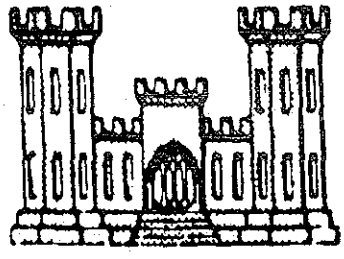
CONNECTICUT RIVER FLOOD CONTROL

COLEBROOK RIVER DAM & RESERVOIR

WEST BRANCH, FARMINGTON RIVER
CONNECTICUT & MASSACHUSETTS

DESIGN MEMORANDUM NO. 9

EMBANKMENTS AND FOUNDATIONS



U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS WALTHAM, MASS.

JUNE 1964

U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM 54, MASS.

RESS REPLY TO:
ISION ENGINEER

REFER TO FILE NO.

NEDED-D

12 June 1964

SUBJECT: Colebrook River Dam and Reservoir, Farmington River, Connecticut River Basin, Connecticut and Massachusetts, Design Memorandum No. 9, Embankment and Foundation

TO: Chief of Engineers
ATTN: ENGCW-E
Washington, D. C.

1. There is submitted herewith for review and approval Design Memorandum No. 9, Embankment and Foundation for the Colebrook River Dam and Reservoir, Farmington River, Connecticut River Basin, in accordance with EM 1110-2-1150.

2. This design memorandum was substantially completed prior to receipt of a supplementary report of the U. S. Fish and Wildlife Service, dated 1 June 1964. The report, including supporting justification and recommending additional storage capacity, has been forwarded to your office. The provision of this storage will require a change in spillway crest elevation to Elevation 761, five (5) feet higher than indicated herein. This change is considered to have no appreciable effect on the stability and constitution of the embankment sections. Necessary revised pages and plates incorporating this change will be submitted at a later date.

FOR THE DIVISION ENGINEER:

JOHN WM. LESLIE
Chief, Engineering Division

Incl (10 cys)
Des Memo No. 9

1963

FLOOD CONTROL PROJECT

COLEBROOK RIVER DAM AND RESERVOIR
WEST BRANCH FARMINGTON RIVER
CONNECTICUT RIVER BASIN
CONNECTICUT AND MASSACHUSETTS

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3	Site Geology	12 Jun 64	
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7	Concrete Materials	27 Sep 63	18 Oct 63
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COLEBROOK RIVER DAM AND RESERVOIR

WEST BRANCH FARMINGTON RIVER

CONNECTICUT RIVER BASIN

CONNECTICUT AND MASSACHUSETTS

DESIGN MEMORANDUM NO. 9

EMBANKMENT AND FOUNDATIONS

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U. S. ARMY ENGINEER DIVISION, NEW ENGLAND

OFFICE OF THE DIVISION ENGINEER

WALTHAM, MASSACHUSETTS 02154

FLOOD CONTROL PROJECT

COLEBROOK RIVER DAM AND RESERVOIR

WEST BRANCH FARMINGTON RIVER

CONNECTICUT RIVER BASIN

CONNECTICUT

DESIGN MEMORANDUM NO. 9

EMBANKMENTS AND FOUNDATIONS

JUNE 1964

A. INTRODUCTION

1. Location and Description of Project. The Colebrook River Dam and Reservoir project is located on the West Branch of the Farmington River in the town of Colebrook, Connecticut. The damsite is about 3.9 miles above the confluence of the West Branch of the Farmington River and the Still River and approximately 1 mile upstream of the Goodwin Water Supply Dam. The Colebrook River Dam lies within the existing West Branch Reservoir. The completed structures will consist of an earth and rockfill dam and an earthfill dike, with appurtenant structures, and highway relocations. Locations, arrangements and details of the structures are shown on Plate Nos. 9-1 through 9-5 and 9-18.

2. Pertinent Data.

a. Purpose. Flood Control and Water Supply

b. Drainage Area at Damsite. 118 square miles

c. Spillway Crest - Goodwin Dam - El 641 MSL

d. Reservoir Elevations - Colebrook River Dam

(1) Water Supply - Maximum Normal Pool - El 700 MSL

(2) Flood Control -

Spillway Crest - El 756 MSL

Maximum Pool - El 780 MSL

e. Dam

Top of Dam El 785 MSL

Maximum Height - 218 feet

Length - 1285 feet

f. Dike

Top of Dike - El 785 MSL

Maximum Height - 49 feet

Length - 1100 feet

3. General Notes. Subsurface investigations and soils engineering studies undertaken for the design of this project are discussed in this memorandum. The subsurface investigations included programs of subsurface explorations and laboratory tests conducted to determine the distribution and characteristics of foundation and embankment materials, soil conditions pertinent to excavations and to the design and construction of embankments and certain of the concrete structures. Soils engineering studies, based on the data obtained from these investigations, were carried out to develop safe and economical earthwork designs and construction methods.

B. SUBSURFACE INVESTIGATIONS

4. Subsurface Explorations. Subsurface explorations were laid out and performed in accordance with the current criteria and practices described in the pertinent sections of the Engineering Manual for Civil Works Construction. The explorations consisted of drive sample borings and machine or hand excavated test pits. The subsurface exploration program completed to date is considered adequate for design and construction control purposes for the dam and dike. Additional explorations are in progress to obtain data for the design of the access road. The locations, types and general purposes of the explorations completed to date, as well as the geology of the site and area pertinent to the types and distribution of soils are described in Design Memorandum No. 3, Site Geology. The locations of all explorations completed to date are shown on Plates Nos. 9-5 through 9-8.

5. Laboratory Tests. All laboratory soil tests, except as otherwise noted, were performed in accordance with the Manual of Laboratory Tests for Soils for Use on Civil Works Projects. All soil samples were classified visually according to the Unified Soil Classification System with the visual classification being confirmed by grain size analyses and Atterberg Limit determinations performed on samples considered to be representative of the major soil types encountered. Additional tests performed on selected samples included determinations of natural moisture content, natural density, compaction tests, minimum and maximum density tests, permeability tests and shear tests.

6. Presentation of Data. The results of subsurface investigations, except for geological sections, are presented in this memorandum. A summary of the results of laboratory tests is presented in Appendix A. Detailed shear test data reports and compaction test reports are presented in Appendix B.

Engineering soils reports are presented in Appendix D. These reports were prepared for all pertinent explorations by the design soils engineer with the aid of laboratory test data and the assistance of an experienced soil classifier. Included in these reports are descriptions of the soils and soils strata based on the engineer's examination of the samples and on his interpretations of all test results and the exploration data. These descriptions include the consistency of the material, estimated or measured percentages of the soil components, color, stratification, presence of foreign matter, geological names, and other information of significance in the determination of the characteristics of the materials for design and construction purposes. Soil profiles of the dam and dike foundations, based on the engineering soil reports, are shown on Plates Nos. 9-9 through 9-12. Plates Nos. 9-13 through 9-15, showing selected laboratory test data, are included in this memorandum.

C. CHARACTERISTICS OF EMBANKMENT FOUNDATION SOILS

7. Dam Embankment.

a. Distribution and Description

(1) Right Abutment. In the right abutment area of the dam embankment foundation, the overburden consists of a relatively shallow heterogeneous deposit of variable gravelly silty sands and silty sandy gravels. This deposit ranges from 1 to 25 feet in thickness and averages about 8 feet in thickness. Topsoil and forest debris cover the area to an average depth of 18 inches. Occasional boulders are scattered over the surface of this abutment. Bedrock is exposed at several locations and is near the surface in

that portion of the abutment above Elev. 700. Throughout the right abutment area, the bedrock surface is generally irregular containing troughs and pockets. The foundation soils are principally variable gray and brown, moderately compact to compact, gravelly silty sands and silty sandy gravels containing numerous cobbles and occasional boulders. For the most part, the gravelly silty sands contain from 10 to 40 percent gravel sizes and have silt contents ranging from 20 to 30 percent of the component passing the No. 4 Sieve. The bulk of the silty sandy gravels contain from 25 to 40 percent sand sizes and have silt contents ranging from 15 to 25 percent of the component passing the No. 4 Sieve. While some of the gravelly silty sands appear to occur as a non-plastic glacial till, there is little or no difference in gradation between these and the other gravelly silty sands on this abutment.

(2) Valley Section. The overburden in the valley section of the dam embankment foundation area is a heterogeneous deposit of variable silty sandy gravels and gravelly silty sands. This deposit fills the narrow bedrock valley to a maximum depth of about 45 feet. Topsoil and forest debris cover most of this area to an average depth of about 12 inches. It appears that the bedrock surface in this part of the foundation area is similar in character to that on the abutments. The foundation soils are principally variable, brown, moderately compact to compact, silty sandy gravels and gravelly silty sands with occasional phases of silty medium to fine sands and sandy gravels. These soils contain numerous cobbles and occasional boulders. For the most part, the silty sandy gravels contain from 10 to 40 percent sand sizes and have silt contents ranging from 5 to 20 percent of the component passing the No. 4 Sieve. The bulk of the gravelly silty sands contain from 10 to 40 percent gravel sizes and have silt contents ranging from 10 to 20 percent of the component passing the No. 4 Sieve. There are a few small isolated pockets of non-plastic glacial till in this area composed of gravelly silty sands having somewhat higher silt contents than the surrounding soils.

(3) Left Abutment. The bedrock surface in the left abutment area of the dam embankment foundation is irregular containing numerous troughs and pockets and is exposed almost continuously except for small isolated pockets of overburden in some of the depressions in the rock. Numerous large boulders and rock blocks are scattered over the surface of this abutment. A pronounced trough in the bedrock surface filled with up to 15 feet of soil forms a significant portion of the downstream part of this area. The embankment has been laid out so that this trough is within the area upon which rockfill is to be placed. The overburden in this trough and in the smaller pockets consists of about 2 feet of topsoil and forest debris overlying bouldery, cobbly, brown, compact, gravelly silty sands and silty gravels having silt contents ranging from 15 to 25 percent of the component passing the No. 4 Sieve.

b. Shear Strengths. Shear tests were not performed on samples of the dam embankment foundation soils. On the basis of experience with similar soils, it is estimated that the dam foundation materials will have undisturbed shear strength parameters of at least $\emptyset = 30^\circ$ and $C = 0$ for both the R (consolidated-undrained) and S (consolidated-drained) conditions.

c. Permeability. Permeability tests were not performed on samples of the dam embankment foundation soils. On the basis of exploration logs, visual examination of samples, grain-size distribution curves, and experience with similar materials, it is estimated that the vertical coefficients of permeability range from 0.1×10^{-4} to 50×10^{-4} cm/sec. Although the foundation soil deposits appear to be heterogeneous, it has been assumed that horizontal coefficients of permeability are 9 times the vertical in order to furnish a conservative basis of design and to account for possible stratification not detected in the explorations.

d. Consolidation. Consolidation tests were not performed on samples of soil from the foundation area of the dam. The compressibility characteristics, generally high natural densities, and relatively shallow deposits of the foundation materials are such that no detrimental settlements of the foundations are anticipated under the proposed embankment loadings.

8. Dike Embankment.

a. Distribution and Description. The overburden in the dike embankment foundation area consists principally of a very sandy glacial till deposit of considerable thickness. The soils in this deposit are variable, brown, compact, gravelly silty sands, silty fine sands and silty sandy gravels with cobbles and boulders, capped by about 12 inches of topsoil and forest debris. The gravelly silty sands have gravel contents varying from 15 to 45 percent and silt contents ranging from 15 to 25 percent of the component passing the No. 4 Sieve. The silty fine sands contain little or no gravel sizes and have silt contents ranging from 15 to 30 percent of the component passing the No. 4 Sieve with occasional phases having higher silt contents. The silty sandy gravels have silt contents ranging from 15 to 30 percent of the component passing the No. 4 Sieve with occasional phases having higher silt contents.

b. Shear Strengths. Shear tests were not performed on samples of the dike embankment foundation soils. On the basis of experience with similar soils, it is estimated that the dike foundation soils will have undisturbed shear strength parameters of at least $\emptyset = 30^\circ$ and $C = 0$ for both the R (consolidated-undrained) and S (consolidated-drained) conditions.

c. Permeability. Permeability tests were not performed on samples of the dike embankment foundation soils. On the basis of exploration logs, visual examination of samples, grain size distribution curves and experience with similar materials, it is estimated that the vertical coefficients of permeability range from 1.0×10^{-4} to 20×10^{-4} cm/sec. While the sandy glacial till deposit in the dike foundation is generally heterogeneous, a horizontal to vertical permeability ratio of 9 has been adopted for design purposes in view of the possibility of stratification not detected in the explorations.

d. Consolidation. Consolidation tests were not performed on samples of soil from the foundation area of the dike embankment. The compressibility characteristics and generally high natural densities of the foundation materials are such that no significant settlements are anticipated under the proposed embankment loadings.

D. CHARACTERISTICS OF FOUNDATION BEDROCK

9. Bedrock Foundation for Dam Embankment. Bedrock at the site consists mainly of gneiss with large areas of granite and schist. The gneiss ranges from schistose to granitic. In the schistose phases the gneiss is fine-grained and thinly foliated. The granitic gneiss is coarser and the foliation is generally obscure and variable. In the areas of granite the rock ranges from a fine-grained, gray, normal granite to pink, very coarse pegmatite. The schist is composed largely of biotite which occurs both finely disseminated and in coarse, felted lenses and pods.

The trend of the foliation of the bedrock is across the river, generally N40°E to N45°E with dips vertical to westward at 60°. The bedrock surface is very irregular with numerous troughs and hollows between abrupt ribs and ridges. Removal of loose blocks and slabs from the ribs and excavation of weathered material from the troughs will tend to accentuate further the natural roughness of the rock surface. The bedrock is weathered along closely spaced joints and foliation planes to depths generally in the order of 10 feet and weathering along more widely scattered seams is common to depths of 20 feet.

10. Bedrock Foundation for Concrete Structures. Foundations for all concrete structures are located in very deep excavations in bedrock. The rock at these depths is satisfactory for support for heavy structural loads. The alignment of structure excavations in relation to the attitude of the bedrock, is generally favorable. Presplitting and line drilling will be utilized as necessary to preserve the excavated slopes in the best possible condition. Where close-jointed pegmatite or felted biotite occurs in the rock, some fall-out

must be expected. Drain holes will be provided as required for relief of pressure at concrete slabs and walls. Detailed discussion of bedrock conditions in relation to concrete structures and the outlet tunnel is presented in Design Memorandum No. 3, "Site Geology" and will be presented in Design Memorandum No. 10, "Detailed Design of Structures."

E. CHARACTERISTICS OF EMBANKMENT MATERIALS

11. General. A very large quantity of rock excavation will be required for the construction of the spillway for this project. The availability of rock material from this nearby source led to the selection of large rockfill zones for the dam embankment section. The quantity of materials available for use in the embankments from required earth excavations will be relatively small. Reconnaissance and exploration made to locate sources of borrow to furnish the quantities of materials required to complete the dam and dike embankments established the presence of an extensive terrace deposit of relatively pervious sandy gravels in the reservoir area upstream of the damsite (Area B on Plate No. 9-1) and of a large relatively impervious glacial till deposit near the dike site (Area C on Plate No. 9-1).

12. Impervious Embankment Material.

a. Distribution and Description. The impervious embankment material in Area C consists of non-plastic to slightly plastic glacial till composed principally of gravelly silty sand and gravelly silty medium to fine sand. The depths of the materials range generally from 18 to 38 feet and average about 27 feet, although in the vicinity of BD-3 depths of overburden may be as great as 65 feet. The area is heavily wooded with numerous boulders visible on the ground surface. The deposit is covered with about 12 inches of topsoil and forest debris. Impervious embankment materials in the deposit consist principally of brown and gray-brown moderately compact to very compact, gravelly silty sands and gravelly silty medium to fine sands with pockets or lenses of silty medium to fine sands, sandy silt, and minor lenses of silty clayey sands and sandy silty clays. The deposit contains buried cobbles and boulders some of which are weathered. The materials, in general, have gravel contents that range from 5 to 35 percent and silt contents that range from 25 to 55 percent based on the component passing the No. 4 Sieve. The bulk of the materials, however, have silt contents ranging from 40 to 50 percent of the component passing the No. 4 Sieve. While most of the material is non-plastic, there are some phases that are slightly plastic with liquid limits of from 19 to 24 and plasticity indices of from 3 to 6. Subsurface water levels in the area range from 4 to 18 feet below the ground surface.

b. Permeability. On the basis of the results of a permeability test, visual examination of the samples and their grain size curves, it is estimated that the coefficient of permeability of the compacted impervious embankment material will be on the order of 0.05×10^{-4} cm/sec, vertically and 0.45×10^{-4} cm/sec, horizontally.

c. Consolidation. Consolidation tests were not performed on samples of impervious embankment material. Experience with similar materials indicates that this material is of low compressibility when compacted and that no significant settlements will occur in compacted fills of this material.

d. Compaction Characteristics. Standard compaction tests were performed on two samples of impervious embankment materials from test trench BTT-20 in Area C with the following results:

Sample	Group Letter Symbol	Maximum dry Density - pcf	Optimum Water Content - Percent
B-3	SM	119.2	12.4
B-7	SM	123.5	10.9

Samples B-3 and B-7 are considered to be representative of the bulk of the impervious embankment material occurring in Area C. Natural water contents of these two samples were 10.4 and 8.9 percent, respectively, for the components passing the No. 4 Sieve, or 2 percent below optimum. Since the samples were obtained in a very dry period, it is anticipated that these are probably the minimum water contents and that due to seasonal changes and other factors, the average placement moisture content will be somewhat higher. Experience with similar materials from glacial till deposits indicate that the placement moisture contents can be expected to range between two percentage points above and below optimum and that they will probably average close to optimum. Density determinations were made on plugs of material from some of the drive sample borings. These indicated that natural densities in this area range from 128 pcf to 141 pcf for the total samples.

e. Shear Strengths. Sample B-7 from BTT-20 was selected for shear testing as being representative with respect to gradation and other physical characteristics of the average of the bulk of the impervious embankment material. Since the soils in Area C fall within a relatively narrow gradation range, it is considered that the shear characteristics of the impervious material as a whole will not differ significantly from those of the sample tested. The tests were performed on specimens compacted at moisture contents of two percent below optimum, at optimum, and two percent above optimum. The Q and R tests were controlled strain triaxial compression tests utilizing rates of strain of 0.06 and 0.01 in./min., respectively. The S tests were of the direct shear type utilizing a rate of strain of 0.017 in./min Specimens for the R and S tests were saturated prior to testing.

13. Pervious Embankment Material.

a. Distribution and Description.

(1) Area B. The pervious embankment material in Area B consists principally of sandy gravels occurring in a relatively shallow terrace deposit ranging from 5 to over 25 feet in thickness. The major portion of Area B is cleared and only scattered boulders are visible on the surface. The deposit is capped with about 12 inches of topsoil and forest debris. The materials in the deposit consist principally of brown, loose to compact, sandy gravel with minor lenses and phases of gravelly sands and silty gravelly sands. The material contains buried boulders and numerous buried cobbles. The sandy gravels, in general, have sand contents that range from 30 to 45 percent and silt contents that are less than 15 percent of the component passing the No. 4 Sieve. The gravelly sands, in general, have gravel contents that range from 10 to 40 percent and silt contents that range from 5 to 15 percent of the component passing the No. 4 Sieve. Area B is located within the reservoir limits of the existing Goodwin Dam and it was found that subsurface water levels during the exploration period varied almost directly as the water elevation of the Goodwin Reservoir. One of the more significant characteristics of the material in this area is the presence of large numbers of stones and cobbles. It was established on the basis of examination of test pits, exploration data, and gradation curves that an 18-inch stone would be the smallest maximum size that could be specified without requiring screening of this material.

(2) Required Earth Excavations. Most of the embankment material available from the required earth excavations will consist of silty sandy gravels and gravelly silty sands from the valley section of the dam foundation area. The silt content of the bulk of this material ranges from 5 to 20 percent of the component passing the No. 4 Sieve. Although this material tends to be somewhat siltier than the pervious embankment material from Area B, it is not considered necessary to establish a different category for it, in view of its general similarity to the material from Area B and the comparatively small quantity of material involved. For purposes of design, it has therefore been assumed that characteristics of pervious embankment material from the required earth excavations are the same as those of the pervious embankment material from Area B.

b. Permeability. On the basis of the results of permeability tests, visual examination of the samples and their grain size curves, it is estimated that the coefficient of permeability of the compacted pervious embankment material will be on the order of 100×10^{-4} cm/sec, vertically, and 900×10^{-4} cm/sec, horizontally.

c. Consolidation. Consolidation tests were not performed on samples of pervious embankment materials. Experience with similar materials indicates that these materials are of low compressibility when compacted and that no significant settlements will occur in compacted fills of these materials.

d. Compaction Characteristics. One Standard Compaction Test and four Providence Vibrated Density Tests were performed on samples of pervious embankment material from Area B from which all particles retained on the 3/4-inch Sieve had been removed. The samples tested and the test results are as follows:

Sample	Group Letter Symbol	Standard Compaction Test		Providence Vibrated Density pcf	Minimum Density pcf
		Max. Dry Density-pcf	Opt. Water Content-Percent		
BTT-3A, B-2	GP	130.7	8.0	139.1	118.2
BTT-5 , B-1	GP			133.7	
BTT-6 , B-2	GP			138.2	
BTT-9 , B-2	GP			131.7	

On the basis of these test results and experience with similar materials, it is estimated that pervious embankment material can be compacted in 18-inch layers with a heavy rubber-tired roller without moisture control to densities corresponding to 100 percent of the maximum Standard Compaction Test Density or 95 percent of the maximum Providence Vibrated Density Test density.

e. Shear Strengths. Sample B-2 from test trench BTT-3A was selected for shear testing as being representative with respect to gradation and other physical characteristics of the bulk of the pervious embankment material. Since this material falls within a relatively narrow gradation range, it is considered that the shear characteristics of the material, as a whole, will not differ significantly from those of the sample tested. Since the pervious embankment material will have high gravel contents, shear tests were run on 6-inch diameter specimens from which all particles retained on the 1-inch Sieve had been removed. Because of the relatively high permeability of this material, only consolidated drained tests were performed. Shear samples were saturated prior to testing using the back pressure method. All tests were of the controlled strain triaxial type using a rate of strain of 0.03 inches per minute. The shear tests were performed on samples compacted to densities representative of those anticipated for the materials after compaction during construction and at water contents representative of the usual placement moisture contents of gravel materials where no moisture control is used.

14. Gravel Fill, Gravel Bedding, Road Gravel, Processed Sand and Rock Filter.

a. General. Investigations made in Area B indicate that materials suitable for use as gravel fill and gravel bedding can be obtained by selective excavation in this area and that road gravel can also be obtained from this area with selective excavation and the removal of oversize stones. While processed sand can be obtained from Area B, it is considered that it would be more economically obtainable from commercial sources. Although rock filter materials can be obtained by screening the cobbles from the material in Area B, it probably will be more economical and feasible to process this material from the required rock excavation.

b. Gradation Specifications.

(1) General. Investigations of the sources of gravel fill, gravel bedding, road gravel, processed sand and rock filter indicate that the following gradation specifications can be satisfied by materials obtained with some selection and processing from Area B and from required rock excavations for the project, or from commercial sources within 20 miles of the project. The specifications for materials which will act as filters have been established in accordance with the filter design criteria set forth in the Engineering Manual for Civil Works Construction.

(2) Gravel Bedding. Gravel bedding material for use in the embankments and elsewhere on the project shall consist of reasonably well graded sandy gravels or gravelly sands obtained by selective borrow excavations in Area B. Of the portion of the material passing the 3-inch Sieve, from 25 to 60 percent shall pass the No. 4 Sieve and of the component passing the No. 4 Sieve, no more than 15 percent shall pass the No. 200 Sieve.

(3) Gravel Fill. Gravel fill material for use in the embankment and elsewhere on the project shall consist of reasonably well-graded sandy gravel obtained by selective borrow excavations in Area B. Of the portion of the material passing the 3-inch Sieve, from 25 to 60 percent shall pass the No. 4 Sieve and of the component passing the No. 4 Sieve, no more than 10 percent shall pass the No. 200 Sieve.

(4) Processed Sand. Processed sand material for use in the drainage blanket and foundation drain of the dike embankment and elsewhere on the project shall consist of material meeting the gradation specifications for fine concrete aggregate.

(5) Rock Filter. Rock filter material for use in the embankment and elsewhere on the project shall be composed of rock fragments obtained from required rock excavations for the project or cobbles obtained from borrow excavations in Area B. In order to produce the required materials from either of the preceding sources, selection and processing of materials from either source will be required. The material shall not contain rock fragments or cobbles greater than 12 inches and shall be reasonably well graded with rock fragments or cobbles varying in size from 3 inch to 8 inch. The material may contain a maximum of 20 percent by dry weight of particles retained on an 8 inch grizzly and a maximum of 15 percent by dry weight of particles that pass the 3-inch Sieve.

(6) Road Gravel. Road gravel for use on the top of the dam and dike and on the access road shall consist of a reasonably well graded sandy gravel or gravelly sand obtained from Area B and processed to meet the following gradation requirements:

U. S. Standard Sieve Size	Percent Passing by Dry Weight
3-Inch	100
No. 4	30-60
No. 200	2-10

(7) Oversize Stones. All stones over 18 inches maximum dimension will be removed from the gravel fill and gravel bedding materials either at the source or from the fill.

c. Permeability. Permeability tests were not performed on samples of gravel fill, gravel bedding and processed sand materials. On the basis of visual examination of the samples, grain size characteristics, the specified gradations and experience with similar materials, it is estimated that vertical coefficients of permeability for these materials will be over 100×10^{-4} cm/sec with horizontal coefficients being 4 times the vertical for the compacted materials.

d. Shear Strengths. Shear tests were not performed on samples of gravel bedding, gravel fill, processed sand fill or rock filter materials. Experience with similar materials indicates that the following estimated shear strength parameters are reasonably conservative.

Material	ϕ - Degrees	C
Gravel Bedding, Gravel Fill and Processed Sand Fill	37°	0
Rock Filter	40°	0

15. Rock Materials. Rock for rockfill and rock slope protection will be obtained from required excavations in rock, boulders from stripping and excavation, and large boulders and rock blocks removed from the uphill side of the spillway excavation. The rock consists predominantly of gneiss with large areas of granite and schist. These rocks are all hard and generally fresh. The schist and gneiss are foliated, however, and contain considerable quantities of mica. The tendency will be for the schist and schistose gneiss to break along the foliation during blasting and handling to produce slabby and elongated fragment shapes. In pegmatitic phases of the granite, blasting and handling will break the rock along mica partings, so generally small sizes will result. In the schist, schistose gneiss and pegmatite, a considerable proportion of micaceous fines must be expected. The fine grained granite and granitic gneiss will produce more blocky, angular fragments and generally cleaner rock material.

A bulking factor of 1.4 over in situ volume is assumed for the excavated rock. Losses in blasting and handling, however, will considerably reduce the bulking. Rock from tunnel excavation will not generally be suitable for use in the rockfill or slope protection. Rock for the rock filter will be obtained by processing rock from the excavations or from cobble from Area B. If additional rock is required, it will be obtained by excavation in the spillway approach channel.

F. DESIGN OF EMBANKMENTS

16. Design Criteria. The designs of the embankments for this project were developed in accordance with the criteria set forth in the pertinent sections of Engineer Manual EM 1110-2-2300 - Earth Embankments and the other Engineer Manuals and technical publications referred to therein.

17. Materials for Embankment Construction.

a. Required Earth Excavation. Of the estimated 162,000 cubic yards of required earth excavation, about 126,000 cubic yards will consist of topsoil, stripping material, and other material unsuitable for use in the construction of the embankments. The remaining 36,000 cubic yards of required earth excavation will be utilized as pervious embankment material and will be placed directly in the compacted pervious fill zone of the dam embankment. Losses due to oversize stones, waste and shrinkage are anticipated to amount to approximately 10 percent. As a result, the 36,000 cubic yards of suitable material available from the required excavation will represent a volume of 32,000 cubic yards of compacted pervious fill in place in the dam embankment.

b. Required Rock Excavation. Exclusive of tunnel muck, preliminary estimates indicate that about 854,000 cubic yards of material from required rock excavation will be available for use as rockfill and rock slope protection materials. At the contractor's option, rock filter material may be obtained by processing material from required rock excavation. If this option is taken, the oversize would be used as rockfill material and the fines would be used as pervious fill material. The rockfill and rock slope protection sections, as presently designed, will require about 945,000 cubic yards of material and the rock filter zones will require about 80,000 cubic yards of material. After computation of final rock excavation volumes, slight adjustments will be made of the internal limits of the upstream rockfill section of the dam embankment, if necessary, to assure complete utilization of material from required rock excavation. Provisions will be made for obtaining additional material by extending the rock excavation in the spillway approach channel, if the actual balance factors are less than those adopted for design.

c. Borrow Excavation.

(1) Area C. Approximately 550,000 cubic yards of compacted impervious fill will be required for this project, materials for which will be obtained from Area C. Anticipating that losses due to oversize stones, waste and shrinkage will average about 10 percent, approximately 610,000 cubic yards of impervious fill material, exclusive of stripping, will have to be excavated from Area C in order to produce the required quantity of compacted impervious fill. Stripping operations required to obtain this volume of material may involve as much as 90,000 cubic yards, thereby resulting in a total of 700,000 cubic yards of borrow excavation in Area C.

(2) Area B. It is estimated that about 871,000 cubic yards of compacted pervious fill, compacted gravel fill, road gravel and gravel bedding will be required for the dam and dike embankments, materials for which will be obtained from Area B. In addition, the contractor, at his option, may process material to produce about 80,000 cubic yards of rock filter material from this area. The payments for the various materials from this area will be based on embankment volume measurements and no separate payment will be made for borrow excavation in Area B, since the volume of this excavation, including stripping, will be dependent upon the contractor's method of operation. It is estimated that there is at least 2,000,000 cubic yards of suitable material available in this area.

d. Material Furnished by the Contractor. Processed sand material for the toe drain and drainage blanket will be furnished by the contractor from approved sources.

e. Materials Usage. A chart showing the proposed usage of materials from required excavations and borrow excavations is shown on Plate No. 9-28. The quantities shown are preliminary and will be subject to modification during the final design studies.

18. Selection of Embankment Sections.

a. General. The selection of the embankment sections for the dam and dike were influenced by the large volume of required rock excavation for the project and by the relative positions of the embankments, required excavation, the limited quantity of materials from required earth excavation, the availability of large quantities of impervious fill material and gravels from sources close to the site, the effect of weather upon construction, embankment foundation conditions and economical considerations. Typical embankment sections for the dam and dike are shown on Plates Nos. 9-5 and 9-18.

b. Dam. The embankment section selected for the dam consists of a central core of compacted impervious fill with a contiguous impervious foundation cutoff to bedrock, upstream and downstream compacted pervious fill, compacted gravel fill, rock filter and rockfill zones. This section is designed to utilize the maximum quantity of material from the required rock excavations which are located adjacent to the damsite. Large zones of pervious and gravel fill materials from Area B have been included so as to facilitate construction and to reduce the overall embankment volume. The rock filter zone between the downstream gravel fill and rockfill zones has been included so as to permit a steeper downstream slope for the embankment. Provision will be made for the placement of material from the required earth excavations in the lower portion of the pervious fill zone to the extent possible and, if necessary, in the upstream pervious fill zone adjacent to the impervious fill. If the contractor elects to grizzly material from the required rock excavations to produce rock filter material, the fines from this operation will be placed in the upstream pervious fill zone adjacent to the impervious fill.

c. Dike. The embankment section selected for the dike consists of a compacted impervious fill zone with a contiguous reservoir side impervious fill blanket, a downstream compacted pervious fill zone, a horizontal drainage blanket and rock slope protection and gravel bedding. In a limited reach where the dike embankment reaches its maximum height, a small downstream rock toe and foundation drain has been provided. This embankment section is designed to utilize the maximum feasible quantity of impervious fill material in view of the proximity of Area C to the dike site.

19. Slope Protection.

a. Dam. The upstream slope of the dam embankment will be subject to the action of waves up to 3.7 feet high. The rockfill material on the outer slopes of the embankment will consist of relatively uniformly graded rock fragments covering the extremely large fragments anticipated in the adjoining Rockfill (Zone B). The rockfill material in this outer zone (Zone C), at the contractor's option, will consist either of fragments graded from 1 cubic foot to 10 cubic feet or from 1/3 to 1 cubic yard in size. Either gradation will be more than adequate to resist the anticipated wave action according to current criteria.

b. Dike. The upstream slope of the dike embankment will be subject to the action of waves of up to 3.7 feet high. For this wave height and a slope of 1 vertical on 2.5 horizontal, current criteria requires a minimum thickness of 20 inches of graded riprap consisting of stones weighing from 14 to 440 pounds and averaging 110 pounds. The rock slope protection layers for the dike embankment will consist of well graded rock fragments having a maximum size equal to that of the largest fragment that can be placed in a 2 foot layer. It is considered that this construction is more than adequate to resist the anticipated wave action according to current criteria.

20. Seepage Control.

a. Dam.

(1) Seepage Through Embankment. Seepage through the embankment will be controlled by the arrangement and differences in permeabilities of the impervious, pervious and gravel fill zones and by the rock filter and large rockfill zones. The pervious, gravel and rock filter zones have been incorporated into the dam embankment section in order to lower the phraetic line and to act as filters preventing the migration of the materials into the adjoining zones. In view of the high permeabilities of these zones, it is considered that no seepage pressures can develop which could affect significantly the stability of either the upstream or downstream portions of the embankment.

(2) Seepage Through Foundation. Seepage through the overburden in the foundation of the dam embankment will be controlled by the impervious foundation cutoff having a maximum bottom width of 40 feet, extended to bedrock and by the downstream pervious fill, gravel fill, rock filter and rockfill zones. Seepage through the bedrock in the foundation of the dam embankment will be controlled by a grout curtain. The drainage effect of the downstream rockfill zone will prevent the development of any significant seepage pressures beneath the downstream portion of the embankment which would otherwise result from any seepage passing through the foundation. A rock filter layer has been provided beneath this rockfill zone to prevent movement of foundation soil into the rockfill.

(3) Seepage Along Bedrock Surfaces. In order to avoid the detrimental effects of seepage along bedrock surfaces against which impervious fill material will be placed, the bedrock surfaces will be prepared by:

(a) The removal of all soil and loose rock fragments.

(b) The removal of all overhangs and irregularities in the bedrock surface which would interfere with the proper placement and compaction of the impervious fill material.

(c) The cleaning and mortaring of all cracks and openings in the bedrock surface.

(d) The filling of large depressions and cracks and areas beneath large overhangs with concrete where the use of mortar is impractical without extensive special rock excavation.

(4) Filters for Drawdown Conditions. The upstream compacted gravel fill and rock filter zones have been incorporated into the embankment section to prevent the migration of materials into adjoining sections as a result of drawdown conditions.

b. Dike.

(1) Seepage Through Embankment. Seepage through the dike embankment will be controlled by the arrangement and differences in permeabilities of the impervious and pervious fill zones, the horizontal drainage blanket, and in a limited reach by a downstream rockfill toe. The pervious fill zone has been incorporated into the embankment section to lower the phraetic line and to act as a filter preventing the migration of impervious fill material into the rock slope protection layers. In view of the high permeability of the pervious fill, it is considered that no seepage pressures can develop which would affect significantly the stability of the downstream portion of the embankment. The drainage blanket has been designed to provide drainage for the pervious fill zone as well as for the foundation.

(2) Seepage Through Foundation. Seepage through the overburden in the foundation of the dike embankment will be controlled by the upstream impervious blanket and in a limited reach (across existing Route 8) by a foundation drain. This method of foundation seepage control was adopted because no impervious materials occur in the foundation at depths considered to be economical and practicable for the construction of a foundation cutoff. The impervious blanket has been designed so that seepage gradients through the foundation

will not exceed 10 percent with the reservoir pool at its maximum level except in the limited reach across existing Route 8 where the seepage gradient may approach 15 percent. In this reach, however, a downstream foundation drain has been provided to prevent the development of detrimental seepage pressures beneath the downstream portion of the embankment. The blanket will be provided with a 3 foot cover of earth stripping material for frost protection. Stripping in the area of the blanket, except in the area of existing Route 8, will not be required.

21. Embankment Stability.

a. General. The embankment sections selected for the dam and dike have been analyzed for stability against shear failure using the wedge method for the dam and the infinitestimal slice method for the dike. The design shear strengths and unit weights for the impervious and pervious embankment materials were selected on the basis of laboratory test results. The design shear strengths and unit weights for rockfill, rock filter, rock slope protection, embankment drainage materials and foundation soils were selected on the basis of experience with similar materials.

b. Conditions Analyzed.

(1) End of Construction. The dam and dike embankments were analyzed for stability at the end of construction on the assumption that the time required to construct the embankments would be too short to permit either consolidation of the impervious embankment materials under the applied embankment loads or the dissipation by drainage of the induced pore pressures in the same materials. Since the conditions of this assumption are analogous to those of the unconsolidated-undrained (Q) shear test, the analyses were made using design shear strength for the impervious embankment materials based on this test condition.

(2) Operating Conditions.

(a) General. It was agreed in conference with representatives of OCE that, in view of the large upstream and downstream zones of rockfill and pervious and gravel fills in the dam embankment, the end of construction condition would be the most critical with respect to stability and that analysis of the dam embankment for the various operating conditions would not be necessary if stability criteria for the end of construction conditions were met.

(b) Steady Seepage. The dike embankment was analyzed for stability under the steady seepage condition. Since the downstream pervious fill zone, drainage blanket and rock toe have been designed to prevent the development of seepage pore pressures in the embankment where they could affect embankment stability significantly, these analyses were made assuming seepage pore pressures in the foundation only. Design shear strengths based on the consolidated-drained (S) and consolidated-undrained (R) shear strengths which shear strengths are considered to govern the ultimate or long term stability of the embankments were used in the analyses.

(c) Partial Pool. The dike embankment was analyzed for stability at various pool levels to determine the pool level at which embankment stability would be at a minimum. Design shear strengths for the consolidated-undrained (R) and consolidated-drained (S) conditions were used for the impervious and pervious fill zones respectively, in these analyses.

(d) Sudden Drawdown. The dike embankment was analyzed for stability during sudden drawdown of the reservoir pool using design shear strengths for the consolidated-undrained (R) and consolidated-drained (S) conditions for the impervious and pervious fill zones respectively. Drawdown conditions from maximum pool (El 780) and from spillway crest (El 756) to existing ground surface elevation at the upstream toe of the maximum section (El 738) were considered. This elevation was assumed to be the elevation of groundwater at the upstream toe after drawdown.

c. Selection of Design Values.

