE FACTOR OF SAFETY AGAINST A SLOPE FAILURE FOR STATIC CONDITIONS
4. FS SEISMIC = THE FACTOR OF SAFETY AGAINST A SLOPE FAILURE DURING AN EARTHQUAKE WITH PEAK ACCELERATION= .18g



FILE No. 2601

GZA

METROPOLITAN DISTRICT COMMISSION
QUABBIN RESEVOIR DAMS
WARE, MASSACHUSETTS

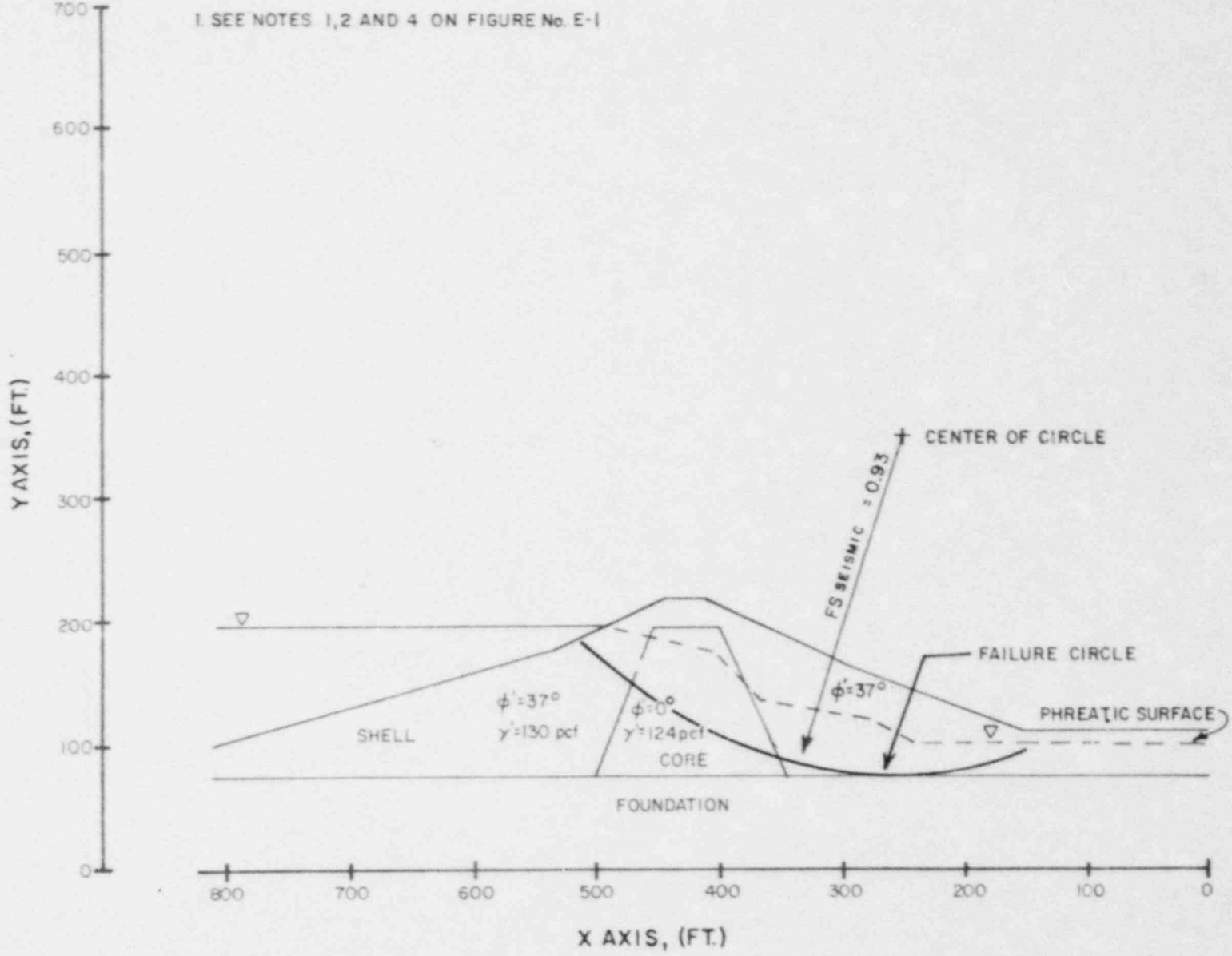
SLOPE STABILITY RESULTS
STATION 15+08
WINSOR DAM

