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OF GENERAL INTEREST

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THE DESIGN OF ECCENTRICALLY LOADED STEEL COLUMNS

By J. M. Biggs*

(Presented at a meeting of the Structural Section of the Boston Society of Civil Engineers, held on April 12, 1950.)

Introduction

Design procedures for eccentrically loaded steel columns in use at the present time are inclined to be vague and irrational. Many design specifications are inadequate and the designer must alter them to suit his particular case. Therefore, they are sometimes used in a manner for which they were not intended and in cases to which they do not apply. It is the purpose of this paper to clarify the situation and to aid the designer in his interpretation of these procedures. The entire problem of column analysis, with or without eccentricity, is far from a solution. However, the author has chosen to consider eccentrically loaded columns for three reasons: (1) It is the more general case, (2) present day practice in the design of "concentrically" leaded columns involves assumed eccentricities, and (3) the many design specifications in use disagree most widely when the eccentricities are the result of computed end moments.

The wide variation in the design procedures of four commonly

*Assistant Professor of Structural Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

[1]"Standard Specifications for Highway Bridges" (1949), The American Association of State Highway Officials.

"Specifications for Steel Railway Bridges" (1948), American Railway Engineering Association.

"Specification for the Design, Fabrication and Erection of Structural Steel for Buildings" (1948), American Institute for Steel Construction.

Building Code of the City of Boston (1944).

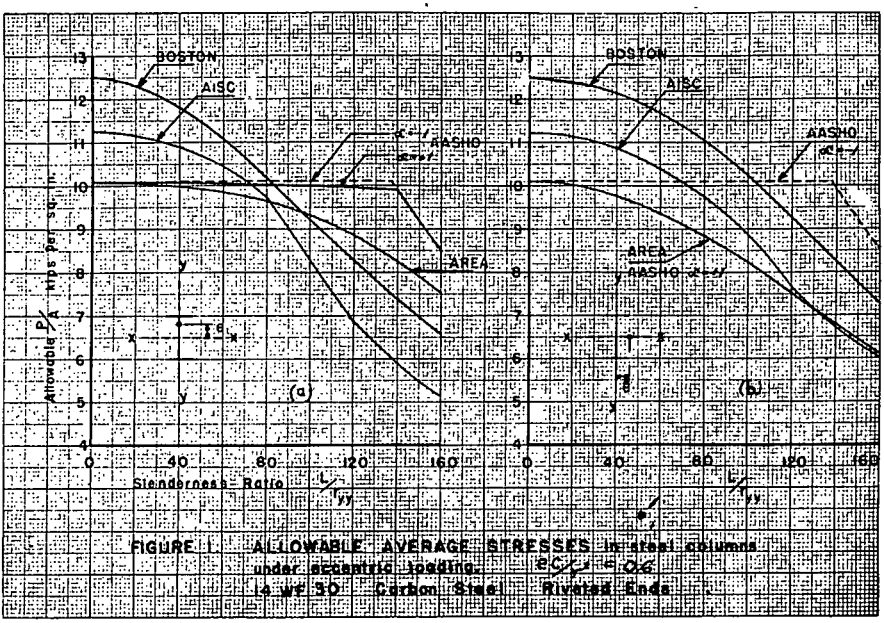


FIGURE 1. ALLOWABLE AVERAGE STRESSES in steel columns under eccentric loading. $\frac{ec}{r^2} = 0.6$ A WF 30 Carbon Steel Riveted Ends

used specifications[1] is shown in Figure 1. The many reasons for this disagreement will be discussed subsequently. For the moment we will merely note that in Fig. 1(a) at $L/r_{yy} = 140$ the range of allowable average stress is about 4 kips per sq. in. or two thirds of the smallest value. It should also be noted that although the building specifications basically permit a lower factor of safety, they allow smaller loads at large L/r values than do the bridge specifications.

The body of this paper will be divided into two principal parts: (A) A review of basic theory, and (B) an evaluation of the four design specifications mentioned. A considerable portion of part (A) is devoted to design formulas for concentric loads. It is impossible to discuss design formulas for eccentric loading without first considering the concentric formulas to which they are closely related. Regarding the comments on design specifications, it must be remembered that each was written for a particular type of structure. The author has selected two specifications for bridges and two for buildings. They will be discussed as general design procedures and some of the criticisms offered may be of small importance in that particular type of structure for which the specification was written. It is not

the author's purpose to condemn the framers of specifications, but rather to throw some light on this rather complicated, yet frequently encountered, aspect of structural design.

Basic Theory

Types of Failure

There are three types of failure generally encountered in an eccentrically loaded column:

a. Buckling in the plane of the eccentricity. In practically all columns encountered in structural design this occurs only after the stress on the extreme fiber has exceeded the yield point.

b. Lateral-torsional buckling. This is the combined result of lateral buckling due to axial load and torsional buckling due to bending and occurs in certain types of cross sections when the eccentricity is in the major principal plane.

c. Local crippling of component parts of the column.

The third type of failure will not be considered because most structural shapes are so proportioned that crippling would not occur until the stress was above the yield point. The first two types of failure will be discussed in detail.

The "Ideal" Column

If a column is perfectly straight and the load is perfectly concentric, the load at which instability occurs is given by the Euler equation,

$$P_{cr} = \frac{\pi^2 EI}{(kL)^2} \qquad (1)$$

in which k is a factor the value of which depends upon the conditions of end restraint. Equation (1) is valid only when the material is not stressed above the proportional limit and hence applies only to a very long, slender member.

If the column is short so that the material reaches the proportional limit before buckling occurs, the critical load must be computed by a method which considers the variation in modulus of elasticity above the proportional limit. Two such methods are the "tangent modulus" theory and the "double modulus" theory. The former is more commonly considered to be correct for design purposes.[2]

[2] "Applied Column Theory", by F. R. Shanley, A.S.C.E. Proceedings, June 1949.

The Practical Column

In practice the columns of a structure are never "ideal". The material is not homogeneous, the member is not perfectly straight, the load is not perfectly concentric and there are residual internal stresses. For these reasons the problem from the start is one of combined direct stress and bending. As the load increases the column deflects laterally. At some load value the material on one side of the column reaches the yield point, the lateral deflection increases more rapidly and eventually collapse occurs. The determination of the ultimate load in this case is very complicated since one must consider the initial imperfections, the shape of the stress-strain curve, the shape of the cross section and the conditions of end restraint.

The Secant Formula

Most present day design formulas for "concentrically" loaded columns are based upon the following assumptions: (1) The effect of all imperfections may be represented by an assumed eccentricity of loading, and (2) the limit of the usefulness of the column is reached when the stress at any point in the cross section reaches the yield point.

On these assumptions the well known Secant Formula may be applied as follows:

In Figure 2 the maximum stress in a pin-ended column occurs at mid-height where the bending moment equals $P \times (e_o + \Delta)$. e_o is the assumed end eccentricity and Δ is the lateral deflection of the column at mid-height. Assuming E to be constant, this maximum is given by,

$$f_m = P/A\ (1 + e_o c/r^2 \operatorname{Sec} L/2r\sqrt{P/EA}) \qquad (2)$$

Letting f_m equal the yield point stress, f_y, according to assumption (2),

$$\frac{P}{A} = \frac{f_y}{1 + e_o c/r^2 \operatorname{Sec} L/2r\ \sqrt{P/EA}} \qquad (2a)$$

Converting Equation (2a) into a design formula, the factor of safety, n, and the length reduction factor, k′, are introduced to obtain,

$$\text{allowable}\ \frac{P}{A} = \frac{f_y/n}{1 + e_o c/r^2 \operatorname{Sec} k'L/2r\ \sqrt{nP/EA}} \qquad (3)$$

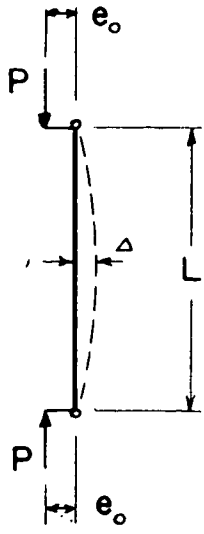


FIG. 2.

It should be noted that the length reduction factor, k′, does not have the same real significance as the factor, k, in Equation (1). The latter indicates the effect of end restraint on elastic stability, whereas the former indicates the effect of end restraint on lateral deflection under eccentric loading.

The Secant Formula has been verified by many laboratory tests, one of the most complete programs being that of the A.S.C.E. Special Committee on Steel Column Research.[3] It should be noted however, that these tests deliberately reproduced the conditions assumed by the Secant Formula rather than those which would exist in an actual structure.

The Secant Formula has been and will continue to be the subject of many differences of opinion. One school of thought believes that it is a mistake to base design on assumed imperfections. It is felt that design should be based on the "ideal" column, and all uncertainties included in the factor of safety. The opposite school believes that if the uncertainties are isolated they can be more effectively dealt with.

[3]Final Report of the Special Committee on Steel Column Research, Transactions, A.S.C.E., Vol. 98, 1933.

It is also felt by some that it is too conservative to base design upon the yield point stress rather than upon the ultimate strength. As mentioned previously, the difference between the two depends upon the shape of the cross section, and is similar to the ultimate resisting moment of a beam as compared to that moment which first produces yielding in the extreme fibers. In the case of a wide-flange section the difference is slight when the eccentricity is in the plane of the web, but is considerable when the eccentricity is in the perpendicular plane. Because of this dependence upon cross section, it would be difficult to include a consideration of ultimate strength in a design specification. It is also questionable that the basis for design of ordinary structures should envisage strains beyond the yield point even though the resulting permanent distortions are normally small until the ultimate load is exceeded. Furthermore, the problem of lateral-torsional stability to be investigated later becomes very serious when the stress on the extreme fiber reaches the yield point. For the present at least, it would seem that the yield point stress should remain the basis for design.

The use of an assumed initial eccentricity as well as a reduced length is contradictory, since the former decreases and the latter increases the allowable load. Actually the two are related. If a column which is riveted to other members at its ends has an initial eccentricity, that eccentricity does not remain constant with increasing load. It may be shown[4] that in certain cases the eccentricity actually becomes negative when the ultimate column load is approached. This end restraint is, of course, exactly what the length reduction factor implies. An assumed eccentricity based upon the initial straightness of the column has a very uncertain effect upon the ultimate strength of the column as part of a frame and is a very arbitrary basis for design.

Experimental determination of these factors is very difficult because it cannot be accomplished by testing isolated columns. The use of an arbitrary length reduction factor for "riveted" ends is a very rough approximation at best. The degree of restraint obviously depends upon the stiffnesses of the members as well as the type of connection. The only complete solution is to determine the critical load by analyzing the frame as a whole rather than by

[4]"Rational Column Analysis", by J. A. Van den Broek, The Engineering Journal, June, 1942.

dealing with members individually. At the present time this is outside the scope of ordinary design practice. This is perhaps the most important and difficult problem in the derivation of rational formulas for column design.

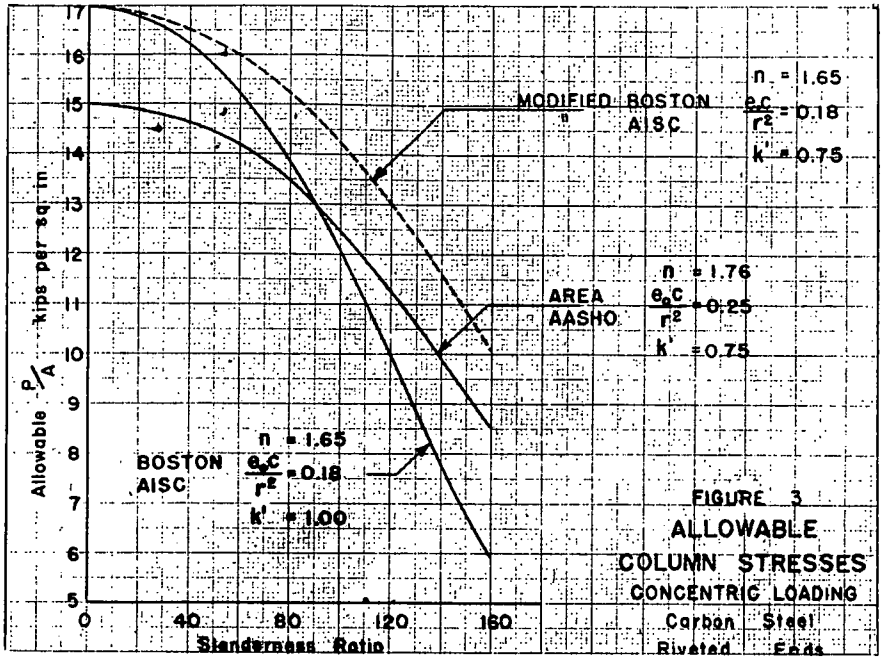
Design Formulas for Concentric Loads

Most design formulas in use at the present time are based upon the Secant Formula. Because it is somewhat cumbersome mathematically, empirical formulas of the parabolic type have been substituted with their constants chosen so as to make them coincide very nearly with the Secant Formula.

To arrive at a design formula from Equation (3) there are three arbitrary factors to be decided upon: (1) The factor of safety, n, (2) the accidental eccentricity ratio, e_oc/r^2, and (3) the length reduction factor, k'. The factor of safety depends upon the type of structure and is the prerrogative of those writing the specification. The A.S.C.E. Committee[3] recommended an eccentricity ratio of 0.25 (e.g., the maximum stress intensity on one side of the column is 1.25 times the average stress) which was meant to include possible secondary bending moment as well as accidental eccentricity or crookedness of the column. The same committee recommended a length reduction factor of 0.75 for riveted ends and 0.85 for pinned ends.

In Figure 3 are shown curves of the concentric column formulas for riveted ends as given by the four specifications under consideration. The two bridge specifications have adopted the following factors in the Secant Formula: $n = 1.76$ for carbon steel, $e_oc/r^2 = 0.25$, $k' = 0.75$ for riveted ends and 0.875 for pinned ends. The two building specifications imply the following factors: $n = 1.65$, $e_oc/r^2 = 0.18$, and $k' = 1.00$ for all end conditions. In the latter case some reduction in length is implied at high slenderness ratios, but within the range shown k' is essentially unity. The lack of length reduction in the building specifications is quite conservative in most cases.

The main purpose in presenting Figure 3 is illustrated by the dashed curve which shows the A.I.S.C. or Boston Code formula with the length reduced as in the A.A.S.H.O. or A.R.E.A. specification, that is, $k' = 0.75$. The percentage difference between the dashed curve and the bridge specifications is essentially constant and is



primarily due to a difference in factor of safety. Thus the length reduction factor is the principal item of disagreement. The assumed eccentricity ratio has a relatively minor effect and is in reality a part of the factor of safety. This point is emphasized because the length reduction factor is also one of the more important reasons for the variation in the design formulas for eccentric loads.

Eccentrically Loaded Columns

The Secant Formula may of course be adapted to the case where the eccentricity is known. The end moment (P x e) may have been computed by considering a column as part of a rigid frame or by a secondary stress analysis of a compression member in a truss. It should be recognized, however, that the Secant Formula represents a very special case. The column is assumed to be in single curvature, and the eccentricities at the two ends of the member are assumed to be of the same magnitude and direction. This case is very rarely encountered in practice.

The length reduction factor, k′, is probably more uncertain in

this case than in the case of "concentrically" loaded columns. In rigid frame construction the computed eccentricity may be the result of a negative end moment in a beam framing into the column. In order for the beam to restrain the column as the length reduction implies, this moment must be reduced thereby creating a condition for which the beam was not designed.

A more general equation for maximum stress was developed by D. H. Young in 1932[5] and proposed as a design procedure in 1936.[6] Figure 4 shows a column subjected to a compression load, P, having

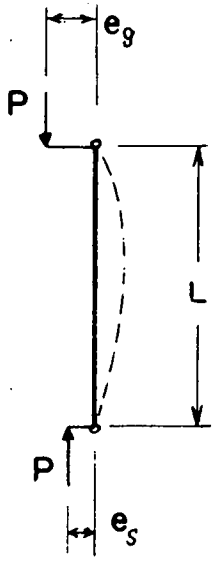


FIG. 4.

an eccentricity of e_g at one end and a smaller eccentricity, e_s, at the other end. Below a certain critical value of the slenderness ratio, L/r, the maximum stress intensity occurs at the end of the column having the larger eccentricity and may be computed by,

$$f_m = \frac{P}{A} + \frac{Mc}{I} = \frac{P}{A}\,(1 + e_g c/r^2) \qquad (4)$$

[5]"Stresses in Eccentrically Loaded Steel Columns", by D. H. Young, Publications, International Assoc. for Bridge & Struct. Eng., 1932.

[6]"Rational Design of Steel Columns", by D. H. Young, A.S.C.E. Transactions, 1936.

The critical slenderness ratio may be determined by,

$$(L/r)_{cr} = (\cos^{-1} \propto) \left[\frac{E\,(1 + e_g c/r^2)}{f_y}\right]^{1/2} \qquad (5)$$

in which $\propto = \frac{e_s}{e_g}$ and may vary from +1 to —1. Above the critical slenderness ratio the point of maximum stress intensity will lie somewhere between the end where the larger eccentricity occurs and the center of the column. As a result, the maximum stress intensity is now a function of the lateral deflection. In this event, the maximum stress is given by,

$$f_m = P/A\ (1 + e_g c/r^2\ B\ \text{Cosec}\ \Phi) \qquad (6)$$

in which, $B = [\propto^2 - 2 \propto \cos \Phi + 1]^{1/2}$, and $\Phi = L/r\sqrt{P/AE}$.

This derivation is based upon a constant value of E. At the critical slenderness ratio, B Cosec $\phi = 1$, and Equation (6) reduces to Equation (4). For $\propto = +1$, the critical slenderness ratio is zero and Equation (6) reduces to the Secant Formula, Equation (2). For $\propto = -1$, Equation (5) is a form of the Euler Equation and Equation (4) usually applies.

These equations have been adopted by the A.A.S.H.O. Specifications and will be considered more thoroughly in Part B.

Lateral-Torsional Stability

When a column is subjected to an eccentric load in the major principal plane, failure may occur not as the result of bending about the major principal axis, but rather as the result of elastic instability in a lateral or torsional sense. This is particularly true of a wide-flange column section with an eccentricity in the plane of the web. The critical concentric load on such a member would of course cause buckling in a plane perpendicular to the web. The eccentricity, even though not in that plane, appreciably reduces this critical load. The resulting instability is a combination of torsional instability as associated with beams and lateral instability as associated with the concentrically loaded column.

A theoretical analysis[7] has been made to determine the critical

[7] "Lateral Buckling of I-Section Columns With Eccentric End Loads in Plane of Web", by Bruce Johnston, A.S.M.E. Journal of Applied Mechanics, Dec., 1941.

load for a column subjected to an eccentric load in the strong plane. The critical condition was found to be,

$$P/P_{cr} + (P \times e)^2/M_{cr}^2 = 1 \qquad (7)$$

in which,

P_{cr} = the critical Euler Load in the weak plane

$$= \frac{\pi^2 EI_{yy}}{(kL)^2}$$

M_{cr} = the critical moment for torsional buckling of the column loaded with equal end moments but no axial load

$M_{cr} = \pi/kL\ [EI_{xx}GK]^{1/2}\ [\pi^2 a^2/(kL)^2+1]^{1/2}$

K, a = torsion constants

Equation (7) was found to be valid for rectangular sections as well as I-sections. It is applicable only when the maximum stress intensity is within the elastic range, although P_{cr} and M_{cr} individually may indicate stresses above the proportional limit.

The equation may be converted to obtain working values by dividing P_{cr} and M_{cr} by a factor of safety as follows,

$$nP/P_{cr} + (n \times P \times e)^2/M_{cr}^2 = 1 \qquad (7a)$$

It may further be converted into terms of stress intensity thus:

$$f_s/F_s + (f_b/F_b)^2 = 1 \qquad (8)$$

in which $F_s = P_{cr}/An$ and $F_b = M_{cr}c/I_{xx}n$

The calculation of M_{cr} is rather laborious and perhaps not feasible for a standard design procedure. An approximate solution could be obtained using F_s and F_b as given by present design specifications for concentrically loaded columns and beams subjected to bending respectively. Such a method would, of course, inherit any errors involved in these two allowable stresses. It would also be approximate due to the fact that F_s would not be exactly associated with the Euler load, but rather with a load having an assumed eccentricity.

Thus we may conclude that the design of an eccentrically loaded column involves two criteria. First, that of inelastic buckling in the plane of bending which is preceded by a yielding of the material on

one side of the column. Second, that of elastic instability which is a combination of column action and beam action. The two criteria have little in common and must be dealt with separately.

Design Specifications Eccentrically Loaded Columns *A.R.E.A.*[1]

The Secant Formula, Equation (2), may be written to include bending in both principal planes as follows:

$$f_m = \frac{P}{A}\left(1 + \frac{e_1c_1}{r_1^2}\,\mathrm{Sec}\,\frac{k'L}{2r_1}\sqrt{\frac{P}{EA}} + \frac{e_2c_2}{r_2^2}\,\mathrm{Sec}\,\frac{k'L}{2r_2}\sqrt{\frac{P}{EA}}\right) \quad (9)$$

The A.R.E.A. has converted Equation (9) into the following design formula:

$$f_s = \text{Allowable}\,\frac{P}{A} = \frac{f_y/n}{1 + \left(\frac{e_1c_1}{r_1^2} + 0.25\right)\mathrm{Sec}\,\frac{k'L}{2r_1}\sqrt{\frac{nP}{AE}} + \frac{e_2c_2}{r_2^2}\,\mathrm{Sec}\,\frac{k'L}{2r_2}\sqrt{\frac{nP}{AE}}} \quad (10)$$

in which the subscript 1 refers to the weaker principal plane and the subscript 2 the stronger. The accidental eccentricity ratio, $\frac{e_oc}{r^2}$, is retained with a value of 0.25 as in the formula for concentric loads. It is significant to note that this eccentricity ratio is specifically placed in the weak direction. The eccentricities e, and e_2 are computed by analysis. The values of n and k′ are the same as in the formulas for concentric loads given in Part A.

Equation (10) includes all of the basic weaknesses of the Secant Formula which were discussed in Part A. Perhaps the most serious weakness is the fact that it assumes the computed eccentricities at the two column ends to be equal in magnitude and direction. This would be the case of $\alpha = +1$ in Equation (6). In each plane, the eccentricity used must be the larger of the values at the two ends of the column. This is true even if the larger values in the two planes occur at opposite ends of the column. Because many columns encountered in practice have reversed curvature, Equation (10) gives a rather conservative design.

The use of an accidental eccentricity ratio is still open to question. Assuming that it should be included and that it could occur in any direction it is logical to place it in the weak plane. For any given length of column the secant term in the weak plane will be larger than that in the strong plane, and an assumed end eccentricity in the former causes a greater reduction in allowable stress.

The length reduction factor, k', is subject to serious criticism as discussed in Part A.

Equation (10) makes no allowance for lateral-torsional stability. The specifications do not indicate when the member ceases to become a column and, in this event, how it should be designed as a beam. As mentioned previously this instability is particularly serious for a wide-flange column section with computed bending moments in the plane of the web. Equation (10) is partially fortified against this possibility by the accidental eccentricity in the weak plane. If the member is very weak in the plane perpendicular to that of bending, the accidental eccentricity is magnified by the secant term and this effect approximately reflects the possibility of lateral-torsional buckling. This point will be illustrated in connection with Figure 5.

The AREA specification, Equation (10), is rather cumbersome in application. However, if the computed bending is in one plane only, charts may be drawn which simplify the solutions considerably.

The effect of the various items mentioned above may be seen in Figure 1. The rather light and narrow wide-flange section was chosen because it illustrated the possibility of lateral-torsional instability. The curves on Figure 1 if drawn for wider or heavier sections would not differ significantly from those shown. The computed eccentricity ratio of 0.6 was chosen arbitrarily and is in the moderate range, that is, the maximum stress intensity is 1.6 times the average stress intensity. Considering Figure 1(a), the case of bending in the strong plane, the reduction in allowable average stress intensity with increasing slenderness ratio as given by the AREA is due primarily to be assumed eccentricity and the resulting lateral deflection in the weak plane. This results from the fact that the slenderness ratio in the weak plane is about four times that in the strong plane. When the computed bending is in the weak plane, the allowable average stress intensity is smaller since there is only one term in the denominator of Equation (10), and that is associated with the larger slenderness ratio.

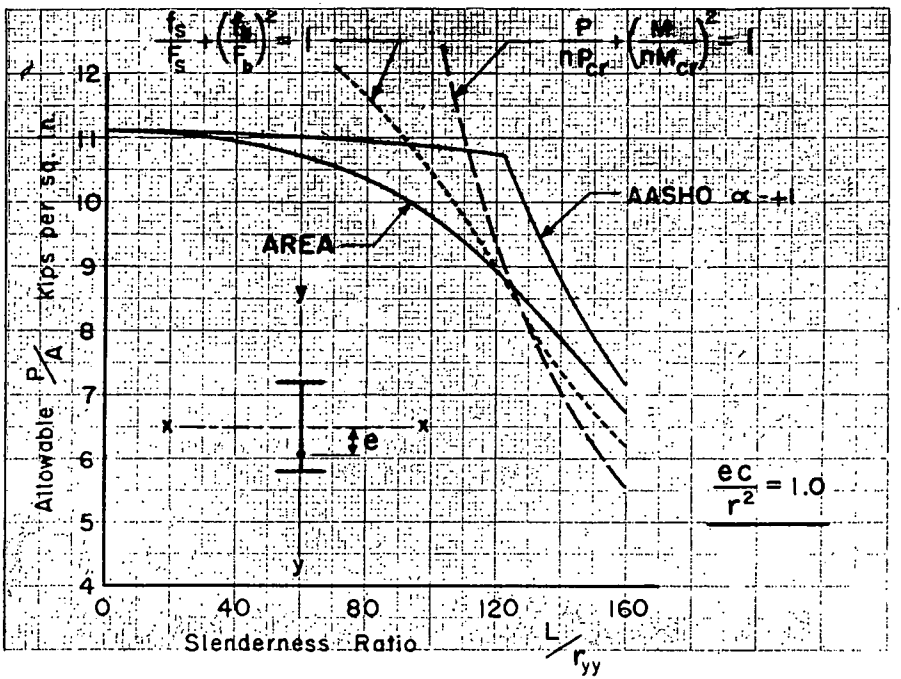


FIG. 5.—RELATIONSHIP OF AASHO & AREA TO TORSIONAL BUCKLING
14WF30 SILICON STEEL PINNED ENDS

A.A.S.H.O.[1]

Equations (4), (5) and (6) have been converted into design formulas by the A.A.S.H.O. as follows:

$$(L/r)_{cr} = \cos^{-1}\alpha \left[\frac{E\,(1 + .25 + e_g c/r^2)}{f_y}\right]^{1/2} \tag{11}$$

for $k'L/r < (L/r)_{cr}$:

$$f_s = \frac{f_y/n}{1 + .25 + e_g c/r^2} \tag{12}$$

for $k'L/r > (L/r)_{cr}$:

$$f_s = \frac{f_y/n}{1 + (.25 + e_g c/r^2)\ B \operatorname{Cosec} \Phi} \tag{13}$$

in which, $\Phi = k'L/r\sqrt{nf_s}/E$ and $\alpha = e_s/e_g$

As described in Basic Theory, this method takes into account the actual magnitude and direction of the eccentricities at the two ends

of the column. All terms in the above equations are in the plane of bending, and the accidental eccentricity ratio of 0.25 is assumed to be in that plane regardless of the direction of the major and minor principal axes. The only mention of the plane perpendicular to that of bending is the additional requirement that the average stress may not exceed the allowable value for a concentrically loaded column using the L/r in that plane. The factor of safety and the very questionable length reduction factor are the same as in the formulas for concentric loading.

The AASHO specification on eccentrically loaded columns is the most complete of all specifications which have come to the author's attention. However, it has several weaknesses all of which tend to make it less conservative than other design specifications. The author does not mean to imply that design by these equations is unsafe, but rather that the true factor of safety is less than many of those using the specification realize.

The effect of the variation in α may be observed in Figure 1. Allowable stresses for $\alpha = +1$ are shown by solid lines and those for $\alpha = -1$ by dashed lines. When bending is in the strong plane, the difference between the two curves is inappreciable, but is considerable when bending is in the weak plane. In the former case the L/r in the plane of bending is small and the cosecant term remains practically constant regardless of the value of α. The curves for intermediate values of α lie between the two extremes shown. For slenderness ratios above 140, the concentric load formula is critical which accounts for the sharp drop in allowable load above that value. When bending is in the weak plane, the concentric load formula may control for small computed eccentricities and negative values of α.

Regarding the determination of α, the AASHO specification uses only the computed eccentricities. If an accidental eccentricity is to be used, it should be included in the calculation for α. That is, .25 should be added algebraically to the eccentricity ratio at both ends making $\alpha = (e_s + 0.25)/(e_g + 0.25.)$ In the case of small computed eccentricities α could be changed from —1 to a positive value by this procedure. It does not seem reasonable to rely upon small eccentricities to stiffen the member. The percentage error is usually small, however, because the concentric load formula controls in this case rather than Equation (12).

When $\alpha = +1$ the AASHO reduces basically to the AREA specification. The notable exception is the plane of the assumed accidental eccentricity. As may be seen in Figure 1(b), the two coincide when bending is in the weak plane. However, for bending in the strong plane as in Figure 1(a), the AREA specification is considerably more conservative for this reason. The AASHO procedure is perhaps justified on the basis that the column has more reserve strength in the weak direction, that is, there is considerable difference between the column's ultimate resisting moment and that which first produces a yield point stress. It is, of course, contrary to the original decision to use the yield stress as the basis for design. A more practical justification is that the AASHO method is too complicated to handle when bending occurs in both principal planes. The specification makes no provision for this case.

The fact that the allowable load on a given section remains practically constant as the slenderness ratio increases from 0 to 140, as in Figure 1(a), is open to serious question. For the case of $\alpha = +1$ the AREA specification would seem to give a more reasonable design than the AASHO.

The AASHO specification makes no provision for lateral-torsional buckling. An example of a case in which this deficiency might be serious is given in Figure 5. The curves are drawn for the same wide flange section, but in this case it is for silicon steel with pinned ends and the eccentricity ratio is 1.0. The dashed line represents the allowable load as given by Equation 7(a), the theoretical critical condition for lateral-torsional buckling. The factor of safety is taken as 1.80 as used in the two specifications. By way of explanation, the bending moment was computed using an eccentricity ratio of 1.25 so as to be consistent with the assumed accidental eccentricities of the specifications. In computing P_{cr} a length reduction factor of 0.875 was included as specified for pinned ends.

It will be observed that lateral-torsional stability becomes critical at $L/r = 110$. The maximum discrepancy occurs at $L/r = 160$ where the AASHO exceeds the stability requirement by about 30%. The dashed curve has no significance where it is above the AASHO curve, because it does not apply after the maximum stress intensity has reached the yield point. Test results[8] when plotted indicate a

[8]"Steel Columns of Rolled Wide Flange Section", Progress Report No. 2, American Institute of Steel Construction.

gentle transition from one curve to the other, rather than the sharp intersection shown in Figure 5, due to the non-linear stress-strain relationship above the proportional limit.

As a consequence of the accidental eccentricity being in the weak direction, the AREA specification shows less tendency to permit lateral-torsional instability.

The dotted curve in Figure 5 is a plot of Equation (8) using allowable stresses for axial load and bending as given by the two specifications. For silicon steel Equations 7(a) and (8) agree quite closely, but this would not be true for carbon steel. In the latter case the theoretical curve would not change, but the dotted curve would shift to the left and thus be more conservative. The higher allowable stress shown by the dotted curve at large slenderness ratios reflects the fact that the specification for bending stress is unconservative for large L/b ratios.

Figure 6 throws additional light upon this situation by showing the effect of varying eccentricity on the possibility of lateral-torsional

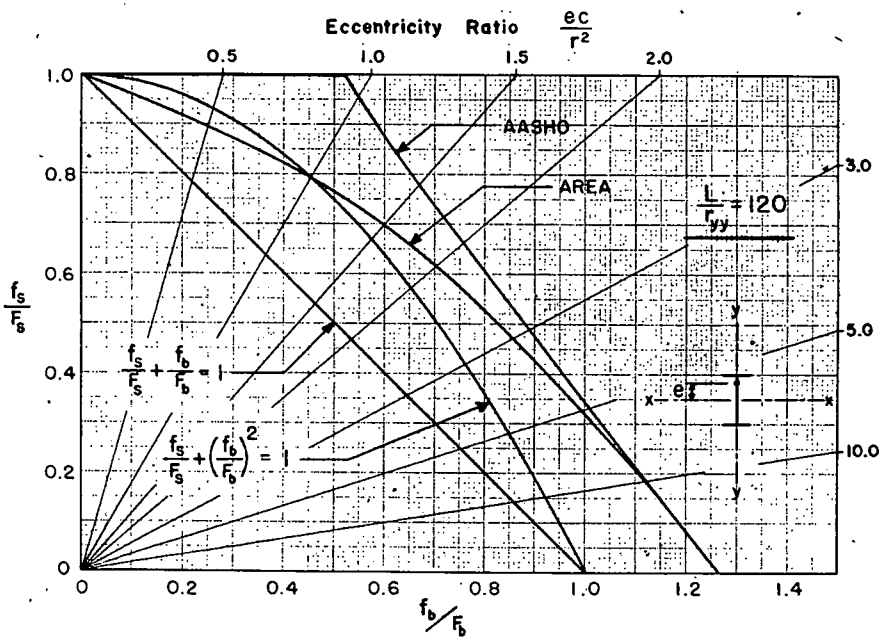


FIG. 6. Relationship of AASHO & AREA to Torsional Buckling
14 WF 30 Silicon Steel- Pinned Ends

instability. These interaction curves are specifically for a slenderness ratio of 120 and include the complete range of eccentricity from zero to infinity. The allowable stresses, F_s and F_b, are taken from the AASHO and AREA Specifications. As a property of this type of chart the lines of constant eccentricity radiate from the lower left corner. The significant point illustrated is that the AASHO specification permits higher stresses than the lateral-torsional buckling criteria for any value of the eccentricity ratio. The AREA specification does so for values above 1.0. The ASSHO curve is cut off at $f_s/F_s = 1$ by the requirement that the average stress intensity shall not exceed that allowed for concentrically loaded columns. It is quite obvious that both design formulas being considered are unsafe if applied to the case of pure bending, and yet neither specification indicates for what range of eccentricity ratios they should be used.

In conclusion, the AASHO Specification is very complete and permits considerable economy in design. However, in some cases the factor of safety is lower than that usually considered to be adequate.

A.I.S.C.[1]

The AISC design method for combined direct stress and bending is probably the most widely used of those under consideration. It is expressed by the formula,

$$\frac{f_s}{F_s} + \frac{f_b}{F_b} = 1 \qquad (14)$$

in which F_s and F_b are the allowable stresses for axial load and pure bending. This procedure which has been in use for many years has no theoretical basis but is founded on the rationalization that if a certain percentage of the strength of the member as a column is utilized, that remaining percentage out of 100 may be devoted to beam action.

As may be observed in Figure 1, this specification is much more conservative than either the AREA or the AASHO Specifications. In spite of the fact that the basic factor of safety is higher for the building specification, the allowable loads for long columns are considerably less. The break in the curve at $L/r = 80$ results from the fact that Ld/bt equals 600 at that point and F_b begins to decrease from the initial value of 20 kips per sq. in. The break at $L/r = 120$ occurs because of the required change in the formula for F_s. In Figure

1(b) the case of bending in the weak plane, no reduction in the allowable bending stress is required.

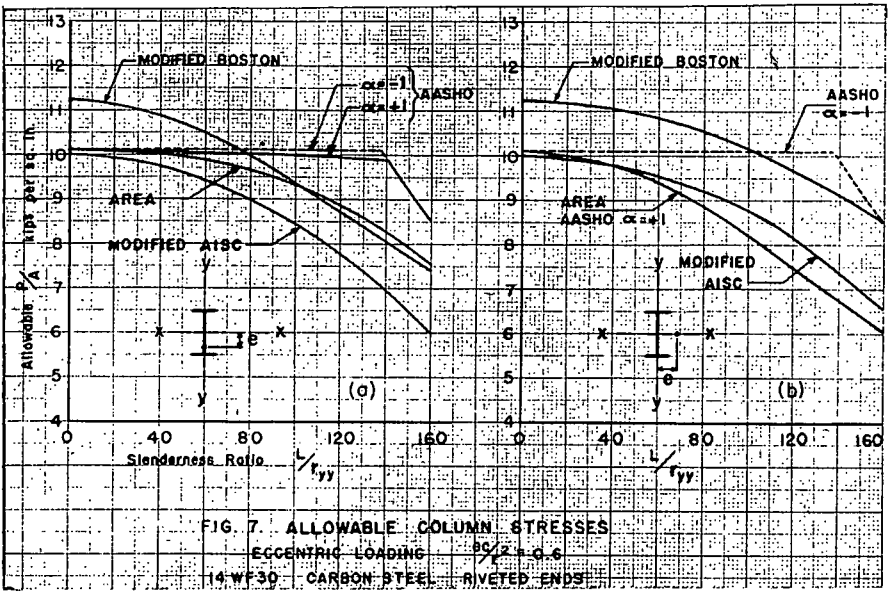
It should be pointed out that the AISC formula is intended to apply to all cases of combined direct stress and bending, that is, lateral loads as well as eccentric compression loads. It is impossible for one formula to be adequate for both cases.

As mentioned in Part A, one of the principal reasons for the difference in the specifications lies in the length reduction factor. The AISC uses the same effective length regardless of end conditions. In order to compare the specifications more effectively, Figure 7 has been constructed in an attempt to isolate some of the fundamental differences. The modified AISC curves in this figure have been constructed using F_s and F_b as given by the bridge specifications. In this manner, two variables have been eliminated; the factor of safety and the length reduction factor. The remaining difference is purely that of method. Having eliminated two of the variables, the AREA and AISC methods agree more closely numerically, but are still quite different theoretically.

Equation (14) is an interaction formula of the type associated with lateral-torsional buckling. In Figure 6 it plots as a straight line and is obviously conservative with respect to this instability in all cases. For the condition shown in Figure 5, lateral-torsional buckling is not critical below a slenderness ratio of 110. Below this value it is of interest to compare Equation (14) with the Secant Formula. Assuming that in this lower range of L/r there is no reduction in F_b and that $F_b = f_y/n$, Equation (14) may be rewritten as:

$$f_s = \frac{f_y/n}{1 + \frac{e_o c}{r_{yy}^2} \operatorname{Sec} \frac{k'L}{2r_{yy}} \sqrt{\frac{nF'_s}{E}} + \frac{ec}{r_{xx}^2}} \tag{15}$$

In this equation it will be noted that the effect of lateral deflection due to the computed eccentricity and the corresponding magnification by the axial load is neglected. However, the lateral deflection due to the assumed eccentricity, e_o, is overestimated because the allowable axial stress, F_s, appears inside the secant term, rather than the smaller value, f_s. In Figure 7 (a) the latter effect is more important and the modified AISC curve is more conservative than the AREA or Secant Formula. In Figure 7(b) the reverse is true and the modified



AISC curve is less conservative. However, as may be seen in Figure 1, this unconservative effect is more than balanced by the lack of a length reduction factor.

To summarize, the AISC specifies an empirical, all-purpose formula which generally gives conservative results. Modern design specifications should include more precise methods.

Boston Building Code

The Boston Building Code states that the maximum stress intensity in a steel column subjected to eccentric loads or other types of bending may not exceed twenty thousand pounds per square inch when calculated by "a method which takes full account of deflection and buckling in any direction" or by the formula,

$$\frac{P}{A}\left(1+\frac{L^2}{18000r^2}\right)+\frac{M\times c}{I-PL^2/10E} \qquad (16)$$

in which L/r is the slenderness ratio in the plane perpendicular to that of bending. No length reduction is permitted regardless of end conditions.

Although the Code permits the use of other methods and Equation

(16) is not, strictly speaking, applicable to the eccentrically loaded column, it is probably used by many designers for this purpose. It will therefore be of interest to investigate the performance of this equation for the case of eccentric loads.

Equation (16) is meant to be used as a general design formula but is derived on the basis of a very particular case. The second term represents the stress intensity due to bending in a column subjected to a uniform lateral load. Referring to Figure 8, it may be shown that the maximum bending moment at mid-height is approximately given by,

$$M' = M + P.\ \Delta = \frac{M}{1 - PL^2/10EI} \tag{16a}$$

in which, M = the moment due to transverse loading only. The maximum stress intensity due to bending only is then,

$$f_b = \frac{M'c}{I} = \frac{Mc}{I - PL^2/10E} \tag{16b}$$

which is the second term of Equation (16).

In the case of eccentric end loads, M is replaced by P × e and for comparison with the design formulas previously discussed, Equation (16) may be written as:

$$\text{allowable } f_s = \frac{20}{1 + \dfrac{(L/r_y)^2}{18000} + \dfrac{ec/r_x^2}{1 - f_s\,(L/r_x)^2/10E}} \tag{17}$$

in which r_x and r_y are interchangeable depending upon the plane of bending. The first term of Equation (16) is taken from the Rankine formula for concentric loads and the second term in the denominator of Equation (17) is equivalent to an accidental eccentricity, the effect of which is assumed to be proportional to $(L/r)^2$. Thus when the slenderness ratio is very small, the effect of the accidental eccentricity is also small. Equation (17) is therefore inconsistent with the Boston Code formula for concentric loads which limits the average stress intensity to 17 kips per sq. in.

It may be observed in Figure 1 that the Boston Code formula gives results quite similar to those of the AISC although the factor

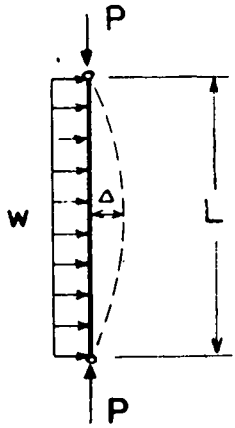


FIG. 8

of safety is consistently lower. The higher allowable loads are the result of the following:

1) In the short column range the assumed accidental eccentricity is small, being zero when $L/r = 0$;
2) In the long column range when bending is in the strong plane no provision is made for lateral-torsional buckling, and when bending is in the weak plane the accidental eccentricity has small effect because it is in the strong plane.

A comparison of the Boston Code formula with the bridge specifications is given by Figure 1. Eliminating the variation in factor of safety and length reduction factor, a further comparison is obtained in Figure 7. This modified Boston Code curve was obtained using a total stress intensity of 18 instead of 20 kips per sq. in. in Equation (17) and a length reduction factor of 0.75. In the case of bending in the strong plane, the modified Equation (17) gives higher values for short columns because of the small accidental eccentricity but agrees very closely with the AREA for high slenderness ratios. For bending in the weak plane the modified Boston Code formula is less conservative throughout because the assumed eccentricity lies in the strong plane.

To summarize, the optional formula for eccentrically loaded columns as given by the Boston Code was derived for the case of a

uniform lateral load, but nevertheless gives fairly reasonable results. It tends to be unconservative although this is counteracted to some extent by using the full length of columns with riveted connections. It does not allow for lateral-torsional buckling and in certain cases may be unsafe in this respect. For a particular case the designer would be wise to take advantage of the optional clause and use a more precise method of design.

Summary

Design specifications for eccentrically loaded steel columns in general use at the present time leave much to be desired. The principal difficulties in a theoretical sense are two related effects, that of accidental crookedness of the column or eccentricity of applied load and that of partial end restraint. Thorough knowledge of these effects in steel structures is lacking and further research along this line is imperative.

Although the above uncertainty is unavoidable at present, most design specifications do not take full advantage of information which is available. The following is a summary of the four specifications considered in this paper:

1) The AREA specification in general gives results which are quite reasonable. It is conservative in many cases because it ignores any difference that may occur between the two end eccentricities and assumes the larger to exist at both ends of the column. The length reduction factors used to account for the end conditions of restraint are questionable but are probably in the right direction.
2) The AASHO specification has the singular advantage of accounting for the difference in magnitude and direction of the two end moments. It is the least conservative of those specifications considered and in some cases may be unduly so. In the case of bending in the major principal plane it is open to question because it assumes the member to be perfectly straight in the minor plane. It neglects the possibility of lateral-torsional buckling which may be serious in a wide flange column with eccentric loading in the plane of the web. The considerable allowance for partial end restraint is questionable as in the AREA specification.

3) The AISC specification is purely empirical and is generally conservative. The same formula is given for all cases of combined direct stress and bending and is not really adequate for the special case of eccentric end loads. No allowance is made for end restraint or the variation of bending moment along the length of the column. It over-estimates the effect of initial crookedness but neglects the effect of lateral deflection due to computed eccentricities.

4) The Boston Building Code suggests but does not require the use of a formula for eccentric loads which is partly empirical and partly theoretical. The theoretical portion, however, is based upon an uniformly distributed lateral load and does not really apply to the case of eccentric end loads. The results obtained would be unconservative except for the fact that no end restraint is assumed. This lower factor of safety results from the assumption that the incidental crookedness of the member is proportional to $(L/r)^2$ and occurs in the plane perpendicular to that of bending even if that be the stronger plane.

Of the four design specifications investigated in this paper the AASHO is probably the most completely adequate and realistic. However, it should be applied with caution in those cases outlined above for which it gives a rather low factor of safety. The ideal solution would be a procedure of the AASHO type which included bending in both principal planes thus permitting the accidental eccentricity to be kept in the weak direction. It would also include a criteria for lateral-torsional stability. Such a procedure would still not be theoretically perfect but would be consistent with present design practice for other types of members.

Discussion

By Oliver G. Julian, *Member**

Professor Biggs has presented an excellent review and comparison of four well known formulae pertaining to eccentrically loaded steel columns. Except due to rare and fortuitous circumstances there is no such thing as a concentrically loaded column. Columns ordinarily are subjected to biaxial flexure as well as axial load. Since the principle

*Chief Structural Engineer, Jackson & Moreland, Consulting Engineers.

of superposition (as ordinarily employed) does not apply to such members we can not in general state that

$$f = \frac{P}{A} + \left(\frac{Mc}{I}\right)_x + \left(\frac{Mc}{I}\right)_y, \qquad \text{(a)}$$

in which the Ms designate the moments resulting from an ordinary frame analysis and the subscripts designate the principal axes to which the moments are referred. The flexure about each axis is increased by the action of the axial load on the deflection. The deflection may be said to breed on itself; the greater its magnitude the greater its tendency to increase. This effect can be taken into account by magnification factors β which are comparable to dynamic magnifiers encountered in vibration problems. Then if we limit the stress to the yield point

$$\frac{P}{A} + \left(\beta\frac{Mc}{I}\right)_x + \left(\beta\frac{Mc}{I}\right)_y \leqq f_y, \qquad \text{(b)}$$

For a pin ended member subjected to an axial load P and initial sinusoidal curvatures of amplitudes e, at midsection, it is easily demonstrated that $\beta = \dfrac{1}{1-P/P_e}$, (c)

in which P_e = Eüler's load $\left(\dfrac{\pi}{L}\right)^2 EI$. Then introducing a factor of safety n, equation (b) becomes

$$\frac{nP}{A}\left[1 + \left(\frac{ec}{r^2}\right)_x \left(\frac{1}{1-nP/P_{ex}}\right) + \left(\frac{ec}{r^2}\right)_y \left(\frac{1}{1-nP/P_{ey}}\right)\right] \leqq f_y, \qquad \text{(d)}$$

In a modified form this equation can be applied to members subjected to lateral loading; the Boston Building Code formula is an example. It however is preferable to apply the safety factor to the loads which tend to destroy the structure rather than to the allowable stress as is done in the Boston Building Code formula. With the safety factor applied to the loads this formula, with π^2 taken as equal to ten would read

$$\frac{nP}{A}\left(1 + \frac{L^2}{18{,}000r^2}\right) + \frac{nWLc/8I}{1-nP/P_e} \leqq 33{,}000 \text{ p.s.i.}, \qquad \text{(e)}$$

It will be noted that this is not equivalent to multiplying both sides of the code formula by the factor of safety, n, which in this case is taken as the ratio of the minimum specified yield point 33,000 psi to the stress allowed by the code 20,000 psi. Formula (e) is somewhat more conservative than the code requirement, unless the axial load is zero in which case the formulae are identical; the difference increases as the axial load increases.

Equation (d) will be recognized as an adaptation of the well known Ayrton and Perry formula[1] which can be transformed into Van den Broek's[2] wow formula, which in turn reduces to Eüler's formula in case e = o.

