

Bulletin No. 270

Series B, Descriptive Geology, 73

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

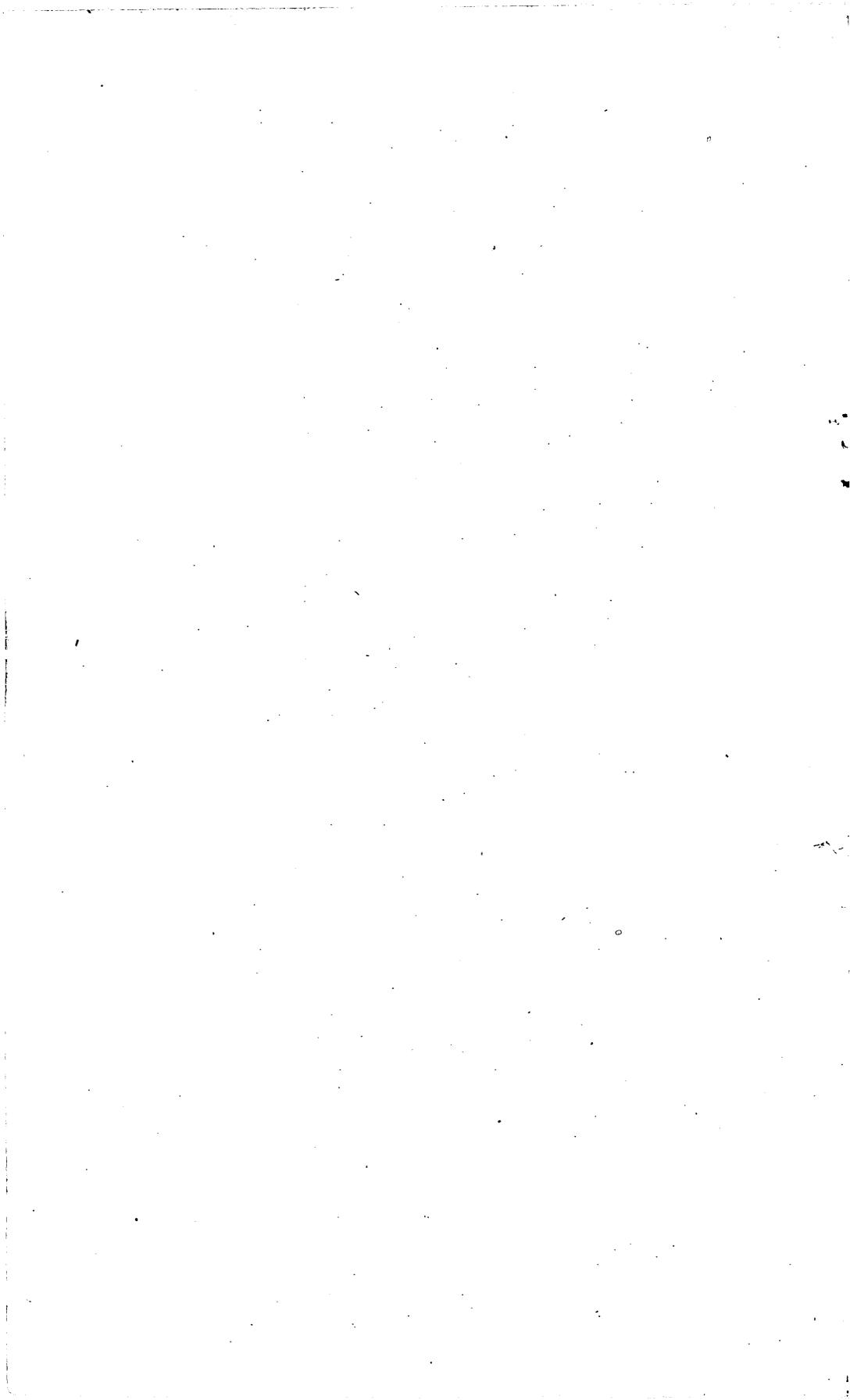
THE
CONFIGURATION OF THE
ROCK FLOOR OF
GREATER NEW YORK

BY

WILLIAM HERBERT HOBBS



WASHINGTON
GOVERNMENT PRINTING OFFICE
1905



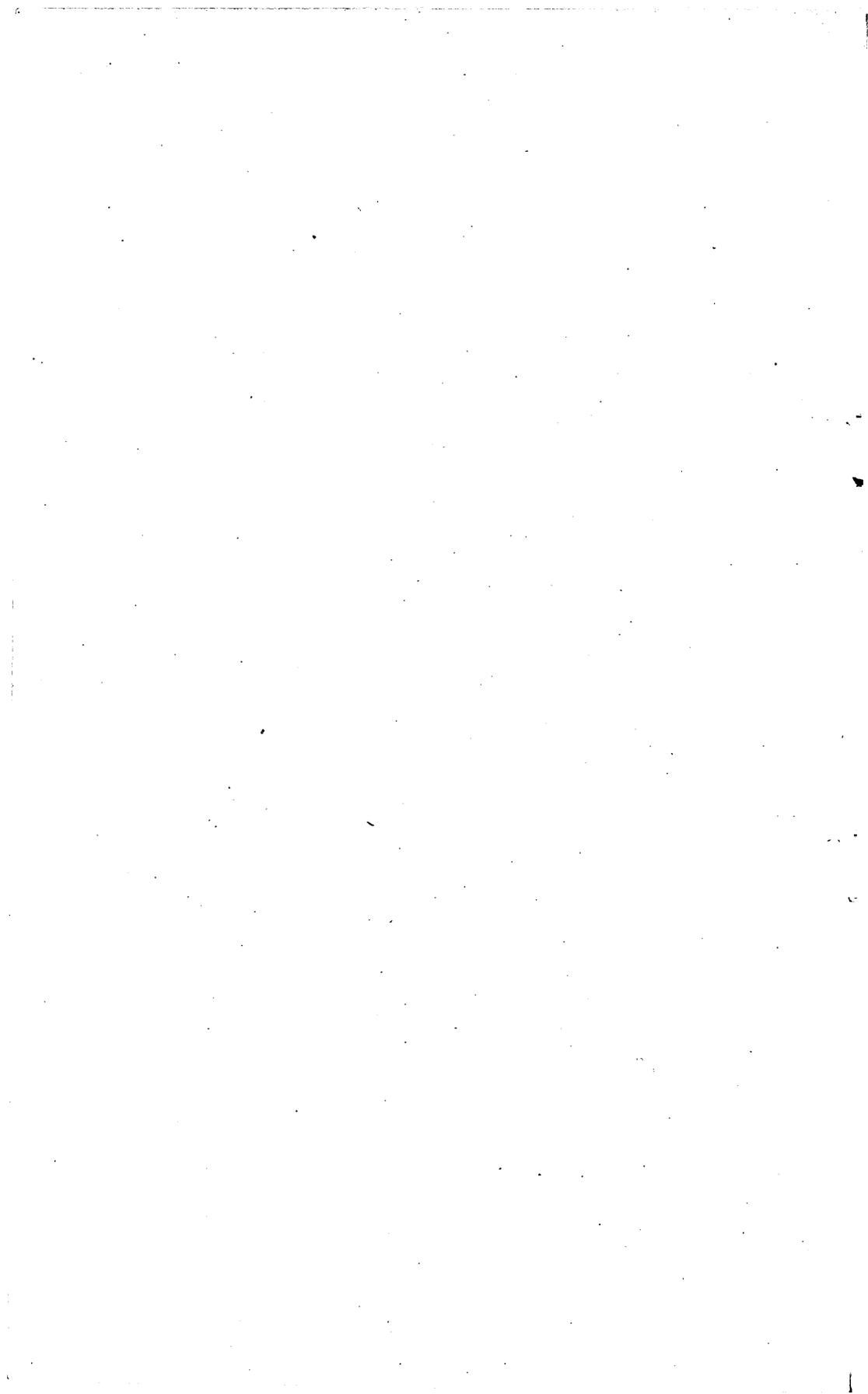
CONTENTS.

	Page.
LETTER OF TRANSMITTAL	7
PART I.—STRUCTURAL STUDIES	9
Introduction	9
Aids to geological studies on Manhattan Island	9
Engineering enterprises that have pierced the rock floor	10
Review of structural geological studies of the New York City area.....	12
Boroughs of Manhattan and the Bronx	12
Gale	12
Mather	12
Cozzens	12
Stevens	12
Credner	13
Newberry	13
Dana	14
Russell	14
Kemp	14
Merrill	15
Eckel	16
Gratacap	16
Julien	17
Peet	19
Hobbs	19
Area west of the Hudson	19
Comment	20
Scope of the present study	20
Form of the rock pedestal of Manhattan	21
Exposed portion of the rock basement	21
Covered portion of the basement	22
Transverse sections of the island	25
Longitudinal sections of the island	26
Along Broadway from the Battery to 33d street	26
Along Lenox and Westchester avenues from 96th street to Melrose avenue	27
Along Broadway and Eleventh avenue between 72d and Dyckman streets	29
PART II.—BORINGS MADE IN NEW YORK AND VICINITY	30
Borings beneath channels on water front	30
East River front	30
Dock and bulkhead lines	30
Miscellaneous	31

PART II.—BORINGS MADE IN NEW YORK AND VICINITY—Continued.	Page.
Borings beneath channels on water front—Continued.	
East River sections.....	32
East River Gas Company's tunnel.....	32
Bridges Nos. 2, 3, and 4.....	32
East River reefs.....	34
Center line of 42d street (produced).....	34
Pennsylvania Railroad tunnel.....	34
New York-Brooklyn tunnel of rapid transit commission.....	35
Hudson River front.....	36
Dock, bulkhead, and pier lines.....	36
Miscellaneous.....	38
Hudson River sections.....	40
Reef one-fourth mile from pier A.....	40
Bedloe Island.....	40
McAdoo tunnel.....	40
Pennsylvania, New York and Long Island Railroad tunnel.....	40
Proposed bridge at 59th street.....	41
Harlem River front and sections.....	41
Spuyten Duyvil Bridge.....	41
Dock line.....	41
Washington and High bridges.....	42
New aqueduct.....	42
Macomb's dam, Central Bridge.....	43
Line 400 feet east of Central Bridge.....	43
New York Central and 145th street bridges.....	43
Rapid-transit tunnel.....	43
Madison, Park, Third, Second, and Willis avenue bridges.....	44
Borings in the Borough of Manhattan.....	44
Line of subway.....	44
On or near Broadway.....	44
On Lexington avenue, 110th street, and 34th street.....	45
Profile along Broadway.....	49
Foundations of tall buildings.....	51
Lines of 31st, 32d, 33d, and 34th streets.....	55
Along Fourth avenue.....	58
Riverside Park extension.....	59
Riverside and Manhattan viaducts and Tenth avenue.....	66
Records from miscellaneous sources.....	67
Borings in the outlying boroughs and in other localities near New York.....	83
Borough of Brooklyn.....	83
Borough of Queens.....	86
Borough of the Bronx.....	87
Adjacent points in New Jersey and elsewhere.....	89
INDEX.....	95

ILLUSTRATIONS.

	Page.
PLATE. I. Map of the southern portion of Manhattan Island, with portions of the Long Island and New Jersey shores, showing the configuration of the rock floor.....	20
II. Map of northern and eastern portions of Manhattan Island, showing the configuration of the rock floor.....	22
III. Sketch map of Manhattan Island, showing the location of some of the river sections.....	24
IV. Series of profiles across the Harlem River, showing the position and configuration of the rock surface.....	26
V. Section of the rock basement of Manhattan along the line of Broadway from the Battery to 33d street.....	28
FIG. 1. I. Rock surface beneath the new Stock Exchange building, between New and Broad streets.....	11
2. Sketch map of Manhattan Island (after Kemp).....	15
3. Sketch map of Manhattan Island, showing location of special transverse and longitudinal sections.....	24
4. Transverse sections across Manhattan Island between 31st and 34th streets.....	25
5. Section along Lenox and Westchester avenues from 96th street, Manhattan, to Melrose avenue, Bronx.....	28
6. Section along Broadway and Eleventh avenue from 72d street to Dyckman street.....	28



LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
Washington, D. C., February 14, 1905.

SIR: I transmit herewith the manuscript of a report on "The Configuration of the Rock Floor of Greater New York," by William H. Hobbs, and recommend its publication as a bulletin.

The report contains a large amount of geological information of the highest importance to engineers engaged in construction work in New York involving excavations for foundations and other purposes. The facts are presented by both verbal and graphic means in such a manner as to be most useful to the engineer, and at the same time to be highly suggestive and valuable to the student of geology.

Very respectfully,

C. W. HAYES,
Geologist in Charge of Geology.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.



CONFIGURATION OF THE ROCK FLOOR OF GREATER NEW YORK.

By WILLIAM H. HOBBS.

PART I.—STRUCTURAL STUDIES.

INTRODUCTION.

AIDS TO GEOLOGICAL STUDIES ON MANHATTAN ISLAND.

Accurate maps.—The early importance of Manhattan Island in commercial and economic lines and its entry upon great engineering enterprises which require a penetration of the rock floor have greatly facilitated the work of the structural geologist within the area. As early as 1821 the city was laid out, and the gridiron of numbered streets and avenues has not only been responsible for a precision and accuracy of the early maps, rarely obtainable elsewhere, but has given to even casual geological observations unusual value. Randall's map of the island, submitted in sections between the years 1811 and 1821, now preserved in the office of the commissioner of public works, gives the precise locations of all the old farms in relation to watercourses and topography. It comprises four volumes of 92 sheets of map, size 25 by 37 inches, on scale of 100 feet to the inch. General Viele's map, on the scale of 1,000 feet to the inch, was published in 1874,^a and is based upon Randall's map. It shows the original shore line of the island, the mainland, the drainage system, the topography, and the location of each exposure south of Manhattanville, all superimposed upon the gridiron of streets and avenues. The accuracy of this map has been abundantly attested by engineers, real estate men, and others, who habitually use it, and, so far as the exposures of rock are concerned, it has been tested by the writer, both by comparison with the early reports of geologists upon Manhattan Island and by examination in the field.

Sections along the cross streets of the city were early made to establish the grade, and many of the engineers made careful note in their

^aViele, Egbert L., Topographic Atlas of the City of New York, 1874.

sections of the surface exposures of rock. These series of sections are on file in the office of the commissioner of public works. The New York City folio ^a has supplied detailed topographic, geological, and surficial geological maps of the area in this vicinity.

ENGINEERING ENTERPRISES WHICH HAVE PIERCED THE ROCK FLOOR.

It is safe to say that at no time in the earth's history has there been such a focus for engineering enterprises as is now to be found within the 50 or more square miles included upon Manhattan Island and its water fronts—enterprises which are estimated to cost several hundred millions of dollars. The subway and the tunnels of the rapid transit commission; the East River bridges, Nos. 2, 3, and 4; the proposed tunnels of the Pennsylvania, New York and Long Island Railroad Company from Weehawken, beneath the island, to Long Island City, with the extensions of the system in Brooklyn and the Bronx, including the projected bridge from Long Island City to the Bronx across Wards and Randall islands; and the United States Government's dredging of the Buttermilk and Ambrose channels and of the Man-o'-War and Diamond reefs are some of the larger of these enterprises. While these vastly outweigh in importance all engineering undertakings that have previously been carried out within the area, the earlier Government work in improving the channel at Hell Gate by removing Flood and Mill rocks, still ranks as an engineering enterprise among the first of its kind in the world. The Brooklyn Bridge, the Croton and the new New York aqueducts, Dyckman's cut in the ship canal at Kingsbridge, the East River Gas Company's tunnel from Manhattan to Long Island City beneath Blackwells Island, the Jersey City-New York tunnel beneath the Hudson River, and the many bridges which now span the Harlem River must all be included in the great engineering undertakings which have facilitated the work of the geologist within the New York City area. These enterprises have together furnished more than 35 sections across the rivers forming the water front of the island, many of them revealing the nature of the subjacent rock, and not a few giving nearly complete sections across it.

The present is, then, an especially favorable time to study the geological structure of Greater New York, and it is perhaps nowhere else so important that observations be made and recorded at once lest the opportunity be forever lost. Not only do the great engineering undertakings above referred to make the present an especially favorable time for study, but the enormous increase in the value of real estate upon Manhattan Island is resulting in a paring down of all rock

^aGeologic Atlas U. S., folio 83, U. S. Geol. Survey, 1902.

masses which project above the general level in order to make room for business blocks and apartment houses. The majority of the rock exposures described by Dana and other early observers are now no longer to be seen, and those still uncovered by blocks and pavements

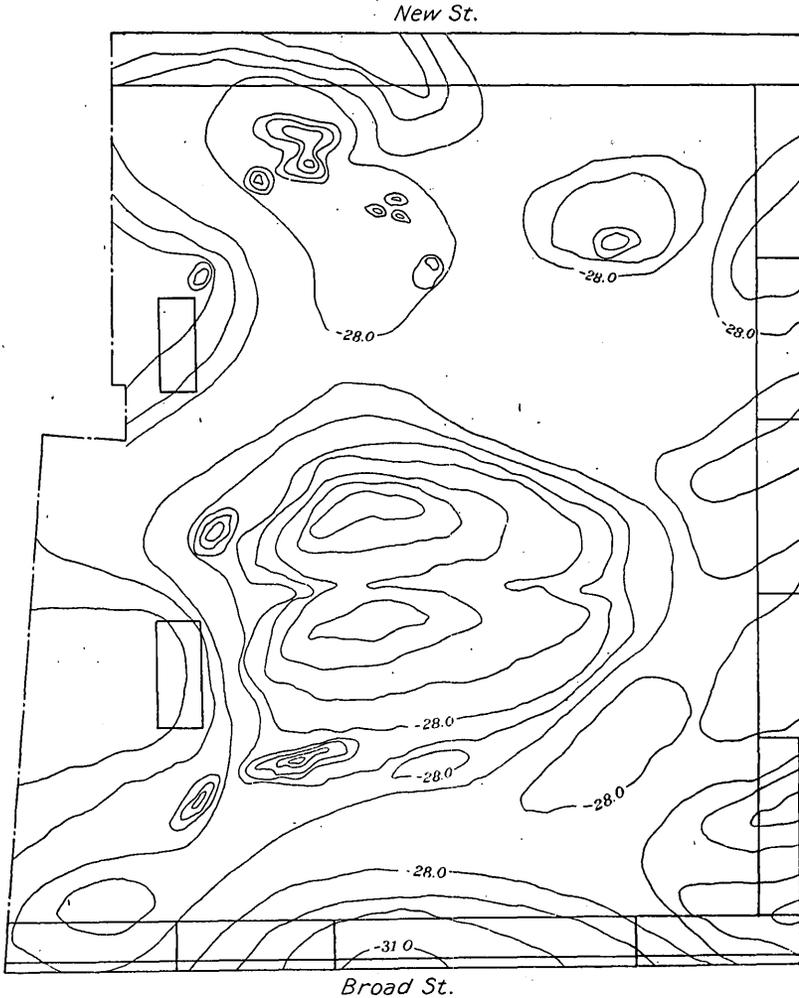


FIG. 1.—Rock surface beneath new Stock Exchange building, between New and Broad streets. Contour interval, 1 foot.

will in a very few years have disappeared from view. That a like irregularity of surface characterizes the covered portions of the basement at the south end of the island is amply demonstrated by recent excavations (see, for example, fig. 1).

REVIEW OF STRUCTURAL GEOLOGICAL STUDIES OF THE NEW YORK CITY AREA.

BOROUGHES OF MANHATTAN AND THE BRONX.

Gale.—The earliest geological work of importance treating of the geology of New York Island is a paper by Dr. L. D. Gale, dated 1839. As quoted by R. P. Stevens, Gale^a describes the geological topography of the island as a “*group of gneissoid islands separated from each other by low levels slightly elevated above tide and filled with drift and alluvium.*” It would be difficult even now to express better the peculiarities of the relief of the island.

Gale’s geological report, published in Mather’s volume, on the Geology of the First District^b is a careful description of outcrops examined along longitudinal sections of the island, corresponding in position with the principal avenues. This descriptive matter has much value as a record of exposures, many of which have since been pared away in grading the city. He says in résumé:

The general direction of the strata is N. 25° E. to N. 35° E. and corresponds with the direction of the avenues; and the dip, though generally to the west, averages within 10° of the vertical.

Mather.—Mather’s report contains a geological map of Manhattan Island and in addition to the valuable section by Gale, above referred to, includes an important table giving a large number of dips and strikes, and a table of joint directions as well.^c

Cozzens.—Isaachar Cozzens published in 1843 a little volume on the Geology of Manhattan Island^d which is chiefly valuable as a record of the character of exposures which are no longer accessible for study.

Stevens.—In 1865 appeared a valuable paper by Mr. R. P. Stevens, of the New York Lyceum of Natural History, in which paper the rock composition and the structure of the island were much more fully discussed than at any previous time.^a The peculiar topographic development of the island was accounted for in part by folding, but more largely by faulting. His diagonal section across the northern end of the island shows five transverse folds in the gneiss and underlying limestone. The western and the eastern anticlines of the series he supposed brought up the limestone in the beds of Hudson and East rivers, respectively, thus accounting in part for the formation of these channels. He supposed another anticline to follow the gorge of the Harlem between Washington and Fordham heights. The remaining two anticlines of his series he based upon the occurrences of lime-

^aStevens, R. P., Hist. Geol. New York Island: Annals Lyceum Nat. Hist. New York, vol. 8, 1865, pp. 108-120.

^bMather, Wm. W., Geol. New York, pt. 1, 1843, pp. 581-604.

^cIdem, pp. 605-625.

^dCozzens, Isaachar, Geol. New York, 1843, pp. 1-114, pls. 1-9.

stone on 132d street, between Fifth and Sixth avenues, and on 122d street, between Third and Fourth avenues. The "islands of gneiss" upon the island, which Gale so well describes, Stevens accounted for by a network of longitudinal and transverse fractures, of which seven transverse fractures are mentioned, including one which separates the island from Westchester County, and five longitudinal ones. The three large longitudinal fractures follow the gorges of Hudson, Harlem (between Washington and Fordham heights), and East rivers. The more important of the cross faults were located along Spuyten Duyvil Creek, through the gorge at Tubby Hook, and through the Manhattanville valley. He says:

Our rocks are a portion of the mainland in Westchester County, from which we are cut off by a profound fault, a cross fracture in part, originally narrow, but widened by the abrading power of water and ice, gravel and boulders, and, in part, by rupture of the strata longitudinally, with subsequent abrasion.

Beginning on the North River, at Spuyten Duyvil Bridge, the first cross fracture extends SSE. 1,500 feet; then commences a longitudinal fracture, extending to Tubby Hook, the Spuyten Duyvil-Creek flowing in it for 2,000 feet. Another cross fracture then commences, extending to the Harlem River, in which the creek flows 1,000 feet, then it enters another longitudinal fracture, in which it flows NNE. 4,000 feet, where it meets with another cross fracture for 2,000 feet. Thence a longitudinal fracture extends as far southward as McComb's dam and bridge, running parallel with the North River; thence the fracture slightly inclines southeastward to Hurlgate, on the East River.

At Tubby Hook there is another cross fracture, extending from the North River into the second longitudinal one. At Manhattanville there is another, reaching across the entire island.

Between the islands in the East River and the New York Island there is a longitudinal fracture through limestone and gneiss, extending from the mainland as far south as Avenue A. South of this point we infer a continuation of it to the southern extremity of the island. A similar longitudinal fracture begins at Dobbs Ferry and Hastings, through the same rocks as the eastern, and extends the whole length of the island, forming the channel of the North River, separating it from New Jersey.

Stevens was the first to recognize clearly the prevailing southerly pitch of the rocks throughout the island as well as in the area of the Bronx.^a

Credner.—A paper by Credner, published in 1865,^b adds little to what was already known of the structural geology of the island.

Newberry.—A very graphic picture of the later phases in the physiographic development of New York Island was given by Newberry in 1878.^c

The elevation of the land in Tertiary times, followed by the sharp incision of the valleys, the subsequent submergence and flooding of these valleys, the abrasion and filling accomplished in the Glacial

^aStevens, R. P., *Hist. Geol. New York Island: Annals Nat. Hist. New York*, vol. 8, 1865, p. 119.

^bCredner, Hermann, *Geognostische Skizze der Umgegend von New York: Zeitschr. Deutsch. geol. Gesell.*, Berlin, vol. 17, 1865, p. 390.

^cNewberry, J. S., *Geol. hist. New York island and harbor: Pop. Sci. Monthly*, vol. 13, 1878, pp. 641-660.

epoch, and the local scouring out of channels during Champlain time, were all well brought out in this paper. Newberry regarded East River as the last reach of Housatonic River of Connecticut before discharging into the Hudson, which was then carrying the waters from the Laurentian system of lakes.^a

Dana.—In an excellent paper on the Geology of Northern Manhattan and the Bronx,^b J. D. Dana printed a geological map covering the areas of the present boroughs of Manhattan and the Bronx north of Central Park, on a scale of 2 inches to the mile. This map, by reason of the numerous dip and strike symbols entered upon it, is practically an outcrop map. The position and the attitudes of the rock masses upon the island Dana accounted for through a system of folds which strike with the avenues. His sections show three synclines and two intervening anticlines between Inwood on the northwest and East River upon the east. The gorge at Manhattanville, which crosses the direction of the strike, Dana thought “probably had its initiation in an oblique wrenching and faulting of the rocks.” He noted the offset between the gneiss upland which lies north of the Manhattanville valley and that to the south. Referring in his résumé to the fundamental features of New York Island, he says:

Finally, we may conclude that the predeterminations of the fundamental features of New York Island date back to the era of the Lower Silurian, and to the epoch of mountain making at its close. No other rocks that now remain have been added by subsequent geological operations excepting the loose or unconsolidated material of the surface. Fissures and faults may have occurred through subterranean movements, but the work of separating its ledges has gone forward chiefly by the action of the sun, atmosphere, ocean, rivers, and ice, and the present condition, barring human encroachments, is the final result.