JULY 1981

FIGURE No. E-2

NOTES

1. SEE NOTES 1,2 AND 4 ON FIGURE No. E-1



FILE No. 2801

GZA

METROPOLITAN DISTRICT COMMISSION
QUABBIN RESEVOIR DAMS
WARE, MASSACHUSETTS

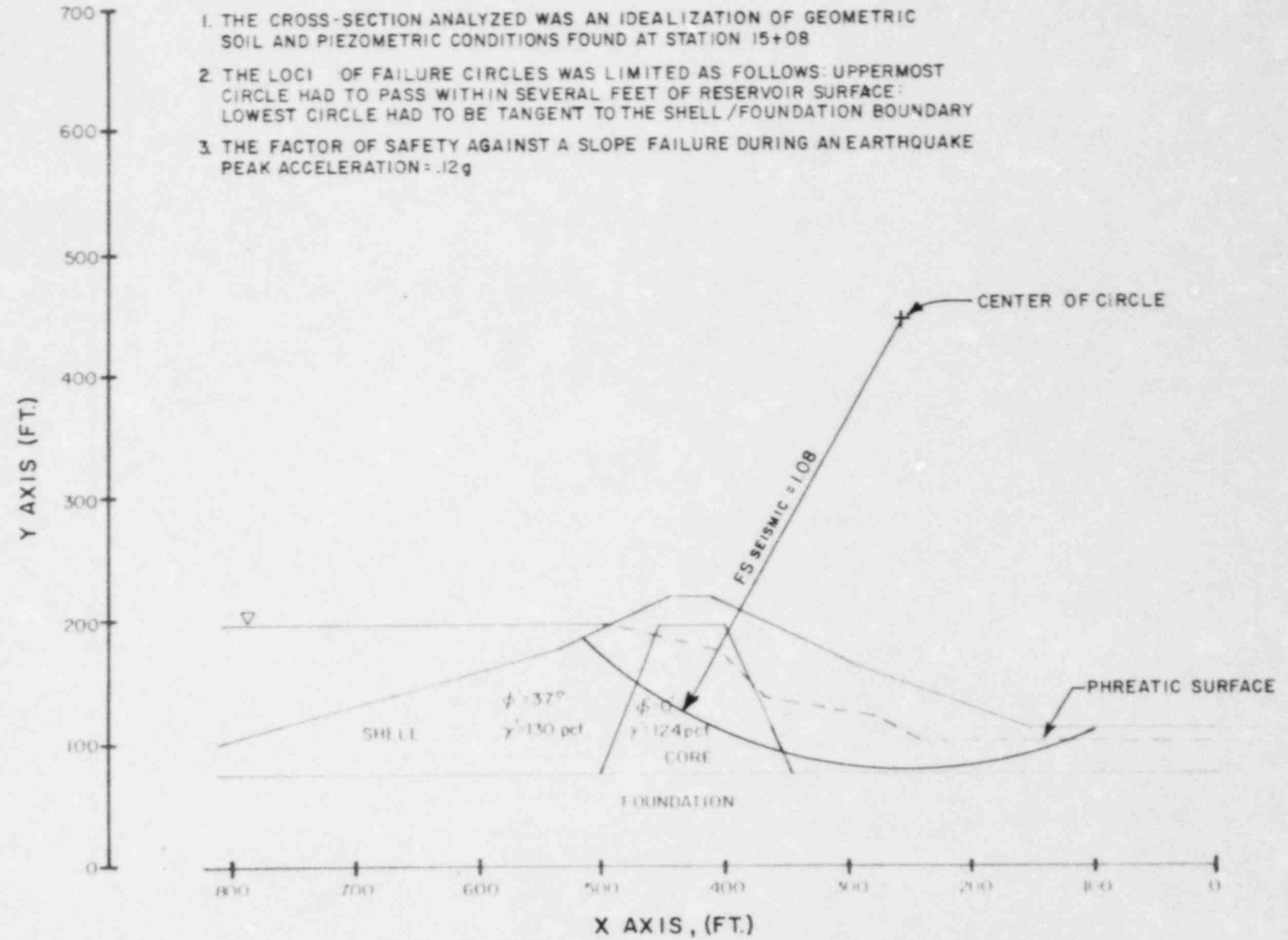
SLOPE STABILITY RESULTS
STATION 15+08
WINSOR DAM

JULY 1981

FIGURE No. E-3

NOTES:

1. THE CROSS-SECTION ANALYZED WAS AN IDEALIZATION OF GEOMETRIC SOIL AND PIEZOMETRIC CONDITIONS FOUND AT STATION 15+08
2. THE LOCI OF FAILURE CIRCLES WAS LIMITED AS FOLLOWS: UPPERMOST CIRCLE HAD TO PASS WITHIN SEVERAL FEET OF RESERVOIR SURFACE; LOWEST CIRCLE HAD TO BE TANGENT TO THE SHELL/FOUNDATION BOUNDARY
3. THE FACTOR OF SAFETY AGAINST A SLOPE FAILURE DURING AN EARTHQUAKE PEAK ACCELERATION = .12g



FILE No. 2801

GZA

METROPOLITAN DISTRICT COMMISSION
QUABBIN RESEVOIR DAMS
WARE, MASSACHUSETTS

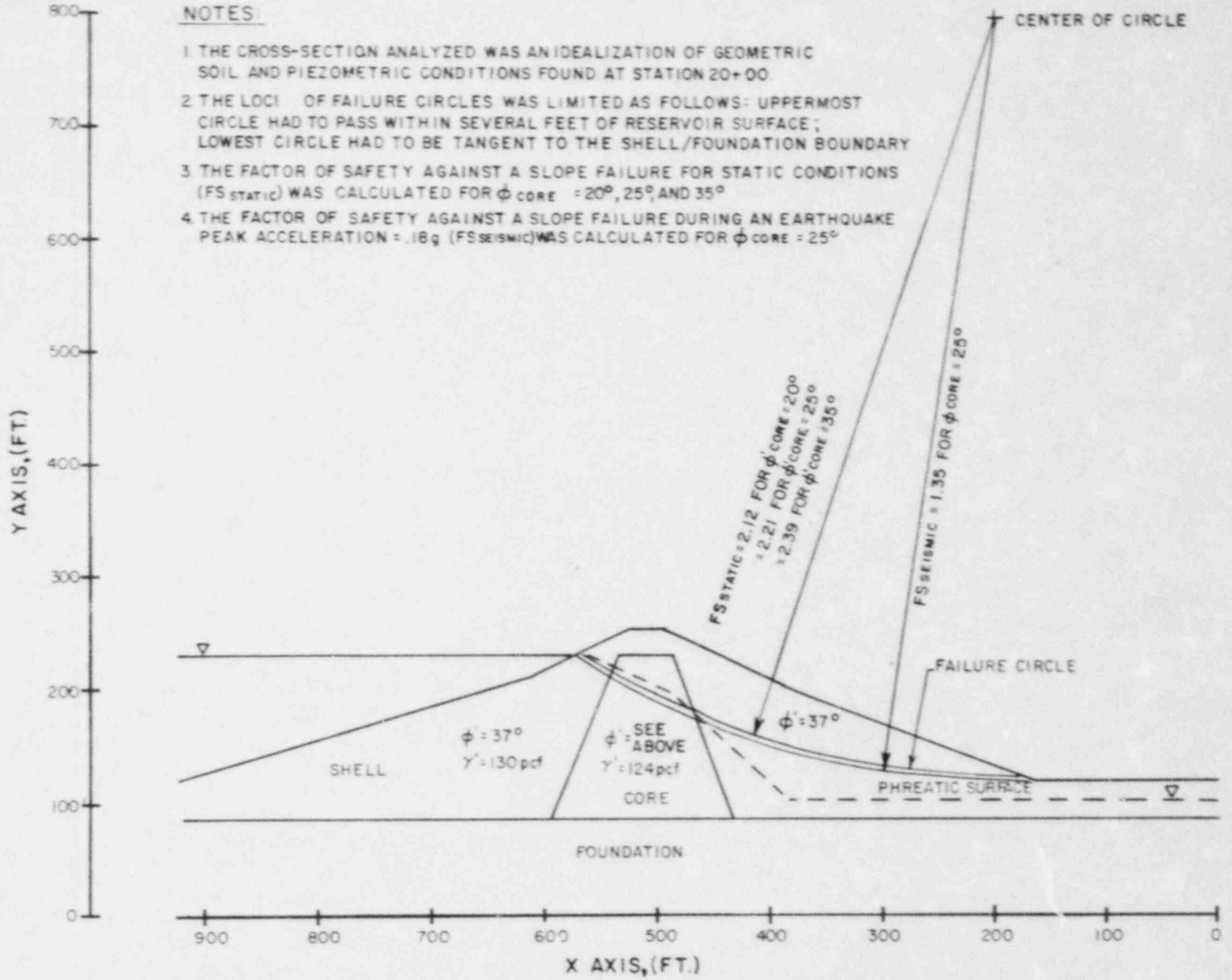
SLOPE STABILITY RESULTS
STATION 20+00
WINSOR DAM