(1) Unit Weights. The impervious materials for the embankments will be compacted with sheepsfoot or rubber-tired rollers in accordance with a compaction specification which has been used by this Division in the past for embankments of similar materials. The pervious embankment materials will be compacted with rubber-tired rollers. Experience with this specification indicates that the densities of the upper layers of the impervious fills compacted at moisture contents within the range anticipated for this project will average about 98 percent of maximum test densities while the densities of the lower layers will approach 100 percent. Experience also indicates that the densities of compacted pervious fill will be in excess of 95 percent of maximum test densities obtained by P.V.D. The design unit weights for the impervious and pervious materials, therefore, have been selected on the basis of maximum test densities as adjusted to include the weight of the average stone content. The design unit weights for the other embankment materials and the foundation materials have been selected on a similar basis, using estimated densities based on experience with similar materials. The various design unit weights selected for this project are tabulated below:

Design Unit Weight in Pounds Per Cubic Foot

Material	Dry	Moist	Saturated	Submerged
Rockfill, Rock Slope Protection and Rock Filter	120	-	140	78
Compacted Pervious, Gravel and Processed Sand Fill and Gravel Bedding	135	142	147	85
Compacted Impervious Fill	130	140	145	83
Foundation Soil	135	142	147	85

(2) Shear Strength. The design shear strength parameters for the various embankment, drainage and foundation materials were selected on the basis of conservative interpretations of laboratory shear test results and experience with similar materials. The design shear strength parameters for the compacted gravel, processed sand fill, gravel bedding, rock materials, and foundation soils were selected on the basis of experience with similar materials. The design shear strength parameters selected for the various materials are tabulated below:

DESIGN SHEAR STRENGTH PARAMETERS

	S Condition (CD)		R Condition (CU)		Q Condition (UU)	
	Ø, degrees	C,TSF	Ø,degrees	C,TSF	Ø, degrees	C,TSF
Rockfill, Rock Slope Protection and Rock Filter	40°	0	-	-	-	-
Compacted Pervious Gravel and Processed Sand Fill and Gravel Bedding	37°	0	-	-	-	-
Compacted Impervious Fill	36°	0	21.3°	0.20	30°	0.75
Foundation Soil	30°	0	30°	0	-	-

d. Sections Analyzed

(1) Dam. The downstream portion of the dam embankment at Station 7+00 was chosen for analysis as being the most critical with respect to stability because the maximum slope height occurred at this location.

(2) Dike. The upstream and downstream portion of the dike embankment at Station 7+20 was chosen for analysis as being the most critical with respect to stability because it combines the maximum slope height and an appreciable depth of foundation soil.

e. Results of Embankment Stability Analyses. The results of the embankment stability analyses are summarized on Plate No. 9-19 for the dam and on Plates No. 9-21 and 9-22 for the dike. Typical stability analyses for the dam and dike are shown on Plates No. 9-20 and Plates Nos. 9-23 through 9-26. The minimum factors of safety against shear failure as determined by the analyses are tabulated below.

Condition Analyzed	Minimum Factor of Safety
Dam	
End of Construction (Downstream Slope)	1.82
Dike	
End of Construction (Land Side Slope)	1.57
End of Construction (Reservoir Side Slope)	2.18
Operating Condition	
Steady Seepage (Land Side Slope)	1.59
Partial Pool (Reservoir Side Slope) Refer to Plate No. 9-24 - for Critical Pool Elevations	1.57
Sudden Drawdown	
Maximum Pool (El. 780) to Assumed Groundwater Elevation (El. 738)	1.09
Spillway Crest (El. 756) to assumed Groundwater Elevation (El. 738)	1.35

The foregoing minimum factors of safety are considered to be adequate and the results of the stability analyses indicate that the selected embankment sections are safe against shear failure.

22. Settlement of Embankments. The foundation and embankment materials for the dam and dike are of types which normally exhibit very low compressibility. To avoid appreciable settlement in the rockfill zones, the materials in Zone A will be placed in 3-foot lifts and each lift will be compacted by a 10 ton vibratory roller. No significant settlements are therefore expected to develop either in the foundation or within the embankment.

23. Stability of Embankment Abutments. The abutments for the dike and the left abutment of the dam are adequately stable for reservoir drawdown conditions. The lower portion of the upstream right abutment of the dam, however, is of marginal stability in this respect. To avoid possible slides in this abutment which could affect the dam embankment, a fillet of rockfill has been incorporated into the dam embankment section as shown on Plate No. 9-3.

24. Construction Considerations.

a. Dewatering Construction Area. The specifications will require the dewatering of all areas in which embankment fill is to be placed for the dam and dike, including the foundation cutoff for the dam and the foundation drain for the dike. The dewatering of other construction areas will be required to the extent necessary to facilitate construction operations. All earth excavations in the dam foundation area, except those for stripping and the removal of unsuitable materials, shall be done in the dry to reduce the quantity of excavated earth to be spoiled because of excessive moisture contents.

b. Rate of Embankment Construction. In general the lengths of the dam and dike abutments and the topography of their foundation areas are such that embankment construction in partial reaches is neither practicable or desirable. Except as otherwise stated below, therefore, construction of the embankments to their full lengths and widths will be specified. Exceptions to this will be permitted in the following cases:

(1) In order to minimize delays due to weather conditions, impervious fill material may be placed in the dam embankment up to 5 feet in advance of the adjacent pervious fill.

(2) Pervious fill material from the required earth excavations for the foundation cutoff of the dam may be placed in advance of the adjoining fills.

(3) At the end of the second construction season, the dam embankment is to be completed to its full length and width to Elev. 635. Construction of the dam embankment above this elevation in this season will be permitted to Elev. 685 providing that a temporary emergency spillway is left at Elev. 635 having a width of 200 feet and that the resulting temporary construction slope is 1 vertical on 4 horizontal or flatter. One side of this temporary spillway shall be one of the abutments. No embankment construction above Elev. 685 will be permitted until the temporary spillway is plugged in the third construction season.

c. Rockfill Placement. In general, rock material in the rockfill sections of the dam embankment will be placed in 3-foot lifts and compacted with a vibratory roller. To avoid secondary blasting of rock fragments too large for placement in 3-foot lifts, the rockfill sections have been divided into three zones. Zone A, forming the bulk of the rockfill sections will consist of all material from required rock excavations that can be placed in 3-foot lifts. Rock fragments too large for placement in Zone A will be placed in Zone B. To cover the large and variable fragments in Zone B, a cover zone (Zone C) of more uniform gradation will be placed. Compaction of rockfill in Zones B and C will not be required.

G. PERMANENT CUT SLOPES

25. Earth Cut Slopes. Rock slope protection and gravel bedding will be placed on all earth cut slopes which may be subject to damage from the action of waves, currents, runoff or seepage. In general, all other permanent earth cut slopes will be topsoiled and seeded for protection against erosion. Permanent earth cut slopes in Area C will be left at 1 on 3 or flatter and topsoiled and seeded.

26. Rock Cut Slopes. The side slopes of permanent rock cuts are up to 200 feet in depth. The relation between the attitude of the bedrock structure and the alignment of the excavation is generally favorable. In areas of close-jointing and felted mica concentrations, however, overbreak and fall-outs must be expected. Rock cut slopes will be excavated to 4 on 1 slopes. In the upper part of the excavations where the rock is close-jointed and weathered, it may be necessary to roll back the crest to flatter slopes. Berms with a minimum width of 10 feet will be cleaned of overburden along the rock surface of the crest of the cuts and boulders and loose rock blocks will be removed from the steep slopes on the uphill side of the spillway excavations.

It is presently planned that pre-splitting will be used where feasible to assist in control of overbreak and possibly to obtain more stable slopes. Rock bolts will be utilized as required and safety mesh secured with rock bolts will be provided to reduce hazards from fall-outs during construction.

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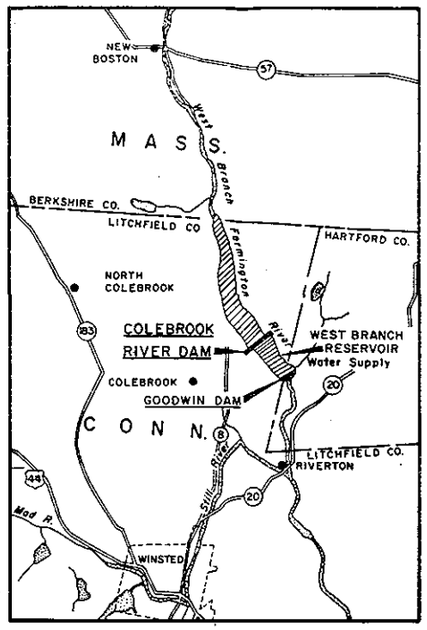
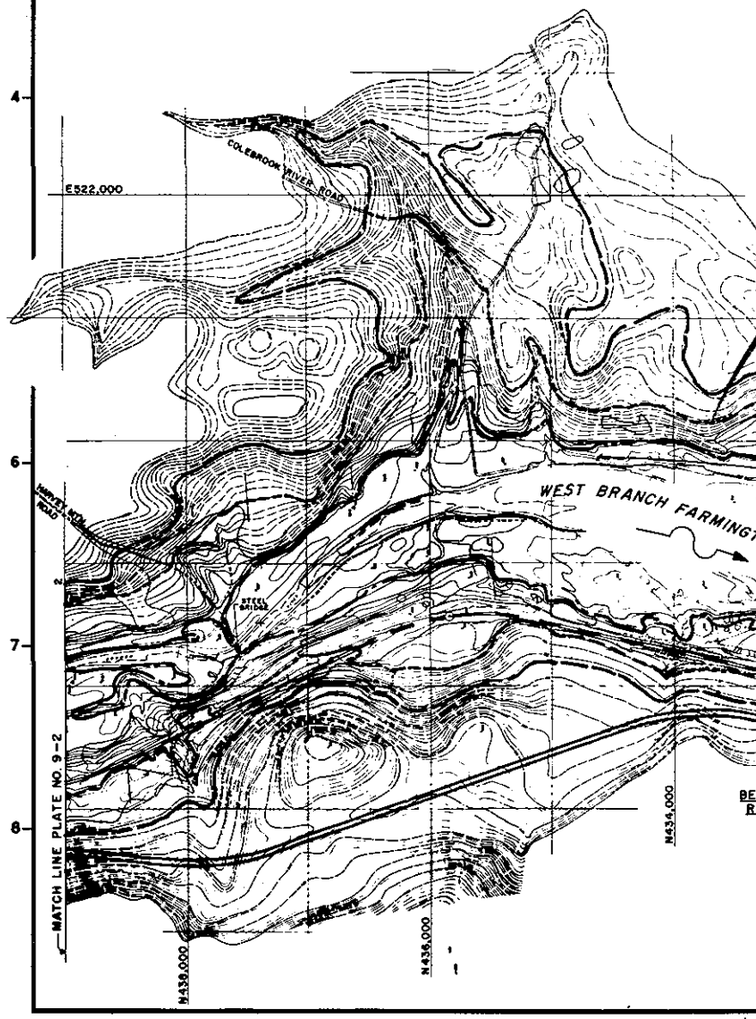
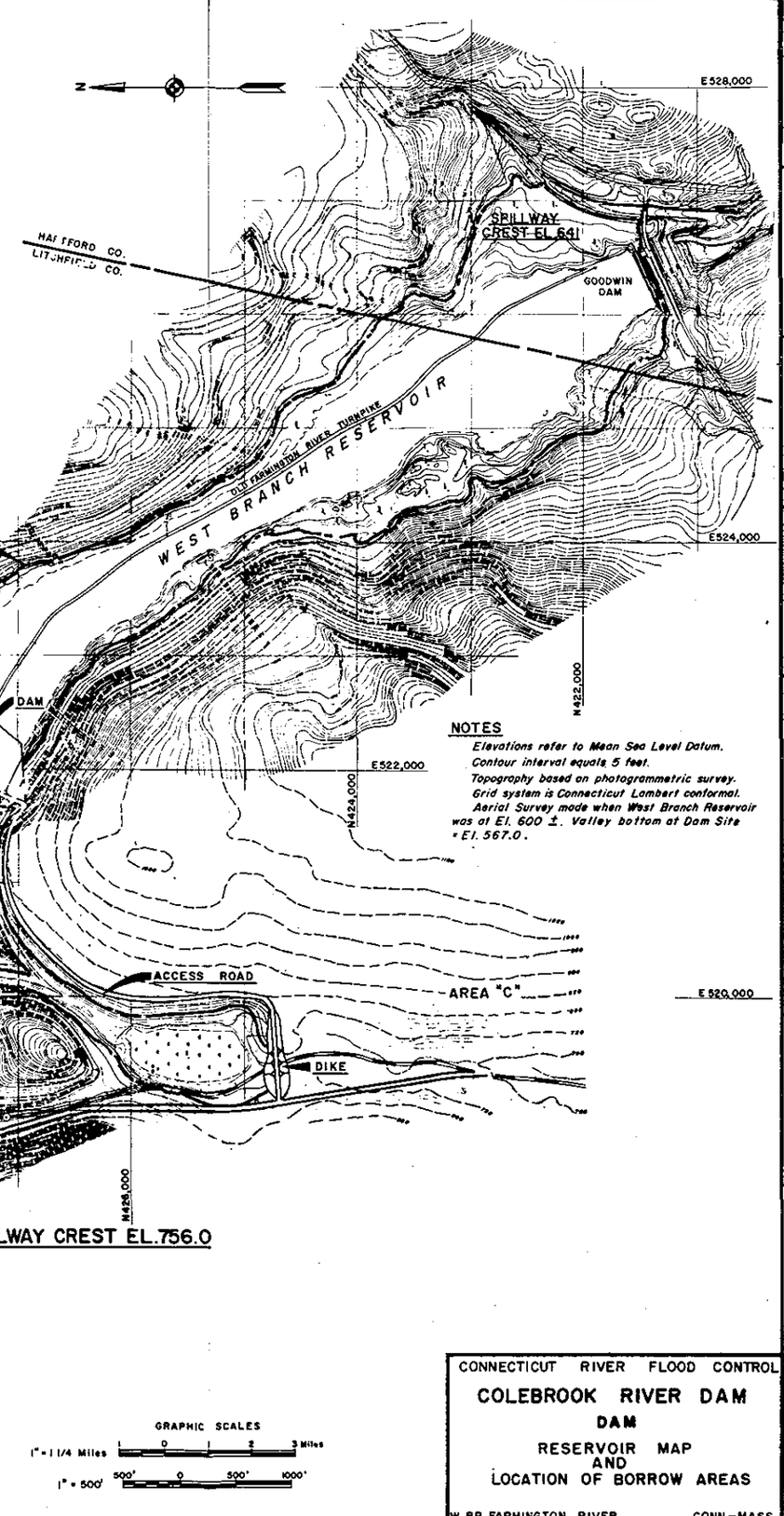


VICINITY MAP

1" = 1 1/4 Miles





NOTES

Elevations refer to Mean Sea Level Datum.
Contour interval equals 5 feet.
Topography based on photogrammetric survey.
Grid system is Connecticut Lambert conformal.
Aerial Survey made when West Branch Reservoir was at El. 600 ±. Valley bottom at Dam Site = El. 567.0.

GRAPHIC SCALES

1" = 1 1/4 Miles 0 2 3 Miles

1" = 500' 500' 0 500' 1000'

CONNECTICUT RIVER FLOOD CONTROL

COLEBROOK RIVER DAM

DAM

RESERVOIR MAP
AND
LOCATION OF BORROW AREAS

W. BR. FARMINGTON RIVER CONN.-MASS.

PLATE NO. 9-1

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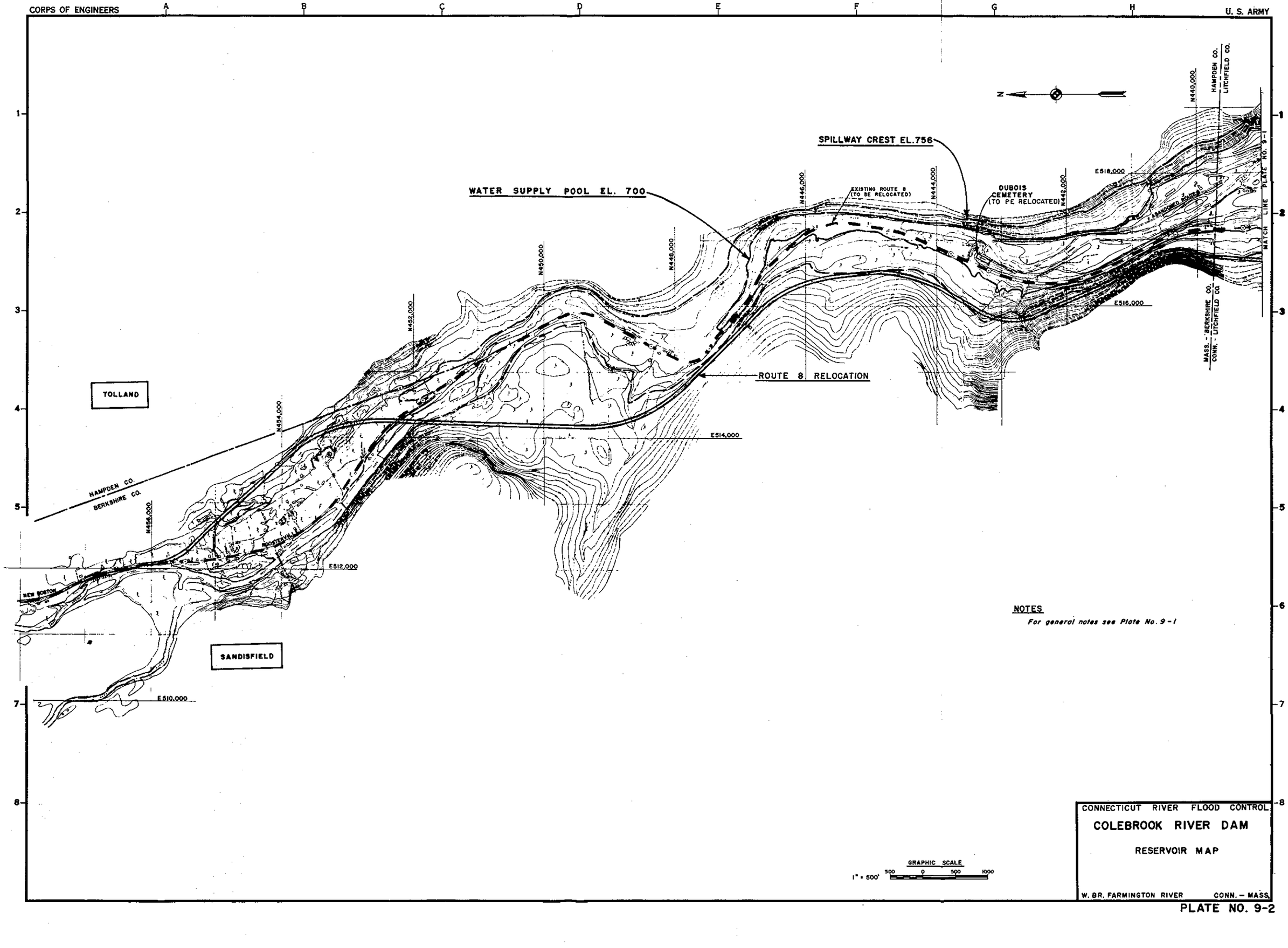

NOTES

For general notes see Plate No. 9-1

GRAPHIC SCALE

1" = 500' 500 0 500 1000

CONNECTICUT RIVER FLOOD CONTROL

COLEBROOK RIVER DAM

RESERVOIR MAP

W. BR. FARMINGTON RIVER CONN. – MASS.

PLATE NO. 9-2

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N

WEST BRANCH FARMINGTON RIVER

INLET CHANNEL

Channel El. 1575.0

℄ SPILLWAY CHANNEL

APPROACH CHANNEL

Sta. 18+00
N428-196.67
E521-668.45

CONTROL TOWER

SERVICE BRIDGE

OUTLET WORKS

SPILLWAY

Crest El. 740.0

Channel El. 734.0

WEIR

Channel El. 734.0

PARKING AREA El. 784

DISCHARGE CHANNEL

10' Rock Toe

CURVE DATA
Δ = 29°-30'
D = 2°-30'
R = 2292.01
Lc = 1167.10
T = 603.44
E = 75.53

Sta. 12+80.0

TUNNEL

DAM

OUTLET STRUCTURE

Water Surface
23 Sept. 63

Slope 1 on 3½

N427-429.30
E521-847.93

℄ Dam
Top of Dam El. 785.0

Foundation Cut-off

Slope 1 on 2

Channel El. 712.0

OUTLET CHANNEL

10' Rock Toe

Water Surface
(West Branch Reservoir)
23 Sept. 63

ACCESS ROAD

R-625'

P.C. Sta. 1+00

Sta. 0+00
N426-758.11
E521-653.40

N428,200
N427,800
N427,400
N427,000
N426,600

E521,200
E521,600
E522,000
E522,400
E522,800
E523,200

PLAN
SCALE 1" = 80'

GRAPHIC SCALE
1" = 80'
80' 0 80' 160'

CONNECTICUT RIVER FLOOD CONTROL

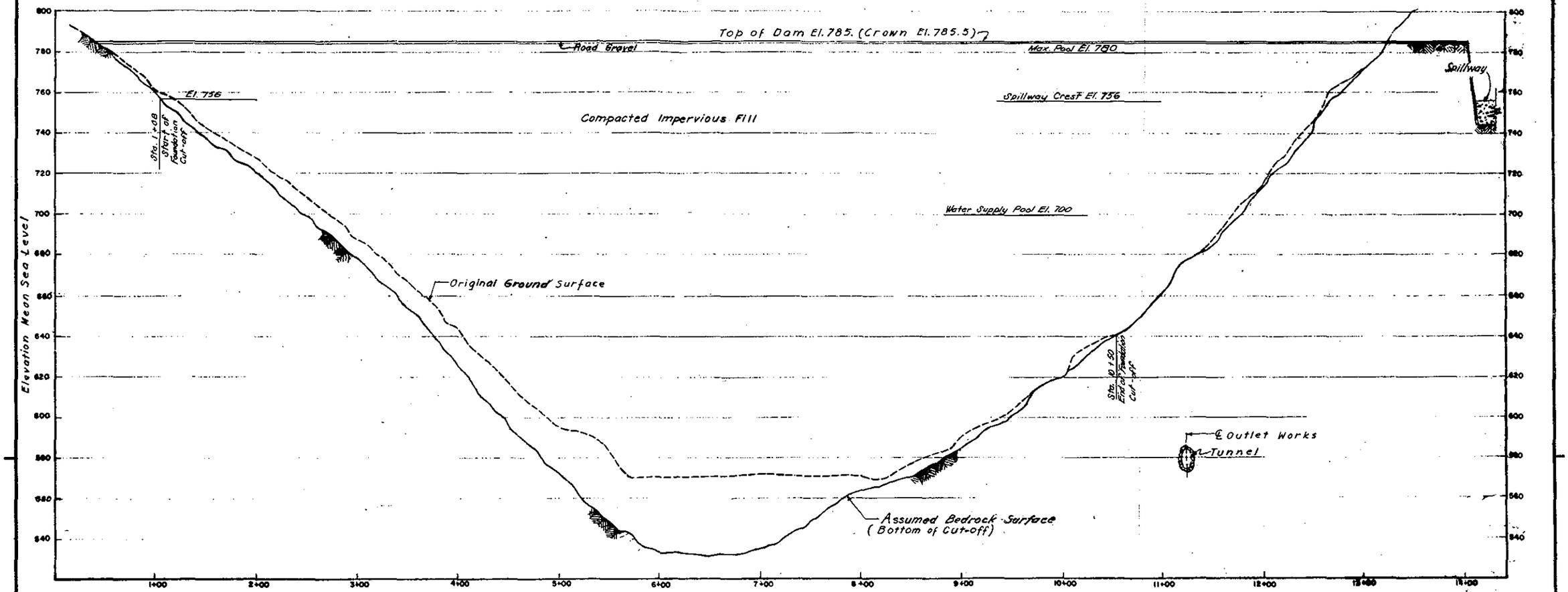
COLEBROOK RIVER DAM
DAM

GENERAL PLAN OF STRUCTURES

W.BR. FARMINGTON RIVER CONN.-MASS.

PLATE NO. 9-3

CORPS OF ENGINEERS U. S. ARMY



PROFILE ALONG ℄ DAM

SCALE: HOR. 1"=40'
VERT. 1"=20'

CONNECTICUT RIVER FLOOD CONTROL

COLEBROOK RIVER DAM

DAM

EMBANKMENT PROFILE

W.BR. FARMINGTON RIVER CONN.-MASS.

PLATE NO. 9-4

CORPS OF ENGINEERS

U. S. ARMY

RESERVOIR SIDE

LAND SIDE

FD-65 FD-68 FD-66 FD-64 FD-62 FD-60 FD-69 FD-67 FD-63 FD-51

3' Compacted Impervious Fill Blanket

45' Compacted Impervious Fill Blanket

10' Rock Toe

Slope 1 on 2.5

℄ Dike and Access Road El. 785.5

Tentative ℄ Relocated Route 8

Existing Route 8

P.I.

N 424,800 N 424,600 N 424,400 N 425,000

E 519,000 E 519,200 E 519,400 E 519,600 E 519,800 E 520,000

5+00 3+00 2+00 1+00 15+00

LEGEND

FD-60 Foundation Test Boring

Location and Direction of Engineering Log Profile

NOTES

Elevations refer to Mean Sea Level Datum

Contour interval is 10 feet

Coordinates refer to Connecticut Lambert conformal grid system

For Engineering Log profile see Plate No. 9-12

For General Location see Plate No. 9-1

PLAN

SCALE: 1"=40'

℄ Dike and Access Road

RESERVOIR SIDE — 30' — LAND SIDE

Top of Dike El. 785.0

2' Rock Slope Protection

2' Gravel Bedding

El. 780

2.5

Compact Impervious Fill

Compacted Pervious Fill

10'

3' Compacted Impervious Fill Blanket (Sta. 8+00 to Sta. 13+00)

3' Stripping Material Seeded

Strip to suitable material

3' Compacted Processed Sand

TYPICAL STA. 8+00 TO STA. 15+00

℄ Dike and Access Road

RESERVOIR SIDE — 30' — LAND SIDE

Top of Dike El. 785.0

2' Rock Slope Protection

2' Gravel Bedding

El. 780.0

2.5

Compacted Impervious Fill

Compacted Pervious Fill

El. 750

Existing Ground Surface

3' Stripping Material Seeded

10'

Strip to suitable material

3' Compacted Processed Sand

Strip to suitable material under blanket within the limits of existing Route 8 only

5' Compacted Impervious Fill Blanket

Compacted Processed Sand

15'

TYPICAL STA. 5+40 TO STA. 8+00

SECTIONS

SCALE: 1" = 20'

ELEVATION IN FEET ABOVE M.S.L.

800 780 760 740 720

Tentative Road Elev. 783±

Relocated Route 8 Embankment

Existing Route 8

Crown Elev. 785.5

Compacted Impervious Fill

Road Gravel

Existing Ground

Strip to suitable material

4+00 5+00 6+00 7+00 8+00 9+00 10+00 11+00 12+00 13+00 14+00

℄ PROFILE

SCALE HOR. 1"=40'
VERT. 1"=20'

GRAPHIC SCALES

1"=20' 20' 0 20' 40'

1"=40' 40' 0 40' 80'

CONNECTICUT RIVER FLOOD CONTROL

COLEBROOK RIVER DAM

DIKE

GENERAL PLAN OF STRUCTURES
PLAN OF FOUNDATION EXPLORATIONS
EMBANKMENT SECTIONS AND PROFILE

W.BR. FARMINGTON RIVER CONN.-MASS.

PLATE NO. 9-5

CORPS OF ENGINEERS

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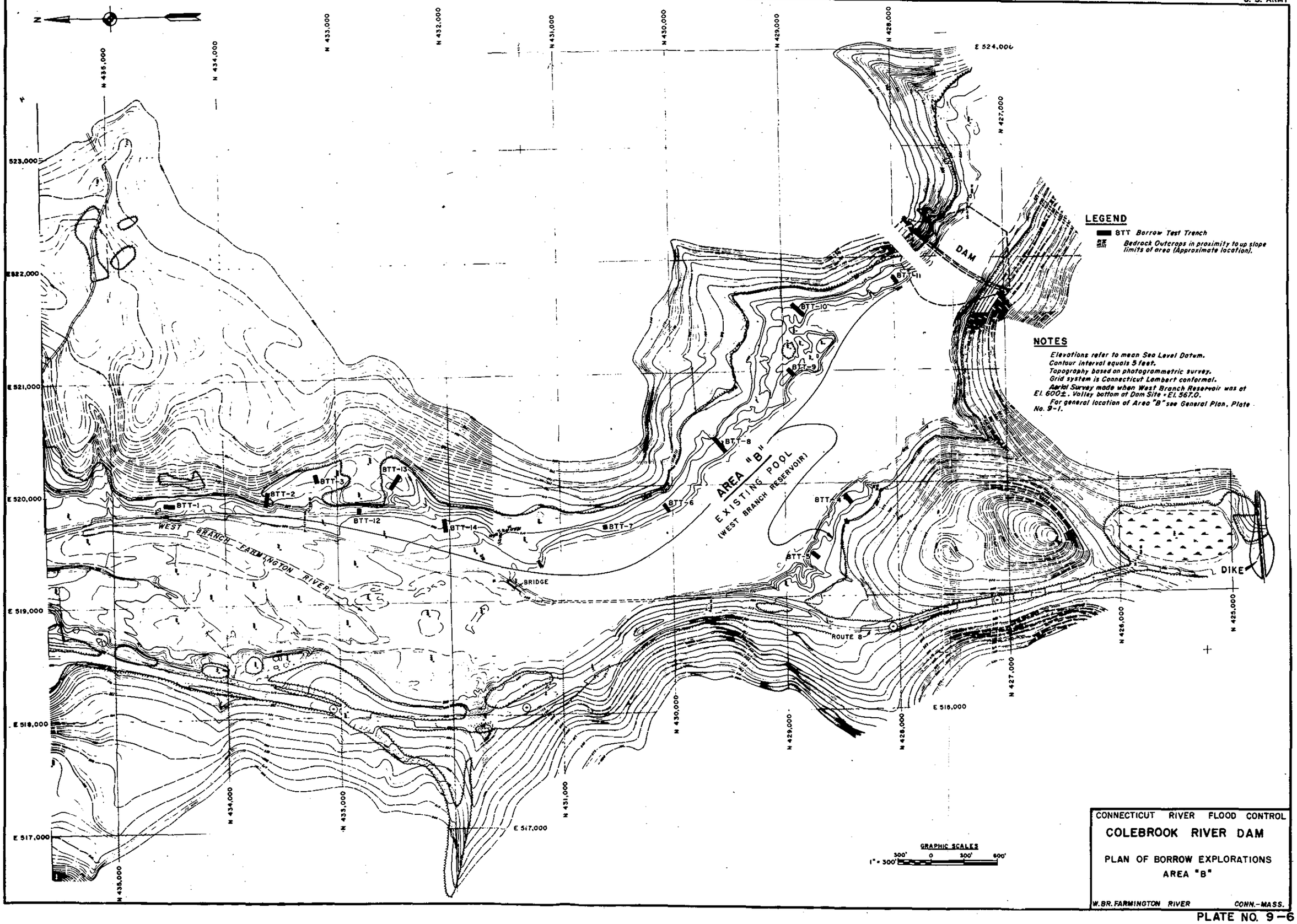


CONNECTICUT RIVER FLOOD CONTROL

COLEBROOK RIVER DAM

PLAN OF BORROW EXPLORATIONS
AREA "B"

W. BR. FARMINGTON RIVER CONN.-MASS.

PLATE NO. 9-6

CORPS OF ENGINEERS

U. S. ARMY

E 522,000

E 521,500

E 521,000

E 520,500

E 520,000

E 519,500

N 424,500

N 424,000

N 423,500

N 423,000

N 422,500

N 422,000

N

1150

1100

1050

1000

950

900

850

800

750

BD-9

BTT-20

BD-8

BD-7

BD-13

BD-6
520.2' North

BD-12

BTT-19

BD-5

BD-4

BD-11

BD-3

BD-10

to Route 8

GRAPHIC SCALE
1"=100'
100' 0 100' 200

LEGEND

BD Borrow Test Boring

BTT Borrow Test Trench

Bedrock Outcrop

NOTES

Elevations refer to Mean Sea Level
Contour interval is 5 feet.
Coordinates refer to Connecticut Lambert Grid System.
For general location of Area "C" see General Plan, Plate No. 9-1

CONNECTICUT RIVER FLOOD CONTROL

COLEBROOK RIVER DAM

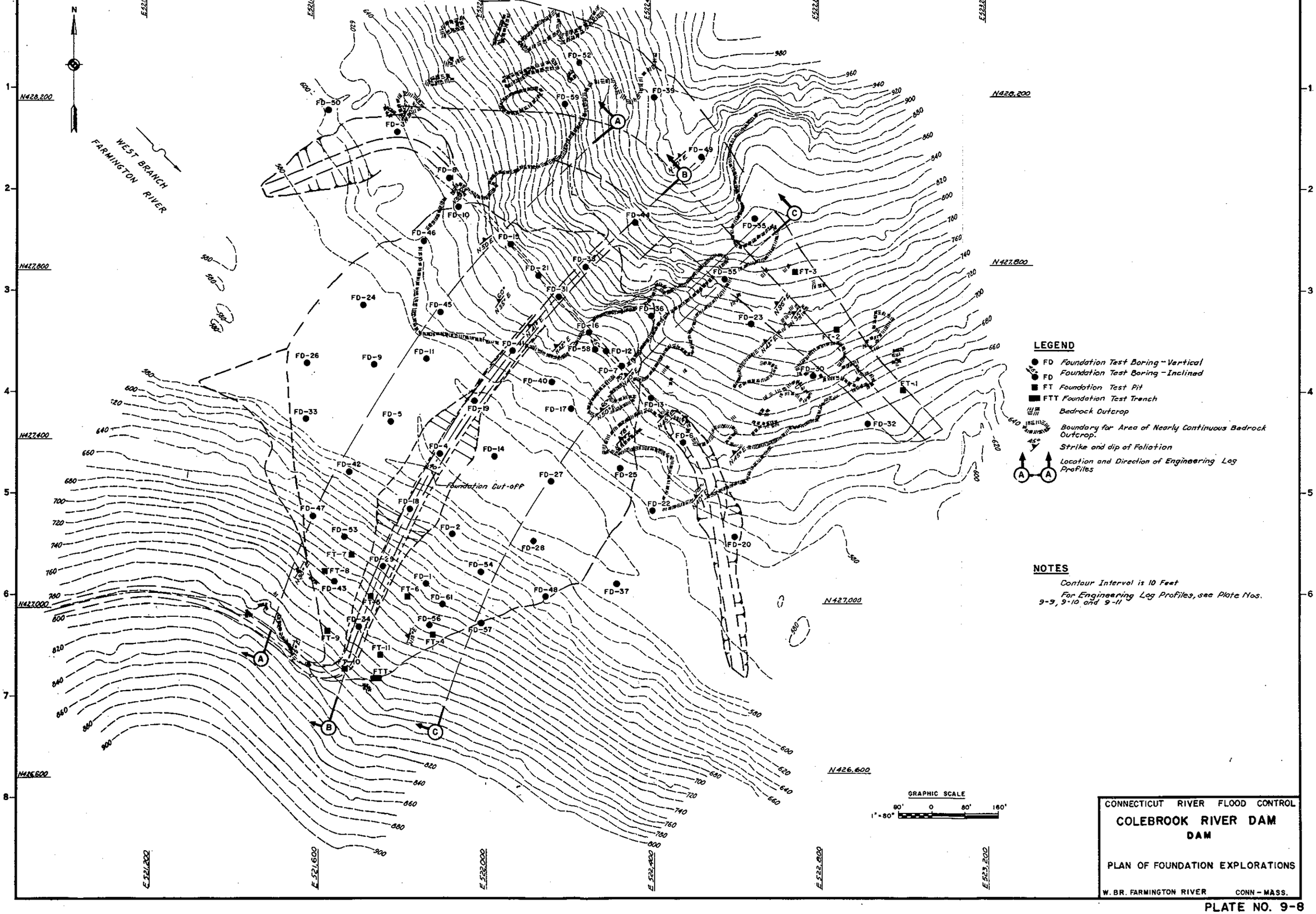
PLAN OF BORROW EXPLORATIONS
AREA "C"

W.BR. FARMINGTON RIVER CONN.-MASS.