Russell.—In his paper on the Geology of Hudson County, N. J.,^c Russell has furnished many important data from borings upon Manhattan Island, which reveal both the depth of rock from the surface and the nature of the rock encountered.

Kemp.—In a paper published in 1887 Kemp^d gives a general summary of the rock distribution upon Manhattan Island and adopts Dana's view of the structure. Reviewing the sections of Stevens, he objects to the four or five synclines suggested. He argues:

But this does not seem to me to be warranted by the facts. If the original stratum has been doubled up so many times, it could only have been very thin when horizontal. * * * It does not seem reasonable that so broadly extended and so thin a stratum could by any possible convulsion be doubled up together so as to give these results. The synclinal mapped seems beyond dispute; as for dividing up the strata each side of it, I do not feel justified in doing it.

^a Newberry, J. S., Techn. Quart., vol. 13, 1900, p. 121; also, Bull. Geol. Soc. America, vol. 13, 1901, p. 24.

^b Dana, J. D., Geological relations of the limestone belts of Westchester County and northern New York Island: Am. Jour. Sci., vol. 21, 1881, pp. 425-443, and vol. 22, 1881, pp. 313-315.

^c Russell, I. C., Geology of Hudson County, N. J.: Annals New York Acad. Sci., vol. 2, 1882, pp. 66-79.

^d Kemp, J. F., Geology of Manhattan Island: Trans. New York Acad. Sci., vol. 7, 1887, pp. 49-65.

Referring to Dana's theory of the origin of the Manhattanville valley, he says:

Professor Dana has noted evidence tending to show that the Manhattanville depression is due to an oblique wrenching and faulting of the rocks, and it is possible that the same movement may have caused the breaks at Inwood and Spuyten Duyvil.

The paper contains a geological map which has the excellent but unusual peculiarity that the larger drift-covered areas are represented. In the alluvial flats of Harlem three parallel tongues of limestone or dolomite are represented trending with the avenues and extending from Harlem River southward for distances averaging 1 mile. (See fig. 2.)

Merrill.—Dr. F. J. H. Merrill, recently the State geologist of New York, has published a number of brief notes^a on the geology of New York Island, and recently a more extended report in the New York City folio.^b He follows Dana in believing the structure of the island to be conditioned largely as a result of a system

of longitudinal and transverse flexures, the trend of the former being in the general direction of the long axis of the island or of its avenues.

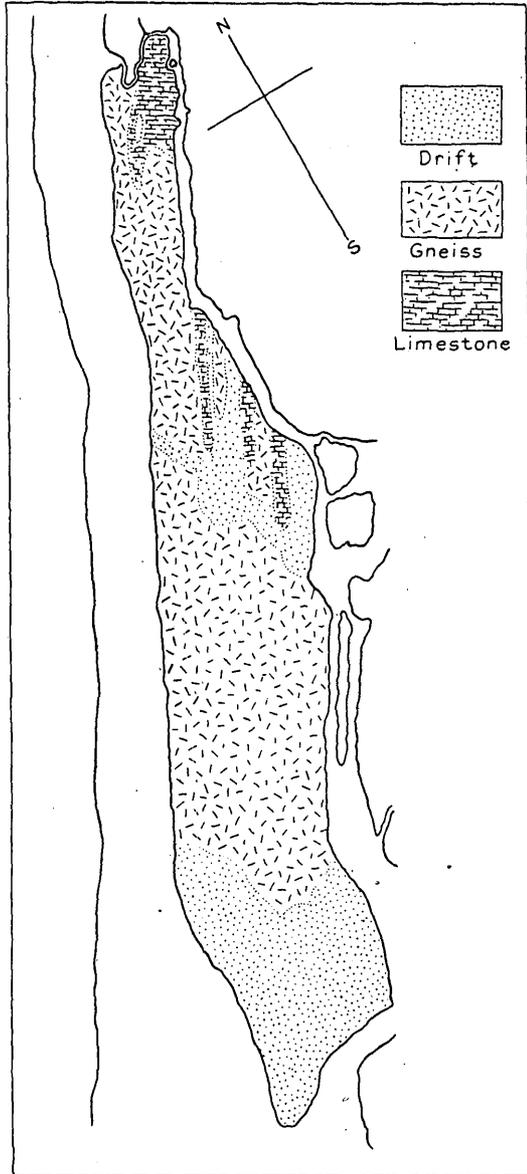


FIG. 2.—Sketch map of Manhattan Island. (After Kemp.)

^a Merrill, F. J. H., (1) Metamorphic strata of southeastern New York: *Am. Jour. Sci.*, 3d ser., vol. 39, 1890, pp. 383-392. (2) New York State Museum, 1896. (3) *Geology of Greater New York*: *Trans. New York Acad. Sci.*, vol. 16, 1897, p. 371. (4) Note on the colored clays recently exposed in railroad cuttings near Morrisania, N. Y.: *Trans. New York Acad. Sci.*, vol. 9, 1889, pp. 45-46.

^b *Geologic Atlas U. S.*, folio 83, U. S. Geol. Survey, 1902, pp. 3-5.

His map has entered upon it also the cross faults located by Dana at Manhattanville, an additional parallel fault south of Hell Gate, and a third between Randall Island and the Bronx. He distinguishes two divisions of the gneiss, the lower or Fordham gneiss of pre-Cambrian age, typically represented in Fordham Heights; the upper Hudson schist of Silurian age, said to be typically represented in Washington Heights. Above the lower gneiss formation is a quartzite (Poughquag quartzite) of Cambrian age, which in the area here considered is exposed at but two localities, viz, on the eastern shore of the Harlem gorge near Morris dock, and three-fourths of a mile farther to the east in the town of Tremont. Above the quartzite and immediately below the Hudson schist is the limestone formation (Stockbridge limestone) of Cambro-Silurian age. This formation is largely developed at Claremont, Melrose, and Mott Haven, within the Bronx area; in numerous exposures in the vicinity of Inwood and Kingsbridge; and it was formerly to be found also at several localities near the northeast end of the Borough of Manhattan. (Pl. II.) Merrill believes the low alluvial flats of Harlem have been eroded in limestone, and draws his boundaries to correspond with this view. It is likewise assumed that a limestone belt crosses the western end of Randall Island, and that two parallel belts cross Wards Island in a north-northeast direction. The main river channels about the island he regards as underlain throughout by limestone and formed in consequence of this fact.

Eckel.—In a brief paper published in 1899, Eckel^a announces the classification of the rocks of southeastern New York, as held by Dr. C. R. Van Hise and Dr. F. J. H. Merrill, to be as follows:

ORDOVICIAN:

1. Manhattan schist—mica schist, containing garnet, fibrolite, kyanite, and staurolite. Hudson River age.
2. Inwood limestone—crystalline dolomite, containing diopside and tremolite. Calciferous-Trenton age.

CAMBRIAN:

1. Lowerre quartzite.

PRE-CAMBRIAN:

1. Fordham gneiss. Algonkian?
2. Granites and gneisses. Archean?

At a time beginning not later than the Upper Silurian, and possibly continuing at intervals to the end of the Paleozoic, these strata were thrown into parallel folds having a general northeasterly trend. Transverse folding has resulted in a general gentle pitch to the southwest, and overthrown folds are common. (F. J. H. Merrill).

Of the formations mentioned above, the Manhattan schist and Inwood limestone form the surface or subsurface strata over the greater part of Manhattan Island, though at one place a small extent of the Fordham gneiss is exposed.

Gratacap.—In a popular treatise on Greater New York,^b Gratacap has brought together the work of many observers and added

^aEckel, E. C., Intrusives in the Inwood limestone of Manhattan Island: *Am. Geol.*, vol. 23, 1899, pp. 122-124, pl. 3.

^bGratacap, L. P., *Geology of the City of Greater New York*, 1902, pp. 1-82. (Privately published.)

observations of his own respecting the topography and geology of the island. He appears to favor the view that the present configuration of the island has been brought about in part as a result of folding and in part by faulting. On page 36, he says:

At the extreme western end of the Spuyten Duyvil Creek the opening of the Hudson suggests a crack, fault, or fissure; but east of this, at the cut of the railroad, the line of the creek seems to mark the delimitation of the limestone on the south from the gneiss on the north, and the creek has its bed in limestone, as the streams generally do in Westchester County (Dana). * * * This limestone underlies the Harlem River and is produced in long prolongations underneath Fourth and Fifth avenues (at 132d street), and also under Eighth avenue, interrupted by gneiss, which appears to hold it in synclinal troughs.

Gratacap apparently accepts the views of Dana regarding the fault at Manhattanville, and infers similar faults at Inwood (Tubby Hook) and along Spuyten Duyvil Creek. Stevens's assumption, and that of Dana and Merrill, that the Hudson has cut a deep gorge in a rock hypothetically considered as limestone, he considers an unlikely supposition (p. 39). The course of the Harlem River below 155th street he thinks probably is in a shortened synclinal trough (p. 40).^a

Julien.—As a result of a careful and thorough investigation of the dikes of basic igneous rock occurring on Manhattan Island, New York, Julien^b has produced a map which gives the orientation of the intrusions of basic rock upon the island. The great majority of these strike practically parallel to the avenues or parallel to the Hudson River shore, as will be clearly shown by inspection of his map. He says (p. 429):

A linear arrangement of many exposures along the strike is apparent, but these were in most cases found to be interrupted without connection in the interspaces.

As to indications of structure displayed by these diorites and hornblende schists, Julien says that they testify at once to both extreme plasticity and extreme rigidity in comparison with the inclosing gneiss (pp. 430–432):

First: Plication and corrugation of layers. The evidence of extreme plasticity in this rock during the general folding and kneading to which the strata of the island have been subjected is very markedly and frequently shown, not only by numerous folds with zigzag crumpling and distortion of the beds, but by corrugation of the layers even down to fine laminae.

Second: Fracture and faulting. Evidence of extreme rigidity and brittleness are often also shown in the same beds in which corrugation and crumpling are prominent. These are crossed often abundantly by seams or veins of gray or white quartz, or of pegmatitic material, which run usually parallel to each other and at right angles to the foliation of the schist. * * * Such fractures plainly testify that the hornblende beds have lain as rigid masses during the movements of the inclosing gneiss and have yielded only by rupture along the cross planes.

^aDescriptions of special outcrops are given by Heinrich Ries in *Trans. New York Acad. Sci.*, vol. 10, 1891, pp. 113–114.

^bJulien, Alexis A., *Genesis of the amphibole schists and serpentines of Manhattan Island*: *Bull. Geol. Soc. America*, vol. 14, 1903, pp. 421–494, pls. 60–63.

An excellent example still remains open to examination on the west side of St. Nicholas avenue, about West One hundred and thirty-eighth street. * * * One such fault vein, 2 feet wide, is filled by a friction breccia made up of angular fragments of the rock inclosed in brownish-white quartz (fig. 1), the walls of the fracture lined by hackly projections of the torn rock along both sides, as if they had been wrenched apart and rubbed together.

At other localities, as, for example, at the huge pit on Spuyten Duyvil Creek, portions of the hornblendic rock are traversed by innumerable veinlets of quartz or pegmatite, indicating a shattered and even brecciated mass.

Julien shows that the hydrated rock masses are in all probability altered basic igneous intrusions, the theory of alteration from impure limestones and that of metamorphism of ferruginous sediments being fully stated and rejected. Concerning the stages of metamorphism of the district, he says (pp. 424-425):

The first was concerned in the early consolidation of the sediments, followed progressively by their crystalline alteration, with development of certain new minerals—biotite, albite, and staurolite.

Then ensued the general impregnation of all the layers with pegmatitic material.

Next came the intrusion of a series of pegmatite dikes, cutting each other in succession, and all, so far as yet known, intersecting the pegmatite lenses of the preceding generation. With these orogenic movements seem to have been connected, with extensive folding, crumpling, and faulting of all the beds of gneiss, schist, and limestone, and a further increase of crystalline structure, development from micas and feldspars of another group of minerals requiring a condition of high temperature, such as muscovite, sillimanite, fibrolite, cyanite, and tourmaline.

Finally, down to the present period, ensued the oxidization, hydration, and partial leeching of the less considerable constituents of the schist by meteoric waters, with partial decomposition, etc.

In regard to the mode of occurrence of the amphibole-schists, this author says:

These occur interpolated among all the gneisses of the island, and though often found in proximity to the limestone are never inclosed by it nor in contact with it.

He further says:

These schists have been observed only in the northern part of the island, the greater part of whose surface, shown on the map, is occupied by buried gneisses in beds tilted up almost everywhere at very high angles, with a general strike of N. 28° E.

In another contribution, referring to the pegmatites of the island of Manhattan, Julien^a shows that these exist in at least two series, of which the oldest is the more extensively intercalated among the foliation seams and is coincident with the strike. The later series, on the other hand, cuts the schist in various directions and inclinations. He adds:

Some of the most prominent features are the results of pressure upon the original veins through orogenic movements of the stratum of schists, viz, fissuring, faulting, crushing, etc.

^aJulien, A. A., Notes on the origin of the pegmatities, Manhattan Island: Science, n. ser., vol. 12, 1900, pp. 1006-1007.

Peet.—In a recent extended report on the Glacial and post-Glacial history of the Hudson Valley, Peet^a favors the view that the Hudson water body was in post-Glacial time a lake impounded by the moraine, the inlet now existing through the moraine having been formed by the cutting down of the lake outlet to the present narrows. He says:

In conclusion it may be stated that, while no single argument seems to be fatal to the salt-water hypothesis accounting for the Hudson water body, unless those drawn from the phenomena on the outside of the moraine be such, it is likewise true that the facts are not fatal to the lake hypothesis, unless the sponge spicules reported from Croton represent salt-water species. Aside from these sponge spicules, the weight of the evidence seems to be in favor of the lake hypothesis.

Hobbs.—Still more recently the writer^b has made a study of the channels surrounding Manhattan Island, and has shown that limestone has been but seldom encountered in them, except along Harlem River, where for a portion of its length, between Kingsbridge and McComb's dam, the stream flows in a fault gorge, and where in another portion it cuts diagonally across belts of gneiss and limestone south of McComb's dam. In this latter section of the river there is no rock channel corresponding to the present river and the rock floor is without uniform slope in either direction, but is characterized by marked irregularity. Stevens's view that the location of the channels has been largely conditioned by a set of fractures is adopted as the most probable one.

AREA WEST OF THE HUDSON.

It will not be necessary here to review the voluminous literature descriptive of the type area of the Newark series. The rocks of this series, which are represented in the New York area, as here limited, comprise sandstones and shales with intrusive sills and dikes of basalt or diabase, all of which, except the dikes, dip at a low angle (10°–15°) to the northwest. All recent writers on this area have regarded the system as a faulted monocline with the main faults trending in a north-northeast direction. All are in accord in stating that the number of faults which must be present is in excess of those which have been described. The more important papers upon the area are the following:

RUSSELL, I. C. Physical history of the Triassic formation in New Jersey and the Connecticut Valley: *Annals New York Acad. Sci.*, vol. 1, 1878, pp. 220–256.

COOK, G. H. Red sandstone or Triassic formation: *Ann. Rept. State Geologist New Jersey*, 1879, pp. 18–35. (Contains colored map.)

RUSSELL, I. C. Geology of Hudson County, N. J.: *Annals New York Acad. Sci.*, vol. 2, 1882, pp. 27–80.

DAVIS, Wm. M. Relations of the Triassic traps and sandstones of the eastern United States: *Bull. Mus. Comp. Zool. Harv. Coll.*, vol. 7, 1883, pp. 250–309.

^aPeet, C. E., Glacial and post-Glacial history of the Hudson and Champlain valleys: *Jour. Geol.*, vol. 12, 1904, pp. 415–469, 617–660.

^bHobbs, W. H., Origin of the channels surrounding Manhattan Island: *Bull. Geol. Soc. America*, vol. 16, 1905, pp. 157–182, pl. 35.

- DARTON, N. H. Relations of the traps of the Newark system in the New Jersey region: Bull. U. S. Geol. Survey No. 67, 1890, pp. 1-82, 6 pls.
- RUSSELL, I. C. Correlation papers—the Newark system: Bull. U. S. Geol. Survey No. 85, 1892, pp. 1-344, 13 pls. (Especially pp. 83-95.)
- KÜMMEL, H. B. The Newark system, report of progress: Ann. Rept. State Geologist New Jersey, 1896-97, pp. 25-88; 1897-98, pp. 25-159.
- DARTON, N. H. Geologic Atlas U. S., folio 83, U. S. Geol. Survey, 1902, pp. 6-10.

COMMENT.

In the opinion of the writer too little weight has been accorded by recent observers to the importance of normal faulting in determining the structure of Manhattan Island. Particularly, in view of the proximity of the much-faulted Newark area across Hudson River, the markedly rectilinear boundaries of the island uplands, and the known zones of discontinuity discovered by engineers in subterranean workings. Stevens, among the earlier writers, and Julien and the present writer among the later ones have accorded greater weight to this consideration. Dana assumed a cross fault at Manhattanville, and this has been accepted by Kemp, who suggests also that there may be similar cross breaks at Inwood and Spuyten Duyvil. Merrill has entered upon his map, in addition to the fault at Manhattanville, two additional cross faults, one between Hell Gate and Blackwells Island, and another between Randall Island and the mainland, in order to account for the present positions and attitudes of the formations in those localities. Julien has described among others an additional cross fault accompanied by friction breccia at 138th street and St. Nicholas avenue, and has called attention to the shattering and brecciation at Spuyten Duyvil. The writer has described a number of additional fault planes which have been recently located.

SCOPE OF THE PRESENT STUDY.

An attempt has here been made to determine the depth and the nature of bed rock beneath Greater New York, by means of wells and borings, the numerous bridge and tunnel sections, the Government dredgings, the reefs in mid-channel, etc., in the belief that it will contribute not only toward the solution of the geological problems of the area, but will greatly aid the engineers who are carrying out the enterprises previously referred to, as well as architects, contractors, and many others.

The investigation has been conducted by personal interviews and correspondence with engineers who have been in charge of public works, by examination of drill cores, by study of municipal and other reports, and by kindred methods, rather than by attack on the rocks themselves, though this has so far as possible been undertaken. The writer takes this opportunity to acknowledge his obligation to the



MAP OF THE SOUTHERN PORTION OF MANHATTAN ISLAND
 WITH PORTIONS OF THE LONG ISLAND AND NEW JERSEY SHORES,
 SHOWING CONFIGURATION OF THE ROCK FLOOR.

Scale
 1 1/2 0 1 mile

1905

- Boring's to rock, figures give elevation of rock surface, referred to mean tide at Sandy Hook.
- ◊ Boring's which do not reach rock figures give elevation of bottom, referred to mean tide at Sandy Hook.
- The blue lines are contours of the rock floor, referred to the datum plane adopted.

many engineers who have so courteously responded to his application for information in their possession. To mention all of them would require more space than is here available for the purpose, but acknowledgment should be made especially of the assistance rendered by the following gentlemen: Mr. George S. Rice, acting chief engineer of the rapid transit commission; Mr. J. Vipond Davies, consulting engineer; Messrs. Richard S. Buck, H. A. La Chicotte, Martin Gay, and Edward A. Byrne, of the department of bridges of the city of New York; Mr. Alfred P. Boller, consulting engineer; Messrs. A. Noble and Charles M. Jacobs, chief engineers, and their assistants of the Pennsylvania, New York and Long Island Railroad Company; Mr. Wm. R. Hutton, consulting engineer; Lieutenant-Colonel Raymond and Capt. Edgar Jadwin, of the Corps of Engineers, U. S. Army; Mr. Corydon T. Purdy, chief engineer of the George A. Fuller Company; Mr. John Goodell, formerly editor of the *Engineering Record*; Mr. Oliver W. Barnes, civil engineer; and Mr. F. L. Chase, engineer of bridges, New York Central and Hudson River Railroad Company.^a The writer is especially indebted to Mr. William E. Brown, a member of the class of 1905 of the University of Wisconsin, who has prepared the illustrations of this report from the original data.

The waterways immediately surrounding Manhattan Island are, as is now well known, rock canyons having a depth to rock of nearly 200 feet in East River, and of 300 feet or more in North River. These canyons are now partly filled with drift deposits—boulders, gravel, sand, and clay—and silt. The depths to which the channels have locally been filled by this material are to some extent dependent upon the velocity of the tidal currents. At Hell Gate, where these currents are at a maximum, the channels have been scoured out to a depth of over 150 feet, though the average depth of water in the eastern channels ranges between 30 and 60 feet. In the Hudson channel, west of the island, the water depths vary between 30 and 150 feet, and the underlying beds of detritus have been penetrated to depths of 150 to 240 feet without meeting rock.

FORM OF THE ROCK PEDESTAL OF MANHATTAN.

EXPOSED PORTION OF THE ROCK BASEMENT.

Doctor Gale's statement that the island of New York is composed of "gneissoid islands" separated by low areas fitly describes that portion of the rock basement which projects above the drift. The maps of Mather^b and Kemp,^c which outline the areas of drift and alluvium

^aOther acknowledgments are made on page 23 and in connection with the tables of Part II.

^bMather, Wm. M., *Geol. New York*, pt. 1, 1843, pp. 501-625.

^c*Trans. New York Acad. Sci.*, vol. 7, 1887, plate facing page 64.

upon the island, disclose the quite striking rectilinear outlines of these islets. On Kemp's map in particular (fig. 2, p. 15) it is seen that there are two large islets and a number of smaller ones. The largest occupies the central part of Manhattan, and is roughly bounded on the northwest and southeast by Hudson and East rivers, respectively, while to the northeast and southwest it is limited by parallel and nearly straight lines, which conform in direction with the southerly course of the Harlem. The northeastern boundary, starting from the Hudson shore at Manhattanville, crosses the island to the northern limit of the Blackwells Island gorges, just south of Hell Gate. The southwestern boundary begins at 32d street and Hudson River and, crossing the island in the same general direction as the other, would pass through Corlear's Hook—a salient of the island upon the south. The other large islet upon Manhattan comprises that portion of the island which is north of the Manhattanville valley, west of Eighth avenue, and south of Shermans Creek. These two islets may be called, respectively, the Morningside Heights and the Washington Heights masses from the highest points of each. These highest points are in each case at the northern ends, from which the surface of the terrane slopes gently to the south, probably largely because of a persistent southerly pitch of the rocks, as was early pointed out by Stevens. One of the group of small islets upon the island borders the Hudson between Tubby Hook and Spuyten Duyvil Creek. Another formerly covered some 90 acres of the middle portion of the Harlem flats, but has since been reduced to the narrow limits of Mount Morris. A third, about 30 acres in extent, once formed the continuation of Fordham Heights upon Manhattan, and a fourth, of limestone, measured but a few acres and projected from the Harlem flats at 132d street and Sixth (Lenox) avenue. Two other small islets were located between Fort George and Kingsbridge—the one on the south being composed of schist and the other of limestone. Blackwells, Wards, and Randall islands, the near-lying "sunken meadow," Flood and Mill rocks, and the several remaining reefs of the eastern channel should all be included in the list.

COVERED PORTION OF THE ROCK BASEMENT.

So far as the writer is aware, no serious attempt has been made to learn the configuration of the rock floor of Manhattan beyond what has been accomplished in recording a small number of scattered observations from borings. Gale, in Mather's report, recorded some 23 borings to rocks, to which number Russell added 86, and Kemp, Gratacap, and others each added a few.

The recent engineering developments within the area of Manhattan suggested to the writer in 1901 the advisability of gathering data of this nature with a view to restoring in a contour map the submerged

rock surface of the island, the significance of rock contours within the Massachusetts-Connecticut area having demonstrated the value of such studies. In the area on and immediately surrounding the island observations from nearly 1,500 borings or excavations to rock have been collected through the courtesy of many corporations and private individuals. For these valuable data the writer has been placed under obligations to many city and Government officials, engineers, architects, artesian-well borers, and others. In addition to those mentioned on page 21 as supplying the greater number of data bearing on the nature and depth of the rock bed of river channels, there should be mentioned Mr. Russell Bleicker, secretary of the department of docks; Mr. George Livingston, commissioner, and Mr. Joseph O. B. Webster, engineer of street borings, of the department of public works; Mr. Watson G. Clark and Mr. Peter Elbert Nostrand, city surveyors; Mr. Robert Maynicke, and Messrs. Clinton & Russell, architects; Mr. Palmer Campbell, general manager of the Hoboken Land and Improvement Company; Mr. M. S. Starrett, engineer of the Interurban Street Railway Company; Mr. Daniel E. Moran, of the Foundation and Construction Company; Mr. William D. H. Washington, Washington Building; Mr. A. C. Veatch, of the Hydrographic Division, United States Geological Survey, and Mr. C. B. J. Snyder, architect, of the department of education. Among the contractors for artesian wells who have supplied valuable information are Mr. Isaac H. Ford, 104 Fulton street; Messrs. Stothoff Brothers, Flemington, N. J., and Mr. Harry E. Estes, of the New York and New Jersey Well Company. Brewing companies of the city have freely supplied information concerning the driven or bored wells upon their premises.