JULY 1981

FIGURE No. E-4

NOTES:

1. THE CROSS-SECTION ANALYZED WAS AN IDEALIZATION OF GEOMETRIC SOIL AND PIEZOMETRIC CONDITIONS FOUND AT STATION 20+00.
2. THE LOCI OF FAILURE CIRCLES WAS LIMITED AS FOLLOWS: UPPERMOST CIRCLE HAD TO PASS WITHIN SEVERAL FEET OF RESERVOIR SURFACE; LOWEST CIRCLE HAD TO BE TANGENT TO THE SHELL/FOUNDATION BOUNDARY
3. THE FACTOR OF SAFETY AGAINST A SLOPE FAILURE FOR STATIC CONDITIONS (FS_{STATIC}) WAS CALCULATED FOR ϕ_{CORE} = 20°, 25°, AND 35°
4. THE FACTOR OF SAFETY AGAINST A SLOPE FAILURE DURING AN EARTHQUAKE PEAK ACCELERATION = .18g ($FS_{SEISMIC}$) WAS CALCULATED FOR ϕ_{CORE} = 25°



FILE No 2901

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METROPOLITAN DISTRICT COMMISSION
QUABBIN RESEVOIR DAMS
WARE, MASSACHUSETTS

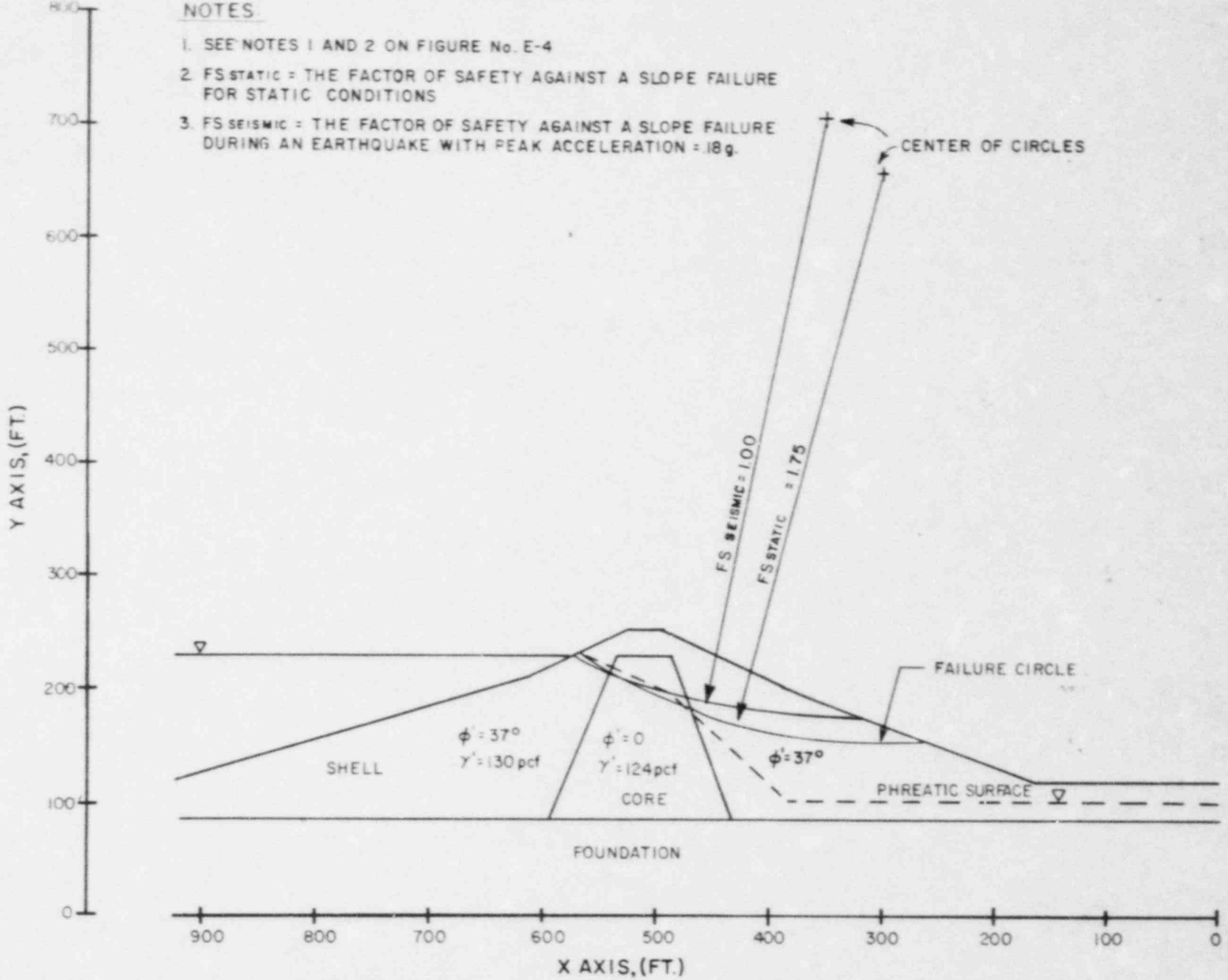
SLOPE STABILITY RESULTS
STATION 20+00
WINSOR DAM

JULY 1981

FIGURE No E-5

NOTES

1. SEE NOTES 1 AND 2 ON FIGURE No. E-4
2. FS STATIC = THE FACTOR OF SAFETY AGAINST A SLOPE FAILURE FOR STATIC CONDITIONS
3. FS SEISMIC = THE FACTOR OF SAFETY AGAINST A SLOPE FAILURE DURING AN EARTHQUAKE WITH PEAK ACCELERATION = .18g.