PLATE NO. 9-7

CORPS OF ENGINEERS

U. S. ARMY



LEGEND

- FD Foundation Test Boring – Vertical
- 45° FD Foundation Test Boring – Inclined
- FT Foundation Test Pit
- FTT Foundation Test Trench
- Bedrock Outcrop
- Boundary for Area of Nearly Continuous Bedrock Outcrop.
- 45° Strike and dip of Foliation
- Location and Direction of Engineering Log Profiles

NOTES

Contour Interval is 10 Feet

For Engineering Log Profiles, see Plate Nos. 9-9, 9-10 and 9-11

GRAPHIC SCALE

80' 0 80' 160'

1"=80'

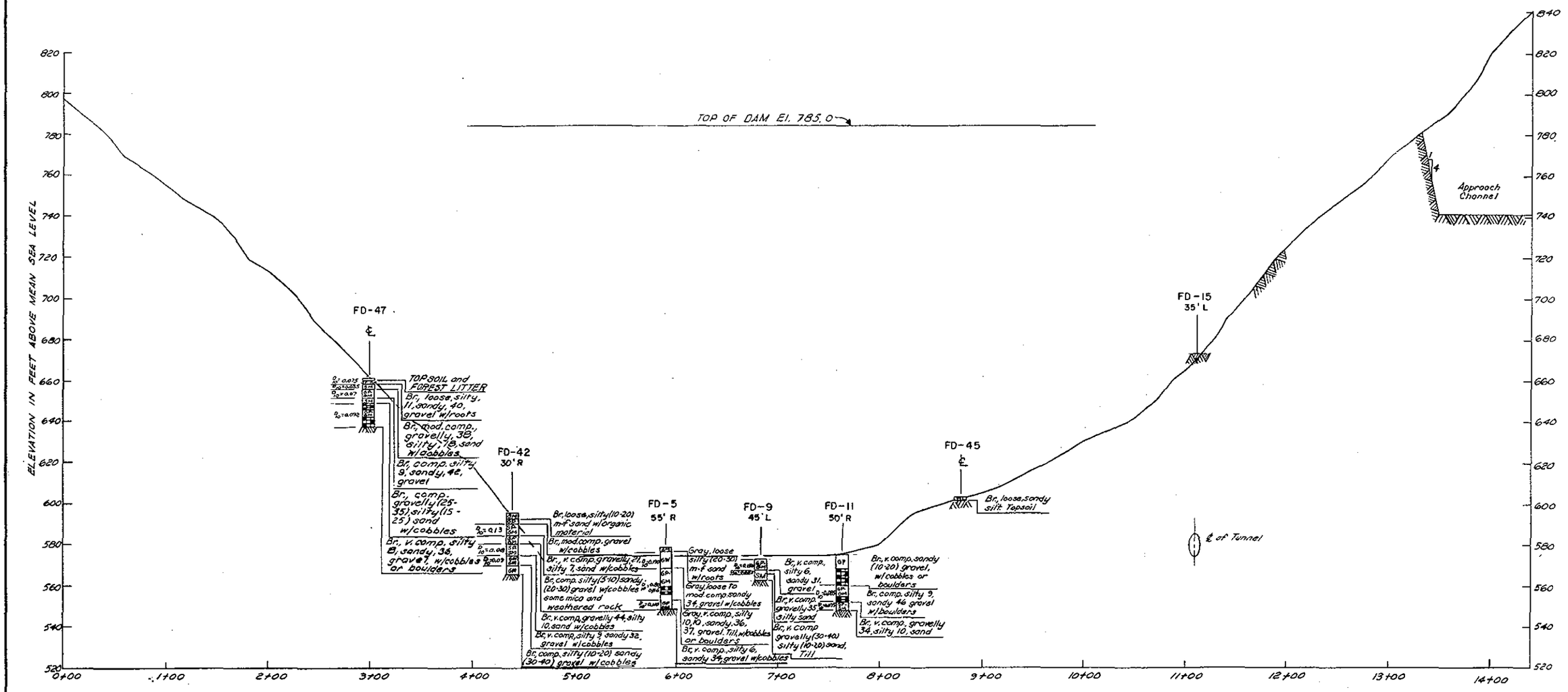
CONNECTICUT RIVER FLOOD CONTROL

COLEBROOK RIVER DAM DAM

PLAN OF FOUNDATION EXPLORATIONS

W. BR. FARMINGTON RIVER CONN – MASS.

PLATE NO. 9-8



ENGINEERING LOG PROFILE A-A, 200 FEET UPSTREAM. FROM DAM ℄

(LOOKING UPSTREAM)

LEGEND FOR ENGINEERING LOGS

W_T	Natural water content of sample except for certain soils containing gravel for which W_T represents the water content of that part of the sample from which portions of the coarse gravel sizes have been removed.
W_4	Natural water content determined for that portion of the soil passing the No. 4 U.S. Standard sieve.
D_{10}	Effective grain size in millimeters.
26	A single numeral following a soil component in the description of a soil represents the percentage, by weight of that component in the soil as determined by a mechanical analysis.
(10-20)	A range of numbers in parentheses following a soil component in the description of a soil, represents the estimated limits between which lies the percentage, by weight, of that component in the soil determined by visual inspection.
SM	Soil Symbol, Unified Soil Classification System.
	Cobble or boulder (Core-drilled)
	Cobbles or boulders, continuous or nested (Core-drilled and/or blasted and chopped)
	Bedrock

NOTES

For Location of Explorations, see Plate No. 9-8

CONNECTICUT RIVER FLOOD CONTROL

COLEBROOK RIVER DAM

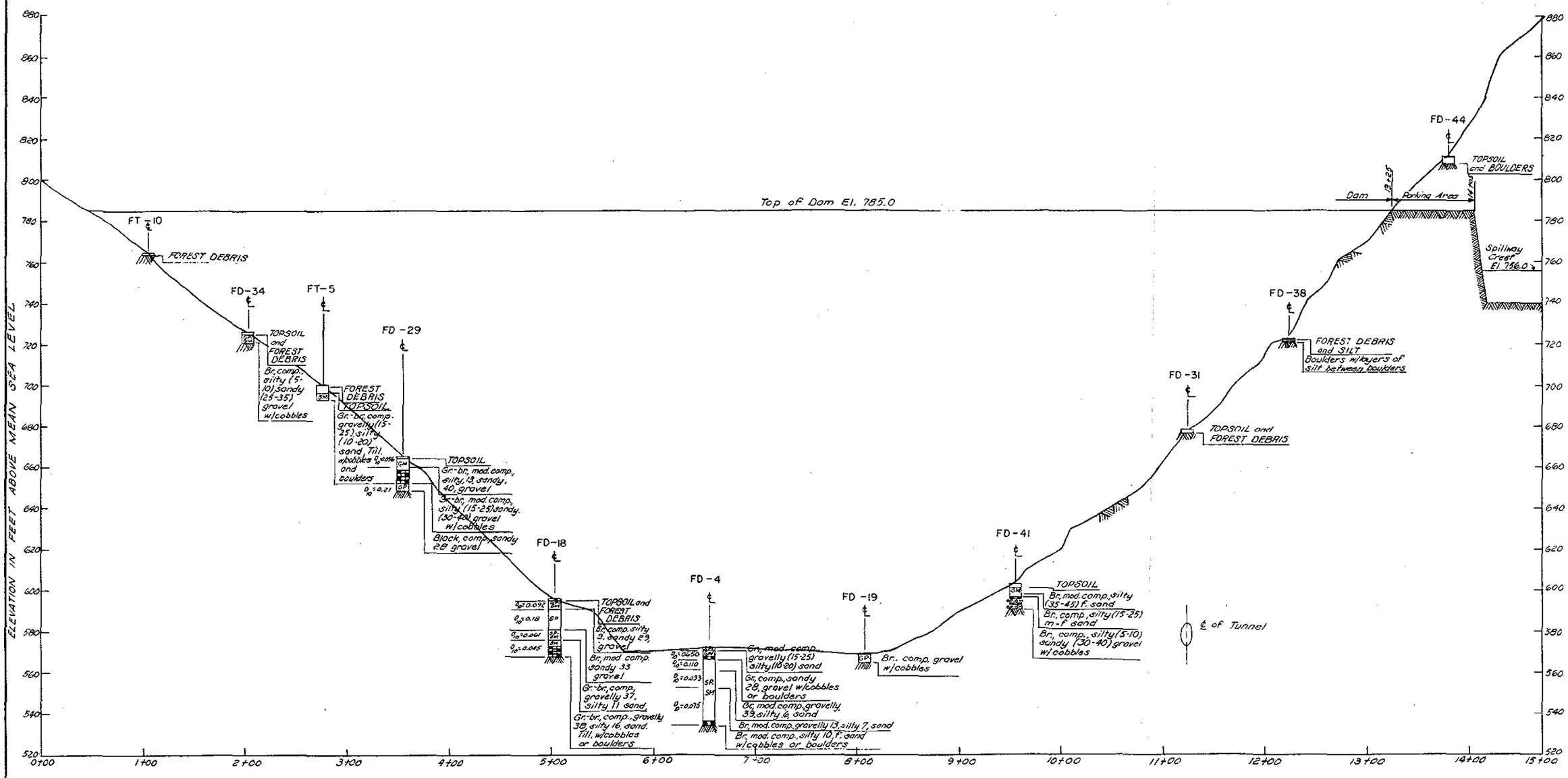
DAM

ENGINEERING LOG PROFILE A-A

W. BR. FARMINGTON RIVER CONN.-MASS.

PLATE NO. 9-9

CORPS OF ENGINEERS U. S. ARMY



ENGINEERING LOG PROFILE B-B, ALONG DAM ℄ AND FOUNDATION CUT-OFF

(LOOKING UPSTREAM)

NOTES

For Location of Explorations, see Plate No. 9-8

For Legend of Engineering Logs, see Plate No. 9-9

CONNECTICUT RIVER FLOOD CONTROL

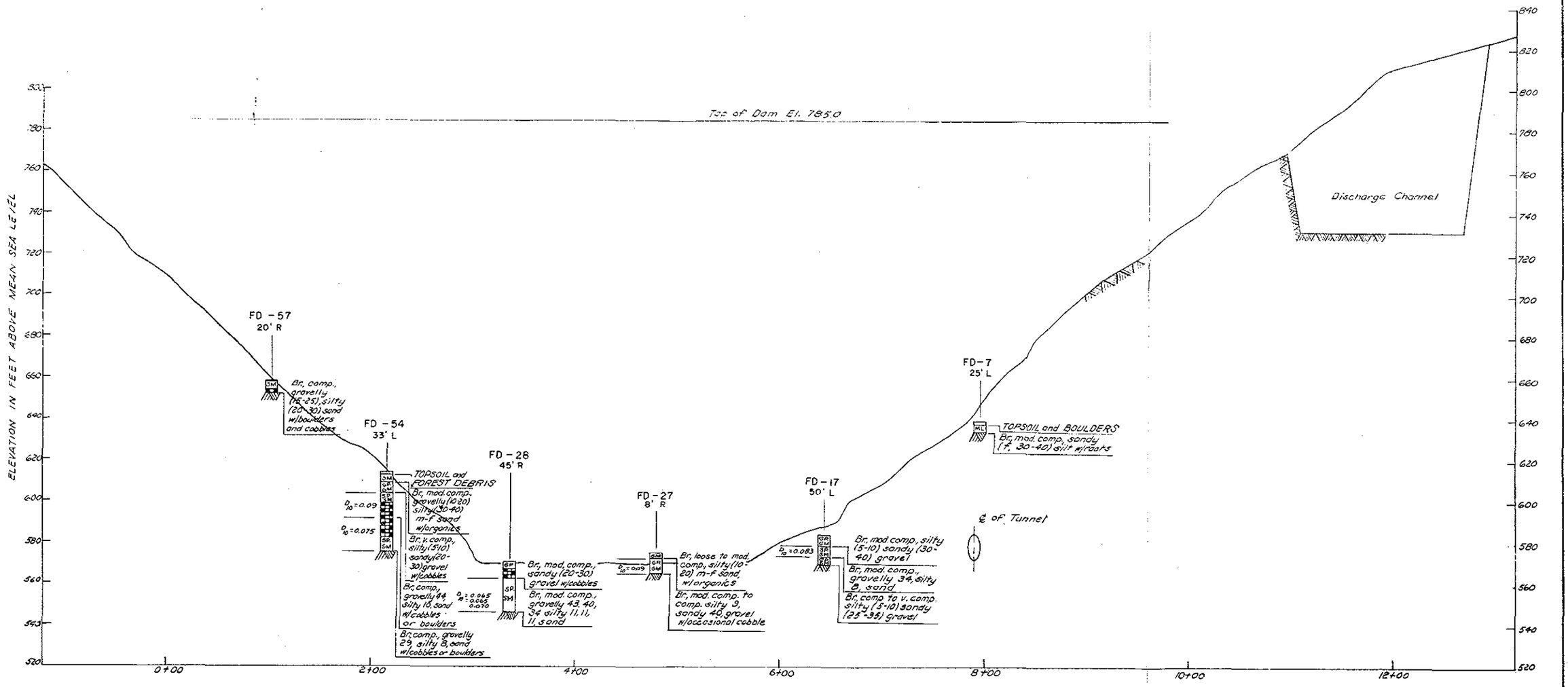
COLEBROOK RIVER DAM

DAM

ENGINEERING LOG PROFILE B - B

W. BR. FARMINGTON RIVER CONN.-MASS.

PLATE NO. 9-10



ENGINEERING LOG PROFILE C-C, 250 FEET DOWNSTREAM FROM DAM ℄

(LOOKING UPSTREAM)

NOTES

For Location of Explorations, see Plate No. 9-8

For Legend of Engineering Logs, see Plate No. 9-9

CONNECTICUT RIVER FLOOD CONTROL

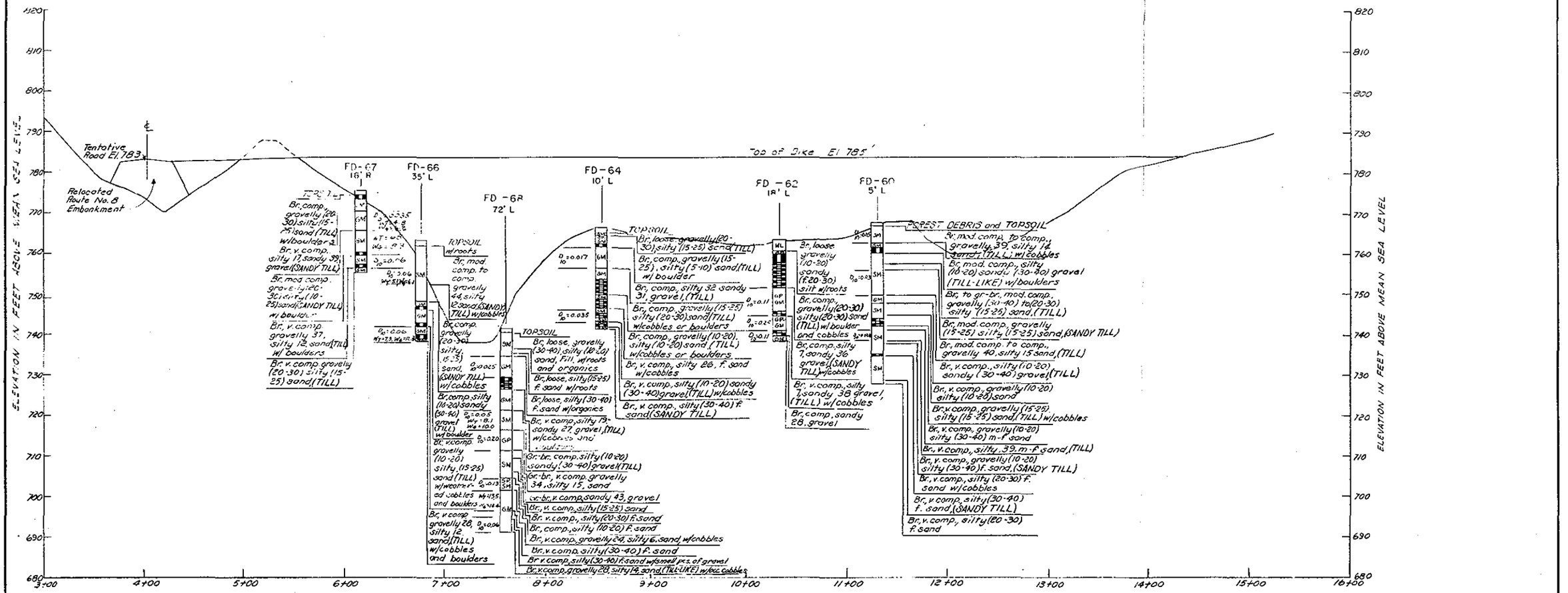
COLEBROOK RIVER DAM

DAM

ENGINEERING LOG PROFILE C-C

W. BR. FARMINGTON RIVER CONN.-MASS.

PLATE NO. 9-11



ENGINEERING LOG PROFILE A-A, ALONG DIKE ℄

(LOOKING TOWARD THE RESERVOIR)

NOTES

For Location of Explorations, see Plate No. 9-5

For Legend of Engineering Logs, see Plate No. 9-9

CONNECTICUT RIVER FLOOD CONTROL

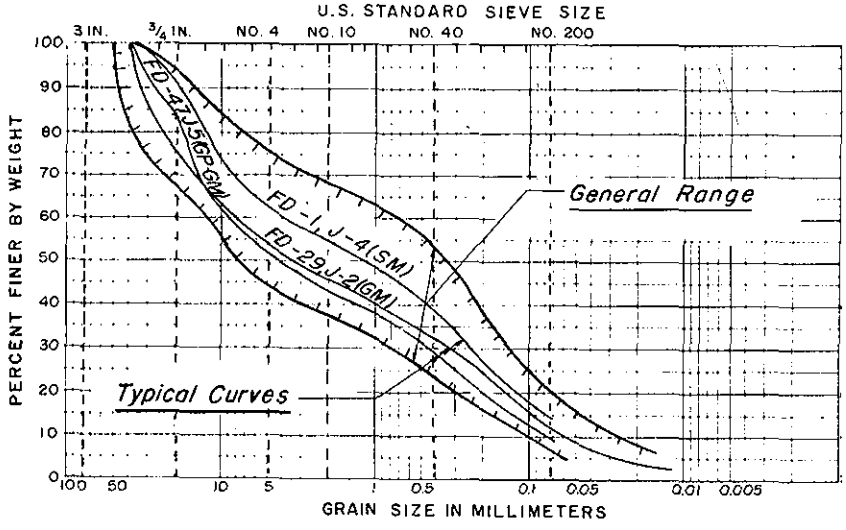
COLEBROOK RIVER DAM

DIKE

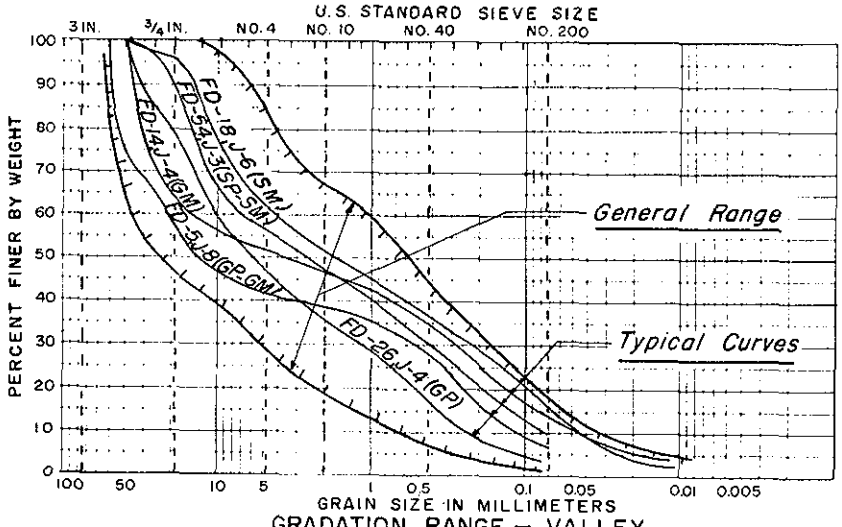
ENGINEERING LOG PROFILE A-A

W.BR. FARMINGTON RIVER CONN.-MASS.

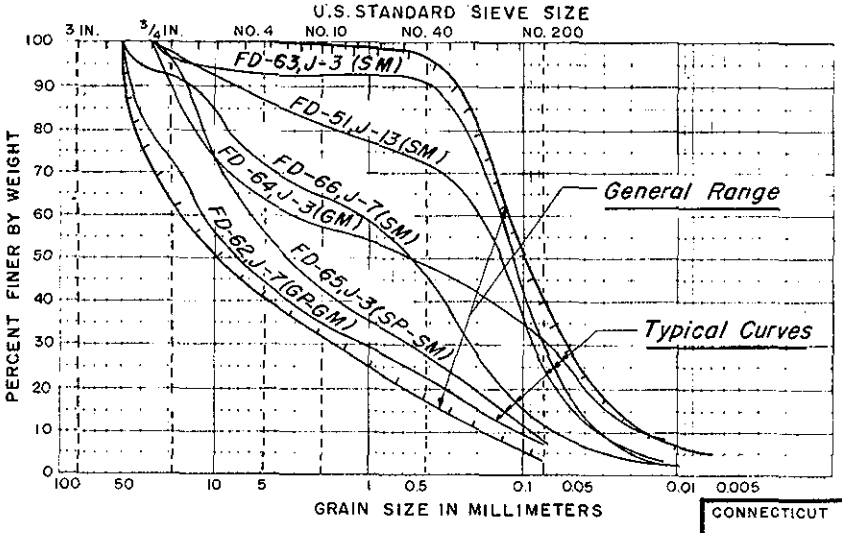
PLATE NO. 9-12



GRADATION RANGE — RIGHT ABUTMENT



GRADATION RANGE — VALLEY DAM



GRADATION RANGE

DIKE

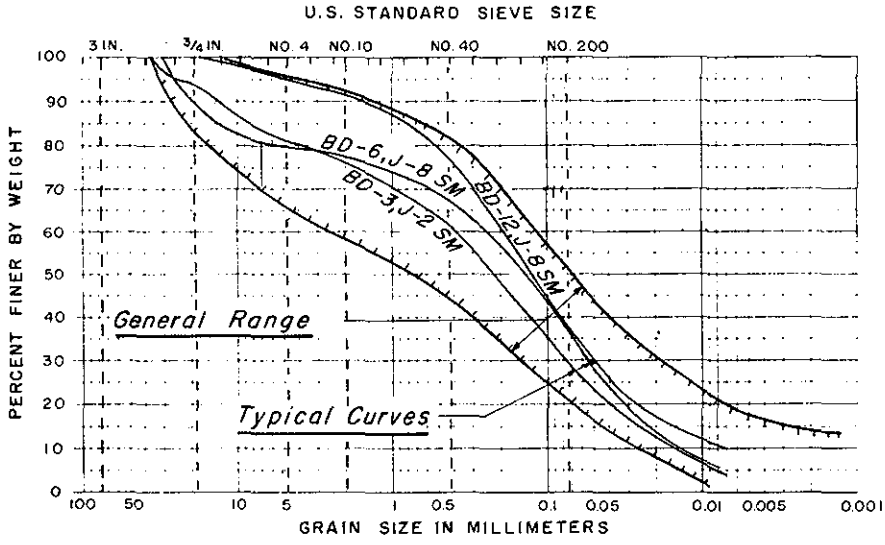
CONNECTICUT RIVER FLOOD CONTROL

COLEBROOK RIVER DAM

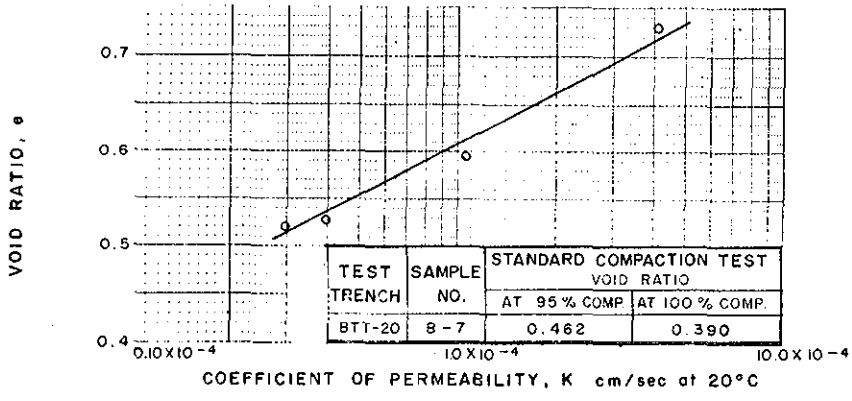
SELECTED TEST DATA
FOUNDATIONS
DAM AND DIKE

W. BR. FARMINGTON RIVER CONN-MASS.

PLATE NO. 9-13

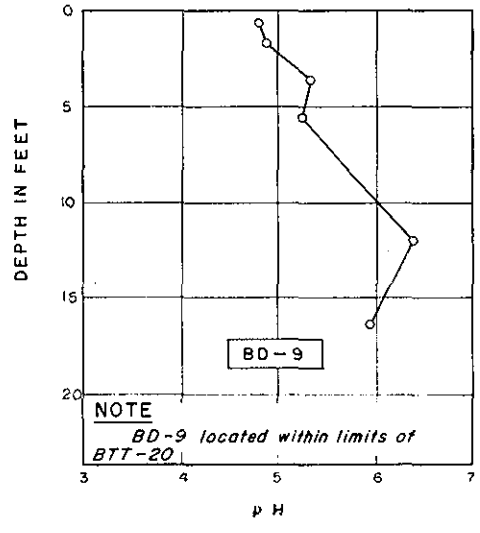


GRADATION RANGE



TEST TRENCH	SAMPLE NO.	STANDARD COMPACTION TEST VOID RATIO AT 95 % COMP.	STANDARD COMPACTION TEST VOID RATIO AT 100 % COMP.
BTT-20	B-7	0.462	0.390

PERMEABILITY VS. VOID RATIO



pH VS DEPTH

CONNECTICUT RIVER FLOOD CONTROL

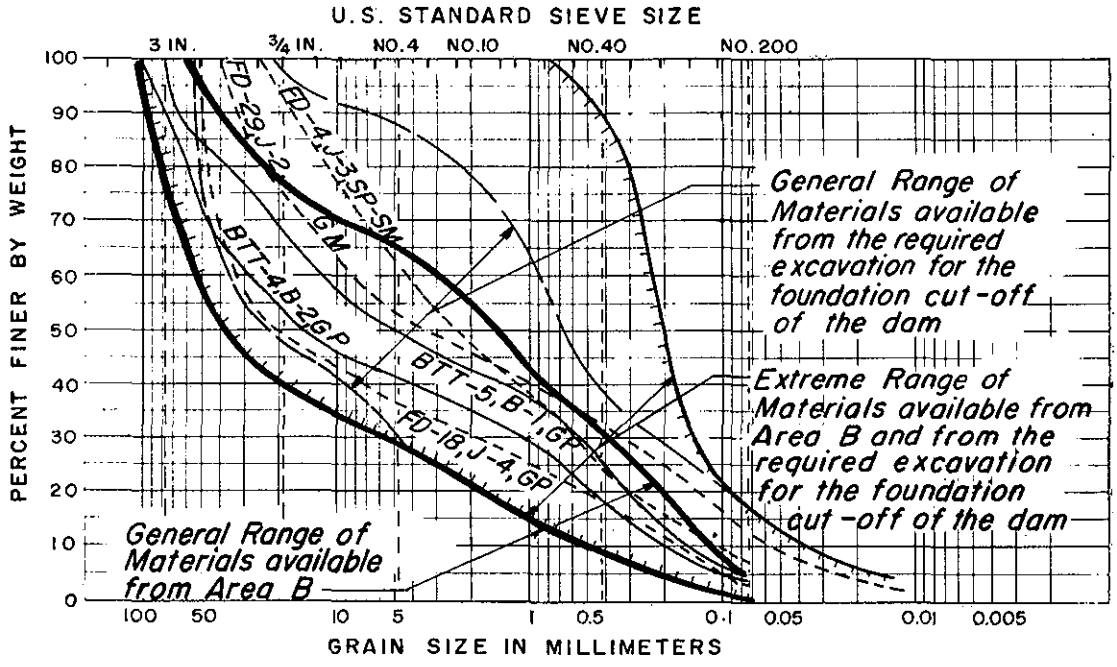
COLEBROOK RIVER DAM

SELECTED TEST DATA

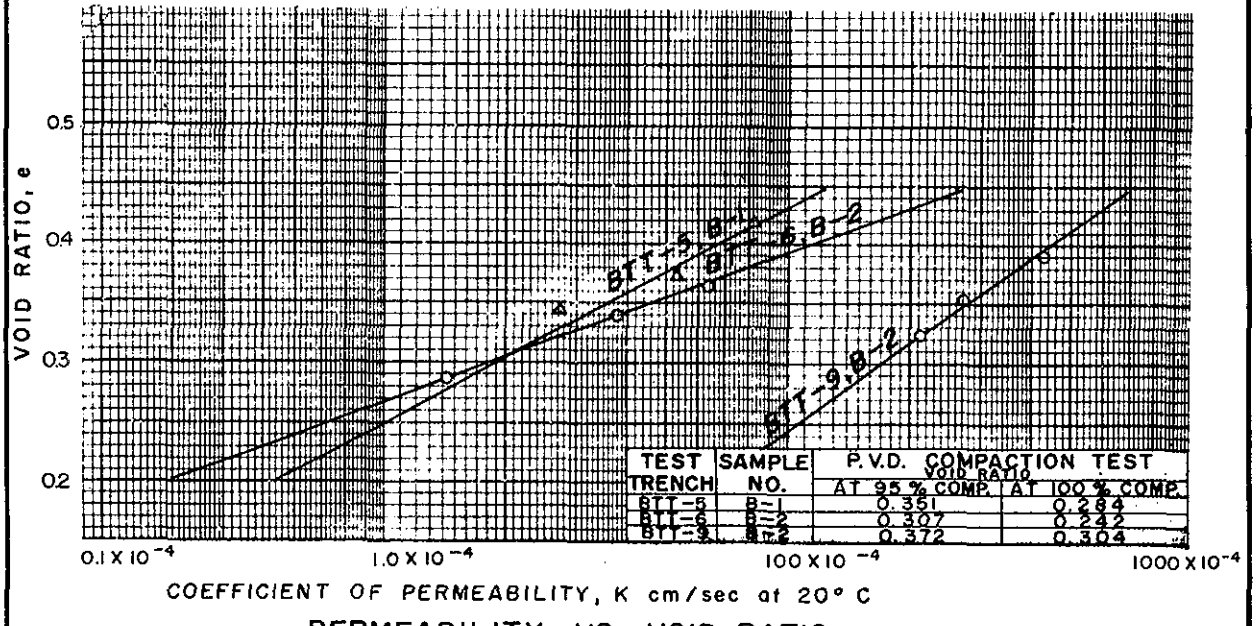
IMPERVIOUS EMBANKMENT MATERIALS

W. BR. FARMINGTON RIVER CONN-MASS

PLATE NO. 9-14



GRADATION RANGE



TEST TRENCH	SAMPLE NO.	P.V.D. COMPACTION TEST VOID RATIO AT 95 % COMP.	AT 100 % COMP.
BTT-5	B-1	0.351	0.284
BTT-6	B-2	0.307	0.242
BTT-9	B-2	0.372	0.304

PERMEABILITY VS. VOID RATIO

NOTES

1. *Permeability test performed on the component of the sample passing the ¾" Sieve.*

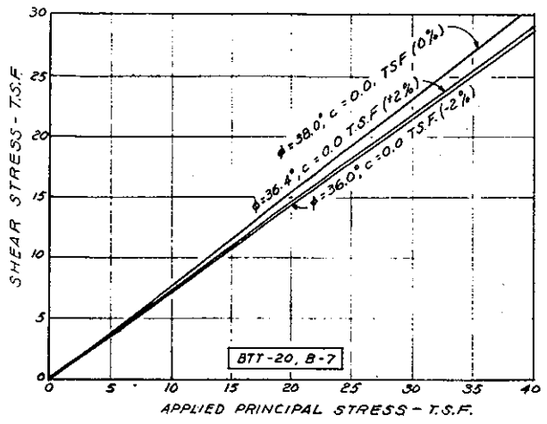
CONNECTICUT RIVER FLOOD CONTROL

COLEBROOK RIVER DAM

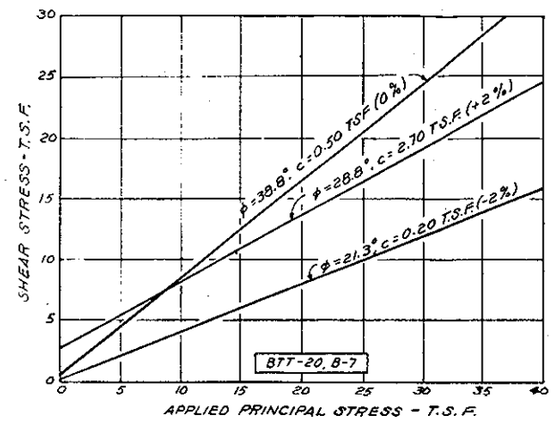
SELECTED TEST DATA
PERVIOUS EMBANKMENT MATERIALS

W. BR. FARMINGTON RIVER CONN-MASS.

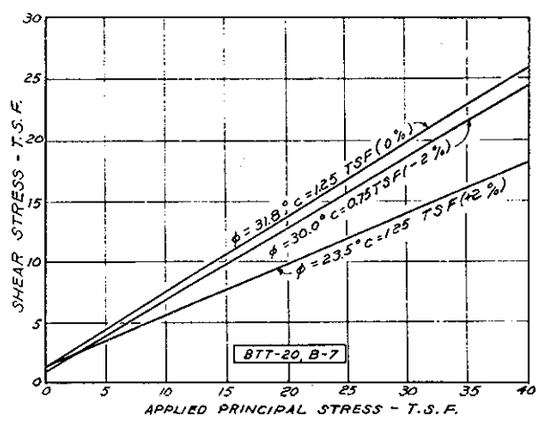
PLATE NO. 9-15



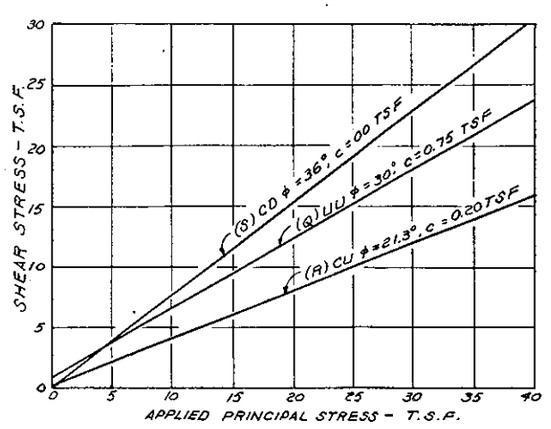
CONSOLIDATED DRAINED DIRECT SHEAR TEST
S TEST



CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST
R TEST

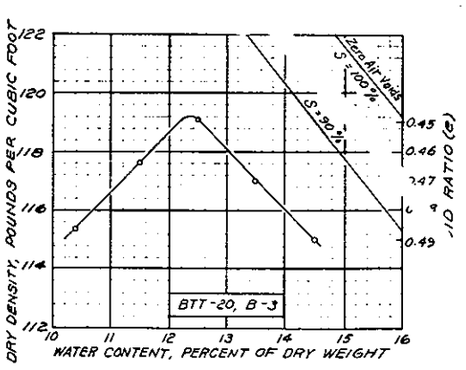


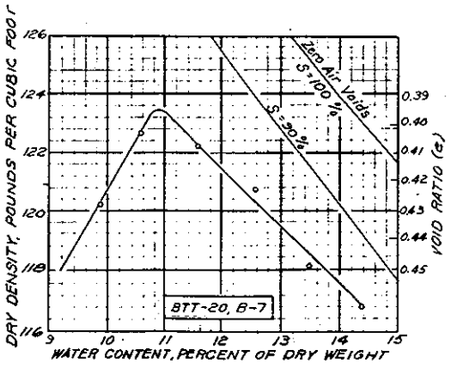
UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST
Q TEST



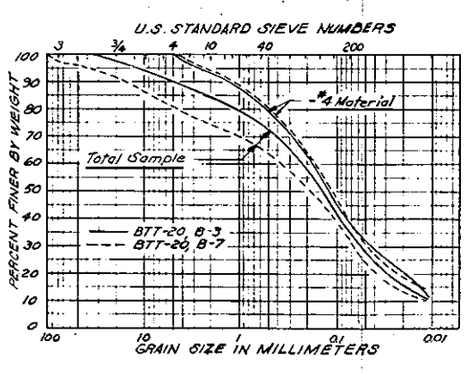
DESIGN SHEAR STRENGTHS

SHEAR STRENGTH CURVES





STANDARD COMPACTION TEST CURVES



GRADATION CURVES, BTT-20, B-3 & B-7

NOTES

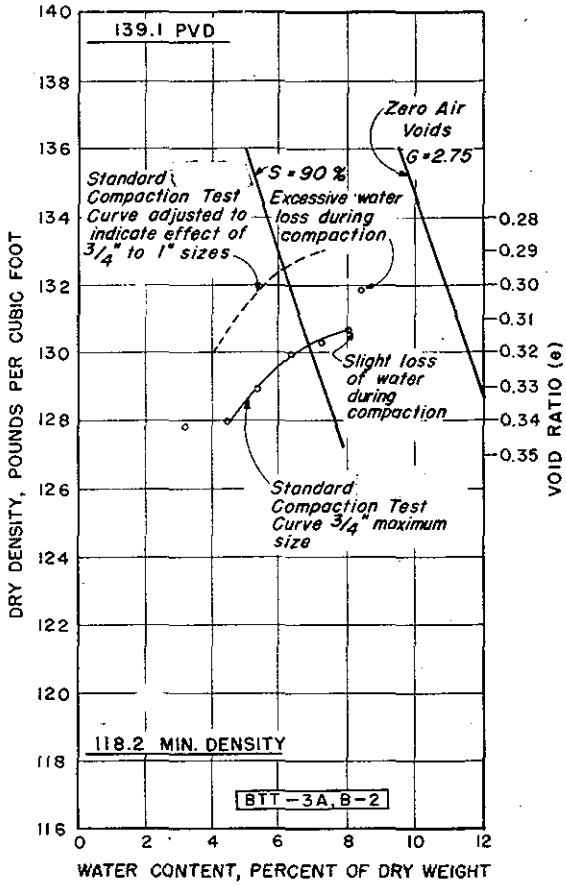
Shear tests performed on component of samples passing No. 4 Sieve.

Figures in parentheses represent differences between molding water content and optimum water content.

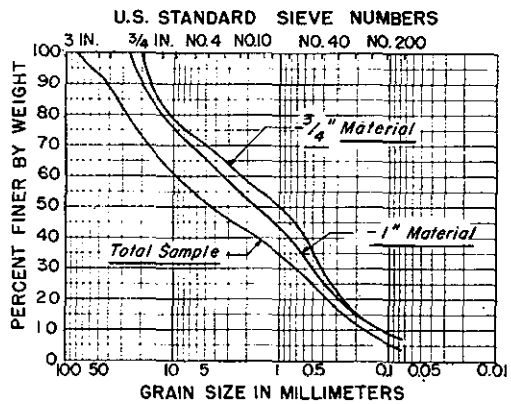
Refer to Appendix B for detailed shear test data.

CONNECTICUT RIVER FLOOD CONTROL
COLEBROOK RIVER DAM
SHEAR STRENGTH AND COMPACTION TEST DATA
IMPERVIOUS EMBANKMENT MATERIALS
W.BR. FARMINGTON RIVER CONN.- MASS.

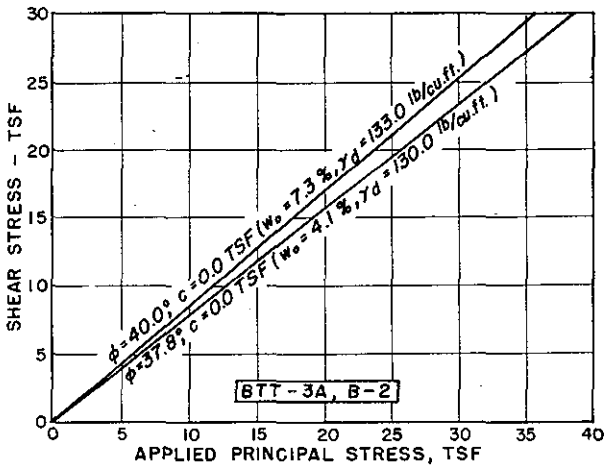
PLATE NO. 9-16



COMPACTION TEST RESULTS



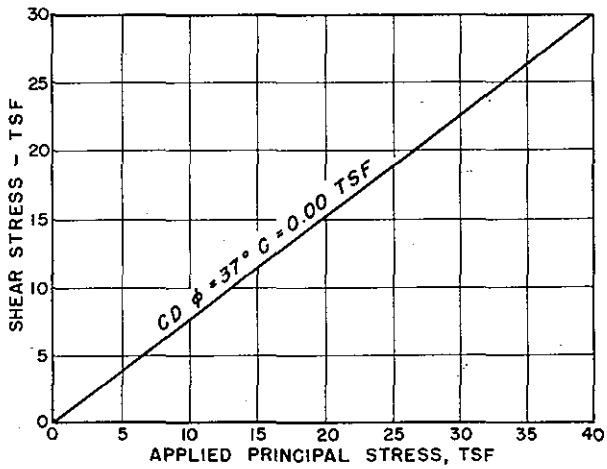
GRADATIONS - BTT-3A, B-2



CONSOLIDATED DRAINED TRIAXIAL COMPRESSION TEST

S TEST

SHEAR STRENGTH CURVES



DESIGN SHEAR STRENGTH

NOTES

Shear tests performed on component of samples passing 1" Sieve

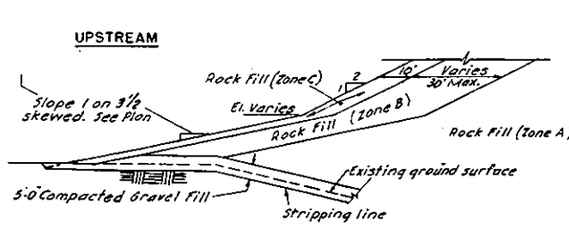
Figures in parentheses on shear test curves are molding water contents and initial dry densities respectively

For detailed shear test data, refer to Appendix B

CONNECTICUT RIVER FLOOD CONTROL
COLEBROOK RIVER DAM
SHEAR STRENGTH AND COMPACTION TEST DATA
PERVIOUS EMBANKMENT MATERIALS
W. BR. FARMINGTON RIVER CONN.-MASS.