Voluminous data from these sources have been included in Part II, pp. 30 to 93. The greater number apply particularly to the "downtown" portion of Manhattan, south of the gneiss upland area, and to the area of the Harlem flats north of 110th street. The data from the downtown area have been entered on the map forming Pl. I, after having been corrected so as to refer to the United States datum plane of mean tide at Sandy Hook.^a

The observations from the Harlem area have been similarly entered on the map forming Pl. II. The grades of street intersections from which the depths below datum have been computed, were obtained in part directly from the official records, through the courtesy of Mr. George Livingston, commissioner, and Mr. Joseph O. B. Webster, engineer of street openings, of the department of public works. The larger

^aThis datum plane is the one adopted by the U. S. Coast and Geodetic Survey and the Pennsylvania Railroad Company. It is located 2.49 feet below the datum of mean high water at New York City, adopted by the New York department of public works and the Rapid Transit Commission. It is 2.25 feet above the datum plane of mean low water at New York City, which has been adopted by the New York dock department. The Pennsylvania, New York and Long Island Railroad Company has adopted the datum of mean high water, and to avoid the use of signs has fixed this elevation as 300 feet.

number, however, have been obtained from the valuable "Memoranda of Elevations,"^a which is in use among engineers.

It is well understood that this list does not include the records of all borings which have been made on the island, and it is therefore hoped that others will supplement them so far as possible.

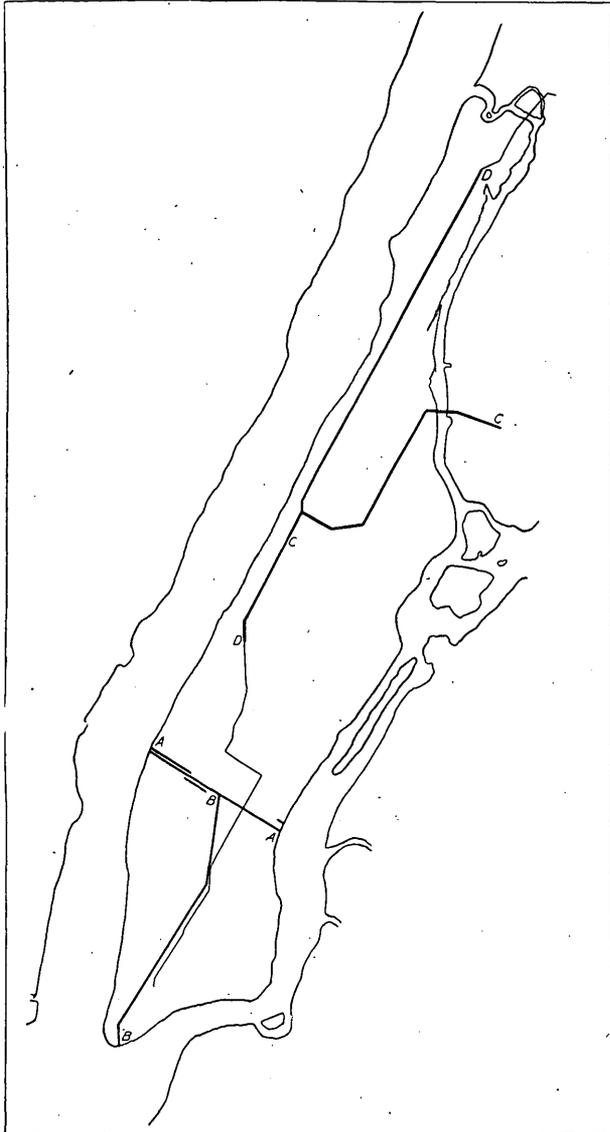
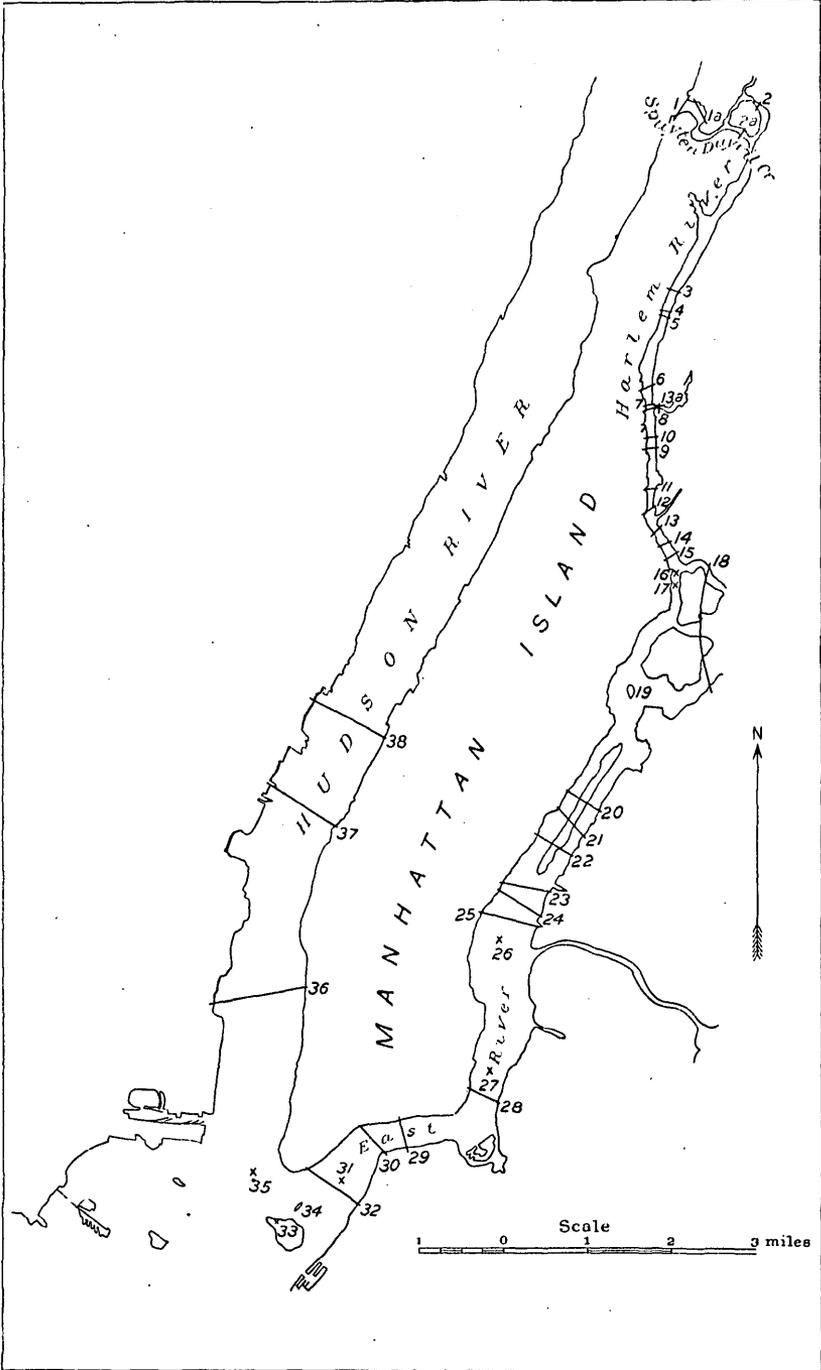


FIG. 3.—Sketch map of Manhattan Island showing location of special longitudinal and transverse sections.

It will be well to consider the form of the rock pedestal of the island as it appears in important sections, which, as the result of recent

^aBrown, M. B., *Memoranda of Elevations, New York City* (unofficial), 1883, pp. 175. (New York, 49-51 Park place.)



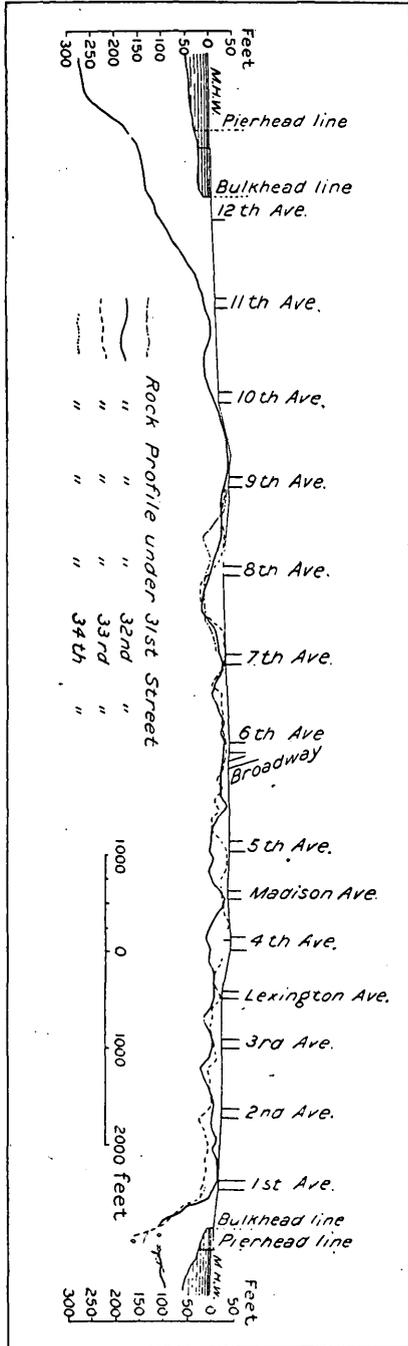
SKETCH MAP OF MANHATTAN ISLAND, SHOWING THE LOCATIONS OF SOME OF THE RIVER SECTIONS.

engineering works upon the island, are unusually complete. These are: (a) A transverse series of sections near the line of 32d street; (b) a longitudinal section along Broadway from the Battery to 33d street (Pl. V); (c) a longitudinal section from near the north end of Central Park, 96th street, along Lenox and Westchester avenues to Melrose avenue in the Bronx; and (d) a longitudinal section along Broadway and Eleventh avenue between 72d and Dyckman streets. The location of these sections will be clear from fig. 3.

TRANSVERSE SECTIONS OF THE ISLAND.

The elaborate system of borings made by the Pennsylvania, New York and Long Island Railroad Company in connection with the projected tunnels from Weehawken to Long Island City have been kindly placed at the writer's disposal by Messrs. Charles M. Jacobs and A. Noble, the chief engineers, respectively, of the North River and East River sections of the tunnels. The sections of fig. 4 have been prepared by combining the records of the North River tunnel section, the elaborate profiles in the neighborhood of the terminal site, between Seventh and Ninth avenues, and the sheets 7 to 10 of the East River section of the tunnels. Thus combined, these sections comprise a complete section across the island near the line of 32d street, an almost complete section along 33d street, an additional section along 31st street between Seventh and Ninth avenues, and a section of the steep eastern slope at East River near 34th street.

Fig. 4.—Transverse sections across Manhattan Island between 31st and 34th streets (after Jacobs and Noble).



The borings which have been utilized in making these sections comprise some 90 well-distributed core borings, supplemented by 75 or more intermediate wash borings. The rock was penetrated by the diamond drills in some cases as far as 100 feet, and revealed in all cases some phase of granite or gneiss, no limestone having been anywhere found.

A number of interesting results have followed from this work. It is first to be noted that the steep rock wall which forms the western margin of the island from 81st street northward to Manhattanville is on the line of these sections continued beneath the pierhead line of the Hudson shore as an equally definite topographic feature. The eastern wall of the island is even steeper than the western. Its surface was followed down to depths of 100 feet beneath the bulkhead line, and was found to rise gradually from this depth in going eastward from the pierhead line. Between the bulkhead and pierhead lines the rock surface is of great depth and was determined with difficulty. Under the old A pier of the 34th street ferry, approximately on the extended center line of 34th street and immediately in the rear of the A pier as it now exists, thirty-five soundings with a water-pressure drill were first made before a passageway was found under the surface cribwork and riprap of the island. The casing was finally driven to a depth of 208 feet. Below a depth of 129½ feet, mean low water, it is stated that the drill entered a rotten, decomposed gneiss. Though the diamond drill was put in it would not make a core, and the material crumbled under it.^a This apparently decomposed rock would appear to be in all respects like that which was found along the supposed fault crevice in the driving of the siphon for the New York aqueduct under Harlem River. As regards position it would correspond in this instance to the continuation of one of the possible faults of the Blackwells Island series.

In the vicinity of the terminal site, near Eighth avenue, there is a deep depression in the rock surface, which has inward-sloping walls, not only upon the east and west but to the north and south as well. To the east of Seventh avenue the surface is broken into a series of remarkably sharp and regular troughs which run transverse to the section, or longitudinally along the island, the surface as a whole sloping steeply to the south.

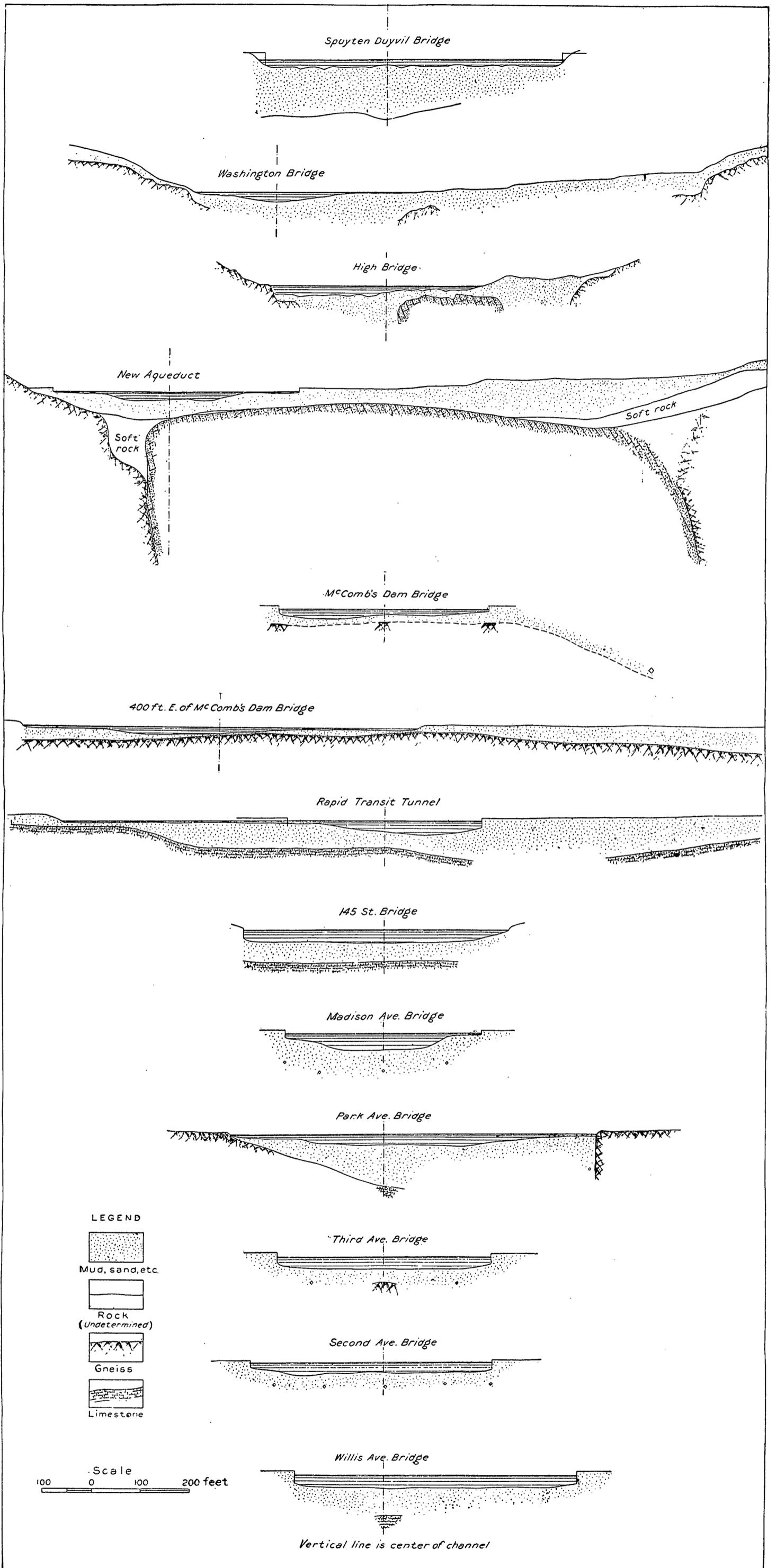
LONGITUDINAL SECTIONS OF THE ISLAND.

ALONG BROADWAY FROM THE BATTERY TO THIRTY-THIRD STREET.

The extensive series of borings made by the rapid transit commissioners in connection with the subway recently constructed,^b has

^a Information kindly furnished by A. Noble, chief engineer, East River division, and J. Vipond Davies, who was in charge of the drilling.

^b Parsons, Wm. B., Borings in Broadway, New York: Trans. Am. Soc. Civil Eng., vol. 28, 1893, pp. 13-18, pl. 6. See also Engineering News, vol. 26, July 18, 1891, p. 62 (fig.).



SERIES OF PROFILES ACROSS THE HARLEM RIVER TO SHOW THE POSITION AND CONFIGURATION OF THE ROCK SURFACE.

furnished a detailed profile of the rock surface between these limits. South of Union square this profile is characterized by the most abrupt changes in level, the greatest depression being found at Duane street, though less marked interruptions of its course are encountered at Walker, Canal, and Houston streets and at Clinton place. Just south of 14th street (Union square) also, a marked though somewhat less profound trough is disclosed. North of Union square and south of Chambers street the rock surface shows a comparatively regular slope (Pl. V). At Duane street, where the maximum depth of 163.25 feet was found, a second or check boring was put down on the opposite side of Broadway, where a depth of 149 feet (13.75 feet less) was found. Records obtained by the writer from other sources show that the deepest part of the depression is not upon the line of Broadway but to the southwest (Pl. I).

ALONG LENOX AND WESTCHESTER AVENUES FROM NINETY-SIXTH STREET TO MELROSE AVENUE.

This section (fig. 5) has been reproduced from the map and profile prepared by the rapid transit commission. It shows that the high bluff of gneiss, which forms the northern boundary of the Manhattan uplands near the northern line of Central Park, descends beneath the level of the grade in the Harlem flats. Rock was nowhere encountered in tunneling between this point and 145th street, where the tunnels descend in order to go beneath Harlem River. At that point, however, limestone was met with and was penetrated by the tunnels beneath the river. Records from borings derived from other sources show that the rock surface beneath the Harlem flats is at distances varying from 40 to 125 feet below its comparatively level grade. Out of these depths rise, like islets, the reefs of rock which are now so fast being leveled to grade.

It has been rather generally assumed that the area of the Harlem flats has been eroded in limestone. In the opinion of the writer it appears more probable that it represents a depressed composite orographic block of gneiss and limestone, outlined on the west and south by faults along Eighth avenue and the northern wall of the Manhattan uplands. From this depressed composite block reefs of gneiss and limestone alike rise along precipitous slopes to and above the present surface. A limestone reef of this kind has been described by Gale,^a Stevens,^b Ries,^c and Dana,^d and the latter was evidently at some pains to explain his theory of the New York river channels because of this

^a Mather, Wm. W., Geol. New York, pt. 1, 1843, pp. 581-604.

^b Stevens, R. P., Hist. Geol. New York Island: Annals Lyceum Nat. Hist. New York, vol. 8, 1865, pp. 116-117.

^c Ries, Heinrich, Trans. New York Acad. Sci., vol. 10, 1891, pp. 113-114.

^d Dana, J. D., Geological relations of the limestone belts of Westchester County and northern New York Island: Am. Jour. Sci., vol. 21, 1881, p. 440.

fact. The rock surface of the southern part of the island is apparently in most respects similar to that of the Harlem flats, except that no

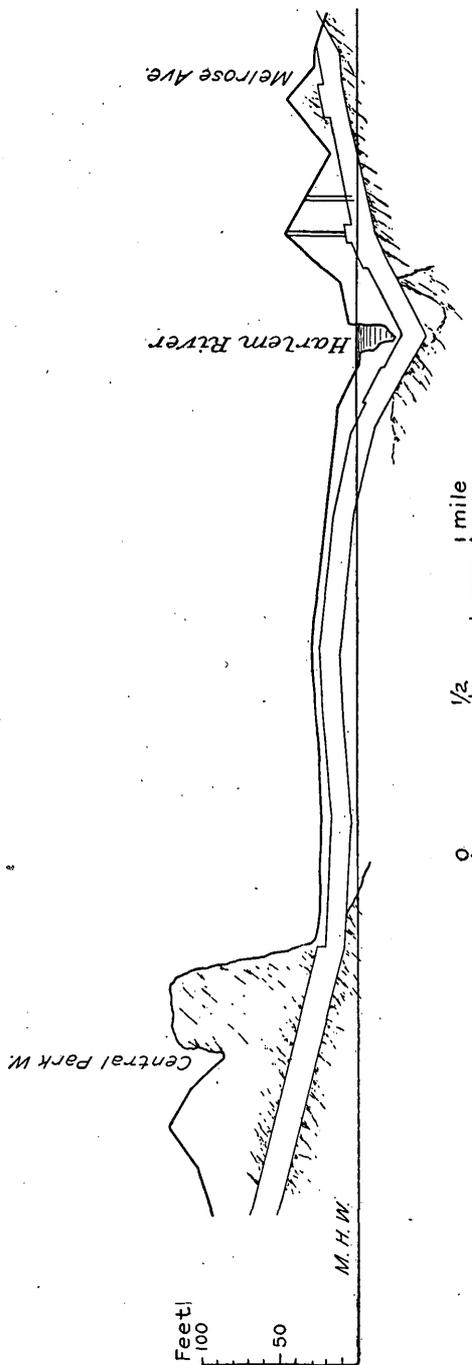


FIG. 5.—Section along Lenox and Westchester avenues from 96th street, Manhattan, to Melrose avenue, Bronx.

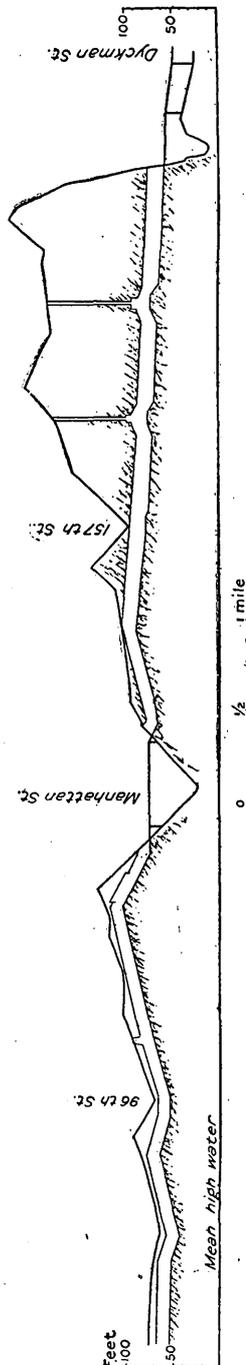
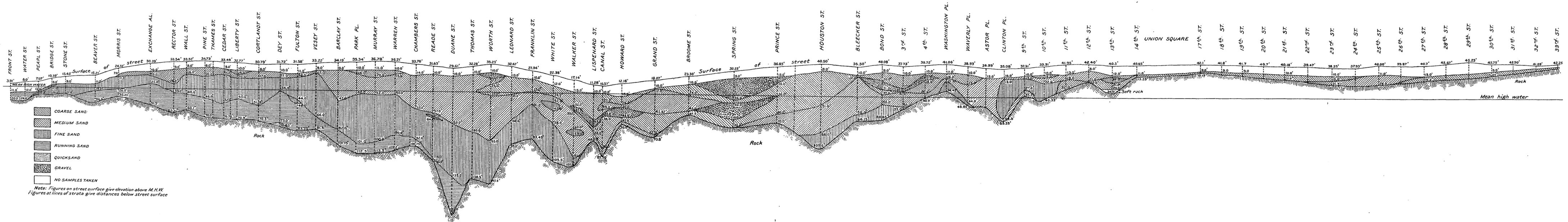


FIG. 6.—Section along Broadway and Eleventh avenue, from 72d street to Dyckman street. (Rapid transit commission.)

limestone reefs have been found, and the same explanation has, therefore, not been offered for its low position.



SECTION OF THE ROCK BASEMENT OF MANHATTAN ALONG THE LINE OF BROADWAY FROM THE BATTERY TO THIRTY-THIRD STREET.

ALONG BROADWAY AND ELEVENTH AVENUE BETWEEN SEVENTY-SECOND
AND DYCKMAN STREETS.

This section (fig. 6), like the last, is along the line of the subway, and has been furnished the writer through the courtesy of the rapid transit commission.

Its chief interest is in showing the regular transverse breaks in the continuity of the surface—breaks which were long ago described by Stevens as lines of dislocation. At Manhattan street there is a deep transverse crevice filled with gravel to a depth of more than 135 feet below the present grade (serial number 1202, p. 80). At 96th street also there is evidence that a filled crevice extends to a distance of about 100 feet below the bottom of the present valley (serial number 1199, p. 80). The deep embayment at 157th street marks a line south of which the rocks forming the upland project east for a distance of about one-eighth of a mile. It is also the line along which the mass of Fordham Heights abruptly terminates at Harlem River. The valley north of Washington Heights (fig. 6) is that of Shermans Creek, and north of this bars were driven by the engineers of the commission, to moderate depths, without encountering rock. The break at Shermans Creek, and those at 157th street, Manhattan street, and 96th street include subequal space intervals.