FILE No. 2811

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METROPOLITAN DISTRICT COMMISSION
QUABBIN RESEVOIR DAMS
WARE, MASSACHUSETTS

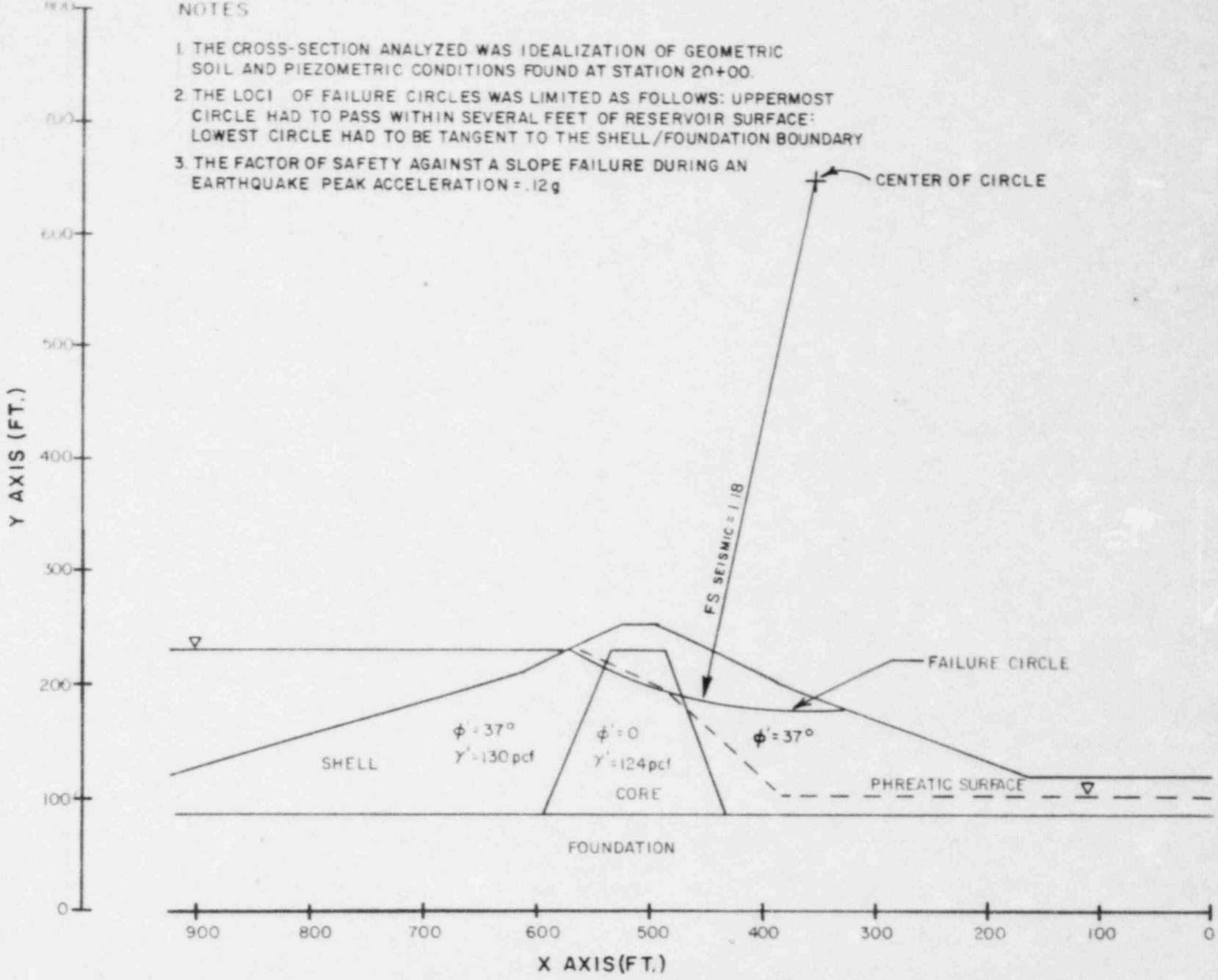
SLOPE STABILITY RESULTS
STATION 20+00
WINSOR DAM

JULY 1981

FIGURE No. E-6

NOTES

1. THE CROSS-SECTION ANALYZED WAS IDEALIZATION OF GEOMETRIC SOIL AND PIEZOMETRIC CONDITIONS FOUND AT STATION 20+00.
2. THE LOCI OF FAILURE CIRCLES WAS LIMITED AS FOLLOWS: UPPERMOST CIRCLE HAD TO PASS WITHIN SEVERAL FEET OF RESERVOIR SURFACE: LOWEST CIRCLE HAD TO BE TANGENT TO THE SHELL/FOUNDATION BOUNDARY
3. THE FACTOR OF SAFETY AGAINST A SLOPE FAILURE DURING AN EARTHQUAKE PEAK ACCELERATION = .12g