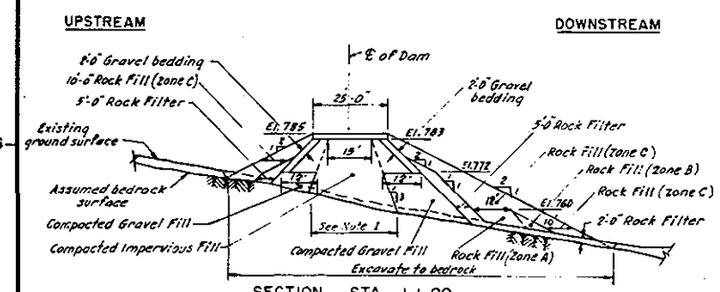
PLATE NO. 9-17

CORPS OF ENGINEERS — U. S. ARMY

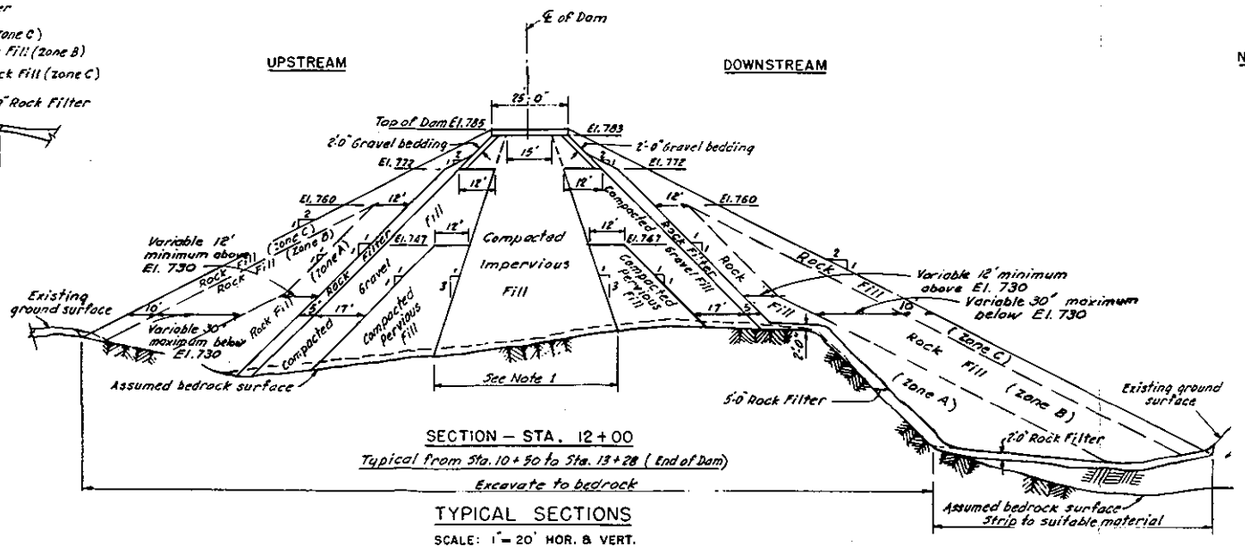


DETAIL "A"
Sta. 3+10 to Sta. 6+90

SECTION — STA. 7+00
Typical from Sta. 1+08 to Sta. 10+50
Except as modified by Detail A



SECTION — STA. 1+00
Typical from Sta. 0+40 (beginning of Dam) to Sta. 1+08



SECTION — STA. 12+00
Typical from Sta. 10+50 to Sta. 13+28 (End of Dam)
Excavate to bedrock

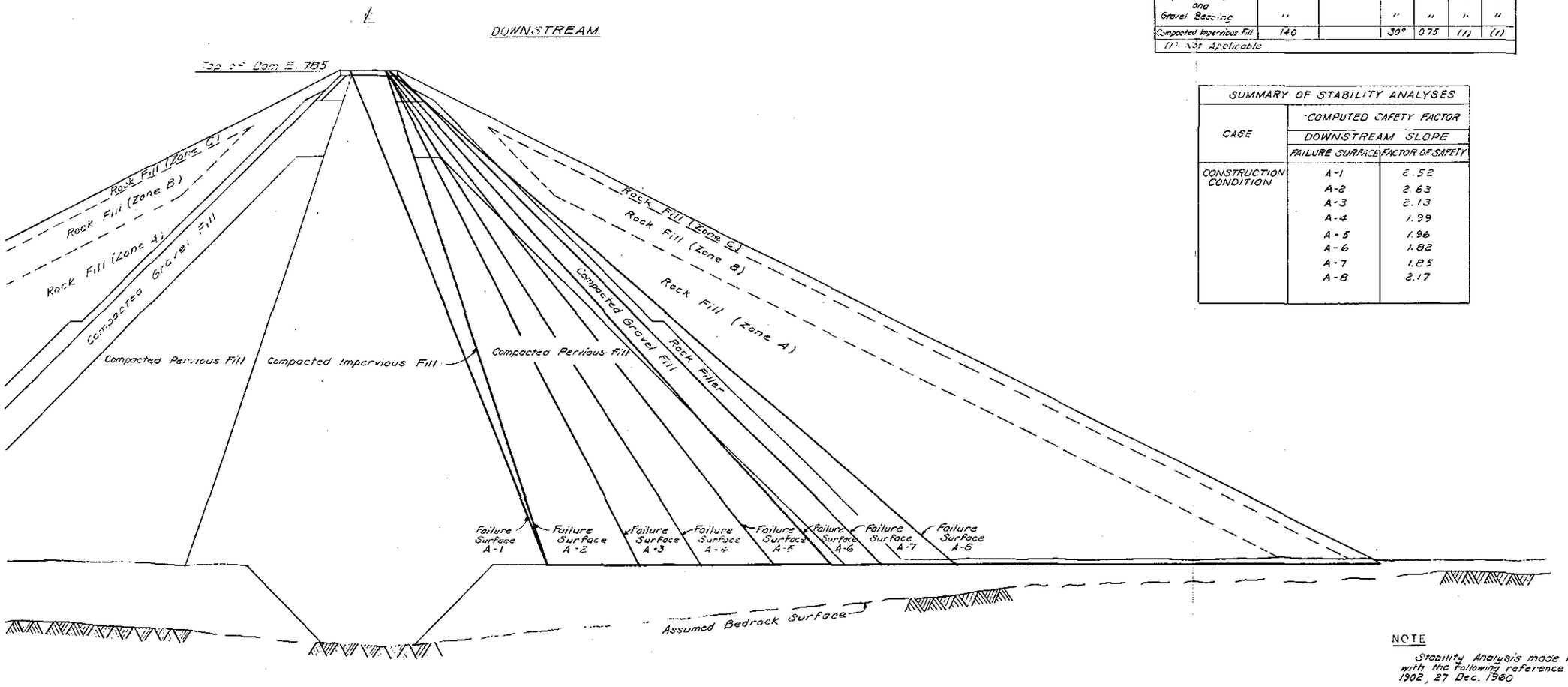
TYPICAL SECTIONS
SCALE: 1" = 20' HOR. & VERT.

NOTES

1. Bedrock surfaces within the limits of the compacted Impervious Fill Sections that are exposed or become exposed during stripping or excavation operations shall be hand cleaned.

CONNECTICUT RIVER FLOOD CONTROL
COLEBROOK RIVER DAM
DAM
EMBANKMENT
TYPICAL SECTIONS
W.BR. FARMINGTON RIVER — CONN.-MASS.

PLATE NO. 9-18



CONSTRUCTION CONDITION - STA. 7 + 00

DESIGN VALUES						
MATERIALS	UNIT WEIGHT (S)RCF		SHEAR STRENGTH			
	γ MOIST	γ DRY	Q(UU)		S(CD)	
			ϕ	C,TSF	ϕ	C,TSF
Rock Fill, (Zone A)		120	(1)	(1)	40°	0
" " (Zone B)		"	"	"	"	"
" " (Zone C)		"	"	"		"
and Rock Filter		"	"	"	"	"
Compacted Pervious Fill	142		"	"	37°	0
Compacted Gravel Fill and Gravel Bedding	"		"	"	"	"
Compacted Impervious Fill	140		30°	0.75	(1)	(1)

(1) Not Applicable

SUMMARY OF STABILITY ANALYSES		
CASE	COMPUTED SAFETY FACTOR	
	DOWNSTREAM SLOPE	
	FAILURE SURFACE	FACTOR OF SAFETY
CONSTRUCTION CONDITION	A-1	2.52
	A-2	2.63
	A-3	2.13
	A-4	1.99
	A-5	1.96
	A-6	1.82
	A-7	1.85
	A-8	2.17

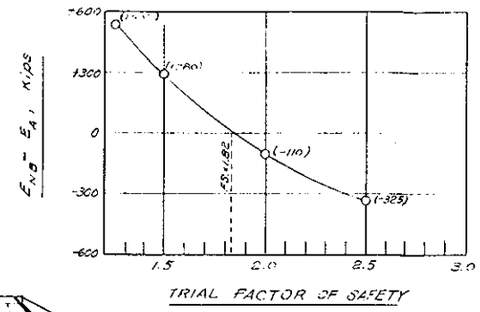
NOTE

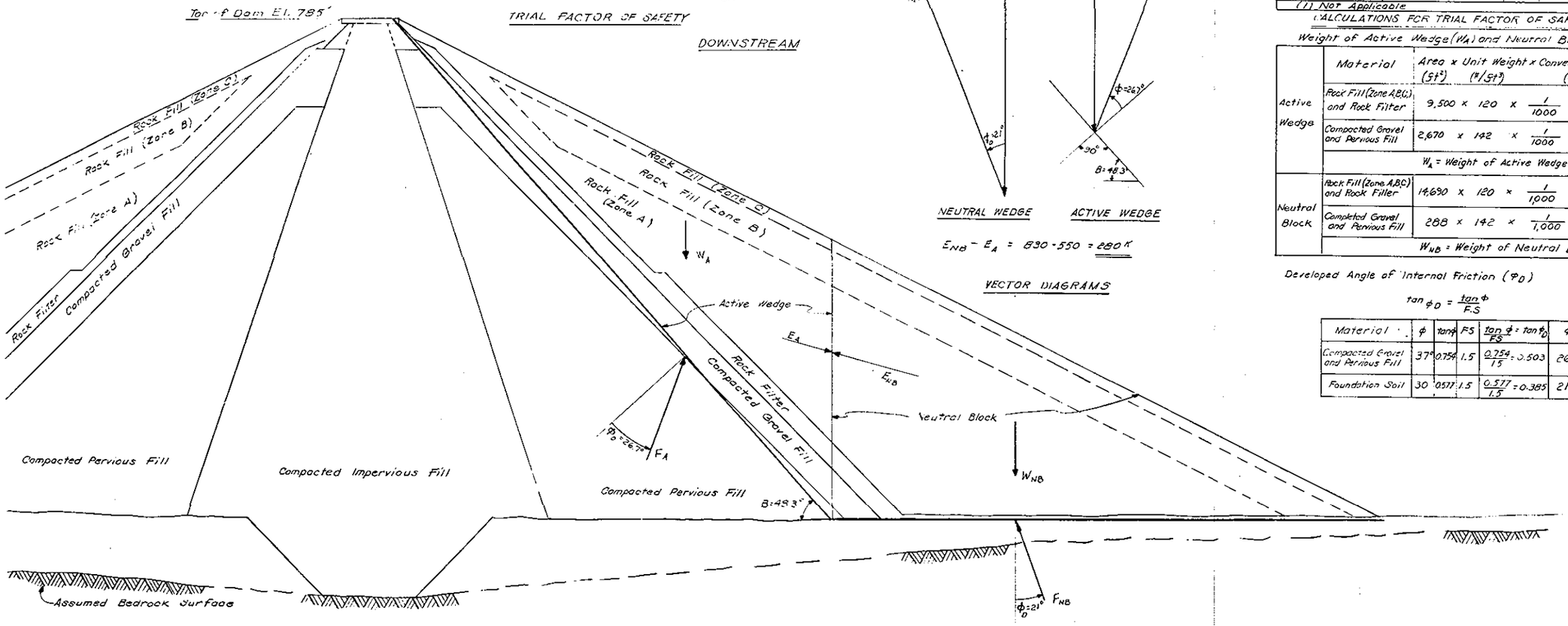
Stability Analysis made in accordance with the following reference EM-1110-2-1902, 27 Dec. 1960

SPACE SCALE
20 0 20 40 ft.

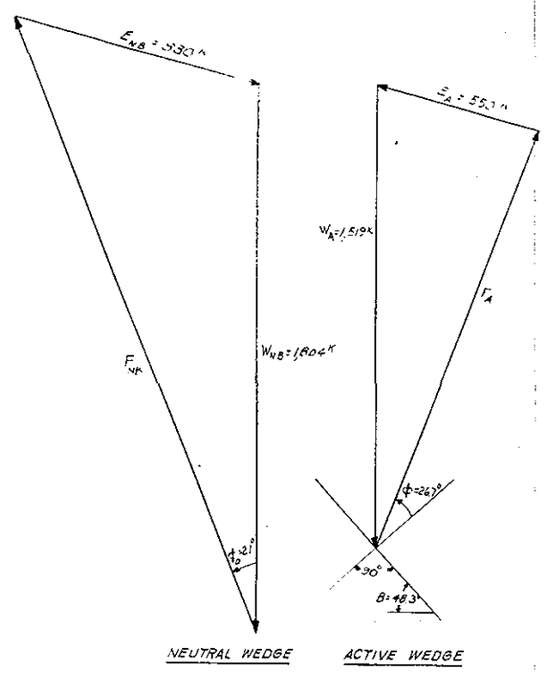
CONNECTICUT RIVER FLOOD CONTROL
COLEBROOK RIVER DAM
DAM
SUMMARY OF STABILITY ANALYSES
CONSTRUCTION CONDITION
W.BR. FARMINGTON RIVER CONN.-MASS.

PLATE NO. 9-19





STATION 7+00



$E_{NB} - E_A$ = 830 - 550 = 280 K

VECTOR DIAGRAMS

DESIGN VALVES						
MATERIALS	UNIT WEIGHT(γ) PCF		SHEAR STRENGTH			
	γ MOIST	γ DRY	Q (UU)		S (CD)	
			φ	C, TSF	φ	C, TSF
Rock Fill (Zone A)		120	(1)	(1)	40°	0
" " (Zone B)		"	"	"	"	"
" " (Zone C) and Rock Filter		"	"	"	"	"
		"	"	"	"	"
Compacted Pervious Fill	142		"	"	37°	0
Compacted Gravel Fill and Gravel Bedding	"		"	"	"	"
	"		"	"	"	"
Compacted Impervious Fill	140		30°	0.75	(1)	(1)
Foundation					30°	"

(1) Not Applicable

CALCULATIONS FOR TRIAL FACTOR OF SAFETY = 1.5

Weight of Active Wedge (W_A) and Neutral Block (W_{NB})

	Material	Area × Unit Weight × Conver Factor = Weight (Ft²) (#/Ft³) (Kips/#) (Kips)
Active Wedge	Rock Fill (Zone A,B,C) and Rock Filter	9,500 × 120 × 1/1000 = 1,140
	Compacted Gravel and Pervious Fill	2,670 × 142 × 1/1000 = 379
		W_A = Weight of Active Wedge = 1,519
Neutral Block	Rock Fill (Zone A,B,C) and Rock Filter	14,690 × 120 × 1/1,000 = 1,763
	Completed Gravel and Pervious Fill	288 × 142 × 1/1,000 = 41
		W_{NB} = Weight of Neutral Block = 1,804

Developed Angle of Internal Friction (ϕ_D)

$$\tan\phi_D = \frac{\tan\phi}{F.S}$$

Material	φ	tanφ	FS	$\frac{\tan\phi}{FS} = \tan\phi_D$	ϕ_D
Compacted Gravel and Pervious Fill	37°	0.754	1.5	$\frac{0.754}{1.5}$ = 0.503	26.7°
Foundation Soil	30	0.577	1.5	$\frac{0.577}{1.5}$ = 0.385	21°

SPACE SCALE

20 0 20 40 Feet

200 0 200 400 Kips

VECTOR SCALE

CONNECTICUT RIVER FLOOD CONTROL

COLEBROOK RIVER DAM

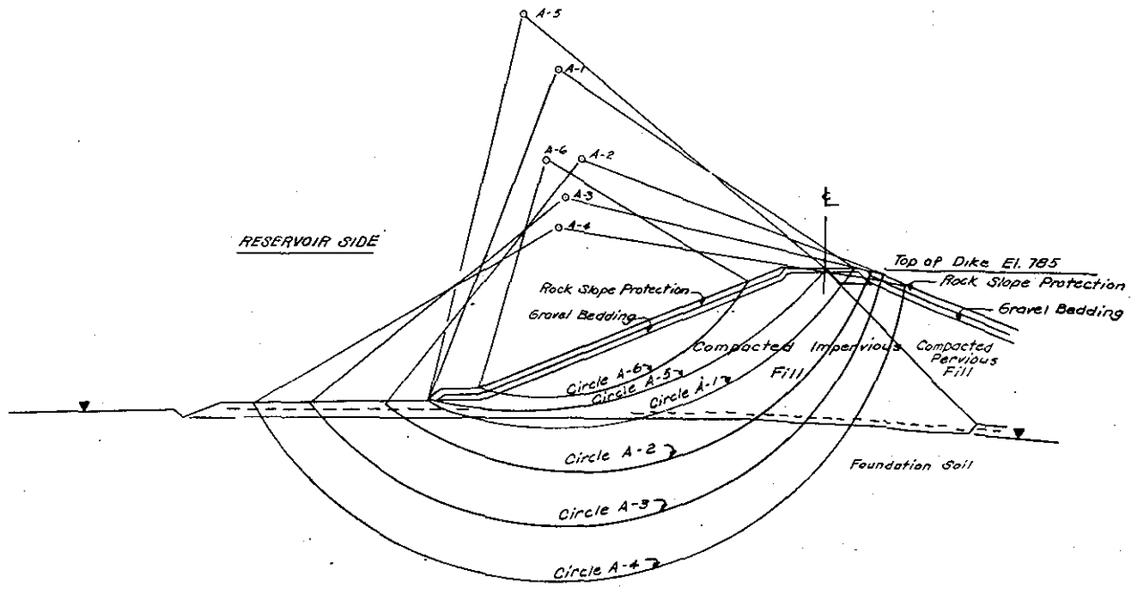
DAM

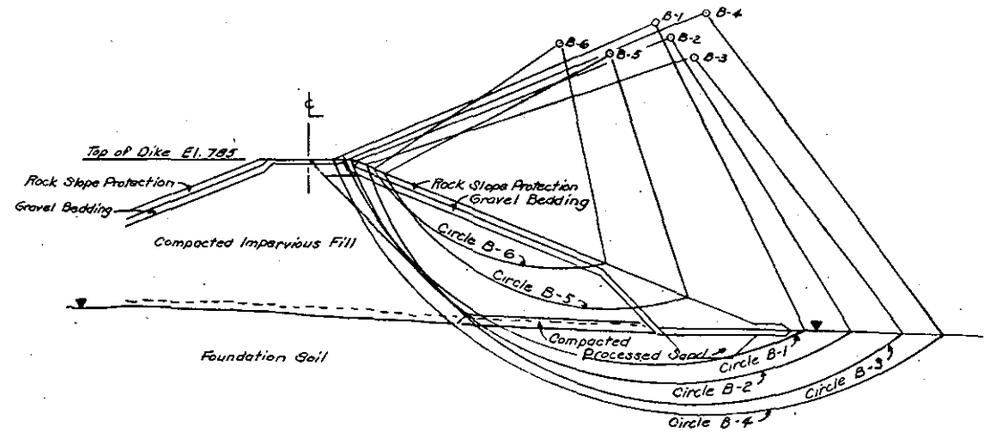
TYPICAL WEDGE ANALYSIS

CONSTRUCTION CONDITION-FAILURE SURFACE A-6

W. BR. FARMINGTON RIVER CONN.-MASS.

PLATE NO. 9-20





CONSTRUCTION CONDITION ANALYSIS - STATION 7 + 20

SUMMARY OF STABILITY ANALYSES

CASE	PORE PRESSURE ASSUMPTION	COMPUTED SAFETY FACTOR — UPSTREAM SLOPE ARC	UPSTREAM SLOPE S.F.	DOWNSTREAM SLOPE ARC	DOWNSTREAM SLOPE S.F.
1. CONSTRUCTION CONDITION Q Strength Sta. 7+20	—	A-1 A-2 A-3 A-4 A-5 A-6	3.14 2.40 2.18 2.62 4.67 5.71	B-1 B-2 B-3 B-4 B-5 B-6	1.70 1.63 1.57 2.06 2.09 2.24
2. OPERATING CONDITION a. Partial Pool Analysis R Strength Sta. 7+20	(1)	C-1 C-2 C-3 C-4 C-5	1.57 (El. 755.5) 1.67 (El. 758.5) 1.91 (El. 738.0) 2.33 (El. 755.5) 1.76 (El. 751.0)		
b. Steady Seepage Analysis Pond 8 Strengths Sta. 7+20	(1)			D-1 D-2 D-3 D-4 D-5 D-6	S = 1.64, R = Not Applicable } 1.64 S = 1.53, R = Not Applicable } 1.53 S = 1.61, R = Not Applicable } 1.61 S = 1.62, R = 1.57 } 1.60 S = 1.61, R = 1.63 } 1.60 S = 1.83, R = 1.83 } 1.84
3. SUDDEN DRAWDOWN a. Strength a. From Maximum Pool (El. 780 to El. 738) Sta. 7+20	(2)	E-1 E-2 E-3 E-4 E-5 E-6	1.09 1.21 1.37 1.74 1.23 1.39		
b. From Spillway Crest (El. 756 to El. 738) Sta. 7+20		E-1 E-2 E-3 E-4 E-5 E-6	1.35 1.44 1.53 2.06 1.49 1.63		

(1) Submerged weights below pool elevation
(2) Saturated weights for driving forces and submerged weights for resisting forces

DESIGN VALUES

MATERIAL	UNIT WEIGHT (γ) PCF — γ SAT	γ MOIST	γ DRY	γ SUB	SHEAR STRENGTH — Q (UU) φ	Q (UU) C, TSF	R (CU) φ	R (CU) C, TSF	S (CD) φ	S (CD) C, TSF
Rock Slope Protection	140	—	120	78					40°	0
Compacted Pervious and Processed Sand Fill and Gravel Bedding	147	142	135	85					37°	0
Compacted Impervious Fill	145	140	130	83	36°	0.75	21.3°	0.20	36°	0
Foundation Soil	147	142	135	85			30°	0	30°	0

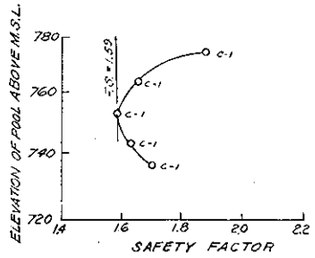
NOTE

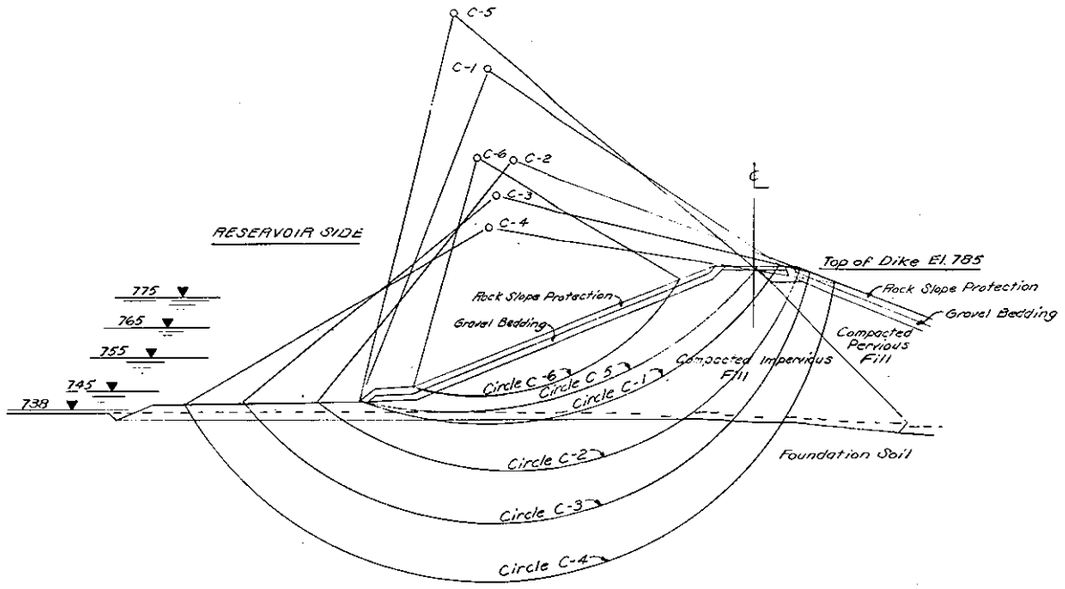
Stability analysis made in accordance with the following reference: EM-1110-2-1902 27 Dec. 1960

SPACE SCALE
20 0 20 40 FT.

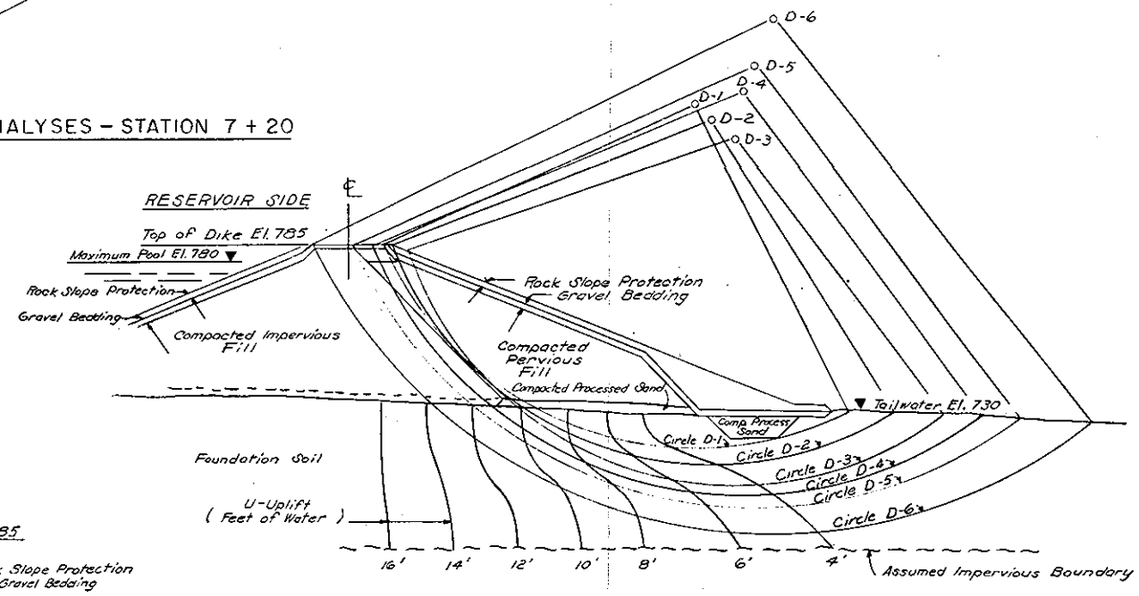
CONNECTICUT RIVER FLOOD CONTROL
COLEBROOK RIVER DAM
DIKE
SUMMARY OF STABILITY ANALYSES
W. BR. FARMINGTON RIVER, CONN.-MASS.

PLATE NO. 9-21

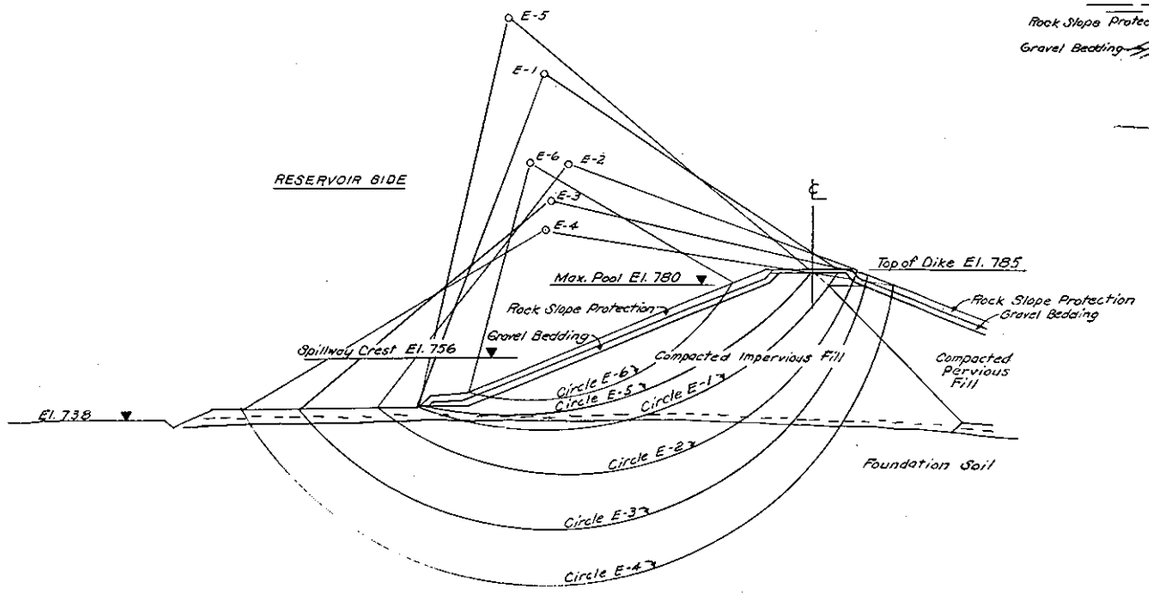




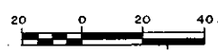
OPERATING CONDITION – PARTIAL POOL ANALYSES – STATION 7 + 20



STEADY SEEPAGE ANALYSES – STATION 7 + 20



SUDDEN DRAWDOWN ANALYSES FROM MAXIMUM POOL AND SPILLWAY CREST – STATION 7 + 20



CONNECTICUT RIVER FLOOD CONTROL

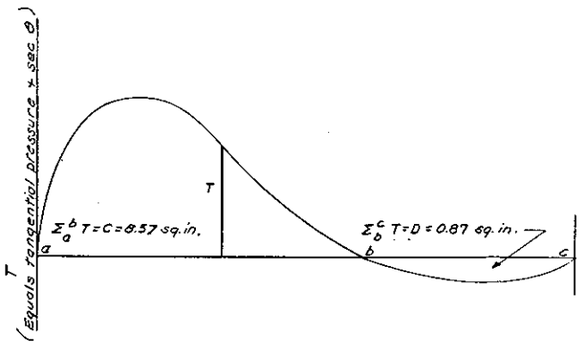
COLEBROOK RIVER DAM

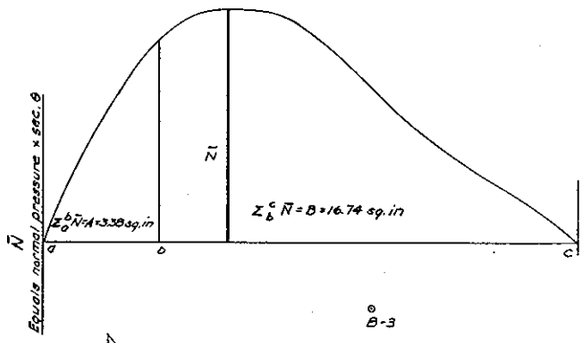
DIKE

SUMMARY OF STABILITY ANALYSES

W. BR. FARMINGTON RIVER CONN-MASS.

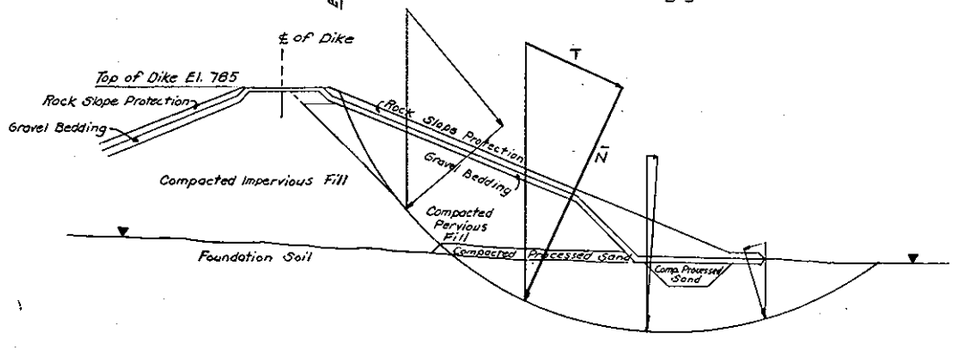
PLATE NO. 9-22





RESERVOIR SIDE

B-3



STATION 7 + 20

WEIGHT VECTOR RATIOS 62.4 lbs. = 1.00		
MATERIALS		VECTOR RATIO (V_R)
Rock Fill and Rock Slope Protection	(Dry)	120 ÷ 62.4 = 1.92
Comp. Pervious, Processed Sand Fill and Gravel Bedding	(Moist)	142 ÷ 62.4 = 2.27
" " " " " " " "	(Sub)	85 ÷ 62.4 = 1.36
Compacted Impervious Fill	(Moist)	140 ÷ 62.4 = 2.24
Foundation Soil	(Sub)	85 ÷ 62.4 = 1.36

RESISTING FORCE = Summation $\bar{N}$ tan ϕ + CL

$\left(K = \text{Vector Scale Conversion Factor} = 20\frac{ft.}{in.} \times 20\frac{ft.}{in.} \times 62.4\frac{lbs.}{cu.ft.} \times \frac{1\ kips}{1000\ lbs.} = 25\frac{kips}{sq.in.}\right)$

$\int_0^C N \tan\phi = [A \tan 37° + B \tan 30°]K$

$= [(3.38)(0.754) + (16.74)(0.577)]25 = 303^K$

$CL = 0 \quad = 0^K$

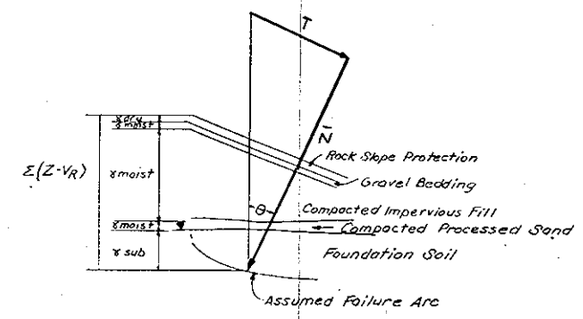
Total Resisting Force / Ft. Dam = 303^K

DRIVING FORCE = Summation Tangential Forces

$\int_0^C T = (C-D)K = (8.57 - 0.87)25.0 = 193^K$

Total Driving Force / Ft. Dam = 193^K

FACTOR OF SAFETY = $\frac{\text{Total Resisting Force / Ft. Dam}}{\text{Total Driving Force / Ft. Dam}} = \frac{303^K}{193} = 1.57$



Z = Vector Distance

γ = Unit Weight of Soil

V_R = Vector Ratio

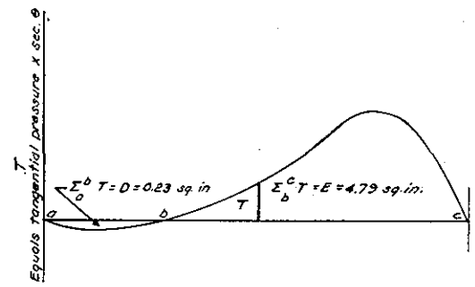
TYPICAL VECTOR DIAGRAM

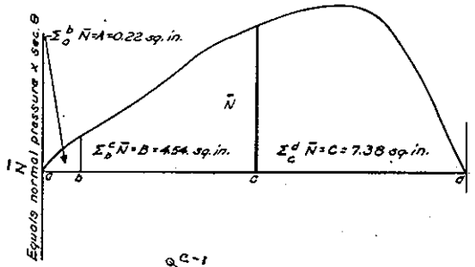
SPACE SCALE
20 0 20 40 FT

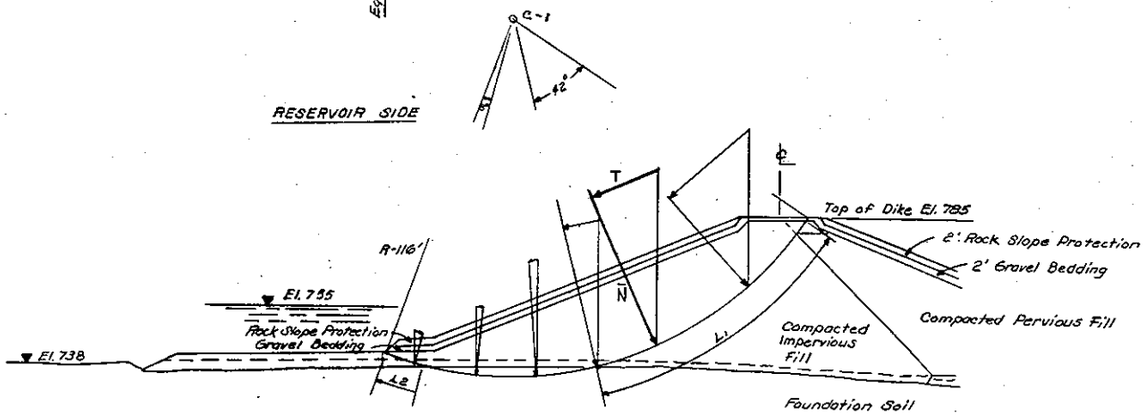
VECTOR SCALE
1250 0 1250 2500 LBS.

CONNECTICUT RIVER FLOOD CONTROL
COLEBROOK RIVER DAM
DIKE
TYPICAL STABILITY ANALYSIS
CONSTRUCTION CONDITION – CIRCLE B-3
W. BR. FARMINGTON RIVER CONN.-MASS.