The above-described sections only partly display the peculiarly rugged configuration of the rock basement of Manhattan. Attention should be especially called to the revelations of the map (Pl. I) as to the zigzagging course of the lower Hudson channel, below Weehawken, and to the knob of gneiss which rises at the Battery from the downtown lowlands.

PART II.—BORINGS MADE IN NEW YORK AND VICINITY.

Summary of records of borings made in New York and vicinity.

1. BORINGS BENEATH CHANNELS ON WATER FRONT.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
	EAST RIVER FRONT.			
	<i>At dock line. a</i>			
	Foot of—			
1	Rivington street		— 55	
2	Stanton street.....		— 42	
3	24th and 25th streets (between)		— 45	
4	25th street.....		— 65	
5	26th street.....		— 60	
6	27th street (produced)		— 35	
7	91st street		— 15	
8	91st and 92d streets (between)		— 35	
9	94th street.....		— 35	
10	95th street.....		— 85	
11	96th street.....		—115	
12	99th street.....		— 98	
13	100th street.....		— 70	
14	101st street		— 75	
15	103d street.....		— 40	
16	104th street.....		— 35	
17	107th and 108th streets (between)		— 65	
18	110th street.....		— 45	
19	116th street.....		— 25	
20	120th and 121st streets (between)		— 15	
21	121st street		— 18	
22	123d street.....		— 20	
23	123d and 124th streets (between)		— 20	

^a New York department of docks.

Summary of records of borings made in New York and vicinity—Continued.

1. BORINGS BENEATH CHANNELS ON WATER FRONT—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
EAST RIVER FRONT—continued.				
<i>At bulkhead line (4-inch borings).^a</i>				
Pier—				
24	1, Battery	— 23.99	— 26	Granite.
25	2, Whitehall street	— 18.77	— 21	Do.
26	3, Coenties slip	— 20.94	— 23	Syenitic granite.
27	9, between Coenties and Old slips.	— 29.93	— 32	Do.
28	12, Old slip	— 30.95	— 33	Do.
29	15, Wall street	— 53.23	— 56	Granite.
30	18, Maiden lane	—159.89	—162	Do.
31	19, Fletcher street	—142.7	—145	Gneiss.
32	21, Burling slip	—135.91	—138	Granite.
33	24, near Peck slip	—146.62	—149	Do.
34	28, near Roosevelt street	— 98.06	—100	Do.
35	Brooklyn Bridge	— 75	— 73	Do.
36	33 and 34 (between), near Catherine slip.	—108.79	—111	Do.
37	37, Market slip	— 85.28	— 88	Do.
38	41, Pike slip	— 90.99	— 93	Do.
39	43 (old), Rutgers slip	—109.43	—112	Do.
40	46 (old), Jefferson street	— 51	— 53	Do.
41	49 (old), near Clinton street	— 30.86	— 33	Do.
42	52 (old), Gouverneur slip	— 66.56	— 69	Do.
<i>Miscellaneous.^b</i>				
North line of 80th street—				
43	7 feet east of bulkhead line	— 24	— 26	
44	32 feet west of bulkhead line	— 10	— 12	
Half block south of 81st street—				
45	23 feet east of bulkhead line	— 15	— 17	
46	18 feet west of bulkhead line	— 13	— 15	
South line of 81st street—				
47	48 feet east of bulkhead line	— 10	— 12	
48	7 feet west of bulkhead line	— 5	— 7	

^aNew York department of docks; 4-inch borings. No. 31, top micaceous gneiss; core 10 feet 6 1/4 inches in length.

^bNew York department of docks. Records 45-49 from a series of 32 borings, being, in the order given, Nos. 22, 18, 13, 11, and 4 of such series.

Summary of records of borings made in New York and vicinity—Continued.

1. BORINGS BENEATH CHANNELS ON WATER FRONT—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		Asgiven.	Referred to U. S. datum, Sandy Hook.	
EAST RIVER FRONT—continued.				
<i>Miscellaneous—Continued.</i>				
30 feet north of 81st street—				
49	4 feet east of bulkhead line . . .	— 19	— 21	
South line of 91st st. (produced)—				
50	25 feet east of bulkhead line . . .	— 35	— 37	
51	35 ft. south and 45 ft. east of 50.	— 14	— 16	
52	150 ft. south and 5 ft. west of 51. . .	— 20	— 22	
53	40 feet east of 52	— 20	— 22	
54	10 feet east of 53	— 40	— 42	Fine brown sand.
55	460 feet south and 10 feet east of 51.	— 17	— 19	
EAST RIVER SECTIONS.				
<i>East River Gas Company's tunnel.^a</i>				
New York bulkhead—				
56	100 feet west of line		—106	Gneiss.
57	Center of west channel		—108	Mica schist.
Blackwells Island—				
58	West shore		—111	Gneiss.
59	East shore		—114	Do.
60	Center of east channel		—116	Limestone.
Long Island City—				
61	100 feet east of shore		—118	Gneiss.
<i>East River bridge No. 2.^b</i>				
Brooklyn tower,—				
62	Center line of bridge (D)	— 85.0	} — 81	Gneiss.
63	(B)	— 80.4		
64	North edge of pier (M)	—104.27	} —101	Do.
65	(K)	—102.30		
66	South Pier (D)	— 85.0	} — 81	Do.
67	(B)	— 80.4		
68	(C ₂)	— 89.4		
69	(H ₂)	— 81		

^a Aims, Walter J., Jour. Assoc. Eng. Soc., vol. 14, 1895, p. 409, pl.^b New York department of bridges. Diamond-drill borings; datum, mean high water.

Summary of records of borings made in New York and vicinity—Continued.

1. BORINGS BENEATH CHANNELS ON WATER FRONT—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
EAST RIVER SECTIONS—continued.				
<i>East River bridge No. 2—Continued.</i>				
New York tower—				
70	North pier (F)	— 54.5	} — 50	Gneiss.
71	(H)	— 54.5		
72	(A)	— 45		
73	(C)	— 56		
74	South pier, northeast corner (D) ..	— 71	— 69	Do.
75	East end (K)	— 56.9	} — 56	Do.
76	(B)	— 60		
77	Pierhead line 175 feet south of K (C).	— 73.5	— 71	Do.
<i>East River bridge No. 3. a</i>				
Manhattan tower—				
78	850 feet north of (anchorage) ..	.....	— 76	Gneiss.
79	300 feet south of bulkhead line (a).	—119	—118	Do.
80	(b)	—133	—131	Do.
81	(c)	—108	—106	Do.
82	(d)	—126	—124	Do.
83	(e)	—126	—124	Do.
84	(f)	—133	—131	Marble.
85	(g)	—123	—121	Gneiss.
86	(h)	—115	—113	Do.
87	(i)	—113	—111	Do.
Brooklyn tower—				
88	200 feet north of bulkhead line ..	.....	— 92	Do.
89	850 feet south of (anchorage) ..	.....	— 70	Do.
<i>East River bridge No. 4. a</i>				
60th street pier—				
90	80 feet east of east line of avenue A.	+ 8.92	+ 11	Gneiss.
91	40 feet from east end of pier ...	— 76.05	— 74	Do.

^aNew York department of bridges. Diamond-drill borings (averages); datum, mean high water.

Summary of records of borings made in New York and vicinity—Continued.

1. BORINGS BENEATH CHANNELS ON WATER FRONT—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
EAST RIVER SECTIONS—continued.				
<i>East River bridge No. 4—Continued.</i>				
Blackwells Island pier, west bulkhead line—				
92	Boring 3	— 3.32	} — 4	Gneiss.
93	Boring 7	— 4.49		
94	Boring 1	— 12.89		
95	Center line of bridge, east bulkhead line.	+ 1	+ 3	Do.
<i>East River reefs.^a</i>				
96	Man-o'-War reef	Near datum		Gneiss.
97	Blackwells Island reef	do		Do.
98	Reef off 26th street		— 16	Do.
99	3d street		— 16	Do.
100	42d street		0	Do.
101	47th street	— 14	— 12	Do.
<i>Center line of 42d street (produced).^b</i>				
East of bulkhead line—				
101a	About 200 feet		— 99	Gneiss.
101b	About 730 feet		—108	Do.
101c	About 1,540 feet		—108	Do.
101d	About 1,950 feet		— 88	Do.
101e	About 400 feet east of 101d		— 88	Do.
101f	About middle of eastern channel.		— 94	Dolomite.
<i>Pennsylvania Railroad tunnel, foot of Flushing street, Long Island City, to near foot of 53d street, New York City.^c</i>				
102	1,750 feet east of New York bulkhead line (a).	—116	}108 —106	Rock or boulder.
103	(b)	—101		

^aHydrography of East River, U. S. Coast and Geodetic Survey.

^bNos. 101a-101f records of core borings furnished by Alan A. Robbins, resident engineer, New York and Long Island Railroad. Rock of 101a-101e, "decomposed gneiss." No. 101b is 100 feet west of Man-o'-War reef, 101c is 400 feet east of Man-o'-War reef, 101d is midway between Man-o'-War reef and the east shore, and 101e is about 500 feet west of the eastern shore. Rock of 101f, "white crystalline dolomite."

^cNoble, A., and Jacobs, C. M., chief engineers, Pennsylvania, New York and Long Island Railroad Company; wash borings.

Summary of records of borings made in New York and vicinity—Continued.

1. BORINGS BENEATH CHANNELS ON WATER FRONT—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.	
		As given.	Referred to U. S. datum, Sandy Hook.		
EAST RIVER SECTIONS—continued.					
<i>Pennsylvania Railroad tunnel, foot of Flushing street, etc.—Cont'd.</i>					
104	1,500 feet east of New York bulk-head line (a).	-103	109	-107	Rock or bowlder.
105	(b)	-115			
106	1,400 feet east of New York bulk-head line (a).	- 59	79	- 77	Do.
107	(b)	- 69			
108	(c)	- 94			
109	1,000 feet east of New York bulk-head line (a).	- 73	59	- 57	Do.
110	(b)	- 46			
111	800 feet east of New York bulk-head line.	- 77		- 75	Do.
112	600 feet east of New York bulk-head line (a).	- 97	99	- 97	Do.
113	(b)	-100			
114	560 feet east of New York bulk-head line.	- 74		- 72	Do.
115	440 feet east of New York bulk-head line.	- 95		- 93	Do.
116	320 feet east of New York bulk-head line.	-111		-109	Do.
117	Pierhead line, between 32d and 33d streets.	-110		-108	Do.
<i>New York-Brooklyn tunnel of rapid transit commission. a</i>					
East of pier 4 (foot of Broad street)—					
118	3,210 feet east of pier end.....	- 65.8		- 63	No rock.
119	2,145 feet east of pier end.....	- 65		- 63	Gneiss.
120	1,988 feet east of pier end.....	- 89.2		- 87	No rock.
121	1,558 feet east of pier end.....	-100		- 98	Do.
122	1,152 feet east of pier end.....	- 69		- 67	Gneiss.
123	857 feet east of pier end	- 62.24		- 60	Do.
124	510 feet east of pier end	- 54.8		- 52	Do.
125	End of pier.....	- 30		- 28	Do.
126	Near end of pier 3	- 27.9		- 25	Do.
127	Same as 331 (Battery series)...	- 22.2		- 16	Do.

^a Rapid transit commission. Datum mean high water.

Summary of records of borings made in New York and vicinity—Continued.

1. BORINGS BENEATH CHANNELS ON WATER FRONT—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
	HUDSON RIVER FRONT.			
	<i>Dock line.^a</i>			
	Pier—			
	A.....		— 50	
128	1 (new).....		— 50	
129	1 (old), foot of Battery place.....		— 50	
130	3 (old).....		— 43	
131	4 (old), foot of Morris place.....		— 45	
132	8 (old), foot of Rector street.....		— 42	
133	11 (old), foot of Carlisle street.....		— 40	
134	14 (old), foot of Cedar street.....		— 40	
135	16 (old), foot of Liberty street.....		— 35	
135	13 (new), foot of Cortlandt street.		— 40	
136	14 (new), between Dey and Fulton streets.		— 40	
137	15 (new), foot of Vesey street.....		— 45	
138	25 (old), foot of Barclay street.....		— 53	
139	27 (old), foot of Park place.....		— 48	
140	18 (new), foot of Murray street.....		— 50	
141	19 (new), foot of Warren street.....		— 78	
142	20 (new), foot of Chambers street.		— 88	
143	23 (new), foot of Harrison street.....		— 90	
144	25 (new), foot of North Moore street.		— 80	
145	27 (new), foot of Hubert street.....		— 83	
146	40 (old), foot of Watts street.....		— 80	
148	35 (new), foot of Spring street.....		— 80	
149	37 (new), foot of Charlton street.....		— 90	
150	39 (new), foot of Houston street.....		— 90	
151	41 (new), foot of Leroy street.....		— 90	
152	42 (new), foot of Morton street.....		—100	
153	43 (new), foot of Barrow street.....		—124	
154	64 (old), foot of Perry street.....		—100	
155	47 (new), foot of Perry street (extended).		—150	
156	48 (new), foot of 11th street.....		— 60	
157	Foot of Bank street.....		—100	

^a Depths taken from profile of rock furnished by New York department of docks.

Summary of records of borings made in New York and vicinity—Continued.

1. BORINGS BENEATH CHANNELS ON WATER FRONT—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
HUDSON RIVER FRONT—continued.				
<i>Dock line—Continued.</i>				
Pier—Continued.				
158	Foot of Bethune street		— 95	
159	12th street		— 85	
160	55 (old), foot of Horatio street		—110	
161	52 (new), foot of 22d street		—180	
162	53 (new), foot of 23d street		—175	
163	56 (new), foot of 26th street		—170	
164	Foot of 35th street		—152	
165	36th street		—105	
166	38th street		— 85	
167	39th street		-- 80	
168	44th street		— 60	
169	46th street		— 50	
170	50th street		— 40	
171	53d street		— 30	
172	56th street		— 40	
173	57th street		— 29	
174	59th street		— 55	
<i>Bulkhead line.^a</i>				
Pier—				
175	1 (old), Battery place	— 35. 2	— 38	Granite.
176	3 (old), between Battery place and Morris street.	— 40. 2	— 43	Do.
177	6 (old), near Rector street	— 42. 2	— 45	Do.
178	10 (old), near Carlisle street	— 46. 09	— 48	Mica-schist.
179	13 (old), near Albany street	— 40. 51	— 43	Syenitic granite.
180	18 (old), near Cortlandt street	— 44. 35	— 47	Do.
181	24 (old), near Vesey street	— 51. 08	-- 53	Coarse granite.
182	Barclay street ferry	— 45. 38	— 48	
Pier—				
183	28 (old), near Murray street	— 75. 44	— 78	Granite.
184	30 (old), near Chambers street	— 85. 65	— 88	Do.
185	35 (old), near Franklin street	— 78. 36	— 81	Do.

^aDepths taken from profile of rock furnished by New York department of docks. No. 183, mica-schist 8.91 feet, rest granite; 191, 4-inch boring; 192, 10 feet from end of pier; 193, 20 feet west of bulkhead line, dark sand last recorded material; 196, 15 feet east of bulkhead line; 198, 8 feet from end of pier.

Summary of records of borings made in New York and vicinity—Continued.

1. BORINGS BENEATH CHANNELS ON WATER FRONT—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
	HUDSON RIVER FRONT—continued.			
	<i>Bulkhead line—Continued.</i>			
	<i>Pier—Continued.</i>			
186	38 (old), near Hubert street . . .	— 80.11	— 83	Granite.
187	Desbrosses street	— 81.36	— 84	Do.
188	42 (old), near Canal street	— 80.08	— 82	Do.
189	45 (old), near Charlton street . . .	— 86.17	— 89	Mica-schist.
190	49 (old), near Leroy street	— 85.90	— 88	Do.
191	51 (old), Christopher street	—124	—126	Do.
192	Foot of Bethune street	—157.97	—160	Granite.
193	60 (old), foot of 13th street	—196	.....	No rock.
194	Foot of 23d street	—175.16	—177	Granite.
195	30th street	—149.41	—152	Do.
196	38th street	— 84.78	— 87	Do.
197	46th street	— 94.79	— 97	Do.
198	57th street	— 28.88	— 31	Do.
	<i>At ends of piers.^a</i>			
	<i>Pier—</i>			
199	1 (new 2)	— 50.7	— 53	
200	3 (new)	— 45.1	— 48	
201	6 (new)	— 45.3	— 48	
202	8 (new)	— 46.9	— 49	
203	11 (new)	— 46.8	— 49	
204	12 (new)	— 43.2	— 46	
205	24 (new 15)	— 48.6	— 51	
206	28 (new 18)	— 61.1	— 63	
207	30 (new 20)	— 64	— 66	
208	35 (new 24)	— 50.2	— 53	
209	39 (new 29)	— 71.1	— 74	
210	42 (new 33)	— 73	— 75	
211	45 (new 37)	— 68.6	— 71	
	<i>Miscellaneous.^b</i>			
	<i>Bulkhead line north of crib—</i>			
212	Center line of 135th street (produced).	— 90	— 92	No rock.
213	160 feet north of 135th street . . .	— 81	— 83	Do.

^aRussell, I. C., Annals New York Acad. Sci., vol. 2, 1882, pp. 66-77.^bNew York department of docks. No. 212, average of two borings 10 feet apart; 214-221 from test piling; 226 and 228 from series of 24 borings—226 on line z-z, 228 on line u-u.

Summary of records of borings made in New York and vicinity—Continued.

1. BORINGS BENEATH CHANNELS ON WATER FRONT—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
	HUDSON RIVER FRONT—continued.			
	<i>Miscellaneous—Continued.</i>			
	Center line of 97th street (produced)—			
214	30 feet east of bulkhead line...	— 55	— 57	No rock.
215	Bulkhead line.....	— 60	— 64	Do.
	130 feet north of 97th street—			
216	30 feet east of bulkhead line...	— 26	— 28	Do.
217	Bulkhead line.....	— 34	— 36	Do.
	140 feet north of 98th street—			
218	30 feet east of bulkhead line...	— 43	— 45	Do.
219	Bulkhead line.....	— 53	— 55	Do.
	30 feet north of 99th street—			
220	30 feet east of bulkhead line...	— 30	— 32	Do.
221	Bulkhead line.....	— 38	— 40	Do.
	Foot of 132d street—			
222	200 feet west of end of pier....	—128	—130	Rock or bowlder.
223	75 feet west of end of pier....	—113	—115	Do.
	Foot of 158th street, along north side—			
224	5 feet east of bulkhead line of the year 1868.	— 35	— 37	Do.
225	200 feet west of bulkhead line..	— 79	— 81	Do.
	Foot of 129th street, along south side—			
226	Dock line.....	— 10	— 12	
227	60 feet west of dock line.....	— 35	— 37	
	Foot of 128th street, along south side—			
228	Dock line.....	— 11	— 13	
229	60 feet west of dock line.....	— 25	— 27	
	Foot of 96th street, along south line of street—			
230	50 feet west of present dock....	— 60	— 62	
231	125 feet west of present dock...	— 74	— 76	
232	Seventh avenue and 155th street.	— 29	— 31	Rock or bowlder.
	Center of 154th street (produced)—			
233	50 feet east of bulkhead line...	— 38	— 40	Do.

Summary of records of borings made in New York and vicinity—Continued.

1. BORINGS BENEATH CHANNELS ON WATER FRONT—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
HUDSON RIVER SECTIONS.				
<i>Reef ½ mile west-southwest of pier A.^a</i>				
234	Government boring	— 28	— 30	
<i>Bedloe Island.^b</i>				
235	Well 150 feet north of fort.....	— 43	.....
<i>McAdoo tunnel, between 15th street, Jersey City, and Morton street.^c</i>				
From bulkhead, New York City—				
236	1,950 feet west of wall.....	—156	—154	
237	1,730 feet west of wall.....	—107.6	—105	Rock or boulder.
238	1,640 feet west of wall.....	—102.1	—100	Do.
239	1,570 feet west of wall.....	—101.7	— 99	Do.
240	1,480 feet west of wall.....	—100.4	— 98	Do.
241	1,380 feet west of wall.....	— 98.9	— 96	Do.
242	1,260 feet west of wall.....	— 96.2	— 94	Do.
243	1,215 feet west of wall.....	— 97.7	— 95	Do.
244	1,120 feet west of wall.....	— 95.9	— 93	Do.
245	1,030 feet west of wall.....	— 92.4	— 90	Do.
246	960 feet west of wall.....	— 84.8	— 82	Do.
247	830 feet west of wall.....	— 78.4	— 76	Do.
248	800 feet west of wall.....	— 84.8	— 82	Do.
249	660 feet west of wall.....	— 82.5	— 80	Do.
250	515 feet west of wall.....	—107.5	—105	Do.
<i>Pennsylvania, New York and Long Island Railroad tunnel.^d</i>				
251	850 feet west of Weehawken bulkhead line (D).	+285.4	— 13	Gneiss.
252	750 feet west of Weehawken bulkhead line (C).	+204.5	— 93	Do.
253	Weehawken pierhead line (A)...	+ 77	—221	Do.

^aGuthrie, W. L., second lieutenant, Corps of Engineers, U. S. Army.

^bLong, C. O., superintendent, American committee on Statue of Liberty. Rock containing "large quantity of mica," probably gneiss. A 6-inch hole was drilled 57 feet into the soft rock. Statue of Liberty has foundation on hardpan and boulders 15 feet below surface and 10 feet above mean high water.

^cJacobs, Chas. M., chief engineer, from borings made by C. B. Brush, C. E. Datum, mean high water. No. 236 encountered obstruction of unknown character.

^dNoble A., and Jacobs, Chas. M., chief engineers. Depths as reported referred to datum 300 feet below mean high water; Nos. 251, 252, and 253, diamond-drill (core) borings; 254-262, wash borings.

Summary of records of borings made in New York and vicinity—Continued.

1. BORINGS BENEATH CHANNELS ON WATER FRONT—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
HUDSON RIVER SECTIONS—cont'd.				
<i>Pennsylvania, New York and Long Island Railroad tunnel—Continued.</i>				
254	200 feet west of Weehawken bulkhead line (W-12). Weehawken pierhead line—	168.3	—129	Rock or boulder.
255	300 feet east of line (W-10).....	— 61.2	—237	Do.
256	700 feet east of line (W-9).....	— 42.6	—255	Do.
257	1,650 feet east of line (W-7)...	— 30	—268	Do.
258	2,000 feet east of line (W-6)...	— 24	—274	Do.
259	2,300 feet east of line (W-5)...	— 28.9	—269	Do.
260	2,600 feet east of line (W-4)...	— 43	—255	Do.
261	2,900 feet east of line (W-3)...	—115	—183	Do.
262	3,100 feet east of line (W-2)...	—148.5	—149	Do
<i>On line of proposed bridge at 59th street.^a</i>				
New York side—				
263	460 feet east of bulkhead line.....		— 28	Rock or boulder.
264	450 feet west of bulkhead line.....		—123	Do.
New Jersey side—				
265	880 feet west of bulkhead line.....		— 58	Do.
266	100 feet west of bulkhead line.....		—115	Do.
267	200 feet east of bulkhead line.....		—123	Do.
268	700 feet east of bulkhead line.....		—190	Do.
269	1,200 feet east of bulkhead line.....		—251	Do.
270	2,000 feet east of bulkhead line.....		—300	Do.
HARLEM RIVER FRONT AND SECTIONS.				
<i>Spuyten Duyvil Bridge.^b</i>				
271	First pier on Manhattan side.....		—110	Rock not known.
272	Center pier.....		—115	Do.
273	Pier at north end of swing span.....		— 90	Do.
<i>Dock line.^c</i>				
274	125th street.....	—151	—153	
275	Intersection of 155th street and Seventh avenue.	— 29	— 31	Rock or boulder.

^aMacdonald, Charles, Engineering News, vol. 33, 1895, p. 159 (wash borings).^bEngineering News, vol. 43, 1900, p. 397.^cNew York department of docks. No. 276 taken from series of 33, average of three adjacent borings; 277 from test piling.

Summary of records of borings made in New York and vicinity—Continued.

1. BORINGS BENEATH CHANNELS ON WATER FRONT—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
	HARLEM RIVER FRONT AND SECTIONS—continued.			
	<i>Dock line—Continued.</i>			
	Center of 154th street (produced)—			
276	50 feet east of bulkhead line . . .	— 38	— 40	Rock or bowlder.
277	55 feet north of south line of 138th street on bulkhead line.	— 98	—100	Do.
	<i>Washington Bridge.^a</i>			
278	200 feet west of west pier of west arch.	.....	60	Gneiss.
279	Low-water line, west side.....	.....	— 25	Do.
280	Center pier.....	.....	— 30	} Gneiss, marble, and fault rock.
281	East pier of east arch.....	.....	0	
282	200 feet east of last.....	.....	75	Do.
	<i>High Bridge.^b</i>			
283	150 feet west of west bank of river.....	.....	70	Gneiss.
284	130 feet (about) east of west bank river.	.....	— 80	Do.
285	Under central pier.....	.....	— 70	No rock.
286	200 feet east of central pier.....	.....	— 20	Marble or limestone.
287	280 feet east of east bank of river.	.....	0	} Mica-schist and gneiss.
	<i>New aqueduct.^c</i>			
	Near west shore bulkhead line—			
288	200 feet west.....	.....	100	Gneiss.
289	50 feet west.....	.....	0	Do.
290	175 feet east.....	.....	— 50	Soft rock.
	Near east bulkhead line—			
291	At line.....	.....	— 25	Limerock or marble.
292	600 feet east of line.....	.....	— 80	Soft rock.
293	750 feet east of line.....	.....	0	Do.
294	1,000 feet east of line.....	.....	50	Limerock or marble.