FILE No 2801

GZA

METROPOLITAN DISTRICT COMMISSION
QUABBIN RESEVOIR DAMS
WARE, MASSACHUSETTS

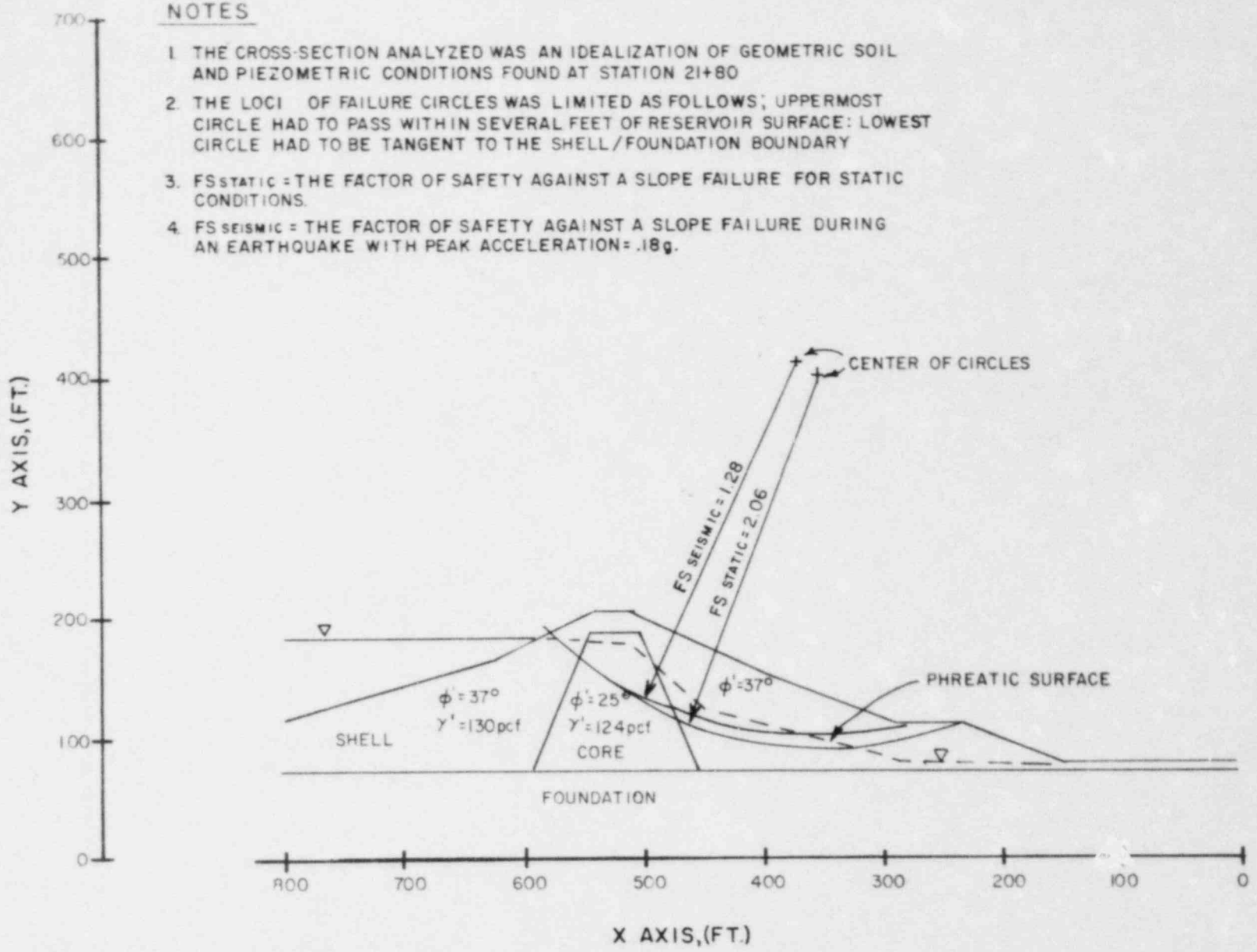
SLOPE STABILITY RESULTS
STATION 21+80
GOODNOUGH DIKE

JULY 1981

FIGURE No. E-7

NOTES

1. THE CROSS-SECTION ANALYZED WAS AN IDEALIZATION OF GEOMETRIC SOIL AND PIEZOMETRIC CONDITIONS FOUND AT STATION 21+80
2. THE LOCI OF FAILURE CIRCLES WAS LIMITED AS FOLLOWS; UPPERMOST CIRCLE HAD TO PASS WITHIN SEVERAL FEET OF RESERVOIR SURFACE: LOWEST CIRCLE HAD TO BE TANGENT TO THE SHELL/FOUNDATION BOUNDARY
3. FS STATIC = THE FACTOR OF SAFETY AGAINST A SLOPE FAILURE FOR STATIC CONDITIONS.
4. FS SEISMIC = THE FACTOR OF SAFETY AGAINST A SLOPE FAILURE DURING AN EARTHQUAKE WITH PEAK ACCELERATION = .18g.