For initial end moments M_1 and M_2 with $M_1 > M_2$ it is not difficult to show[3] that

$$M' = M_1 \beta = M_1 \left[\frac{\sin \pi/L \sqrt{P/P_e}\,(L-x) + M_2/M_1 \sin \pi/L \sqrt{P/P_e} \times}{\sin \pi \sqrt{P/P_e}} \right], \qquad (f)$$

in which M' includes the effect of the axial load acting on the deflection and x is distance measured along the axis of the member from the end subjected to M_1 to where M' applies. In case $M_1 = M_2$ and x is taken as L/2 equations (f) and (b) combined reduce to the double Scheffler secant formula, on which the A.R.E.A. formula is based. Equations (f) and (b) combined also include Young's[4] and the A.A.S.H.O. formula for axial load and flexure in the plane of one principal axis. They all approach Eüler's formula as M_1 and M_2 approach zero and are derived from the fundamental equation of flexure $M = -EI \frac{d^2 4}{dx^2}$. As forcefully pointed out by Professor Biggs they do not take account of torsional instability. Therein lies their principal weakness.

The transcendental equation (f) for β is too complicated for practical use. However, it has been reduced to a family of curves* so as to permit the solution of equation (b) for maximum stress in a

[1]Published in "The Engineer" (London) 1886.

[2]"Rational Column Analysis" by J. A. Van den Broek, "The Engineering Journal" (Canada) June 1942.

[3]"Buckling of Elastic Structures" by H. M. Westergaard, Transactions A.S.C.E. Vol. 85 (1922) p. 593.

[4]Equation (6) see also reference 6 by Professor Biggs.

*Not published.

matter of minutes. It is, of course, realized that the maximum stress due to flexure about each of the principal axes may be located at widely separated sections. In substituting in equation (b) the section should be so chosen as to give the maximum stress occurring at any one section.

Prior to designing a column in a framed structure one must have made a reasonable frame analysis. Given such an analysis it would appear that the effect of end restraint is included in the end moments and therefore, there is no need for using a modified column length. Professor Biggs is quite right in characterizing such a practice as "very questionable".

I agree with Professor Biggs' thought—"If an accidental eccentricity is to be used it should be included in the calculations for α", or $\frac{M_2}{M_1}$. A fair allowance for accidental end eccentricity is most debatable.[5] It appears reasonable to take it as a constant times the applicable cross sectional dimension, and to allow for its effect about both principal axes. In this form, it causes the eccentricity ratio, $\frac{ec}{r^2} = \frac{eA}{S}$ due to accidental causes to vary directly with the breadth, area and weight of the member and inversely as the section modulus S. I incline to the view that a fair allowance for accidental eccentricity is 2.5% of the breadth of the member parallel to the plane of eccentricity. For most short H columns this allowance would increase the computed stress by approximately 7 and 20% about the major and minor principal axes respectively. Care should be taken to so apply this allowance as to increase rather than decrease the computed stress.

It should be emphasized that strictly speaking the expression for critical moment following equation (7) applies only to a restricted class of symmetrical sections subjected to pure flexure. Other cases applicable to symmetrical sections have been discussed elsewhere.[6] Formulae applicable to asymmetrical sections subjected to biaxial flexure and axial load have been developed[7] by Professor J. N.

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[5]For a detailed discussion see "Columns" by E. H. Salmon (London 1921) p. 137 et seq.

[6]Transactions A.S.C.E. Vol. 112 (1947) p. 1304 and Errata Vol. 113 (1948) p. XIII.

[7]Cornell University Engineering Experiment Station, Bulletin No. 27 (Dec. 1941) and No. 28 (Jan. 1942).

Goodier. His work demonstrates that the subject is dominated by two basic parameters, Euler's load and Wagner's load,

$$P_w = \frac{1}{\rho^2}\left[GK + P_e\left(\frac{h}{2}\right)^2\right], \qquad (g)$$

in which ρ^2 = polar radius of gyration and h = distance between flange centroids. It will be noted that Wagner's load is a function of the torsional resistance GK as well as the flexural resistance EI. For symmetrical sections and provided the axial load does not equal Euler's load about either principal axis or Wagner's load, Goodier's criterion may be represented by the ellipse

$$\frac{M_y^2}{\rho^2\,(P_{ex}-P)\,(P_w-P)} + \frac{M_x^2}{\rho^2\,(P_{ey}-P)\,(P_w-P)} = 1, \qquad (h)$$

Unfortunately this formula does not take into account variation of moment along the axis of the member.

I heartily concur in the thought that further research on the subject of columns is imperative. This need seems to have been recognized in the formation of the Column Research Council. This organization is presently conducting a number of theoretical and experimental research projects. It is sponsored by leading engineering organizations. Among these sponsors our society appears to be conspicuous by its absence.

Professor Biggs is to be congratulated upon the preparation of a most worth while paper. He has given us considerable food for thought.

THE NEW JERSEY TURNPIKE

By Howard J. Williams*, Member

(Presented at a meeting of the Transportation Section of the Boston Society of Civil Engineers. held on February 28, 1951.)

Northeastern United States Expressways. Modern toll highways in the United States are of recent origin. The Pennsylvania Turnpike was the first such route in the northeastern United States. The Westchester Parkway is a similar toll road which was also built before the recent war. Since the war, many toll expressways have been built in this area, the principal ones being the east and west extensions of the Pennsylvania Turnpike, the parkways in Connecticut from New York City to the Massachusetts line, and the Maine and New Hampshire Turnpikes. In addition, other states are planning or starting work on projects such as the New York and Ohio throughways, and the shore route by-passing Baltimore and Washington.

Figure No. 1 shows the principal expressways in the northeastern United States. In Massachusetts, construction is underway on a freeway to connect the Connecticut and New Hampshire toll roads. The freeway in Massachusetts will consist in part of existing routes con-

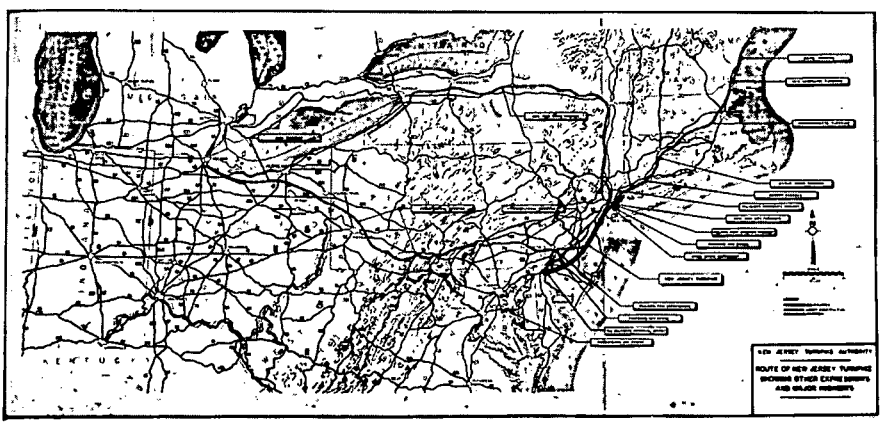


Fig. 1.—Express Highways in Northeast United States.

*Partner, Fay, Spofford & Thorndike, Boston, Mass.

nected by sections of new highways. No toll is to be charged in Massachusetts and interchanges are located close together to serve the needs of local traffic.

Toll Versus Free Expressways. There has been considerable discussion and many articles on the advantages and disadvantages of toll roads. The deciding factor in most cases is the ability of the state to provide the funds necessary to build a throughway in a short time without the help from special tolls.

Mr. Roy Jorgensen, former Deputy Commissioner of Public Works for Connecticut, in a recent talk before the American Society of Civil Engineers briefly summarized the arguments for and against toll roads as follows:

Advantages:

(1) Toll roads provide good highways quickly with high standards, limited access.
(2) Toll road financing counters diversion and dispersion of funds, freedom from politics, pay as you go, not pay before you go.

Disadvantages:

(1) Loss of Federal Aid.
(2) Loss of a large volume of traffic which, with more frequent access and convenience for short trips, uses a freeway.

New Jersey Turnpike. In New Jersey the very heavy traffic along the existing north and south route (U. S. 1) requires a new express road. After several years of partially constructing a few miles of such a road as a freeway, the Legislature decided that the only practical way to have construction completed promptly would be by financing as a toll road. In considering the magnitude of the over-all project, the high type of design, the important part it will play in expediting highway movements in and through a congested and highly industrialized area, the brief description of both its general and engineering aspects should be of special interest.

As indicated on Figure No. 2, the turnpike extends from Route 6 at a point two miles southwest of the George Washington Bridge down the entire length of the State to the Delaware Memorial Bridge at Deepwater near Wilmington, Delaware. This latter structure is

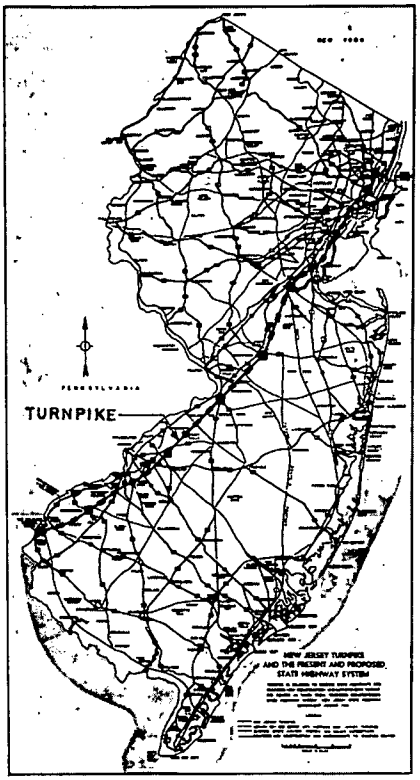


FIG. 2.—LOCATION—NEW JERSEY TURNPIKE.

now under construction and will be completed in the summer of 1951. The total length of the turnpike is 118 miles. Financing has been accomplished by revenue bonds to be repaid by tolls collected from users of the turnpike. There is no State guarantee of the bonds nor is there any Federal aid.

Tolls will vary in accordance with the construction costs and the saving in time compared with the use of present highways. The tolls at the southerly end will average about one cent per mile and at the northerly end about three cents per mile.

The Turnpike Authority consists of three non-paid businessmen. Under their direction an executive director, chief engineer and key personnel carry on the business of directing the construction activities. The engineering work has been divided by sections among various consulting engineers from New York, Newark, Baltimore, Harrisburg,

Chicago and Boston, with a New York firm of Engineers as general consultant and a firm of Architects for the buildings. Fay, Spofford & Thorndike have been assigned the 14-mile strip known as Section 5 extending from New Brunswick to Elizabeth.

The original financing was based on preliminary estimates showing a construction cost (including reimbursement for work previously done by the State) of $170,000,000; engineering, financing and interest during construction $50,000,000; making a total of $220,000,000. Instead of selling the entire bond issue before work was started, arrangements were made with a group of insurance companies and State agencies to issue the bonds as funds are needed, thereby saving considerable interest charges. These are 35-year bonds carrying 3¼ per cent interest. For the service of issuing the bonds as needed there is a stand-by interest charge of ½ per cent up to the time of issue of each group of bonds.

Bridges. A discussion of the design of the Turnpike has been divided into two parts. First the bridges will be discussed, and secondly, the highways and related parts of the Turnpike. South of Route 35, which is the road along the shore to Atlantic City and

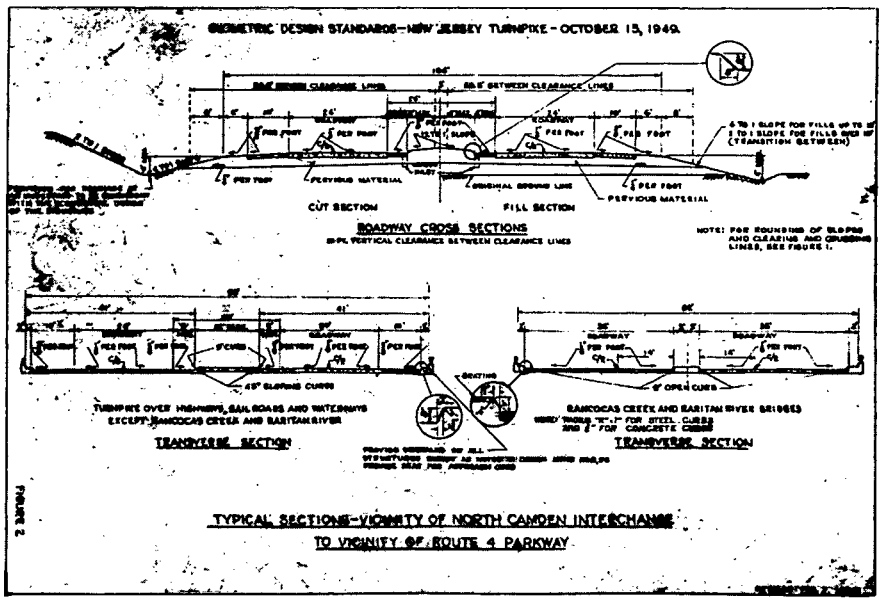


FIG. 3.—CROSS SECTIONS—HIGHWAY AND BRIDGE—SECTION 5 SOUTH.

Cape May, the bridges carrying turnpike traffic are single structures with raised medians to separate the northbound and the southbound traffic. Typical sections of the bridges and highways in this area are shown in Figure No. 3. Each of the two roadways is two lanes wide with provision for building a third lane in the future. There is a 5-foot paved shoulder on the inside and a 10-foot paved shoulder on the outside of each roadway. This latter shoulder can be used in emergencies for vehicles broken down or changing tires.

North of Route 35 to the northerly end of Section 5 the bridges are dual and separated. In the initial construction each road has three lanes, while in the future, space for four 2-lane roads is provided. In the initial construction the highways are located at the outer edge of the future dual-dual roads, leaving a wide median. Typical cross sections of the initial roads and bridges are shown on Figure No. 4.

For bridges with spans less than 75 feet, I-beam stringers are used. For spans from 75 feet to 150 feet, built-up girder stringers are used. Concrete decks are used for the roadways without any additional surfacing. Structural steel or concrete ballustrades are used with a 6-inch steel pipe top rail. A typical highway bridge over

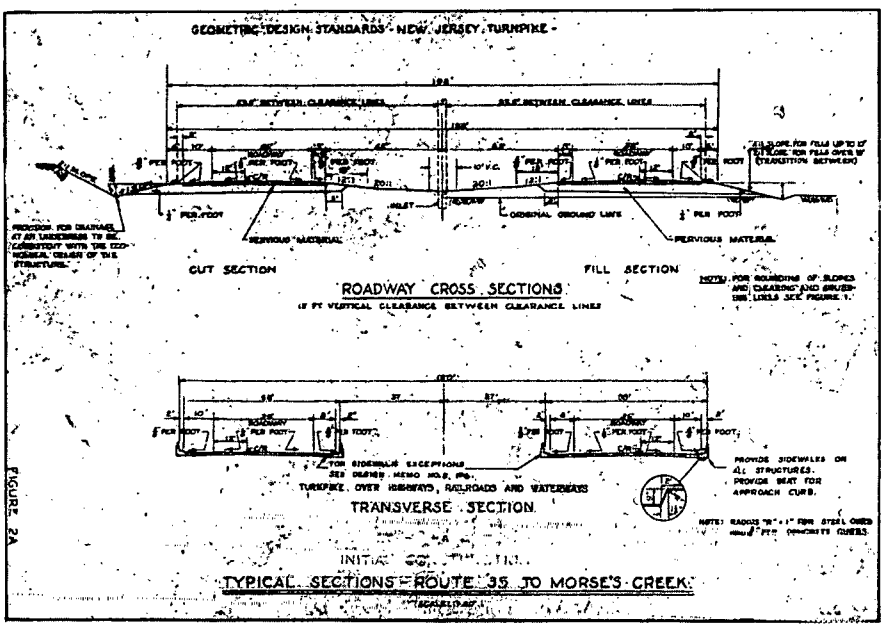


FIG. 4.—CROSS SECTIONS—HIGHWAY AND BRIDGE—SECTION 5 NORTH.

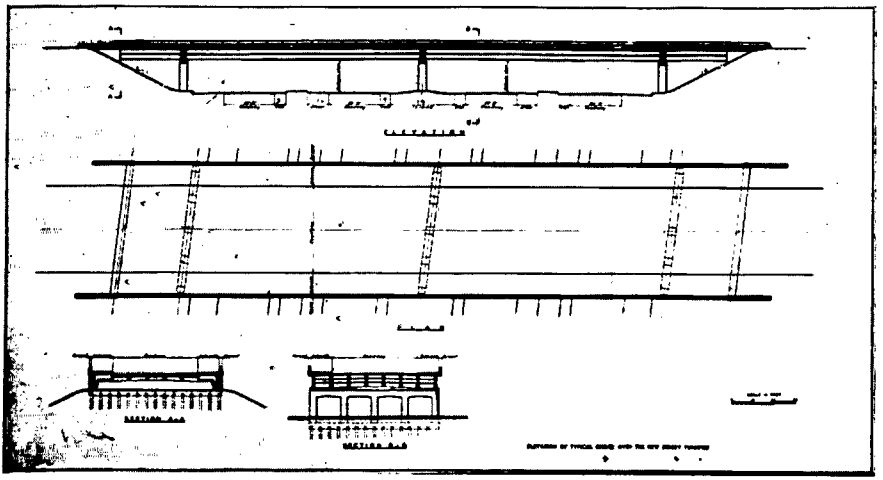


FIG. 5.—TYPICAL BRIDGE OVERPASS.

the Turnpike is shown in Figure No. 5. Railroad bridges crossing over the Turnpike have two, half-through plate girders, with concrete and ballasted deck. For long span bridges, deck plate girders are used. The maximum span in Section 5 is the 212-foot center span at the Raritan River Bridge. Figures No. 6 and No. 7 show the elevation, section and perspective of this structure. Similar spans up to 350 feet are used at river crossings near the north end of the Turnpike. All

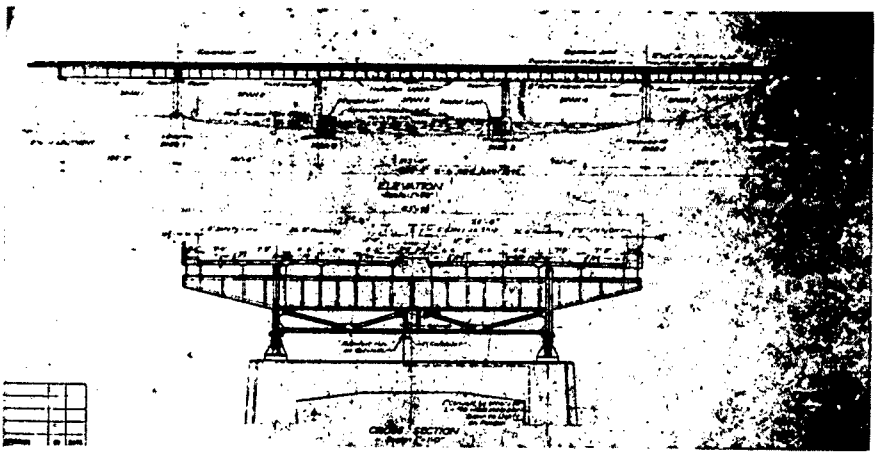


FIG. 6.—RARITAN RIVER BRIDGE—ELEVATION & SECTION.

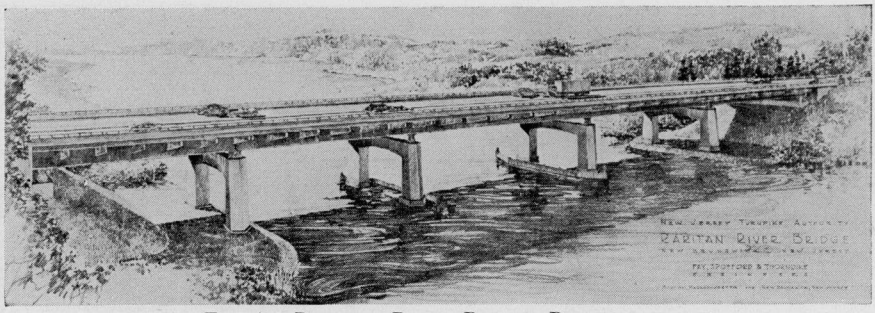


FIG. 7.—RARITAN RIVER BRIDGE—PERSPECTIVE.

bridges carrying turnpike traffic are designed for H-20-S16 loading of the A.A.S.H.O. specifications.

Highway. Highway embankments were built in the usual manner with the stipulation that ninety per cent compaction in layers be secured to within 3 feet of finished grade. Ninety-five per cent compaction was required above this level. A noteworthy feature in the embankment construction was the use of sand drains to speed compaction of deep underlying soft material. The method of constructing sand drains is shown in Figure No. 8. A steel mandrel 14 inches to 18 inches diameter, with bottom closed by a plate, was driven through the material to be drained. This mandrel was filled with sand, which was forced out by steam or compressed air as the mandrel was withdrawn.

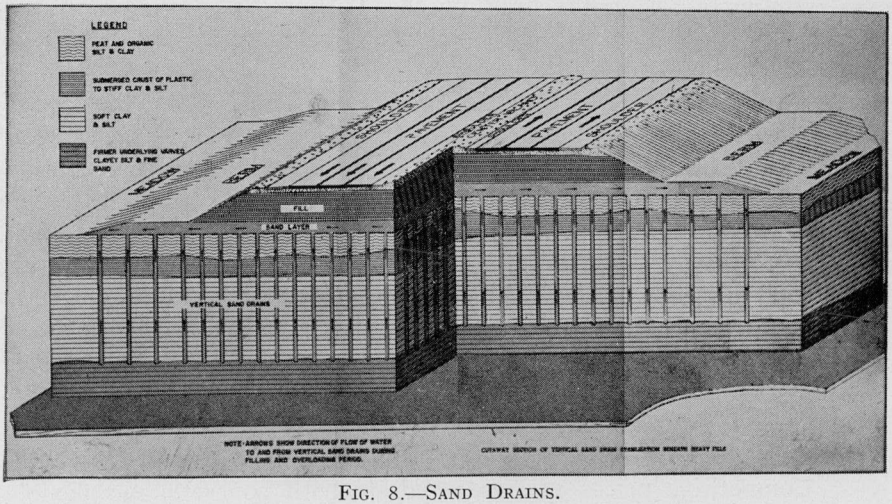


FIG. 8.—SAND DRAINS.

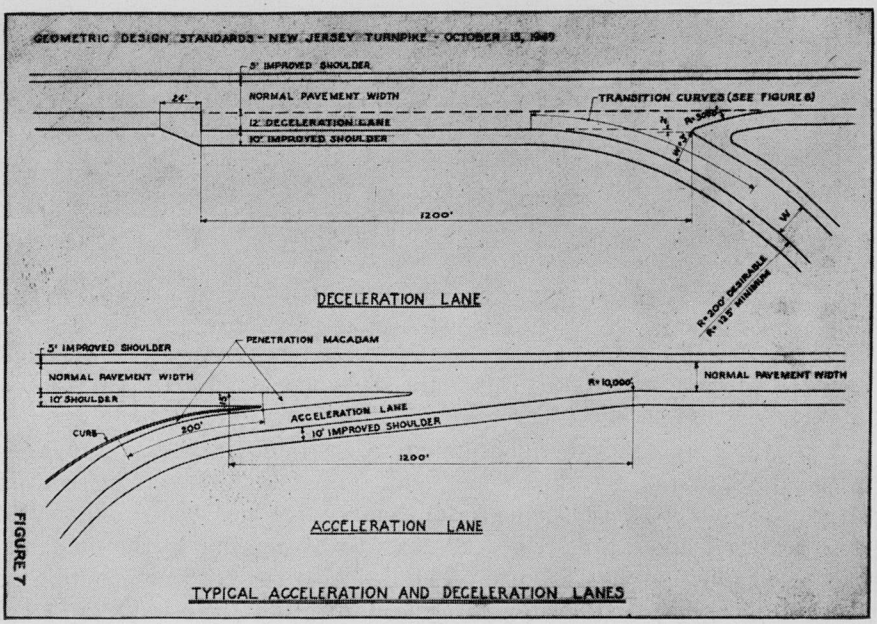


FIG. 9.

The sand pile thus formed allows the water to escape as the embankment load is applied. Usually an overload is applied by increasing the height of the embankment to speed the rate of compaction.

Ample provision for draining the Turnpike is provided on the basis of a 10-year storm for the roadway and more severe storms for the culverts and cross drainage.

The Turnpike is designed for speeds of 70 and 75 miles per hour with a 10,000-foot minimum radius, usual maximum grade 3 per cent, and sight distance of 1,000 feet. At all traffic interchanges, acceleration and deceleration lanes 1200 feet long are provided as indicated in Figure No. 9. Traffic interchanges are provided at all important highways and usually occur at about 5-mile intervals. The standard interchange is a double J loop to provide for collecting tolls at a single toll booth for traffic in all directions, on or off the Turnpike. A ticket is given at point of entry and payment made at point of departure. The Route 35 interchange is shown in Figure No. 10. This interchange has been arranged to favor the heavy traffic between the northerly end of the Turnpike and Route 35 south.

Competitive prices were secured on both concrete and flexible

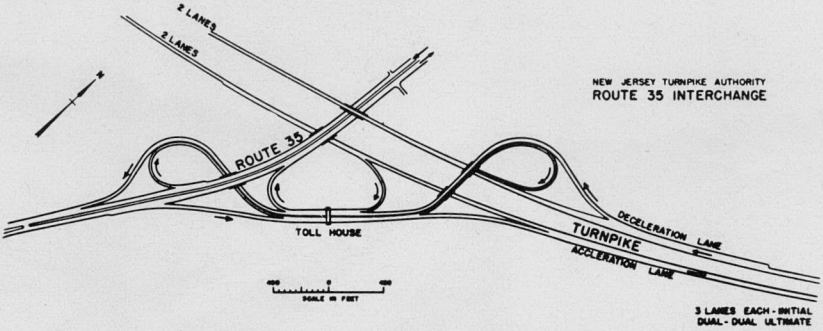


FIG. 10.—INTERCHANGE AT ROUTE 35.

FIG. 11.—PAVEMENT SUBBASE.

type pavements, each type being designed by a committee of the Turnpike consulting engineers for axle loads of 36,000 pounds. It was decided to use the flexible pavement because of the lower prices obtained on all contracts. This pavement consists of 4½ inch plant mix asphaltic concrete laid in three courses, 7½ inches of penetrated macadam base, laid in two courses, and a 6½ inch gravel subbase, making a total thickness of 18½ inches above an 18-inch layer of free draining gravel. The total cost of this pavement was approximately $6.25 per square yard.

FIG. 12.—PAVEMENT BITUMINOUS CONCRETE SURFACING.

Standard specifications for the Turnpike were prepared by the general consultant based in part on the New Jersey State Highway Department specifications. The special provisions for each contract were prepared by the section engineers.

Restaurant and gasoline station facilities are being constructed at strategic locations to serve the Turnpike users. These require 14-acre sites on each side of the Turnpike, with plenty of space for parking, all facilities set back several hundred feet from the roadway and with ample deceleration and acceleration lanes at entry and exit.

Plans were made for truck rests at other locations, but these will not be built under the initial construction.

The Turnpike right of way, which is usually 250 feet wide, will be fenced throughout its length.

Construction. Improved earth moving equipment has largely offset increased labor costs during the past ten years. Much of the earth moving on the Turnpike was done by large Tournapulls, or

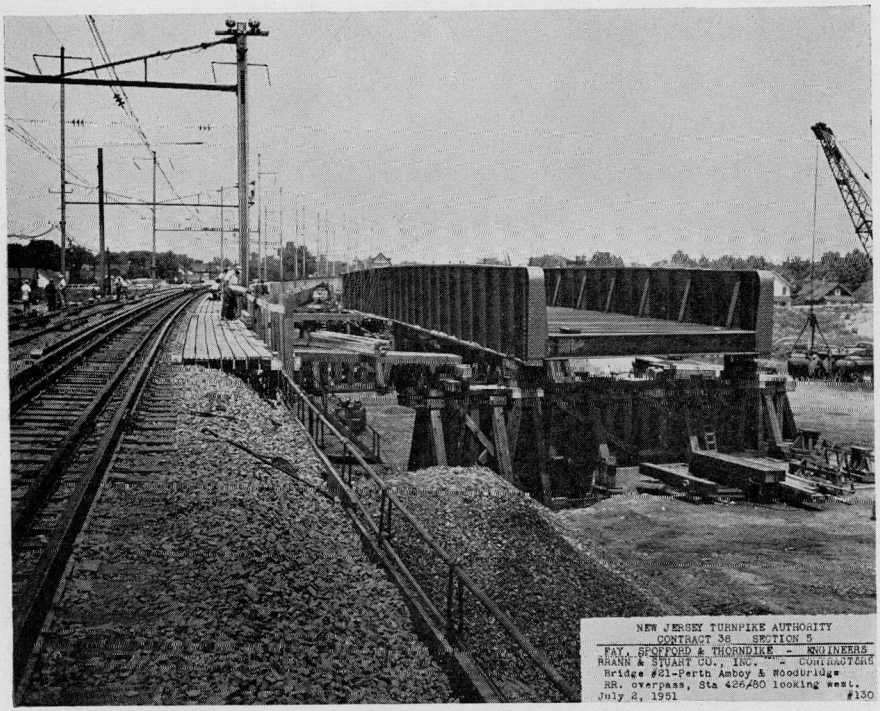


FIG. 13.—PERTH AMBOY & WOODBRIDGE RAILROAD BRIDGE.

similar self-loading scrapers, which hauled the excavated materials considerable distances from the cuts to the embankments.

Figure No. 11 shows the subbase on the right side and the crushed stone lower base course of the pavement being rolled on the left. Figure No. 12 shows a section of the Turnpike with 2 of the 3 courses of the finished pavement in place and a drainage ditch along one side of the roadway being excavated.

Figure No. 13 shows the Perth Amboy and Woodbridge Railroad Overpass bridge superstructure being erected on falsework so that it can be rolled into place when the pier and abutments are ready. The latter substructure is being built under the track while railroad service is maintained. Some weekend, when both parts of the structure are completed, service will be interrupted long enough to roll the superstructure into place.

HYDRO-ELECTRIC DEVELOPMENT IN TURKEY

By Wilfred M. Hall*

(Presented at a meeting of the Boston Society of Civil Engineers, held on September 28, 1951.)

Historical

Although the civilization in Turkey is over 4,000 years old, it took World War I to awaken the nation to the facts of industrial progress. It came about because Turkey bet on the wrong side—allying itself with the Central Powers. After World War I the country was well along into a state of chaos. The situation was so serious that in the early 20's Greece invaded Turkey.

This invasion led to the rise of Kemal Ataturk, the George Washington of Turkey. Ataturk successfully exploited the fine fighting qualities of the Turkish people to expel the Greek invaders. Being a progressive and benevolent man, even though a dictator, Ataturk set about to westernize Turkey, on the theory that reaction to interior progress had its foundation in the native culture. Ataturk outlawed many of the outward and visible signs of the old caliphates.

The fez, veils, sultans, harems, and the Arabic language and alphabet were all outlawed by edict. One suspects that the culture was not too deeply rooted, for the Turkish people readily adopted the new clothing, language, and election and business practices of the west.

The transition to an industrial society from agronomy that has characterized Turkey for centuries has been much slower. The farmer is still the dominant factor in the economic life of Turkey, probably accounting for the natural vigor, stamina, and progressiveness of its people.

Geographic

The country embraces about 1/10th the area of the United States. It is roughly a rectangle 300 by 1,000 miles. The interior of the country is characterized by rough mountainous terrain. The biblical

*Director, Chas. T. Main, Inc., Boston, Mass.

Mt. Ararat reaches 16,000 ft. above sea level. Many other mountains rise over 10,000 ft.

Ankara, the capital city, is situated on the only plateau. The climate in the interior is invigorating, similar to that of Denver, Colorado, and other of our moderately large cities. Along the coast the climate is similar to that of Philadelphia and Baltimore.

This fine country supports about 20,000,000 people with concentrations in the northwest section and along the coasts.

Power Development

Electric power, the backbone of industry, has been rather slow in developing. In 1923 the installed capacity was only 33,000 kilowatts, by 1949 the country produced 375,000 kilowatts. Although the country has excellent hydro-electric potentials, almost none has been developed. Most of the power now available is produced by small unit steam plants. Transmission lines are virtually non-existent, so the application of the installed capacity is inflexible and generally speaking the power is very costly.

Following World War II, the Turkish government began a series of studies and reports aimed at the development of the hydro-electric potential in the country. Since the war about 60,000 kilowatts of steam capacity has been installed. The three-unit station transmits its power from the site some 50 kilometers to coal centers on the coast. The transmission lines are copper on steel towers and carry the current at 66 KV. A 154 KV line covers 250 kilometers from the station at Eregli to the Bosporus and Istanbul.

Construction is now underway on a 160,000 kilowatt hydro-electric plant designed and supervised by Chas. T. Main, Inc. Involved in this project will be some 500 Km of transmission lines to serve both Istanbul and Ankara, as well as certain major industrial centers.

By 1954 Istanbul will be served by connections from the new hydro plant and from steam plants which are to be built. Ankara will also be tied into the hydro and steam electric power distribution system.

Power Need

There is no question that Turkey needs every kilowatt of power it can get. On a population basis the United States has 2300 kilowatts of installed capacity per capita. France and Germany have about 650 to 700 kilowatts per capita. Turkey has merely 33 kilowatts

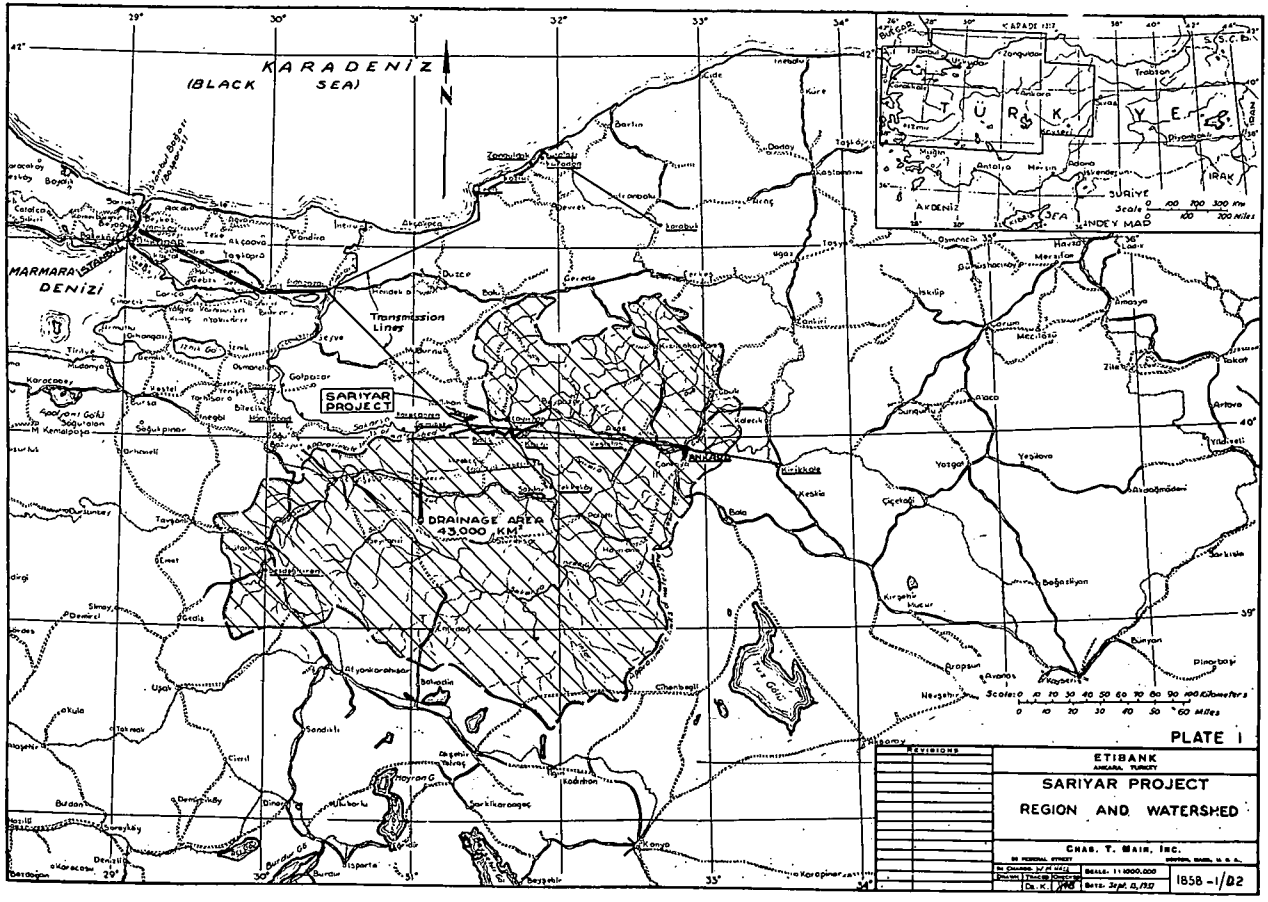


PLATE I

ETIBANK
ANKARA, TURKEY

SARIYAR PROJECT
REGION AND WATERSHED

CHAS. T. MAIN, INC.
80 FEDERAL STREET BOSTON, MASS., U.S.A.

1858-1/B2

per capita. Domestic use of power amounts to only 10% of the total available.

Hydro-Electric Potential

Generally speaking Turkey has good hydro potentials. The weather averages on the dry side, but sufficient rainfall is available.

The best section of Turkey from the standpoint of hydro-electric power potential is in the northwest. The principal stream draining this area is the Sakarya River which is the largest river between Istanbul and Ankara and drains much of the northwest including Ankara.

Economically it is feasible to install more than 600,000 KW on the Sakarya River as it is needed.

Although there are larger rivers in eastern Turkey which have excellent hydro sites, these rivers are at a considerable distance from the load centers. It will be some time in the future before it is economical to develop these potential sites.

With reference to the Sakarya River, it drains an area from east of Ankara to the mouth of the Black Sea (see Plate 1). This amounts to some 25,000 square miles, this area being largely plateau and mountainous country. There are seven good hydro sites—two upstream and four downstream from the Sariyar dam site. Sariyar is the second largest of these sites. Ultimately Sariyar will produce 160,000 KW. However the initial installation will be about 80,000 KW. The only larger site has a potential of 320,000 KW, but the cost to build it is prohibitive at present. The five other sites are much smaller and will be developed in the future.

Details of the Sariyar Site

The Sariyar hydro plant is located at a 180° bend in the river (see Plate 2). It is in the mountains about 100 miles west of Ankara. The principal structures in the development are the dam, the tunnel and the power house. The dam is a concrete gravity type with an overflow spillway in the center (see Plate 3). A tunnel takes advantage of the 180° bend in the river to drain the bend for construction of the dam and power house. While the tunnel will be used for diversion during the construction phase it will ultimately be used as the intake tunnel to conduct the reservoir flow to the power house. A surge tank will be located on the hill behind the power house and connected to the intake tunnel.

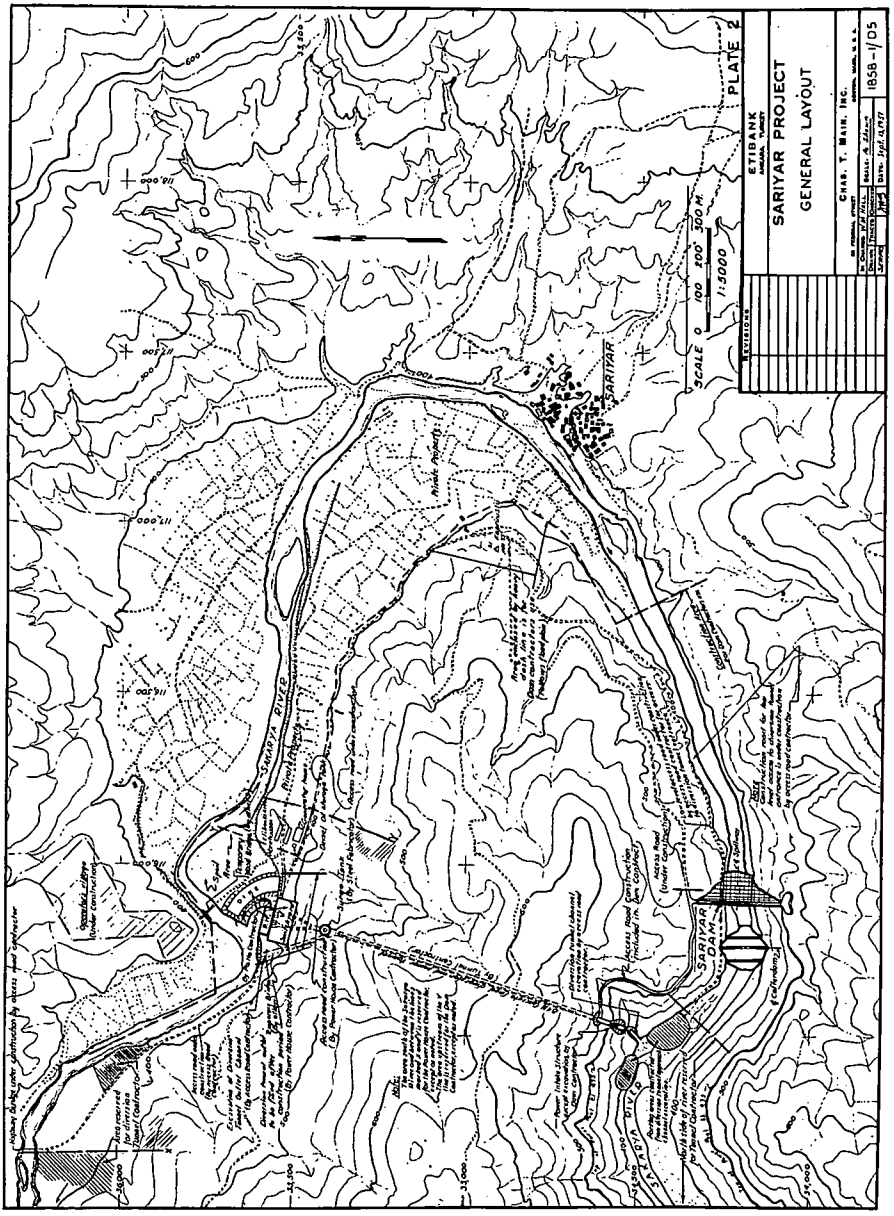


PLATE 2
ETIBANK
ANKARA, TURKEY
SARIYAR PROJECT
GENERAL LAYOUT
CHAS. T. MAIN, INC.
1858-1/D5
REVISIONS
SCALE 0 100 200 300 M
1:5000
SARIYAR
SAKARYA RIVER
SARIYAR DAM
SAKARYA RIVER

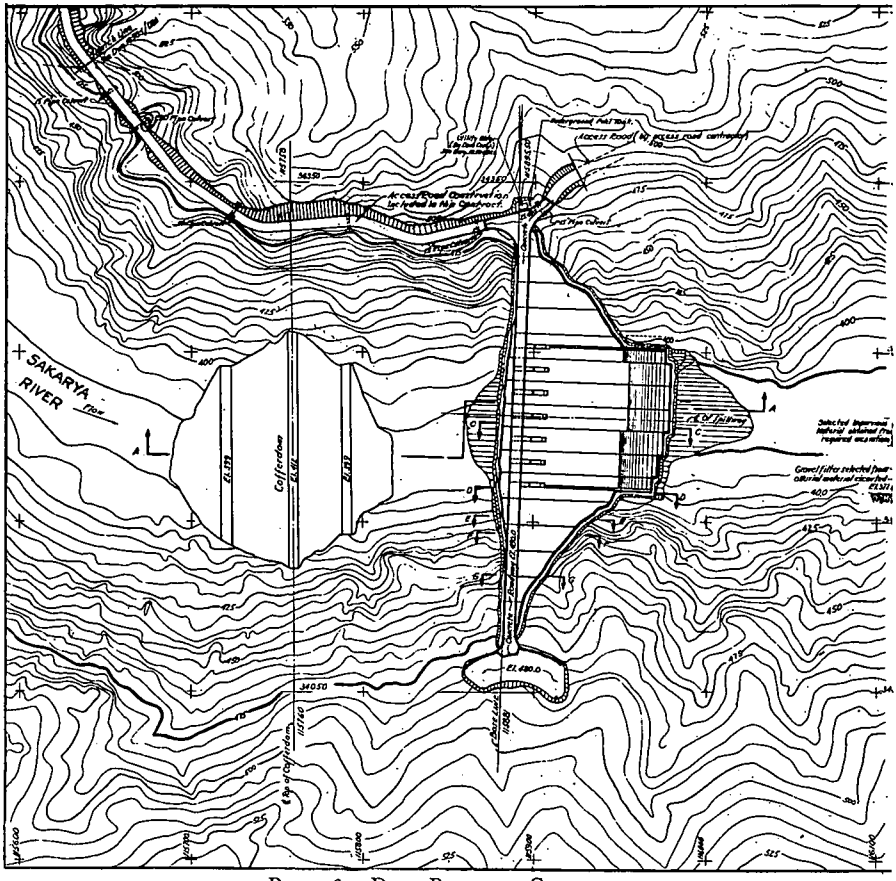


PLATE 3.—DAM, ROAD AND COFFERDAM

Reservoir

The reservoir when filled will back up 30 miles in the main river and more in the two tributary streams running in from the north. The reservoir capacity will be sufficient for full season storage through almost all years, with no spillage. Major floods are apparently infrequent and relatively small because of the large drainage area in an essentially dry country.

Direct effects of water backed up by the reservoir will include relocation of the Istanbul to Ankara highway for about 10 kilometers and relocation of several small villages.

Geology of the Dam Site

The country in which the dam will be situated is a geologist's paradise. To the west of the dam site, the rock is mainly igneous. To the east, sandstone and limestone predominate.

Description of the Dam

The dam will be 700,000 cu. yds. in volume and will be 360 ft. high and 300 ft. in section at the base. Plate 4 shows details of the size and shape.

The abutment will be set entirely in exposed rock, except in the river bed. A cofferdam will be used to reach the rock through about 50 ft. of silt. The dam includes the inspection gallery, drains, seals, grouting and the usual design elements including the concrete.

Concrete aggregates will be manufactured from nearby rock. Cement will be manufactured in Europe and will be brought in through the port of Ismit, then over the road to the site.

Spillway capacity will be more than 300,000 cfs. Six taintor gates will control flood routing through the reservoir. Hoists for operation of the gates will be mounted on the bridge over the gates. An emergency supply will be provided.

The Tunnel

The power and diversion tunnel will be entirely in rock. It will be 3,300 ft. long with an inside diameter of 28 ft. and a 16 in. concrete lining. Plate 5 shows details of this tunnel. The lower entrance is the diversion entrance, while the upper is the water intake to feed the power house. There is an outlet to penstocks leading to the turbines and a by-pass for diversion.

Closure gates will shut off stream diversion and permit installation of concrete tunnel plugs to convert the tunnel from its initial purpose for diversion to its ultimate purpose for intake supply to the turbines. The power intake will draw water 100 ft. below the normal reservoir level. It will be equipped with two service gates, hoists at road level and emergency gates.