^a Hutton, W. R., chief engineer, "The Washington Bridge," New York, 1890, p. 21, pl. 2.^b Church, B. S., resident engineer, quoted by Dana, J. D., Am. Jour. Sci., 3d ser., vol. 21, p. 435.^c Rept. New York aqueduct commission, 1887-1895, p. 88, sheet 32. No. 292 had 20 feet and No. 293 had 40 feet of "lime rock or marble."

Summary of records of borings made in New York and vicinity—Continued.

1. BORINGS BENEATH CHANNELS ON WATER FRONT—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
HARLEM RIVER FRONT AND SECTIONS—continued.				
<i>Macomb's dam, Central Bridge. a</i>				
Near east bulkhead line—Cont'd.				
295	West pier	—30	— 33	Gneiss.
296	Central pier	—24	— 27	Do.
297	East pier	—27	— 30	Do.
<i>On line 400 feet east of Central Bridge. b</i>				
298	About 100 feet east of west shore	—27 to —29	— 30	Do.
299	Middle of river	—21 —23½	— 25	Do.
300	East shore	— 6 to — 8	— 9	Do.
301	600 feet east of east shore	—38. 2 —43. 1	— 44	Do.
302	2,400 feet east of west shore....	—74. 9	— 77	Do.
303	2,800 feet east of west shore....	—51	— 53	Do.
<i>N. Y. C. R. R. bridge.</i>				
304	Shermans Creek <i>c</i>	120	.....	No rock.
<i>145th street bridge. d</i>				
305	West approach pier	—61. 8	— 59	White marble.
306	West rest pier	—66. 7	— 64	Do.
307	Center pier	—61. 38	— 59	Do.
308	East rest pier	—63. 05	— 61	Do.
309	East approach pier	—75. 08	— 73	Hardpan.
<i>Rapid-transit tunnel. e</i>				
310	1,000 feet west of bulkhead line..	.....	— 30	Limestone.
311	600 feet west of bulkhead line....	.....	— 10	Do.
312	West bulkhead line .....	.....	— 50	Do.
313	Center of channel .....	.....	— 52	Do.
314	75 feet west of east bulkhead line.	.....	— 70	Do.
315	150 feet east of east bulkhead line.	.....	— 70	No rock.
316	300 feet east of east bulkhead line.	.....	— 60	Limestone
317	900 feet east of east bulkhead line.	.....	0	Do.

a Gay, Martin, assistant engineer, New York department of bridges.

b Department of public parks, quoted by Russell, I. C., Annals New York Acad. Sci., vol. 2, 1882, p. 75; assumes that borings are referred to mean low water.

c Chase, F. L., engineer of bridges, New York Central Railroad. Piles go down 120 feet, but do not reach rock.

d Allen, F. W., engineer for contractor.

e Rice, Geo. S., acting chief engineer, rapid transit commission.

Summary of records of borings made in New York and vicinity—Continued.

1. BORINGS BENEATH CHANNELS ON WATER FRONT—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
HARLEM RIVER FRONT AND SECTIONS—continued.				
<i>Madison avenue bridge. a</i>				
318	First pier from New York side.....	-75	- 73	No rock.
319	Central pier	-71.7	- 69	Do.
320	Pier at north end	-57.5	- 55	Do.
<i>Park avenue bridge. b</i>				
321	West shore		+ 20	Gneiss.
322	South shore (in river)		- 50	Rock or boulder.
323	Central pier		-104	Do.
324	Pier near Bronx shore		- 70	No rock.
325	50 feet north of above		+ 20	Gneiss.
<i>Third avenue bridge. c</i>				
326	South rest pier		- 49	Gneiss.
<i>Second avenue bridge. d</i>				
327	South pier		- 41	No rock.
328	Central pier		- 45	Do.
329	North bulkhead line		- 40	Do.
<i>Willis avenue bridge. e</i>				
330	Center pier		- 78	Limestone.

2. BORINGS IN THE BOROUGH OF MANHATTAN.

<i>Line of subway, on or near Broadway. e</i>				
Whitehall street—				
331	North line of South street.....	-22.2	-16	Gneiss.
Battery Park—				
332	Southeast corner Whitehall street.	-15	- 7	Do.
333	About 200 feet southwest of 332.	-12.5	- 4	Do.
334	450 feet west of 332 and 200 feet south of State street.	-32	-22	Do.

^a Boller, A. P., consulting engineer, and Eugene McLean, engineer of comptroller's office.

^b Boller, A. P., consulting engineer.

^c Byrne, E. A., assistant city engineer, New York. Other piers of Third avenue bridge at same depth as 326 rest upon boulders.

^d Croes, J. J. R., chief engineer.

^e Rice, Geo. S., acting chief engineer, rapid transit commission. Wash borings.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
<i>Line of subway, on or near Broadway—Con.</i>				
Battery Park—Continued.				
335	Corner State and Whitehall streets.	-16.5	- 9	Gneiss.
336	Pearl street.....	-20	- 8	Do.
337	Bridge street.....	-22.4	- 9	Do.
338	State street 50 feet south of Battery place.	-14.2	- 2	Do.
339	Morris street.....	-35.2	- 8	Do.
340	Exchange place.....	-51.5	-19	Do.
341	Rector street.....	-63.11	-27	Do.
342	Wall street.....	-50.1	-24	Do.
343	Pine street.....	-70	-33	Do.
344	Cedar street.....	-70.7	-34	Do.
345	Liberty street.....	-70.9	-36	Do.
346	Cortlandt street.....	-70.3	-37	Rock or bowlder.
347	Dey street.....	-76.8	-43	Do.
348	Fulton street.....	-83.2	-49	Do.
349	Vesey street.....	-81.6	-44	Do.
<i>Line of subway, on Lexington avenue.^a</i>				
350	15th street.....	- 13	26	
351	16th street.....	- 8	30	
352	17th street.....	- 8	19	
353	18th street.....	- 14	20	
354	19th street.....	- 9	23	
355	20th street.....	- 23	8	
356	21st street.....	- 35	- 6	
357	22d street.....	- 28	- 1	
358	23d street.....	- 29	- 1	
359	24th street.....	- 12	18	
360	25th street.....	- 11	19	
361	26th street.....	- 14	18	
362	27th street.....	- 8	26	
363	28th street.....	- 8	26	
364	29th street.....	- 6	26	
365	30th street.....	- 14	16	

^aRice, Geo. S., acting chief engineer, rapid transit commission. Wash borings; nature of rock not determined.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
<i>Line of subway, on Lexington avenue—Con.</i>				
366	31st street	—33	— 3	
367	32d street	— 6	24	
368	33d street	—16	19	
369	34th street.....	— 9	34	
370	35th street.....	—13	43	
371	36th street.....	—12	51	
372	37th street.....	— 3	61	
373	38th street.....	— 3	61	
374	39th street.....	—15	40	
375	40th street.....	— 8	43	
376	41st street.....	—10	34	
377	43d street	—13	32	
378	44th street.....	—18	28	
379	45th street.....	— 4.5	42	
380	46th street (120 feet east).....	— 1	45	
381	47th street.....	—15	31	
382	Halfway between 48th and 49th streets.	1	47	
383	49th street.....	— 3	46	
384	50th street.....	— 3	45	
385	51st street.....	—24	22	
386	52d street	— 3	39	
387	53d street	— 5	38	
388	54th street.....	— 5	38	
389	55th street.....	—18	25	
390	56th street.....	—27	13	
391	57th street.....	—34	7	
392	58th street.....	—33	9	Rock.
393	59th street.....	—18	27	Do.
394	60th street.....	—26	21	Do.
395	61st street.....	—11	37	Do.
396	62d street	—13	38	Do.
397	63d street	—12	40	Do.
398	64th street.....	—17	37	Do.
399	65th street.....	—41	16	Do.
400	66th street.....	—26	41	Do.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
<i>Line of subway, on Lexington avenue—Con.</i>				
401	67th street.....	— 4	69	Rock.
402	68th street.....	— 9	72	Do.
403	69th street.....	—10	73	Do.
404	70th street.....	—21	60	Do.
405	71st street.....	—20	58	Do.
406	72d street.....	—11	55	Do.
407	73d street.....	—13	50	Do.
408	74th street.....	—29	25	Do.
409	75th street.....	—22	31	Do.
410	76th street.....	—32	23	Do.
411	77th street.....	—16	42	Do.
412	78th street.....	—18	41	Do.
413	79th street.....	— 4	57	Do.
414	80th street.....	— 4	67	Do.
415	81st street.....	— 3	76	Do.
416	82d street.....	— 2	82	Do.
417	83d street.....	— 9	80	Do.
418	84th street.....	— 9	77	Do.
419	85th street.....	— 8	78	Do.
420	86th street.....	— 4	83	Do.
421	87th street.....	—10	76	Do.
422	88th street.....	—12	76	Do.
423	89th street.....	—25	63	Do.
424	90th street.....	—12	76	Do.
425	91st street.....	—18	69	Do.
426	92d street.....	— 3	90	Do.
427	93d street.....	— 9	83	Do.
428	94th street.....	— 7	80	Do.
429	95th street.....	— 6	73	Do.
430	96th street.....	—10	54	Do.
431	97th street.....	— 9	45	Do.
432	98th street.....	— 9	49	Do.
433	99th street.....	— 3	57	Do.
434	100th street.....	—10	52	Do.
435	101st street.....	— 3	49	Do.
436	102d street.....	— 8	37	Do.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
<i>Line of subway, on Lexington avenue—Con.</i>				
437	103d street	— 4	13	Rock.
438	104th street.....	—42	—30	Do.
439	105th street.....	—51	—37	Do.
440	106th street.....	—62	—44	Do.
441	107th street.....		—30	No rock.
442	108th street.....		—38	Do.
443	109th street.....		—35	Do.
444	110th street.....		—15	Do.
445	111th street.....	—45	—27	Rock.
446	112th street.....		—25	No rock.
447	113th street.....		—30	Do.
448	114th street.....	—41	—18	Rock.
449	115th street.....	—17	7	Do.
<i>Line of subway, on 110th street.^a</i>				
450	About 270 feet east of Lexington avenue.	—25	—12	Do.
451	About 60 feet west of Park avenue.	—52	—39	Do.
452	About 230 feet east of Park avenue.	—62	—48	Do.
453	About 30 feet east of Madison avenue.		—34	No rock.
454	About 160 feet west of Fifth avenue.		—44	Do.
455	About 180 feet east of Fifth avenue.	—19	— 3	Rock.
456	About 510 feet east of Fifth avenue.		—43	No rock.
457	About 90 feet west of Lenox avenue.	—70	—47	Do.
<i>Line of subway, on 34th street.^a</i>				
458	West side of First avenue.....	—27	—18	Rock.
459	About 325 feet east of Second avenue.	— 4	10	Do.
460	About 275 feet east of Second avenue.	—22	— 7	Do.
461	About 50 feet east of Second avenue.	—28	—11	Do.
462	About halfway between Second and Third avenues.	—24	— 1	Do.

^aRice, Geo. S., acting chief engineer, rapid transit commission. Wash borings; nature of rock not determined.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
<i>Line of subway, on 34th street—Continued.</i>				
463	East side of Third avenue	— 2	25	Rock.
464	Fourth avenue.....	— 9	34	Do.
465	Middle of Park avenue	—5 to 29	46 to 60	Do.
466	Madison avenue	— 2	43	Do.
467	Fifth avenue	— 0	52	Do.
468	About halfway between Fifth avenue and Astor court.	— 21	30	Do.
469	About halfway between Astor court and Sixth avenue.	— 15	34	Do.
470	West side of Broadway.....	— 6	40	Do.
471	About 300 feet east of Seventh avenue.	— 2	40	Do.
472	Seventh avenue.....	— 2	39	Do.
473	About halfway between Seventh and Eighth avenues.	— 32	6	Do,
474	Eighth avenue.....	— 31	4	Do.
475	About 400 feet east of Ninth avenue.	— 11	31	Do.
476	Ninth avenue.....	— 10	37	Do.
<i>Profile along Broadway—Barclay street to 33d street.^a</i>				
477	Barclay street	— 10. 15	65	Rock or boulder.
478	Park place	—112. 5	— 75	Do.
479	Murray street	—113. 5	— 75	Do.
480	Warren street	—109. 2	— 71	Do.
481	Chambers street	—100. 75	— 65	Do.
482	Reade street.....	—116	— 82	Do.
483	Duane street.....	—167. 25	—131	Do.
484	Thomas street	—138. 5	—104	Do.
485	Worth street	—147. 5	—110	Do.
486	Leonard street.....	— 95	— 60	Do.
487	Franklin street	— 83. 45	— 53	Do.
488	White street.....	—105. 5	— 80	Do.
489	Walker street.....	—107. 2	— 88	Do.
490	Lispenard street	— 68. 25	— 55	Do.
491	Canal street	— 87. 5	— 74	Do.

^a Parsons, W. B., Trans. Am. Soc. Civil Eng., vol. 28, 1893, pp. 13-18, pl. 6.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
	<i>Profile along Broadway—Barclay street to 33d street—Continued.</i>			
492	Howard street.....	— 50	— 35	Rock or bowlder.
493	Grand street.....	— 70.8	— 56	Do.
494	Broome street.....	— 47.5	— 22	Do.
495	Spring street.....	— 70.1	— 38	Do.
496	Prince street.....	— 70	— 32	Do.
497	Houston street.....	—105.6	— 63	Do.
498	Bleecker street.....	— 66.15	— 23	Do.
499	Bond street.....	— 68.65	— 27	Do.
500	3d street.....	— 53.01	— 13	Do.
501	4th street.....	— 40.1	2	Do.
502	Washington place.....	— 34.45	9	Do.
503	Waverly place.....	— 48.85	— 8	Do.
504	Astor place.....	— 50 ^a	.....	Do.
505	Clinton place.....	— 65.25	— 27	Do.
506	9th street.....	— 35.25	5	Do.
507	10th street.....	— 40.33	2	Do.
508	11th street.....	— 31.15	13	Do.
509	12th street.....	— 22	23	Do.
510	13th street.....	— 34	9	Do.
511	14th street.....	— 13.25	30	Gneiss.
512	17th street.....	— 10.15	34	Do.
513	18th street.....	.....	31	Do.
514	19th street.....	.....	29	Do.
515	20th street.....	.....	27	Do.
516	21st street.....	— 17	25	Do.
517	22d street.....	.....	22	Do.
518	23d street.....	— 21.5	19	Do.
519	24th street.....	.....	18	Do.
520	25th street.....	— 24	19	Do.
521	26th street.....	.....	21	Do.
522	27th street.....	— 19.2	24	Do.
523	28th street.....	.....	26	Do.
524	29th street.....	.....	28	Rock or bowlder.
525	30th street.....	— 16.7	29	Do.

^a From profile; no figure given.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
<i>Profile along Broadway—Barclay street to 33d street—Continued.</i>				
526	31st street .....	.....	33	Rock or bowlder.
527	32d street .....	.....	37	Do.
528	33d street	-40	41	Do.
<i>Foundations of tall buildings.</i>				
529	New custom-house, Battery place. ^a	-32 to -40	.....	Gneiss.
530	Battery place building, between West and Washington streets. ^b	{ -52 } -43	-41	Do.
531	Hallenbeck building, Park and Pearl streets. ^c	-40	-25	Rock not sounded.
532	Corn Exchange (addition), Beaver and Williams streets. ^d	-35	-19	Rock, presumably gneiss.
533	Blair building, Broad street and Exchange place. ^e	-45	-29	Rock.
534	Broad-Exchange, southeast corner Exchange place and Broad street. ^b	{ -41 } -49.6 } -48.8 }	-46 -31	Gneiss.
535	Wall Street Exchange, north side Exchange place, between Williams and Broad streets. ^b	{ -41.1 } -43.6 } -46.5 } -42.3 }	-43 -26	Do.
536	Bank of State of New York, Exchange place, between Broad and Williams streets. ^f	-40	-22	Do.
537	New York Stock Exchange, Broad street, near Wall street. ^g	-60	-29	Do.
538	Atlantic Mutual building, Wall and Williams streets. ^h	-51 to -55	-22 to -26	Do.
539	Hanover National Bank, Pine and Nassau streets. ⁱ	-28 to -48	6 to -14	Rock.

^aFry, Capt. A. B., chief engineer and superintendent United States public buildings No. 156, post-office building.

^bPurdy, C. T., consulting engineer, Geo. A. Fuller Construction Company.

^cEngineering Record, vol. 47, 1903, p. 377.

^dRobertson & Potter, architects, 160 Fifth avenue, Engineering Record, vol. 45, 1902, p. 557.

^eEngineering Record, vol. 46, 1902, p. 227. Rock believed to be gneiss.

^fIdem, p. 299.

^gIdem, p. 155. Maximum depth below new street curb.

^hIdem, vol. 42, 1900, pp. 157-158.

ⁱIdem, vol. 45, 1902, p. 298. Rock presumably gneiss.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
<i>Foundations of tall buildings—Cont'd.</i>				
540	Johnston building, southwest corner Broad street and Exchange place. ^a	— 35	—19	Rock.
541	Empire building, 71 Broadway, near Rector street. ^b	— 54	—19	No rock.
542	Gillender building, northwest corner Wall and Nassau streets. ^c	70	—45	Rock.
543	New York Stock Exchange, Broad and New streets. ^d	— 60	—29	Do.
544	Stokes building, Williams and Cedar streets. ^e	— 48	—22	Do.
545	Mutual Life building, Nassau, Liberty, and Cedar streets. ^f Broadway—	—100	—63	Do.
546	Washington Life building, between Cedar and Liberty streets. ^b	— 75	—40	No rock.
546a	Southwest corner Walker street. ^g	— 39	—19	Do.
546b	Plot 476 (near Grand and Broome streets).	— 39	.....
546c	Southeast corner 20th street....	— 33 to —22	21 to 10	Rock or boulder.
546d	Lot 438 West 39th street (south side, between Ninth and Tenth avenues).	— 15 to —19	.....	Do.
546e	Bowery, northwest corner Spring street.	— 39	.....	No rock.
547	Park Row building, ^h 13 Park row. ⁱ	— 86	—47	Rock or boulder.
548	American Tract Society building, Nassau and Spruce streets. ^h	—100	.....	No rock.
549	Morse building, Nassau and Beekman streets. ^j	— 35.5	— 6.5	Do.
550	Standard building, Broadway and New street. ^k	— 45	—14	Rock.

^a Engineering Record, vol. 32, 1895, p. 117.^b Gratacap, L. P., Geol. City of New York, pp. 10-12.^c Engineering Record, vol. 35, 1897, p. 140. Rock, presumably gneiss.^d Idem, vol. 44, 1901, p. 289. Average depth below new street curb. Rock and hardpan.^e Idem, vol. 34, 1896, p. 184. Rock, presumably gneiss.^f Idem, vol. 45, 1902, p. 368. (Maximum.)^g Records 546a-546e furnished by Mr. Robert Maynicke, architect, 725-727 Broadway.^h Robertson & Potter, architects, 160 Fifth avenue.ⁱ Engineering Record, vol. 38, 1898, p. 166.^j Idem, vol. 44, 1901, p. 422.^k Idem, vol. 34, 1896, pp. 107-108. Average depth; rock presumably gneiss.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook:	
<i>Foundations of tall buildings—Cont'd.</i>				
551	American Exchange National Bank, Broadway and Cedar street. ^a	— 70	—33	Rock.
552	Exchange court building, 52-56 Broadway. ^b	.....	—16	No rock.
553	Manhattan Life building, 64-68 Broadway, between Exchange place and Wall street. ^c	— 43	— 9	Gneiss.
554	American Surety building, Broadway and Pine street. ^d	— 68	—30	Do.
555	R. G. Dun building, northeast corner Broadway and Reade streets. ^e	—105	—83	Rock.
556	Meyer-Jonassen building, Broadway and 12th street. ^f	—25 to —55	19 to —11	Mica-schist.
557	Decker building, northwest corner 16th street and Union square. ^g	—15	26	Rock.
558	Warehouse building, 6 east 18th street, near Fifth avenue. ^h	—37	3	No rock.
559	Flatiron building, 22d to 23d streets, between Fifth avenue and Broadway. ⁱ	—35	.....	Rock.
560	Siegel-Cooper building, Sixth avenue, 18th to 19th streets. ^j	—16 to —28	17 to — 5	Do.
561	Hospital, Second avenue, 17th to 18th streets. ^k	—22.5	0	Do.
562	Y. M. C. A. building, 23d and 24th streets and Fourth avenue. ^l	— 4 to —16	17 to —29	Gneiss.
563	Court of Appeals building, Madison avenue and 25th street. ^m	— 7.2	29	Do.

^a Engineering Record, vol. 40, 1899, p. 463. "Rock or hardpan."
^b Idem, vol. 38, 1898, pp. 35-36. Piles driven 50 feet.
^c Gratacap, L. P., Geol. City of New York, pp. 10-12; about 50 feet according to Engineering Record, vol. 30, 1894, p. 189.
^d Engineering Record, vol. 33, 1896, p. 81; —71 according to Gratacap, L. P., Geol. City of New York, pp. 10-12.
^e Idem, vol. 37, 1898, p. 211. "Rock or hardpan."
^f Idem, vol. 33, 1896, p. 315. Very irregular surface, varies 6 to 8 feet in distances of 15 feet. About the middle of the building there was a kind of pocket in the rock, a V-shaped section about 40 feet wide at top and 10 feet deep, beginning near the south side of the site and running northwest, so that the rock surface sloped in three directions. Rock "rotten mica-schist."
^g Idem, vol. 45, 1902, p. 442. Rock presumably gneiss.
^h Idem, p. 87.
ⁱ Idem, p. 298. Cellar excavated to this depth.
^j Idem, vol. 34, 1896, p. 315. Rock presumably gneiss.
^k Robertson, R. H., architect, 160 Fifth avenue.
^l Boller & Hodge, engineers, 1 Nassau street.
^m Wills, Chas. T., builder, 156 Fifth avenue. (Average depth.)

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
<i>Foundations of tall buildings—Cont'd.</i>				
564	Park Realty building, 63d street and Madison avenue. ^a	—30 to —40	.....	Rock.
565	Fabbri residence, East 62d street near Fifth avenue. ^b	—30 to —40	23 to 13	Do.
566	Ansonia Hotel, 23d street and Broadway, near curb. ^c	—72	—35	
567	Hotel Belmont, southwest corner Park avenue and 42d street, near curb. ^d	—20	33	
568	Center 41st street opposite Hotel Belmont, on west side Park avenue. ^d	— 5	58	
569	Macy building, 34th and 35th streets on Broadway. ^e	—26	21	
570	Imperial Hotel extension, Broadway between 31st and 32d streets. ^f	— 3 to —30	39 to 12	
Fifth avenue <i>g</i> —				
570a	North west corner 14th street...	—11 to —22	25 to 14	Rock or boulder.
570b	Plots 87-89, between 16th and 17th streets.	—12 to —21	29 to 20	Do.
570c	Northeast corner 17th street ...	—19 to —28	21 to 12	Do.
570d	Southeast corner 17th street ...	—18 to —23	23 to 18	Do.
570e	Southeast corner 18th street ...	—19 to —36	20 to 3	Do.
570f	Northwest corner 18th street ..	—17 to —27	23 to 13	Do.
570g	Southwest corner 18th street ..	—12 to —31	28 to 9	Do.
570h	Southwest corner 19th street ..	—23 to —27	17 to 13	Do.
570i	Northwest corner 19th street ..	—21 to —32	19 to 8	Do.
570j	Lot 137 (28½ feet north of 20th street).	—34 to —43	7 to —2	Soft rock.
570k	Southeast corner 20th street ...	—33 to —36	9 to 6	Do.
570l	Southwest corner 22d street....	—30 to — 34	8 to 4	Rock or boulder.
570n	Northwest corner 52d street....	—37 to —44	8 to 1	Do.

^a Engineering Record, vol. 44, 1901, p. 12. Below the bottom of the cellar of the old building which formerly occupied the site. Rock presumably gneiss.

^b Idem, vol. 39, 1898, p. 31. Old stream valley. Rock presumably gneiss.

^c Idem, vol. 47, 1902, pp. 50-51. "Cellar excavated in solid rock;" depths approximate.

^d Idem, p. 146. "Rock surface rises toward south at steep angle."

^e Idem, vol. 48, 1903, p. 332. (Maximum.)

^f Idem, vol. 49, 1904, p. 484. Surface "very irregular, dropping vertically several feet in a number of the pits. Many seams were encountered which were filled with chlorite of the consistency of soft putty."