FILE No. 2801

GZA

METROPOLITAN DISTRICT COMMISSION
QUABBIN RESEVOIR DAMS
WARE, MASSACHUSETTS

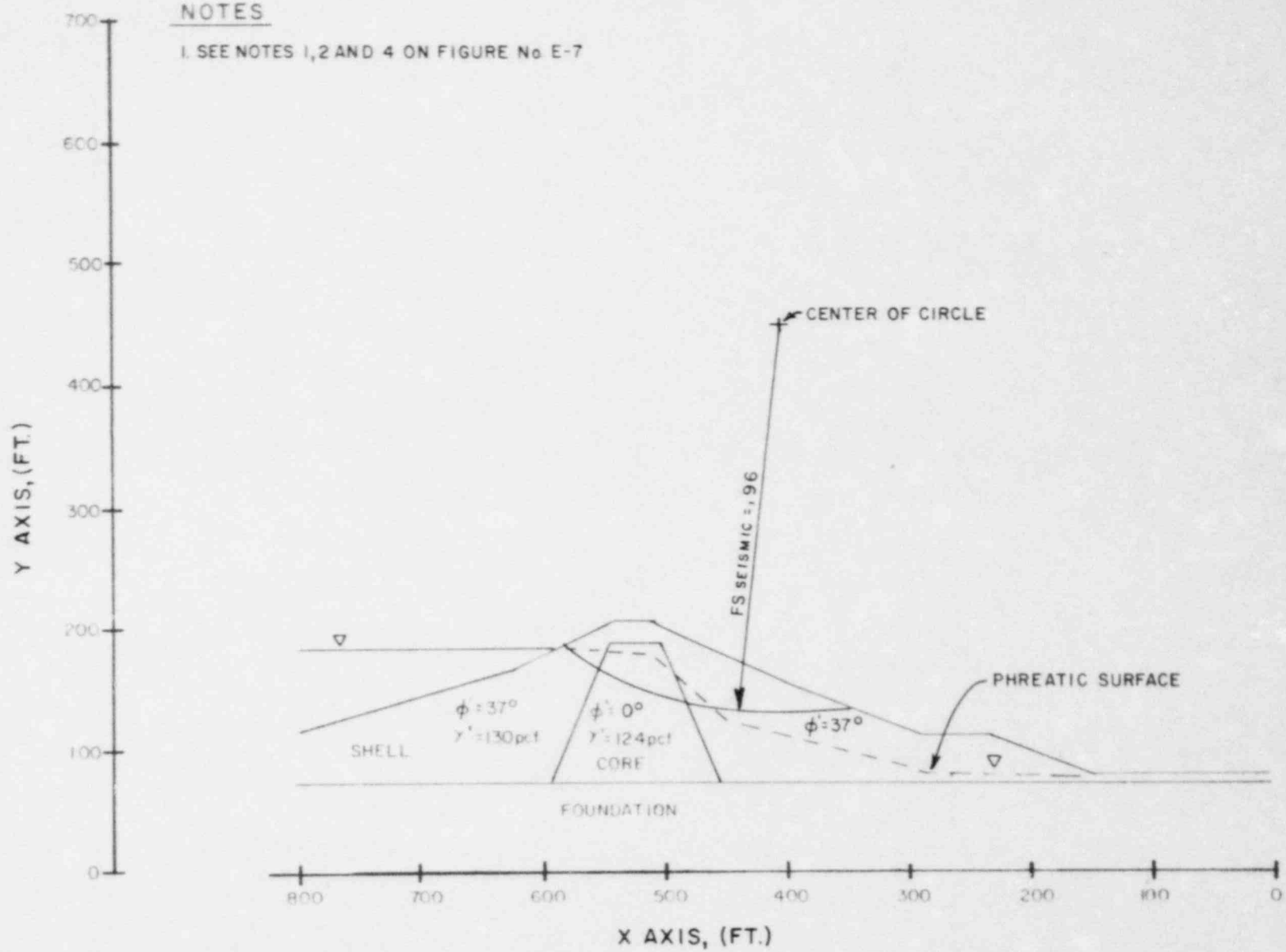
JULY 1981

SLOPE STABILITY RESULTS
STATION 21+80
GOODNOUGH DIKE

FIGURE No. E-8

NOTES

1. SEE NOTES 1, 2 AND 4 ON FIGURE No. E-7



FILE No 2801

GZA

METROPOLITAN DISTRICT COMMISSION
QUABBIN RESEVOIR DAMS
WARE, MASSACHUSETTS

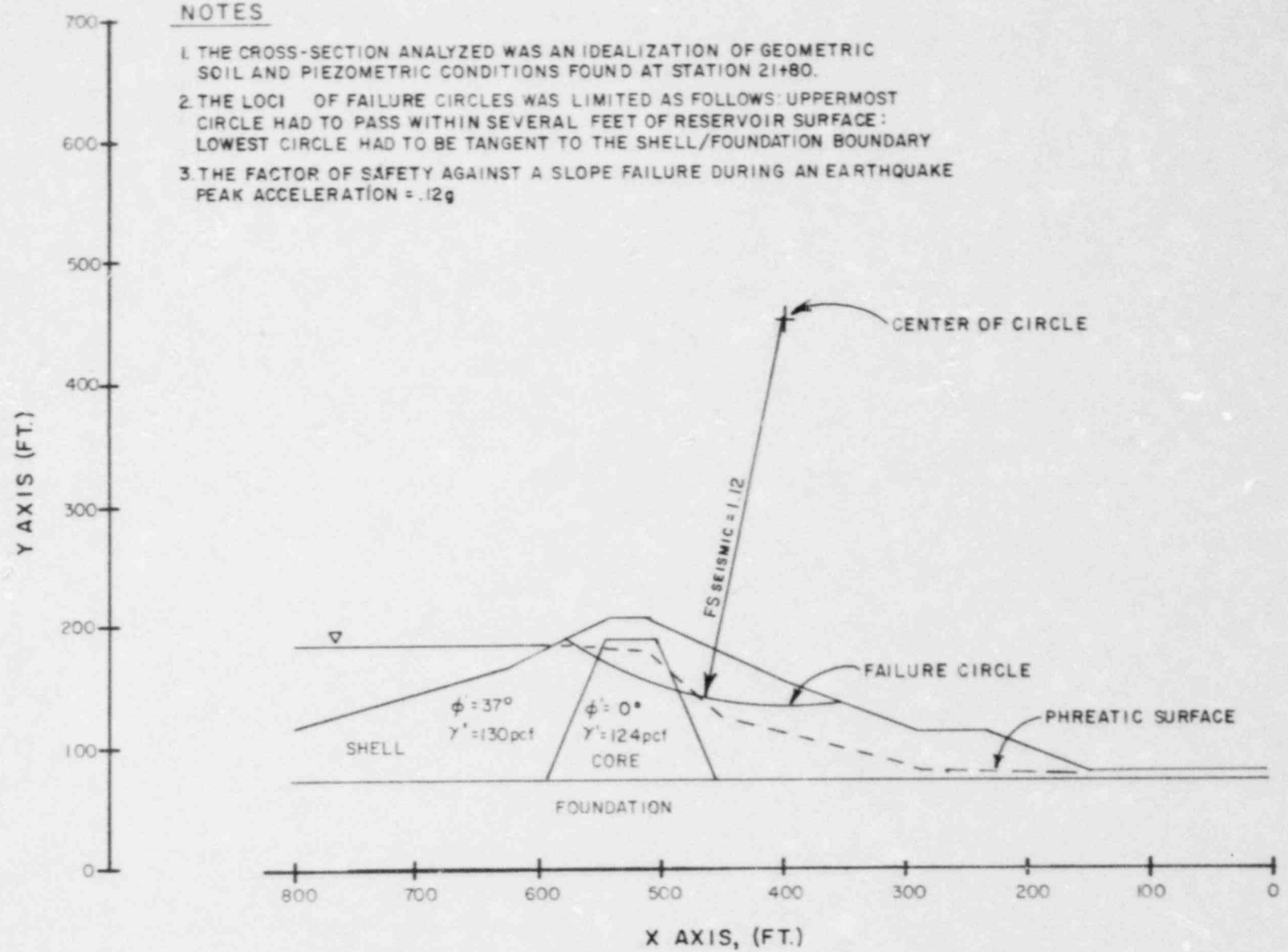
SLOPE STABILITY RESULTS
STATION 21+80
GOODNOUGH DIKE