Surge Tank and Penstocks

Plate 5 shows the layout of the surge tank and penstocks. The surge tank shaft is 24 ft. in diameter and is concrete lined. The surge tank is 92 ft. in diameter and over 150 ft. high. It is steel the full

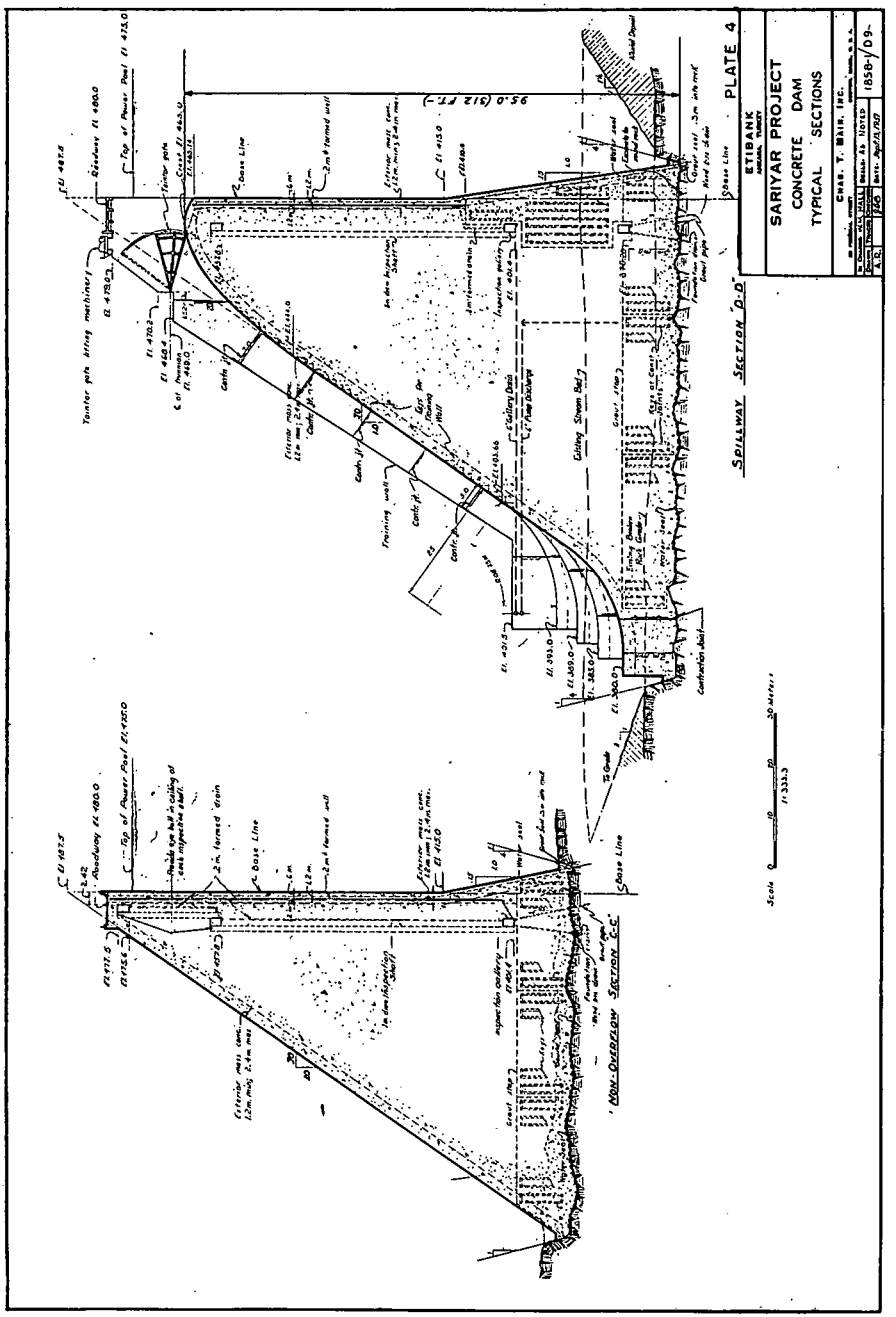
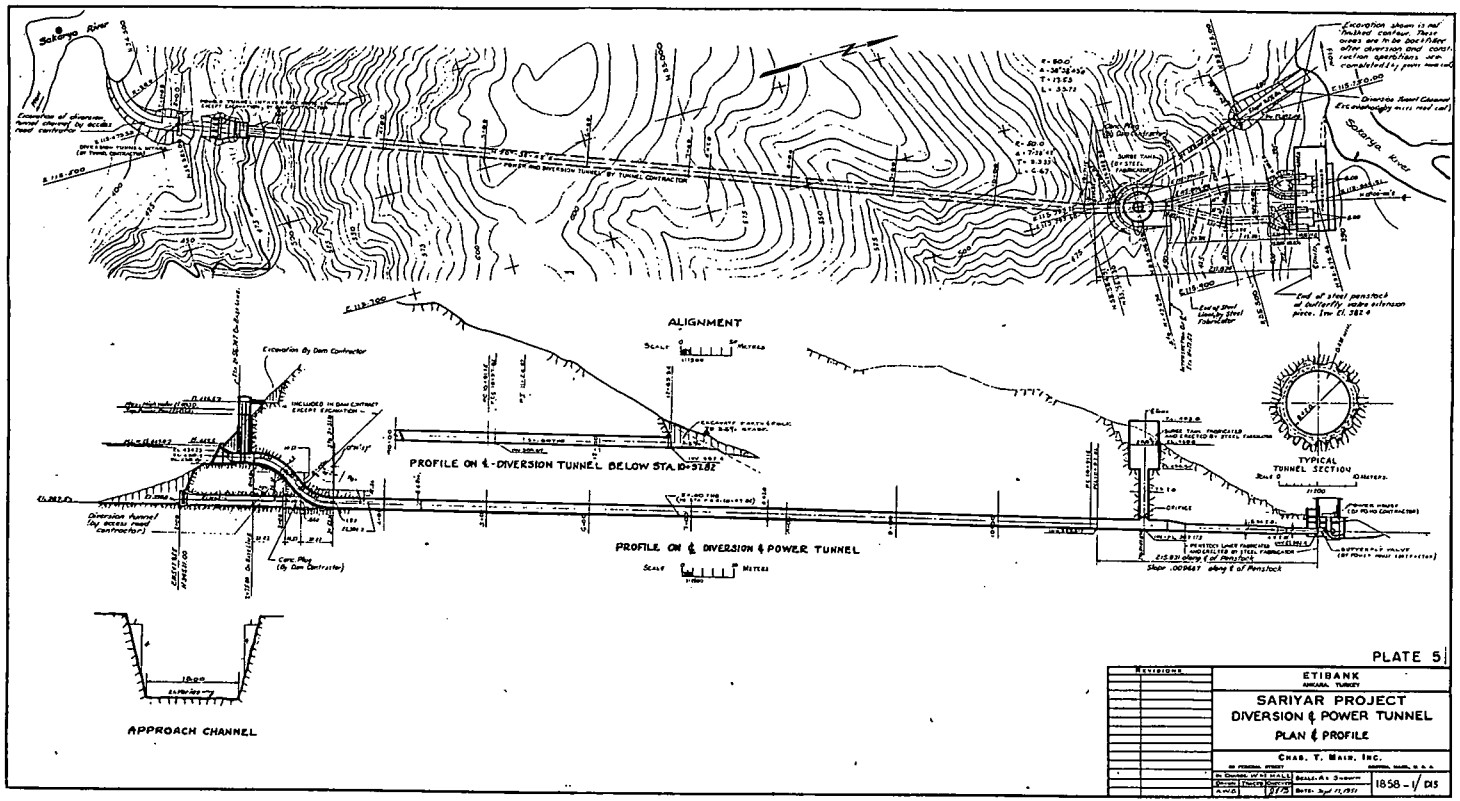
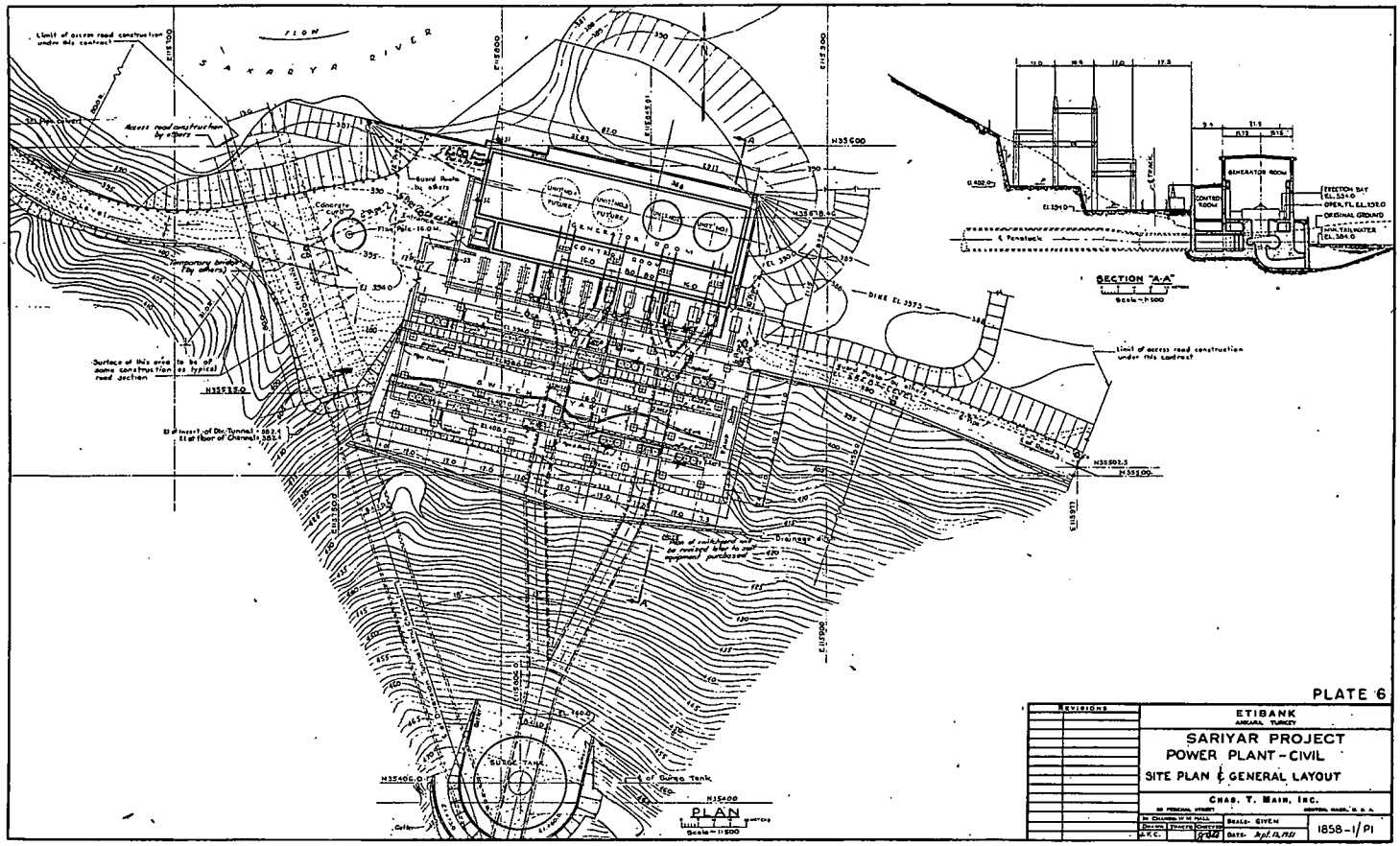


PLATE 4
ETIBANK
SARIYAR PROJECT
CONCRETE DAM
TYPICAL SECTIONS
CHAS. T. MAIN, INC.
1858-1/09-
SPILLWAY SECTION D-D
NON-OVERFLOW SECTION E-E
95.0 (312 FT.)
Scale
50 Metres


Sakarya River
Sariyar River
ALIGNMENT
PROFILE ON ℄ - DIVERSION TUNNEL BELOW STA. 8+57.82
PROFILE ON ℄ DIVERSION & POWER TUNNEL
TYPICAL TUNNEL SECTION
APPROACH CHANNEL
Excavation By Dam Contractor
Diversion Tunnel (by access road contractor)
Conc. Plug (By Dam Contractor)
Slope .009667 along ℄ of Penstock
PLATE 5
ETIBANK
ANKARA, TURKEY
SARIYAR PROJECT
DIVERSION & POWER TUNNEL
PLAN & PROFILE
CHAS. T. MAIN, INC.
BOSTON, MASS., U.S.A.
1858 - 1/ D15


SAKARYA RIVER
FLOW
Limit of access road construction under this contract
Access road construction by others
Guard house by others
Concrete curb
Temporary bridge (by others)
Surface of this area to be of same construction as typical road section
Dike El. 337.5
Limit of access road construction under this contract
Drainage
Surge Tank
Generator Room
Control Room
Unit No. 1
Unit No. 2
Unit No. 3
Future
Tailrace
Penstock
Section "A-A"
Generator Room
Control Room
Erection Bay
Original Ground
Max. Tailwater
PLAN
Scale = 1:500
PLATE 6
REVISIONS
ETIBANK
ANKARA, TURKEY
SARIYAR PROJECT
POWER PLANT - CIVIL
SITE PLAN & GENERAL LAYOUT
CHAS. T. MAIN, INC.
BOSTON, MASS., U.S.A.
Scale: GIVEN
Date: April 15, 1961
1858-1/P1

height. The lower 77 ft. of steel provides a form for concrete lining in rock.

The foundations of the surge tanks and the penstocks are in rock. The penstocks will be steel with welded connections that will be partly fabricated in the shop and finished in the field. The fabrication will include the tank and special equipment.

The 28 ft. diameter power tunnel branches to two 20 ft. diameter, each branch of which is steel lined from the downstream end of the concrete wye to the twin portals. From each portal the steel penstock splits again into two 14 ft. diameter steel penstocks leading to the units.

Powerhouse

A powerhouse will be located 600 ft. downstream from the surge tank as shown in Plates 6 and 7. Ultimately it will have four 40,000 KW generator units. The initial installation calls for two units.

Ten 26 ft. bays will be provided in the generator room. Each unit will occupy two bays. The unit will require about 60 ft. headroom above the generator room floor and about 50 ft. below. A 250 ton overhead crane with a 65 ft. span will be provided to install and service the units.

The electrical bay for services, offices, and shops will be about 35 by 260 ft. in plan.

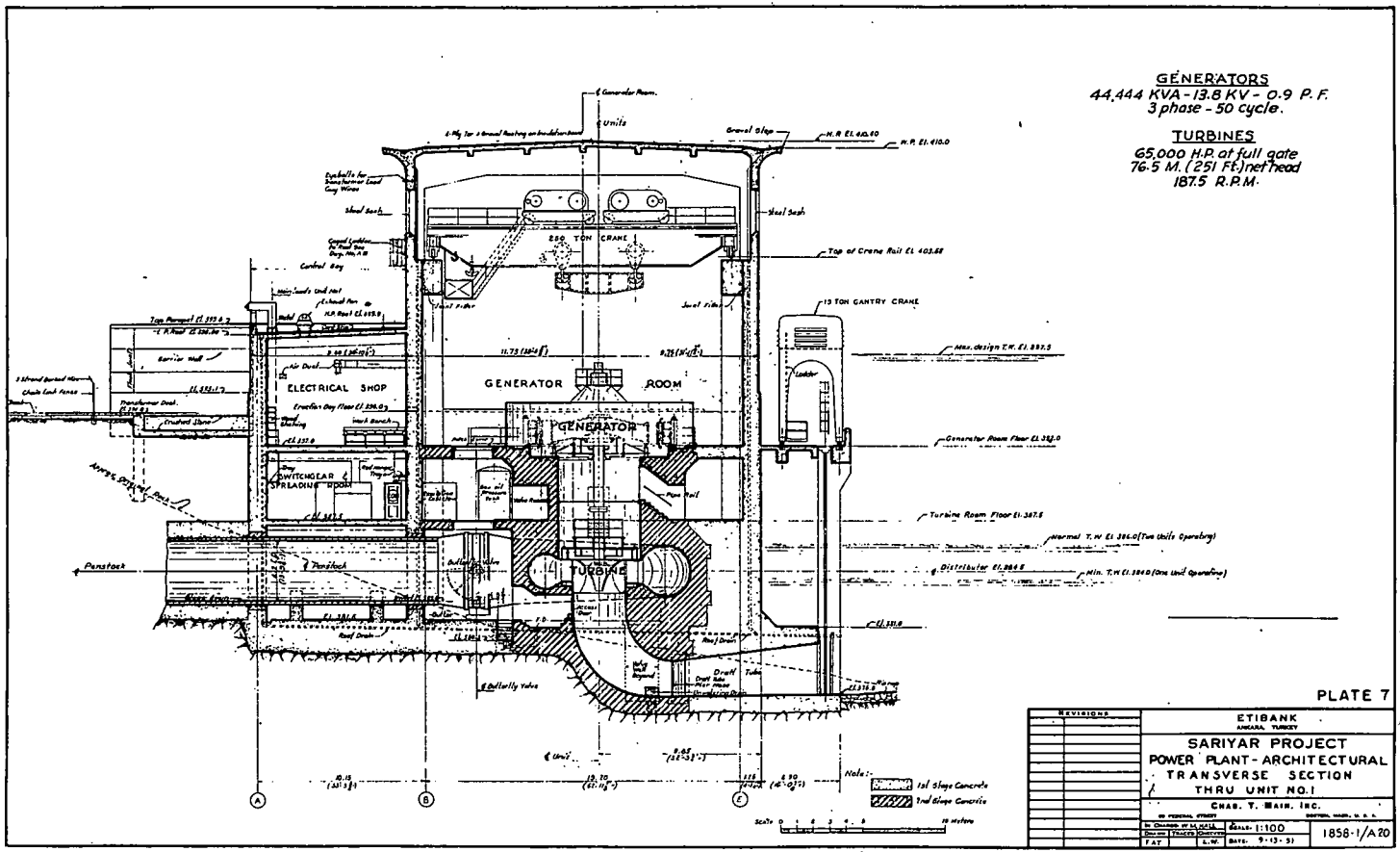
The turbines will be 65,000 HP with a 260 ft. head. They will be direct-connected to their 13,800 volt generators and will be provided with the usual services.

Switchyard

An area behind the powerhouse and directly over the penstocks will accommodate the switchyard (See Plate 6). It will be 150 by 350 ft. at two levels.

Each transformer will consist of three single phase units rated 13,667 KVA, direct-connected to the respective generator, and stepping up from 13.8 KV to the 154 KV transmission voltage.

The transformers will be directly upstream from the electrical bay. A transferway will provide for movement of transformers into the powerhouse for servicing. The switchyard is a double bus, double breaker arrangement, utilizing air blast circuit breakers. The outgoing lines will pass over the roof of the power house.


GENERATORS
44,444 KVA-13.8 KV - 0.9 P.F.
3 phase - 50 cycle.
TURBINES
65,000 H.P. at full gate
76.5 M. (251 Ft.) net head
187.5 R.P.M.
250 TON CRANE
15 TON GANTRY CRANE
ELECTRICAL SHOP
GENERATOR ROOM
GENERATOR
SWITCHGEAR SPREADING ROOM
TURBINE
Penstock
Top of Crane Rail El. 403.66
Generator Room Floor El. 392.0
Turbine Room Floor El. 387.5
Distributor El. 366.5
Note:-
1st Stage Concrete
2nd Stage Concrete
Scale 1:100
1858-1/A20
PLATE 7
ETIBANK
ANKARA, TURKEY
SARIYAR PROJECT
POWER PLANT - ARCHITECTURAL
TRANSVERSE SECTION
THRU UNIT NO. 1
CHAS. T. MAIN, INC.
Date: 9-13-51

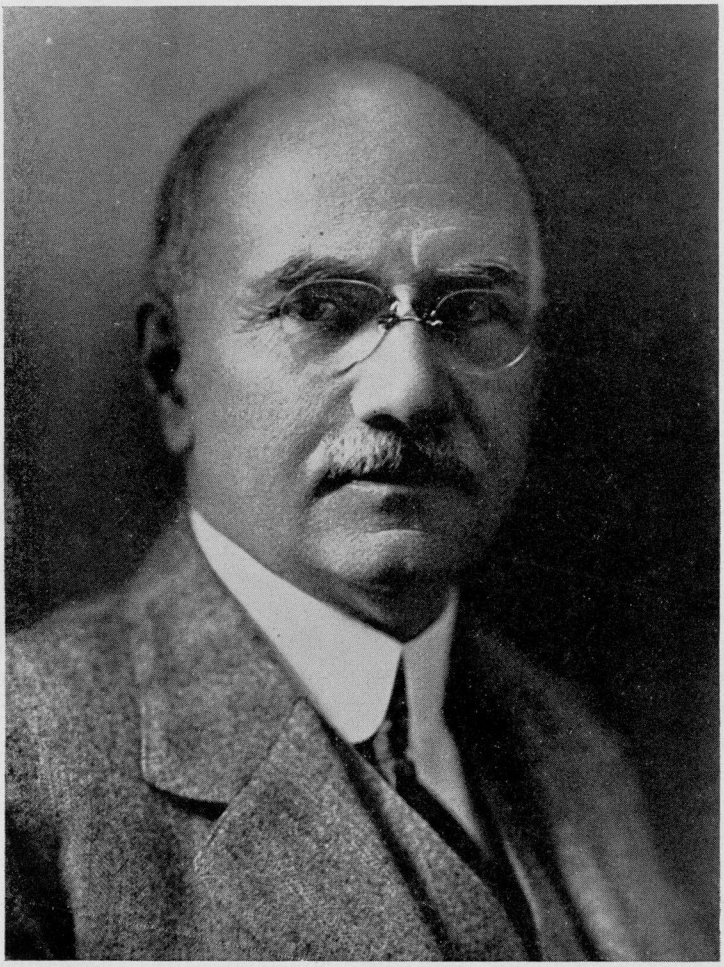
Substations

In all, nine substations will be provided. The Istanbul station will handle 75,000 KVA in two banks of single phase units. Stepdown will be from 154 to 33 KV with condenser operation on 13.8 KV.

The Adapazari station will be 20,000 KVA in two three-phase units and at Ankara three single-phase units will be provided for 37,500 KVA with stepdown from 154 to 33 KV. Another substation at Ankara and one at Kirikkale will each handle 20,000 KVA on two units each.

Karabuk substation will handle 30,000 KVA in two units, with stepdown from 66 to 6 KV.

Provision is made in each substation for future load growth.



DUGALD C. JACKSON

1865-1951

DUGALD C. JACKSON

1865-1951

Dr. Dugald Caleb Jackson, internationally known engineer and educator, was born in Kennett Square, Pa., in 1865. Dr. Jackson was the son of Josiah Jackson, professor of mathematics at Pennsylvania State College, and Mary Detweiler (Price) Jackson.

He was graduated as a civil engineer from Pennsylvania State College in 1885, at the age of twenty, and for the next two years carried on graduate work at Cornell University.

In the years between 1887 and 1907, Dr. Jackson held a number of important positions in which he gained the wide experience which led to the development of a unique educational philosophy. He helped organize the Western Engineering Company in Lincoln, Nebraska, and in 1889 joined the staff of the Sprague Electric Railway Company. Later he became chief engineer of the Central District of the Edison General Electric Company. His career as an educator began at the University of Wisconsin, where he served for sixteen years as Head of the Department of Electrical Engineering. During this period he wrote three well-known textbooks on electricity and magnetism and alternating current machinery.

When Dr. Jackson joined the staff of the Massachusetts Institute of Technology in 1907, as professor and head of the electrical engineering department, he established three principles which have since been adopted for engineering education throughout American universities. These objectives concerned an alliance of undergraduate research with undergraduate teaching for greater independence of student thinking; a cooperative plan for paid industrial work alternating with scientific instruction; and a provision, known as the honor system, for releasing exceptionally able students from rigid schedules of hours and strict adherence to textbooks, thus allowing them to pursue individually selected fields of study. He was head of the department of electrical engineering at the Massachusetts Institute of Technology for more than a quarter of a century, and witnessed and took part

in almost the entire growth of the electrical industry as it is known today. He retired in 1935.

For his contributions to education, Dr. Jackson was awarded the Lamme Medal of the Society for the Promotion of Engineering Education in 1931. The following year he was awarded the honorary degree of Doctor of Science by Columbia University, and in 1938 he received the Edison Medal, the highest award in engineering.

Before World War I, Dr. Jackson did extensive work as a consulting engineer, and in 1919 he organized the firm of Jackson & Moreland, of which he was the senior partner until his retirement from active consulting work in 1930. Through his connection, Dr. Jackson took a leading part in numerous engineering projects, including the Conowingo hydroelectic project, the electrification of the Cascade Division of the Great Northern Railroad and of the suburban division of the Delaware, Lackawanna and Western Railroad, as well as the appraisal of many public utility properties.

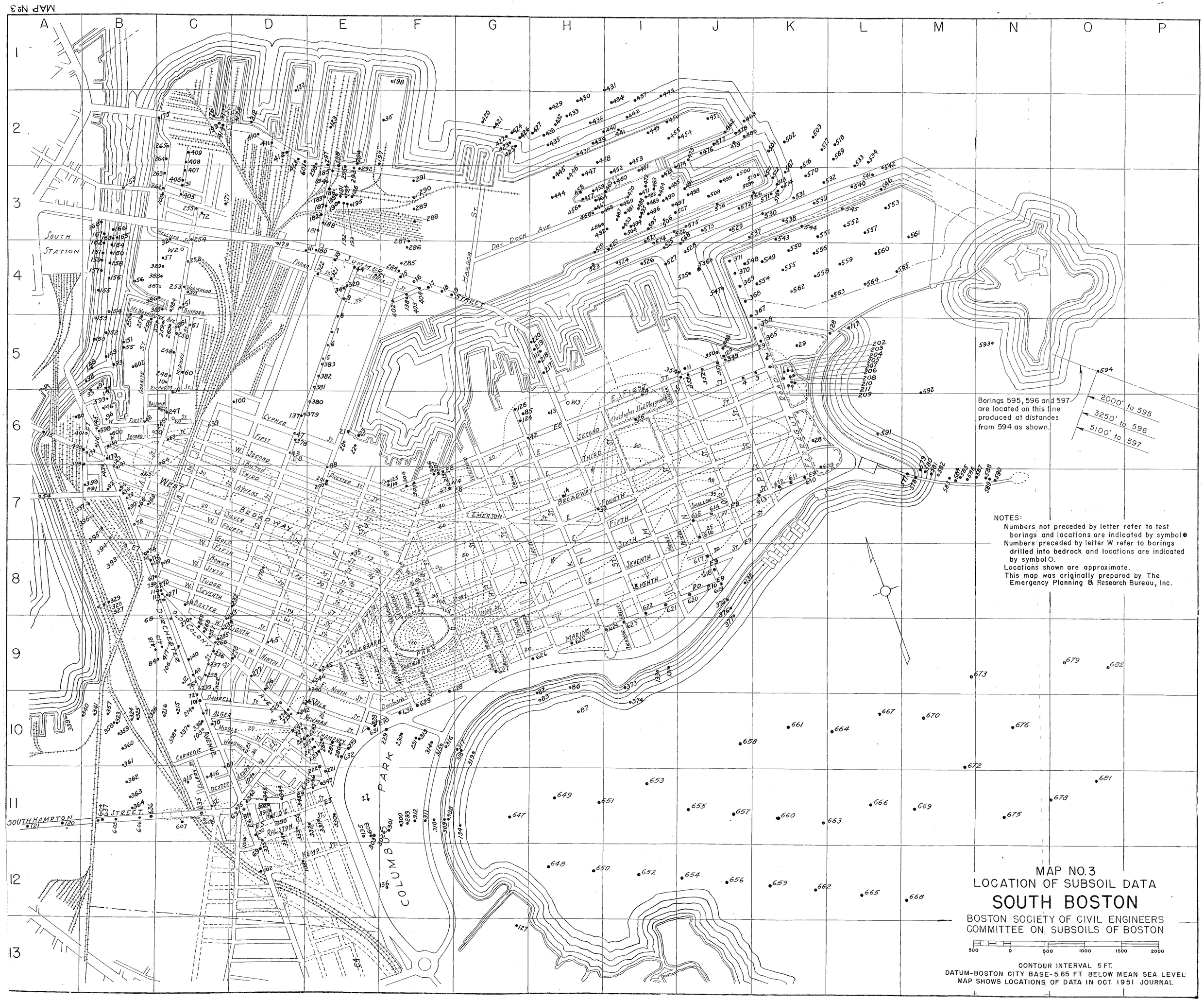
During the first World War he served first as a Major and later as a Lieutenant-Colonel of Engineers in France and, as Chief Engineer of the Technical Board, planned extensive power supply systems and installed plants aggregating about 70,000 horse-power. In recognition of that work and of his service on the War Damage Board after the Armistice, he was made a Chevalier of the Legion of Honor.

Among the boards and committees on which Dr. Jackson served are the International Juries of Award at the World's Fair of 1893; the Buffalo Exposition of 1901; the Division of Engineering and Industrial Research of the National Research Council (Chairman, 1930-1932); the Council of the Society for the Promotion of Engineering Education (President, 1905); the Board of Investigation and Coordination of that society, and the World Engineering Congress at Tokyo, Japan, in 1930. When Dr. Jackson was retired from his post as Head of M.I.T.'s Department of Electrical Engineering in 1935, and became Professor Emeritus and Honorary Lecturer, he edited a series of technical books and continued his active participation in engineering work.

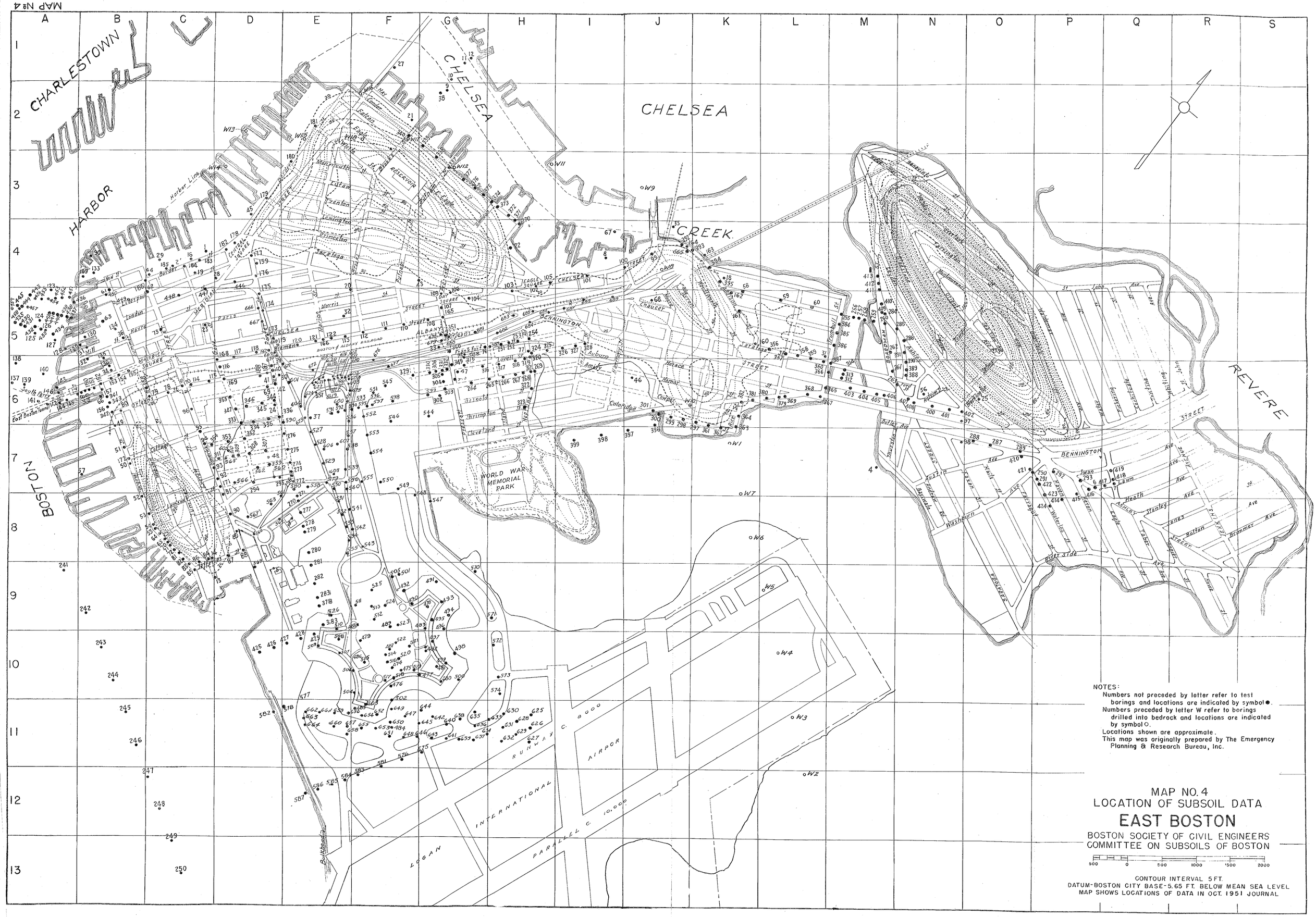
Dr. Jackson was President of the American Institute of Electrical Engineers in 1910, and was a Fellow of that Institute, and a former President of the American Academy of Arts and Sciences. He was also a member of the American Association for the Advancement of Science, the American Physical Society, the American Philosophical

Society, the American Society of Civil Engineers, the American Society of Mechanical Engineers, the English Institute of Electrical Engineers, the Societe Francaise des Electricians, the American Institute of Consulting Engineers, the Boston Society of Civil Engineers (President 1922-23), the Illuminating Engineering Society, and Sigma Xi.

Dr. Jackson died at his home in Cambridge, Mass. on July 1, 1951. He is survived by his wife, the former Mabel Foss, a son, Dugald C. Jackson, Jr., and a sister, Mrs. Louis S. Reber of West Palm Beach, Florida.



MAP NO.3 - SOUTH BOSTON


CHARLESTOWN
CHELSEA
CHELSEA
CREEK
BOSTON
HARBOR
REVERE
WORLD WAR MEMORIAL PARK
LOGAN
INTERNATIONAL
AIRPORT
RUNWAY C. 8000
PARALLEL C. 10,000
BENNINGTON
NOTES:
Numbers not preceded by letter refer to test borings and locations are indicated by symbol ●.
Numbers preceded by letter W refer to borings drilled into bedrock and locations are indicated by symbol O.
Locations shown are approximate.
This map was originally prepared by The Emergency Planning & Research Bureau, Inc.
MAP NO. 4
LOCATION OF SUBSOIL DATA
EAST BOSTON
BOSTON SOCIETY OF CIVIL ENGINEERS
COMMITTEE ON SUBSOILS OF BOSTON
500 0 500 1000 1500 2000
CONTOUR INTERVAL 5 FT.
DATUM-BOSTON CITY BASE-5.65 FT. BELOW MEAN SEA LEVEL
MAP SHOWS LOCATIONS OF DATA IN OCT. 1951 JOURNAL

BORING DATA FROM GREATER BOSTON

Section 3: South Boston and East Boston

PREPARED BY COMMITTEE ON SUBSOILS OF BOSTON

SECTIONS 1 and 2 of this series of articles on Boring Data appeared in the JOURNALS for October 1949 and October 1950, respectively.

The tabulations which follow cover 668 borings in South Boston and 638 borings in East Boston. A separate map is given for each region, with South Boston represented on Map No. 3 and East Boston on Map No. 4.

Keys to boring notations and notes covering symbols are given on the maps. Column 1 of the tabulation contains two items, the boring number and the coordinates defining the location on the map. Columns 2 and 3 give elevations or depths; elevations always are given with plus or minus signs and refer to Boston City Base (5.65 feet below mean sea level), whereas depths are used when elevations are not known and it is to be noted that figures without sign always represent depths. In the final column soil types are given.

Since the data represented are from many sources, it is inevitable that the terminology used will not be entirely consistent. It is believed, however, that the various terms used for describing soil types are in reasonable agreement with those most commonly used and with those given in the Building Code of the City of Boston, 1944 edition, page 234. Data are generally presented in these articles in essentially the original form of the records.

ARTHUR CASAGRANDE
MILES N. CLAIR
IRVING B. CROSBY
LAWRENCE G. ROPES
DONALD W. TAYLOR, *Chairman*
Committee on Subsoils of Boston

October 8, 1951

Boring Data—South Boston

No. and location	Elevations or depths From	To	Formation
1 K5	+23	+19	Hard sand and gravel fill
	+19	+12	Soft clay and gravel fill
	+12	+ 2.5	Hard sand and gravel
2 K5	+21	+11	Fill; sand, gravel, clay
	+11	+ 9	Peat and clay fill
	+ 9	0	Medium clay, sand, gravel
	0	−10	Loose coarse gravel
3 K5	+22	+18	Hard sand and gravel
	+18	+16	Loamy sand
	+16	−20	Hard fine sand, clay
4 J5	+22.0	+18.0	Hard sand and gravel
	+18.0	+16.3	Loamy sand
	+16.3	+ 2.0	Hard fine sand, clay
5 E5	+17	− 6	Fill
	− 6	− 7	Silty sand
	− 7	−14	Hard yellow clay
6 E5	+17	− 5	Fill
	− 5	− 6	Silty sand and gravel
	− 6	−14	Hard yellow clay
7 E5	+17	− 7	Fill
	− 7	−14	Hard yellow clay
8 E5	+19	− 4	Fill
	− 4	− 6	Silty sand
	− 6	− 8	Peat
	− 8	−14	Hard yellow clay
9 E4	+22	− 4	Fill
	− 4	− 6	Silty sand
	− 6	−14	Hard yellow clay
10 C5	Surface	15	Silt, fine sand
	15	20	Medium yellow clay, little fine sand
	20	32	Medium clay
11 J5	Surface	15	Fill
	15	25	Blue clay, fine sand
	25	31	Sand, little clay
12 C9	+16	0	Miscellaneous fill
	0	− 1	Silt
	− 1	− 3	Medium blue clay
	− 3	− 5	Hard sand
	− 5	− 6	Stiff yellow clay
13 H6	Surface	10	Fill
	10	16	Hard packed sand, gravel
	16	28	Fine loose sand
	28	33	Sand, clay, stones
	33	36	Hard yellow clay
14 H7	Surface	18	Sand and clay fill
	18	26	Loose sand, gravel
	26	35	Hard packed sand, gravel
15 F4	+16	− 1.5	Fill; sand, gravel, clay
	− 1.5	− 6.0	Loose dirty sand
	− 6.0	−18.5	Soft silty sand, shells
	−18.5	−21.0	Hard blue clay
16 F4	+16.0	− 6.0	Fill; sand, gravel, clay
	− 6.0	−18.5	Soft silt, shells
	−18.5	−21.5	Hard blue clay
17 F4	+15.5	− 4.0	Fill; sand, gravel, clay
	− 4.0	−18.0	Soft silt, shells
	−18.0	−21.5	Hard blue clay
18 F4	+15.0	− 5.0	Fill; sand, gravel, clay
	− 5.0	−20.0	Soft silt, shells
	−20.0	−23.5	Hard blue clay
19 F4	+15.0	− 4.5	Loose sand, gravel and clay fill
	− 4.5	−12.0	Soft silt, shells
	−12.0	−16.0	Loose coarse dirty sand, gravel
	−16.0	−19.5	Hard blue clay
20 E6	+12	0	Fill
	0	− 2	Silty sand, gravel
	− 2	−13	Stiff yellow clay
21 E6	+14.0	0	Fill
	0	− 2.0	Silty sand, gravel
	− 2.0	− 3.5	Stiff blue clay
	− 3.5	− 4.5	Soft clay and sand
22 E6	+ 8	0	Fill
	0	− 6	Silty sand
	− 6	− 8	Coarse sand, gravel
	− 8	−17	Medium stiff blue clay
23 E6	+ 5	0	Fill
	0	− 4	Silty sand, gravel.
	− 4	− 9	Sand, little gravel and blue clay
	− 9	−19	Medium stiff blue clay
24 I5	Surface	11	Yellow clay, sand
	11	22	Blue clay, sand
	22	35	Medium blue clay
	35	42.5	Medium blue clay, sand
25 J5	Surface	10	Fill
	10	14	Fine sand, clay
	14	25	Hard packed medium sand
26 I6	Surface	3	Hard packed gravel
	3	10	Compact sand, little clay
	10	25	Hard packed sand, gravel

No. and location	Elevations or depths From	To	Formation
27 E11	Surface	15	Soft clay and sand fill mixed with mud
	15	30	Sand, mud
	30	40	Soft blue clay
28 K6	Surface	5.0	Sand, gravel, little clay
	5.0	18.5	Hard packed sand and gravel
	18.5	25.0	Hard packed fine dark sand
	25.0	40.0	Medium clay
29 K5	Surface	21	Sand and gravel fill
	21	30	Mud, silt
	30	45	Hard clay
30 C6	Surface	17	Fill
	17	36	Mud
	36	44	Hard clay
31 C3	Surface	14	Fill
	14	38	Mud
	38	54	Hard blue clay
32 C3	Surface	14.5	Fill
	14.5	16.7	Dock mud
	16.7	20.0	Clay
	20.0	34.5	Dock mud, fine sand
	34.5	36.7	Hard blue clay
33 H7	Surface	4	Sand, gravel
	4	12	Gravel, stones
	12	24	Hard sand, gravel
34 E4	Surface	5	Fill
	5	22	Soft mud
	22	26	Sand
	26	40	Hard clay
35 F2	Surface	17	Sand and gravel fill
	17	34	Sand, gravel; fairly hard packed
	34	54.5	Clay, sand
	54.5	56	Clay, stones, hardpan
36 B7	Surface	11	Fill
	11	50	Soft blue clay
37 F7	Surface	15	Fill; coarse sand, gravel
	15	45	Blue clay
38 E4	Surface	12	Clay fill
	12	17.5	Fine sand and mud mixed
	17.5	22	Hard clay
39 C6	Surface	14.7	Fill
	14.7	28	Hardpan
40 C9	Surface	12	Fill
	12	16	Mud
	16	20	Clay, fine sand
	20	30	Hard clay
41 D4	Surface	17	Clay fill
	17	19	Sand, mud
	19	32	Clay mixed with fine sand
	32	44	Medium blue clay
42 G6	Surface	5	Fill
	5	38	Fine sand, fairly hard packed
	38	50	Medium hard blue clay
43 D6	Surface	14	Clay, gravel, sand (apparently fill)
	14	26	Hard clay
44 E4	Surface	23	Fill
	23	30	Clay, fine sand
	30	51	Fine compact sand
	51	58	Clay
45 D9	Surface	4	Fill
	4	11	Hard clay, stones
	11	12	Gravel, stones, obstruction
46 C8	Surface	11	Fill
	11	19.5	Fine sand
	19.5	38	Clay, little fine sand
47 D6	Surface	14	Fill
	14	16	Mud
	16	30	Blue clay
48 B6	Surface	24	Fill
	24	36	Clay
49 C8	Surface	11	Fill
	11	17	Mud
	17	24	Sand
	24	29	Fine gray sand
	29	42	Medium clay and fine sand mixed
50 B6	Surface	6	Fill
	6	17	Clay and sand mixed
	17	43	Hard clay
51 E4	Surface	15	Fill
	15	35	Mud
	35	44	Clay
52 C11	Surface	8	Fill
	8	13	Peat mud
	13	18	Sand
	18	27	Blue clay
53 B3	Surface	14	Water
	14	15	Silt
	15	16	Silty sand, gravel
	16	22	Stiff blue clay
	22	64	Soft blue clay
	64	73	Clay, sand, gravel; hard stone, boulder or ledge
54 A7	—18 (approx.)		Surface of yellow clay
	—64		No rock
55 B5	Surface	10	Air and water
	10	14	Silt
	14	47	Fairly stiff blue clay
	47	51	Fairly stiff blue clay, sand, gravel

No. and location	Elevations or depths From	To	Formation
	51	68	Hard blue clay, sand, gravel
			Till (boulder clay)
			Rock
56 B4	+14	− 8	Water
	− 8	−10	Silt
	−10	−37	Fairly stiff blue clay
	−37	−60	Hard blue clay, sand, gravel (boulder clay);
			Rock
57 C4	+17	+ 3	Fill; sand, gravel, cinders
	+ 3	− 1	Silt, some sand
	− 1	− 4	Coarse sand
	− 4	− 9	Silt
	− 9	−35	Hard blue clay
	−35	−40	Stiff blue clay
	−40	−59	Clay, sand, gravel
	−59	−73	Very hard blue clay, little sand
58 C4	+15	+ 1	Fill; sand, gravel, cinders
	+ 1	−19	Stiff clay, little sand
	−19	−34	Soft blue clay
	−34	−53	Clay, sand, gravel
	−53	−59	Clay, sand, little gravel
	−59	−62	Clay, very little sand
			Rock
59 B5	+15	+ 4	Fill; blue clay, little sand and gravel
	+ 4	− 2	Silt, shells, very little sand
	− 2	−35	Stiff blue clay, little sand
	−35	−44	Hard blue clay, little sand and gravel
			Rock
60 C5	+15	+ 1	Fill; cinders, gravel, sand
	+ 1	− 3	Silt
	− 3	−16	Peat
	−16	−21	Stiff blue clay
	−21	−23	Sand, gravel, clay. Rock, probably ledge
61 C5	+15	+ 1	Fill; cinders, sand, little gravel
	+ 1	−10	Silt
	−10	−12	Peat
	−12	−23	Stiff blue clay
	−23	−36	Clay, sand, very little gravel
	−36	−42	Clay, sand, gravel
			Rock
62 C6	+15	+ 5	Fill; sand, gravel, clay
	+ 5	+ 1	Silt
	+ 1	− 4	Peat
	− 4	−12	Silt, shells
	−12	−30	Hard blue clay
	−30	−30.5	Gravel—rock
63 C6	+24	+14	Clay, sand, gravel
	+14	+ 6	Clay, sand, very little gravel
	+ 6	−14	Hard clay, sand, some gravel
	−14	−27	Hard clay, sand, much gravel
			Rock
64 C6	+31	+25	Coarse sand, gravel
	+25	+ 1	Stiff clay, sand, gravel
	+ 1	− 6	Stiff clay, sand, little gravel
	− 6		Rock
65 B7	+28	+11	Sand, gravel, clay
	+11	+ 3	Hard sand, gravel, little clay
	+ 3	− 2	Sand, gravel, clay
	− 2		Rock
66 B7	+19	− 5	Fine yellow sand, little clay
	− 5	−11	Soft blue clay
67 B8	+17	+ 8	Sand, little gravel
	+ 8	+ 4	Black peat
	+ 4	− 7	Sand, clay
	− 7	−20	Sand, very little clay
	−20	−22	Sand, clay
	−22	−43	Soft blue clay
68 C9	+15	+ 8	Sand, little gravel
	+ 8	+ 3	Fine sand, very little gravel
	+ 3	− 4	Clay, little sand
	− 4	−45	Stiff blue clay
69 D12	+24	+19	Fine sand
	+19	+17	Brick and clay fill
	+17	+12	Fair hard sand, little gravel, little clay
	+12	+ 8	Loose sand, little clay
	+ 8	+ 2	Peat
	+ 2	−12	Stiff blue clay
	−12	−17	Fairly stiff blue clay
70 C10	+16	+ 6	Sand, gravel, clay
	+ 6	+ 5	Peat
	+ 5	− 3	Stiff blue clay
	− 3	−19	Yellow sand, little clay
71 C10	+15	+ 4	Sand, gravel, little clay
	+ 4	− 2	Peat
	− 2	− 4	Fine sand, clay
	− 4	−14	Stiff blue clay
	−14	−18	Fairly stiff blue clay
	−18	−25	Little softer blue clay

No. and location	Elevations or depths From	To	Formation
72	+15	+13	Paving
C10	+13	+10	Sand, little gravel, very little clay
	+10	+ 5	Silt, ashes
	+ 5	+ 4	Sand, little gravel; loose
	+ 4	−12	Peat
	−12	−18	Stiff blue clay
	−18	−25	Fair stiff blue clay
73	+20	+18	Paving
B8	+18	+ 3	Sand, gravel, little clay
	+ 3	− 2	Silt, little clay
	− 2	−25	Sand, clay
74	+16	+14	Paving
B8	+14	+10	Sand, gravel, little clay
	+10	+ 6	Peat
	+ 6	−21	Sand, clay
	−21	−30	Blue clay, little sand
	−30	−34	Fair stiff blue clay
75	+19	+13	Fill
D11	+13	+12	Hard fill
	+12	+10	Fine sand, little clay and gravel
	+10	0	Hard clay
	0	− 4	Stiff yellow clay, fine sand
	− 4	− 8	Stiff yellow clay, little sand
	− 8	−12	Fine sand, very little clay
	−12	−16	Stiff blue clay
	−16	−29	Fine sand, little clay
	−29	−32	Clay, sand, little gravel
	−32	−35	Stiff blue clay, little fine sand
76	+14	+ 8	Sand and gravel fill
C9	+ 8	+ 6	Silty sand, gravel
	+ 6	− 5	Silty peat
	− 5	− 9	Peat
	− 9	−14	Stiff blue clay
	−14	−31	Medium stiff blue clay
77	+17	+15	Paving
C8	+15	−18	Peaty blue clay then stiff blue clay
	−18	−33	Stiff blue clay, very little sand
78	+17	+ 6	Coarse sand
B7	+ 6	+ 5	Coarse sand, little gravel
	+ 5	−21	Fine sand, little clay
	−21	−36	Stiff blue clay
	−36	−53	Medium stiff blue clay
79	+18	+ 7	Sand, gravel, little clay fill
B7	+ 7	+ 1	Fine sand, little clay
	+ 1	−14	Soft blue clay, sand
	−14	−27	Soft blue clay, very little fine sand
	−27	−39	Medium stiff blue clay
	−39	−41	Coarse sand, gravel Rock
80	+16	+14	Cinder fill
A6	+14	0	Fill; clay, sand, gravel
	0	−11	Silt, little fine sand
	−11	−23	Soft silt, little sand and shells
	−23	−28	Silt, fine sand
	−28	−55	Medium soft blue clay
	−55	−70	Medium soft blue clay, little fine sand
81	+19	+16	Fill
D11	+16	+11	Yellow clay, little sand, very little gravel
	+11	+ 6	Peat
	+ 6	+ 4	Stiff blue clay, very little sand
	+ 4	0	Stiff blue clay
	0	− 9	Fairly stiff blue clay
	− 9	−17	Fine sand, very little clay
82	+ 4.0	+ 2.5	Sand
H10	+ 2.5	− 1.5	Sandy muck
	− 1.5	− 2.5	Hard blue clay
83	+ 1	− 1	Soft mud
H10	− 1	− 5	Silt
	− 5	− 6	Hard blue clay
84	+15.7	− 0.8	Fill
C9	− 0.8	− 5.3	Peat
	− 5.3	− 7.8	Fine sand, little clay
	− 7.8	−13.3	Hard yellow clay, little fine sand
85	Surface	18.5	Fill
G6	18.5	23.9	Mud
	23.9	30	Hard packed sand and gravel
86	+ 3.5	− 1.5	Muck, sand
H9	− 1.5	− 2.5	Fine sand
87	+ 0.5	− 1.0	Mud
H10	− 1.0	−12.5	Black mire, sand
	−12.5	−13.5	Fine sand
88	− 3.5	− 6.1	Soft silt
E7	− 6.1	−28.5	Medium blue clay
89	Surface	21	Fill
C11	21	25	Silty sand, mud
	25	37	Fine loose sand
	37	59	Fine compact sand
	59	65	Medium blue clay