PLATE NO. 9-23







STATION 7 + 20

WEIGHT VECTOR RATIOS 62.4 lbs = 100	
MATERIAL	VECTOR RATIO (V_R)
Rock Slope Protection (Dry)	120 ÷ 62.4 = 1.92
Rock Slope Protection (Sub)	78 ÷ 62.4 = 1.25
Gravel Bedding (Moist)	142 ÷ 62.4 = 2.27
Gravel Bedding (Sub)	85 ÷ 62.4 = 1.36
Compacted Impervious Fill (Moist)	140 ÷ 62.4 = 2.24
Compacted Impervious Fill (Sub)	83 ÷ 62.4 = 1.33
Foundation Soil (Sub)	85 ÷ 62.4 = 1.35

RESISTING FORCE = Summation $\bar{N}$ tan ϕ + cL

(K = Vector Scale Conversion Factor)

$= 20 \frac{ft}{in} \times 20 \frac{Ft}{in.} \times 62.4 \frac{lbs.}{sq.ft.} \times \frac{1 Kip}{1000 lbs} = 25 \frac{K}{sq.ft}$

$\int_a^d N \tan\phi = [A \tan 21.3° + B \tan 30° + C \tan 21.3°]K$

$= [70.22(0.390) + (4.54)(0.577) + (7.38)(0.390)]25 = 139$

$CL = (C)(L_1 + L_2) = (0.4)(101) = 40$

TOTAL RESISTING FORCE/FT DAM = 179 K

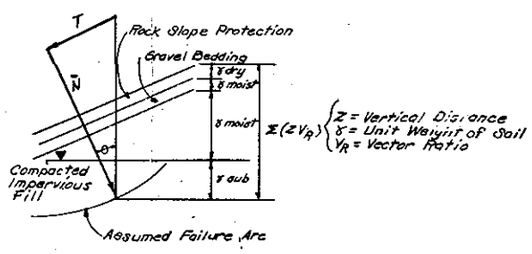
DRIVING FORCE = Summation Tangential Forces

$\int_a^c (D - E) K = (4.79 - 0.23) 25 = (4.56)(25) = 114$

TOTAL DRIVING FORCE / FT DAM = 114 K

FACTOR OF SAFETY

$F.S. = \frac{\text{RESISTING FORCE}}{\text{DRIVING FORCE}} = \frac{179}{114} = 1.57$



TYPICAL VECTOR DIAGRAM

SPACE SCALE
20 0 20 40 FT.
1250 0 1250 2500 LBS.
VECTOR SCALE

CONNECTICUT RIVER FLOOD CONTROL

COLEBROOK RIVER DAM

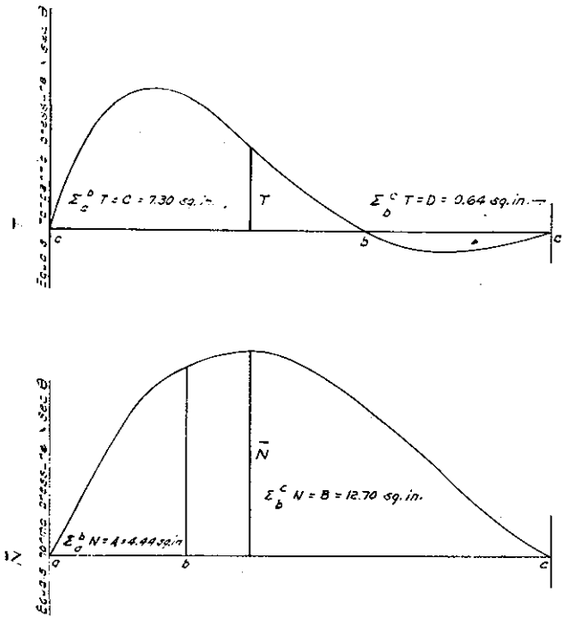
DIKE

TYPICAL STABILITY ANALYSIS

PARTIAL POOL CONDITION – CIRCLE C-1

W. BR. FARMINGTON RIVER CONN.-MASS.

PLATE NO. 9-24



S STRENGTH

RESISTING FORCE Summation $\bar{N}$ tan ϕ

K = Vector Scale Conversion Factor

$$K = 20\frac{ft}{in} \times 20\frac{ft}{in} \times 62.4\frac{lbs.}{sq.ft.} \times \frac{1\,Kip}{1000\,lbs} = 25\frac{Kips}{sq.in.}$$

$$\int_a^c \bar{N} \tan\phi = [A \tan 37° + B \tan 30°]K$$

$$= [(4.38)(0.754) + (12.6)(0.577)]25 = 265^{K}$$

TOTAL RESISTING FORCE / FT. DAM = 265 K

DRIVING FORCE Summation Tangential Forces

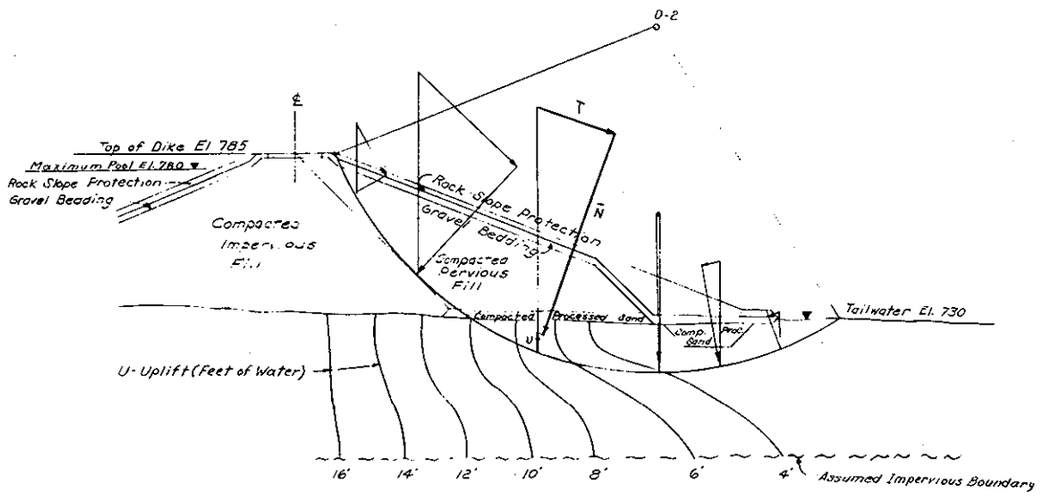
$$\int_a^c T = (C - D)K = (7.30 - 0.64)(25.0) = (6.66)(25) = 166^{K}$$

TOTAL DRIVING FORCE / FT. DAM = 166 K

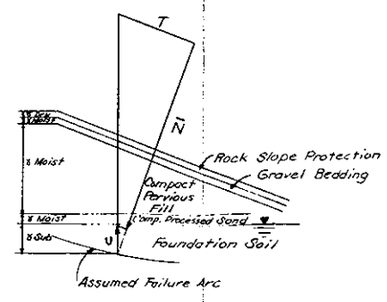
$$\text{FACTOR OF SAFETY} = \frac{\text{RESISTING FORCE}}{\text{DRIVING FORCE}} = \frac{265}{166} = 1.59$$

"R" Strength – Same as above

WEIGHT VECTOR RATIOS 1.24 lbs. = 1.00	
MATERIALS	VECTOR RATIO (VR)
Rock Slope Protection (Dry)	120 ÷ 62.4 = 1.92
Compacted Pervious Processed Sand and Gravel Fill and Gravel Bedding (Moist)	140 ÷ 62.4 = 2.24
Compacted Pervious Processed Sand and Gravel Fill and Gravel Bedding (Sub)	85 ÷ 62.4 = 1.36
Compacted Impervious Fill (Moist)	140 ÷ 62.4 = 2.24
Foundation Soil (Sub)	84 ÷ 62.4 = 1.36



STATION 7 + 20

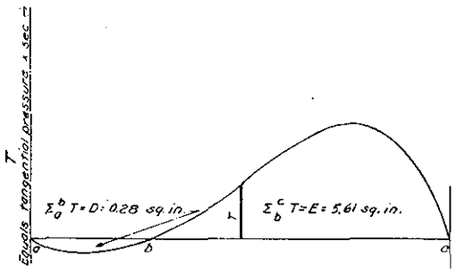


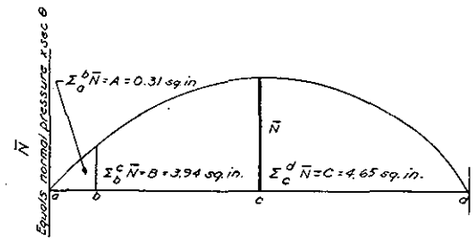
TYPICAL VECTOR DIAGRAM

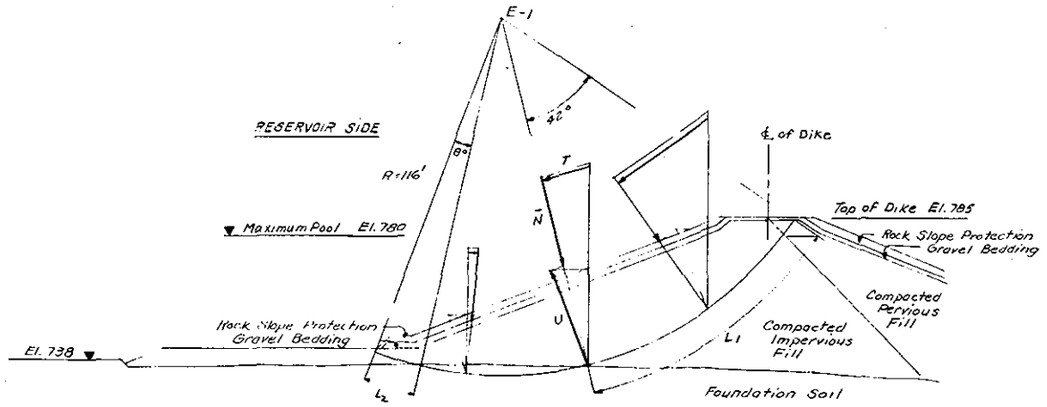
SPACE SCALE
20 0 20 40 FT
1250 0 1250 2500 LBS
VECTOR SCALE

CONNECTICUT RIVER FLOOD CONTROL
COLEBROOK RIVER DAM
DIKE
TYPICAL STABILITY ANALYSIS
STEADY SEEPAGE CONDITION – CIRCLE D-2
W. BR. FARMINGTON RIVER CONN. – MASS.

PLATE NO. 9-25







STA. 7 + 20

RESISTING FORCE = Summation $\bar{N}$ tan ϕ + CL

(K = Vector Scale Conversion Factor
= 20 $\frac{ft}{in}$ x 20 $\frac{ft}{in}$ x 62.4 $\frac{lbs}{Sq.ft}$ x 1 $\frac{Kip}{1000\ lbs}$ = 25 $\frac{Kips}{Sq.in}$)

$\int_a^d \bar{N} \tan \phi = [A \tan 21.3° + B \tan 30° + C \tan 21.3°]K$

$= [(0.31)(0.390) + (3.94)(0.577) + (4.65)(0.390)]25 = 105$

$CL = C(L_1 + L_2) = (0.4)(85+16) = (0.4)(101)$ = 41

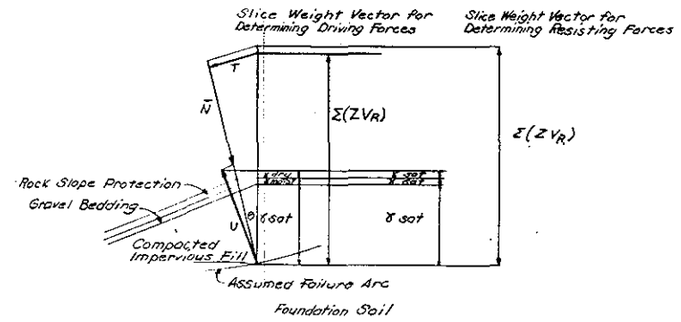
Total Resisting Force/Ft Dam 146

DRIVING FORCE = Summation Tangential Forces

$\int_a^c (E-D)K\ (5.61 - 0.28)\ 25$ = 133

FACTOR OF SAFETY = $\frac{\text{Total Resisting Force/Ft Dam}}{\text{Total Driving Force/Ft Dam}} = \frac{146}{133} =$ 1.09

WEIGHT VECTOR RATIOS 62.4 lbs = 1.00	
MATERIAL	VECTOR RATIO (VR)
Rock Slope Protection (Sat)	140 ÷ 62.4 = 2.24
Rock Slope Protection (Dry)	120 ÷ 62.4 = 1.92
Gravel Bedding (Sat)	147 ÷ 62.4 = 2.36
Gravel Bedding (Moist)	142 ÷ 62.4 = 2.27
Compacted Impervious Fill (Sat)	145 ÷ 62.4 = 2.32
Compacted Impervious Fill (Moist)	140 ÷ 62.4 = 2.24
Foundation Soil (Sat)	147 ÷ 62.4 = 2.36

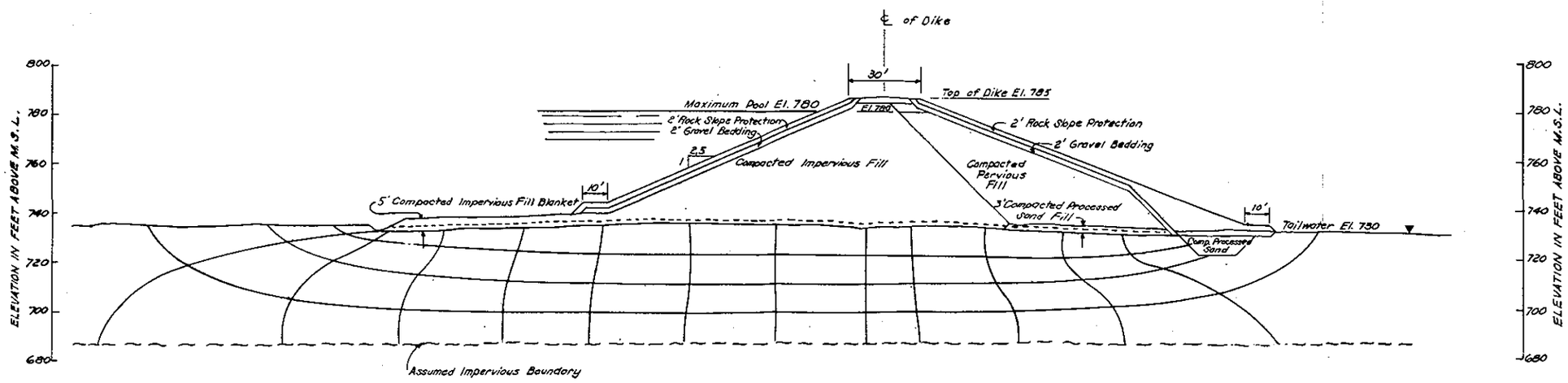


TYPICAL VECTOR DIAGRAM

SPACE SCALE
20 0 20 40 FT.
1250 0 1250 2500 LBS.
VECTOR SCALE

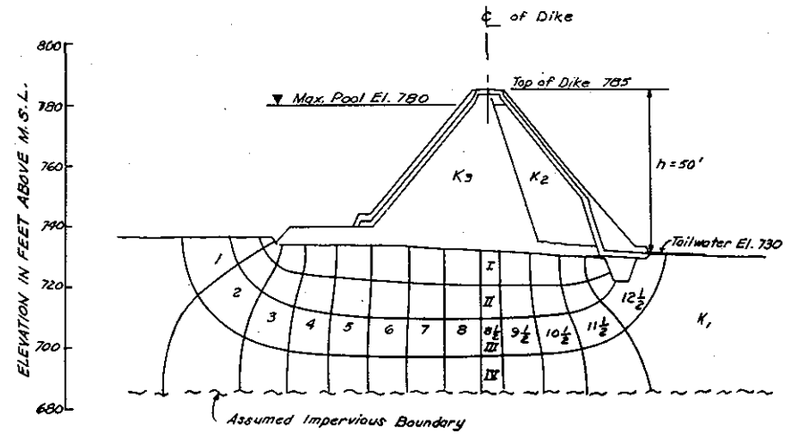
CONNECTICUT RIVER FLOOD CONTROL
COLEBROOK RIVER DAM
DIKE
TYPICAL STABILITY ANALYSIS
SUDDEN DRAWDOWN FROM MAXIMUM POOL
CIRCLE E-1
W. BR. FARMINGTON RIVER CONN.-MASS.

PLATE NO. 9-26



STATION 7 + 20 — NATURAL SCALE SECTION

RESERVOIR SIDE



STATION 7 + 20-TRANSFORMED SECTION

Horizontal Dimensions Reduced by $\sqrt{\frac{K_H}{K_V}} = \sqrt{\frac{1}{9}} = \frac{1}{3}$

$K_2 = 1000$ K_3

$K_2 = 10$ K_1

NOTE

Flow net applicable to stability analysis of failure by shear movement

GRAPHIC SCALE

20 0 20 40 FT.

CONNECTICUT RIVER FLOOD CONTROL

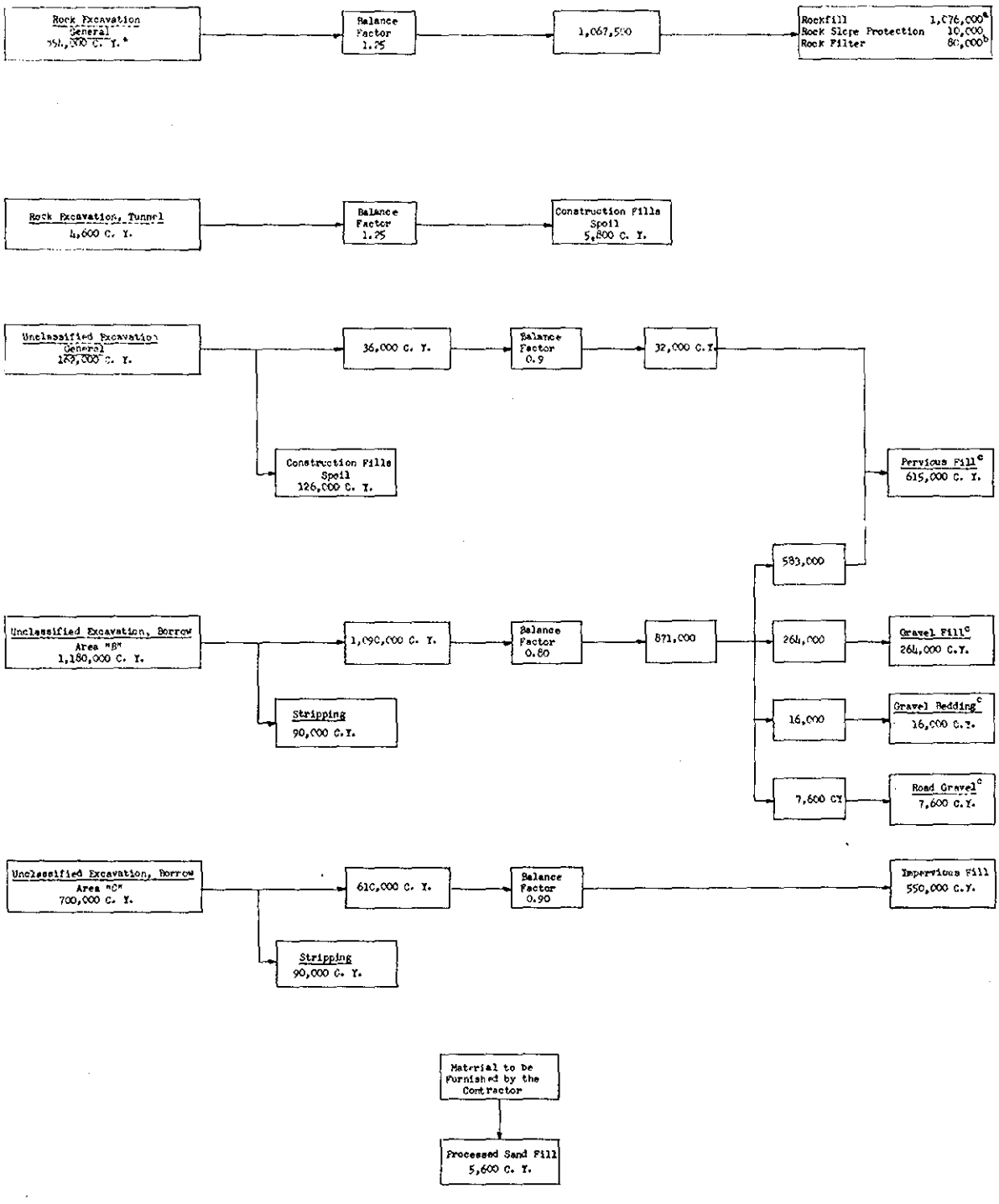
COLEBROOK RIVER DAM

DIKE

STEADY SEEPAGE FLOW NET

W. BR. FARMINGTON RIVER CONN.-MASS.

PLATE NO. 9-27



NOTES

(a) Sections and Quantities to be adjusted when final excavation quantity estimate is completed.

(b) At contractor's option Rock Filter material may be obtained by processing material from Area B.

(c) No separate payment for borrow excavation in Area B.

CONNECTICUT RIVER FLOOD CONTROL

COLEBROOK RIVER DAM

MATERIAL USAGE CHART

(PRELIMINARY)

W. BR. FARMINGTON RIVER CONN.-MASS.

PLATE NO. 9-28

APPENDIX A

SUMMARY OF LABORATORY TEST RESULTS

COLEBROOK RIVER DAM AND RESERVOIR

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA STANDARD		* PVD. LBS/CU FT	NAT. DRY DENSITY LBS/CU FT		OTHER TESTS			
					GRAVEL %	SAND %	FINES %	D_{10} mm.	LL	PL		TOTAL	-NO4	OPT. WATER % DRY WT	MAX. DRY DENS. LBS/CU FT		TOTAL	-NO4	SHEAR	CONSOL	PERM.	
FD-1	649.9	J-2	1.2- 5.0	SM	31	53	16															
		J-4	10.0-15.0	SM	39	47	14															
		J-5	15.0-18.0	SM	25	54	21															
FD-2	594.0	J-1	0.0- 5.0	GP-GM	46	44	10	0.068														
		J-4	10.9-14.5	GP-GM	55	35	10	0.080														
		J-6	19.5-24.0	GP-GM	49	43	8	0.085														
		J-10	29.5-34.5	SM	38	46	16															
FD-4	572.2	J-2	2.0- 3.4	GW	70	28	2	0.650														
		J-5	6.2-11.2	SP-SM	39	55	6	0.110														
		J-6	14.6-19.6	SP-SM	13	80	7	0.093														
		J-8	24.6-29.6	SP-SM	0	90	10	0.075														
FD-5	578.9	J-3	5.0-10.0	GW	63	34	3	0.190														
		J-4	10.0-15.0	GP-GM	53	37	10	0.080														
		J-6	15.0-18.6	GP-GM	54	36	10	0.080														
		J-8	25.0-28.9	GP-GM	59	34	7	0.110														
FD-9	572.5	J-1	0.0- 5.0	GW-GM	63	31	6	0.150														
		J-3R	5.0- 6.2	SM	35	52	13	0.055														
FD-11	575.6	J-2	15.5-20.5	GP-GM	45	46	9	0.085														
		J-3	22.5-26.8	SP-SM	34	56	10	0.075														
FD-14	574.5	J-2	3.0- 4.6	GP	53	44	3	0.200														
		J-4	10.0-15.0	GM	49	37	14	0.043														
		J-6	20.0-25.0	SP-SM	37	52	11	0.065														
FD-19	583.9	J-2	5.0-10.0	SP-SM	34	58	8	0.083														

NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST

Colebrook River Dam

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS		
					GRAVEL %	SAND %	FINES %	D 10 m.m.	LL	PL		TOTAL	-NO4	OPT. WATER % DRY WT	MAX. DRY DENS. LBS/CU FT.	* PVD LBS/CU FT	TOTAL	-NO4	SHEAR	CONSOL.	PERM.
FD-18	595.9	J-2	1.0- 5.0	GP-GM	62	29	9	0.092													
		J-4	10.0-15.0	GP	63	33	4	0.160													
		J-5	15.0-20.0	SP-SM	37	52	11	0.061													
		J-6	20.0-23.1	SM	38	46	16	0.045													
FD-20	586.2	J-1	0.0- 5.0	GP-GM	51	40	9	0.085													
		J-4	10.0-15.0	SP	0	95	5	0.130													
		J-8	25.0-30.0	SP-SM	34	56	10	0.075													
		J-12	35.0-40.0	SP-SM	37	53	10	0.085													
FD-24	580.0	J-1	0.0- 4.5	SM	0	54	46	0.007													
		J-6	10.0-14.1	GP-GM	51	42	7	0.100													
FD-26	577.3	J-2	5.0- 7.5	SP-SM	25	69	6	0.085													
		J-4	10.0-15.0	GP	55	42	3	0.130													
		J-6	15.0-20.0	SP	43	53	4	0.075													
		J-8	21.5-25.0	SM	0	71	29	0.075													
FD-27	575.1	J-4	5.0- 8.9	GP-GM	51	40	9	0.09													
FD-28	570.4	J-3	8.0-13.0	SP-SM	43	46	11	0.070													
		J-4	13.0-17.5	SP-SM	40	49	11	0.065													
		J-7	18.0-23.2	SP-SM	34	55	11	0.065													
FD-29	661.9	J-2	1.1- 5.0	GM	47	40	13	0.056													
		J-4	13.0-16.5	GP	68	28	4	0.210													
FD-33	575.0	J-1	0.0- 5.0	SP-SM	27	66	7	0.120													
		J-3	5.0-10.0	GP	68	28	4	0.180													
		J-5	10.0-11.0	SP-SM	31	63	6	0.098													
		J-7	15.0-20.0	SP-SM	2	90	8	0.081													
		J-9	25.0-30.0	GP-GM	78	16	6	0.240													
		J-10	30.0-35.0	GP-GM	58	36	6	0.120													

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NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST

Colebrook River Dam

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS			
					GRAVEL %	SAND %	FINES %	D_{10} mm.	LL	PL		TOTAL	- NO 4	OPT. WATER % DRY WT	MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	- NO 4	SHEAR	CONSOL.	PERM.	
FD-40	595.8	J-1	0.0- 5.0	SP-SM	0	92	8	0.090														
		J-3	10.0-15.0	GP-GM	55	38	7	0.110														
FD-42	596.0	J-3	5.0-10.0	SP-SM	21	72	7	0.130														
		J-6	15.0-20.0	SP-SM	44	46	10	0.080														
		J-8	20.0-25.0	GW-GM	59	32	9	0.090														
FD-47	662.0	J-2	0.7- 2.5	GP-GM	49	40	11	0.075														
		J-3	2.5- 5.0	SM	38	44	18	0.035														
		J-5R	5.0-10.0	GP-GM	49	42	9	0.070														
		J-7	15.0-17.9	GP-GM	56	36	8	0.092														
FD-48	599.7	J-2	5.0-10.0	GP-GM	64	27	9	0.090														
		J-3	10.0-15.0	GP-GM	64	28	8	0.090														
		J-5	15.0-20.0	SP-SM	35	58	7	0.090														
		J-7	20.0-25.0	GP-GM	41	48	11	0.075														
FD-50	601.7	J-2	1.8- 4.5	SM	17	58	25	0.020														
		J-5	10.0-15.0	SP-SM	31	61	8	0.085														
FD-51	754.8	J-2	2.8- 5.0	SM	42	41	17	0.032														
		J-6	10.0-12.7	SM	36	48	16	0.040														
		J-10	18.0-19.2	SM	9	55	36	0.018														
		J-13	25.0-26.8	SM	13	62	25	0.035														
FD-54	614.0	J-3	10.0-15.0	SP-SM	44	46	10	0.090														
		J-4	31.0-36.0	SP-SM	38	53	9	0.075														

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NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST

Colebrook River Dam

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS			
					GRAVEL %	SAND %	FINES %	D_{10} mm.	LL	PL		TOTAL	-NO4	OPT. WATER % DRY WT	MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	-NO4	SHEAR	CONSOL	PERM.	
FD-60	767.0	J-2	0.8- 3.9	SM	39	47	14	0.050														
		J-9	11.6-15.0	SM	40	45	15	0.030														
		J-15	26.5-27.4	SM	0	61	39	0.028														
FD-62	763.3	J-4	12.0-16.0	GP-GM	57	36	7	0.110														
		J-7	19.3-22.4	GP-GM	55	38	7	0.110														
		J-8	23.6-25.0	GP	68	28	4	0.250														
FD-63	738.1	J-2	5.0-10.0	SP-SM	7	84	9	0.080														
		J-3	10.0-13.9	SM	7	63	30	0.031														
		J-5	20.0-23.2	SM	17	67	16	0.055														
		J-7	25.5-30.0	SP-SM	26	69	5	0.100														
FD-64	766.2	J-3	5.0-10.0	GM	37	31	32	0.017														
		J-6	20.0-21.3	SM	0	74	26	0.035														
FD-65	737.1	J-2	2.3- 5.0	SP-SM								12.5	15.8									
		J-3	5.0-10.0	SP-SM	44	47	9	0.090														
		J-6	20.0-25.0	SM	34	46	20	0.029				9.6	11.2									
FD-66	763.3	J-3	5.0-10.0	SP-SM	44	44	12	0.060				5.1	6.1									
		J-7	21.5-23.7	SP-SM	28	60	12	0.060				7.3	12.3									
FD-67	775.6	J-2	5.0-10.0	GM	44	39	17	0.035				4.8	6.2									
		J-3	10.0-15.0	SM								6.8	8.3									
		J-4	15.9-18.0	SP-SM	37	51	12	0.060														

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NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST

COLEBROOK RIVER DAM

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA			NAT. DRY DENSITY LBS/CUFT		OTHER TESTS		
					GRAVEL %	SAND %	FINES %	D_{10} mm.	LL	PL		TOTAL	- NO4	STANDARD OPT. WATER % DRY WT	STANDARD MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	- NO4	SHEAR	CONSOL.	PERM.
FD-68	741.4	J-4	6.8-10.0	GM	54	27	19	0.025													
		J-7	20.0-25.0	SM	34	51	15	0.050				8.1	10.0								
		J-8	25.0-30.0	GP	52	43	5	0.200													
		J-12	36.7-40.0	SP-SM	24	70	6	0.130													
		J-13	40.0-43.0	SM								13.5	14.4								
		J-15	46.2-50.0	SM	28	58	14	0.060													
FD-69	740.2	J-4	10.0-12.7	SP-SM	45	48	7	0.100													
		J-6	16.0-20.0	GW	75	23	2	0.500													
		J-7	20.0-25.0	SM	0	86	14	0.060													
FIT-1	752.5	B-1	0.2- 3.5	SM	36	44	20														

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FORM 510

* PROVIDENCE VIBRATED DENSITY TEST

COLEBROOK RIVER DAM

SOIL TESTS RESULTS

EXPL NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS		
					GRAVEL %	SAND %	FINES %	D_{10} mm.	LL	PL		TOTAL	-NO4	OPT. WATER % DRY WT	MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	-NO4	SHEAR	CONSOL	PERM.
BD-2	726.9	J-6	10.0-15.0	ML	5	36	59	0.005													
		J-21	46.0-48.0	ML	6	32	62	0.0014													
BD-3	814.1	J-1	1.1- 5.0	SM	8	46	46	0.0031													
		J-2	5.0- 8.4	SM	19	51	30	0.014				9.4	10.7								
		J-3	8.4-10.0	SM	20	50	30	0.022													
		J-4	10.0-15.0	SM	4	53	43	0.0025				8.3	8.8								
		J-5	10.0-15.0	SM													140.6 (1)				
		J-6	15.0-20.0	SM	12	50	38	0.0021				6.0	7.7								
		J-8	22.5-25.0	SM	15	47	38	0.007				9.4	9.7								
		J-11	34.0-35.4	SM								8.2	9.0								
		J-12	35.4-37.2	SM	15	47	38	0.008													
		J-15	42.0-43.4	SM	15	51	34	0.009													
		J-16	43.4-44.0	SM								11.9	13.1								
		J-19	45.4-47.9	SM	9	48	43	0.0075				8.9	9.3								
BD-4	846.0	J-2	2.2- 5.0	SM	21	54	25	0.021													
		J-3	5.0-10.0	SM	22	49	29	0.014				6.9	7.9								
		J-4	10.0-15.0	SM	27	52	21	0.030													
		J-5	15.0-19.1	SM	25	53	22	0.025				6.0	7.4								
		J-7	23.0-25.0	SM								9.1	12.1								
		J-8	25.0-26.5	SM	32	42	26	0.013													
BD-5	844.5	J-1	0.6- 5.0	SM	32	46	22	0.022				14.0	18.2								
		J-2	5.0-10.0	SM	29	50	21	0.030				6.7	9.9								
		J-3	10.0-14.1	ML	0	32	68	0.036	Non Plastic			12.0	13.4								
BD-6	903.7	J-4	5.0-10.0	SM	16	54	30	0.015													
		J-5	5.0-10.0	SM								8.4	9.5								

(1) Test performed on plug sample approximately 1 year after sample taken

NED FORM JUL 63 510 * PROVIDENCE VIBRATED DENSITY TEST

Colebrook River Dam

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA STANDARD		* PVD LBS/CU FT	NAT. DRY DENSITY LBS/CU FT		OTHER TESTS			pH
					GRAVEL %	SAND %	FINES %	D_{10} mm.	LL.	PL		TOTAL	-NO4	OPT. WATER % DRY WT	MAX. DRY DENS. LBS/CU FT		TOTAL	-NO4	SHEAR	CONSOL	PERM.	
BD-6	(Continued)																					
		J-6	10.0-15.0	SM	13	57	30	0.020														
		J-7	10.0-15.0	SM								5.7	7.5									
		J-8	15.0-17.6	SM	20	42	38	0.014														
BD-7	983.7	J-3	5.0-10.0	ML-CL	9	37	54		21	15		7.3	8.2									
		J-5	10.0-13.5	SM-SC	6	45	49	0.006														
		J-7	14.6-18.0	SM-SC	7	39	54	0.003														
		J-8	18.0-20.0	ML-CL	6	41	53	0.0023	24	17		8.9	9.4									
BD-8	1040.7	J-3	1.5- 5.0	SM	4	47	49	0.0038														
		J-4	5.0-10.0	ML	7	42	51	0.0038	Non Plastic													
		J-5	5.0-10.0	ML								12.1	12.5									
		J-7	10.0-13.2	SM	8	56	36	0.007				9.7	10.3									
		J-9	15.0-17.0	SM	15	37	48	0.004	19	16												
		J-11	24.2-26.5	SM	24	39	37	0.014														
BD-9	1043.4	J-1	0.2- 1.0	ML																		4.8
		J-2	1.0- 2.3	ML																		4.9
		J-3	2.3- 5.0	SM	10	49	41	0.0075														5.5
		J-4	2.3- 5.0	SM								11.5	12.3									5.2
		J-5	5.0- 6.0	SM																		5.2
		J-6	9.5-14.5	SM	7	50	43	0.0055										(1)				6.5
		J-7	9.5-14.5	SM								7.4	7.6				134.1					6.3
		J-8	15.0-18.0	SM	12	51	37	0.011														5.7
		J-9	15.0-18.0	SM								9.4	10.0									6.2
BD-10	750.0	J-2	1.5- 5.0	SM	35	47	18	0.040														
		J-6	10.0-15.0	SM	33	45	22	0.021														

(1) Test performed on plug sample approximately 1 year after sample taken

NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA [illegible]		* PVD LBS/CU FT	NAT. DRY DENSITY LBS/CUFT		OTHER TESTS		
					GRAVEL %	SAND %	FINES %	D_{10} mm.	LL	PL		TOTAL	-NO4	OPT. WATER % DRY WT	MAX. DRY DENS. LBS/CU FT		TOTAL	-NO4	SHEAR	CONSOL.	PERM.
BD-11	878.4	J-3	1.5- 5.0	SM								11.6	12.4								
		J-4	5.0-10.0	SM	19	49	32	0.010													
		J-5	5.0-10.0	SM								10.0	11.0				131.6	(1)			
		J-8	15.0-19.0	SM	26	39	35	0.013													
		J-9	15.0-19.0	SM								9.2	9.6				136.5	(1)			
		J-11	22.5-24.6	ML	0	39	61	0.005													
		J-15	30.0-31.6	SM	17	48	35	0.014													
		J-16	30.0-31.6	SM													127.7	(1)			
BD-12	908.0	J-2	1.4- 5.0	SM								13.6	15.7								
		J-3	5.0-10.0	SM	29	51	20	0.028													
		J-4	5.0-10.0	SM								9.5	14.1								
		J-5	10.0-13.8	SM	12	60	28	0.018				12.3	14.4								
		J-8	15.0-20.6	SM	6	58	36	0.065									135.2	(1)			
		J-9	15.0-20.0	SM								11.3	11.6								
BD-13	957.0	J-2	1.3- 5.0	SM								8.4	9.5								
		J-3	5.0-10.0	SM	19	46	35	0.091													
		J-4R	5.0-10.0	SM								8.3	10.7								
		J-9	21.0-23.0	SM	6	50	44	0.0055													
		J-10	21.0-23.0	SM								8.6	9.9								
		J-13	29.0-30.0	SM								8.4	9.6								
		J-14	30.0-31.6	SM	11	44	45	0.008													

(1) Test performed on plug sample approximately 1 year after sample taken

NED FORM 510 JUL 63 * PROVIDENCE VIBRATED DENSITY TEST

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA			NAT. DRY DENSITY LBS/CU FT		OTHER TESTS			
					GRAVEL %	SAND %	FINES %	D_{10} mm.	LL	PL		TOTAL	-NO4	STANDARD OPT. WATER % DRY WT	STANDARD MAX. DRY DENS. LBS/CU FT	* PVD LBS/CU FT	TOTAL	-NO4	SHEAR	CONSOL.	PERM.	
BTT-3	660.8	B-1	0.0-10.0	GP	48	48	4	0.180														
		B-2	10.0-19.0	GP	54	42	4	0.180														
BTT-3A	660±	B-1	3.0- 6.0	GP	57	40	3	0.300														
		B-2	6.0- 9.0	GP	54	42	4	0.170						8.1	130.6	139.1			X			(2)
		B-3	9.0-12.0	GP	49	47	4	0.170														
		B-4	12.0-19.0	SP-SM	44	49	7	0.095														
BTT-4	625.4	B-2	3.2- 5.8	GP	60	37	3	0.200														
		B-4	9.6-16.5	GP	55	41	4	0.150														
		B-5	16.5-20.0	SP-SM	0	95	5	0.090														
BTT-5	630.5	B-1	1.3- 8.0	GP	51	45	4	0.170								133.7					X	
		B-4	15.0-20.0	GP	58	40	2	0.400														
BTT-6	618.1	B-1	1.6- 6.8	GP	52	44	4	0.140														
		B-2	6.8-12.0	GP	57	39	4	0.250								138.2					X	
		B-3	12.0-16.0	GP	59	39	2	0.460														
BTT-7	622.3	B-2	1.8-7.0	GP	66	30	4	0.250														
		B-3	7.0-12.0	GP	50	48	2	0.330														
		B-5	17.0-21.5	SW	33	62	5	0.250														
BTT-8	624.7	B-1	1.0- 5.0	GW	66	30	4	0.300														
		B-3	9.0-13.3	GW	66	31	3	0.310														
BTT-9	617.3	B-1	2.8-10.0	GP	55	43	2	0.290														
		B-2	10.0-17.9	GP	56	42	2	0.380								131.7					X	
		B-4	20.0-23.5	SP	1	98	1	0.310														
		(2)	Minimum density test indicated a minimum dry density of 118.3 P.C.F.																			