JULY 1981

FIGURE No. E-9

NOTES

1. THE CROSS-SECTION ANALYZED WAS AN IDEALIZATION OF GEOMETRIC SOIL AND PIEZOMETRIC CONDITIONS FOUND AT STATION 21+80.
2. THE LOCI OF FAILURE CIRCLES WAS LIMITED AS FOLLOWS: UPPERMOST CIRCLE HAD TO PASS WITHIN SEVERAL FEET OF RESERVOIR SURFACE: LOWEST CIRCLE HAD TO BE TANGENT TO THE SHELL/FOUNDATION BOUNDARY
3. THE FACTOR OF SAFETY AGAINST A SLOPE FAILURE DURING AN EARTHQUAKE PEAK ACCELERATION = .12g



APPENDIX F

SEISMIC EVENTS IN CENTRAL NEW ENGLAND

EARTHQUAKE INTENSITY - MODIFIED MERCALLI (1931)

INTENSITY	CHARACTERISTICS	ACCELERATION
I	Not felt, animals uneasy.	To 0.002g
II	Barely felt by people at rest.	To 0.005g
III	Felt indoors, like passing truck; some hanging objects swing.	0.003-0.007g
IV	Like passing heavy truck, hanging objects swing, autos rock, windows, dishes, etc. rattle, walls crack.	0.007-02g
V	Felt outdoors, sleepers awakened, small objects upset, doors swing open or close.	0.015-0.04g
VI	Felt by all. People frightened and run out-doors. Dishes, glassware broken. Furniture moved, overturned. Weak masonry cracked, small bells ring.	0.03-0.09g
VII	Difficult to stand; noticed in moving autos furniture, masonry broken, chimneys break at roof line, ponds become turbid.	0.07-0.20g
VIII	Auto steering affected; masonry damage, some collapse, frame houses move on foundation; twisting and fall of large chimneys, branches broken from trees.	0.16-.50g
IX	General panic. Masonry damaged or destroyed; frame buildings wracked, underground pipes broken; sand soils, soil cracks.	0.30-0.90g
X	Most masonry buildings destroyed; wood frame buildings destroyed, landslides, railroad rails bent.	0.8-2.0g
XI	Railroad rails badly bent; underground piping destroyed.	
XII	Total damage; objects thrown into air.	

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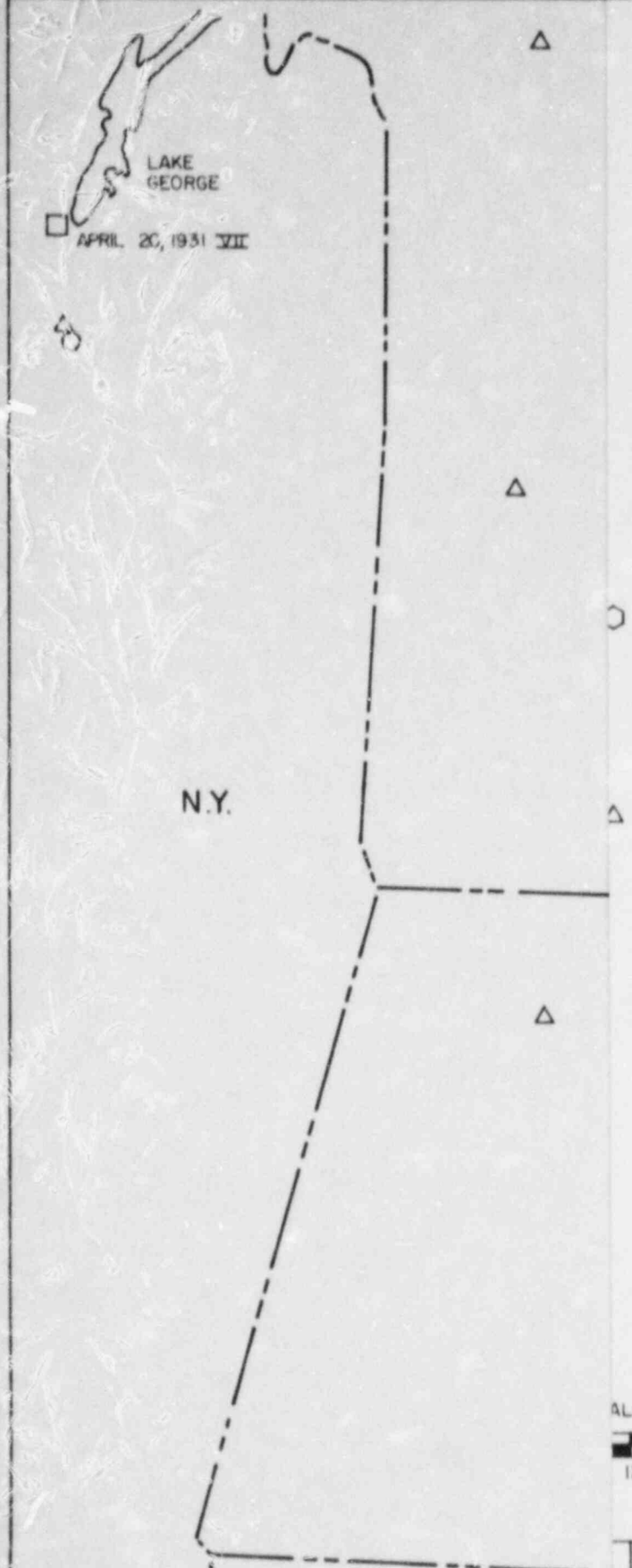
METROPOLITAN DISTRICT COMMISION
QUABBIN RESERVOIR DAMS
WARE, MASSACHUSETTS

EARTHQUAKE INTENSITY
MODIFIED MERCALLI
(1931)

OCT 1981 FIGURE No F-1



NOTES:

1) BASE MAP TAKEN FROM FIGURE 4 OF A REPORT FOR EBASCO SERVICES INC. UNDER THE DIRECTION OF GOLDBERG - ZOINO & ASSOCIATES.