No. and location	Elevations or depths From	To	Formation
90 B7	+17	+10	Sand and gravel fill
	+10	− 4	Fine sand, little clay
	− 4	−18	Medium stiff blue clay, fine sand
	−18	−58	Medium stiff blue clay
91 B7	+15	+ 9	Coarse sand
	+ 9	− 5	Sand, gravel, clay
	− 5	− 8	Silty sand, small shells
	− 8	−16	Peat
	−16	−23	Stiff blue clay
	−23	−60	Medium stiff blue clay
	−60	−64	Coarse sand, gravel, little clay
			Rock
92 B7	+16	+12	Ash fill
	+12	+10	Coarse sand fill
	+10	0	Sand, little clay
	0	− 5	Coarse sand, very little clay
	− 5	−61	Medium stiff blue clay
	−61	−67	Sand, coarse gravel, little clay
			Rock
93 B5	+15	0	Air
	0	− 7	Water
	− 7	−23	Silt
	−23	−64	Fairly stiff blue clay
	−64	−68	Hard blue clay, sand and gravel (boulder clay)
			Rock?
94 B7	+19	+11	Sand and gravel fill
	+11	+ 2	Fine sand, little clay
	+ 2	−12	Soft blue clay and sand
	−12	−26	Soft blue clay, very little sand
	−26	−36	Medium stiff blue clay
	−36	−38	Coarse sand, gravel
			Rock
95 E8	+50	+47	Overburden
	+47	−11	Slate bedrock
96 B6	Surface	7	Fill
	7	16	Fill, mud
	16	25	Fill; loose gravel, stones
	25	32	Silt, mud
	32	42	Hard yellow clay
	42	53	Medium yellow clay
97 B5	Wharf +14	0	Air
	0	−11.5	Water
	−11.5	−16.0	Silty sand
	−16.0	−29.5	Stiff blue clay
98 B5	Wharf +12	0	Air
	0	− 9	Water
	− 9	−22.5	Silt
	−22.5	−35.0	Stiff blue clay
99 B5	Wharf +10	0	Air
	0	−11	Water
	−11	−23	Silt
	−23	−34	Stiff blue clay
100 D6	Surface	12	Cinder fill
	12	19	Clay and cinder fill
	19	29	Silt
	29	34	Black peat
	34	40	Stiff blue clay
101 C10	+16	+ 5	Sand, very little gravel, very little clay
	+ 5	− 6	Stiff silt
	− 6	−18	Stiff blue clay
	−18	−24	Fairly stiff blue clay
102 D12	+16	+13	Ash fill
	+13	+ 7	Sand, gravel, little clay
	+ 7	+ 3	Clay, little gravel
	+ 3	− 5	Stiff blue clay
	− 5	−21	Medium stiff blue clay
103 C10	+16	+ 9	Fill, sand, gravel, little clay
	+ 9	+ 4	Fine sand, very little clay
	+ 4	− 2	Sand, gravel, very little clay
	− 2	−22	Fine sand, little clay
	−22	−27	Fine sand, gravel
	−27	−29	Hard sand, gravel and clay
	−29	−33	Sand, gravel, little clay
	−33	−39	Fine sand, gravel, little clay
	−39	−42	Hard sand, gravel little clay
104 D11	+18	+ 7	Sand and gravel fill
	+ 7	+ 3	Sand, gravel, little clay
	+ 3	− 4	Sand, gravel, very little clay
	− 4	− 7	Sand, little gravel
	− 7	−14	Sand, coarse gravel
	−14	−26	Fine sand, very little clay
	−26	−37	Fine sand, clay
	−37	−40	Sand, gravel, very little clay
105 D11	+20	+16	Fill
	+16	+10	Loose sand, very little clay
	+10	+ 3	Blue clay, sand, little gravel
	+ 3	− 4	Hard blue clay
	− 4	− 8	Sand, blue clay
	− 8	−15	Fine sand, blue clay
106 C9	+15	+ 8	Fill; coarse sand, little gravel
	+ 8	+ 7	Peat
	+ 7	+ 3	Silty sand, little peat
	+ 3	− 8	Fine sand, very little clay
	− 8	−27	Stiff blue clay

No. and location	Elevations or depths From	To	Formation
107 B8	+13	+ 7	Ash fill
	+ 7	+ 1	Coarse sand
	+ 1	− 4	Very fine sand, little clay
	− 4	− 8	Coarse sand, very little clay
	− 8	−19	Fine sand, very little clay
	−19	−24	Fine sand, little clay
	−24	−42	Stiff blue clay
108 D12	+11.0	− 2.5	Brown peat
	− 2.5	−10.0	Stiff blue clay
109 C3	+15	+ 2	Sand and gravel
	+ 2	−15	Silt
110 F7	Surface	19	Fill
	19	22	Mud and fill
	22	26	Peat mud
	26	33	Medium blue clay
	33	43	Soft blue clay
111 H5	Surface	15.6	Fill
	15.6	25.7	Dark mud, sand
	25.7	31.0	Hard packed sand and gravel
	31.0	42.0	Compact medium sand
	42.0	48.0	Hard packed coarse sand
112 B8	Surface	11.0	Fill
	11.0	17.2	Peat mud
	17.2	25.0	Compact medium sand
113 C8	Surface	9.2	Fill
	9.2	16.0	Medium sand, little clay
	16.0	25.0	Fine compact sand, clay
114 C8	Surface	7	Fill
	7	15	Fine sand, little clay
	15	30	Medium blue clay with layers of fine sand
	30	37	Medium blue clay
115 A6		−98	Rock
116 B6	Surface	19	Fill
	19	35	Clay
117 L5	Ends in quicksand at −85		
120 A11	+18	+ 8	Sand
	+ 8	− 7	Clay
121 A11	+18	− 1	Sand
	− 1	−11	Clay
122 D1	Pier	118	No rock
123 E2	At −35		Rock
124 G6	+21.5	+ 5.5	Fill; ash, sand, brick
	+ 5.5	− 3.5	Gray clay (soft)
125 F7	Surface	5	Ash fill
	5	15	Hard packed sand gravel fill
	15	26	Ash and gravel fill, mud
	26	38	Medium clay
126 G6	+19.5	+ 1.5	Fill; ash, sand, brick
	+ 1.5	− 5.5	Gray clay
127 G13	Surface	1.0	Silt, sand
	1.0	2.5	Sharp sand, little gravel
	2.5	17.0	Fine sharp sand
	17.0	27.0	Soft blue clay, strata of fine sand
	27.0	38.2	Soft blue clay, little fine sand
	38.2	45.0	Sharp sand, very little clay
	45.0	76.5	Soft blue clay, little fine sand
128 L5	Surface	8.7	Sand and gravel fill
	8.7	17.5	Silty sand
	17.5	31.0	Silt, fine sand, shells
	31.0	32.0	Medium blue clay
	32.0	39.5	Hard yellow clay
129 J5	Surface	17.0	Ash fill
	17.0	27.0	Medium blue clay
	27.0	43.5	Medium sand
	43.5	49.0	Soft blue clay, little sand
	49.0	55.0	Soft blue clay, sand
131 I9	Surface	9.5	Sand and gravel fill
	9.5	10.7	Soft silt, shells
	10.7	14.0	Firm fine sand
	14.0	20.0	Hard yellow clay
132 J8	Surface	8.0	Hard coarse sand and gravel fill
	8.0	11.4	Firm fine sand
	11.4	21.2	Medium blue clay
	21.2	23.3	Loose fine sand
	23.3	37.4	Soft blue clay
	37.4	38.2	Coarse sand, gravel
	38.2	50.0	Soft blue clay
133 I9	Surface	6.5	Fill; sand, little gravel
	6.5	9.3	Firm fine sand
	9.3	10.5	Soft silt
	10.5	20.0	Firm coarse sand, little fine gravel
	20.0	27.0	Hard blue clay
134 G11	Surface	1.5	Loam
	1.5	13.0	Sand and clay fill
	13.0	22.0	Soft silt
	22.0	25.0	Hard yellow clay

No. and location	Elevations or depths From	To	Formation
135 E11	Surface	8.0	Fill; loamy sand, gravel
	8.0	14.5	Clay and sand fill
	14.5	21.0	Soft silt and fine sand
	21.0	24.5	Silty sand
	24.5	28.0	Medium peat
	28.0	36.0	Sharp sand
	36.0	41.0	Coarse sand
	41.0	45.5	Medium blue clay, little fine sand
136 F12	Surface	9.0	Fill; sand, gravel, brick
	9.0	11.7	Silt
	11.7	15.0	Peat
	15.0	17.7	Fine sand
	17.7	25.0	Hard yellow clay, little fine sand
137 D6	From 5′ below first floor	2.5	Rubbish fill
	2.5	11.0	Soft silt fill
	11.0	24.5	Silty sand fill
	24.5	29.7	Peat
	29.7	32.0	Clay, little sand, little coarse gravel
	32.0	40.0	Hard yellow clay
138 F4	Surface	0.7	Cobblestone
	0.7	4.5	Sand and gravel fill
	4.5	17.2	Silt and clay fill
	17.2	37.0	Silt, shells
	37.0	40.5	Medium blue clay
	40.5	44.0	Hard yellow clay
139 D11	+24.5	+23.5	Paving
	+23.5	+19.5	Fine sand
	+19.5	+17.0	Fill
	+17.0	+12.5	Fine sand, little gravel
	+12.5	+ 8.0	Loose sand, clay
	+ 8.0	+ 2.0	Peat
	+ 2.0	−12.0	Stiff clay
	−12.0	−17.0	Medium stiff blue clay
140 C9	+15.0	+13.5	Paving
	+13.5	+ 8.0	Sand, little gravel
	+ 8.0	+ 3.0	Fine sand, clay
	+ 3.0	− 4.0	Clay, little sand
	− 4.0	−45.0	Stiff clay
141 B7	+ 1	−39	Hard sand, coarse gravel, clay
142 B7	+22.0	+21.0	Paving
	+21.0	+15.0	Hard sand, little clay, little gravel
	+15.0	+11.5	Loose sand, gravel, little clay
	+11.5	+ 7.0	Hard yellow clay, sand, gravel
	+ 7.0	+ 0.0	Hardpan
143 B7	+20	+19	Paving
	+19	+16	Fine sand
	+16	+ 8	Blue clay, sand, little gravel
	+ 8	+ 3	Loose sand, gravel, little clay
	+ 3	+ 1	Peat
	+ 1	− 2	Sand
	− 2	− 3.5	Sand, coarse gravel, very little clay
	− 3.5	− 5.5	Hard yellow clay, sand, gravel
	At − 5.5		Hardpan
144 B6	+19	+18	Paving
	+18	+11	Hard sand, coarse gravel, little clay
	+11	+ 8	Sand, little gravel blue clay
	+ 8	− 8	Stiff yellow clay, little sand
	− 8	−18	Medium stiff blue clay
	−18	−25	Sand, coarse gravel, clay
	−25	−47	Hard blue clay, little sand and coarse gravel
	At −47		Hardpan
145 B6	+16	+15	Paving
	+15	− 1	Fill
	− 1	− 3	Silt, sand
	− 3	−13	Stiff blue clay, little sand
	−13	−61	Medium stiff blue clay
	−61	−63	Sand, clay, gravel
	At −63		Hardpan
146 B6	+16	+15	Paving
	+15	− 1	Fill
	− 1	− 3	Stiff silt
	− 3	−24	Stiff yellow clay
	−24	−48	Medium stiff blue clay
	−48	−50	Sand, clay, gravel
	At −50		Hardpan
147 B5	Water level	− 2	Water
	− 2	−18	Silt, little gravel
	−18	−25	Stiff clay
	−25	−59	Medium stiff blue clay
	−59	−80	Hard blue clay, sand, little gravel
	At −80		Hardpan
148 B5	0	−22	Water
	−22	−25	Black silt, little sand
	−25	−37	Stiff clay
	−37	−78	Medium stiff blue clay
	−78	−89	Hard blue clay, little sand, gravel
	At −89		Hardpan

No. and location	Elevations or depths From	To	Formation
149 B5	0	−25	Water
	−25	−29	Black silt, little sand
	−29	−53	Medium stiff blue clay
	−53	−65	Hard blue clay, little sand, gravel
	−65	−66	Firm clay, gravel, sand
	At −66		Hardpan
150 B5	0	−17	Water
	−17	−19	Black silt, little sand
	−19	−28	Fairly stiff silt
	−28	−52	Medium stiff blue clay
	−52	−65	Fairly stiff blue clay, little sand and gravel
	−65	−71	Hard blue clay, little sand, little gravel
	At −71		Hardpan
151 B5	Water level	− 9	Water
	− 9	−15	Silt
	−15	−48	Medium stiff blue clay
	−58	−51.5	Fairly stiff blue clay, sand, gravel
	−51.5	−69.0	Hard blue clay, sand, gravel
	At −69		Hardpan
152 B5	0	−22	Water
	−22	−24	Black silty sand
	−24	−47.5	Medium stiff blue clay
	−47.5	−60	Hard blue clay, little sand and gravel
	At −60		Hardpan
153 B5	0	−10	Water
	−10	−13	Black silt, little sand
	−13	−21	Peat
	−21	−29	Stiff clay
	−29	−54	Medium stiff blue clay
	−54	−63	Hard blue clay, little sand, little gravel
	At −63		Hardpan
154 B4	0	−22.5	Water
	−22.5	−25	Black silt, little sand
	−25	−43	Medium stiff blue clay
	−43	−62	Hard clay, little sand, little gravel
	−62	−63	Indurated clay
	At −63		Hardpan
155 B4	0	−10	Water
	−10	−13	Black silty sand
	−13	−24	Soft silt, little sand
	−24	−42.5	Medium stiff blue clay
	−42.5	−58	Clay, sand, little gravel
	−58	−59	Indurated clay
	−59	−70	Hardpan
156 B4	0	−25	Water
	−25	−28	Black silt, little sand
	−28	−40	Medium stiff blue clay
	−40	−50	Hard clay, little sand, little gravel
	−50	−58	Indurated clay
	At −58		Ledge
157 B4	0	−11	Water
	−11	−17.5	Black silt
	−17.5	−28	Silt, little sand
	−28	−40	Medium stiff blue clay
	−40	−51.5	Hard clay, little sand, little gravel
	−51.5	−53	Indurated clay
	At −53		Ledge
158 B4	0	−25	Water
	−25	−31	Black silt, sand, medium stiff blue clay
	−31	−39	Sand, little gravel, very little clay
	−39	−43	Sand, clay, gravel
	−43	−48	Hard blue clay, little sand and coarse gravel
	−48	−49	Indurated clay
	At −49		Ledge
159 B4	0	−11	Water
	−11	−22	Black silt, little sand
	−22	−27	Silty sand
	−27	−41	Stiff clay
	−41	−49	Sand, little gravel, very little clay
	−49	−56	Hard clay, little sand, little gravel
	−56	−70	Ledge
160 B4	0	−22.5	Water
	−22.5	−25	Silt, little sand
	−25	−38	Medium stiff blue clay
	−38	−67	Coarse sand, little gravel, little clay
	At −67		Ledge
161 B4	0	−11	Water
	−11	−13	Black silt, little sand
	−13	−28	Silt, little sand
	−28	−43	Medium stiff blue clay
	−43	−57	Coarse sand, little gravel, little clay
	At −57		Ledge
162 B4	0	− 9	Water
	− 9	−12	Black silt, sand
	−12	−28	Silt, little sand
	−28	−47	Medium stiff blue clay
	−47	−58	Coarse sand, little gravel, little clay
	At −58		Hardpan

No. and location	Elevations or depths From	To	Formation
163 B3	Surface	−13.5	Water
	−13.5	−15	Silt
	−15	−29	Silty sand
	−29	−46	Stiff clay
	−46	−62	Hard sand, little gravel, little clay
	At −62		Hardpan
164 B4	0	−24	Water
	−24	−29	Silty sand
	−29	−45	Medium stiff blue clay
	−45	−60	Coarse sand, coarse gravel, clay
	At −60		Hardpan
165 B3	Surface	−13	Water
	−13	−15	Silt
	−15	−18	Sand, gravel, shells
	−18	−28	Silt, sand
	−28	−40	Stiff clay
	−40	−48	Clay, sand, gravel
	−48	−64	Coarse sand, gravel, little clay
	−64	−85	Hard blue clay, little sand
166 B3	0	−14	Water
	−14	−26	Soft black silt
	−26	−45	Medium stiff blue clay
	−45	−57	Hard blue clay, little sand, gravel
	At −57		Hardpan
167 B3	0	− 8	Water
	− 8	−10	Black silt, little gravel
	−10	−15	Silt, little sand
	−15	−17.5	Stiff blue clay, coarse gravel, little clay
	−17.5	−27.5	Stiff clay
	−27.5	−46	Stiff or medium stiff blue clay
	−46	−56	Clay, little sand, little gravel
	−56	−59	Hard blue clay, sand, little gravel
	At −59		Hardpan
168 B3	0	− 9	Water
	− 9	−13	Black silt, little sand
	−13	−39.5	Medium stiff blue clay
	−39.5	−47	Clay, little sand, little gravel
	At −47		Hardpan
169 B7	+19	+17.5	Paving
	+17.5	0	Peat
	0	−31	Fine sand, little clay
170 D8	+15	+ 8	Fill
	+ 8	+ 6	Peat
	+ 6	+ 1	Coarse sand
	+ 1	− 7	Fairly stiff yellow clay
	− 7	−44	Soft clay
171 C3	+17	+ 1	Fill
	+ 1	−19	Silt
	−19	−23	Silty peat
	−23	−25	Silty sand
	−25	−29	Clay, sand
	−29	−40	Clay, sand, gravel
172 C3	+17	+ 5	Fill
	+ 5	+ 2	Soft black sandy silt
	+ 2	− 2	Mud
	− 2	− 3.5	Sand, little gravel
	− 3.5	− 7	Fine silty sand, shells
	− 7	−11	Peat
	−11	−19	Stiff clay
173 B6	+20	+11	Fill
	+11	+ 4	Silty sand, coarse gravel
	+ 4	− 2	Soft silt, shells
	− 2	− 4	Silty peat
	− 4	−14	Hard yellow clay
174 B6	+20	+ 7	Fill
	+ 7	+ 1	Silty sand, shells
	+ 1	−10	Hard yellow clay
175 C2	0	−20	Soft black silt
	−20	−32	Soft fine silty sand
	−32	−78	Black clay or clay
	−78	−87	Clay, sand, gravel; hard
176 C2	−18	−24	Soft black silt
	−24	−31	Stiff blue clay or stiff clay
	−31	−63	Black clay or clay
177 C2	−25	−28	Soft black silt
	−28	−31.5	Stiff blue clay or stiff clay
	−31.5	−64	Black clay or clay
178 D2	−20	−31	Soft black silty sand
	−31	−39	Stiff blue clay or stiff clay
	−39	−62	Black clay or clay
179 D4	+15	+ 8	Fill
	+ 8	+ 4.5	Soft clay and sand
	+ 4.5	− 1	Silty sand, soft
	− 1	− 3	Soft clay and sand
	− 3	−11	Hard yellow clay
	−11	−21	Stiff clay
180 E4	+15.5	+ 9.5	Fill
	+ 9.5	+ 1.5	Fine silty sand
	+ 1.5	− 1.0	Soft clay and sand
	− 1.0	− 4.0	Stiff black silt
	− 4.0	−24.0	Stiff clay
181 E3	+17.0	+ 0.5	Fill
	+ 0.5	− 8.0	Sand, gravel
	− 8.0	−76.0	Soft clay
	−76.0	−81.0	Gravel, clay, hard
	At −81		Rock
182 E3	+14.5	− 1.5	Fill
	− 1.5	−18.0	Sand
	−18.0	−22.0	Stiff clay

No. and location	Elevations or depths From	To	Formation
183 E3	+15	− 3	Fill
	− 3	−18	Fine sand
	−18	−23.5	Soft clay
184 E3	+15	+ 9	Fill
	+ 9	− 1	Soft clay
	− 1	−13	Fine sand
	−13	−21	Sand
	−21	−107	Soft clay
	−107	−111	Gravel
At	−111		Rock
185 E3	+15.5	− 2	Fill
	− 2	−17	Fine sand
	−17	−22	Clay
186 E3	+15	0	Fill
	0	− 3	Stiff clay
	− 3	−15	Fine sand, little clay
	−15	−21	Stiff clay
187 E3	+15	− 2	Fill
	− 2	−14	Sand
	−14	−19	Soft clay
188 E3	+14.5	− 4	Fill
	− 4	− 9	Sand
	− 9	−25	Stiff clay
189 E3	+15	+ 2	Fill
	+ 2	− 5	Soft blue clay, some peat
	− 5	− 8	Sand, little gravel
	− 8	−15	Fine sand, little clay
	−15	−22	Stiff clay
190 E3	+15.5	+ 4	Fill
	+ 4	+ 2	Peat
	+ 2	− 2	Coarse sand, peat
	− 2	− 9	Fine sand
	− 9	−33	Sand
	−33	−36	Sand, clay
	−36	−38	Fairly soft blue clay
191 E3	+16	+ 5	Fill
	+ 5	+ 0.5	Soft yellow clay
	+ 0.5	− 4	Soft blue clay, some gravel
	− 4	−24	Fine sand
	−24	−34	Sand, clay
	−34	−86	Soft clay
192 E3	+17	+ 5	Fill
	+ 5	+ 1	Peat
	+ 1	− 2	Stiff clay
	− 2	− 5	Sand, peat, gravel
	− 5	−19	Sand
	−19	−23	Fine sand, little clay
193 E3	+16.5	+ 6	Fill
	+ 6	+ 1	Peat
	+ 1	− 1	Medium stiff blue clay
	− 1	− 3.5	Sand, peat, gravel
	− 3.5	−11	Sand
	−11	−27	Fine sand, little clay
	−27	−54	Medium stiff blue clay
	−54	−100	Stiff clay
	−100	−124	Gravel, sand
	−124	−128	Coarse sand, gravel
	−128	−132	Coarse gravel, some clay
At	−132		Rock
194 E3	+13	+ 1	Fill
	+ 1	− 2	Sand, clay
	− 2	− 9	Peat
	− 9	−26	Sand, clay
	−26	−28	Fine sand, little clay
	−28	−47	Soft clay
195 E3	+17	+ 6	Fill
	+ 6	− 2	Stiff clay
	− 2	− 6	Sand, clay, peat
	− 6	−22	Fine sand
	−22	−57	Stiff clay
	−57	−107	Soft clay
	−107	−110	Compact gravel, little sand and clay
196 E3	+16	+ 4.5	Fill
	+ 4.5	− 4	Soft clay
	− 4	−10.5	Fine sand, little clay
	−10.5	−18	Fine sand
	−18	−29	Medium stiff blue clay
	−29	−37	Soft clay
197 E2	− 1	− 4	Fill
	− 4	− 6	Soft black silt
	− 6	− 9	Silty peat
	− 9	−41	Stiff clay
198 F1	−13	−17	Silt
	−17	−39	Stiff clay
199 C2	+16.5	+15.5	Paving
	+15.5	− 2.5	Hard sand, gravel, stones, little clay fill
	− 2.5	− 6.0	Silty gravel, stones, shells
	− 6.0	− 9.0	Fine sand, little clay
	− 9.0	−10.5	Stiff yellow clay, little fine sand
	−10.5	−14.5	Fine sand, little clay
	−14.5	−23.5	Fairly stiff blue clay
200 E7	− 1	− 7	Fill
	− 7	−11	Peat, soft silty sand
	−11	−16	Stiff clay
201 E7	− 1	− 7	Fill
	− 7	−11	Fine silty sand, fine gravel
	−11	−17	Stiff clay
202 K5	+25	+24	Loam
	+24	+23	Peat
	+23	+15	Clay, sand
	+15	+ 3	Coarse sand, gravel
203 K5	+25	+24	Loam
	+24	+21	Clay
	+21	+15	Gravel, sand
	+15	+11	Clay
	+11	+ 5	Soft clay
	+ 5	+ 2	Coarse gravel, sand

No. and location	Elevations or depths From	To	Formation
204 K5	+18	+15	Loam
	+15	+ 5	Clay
	+ 5	+ 3	Clay, mud
	+ 3	− 1	Coarse gravel, sand
205 K5	+16	+14	Fill
	+14	+10	Clay
	+10	+ 7	Gravel, sand
	+ 7	+ 4	Fine sand
	+ 4	− 1	Coarse sand, gravel
	− 1	− 5	Clay
206 K5	+18	+15	Loam
	+15	+13	Clay
	+13	+ 6	Gravel, coarse sand
	+ 6	+ 4	Clay, sand
	+ 4	+ 2	Coarse gravel
	+ 2	− 2.5	Fine gravel, sand
207 K5	+16	+13	Loam
	+13	+11	Clay
	+11	+ 9	Coarse sand, gravel
	+ 9	+ 6	Fine sand, gravel
	+ 6	+ 3	Coarse gravel
	+ 3	− 1	Sand, mud
	− 1	− 3	Hard gravel
208 K5	+19	+17	Loam
	+17	+15	Clay
	+15	+ 7	Stiff clay
	+ 7	+ 4	Clay, mud
	+ 4	− 1	Gravel, coarse sand
	− 1	− 4	Gravel, sand
209 K5	+24	+23	Loam
	+23	+22	Clay
	+22	+ 5	Gravel, coarse sand
	+ 5	− 1	Gravel, sand
210 K5	+18	+17	Loam
	+17	+13	Blue clay or clay
	+13	+ 5	Brown clay, mud
	+ 5	+ 2	Peaty clay, mud
	+ 2	− 1	Gravel, sand, stone
211 K5	+20	+19	Loam
	+19	+17	Clay
	+17	+15	Sand, clay
	+15	+ 9	Clay
	+ 9	+ 6	Coarse gravel, sand
212 D2	0	− 3	Soft black silty sand
	− 3	− 5	Fine sand
	− 5	−15	Coarse sharp sand, little gravel
	−15	−19	Blue sand, clay
	−19	−29	Stiff blue clay or stiff clay
	−29	−48	Black clay or clay
213 F7	+18	+ 3	Fill; sand, little gravel
	+ 3	+ 1	Fill; yellow clay, sand, gravel
	+ 1	− 8	Stiff blue clay
	− 8	−22	Fairly stiff blue clay
214 C10	+15.0	+14.5	Hard stone, dirt and ash fill
	+14.5	+ 1.5	Cinder and dirt fill
	+ 1.5	− 9.5	Silt
	− 9.5	−12.0	Soft blue clay
	−12.0	−14.5	Hard yellow clay
215 C10	+ 4.0	− 0.5	Cinder fill
	− 0.5	− 2.5	Silt, sand cinders
	− 2.5	− 6.5	Marsh mud
	− 6.5	−11.5	Soft blue clay
	−11.5	−16.5	Hard blue clay
	−16.5	−19.0	Hard yellow clay
216 C10	+10.5	+ 3.5	Cinder fill, silt
	+ 3.5	− 1.5	Silt
	− 1.5	− 6.5	Silt, marsh mud
	− 6.5	−11.5	Hard yellow clay
217 H5	+20.5	+ 5.0	Fill
	+ 5.0	− 4.5	Dock mud, sand
	− 4.5	− 9.5	Hard packed sand, gravel
	− 9.5	−20.5	Compact medium sand
	−20.5	−27.0	Hard packed coarse sand
218 H5	+20	− 4	Fill
	− 4	− 9	Hard packed coarse sand
	− 9	−19	Hard yellow clay
219 H5	+20	− 4	Fill
	− 4	− 7.5	Hard packed coarse sand
	− 7.5	−16.5	Hard yellow clay
220 H5	+20	− 4	Fill
	− 4	−14	Hard yellow clay
221 E11	+16.5	+ 9.5	Fill, cinders, gravel
	+ 9.5	+ 5.5	Silt and mud fill
	+ 5.5	+ 3.0	Blue clay, little sand fill
	+ 3.0	− 3.0	Clay, little sand
	− 3.0	− 8.0	Fine sand, little clay
222 E10	+16.5	+10.0	Fill; sand, gravel, ash
	+10.0	+ 5.0	Clay and sand fill
	+ 5.0	− 1.0	Fine sand, little clay
	− 1.0	− 7.0	Blue clay, little sand (stiff)
223 E10	+15.5	+ 7.5	Fill; cinders, sand, gravel
	+ 7.5	+ 2.0	Fill; blue clay, gravel
	+ 2.0	− 0.5	Yellow clay, sand
	− 0.5	− 6.5	Sand, little hard clay
224 E10	+17	+16	Loam
	+16	+ 9	Sand and gravel fill (soft)
	+ 9	− 1	Fine sand, little clay
	− 1	− 7	Medium sand (hard)

No. and location	Elevations or depths From	To	Formation
225 E10	+17.5	+12.5	Cinder and gravel fill
	+12.5	+11.0	Yellow clay, little sand and gravel (Struck boulder)
226 E10	+19.5	+16.0	Fill; gravel, ashes, rubbish
	+16.0	+12.5	Sand, coarse gravel; hard (Struck boulder)
227 D10	+18	+13	Sand, gravel; hard
	+13	+10	Sand, gravel, little clay
	+10	+ 5	Stiff yellow clay (Struck boulder)
228 E10	+17	+ 4.5	Fill; sand, gravel, clay
	+ 4.5	− 1.5	Brown peat
	− 1.5	−13.0	Hard blue clay
229 F10	+17	+ 2	Fill; sand, gravel, clay
	+ 2	− 2	Brown peat
	− 2	− 6	Blue clay
	− 6	−16.5	Fine sand, yellow clay
230 F10	+16.0	− 0.5	Fill; sand, gravel, clay
	− 0.5	− 8.0	Brown peat
	− 8.0	−14.0	Blue clay
	−14.0	−17.5	Sand, yellow clay
231 F10	+17.0	− 4.0	Sand and gravel fill
	− 4.0	−10.5	Silt, shells
	−10.5	−18.0	Blue clay
232 D8	+16.0	+ 7.7	Fill; clay, gravel, sand
	+ 7.7	+ 4.0	Peat
	+ 4.0	− 2.5	Clay, sand
233 C9	+15.5	+10.0	Fill; clay, gravel, sand
	+10.0	+ 4.5	Sand and clay fill
	+ 4.5	+ 2.5	Peat
	+ 2.5	− 4.0	Hard yellow clay, sand
234 C9	+15.5	+10.5	Crushed stone, gravel, sand
	+10.5	+ 6.0	Clay, gravel
	+ 6.0	+ 4.0	Peat
	+ 4.0	+ 1.5	Sand, gravel
	+ 1.5	− 2.5	Stiff yellow clay
235 C9	+10.5	+ 8.5	Crushed stone
	+ 8.5	+ 5.5	Sand, gravel
	+ 5.5	0	Peat
	0	− 3.5	Fine sand
	− 3.5	− 8.0	Stiff yellow clay
236 C9	+12.0	+ 9.0	Crushed stone
	+ 9.0	+ 6.5	Clay, gravel, sand
	+ 6.5	− 4.0	Peat
	− 4.0	− 7.0	Fine sand
	− 7.0	−13.0	Blue clay
237 C9	+14.0	+12.0	Crushed stone, gravel
	+12.0	+ 4.0	Fill; clay, sand, gravel
	+ 4.0	+ 0.5	Coarse sand
	+ 0.5	− 2.5	Peat
	− 2.5	− 5.0	Fine sand
	− 5.0	−10.0	Hard yellow clay
238 C9	+14.0	+ 9.0	Crushed stone, gravel
	+ 9.0	+ 7.0	Cinders and gravel fill
	+ 7.0	+ 5.0	Blue clay
	+ 5.0	− 0.5	Silty sand
	− 0.5	− 6.0	Peat
	− 6.0	− 7.5	Fine sand
	− 7.5	−13.0	Stiff blue clay
239 C9	+15	+12.5	Fill; crushed stone, gravel
	+12.5	+ 8	Cinders and sand fill
	+ 8	+ 4	Blue clay fill
	+ 4	+ 1	Fine sand
	+ 1	− 5	Peat
	− 5	−11	Blue clay
240 E9	+16.0	+ 5.0	Fill; sand, gravel, ash
	+ 5.0	+ 2.5	Soft peat, sand and gravel fill
	+ 2.5	− 7.0	Stiff blue clay, sand
241 D10	+15.0	+ 8.0	Fill; sand, gravel, ash
	+ 8.0	+ 5.5	Soft peat, sand and gravel fill
	+ 5.5	+ 3.0	Coarse sand, gravel
	+ 3.0	− 2.5	Stiff blue clay, sand
	− 2.5	− 5.0	Sharp sand, fine gravel
242 D10	+14.5	+ 9.0	Fill; sand, gravel, ash
	+ 9.0	+ 7.5	Soft peat, sand and gravel fill
	+ 7.5	− 5.5	Stiff blue clay with little sand
243 D10	+18.0	+16.5	Fill; sand, gravel, ash
	+16.5	+ 8.5	Yellow clay, gravel and sand (Struck boulder)
244 E9	+15.5	+10.0	Fill; sand, gravel, ash
	+10.0	+ 8.0	Soft peat, sand, gravel
	+ 8.0	+ 4.0	Stiff blue clay
	+ 4.0	+ 2.5	Sharp sand, fine gravel, clay
	+ 2.5	− 5.0	Stiff blue clay, sand
245 E9	+16	+13	Fill; sand, gravel, ash
	+13	+10	Soft blue clay, gravel, sand
	+10	+ 7	Blue slaty ledge (rotten) (Struck ledge)

No. and location	Elevations or depths From	To	Formation
246 C6	+15.0	+ 1.5	Fill; clay, sand, gravel
	+ 1.5	0	Silt
	0	− 4.5	Stiff blue clay, gravel
247 C6	+13	+ 6	Fill; sand, gravel, brick
	+ 6	− 7	Peat
	− 7	−15.5	Silt, shells
248 C5	+14	− 9	Fill; sand, gravel, clay
	− 9	−15	Peat
249 C5	+14	− 2	Sand and gravel fill
	− 2	− 8	Silt
	− 8	−15	Hard blue clay
250 C5	+14.5	+ 2.5	Sand and gravel fill
	+ 2.5	− 1.5	Silt
	− 1.5	− 4.5	Stiff yellow clay
251 C4	+15.0	+ 7.0	Sand and gravel fill
	+ 7.0	+ 1.5	Stiff blue clay
	+ 1.5	− 6.5	Sand and gravel fill
	− 6.5	−10.5	Stiff yellow clay
252 C4	+14.5	− 4.5	Sand and gravel fill
	− 4.5	− 8.5	Silt
	− 8.5	−11.0	Brown peat
	−11.0	−14.5	Stiff blue clay
253 C4	+15.0	− 0.5	Sand and gravel fill
	− 0.5	− 4.5	Stiff yellow clay
254 C3	+14.5	− 2.0	Sand and gravel fill
	− 2.0	−10.5	Silt
	−10.5	−14.5	Stiff blue clay
255 C3	+14.5	+ 0.5	Sand and gravel fill
	+ 0.5	−10.0	Silt, shells
	−10.0	−15.0	Brown peat
256 B4	+15.0	− 1.5	Fill; sand, gravel, stone, cinders
	− 1.5	−18.0	Fine silty sand, shells (soft)
	−18.0	−25.0	Hard blue clay
257 B5	+15.0	− 1.5	Fill; clay, gravel, cinders
	− 1.5	−14.5	Fine silty sand, shells (soft)
	−14.5	−20.0	Hard blue clay
258 B5	+14.0	− 1.5	Fill; clay, gravel, sand, cinders
	− 1.5	− 9.5	Fine silty sand, shells (soft)
	− 9.5	−15.5	Hard blue clay
259 C5	+15.0	− 2.5	Fill; clay, gravel, cinders, silt
	− 2.5	− 9.5	Hard blue clay
260 C5	+15	+ 2	Fill; clay, gravel, cinders, sand
	+ 2	− 1	Fine silty sand, shells (soft)
	− 1	−10	Hard blue clay
261 C5	+15.0	+ 5.5	Fill; clay, gravel, cinders, wood
	+ 5.5	− 2.5	Fine silty sand, shells
	− 2.5	−10.0	Hard blue clay
262 C3	+15.0	+ 2.5	Sand and gravel fill
	+ 2.5	−16.5	Soft silt
	−16.5	−28.0	Soft silt, little sand
	−28.0	−35.5	Soft blue clay
263 C3	+15.0	− 3.5	Fill; sand, gravel, ash
	− 3.5	−15.5	Soft clay
	−15.5	−27.5	Soft clay and sand
	−27.5	−32.5	Sand
	−32.5	−36.5	Clay, fairly stiff
264 C2	+15.0	+ 0.5	Fill; sand, gravel, ash
	+ 0.5	−17.0	Soft silt and sand
	−17.0	−29.0	Silt, stone, boulder
265 C2	+16	+11	Wet fill
	+11	+ 5	Very soft blue clay
	+ 5	−11.5	Fine sand, trace of clay and silt
	−11.5	−34.0	Fine sand, wet and soft
266 C9	+10.5	+ 8.0	Crushed stone
	+ 8.0	+ 5.0	Sand and gravel
	+ 5.0	− 0.5	Peat
	− 0.5	− 4.0	Fine sand
	− 4.0	− 8.0	Stiff yellow clay
267 C9	+16.5	+ 2.5	Sand and gravel fill
	+ 2.5	− 7.5	Stiff sand
	− 7.5	−16.5	Stiff blue clay
268 C9	+16.0	+ 7.5	Sand and gravel fill
	+ 7.5	+ 3.5	Fine sand
	+ 3.5	− 6.0	Blue clay and sand
269 C9	+16.5	+ 5.5	Sand and gravel fill
	+ 5.5	+ 3.5	Sand
	+ 3.5	− 2.5	Yellow clay, sand
270 C9	+18	+ 6	Sand and gravel fill
	+ 6	− 2	Fine sand
271 C8	+18.0	+ 9.0	Sand and gravel fill
	+ 9.0	− 2.5	Fine sand
272 C8	+19.5	+ 6.5	Sand and gravel fill
	+ 6.5	− 2.5	Fine sand
273 D10	+12.5	+ 3.0	Fill; sand, gravel, peat
	+ 3.0	− 3.0	Clay, sand
274 D10	+14.5	+ 6.0	Sand and fill
	+ 6.0	+ 2.0	Blue clay
275 D10	+18.0	+ 5.5	Sand and gravel fill
	+ 5.5	0	Sand, clay
276 D9	+16.5	+ 2.5	Sand and gravel fill
	+ 2.5	− 3.5	Blue clay

No. and location	Elevations or depths From	To	Formation
277 D9	−16.0	+ 3.5	Fill; sand, gravel, ash, mud
	+ 3.5	− 4.0	Sharp sand
278 D9	+16.0	+13.0	Broken stone
	+13.0	+ 4.5	Sand and gravel fill
	+ 4.5	− 6.0	Fine sand
	− 6.0	−12.0	Blue clay
279 E10	+17	+16	Sand, gravel, cinders
	+16	+ 5	Fill; ashes, sand, gravel, shells
	+ 5	+ 4	Silt, sand
	+ 4	− 1	Stiff blue clay
280 E10	+16.5	+15.5	Cinders, sand, gravel
	+15.5	+ 6.0	Fill; ashes, sand, gravel, shells
	+ 6.0	+ 5.0	Clay, sand (soft)
	+ 5.0	− 0.5	Brown clay, sand
281 E10	+17	+16	Ashes
	+16	+13	Fill; clay, ashes, gravel
	+13	+ 7	Ashes, sand, gravel, soft shells
	+ 7	+ 4	Medium sand, fine gravel
	+ 4	− 0.5	Stiff blue clay
282 E10	+18.0	+16.0	Sand, gravel, cinders
	+16.0	+14.5	Sand, gravel
	+14.5	+ 5.5	Sand, gravel, slatey stone
	+ 5.5	+ 3.0	Stiff blue clay
283 E10	+19	+18	Cinders
	+18	+17	Sand
	+17	+16	Clay, sand, gravel (Struck ledge)
284 F4	+19.5	+ 4.5	Gravel
	+ 4.5	−10.5	Sand, gravel, trace of clay
	−10.5	−30.5	Clay
285 F4	+16	+ 6	Gravel
	+ 6	− 9	Gravel, clay
	− 9	−34	Clay
286 F4	+15	−10	Ground gravel, clay
	−10	−35	Clay
287 F3	+15.5	− 9.5	Gravel, clay
	− 9.5	−19.5	Gravel, clay, mud
	−19.5	−44.5	Clay
288 F3	+15.0	− 0.5	Gravel, clay
	− 0.5	−10.5	Gravel, clay, some mud
	−10.5	−36.0	Clay
289 F3	+15	0	Gravel, clay
	0	−10	Gravel, clay, some mud
	−10	−35	Clay
290 F3	+15.5	+10.5	Gravel, clay
	+10.5	− 4.5	Mud, cinders, clay
	− 4.5	− 9.5	Clay, sand
	− 9.5	−34.5	Clay
291 F3	+14.0	+ 9.5	Gravel, cinders
	+ 9.5	+ 4.5	Gravel
	+ 4.5	− 5.5	Gravel, clay
	− 5.5	−20.5	Clay, sand
	−20.5	−35.5	Clay
292 E3	+14	+ 9	Cinders
	+ 9	+ 4	Gravel, bricks
	+ 4	−21	Sand, clay
	−21	−36	Clay
293 E3	+14	+ 9	Cinders
	+ 9	−26	Sand, clay
	−26	−61	Clay
294 E2	+12.5	+ 1.5	Ash fill (loose)
	+ 1.5	− 4.5	Sand, clay and ash fill (wet and loose)
	− 4.5	− 9.5	Fine sand, silty (wet and loose)
	− 9.5	−27.0	Very soft silt, little sand
	−27.0	−32.5	Fairly stiff blue clay
295 E3	+16.5	+ 4.5	Ash, sand and gravel fill (wet)
	+ 4.5	− 1.5	Fine sand, gravel and clay fill (soft)
	− 1.5	−12.5	Fine sand, little silt (soft)
	−12.5	−17.0	Soft peat
	−17.0	−21.0	Stiff yellow clay
296 E2	+16.5	+10.5	Ash, sand and gravel fill (soft and wet)
	+10.5	−16.0	Clay fill, little sand and gravel (soft)
	−16.0	−20.0	Stiff yellow clay
297 E2	+16.5	− 1.0	Ash, sand, gravel and brick fill (loose and wet)
	− 1.0	− 8.5	Clay and sand fill (soft)
	− 8.5	−12.5	Fine sand (soft)
298 E2	+16.5	+10.0	Ash, sand, gravel and brick fill (loose and wet)
	+10.0	− 4.5	Clay, sand and gravel fill (soft)
	− 4.5	− 8.5	Stiff sand
299 F11	+ 6	− 1.5	Fill; sand, gravel, brick, wood, ash
	− 1.5	− 3	Soft silt, peat
	− 3	− 6	Coarse sand (wet)
	− 6	−11	Stiff blue clay
300 F11	+12.5	− .5	Fill; sand, gravel, brick, wood, ash
	− .5	− 3.0	Soft silt, peat
	− 3.0	− 5.5	Coarse sand
	− 5.5	−10.5	Stiff blue clay
301 F11	+14.0	+ 2.0	Fill; sand, gravel, brick, wood, ash
	+ 2.0	− 2.5	Soft silt, peat
	− 2.5	− 5.0	Coarse sand
	− 5.0	−10.0	Stiff blue clay

No. and location	Elevations or depths From	To	Formation
302 F11	+ 3	− 1	Silt
	− 1	− 4	Fine sand
	− 4	− 9	Blue clay
303 E11	+ 3.5	− 1.5	Silt, shells
	− 1.5	− 6.5	Blue clay
304 F7	+19.0	+ 7.5	Fill; rubbish, little sand and gravel
	+ 7.5	+ 5.5	Coarse silty sand, little gravel
	+ 5.5	− 5.0	Very stiff blue clay
	− 5.0	−16.0	Stiff blue clay
305 F7	+18	+ 6	Fill; rubbish, little sand and gravel
	+ 6	+ 3	Silt
	+ 3	+ 1	Coarse sand, gravel
	+ 1	−17	Stiff blue clay
306 F7	+ 5.5	+ 2.5	Black silt
	+ 2.5	+ 1.0	Coarse silty sand, little gravel
	+ 1.0	−16.5	Stiff blue clay
	−16.5	−27.0	Fairly stiff blue clay
307 F7	+ 4.0	0	Silt
	0	− 1.5	Coarse silty sand
	− 1.5	−20.5	Stiff blue clay
	−20.5	−27.0	Fairly stiff blue clay
308 F11	+ 2	+ 1	Mud
	+ 1	− 2	Hard sand
	− 2	− 3	Soft blue clay
309 F11	+ 2.0	+ 1.0	Black silt
	+ 1.0	− 3.5	Fine sand
	− 3.5	− 5.5	Hard blue clay
310 F11	+ 2.0	− 0.5	Mud
	− 0.5	− 3.0	Sand
	− 3.0	−11.0	Hard yellow clay
	−11.0	−21.0	Blue clay
311 F11	+ 2.0	− 0.5	Soft yellow mud
	− 0.5	− 4.5	Fine sand, soft clay
	− 4.5	− 5.5	Hard blue clay
312 F11	+ 2.5	+ 0.5	Soft yellow mud
	+ 0.5	− 4.5	Sand, clay
	− 4.5	− 5.5	Hard blue clay
313 F10	+11.0	+ 9.0	Soft yellow clay
	+ 9.0	− 7.5	Black sea mud
	− 7.5	− 8.5	Hard blue clay
314 F10	+ 2.5	− 1.0	Soft yellow mud
	− 1.0	−10.5	Black silt
	−10.5	−14.0	Soft blue clay
315 F10	+ 1.5	−14.0	Mud (silt)
	−14.0	−22.0	Hard clay
	−22.0	−27.0	Blue clay
316 F10	+ 1.5	+ 1.0	Soft yellow mud
	+ 1.0	−10.5	Black sea mud
	−10.5	−13.0	Hard clay
317 G10	+ 2	−11	Mud
	−11	−16	Hard yellow clay
	−16	−23	Blue clay
318 G10	+ 2	− 7	Silt
	− 7	− 8	Hard yellow clay
319 G10	+ 2	− 8	Mud
	− 8	−20	Hard yellow clay
	−20	−27	Blue clay
320 E4	+23.5	+10.5	Dirt fill
	+10.5	+ 7.5	Soft blue clay
	+ 7.5	+ 4.5	Stiff yellow clay
321 E4	+20	+11	Dirt fill, some clay
	+11	+ 3	Soft yellow clay
	+ 3	− 3	Stiff yellow clay
322 E4	+17.0	+13.5	Gravel fill
	+13.5	− 2.5	Soft blue clay
	− 2.5	− 5.5	Stiff yellow clay
323 B10	− 1.5	−11	Silt, mud
	−11	−16	Silt, sand
	−16	−19	Stiff yellow clay
324 B10	− 2	−12	Mud
	−12	−18	Silt, sand
	−18	−21	Stiff yellow clay
325 B10	− 2	−13	Mud
	−13	−17	Silt, sand
	−17	−19	Stiff yellow clay
326 B10	+ 1.0	− 5.0	Mud
	− 5.0	−10.5	Broken stone
	−10.5	−14.5	Mud
	−14.5	−22.5	Hard clay
	−22.5	−29.0	Mud
327 B8	− 2.0	− 4.5	Cinder fill
	− 4.5	−10.0	Silt, sand
	−10.0	−19.0	Hard yellow clay
328 B8	+ 2	− 1	Ash and sand fill
	− 1	− 7	Mud
	− 7	−14	Hard yellow clay
329 B8	+15.5	− 0.5	Ash fill
	− .5	−14.5	Blue clay
330 E11	+14.0	+ 3.0	Sand and gravel fill
	+ 3.0	− 2.5	Peat
	− 2.5	− 6.0	Silt
	− 6.0	− 7.5	Stiff blue clay
331 E11	+14.0	+ 3.0	Sand and gravel fill
	+ 3.0	− 5.5	Silt, mud
	− 5.5	− 8.0	Stiff blue clay
332 E11	+13.0	+ 4.5	Fill; sand, gravel, cinders
	+ 4.5	− 2.5	Silt, peat
	− 2.5	− 6.5	Stiff yellow clay
333 D11	+15.0	+ 5.5	Fill; sand, gravel, cinders
	+ 5.5	− 3.5	Black mud
	− 3.5	− 7.5	Fine sand
	− 7.5	−10.5	Stiff blue clay