NED FORM JUL 69 510

* PROVIDENCE VIBRATED DENSITY TEST

SOIL TESTS RESULTS

EXPL. NO.	TOP ELEV. FT.	SAMPLE NO.	DEPTH FT.	SOIL SYMBOL	MECHANICAL ANALYSIS				ATT. LIMITS		SPECIFIC GRAVITY	NAT. WATER CONTENT % DRY WT		COMPACTION DATA STANDARD		* PVD LBS/CU FT	NAT. DRY DENSITY LBS/CU FT		OTHER TESTS			
					GRAVEL %	SAND %	FINES %	D_{10} mm.	LL	PL		TOTAL	- NO4	OPT. WATER % DRY WT	MAX. DRY DENS LBS/CU FT		TOTAL	- NO4	SHEAR	CONSOL.	PERM.	
BTT-10	625.9	B-1	1.3- 6.0	GP	56	42	2	0.420														
		B-4	16.0-21.0	SP	1	92	7	0.160														
BTT-12	637.6	B-1	2.2- 4.1	GP	58	42	0	0.340														
		B-2	4.1- 8.5	GP	59	39	2	0.350														
		B-3	8.5-21.0	GP	60	39	1	0.290														
BTT-14	628.3	B-1	2.1- 6.7	GP	58	42	0	0.120														
		B-2	6.7-13.9	GP	54	42	4	0.220														
BTT-16	632.3	B-1	1.4- 7.0	GP	57	40	3	0.180														
		B-2	7.0-13.0	GP	72	25	3	0.280														
		B-3	13.0-19.0	GW	71	27	2	0.400														
BTT-20	1040±	J-2R	2.5- 5.0	SM								9.0	10.4									
		B-3	2.5- 5.0	SM										12.4	119.2							
		J-4R	5.0- 7.0	SM								7.4	8.7									
		J-6R	7.0- 9.0	SM								6.0	8.9									
		B-7	7.0- 9.0	SM										10.9	123.5				X		X	

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NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST

COLEBROOK RIVER DAM

APPENDIX B

DETAILED COMPACTION AND SHEAR TEST DATA

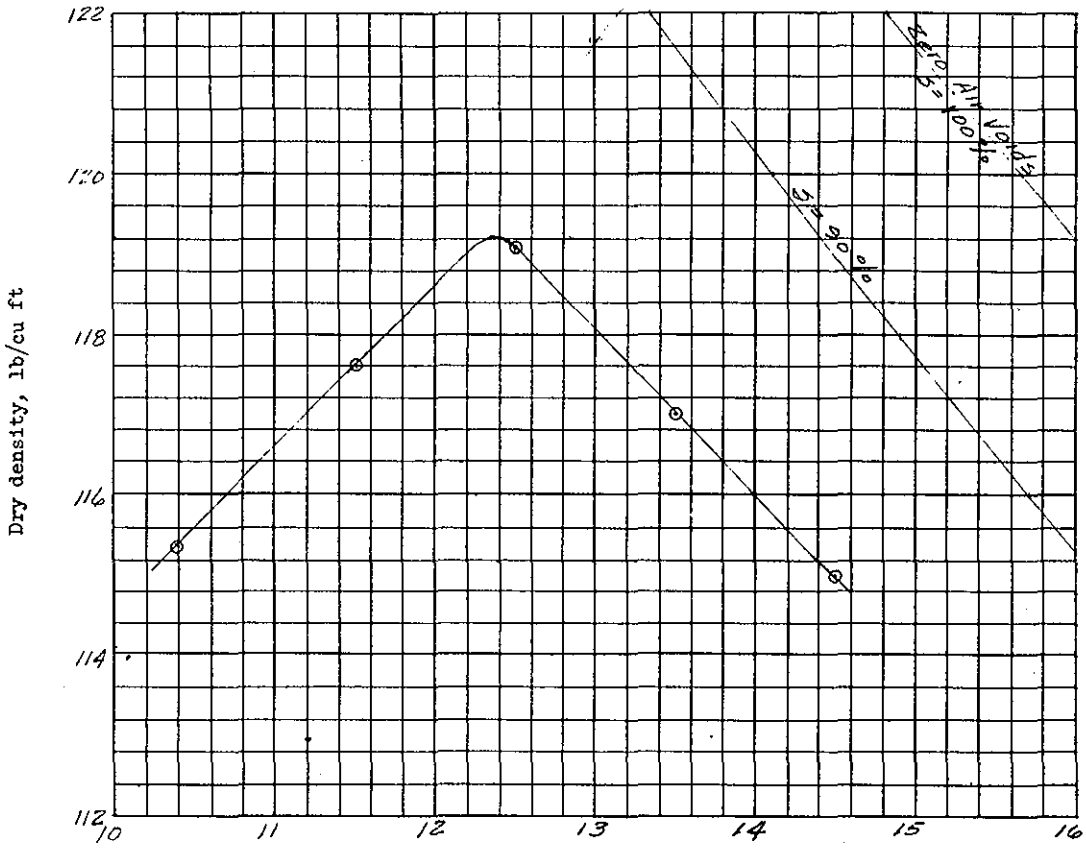
IMPERVIOUS AND PERVIOUS EMBANKMENT MATERIALS

COLEBROOK RIVER DAM AND RESERVOIR

PLATE NO.	TITLE
	IMPERVIOUS EMBANKMENT MATERIALS
B-1	Compaction Test Report BTT-20, B-3
B-2	Compaction Test Report BTT-20, B-7
(B-3 to B-8)	Triaxial Compression Test Reports BTT-20, B-7
B-3	Q Test - Optimum - 2%
B-4	Q Test - Optimum
B-5	Q Test - Optimum + 2%
B-6	R Test - Optimum - 2%
B-7	R Test - Optimum
B-8	R Test - Optimum + 2%
(B-9 to B-11)	Direct Shear Test Reports, BTT-20, B-7
B-9	S Test - Optimum - 2%
B-10	S Test - Optimum
B-11	S Test - Optimum + 2%

PERVIOUS EMBANKMENT MATERIALS

PLATE NO.	TITLE
B-12	Compaction Test Report BTT-3A, B-2
(B-13 to B-14)	Triaxial Compression Test Reports, BTT-3A, B-2
B-13	S Test - w_o = 4.1, γ_d = 130
B-14	S Test - w_o = 7.3, γ_d = 133



Standard compaction test

25 blows per each of 3 layers, with 5.5 lb rammer and

12 inch drop. 4.0 inch diameter mold

Sample No.	~~Elev or~~ Depth	Classification	G	LL	PL	% > No. 4	% > 3/4 in.
B-3	2.5'-5.0'	gravelly silty SAND (SM)	2.75 (assum)				

Sample No.	B-3			
Natural water content in per cent				
Optimum water content in per cent	12.4			
Max dry density in lb/cu ft	119.2			

Remarks: Test performed on Illinois No. 9 Material

Project: Colebrook Dam Conn.

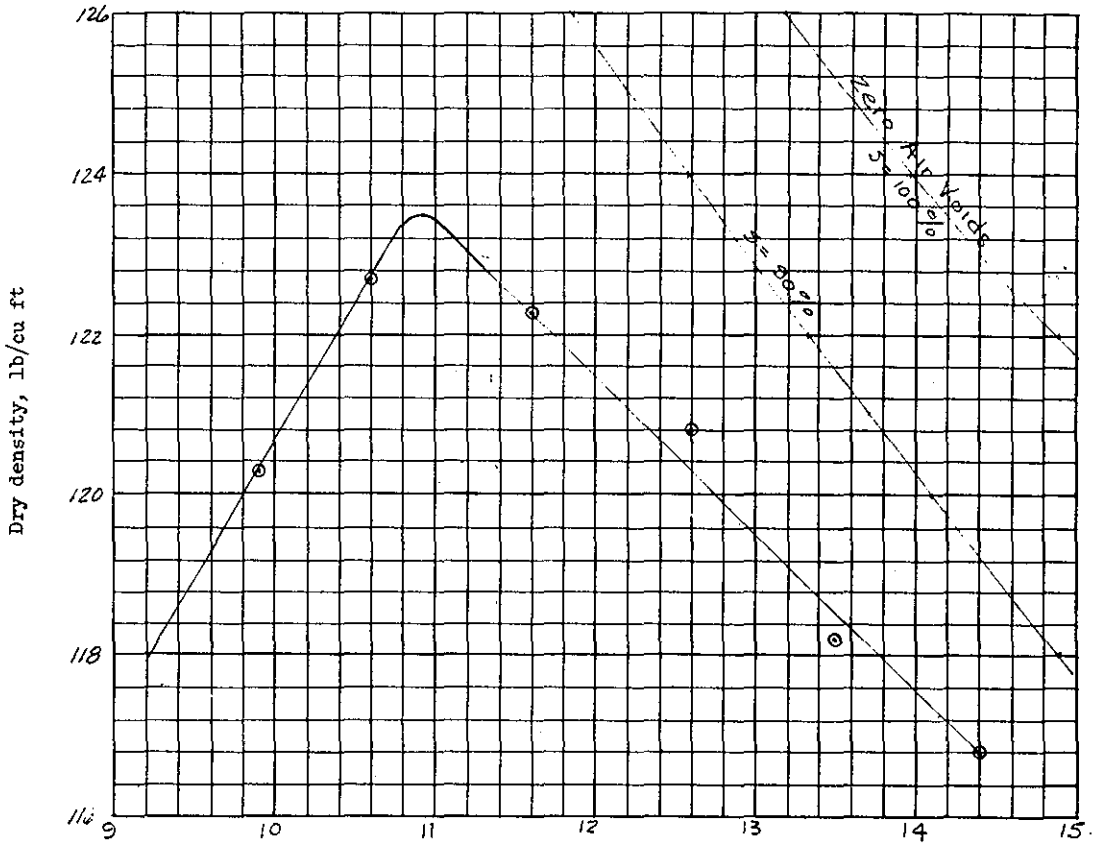
Area

Boring No. BTT-20

Date 7 November 1963

COMPACTION TEST REPORT

ENG FORM 2091 1 MAY 63 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)



Standard compaction test

25 blows per each of 3 layers, with 5.5 lb rammer and

12 inch drop. 4.0 inch diameter mold

Sample No.	Elev or Depth	Classification	G	LL	PL	% > No. 4	% > 3/4 in.
B-7	7.0'-9.7'	gravelly silty SAND (SM)	2.75				

Sample No.	B-7			
Natural water content in per cent				
Optimum water content in per cent	10.9			
Max dry density in lb/cu ft	123.5			

Remarks: Tests performed on minus No. 4 Material

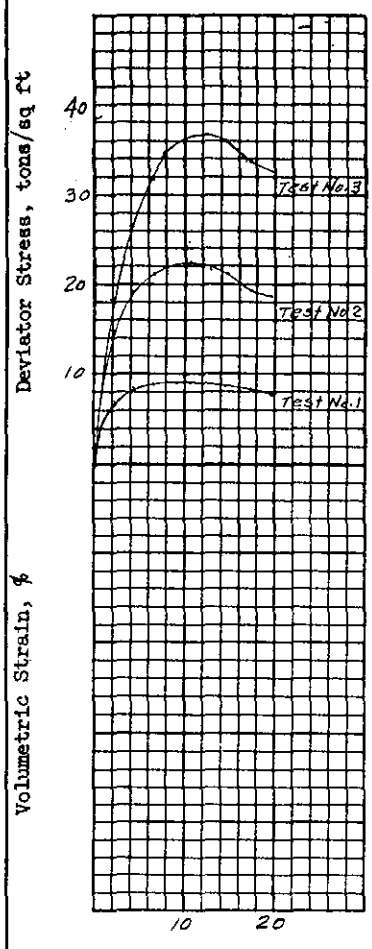
Project: Colebrook Dam, Conn.

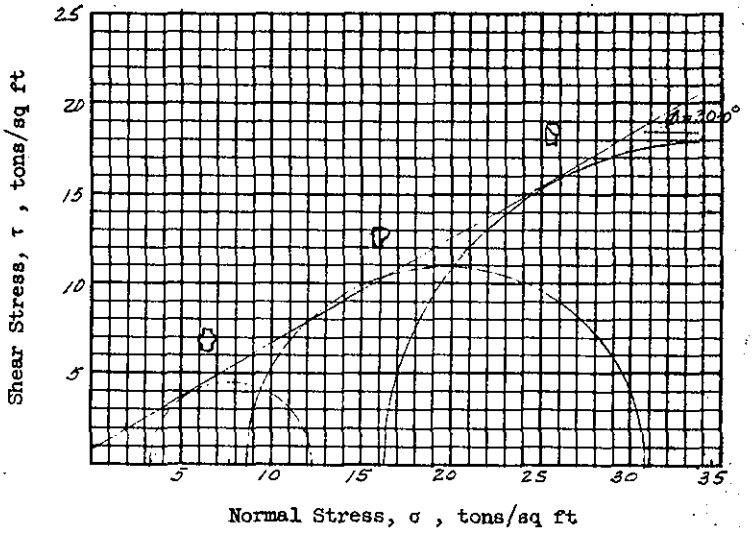
Area

Boring No. BTT-20 Date 7 November 1963

COMPACTION TEST REPORT

ENG FORM 2091 1 MAY 63 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)





Test No.			1	2	3	
Initial	Water content	w_o	9.2 %	9.0 %	9.2 %	%
	Void ratio	e_o	0.473	0.471	0.473	
	Saturation	S_o	53 %	53 %	53 %	%
	Dry density lb/cu ft	γ_d	116.5	116.7	116.5	
Before Test	Water content	w_c	9.2 %	9.0 %	9.2 %	%
	Saturation	S_c	53 %	53 %	53 %	%
	Consolidation press., tons/sq ft	σ_c	—	—	—	
	Void ratio	e_c	0.473	0.471	0.473	
Final	Water content	w_f	9.2 %	9.0 %	9.2 %	%
	Void ratio	e_f	0.473	0.471	0.473	
Major principal stress, tons/sq ft		σ_1	12.18	30.66	52.77	
Minor principal stress, tons/sq ft		σ_3	3.24	8.64	16.20	
Time to failure, min			11	11	13	
Initial diameter, cm			7.11	7.11	7.11	
Initial height, H_o, cm			16.00	16.00	16.00	

Shear Values

ϕ = 30.0 °

tan ϕ = 0.600

c = 0.75 tons/sq ft

Type Test Q

Method of Saturation None ☐ Controlled Stress ☒ Controlled Strain

Type of specimen Remolded Rate of strain 0.06 in./min

Classification gravelly silty SAND (SM)

LL	PL	PI	D_{10} 0.012

Remarks Specimens molded at approx water content of 8.9% and approx dry density of 116.8 pcf as determined from standard compaction curve at optimum minus 2%

Project Colebrook River Dam, Conn.

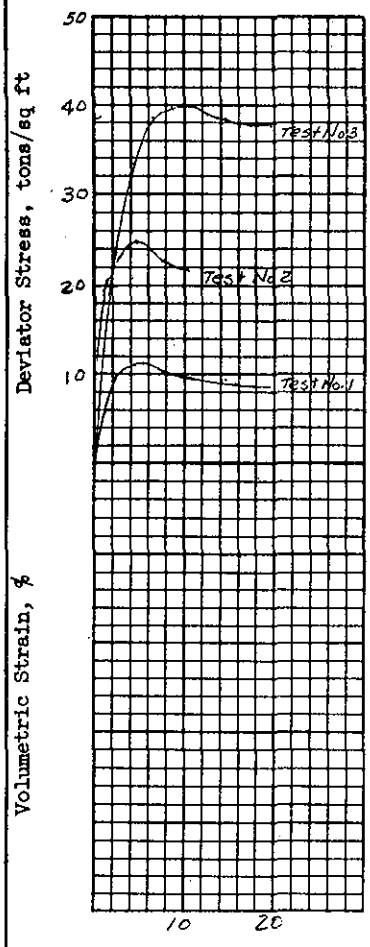
Area

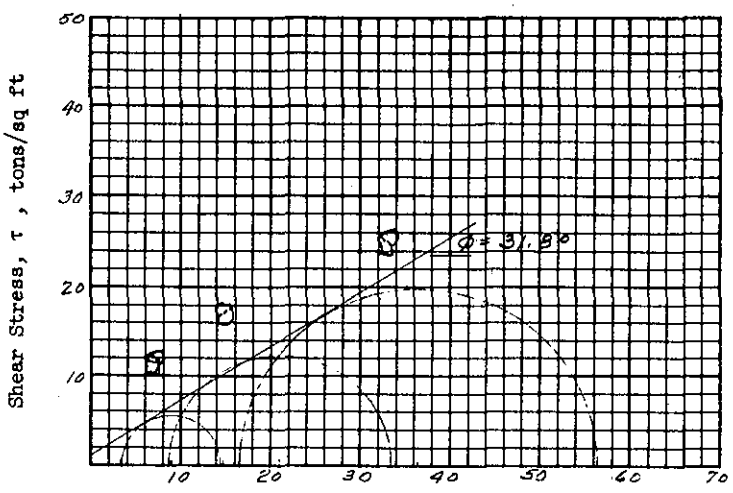
Boring No. BTT-20 Sample No. B-7

Depth 7.0'-9.7' Date 20 December 1963

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 2089 1 MAY 63 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) B 51832





Test No.			1	2	3	
Initial	Water content	w_o	11.1 %	11.1 %	11.0 %	%
	Void ratio	e_o	0.392	0.392	0.391	
	Saturation	S_o	78 %	78 %	77 %	%
	Dry density lb/cu ft	γ_d	123.3	123.3	123.4	
Before Test	Water content	w_c	11.1 %	11.1 %	11.0 %	%
	Saturation	S_c	78 %	78 %	77 %	%
	Consolidation press., tons/sq ft	σ_c	—	—	—	
	Void ratio	e_c	—	—	—	
Final	Water content	w_f	11.1 %	11.1 %	11.0 %	%
	Void ratio	e_f	0.392	0.392	0.391	
Major principal stress, tons/sq ft		σ_1	14.44	33.54	56.12	
Minor principal stress, tons/sq ft		σ_3	3.24	8.64	16.2	
Time to failure, min			6	4	11	
Initial diameter, cm			7.11	7.11	7.11	
Initial height, H_o, cm			16.00	16.00	16.00	

Shear Values

ϕ = 31.8° °

tan ϕ = 0.620

c = 1.25 tons/sq ft

Type Test "Q"

Method of Saturation None ☐ Controlled Stress ☒ Controlled Strain

Type of specimen Remolded Rate of strain 0.06 in./min

Classification gravelly silty SAND (SM)

LL	PL	PI	D_{10} 0.012

Remarks Specimens molded at approx. water content of 10.9% and approx. dry density of 123.5 pcf as determined from standard compaction test at optimum.

Project Colebrook River Dam, Conn.

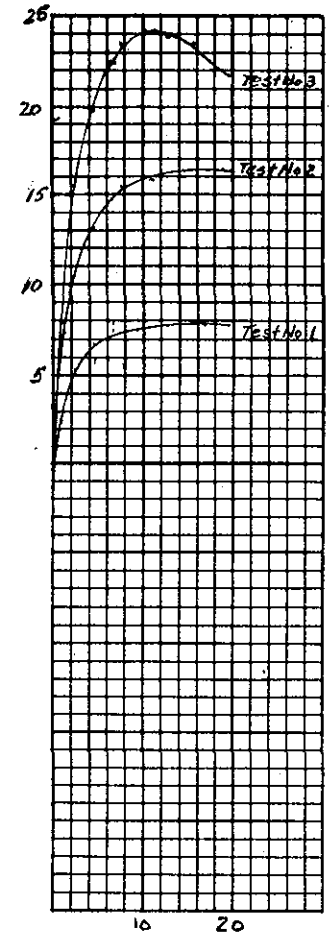
Area

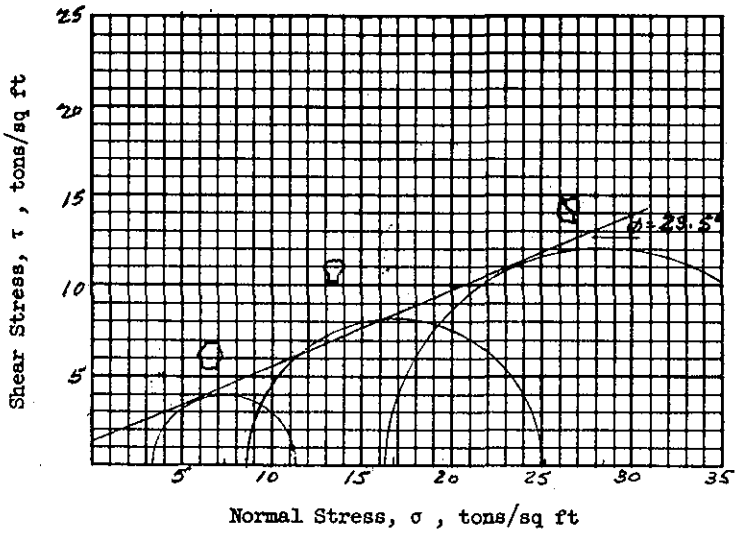
Boring No. BTT-20 Sample No. B-7

Depth ~~El~~ 7.0' - 9.7' Date 20 December 1963

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 2089 1 MAY 63 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) B 51832





Test No.			1	2	3	
Initial	Water content	w_o	12.9 %	13.0 %	13.2 %	%
	Void ratio	e_o	0.433	0.434	0.436	
	Saturation	S_o	82 %	82 %	83 %	%
	Dry density lb/cu ft	γ_d	119.8	119.7	119.5	
Before Test	Water content	w_c	12.9 %	13.0 %	13.2 %	%
	Saturation	S_c	82 %	82 %	83 %	%
	Consolidation press., tons/sq ft	σ_c	—	—	—	
	Void ratio	e_c	0.433	0.434	0.436	
Final	Water content	w_f	12.9 %	13.0 %	13.2 %	%
	Void ratio	e_f	0.433	0.434	0.436	
Major principal stress, tons/sq ft		σ_1	11.18	25.02	40.26	
Minor principal stress, tons/sq ft		σ_3	3.24	8.64	16.20	
Time to failure, min			18	20	12	
Initial diameter, cm			7.11	7.11	7.11	
Initial height, H_o, cm			16.00	16.00	16.00	

Shear Values

ϕ = 23.5 °

tan ϕ = 0.435

c = 1.25 tons/sq ft

Type Test "Q"

Method of Saturation None ☐ Controlled Stress ☒ Controlled Strain

Type of specimen, Remolded Rate of strain 0.06 in./min

Classification gravelly silty SAND (SM)

LL	PL	PI	D_{10} 0.012

Remarks Specimens molded at approx. water content of 12.9% and approx. dry density of 119.7 pcf as determined from standard compaction curve at optimum plus 2%.

Project Colebrook River Dam, Conn.

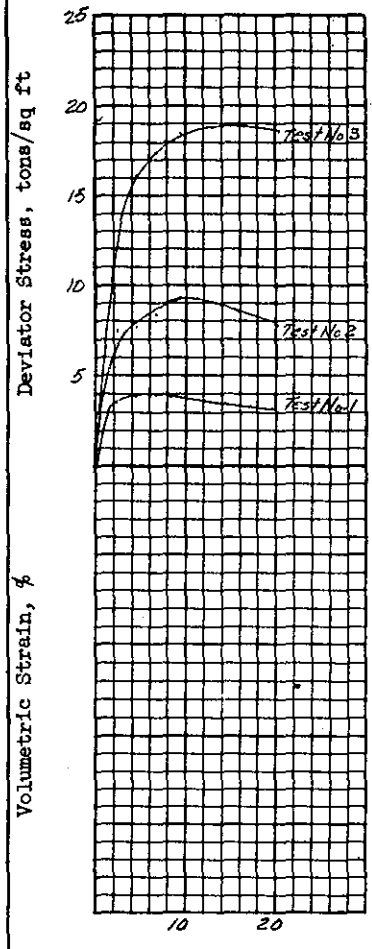
Area

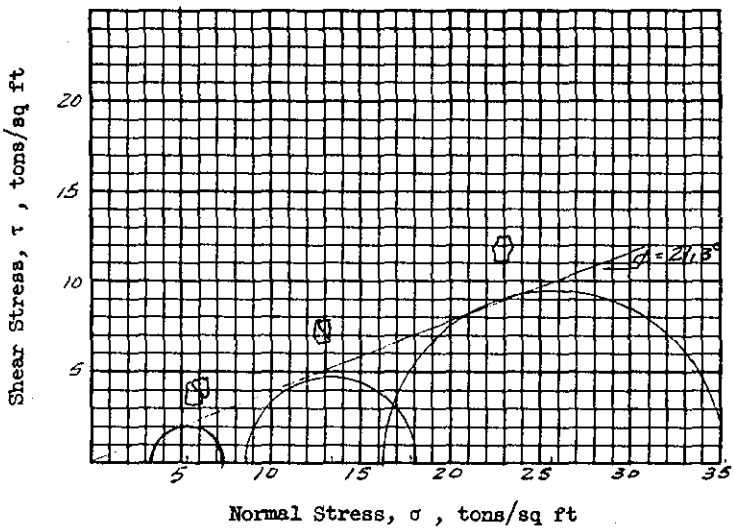
Boring No. BTT-20 Sample No. B-7

Depth ~~Ft~~ 7.0' - 9.7' Date 23 December 1963

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 2089 1 MAY 63 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) B 51832





Test No.			1	2	3	
Initial	Water content	w_o	8.9 %	8.9 %	8.9 %	%
	Void ratio	e_o	0.469	0.469	0.469	
	Saturation	S_o	58 %	58 %	58 %	%
	Dry density lb/cu ft	γ_d	116.8	116.8	116.8	
Before Test	Water content	w_c	16.1 %	14.9 %	14.5 %	%
	Saturation	S_c	100 %	99 %	100 %	%
	Consolidation press., tons/sq ft	σ_c	3.24	8.64	16.20	
	Void ratio	e_c	0.443	0.414	0.398	
Final	Water content	w_f	16.1 %	14.9 %	14.5 %	%
	Void ratio	e_f	0.443	0.414	0.398	
Major principal stress, tons/sq ft		σ_1	7.24	17.88	35.16	
Minor principal stress, tons/sq ft		σ_3	3.24	8.64	16.20	
Time to failure, min			40	65	100	
Initial diameter, cm			7.11	7.11	7.11	
Initial height, H_o, cm			16.00	16.00	16.00	

Shear Values

ϕ = 21.3 °

tan ϕ = 0.390

c = 0.2 tons/sq ft

Type Test "R"

Method of Saturation Percolation & Back pressure ☐ Controlled Stress ☐ Controlled Strain

Type of specimen Remolded Rate of strain 0.01 in./min

Classification gravelly silty SAND (SM)

LL	PL	PI	D_{10} 0.012

Remarks Specimens molded at approx water content of 8.9% and approx dry density of 116.8 pcf as determined from standard compaction test at optimum minus 2%

Project Colebrook River Dam, Conn.

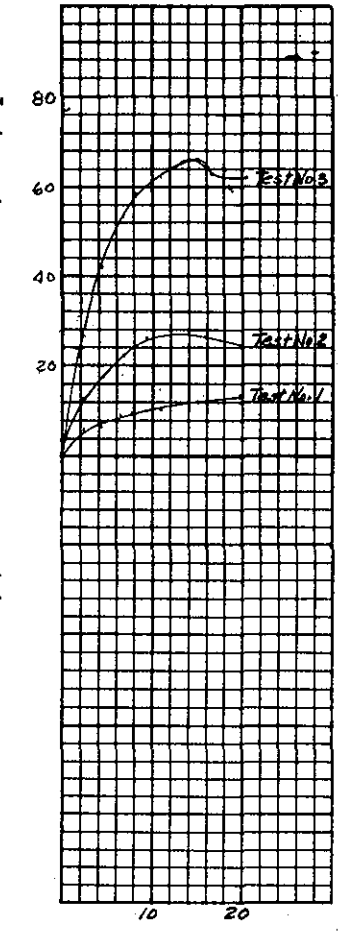
Area

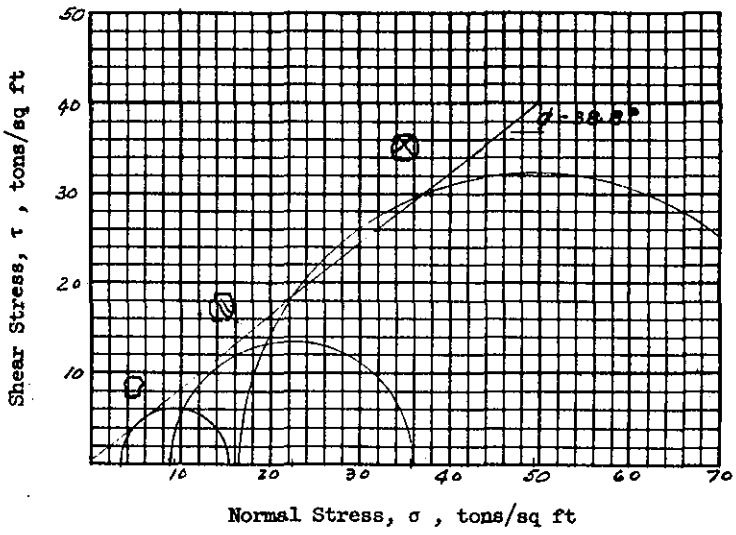
Boring No. BTT-20 Sample No. B-7

Depth El 7.0'-9.7' Date March, 1964

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 2089 1 MAY 63 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) B 51832





Test No.			1	2	3	
Initial	Water content	w_o	10.9 %	10.9 %	10.9 %	%
	Void ratio	e_o	0.390	0.390	0.390	
	Saturation	S_o	77 %	77 %	77 %	%
	Dry density lb/cu ft	γ_d	123.5	123.5	123.5	
Before Test	Water content	w_c	13.8 %	13.3 %	11.9 %	%
	Saturation	S_c	100 %	100 %	100 %	%
	Consolidation press., tons/sq ft	σ_c	3.24	8.64	16.20	
	Void ratio	e_c	0.380	0.365	0.327	
Final	Water content	w_f	13.8 %	13.3 %	11.9 %	%
	Void ratio	e_f	0.380	0.365	0.327	
Major principal stress, tons/sq ft		σ_1	15.36	35.77	82.65	
Minor principal stress, tons/sq ft		σ_3	3.24	8.64	16.20	
Time to failure, min			95	80	95	
Initial diameter, cm			7.11	7.11	7.11	
Initial height, H_o, cm			16.00	16.00	16.00	

Shear Values

ϕ = 38.8 °

tan ϕ = 0.805

c = 0.5 tons/sq ft

Type Test "R"

Method of Saturation Percolation & Backpressure ☐ Controlled Stress ☒ Controlled Strain

Type of specimen Remolded Rate of strain 0.01 in./min

Classification gravelly silty SAND (SM)

LL	PL	PI	D_{10} 0.012

Remarks Specimens molded at approx. water content of 10.9% and approx dry density of 123.5 pcf as determined from standard compaction curve at optimum water content.

Project Colebrook River Dam

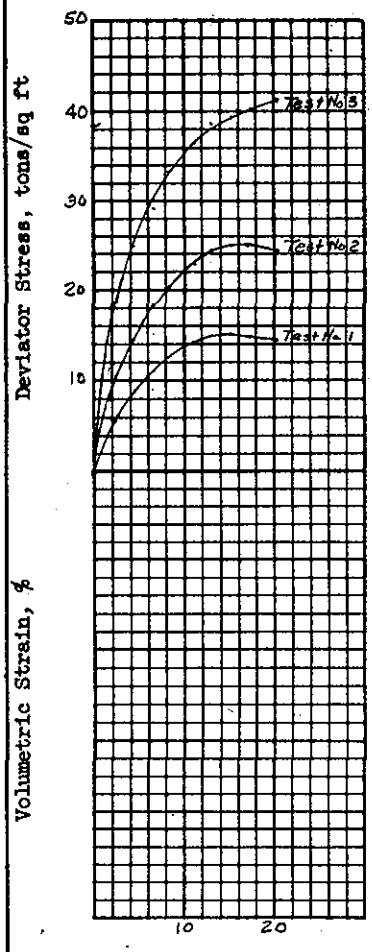
Area

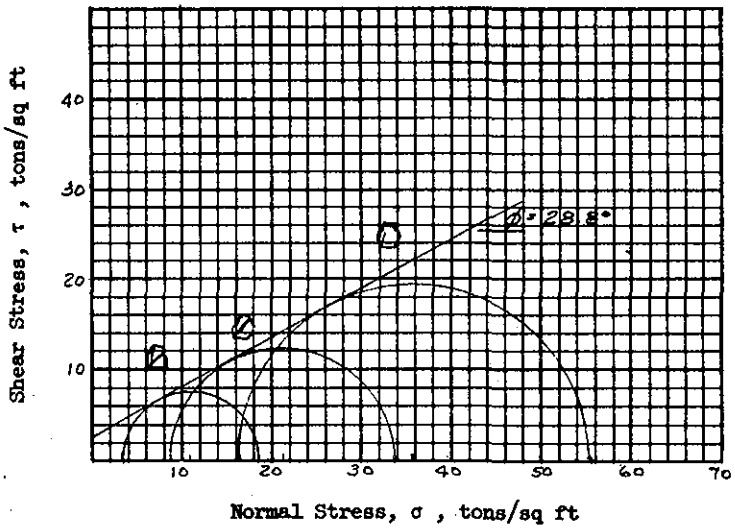
Boring No. BTT-20 Sample No. B-7

Depth El 7.0'-9.7' Date March 1964

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 2089 1 MAY 63 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) B 51832





Test No.			1	2	3	
Initial	Water content	w_o	12.9 %	12.9 %	12.9 %	%
	Void ratio	e_o	0.433	0.433	0.433	
	Saturation	S_o	82 %	82 %	82 %	%
	Dry density lb/cu ft	γ_d	119.7	119.7	119.7	
Before Test	Water content	w_c	13.7 %	12.8 %	12.5 %	%
	Saturation	S_c	100 %	100 %	100 %	%
	Consolidation press., tons/sq ft	σ_c	3.24	8.64	16.20	
	Void ratio	e_c	0.379	0.351	0.346	
Final	Water content	w_f	13.7 %	12.8 %	12.5 %	%
	Void ratio	e_f	0.379	0.351	0.346	
Major principal stress, tons/sq ft		σ_1	18.30	33.69	55.55	
Minor principal stress, tons/sq ft		σ_3	3.24	8.64	16.20	
Time to failure, min			100	105	93	
Initial diameter, cm			7.11	7.11	7.11	
Initial height, H_o, cm			16.00	16.00	16.00	

Shear Values

ϕ = 28.8 °

tan ϕ = 0.550

c = 2.70 tons/sq ft

Type Test "R"

Method of Saturation Percolation & Backpressure ☐ Controlled Stress ☒ Controlled Strain

Type of specimen Remolded Rate of strain 0.01 in./min

Classification gravelly silty SAND (SM)

LL	PL	PI	D_{10} 0.012

Remarks Specimens molded at approx. water content of 12.9% and approx. dry density of 119.7 pcf as determined from standard compaction curve at optimum plus 2%

Project Colebrook Dam, Conn.

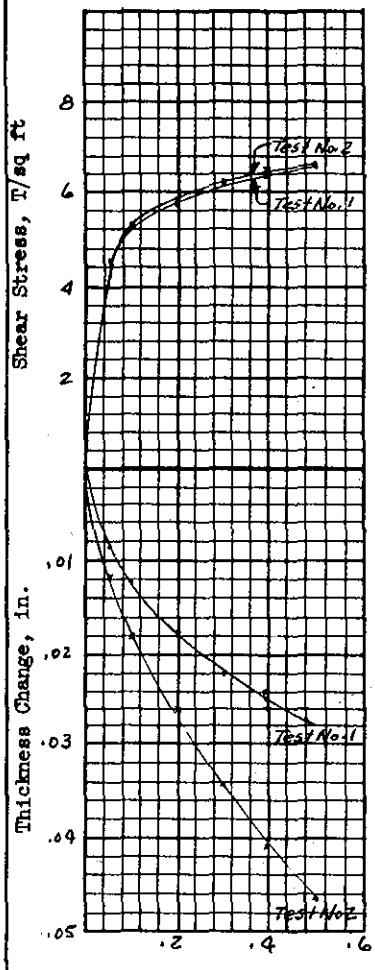
Area

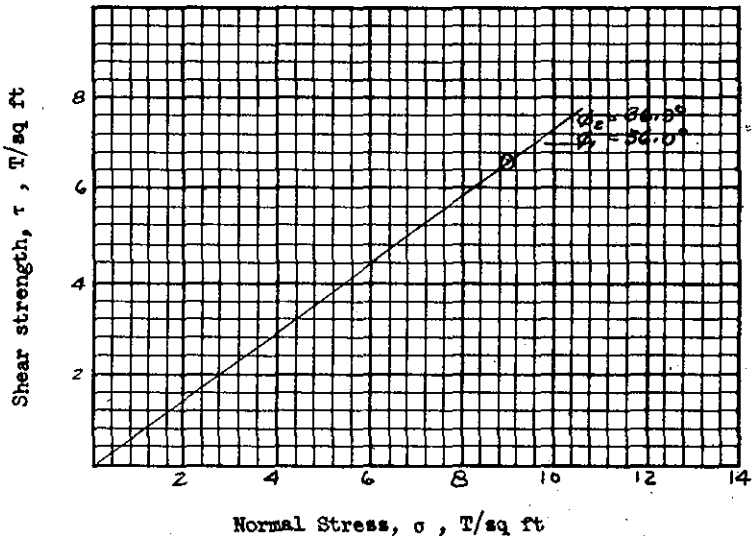
Boring No. BTT-20 Sample No. B-7

Depth El 7.0' - 9.7' Date March 1964

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 2089 1 MAY 63 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) B 51832





Test No.			1	2		
Initial	Water content	w_o	8.9 %	8.9 %	%	%
	Void ratio	e_o	.472	.475		
	Saturation	S_o	52 %	52 %	%	%
	Dry density lb/cu ft	γ_d	116.5	116.3		
Void ratio after consolidation		e_c	.482	.496		
Time for 50% consolidation, min		t_{50}	0.3	0.2		
Final	Water content	w_f	11.6 %	11.5 %	%	%
	Void ratio	e_f	.334	.323		
	Saturation	S_f	97 %	98 %	%	%
Actual time to failure, min.		t_f	21	21		
Normal stress T/sq ft		σ	9.00	9.00		
Maximum shear strength, T/sq ft		τ	6.55	6.61		

Shear Values

ϕ' = 36.0°

tan ϕ' = 0.728

c' = 0

Test Type (Check One) ☐ Controlled, stress ☒ Controlled, strain

Type of Specimen Remolded | 3.0 in. Square | 0.50 in. Thickness

Classification gravelly silty SAND (SM)

LL | PL | PI | D_{10} 0.012

Remarks Specimens molded at approx water content of 8.9 and approx. dry density of 116.8 pcf as determined from std compaction curve at optimum minus 2%

Project Colebrook River Dam

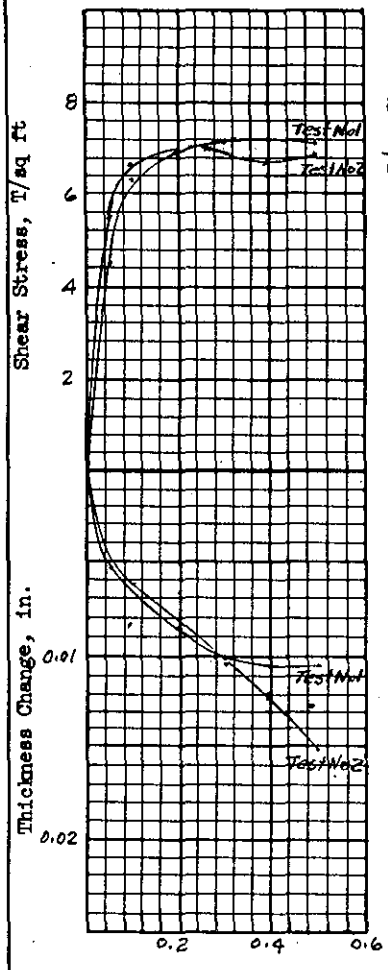
Area

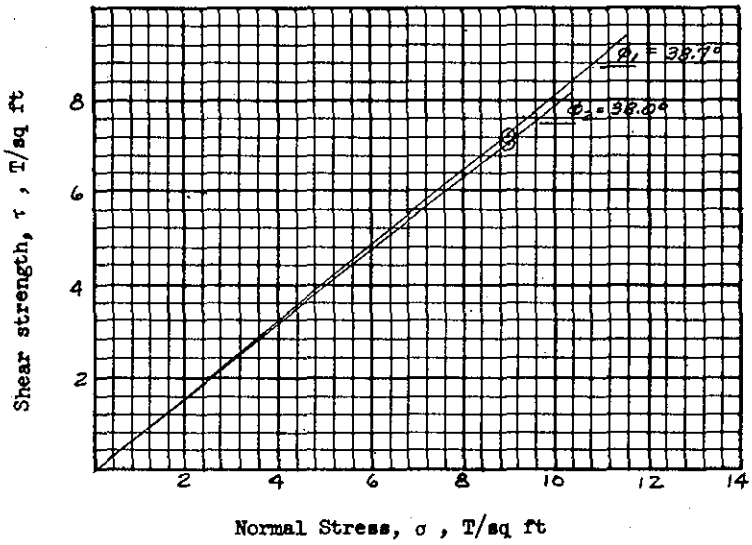
Boring No. BTT-20 | Sample No. B-7

Depth El 7.0'-9.7' | Date March 1964

DIRECT SHEAR TEST REPORT

ENG FORM 2092 1 MAY 63 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) B 52221





Test No.			1	2		
Initial	Water content	w_o	10.9 %	10.9 %	%	%
	Void ratio	e_o	0.385	0.387		
	Saturation	S_o	78 %	78 %	%	%
	Dry density lb/cu ft	γ_d	124.0	123.7		
Void ratio after consolidation		e_c	0.275	0.259		
Time for 50% consolidation, min		t_{50}	0.3	0.3		
Final	Water content	w_f	11.1 %	11.0 %	%	%
	Void ratio	e_f	.248	.218		
	Saturation	S_f	100 %	100 %	%	%
Actual time to failure, min.		t_f	23	26		
Normal stress T/sq ft		σ	9.00	9.00		
Maximum shear strength, T/sq ft		τ	7.21	7.03		