^g Records 570a-570z furnished by Mr. Robert Maynicke, architect, 725-727 Broadway, New York City.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
<i>Foundations of tall buildings—Cont'd.</i>				
West of Fifth avenue—				
570p	60 feet on 17th street, north side	— 20	20	Rock or boulder.
570g	184 feet west of 570g	— 24	15	Do.
570r	335 feet west of 570f	— 25	14	Do.
570s	65 feet west of 570f	— 25	14	Do.
570t	220 feet on 19th street	— 24	15	Do.
570u	320 feet west of 570h	— 21	18	Do.
570v	125 feet west of 570t	— 25	14	Do.
570x	400 feet west of 570h	— 21	18	Do.
570y	245 feet on 20th street	— 18	11	Do.
570z	100 feet west of 570y	— 16	23	Rock.
<i>On line of 31st street,^a</i>				
Near Ninth avenue—				
571	20 feet east of east line (core)	336.1	39	Gneiss.
572	250 feet east of east line (core)	329.4	32	Do.
573	500 feet east of east line (core)	287.6	— 10	Do.
574	740 feet east of east line	304	6	Do.
Near Eighth avenue—				
575	90 feet east of east line	290.4	— 7	Do.
576	420 feet east of east line	290.3	— 7	Do.
577	580 feet east of east line	304.5	7	Do.
578	740 feet east of east line	313.9	16	Do.
<i>On line of 32d street.</i>				
Near Twelfth avenue—				
579	East side (core)	187.3	—110	Gneiss.
580	300 feet east of east line (core)	235.7	— 62	Do.
581	Bulkhead line (D-1)	181.9	—116	Do.
582	Near Eleventh avenue, west line.	289.6	— 8	Do.
583	East line	289.8	— 8	Do.
584	300 feet east of east line	303	— 15	Do.

^a Records 571-657 on 31st, 32d, 33d, and 34th streets reported by A. Noble and Chas. M. Jacobs, chief engineers. Depths referred to datum 300 feet below mean high water, except 597-620 and 629-654 referred to mean high water. Nos. 574-578, 581-596, and 621-628 are borings by Davis calyx drill.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
	<i>On line of 32d street—Continued.</i>			
	Near Tenth avenue—			
585	150 feet west of west line	290.9	— 7	Gneiss.
586	150 feet east of east line	320.9	23	Do.
587	400 feet east of east line	335	37	Do.
588	700 feet east of east line	340.9	43	Do.
	Near Ninth avenue—			
589	120 feet east of east line	320.6	23	Do.
590	350 feet east of east line	327.8	30	Do.
591	550 feet east of east line	323.6	26	Do.
592	720 feet east of east line	311.8	14	Do.
	Near Eighth avenue—			
593	90 feet east of east line	292	— 6	Do.
594	340 feet east of east line	282.8	— 15	Do.
595	550 feet east of east line	311.3	14	Do.
596	760 feet east of east line	321.1	24	Do.
597	Near Fifth avenue, west line (wash).	— 1	3	Rock or bowlder.
598	Halfway to Broadway (core) ..	— 38	40	Gneiss.
599	Near Sixth avenue, west line (wash).	— 10	12	Rock or bowlder.
600	200 feet west of west line (core).	— 31	33	Gneiss.
601	Half block west (core)	— 14	16	Do.
602	Seventh avenue, east line (core) ..	— 30	32	Do.
603	Third avenue, west line (wash) ..	— 2	4	Rock or bowlder.
604	Halfway to Lexington avenue (wash).	— 15	— 13	Do.
605	Lexington avenue (core)	— 8	} 10	Gneiss.
606	Wash	— 8		
607	Fourth avenue, east line (core) ..	— 0	2	Do.
608	West line (wash)	{ — 12	} 6	Rock or bowlder.
		{ — 5		
609	Halfway to Madison avenue (wash).	— 7	9	Do.
610	Madison avenue (core)	— 21	} 28	Gneiss.
611	Wash	— 30		
612	Halfway to Fifth avenue (core) ..	— 2	0	Do.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
<i>On line of 32d street—Continued.</i>				
613	Fifth avenue, east line (core)	— 0	2	Gneiss.
614	First avenue, west line (core) . . .	— 13	15	Do.
615	Halfway to Second ave. (wash) . . .	— 3	5	Rock or bowlder.
616	Second avenue (core)	{ 0 — 7} 3.5	6	Gneiss.
617	Halfway to Third avenue (wash) . . .	— 16	— 14	Rock or bowlder.
618	Third avenue, east line (core) . . .	— 1	3	Gneiss.
619	Bulkhead line, foot of 32d street (core).	—112	—110	Do.
620	First avenue, 100 feet east of east line (core).	— 4	— 2	Do.
<i>On line of 33d street.</i>				
Near Ninth avenue—				
621	20 feet east of east line	334.4	37	Gneiss.
622	240 feet east of east line	324.4	27	Do.
623	475 feet east of east line	332.7	35	Do.
624	720 feet east of east line	322.6	25	Do.
Near Eighth avenue—				
625	70 feet east of east line	282.5	— 15	Do.
626	370 feet east of east line	286.9	— 11	Do.
627	570 feet east of east line	330	32	Do.
628	770 feet east of east line	334.2	37	Do.
629	Near Fifth avenue, west line (core).	— 23	25	Do.
630	100 feet west of west line (wash) . . .	— 3	5	Rock or bowlder.
631	600 feet west of west line (core) . . .	— 15	17	Gneiss.
632	Broadway, east line (core)	— 34	36	Do.
633	Near Sixth avenue, west line (wash) . . .	— 32	34	Rock or bowlder.
634	500 feet west of west line (wash) . . .	— 2	26	Do.
635	575 feet west of west line (core) . . .	— 5	5	Gneiss.
636	Seventh avenue, east line (wash) . . .	— 56	38	Rock or bowlder.
637	Near Third avenue, west line (wash).	— 3	5	Do.
638	Half block west (wash)	— 6	8	Do.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.	
		As given.	Referred to U. S. datum, Sandy Hook.		
<i>On line of 53d street—Continued.</i>					
639	Near Lexington avenue (wash) ..	— 22	}20	22	Gneiss.
640	Core	— 18			
641	Half block west (core)	— 11		13	Do.
Near Fourth avenue—					
642	100 feet west of west line (core) ..	— 41		43	Do.
643	Madison avenue (wash)	— 24	}25	27	Do.
644	Core	— 26			
645	Fifth avenue, east line (wash) ...	— 36		38	Rock or boulder.
646	Near First avenue (core)	— 13		— 11	Gneiss.
647	Halfway to Second avenue (wash).	— 5		— 3	Rock or boulder.
648	Near Second avenue, east line (wash).	— 24		— 22	Do.
649	West line (core)	— 2		4	Gneiss.
650	Halfway to Third avenue (wash)	— 1		1	Rock or boulder.
651	Third avenue, east line (core) ...	— 9		11	Gneiss.
652	Bulkhead line (core)	— 96		— 94	Do.
653	First avenue, east line	— 21		— 19	Do.
654	Pierhead line	—163		—161	No rock.
<i>On line of 34th street.</i>					
655	Pierhead line (wash)	—140		—138	Rock or boulder.
656	First avenue, 100 feet east of east line (core).	— 32		— 30	Gneiss.
657	West side, 75 feet south of south line 34th street (core).	— 10		— 8	Do.
<i>Along Fourth avenue,^a</i>					
658	14th street	— 10		35	Gneiss.
659	15th street	— 8		35	Do.
660	16th street	— 10		30	Do.
661	17th street	— 15		25	Do.
662	18th street	— 15		23	Do.
663	19th street	— 10		23	Do.
664	20th street	— 9		23	Do.
665	21st street	— 17		15	Do.
666	22d street	— 23		10	Do.

^aGraether, L. F., Atlas of building laws of United States, New York, vol. 1, pl. 2. Depths (circa) scaled from section. Rock, gneiss interstratified with granite and anthophyllite.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
<i>Along Fourth avenue—Continued.</i>				
667	23d street	-27	3	Gneiss.
668	24th street	-30	0	Do.
669	25th street	-20	10	Do.
670	26th street	-17	16	Do.
671	27th street	-15	25	Do.
672	28th street	-12	24	Do.
673	29th street	-17	23	Do.
674	30th street	-25	15	Do.
675	31st street	-30	8	Do.
676	32d street	-15	25	Do.
677	33d street	- 8	35	Do.
678	34th street	- 5	57	Do.
679	35th street	0	70	Do.
<i>Riverside Park extension. a</i>				
Twelfth avenue—				
680	Southwest corner 137th street..	-27	-15	Rock or bowlder.
681	3 feet west of 680	-31. 50	-19	Do.
682	100 feet north of 680	-32	-20	Do.
683	Southeast corner 138th street..	-41. 50	-29	Do.
684	Northeast corner 138th street..	-44. 66	-31	Do.
685	160 feet southeast of 684	-38	-26	Do.
686	100 feet east of 685	-27. 50	-16	Do.
687	160 feet northeast of 684	-29	-17	Do.
688	100 feet north of 687	-33	-21	Do.
689	100 feet north of 684	-27	-15	Do.
690	Northeast corner 139th street..	- 8	4	Do.
691	2 feet west of 690	-10	2	Do.
692	2 feet east of 690	- 8. 50	3	Do.
693	100 feet north of 139th street..	-11	1	Do.
694	3 feet west of 693	-15	- 3	Do.
695	140th street	-32	-20	Do.
696	100 feet north of 695	-37. 16	-26	Do.
697	141st street	-15	- 3	Do.
698	3 feet north of 697	-15	- 3	Do.

^a Williamson, F. S., consulting engineer, 25 Broad street; wash borings.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
	<i>Riverside Park extension—Continued.</i>			
	<i>Twelfth avenue—Continued.</i>			
699	3 feet north of 698	-18.50	- 7	Rock or bowlder.
700	50 feet north of 697	-12.33	1	Do.
701	8 feet east of 700	-18.50	- 7	Do.
702	2 feet east of 701	-18	- 6	Do.
703	50 feet north of 700	-17	- 5	Do.
704	55 feet north of 697	-28.50	-17	Do.
705	4 feet north of 704	-16.75	- 5	Do.
706	50 feet north of 705	-13	- 1	Do.
707	142d street	-33.50	-22	Do.
708	70 feet north of 707	-31.16	-19	Do.
709	30 feet north of 708	-29	-17	Do.
710	100 feet north of 707	-18.75	- 7	Do.
711	50 feet north of 710	-33	-21	Do.
712	50 feet north of 711	-28.33	-16	Do.
713	143d street	-25	-13	Do.
714	4 feet south of 713	-22.5	-11	Do.
715	25 feet north of 713	-26.66	-15	Do.
716	50 feet north of 715	-12	0	Do.
717	5 feet north of 716	-11	- 1	Do.
718	25 feet north of 717	- 8.50	3	Do.
719	100 feet north of 713	- 8	4	Do.
720	25 feet north of 719	- 8	4	Do.
721	25 feet north of 720	- 8	4	Do.
722	5 feet north of 721	- 9.16	3	Do.
723	5 feet east of 722	-11.50	0	Do.
724	20 feet north of 722	- 8.33	4	Do.
725	5 feet north of 724	- 5	7	Do.
726	25 feet north of 725	- 6	6	Do.
727	144th street	- 8	4	Do.
728	5 feet north of 727	- 9.50	2	Do.
729	25 feet north of 728	- 9.16	3	Do.
730	25 feet north of 729	- 8	4	Do.
731	25 feet north of 730	- 8.50	3	Do.
732	100 feet north of 727	- 9	3	Do.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
<i>Riverside Park extension—Continued.</i>				
<i>Twelfth avenue—Continued.</i>				
733	10 feet north of 732	— 8.50	3	Rock or boulder.
734	25 feet north of 733	—12.50	— 1	Do.
735	50 feet north of 734	— 9.66	2	Do.
736	Southeast corner 145th street ..	— 9	3	Do.
737	25 feet north of 736	— 7.50	4	Do.
738	5 feet north of 737	— 7	5	Do.
739	25 feet north of 738	— 6	6	Do.
740	5 feet north of 739	— 5.50	6	Do.
741	25 feet north of 740	—13.33	— 1	Do.
742	25 feet north of 741	—10.33	2	Do.
743	Northeast corner 145th street ..	— 7.33	5	Do.
744	25 feet north of 743	— 6.50	5	Do.
745	25 feet north of 744	— 7	5	Do.
746	25 feet north of 745	— 8.50	3	Do.
747	100 feet north of 743	—10.16	2	Do.
748	25 feet north of 747	— 8.66	3	Do.
749	25 feet north of 748	—12.33	0	Do.
750	25 feet north of 749	—15	— 3	Do.
751	146th street	— 8.33	4	Do.
752	50 feet north of 751	—12.50	— 1	Do.
753	25 feet north of 752	—15.66	— 4	Do.
754	100 feet north of 751	—16	— 4	Do.
755	25 feet north of 754	—14.50	— 3	Do.
756	25 feet north of 755	—12	0	Do.
757	147th street	—14.50	— 3	Do.
758	25 feet north of 757	—19.16	— 7	Do.
759	25 feet north of 758	—17.50	— 6	Do.
760	100 feet north of 757	—18.50	— 7	Do.
761	50 feet north of 760	—21.50	—10	Do.
762	148th street	—19.50	— 9	Do.
763	25 feet north of 762	—15	— 3	Do.
764	25 feet north of 763	—10.50	— 1	Do.
765	25 feet north of 764	— 9.16	3	Rock in sight.
766	100 feet north of 762	— 2	10	Do.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
	<i>Riverside Park extension—Continued.</i>			
	<i>Twelfth avenue—Continued.</i>			
767	50 feet north of 766	— 2	10	Rock in sight.
768	25 feet north of 767	— 2	10	Do.
769	149th street.....	0	12	Do.
770	25 feet north of 769	— 4	8	Do.
771	12 feet north of 770	— 4.50	7	Rock or bowlder.
772	25 feet north of 771	— 5.50	6	Do.
773	13 feet north of 772	— 4.50	7	Do.
774	25 feet north of 773	— 5.50	6	Do.
775	100 feet north of 769	— 5	7	Do.
776	25 feet north of 775	— 5.16	7	Do.
777	25 feet north of 776	— 5.50	6	Do.
778	25 feet north of 777	— 5.33	7	Do.
779	25 feet north of 778	— 6.50	5	Do.
780	150th street	— 4.50	7	Do.
781	25 feet north of 780	— 4.66	6	Do.
782	25 feet north of 781	— 5	6	Do.
783	25 feet north of 782	— 4	7	Do.
784	100 feet north of 780	— 3.66	7	Do.
785	25 feet north of 784	— 5	6	Do.
786	25 feet north of 785	— 5.33	6	Do.
787	25 feet north of 786	— 4.50	6	Do.
788	151st street.....	— 4.66	5	Do.
789	25 feet north of 788	— 5	5	Do.
790	25 feet north of 789	— 3	7	Do.
791	3 feet north of 790	— 3.50	6	Do.
792	22 feet north of 791	— 5.16	5	Do.
793	25 feet north of 792	— 5	5	Do.
794	125 feet north of 788	— 4.66	5	Do.
795	25 feet north of 794	— 5.50	4	Do.
796	25 feet north of 795	— 7	3	Do.
797	25 feet north of 796	— 6.16	4	Do.
798	Southeast corner 152d street...	— 5.50	2	Do.
799	25 feet north of 798	— 7.50	0	Do.
800	6 feet north of 799	— 8	0	Do.

Summary of records of borings made in New York and vicinity—Continued

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
<i>Riverside Park extension—Continued.</i>				
Twelfth avenue—Continued.				
801	19 feet north of 800	— 8.16	0	Rock or bowlder.
802	Northeast corner 152d street...	—10.33	— 2	Do.
803	25 feet north of 802	—10.66	— 3	Do.
804	15 feet west of 803	— 7.50	0	Do.
805	25 feet north of 802	— 9.16	— 1	Do.
806	25 feet north of 805	— 7.66	0	Do.
807	25 feet north of 806	— 8.50	— 1	Do.
808	125 feet north of 802	— 7.66	0	Do.
809	25 feet north of 808	— 8	0	Do.
810	25 feet north of 809	— 7.16	1	Do.
811	25 feet north of 810	— 8.33	0	Do.
812	Southeast corner 153d street...	—14.16	— 6	Do.
813	Northeast corner 153d street...	—22.50	—15	Do.
814	25 feet north of 813	— 7	1	Do.
815	25 feet north of 814	—19.16	—11	Do.
816	25 feet north of 815	—20	—12	Do.
817	100 feet north of 813	—12.66	— 5	Do.
818	5 feet north of 817	—17.50	—10	Do.
819	20 feet north of 818	—17	— 9	Do.
820	25 feet north of 819	—21	—13	Do.
821	25 feet north of 820	—16.50	— 9	Do.
822	25 feet north of 821	—11.16	— 3	Do.
823	4 feet west of 822	—20.66	—13	Do.
824	125 feet north of 817	—21.50	—14	Do.
825	25 feet north of 824	—23	—15	Do.
826	25 feet north of 825	— 9.16	— 1	Do.
827	3 feet west of 826	—22.50	—15	Do.
828	25 feet north of 827	—22.16	—14	Do.
829	25 feet north of 828	—21.50	—14	Do.
830	25 feet north of 829	—12	— 4	Do.
831	5 feet north of 830	—19	—11	Do.
832	25 feet north of 831	—17.50	—10	Do.
833	25 feet north of 832	—16	— 8	Do.
834	25 feet north of 833	—16.50	— 9	Do.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
<i>Riverside Park extension—Continued.</i>				
Twelfth avenue—Continued.				
835	25 feet north of 834	-22. 66	-15	Rock or boulder.
836	25 feet north of 835	-32. 16	-24	Do.
837	Southeast corner 155th street ..	-12	- 4	Do.
838	3 feet west of 837	-15	- 7	Do.
839	50 feet north of 837	-22	-14	Do.
840	70 feet east of northeast corner of 155th street.	-13. 50	- 6	Do.
841	6 feet west of 840	-20. 50	-13	Do.
842	100 feet east of 840	- 7	1	Do.
843	5 feet west of 842	- 9. 50	- 2	Do.
844	50 feet north of 842	-19. 66	-12	Do.
845	50 feet north of 841	-22. 33	-14	Do.
846	100 feet north of 840	-12	- 4	Do.
847	6 feet west of 846	-25. 50	-18	Do.
848	25 feet north of 846	-26	-18	Do.
849	25 feet north of 848	-21. 33	-13	Do.
850	25 feet north of 849	-19. 50	-12	Do.
851	Southeast corner 156th street ..	-14	- 6	Do.
852	7 feet south of 851	-22. 16	-14	Do.
853	45 feet south of 851	-22	-14	Do.
854	25 feet north of 853	-20. 33	-12	Do.
855	25 feet north of 854	- 8. 50	1	Do.
856	5 feet north of 855	-16. 66	- 9	Do.
857	20 feet north of 856	-17. 50	-10	Do.
858	25 feet north of 857	-17	- 9	Do.
859	25 feet north of 858	-16. 66	- 9	Do.
860	200 feet north of 851	-18	-10	Do.
861	25 feet north of 860	-17	- 9	Do.
862	25 feet north of 861	-19. 66	-12	Do.
863	25 feet north of 862	-13. 25	- 5	Do.
864	5 feet north of 863	-13. 50	- 6	Do.
865	20 feet north of 864	-10. 16	- 2	Do.
866	25 feet north of 865	- 8. 50	1	Do.
867	25 feet north of 866	- 5. 50	2	Do.
868	25 feet north of 867	- 6	2	Do.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
<i>Riverside Park extension—Continued.</i>				
Twelfth avenue—Continued.				
869	20 feet north of 868	— 5.33	3	Rock or boulder.
870	5 feet north of 869	— 5	3	Do.
871	25 feet north of 870	— 2	6	Do.
872	5 feet north of 871	— 3.50	4	Do.
873	25 feet north of 872	— 1.50	6	Do.
874	3 feet north of 873	— 2.66	5	Do.
875	20 feet north of 874	— 3.50	4	Do.
876	20 feet north of 875	— 5	3	Do.
877	25 feet north of 876	— 4.50	3	Do.
878	25 feet north of 877	— 4.16	4	Do.
879	Southeast corner 158th street ..	— 6.33	2	Do.
880	100 feet east of 879	— 3.75	4	Do.
881	25 feet south of 880	— 4.16	4	Do.
882	25 feet south of 881	— 5.16	3	Do.
883	25 feet south of 882	— 6	2	Do.
884	25 feet south of 883	— 5.50	2	Do.
885	25 feet south of 884	— 4.33	4	Do.
886	25 feet south of 885	— 5	3	Do.
887	175 feet south of 880	— 3.50	4	Do.
888	25 feet south of 887	— 2.66	5	Do.
889	25 feet south of 888	— 3.50	4	Do.
890	25 feet south of 889	— 5.50	2	Do.
891	25 feet south of 890	— 9.66	— 2	Do.
892	25 feet south of 891	— 6.16	2	Do.
893	15 feet west of 892	—11	— 3	Do.
894	25 feet south of 893	—11.66	— 4	Do.
895	25 feet south of 894	—12.50	— 5	Do.
896	200 feet south of 887	— 7.16	1	Do.
897	5 feet south of 896	—15.75	— 8	Do.
898	20 feet south of 897	—12.33	— 4	Do.
899	25 feet south of 898	— 6.16	2	Do.
900	20 feet south of 899	—10.50	— 3	Do.
901	25 feet south of 900	— 7	1	Do.
902	5 feet south of 901	— 5	3	Do.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
<i>Riverside Park extension—Continued.</i>				
Twelfth avenue—Continued.				
903	20 feet south of 902.....	— 5.66	2	Rock or bowlder.
904	25 feet south of 903.....	—11.50	— 4	Do.
905	5 feet south of 904.....	—12.33	— 4	Do.
906	25 feet south of 905.....	—14	— 6	Do.
907	200 feet south of 896.....	—14.50	— 7	Do.
908	25 feet south of 907.....	—15	— 7	Do.
909	25 feet south of 908.....	—16.33	— 8	Do.
910	25 feet south of 909.....	—15.16	— 7	Do.
911	25 feet south of 910.....	—16.66	— 9	Do.
912	25 feet south of 911.....	—18	—10	Do.
913	80 feet east of northeast corner 158th street.	— 8	0	Do.
914	25 feet north of 913.....	— 5.50	2	Do.
915	25 feet north of 914.....	— 8.33	0	Do.
916	25 feet north of 915.....	— 5.66	2	Do.
917	25 feet north of 916.....	— 8.16	0	Do.
918	25 feet north of 917.....	— 7.66	0	Do.
919	160 feet north of 913.....	— 5.16	3	Do.
920	100 feet east of 919.....	— 5	3	Do.
921	160 feet south of 920.....	— 3.50	4	Do.
<i>Riverside viaduct.</i>				
922	Throughout length ^a	—60	—47	No rock.
<i>Manhattan viaduct on Broadway. ^b</i>				
923	125th street.....	—13	.....	No rock.
924	126th street.....	—10	.....	Do.
925	127th street.....	—13	.....	Do.
926	Manhattan street.....	—30	— 6	Do.
927	129th street.....	—13	13	Do.
928	130th street.....	— 9	26	Do.
929	50 feet south of 131st street.....	— 5	39	Gneiss.
930	131st street to 133d street.....	{ — 1 — 7 }	38 to 59	Do.

^a Williamson, F. S., consulting engineer, 25 Broad street. Riverside viaduct extends along Hudson River from 127th street to 135th street. Wash borings were made at short intervals for the entire distance to depths of 60 feet, and at the corner of 131st street and Twelfth avenue to depth of 75 feet. No rock was encountered. The elevation of the street throughout is 12.5 feet above mean tide. (For 96th street viaduct see serial number 1199, p. 80.)

^b Klapp, Eugene, division engineer, rapid transit commission. "Rock not sounded."

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
	<i>Tenth avenue.^a</i>			
931	125th street.....	— 25	— 5	No rock.
932	Manhattan street.....	— 20	0	Do.
933	145th street.....	— 10	120	Gneiss.
934	146th street.....	— 15	115	Do.
935	147th street.....	— 18	115	Do.
936	148th street.....	— 18	115	Do.
937	150th street.....	— 20	108	Do.
938	151st street.....	— 18	115	Do.
	<i>Miscellaneous—Report of Lawyers' Title Insurance Company.^b</i>			
939	Pearl and State streets.....	— 37.50	— 26	Gneiss.
940	Battery place, West and Washington streets.	— 38.50	— 33	Do.
941	6-10 Bridge street.....	— 19	— 5	Do.
942	Pearl and Beaver streets.....	— 35	— 14	Do.
	Wall street—			
943	Southeast corner Pearl.....	— 33	— 20	Do.
944	Northwest corner William.....	— 28.16	— 18	Do.
945	Southwest corner William.....	— 47.50	— 31	Do.
946	Broadway, southwest corner Cedar street.	— 82.33	— 47	Do.
	Liberty street—			
947	Southwest corner William.....	— 47	— 30	Do.
948	Northeast corner William.....	— 47	— 30	Do.
949	Northwest corner William.....	— 45	— 28	Do.
950	Southeast corner William.....	— 40.75	— 24	Do.
951	Southeast corner Nassau.....	— 61.66	— 26	Do.
952	Broadway, southeast corner Maiden lane.	— 70	— 37	Do.
953	Northeast corner Cliff and John streets.	— 59.50	— 47	Do.
954	9 Murray street, 155 feet west of Broadway.	— 122.41	— 87	Do.
955	North Moore street, east of Hudson street.	— 55.50	— 40	Do.

^a Graether, L. F., Atlas of building laws of United States, New York, vol. 1, pl. 2. Depths (circa) scaled from section, except 931 and 932, which appear to refer to the old grades before the "fill" was made. "Rock not sounded."