No. and location	Elevations or depths From	To	Formation
334 D11	+14.5	+ 2.5	Fill; sand, gravel, cinders
	+ 2.5	− 2.5	Fill; coarse sand, gravel
	− 2.5	− 6.5	Silty sand, mud
	− 6.5	− 9.5	Stiff blue clay
335 D11	+18.5	+ 3.5	Sand and gravel fill
	+ 3.5	− 1.5	Fill; coarse sand, gravel
	− 1.5	− 3.5	Silty sand, mud
	− 3.5	− 6.5	Stiff blue clay
336 C10	+16.0	+ 5.0	Fill, ashes, sand
	+ 5.0	+ 0.5	Peat
	+ 0.5	− 1.5	Mud, peat
	− 1.5	− 4.0	Fine sand
	− 4.0	−10.5	Stiff yellow clay
337 C10	+16.5	+ 3.5	Fill, ashes, clay, gravel
	+ 3.5	− 7.0	Peat, mud
	− 7.0	−14.0	Stiff blue clay
338 C10	+17.0	− 1.5	Fill, ashes, clay, mud
	− 1.5	−14.0	Peat, mud
	−14.0	−18.0	Fine sand
	−18.0	−24.0	Stiff blue clay
339 A10	+ 2	− 8	Silt, black mud
	− 8	−21	Silty peat
	−21	−30	Fine sand
	−30	−32.5	Stiff yellow clay
340 B10	+14	+ 4	Cinder fill
	+ 4	−11	Silt, sand
	−11	−25	Fine sand
	−25	−29.5	Stiff yellow clay
341 B10	+16.0	+ 5.5	Cinder fill
	+ 5.5	− 7.5	Fine sand, silt
	− 7.5	−24.5	Fine sand
	−24.5	−26.5	Stiff yellow clay
342 D11	+17.5	+ 8.5	Fill
	+ 8.5	+ 3.5	Compact medium sand
	+ 3.5	− 2.5	Medium yellow clay, little sand
343 D11	+19.0	+10.0	Fill
	+10.0	+ 2.5	Compact sand, thin layer of clay
	+ 2.5	+ 0.5	Compact sand and gravel
	+ 0.5	− 1.0	Medium yellow clay, little sand
344 D11	+17.5	+ 8.5	Fill
	+ 8.5	+ 1.5	Medium sand, little clay
	+ 1.5	− 7.5	Fine compact sand, little clay
345 D11	+16.5	+ 5.0	Fill
	+ 5.0	− 3.5	Fine compact sand, little clay
346 E11	+14.5	+ 7.0	Fill
	+ 7.0	+ 0.5	Sand, gravel little clay
	+ 0.5	− 5.5	Compact medium sand
	− 5.5	− 6.5	Fine compact sand, little clay
347 E11	+14.5	+ 5.0	Fill
	+ 5.0	− 0.5	Hard blue clay
	− 0.5	− 7.5	Fine compact sand, little clay
348 J5	+20.0	+14.0	Gravel, stones
	+14.0	0	Sand
349 J5	+20	+15	Rock, gravel
	+15	− 7	Sand, gravel
350 J5	+20.5	+14	Ash fill
	+14	+ 2	Hard clay
	+ 2	− 8	Sand, gravel
351 J5	+20	+12	Ash fill
	+12	− 5	Sand, gravel
352 J5	+22	+19	Stones, clay
	+19	+ 6	Stones, sand, gravel
353 J5	+23.5	+20.0	Hard gravel, stones
	+20.0	− 2.5	Sand
354 J5	+24	+21	Hard fill, gravel, stones
	+21	+10	Sand, little clay
	+10	− 8	Stiff blue clay
357 B10	+ 3.5	− 2	Silt, black mud
	− 2	−15	Fine sand
	−15	−18	Stiff yellow clay
358 B10	− 1	−11	Silt, mud
	−11	−16	Silt and sand
	−16	−19	Stiff yellow clay
359 B10	+ 0.5	− 6.5	Silt
	− 6.5	−17.5	Silt, sand
	−17.5	−20.5	Stiff yellow clay
360 B10	+ 1	− 4	Sand, black mud
	− 4	−13	Silt, sand
	−13	−19	Coarse sand
361 B10	− 1	−12	Coarse sand, silt
	−12	−17	Silt, sand
	−17	−22	Coarse sand
	−22	−26	Stiff blue clay
362 B11	− 1	−12	Coarse sand, silt
	−12	−17	Silt, sand
	−17	−24	Coarse sand
	−24	−26	Stiff blue clay
363 B11	+ 0.5	−15.5	Silt, sand
	−15.5	−20.5	Coarse sand, clay
364 B11	− 2	−13	Silt, some clay
	−13	−18	Silt, yellow clay, sand

No. and location	Elevations or depths From	To	Formation
365	+ 5.0	+ 1.0	Fill
K5	+ 1.0	− 8.5	Fill; silt sand, gravel, little clay
	− 8.5	−12.0	Fine silty sand
	−12.0	−16.5	Fine sand, little gravel
	−16.5	−20.0	Fine sharp sand
366	+ 3.0	0	Fill
K5	0	− 1.5	Soft black silt, sand
	− 1.5	− 9.0	Hard clay, gravel, sand
	− 9.0	−12.0	Hard fine sand, clay
367	+ 1.0	− 2.0	Silty sand, gravel
J4	− 2.0	−10.0	Medium blue clay
	−10.0	−12.5	Fine sand, clay
	−12.5	−22.0	Medium blue clay
368	− 0.5	− 1.0	Soft silt
J4	− 1.0	− 3.5	Silty sand, gravel
	− 3.5	−23.0	Fine sharp sand
	−23.0	−28.5	Hard blue clay, fine sand
369	− 1.0	− 4.0	Soft silt
J4	− 4.0	− 5.5	Silty sand, gravel
	− 5.5	−17.5	Medium sand, very little gravel
	−17.5	−22.0	Medium blue clay, little fine sand
370	− 0.5	− 4.5	Fill; silty sand, gravel
J4	− 4.5	−12.0	Silty sand
	−12.0	−16.0	Medium blue clay
	−16.0	−20.5	Medium blue clay, little fine sand
	−20.5	−23.0	Fine sand, little clay
	−23.0	−27.0	Medium blue clay, fine sand
371	− 1.0	− 6.5	Soft silt
J4	− 6.5	− 7.5	Silty sand, gravel
	− 7.5	−19.0	Medium blue clay
	−19.0	−24.0	Compact sharp sand, little clay
373	− 1.5	− 6.0	Mud
I9	− 6.0	−13.5	Medium blue clay
	−13.5	−17.0	Medium sand
	−17.0	−27.0	Medium blue clay
374	− 4.0	− 6.5	Mud
I10	− 6.5	−20.0	Hard yellow clay
	−20.0	−30.0	Medium blue clay
375	+ 6.5	− 0.5	Fill
J8	− 0.5	− 5.0	Peat
	− 5.0	−15.5	Medium sand, little clay
376	+ 2.0	− 0.5	Fine sand, gravel
J8	− 0.5	− 4.5	Fine sand
	− 4.5	− 8.5	Medium blue clay
	− 8.5	−23.5	Medium yellow clay
377	0	− 2.5	Silty sand
J8	− 2.5	−10.0	Sand
	−10.0	−22.5	Medium blue clay
378	+17.0	+ 1.0	Cinder fill
D6	+ 1.0	− 3.0	Silt, peat
	− 3.0	−13.5	Medium blue clay
	−13.5		Hardpan—sand, gravel, clay
379	+17.0	+ 1.5	Cinder fill
D6	+ 1.5	+ 0.5	Silt
	+ 0.5	−25.0	Medium blue clay
	−25.0		Ledge
380	+17.5	+14.0	Sand and gravel fill
E6	+14.0	+ 0.5	Clay fill
	+ 0.5	−25.0	Medium blue clay
	−25.0	−32.5	Medium sand, gravel
381	+17.0	+14.0	Hard sand and gravel fill
E5	+14.0	− 0.5	Clay fill
	− 0.5	−12.5	Medium blue clay
	−12.5	−15.0	Hard sand, gravel, clay
	−15.0		Ledge or boulder
382	+16.0	+ 9.5	Sand and gravel fill
E5	+ 9.5	+ 1.0	Clay fill
	+ 1.0	− 9.5	Medium clay
	− 9.5	−14.0	Hard sand, gravel, little clay
383	+16	+11	Sand and gravel fill
E5	+11	+ 2	Fill; clay, cinders, little silt
	+ 2	− 1	Fill; coarse dirty sand, little silt
	− 1	− 4	Medium clay
	− 4	− 8	Hard sand, gravel, clay
	− 8		Ledge or boulder
384	+16.0	+ 1.0	Compact fill
C4	+ 1.0	− 7.5	Fill; sand, gravel
	− 7.5	−19.0	Dock mud
	−19.0	−31.0	Soft blue clay
385	+16.0	+ 4.0	Loose fill
C4	+ 4.0	− 5.5	Dock mud
	− 5.5	−19.5	Soft blue clay
386	+15.5	− 9.5	Compact fill
C4	− 9.5	−11.5	Fine sand, mud
	−11.5	−16.5	Sand and gravel
	−16.5	−26.5	Soft blue clay
387	+16.0	+ 5.0	Fill
C4	+ 5.0	− 3.5	Dock mud
	− 3.5	−19.0	Medium yellow clay
388	+15.5	+ 4.5	Fill
C4	+ 4.5	− 3.5	Dock mud
	− 3.5	−20.0	Medium yellow clay
389	+17.5	+ 7.5	Fill
C4	+ 7.5	− 3.0	Dock mud
	− 3.0	−17.0	Medium yellow clay
390	+17.0	+ 7.5	Ash and sand fill
D11	+ 7.5	+ 5.0	Fill and mud
	+ 5.0	−13.0	Hard blue clay

No. and location	Elevations or depths From	To	Formation
391 D11	+17.5	+11.5	Ash fill
	+11.5	+ 7.0	Fill and mud
	+ 7.0	− 7.5	Hard blue clay
392 D11	+19	+12	Ash fill
	+12	+ 9	Sand and clay fill
	+ 9	+ 1	Hard blue clay
	+ 1	−11	Fine sand, clay
393 B8	+17.5	+ 9.5	Gravel
	+ 9.5	+ 1.0	Gravel, mud
	+ 1.0	−11.0	Clay, gravel
394 B7	+17.0	+10.0	Gravel
	+10.0	− 2.5	Gravel, mud
	− 2.5	−13.5	Clay, gravel
395 B7	+15.0	+ 7.5	Gravel
	+ 7.5	− 4.0	Gravel, mud
	− 4.0	− 8.5	Clay
	− 8.5	−16.5	Clay, gravel
396 B7	+15.0	+ 7.5	Gravel
	+ 7.5	−11.5	Gravel, mud
	−11.5	−13.0	Clay
	−13.0	−14.5	Gravel
	−14.5	−19.0	Clay, gravel
397 B7	+15.0	+ 8	Gravel
	+ 8	− 5	Gravel, mud
	− 5	−14	Clay
	−14	−16	Clay, gravel
398 B7	+15.5	+ 8.5	Gravel
	+ 8.5	−12.5	Gravel, mud
	−12.5	−15.5	Clay
399 B6	+15.0	− 1.0	Gravel
	− 1.0	−13.5	Gravel, mud
	−13.5	−15.0	Clay, gravel
400 B6	+15.0	+ 6.5	Gravel
	+ 6.5	−14.5	Gravel, mud
	−14.5	−18.5	Clay, gravel
401 B6	+15.5	+ 8.0	Gravel
	+ 8.0	− 7.5	Gravel, mud
	− 7.5	−15.5	Clay
	−15.5	−32.5	Clay, gravel
402 F4	+15	+14	Cobble stone
	+14	+10	Sand and gravel fill
	+10	− 4	Clay and silt fill
	− 4	−22	Silt, shells
	−22	−24	Medium blue clay
	−24	−30	Hard yellow clay
403 F4	+14.5	+13.5	Cobble stone
	+13.5	+10.0	Sand and gravel fill
	+10.0	− 5.0	Clay and silt fill
	− 5.0	−22.0	Silt, shells
	−22.0	−24.5	Medium blue clay
	−24.5	−30.5	Hard yellow clay
404 F4	+15.0	+14.0	Cobble stone
	+14.0	+10.5	Sand and gravel fill
	+10.5	− 2.0	Clay and silt fill
	− 2.0	−22.0	Silt, shells
	−22.0	−25.5	Medium blue clay
	−25.5	−29.0	Hard yellow clay

No. and location	Elevations or depths From	To	Formation
405 C3	+14.5	+13.5	Paving block
	+13.5	+11.5	Sand
	+11.5	+ 0.5	Black mud, silt
	+ 0.5	− 4.0	Soft blue clay
	− 4.5	−29.5	Soft gray clay
406 C3	+14.5	+ 4.0	Fill; sand, ash, brick
	+ 4.0	+ 0.5	Black mud
	+ 0.5	− 4.5	Soft gray clay
	− 4.5	−20.5	Soft blue clay
407 C3	+14.5	− 0.5	Fill; sand, ash, brick
	− 0.5	−20.5	Soft blue clay
408 C2	+14.0	+ 4.0	Fill; sand, ash; brick
	+ 4.0	+ 1.5	Gray clay
	+ 1.5	− 6.0	Brown clay
	− 6.0	−16.0	Blue clay
409 C2	+14.0	+13.0	Paving block
	+13.0	+ 7.0	Fill; sand, ash, brick
	+ 7.0	−16.0	Soft gray clay
410 D2	+16.0	+11.0	Fill; sand, gravel, brick (loose and wet)
	+11.0	− 3.0	Fill; clay, sand, gravel (soft)
	− 3.0	− 7.0	Stiff sand
411 D2	+16.0	+15.0	Paving
	+15.0	+ 6.5	Hard sand, gravel and cinder fill
	+ 6.5	− 4.0	Soft blue clay fill
	− 4.0	−14.0	Fine silty sand
	−14.0	−19.5	Fine sand
	−19.5	−24.0	Fairly stiff blue clay
412 D2	+15.0	+14.0	Paving
	+14.0	+ 5.0	Hard sand, gravel and cinder fill
	+ 5.0	+ 1.0	Silty sand
	+ 1.0	− 4.5	Stiff clay fill
	− 4.5	−10.0	Fine silty sand
	−10.0	−17.0	Fine sand
	−17.0	−20.0	Soft blue clay
	−20.0	−23.0	Stiff blue clay
	−23.0	−25.0	Fine sand
	−25.0	−30.0	Fairly stiff blue
413 D2	+16.0	+15.5	Paving
	+15.5	+ 7.0	Hard sand, gravel and cinder fill
	+ 7.0	+ 0.5	Fairly stiff clay fill
	+ 0.5	− 9.5	Silty sand
	− 9.5	−18.0	Fine sand
	−18.0	−22.0	Fine sand, little clay
	−22.0	−26.5	Soft blue clay
	−26.5	−30.0	Stiff blue clay

No. and location	Elevations or depths From	To	Formation
414	+16.5	+15.5	Paving
C2	+15.5	+ 9.5	Hard sand, gravel and cinder fill
	+ 9.5	+ 6.5	Stiff clay fill
	+ 6.5	+ 1.5	Soft clay fill
	+ 1.5	− 5.5	Silty sand
	− 5.5	−10.5	Fine sand, very little clay
	−10.5	−15.5	Soft blue clay, little sand
	−15.5	−23.5	Fairly stiff blue clay
415	+18	+ 4'	Fill
C11	+ 4	+ 1	Soft silt, little sand and peat
	+ 1	0	Silty clay
	0	−10	Stiff clay
416	+18	+ 6	Fill
C11	+ 6	+ 3	Peat
	+ 3	− 1	
	− 1	− 6	Stiff clay
	− 6	− 7	Stiff blue clay, fine sand
	− 7	−12	Stiff clay
417	+16	+ 1	Fill
C9	+ 1	− 2	
	− 2	− 6	Stiff clay
418	+16	+14	Fill
B9	+14	+ 5	Clay, sand, gravel
	+ 5	+ 2	Silt
	+ 2	− 3	Stiff clay
419	+16	+ 1	Fill
C9	+ 1	− 2	Black silt
	− 2	− 7	Stiff clay
420	− 6	− 8	Silt
G2	− 8	−14	Sand, clay, gravel
	At −14		Rock
421	− 5	− 8	Silt
G2	− 8	−12	Sand, clay, gravel
	−12	−36	Stiff clay
	At −36		Rock
422	− 5	− 8	Silt
G2	− 8	−22	Sand, gravel, clay, boulders
	At −22		Sand, gravel, clay, boulders
423	− 6	−11	Silt
G2	−11	−26	Stiff clay
	−26	−38	Sand, clay, gravel
	At −38		Rock
424	− 6	− 9	Silt
G2	− 9	−12	Stiff clay
	−12	−15	Sand, clay, gravel
	At −15		Rock
425	−19	−33	Stiff clay
G2	−33	−38	Sand, clay, gravel
	At −38		Rock
426	−19	−20	Silt
G2	−20	−31	Sand, clay gravel
	At −31		Rock
427	− 7	−10	Silt
H2	−10	−25	Stiff clay
	−25	−27	Sand, clay, gravel
	At −27		Rock
428	− 6	−12	Silt
H2	−12	−26	Stiff clay
	−26	−39	Sand, clay, gravel
	At −39		Sand, clay, gravel
429	−16	−18	Silt
H2	−18	−35	Clay
	At −35		Rock
430	−18	−21	Silt
H2	−21	−38	Stiff clay
	−38	−40	Clay, sand, gravel
431	−30	−32	Silt
H1	At −32		Rock
432	−10	−12	Silt
H2	−12	−24	Clay
	−24	−27	Clay, sand, gravel
	At −27		Rock
433	−14	−16	Silt
H2	−16	−28	Stiff clay
	−28	−33	Clay, sand, gravel
	At −33		Rock
434	−17	−21	Silt
I2	At −21		Rock
435	− 6	−15	Silt
H2	−15	−18	Peat
	−18	−40	Stiff clay
436	−16	−18	Silt
H2	−18	−30	Stiff clay
	−30	−31	Clay, sand, gravel
	At −31		Rock
437	−22	−24	Silt
I2	−24	−36	Stiff clay
	−36	−39	Clay, sand, gravel
438	− 6	−15	Silt
H2	−15	−39	Stiff clay
439	− 7	−19	Silt
H2	−19	−39	Stiff clay
	−39	−40	Clay, sand, gravel
	At −40		Rock
440	−12	−19	Silt
H2	−19	−39	Stiff clay
	−39	−41	Clay, sand, gravel
441	−14	−23	Silt
I2	−23	−41	Stiff clay
442	−16	−25	Silt
I2	−25	−35	Stiff clay
	−35	−40	Clay, sand, gravel
	At −40		Rock
443	−19	−20	Silt
I2	−20	−40	Stiff clay
444	− 8	−18	Silt
H3	−18	−39	Stiff clay

No. and location	Elevations or depths From	To	Formation
445	— 5	—15	Silt
H3	—15	—39	Stiff clay
446	— 5	—15	Silt
H3	—15	—17	Stiff clay
	—17	—40	Clay, sand, gravel
447	— 5	—15	Silt
H3	—15	—18	Peat
	—18	—40	Stiff clay
448	— 5	—15	Silt
H2	—15	—18	Peat
	—18	—40	Stiff clay
449	—12	—21	Silt
I2	—21	—23	Silt, clay
	—23	—40	Stiff clay
450	—12	—22	Silt
I2	—22	—39	Stiff clay
451	—14	—18	Silt
J2	—18	—19	Silty clay
	—19	—39	Stiff clay
452	— 6	—15	Silt
I3	—15	—40	Stiff clay
453	— 6	—16	Silt
I2	—16	—23	Soft peat
	—23	—39	Stiff clay
454	— 9	—16	Silt
J2	—16	—20	Peat
	—20	—39	Stiff clay
455	—11	—21	Silt
I2	—21	—39	Stiff clay
456	— 5	—13	Silt
H3	—13	—28	Stiff clay
	—28	—31	Sand, clay, gravel
	At —31		Rock
457	—10	—19	Silt
H3	—19	—40	Stiff clay
458	— 5	—11	Silt
H3	—11	—16	Sand, clay
	—16	—38	Stiff clay
	—38	—40	Clay, sand, gravel
459	— 7	—15	Silt
H3	—15	—18	Peat
	—18	—40	Stiff clay
460	— 5	—14	Silt
I3	—14	—18	Peat
	—18	—40	Stiff clay
	At —40		Rock
461	— 6	—15	Silt
I3	—15	—18	Peat
	—18	—40	Stiff clay
462	—21	—25	Silt
J2	—25	—37	Stiff clay
	At —37		Rock
463	—15	—18	Silt
J2	—18	—37	Stiff clay
	—37	—41	Sand, clay, gravel
464	— 5	—15	Silt
H3	—15	—33	Stiff clay
	—33	—40	Sand, clay, gravel
465	— 6	—15	Silt
I3	—15	—29	Stiff clay
	—29	—39	Clay, sand, gravel
	At —39		Rock
466	— 4	—12	Silt
H3	—12	—18	Stiff clay
	—18	—39	Sand, clay, gravel
467	— 5	—12	Silt
H3	—12	—24	Stiff clay
	—24	—26	Sand, clay, gravel
	At —26		Rock
468	—11	—14	Silt
H3	—14	—17	Peat
	—17	—19	Stiff clay
	—19	—21	Sand, clay, gravel
	—21	—24	Stiff clay
	—24	—28	Sand, clay, gravel
	At —28		Rock
469	— 8	—18	Silt
I3	—18	—22	Stiff clay
	At —22		Rock
470	—10	—16	Silt
I3	—16	—22	Sand, clay, gravel
	At —22		Rock
471	— 5	—13	Silt
I3	—13	—27	Stiff clay
	—27	—31	Sand, gravel, boulders
472	— 6	—15	Silt
I3	—15	—21	Stiff clay
	At —21		Rock
473	— 6	—18	Silt
I3	—18	—20	Peat
	—20	—40	Stiff clay
474	— 7	—14	Silt
I2	—14	—40	Stiff clay
475	— 9	—18	Silt
J2	—18	—40	Stiff clay
476	—11	—21	Silt
J2	—21	—42	Stiff clay
477	—11	—16	Silt
J2	—16	—18	Peat
	—18	—40	Stiff clay
478	—22	—25	Silt
J2	—25	—31	Stiff clay
	—31	—34	Sand, clay, gravel
	At —34		Rock
479	—13	—19	Silt
J2	—19	—39	Stiff clay

No. and location	Elevations or depths From	To	Formation
480	−12	−18	Silt
J2	−18	−37	Stiff clay
481	− 8	−15	Silt
I3	−15	−21	Stiff clay
	−21	−26	Sand, clay, gravel
	At −26		Rock
482	− 4	−11	Silt
I3	−11	−16	Stiff clay
	−16	−26	Sand, gravel, boulders
483	− 5	−11	Silt
I3	−11	−17	Stiff clay
	−17	−39	Sand, clay, gravel
484	− 6	−12	Silt
I3	−12	−25	Stiff clay
	−25	−40	Sand, clay, gravel
485	− 6	−16	Silt
I3	−16	−25	Stiff clay
	−25	−29	Sand, clay, gravel
	At −29		Rock
486	0	− 8	Silt
H3	− 8	−25	Stiff clay
	−25	−40	Sand, clay, gravel
487	− 6	−11	Silt
I3	−11	−31	Stiff clay
	At −31		Rock
488	− 9	−12	Silt
I3	−12	−16	Stiff clay
	−16	−20	Sand, clay, gravel
	At −20		Rock
489	− 4	− 7	Silt
I3	− 7	−10	Sand, clay, gravel
	At −10		Rock
490	− 8	−12	Silt
I3	−12	−29	Stiff clay
	−29	−31	Sand, clay, gravel
	At −31		Rock
491	− 6	−15	Silt
J3	−15	−17	Sand, clay, gravel
	−17	−36	Stiff clay
	−36	−40	Sand, clay, gravel
492	0	− 9	Silt
I3	− 9	−15	Silty sand
	−15	−19	Sand, clay, gravel
	−19	−40	Stiff clay
493	− 8	−12	Silt
I3	−12	−15	Stiff clay
	−15	−45	Sand, clay, gravel
494	−10	−19	Silt
I3	−19	−33	Stiff clay
	−33	−40	Sand, clay, gravel
495	−12	−20	Silt
I3	−20	−26	Stiff clay
	−26	−40	Clay, sand, gravel
496	−12	−15	Silt
I3	−15	−24	Stiff clay
	−24	−31	Sand, clay, gravel
	At −31		Rock
497	− 6	−15	Silt
I3	−15	−25	Stiff clay
	−25	−29	Sand, clay, gravel
	At −29		Rock
498	− 6	−16	Silt
J3	−16	−33	Stiff clay
	−33	−40	Sand, clay, gravel
	At −40		Rock
499	− 7	−12	Silt
J3	−12	−20	Stiff clay
	−20	−28	Sand, clay, gravel
	At −28		Rock
500	− 8	−12	Silt
J3	−12	−39	Stiff clay
501	−11	−15	Silt
K2	−15	−39	Stiff clay
502	− 9	−12	Silt
K2	−12	−23	Stiff clay
503	− 9	−12	Silt
K2	−12	−26	Stiff clay
	−26	−39	Sand, clay, gravel
	At −39		Rock
504	− 5	− 9	Silt
I3	− 9	−19	Sand, clay, gravel
	−19	−39	Stiff clay
505	−11	−17	Silt
I3	−17	−39	Stiff clay
506	− 5	−10	Silt
I3	−10	−24	Stiff clay
	−24	−26	Sand, clay, gravel
	At −26		Rock
507	− 6	−11	Silt
I3	−11	−33	Stiff clay
	−33	−39	Sand, clay, gravel
508	− 7	−13	Silt
J3	−13	−40	Stiff clay
509	− 7	−11	Silt
J3	−11	−32	Stiff clay
	−32	−37	Sand, clay, gravel
	At −37		Rock
510	− 7	−10	Silt
K3	−10	−35	Stiff clay
	At −35		Rock
511	− 6	−10	Silt
K3	−10	−12	Sand, clay, gravel
	At −12		Rock
512	− 5	− 7	Silt
K3	− 7	−39	Stiff clay
513	− 5	− 7	Silt
K3	− 7	−16	Stiff clay
	−16	−32	Sand, clay, gravel
	At −32		Rock

No. and location	Elevations or depths From	To	Formation
514 K3	— 5	— 7	Silt
	— 7	—30	Stiff clay
	—30	—35	Sand, clay, gravel
	At —35		Rock
515 K3	— 4	— 6	Silt
	— 6	—39	Sand, clay, gravel
516 K2	— 7	—10	Silt
	—10	—39	Stiff clay
517 K2	— 7	—10	Silt
	—10	—23	Stiff clay
	—23	—28	Sand, clay, gravel
	At —28		Rock
518 L2	—27	—29	Silt
	—29	—34	Stiff clay
	—34	—37	Sand, clay, gravel
519 H4	— 2	—11	Silt
	—11	—21	Peat
	—21	—42	Stiff clay
520 I4	— 2	— 6	Silt
	— 6	— 8	Peat
	— 8	—39	Stiff clay
521 I3	— 3	—12	Silt
	—12	—18	Peat
	—18	—39	Stiff clay
522 I3	— 3	— 9	Silt
	— 9	—35	Stiff clay
	—35	—38	Sand, clay, gravel
523 H4	— 2	—14	Silt
	—14	—39	Stiff clay
524 I4	— 4	—15	Silt
	—15	—18	Peat
	—18	—40	Stiff clay
525 I4	— 3	—10	Silt
	—10	—12	Peat
	—12	—40	Stiff clay
526 I4	— 3	—12	Silt, little fine sand
	—12	—27	Hard blue clay
	—27	—38	Stiff clay
	—38	—44	Fairly stiff blue clay
527 I4	—21	—22	Soft silt
	—22	—23	Sandy silt
	—23	—36	Fine sand
	—36	—41	Sand, clay
528 J4	— 2	— 9	Silt
	— 9	—12	Sand
	—12	—36	Stiff clay
	—36	—41	Fine sand, little clay
529 J3	— 4	— 5	Silt
	— 5	— 7	Silt, little sand
	— 7	—43	Stiff clay
530 K3	— 4	— 7	Silty sand
	— 7	—14	Firm sand, little clay
	—14	—20	Sand, gravel, very little clay
	—20	—40	Hard sand, little gravel
531 K3	— 4	— 5	Silt
	— 5	— 7	Clay, gravel
	— 7	— 9	Sand, little clay
	— 9	—11	Clay, gravel
	—11	—14	Sand, gravel
	—14	—21	Stiff blue clay, little sand
	—21	—40	Hard sand, little clay
532 K3	— 5	— 7	Silt, little coarse sand
	— 7	—10	Hard sand, little gravel
	—10	—24	Sand, gravel, clay; hard
	—24	—29	Loose sand, clay
	—29	—38	Stiff blue clay, little coarse sand
	—38	—40	Stiff blue clay, sand, little gravel
533 L2	— 5	— 7	Silty sand, gravel
	— 7	—26	Stiff clay
	—26	—30	Sand, little gravel
	—30	—36	Fairly stiff blue clay
	—36	—40	Clay, little gravel
534 L2	—26	—28	Silt
	—28	—40	Stiff clay
535 J4	— 2	— 4	Silt, fine sand
	— 4	— 7	Sand, clay, gravel
	— 7	—25	Coarse gravel, some clay
	—25	—35	Gravel, small boulders
536 J4	— 3	— 7	Sandy silt
	— 7	—19	Sand
	—19	—32	Sand, clay
	—32	—37	Stiff clay
	—37	—40	Fairly stiff blue clay
537 J3	— 2	— 6	Silt, sand, gravel
	— 6	—11	Stiff yellow clay, little fine sand
	—11	—18	Fine sand, little clay
	—18	—21	Clay, sand
	—21	—40	Clay, sand, little gravel
538 K3	— 4	— 9	Silt, little sand
	— 9	—14	Hard blue clay
	—14	—40	Fairly stiff blue clay

No. and location	Elevations or depths From	To	Formation
539	— 4	— 6	Silt, little gravel
K3	— 6	—20	Stiff clay
	—20	—27	Clay, little sand, little gravel
	—27	—37	Fine sand, little clay
	—37	—39	Stiff clay
	—39	—40	Fine sand, little clay
540	— 5	— 8	Silt, little sand, little gravel
L3	— 8	—16	Stiff clay
	—16	—40	Fairly stiff blue clay
541	— 6	—10	Silt, little sand
L3	—10	—22	Hard blue clay
	—22	—39	Fairly stiff blue clay
	—39	—40	Fine sand, little clay
542	—27	—29	Silt
L2	—29	—40	Stiff clay
543	— 2	— 4	Silt
K3	— 4	—16	Sand, clay, gravel
	—16	—38	Stiff clay
544	— 9	—14	Silt
K3	—14	—40	Stiff clay
545	— 6	— 9	Silt
L3	— 9	—40	Stiff clay
546	— 6	—10	Silt
L3	—10	—40	Stiff clay
547	— 2	— 3	Fine sand, silt
J4	— 3	— 6	Sand
	— 6	—16	Hard blue clay
	—16	—25	Sand
	—25	—35	Soft clay
548	— 3	— 6	Soft silt
J4	— 6	—23	Medium stiff blue clay
	—23	—28	Blue clay, little sand
	—28	—37	Fairly stiff blue clay
	—37	—40	Clay, gravel
549	— 3	— 7	Silt
K4	— 7	—40	Sand, clay, gravel
550	— 4	—11	Silt
K4	—11	—21	Stiff clay
	—21	—40	Sand, clay, gravel
551	—12	—16	Silt
K3	—16	—40	Stiff clay
552	— 6	— 9	Silt
L3	— 9	—40	Stiff clay
553	— 5	—11	Silt
L3	—11	—40	Stiff clay
554	— 3	— 8	Soft silt and sand
K4	— 8	—10	Sand, shells, little gravel
	—10	—24	Sand, little clay
	—24	—35	Stiff clay
555	— 4	— 7	Soft silt
K4	— 7	— 9	Sand, silt
	— 9	—15	Silt, peat
	—15	—33	Fine sand, little clay
	—33	—38	Stiff clay
	—38	—40	Clay, little sand
556	— 5	—16	Silt
K4	—16	—40	Stiff clay
557	— 5	—15	Silt
L3	—15	—40	Stiff clay
558	— 4	—15	Silt
K4	—15	—34	Soft clay
	—34	—39	Sand, clay
559	— 6	—19	Silt, shells
L4	—19	—35	Stiff clay
	—35	—40	Stiff blue clay, little sand
560	— 5	—18	Soft silt
L4	—18	—20	Peat
	—20	—39	Fairly stiff blue clay
561	— 4	— 8	Soft silty sand
M3	— 8	—16	Stiff clay
	—16	—39	Soft clay
562	— 3	— 9	Sand, silt
K4	— 9	—17	Stiff clay
	—17	—35	Fine sand, little clay
563	— 3	—10	Silt, sand
L4	—10	—11	Sand, little silt
	—11	—22	Stiff yellow clay
	—22	—29	Fairly stiff blue clay
	—29	—35	Fine sand, little clay
564	— 4	—10	Soft silt, little sand
L4	—10	—12	Sand, little silt
	—12	—22	Fairly stiff yellow clay
	—22	—34	Soft yellow clay
565	— 4	—10	Silt sand, little gravel
L4	—10	—18	Stiff yellow clay
	—18	—34	Soft clay
566	— 6	— 7	Silt
K3	— 7	— 9	Silt, sand
	— 9	—11	Stiff clay
	—11	—12	Sand, clay
	—12	—19	Stiff clay
	—19	—25	Firm clay, gravel, sand
	At —25		Ledge or boulder
567	— 8	—10	Silt, shells
K3	—10	—41	Stiff clay

No. and location	Elevations or depths From	To	Formation
568 J4	−20	−21	Silt
	−21	−22	Silty clay
	−22	−23	Clay, little sand
	−23	−35	Stiff clay
	−35	−40	Hard blue clay, sand, gravel
569 L2	− 5	− 7	Silt, shells
	− 7	− 9	Silt, sand, little gravel
	− 9	−14	Clay, sand, gravel
	−14	−16	Blue clay, little coarse sand
	−16	−22	Stiff clay
	−22	−32	Blue clay, coarse sand, little gravel
	At −32		Ledge or boulder
570 K3	− 6	− 8	Silt, shells
	− 8	−36	Stiff clay
	−36	−39	Hard clay, little sand, little gravel
571 K3	− 5	− 6	Silty sand, gravel
	− 6	−23	Clay, sand, gravel
	−23	−39	Fine sand, little gravel
572 J3	− 6	− 9	Silt
	− 9	−10	Silt, little sand
	−10	−27	Stiff clay
	−27	−41	Fairly stiff blue clay
573 J3	− 4	− 5	Silt
	− 5	− 8	Silt, sand
	− 8	−18	Stiff clay
	−18	−39	Clay, sand, gravel
574 I3	− 3	− 7	Silt, shells
	− 7	−15	Silt
	−15	−17	Peat
	−17	−40	Stiff clay
575 J3	−21	−24	Silt, little sand
	−24	−31	Soft clay
	−31	−41	Sand, coarse gravel, little clay
576 J3	− 6	−12	Silt, shells
	−12	−34	Stiff clay
	At −34		Ledge or boulder
577 M7	At −27		Clay
578 M7	At −33		Clay
579 M7	At −33		Clay
580 M7	At −33		Clay
581 M7	At −29		Clay
582 M7	At −26		Clay
583 M7	At −27		Clay
584 M7	At −27		Clay
585 M7	At −29		Clay
586 M7	At −29		Clay
587 N7	At −26		Clay
588 N7	At −26		Clay
589 N7	At −25		Clay
590 N7	At −23		Clay
591 L6	0	− 6.0	Marsh mud
	− 6.0	−15.0	Very tough clay
	−15.0	−57.0	Tough gray clay
	−57.0	−61.5	Sand, clay
	−61.5	−67.0	Coarse sand, fine gravel; hard packed
	−67.0	−68.0	Loose gravel
	−68.0	−74.0	Loose running sand
	−74.0	−76.0	Coarse loose gravel
	−76.0	−85.5	Loose running sand
592 M5	0	− 9.5	Water
	− 9.5	−16.5	Marsh mud
	−16.5	−33.5	Very hard blue clay
	−33.5	−75.5	Gray clay; tough (top) to softer (bottom)
	−75.5	−80.3	Sand, clay
593 N5	0	−10.0	Marsh mud
	−10.0	−17.0	Very hard clay; blue then yellow-streaked
	−17.0	−24.0	Very hard yellow clay; 1″ of sand at −22
	−24.0	−62.6	Gray clay; firm (top) to very soft (bottom)
	−62.6	−63.0	Slate (apparently ledge)
594 O5	0	− 2.5	Marsh mud
	− 2.5	− 6.0	Fine and coarse packed gravel
	− 6.0	−10.0	Blue clay, fine gravel; very hard packed
	−10.0	−11.0	Hard green clay
	−11.0	−20.0	Hard gray clay; sand streaks −12.0 to −14.0
	−20.0	−51.0	Gray clay; hard (top) to soft (bottom)

No. and location	Elevations or depths From	To	Formation
595 Q6	0	−17	Water
	−17	−26	Sand, marsh mud; one small gravel strata
	−26	−29	Hard green clay
	−29	−40	Hard yellow clay
	−40	−48	Gray clay; softer
596 R6	0	−21	Water.
	−21	−24	Marsh mud
	−24	−31	Hard green clay
	−31	−51	Gray clay; hard (top) to softer (bottom)
597 T7	0	−20.8	Water
	−20.8	−44.3	Marsh mud; 6″ soft clay at −31.8
	−44.3	−52.8	Soft gray clay
598 B6	Surface	5	Loose ash fill
	5	15	Hard packed sand and gravel
	15	26	Ashes and gravel fill; mud
	26	38	Medium clay
599 B6	Surface	27	Fill
	27	34	Mud
	34	41	Hard yellow clay
	41	55	Medium blue clay
600 B6	Surface	11	Fill
	11	13	Mud
	13	35	Hard yellow clay
601 D2	Sidewalk	16	Cinder clay fill
	16	22	Silt
	22	41	Packed coarse sand
	41	45	Medium blue clay
	45	55	Soft blue clay
602 B5	Surface 30′ below wharf	4	Soft silt
	4	14	Hard yellow clay
	14	64	Medium blue clay
	64	73	Compact sand, gravel, clay
603 E11	+11.0	− 3.0	Brown peat
	− 3.0	− 3.5	Fine sand
	− 3.5	−14.0	Stiff blue clay
604 B11	+14	+ 3	Sand and gravel fill
	+ 3	− 5	Fine sand, gravel
	− 5	− 9	Peat
	− 9	−20	Silt
	−20	−25	Sand
605 B11	+15.5	+ 6.5	Sand and gravel fill
	+ 6.5	− 2.5	Fine sand and gravel
	− 2.5	− 4.5	Peat
	− 4.5	−16.5	Silt
	−16.5	−17.5	Blue clay
606 B11	+17.7	+ 7.0	Sand and gravel fill
	+ 7.0	− 5.0	Coarse sand, gravel
	− 5.0	− 8.0	Fine sand
	− 8.0	−12.0	Blue clay
607 C11	+14.5	+ 6.5	Fill; sand, gravel, ash
	+ 6.5	− 1.5	Fine sand
	− 1.5	− 4.5	Blue clay
608 C11	+17	+10	Fill; sand, gravel, ash
	+10	+ 2	Fine sand
	+ 2	− 3	Blue clay, little sand
609 K6	+13	−15	Sand
610 K7	+13	−15	Sand
611 K7	+13	−15	Sand
612 K7	+20	−11	Sand
613 K7	+28	−14	Sand
614 J7	+32	−13	Sand
615 J7	+30	−12	Sand
616 J7	+23	+ 1	Sand
	+ 1	−10	Gravel
617 J8	+20	+ 8	Gravel
	+ 8	−11	Fine sand
618 J8	+18	+10	Gravel
	+10	−15	Fine sand
619 J8	+11	+ 4	Mud
	+ 4	−14	Fine sand
620 J8	+19	+ 9	Sand
	+ 9	+ 2	Mud
	+ 2	−12	Fine sand, clay
621 I8	+20	+15	Gravel
	+15	+ 2	Sand
	+ 2	−10	Fine sand, clay
622 I8	+22	−16	Sand
623 I9	+23	−14	Sand
624 I9	+26	+ 4	Sand
	+ 4	−11	Sand, clay
625 H9	+22	+ 3	Sand
	+ 3	−15	Sand, clay
626 H9	+18	− 7	Sand
	− 7	−21	Clay

No. and location	Elevations or depths From	To	Formation
627	Surface	8	
G9	8	4	Sand
	4	−22	Sand, clay
628	+ 7	−17	Mud
F9			
629	+14	+ 7	Sand
F10	+ 7	−11	Sand, mud
630	+18	+ 8	Sand
F10	+ 8	+ 5	Mud
	+ 5	− 7	Clay, sand
631	+16	+10	Sand
E10	+10	+ 3	Mud
	+ 3	− 3	Sand, clay
	− 3	−19	Clay
632	+11	+ 2	Mud
E10	+ 2	−11	Sand, clay
	−11	−27	Clay
633	+16	+11	Sand
D11	+11	+ 6	Mud
	+ 6	−20	Sand
	−20	−23	Gravel
634	+17	+15	Gravel (fill?)
D11	+15	+10	Mud
	+10	−19	Gravel
635	+18	+ 7	Sand
C11	+ 7	+ 4	Mud
	+ 4	−15	Sand
636	+18	− 4	Sand
B11	− 4	−27	Clay
637	+14	−24	Sand
B11	−24	−27	Probably clay
G11	−26	−45	Soft clay
647	+ 7	−26	Sand, mud
648	−12.5	−20.0	Mud, sand
H12	−20.0	−42.0	Soft clay
649	+ 0.8	−11.8	Mud, sand
H11	−11.8	−13.8	Gravel
	−13.8	−41.8	Soft clay
650	+ 0.7	−14.7	Sand, mud
H12	−14.7	−43.7	Soft clay
651	+ 2.2	−15.2	Sand, mud
H11	−15.2	−46.2	Soft clay
652	0	−11	Sand, mud
I12	−11	−17	Stiff clay
	−17	−44	Soft blue clay
653	− 1.5	−22.5	Sand, mud
I11	−22.5	−45.5	Soft blue clay
654	− 0.7	−12.8	Sandy mud
J12	−12.8	−20.8	Stiff clay, gravel
	−20.8	−42.8	Soft blue clay
655	+ 1.2	−15.2	Sandy mud
J11	−15.2	−18.2	Hard blue clay
	−18.2	−42.2	Soft blue clay
656	0	− 7.0	Sand
J12	− 7.0	−43.4	Soft blue clay
657	+ 2.0	−16.0	Sand
J11	−16.0	−17.5	Hard blue clay
	−17.5	−46.0	Soft blue clay
658	− 4.2	−25.2	Sand, mud
J10	−25.2	−47.2	Soft blue clay
659	+ 0.6	− 6.6	Sand, mud
K12	− 6.6	−13.6	Medium clay
	−13.6	−26.6	Gravel
	−26.6	−41.6	Soft clay
660	− 1.3	−17.3	Mud, sand
K11	−17.3	−41.3	Soft clay
661	− 6.4	−13.4	Mud, sand
K10	−13.4	−41.4	Soft clay
662	+ 0.5	−13.5	Mud, sand
K12	−13.5	−32.5	Sandy clay
	−32.5	−41.5	Soft clay
663	− 1.8	− 7.8	Mud, sand
K11	− 7.8	−42.8	Soft clay
664	− 4.5	−19.5	Mud, sand
L10	−19.5	−45.5	Soft clay
665	− 3.8	−25.6	Sand, mud
L12	−25.6	−45.6	Soft clay
666	− 1.5	−15.5	Gravel, sand
L11	−15.5	−41.5	Medium clay
667	− 5	−15	Mud, sand
L10	−15	−44	Medium clay
668	− 5.9	−21.1	Sand, mud
M12	−21.1	−41.6	Soft clay
669	− 2.5	−18.5	Sand, gravel
M11	−18.5	−41.5	Clay, gravel
670	− 4.3	−24.7	Mud, sand
M10	−24.7	−41.7	Soft clay
672	− 6.4	−20.4	Mud, sand
M10	−20.4	−47.9	Gravel, sand
673	− 6.3	−38.3	Mud, sand
M9	−38.3	−43.3	Soft clay
675	− 5.5	−33.5	Mud, sand
N11	−33.5	−42.0	Sand, hard packed gravel
676	− 6.7	−20.7	Mud, sand
N10	−20.7	−42.7	Soft sticky blue clay
678	−19.3	−37.3	Mud, sand
O11	−37.3	−43.3	Medium clay
679	− 8	−11	Sand, gravel
O9	−11	−43	Soft and medium clay
681	−21.6	−44.6	Mud, sand
O11			
682	− 8	−17	Mud, sand
O9	−17	−43	Medium clay
W-1	+17	−55	Overburden—hardpan
C6	−55	−385	Bedrock
W-2	+15±	−65±	Overburden
C4	−65±	−378±	Bedrock
W-3	+22±	−63±	Overburden
H6	−63±	−384±	Bedrock
W-4	+30	−97	Overburden
F7	−97	−298	Bedrock

Boring Data—East Boston

No. and location	Elevations or depths From	To	Formation
1 C4	Sidewalk	7.5	Fill; cinders, sand, wood
	7.5	12.0	Clay and gravel fill
	12.0	15.0	Silty sand
	15.0	17.0	Fine sand
	17.0	20.5	Sharp sand, little gravel
	20.5	22.5	Soft blue clay, sand
	22.5	27.0	Stiff blue clay
2 C4	Surface	8.0	Cinder fill
	8.0	16.0	Fill; sand, gravel, clay
	16.0	21.3	Soft silty sand
	21.3	28.0	Hard yellow clay
3 E8	Surface	2	Ash fill
	2	21	Blue clay fill
	21	27	Sand, little gravel, fill
	27	33	Coarse sand
	33	45	Medium blue clay
4 M7	Surface	2.5	Soft mud
	2.5	13.0	Medium yellow clay
	13.0	40.0	Soft blue clay
5 D9	Surface	9	Fill; sand, gravel boulder
	9	16	Sand fill
	16	22	Silty sand, shells
	22	25	Hard yellow clay
6 P7	+12.5	+11.0	Sandy loam
	+11.0	− 5.0	Clay, gravel, sand
7 Q7	+12.0	+ 8.0	Peat
	+ 8.0	− 0.5	Yellow clay, sand
	− 0.5	− 4.5	Blue clay
8 I4	Surface	6	Ash and sand fill
	6	30	Clay fill, some mud and ashes
	30	46	Hard yellow clay
9 G2	− 5	−12	Silt
	−12	−39	Fine silty sand
	−39	−52	Hard sand, clay, gravel
10 G1	−15	−19	Silt
	−19	−35	Fine silty sand
	−35	−49	Sand, fine gravel
11 G1	−15	−22	Silt
	−22	−27	Sand, clay
	−27	−31	Sand
	−31	−51	Hard sand, clay, gravel
12 G1	0	− 5	Silty sand
	− 5	−23	Sand, clay, gravel
	−23	−27	Sand
	−27	−54	Sand, clay, gravel, hard
13 D9	Harbor bottom	3	Dock mud
	3	50	Medium blue clay
14 C8	Surface	6.5	Fill
	6.5	11.5	Mud
	11.5	25.0	Hard clay and stones, mixed
16 C4	River bed	15	Mud
	15	40	Fine sand
	40	47	Gravel
18 K4	Surface	13	Soft mud
	13	16	Coarse sand, clay
	16	43	Clay, little sand
	43	51	Soft clay
19 C4	Surface	9	Fill
	9	13	Mud
	13	18	Coarse sand
	18	30	Hard blue clay
20 E5	Cellar bottom	14	Peat mud
	14	30	Hard clay
21 F2	Surface	8	Clay fill
	8	19	Fine silty sand, mud
	19	46	Fine sand
22 H4	Surface	12.5	Fill
	12.5	17.5	Fine silty sand, mud
	17.5	21.0	Blue clay
	21.0	25.0	Yellow clay
	25.0	32.0	Clay, sand, gravel
23 C5	Surface	12.3	Fill, traces of mud
	12.3	20.0	Medium blue clay, little fine sand
	20.0	35.0	Hard yellow clay
24 D6	Surface	16.0	Fill
	16.0	18.5	Mud
	18.5	24.3	Sand, gravel
	24.3	40.0	Medium hard blue clay
25 O6	Surface	2.6	Fill
	2.6	9.0	Rocks
	9.0	20.6	Hardpan, clay, stones
27 F1	River bottom	8	Mud
	8	18	Sand
	18	48	Soft clay
	48	55	Hardpan
28 D4	Surface	14	Fill, mud
	14	19	Sand, gravel
	19	26	Blue clay
29 C4	Surface	11	Soft fill
	11	15	Soft sand
	15	25	Medium hard blue clay