Shear Values

ϕ' = 38.0°

tan ϕ' = 0.781

c' = 0

Test Type (Check One) ☐ Controlled, stress ☒ Controlled, strain

Type of Specimen Remolded.	3.00 in. Square	0.50 in. Thickness
Classification gravelly silty SAND (SM)		
LL	PL	PI	D_{10} 0.012

Remarks Specimens molded at approx water content of 10.9% and approx dry density of 123.5 pcf as determined from Std compaction curve at optimum

Project Colebrook River Dam

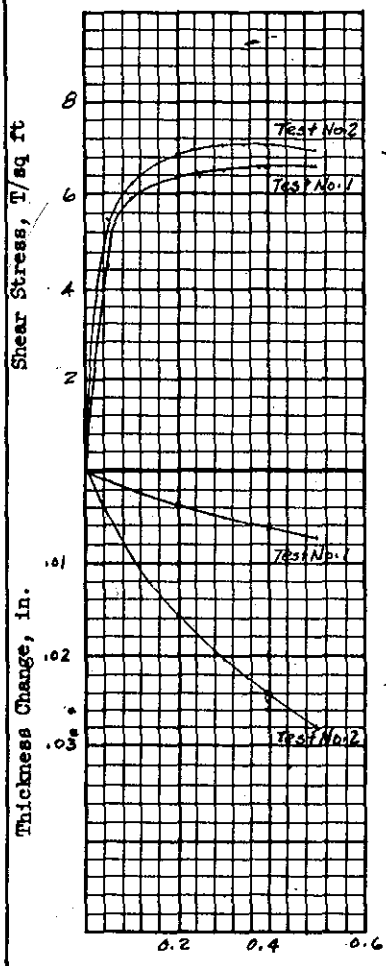
Area

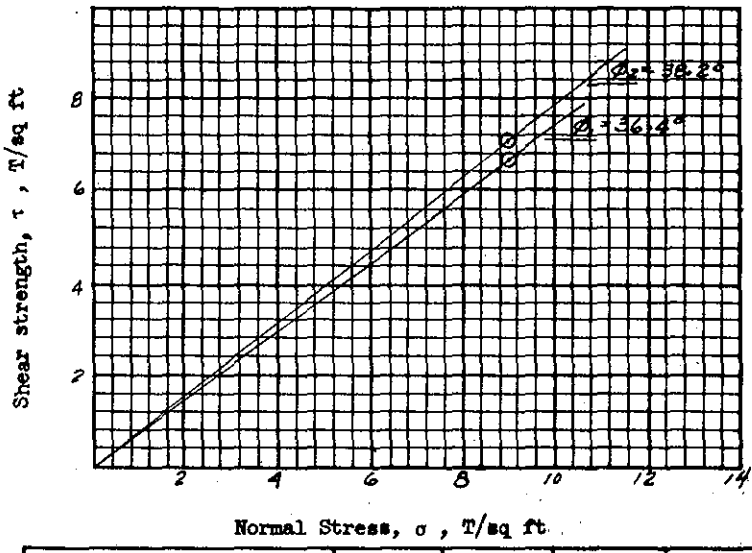
Boring No. BTT-20 Sample No. B-7

Depth El 7.0'-9.7 Date March 1964

DIRECT SHEAR TEST REPORT

ENG FORM 2092 1 MAY 63 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) B 52221





Test No.			1	2		
Initial	Water content	w_o	12.9 %	12.9 %	%	%
	Void ratio	e_o	.431	.411		
	Saturation	S_o	82 %	86 %	%	%
	Dry density lb/cu ft	γ_d	119.9	121.6		
Void ratio after consolidation		e_c	0.339	.337		
Time for 50% consolidation, min		t_{50}	—	0.22		
Final	Water content	w_f	11.62 %	11.66 %	%	%
	Void ratio	e_f	0.319	.256		
	Saturation	S_f	100 %	100 %	%	%
Actual time to failure, min.		t_f	34	21		
Normal stress T/sq ft		σ	9.00	9.00		
Maximum shear strength, T/sq ft		τ	6.64	7.07		

Shear Values

ϕ' = 36.4°

tan ϕ' = 0.737

c' = 0

Test Type (Check One) ☐ Controlled, stress ☒ Controlled, strain

Type of Specimen Remolded | 3.00 in. Square | 0.50 in. Thickness

Classification gravelly silty SAND (SM)

LL | PL | PI | D_{10} 0.012

Remarks Specimens molded at approx water content of 12.9% and approx dry density of 119.7 pcf as determined from std compaction curve at optimum plus 2%. Vertical dial readings erratic for Test No. 1 during consolidation

Project Colebrook River Dam

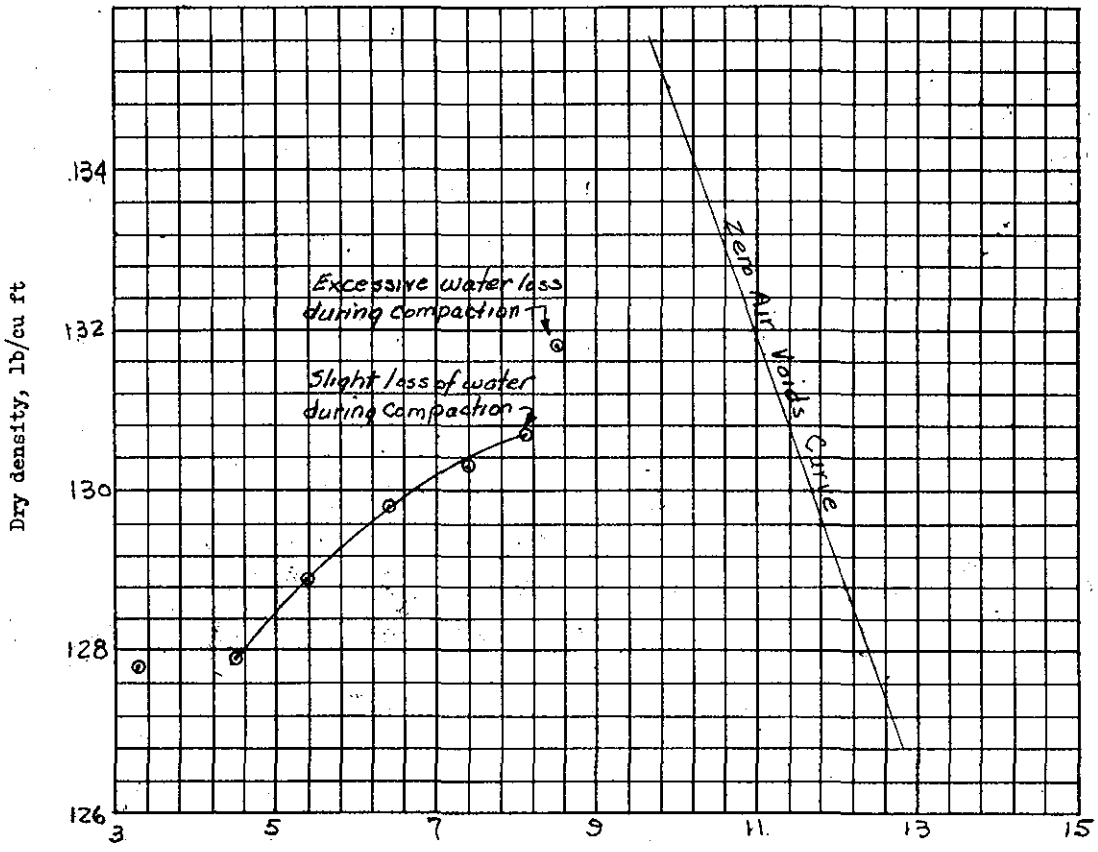
Area

Boring No. BTT-20 | Sample No. B-7

Depth El 7.0'-9.7 | Date March 1964

DIRECT SHEAR TEST REPORT

ENG FORM 2092 1 MAY 63 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) B 52221



Standard compaction test

55 blows per each of 3 layers, with 5.5 lb rammer and

12 inch drop. 6.0 inch diameter mold

Sample No.	~~Elev or~~ Depth	Classification	G	LL	PL	% > No. 4	% > 3/4 in.
B-2	6.0'-9.0'	Sandy GRAVEL (GP)	2.75			54.2	33.1

Sample No.	B-2			
Natural water content in per cent				
Optimum water content in per cent				
Max dry density in lb/cu ft				

Remarks: Test peformed on minus 3/4" material with no replacement for plus 3/4" mat'l.

Project: Colebrook River Dam, Conn.

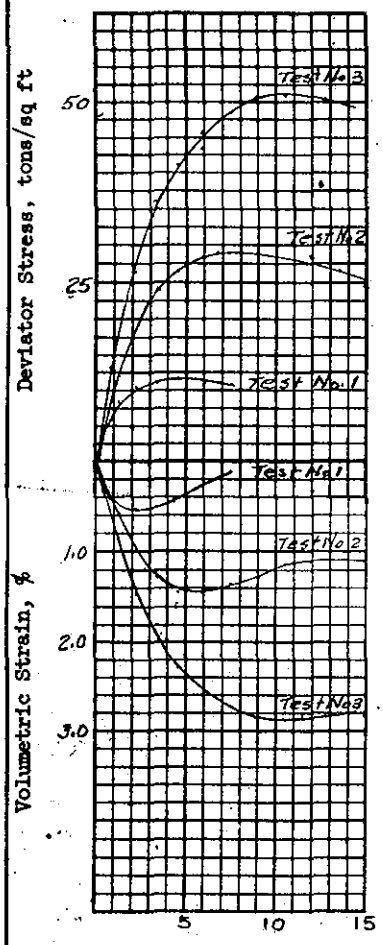
Area

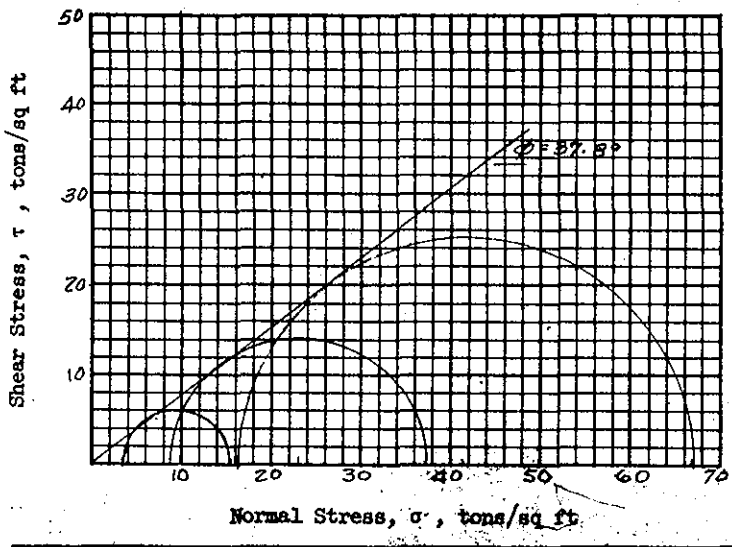
Boring No. BTT-3A

Date: 1 July 1963

COMPACTION TEST REPORT

ENG FORM 2091 1 MAY 63 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)





Test No.			1	2	3	
Initial	Water content	w_o	4.1 %	4.1 %	4.5 %	%
	Void ratio	e_o	0.325	0.325	0.329	
	Saturation	S_o	35 %	36 %	38 %	%
	Dry density lb/cu ft	γ_d	130.0	130.0	129.5	
Before Test	Water content	w_c	11.4 %	10.9 %	10.9 %	%
	Saturation	S_c	100 %	99 %	100 %	%
	Consolidation press., tons/sq ft	σ_c	3.24	8.64	16.20	
	Void ratio	e_c	0.316	0.305	0.294	
Final	Water content	w_f	11.4 %	10.4 %	9.7 %	%
	Void ratio	e_f	0.315	0.292	0.259	
Major principal stress, tons/sq ft		σ_1	15.24	37.28	66.69	
Minor principal stress, tons/sq ft		σ_3	3.24	8.64	16.20	
Time to failure, min			20	30	47	
Initial diameter, cm			14.55	14.55	14.55	
Initial height, H_o, cm			34.00	34.00	34.00	

Shear Values

ϕ = 37.8 °

tan ϕ = 0.775

c = 0 tons/sq ft

Type Test "S"

Method of Saturation See remarks ☐ Controlled Stress ☒ Controlled Strain

Type of specimen Remolded Rate of strain 0.03 in./min

Classification sandy GRAVEL (GP)

LL NP | PL NP | PI NP | D_{10} 0.18

Remarks Saturation accomplished by percolation and then 100 psi backpressure

Tests performed on minus 1 inch material

Project Colebrook River Dam, Conn.

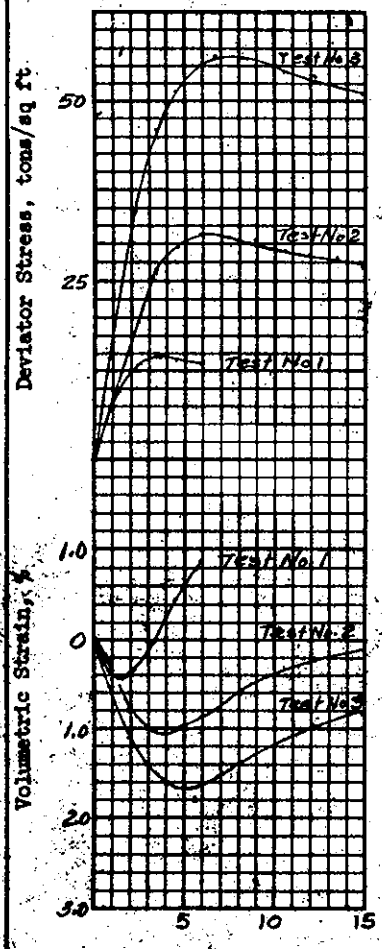
Area

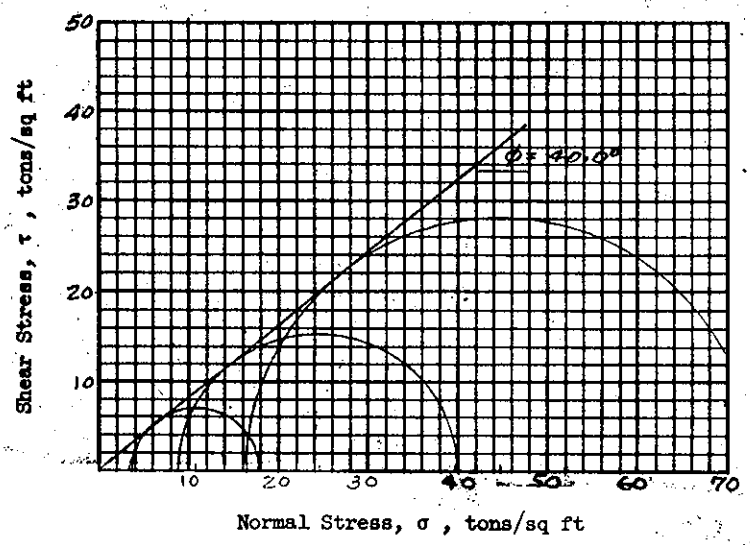
Boring No. BTT-3A | Sample No. B-2

Depth El 6.0'-9.0' | Date 3 October 1963

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 2089 1 MAY 63 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) B 51832





Shear Values

ϕ = 40.0 °

tan ϕ = 0.840

c = 0 tons/sq ft

Test No.			1	2	3	
Initial	Water content	w_o	7.3 %	7.8 %	7.3 %	%
	Void ratio	e_o	0.295	0.296	0.295	
	Saturation	S_o	68 %	68 %	68 %	%
	Dry density lb/cu ft	γ_d	133.0	133.0	133.0	
Before Test	Water content	w_c	10.3 %	9.9 %	9.3 %	%
	Saturation	S_c	100 %	99 %	99 %	%
	Consolidation press., tons/sq ft	σ_c	3.24	8.64	16.20	
	Void ratio	e_c	0.284	0.274	0.262	
Final	Water content	w_f	10.7 %	9.8 %	8.8 %	%
	Void ratio	e_f	0.297	0.273	0.250	
Major principal stress, tons/sq ft		σ_1	17.98	39.97	72.84	
Minor principal stress, tons/sq ft		σ_3	3.24	8.64	16.20	
Time to failure, min			16	23	80	
Initial diameter, cm			14.55	14.55	14.55	
Initial height, H_o, cm			34.00	34.00	34.00	

Type Test "S"
Method of Saturation See remarks ☐ Controlled Stress ☒ Controlled Strain

Type of specimen Remolded Rate of strain 0.03 in./min

Classification Sandy GRAVEL (GP)

LL NP | PL NP | PI NP | D_{10} 0.18

Remarks Saturation accomplished by percolation and then 100psi back pressure.
Tests performed on minus 1 inch material.

Project Colebrook River Dam, Conn.

Area

Boring No. BTT-3A | Sample No. B-2

Depth El 6.0' - 9.0' | Date 3 October 1963

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 2089 1 MAY 63 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

APPENDIX D

ENGINEERING LOGS OF SOILS EXPLORATIONS
COLEBROOK RIVER DAM

LEGEND

mod.	moderately
v.	very
comp.	compact
w/	with
f.	fine
m.	medium
c.	coarse
m-f	medium to fine
SM	Soil Symbol, Unified Soil Classification System
W_n	Natural water content of sample except for certain soils containing gravel for which W_n represents the water content of that part of the sample from which portions of the coarse gravel sizes have been removed.
W_4	Natural water content determined for that portion of the soil passing the No. 4 U.S. Standard Sieve
γ_d	Natural dry density (pcf)
D_{10}	Effective grain size in millimeters
LL	Atterberg Liquid Limit
PI	Atterberg Plasticity Index
26	A single numeral following a soil component in the description of a soil represents the percentage, by weight, of that component in the soil as determined by a mechanical analysis
(25-35)	A range of numbers in parenthesis following a soil component in the description of a soil, represents the estimated limits between which lies the percentage, by weight, of that component in the soil as determined by visual inspection

FD-1 Elev. 649.9

0.0' - 0.2'	Forest debris
0.2' - 1.2'	Topsoil
1.2' - 5.0'	Brown, mod. comp., gravelly 31 silty 16 sand, SM, w/cobbles
5.0' - 10.0'	Brown, mod. comp., gravelly (20-30) silty (15-25) sand, SM, Till, w/cobbles
10.0' - 15.0'	Brown, mod. comp., gravelly 39 silty 14 sand, SM, Till
15.0' - 18.0'	Brown, comp., gravelly 25 silty 21 sand, SM, Till
18.0' - 18.5'	Brown, comp., gravelly (30-40) silty (15-25) sand, SM, Till, w/cobbles
18.5' - 20.5'	Brown, comp., gravelly (20-30) silty (15-25) sand, SM, Till, w/cobbles
20.5'	Top of bedrock

FD-2 Elev. 594.0

0.0' - 9.5'	Brown, loose to comp., silty 10 sandy 44 gravel, GP-GM, w/roots weathered rocks, cobbles and boulders D_{10} = 0.068
9.5' - 10.9'	Gray, v. comp., sandy (30-40) gravel, GP, w/cobbles
10.9' - 14.5'	Gray, v. comp., silty 10 sandy 35 gravel, GP-GM, w/cobbles, D_{10} = 0.080
14.5' - 19.5'	Gray, mod. comp., gravelly (30-40) silty (15-25) sand, SM, w/cobbles
19.5' - 24.0'	Gray, mod. comp., silty 8 sandy 43 gravel, GP-GM, w/cobbles, D_{10} = 0.085
24.0' - 27.5'	Brown, loose to mod. comp. silty (20-30) sand, w/occasional piece of gravel
27.5' - 29.5'	Brown, comp., gravelly (25-35) silty (15-25) sand, SM
29.5' - 38.3'	Brown, comp., gravelly 38 silty 16 sand, SM
38.3'	Top of bedrock

FD-3 Elev. 618.5

0.0' - 1.5'	Brown, loose, sandy (f. 10-20) silt, ML, w/hair roots
1.5' - 3.5'	Brown, loose, silty (20-30) m-f sand, SM, w/roots
3.5'	Top of bedrock

FD-4 Elev. 572.2

0.0' - 2.0'	Gray, mod. comp., gravelly (15-25) silty (10-20) sand, SM
2.0' - 6.2'	Gray, comp., sandy 28 gravel, GW, w/cobbles or boulders, D_{10} = 0.650

FD-4 (Continued)

6.2' - 11.2'	Gray, mod. comp., gravelly 39 silty 6 sand, SP-SM, D_{10} = 0.110
11.2' - 19.6'	Brown, mod. comp., gravelly 13 silty 7 sand, SP-SM, D_{10} = 0.093
19.6' - 38.0'	Brown, mod. comp., silty 10 f. sand, SP-SM, w/cobbles or boulders, D_{10} = 0.075
38.0'	Top of bedrock

FD-5 Elev. 578.9

0.0' - 1.5'	Gray, loose, silty (20-30) m-f sand, SM, w/roots
1.5' - 10.0'	Gray, loose to mod. comp., sandy 34 gravel, GW, w/cobbles, D_{10} = 0.190
10.0' - 25.0'	Gray, v. comp., silty 10, 10 sandy 37, 36 gravel, GP-GM, Till, w/cobbles, D_{10} = 0.80, 0.80
25.0' - 28.9'	Brown, v. comp., silty 7 sandy 34 gravel, GP-GM, w/cobbles, D_{10} = 0.110
28.9'	Top of bedrock

FD-6 Elev. 630.8

0.0' - 1.3'	Brown, loose, gravelly (10-15) sandy (10-20) silt, ML, w/roots
1.3'	Top of bedrock

FD-7 Elev. 638.4

0.0' - 2.0'	Topsoil and boulders
2.0' - 5.0'	Brown, mod. comp., sandy (f. 30-40) silt, ML, w/roots
5.0'	Top of bedrock

FD-8 Elev. 627.7

0.0' - 0.8'	Brown, loose, sandy (30-40) silt, ML, w/roots and cobbles
0.8'	Top of bedrock

FD-9 Elev. 572.5

0.0' - 5.0'	Brown, v. comp., silty 6 sandy 31 gravel, GP-GM, D_{10} = 0.150
5.0' - 6.2'	Brown, v. comp., gravelly 35 silty 13 sand, SM, D_{10} = 0.053
6.2' - 10.0'	Brown, v. comp., gravelly (30-40) silty (10-20) sand, SM, Till
10.0'	Top of bedrock

FD-10 Elev. 646.2

0.0' - 2.9'	Brown, loose, sandy (f. 20-30) silt, ML, w/roots and gravel
2.9' - 5.8'	Brown, mod. comp., sandy (30-40) gravel, GP, w/cobbles
5.8'	Top of bedrock

FD-11 Elev. 575.6

0.0' - 15.5'	Brown, v. comp., sandy (10-20) gravel, GP, w/cobbles
15.5' - 22.5'	Brown, comp., silty 9 sandy 46 gravel, GP-GM, D_{10} = 0.085 w/boulder
22.5' - 26.8'	Brown, v. comp., gravelly 34 silty 10 sand, SP-SM, D_{10} = 0.075
26.8'	Top of bedrock

FD-12 Elev. 639.5

0.0' - 2.0'	Topsoil
2.0' - 8.7'	Brown, comp., gravelly (10-20) silty (15-25) m-f sand, SM, w/roots and cobbles or boulders
8.7'	Top of bedrock

FD-13 Elev. 648.3

0.0' - 2.2'	Topsoil and forest debris
2.2' - 3.1'	Brown, comp., gravelly (10-20) silty (15-25) sand, SM
3.1'	Top of bedrock

FD-14 Elev. 574.5

0.0' - 3.0'	Brown, loose, gravelly (10-20) silty (10-20) sand, SM, w/roots
3.0' - 5.0'	Brown, comp., sandy 44 gravel, GP, D_{10} = 0.200
5.0' - 10.0'	Brown, comp., sandy (25-35) gravel, GP
10.0' - 15.0'	Brown, comp., silty 14 sandy 37 gravel, GM, Till, D_{10} = 0.043
15.0' - 20.0'	Brown, comp., gravelly (0-5) silty (15-25) sand, SM, Till, w/weathered cobbles
20.0' - 25.0'	Brown, comp., gravelly 37 silty 11 sand, SP-SM, D_{10} = 0.065
25.0' - 39.0'	Brown, comp., silty (15-25) sandy (30-40) gravel, GM, w/cobbles or boulders

FD-15 Elev. 673.0

0.0'	Top of bedrock

FD-16 Elev. 650.8

0.0' - 2.0'	Boulders
2.0' - 5.0'	Brown, mod. comp., silty (10-20) sandy (30-40) gravel, GM, w/hair roots and cobbles
5.0'	Top of bedrock

FD-17 Elev. 583.9

0.0' - 5.0'	Brown, mod. comp., silty (5-10) sandy (30-40) gravel, GP-GM
5.0' - 10.0'	Brown, mod. comp., gravelly 34 silty 8 sand, SP-SM, D_{10} = 0.083
10.0' - 13.3'	Brown, comp. to v. comp., silty (5-10) sandy (25-35) gravel, GP-GM
13.3'	Top of bedrock

FD-18 Elev. 595.9

0.0' - 1.0'	Topsoil and forest debris
1.0' - 5.0'	Brown, comp., silty 9 sandy 29 gravel, GP-GM, D_{10} = 0.092
5.0' - 15.0'	Brown, mod. comp., sandy 33 gravel, GP, D_{10} = 0.18
15.0' - 20.0'	Gray brown, comp., gravelly 37 silty 11 sand, SP-SM, D_{10} = 0.061
20.0' - 28.0'	Gray brown, comp., gravelly 38 silty 16 sand, Till , w/cobbles or boulders, D_{10} = 0.045
28.0'	Top of bedrock

FD-19 Elev. 569.1

0.0' - 2.9'	Brown, comp., gravel, GP w/cobbles
2.9'	Top of bedrock

FD-20 Elev. 586.2

0.0' - 5.0'	Brown, mod. comp., silty 9 sandy 40 gravel, GP-GM, w/cobbles, D_{10} = 0.085
5.0' - 10.0'	Brown, mod. comp., gravelly (30-40) silty (10-20) sand, SM, w/cobbles
10.0' - 15.0'	Brown, loose, m-f sand, SP, D_{10} = 0.13
15.0' - 20.0'	Brown, loose, silty (15-20) f. sand, SM
20.0' - 25.0'	Brown, mod. comp., silty (5-10) sandy (30-40) gravel, GP-GM, w/cobbles
25.0' - 30.0'	Brown, mod. comp., gravelly 34 silty 10 sand, SP-SM, w/cobbles, D_{10} = 0.075
30.0' - 35.0'	Brown, mod. comp., silty (5-10) sandy (30-40) gravel, GP-GM, w/cobbles
35.0' - 45.6'	Brown, mod. comp., gravelly 37 silty 10 sand, SP-SM, w/cobbles, D_{10} = 0.085
45.6'	Top of bedrock

FD-21	Elev. 671.1	
0.0' - 0.4'		Forest debris
0.4' - 2.7'		Topsoil and forest debris, w/boulders, cobbles and roots
2.7'		Top of bedrock
FD-22	Elev. 582.2	
0.0' - 0.8'		Forest debris
0.8'		Top of bedrock
FD-23	Elev. 742.9	
0.0' - 0.5'		Topsoil and forest debris
0.5'		Top of bedrock
FD-24	Elev. 580.0	
0.0' - 4.5'		Brown, loose, silty 46 m-f sand, SM, D_{10} = 0.007
4.5' - 5.0'		Brown, mod. comp., gravelly (10-20) silty (15-25) m-f sand, SM
5.0' - 8.5'		Brown, mod. comp., silty (5-10) sandy (25-35) gravel, GP-GM
8.5' - 10.0'		Brown, comp., gravelly (10-20) silty (10-20) sand, SM
10.0' - 14.1'		Brown, mod. comp., silty 7 sandy 42 gravel, GP-GM D_{10} = 0.1
14.1'		Top of bedrock
FD-25	Elev. 585.5	
0.0' - 5.0'		Brown, loose, gravelly (15-25) silty (15-25) f. sand, SM
5.0' - 6.9'		Brown, mod. comp., silty (15-25) sandy (30-40) gravel, GM
6.9'		Bottom of exploration
FD-26	Elev. 577.3	
0.0' - 5.0'		Dark brown, loose, silty (15-25) m-f sand, SM, w/roots and organics
5.0' - 7.5'		Brown, mod. comp., gravelly 25 silty 6 m-f sand, SP-SM, D_{10} = 0.085
7.5' - 10.0'		Brown, mod. comp., silty (5-10) sandy (30-40) gravel, GP-GM
10.0' - 15.0'		Brown, mod. comp., sandy 42 gravel, GP, D_{10} = 0.13
15.0' - 20.0'		Brown, mod. comp., gravelly 43 sand, SP, w/occasional cobbles, D_{10} = 0.075

FD-26 (Continued)

20.0' - 21.5'	Brown, mod. comp., gravelly (10-20) silty (15-25) sand, SM
21.5' - 29.0'	Brown, mod. comp., silty 29 f. sand, SM, D_{10} = 0.075
29.0'	Top of bedrock

FD-27 Elev. 575.1

0.0' - 3.0'	Brown, loose to mod. comp., silty (10-20) m-f sand, SM, w/organics
3.0' - 8.9'	Brown, mod. comp to comp., silty 9 sandy 40 gravel, GP-GM w/occasional cobble, D_{10} = 0.09
8.9'	Top of bedrock

FD-28 Elev. 570.4

0.0' - 8.0'	Brown, mod. comp., sandy (20-30) gravel, GP, w/cobbles
8.0' - 23.2'	Brown, mod. comp., gravelly 43, 40, 34 silty 11, 11, 11 sand, SP-SM w/cobbles, D_{10} = 0.070, 0.065, 0.065
23.2'	Top of bedrock

FD-29 Elev. 664.9

0.0' - 1.1'	Topsoil
1.1' - 5.0'	Gray brown, mod. comp., silty 13 sandy 40 gravel, GM, D_{10} = 0.056
5.0' - 13.0'	Gray brown, mod. comp., silty (15-25) sandy (30-40) gravel, GM w/cobbles
13.0' - 16.5'	Black, comp., sandy 28 gravel, GP, D_{10} = 0.21
16.5'	Top of bedrock

FD-30 Elev. 705.0

0.0' - 1.9'	Topsoil and forest debris
1.9'	Top of bedrock

FD-31 Elev. 678.0

0.0' - 1.0'	Topsoil and forest debris
1.0'	Top of bedrock

FD-32 Elev. 644.4

0.0' - 0.8'	Topsoil
0.8' - 2.0'	Brown, mod. comp., gravelly (15-25) silty (30-40) sand, SM

FD-32 (Continued)

2.0' - 3.3'	Brown, mod. comp., gravelly (15-25) silty (25-35) m-f sand, SM
3.3' - 4.5'	Brown, comp., gravelly (10-20) silty (30-40) sand, SM
4.5' - 11.0'	Cobbles, w/gravel
11.0'	Top of bedrock

FD-33 Elev. 575.0

0.0' - 5.0'	Brown, mod. comp. gravelly 27 silty 7 sand, SP-SM, w/cobbles D_{10} = 0.12
5.0' - 10.0'	Brown, mod. comp., silty 4 sandy 28 gravel, GP, w/cobbles, D_{10} = 0.18
10.0' - 11.5'	Brown, mod. comp., gravelly 31 silty 6 m-f sand, SP-SM, D_{10} = 0.098
11.5' - 25.0'	Brown, loose to mod. comp., silty 8 m-f sand, SP-SM, D_{10} = 0.081
25.0' - 30.0'	Brown, mod. comp., silty 6 sandy 16 gravel, GP-GM, w/cobbles D_{10} = 0.24
30.0' - 42.2'	Brown, comp., silty 6 sandy 36 gravel, GW-GM, w/cobbles D_{10} = 0.12
42.2'	Top of bedrock

FD-34 Elev. 725.7

0.0' - 0.6'	Topsoil and forest debris
0.6' - 5.6'	Brown, comp., silty (5-10) sandy (25-35) gravel, GP-GM, w/cobbles
5.6'	Top of bedrock

FD-35 Elev. 827.3

0.0' - 0.8'	Topsoil
0.8' - 2.0'	Boulder
2.0' - 2.6'	Brown, loose, silty (35-45) f. sand, SM, w/roots
2.6' - 3.4'	Brown, loose, gravelly (10-20) silty (20-30) sand, SM
3.4' - 6.7'	Brown, mod. comp., gravelly (10-20) silty (10-20) m-f sand, SM, w/cobbles or boulders
6.7'	Top of bedrock

FD-36 Elev. 690.5

0.0' - 14.0'	Cobbles or boulders mixed w/soil
14.0'	Top of bedrock

FD-37 Elev. 584.4

0.0' - 10.0'	Brown, mod. comp., silty (5-10) sandy (25-35) gravel, GP-GM w/cobbles
10.0'	Top of bedrock

FD-38	Elev. 722.6	
0.0' - 0.2'		Forest debris and silt
0.2' - 2.0'		Boulders, w/layers of silt between boulders
2.0'		Top of bedrock
FD-39	Elev. 909.7	
0.0'		Top of bedrock
FD-40	Elev. 595.8	
0.0' - 5.0'		Brown, mod. comp., silty 8 m-f sand, SP-SM, D_{10} = 0.09
5.0' - 10.0'		Brown, comp., gravelly (30-40) silty (5-10) sand, SP-SM
10.0' - 15.0'		Brown, comp., silty 7 sandy 38 gravel, GP-GM, D_{10} = 0.11
15.0' - 17.1'		Brown, comp., gravelly (15-25) silty (10-20) sand, SM
17.1'		Top of bedrock
FD-41	Elev. 603.3	
0.0' - 2.0'		Topsoil
2.0' - 4.0'		Brown, mod. comp., silty, (35-45) f. sand, SM
4.0' - 5.0'		Brown, comp., silty (15-25) m-f sand, SM
5.0' - 12.0'		Brown, comp., silty (5-10) sandy (30-40) gravel, GP-GM, w/cobbles
12.0'		Top of bedrock
FD-42	Elev. 596.0	
0.0' - 3.0'		Brown, loose, silty (10-20) m-f sand, SM, w/organic material
3.0' - 5.0'		Brown, mod. comp., gravel, GP, w/cobbles
5.0' - 10.0'		Brown, v. comp., gravelly 21 silty 7 sand, SP-SM, w/cobbles, D_{10} = 0.13
10.0' - 15.0'		Brown, comp., silty (5-10) sandy (20-30) gravel, GP-GM, w/cobbles some mica and weathered rock
15.0' - 20.0'		Brown, v. comp., gravelly 44 silty 10 sand, SP-SM, w/cobbles, D_{10} = 0.08
20.0' - 25.0'		Brown, v. comp., silty 9 sandy 32 gravel, GW-GM w/cobbles, D_{10} = 0.09
25.0' - 29.2'		Brown, comp., silty (10-20) sandy (30-40) gravel, GM, w/cobbles
29.2'		Top of bedrock

FD-43 Elev. 707.7

0.0' - 0.7'	Topsoil and forest debris
0.7' - 5.0'	Brown, mod. comp., gravelly (10-20) silty (20-30) sand, SM w/forest debris and cobbles
5.0' - 6.5'	Brown, mod. comp., silty (5-10) sandy (30-40) gravel, GP-GM
6.5'	Top of bedrock

FD-44 Elev. 811.4

0.0' - 2.7'	Topsoil and boulders
2.7'	Top of bedrock

FD-45 Elev. 602.5

0.0' - 1.0'	Brown, loose, sandy, silt, topsoil
1.0'	Top of bedrock

FD-46 Elev. 607.5

0.0' - 1.0'	Topsoil and boulders
1.0'	Top of bedrock

FD-47 Elev. 662.0

0.0' - 0.7'	Topsoil and forest debris
0.7' - 2.5'	Brown, loose, silty 11 sandy 40 gravel GP-GM, w/roots, D_{10} = 0.075
2.5' - 5.0'	Brown, mod. comp., gravelly 38 silty 18 sand, SM, w/cobbles, D_{10} = 0.035
5.0' - 10.0'	Brown, comp., silty 9 sandy 42 gravel, GP-GM, w/cobbles, D_{10} = 0.07
10.0' - 12.0'	Brown, comp., gravelly (25-35) silty (15-25) sand, SM, w/cobbles
12.0' - 23.0'	Brown, v. comp., silty 8 sandy 36 gravel, GP-GM, w/c o bbles or boulders, D_{10} = 0.092
23.0'	Top of bedrock

FD-48 Elev. 599.7

0.0' - 5.0'	Topsoil, cobbles and boulders
5.0' - 15.0'	Brown, mod. comp., silty 9, 8 sandy 27, 28 gravel, GP-GM w/cobbles and boulders, D_{10} = 0.090, 0.090
15.0' - 20.0'	Brown, mod. comp., gravelly 35 silty 7 sand, SP-SM, D_{10} = 0.90
20.0' - 25.0'	Brown, mod. comp., silty 12 sandy 48 gravel, GP-GM, D_{10} = 0.075
25.0' - 30.0'	Brown, mod. comp., gravelly (20-30) silty (15-25) sand, SM
30.0'	Top of bedrock

FD-49 Elev. 912.5

0.0' - 0.4'	Topsoil and forest debris
0.4' - 1.5'	Brown, loose, sandy (f) silt, ML, w/organics
1.5'	Top of bedrock

FD-50 Elev. 601.7

0.0' - 1.8'	Brown, loose, silty (25-35) f. sand, SM, w/organics
1.8' - 4.5'	Brown, loose, gravelly 17 silty 25 m-f sand, SM, D_{10} = 0.02
4.5' - 5.0'	Brown, loose, sandy (25-35) gravel, GP, w/cobbles
5.0' - 24.6'	Brown, loose to mod. comp., gravelly 31 silty 8 sand, SP-SM, w/cobbles or boulders, D_{10} = 0.085
24.6'	Top of bedrock

FD-51 Elev. 754.8

0.0' - 2.8'	Brown, loose, silty (35-45) f. sand, SM
2.8' - 5.0'	Brown, v.comp., gravelly 42 silty 17 sand, D_{10} = 0.032
5.0' - 10.0'	Brown, v. comp., gravelly (15-25) to (20-30) silty (15-25) sand, SM
10.0' - 14.1'	Brown, comp., gravelly 36 silty 16 sand, SM, w/cobbles, D_{10} = 0.04
14.1' - 15.0'	Brown, v. comp., silty (5-10) sandy (30-40) gravel, GP-GM
15.0' - 18.0'	Brown, v. comp., gravelly (15-25) silty (15-25) sand, SM
18.0' - 20.0'	Brown, v. comp., gravelly 9 silty 36 m-f sand, SM, D_{10} = 0.018
20.0' - 23.0'	Brown, v. comp., silty (20-30) f. sand, SM
23.0' - 28.0'	Brown, v. comp., gravelly 13 silty 25 m-f sand, SM, D_{10} = 0.035
28.0' - 30.0'	Brown, v. comp., silty (20-30) f. sand, SM
30.0'	Bottom of exploration

FD-52 Elev. 833.4

0.0' - 0.8'	Topsoil and forest debris
0.8' - 2.5'	Brown, loose, sandy f. silt, ML w/organics
2.5'	Top of bedrock