^b Nostrand, P. E., official surveyor of the company.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
	<i>Miscellaneous—Lawyers' Title Insurance Company—Continued.</i>			
956	Broadway, southeast corner Spring street.	—40	— 1	Gneiss.
957	Center street, west side, 101 feet south of Howard.	—39	—21	Do.
958	Southeast corner Rivington and Eldridge streets.	—33	8	Do.
959	386-392 West 12th street, 155 feet west of Greenwich.	—44	—33	Do.
960	13th street, north side, near Fifth avenue.	—26	10	Do.
961	13th street and Sixth avenue.....	—15	11	Do.
962	Sixth avenue, between 13th and 14th streets.	—23	4	Do.
963	58 West 14th street, 125 feet east of Sixth avenue.	—41.25	—13	Do.
964	Irving place, northwest corner 16th street.	—18	25	Do.
965	19th street, north side, west of Sixth avenue.	—29	1	Do.
966	23d street, north side, east of Eleventh avenue.	—41	—31	Do.
967	Fifth avenue, west side 23d street.	—23	18	Do.
968	Madison avenue, southeast corner 26th street.	—16	21	Do.
969	Broadway, between 34th and 35th streets.	—11	35	Do.
970	Fifth avenue, southwest corner 34th street.	—19.66	33	Do.
971	54-56 West 40th street, 225 feet east of Sixth avenue.	—21.25	45	Do.
972	Seventh avenue, west side, between 41st and 42d streets.	— 6.75	44	Do.
973	Sixth avenue, between 43d and 44th streets.	—11.83	52	Do.
974	Fifth avenue, southwest corner 44th street.	—24.25	41	Do.
975	Madison avenue, southeast corner 63d street.	—67.50	—15	Do.
976	Fifth avenue, northeast corner 64th street.	—29.50	27	Do.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
<i>Miscellaneous—Lawyers' Title Insurance Company—Continued.</i>				
977	7-15 East 73d street, 125 feet east of Fifth avenue.	-24.50	42	Gneiss.
978	Central Park West, between 76th and 77th streets.	-59	32	Do
979	Madison avenue, southwest corner 78th street.	-13.25	58	Do.
980	Northwest corner 78th street...	-12.50	58	Do
981	Second avenue, between 92d and 93d streets.	-47.41	-19	Do.
982	Third avenue, northeast corner 98th street.	-20	9	Rock not sounded.
983	10th street, west of First avenue.	-44	-32	Gneiss.
<i>Miscellaneous—On or near Fifth avenue. a</i>				
984	28 feet south of 28th street, 90 feet west of Fifth avenue.	{ -21.83 -20.66 }	20	Gneiss.
985	Fifth avenue, northeast corner 17th street.	{ -26.5 -28.1 }	13	Do.
986	100 feet east of 985.....	{ -21.16 -19.60 }	20	Do.
987	Fifth avenue, southeast corner 20th street.	{ -32.9 -33.8 -37.0 -37.3 -38.0 }	6	Do.
988	Northwest corner 18th street ..	{ -26.16 -26.75 -22.40 -19.90 }	13	Do.
989	Southwest corner 22d street....	{ -29.9 -29.7 -33.9 -33.9 }	8	Do.
990	Northwest corner 19th street ..	{ -21.9 -23.8 -29.5 }	15	Do.

^aMaynicke, Robert, architect. Depths of 985-1001 referred to curb datum. No. 997 "checks within 2 inches of borings on either side of street."

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
	<i>Miscellaneous—On or near Fifth avenue—Continued.</i>			
	Between Fifth and Sixth avenues—			
991	North line of 19th street.....	{ -24.4 -23.8 -29.2 -24.7 }	{ 14 }	Gneiss.
992	South line of 19th street.....	{ -21.75 -21.90 -21.10 }	{ 17 }	Do.
993	20th street, north of 991.....	{ -16.25 -15.6 -23.9 -28.0 }	{ 18 }	Do.
994	Platt street, southeast corner Williams.	{ -45.25 -44.90 }	{ -26 }	Do.
995	Broadway, southeast corner 13th street.	{ -24.83 -20.0 -21.83 }	{ 6 }	Do.
996	Fifth avenue, southeast corner 18th street.	{ -23.75 -20.67 -27.50 -29.25 }	{ 14 }	Do.
997	East side, 200 feet north of corner of 20th street.	{ -34.3 -33.7 }	{ 8 }	Do.
998	Northwest corner 14th street...	{ -16.9 -18.7 -11.1 -10.8 }	{ 22 }	Do.
999	East side, about 50 feet north of 16th street.	{ -12.1 -13.4 -15.0 }	{ 28 }	Do.
1000	Southeast corner 17th street.....	{ -16.5 }	{ 21 }	Do.
1001	Southwest corner 18th street...	{ -13.3 -20.4 }	{ 23 }	Do.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
<i>Miscellaneous—Foundations for school buildings.^a</i>				
Wadsworth avenue—				
1002	Northeast corner 182d street...	— 8	.....	“Gneiss.”
1003	Southeast corner 183d street...	— 1.50	.....	Do.
1004	182d street, 150 feet east of 1002.	— .50	.....	Do.
1005	183d street, 150 feet east of 1003.	— 2.08	.....	Do.
1006	75 feet east and 92 feet north of 1002.	—14	.....	Do.
West side Fulton avenue—				
1007	34 feet north of East 173d street.	—13.75	.....	“Granite.”
1008	214 feet north of East 173d street.	—10.75	.....	Do.
1009	86 feet west of 1007	—13.25	.....	Do.
1010	86 feet west of 1008	—17	.....	Do.
5 feet west of Anthony avenue—				
1011	18 feet north of Mount Hope avenue.	—20.83	.....	“Mica.”
1012	36 feet north of Mount Hope avenue.	— 7.75	.....	Do.
1013	56 feet north of Mount Hope avenue.	—18.50	.....	Do.
1014	75 feet north of Mount Hope avenue.	—17.33	.....	Do.
1015	61 feet west of 1011	—10.83	.....	Do.
1016	19 feet north of 1015	— 8.41	.....	Do.
1017	18 feet north of 1016	—10.25	.....	Do.
1018	20 feet north of 1017	— 7.50	.....	Do.
6 feet west of Trinity avenue—				
1019	18 feet north of 135th street...	— 9.50	.....	Do.
1020	105 feet north of 135th street...	—18.50	.....	Do.
1021	34 feet west of 1019	—21.16	.....	Do.
1022	34 feet west of 1020	—14.16	.....	Do.
45 feet west of 177th street ^b —				
1023	63 feet south of Vyse avenue...	9.50	.....	“Granite.”
1024	150 feet south of Vyse avenue..	1.83	.....	Do.

^aSnyder, C. B. J., architect, department of education. Datum of Nos. 1002-1006 is point on curb of sidewalk directly opposite the boring; of 1007-1022, surface of ground; all others refer to highest point of curb of sidewalks adjoining site.

^b Datum of Nos. 1023-1027 is point on curb corner 177th street and Vyse avenue.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
	<i>Miscellaneous—Foundations for school buildings—Continued.</i>			
	45 feet west of 177th street—Con.			
1025	270 feet south of Vyse avenue..	4.66	.....	"Granite."
1026	60 feet west of 1024	5.08	.....	Do.
1027	120 feet south of 1026	8.50	.....	Do.
	Amethyst avenue <i>a</i> —			
1028	205 feet west of Morris Park avenue.	-12.25	.....	"Gneiss."
1029	335 feet west of Morris Park avenue.	-1.33	.....	Do.
1030	69 feet north of 1028	-6.66	.....	Do.
1031	69 feet north of 1029	-3.75	.....	Do.
	100 feet east of Boston road <i>b</i> —			
1032	35 feet north of 166th street ...	.33	.....	Do.
1033	65 feet west and 102 feet north of 1032.	-2.25	.....	Do.
1034	45 feet east and 160 feet north of 1032.	10.58	.....	Do.
	Jackson avenue—			
1035	35 feet north of 166th street ...	-19.25	.....	Do.
1036	137 feet north of 166th street ..	-15.25	.....	Do.
	170th street <i>c</i> —			
1037	30 feet east of Third avenue ...	-8.41	.....	"Mica."
1038	70 feet east of Third avenue ...	3	.....	Do.
1039	75 feet south and 60 feet east of 1036.	-1.41	.....	Do.
1040	70 feet south of 1036	-23.16	.....	Do.
1041	165th street and Tinton avenue <i>d</i> ..	-21.41	.....	"Gneiss."
1042	Union avenue	-15.50	.....	Do.
1043	107 feet north of 1041	-17	.....	Do.
1044	106 feet north of 1042	-16.50	.....	Do.
1045	58 feet north and 130 feet east of 1041.	-17.66	.....	Do.
	163d street <i>e</i> —			
1046	34 feet west of Morris avenue ..	-12.66	.....	"Granite."
1047	175 feet west of Morris avenue ..	-22.50	.....	Do.

a Datum of Nos. 1028-1031 is point on curb 375 feet west of Morris Park avenue.
b Datum of Nos. 1032-1036 is point on curb corner Boston road and Jackson avenue.
c Datum of Nos. 1037-1040 is point on curb corner Third avenue and 170th street.
d Datum of Nos. 1041-1045 is point on curb corner Union avenue and 165th street.
e Datum of Nos. 1046-1047 is point on curb corner Morris avenue and 163d street.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
<i>Miscellaneous—Foundations for school buildings—Continued.</i>				
1048	65 feet north and 1 foot west of 1046.	—13	.....	“Granite.”
1049	136 feet west of 1048.	—18.33	.....	Do.
1050	145th street, 325 feet east of Broadway. ^a	—23.58	86	Do.
1051	475 feet east of Broadway.	—28.41	81	Do.
1052	146th street, 325 feet east of Broadway.	—17	95	Do.
1052 ^a	475 feet east of Broadway.	—17.16	95	Do.
1053	100 feet north and 75 feet east of 1050.	—29.41	80	Do.
1054	119th street, 118 feet west of Second avenue. ^b	—15.91	2	Do.
1055	270 feet west of Second avenue.	—27.41	—10	Do.
1056	120th street, 110 feet west of Second avenue.	—25.58	—11	Do.
1057	260 feet west of Second avenue.	—18.91	—4	Do.
1058	101 feet north and 66 feet west of 1054.	—17.75	0	Do.
	35 feet north of 116th street ^c —			
1059	450 feet east of Lenox avenue..	—29.25	—8	Do.
1060	600 feet east of Lenox avenue..	—28	—7	Do.
1061	117th street, 450 feet east of Lenox avenue.	—30.66	—8	Do.
1062	600 feet east of Lenox avenue..	—23.91	—2	Do.
1063	65 feet north and 75 feet east of 1059.	—27.50	—6	Do.
1064	82d street, 100 feet east of Second avenue. ^d	—10.25	45	“Gneiss.”
1065	250 feet east of Second avenue..	—9.50	46	Do.
1066	56 feet north of 1064.	—10.83	44	Do.
1067	150 feet east of 1066.	—6.08	49	Do.

^a Datum of Nos. 1050–1053 is point on curb 475 feet east of Broadway on 146th street.

^b Datum of Nos. 1054–1058 is point on curb 270 feet west of Second avenue.

^c Datum of Nos. 1059–1063 is point on 117th street curb 450 feet east of Lenox avenue.

^d Datum of Nos. 1064–1067 is point on 82d street curb 100 feet east of Second avenue.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
	<i>Miscellaneous—Foundations for school buildings—Continued.</i>			
	101st street ^a —			
1068	350 feet west of Amsterdam avenue.	—33.33	66	“Gneiss.”
1069	225 feet west of Amsterdam avenue.	—18.50	80	Do.
	102d street—			
1070	200 feet west of Amsterdam avenue.	—9.75	91	Do.
1071	350 feet west of Amsterdam avenue.	—24.08	76	Do.
1072	100 feet north and 50 feet west of 1069.	—21.75	77	Do.
1073	Avenue A and 77th street ^b	—5	26	“Granite.”
1074	Avenue A and 78th street		34	Do.
1075	138 feet east of 1073.....	—4.91	26	Do.
1076	138 feet east of 1074.....	—3.66	30	Do.
	76th street—			
1077	105 feet east of Third avenue ^c .	—18.83	32	Do.
1078	205 feet east of Third avenue ..	—35.83	15	Do.
1079	68 feet south of 1077.....	—34.25	17	Do.
1080	68 feet south of 1078.....	—40.58	10	Do.
1081	31 feet south and 50 feet east of 1077.	—36.91	14	Do.
1082	66th street, 163 feet east of First avenue. ^d	—12.58	32	“Granite.”
1083	313 feet east of First avenue ...	—17.16	28	Do.
1084	67th street, 163 feet east of First avenue.	—8	40	Do.
1085	313 feet east of First avenue ...	—12.75	35	Do.
1086	238 feet east of Second avenue and 100 feet north of 66th street.	—14	45	Do.
	66th street ^e —			
1087	225 feet east of Amsterdam avenue.	—6.91	56	“Gneiss.”
1088	325 feet east of Amsterdam avenue.	—8.66	54	Do.

^a Datum of Nos. 1068-1072 is point on 102d street curb 350 feet west of Amsterdam avenue.

^b Datum of Nos. 1073-1076 is point on curb corner Avenue A and 77th street.

^c Datum of Nos. 1077-1081 is point on curb 105 feet east of Third avenue.

^d Datum of Nos. 1082-1086 is point on 67th street curb 163 feet east of First avenue.

^e Datum of Nos. 1087-1091 is point on 66th street curb 325 feet east of Amsterdam avenue.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
	<i>Miscellaneous—Foundations for school buildings—Continued.</i>			
	65th street—			
1089	225 feet east of Amsterdam avenue.	—19.08	41	“Gneiss.”
1090	325 feet east of Amsterdam avenue.	—25.83	37	Do.
1091	100 feet south and 50 feet east of 1087.	—13.08	50	Do.
1092	Tenth avenue, corner 58th street. ^a	— 6.58	63	Do.
1093	Corner 59th street	— 3.16	70	Do.
1094	200 feet west of 1092	—27.50	42	Do.
1095	200 feet west of 1093	— 9	64	Do.
1096	100 feet north and 100 feet west of 1092.	—16.41	54	Do.
1097	45th street, 225 feet east of Tenth avenue. ^b	— 3.66	29	“Granite.”
1098	325 feet east of Tenth avenue ..	— 2.75	30	Do.
1099	58 feet north of 1097	— 4.66	28	Do.
1100	58 feet north of 1098	— 8.08	25	Do.
1101	28 feet north and 50 feet east of 1097.	— 1.50	31	Do.
1102	20th street, 300 feet west of First avenue. ^c	—16.25	— 1	Do.
1103	496 feet west of First avenue...	—13.83	2	Do.
1104	84 feet south of 1102	—14.08	1	Do.
1105	84 feet south of 1103	—12.58	2	Do.
1106	41 feet north of 19th street, 396 feet west of First avenue.	—19.75	— 2	Do.
1107	15th street, 80 feet west of First avenue. ^d	—23.25	— 2	“Gneiss.”
1108	16th street, 80 feet west of First avenue.	—22	— 4	Do.
1109	82 feet north and 43 feet west of 1106.	—22.08	— 1	Do.
1110	67 feet south and 40 feet west of 1107.	—26.25	— 7	Do.

^a Datum of Nos. 1092-1096 is point on curb corner opposite boring.

^b Datum of Nos. 1096-1101 is point on curb 275 feet east of Tenth avenue.

^c Datum of Nos. 1102-1106 is point on 19th street curb 396 feet west of First avenue.

^d Datum of Nos. 1107-1110 is point on 15th street curb 80 feet west of First avenue.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
	<i>Miscellaneous—Foundations for school buildings—Continued.</i>		o	
1111	168th street, corner Audubon avenue. ^a	-11	.....	"Gneiss."
1112	60 feet west of 1111	-20.08	.....	Do.
1113	169th street, corner Audubon avenue.	-12.58	.....	Do.
1114	60 feet west of 1113	-12.58	.....	Do.
	Near Amsterdam avenue ^b —			
1115	300 feet west on 108th street...	-21.66	86	Do.
1116	500 feet west on 108th street...	-12.66	95	Do.
1117	300 feet west on 109th street...	- 5.75	102	Do.
1118	500 feet west on 109th street...	- 5.91	102	Do.
1119	100 feet west and 100 feet north of 1115.	- 7.91	100	Do.
	<i>Miscellaneous—Approach to East River bridge No. 2. ^c</i>			
	Tompkins street—			
1120	Corner Delancey (D).....	-69.5	- 67	
1121	90 feet south of south line Delancey street (H).	-95.1	- 93	
1122	Delancey street, southeast corner Mangin (C).	-70.8	- 68	
	Center line of bridge—			
1123	70 feet west of west line of Mangin street (A).	-61.16	- 59	
1124	West line of Cannon street (B).	-56.25	- 54	
1125	West line of Columbia street (C)	-62.66	60	
1126	West line of Sheriff street (H).	-51.58	49	
1127	West line of Willett street (E-I)	-51.50	49	
1128	West line of Pitt street (G)....	-56.08	54	
	<i>Miscellaneous—Records not classified.</i>			
1129	Near Trinity Church, Broadway, facing Wall street. ^d	-26	11	Supposed to have reached rock.
1130	Washington street, between Fulton and Vesey.	-70	- 60	

^aDatum of Nos. 1111-1115 is point on curb corner Audubon avenue and 169th street.^bDatum of Nos. 1116-1120 is point on 109th street curb 300 feet west of Amsterdam avenue.^cLa Chicotte, H. A., chief engineer. Datum, mean high water.^dNos. 1129-1144, I. C. Russell, Annals New York Acad. Sci., vol. 2, 1882, pp. 66-77.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
<i>Miscellaneous—Records not classified—Continued.</i>				
1131	Bleecker street, corner Broadway.	— 42	— 4	Well 406 feet deep.
1132	“Factory, corner Perry”.....	— 70	— 44	
1133	16th street, near the Hudson	— 20	5	
1134	26th street and Tenth avenue	— 79	— 66	
1135	U. S. Hotel, corner Fulton and Water streets.	—126	—118	
1136	Between Ferry, Cliff, Frankfort, and Pearl. ^a	— 92.5	— 90	
1137	118 Elm street, between Canal and Howard.	—130	—117	
1138	Cherry street, Corlears Hook....	— 80	— 63	No rock.
1139	Foot of Jefferson street, East River.	— 50	— 42	
1140	Houston street, corner Lewis	— 94	— 85	
1141	Avenue D and Houston street....	— 93	— 86	
1142	Avenue D and 5th	—109	— 98	
1143	Avenue D and 7th	—100	— 89	
1144	Avenue D and 10th	—100	— 90	Gneiss.
1145	Washington Market, North River, between Fulton and Vesey streets. ^b	— 70	— 60	
1146	St. Francis Hospital, 5th street, between B and C avenues.	—100	— 80	
1147	Purinton and Columbia streets..	— 60	— 46	
1148	Allen and Hester streets	— 67	— 28	
1149	Tombs, Franklin and Center streets.	—155	—139	
1150	Grand and Wooster streets	— 72	— 60	
1151	Perry and West 11th streets	— 63	— 38	
1152	Manhattan Life building, 66 Broadway, between Exchange place and Wall street.	— 42.96	— 8	Do.
1153	Standard Oil building, 26 Broadway.	— 44	— 19	No rock.
1154	American Surety building, 100 Broadway. ^c	— 71	— 35	Do.

^a Datum is mean high water.^b Nos. 1145–1156, L. F. Gratacap, Geol. City of New York, pp. 10–12.^c Depth is below curb.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
	<i>Miscellaneous—Records not classified—Continued.</i>			
1155	Empire building, 71 Broadway <i>a</i> ..	— 54	— 19	No rock.
1156	Washington Life building, 141 Broadway. <i>a</i>	— 75	— 40	Do.
1157	City reservoir, corner Third avenue and 13th street. <i>b</i>	— 15	22	
1158	7th and Lewis streets <i>b</i>	— 93	— 83	
	West 39th street <i>c</i> —	{ — 18. 9 }		
1159	150 feet east of Tenth avenue <i>a</i> ..	{ — 17. 5 } { — 15. 3 }	17 19	
	New Mutual Life building—			
1160	16 Liberty street, on street line		— 61	
1161	39 Cedar street, on street line ..		— 41	
	Broad-Exchange <i>d</i> —			
1162	Exchange place and Broad street, southeast corner. <i>a</i>	{ — 41 } { — 47. 6 } { — 48. 8 }	46 — 31	Gneiss.
	Wallstreet, Exchange building <i>d</i> —			
1163	North side Exchange place, between William and Broad streets. <i>a</i>	{ — 41. 1 } { — 43. 6 } { — 46. 5 } { — 42. 3 }	43 — 26	Do.
	Battery place building <i>d</i> —			
1164	Battery place, between West and Washington streets. <i>a</i>	{ — 52 } { — 35 }	43 — 41	Do.
1165	James Everhardt's brewery, south side 133d street, 200 feet east of Fifth avenue (well). <i>e</i>	— 98	— 80	Rock or boulder.
1166	Fourth avenue and 50th street (surface). <i>f</i>	.....	57	Gneiss.
1167	Morris Park, northwest corner <i>g</i> ..	— 40	— 14	Do.
1168	125th street and Madison avenue.	— 125	— 121	
1169	Lenox and 160th streets	— 60	— 60	
1170	116th street and East River	— 45	— 45	
1171	112th street and First avenue	— 55	— 46	

a Depth is below curb.*b* Mather, Wm. M., Geol. New York, pp. 605-625.*c* Maynicke, Robt., architect. Curb datum.*d* Purdy, C. T., consulting engineer, Geo. A. Fuller Construction Company.*e* Communicated at brewery.*f* Waller, Elwyn, chemist.*g* Nos. 1167-1176, Washington, Wm. De H.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial num ber.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
	<i>Miscellaneous—Records not classified—Continued.</i>			
1172	79th street and Columbus avenue.	-17	69	
1173	East Houston and Attorney streets.	-60	-36	
1174	Third avenue and 21st street.....	-11 to -17	-11	
1175	Third avenue and 9th street.....	-35	- 4	
1176	Eleventh avenue and 27th street.	-60	-50	
1177	Park avenue, northeast corner 51st street. ^a	(b)	56	Gneiss.
1178	60 feet east of Park avenue between 50th and 51st streets.	(b)	56	Do.
1179	50 feet west of Second avenue and 40 feet north of 92d street. ^c	(b)	28	Rock.
	Block 38th to 39th streets, east of First avenue, ^d about 60 feet west of bulkhead line—			
1180	50 feet north of 38th street produced.	-69.4	-66	
1181	50 feet south of 39th street produced.	-64.4	-61	
1182	About 205 feet west of bulkhead line, north side 38th street.	-12.33	- 9	
1183	About 225 feet west of bulkhead line, and 7 feet south of 39th street.	- 5	- 2	
	First avenue—			
1184	39th street, southeast corner...	- 9.66	7	
1185	38th street, northeast corner...	- 2.25	- 1	
1186	Midway between 1184 and 1185..	- 7.16	4	
	Block 39th to 40th streets, east of First avenue, about 30 feet west of East River—			
1187	6 feet south of 40th street.....	-44.98	-42	
1188	99 feet south of 40th street....	-48.10	-45	
1189	About 6 feet north of 39th street.	-46.21	-43	

^aSchaefer, F. and M., Brewing Company.

^bNos. 1177-1179, street level referred to U. S. datum.

^cEhret, George, Brewing Company. Depth of well, 700 feet; at near 300 feet encountered limestone, also a little quartz.