No. and location	Elevations or depths From	To	Formation
30 D6	Surface	9.5	Fill, mud
	9.5	12.5	Fine sand, very soft clay
	12.5	17.0	Yellow clay
	17.0	30.0	Blue clay
31 L5	Surface	5	Fill
	5	16	Mud
	16	32	Clay and fine sand mixed
32 E5	Surface	9	Peat mud
	9	25	Loose sand
	25	29	Soft clay mixed with little sand
33 G5	Surface	8	Peat mud
	8	30	Fine sand, clay
	30	55	Soft blue clay
34 B6	Bottom harbor	8	Sand, little clay
	8	15	Clay, sand streaks
	15	38	Tough blue clay
35 J4	River bed	20	Mud
	20	26	Sand, stones, clay—hardpan
36 B5	Bottom of test pit	7	Clay
	7	10	Sand, mud, stones
	10	28	Hard blue clay
37 E6		100	Ends in clay—no rock
38 G2	+ 2	− 4	Silt
	− 4	−39	Fine silty sand
	−39	−41	Sand, clay, gravel
39 D6	+13.5	+ 9	Fill; sand, gravel, ash
	+ 9	+ 2	Silt, sand, shells
	+ 2	− 4	Fine, sand, fine gravel
	− 4	−11	Soft blue clay, fine sand
	−11	−14	Soft blue clay
	−14	−18.5	Stiff blue clay
40 D6	+ 8.0	+ 2.5	Black silt, gravel
	+ 2.5	− 6.5	Medium sand
	− 6.5	−12.0	Blue clay, fine sand
41 D6	+ 6.0	− 0.5	Black silt, sand
	− 0.5	− 6.0	Medium sand
	− 6.0	−10.0	Blue clay, fine sand
42 D6	+ 5.5	+ 3.5	Black silt
	+ 3.5	− 1.5	Medium sand
	− 1.5	−12.5	Soft blue clay, fine sand
	−12.5	−16.5	Blue clay
43 G4	Surface	4.0	Fill; brick, cinders, rubbish
	4.0	16.5	Medium yellow clay
	16.5	21.6	Soft blue clay
	21.6	24.5	Hard sand, gravel and clay
44 C4	Surface	10	Fill
	10	20	Fine silty sand, mud
	20	35	Medium blue clay
45 D3	Surface	6	Hard packed sand and gravel
	6	21	Fine compact sand
	21	25	Hard packed gravel
46 J6	Surface	7.0	Clay and gravel fill
	7.0	10.7	Flat mud
	10.7	20.0	Medium yellow clay
	20.0	26.0	Medium blue clay
47 G6	+14.5	+ 7.0	Rubbish fill
	+ 7.0	−11.9	Very soft peat (very wet)
	−11.9	−18.0	Sharp, fine, loose sand
	−18.0	−24.0	Medium blue clay, fine sand
48 D7	2 ft. above Gove St.	14.7	Fill
	14.7	19.6	Soft silty sand
	19.6	25.0	Firm, coarse, dirty sand
	25.0	32.0	Medium blue clay
49 B7	+15	+ 6	Sand, gravel
	+ 6	− 5	Sand, gravel, clay
50 B7	+18	+ 1	Soft sand, gravel, clay
51 B7	+17	+ 7	Gravel, clay
	+ 7	− 1	Fine sand
	− 1	− 5	Clay, sand
52 B8	+19	+14	Gravel
	+14	+ 1	Sand, gravel, clay
	+ 1	− 5	Clay
53 C8	+18	+ 6	Sand, gravel
	+ 6	+ 1	Sand, gravel, clay
54 C8	+18	+ 3	Sand, gravel
	+ 3	− 5	Sand, gravel, clay
55 C8	+18	+ 8	Sand, gravel
	+ 8	+ 1	Sand, clay, very little mud mixed
	+ 1	− 3	Fine clayey sand
	− 3	− 4	Clay
56 N6	+13.0	+10.0	Sand and gravel fill
	+10.0	+ 4.5	Clay, sand, gravel
	+ 4.5	0	Silt, peat
	0	− 3.0	Sand
57 B7	0	−100	No rock
58 K5	+ 9.0	− 4.0	Peat
	− 4.0	−20.5	Soft clay, sand
	−20.5	−25.0	Fine sand, very little gravel
59 L5	+ 8.5	+ 0.5	Silty peat
	+ 0.5	− 3.5	Blue clay
	− 3.5	−11.5	Fine sand, little clay

No. and location	Elevations or depths From	To	Formation
60 L5	+ 8.5	+ 3.0	Peat
	+ 3.0	− 7.5	Silt, shells
	− 7.5	−13.5	Stiff blue clay
61 B5	+19	+ 5	Sand, gravel
	+ 5	−12	Gravel, some clay
	−12	−48	Stiff clay, sand, gravel
62 C5	+20	+ 4	Yellow clay, gravel
	+ 4	−24	Stiff clay, sand, gravel
63 B5	+14	− 2	Mud
	− 2	−59	Medium clay
	−59	−64	Stiff blue clay, some gravel
64 C8	+17	+13	Fill; sand, gravel, broken stone
	+13	+ 4	Fine sand
	+ 4	− 2	Sand, gravel, clay (till)
			Rock about −2
65 C8	Surface	12	Sand, gravel
	12	13	Fine sand
	13	16	Sand, gravel, clay (till)
			Rock
66 B6	Surface	21	Fine clayey gravel mixed with mud
	21	23	Gravel, clay, little sand
67 I4	Surface	24	Clay, sand
	24	40	Sand
	40	46	Hardpan
68 J5	Surface	10	Sand
	10	28	Fine sand mixed with little clay
	28	30	Hard gravel, stones
			No ledge
69 D6	+15	+ 3	Fill
	+ 3	− 3	Silt, peat
	− 3	− 8	Coarse sand
	− 8	−13	Blue clay, sand
70 C8	Surface	4	Fill, sand, gravel, clay
	4	14	Sand, clay
	14	16	Sand, gravel, clay (till)
			Rock
71 C8	Surface	2	Gravel
	2	15	Sand, gravel, clay, (till)
			Rock
72 C8	Surface	5	Sand, gravel
	5	13	Fine sand
	13	15	Sand, gravel, clay (till)
			Rock
73 C5	+19	+15	Mud
	+15	− 2	Yellow clay, gravel
	− 2	−40	Hard clay and gravel
75 G5	+14.0	+ 8.5	Fill; clay, sand, gravel
	+ 8.5	+ 2.0	Stiff brown peat
	+ 2.0	− 3.0	Stiff blue clay, sand
76 G5	+12.5	+ 7.5	Clay, sand, gravel
	+ 7.5	+ 2.5	Stiff brown peat
	+ 2.5	− 4.5	Coarse sand, fine gravel
77 H5	+17	+ 8	Sand, gravel and fill
	+ 8	+ 2	Silt
	+ 2	0	Peat
	0	− 5	Blue clay (hard)
78 C6	+15	+ 7	Sand, gravel
	+ 7	− 3	Sand, clay
79 C6	+16	+ 8	Sand, gravel
	+ 8	− 2	Gravel, sand, clay
80 B6	+16	+ 6	Clay, gravel
	+ 6	0	Silt
	0	− 4	Sand, clay
81 C8	Surface	6	Sand, gravel
	6	15	Fine sand
			Rock
82 C8	Surface	5	Sand, gravel
	5	10	Fine sand
	10	13	Sand, gravel, clay (till)
			Rock
83 C9	Surface about 17	13	Sand, gravel
	13	5	Fine sand
	5	3	Sand, gravel, clay (till)
	3		Rock about 3
84 C8	+20	+12.7	Sand, gravel, clay (till)
	+12.7		Rock at about 13
85 C9	Surface	7.4	Coarse gravel
	7.4	9.5	Sand, gravel, clay (till)
			Rock
86 C8	+25	+ 9	Sand, gravel, clay
87 D8	+20	+17	Gravel
	+17	+16	Fine sand
	+16	+11	Boulder
88 D8	+17	+ 2	Clay, gravel
	+ 2	+ 1	Fine sand
89 D8	+17	+12	Sand, gravel
	+12	+ 5	Clay, sand
	+ 5	+ 1	Coarse sand

No. and location	Elevations or depths From	To	Formation
90 D8	+18	+11	Sand, gravel
	+11	+ 6	Clay, sand, peat
	+ 6	+ 1	Coarse sand
91 D8	+16	+ 8	Sand, gravel, clay
	+ 8	+ 3	Clay, peat
	+ 3	0	Coarse sand
92 D7	+16	+ 9	Sand and gravel fill
	+ 9	+ 6	Peat
	+ 6	+ 4	Gravel
	+ 4	0	Clay
93 D7	+17	+12	Sand and gravel fill
	+12	+ 5	Sand, peat
	+ 5	+ 2	Sand
94 C7	+16	+12	Sand and gravel fill
	+12	+ 3	Clay, sand
	+ 3	+ 2	Sand
95 C7	+15	+10	Sand, gravel
	+10	+ 3	Peat, clay, sand
	+ 3	+ 1	Sand
96 C6	+16	+ 7	Ash fill
	+ 7	− 1	Peat, silt
	− 1	− 3	Coarse sand
	− 3	− 4	Clay
97 N6	+11	+ 8	Cinders
	+ 8	+ 3	Sand
	+ 3	0	Blue clay, little sand
	0	−12	Fine sand
98 N7	+14	+10	Fill; sand, gravel, clay
	+10	+ 7.5	Peat
	+ 7.5	+ 4	Fine sand
	+ 4	− 4	Yellow clay, sand
	− 4	−11	Fine sand
99 J4	+19	+ 7	Hardpan
	+ 7	−17	Blue hardpan, clay
100 J4	+20	+ 4	Gravel, stones
	+ 4	− 7	Hard sand
101 I4	+21	+17	Hard gravel fill
	+17	0	Yellow clay
	0	− 2	Sand
	− 2	−14	Blue hardpan
102 H4	+20	+14	Yellow hardpan, gravel
	+14	0	Yellow clay
	0	− 3	Gravel, clay, boulders (till)
	− 3	− 9	Blue hardpan
103 H5	+22	+12	Sand
	+12	+ 6	Clay
	+ 6	+ 2	Gravel
	+ 2	− 4	Clay
104 G5	+23	+17	Yellow hardpan
	+17	−10	Blue hardpan
105 H4	+20	− 4	Clay, gravel
106 G5	+12	+11	Yellow hardpan
	+11	+ 8	Peat
	+ 8	−13	Hard yellow clay
	−13	−18	Blue hardpan
107 G5	+15	+10	Hardpan, fill
	+10	+ 6	Peat
	+ 6	− 4	Hard yellow clay
	− 4	−15	Soft blue clay
108 G5	+16	+13	Hardpan, fill
	+13	+ 7	Peat
	+ 7	− 3	Clay, small stones
	− 3	−12	Soft blue clay
108 G5	+16	+13	Hardpan, fill
	+13	+ 7	Peat
	+ 7	− 3	Clay, small stones
	− 3	−12	Soft blue clay
109 G5	+19	− 4	Clay, gravel (till)
110 F5	+15	+ 5	Clay, gravel
	+ 5	− 3	Silt
	− 3	− 6	Clay, gravel
111 F5	+16	+11	Hardpan, fill
	+11	+ 8	Peat
	+ 8	− 9	Sand, clay
	− 9	−13	Soft clay
112 F5	+15	+ 5	Clay, gravel
	+ 5	− 1	Peat
	− 1	− 5	Clay, sand
113 E5	+16	+11	Hardpan, fill
	+11	+ 8	Peat, sand
	+ 8	− 5	Sand with clay
	− 5	− 9	Sand
	− 9	−17	Fine sand
	−17	−20	Soft blue clay
114 C6	+16	+10	Clay and gravel fill
	+10	+ 3	Ash fill
	+ 3	− 3	Sand
115 C6	+16	+10	Clay and gravel fill
	+10	+ 3	Ash fill
	+ 3	0	Fine sand
	0	− 4	Clay, sand
116 D6	+17	+ 5	Ash fill
	+ 5	+ 2	Peat
	+ 2	− 1	Fine sand
	− 1	− 5	Clay
117 D6	+16	+11	Gravel fill
	+11	+ 8	Fine sand fill
	+ 8	+ 4	Peat
	+ 4	− 1	Fine sand
	− 1	− 5	Sand, clay
118 D5	+16	+ 7	Sand and gravel fill
	+ 7	0	Peat
	0	− 5	Sand, clay

No. and location	Elevations or depths From	To	Formation
119 D5	+15	+ 4	Sand and gravel fill
	+ 4	+ 1	Peat
	+ 1	− 1	Sand
	− 1	− 5	Sand, clay
120 E5	+16	+ 6	Sand, gravel, clay
	+ 6	+ 4	Peat
	+ 4	− 6	Clay, silt
121 E5	+16	+ 8	Coarse sand
	+ 8	+ 4	Peat
	+ 4	+ 3	Sand, gravel
	+ 3	+ 2	Clay
	+ 2	− 3	Sand
122 E5	+16	+11	Fill; sand, gravel, clay
	+11	+ 8	Peat, sand
	+ 8	− 3	Sand, clay
	− 3	− 9	Coarse sand
123 A5	−36	−38	Sand, gravel, shells
	−38	−55	Stiff blue clay
	−55	−86	Stiff blue clay, fine sand
124 A5	−38	−42	Soft black silt
	−42	−84	Stiff blue clay
	−84	−89	Hard sand, gravel, clay
125 A5	−34	−38	Soft black silt
	−38	−47	Stiff blue clay, little sand
	−47	−83	Stiff blue clay
	−83	−85	Sand, gravel, clay, hard
126 A5	−23	−26	Soft black silt
	−26	−73	Stiff blue clay
	−73	−85	Sand, gravel, clay, hard
127 A5	−23	−26	Soft black silt
	−26	−68	Stiff blue clay, little sand
	−68	−74	Sand, little gravel, blue clay
128 A5	− 5	− 7	Black mud
	− 7	−13	Sand
	−13	−16	Sand, clay
	−16	−71	Very stiff blue clay
129 B5	−22	−25	Soft black silt
	−25	−85	Stiff blue clay
130 B5	− 2	− 5	Mud
	− 5	−10	Sand
	−10	−15	Compact sand
	−15	−17	Blue clay
	−17	−64	Stiff blue clay
	−64	−65	Fine sand
	−65	−76	Stiff blue clay
131 B5	− 2	− 5	Black mud
	− 5	− 9	Sand
	− 9	−61	Stiff blue clay
132 B6	+15	+11	Fill
	+11	+ 9	Wood
	+ 9	+ 7	Light colored mud
	+ 7	− 7	Fine sand
	− 7	−10	Blue clay
	−10	−14	Clay, stones
	−14	−48	Stiff blue clay
	−48	−49	Fine sand
133 B4	+16	+15	Paving
	+15	+12	Fill
	+12	+ 4	Sand, gravel, silt
	+ 4	− 3	Blue silty peat, roots
	− 3	− 6	Hard yellow clay, sand
	− 6	−40	Some gravel, clay
134 B5	+15	+ 4	Fill
	+ 4	− 1	Soft black silt
	− 1	− 4	Fine silty sand, clay, soft
	− 4	− 9	Soft blue clay, sand
	− 9	−36	Stiff blue clay
135 B6	+16	+ 1	Fill
	+ 1	− 3	Fine sand
	− 3	− 4	Blue clay
	− 4	− 6	Fine sand
	− 6	−40	Stiff blue clay
136 B6	+17	+ 1	Compact sand, fine gravel
	+ 1	− 3	Stiff blue clay
	− 3	− 7	Fine sand
	− 7	−34	Stiff blue clay
137 A6	−37	−38	Black silt
	−38	−78	Blue clay, stones
	−78	−92	Sand, clay, gravel
138 A6	−34	−36	Soft black silt
	−36	−70	Stiff blue clay
	−70	−84	Stiff blue clay, little sand
			No till—no rock
139 A6	−29	−32	Black silt
	−32	−79	Blue clay, stones
	−79	−84	Sand, clay, gravel
140 A6	−21	−25	Soft black silt
	−25	−64	Stiff blue clay, little sand
	−64	−72	Stiff blue clay, little sand and gravel
141 A6	−24	−28	Silt
	−28	−80	Blue clay
142 A6	−12	−14	Black silt
	−14	−68	Blue clay
143 A6	−20	−28	Black mud, fine sand
	−28	−50	Stiff blue clay
	−50	−55	Stiff blue clay, stones
	−55	−76	Stiff blue clay

No. and location	Elevations or depths From	To	Formation
144 A6	− 7	−10	Black mud, sand
	−10	−20	Fine sand
	−20	−24	Yellow clay
	−24	−74	Stiff blue clay
145 A6	+14	+ 7	Fill
	+ 7	− 5	Fine silty sand
	− 5	−11	Fine stiff sand, some gravel
	−11	−13	Fine sand
	−13	−19	Fine clayey sand
	−19	−45	Stiff blue clay
146 A6	+15	+ 5	Fill
	+ 5	− 7	Clayey gravel
	− 7	−14	Fine silty sand, shells
	−14	−59	Plastic blue clay
147 A6	+18	+11	Fill
	+11	+10	Wood
	+10	+ 4	Fill
	+ 4	− 5	Black mud, tendency to clay
	− 5	−17	Stiff blue clay
	−17	−18	Fine sand
	−18	−27	Stiff blue clay
	−27	−54	Plastic blue clay
148 B6	+18	+ 8	Fill
	+ 8	+ 2	Soft mud, fine sand
	+ 2	−17	Fine sand
	−17	−60	Stiff blue clay
149 B6	+18	+16	Fill
	+16	+ 3	Yellow clayey gravel
	+ 3	−20	Fine sand, mud
	−20	−37	Stiff blue clay
150 B6	+18	+ 6	Fill
	+ 6	0	Soft mud, sand, some clay
	0	−16	Fine sand, some mud, stones
	−16	−22	Plastic blue clay
	−22	−53	Stiff blue clay
151 B6	+18	+ 3	Fill
	+ 3	− 9	Bog mud, tendency to clay
	− 9	−22	Stiff yellow clay
	−22	−42	Plastic clay, some stones
	−42	−53	Plastic blue clay, sand, stones
152 B6	+18	+16	Fill
	+16	+ 3	Clayey gravel
	+ 3	−12	Black mud, fine sand
	−12	−34	Stiff blue clay
	−34	−42	Stiff blue clay, stones
153 B6	+18	+10	Fill
	+10	+ 1	Clayey gravel
	+ 1	− 2	Coarse sharp sand
	− 2	− 5	Fine sand
	− 5	−35	Plastic blue clay
	−35	−36	Fine sand
	−36	−39	Plastic blue clay
154 B6	+18	+11	Fill
	+11	− 8	Sandy silt
	− 8	−20	Blue clay
155 B6	+19	+15	Sand, gravel, shells
	+15	+ 2	Sand, shells, gravel, little clay
	+ 2	−15	Blue clay
	−15	−20	Clay, gravel
156 B6	+15	+11	Fill
	+11	+ 2	Soft clay, sand
	+ 2	− 4	Little peat, silty sand
	− 4	− 6	Little clay, fine sand
	− 6	−12	Little stiff clay, sand
157 B6	+15	+11	Fill
	+11	+ 3	Soft clay, sand
	+ 3	− 4	Little peat, silty sand
	− 4	− 6	Little clay, fine sand
	− 6	−12	Little stiff clay, sand
158 C6	+17	+14	Compact dry gravel
	+14	+ 6	Loose wet gravel
	+ 6	+ 5	Stone
	+ 5	0	Loose wet gravel
	0	− 1	Blue clay
159 D4	+10	+ 8	Peat, mud
	+ 8	+ 3	Sand, coarse gravel
	+ 3	− 1	Yellow clay, little gravel
	− 1	− 3	Blue clay, little fine sand
	− 3	−15	Blue clay
160 K5	+21	+12	Gravel, clay, loam, stones
	+12	+ 4	Loam
	+ 4	+ 2	Blue clay
	+ 2	− 6	Silty clay
161 K5	+18	+15	Fill
	+15	+14	Loam
	+14		Yellow clay
162 K5	+18	+16	Fill
	+16	+ 5	Hard pan
	+ 5		Hard blue clay
163 K4	+18	+12	Fill
	+12	+ 6	Hardpan
	+ 6	− 6	Hard blue clay, yellow clay
164 J4	+18	+11	Fill
	+11	+ 3	Hardpan
	+ 3	− 6	Hard blue clay
165 G5	+16	+10	Fill
	+10	+ 7	Peat
	+ 7	− 6	Blue clay
166 E5	+14	+ 6	Fill
	+ 6	+ 1	Peat
	+ 1	− 1	Clay, sand
	− 1	− 6	Wet sand

No. and location	Elevations or depths From	To	Formation
167	+16	+ 6	Fill
D5	+ 6	+ 4	Peat
	+ 4	− 6	Wet sand
168	+15	+ 8	Fill
D6	+ 8	+ 6	Peat
	+ 6	− 6	Blue clay
169	+18	+15	Fill
D6	+15	+12	Shells
	+12	+ 9	Yellow clay
	+ 9	+ 6	Peat
	+ 6	− 6	Blue clay
170	+16	+ 7	Fill
C6	+ 7	+ 3	Peat
	+ 3	− 6	Sandy clay
171	+12	+ 5	Fill
D7	+ 5	+ 3	Peat
	+ 3	− 1	Sand
	− 1	− 6	Blue clay
172	+18	+12	Fill
B7	+12	− 4	Gravel, clay
173	+15	+ 5	Fill
D5	+ 5	+ 1	Peat
	+ 1	− 1	Coarse sand
	− 1	− 6	Sand
174	+15	+10	Fill
D5	+10	+ 4	Peat
	+ 4	+ 2	Coarse sand
	+ 2	− 4	Sand
175	+15	+10	Fill
D5	+10	+ 5	Peat
	+ 5	+ 2.5	Coarse sand
	+ 2.5	− 4	Sand
176	+14.0	+ 9.5	Fill
D4	+ 9.5	+ 4.0	Peat
	+ 4.0	+ 1.5	Coarse sand
	+ 1.5	− 4.0	Sand
177	+16	+11	Fill
D4	+11	+ 7	Peat
	+ 7	− 4	Gravel, clay
178	+16.5	+ 4	Fill
D4	+ 4	+ 3	Peat
	+ 3	0	Blue clay
	0	− 4	Sand, gravel
179	+16	+ 7	Fill
D3	+ 7	− 4	Clay, gravel
180	+17	+11	Fill
E3	+11	− 4	Gravel, sand
181	+29	+18	Hardpan
E2	+18	− 4	Clay, gravel
182	+16	+ 9	Fill
D4	+ 9	+ 1	Peat
	+ 1	− 4	Coarse sand
183	+19.0	+ 8.5	Fill
C4	+ 8.5	+ 5.0	Peat
	+ 5.0	− 4.0	Coarse sand
184	+19	+ 5	Fill
C4	+ 5	− 4	Coarse sand
185	+19	+11	Fill
C4	+11	+ 9	Coarse sand
	+ 9	− 4	Fine sand
186	+18.0	+14.0	Fill
B4	+14.0	+12.5	Peat
	+12.5	− 4.0	Blue clay
187	Surface	− 6.0	Fill
D6	− 6.0	−10.5	Clay, sand, gravel
	−10.5	−14.0	Black silt
	−14.0	−23.5	Coarse sand, little gravel
	−23.5	−25.5	Blue clay, little fine sand
	−25.5	−36.0	Medium stiff blue clay
188	Surface	−13	Fill
D6	−13	−20	Little clay, fine sand
	−20	−22	Clay, little sand
	−22	−34	Medium stiff blue clay
189	Surface	− 5.0	Fill
B4	− 5.0	−13.5	Peat
	−13.5	−20.0	Silty sand
	−20.0	−68.0	Stiff blue clay
190	Surface	−11	Yellow clay—gravel
B4	−11	−34	Sand, little gravel and clay
241	Surface		
A9	−18	−24	Silt
	−24	−31	Hard blue clay
	−31	−46	Stiff blue clay
242	−14	−20	Silt
B9	−20	−28	Hard blue clay
	−28	−34	Stiff blue clay
	−34	−42	Soft blue clay
243	−14	−16	Silt
B10	−16	−21	Hard blue clay
	−21	−41	Stiff blue clay
244	−14	−18	Silt
B10	−18	−29	Hard blue clay
	−29	−41	Stiff blue clay
245	−15	−16	Silt
B11	−16	−17	Silty sand, clay
	−17	−27	Hard blue clay
	−27	−41	Stiff blue clay
246	−11	−14	Silt
B11	−14	−15	Silty sand, clay
	−15	−26	Hard blue clay
	−26	−39	Stiff blue clay
247	−14	−20	Silt
C12	−20	−41	Stiff blue clay
248	−15	−19	Silt
C12	−19	−28	Hard blue clay
	−28	−41	Stiff blue clay

No. and location	Elevations or depths From	To	Formation
249 C13	−14	−18	Gravel, silt
	−18	−23	Hard blue clay
	−23	−41	Stiff blue clay
250 C13	−18	−24	Silt
	−24	−31	Hard blue clay
	−31	−46	Stiff blue clay
251 H5	+12.0	+ 7.0	Fill; clay, sand, gravel
	+ 7.0	+ 2.0	Silt, sand
	+ 2.0	− 0.5	Stiff brown peat
	− 0.5	− 5.0	Coarse sand, gravel
252 H5	+13.5	+ 9.5	Fill; clay, sand, gravel
	+ 9.5	+ 4.0	Stiff brown peat
	+ 4.0	− 3.5	Coarse sand, fine gravel
253 H5	+14.5	+10.0	Clay, sand, gravel
	+10.0	+ 4.5	Stiff brown peat
	+ 4.5	− 2.5	Stiff blue clay, sand
254 H5	+16.0	+ 8.5	Sand and gravel fill
	+ 8.5	+ 3.5	Silt, peat
	+ 3.5	− 0.5	Blue clay, sand
255 M5	+ 8.5	+ 5.0	Peat
	+ 5.0	− 1.5	Silty sand, shells
	− 1.5	− 4.0	Soft blue clay, sand
	− 4.0	−10.0	Stiff blue clay
256 M5	− 5.5	− 7.0	Silt
	− 7.0	−11.0	Silty sand
	−11.0	−15.0	Clay, sand
257 M5	− 6.5	− 8.5	Silt
	− 8.5	−10.0	Sand
	−10.0	−15.0	Sand, clay
258 M5	− 4.0	− 5.0	Silt
	− 5.0	− 6.5	Silty sand
	− 6.5	− 7.5	Blue clay, sand
	− 7.5	−15.0	Fine sand, little gravel
259 M5	+ 9.0	− 2.5	Peat
	− 2.5	− 5.0	Silty sand, peat
	− 5.0	−11.0	Blue clay, sand
260 M5	+10.5	+ 4.5	Clay and gravel fill
	+ 4.5	+ 3.0	Peat
	+ 3.0	− 6.5	Silty peat
	− 6.5	− 9.5	Soft blue clay
	− 9.5	−14.5	Fine sand, little clay
261 M6	+14.5	+ 6.5	Fill; clay, gravel, sand
	+ 6.5	− 5.0	Stiff yellow clay, sand
	− 5.0	−10.0	Stiff blue clay
262 M5	+13.0	+ 8.5	Fill; clay, gravel, sand
	+ 8.5	+ 3.0	Silty peat
	+ 3.0	− 1.0	Silty sand
	− 1.0	−10.0	Blue clay, sand
263 N6	+16.0	+ 9.5	Fill; clay, gravel, sand
	+ 9.5	− 9.5	Sand, gravel, small stones
264 G6	+17	+ 7	Clay, sand, gravel
	+ 7	+ 1	Stiff brown peat
	+ 1	− 3	Sharp sand, gravel
265 H6	+17.0	+ 8.5	Fill; clay, sand, gravel
	+ 8.5	+ 2.0	Stiff brown peat
	+ 2.0	− 2.0	Coarse sand, gravel
266 H6	+16.5	+10.0	Fill; clay, sand, gravel
	+10.0	+ 4.0	Stiff brown peat
	+ 4.0	− 0.5	Coarse sand, gravel
267 H6	+17.0	+ 9.5	Fill; clay, sand, gravel
	+ 9.5	+ 3.0	Stiff brown peat
	+ 3.0	+ 1.2	Silt, sand
	+ 1.2	− 2.0	Coarse sand, gravel
268 H6	+16.5	+ 9.0	Fill; clay, sand, gravel
	+ 9.0	+ 7.0	Stiff brown peat
	+ 7.0	+ 0.3	Silt, sand
	+ 0.3	− 3.5	Coarse sand, gravel
269 H6	+16.0	+ 6.5	Clay, sand, gravel
	+ 6.5	+ 0.5	Stiff brown peat
	+ 0.5	− 4.0	Coarse sand, fine gravel
270 E8	+13.0	+ 3.0	Fill
	+ 3.0	− 2.0	Soft silt
	− 2.0	− 5.3	Fine sand
	− 5.3	− 8.0	Coarse sand, gravel
	− 8.0	−12.0	Medium blue clay
271 E8	+12.0	+ 0.5	Fill
	+ 0.5	− 3.5	Silt
	− 3.5	− 9.5	Fine sand
	− 9.5	−17.0	Medium blue clay
272 E7	+10.5	+ 0.5	Fill
	+ 0.5	− 5.0	Fine sand
	− 5.0	−12.0	Medium blue clay
273 E7	+12.0	+ 2.0	Fill
	+ 2.0	− 1.2	Silt
	− 1.2	− 5.5	Fine sand, little fine gravel
	− 5.5	− 8.0	Hard blue clay
274 E7	+19.5	+ 5.0	Fill
	+ 5.0	+ 2.0	Soft silt
	+ 2.0	+ 0.7	Silty sand, shells
	+ 0.7	− 1.0	Medium sand
	− 1.0	− 5.5	Little fine sand

No. and location	Elevations or depths From	To	Formation
275 E7	+16.0	+ 3.0	Fill
	+ 3.0	− 1.5	Dirty sand
	− 1.5	− 4.0	Medium blue clay (wet)
	− 4.0	−15.0	Medium blue clay
276 E7	+16.0	+ 3.0	Fill
	+ 3.0	− 0.5	Soft silt, peat
	− 0.5	− 2.5	Medium dirty sand
	− 2.5	− 4.5	Coarse sand, little fine gravel
	− 4.5	− 6.5	Clay, sand, little gravel
	− 6.5	−19.0	Medium blue clay
277 E8	+14.5	+ 1.0	Clay fill
	+ 1.0	− 1.5	Soft silt
	− 1.5	− 8.7	Coarse sand
	− 8.7	−14.5	Medium blue clay
278 E8	+17.0	+ 1.5	Sand fill
	+ 1.5	− 1.0	Soft silt
	− 1.0	− 3.0	Dirty sand
	− 3.0	− 5.0	Fine sand
	− 5.0	− 8.0	Medium blue clay
279 E8	+15.5	+ 2.0	Fill
	+ 2.0	− 1.7	Silty sand
	− 1.7	− 6.2	Medium sand
	− 6.2	− 9.5	Medium blue clay
280 E8	+19.5	+ 1.5	Fill
	+ 1.5	− 1.2	Soft silt
	− 1.2	− 6.7	Coarse sand
	− 6.7	−12	Medium blue clay
281 E9	+18.0	+ 1.5	Sand and clay fill
	+ 1.5	− 1.2	Soft silt
	− 1.2	− 3.5	Loose coarse sand
	− 3.5	− 9.0	Hard yellow clay
282 E9	+17.5	+ 1.5	Fill
	+ 1.5	− 2.0	Soft silt
	− 2.0	− 3.0	Dirty sand
	− 3.0	−10.5	Medium yellow clay
283 E9	+17.0	+ 7.0	Clay fill
	+ 7.0	− 1.0	Sand fill
	− 1.0	− 2.5	Silt
	− 2.5	− 5.0	Dirty sand
	− 5.0	− 7.5	Hard yellow clay
284 M5	+ 8.5	+ 0.5	Silty peat
	+ 0.5	− 1.5	Silty sand
	− 1.5	− 8.0	Stiff blue clay
	− 8.0	− 9.5	Very stiff blue clay
285 N5	+ 8.0	+ 0.5	Silty peat
	+ 0.5	− 3.0	Sand, little gravel
	− 3.0	−11.0	Soft blue clay, fine sand
	−11.0	−13.0	Stiff blue clay
286 N5	+ 8.0	+ 0.5	Silty peat
	+ 0.5	− 7.0	Sand, little silt
	− 7.0	−11.0	Soft blue clay, very fine sand
	−11.0	−18.0	Stiff blue clay
287 O7	+12.0	+ 6.0	Fill; cinders, gravel, sand
	+ 6.0	+ 2.0	Peat
	+ 2.0	− 1.0	Fine sand
	− 1.0	− 3.0	Sand, gravel
	− 3.0	− 5.5	Blue clay, sand
	− 5.5	− 9.0	Fine sand
	− 9.0	−10.0	Blue clay
288 O7	+14.0	+10.0	Fill; sand, gravel, clay
	+10.0	+ 7.5	Peat
	+ 7.5	+ 4.0	Fine sand
	+ 4.0	− 4.0	Yellow clay, sand
	− 4.0	−11.0	Fine sand
289 O7	+10.0	− 5.0	Fill; sand, gravel, clay
	− 5.0	− 8.2	Peat
	− 8.2	−11.0	Coarse sand, gravel
	−11.0	−17.0	Yellow clay, gravel
290 P7	+10.5	+ 7.5	Peat
	+ 7.5	− 1.5	Coarse sand
	− 1.5	− 5.5	Coarse sand, gravel
291 P7	+10.5	− 1.5	Peat, mud
	− 1.5	− 6.0	Sand, gravel
292 P7	+12.0	+ 4.0	Peat, mud
	+ 4.0	− 4.5	Stiff yellow clay
293 P7	+12.0	+ 6.0	Peat, mud
	+ 6.0	+ 2.0	Sand, gravel
	+ 2.0	− 4.5	Clay
294 D7	+16.0	+ 5.0	Fill
	+ 5.0	+ 1.5	Silt, fine sand
	+ 1.5	+ 0.5	Sand, gravel
	+ 0.5	− 5.0	Hard yellow clay
295 D7	+11.0	+ 3.0	Fill
	+ 3.0	− 2.0	Silt, fine sand
	− 2.0	− 3.7	Sand, gravel
	− 3.7	− 9.0	Hard yellow clay
296 E7	+11.0	+ 3.5	Sand and gravel fill
	+ 3.5	− 2.0	Silt, fine gravel
	− 2.0	− 4.0	Sand, gravel
	− 4.0	− 9.0	Hard blue clay
297 K6	+21.0	+20.2	Roadbed
	+20.2	+13.5	Sand and gravel fill
	+13.5	− 4.0	Yellow clay, gravel, sand
298 J6	+19.5	+18.5	Roadbed
	+18.5	+12.0	Sand and gravel fill
	+12.0	+ 4.0	Gravel, sand
	+ 4.0	− 6.0	Blue clay, gravel, sand
299 J6	+10.0	+ 4.0	Sand and gravel fill
	+ 4.0	− 6.0	Yellow clay, gravel, sand
	− 6.0	−12.0	Blue clay, gravel, sand

No. and location	Elevations or depths From	To	Formation
300 J6	+ 3	− 7	Sand and gravel fill
	− 7	−12	Yellow clay, sand
	−12	−15	Yellow clay, sand, gravel
301 J6	+10.5	+ 5.5	Silt, sand
	+ 5.5	+ 4.0	Yellow clay, gravel, sand
302 G6	+16.0	+ 2.0	Fill
	+ 2.0	−13.5	Fine sand, little clay
	−13.5	−23.0	Medium blue clay
303 G6	+15.0	+ 7.0	Fill
	+ 7.0	+ 2.0	Peat
	+ 2.0	− 3.5	Medium sand, little gravel
	− 3.5	−13.0	Medium blue clay, little fine sand
304 G6	+15.0	+10.0	Fill
	+10.0	+ 1.5	Peat
	+ 1.5	− 5.0	Fine sand, little clay
	− 5.0	−15.0	Medium blue clay, little sand
305 G6	+ 8.5	+ 1.5	Peat
	+ 1.5	−16.5	Fine sand, little clay
306 G6	+11.5	+ 4.2	Mud, silt
	+ 4.2	+ 1.2	Sand, mud
	+ 1.2	− 4.5	Blue clay
307 D7	+14.5	+ 2.5	Fill; sand, gravel, ash
	+ 2.5	− 1.5	Soft silt
	− 1.5	− 4.5	Coarse sand (loose)
	− 4.5	− 6.0	Stiff blue clay
308 D7	+15.0	+ 3.5	Ash fill
	+ 3.5	0	Soft silt
	0	− 2.5	Coarse sand (fairly hard)
309 D7	+15.5	+ 3.0	Ash fill
	+ 3.0	+ 1.0	Soft silt
	+ 1.0	− 4.5	Coarse sand
310 D7	+17	+ 3	Fill; sand, gravel, ashes
	+ 3	+ 1	Sand and gravel, hard
311 D7	+16.5	+ 8.0	Ash fill
	+ 8.0	+ 6.0	Soft peat
	+ 6.0	+ 2.5	Sand, gravel
312 M6	+ 1.5	− 0.5	Silty sand, gravel
	− 0.5	− 2.5	Fine sand, little clay
	− 2.5	− 7.5	Blue clay, soft
	− 7.5	−10.5	Fine sand, blue clay
313 M6	0	− 3.5	Silty mud
	− 3.5	− 9.5	Sand, clay
	− 9.5	−16.5	Fine sand, clay
	−16.5	−22.5	Soft blue clay
	−22.5	−26.0	Stiff blue clay
314 M6	+ 4.0	− 2.5	Silt
	− 2.5	− 7.5	Sand, clay
	− 7.5	−13.5	Fine sand
	−13.5	−15.5	Fine sand, hard clay
315 G6	+18.0	+10.0	Fill; sand, gravel, clay
	+10.0	+ 7.5	Blue clay, gravel
	+ 7.5	+ 4.0	Peat
	+ 4.0	+ 2.5	Soft silt
	+ 2.5	+ 1.5	Silty sand
316 G6	+16	+ 9	Sand and gravel fill
	+ 9	+ 5	Blue clay, gravel
	+ 5	+ 2	Peat
	+ 2	+ 1	Silty sand
317 H6	+16.5	+11.5	Sand and gravel fill
	+11.5	+ 6.3	Blue clay, little gravel
	+ 6.3	+ 1.5	Silty peat
	+ 1.5	− 1.0	Soft silt
	− 1.0	− 1.5	Silty sand
318 H6	+16.5	+11.0	Fill; clay, sand, gravel
	+11.0	+ 3.5	Blue clay, gravel
319 H6	+17.0	+ 7.0	Coarse sand, little clay
	+ 7.0	+ 3.5	Soft silty peat
	+ 3.5	+ 1.0	Soft silt
	+ 1.0	0	Silty sand, little gravel
320 H5	+16.5	+ 7.5	Sand and gravel fill
	+ 7.5	+ 0.5	Silt and peat, soft
	+ 0.5	− 1.5	Sand and gravel (coarse, hard)
321 H6	+16.5	+ 8.0	Sand and gravel fill, loose
	+ 8.0	+ 3.0	Silt and peat, soft
	+ 3.0	+ 1.0	Coarse sand, gravel
322 H6	+17.0	+ 3.0	Sand and gravel fill
	+ 3.0	+ 0.5	Soft silt
	+ 0.5	− 1.5	Coarse sand, hard
323 H6	+24.5	+16.5	Sand and gravel, loose
	+16.5	+ 9.5	Sand and gravel, fairly hard
324 H5	+17.0	+ 8.0	Fill; sand, gravel, ash
	+ 8.0	+ 2.0	Silt
	+ 2.0	− 0.5	Peat
	− 0.5	− 5.5	Blue clay (hard)

No. and location	Elevations or depths From	To	Formation
325 H5	+17.0	+ 4.5	Fill; sand, gravel, ash
	+ 4.5	+ 0.5	Silt, peat
	+ 0.5	− 4.5	Blue clay
326 I5	+13.0	+10.0	Sand and gravel fill
	+10.0	+ 4.5	Silt, peat
	+ 4.5	0	Blue clay
327 I5	+17.5	+15.5	Sand and gravel fill
	+15.5	+ 4.5	Sand, gravel, clay, very hard
328 I5	+22.5	+20.0	Sand and gravel fill
	+20.0	+ 9.0	Coarse sand, gravel, clay, very hard
329 F6	+ 5.5	+ 2.5	Peat, silt
	+ 2.5	−11.5	Blue clay (little sand)
330 G6	+10.5	+ 3.0	Mud, silt
	+ 3.0	− 5.5	Fine sand
	− 5.5	− 9.5	Blue clay, little sand
331 G6	+11.5	+ 4.5	Mud, silt
	+ 4.5	+ 1.5	Sand, mud
	+ 1.5	− 4.5	Blue clay
332 G6	+15.0	+ 2.5	Fill, mud, silt
	+ 2.5	− 5.0	Coarse sand
	− 5.0	−11.0	Blue clay, sand
333 D6	+17	+ 5	Fill
	+ 5	+ 3	Silt, peat
	+ 3	− 5	Coarse sand
334 D6	+16	+ 3	Fill
	+ 3	− 5	Coarse sand
335 D6	+15.0	+ 2.0	Fill
	+ 2.0	− 8.7	Silt, peat
	− 8.7	−12.5	Hard blue clay, sand
336 D6	+14.5	+ 1.5	Fill
	+ 1.5	− 7.0	Sand
	− 7.0	−10.0	Stiff blue clay
337 G3	+22.5	+21.5	Roadbed
	+21.5	+10.5	Sand, gravel
	+10.5	+ 5.0	Sand, gravel, clay
	+ 5.0	+ 2.0	Brown clay
338 G3	+26.5	+20.5	Sand, gravel
	+20.5	+15.0	Sand, gravel
	+15.0	+ 3.5	Sand, gravel, clay
339 G2	+30.5	+15.5	Sand, gravel, little clay
	+15.5	+ 5.0	Sand, gravel
340 F2	+32.0	+26.0	Sand and gravel fill
	+26.0	+16.0	Coarse sand, gravel
	+16.0	+ 4.5	Sand, gravel, clay
341 B6	+16.5	+11.5	Hard gravel fill
	+11.5	+ 2.5	Soft clay fill
	+ 2.5	− 2.5	Silty sand
	− 2.5	− 6.5	Peat
	− 6.5	− 8.5	Fine sand, little clay
	− 8.5	−15.5	Stiff yellow clay
342 B6	+15.0	+12.0	Hard sand fill
	+12.0	+ 7.5	Soft mud
	+ 7.5	− 1.0	Soft clay and silt fill
	− 1.0	− 8.0	Stiff yellow clay
343 B6	+15.5	+11.5	Hard sand and gravel fill
	+11.5	+ 2.0	Soft sand and clay fill
	+ 2.0	− 1.2	Silty peat, sand
	− 1.2	− 4.2	Fine sand, little clay
	− 4.2	−12.5	Stiff yellow clay, little sand
344 D6	+14.5	+ 6.5	Fill
	+ 6.5	+ 2.5	Silt, peat
	+ 2.5	− 7.5	Clay, sand
345 D6	+15	+ 3	Fill
	+ 3	− 1	Silt, peat
	− 1	− 9	Sand, little clay
346 D6	+16.0	+ 4.0	Fill
	+ 4.0	− 0.5	Silt, peat
	− 0.5	− 3.5	Stiff blue clay, sand
347 D6	+17.5	+ 4.5	Fill
	+ 4.5	− 1.2	Silt, peat, sand
	− 1.2	− 5.0	Yellow clay, sand
348 G6	+16.0	+ 8.7	Fill; clay, sand, gravel
	+ 8.7	+ 6.0	Peat, clay, sand
	+ 6.0	+ 3.2	Stiff brown peat
	+ 3.2	+ 1.5	Fine sand
	+ 1.5	− 3.0	Stiff blue clay
349 G6	+16.5	+ 9.5	Fill; clay, sand, gravel
	+ 9.5	+ 8.0	Peat, clay, sand
	+ 8.0	+ 5.5	Silt and sand (soft)
	+ 5.5	+ 2.7	Stiff brown peat
	+ 2.7	− 1.5	Sharp sand, fine gravel
350 G5	+16.5	+ 8.2	Fill; clay, gravel, sand
	+ 8.2	+ 6.2	Fill; peat, sand, gravel
	+ 6.2	+ 3.0	Stiff brown peat
	+ 3.0	− 0.5	Very fine sand
	− 0.5	− 4.5	Sand, gravel
351 G5	+17.0	+ 6.0	Fill; clay, sand, gravel
	+ 6.0	+ 2.7	Stiff brown peat
	+ 2.7	− 2.2	Sharp sand, fine gravel