FD-53	Elev. 661.2	
0.0' - 1.2'		Topsoil
1.2' - 9.0'		Brown, comp., gravelly (20-30) silty (15-25) sand, SM, w/cobbles
9.0'		Top of bedrock
FD-54	Elev. 614.0	
0.0' - 0.9'		Topsoil and forest debris
0.9' - 5.0'		Brown, mod. comp., gravelly (10-20) silty (30-40) m-f sand, SM w/organics
5.0' - 10.0'		Brown, v. comp., silty (5-10) sandy (20-30) gravel, GP-GM, w/cobbles
10.0' - 22.0'		Brown, comp., gravelly 44 silty 10 sand SP-SM w/cobbles or boulders, D_{10} = 0.09
22.0' - 38.2'		Brown, comp., gravelly 38 silty 9 sand, SP-SM, w/cobbles or boulders, D_{10} = 0.075
38.2'		Top of bedrock
FD-55	Elev. 768.3	
0.0' - 0.3'		Topsoil
0.3' - 0.9'		Red brown, loose, gravelly (10-20) sandy (30-40) silt, ML, w/roots
0.9' - 4.2'		Brown, mod. comp., gravelly (20-30) silty (15-25) sand, SM
4.2'		Top of bedrock
FD-56	Elev. 683.8	
0.0' - 5.0'		Topsoil, cobbles and boulders
5.0'		Top of bedrock
FD-57	Elev. 658.4	
0.0' - 5.5'		Brown, comp., gravelly (15-25) silty (20-30) sand, SM, w/boulders and cobbles
5.5'		Top of bedrock
FD-58	Elev. 634.7	
0.0' - 5.0'		Cobbles, boulders and silt
5.0'		Top of bedrock

FD-59 Elev. 779.5

0.0' - 0.2'	Forest debris
0.2' - 1.8'	Brown, loose, sandy f. silt, ML, w/organics and cobbles
1.8'	Top of bedrock

FD-60 Elev. 767.0

0.0' - 0.8'	Forest debris and topsoil
0.8' - 5.0'	Brown, mod. comp. to comp., gravelly 39 silty 14 sand, SM, till, w/cobbles, D_{10} = 0.05
5.0' - 7.1'	Brown, mod. comp., silty (10-20) sandy (30-40) gravel, GM, till like w/boulder
7.1' - 10.0'	Brown, to gray brown, mod. comp., gravelly (30-40) to (20-30) silty (15-25) sand, SM, Till
10.0' - 11.6'	Brown, mod. comp., gravelly (15-25) silty (15-25) sand, SM, sandy till
11.6' - 18.0'	Brown, mod. comp. to comp. gravelly 40 silty 15 sand, SM, till, D_{10} = 0.03
18.0' - 20.0'	Brown, v. comp., silty (10-20) sandy, (30-40) gravel, GM, till
20.0' - 23.0'	Brown, v. comp., gravelly (10-20) silty (10-20) sand, SM
23.0' - 25.5'	Brown, v. comp., gravelly (15-25) silty (15-25) sand, SM, till, w/cobbles
25.5' - 26.4'	Brown, v. comp., gravelly (10-20) silty (30-40) m-f sand, SM
26.4' - 29.0'	Brown, v. comp., silty 39 m-f sand, SM, till, D_{10} = 0.028
29.0' - 30.0'	Brown, v.comp., gravelly (10-20) silty (30-40) f. sand, SM, sandy till
30.0' - 32.7'	Brown, v. comp., silty (20-30) f. sand, SM, w/cobble
32.7' - 39.0'	Brown, v. comp., silty (30-40) f. sand, SM, sandy till
39.0' - 39.8'	Brown, v. comp., silty (20-30) f. sand, SM
39.8'	Bottom of exploration

FD-61 Elev. 659.7

0.0' - 0.4'	Forest debris
0.4' - 1.2'	Topsoil
1.2' - 8.9'	Brown, mod. comp., sand, f. silt, ML, w/boulders and cobbles
8.9'	Bottom of exploration

FD-62 Elev. 763.3

0.0' - 2.8'	Brown, loose, gravelly (10-20) sandy (f. 20-30) silt, ML, w/roots
2.8' - 12.0'	Brown, comp., gravelly (20-30) silty (20-30) sand, SM, Till, w/boulder and cobbles
12.0' - 19.3'	Brown, comp., silty 7 sandy 36 gravel, GP-GM, Sandy, Till, w/ cobbles, D_{10} = 0.11
19.3' - 23.6'	Brown, v. comp., silty 7 sandy 38 gravel, GP-GM, Till, w/cobbles, D_{10} = 0.110
23.6' - 25.0'	Brown, comp., sandy 28 gravel, GP, Till, D_{10} = 0.250
25.0'	Bottom of exploration

FD-63 Elev. 734.1

0.0' - 0.7'	Topsoil
0.7' - 5.0'	Brown, loose to mod. comp., gravelly (10-20) silty (5-10) sand, SP-SM, w/occasional cobbles
5.0' - 10.0'	Brown, mod. comp. to comp., silty 9 sand, SP-SM, w/occasional cobbles, D_{10} = 0.080
10.0' - 15.0'	Brown, comp., silty 30 f. sand, SM, w/cobbles, D_{10} = 0.031
15.0' - 20.0'	Brown, comp., gravelly (10-20) silty (20-30) m-f sand, SM, w/boulder
20.0' - 25.0'	Brown, v. comp., gravelly 17 silty 16 m-f sand, SM, D_{10} = 0.055
25.0' - 25.5'	Brown, comp., silty (20-30) f. sand, SM
25.5' - 30.0'	Gray brown, v. comp., gravelly 26 silty 5 sand, SP-SM, sandy till, D_{10} = 0.100
30.0'	Bottom of exploration

FD-64 Elev. 766.2

0.0' - 1.2'	Topsoil
1.2' - 1.8'	Brown, loose, gravelly (20-30) silty (15-25) sand, SM, Till
1.8' - 5.0'	Brown, comp., gravelly (15-25) silty (5-10) sand, SP-SM, Till, w/boulder
5.0' - 10.0'	Brown, comp., silty 32 sandy 31 gravel, GM, Till, D_{10} = 0.017
10.0' - 16.5'	Brown, comp., gravelly (15-25) silty (20-30) sand, SM, Till, w/cobbles or boulders
16.5' - 20.0'	Brown, comp., gravelly (10-20) silty (10-20) sand, SM, Till, w/cobbles or boulders
20.0' - 23.4'	Brown, v. comp., silty 26 f. sand, SM, w/cobbles, D_{10} = 0.035
23.4' - 24.6'	Brown, v. comp., silty (10-20) sandy (30-40) gravel, GM, Till, w/cobbles
24.6' - 25.0'	Brown, v. comp., silty (30-40) f. sand, SM, Sandy Till
25.0'	Bottom of exploration

FD-65 Elev. 737.1

0.0' - 1.0'	Topsoil
1.0' - 2.3'	Brown, loose, gravelly (20-30) silty (20-30) sand, W/roots and debris
2.3' - 5.0'	Brown, mod. comp., gravelly (20-30) silty (5-10) sand, SP-SM, w/cobbles W_T = 12.5, W_4 = 15.8
5.0' - 10.0'	Brown, mod. comp., gravelly 44 silty 9 sand, SP-SM, Till like w/ cobbles, D_{10} = 0.09
10.0' - 20.0'	Brown, mod. comp. to v. comp. gravelly (30-40) silty (15-25) sand, SM, Till, w/cobbles
20.0' - 25.0'	Brown, v. comp., gravelly 34 silty 20 sand, SM, Till w/cobbles, D_{10} = 0.029, W_T = 9.6, W_4 = 11.2
25.0' - 30.0'	Brown, v. comp., gravelly (10-20) silty (20-30) sand, SM, Till w/cobbles
30.0'	Bottom of exploration

FD-66 Elev. 763.3

0.0' - 1.4'	Topsoil w/roots
1.4' - 10.0'	Brown, mod. comp. to comp., gravelly 44 silty 12 sand, SP-SM, Sandy Till, w/ cobbles, D_{10} = 0.06, W_T = 5.1, W_4 = 6.1
10.0' - 15.0'	Brown, comp., gravelly (20-30) silty (15-25) sand, SM, Sandy Till, w/cobbles
15.0' - 17.0'	Brown, comp., silty (10-20) sandy (30-40) gravel, GM, Till, w/boulder
17.0' - 21.5'	Brown, v. comp., gravelly (10-20) silty (15-25) sand, SM, Till, w/weathered cobbles and boulders
21.5' - 25.0'	Brown, v. comp., gravelly 28 silty 12 sand, SP-SM, Till, w/cobbles and boulders, D_{10} = 0.06, W_T = 7.3, W_4 = 12.3
25.0'	Bottom of exploration

FD-67 Elev. 775.6

0.0' - 1.1'	Topsoil
1.1' - 5.0'	Brown, comp., gravelly (20-30) silty (15-25) sand, SM, Till w/boulders
5.0' - 10.0'	Brown, v. comp., silty 17 sandy 39 gravel, GM, Sandy Till, D_{10} = 0.035, W_T = 4.8, W_4 = 6.2
10.0' - 15.9'	Brown, mod. comp., gravelly (20-30) silty (10-25) sand, SM, sandy Till, w/boulder, W_T = 6.8, W_4 = 8.3
15.9' - 19.0'	Brown, v. comp., gravelly 37 silty 12 sand, SP-SM, Till, w/boulder, D_{10} = 0.06
19.0' - 20.0'	Brown, v. comp., gravelly (20-30) silty (15-25) sand, SM, Till
20.0'	Bottom of exploration

FD-68 Elev. 741.4

0.0' - 1.2'	Topsoil
1.2' - 4.6'	Brown, loose, gravelly (30-40) silty (10-20) sand, SM, Fill, w/roots and organics
4.6' - 5.5'	Brown, loose, silty (15-25) f. sand, SM, w/roots
5.5' - 6.8'	Brown, loose, silty (30-40) f. sand, SM, w/organics

FD-68 Cont'd

6.8' - 15.0'	Brown, v. comp., silty 19 sandy 27 gravel, GM, Till, w/cobbles and boulders, D_{10} = 0.025
15.0' - 20.0'	Gray brown, comp., silty (10-20) sandy (30-40) gravel, GM, Till
20.0' - 25.0'	Gray brown, v. comp., gravelly 34 silty 15 sand, SM, D_{10} = 0.05, W_T = 8.1, W_4 = 10.0
25.0' - 30.0'	Gray brown, v. comp., sandy 43 gravel GP, D_{10} = 0.20
30.0' - 31.5'	Brown, v. comp., silty (15-25) sand, SM
31.5' - 35.0'	Brown, v. comp., silty (20-30) f. sand, SM
35.0' - 36.7'	Brown, comp., silty (10-20) f. sand, SM
36.7' - 40.0'	Brown, v. comp., gravelly 24 silty 6 sand, SP-SM, w/cobbles, D_{10} = 0.13
40.0' - 45.0'	Brown, v. comp., silty (30-40) f. sand, SM, W_T = 13.5, W_4 = 14.4
45.0' - 46.2'	Brown, v. comp., silty (30-40) f. sand, SM, w/small pieces of gravel
46.2' - 50.0'	Brown, v. comp., gravelly 28 silty 14 sand, SM, till like, w/occasional cobbles, D_{10} = 0.06
50.0'	Bottom of exploration

FD-69 Elev. 740.2

0.0' - 3.2'	Black, loose, gravelly (15-25) silty (35-45) sand, SM, w/organics
3.2' - 5.0'	Gray brown, mod. comp., gravelly (15-25) silty (30-40) m-f sand, SM, Sandy Till.
5.0' - 10.0'	Gray brown, comp., silty (5-10) sandy (30-40) gravel, GP-GM, Sandy Till
10.0' - 14.0'	Brown, comp., gravelly 45 silty 7 sand, SP-SM, Sandy Till, w/cobbles, D_{10} = 0.10
14.0' - 16.0'	Brown, comp., sandy (20-30) gravel, GP
16.0' - 20.0'	Brown, comp., sandy 23 gravel, GW, D_{10} = 0.50
20.0' - 29.0'	Brown, mod. comp., silty 14 m-f sand, SM, w/boulders and cobbles, D_{10} = 0.06
29.0' - 30.0'	Brown, comp., gravelly (15-25) silty (15-25) sand, SM
30.0'	Bottom of exploration

FTT-1 Elev. 752.5

0.0' - 0.2'	Forest debris
0.2' - 3.5'	Brown, mod. comp., gravelly 36 silty 20 sand, SM, w/roots
3.5'	Top of bedrock

FT-1	Elev. 658.5	
	0.0' - 0.3'	Forest debris
	0.3' - 1.9'	Topsoil and organic matter
	1.9' - 3.2'	Brown, mod. comp., sandy (m-f 30-40) silt, ML, w/organic matter
	3.2' - 4.6'	Brown, mod. comp., gravelly (15-25) silty (25-35) sand, SM, w/cobbles and hair roots
	4.6'	Top of bedrock
FT-2	Elev. 739.3	
	0.0' - 0.2'	Forest debris
	0.2' - 0.9'	Topsoil
	0.9' - 3.4'	Brown, mod. comp., sandy (m-f 30-40) silt, ML, w/roots
	3.4'	Top of bedrock
FT-3	Elev. 781.3	
	0.0' - 0.3'	Forest debris
	0.3' - 2.5'	Topsoil and organics
	2.5' - 4.0'	Brown, comp., gravelly (10-20) silty (25-35) f. sand, SM, till like, w/hair roots
	4.0' - 5.3'	Gray brown, comp., gravelly (20-30) silty (15-25) sand, SM Till
	5.3'	Top of bedrock
FT-4	Elev. 690.7	
	0.0' - 1.0'	Topsoil and forest debris
	1.0' - 7.0'	Brown, mod. comp., silty (15-25) sandy (30-40) gravel, GM, w/hair roots, cobbles and large fractured boulders
	7.0'	Bottom of exploration
FT-5	Elev. 700.1	
	0.0' - 1.0'	Forest debris
	1.0' - 3.6'	Topsoil
	3.6' - 7.0'	Gray brown, comp., gravelly (15-25) silty (10-20) sand, SM, Till, w/cobbles and boulders
	7.0'	Bottom of exploration

FT-6	Elev. 674.5	
0.0' - 2.2'		Topsoil and forest debris
2.2' - 6.0'		Gray brown, mod. comp., gravelly (10-20) silty (15-25) sand, SM, Till, w/cobbles and boulders
6.0'		Bottom of exploration
FT-7	Elev. 674.6	
0.0' - 2.1'		Topsoil and forest debris
2.1' - 6.0'		Gray brown, mod. comp., gravelly (10-20) silty (15-25) sand, SM, Till, w/cobbles and boulders
6.0'		Bottom of exploration
FT-8	Elev. 704.9	
0.0' - 1.0'		Topsoil and forest debris
1.0' - 3.0'		Brown, mod. comp., gravelly (10-15) silty (25-35) f. sand, SM, w/roots, cobbles and large boulders
3.0'		Refusal due to large boulders
FT-9	Elev. 749.7	
0.0' - 0.6'		Forest debris
0.6'		Top of bedrock
FT-10	Elev. 764.1	
0.0' - 0.9'		Forest debris
0.9'		Top of bedrock
FT-11	Elev. 726.2	
0.0' - 1.0'		Forest debris
1.0' - 2.8'		Topsoil
2.8' - 5.2'		Gray brown, mod. comp., gravelly (10-20) silty (20-30) sand, SM, Till, w/roots, cobbles and boulders
5.2'		Top of bedrock

BD-1 Elev. 715.4

0.0' - 0.2'	Forest debris
0.2' - 1.8'	Dark brown, loose, silty (35-45) f. sand, SM, w/roots and organics
1.8' - 5.0'	Brown and gray, loose to mod. comp., silty (20-30) m-f sand, SM, Till w/boulders
5.0' - 8.0'	Gray brown, mod. comp., gravelly (10-20) silty (20-30) m-f sand, SM, Till, w/weathered boulder, gravel sizes are weathered to decomposed
8.0' - 13.3'	Gray brown, mod. comp., gravelly (15-25) silty (20-30) m-f sand, SM, Till, w/boulders
13.3' - 15.5'	Brown, mod. comp., silty (5-10) sandy (25-35) gravel, GP-GM, Till
15.5'	Top of bedrock

BD-2 Elev. 726.9

0.0' - 0.2'	Forest debris
0.2' - 2.2'	Topsoil
2.2' - 5.0'	Gray brown, mod. comp., gravelly (10-20) silty (30-40) m-f sand, SM, Till
5.0' - 29.0'	Gray brown, mod. comp. to v. comp., sandy (m-f 35) silt, ML, Till, w/cobbles or boulders, D_{10} = 0.005
29.0' - 30.0'	Gray brown, comp., silty (35-45) m-f sand, SM, Till
30.0' - 35.0'	Gray brown, v. comp., gravelly (15-25) silty (35-45) m-f sand, SM, Till, w/cobbles
35.0' - 50.0'	Gray brown, v. comp., sandy, (m-f, 32) silt, ML, Till, w/cobbles
50.0' - 50.8'	Gray, v. comp., gravelly (15-25) sandy (30-40) silt, ML, Till
50.8'	Refusal

BD-3 Elev. 814.1

0.0' - 1.1'	Topsoil and forest debris
1.1' - 5.0'	Brown, mod. comp., gravelly 8 silty 46 sand, SM, Till, D_{10} = 0.0031
5.0' - 8.4'	Brown, loose, gravelly 19 silty 30 sand, SM, Till, W_n = 9.4, W_4 = 10.7, D_{10} = 0.014
8.4' - 10.0'	Gray brown, loose, gravelly 20 silty 30 m-f sand, SM, Till, D_{10} = 0.022
10.0' - 15.0'	Gray brown, mod. comp., silty 43 m-f sand, SM, Till, W_n = 8.3, W_4 = 8.8, γ_d = 140.6, D_{10} = 0.0025
15.0' - 31.6'	Gray brown, comp. to v. comp., gravelly 12, 15, silty 38, 38 m-f sand, SM, Till w/cobbles or boulders and weathered cobbles or boulders, W_n = 6.0, 9.4, W_4 = 7.7, 9.7, D_{10} = 0.0021, 0.007
31.6' - 35.4'	Gray brown, v. comp., silty (30-40) m-f sand, SM, Till, W_n = 8.2, W_4 = 9.0
35.4' - 44.0'	Gray brown, v. comp., gravelly 15, 15 silty 38, 34 m-f sand, SM, Till, w/boulder, W_n = 11.9, W_4 = 13.1, D_{10} = 0.008, 0.009
44.0' - 50.0'	Gray brown, v. comp., gravelly 9 silty 43 m-f sand, SM, Till, W_n = 8.9, W_4 = 9.3, D_{10} = 0.0075
50.0' - 52.4'	Brown, v. comp., stratified, silty (30-40) f. sand, SM, and Silt, ML, layers are approx. 0.2' thick, material also contains weathered rock
52.4' - 59.0'	Weathered rock
59.0' - 59.5'	Brown, v. comp., stratified silt ML and weathered rock
59.5' - 65.0'	Weathered rock
65.0'	Bottom of exploration

BD-4 Elev. 846.0

0.0' - 0.2'	Forest debris
0.2' - 2.2'	Topsoil and brown, loose, gravelly (15-25) silty (20-30) m-f sand, SM, w/roots
2.2' - 5.0'	Brown, mod. comp., gravelly 21 silty 25 sand, SM, Till w/ occasional cobbles, D_{10} = 0.021
5.0' - 10.0'	Brown, mod. comp., gravelly 22 silty 29 m-f sand, SM, Till w/occasional cobbles, W_n = 6.9, W_4 = 7.9, D_{10} = 0.014
10.0' - 15.0'	Brown, mod. comp., gravelly 27 silty 21 sand, SM, Till, w/occasional cobbles, D_{10} = 0.030
15.0' - 21.5'	Brown, comp., gravelly 25 silty 22 sand, SM, Till, w/occasional cobbles, W_n = 6.0, W_4 = 7.4, D_{10} = 0.025
21.5' - 27.2'	Brown, v. comp., slightly variable gravelly (10-20) to 32, silty 26 sand, SM, Till, w/some mica, W_n = 9.1, W_4 = 12.1, D_{10} = 0.013
27.2' - 30.0'	Brown, v. comp., silty (20-30) m-f sand, SM, Till, w/weathered rock
30.0' - 31.5'	Brown, v. comp., stratified silty (30-40) f. sand, SM and silt, ML, layers are approx. 0.2' thick, material also contains weathered rock
31.5' - 34.4'	Weathered rock
34.4'	Top of bedrock

BD-5 Elev. 844.5

0.0' - 0.2'	Forest debris
0.2' - 0.6'	Topsoil
0.6' - 5.0'	Brown, loose to comp., gravelly 32 silty 22 sand, SM, w/roots, W_n = 14.0, W_4 = 18.2, D_{10} = 0.022
5.0' - 10.0'	Brown, comp., gravelly 29 silty 21 sand, SM, Till, w/occasional cobbles, W_n = 6.7, W_4 = 9.9, D_{10} = 0.030

BD-5 Continued

10.0' - 18.2'	Brown, comp., sandy (f. 32) silt, ML Till, w/cobbles or boulders, W_n = 12.0, W_4 = 13.4, D_{10} = 0.036, nonplastic
18.2' - 20.0'	Brown, v. comp., gravelly (10-20) silty (25-35) sand, SM, Till, w/mica and weathered rock
20.0' - 22.0'	Brown, comp., silty (30-40) sand SM, Till
22.0'	Top of bedrock

BD-6 Elev. 903.7

0.0' - 0.2'	Forest debris
0.2' - 0.7'	Topsoil
0.7' - 1.5'	Brown, loose, sandy (25-35) silt, ML, w/roots and organics
1.5' - 2.5'	Brown, loose, gravelly (10-20) silty (20-30) m-f sand, SM, till-like w/roots
2.5' - 5.0'	Brown, mod comp., gravelly (10-20) silty (15-25) sand, SM, till-like, w/occasional cobbles
5.0' - 15.0'	Brown, mod. comp., gravelly 16, 13, silty 30, 30 m-f sand, SM, Till, w/occasional cobbles, W_n = 8.4, 5.7, W_4 = 9.5, 7.5, D_{10} = 0.015, 0.020
15.0' - 17.6'	Brown, mod. comp., to comp., gravelly 20 silty 38 m-f sand, SM Till, D_{10} = 0.014
17.6'	Top of bedrock

BD-7 Elev. 983.7

0.0' - 0.3'	Forest debris and topsoil
0.3' - 5.0'	Gray brown, mod. comp., gravelly (10-20) silty (20-30) sand, SM, Till, w/mica and occasional cobbles
5.0' - 10.0'	Gray, mod. comp., gravelly 9 sandy 37 silty clay, ML-CL, Till, W_n = 7.3, W_4 = 8.2, LL = 21, PI = 6, D_{10} = < 0.001
10.0' - 13.5'	Gray, v. comp., silty clayey 49 sand, SM-SC, Till, D_{10} = 0.006

BD-7 Continued

13.5' - 14.6'	Brown, v. comp., silty clayey (35-45) sand, SM-SC, Till, w/ weathered cobbles
14.6' - 18.0'	Brown, v. comp., gravelly 7 sandy m-f 39 silt, ML, w/cobbles and boulders, D_{10} = 0.003
18.0' - 20.0'	Gray, v. comp., sandy m-f 41 silty clay, ML-CL, Till W_n = 8.9, W_4 = 9.4, LL = 24, PI = 7, D_{10} = 0.0013
20.0' - 21.3'	Gray, v. comp., gravelly (10-20) silty (30-40) m-f sand, SM, Till
21.3'	Top of bedrock

BD-8 Elev. 1040.7

0.0' - 0.2'	Forest debris
0.2' - 1.5'	Brown, loose, sandy (30-40) silt, ML, w/roots
1.5' - 5.0'	Brown, mod. comp., silty 49 m-f sand, SM, Till, D_{10} = 0.0038
5.0' - 10.0'	Brown, mod. comp., sandy 42 silt, ML, Till, W_n = 12.1, W_4 = 12.5, D_{10} = 0.0038, nonplastic
10.0' - 15.0'	Gray, mod. comp., gravelly 8 silty 36 m-f sand, SM, Till, w/occasional cobbles, W_n = 9.7, W_4 = 10.3, D_{10} = 0.007
15.0' - 20.0'	Gray, v. comp., gravelly 15 silty 48 sand, SM, Till, w/occasional cobbles, LL = 19, PI = 3, D_{10} = 0.004
20.0' - 26.5'	Gray, v. comp., gravelly 24 silty 37 m-f sand, SM, Till, w/occasional cobbles, D_{10} = 0.014
26.5' - 27.0'	Gray, v. comp., gravelly (10-20) silty (30-40) m-f sand, SM
27.0' - 27.4'	Weathered rock
27.4'	Top of bedrock

BD-9 Elev. 1043.4

0.0' - 0.2'	Forest debris
0.2' - 1.0'	Brown, soft, gravelly (10-20) sandy (30-40) silt, ML, w/roots and organics
1.0' - 2.3'	Brown, med. stiff, sandy (f.30-40) silt, ML, w/roots

BD-9 Continued

2.3' - 15.0'	Brown, mod. comp. to v. comp., gravelly 10, 7 silty 41, 43, m-f sand, SM, Till, w/cobbles and boulders, W_n = 11.5, 7.4, W_4 = 12.3, 7.6, γ_d = 134.1, D_{10} = 0.0075, 0.0055
15.0' - 19.1'	Brown, v. comp., gravelly 12 silty 37 sand, SM, Till, w/cobbles and boulders, D_{10} = 0.011, W_n = 9.4, W_4 = 10.0
19.1'	Top of bedrock

BD-10 Elev. 750.0

0.0' - 0.2'	Forest debris
0.2' - 1.5'	Brown, loose, gravelly (10-20) silty (25-35) sand, SM, w/roots and organics
1.5' - 5.0'	Brown, mod. comp. to comp., gravelly 35 silty 18 sand, SM, Till, w/cobbles and boulders, D_{10} = 0.040
5.0' - 7.0'	Brown, mod. comp., silty (20-30) sandy (30-40) gravel, GM, Till, w/cobbles and boulders
7.0' - 15.0'	Brown, mod. comp. to v. comp., gravelly 33 silty 22 sand, SM, Till, w/cobbles and boulders, D_{10} = 0.021
15.0' - 19.7'	Brown, mod. comp., gravelly (10-20) silty (20-30) sand, SM, Till w/cobbles, boulders and weathered rock
19.7'	Top of bedrock

BD-11 Elev. 878.4

0.0' - 0.2'	Forest debris
0.2' - 1.5'	Brown, loose gravelly (10-20) sandy (30-40) silt, ML, w/roots
1.5' - 5.0'	Brown, mod. comp., silty (30-40) m-f sand, SM, Till, W_n = 11.6, W_4 = 12.4
5.0' - 15.0'	Brown, mod. comp., gravelly 19 silty 32 sand, SM, Till, W_n = 10.0 W_4 = 11.0, γ_d = 131.6, D_{10} = 0.010

BD-11 Continued

15.0' - 20.0'	Brown, v. comp., gravelly 26 silty 35 sand, SM, Till, w/cobbles, $W_n = 9.2$, $W_4 = 9.6$, $\gamma_d = 136.5$, $D_{10} = 0.013$
20.0' - 22.5'	Brown, mod. comp., gravelly (10-20) silty (30-40) sand, SM, Till, w/ cobbles
22.5' - 25.0'	Gray, v. comp., sandy 39 silt, ML, Till, w/cobbles, $D_{10} = 0.005$
25.0' - 29.0'	Brown, v. comp., gravelly (10-20) silty (35-45) sand, SM, Till, w/cobbles
29.0' - 32.8'	Brown, comp., gravelly 17 silty 35 sand, SM, Till, w/cobbles, $D_{10} = 0.014$
32.8'	Top of bedrock

BD-12 Elev. 908.0

0.0' - 0.3'	Forest debris
0.3' - 1.4'	Black, loose, gravelly (10-20) silty (25-35) sand, SM, w/orgamics
1.4' - 5.0'	Gray brown, mod. comp., silty (30-40) f. sand, SM, w/cobbles stratified, $W_n = 13.6$, $W_4 = 15.7$
5.0' - 10.0'	Gray brown, mod. comp., gravelly 29 silty 20 sand, SM, till-like, $W_n = 9.5$, $W_4 = 14.1$, $D_{10} = 0.028$
10.0' - 13.8'	Gray brown, mod. comp., gravelly 12 silty 28 m-f sand, SM $W_n = 12.3$, $W_4 = 14.4$, $D_{10} = 0.018$
13.8' - 15.0'	Gray brown, mod. comp., silty (30-40) m-f sand, SM, Till
15.0' - 24.0'	Gray brown, comp. to v. comp., gravelly 6 silty 36 m-f sand, SM, Till, $W_n = 11.3$, $W_4 = 11.6$, $\gamma_d = 135.2$, $D_{10} = 0.065$
24.0' - 26.4'	Gray brown, v. comp., gravelly (10-20) silty (25-35) sand, SM, Till
26.4' - 29.3'	Gray brown, v. comp., silty (25-35) m-f sand, SM, Till, w/ weathered rock
29.3'	Top of bedrock

BD-13 Elev. 957.0

0.0' - 0.8'	Topsoil
0.8' - 1.3'	Brown, loose, gravelly (10-20) silty (25-35) m-f sand, SM, w/roots
1.3' - 5.0'	Brown, mod. comp. to comp., silty (25-35) m-f sand, SM, Till, W_n = 8.4, W_4 = 9.5
5.0' - 15.0'	Brown, mod. comp., gravelly 19 silty 35 sand, SM, Till, W_n = 8.3, W_4 = 10.7, D_{10} = 0.091
15.0' - 20.0'	Brown, mod. comp., silty (20-30) f. sand, SM, w/strata of fine sandy silt, ML and inclusion of Till and w/occasional cobbles
20.0' - 29.0'	Gray brown, mod. comp. to v. comp., gravelly 6 silty 44 m-f sand, SM Till, W_n = 8.6, W_4 = 9.9, D_{10} = 0.0055
29.0' - 38.0'	Gray brown, v. comp., gravelly 11 silty 45 sand, SM, Till, W_n = 8.4, W_4 = 9.6, D_{10} = 0.008
38.0'	Top of bedrock

BTT-1 Elev. 639.4

0.0' - 0.8'	Sod and topsoil
0.8' - 2.0'	Brown, loose, gravelly (10-20) silty (15-25) sand, SM, w/cobbles and boulders
2.0' - 4.9'	Brown, comp., sandy (30-40) gravel, GP, w/cobbles and high concentrations of boulders
4.9'	Refusal

BTT-2 Elev. 659.3

0.0' - 1.0'	Sod and topsoil
1.0' - 2.1'	Brown, loose, gravelly (15-25) silty (20-30) m-f sand, SM
2.1' - 14.0'	Brown, loose, sandy (30-40) gravel, GP, w/numerous cobbles and boulders
14.0'	Botton of exploration

BTT-3 Elev. 660.8

0.0' - 19.0'	Brown, mod. comp., sandy 48, 42 gravel, GP, w/cobbles and boulders D_{10} = 0.18, 0.18
19.0'	Bottom of exploration

BTT-3A Elev. 660±

0.0' - 12.0'	Brown, mod. comp., sandy 40, 42, 47 gravel, GP, w/cobbles and boulders D_{10} = 0.30, 0.17, 0.17
12.0' - 19.0'	Brown, mod. comp., gravelly 44 silty 7 sand, SP-SM, w/cobbles and boulders, D_{10} = 0.095
19.0'	Bottom of exploration

BTT-4 Elev. 625.4

0.0' - 2.1'	Topsoil mixed with roots
2.1' - 3.2'	Brown, comp., silty (5-10) sandy (30-40) gravel, GP-GM, w/cobbles
3.2' - 9.6'	Brown, comp., sandy 37 gravel GP, w/numerous cobbles, D_{10} = 0.20
9.6' - 16.5'	Brown, comp., m-f sandy 41 gravel, GP, w/numerous cobbles. Bedrock encountered at 16.5 at the west end of trench, D_{10} = 0.15
16.5' - 20.0'	Brown, comp., silty 5 f. sand SP-SM, D_{10} = 0.09
20.0'	Top of bedrock

BTT-5 Elev. 630.5

0.0' - 0.6'	Topsoil
0.6' - 1.3'	Brown, loose, gravelly,sandy, silt, ML, w/roots, cobbles and boulders

BTT-5 (Continued)

1.3' - 8.0'	Brown, comp., sandy 45 gravel, GP, w/cobbles and boulders, D_{10} = 0.17
8.0' - 9.1'	Gray, comp., silty (25-35) f. sand, SM
9.1' - 20.0'	Brown, comp., sandy 40 gravel, GP, w/ cobbles, boulders and sand lenses, D_{10} = 0.40
20.0'	Bottom of exploration

BTT-6 Elev. 618.1

0.0' - 0.9'	Topsoil
0.9' - 1.6'	Brown, loose, sandy silt, ML
1.6' - 20.0'	Brown, mod. comp., sandy 44, 39, 39 gravel, GP, w/numerous cobbles and w/a pocket of medium sand between 8.3' and 9.6' approx. 9' long and w/ a pocket of coarse sand between 11.4' and 12.4' approx. 6' long, D_{10} = 0.14, 0.25, 0.46
20.0'	Bottom of exploration

BTT-7 Elev. 622.3

0.0' - 0.6'	Topsoil
0.6' - 1.8'	Gray brown , loose, sandy (f. 30-40) silt, ML, w/ a trace of gravel
1.8' - 7.0'	Brown, comp., sandy 30 gravel, GP, w/ numerous cobbles, boulders and w/pockets of cobbles D_{10} = 0.25
7.0' - 12.0'	Brown, comp., sandy 48 gravel, GP w/numerous cobbles, boulders and w/pockets of c-f sand, D_{10} = 0.33
12.0' - 17.0'	Brown, comp., sandy (30-40) gravel, GP
17.0' - 21.5'	Brown, comp., gravelly 33 sand, SW, D_{10} = 0.25
21.5'	Bottom of exploration

BTT-8 Elev. 624.7

0.0' - 1.0'	Brown, mod. comp., silty, sandy gravel
1.0' - 20.6'	Brown, mod. comp., sandy 30, 31 gravel, GW, w/numerous cobbles D_{10} = 0.30, 0.31
20.6'	Bottom of exploration

BTT-9 Elev. 617.3

0.0' - 0.3'	Topsoil
0.3' - 2.8'	Brown, comp., silty, sandy gravel, GP-GM, w/cobbles
2.8' - 17.9'	Brown, comp., sandy 43, 42 gravel, GP, w/numerous cobbles, D_{10} = 0.29, 0.38

BTT-9 (Continued)

17.9' - 20.0'	Brown, loose, gravelly (20-30) sand, SP, w/strata of f. gravel
20.0' - 23.5'	Gray brown , loose, sandy, SP, w/strata of f. gravel, D_{10} = 0.31
23.5'	Bottom of exploration

BTT-10 Elev. 625.9

0.0' - 1.3'	Topsoil
1.3' - 12.0'	Brown, mod. comp., sandy 42 gravel, GP, w/cobbles, D_{10} = 0.42
12.0' - 21.0'	Brown, mod. comp., m-f sand, SP, stratified as follows: 13.8' - 14.1' Dark gray silty f sand 15.5' - 15.9' Sandy gravel 16.6' - 17.3' Sandy gravel, D_{10} = 0.16
21.0'	Bottom of exploration

BTT-11 Elev. 617.1

0.0' - 1.3'	Brown, sandy, silty gravel, GM, w/cobbles
1.3' - 16.2'	Brown, mod. comp., sandy (30-40) gravel, GP, w/cobbles
16.2' - 20.0'	Brown, mod. comp., m-f sand, SP, w/trace of gravel
20.0'	Bottom of exploration

BTT-12 Elev. 640.7

0.0' - 1.4'	Topsoil
1.4' - 3.0'	Brown, mod. comp., sandy (f. 30-40) silt, ML
3.0' - 7.5'	Brown, mod. comp., gravelly (30-40) silty (5-10) sand, SP-SM
7.5' - 11.5'	Brown, mod. comp., sandy (30-40) gravel, GP
11.5' - 21.0'	Brown, mod. comp., gravelly (30-40) silty (5-10) sand, SP-SM, stratified
21.0'	Bottom of exploration

BTT-13 Elev. 657.6

0.0' - 2.2'	Brown, comp., silty, sandy, gravel, GM
2.2' - 8.5'	Brown, mod. comp., sandy 40, 39 gravel, GP, w/cobbles and boulders D_{10} = 0.34, 0.35
8.5' - 21.0'	Brown, mod. comp., sandy 39 gravel, GP, D_{10} = 0.29, stratified w/m-f sand pockets 2' thick by 9' long and 2.5' thick by 11' long
21.0'	Bottom of exploration

BTT-14 Elev. 624.3

0.0' - 2.1'	Brown, loose, sandy (f) silt, ML w/trace of gravel
2.1' - 22.0'	Brown, mod. comp., sandy 42, 42, gravel, GP, w/cobbles and boulders, D_{10} = 0.12, 0.22
22.0'	Bottom of exploration

BTT-15 Elev. 627.3

0.0' - 2.3'	Topsoil
2.3' - 9.4'	Brown, mod. comp., sandy (30-40) gravel, GP, w/numerous boulders and w/ a pocket of stratified sand SP, 9' long between 4.7' and 5.9'
9.4'	Bottom of exploration

BTT-16 Elev. 632.3

0.0' - 1.4'	Topsoil
1.4' - 7.0'	Brown, mod. comp., sandy 40 gravel, GP, w/ cobbles and boulders, D_{10} = 0.18
7.0' - 13.0'	Brown, mod. comp., sandy 25 gravel, GP, w/cobbles and boulders, D_{10} = 0.28
13.0' - 19.0'	Brown, mod. comp., sandy 27 gravel, GW, w/cobbles and boulders, and w/ a 5' pocket of med. sand, large boulder on bottom of trench
19.0'	Bottom of exploration

BTT-17 Elev. 632.6

0.0' - 2.5'	Topsoil
2.5' - 15.2'	Brown, mod. comp., sandy (30-40) gravel, GP, w/cobbles and boulders
15.2' - 20.0'	Brown, mod. comp., silty (5-10) sandy (30-40) gravel, GP-GM, w/cobbles and boulders
20.0'	Bottom of exploration

BTT-18 Elev. 633.6

0.0' - 1.8'	Topsoil
1.8' - 8.0'	Brown, mod. comp., sandy (25-35) gravel, GP, w/cobbles
8.0' - 17.5'	Brown, mod. comp., sandy (30-40) gravel, GP, w/cobbles and boulders
17.5' - 20.0'	Brown, mod. comp., gravelly (25-35) sand, SP, w/cobbles
20.0'	Bottom of exploration

BTT-19 Elev. 940.0

0.0' - 0.2'	Forest debris
0.2' - 2.0'	Brown, loose, gravelly (10-20) silty (30-40) sand, SM, w/roots and organics
2.0'	Top of bedrock

BTT-20 Elev. 1040±

0.0' - 0.8'	Topsoil and forest debris
0.8' - 2.5'	Brown, mod. comp., gravelly (10-20) silty (25-35) sand, SM, w/roots and cobbles
2.5' - 5.0'	Brown, mod. comp., gravelly 10 silty 36 sand, SM, Till, w/cobbles, D_{10} = 0.01
5.0' - 7.0'	Brown, comp., gravelly 17 silty 32 sand, SM, Till, w/cobbles, D_{10} = 0.012
7.0' - 9.7'	Brown, comp., gravelly 19 silty 32 sand, SM, Till, w/boulders, D_{10} = 0.011
9.7'	Bottom of exploration