LEGEND

- ○ — INTENSITY IV OR LESS
- △ — INTENSITY V
- ⬡ — INTENSITY VI
- □ — INTENSITY VII OR GREATER AS NOTED

ALE

12 24 (mi)

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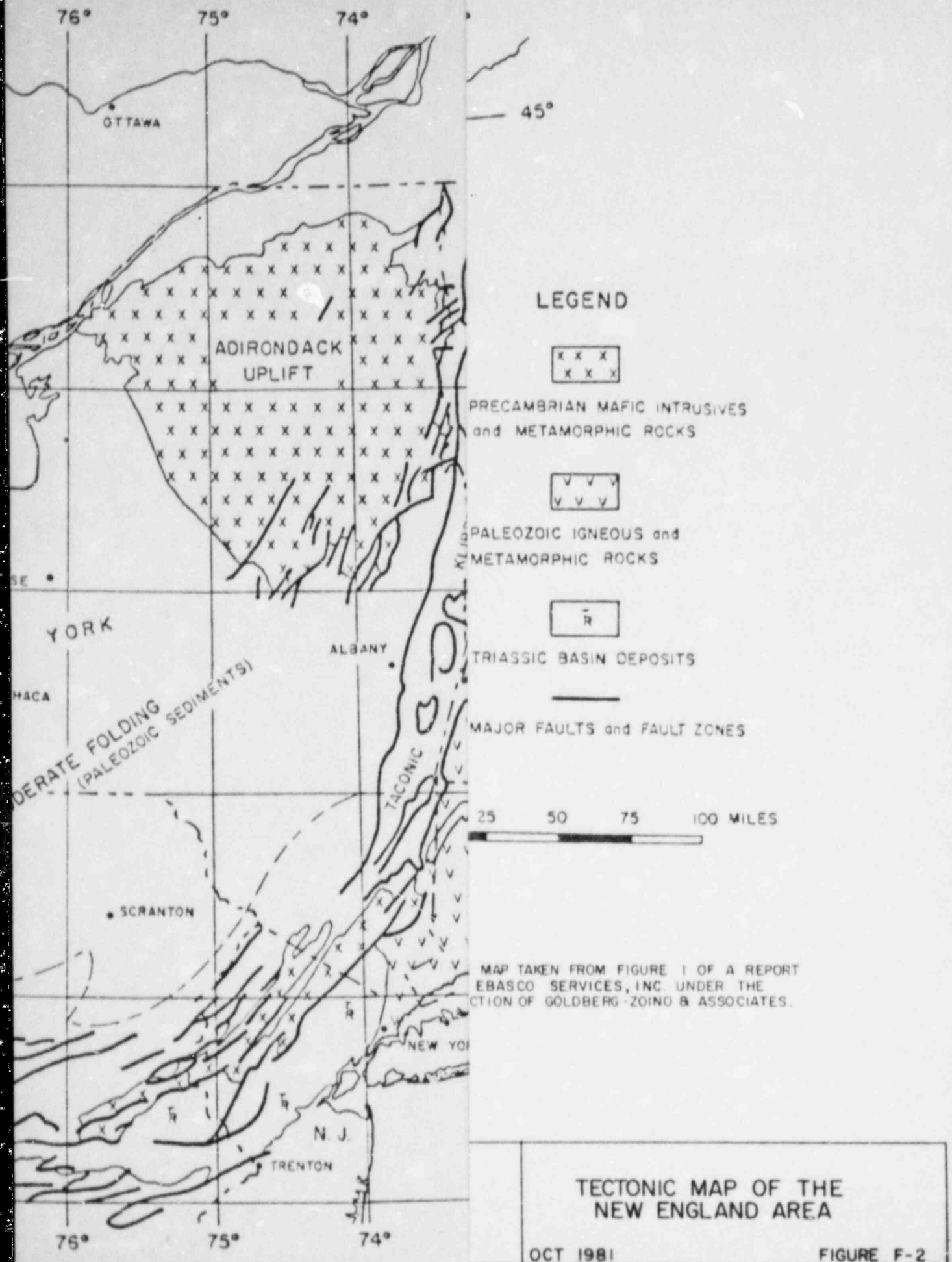
COMPILATION OF EARTHQUAKES CENTRAL NEW ENGLAND AREA

OCT 1981

FIGURE F-1A



TECTONIC MAP OF THE
NEW ENGLAND AREA

OCT 1981 FIGURE F-2

APPENDIX G

LIMITATIONS

APPENDIX G

LIMITATIONS

1. The analysis and conclusions submitted in this report are based in part upon the data obtained from subsurface explorations. The explorations were limited to a total of three cross-sections along the Main Dam and Dike. Actual conditions between the boreholes or at other cross-sections within the dam may be different. Refer to the boring logs for detailed descriptions of soil conditions at the borehole.

2. Water level readings have been made in the boreholes and piezometers at the times specified. Water level conditions within the embankment are expected to change with changes in the reservoir level.

3. It should be noted that the conditions of a dam isnot static but depends on many and constantly changing internal and external factors which may affect future performance.

4. This report has been prepared for the exclusive use of the Commonwealth of Massachusetts, Metropolitan District Commission for specific application to the Quabbin Reservoir Dams in Ware/Belchertown, Massachusetts, in accordance with generally acccepted soil and foundation engineering practices. No other warranty, expressed or implied, is made.

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