No. and location	Elevations or depths From	To	Formation
352 D7	+16.5	+10.0	Cinder fill
	+10.0	+ 3.0	Ash fill, little clay
	+ 3.0	+ 1.0	Soft silt
353 D7	+17	+12	Fill
	+12	+ 4	Ash fill
	+ 4	0	Sand, fairly hard
354 C7	+17.0	+12.0	Fill
	+12.0	+ 5.5	Ash fill
	+ 5.5	+ 4.5	Sand and peat (soft)
	+ 4.5	+ 2.0	Sand, fairly hard
355 D6	+17.5	+ 6.0	Fill
	+ 6.0	+ 2.0	Silt, peat
	+ 2.0	− 3.0	Coarse sand
	− 3.0	− 7.5	Blue clay, sand
356 L5	+ 9.5	− 1.5	Brown peat
	− 1.5	−10.5	Blue clay
357 L5	+10	− 3	Brown peat
	− 3	−10	Stiff blue clay
358 L5	+ 9.0	− 2.5	Brown peat
	− 2.5	−12.0	Stiff blue clay
359 L5	+10.5	− 1.0	Brown peat
	− 1.0	− 2.5	Silt, sand
	− 2.5	− 5.0	Fine sand
	− 5.0	−11.0	Stiff blue clay, fine sand
360 L6	+ 9.0	+ 7.0	Sand and gravel fill
	+ 7.0	− 5.0	Brown peat
	− 5.0	− 7.5	Fine sand, clay
	− 7.5	−10.0	Stiff blue clay
	−10.0	−12.0	Fine sand
	−12.0	−13.5	Blue clay
	−13.5	−20.0	Fine sand, very soft
	−20.0	−25.0	Blue clay
361 K6	+20	+19	Roadbed
	+19	− 5	Very coarse sand and gravel, little clay
362 K6	+19.5	+18.5	Silt, sand, shells
	+18.5	+ 4.5	Hard yellow clay, sand
363 K6	+ 5.0	+ 3.0	Beach sand, gravel
	+ 3.0	− 9.5	Hard yellow clay, little sand
364 K6	+ 9.5	+ 3.5	Fill; loam, sand, gravel
	+ 3.5	− 0.5	Coarse sand, gravel
	− 0.5	− 8.0	Sharp sand
	− 8.0	−10.5	Yellow clay
365 L6	+13.0	+11.0	Sand and gravel fill
	+11.0	+ 4.0	Stiff brown peat
	+ 4.0	− 2.5	Stiff blue clay, sand
	− 2.5	−12.0	Fine sand, clay
366 M6	+10.0	+ 8.0	Silt, sand, shells
	+ 8.0	+ 5.5	Stiff brown peat
	+ 5.5	+ 1.5	Stiff blue clay, sand
	+ 1.5	− 5.0	Hard blue clay, sand
	− 5.0	−11.0	Fine sand, clay
367 L6	+10.5	+ 7.5	Silt, sand
	+ 7.5	+ 6.0	Soft brown peat
	+ 6.0	− 4.5	Fine sand, little clay
368 L6	+12	+10	Silt, sand, shells
	+10	− 2	Fine sand, little clay
369 L6	+12	+10	Silt, sand, shells
	+10	− 3	Fine sand, little clay
370 H4	+15.5	− 5.5	Slag fill
	− 5.5	− 7.5	Blue clay
371 H4	+15.0	+ 9.0	Sand, mud, gravel
	+ 9.0	+ 2.0	Peat
	+ 2.0	− 2.5	Sand, gravel, clay
372 H3	+17.0	+10.5	Sand, gravel, peat
	+10.5	+ 3.5	Mud, clay, peat
	+ 3.5	− 1.5	Sand, gravel
373 H3	+18.0	+12.5	Sand, gravel
	+12.5	+ 8.0	Sand, gravel, peat
	+ 8.0	+ 0.5	Sand, gravel
374 H3	+16.0	+10.0	Fill; cinders, clay, gravel
	+10.0	+ 4.5	Mud, cinders, gravel
	+ 4.5	− 1.0	Blue clay, little gravel
375 G3	+17.0	+ 5.0	Cinders, sand, gravel
	+ 5.0	+ 0.5	Sand, gravel, clay
376 G3	+18.5	+ 2.5	Sand, gravel, stones, clay
377 G3	+19.5	+14.5	Sand, gravel, cinders
	+14.5	+ 3.0	Sand, gravel, clay
378 E9	+16.0	− 1.5	Clay and sand fill
	− 1.5	− 4.5	Soft silt
	− 4.5	− 6.0	Sand, gravel, clay
	− 6.0	− 8.5	Hard yellow clay
379 L6	+11.0	+ 8.5	Silt, sand, shells
	+ 8.5	+ 7.0	Stiff brown peat
	+ 7.0	+ 4.0	Soft blue clay
	+ 4.0	+ 1.0	Fine sand, little clay
	+ 1.0	− 4.0	Fine sand, clay
380 L6	+13.0	+11.0	Silt, sand
	+11.0	+10.5	Stiff brown peat
	+10.5	− 2.0	Fine sand, little clay

No. and location	Elevations or depths From	To	Formation
381 K6	+12.0	+ 6.5	Silt, sand, peat
	+ 6.5	− 3.0	Fine sand, little clay
382 K6	+13.5	+ 7.0	Sand and gravel fill
	+ 7.0	+ 4.5	Stiff brown peat
	+ 4.5	− 6.5	Stiff blue clay, sand
383 E9	+16	+ 6	Sand and gravel fill
	+ 6	+ 2	Soft blue clay fill
	+ 2	− 3	Silty peat
	− 3	− 9	Clay and sand fill
	− 9	−14	Stiff blue clay
384 M5	+ 8.0	− 4.0	Peat, silt, sand
	− 4.0	− 8.5	Stiff blue clay, sand
	− 8.5	−17.5	Fine sand, clay
385 M5	+ 4.5	− 1.0	Silt, sand, shells
	− 1.0	−11.0	Stiff blue clay, sand
	−11.0	−14.0	Fine sand, clay
	−14.0	−16.0	Fine sand, clay
386 M5	+ 3.0	+ 1.5	Soft silt, sand
	+ 1.5	− 4.0	Stiff brown peat
	− 4.0	− 7.5	Stiff blue clay, sand
	− 7.5	−17.0	Fine sand, clay
387 M6	+15.5	+10.5	Fill; loam, sand, gravel
	+10.5	+ 4.0	Fill; silt, sand, gravel
	+ 4.0	+ 0.5	Fine sand, clay
	+ 0.5	− 1.0	Silt, sand, gravel
	− 1.0	− 3.5	Fine sand
	− 3.5	−29.0	Fine sand, very little clay
388 N6	+13.0	+ 8.5	Sand, gravel
	+ 8.5	+ 6.5	Soft blue clay
	+ 6.5	+ 1.0	Fine sand, little clay
	+ 1.0	− 0.5	Blue clay
	− 0.5	− 4.0	Fine sand, little clay
	− 4.0	−10.0	Sand, gravel, very little clay
	−10.0	−15.0	Sand, gravel, clay —hard
389 N6	+12.5	+ 9.0	Sand and gravel fill
	+ 9.0	+ 7.0	Clay, little gravel
	+ 7.0	+ 5.0	Coarse sand, gravel
	+ 5.0	− 1.0	Fine sand
	− 1.0	− 5.0	Fine sand
	− 5.0	−18.5	Sand, gravel
390 N6	+11.5	− 2.0	Peat, sand
	− 2.0	− 9.0	Fine sand
	− 9.0	−15.0	Sand, gravel, water
	−15.0	−18.5	Coarse gravel, sand
391 N5	+ 8.5	+ 0.5	Peat
	+ 0.5	− 2.5	Sand, gravel, little clay
	− 2.5	− 6.0	Coarse gravel
	− 6.0	− 7.5	Clay, sand, gravel
	− 7.5	− 9.0	Hard blue clay
	− 9.0	−16.5	Sand, gravel, clay
392 J4	+18.5	+14.0	Fill; sand, gravel, clay
	+14.0	− 3.5	Yellow clay, gravel
	− 3.5	−13.5	Blue clay, gravel, stones
393 K4	+19.5	+18.0	Sandy loam
	+18.0	+ 5.0	Yellow clay, gravel
	+ 5.0	−16.5	Blue clay, gravel
394 K4	+18.0	+16.5	Loam
	+16.5	+ 5.5	Yellow clay, gravel, small stones
	+ 5.5	−14.5	Blue clay, gravel
395 K4	+18.5	+17.0	Loam
	+17.0	+ 7.5	Yellow clay, gravel Rock or boulder
396 J6	+ 3	− 5	Silt, sand
	− 5	−10	Coarse sand, gravel
397 J7	+ 3	− 3	Silt, sand, shells
	− 3	−10	Sand, gravel
398 I7	+ 3.0	− 2.5	Silt, sand
	− 2.5	− 9.0	Coarse sand, gravel
399 I7	+ 3.0	+ 0.5	Silt, sand
	+ 0.5	− 0.5	Fine sand
	− 0.5	− 6.0	Hard blue clay
400 N6	+17.5	+ 6.5	Fill; sand, gravel, clay
	+ 6.5	+ 2.5	Peat
	+ 2.5	+ 1.0	Fine sand
	+ 1.0	− 9.0	Stiff blue clay
401 N6	+18.0	+ 6.5	Fill; sand, gravel, clay
	+ 6.5	+ 1.5	Peat
	+ 1.5	− 5.5	Fine sand
	− 5.5	− 9.0	Sand, gravel, stones
402 N6	+18.5	+13.5	Fill; sand, gravel, clay
	+13.5	+ 8.0	Peat
	+ 8.0	+ 3.0	Fine sand
	+ 3.0	− 2.0	Sand, gravel, stone
	− 2.0	− 5.5	Sand, gravel, little clay
403 M6	+17	+13	Fill
	+13	− 7	Silt
	− 7	−22	Fine sand, clay
	−22	−25	Stiff blue clay
404 M6	+16.5	+13.0	Fill
	+13.0	+ 2.0	Peat
	+ 2.0	−18.0	Fine sand, clay
	−18.0	−25.0	Stiff blue clay

No and location	Elevations or depths From	To	Formation
405 M6	+17.5	+13.0	Fill
	+13.0	+ 5.0	Sand, gravel and fill
	+ 5.0	−10.0	Sand, little clay
	−10.0	−15.0	Stiff blue clay
406 M6	+17	+13	Fill
	+13	+ 9	Fill; sand, gravel, stone
	+ 9	− 2	Sand, little clay
	− 2	−12	Stiff blue clay
407 N6	+16.5	+11.0	Fill; cinder, gravel, sand
	+11.0	+ 4.5	Silt
	+ 4.5	− 6.5	Yellow clay, stones
	− 6.5	− 9.5	Blue clay, stones
408 N6	+17.0	+11.5	Fill; cinder, gravel, sand
	+11.5	+10.0	Fine sand
	+10.0	− 9.0	Sand, gravel, small stones
409 M5	+11	+ 6	Gravel fill
	+ 6	+ 1	Peat
	+ 1	− 1	Very coarse sand
410 M5	+11.0	+ 3.0	Gravel fill
	+ 3.0	+ 1.0	Peat
	+ 1.0	− 1.5	Sand, gravel
411 M4	+11.5	+ 2.0	Gravel fill
	+ 2.0	− 1.0	Peat
	− 1.0	− 2.0	Sand, gravel
412 M4	+12	+ 2	Sand, gravel
413 M4	+12.5	+ 3.5	Sand, gravel
414 P8	+10	− 2	Peat
	− 2	− 9	Sand, gravel
415 P7	+10.5	− 1.5	Peat
	− 1.5	− 6.5	Sand, gravel
	− 6.5	− 9.5	Sand, clay
416 P7	+11.0	+ 6.5	Peat
	+ 6.5	+ 3.0	Blue clay
	+ 3.0	− 7.0	Yellow clay, gravel
417 Q7	+14.0	+12.5	Loam
	+12.5	+10.0	Sand, gravel
	+10.0	− 4.5	Clay, sand, gravel
418 Q7	+12.0	+10.5	Peat
	+10.5	− 6.0	Clay, sand, gravel
419 Q7	+13	+12	Peat
	+12	− 5	Clay, sand, gravel
420 O7	+11.0	+ 1.5	Peat
	+ 1.5	− 2.5	Sand, gravel, stones
	− 2.5	−12.0	Stiff blue clay, gravel
421 O7	+10.0	− 0.5	Peat
	− 0.5	− 5.0	Coarse sand
	− 5.0	−10.0	Stiff blue clay

No. and location	Elevations or depths From	To	Formation
422 P7	+10	− 2	Peat
	− 2	− 6	Sand, gravel
	− 6	−11	Stiff blue clay
423 P7	+10	− 2	Peat
	− 2	− 8	Sand, coarse gravel
424 P8	+ 9.5	− 1.0	Peat
	− 1.0	− 7.0	Sand, coarse gravel
	− 7.0	−10.0	Sand, clay
425 D10	+14.5	+ 7.5	Sand and gravel fill
	+ 7.5	+ 0.5	Soft blue clay, fill
	+ 0.5	−10.5	Fill; clay, sand, gravel
	−10.5	−16.5	Stiff blue clay
426 D10	+15.5	+ 6.0	Sand and gravel fill
	+ 6.0	− 0.5	Soft blue clay fill
	− 0.5	− 7.0	Fill; clay, sand, gravel
	− 7.0	−14.0	Stiff blue clay
427 E10	+17.5	+ 9.5	Sand and gravel fill
	+ 9.5	+ 0.5	Soft blue clay fill
	+ 0.5	− 4.5	Fill; clay, sand, gravel
	− 4.5	−12.5	Stiff blue clay
428 E10	+17	+ 8	Sand and gravel fill
	+ 8	+ 3	Soft blue clay fill
	+ 3	− 3	Silty peat
	− 3	− 6	Fill; clay, sand, gravel
	− 6	−13	Stiff blue clay
429 E10	+16.5	+ 9.5	Sand and gravel fill
	+ 9.5	+ 1.5	Fill; soft blue clay, gravel
	+ 1.5	− 3.5	Silty peat
	− 3.5	− 7.5	Clay and sand fill
	− 7.5	−13.5	Stiff blue clay
430 A5	Harbor bed		
	−40	−48	Mud
	−48	−91	Stiff blue clay
	−91	−94	Sand, gravel, stiff clay
431 A5	Harbor bed		
	−40	−49	Mud
	−49	−91	Stiff blue clay
	−91	−94	Stiff clay, some gravel
432 A5	Harbor bed		
	−36	−41	Mud
	−41	−66	Stiff blue clay
	−66	−74	Stiff clay
	−74	−88	Stiff clay, gravel
433 A5	Harbor bed		
	−37	−40	Mud
	−40	−81	Stiff blue clay
	−81	−91	Stiff clay, some gravel

No. and location	Elevations or depths From	To	Formation
434	Harbor bed		
A5	−21	−28	Mud
	−28	−74	Stiff blue clay
	−74	−76	Gravel
	−76	−85	Stiff clay
435	Harbor bed		
A5	−40	−43	Mud
	−43	−87	Stiff clay
	−87	−91	Sand, gravel, stiff clay
436	Harbor bed		
A5	−19	−21	Mud
	−21	−39	Medium clay
	−39	−57	Clay, some sand
	−57	−81	Clay, some gravel
	−81	−91	Soft clay
437	Harbor bed		
A5	−18	−20	Mud
	−20	−44	Medium clay
	−44	−70	Clay, little gravel
	−70	−96	Medium clay
	−96	−101	Hard clay, sand, gravel
438	Harbor bed		
A5	−34	−38	Mud
	−38	−54	Medium clay
	−54	−67	Clay, gravel
	−67	−87	Medium clay
	−87	−92	Clay, some gravel
	−92	−100	Hard clay, sand, gravel
439	Harbor bed		
A5	−34	−38	Mud
	−38	−56	Medium clay
	−56	−79	Medium clay, gravel
	−79	−83	Clay
	−83	−96	Hard clay, gravel
	−96	−100	Sand, gravel
440	Harbor bed		
A5	−33	−38	Mud
	−38	−62	Medium clay
	−62	−93	Soft clay
	−93	−100	Hard clay, gravel
441	Harbor bed		
A5	−34	−38	Mud
	−38	−63	Medium clay
	−63	−74	Soft clay
	−74	−100	Hard clay, gravel
442	Harbor bed		
A5	−35	−39	Mud
	−39	−58	Medium clay
	−58	−72	Soft clay, some gravel
	−72	−79	Soft clay
	−79	−98	Medium clay
	−98	−101	Hard clay, gravel
443	Harbor bed		
A5	−35	−37	Mud
	−37	−62	Clay
	−62	−79	Clay, gravel
	−79	−94	Soft clay
	−94	−102	Clay, gravel
444	Harbor bed		
A5	−34	−38	Mud
	−38	−52	Medium clay
	−52	−58	Clay, sand, gravel
	−58	−60	Sand, gravel
	−60	−74	Sand, clay, gravel
	−74	−88	Loose sand, gravel
	−88	−104	Hard clay, sand, gravel
445	Harbor bed		
A5	−35	−38	Mud
	−38	−75	Medium clay
	−75	−80	Soft clay
	−80	−92	Clay, gravel
			Rock or boulder
446	+16	+ 8	Fill
D4	+ 8	+ 6	Fine silty sand, mud
	+ 6	− 2	Hard packed coarse sand
	− 2	− 6	Compact fine sand
	− 6	−12	Hard blue clay
447	+15	+ 4	Fill
C5	+ 4	+ 1	Fine silty sand, mud
	+ 1	− 7	Fine sand, clay
	− 7	−31	Medium blue clay
448	+18	+ 8	Fill
C5	+ 8	+ 4	Peat, mud
	+ 4	− 6	Hard yellow clay
	− 6	−26	Hard blue clay
	−26	−36	Medium blue clay
	−36	−40	Fine sand, some clay
449	+20	+ 7	Hard yellow clay, sand, gravel, rocks
B5	+ 7	−34	Hard blue clay, sand, gravel, rocks
	−34	−38	Boulders
	−38	−60	Hard blue clay, sand, gravel, stones
450	+17	+ 5	Fill
B5	+ 5	− 2	Fine silty mud, sand
	− 2	−14	Hard yellow clay
	−14	−20	Hard blue clay, sand, gravel
	−20	−25	Hard packed sand, gravel
	−25	−64	Hard blue clay, gravel
	−64	−78	Hard blue clay, gravel, stones
451	Harbor bed		
A5	−28	−30	Fine silty sand, mud
	−30	−95	Soft blue clay
452	Harbor bed		
A5	−34	−39	Fine silty sand, mud
	−39	−104	Soft blue clay

No. and location	Elevations or depths From	To	Formation
453 A5	Harbor bed		
	−34	−37	Fine silty sand, mud
	−37	−96	Soft blue clay
454 A5	Harbor bed		
	−34	−40	Fine silty sand, mud
	−40	−96	Soft blue clay
455 A5	Harbor bed		
	−36	−40	Fine silty sand, mud
	−40	−94	Soft blue clay
456 A5	Harbor bed		
	−35	−39	Fine silty sand, mud
	−39	−95	Soft blue clay
457 A5	Harbor bed		
	−35	−40	Silty sand, mud
	−40	−76	Soft blue clay
	−76	−86	Soft blue clay, layer fine sand
	−86	−96	Hard blue clay, sand, gravel
458 A5	Harbor bed		
	−34	−40	Silty sand, mud
	−40	−60	Soft blue clay
	−60	−75	Soft blue clay, thin layer fine sand
	−75	−95	Hard blue clay, sand, gravel
459 A5	Harbor bed		
	−36	−41	Silty sand, mud
	−41	−54	Soft blue clay
	−54	−56	Soft blue clay, sand
	−56	−87	Soft blue clay
	−87	−96	Hard packed sand, gravel, some clay
474 F10	+16.4	+14.9	Cinder fill
	+14.9	+ 6.9	Clay fill
	+ 6.9	− 4.1	Silt, little fine sand
	− 4.1	− 6.1	Firm coarse gravel
	− 6.1	−12.1	Hard yellow clay, little fine sand
	−12.1	−53.6	Soft blue clay, little fine sand
475 F10	+16.3	+13.8	Firm cinder and stone fill
	+13.8	+ 1.3	Fill; loose sand, gravel, clay
	+ 1.3	− 1.2	Soft silt, little sand
	− 1.2	− 4.7	Silty sand, shells
	− 4.7	− 6.2	Loose coarse sand
	− 6.2	− 9.7	Hard yellow clay
	− 9.7	−53.7	Soft blue clay
	−53.7	−55.7	Hard sand, gravel
476 F10	+15.9	+14.9	Cinder fill
	+14.9	− 1.6	Fill; sand, gravel, clay, silt
	− 1.6	− 6.6	Peaty silt, little sand
	− 6.6	−12.6	Medium yellow clay
	−12.6	−53.6	Soft blue clay
	−53.6	−56.1	Hard sand, gravel, clay and boulders
477 G10	+15.5	+14.0	Firm cinder fill
	+14.0	− 3.5	Soft clay fill
	− 3.5	− 6.0	Silty sand, little shells
	− 6.0	− 8.0	Firm sand, little clay
	− 8.0	−11.5	Hard yellow clay
	−11.5	−48.5	Soft blue clay
	−48.5	−50.0	Firm coarse sand
478 G9	+15.7	+14.7	Cinder fill
	+14.7	+ 5.2	Blue clay fill
	+ 5.2	− 7.3	Silty and fine sand
	− 7.3	− 8.3	Hard yellow clay
	− 8.3	−17.8	Hard yellow clay, little sand
	−17.8	−71.8	Soft blue clay, little fine sand
479 F10	+16.8	+14.3	Firm cinder and stone fill
	+14.3	+ 6.8	Fill; sand, gravel, clay
	+ 6.8	+ 1.8	Soft clay fill
	+ 1.8	− 2.2	Fill; sand, gravel, clay
	− 2.2	− 4.7	Soft silt
	− 4.7	− 5.7	Silty sand, shells
	− 5.7	−10.7	Hard yellow clay, little fine sand
	−10.7	−25.2	Soft blue clay
480 G10	+15.4	+14.4	Cinder fill
	+14.4	− 5.6	Silty sand fill
	− 5.6	− 9.1	Loose medium silty sand
	− 9.1	−17.6	Medium yellow clay
	−17.6	−33.1	Soft blue clay
481 G10	+15.7	+14.2	Firm cinder fill
	+14.2	+10.2	Soft clay fill
	+10.2	− 1.8	Soft silt, little shells
	− 1.8	− 5.8	Silty sand, shells
	− 5.8	− 9.3	Firm coarse sand
	− 9.3	−29.3	Soft blue clay
482 G10	+14.0	+13.0	Firm cinder fill
	+13.0	+ 7.5	Soft clay fill
	+ 7.5	+ 1.0	Soft silt
	+ 1.0	− 6.0	Silty sand, silt, shells
	− 6.0	−13.0	Hard yellow clay
	−13.0	−33.0	Soft blue clay
483 G9	+14.4	+12.4	Fill; sand, gravel, cinder
	+12.4	+ 0.9	Clay fill
	+ 0.9	− 6.1	Fine silty sand
	− 6.1	−12.6	Coarse sand, little fine gravel
	−12.6	−35.6	Soft blue clay, very little fine sand
484 F11	+17.1	+16.1	Cinder fill
	+16.1	+ 0.1	Fill; sand, gravel, clay, silt
	+ 0.1	− 7.9	Loose silty sand
	− 7.9	−16.4	Medium yellow clay
	−16.4	−22.9	Soft blue clay

No. and location	Elevations or depths From	To	Formation
485 F11	+16.6	+15.6	Cinder fill
	+15.6	+ 6.6	Fill; sand, gravel, clay, wood
	+ 6.6	− 1.9	Soft silt
	− 1.9	−11.4	Loose coarse sand
	−11.4	−15.4	Soft blue clay
	−15.4	−17.4	Medium yellow clay
	−17.4	−53.4	Soft blue clay
486 F10	+16.4	+12.9	Cinder and rip-rap fill
	+12.9	+ 3.9	Silt and clay fill
	+ 3.9	− 0.6	Soft silt
	− 0.6	− 4.6	Loose coarse sand
	− 4.6	−10.6	Hard yellow clay
	−10.6	−25.6	Soft blue clay
487 F10	+16.2	+14.2	Cinder and slag fill
	+14.2	+ 4.2	Clay and sand fill
	+ 4.2	− 4.3	Silty sand
	− 4.3	− 8.3	Coarse sand
	− 8.3	−14.3	Hard yellow clay, little fine sand
	−14.3	−43.8	Soft blue clay, little fine sand
	−43.8	−53.8	Soft blue clay, very little fine sand
488 F9	+17.6	+15.6	Cinder fill
	+15.6	+ 3.1	Sand and clay fill
	+ 3.1	− 4.4	Silty sand, shells
	− 4.4	− 9.9	Hard yellow clay
	− 9.9	−24.4	Soft blue clay, little fine sand
489 F9	+16.6	+15.1	Cinder and gravel fill
	+15.1	− 1.9	Fill; clay, sand, gravel
	− 1.9	− 5.9	Soft silt, little fine sand
	− 5.9	−15.4	Hard yellow clay
	−15.4	−29.4	Medium blue clay
490 F9	+16.3	+15.5	Cinders
	+15.5	+ 5.7	Fill; firm clay, sand, little gravel
	+ 5.7	− 4.1	Fill; soft clay, very little sand and gravel
	− 4.1	− 7.9	Silt
	− 7.9	− 9.4	Sharp sand, little clay
	− 9.4	−15.7	Blue clay, sand
	−15.7	−18.7	Soft blue clay
491 G9	+16.2	+15.5	Concrete
	+15.5	− 1.6	Fill; clay, silt, sand, gravel
	− 1.6	− 4.4	Silt
	− 4.4	− 6.1	Silty peat
	− 6.1	− 8.5	Fine sand, trace of clay
	− 8.5	−11.3	Fine sand, clay
	−11.3	−15.8	Blue clay, sand
492 F9	+16.1	+15.4	Cinders
	+15.4	+12.6	Hard clay fill
	+12.6	+ 4.1	Medium clay fill
	+ 4.1	− 3.9	Soft clay and sand fill
	− 3.9	− 6.4	Silt
	− 6.4	−10.9	Hard yellow clay
	−10.9	−79.9	Soft blue clay
493 G9	+16.1	+13.6	Cinder fill
	+13.6	+ 7.6	Clay and sand fill
	+ 7.6	− 0.1	Silty sand fill
	− 0.1	− 5.9	Silt, fine sand
	− 5.9	− 8.1	Coarse silty sand
	− 8.1	−24.9	Soft blue clay, little fine sand
494 G9	+15.2	+14.8	Cinders, gravel
	+14.8	+10.7	Fill; coarse sand, gravel
	+10.7	+ 6.8	Sand and clay fill
	+ 6.8	− 3.3	Silty sand fill
	− 3.3	− 7.8	Silt, fine sand
	− 7.8	−10.2	Coarse silty sand
	−10.2	−13.3	Yellow clay, fine sand
495 G9	+14.5	+14.0	Cinders
	+14.0	− 3.2	Fill; clay, silty sand, gravel
	− 3.2	− 7.1	Silt, fine sand
	− 7.1	− 9.7	Sharp silty sand
	− 9.7	−24.7	Fine sand, clay
	−24.7	−28.5	Blue clay
496 G9	+14.5	+14.0	Cinders
	+14.0	+ 7.5	Fill; sand, little clay
	+ 7.5	− 1.9	Silty sand fill
	− 1.9	− 9.1	Silt, fine sand
	− 9.1	−11.0	Loose coarse silty sand
	−11.0	−14.5	Yellow clay, fine sand
497 G10	+14.2	+13.2	Cinders
	+13.2	+ 5.8	Sand and clay fill
	+ 5.8	− 3.1	Silty sand fill
	− 3.1	− 7.8	Silt, fine sand
	− 7.8	−12.3	Firm coarse silty sand
	−12.3	−16.2	Yellow clay, fine sand
	−16.2	−73.8	Soft blue clay
498 G10	+14.6	+13.9	Cinders
	+13.9	+ 1.3	Fill; clay, sand, gravel
	+ 1.3	− 2.1	Fill; soft clay, silt
	− 2.1	− 9.6	Silt, fine sand, shells
	− 9.6	−11.2	Sharp sand, little gravel
	−11.2	−13.4	Yellow clay, fine sand
499 G10	+16.1	+14.6	Cinder fill
	+14.6	+ 4.1	Sand and clay fill
	+ 4.1	− 0.9	Silty sand fill
	− 0.9	− 8.6	Silt, fine sand
	− 8.6	−11.9	Coarse sand, fine gravel
	−11.9	−65.5	Blue clay, little fine sand
	−65.5	−68.1	Sand, gravel, clay

No. and location	Elevations or depths From	To	Formation
500 G10	+16.1	+15.7	Cinders
	+15.7	+ 0.8	Fill; sand, silty sand, little clay, little gravel
	+ 0.8	− 6.7	Silt
	− 6.7	− 7.2	Dirty sharp sand
	− 7.2	−14.9	Hard yellow clay, little sand
	−14.9	−16.9	Blue clay
501 F9	+16.1	+15.1	Cinders
	+15.1	+ 8.1	Sand and clay fill
	+ 8.1	− 8.7	Silt, fine sand
	− 8.7	−13.1	Coarse sand
	−13.1	−18.9	Blue clay, fine sand
	−18.9	−79.9	Soft blue clay
502 F10	+15.9	+14.9	Cinders
	+14.9	+11.7	Slag
	+11.7	+ 5.5	Clay and sand fill
	+ 5.5	− 0.1	Sand fill
	− 0.1	− 7.3	Silt
	− 7.3	− 8.6	Fine sand, little clay
	− 8.6	−13.5	Yellow clay, sand
	−13.5	−17.1	Blue clay
503 F11	+16.3	+13.8	Slag fill
	+13.8	+ 6.8	Hard sand and clay fill
	+ 6.8	− 5.1	Silt, fine sand
	− 5.1	− 8.0	Coarse sand
	− 8.0	−16.7	Blue clay, fine sand
504 F10	+16.2	+13.2	Slag fill
	+13.2	+ 3.5	Sand and clay fill
	+ 3.5	+ 0.6	Silt, little fine sand
	+ 0.6	− 5.1	Silt, fine sand
	− 5.1	− 8.0	Coarse sand, fine gravel
	− 8.0	−17.3	Blue clay, little fine sand
505 F9	+15.9	+12.9	Firm sand, clay, gravel, silt, shells
	+12.9	+ 5.9	Medium clay, sand, silt and fine gravel fill
	+ 5.9	− 2.5	Soft clay, sand, mud, and silt fill
	− 2.5	− 6.1	Silt
	− 6.1	−11.5	Fine sand
	−11.5	−15.8	Medium clay, sand
	−15.8	−79.1	Soft blue clay
506 F10	+15.7	+12.1	Hard slag fill
	+12.1	+ 3.4	Sand and clay fill
	+ 3.4	− 0.1	Fill; silt, sand, gravel
	− 0.1	− 3.5	Silt, fine sand
	− 3.5	− 9.3	Yellow clay, fine sand
	− 9.3	−20.3	Blue clay, fine sand
	−20.3	−44.7	Blue clay, little fine sand
	−44.7	−46.5	Coarse gravel, stones, little clay
507 E10	+16.4	+14.4	Cinder and clay fill
	+14.4	+10.8	Fill; clay, sand, little gravel
	+10.8	+ 1.0	Clay and gravel fill
	+ 1.0	− 4.0	Silt, sand
	− 4.0	− 6.8	Firm coarse sand
	− 6.8	−11.6	Medium blue clay, little fine sand
508 E10	+16.0	+15.0	Cinders
	+15.0	+ 0.3	Fill; firm sand, gravel, clay, little silt
	+ 0.3	− 4.8	Silt
	− 4.8	− 8.5	Sharp sand
	− 8.5	− 9.0	Firm sand, gravel
	− 9.0	−12.0	Blue clay, very little sand
509 E10	+17.2	+ 1.0	Hard clay, sand and gravel fill
	+ 1.0	− 4.6	Silt, mud
	− 4.6	−12.3	Fine sand, little clay
	−12.3	−15.8	Blue clay
510 E9	+16.4	+ 4.0	Fill; cinders, sand, clay, gravel
	+ 4.0	+ 0.1	Fill; clay, silt, sand, gravel
	+ 0.1	− 7.8	Silt
	− 7.8	−13.3	Sharp sand
	−13.3	−16.6	Blue clay
511 F9	+16.8	+15.4	Sand, gravel
	+15.4	+13.6	Cinders
	+13.6	+ 3.3	Clay and sand fill
	+ 3.3	− 4.6	Silt, fine sand
	− 4.6	− 5.4	Coarse sand, gravel
	− 5.4	−12.7	Yellow clay, fine sand
	−12.7	−17.2	Blue clay, little fine sand
512 F9	+18.0	+17.7	Cinders
	+17.7	+ 3.2	Fill; sand, gravel, clay, silt
	+ 3.2	− 2.4	Silt
	− 2.4	− 6.7	Sharp sand
	− 6.7	−11.0	Yellow clay
	−11.0	−15.0	Blue clay
513 F9	+17.7	+16.1	Sand, gravel
	+16.1	+ 5.7	Clay and sand fill
	+ 5.7	+ 0.2	Silty sand fill
	+ 0.2	− 4.0	Silt, fine sand
	− 4.0	−11.3	Yellow clay, fine sand
	−11.3	−16.3	Blue clay
514 F10	+15.8	+15.0	Cinders
	+15.0	+13.8	Slag
	+13.8	+ 0.4	Firm sand, clay, gravel, and silt fill
	+ 0.4	− 4.2	Fine sand, silt
	− 4.2	− 5.7	Silty peat
	− 5.7	− 8.2	Dirty sharp sand
	− 8.2	−12.4	Blue clay, sand
	−12.4	−16.2	Blue clay

No. and location	Elevations or depths From	To	Formation
515 F10	+16.6	+15.6	Slag
	+15.6	+10.1	Coarse sand fill
	+10.1	+ 4.6	Fill; clay, sand, gravel
	+ 4.6	+ 1.1	Silty sand, gravel
	+ 1.1	− 3.8	Silt, fine sand, shells
	− 3.8	− 4.9	Coarse sand, fine gravel
	− 4.9	−11.4	Yellow clay, fine sand
	−11.4	−17.4	Blue clay, little fine sand
516 F10	+16.0	+14.6	Cinders
	+14.6	+11.0	Firm sand, clay, and gravel fill
	+11.0	− 1.7	Loose sity sand, clay, and mud fill
	− 1.7	− 4.0	Silt
	− 4.0	− 6.2	Sand, little clay, gravel
	− 6.2	−12.4	Yellow clay, sand
	−12.4	−55.0	Blue clay
	−55.0	−59.0	Fine sand, gravel, little clay
	−59.0	−Refusal	−Boulder.
517 F10	+16.0	+14.0	Slag fill
	+14.0	− 7.8	Silty sand fill
	− 7.8	−12.5	Yellow clay, fine sand
	−12.5	−54.5	Blue clay, little fine sand
	−54.5	−57.5	Hard sand, gravel, and clay
	−57.5	Refusal	
518 F10	+16.0	+14.5	Slag fill
	+14.5	+ 7.7	Sand and clay fill
	+ 7.7	− 1.4	Silty sand fill
	− 1.4	− 5.0	Silt, sand
	− 5.0	− 6.5	Coarse sand
	− 6.5	− 7.5	Clay, fine sand
	− 7.5	−13.0	Blue clay, little fine sand
	−13.0	−47.7	Soft blue clay
	−47.7	−49.0	Clay, sand, gravel, boulders
	−49.0	Refusal	
519 F10	+15.4	+13.9	Slag fill
	+13.9	+ 6.6	Clay, fine sand
	+ 6.6	− 3.6	Fill; soft clay, fine sand
	− 3.6	− 4.8	Silt, sand
	− 4.8	− 8.1	Coarse sand
	− 8.1	−49.9	Blue clay, fine sand
	−49.9	−52.0	Sand, gravel, clay, boulders
	Refusal		
520 F10	+15.6	+15.3	Cinders
	+15.3	+13.8	Slag
	+13.8	+ 0.0	Loose sand, gravel and clay fill
	+ 0.0	− 4.8	Silt
	− 4.8	− 6.4	Sharp sand, little gravel
	− 6.4	− 9.2	Yellow clay
	− 9.2	−59.7	Blue clay
	Refusal	−Boulder	
521 F10	+14.9	+13.4	Cinders, slag
	+13.4	+ 3.9	Medium hard clay fill
	+ 3.9	− 2.4	Soft clay and silt fill
	− 2.4	− 4.6	Silty sand
	− 4.6	− 6.6	Sharp sand
	− 6.6	−13.1	Yellow clay, fine sand
	−13.1	−52.1	Blue clay
	Refusal	−Ledge	or Boulder
522 F10	+15.9	+13.9	Slag
	+13.9	+ 6.5	Fill; clay, sand, gravel
	+ 6.5	+ 0.4	Fill; silty sand, gravel
	+ 0.4	− 4.7	Silt, sand, shells
	− 4.7	− 9.1	Coarse sand
	− 9.1	−20.1	Blue clay, fine sand
523 F9	+16.4	+15.4	Cinders
	+15.4	− 0.6	Clay and sand fill
	− 0.6	− 5.3	Silt
	− 5.3	−17.0	Yellow clay
	−17.0	−19.6	Blue clay
524 F9	+15.9	+14.3	Cinder fill
	+14.3	+ 8.4	Clay and sand fill
	+ 8.4	− 0.6	Silt and sand fill
	− 0.6	− 4.3	Silt, fine sand
	− 4.3	−12.1	Yellow clay, fine sand
	−12.1	−17.6	Blue clay, little fine sand
525 F9	+17.0	+15.7	Sand, cinders
	+15.7	+ 4.5	Clay and sand fill
	+ 4.5	− 4.2	Silty sand fill
	− 4.2	− 5.0	Blue clay, fine sand
	− 5.0	−11.5	Yellow clay, fine sand
	−11.5	−16.5	Blue clay, little fine sand
526 E9	+17.3	+16.7	Concrete
	+16.7	+14.7	Cinders
	+14.7	+13.3	Hard sand, gravel, and clay fill
	+13.3	+ 1.0	Firm clay, silt, sand and gravel
	+ 1.0	− 2.7	Silt
	− 2.7	− 6.9	Sharp sand, little fine gravel
	− 6.9	− 8.3	Clay, sand, gravel
	− 8.3	−60.1	Blue clay
	−60.1	−62.7	Sand, gravel, clay
	Refusal	−ledge	or boulder
527 E7	+15.3	+ 7.9	Clay, sand, gravel
	+ 7.9	− 0.2	Soft silt
	− 0.2	− 3.7	Firm silty sand
	− 3.7	− 9.7	Hard yellow clay, fine sand
528 E7	+14.6	+ 7.1	Clay, sand, gravel
	+ 7.1	− 1.2	Soft silt
	− 1.2	− 4.8	Fine silty sand
	− 4.8	− 7.4	Hard sand, little clay
	− 7.4	−10.4	Blue clay, fine sand

No. and location	Elevations or depths From	To	Formation
529 E7	+16.0	+10.0	Fill; clay, sand, gravel
	+10.0	− 3.4	Fill; loose sand, little clay
	− 3.4	− 5.8	Firm fine sand, clay
	− 5.8	− 9.0	Hard fine sand, clay
530 E7	+17.0	+16.0	Slag fill
	+16.0	+14.5	Hard clay and sand fill
	+14.5	+ 1.0	Soft clay and sand fill
	+ 1.0	− 4.5	Silt, sand
	− 4.5	− 6.0	Firm coarse silty sand
	− 6.0	− 8.0	Hard yellow clay, fine sand
531 E8	+16.4	+13.6	Slag fill
	+13.6	+11.4	Fill; clay, sand, gravel
	+11.4	− 7.6	Silty sand
	− 7.6	− 8.6	Coarse silty sand
532 E8	+16.5	+14.0	Cinder and slag fill
	+14.0	+10.8	Fine sand, clay
	+10.8	− 4.5	Soft clay, silt
	− 4.5	− 5.9	Silty peat
	− 5.9	− 8.5	Clay, sand
533 E8	+16.5	+13.5	Hard cinder and slag fill
	+13.5	+12.5	Fine sand
	+12.5	+ 3.8	Soft mud and clay
	+ 3.8	− 5.8	Firm fine sand
	− 5.8	− 8.5	Fine sand, little gravel
534 E8	+16.7	+11.7	Fill; sand, gravel, cinders
	+11.7	+ 5.2	Soft clay and silt
	+ 5.2	− 0.7	Firm fine sand fill
	− 0.7	− 4.3	Silty peat
	− 4.3	− 8.3	Hard fine sand, little clay
535 E8	+16.4	+16.2	Asphalt
	+16.2	+12.4	Sand, gravel
	+12.4	− 2.9	Clay, fine sand
	− 2.9	− 5.1	Firm fine sand
	− 5.1	− 8.6	Hard yellow clay, fine sand
536 E6	+14.7	+ 7.3	Fill; clay, sand, gravel
	+ 7.3	+ 1.2	Soft silt, fine sand
	+ 1.2	− 6.3	Coarse sand
	− 6.3	−10.3	Fine sand, little clay
537 E7	+14.7	+ 8.7	Fill; clay, sand, gravel
	+ 8.7	− 0.3	Soft silt and clay fill
	− 0.3	− 5.6	Firm coarse sand
	− 5.6	−10.3	Fine sand, clay
538 E7	+15.0	+ 7.5	Fill; clay, sand, gravel
	+ 7.5	+ 3.4	Silty sand fill
	+ 3.4	− 1.8	Silty peat
	− 1.8	− 6.5	Fine sand, clay
	− 6.5	−10.0	Fine sandy clay
539 E7	+16.5	+10.8	Fill; clay, sand, gravel
	+10.8	+ 0.9	Soft silt
	+ 0.9	− 3.0	Silt, fine sand
	− 3.0	− 4.5	Fine silty sand
	− 4.5	− 8.5	Hard sharp fine sand
540 E7	+16.6	+13.4	Cinder fill
	+13.4	+11.1	Fill; blue clay, sand
	+11.1	+ 6.1	Soft clay fill
	+ 6.1	+ 0.0	Fine silty sand
	+ 0.0	− 3.9	Silt, little fine sand
	− 3.9	− 8.4	Firm fine sand, clay
541 E8	+16.8	+15.3	Sand, gravel
	+15.3	+14.8	Slag fill
	+14.8	+12.8	Fill; clay, sand, gravel
	+12.8	+ 5.8	Soft clay and silt fill
	+ 5.8	− 2.7	Loose silty sand
	− 2.7	− 5.6	Silty sand, shells
	− 5.6	− 7.2	Silt, fine sand
	− 7.2	− 8.2	Coarse silty sand
542 F8	+17.3	+17.1	Cinders
	+17.1	+15.7	Sand, gravel
	+15.7	+13.5	Slag fill
	+13.5	− 4.5	Silt, fine sand
	− 4.5	− 7.7	Clay, sand, little gravel
543 F8	+17.8	+17.5	Asphalt
	+17.5	+12.3	Hard sand, gravel
	+12.3	+ 4.4	Soft clay fill
	+ 4.4	+ 0.0	Fine silty sand
	+ 0.0	− 5.0	Soft silt, shells
	− 5.0	− 7.2	Firm fine sand
544 G6	+14.1	+ 7.1	Fill; sand, gravel, clay
	+ 7.1	+ 3.6	Soft silt
	+ 3.6	− 8.9	Hard yellow clay
	− 8.9	−16.9	Hard sand, gravel and clay
545 F6	+13.3	+ 6.3	Sand and gravel fill
	+ 6.3	+ 0.3	Soft silt
	+ 0.3	−10.2	Firm coarse sand
	−10.2	−16.7	Hard compact fine sand, little clay
546 F6	+13.6	+ 6.6	Fill; sand, gravel, clay
	+ 6.6	− 1.4	Soft silt
	− 1.4	− 7.1	Fine sand
	− 7.1	−17.4	Fine firm sand, clay

No. and location	Elevations or depths From	To	Formation
547 G8	+15.6	+13.1	Cinder fill
	+13.1	+ 4.1	Clay fill
	+ 4.1	− 2.4	Silty sand fill
	− 2.4	− 7.4	Silt, sand, shells
	− 7.4	−10.9	Fine sand
	−10.9	−15.4	Firm fine sand, clay
548 F8	+15.3	+12.8	Cinder fill
	+12.8	+ 3.3	Clay fill
	+ 3.3	− 2.7	Silt, fine sand
	− 2.7	− 5.2	Peat
	− 5.2	−11.7	Firm coarse sand
	−11.7	−15.7	Firm fine sand, clay
549 F7	+15.3	+12.8	Cinder fill
	+12.8	− 1.7	Clay fill
	− 1.7	− 7.2	Silt, fine sand
	− 7.2	−10.7	Firm fine sand
	−10.7	−15.7	Firm fine sand, clay
550 F7	+15.9	+13.9	Cinder fill
	+13.9	− 2.1	Clay and sand fill
	− 2.1	− 7.1	Silt, fine sand
	− 7.1	−10.6	Firm coarse silty sand
	−10.6	−15.1	Fine sand, clay
551 F6	+13.3	+ 5.8	Fill; sand, gravel, clay
	+ 5.8	− 2.2	Soft silt
	− 2.2	−7.7	Firm coarse silty sand, gravel
	− 7.7	−18.7	Firm fine sand and clay
552 F6	+13.8	+ 5.8	Fill; sand, gravel, clay
	+ 5.8	+ 0.3	Soft silt
	+ 0.3	− 9.2	Hard coarse sand
	− 9.2	−17.2	Firm fine sand and clay
553 F7	+14.1	+ 6.1	Fill; sand, gravel, clay
	+ 6.1	+ 1.1	Silt, sand
	+ 1.1	− 3.4	Peat
	− 3.4	−17.9	Firm fine sand
554 F7	+13.6	+ 4.1	Fill; sand, gravel, clay
	+ 4.1	− 3.9	Soft silt
	− 3.9	− 9.4	Firm coarse sand
	− 9.4	−17.4	Firm fine sand, little clay
555 F7	+15.7	+13.7	Cinder, fill
	+13.7	− 0.8	Clay fill
	− 0.8	− 5.3	Silt and sand fill
	− 5.3	− 9.8	Silt, fine sand
	− 9.8	−15.3	Firm fine sand, clay
556 E7	+16.5	+ 9.5	Hard fill
	+ 9.5	0	Clay fill
	0	− 6.0	Soft silt
	− 6.0	−15.5	Firm fine sand, clay
557 E6	+15.2	+13.2	Sand and gravel fill
	+13.2	+ 4.2	Fill; sand, gravel, clay
	+ 4.2	+ 2.2	Silty sand
	+ 2.2	− 3.3	Hard yellow clay
	− 3.3	− 7.8	Hard sand, gravel, clay, boulders
	− 7.8	−15.3	Hard sand, gravel, clay
558 E7	+15.2	+ 5.2	Sand and gravel fill
	+ 5.2	− 5.3	Fine silty sand
	− 5.3	−11.8	Fine coarse sand
	−11.8	−15.8	Hard blue clay
559 D7	+18.5	+ 7.0	Misc. fill
	+ 7.0	− 2.5	Soft silt
	− 2.5	−11.0	Firm coarse sand, little gravel
	−11.0	−13.0	Firm coarse sand
	−13.0	−16.5	Soft blue clay
560 D7	+14.5	+ 7.0	Sand and gravel fill
	+ 7.0	− 0.5	Soft silt
	− 0.5	− 9.0	Firm coarse sand
	− 9.0	−16.5	Soft blue clay
561 D8	+15.3	+ 8.3	Fill; sand, gravel, clay
	+ 8.3	− 6.2	Silt, fine sand
	− 6.2	−11.2	Firm coarse sand
	−11.2	−15.7	Soft blue clay
562 D7	+19.2	+ 7.7	Rubbish fill
	+ 7.7	+ 3.2	Soft silt
	+ 3.2	−11.8	Hard coarse sand
	−11.8	−15.8	Hard yellow clay
563 D8	+15.5	+ 8.5	Fill; sand, gravel, clay
	+ 8.5	+ 1.0	Silty sand fill
	+ 1.0	− 2.5	Silt, fine sand
	− 2.5	−15.5	Hard yellow clay
564 D8	+17.9	+15.9	Cinder fill
	+15.9	+ 8.4	Clay fill
	+ 8.4	− 0.1	Silty sand fill
	− 0.1	− 5.1	Silt, fine sand
	− 5.1	−15.1	Hard yellow clay
565 D7	+16.3	+13.8	Cinder fill
	+13.8	+ 5.3	Rubbish fill
	+ 5.3	+ 0.8	Firm sand and gravel
	+ 0.8	− 5.7	Hard sand, gravel, clay
	− 5.7	−15.7	Hard yellow clay
566 D7	+15.6	+11.1	Loamy sand fill
	+11.1	+ 4.6	Misc. fill
	+ 4.6	− 4.4	Hard coarse sand, coarse gravel
	− 4.4	−15.4	Hard yellow clay
567 D8	+18.0	+ 5.5	Fill; clay, sand, gravel
	+ 5.5	+ 1.0	Silt, fine sand
	+ 1.0	− 9.5	Hard yellow clay
	− 9.5	−15.0	Soft blue clay

No. and location	Elevations or depths From	To	Formation
568 D8	+18.9	+ 8.9	Fill; sand, gravel, clay
	+ 8.9	+ 1.9	Silty sand fill
	+ 1.9	− 2.1	Soft silt
	− 2.1	− 4.6	Hard sand
	− 4.6	−15.1	Hard yellow clay
569 D9	+16.7	+ 2.7	Fill; cinders, sand, gravel
	+ 2.7	− 0.8	Silty sand
	− 0.8	−16.3	Hard yellow clay
570 G9	+17.1	− 9.4	Fill; clay, sand, gravel
	− 9.4	−11.9	Silt
	−11.9	−15.9	Silt, sand
571 H9	+14.9	+ 8.4	Fill; sand, gravel, clay
	+ 8.4	− 9.6	Clay fill
	− 9.6	−13.6	Soft silt
	−13.6	−18.1	Soft blue clay
572 H10	+16.3	+ 5.3	Fill; sand, gravel, clay
	+ 5.3	− 7.7	Clay fill
	− 7.7	−12.7	Soft silt
	−12.7	−16.7	Hard blue clay
573 H10	+17.4	− 7.1	Clay fill
	− 7.1	−12.6	Soft silt, fine sand
	−12.6	−15.6	Medium blue clay
574 H10	+16.5	+ 3.0	Clay fill
	+ 3.0	− 6.0	Silty sand fill
	− 6.0	−10.0	Soft silt
	−10.0	−13.5	Firm fine sand
	−13.5	−15.5	Medium blue clay
575 G11	+15.4	+ 6.4	Fill; clay, sand, gravel
	+ 6.4	+ 0.4	Fill; coarse silty sand, gravel
	+ 0.4	−12.1	Silt, little fine sand
	−12.1	−17.6	Fine silty sand
576 F11	+17.1	− 0.4	Fill; clay, sand, gravel
	− 0.4	− 7.9	Soft silt, little fine sand
	− 7.9	−11.4	Firm coarse sand
	−11.4	−15.9	Medium blue clay
577 E10	+16.0	+13.5	Cinder fill
	+13.5	− 5.0	Clay fill
	− 5.0	−10.0	Silt, fine sand
	−10.0	−15.0	Hard yellow clay
578 E11	+16.0	+13.5	Cinder fill
	+13.5	−10.0	Clay fill
	−10.0	−12.5	Silty sand
	−12.5	−15.0	Medium clay, little fine sand
579 E7	+16.5	+ 9.0	Hard sand and gravel fill
	+ 9.0	+ 3.5	Clay fill
	+ 3.5	− 2.0	Loose coarse silty sand fill
	− 2.0	− 6.0	Soft silt
	− 6.0	−10.5	Firm coarse sand
	−10.5	−18.5	Hard blue clay
	−18.5	−40.5	Soft blue clay
580 E7	+14.7	+ 7.2	Hard sand, gravel, clay and misc. fill
	+ 7.2	− 0.3	Coarse silty sand, fine gravel
	− 0.3	− 7.3	Black silt
	− 7.3	−12.8	Hard coarse sand, fine gravel
	−12.8	−19.8	Hard blue clay
	−19.8	−40.3	Soft blue clay
581 F11	+15.9	+ 5.4	Misc. fill
	+ 5.4	− 1.6	Silty sand fill
	+ 1.6	− 5.1	Silt
	− 5.1	−11.6	Firm coarse sand
	−11.6	−19.1	Medium blue clay
	−19.1	−40.1	Soft blue clay
582 D11	+16.1	+13.6	Cinder and gravel fill
	+13.6	− 7.4	Clay fill
	− 7.4	−16.9	Silt, sand
	−16.9	−23.9	Medium blue clay
	−23.9	−40.9	Soft blue clay
583 F12	+15.7	+13.2	Cinder fill
	+13.2	+ 4.7	Clay fill
	+ 4.7	− 0.8	Silty sand fill
	− 0.8	− 5.8	Silt, little fine sand
	− 5.8	−12.3	Firm coarse sand
	−12.3	−18.8	Medium blue clay
	−18.8	−41.3	Soft blue clay
584 E12	+16.3	+14.3	Fill; sand, gravel, clay
	+14.3	+ 4.8	Clay fill
	+ 4.8	+ 0.3	Silty sand fill
	+ 0.3	− 9.2	Soft silt
	− 9.2	−11.2	Firm coarse sand
	−11.2	−16.7	Medium blue clay
	−16.7	−41.7	Soft blue clay
585 E12	+14.6	+ 4.1	Clay fill
	+ 4.1	− 3.4	Silty sand fill
	− 3.4	−12.4	Silt, fine sand
	−12.4	−15.9	Firm fill; coarse sand, coarse gravel
	−15.9	−19.9	Firm fine silty sand
	−19.9	−41.4	Soft blue clay
586 E12	+16.2	+ 6.2	Clay and sand fill
	+ 6.2	− 3.3	Silty sand fill
	− 3.3	−13.8	Silt, fine sand
	−13.8	−32.3	Silty sand
	−32.3	−41.8	Soft blue clay
587 E12	+14.1	+12.1	Riprap fill
	+12.1	− 7.4	Clay fill
	− 7.4	−18.4	Silt, fine sand
	−18.4	−23.4	Coarse silty sand
	−23.4	−44.9	Soft blue clay
588 G5	+15.7	+ 6.7	Sand and clay fill
	+ 6.7	+ 1.7	Mud, peat
	+ 1.7	− 8.3	Coarse sand
	− 8.3	−25.3	Sand, clay
589 H5	+15.9	+ 3.9	Sand and gravel fill
	+ 3.9	+ 0.3	Mud
	+ 0.3	−10.1	Sand, clay
	−10.1	−24.1	Soft clay, fine sand

No. and location	Elevations or depths From	To	Formation
590 E6	+16.6	+ 0.3	Fill; brick, cinders, boulder
	+ 0.3	− 1.8	Blue clay, little gravel
	− 1.8	− 6.9	Yellow clay, sand
	− 6.9	−42.6	Blue clay, little sand
591 E6	+ 7.9	+ 0.9	Soft mud
	+ 0.9	− 0.6	Coarse sand
	− 0.6	− 2.5	Soft blue clay
	− 2.5	−10.7	Soft blue clay, sand
	−10.7	−20.4	Soft blue clay
	−20.4	−25.5	Hard sand, gravel, clay
592 E6	+ 8.2	+ 1.7	Soft mud
	+ 1.7	− 8.6	Coarse sand, gravel
	− 8.6	−25.8	Stiff blue clay, stones
593 E6	+ 8.3	+ 1.3	Soft mud
	+ 1.3	− 6.9	Sharp sand, gravel
	− 6.9	−13.1	Blue clay, fine sand
	−13.1	−24.0	Stiff blue clay
594 E6	+ 8.6	+ 1.9	Soft mud
	+ 1.9	− 5.6	Sharp sand, gravel
	− 5.6	−14.1	Blue clay, fine sand
	−14.1	−23.8	Stiff blue clay
595 F6	+ 8.6	+ 1.6	Soft mud and sand
	+ 1.6	− 3.7	Coarse sand, fine gravel
	− 3.7	−21.4	Fine sand, little clay
596 F6	+ 8.4	+ 1.1	Soft mud and sand
	+ 1.1	− 5.0	Coarse sand, fine gravel
	− 5.0	−22.8	Sand, clay
597 F6	+ 8.2	+ 1.0	Soft mud and sand
	+ 1.0	− 2.8	Sharp sand, fine gravel
	− 2.8	− 4.1	Yelow clay
	− 4.1	−21.8	Fine sand, clay
598 F6	+13.8	+ 3.8	Cinder fill
	+ 3.8	+ 1.1	Soft mud
	+ 1.1	+ 0.8	Soft blue clay
	+ 0.8	− 5.6	Blue clay, sharp sand, little gravel
	− 5.6	−14.7	Fine sand, clay
	−14.7	−41.5	Soft blue clay
599 G6	+16.9	+ 3.7	Cinders and mud fill
	+ 3.7	+ 2.4	Coarse sand
	+ 2.4	+ 1.5	Fine sand, clay
	+ 1.5	− 0.9	Yellow clay, fine sand
	− 0.9	−13.1	Blue clay, sand
600 E6	+ 8.8	+ 3.8	Soft mud
	+ 3.8	− 1.9	Dirty sharp sand
	− 1.9	−10.7	hard fine sand
601 E6	+16.1	+13.1	Hard cinders, sand, and gravel fill
	+13.1	+ 7.6	Medium hard clay, cinders, ashes and wood fill
	+ 7.6	+ 3.4	Loose cinders and ash fill
	+ 3.4	− 0.4	Silt
	− 0.4	− 1.3	Dirty fine sand, little clay
	− 1.3	−11.1	Blue clay, very little sand
602 E6	+16.0	+13.0	Hard cinders, ashes, sand and gravel fill
	+13.0	+ 5.5	Med. hard cinders, ashes and brick fill
	+ 5.5	+ 3.0	Fill mixed with mud
	+ 3.0	− 1.5	Blue clay, sand, very little gravel
	− 1.5	− 5.7	Fine sand, very little clay
	− 5.7	− 9.0	Fine sand
603 E6	+15.7	+ 9.1	Firm cinders, ashes, tin and brick fill
	+ 9.1	+ 5.0	Loose cinders, sand, ashes and tin fill
	+ 5.0	+ 1.7	Firm ashes, cinders, sand and gravel fill
	+ 1.7	− 0.5	Firm sand, very little clay
	− 0.5	− 2.2	Sharp sand, very little clay
	− 2.2	− 9.3	Fine sand, very little clay
604 E6	+14.5	+10.5	Firm cinders, loam, ashes and gravel fill
	+10.5	+ 2.4	Medium firm ashes, cinders, tin, sand and gravel fill
	+ 2.4	− 4.5	Mud and clay mix
	− 4.5	− 7.0	Fine sand, little clay
	− 7.0	−10.5	Med. stiff blue clay
605 D7	+15.8	+14.8	Concrete blocks fill
	+14.8	+ 3.5	Fill; firm sharp sand, fine gravel, bricks
	+ 3.5	+ 1.4	Silt
	+ 1.4	− 7.2	Sharp sand, little gravel
	− 7.2	− 9.2	Fine sand, little clay
606 E7	+ 9.4	− 0.6	Mud
	− 0.6	− 1.0	Silt
	− 1.0	(no figure)	Sand, clay
607 E7	+ 8.4	+ 2.4	Mud
	+ 2.4	− 0.6	Silt
	− 0.6	(no figure)	Clay

No. and location	Elevations or depths From	To	Formation
608 E7	+14.3	+13.0	Fill; hard sand, gravel
	+13.0	+ 7.2	Medium hard sand, gravel, little cinders
	+ 7.2	+ 0.3	Black mud fill
	+ 0.3	− 3.3	Peaty silt
	− 3.3	− 7.9	Fine sand
	− 7.9	−10.7	Fine sand, trace of clay
609 E6	+15.4	+ 5.9	Misc. rubbish fill
	+ 5.9	+ 2.9	Fill and mud
	+ 2.9	+ 0.7	Fairly firm coarse sand, gravel
	+ 0.7	−18.6	Loose fine sand, very little clay
	−18.6	−39.6	Soft blue clay, very little fine sand
	−39.6	−124.1	Soft blue clay
	−124.1	−127.7	Hard clay, sand, gravel
	Refusal—Boulder		
610 E6	+16.2	+ 5.7	Misc. rubbish fill
	+ 5.7	+ 1.7	Soft peat
	+ 1.7	+ 0.7	Loose sharp silty sand
	+ 0.7	− 4.1	Loose fine sand, very little clay
	− 4.1	−10.3	Fairly firm fine sand
	−10.3	−23.3	Loose fine sand, clay
	−23.3	−115.1	Soft blue clay
	−115.1	−124.3	Hard clay, sand, gravel
611 E6	+16.1	+ 8.3	Cinder and rubbish fill
	+ 8.3	+ 3.8	Silty peat
	+ 3.8	− 1.9	Loose fine sand, little clay
	− 1.9	−14.4	Fairly firm fine sand, very little clay
	−14.4	−104.9	Soft blue clay
	−104.9	−109.5	Hard sand, gravel, very little clay
	Refusal		
612 E6	+16.7	+ 6.2	Cinder and rubbish fill
	+ 6.2	+ 3.9	Soft silty peat
	+ 3.9	− 1.3	Loose fine sand, very little clay
	− 1.3	− 7.7	Firm sand, very little clay
	− 7.7	−10.3	Loose fine sand, clay
	−10.3	−23.3	Soft blue clay, fine sand
	−23.3	−107.2	Soft blue clay
	Refusal—Boulder		
613 E6	+16.0	+ 9.0	Cinder and rubbish fill
	+ 9.0	+ 2.8	Soft peat
	+ 2.8	− 1.3	Fairly firm sharp sand
	− 1.3	−13.5	Loose fine sand, very little clay
	−13.5	−98.8	Soft blue clay
	−98.8	−105.0	Hard sand, gravel, clay
	−105.0	−107.5	Hard sand, gravel, little clay
	Refusal		
614 E6	+16.3	+ 9.6	Firm misc. rubbish fill
	+ 9.6	+ 2.5	Soft peat
	+ 2.5	− 6.2	Fairly firm fine sand, clay
	− 6.2	−26.2	Loose fine sand, very little clay
	−26.2	−103.2	Soft blue clay
	−103.2	−105.4	Firm sand, gravel, little clay
	−105.4	−114.4	Hard coarse sand, gravel, little loose clay
	Refusal		
615 E6	+16.4	+ 6.6	Misc. rubbish fill
	+ 6.6	+ 3.1	Soft peat
	+ 3.1	− 5.0	Loose fine sand
	− 5.0	−20.1	Loose fine sand, little clay
	−20.1	−88.1	Soft blue clay
	−88.1	−92.1	Hard sand, gravel, clay
	−92.1	−95.4	Hard clay, sand, coarse gravel
616 E6	+16.1	+ 7.8	Misc. rubbish fill
	+ 7.8	+ 2.6	Soft peat
	+ 2.6	+ 0.8	Loose sharp silty sand
	+ 0.8	− 6.7	Loose fine sand
	− 6.7	−15.9	Soft blue clay, fine sand
	−15.9	−88.4	Soft blue clay
	−88.4	−91.9	Hard clay, sand, gravel
	−91.9	−94.9	Soft clay, sand, gravel
	Boulder		
617 E6	+16.2	+ 6.4	Misc. rubbish fill
	+ 6.4	+ 2.9	Soft peat
	+ 2.9	− 7.3	Loose fine sand, very little clay
	− 7.3	−19.8	Loose fine sand, clay
	−19.8	−64.9	Soft blue clay
	−64.9	−96.8	Hard clay, sand, gravel
618 E6	+16.1	+ 7.3	Rubbish fill
	+ 7.3	+ 0.8	Soft peat
	+ 0.8	− 9.6	Loose fine sand
	− 9.6	−23.9	Soft blue clay, sand
	−23.9	−73.9	Soft blue clay
	−73.9	−76.4	Firm clay, sand, gravel
	−76.4	−82.4	Hard clay, sand, gravel
	Refusal—Boulder		

No. and location	Elevations or depths From	To	Formation
619 E6	+16.1	+ 6.0	Misc. rubbish fill
	+ 6.0	+ 2.3	Soft peat
	+ 2.3	− 7.4	Loose fine sand
	− 7.4	−22.7	Soft blue clay, very fine sand
	−22.7	−44.1	Soft blue clay
	−44.1	−50.9	Hard clay, sand, gravel
		Refusal	
620 E6	+16.1	+12.1	Medium firm misc. fill
	+12.1	+ 7.8	Loose cinder fill
	+ 7.8	+ 1.5	Loose silty peat
	+ 1.5	+ 0.9	Coarse sand, gravel
	+ 0.9	− 1.7	Fine sand
	− 1.7	−10.9	Sand, clay
	−10.9	−26.5	Blue clay, very little sand
621 E6	+12.5	+ 4.9	Medium firm misc. fill
	+ 4.9	+ 2.2	Silty peat
	+ 2.2	+ 1.5	Sand, gravel
	+ 1.5	− 0.2	Fine sand, little clay
	− 0.2	−17.6	Blue clay, very little sand
	−17.6	−19.9	Yellow clay, sand, gravel
	−19.9	−24.1	Hard clay, sand, gravel
622 E6	+12.1	+ 6.5	Firm misc. rubbish fill
	+ 6.5	+ 3.8	Peat
	+ 3.8	− 3.1	Fine sand, very little clay
	− 3.1	− 8.6	Medium stiff blue clay, very little sand
	− 8.6	−14.3	Yellow clay, sand, gravel
		Refusal	
623 E6	+12.9	+ 7.5	Medium firm misc. fill
	+ 7.5	+ 4.6	Peat
	+ 4.6	− 2.2	Fine sand, little clay
	− 2.2	− 9.4	Blue clay, very little sand
	− 9.4	−18.9	Yellow clay, sand, gravel
	−18.9	−21.5	Clay, sand, gravel
	−21.5	−26.4	Hard clay, sand, gravel
624 E6	+15.4	+ 4.6	Misc. firm junk fill
	+ 4.6	+ 2.4	Silt
	+ 2.4	− 2.8	Yellow sand, clay
	− 2.8	−19.3	Yellow clay, sand
		Refusal	
625 H11	+12.2	− 7.4	Soft clay fill
	− 7.4	−12.8	Soft black silt
	−12.8	−17.8	Hard yellow clay
626 H11	+16.6	− 9.4	Soft clay fill
	− 9.4	−13.4	Soft clay and silt
	−13.4	−18.4	Hard yellow clay
627 H11	+11.4	− 9.6	Soft clay fill
	− 9.6	−12.6	Clay, silt, little fine sand
	−12.6	−15.1	Blue clay, little fine sand
	−15.1	−18.6	Yellow clay
628 H11	+15.6	− 5.9	Soft clay fill
	− 5.9	− 7.4	Med. dirty sand
	− 7.4	−12.4	Med. sand, little clay
	−12.4	−16.4	Hard yellow clay
629 H11	+17.2	−18.8	Soft clay fill
	−18.8	−22.8	Med. yellow clay
630 H11	+ 9.2	− 4.3	Fill; sand, gravel, clay, boulder
	− 4.3	− 7.8	Soft silty fill
	− 7.8	−10.8	Med. dirty sand
	−10.8	−13.3	Medium sand
	−13.3	−18.8	Blue clay.
631 H11	+16.2	+ 0.2	Hard clay, sand and gravel fill
	+ 0.2	− 5.8	Silt, fine sand
	− 5.8	− 9.8	Coarse sand
	− 9.8	−13.8	Blue clay
632 H11	+ 7.9	− 3.1	Fill; clay, sand, gravel
	− 3.1	− 9.6	Silt, little fine sand
	− 9.6	−15.1	Medium blue clay
633 H11	+15.5	+10.5	Hard clay fill
	+10.5	− 2.0	Soft clay fill
	− 2.0	−10.5	Fill; stiff clay, little gravel
	−10.5	−12.8	Black silt
	−12.8	−15.5	Medium blue clay
634 G11	+14.8	+ 9.8	Hard clay fill
	+ 9.8	− 0.2	Soft clay fill
	− 0.2	−10.2	Fill; stiff clay, little gravel
	−10.2	−11.7	Silty sand
	−11.7	−14.2	Soft blue clay
635 G11	+15.5	+ 8.5	Hard sand, gravel, clay and boulder fill
	+ 8.5	− 3.0	Loose dirty sand, gravel
	− 3.0	− 8.5	Silt, little fine sand
	− 8.5	−14.5	Medium yellow clay
636 G11	+15.7	+ 5.7	Hard clay, sand, gravel and bouder fill
	+ 5.7	− 4.3	Fill; dirty sand, gravel
	− 4.3	−12.3	Medium dirty sand
	−12.3	−17.3	Medium yellow clay
637 G11	+ 8.4	−14.6	Fill; clay, sand, gravel, boulder
	−14.6	−19.6	Yellow clay

No. and location	Elevations or depths, From	To	Formation
638 G11	+15.3	+14.3	Hard cinder fill
	+14.3	+ 9.8	Compact sand and clay fill
	+ 9.8	+ 1.3	Soft silt
	+ 1.3	− 6.2	Compact fine sand, little silt
	− 6.2	− 8.7	Coarse dirty sand, little fine gravel
	− 8.7	−13.7	Hard yellow clay
639 G11	+14.0	−13.0	Hard sand, gravel, clay and boulder fill
	−13.0	−15.5	Silt, little fine sand
	−15.5	−19.0	Coarse dirty sand
	−19.0	−21.0	Peaty silt
	−21.0	−27.0	Coarse sand, little gravel
	−27.0	−31.0	Medium yellow clay
640 G11	+15.8	+14.8	Hard cinder fill
	+14.8	+ 7.8	Clay fill
	+ 7.8	+ 0.6	Loose coarse sand fill
	+ 0.6	− 2.2	Soft silt
	− 2.2	− 5.7	Stiff silt
	− 5.7	− 9.1	Compact coarse sand, little clay
	− 9.1	−15.2	Hard yellow clay
641 G11	+15.5	+11.5	Stiff clay fill
	+11.5	− 0.5	Medium clay fill
	− 0.5	− 6.5	Firm silty sand
	− 6.5	−27.0	Soft black silt, little gravel
	−27.0	−31.5	Medium blue clay
642 G11	+15.9	+14.9	Hard cinder fill
	+14.9	+ 8.9	Fill; sand, gravel, clay
	+ 8.9	− 1.6	Soft silt
	− 1.6	− 7.4	Coarse sand, little silt
	− 7.4	− 9.6	Medium blue clay
	− 9.6	−14.1	Hard yellow clay
643 G11	+13.9	−11.1	Hard sand, gravel, clay, boulders and wood fill
	−11.1	−15.1	Stiff fine silty sand
	−15.1	−29.1	Yellow clay
644 G11	+16.2	+13.2	Hard cinder fill
	+13.2	− 6.3	Soft clay fill
	− 6.3	−14.4	Hard yellow clay
645 G11	+16.4	+13.9	Hard cinder fill
	+13.9	− 4.6	Soft clay fill
	− 4.6	− 6.2	Silty sand
	− 6.2	−11.2	Hard yellow clay
646 F11	+ 4.7	−28.3	Silt, little sand
	−28.3	−32.3	Dirty sand, gravel, silt
	−32.3	−33.3	Soft
647 F11	+16.7	+14.7	Hard cinder fill
	+14.7	+ 2.1	Silty sand
	+ 2.1	− 7.6	Soft black silt
	− 7.6	− 8.9	Medium blue clay
	− 8.9	−13.3	Hard yellow clay
648 F11	+15.2	+ 0.4	Fill; sand, gravel, clay
	+ 0.4	− 2.8	Stiff silt
	− 2.8	− 5.4	Firm coarse sand, clay
	− 5.4	−10.8	Hard yellow clay
649 F11	+17.0	+14.7	Hard cinder fill
	+14.7	+11.0	Hard sand and gravel fill
	+11.0	− 1.3	Loose silty sand
	− 1.3	− 4.0	Stiff silt
	− 4.0	− 5.5	Coarse silty sand, shells
	− 5.5	− 6.6	Medium blue clay
	− 6.6	−12.0	Hard yellow clay
650 F11	+16.1	+15.1	Hard cinder fill
	+15.1	+ 4.5	Sand and gravel fill
	+ 4.5	+ 0.1	Soft silt, fine sand
	+ 0.1	− 7.2	Soft silt
	− 7.2	− 9.5	Medium blue clay
	− 9.5	−13.9	Hard yellow clay
651 F11	+16.1	+ 6.1	Fill; sand, gravel, clay
	+ 6.1	− 1.2	Soft clay fill
	− 1.2	− 3.9	Stiff silt
	− 3.9	− 6.5	Firm dirty sand
	− 6.5	−11.9	Hard yellow clay
652 F11	+16.0	+15.4	Hard cinder fill
	+15.4	+11.0	Sand fill
	+11.0	− 1.0	Soft clay fill
	− 1.0	− 3.5	Stiff silt
	− 3.5	− 6.0	Compact coarse sand, little clay
	− 6.0	−11.0	Hard yellow clay
653 F11	+16.0	+15.4	Cinder fill
	+15.4	+11.4	Sand and clay fill
	+11.4	− 2.3	Soft clay fill
	− 2.3	− 4.6	Stiff silt
	− 4.6	− 8.5	Firm coarse sand
	− 8.5	−14.0	Medium blue clay
654 F11	+16.2	+15.9	Cinder fill
	+15.9	+10.2	Sand and clay fill
	+10.2	− 1.8	Soft clay fill
	− 1.8	− 5.3	Stiff silt
	− 5.3	− 9.3	Compact sand, clay
	− 9.3	−13.8	Firm coarse sand
	−13.8	−20.8	Medium blue clay
655 F11	+16.0	+15.4	Hard cinder fill
	+15.4	+ 9.7	Sand and clay fill
	+ 9.7	+ 3.5	Soft clay fill
	+ 3.5	− 0.8	Soft clay fill
	− 0.8	− 4.0	Stiff silty sand
	− 4.0	−13.0	Firm coarse sand
	−13.0	−19.0	Medium blue clay
656 E11	+15.8	+12.8	Hard cinder fill
	+12.8	− 5.2	Soft clay fill
	− 5.2	−11.2	Coarse sand
	−11.2	−15.2	Firm coarse sand
	−15.2	−19.2	Medium blue clay

No. and location	Elevations or depths From	To	Formation
657 E11	+15.3	+14.3	Hard cinder fill
	+14.3	+ 8.1	Stiff sand and clay fill
	+ 8.1	+ 5.0	Soft silt
	+ 5.0	− 1.2	Silty sand
	− 1.2	− 4.7	Silt
	− 4.7	−14.3	Hard coarse sand
	−14.3	−18.7	Hard yellow clay
658 E11	+14.8	+ 9.2	Sand and gravel fill
	+ 9.2	+ 2.8	Soft black silt
	+ 2.8	+ 1.5	Silty sand
	+ 1.5	− 4.7	Soft black silt
	− 4.7	−12.2	Firm coarse sand
	−12.2	−18.2	Medium blue clay
659 E11	+15.7	+14.2	Hard cinder fill
	+14.2	+ 9.7	Fill; sand, gravel, clay
	+ 9.7	+ 5.7	Soft black silt
	+ 5.7	− 0.6	Fill; sand, gravel, clay
	− 0.6	− 5.8	Stiff silt
	− 5.8	− 9.3	Compact sand, little small gravel
	− 9.3	−14.3	Medium blue clay
660 E11	+15.6	+14.4	Hard cinder fill
	+14.4	+ 9.6	Fill; sand, gravel, clay
	+ 9.6	+ 3.3	Soft silt
	+ 3.3	− 0.4	Silty sand
	− 0.4	− 4.4	Soft silt
	− 4.4	−11.7	Coarse sand, fine gravel
	−11.7	−18.4	Medium blue clay
661 E11	+15.3	+14.5	Hard cinder fill
	+14.5	+ 8.5	Fill; sand, yellow clay
	+ 8.5	+ 2.0	Soft silt
	+ 2.0	− 0.3	Loose fine sand, little silt
	− 0.3	− 2.7	Soft silt
	− 2.7	− 7.0	Coarse black sand, silt
	− 7.0	−20.7	Stiff silt
	−20.7	−25.7	Medium yellow clay
662 E11	+15.3	+14.7	Hard cinder fill
	+14.7	+ 9.3	Hard sand, gravel and clay fill
	+ 9.3	+ 4.3	Soft silt
	+ 4.3	− 1.0	Silty sand
	− 1.0	− 7.7	Silt, little sand and gravel
	− 7.7	−17.8	Stiff silt
	−17.8	−21.7	Medium yellow clay
663 E11	+15.8	+15.0	Hard cinder fill
	+15.0	+10.8	Fill; sand, gravel, clay
	+10.8	− 2.2	Soft clay fill
	− 2.2	− 5.7	Soft black silt
	− 5.7	−19.2	Soft clay fill
	−19.2	−23.6	Black silt, little clay
	−23.6	−29.2	Medium yellow clay
664 E11	+15.3	+10.8	Hard sand, gravel and clay fill
	+10.8	− 2.2	Soft clay fill
	− 2.2	− 4.7	Silty sand, shells
	− 4.7	−14.7	Soft silt
	−14.7	−19.7	Soft blue clay
665 J4	+18	− 7	Clay, gravel; compact
	− 7	− 9	Gray clay
	− 9	−22	Clay, stone, gravel; compact
	−22	−42	Hard compact gray clay and gravel
666 D5	+15.7	+14.7	Concrete
	+14.7	+10.3	Hard sand, gravel and brick fill
	+10.3	+ 4.3	Silt, sand
	+ 4.3	+ 1.4	Sand, peat
	+ 1.4	− 8.5	Mud, coarse sand
	− 8.5	−13.8	Fine sand, little clay
	−13.8	−24.1	Medium blue clay
	−24.1	−38.5	Soft blue clay
667 D5	+16.2	+15.5	Concrete
	+15.5	+12.2	Fill; sand, gravel, asphalt
	+12.2	+ 8.6	Hard sand and gravel fill
	+ 8.6	+ 7.9	Clay and sand fill
	+ 7.9	+ 3.5	Silty peat
	+ 3.5	− 2.5	Medium coarse sand
	− 2.5	− 5.6	Sharp sand
	− 5.6	−11.5	Fine sand, very little clay
	−11.5	−17.3	Fine sand, soft blue clay
	−17.3	−56.7	Soft blue clay
	−56.7	−66.5	Medium blue clay, fine sand
	−66.5	−66.51	Clay, gravel, stones
	−66.51		Refusal
668 D5	+13.2	+ 5.0	Fill; sand, gravel, cinders
	+ 5.0	+ 3.5	Peat
	+ 3.5	+ 0.5	Fine sand
	+ 0.5	−18.6	Fine sand, clay
	−18.6	−51.3	Soft blue clay
	−51.3	−73.5	Firm clay and gravel
	−73.5		Refusal
669 D5	+13.8	+ 7.2	Ashes and gravel fill
	+ 7.2	+ 1.0	Soft mud
	+ 1.0	− 7.5	Loose medium sand
	− 7.5	−20.5	Very fine sand, clay; soft
	−20.5	−65.5	Medium blue clay
	−65.5	−80.5	Soft blue clay
	−80.5		Rock obstruction

No. and location	Elevations or depths From	To	Formation
670 D5	+ 9.4	+ 2.9	Ashes and gravel fill, mud
	+ 2.9	+ 0.8	Soft mud
	+ 0.8	− 8.3	Loose medium sand
	− 8.3	−19.8	Very fine sand, clay; soft
	−19.8	−70.8	Medium blue clay
	−70.8	−90.8	Soft blue clay
	−90.8	−115.5	Soft blue clay with thin layers of sand
	−115.5		Rock obstruction
671 E6	+13.7	+ 5.1	Loam and clay fill, mud
	+ 5.1	+ 0.9	Mud
	+ 0.9	− 7.5	Compact medium sand
	− 7.5	−20.5	Very fine sand, clay
	−20.5	−61.5	Medium blue clay
	−61.5	−86.1	Soft blue clay
	−86.1		Rock obstruction
672 E6	+16.6	+ 7.9	Cinder fill
	+ 7.9	+ 1.9	Peat
	+ 1.9	− 5.9	Fine sand, very little clay
	− 5.9	−14.7	Fine sand
	−14.7	−20.8	Soft clay, fine sand
	−20.8	−80.7	Soft blue clay
	−80.7	−85.2	Hard clay and gravel
	−85.2		Refusal—Ledge or boulder
673 E6	+17.2	+ 3.5	Cinder and gravel fill
	+ 3.5	− 0.1	Silt
	− 0.1	− 0.6	Soft clay and sand
	− 0.6	− 4.3	Hard clay and fine sand
	− 4.3	−12.5	Fine sand, soft clay
	−12.5	−28.6	Soft clay
	−28.6	−36.0	Hard clay, sand and gravel
	−36.0		Ledge or boulder
674 E6	+16.1	+ 3.6	Cinder fill
	+ 3.6	+ 2.5	Silt, shells
	+ 2.5	− 0.4	Coarse sand, fine gravel
	− 0.4	− 6.6	Yellow clay, fine sand
	− 6.6	−18.5	Fine sand, little clay
	−18.5	−23.4	Soft clay and fine sand
	−23.4	−116.4	Soft blue clay
	−116.4	−119.5	Sand, fine gravel, little clay
675 E6	+14.7	+ 6.4	Cinders and gravel fill
	+ 6.4	+ 2.0	Silt, fine sand
	+ 2.0	− 0.6	Coarse sand
	− 0.6	−18.8	Blue clay, fine sand
	−18.8	−26.5	Blue clay, fine sand
	−26.5	−102.5	Soft blue clay
676 F6	+14.6	+ 5.3	Cinder and gravel fill
	+ 5.3	+ 2.3	Silt, cinders
	+ 2.3	− 1.2	Fine sand
	− 1.2	− 7.9	Fine sand, clay
	− 7.9	−24.1	Soft clay, fine sand
	−24.1	−40.4	Soft blue clay
677 F6	+14.3	+ 8.7	Sand and gravel fill
	+ 8.7	+ 1.6	Cinder fill
	+ 1.6	+ 1.5	Silt
	+ 1.5	− 4.3	Cinders, medium coarse sand, fine gravel
	− 4.3	− 9.9	Loose fine sand
	− 9.9	−16.3	Fine sand, clay
	−16.3	−26.5	Soft clay, fine sand
	−26.5	−40.9	Soft clay
678 G5	+26.4	+ 9.4	Compact sand, gravel and clay fill with mud
	+ 9.4	+ 2.2	Gravel and clay fill; mud
	+ 2.2	− 1.8	Compact gravel and sand
	− 1.8	−33.8	Compact very fine sand and clay
	−33.8	−108.8	Soft blue clay
	−108.8		Rock obstruction
679 G5	+24.7	+ 6.1	Compact gravel, sand and clay fill; very hard
	+ 6.1	− 0.4	Mud, soft sand
	− 0.4	− 4.1	Compact sand and gravel
	− 4.1	−32.1	Clay, very fine sand; hard
	−32.1	−134.1	Soft blue clay
	−134.1		Rock obstruction
680 G5	+25.2	+ 4.0	Fill; gravel, ashes, clay
	+ 4.0	+ 1.6	Marsh mud
	+ 1.6	− 1.4	Compact sand and gravel
	− 1.4	−35.0	Clay, very fine sand
	−35.0	−105.0	Soft blue clay
	−105.0		Rock obstruction
681 G5	+13.8	+12.8	Crushed stone
	+12.8	+ 7.5	Cinder and gravel fill
	+ 7.5	+ 1.5	Peat
	+ 1.5	−10.7	Medium clay, fine sand
	−10.7	−28.7	Soft clay and fine sand
	−28.7	−71.7	Soft blue clay
	−71.7	−78.6	Clay, sand, gravel, stones
	−78.6		Ledge or boulder

No. and location	Elevations or depths From	To	Formation
682 H5	+13.9	+ 7.9	Fill; sand, gravel, wood
	+ 7.9	− 4.7	Hard yellow clay, little fine sand
	− 4.7	−20.7	Soft blue clay, little fine sand
	−20.7	−32.3	Firm sand and gravel
	−32.3	−40.3	Hard sand and gravel; little clay
683 H5	+19.6	+10.9	Fill; sand, gravel, clay
	+10.9	+ 1.0	Hard yellow clay
	+ 1.0	−13.4	Soft blue clay, little fine sand
	−13.4	−19.0	Firm sand, fine gravel, clay
	−19.0	−24.4	Hard sand, gravel and clay
684 H5	+23.0	+14.7	Fill; clay, sand, gravel
	+14.7	+13.0	Firm sand, clay and gravel
	+13.0	+10.6	Loamy peat
	+10.6	+ 6.7	Yellow clay
	+ 6.7	− 0.4	Yellow clay, fine sand
	− 0.4	−14.5	Soft blue clay
	−14.5	−16.8	Yellow clay, fine sand
	−16.8		Refusal
685 H5	+23.5	+10.9	Sand and gravel fill
	+10.9	+ 9.9	Soft mud
	+ 9.9	+ 1.3	Hard yellow clay
	+ 1.3	− 7.3	Soft blue clay, little fine sand
	− 7.3	− 9.7	Firm sand and gravel; little clay
	− 9.7	−16.7	Hard sand, gravel and clay
686 H5	+22.3	+16.3	Sand and gravel fill
	+16.3	+14.7	Soft mud
	+14.7	+12.7	Hard sand and gravel, little clay
	+12.7	+ 0.5	Hard yellow clay
	+ 0.5	− 6.5	Medium blue clay, little fine sand
	− 6.5	− 9.5	Firm sand, gravel and clay
	− 9.5	−14.9	Hard sand, gravel and clay
687 I5	+27.4	+25.8	Sandy loam
	+25.8	+23.8	Sand and gravel fill
	+23.8	+ 1.2	Hard cemented blue sand, gravel, clay and boulders; hardpan
688 I5	+30.6	+27.2	Sand and gravel fill
	+27.2	+17.6	Hard cemented sand, gravel and clay, boulders; hardpan
	+17.6	− 5.4	Hard cemented sand, gravel and clay; hardpan
689 I5	+28.1	+19.1	Fill; fine sand, little gravel
	+19.1	+10.7	Firm sand, little clay
	+10.7	− 6.1	Fine sand
	− 6.1	−15.1	Hard coarse sand, coarse gravel
W1 K7	+ 14	+ 7	Fill; brick, stone, rubbish
	+ 7	+ 2	Black muck, fill
	+ 2	− 11	Hard packed clay, wood
	− 11	− 15	Gray packed sandy clay
	− 15	− 17	Brown clay and stone, packed
	− 17	− 23	Sand, gravel
	− 23	− 99	Sandy gray clay, gravel, packed
	− 99	−106	Decomposed shale, quartz fragments
	−106	−108	Very soft shale, quartz binders
	−108	−114	Quartz and soft shale
	−112	−149	Gray shale, medium hard and soft streaks
	−149	−215	Soft gray shale with clay streaks
	−215	−228	Hard gray shale
	−228	−233	Soft gray shale with hard streaks
	−233	−263	Hard gray shale
W2 L12	+ 2	− 3	Very tough gray clay
	− 3	− 28	Tough gray clay
	− 28	− 33	Packed fine sand
	− 33	− 39	Sand
	− 39	− 74	Hardpan, sand, gravel, clay
	− 74	− 85	Soft weathered shale
	− 85	− 98	Hard gray shale
W3 L11	+ 1	− 2	Silt or mud
	− 2	− 15	Stiff light brown clay
	− 15	− 23	Plastic gray clay
	− 23	− 27	Fine sand, little clay
	− 27	− 33	Sand
	− 33	− 41	Sand, little clay
	− 41	− 47	Gray clay, gravel
	− 47	− 67	Sand (blown)
	− 67	− 76	Sand, clay and gravel, hardpan
	− 76	− 82	Soft broken gray shale
	− 82	−102	Gray shale

No. and location	Elevations or depths From	To	Formation
W4 L10	+ 2	− 2	Soft sandy dark clay, shells
	− 2	− 7	Soft gray sandy clay
	− 7	− 13	Yellow sandy clay, tough
	− 13	− 79	Plastic gray clay
	− 79	− 87	Fine sand
	− 87	− 90	Fine sand to small gravel
	− 90	−132	Fine sand
	−132	−150	Gray sandy clay
	−150	−159	Gray shale, hard broken
	−159	−161	Layer of sand
	−161	−168	Hard shale
W5 L9	+ 3	− 5	Black muck
	− 5	− 12	Fine sand, little clay
	− 12	− 21	Fine sandy gray clay
	− 21	−131	Plastic gray clay
	−131	−144	Fine gray sand
	−144	−151	Soft shale
	−151	−187	Hard gray shale
W6 K8	+ 4	0	Muck
	0	− 5	Fine sand, loose
	− 5	− 9	Compact fine sand
	− 9	− 16	Plastic gray clay mixed with sand
	− 16	− 33	Plastic gray clay
	− 33	− 35	Fine sand, little clay
	− 35	− 92	Plastic gray clay
	− 92	−109	Sand
	−109	−111	Boulders
	−111	−130	Clay, sand, gravel
	−130	−134	Fine sand
	−134	−139	Gray clay
	−139	−205	Soft shale
W7 K7	+ 1	− 8	Sand
	− 8	− 19	Plastic sand and clay
	− 19	− 55	Plastic gray clay
	− 55	− 68	Sand
	− 68	−101	Clay, gravel, sand
	−101	−109	Soft gray shale
	−109	−124	Hard gray shale
W8 J4	+ 21	+ 10	Stiff clay, sand, stones
	+ 10	+ 5	Stiff clay, pebbles
	+ 5	0	Stiff clay, sand, stones
	0	− 10	Stiff clay, stones
	− 10	− 16	Soft clay, pebbles
	− 16	− 31	Sandy clay, pebbles
	− 31	− 54	Soft sandy clay, pebbles
	− 54	− 59	Clay, stones
	− 59	− 64	Clay and sand, mixed
	− 64	− 70	Clay and sandstone
	− 70	− 85	Sand, small stones
	− 85	− 92	Soft broken rock, sand
	− 92	−113	Bedrock (gray-green)
W9 J3	+ 14	+ 4	No record
	+ 4	− 46	Soupy fine sand
	− 46	− 51	Clay
	− 51	− 56	Coarse gravel, clay
	− 56	− 68	Boulders
	− 68	− 77	Coarse sand
	− 77	− 81	Gray putty clay
	− 81	− 86	Hard gray clay
	− 86	−106	Gray clay
	−106	−116	Putty-like clay
	−116	−121	Clay, fine stone
	−121	−206	Hard, gray clay, much like rock
	−206	−242	Bedrock
W10 J6	+ 20	+ 15	Black muck, fine sand
	+ 15	+ 10	Clay, little gravel
	+ 10	+ 5	Solid gray clay
	+ 5	− 55	Clay mixed with gravel
	− 55	− 72	Hard greenish clay mixed with gravel
	− 72	− 80	Hard greenish brown clay, some gravel
	− 80	− 89	Gray clay
	− 89	− 98	Blue-black clay (hard)
	− 98	−105	Black slate clay
	−105	−174	Bedrock
W11 H3	+ 12	− 23	Mud, cinders, slag
	− 23	− 44	Muddy green-brown soft clay
	− 44	− 68	Very soft green-brown clay
	− 68	− 78	Light green clay (clean)
	− 78	− 89	Green clay, coarse sand, stone
	− 89	− 96	Greenish clay, silt, fine sand
	− 96	−106	Coarse sand, small stone, silt
	−106	−121	White powdery sand-like material (silica sand)
	−121	−147	Bedrock
W12 G3	+ 25	+ 15	Cinders, dirt
	+ 15	+ 5	Red brick, mud
	+ 5	− 15	Brown hard clay, gravel
	− 15	− 19	Hard yellow clay, stones
	− 19	− 24	Gray blue clay, gravel
	− 24	− 35	Greenish clay mixed with small amount of gravel
	− 35	− 65	Coarse sand
	− 65	− 70	Fine sand
	− 70	− 75	Fine sand with clay silt
	− 75	− 90	Fine clay (almost liquid)
	− 90	−100	Greenish-colored fairly solid clay
	−100	−126	Solid green clay (not hard)
	−126	−146	Bedrock

No. and location	Elevations or depths From	To	Formation
W13 D2	− 7	− 22	Green silty clay
	− 22	− 47	Greenish clay, soft to fairly solid
	− 47	− 92	Firm green clay
	− 92	−112	Green clay, some sand and gravel
	−112	−132	Clay, gravel, small stones
	−132	−137	Blue clay
	−137	−142	Soft slate
	−142	−159	Green clay in laminations with soft slate
	−159	−191	Bedrock
W14 D3	− 2	− 7	Very liquid green soft silt
	− 7	− 27	Liquid greenish silt, sand
	− 27	− 62	Greenish clay
	− 62	− 72	Silty sand, very coarse gravel
	− 72	− 77	Sand, coarse gravel
	− 77	−122	Coarse sand
	−122	−127	Fine sand
	−127	−132	Firm clay
	−132	−135	Clay—shale
	−135	−142	Shale
	−142	−187	Bedrock
W15 E2	+ 22	+ 12	Clay, gravel
	+ 12	+ 2	Clay, silt, gravel
	+ 2	− 8	Blue clay, gravel
	− 8	− 18	Sand, silt, small stones
	− 18	− 48	Clay, gravel, stones
	− 48	− 68	Hard blue clay, coarse gravel, small stones
	− 68	− 88	Clay, gravel to 1½″ dia.
	− 88	−103	Heavy blue clay (indications of argillite in formative stages)
	−103	−131	Soft argillite—blue green color
	−131	−160	Incipient argillite
	−160		Argillite with ability to fracture
W16 F2	+ 23	+ 16	Gravel, coarse sand
	+ 16	+ 11	Fine sand, some coarse particles
	+ 11	− 12	Silt, large percent of gravel
	− 12	− 17	Uniform fine sand
	− 17	− 32	Silt, large percent of gravel (hardpan)
	− 32	− 37	Fine silt
	− 37	− 72	Silt, large percent of gravel
	− 72	− 77	Greenish clay
	− 77	−131	Silt, large percent of gravel Streak of ledge rock at —118 and —122
	−131	−171	Bedrock—greenish shale
W17 F2	+ 33	+ 13	Gravel, coarse sand
	+ 13	− 57	Silt, large percent of gravel (hardpan)
	− 57	− 77	Fine silt (strata of sandstone at —72)
	− 77	−102	Silt, large percent of gravel
	−102	−111	Uniform medium sand, some boulders
	−111	−128	Uniform fine sand, some boulders
	−128	−181	Bedrock—greenish shale and sandstone
W18 F2	+ 61	+ 51	Gravel, coarse sand
	+ 51	+ 46	Silt, large percent of gravel (hardpan)
	+ 46	+ 41	Gravel, coarse sand
	+ 41	− 53	Silt, large percent of gravel (hardpan)
	− 53	− 58	Fine silt
	− 58	− 78	Silt, large percent of gravel (hardpan)
	− 78	−108	Fine silt
	−108	−126	Bedrock—light greenish shale

OF GENERAL INTEREST

PROCEEDINGS OF THE SOCIETY

MINUTES OF MEETING
Boston Society of Civil Engineers

SEPTEMBER 26, 1951.—A regular meeting of the Boston Society of Civil Engineers was held this evening at the American Academy of Arts & Sciences, 28 Newbury Street, Boston, Mass. Due to the absence of President Wilbur the meeting was called to order by Vice President Emil A. Gramstorff, at 7:00 P.M.

Vice President Gramstorff announced that the reading of the minutes of the previous meeting (May 16, 1951) would be waived unless there was objection.

It was *VOTED* "to dispense with the reading of the minutes of the May 16, 1951 meeting".

Vice President Gramstorff announced the death of the following members:—

Edward L. Moreland who was elected a member November 23, 1922 and who died June 17, 1951.

Fred J. Nebbiker who was elected a member December 20, 1950 and who died June 29, 1951.

Dugald C. Jackson who was elected a member March 17, 1909, and elected an Honorary Member, March 24, 1948, and who died July 1, 1951.

Dean Peabody, Jr., who was elected a member March 15, 1916 and who died August 8, 1951.

G. Nelson Perry who was elected a member June 20, 1950 and who died September 5, 1951.

Chester A. Richardson who was elected a member November 15, 1939 and who died September 7, 1951.

Charles F. Knowlton elected a member March 20, 1907 and who died September 19, 1951.

Vice President Gramstorff called upon Secretary Robert W. Moir to announce the names of applicants for membership in the B.S.C.E.

Vice President Gramstorff announced that the next meeting of the Society would be held on October 17, 1951 and would be the Annual Student Night Meeting. Dr. D. B. Steinman, Consulting Engineer, New York, to be the speaker.

Vice President Gramstorff then introduced the speaker of the evening, Mr. Wilfred M. Hall, Member of the Board of Directors of Chas. T. Main, Inc., who gave a very interesting talk on "Power Production and Transmission in Turkey". The talk was illustrated with slides.

A rising vote of thanks was given the speaker.

At the close of the meeting the members and guests gathered in the Lounge where a collation was served.

One hundred ten members and guests attended the meeting.

The meeting adjourned at 8:30 P.M.

ROBERT W. MOIR, *Secretary*

STRUCTURAL SECTION

April 11, 1951, at the Society Rooms, Chairman Cundari presiding. The speakers were Dr. Ruth D. Terzaghi, Geologist, Harvard University and Mr. Herman G. Protze, Materials Technologist, on the subject "Recent Progress in Testing and Examining Aggregate and Other Concrete Constituents.

Mr. Protze described current testing procedures and gave his recommendations for specific requirements that should be included in job specifications (in addition to references to national standards) for gradation, organic matter, mortar strength, wear and soundness. He discussed tests for light weight aggregates; and also recommended, for important projects, special full-size tests of concrete made from the cement being considered.

Dr. Terzaghi spoke on the problem of rocks that have been found deleterious in concrete because of their reactivity with high alkali amounts. She described investigations that have been made to identify the offending rocks, how they act with the alkali to cause deterioration of concrete, and measures that may be taken if known reactive aggregates must be accepted (use of puzzolans or pulverized fly ash to replace some of the cement).

A question period followed, in which it was brought out that, although top quality natural gravel aggregate is becoming scarce in this area, the long range prospect is not too bad, since there is an unlimited amount of granite and other rock that can be crushed for coarse aggregate. It will be more expensive, however, and its use will require changes in present habits of proportioning.

The attendance was 46.

Edward C. Keane, *Acting Clerk*

SURVEYING AND MAPPING SECTION

April 4, 1951.—The fourteenth meeting of the Surveying and Mapping section was held in the Society Rooms at 7:15 P.M. Approximately sixty members and guests were present.

The meeting was called to order by Chairman John J. Vertic. The minutes of the January 17th meeting were read by the clerk and approved. There was no business either old or new to be presented before the gathering.

The speaker of the evening was Mr. Gordon E. Ainsworth, surveyor on the orginal Portland-Montreal oil pipe line. His subject was Method and Procedures on Pipe-Line Surveying. A very interesting account on this subject was given.

Following the talk a long and interesting discussion was held in which many took part.

The meeting adjourned at 9:00 P.M.

George W. Hankinson, *Clerk*

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