^dLieb, J. W., asst. genl. mgr. New York Edison Co. water-side power station, Nos. 1180-1186: Records include some 50 borings, covering the area of the block and eastward to the bulkhead line at about 50-foot intervals in either direction. New water-side power station, Nos. 1187-1193: Borings made every 25 feet in either direction within area.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
	<i>Miscellaneous—Records not classified—Continued.</i>			
1190	6 feet south of 40th street and about 212 feet east of First avenue.	0.69	— 2	
1191	6 feet north of 39th street and 206 feet east of First avenue.	— 1.42	— 1	
	31 feet east of First avenue—			
1192	6 feet north of 39th street.....	— 16.35	13	
1193	6 feet south of 40th street.....	— 19.14	16	
1194	Grand Union Hotel, 42d street and Park avenue, near curb of well <i>a</i>	.....	50	"Micaceous gneiss."
1195	Waldorf-Astoria Hotel, 35th street and Fifth avenue, near curb of well. <i>a</i>	.....	62	
	50th street near Tenth avenue <i>b</i> —			
1196	Columbia College, at curb.....	.....	40	"Gray gneiss and mica."
1197	Cushman's bakery, at curb.....	.....	40	Do.
1198	Block 95th to 96th streets, east of First avenue. <i>c</i>	—125	—113	
1199	Riverside drive viaduct, 96th street. <i>d</i>	— 90 to —100	— 72	No rock.
1200	New York tower, Brooklyn bridge <i>e</i>	— 75	— 73	
1201	Liberty and Nassau streets <i>f</i>	— 90	— 60	
1202	128th street and Tenth avenue <i>g</i> ..	—135	—104	
1203	129 East 61st street <i>h</i>	— 14.5	35	Do.
1204	Fifth avenue between 73d and 74th streets. <i>h</i>	— 15	53	Rock.
1205	Fifth avenue and 116th street <i>i</i> ...	— 6	15	Gneiss.
1206	Park avenue and 130th street <i>i</i> ...	— 5	11	Do.
1207	Fulton Market, corner South and Fulton streets. <i>j</i>	—130	—126	Rock.

a Conlan, P. H. and J., artesian wells, Ann. Rept. State Geol. New Jersey, 1901, p. 120. Depth of (1194) well 420 feet. Rock as elsewhere, gneiss. Depth of (1195) well, 650 feet. "Rock as elsewhere on Manhattan Island."

b Idem., 1896, p. 185.

c Interurban Street Railway Company.

d Boller, Alf. P.

e Report chief engineer, Brooklyn Bridge.

f Darton, N. H., U. S. Geol. Survey.

g Stothoff Bros., Flemington, N. J. Surface datum.

h Bunn & Nase, architects, 1123 Broadway.

i Hickey, J., 83, 110th street.

j Nos. 1207-1225, Graether, L. F., Atlas of building laws of United States, vol. 1, 1898, pl. 2.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
	<i>Miscellaneous—Records not classified—Continued.</i>			
1208	Holt's well, near Fulton Market (130 feet deep).	-126	-----	Rock.
1209	Perry and 4th streets (well at corner).	- 70	- 40	Do.
1210	Ehret's brewery, corner Second avenue and 92d street.	0	28	Gneiss.
1211	Well, near Broadway and 13th street (113 feet deep).	- 15	28	Rock.
1213	City Hall Park, well	- 90	-----	Do.
1214	Manhattan well, Duane street, near Center street.	- 30	- 5	No rock
1215	Tenth avenue and 14th street....	- 40	- 30	Rock.
1216	Seventh avenue and 16th street..	- 20	8	Do.
1217	Ninth avenue and 16th street (120 feet deep).	- 20	- 4	Do.
1218	Eleventh avenue and 19th street.	-190	-181	Do.
1219	Eleventh avenue and 20th street.	-170	-160	Do.
1220	Fifth avenue and 23d to 24th streets (well 2,103 feet deep).	0	40	Do.
1221	Lenox avenue and 110th street...	- 50	- 25	Do.
1222	Lenox avenue and 116th street...	- 40	- 19	Do.
	Speedway ^a —			
1223	West 172d street.....	- 88.5	-----	Do.
1224	West 173d street (32.5 feet into rock).	- 52	-----	Gneiss.
1225	West 174th street (56.8 feet into rock).	- 53	-----	Do.
1226	Harlem River power house, Ninth avenue and 218th street. ^b	-116	-113	Rock or boulder.
1227	103d street, near First avenue (well). ^c	- 40	- 30	No rock.
1228	104th street, east of Fourth avenue (well). ^d	- 40	- 25	Do.
1229	105th street and East River (well). ^d	- 40	- 34	Do.
1230	Power station, First avenue, 95th to 96th streets. ^e	-125	-115	Rock.

^a Nos. 1207-1225, Graether, L. F., Atlas of building laws of United States, vol. 1, 1898, pl. 2. No. 1223, decomposed gneiss; margin with overlying gravel not sharp; 159.2 feet to hard rock.

^b Starratt, M. G., chief engineer, New York City Railway Company.

^c Miller, David, owner. "Rock not sounded."

^d Henry, M. C., Company. "Rock not sounded."

^e Engineering Record, vol. 40, 1899, p. 690. Other borings to 80 feet did not reach rock.

Summary of records of borings made in New York and vicinity—Continued.

2. BORINGS IN THE BOROUGH OF MANHATTAN—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
	<i>Miscellaneous—Records not classified—Continued.</i>			
1231	125th street, 300 feet east of Eighth avenue. ^a	— 50	—24	No rock.
	St. Nicholas avenue—			
1232	125th street, northwest corner ^a .	— 10	20	Do.
1233	126th street, southwest corner ^a .	0	33	Gneiss.
1234	409 West 14th street (well) ^b	— 20	— 7	Rock.
1235	Hunters Point, near Long Island depot.	— 69	—59	Do.
1236	Quarantine station, Hoffman Island.	—450	-----	Do.
1237	East 13th street, between Third and Fourth avenues.	— 19	16	Do.
1238	Third avenue and 14th street (well).	— 15	22	Do.
1239	Cornell iron foundry, 25th street between Tenth and Eleventh avenues. ^c	— 63	—52	
1240	55th street and Fifth avenue, Tidewater Bldg. Co.	— 12.5	48	
1241	Another boring.	— 5.16	55	
1242	21 and 23 West 22d street, F. H. Leggett.	— 7	45	
1243	28-32 West 22d street, Thompson-Starret Co.	— 16.3'	22	
1244	Allaire's well, foot of Cherry street, near Corlear. ^d	— 76 to —80	—61 to —65	Do.
1245	Nagle avenue ^e	— 35 to —55	-----	Do.
	59th street and West End avenue, northeast corner ^f —			
1246	100 feet north of corner.	— 35	-----	
1247	100 feet east of corner.			

^a Ford, I. H., artesian wells; surface datum. "Rock not sounded."

^b Nos. 1234-1238, Veatch, A. C., U. S. Geol. Survey.

^c Phillips & Worthington. Record of well 1239: 0-10 feet, filling; 10-12, sand and gravel; 12-15, fine brown sand; 15-18, fine black sand; 18-24, mud; 24-27, medium sand; 27-43, medium brown sand; 43-47, coarse sand and gravel; 47-58, medium sand; 58-63, coarse sand to rock. Record of well 1240: 0-10½ feet, loam; 10½-12½, sand and gravel; 12½-14, disintegrated rock derived from schists and gneisses. Record of well 1241: 0-5 feet, loam mixture; 5-10½, soft light-colored rock; 10½-12, black soft rock. Record of well 1242: 0-1 foot, loam; 1-3 feet, clay; 3-5, medium sand; 5-7, gravel and clay mixture; 7-9, disintegrated rock. (Pennsylvania Railroad tests show rock in this block to be at from 5 to 41 feet). Record of well 1243: 0-7½ feet, filling; 7½-12, fine dark sand; 12-12½, sand and muck mixture; 12½-16½, gravel and mica to rock.

^d Hale, M., Spring water vs. river water for supplying the city of New York, 1835, p. 15. (Astor library.)

^e Klapp, Eugene, division engineer, rapid transit commission. From Dyckman street north 1,000 feet, piles were driven to a depth of 35 to 45 feet, and in one instance to 55 feet.

^f Claussen & Price Brewing Company. Wells 1246 and 1247, 625 feet deep to "limestone" (doubtless serpentine filled with calcite).

Summary of records of borings made in New York and vicinity—Continued.

3. BORINGS IN THE OUTLYING BOROUGHS AND IN OTHER LOCALITIES NEAR NEW YORK.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
<i>Borough of Brooklyn.</i> ^a				
1248	Artesian well, Calvary cemetery ^b .	— 182	— 130 to — 140	Gneiss.
1249	Brooklyn Navy-Yard ^c	— 93	.....	Do.
1250	East line of Furman street ^d	— 71	— 63	No rock.
1251	"Hicks street".....	— 87. 8	— 31	Do.
1252	Borough hall.....	— 58. 4	2	Do.
1253	Fulton street, corner Bond street.	— 35	5	Do.
1254	Keep street and Kent avenue ^e ...	— 65	.....	Do.
1255	Forrest street and Evergreen avenue. ^f	— 275	.....	Do.
1256	Lewis avenue and Pulaski street ^g .	— 105	.....	Do.
1257	68-84 Meserole street ^h	— 35 to — 45	.....	Do.
1258	100 feet west of Bremen street and 300 feet north of Noll street. ⁱ	— 70	.....	Do.
1259	200 feet east of Brunswick avenue and 290 feet south of 1258.	— 65	.....	Do.
1260	100 feet east and 90 feet north of 1259.	— 65	.....	Do.
1261	Bridge street, corner Plymouth ^j .	— 50	.....	Do.
1262	Hamilton avenue and Conover street. ^k	— 60	.....	Do.
1263	Meserole, Humboldt, and Schole streets. ^l	— 90	.....	Do.
1264	Metropolitan avenue, 125 feet east of Weithe avenue. ^m	— 60	.....	Do.
1265	New Lots road and Fountain avenue. ⁿ	— 78	— 85	

^a See Crosby, W. O., Techn. Quart., vol. 13, 1900, p. 117, for records of many other borings upon Long Island.

^b Lewis, Elias, quoted by F. J. H. Merrill, Annals New York Acad. Sci., vol. 3, 1885, p. 346. Surface datum. Elevation of ground taken from topographic sheet of New York City.

^c Superintendent of navy-yard.

^d Nos. 1250-1253, rapid transit commission. Surface datum.

^e Chrome Steel Works, well 65 feet deep, 27 feet from Keep street curb line and 70 feet from Kent avenue curb line.

^f S. Liebman's Sons Brewing Company. Record of well 1255: 1-23 feet, loam and bowlders; 23-105 feet, yellow gravel and sand; 105-275 feet, blue clay.

^g H. B. Scharman & Sons, brewers. Three wells through sand.

^h Burger Brewing Company. Wells through sand.

ⁱ Obermeyer & Liebman, brewers. Three wells, 1258-1260, through sand.

^j Howard & Fuller Brewing Company. Well through coarse sand.

^k India Wharf Brewing Company wells.

^l Congress Brewing Company. Three wells through clay, sand, and hardpan.

^m Streeter & Dennison well.

ⁿ New Lots pumping station (formerly Long Island Water Supply Company); 11 6-inch wells.

Summary of records of borings made in New York and vicinity--Continued.

3. BORINGS IN THE OUTLYING BOROUGHS AND IN OTHER LOCALITIES NEAR NEW YORK--Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum. Sandy Hook.	
<i>Borough of Brooklyn--Continued.</i>				
1266	50 feet east of Bushwick avenue, between Meserole and Schole streets. ^a	- 63	.....	No rock.
1267	70 feet north of Meserole street, between Bushwick avenue and Waterbury street.	-115	.....	Do.
1268	Foot of 34th street ^b	-215	-205	
1269	Meeker and Kingsland avenue ^c	-215	-175	
1270	In block bounded by Pearl, Plymouth, John, and Jay streets ^d	- 97	.....	"Trap."
1271	Astoria, end of Ditman street ^e	100	- 98	
1272	Nassau Gas Light Company, Williamsburg. ^f	-102.5	.....	Rock not sounded.
<i>Brooklyn bridge ^g--</i>				
1273	Anchorage 930-1,060 feet from river.	-145	-143	Rock or boulder.
1274	Tower, Brooklyn end.....	- 88	- 86	Mica schist.
1275	Arch street ^h	{ - 41 } 38 {- 36 }	- 36	Rock or boulder.
1276	Beech street.....	{ - 15 } 18 {- 21 }	- 16	Do.
1277	Crane street.....	{ - 42 } 39 {- 36 }	- 37	Do.
1278	Nott avenue, halfway between Crane and Davis streets.	- 59	- 57	Do.
1279	Davis street.....	{ - 42 } 46 {- 51 }	- 44	Do.
1280	Pierson street.....	- 11	- 9	Do.
1281	Anable avenue.....	{ - 2 } 2 {- 1 }	0	Do.
1282	Court street.....	{ - 34 } 27 {- 21 }	- 25	Do.

^a Eastern Brewing Company wells. No. 1267 in sand and clay exclusively.

^b Gregory, Elisha, per A. C. Veatch. Record of well 1268: 0-212 feet, sand and clay; 215-1,500 feet hard rock.

^c A. C. Veatch.

^d Stewart, H. S., Pittsburg, Pa. Well 800 feet deep.

^e New York Connecting Railroad Company, A. P. Boller, president and chief engineer. Line of projected Hell Gate railroad bridge (mean high water).

^f Crosby, W. O., Outline of the geology of Long Island. Techn. Quart., vol. 13, 1900, p. 117.

^g Russell, I. C., Annals New York Acad. Sci., vol. 2, 1882, p. 73. Boulders of "gneiss, trap, etc."

^h Tide datum.

ⁱ Nos. 1275-1282, wash borings.

Summary of records of borings made in New York and vicinity—Continued.

3. BORINGS IN THE OUTLYING BOROUGHS AND IN OTHER LOCALITIES NEAR NEW YORK—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.	
		As given.	Referred to U. S. datum, Sandy Hook.		
<i>Borough of Brooklyn—Continued.</i>					
1283	Hunters Point avenue ^a	{ — 18 — 34 — 21	26	— 24	Gneiss.
1284	Fourth street	{ — 24 — 29 — 26	26	— 24	Do.
1285	Van Alst avenue, southeast corner 3d street.	— 35		— 33	Do.
1286	3d street 150 feet east of east line of East avenue.	{ — 5 — 8	6	— 4	Do.
1287	East avenue 100 feet south of south line of 3d street.	— 2		0	Do.
Borden avenue—					
1288	200 feet west of west line of East avenue.	— 22		— 20	Do.
1289	Southeast corner of Vernon avenue.	— 6		— 4	Do.
1290	Southwest corner of Vernon avenue.	{ — 43 — 19	31	— 29	Do.
1291	Halfway between West and Vernon avenues.	{ — 34 — 15	24	— 22	Do.
1292	West side of Vernon avenue, 100 feet north of Flushing street.	— 8		— 6	Do.
1293	West avenue, 200 feet north of north line of Flushing street.	— 18		— 16	Do.
1294	250 feet east of Front street, 150 feet south of Borden.	{ — 20 — 42 — 17	26	— 24	Do.
1295	Front street, between Borden and Flushing.	{ — 56 — 34 — 42	44	— 42	Do.
1296	Pierhead line, foot of Flushing street.	{ — 44 — 46	45	— 43	Do.
1297	Slip on line of 1st street extended, shore end.	{ — 25 — 40	32	— 30	Do.
1298	Slip on line of 1st street, bulkhead line.	{ — 46 — 49	47	— 45	Do.

^aNos. 1283-1305, core borings.

Summary of records of borings made in New York and vicinity—Continued.

3. BORINGS IN THE OUTLYING BOROUGHS AND IN OTHER LOCALITIES NEAR NEW YORK—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
<i>Borough of Brooklyn—Continued.</i>				
Pier at foot of Pidgeon street—				
1299	Dock	— 19	— 17	Gneiss.
1300	End of pier	— 54	— 52	Do.
Pier at foot of Flushing street—				
1301	Dock	— 26	— 24	Do.
1302	End of pier	— 37	— 35	Do.
475 feet west of Vernon avenue—				
1303	Between 1st street and Flushing street.	{ — 33 } 24	— 22	Do.
1304	175 feet east of 1303	12	14	Do.
1305	4th street, 100 feet east of Vernon avenue. ^a	— 10	— 4	Do.
<i>Borough of Queens—Right of way, Pennsylvania Railroad.^b</i>				
Near bulkhead, Long Island City—				
1306	200 feet west of line	{ — 68 } 58	— 56	Rock or boulder.
1307	325 feet west of line	{ — 82 } 82	— 80	Do.
1308	600 feet west of line	{ — 95 } 100	— 98	Do.
1309	750 feet west of line	{ — 115 } 115	— 113	Do.
1310	1,100 feet west of line	{ — 100 } 91	— 89	Do.
<i>Borough of Queens—Miscellaneous.^c</i>				
1311	Long Island Railroad depot, Hunters Point.	— 69	— 59	
1312	East River Gas Company, Vernon avenue.	.....	20	Rock.
1313	Astoria Silk Works, Steinway avenue.	— 79.75	20	

^a Surface datum.^b Noble, A., and Jacobs, C. M., chief engineers, Pennsylvania, New York and Long Island Railroad Company; wash borings.^c Veatch, A. C., U. S. Geol. Survey. Well 1312, 100 feet deep, through rock from near surface. In well 1313 on drilling 32 feet through rock quicksand was encountered. Wells 1314–1317, 70–80 feet sand, then clay and limestone; 375 feet, 300 feet, 450 feet, and 490 feet deep, respectively.

Summary of records of borings made in New York and vicinity—Continued.

3. BORINGS IN THE OUTLYING BOROUGHS AND IN OTHER LOCALITIES NEAR NEW YORK—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
<i>Borough of Queens—Miscellaneous—Cont'd.</i>				
Fleishman Manufacturing Company wells, between Howard and Spring streets—				
1314	Between Review street and L. I. R. R. (a).	—124	—114	Limestone.
1315	(b)	—124	—114	Do.
1316	(c)	—124	—114	Do.
1317	Between L. I. R. R. and Newtown Creek. (d)	—124	—114	Do.
<i>Borough of the Bronx—Section along line of rapid transit on Westchester avenue and Southern boulevard.^a</i>				
1318	Brook avenue to about 100 feet southwest of Caldwell avenue.	—7 to —12	.....	No rock.
1319	Caldwell avenue to 100 feet northeast of Robbins avenue.	0 to — 4	23 to 41	Rock.
1320	From 1319 to Wales avenue.....	—9 to —11	.....	No rock.
1321	From Wales avenue northeast 300 feet.	—1 to — 9	27 to 41	Rock.
1322	From 1321 to point 50 feet east of Beach avenue.	—5 to — 8	.....	No rock.
1323	From 1322 to point 50 feet northeast of Union avenue.	—3 to —10	45 to 51	Rock.
1324	From 1323 to point 120 feet southwest of Longwood avenue.	—7 to —10	.....	No rock.
1325	From 1324 to Longwood avenue..	—7 to — 9	56 to 59	Rock.
1326	Longwood avenue to point 225 feet northeast.	—9 to —10	.....	No rock.
1327	From 1326 about 150 feet northeast.	—3 to —10	56 to 61	Rock.
1328	From 1327 to Intervale avenue..	—5 to — 7	.....	No rock.
1329	From 1328 about 80 feet northeast.	—7 to — 8	24 to 25	Rock.
1330	From 1329 to Kelly street	—6 to — 9	.....	No rock.

^a Klapp, Eugene, division engineer, rapid transit commission. Bottoms of even-numbered borings, where rock was not sounded, are stated to be as follows: 1318 and 1320, sand or mainly sand; 1322, 1330, 1332, 1334, 1340, 1346, and 1352, sandy clay; 1324 and 1326, sand, gravel, and clay; 1328, 1342, and 1344, clay or mainly clay; 1338, sand and gravel; 1344, east of 172d street, largely sand and gravel; 1348, sandy clay and sandy loam; 1350, west of 177th street, clay bottom, east of 177th street, sand, gravel, and clay. In certain odd-numbered borings, where rock was encountered, the record reads as follows: 1323, rock, except for about 40 feet west of Union avenue; 1339, rock, having steep slope near Freeman street; 1349, at "about 100 feet northeast of East 176th street is a deep V-shaped depression in rock surface, with quicksand in bottom."

Summary of records of borings made in New York and vicinity—Continued.

3. BORINGS IN THE OUTLYING BOROUGHS AND IN OTHER LOCALITIES NEAR NEW YORK—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy hook.	
	<i>Borough of the Bronx—Section along line of rapid transit on Westchester avenue and Southern boulevard—Continued.</i>			
1331	From 1330 about 50 feet northeast.	— 7 to — 8	33	Rock.
1332	From 1331 about 160 feet northeast.	— 5 to — 8	.....	No rock.
1333	From 1332 to about 40 feet northeast of Barretto street.	— 2 to — 4	43 to 58	Rock.
1334	From 1333 to about 100 feet southwest of East 167th street.	— 4 to — 10	.....	No rock.
1335	From 1334 to a little north of East 167th street.	— 5 to — 9	53 to 56	Rock.
1336	From 1335 to about 120 feet farther north.	— 7 to — 9	.....	No rock.
1337	From 1336 to about 200 feet north of Home street.	— 2 to — 8	50 to 60	Rock.
1338	From 1337 north 150 feet.....	— 8	.....	No rock,
1339	From 1338 to about 40 feet south of Freeman street.	— 8 to — 15	32 to 43	Rock.
1340	From 1339 northeast 450 feet	— 10 to — 15	.....	No rock.
1341	From 1340 northeast 225 feet	— 7 to — 10	40 to 43	Rock.
1342	From 1341 to point 25 feet northeast of Jennings street.	— 8 to — 9	.....	No rock.
1343	From 1342 northeast 200 feet	— 6 to — 8	43 to 46	Rock.
1344	From 1343 to point 100 feet northeast of East 173d street.	— 8 to — 10	.....	No rock.
1345	From 1344 northeast 200 feet	— 8	60 to 63	Rock.
1346	From 1345 northeast 275 feet	— 7 to — 9	.....	No rock.
1347	From 1346 to point 50 feet northeast of East 174th street.	— 6 to — 8	64 to 67	Rock.
1348	From 1347 to near 176th street....	— 6 to — 9	.....	No rock.
1349	From 1348 northeast 725 feet	— 3 to — 12	40 to 66	Rock.
1350	From 1349 to about 60 feet southwest of East 178th street.	— 8 to — 13	.....	No rock
1351	From 1350 to about 25 feet northeast of East 180th street.	— 1 to — 5	26 to 33	Rock.
1352	From 1351 to East 181st street	— 6 to — 10	.....	No rock.

Summary of records of borings in New York and vicinity—Continued.

3. BORINGS IN THE OUTLYING BOROUGHS AND IN OTHER LOCALITIES NEAR NEW YORK—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
<i>Borough of the Bronx—Miscellaneous. a</i>				
1353	North side 158th street, between St. Ann's avenue and German place.	— 30	.....	Rock not sounded.
1354	East side Brook avenue 100 feet south of Third avenue.	Near surface.	.....	Limestone.
1355	West side of St. Ann's avenue 300 feet from Third avenue.	— 60	.....	Rock not sounded.
<i>Hoboken, water front.</i>				
1356	South end of Grand street <i>b</i>	.....	— 40	
Pier at foot of <i>c</i> —				
1357	Newark street	—134	—132	Rock or boulder.
1358	1st street	—136	—134	Do.
1359	2d street, shore end	— 46	} — 47	Do.
		— 59		
		— 43		
		— 49		
1360	2d street at pierhead	—141	—139	Do.
Pier between—				
1361	2d and 3d streets, at dock	{ — 41	} — 39	Do.
		{ — 41		
1362	2d and 3d streets, at pierhead..	—136	—134	Do.
1363	Dock at foot of 3d street.....	—142	—140	Do.
1364	River street and 3d street.....	— 12	} — 12	Do.
		— 5		
		— 26		
1365	Pier at foot of 4th street.....	— 41	— 39	Do.
1366	Southeast corner Hudson square	— 18	— 16	Do.
1367	Northeast corner Hudson square	— 17	— 15	Do.
1368	Dock at foot of 5th street.....	— 52.0	} — 42	Do.
		— 43.0		
		— 40.3		
1369	Hoboken shore road, between 6th and 7th streets.	— 8	— 6	Do.

a A Hupfel's Sons Brewing Company. No. 1354, well 1,600 feet deep; rock near surface.
b Russell, I. C., Annals New York Acad. Sci., vol. 2, p. 69. Datum assumed at 5 feet above mean tide. No. 1356 in marsh at corner Hoboken avenue and Grand street.
c Nos. 1357-1397, wash borings by Hoboken Land and Improvement Company. Datum, mean high water.

Summary of records of borings made in New York and vicinity—Continued.

3. BORINGS IN THE OUTLYING BOROUGHS AND IN OTHER LOCALITIES NEAR NEW YORK—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
	<i>Hoboken, water front—Continued.</i>			
1370	Dock at foot of 7th street.....	— 19	—17	Rock or boulder.
1371	Pier at foot of 8th street (extended)	{ — 73.8 — 70.0 — 72.0 }	—68	Do.
1372	Dock at foot of 8th street.....	{ — 41 — 45 — 22 — 33 }	—34	Do.
1373	Pier between 10th and 11th streets.	{ — 38.4 — 25.0 }	{ —36 —23 }	Do.
1374	Pier at foot of 11th street.....	— 75	—73	Do.
1375	End of present dock	— 34	—32	Do.
1376	Pier north of 11th street end.....	— 95	—93	Do.
1377	Between 12th and 13th streets— Dock line	— 79	—77	Do.
1378	Between dock line and shore ..	{ — 43 — 37 }	—38	Do.
1379	Shore line.....	{ — 20 — 22 — 27 — 32 }	—23	Do.
1380	Between 13th and 14th streets— Dock line	{ — 77 — 81 }	—77	Do.
1381	Shore line.....	{ — 28 — 33 }	—28	Do.
1382	Pier between 14th and 15th streets, dock line.	— 58	—56	Do.
1383	Between 14th and 15th streets, about 300 feet east of east line of Hudson street (produced). Streets produced—	— 35	—33	Do.
1384	Dock line and 15th	{ — 55 — 61 }	—56	Do.
1385	Dock line and 16th	{ — 73 —103 }	—84	Do.

Summary of records of borings made in New York and vicinity—Continued.

3. BORINGS IN THE OUTLYING BOROUGHS AND IN OTHER LOCALITIES NEAR NEW YORK—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
<i>Hoboken, water front—Continued.</i>				
Streets produced—Continued.				
1386	17th and River	{ -53 -48 -47	{ -47	Rock or boulder.
1387	17th and Hudson	{ -46 -40	{ -36	
1388	17th and Washington	{ -32 -35		{ -37	Do.
1389	17th and Bloomfield	{ -33 -34	{ -41	
1390	17th and Garden	{ -52 -44 -38 -49		{ -13	Do.
1391	15th and Hudson boulevard ...	-15	{ -4	
1392	15th and Bloomfield	- 6.5		{ -19	Do.
1393	15th and Hudson	-21	{ -22	
1394	Washington street, between 15th and 16th.	{ -25 -24		{ -38	Do.
1395	16th and Bloomfield	{ -36 -45	{ -41	
1396	16th and Washington	{ -42 -43		{ -30	Do.
1397	16th and Hudson	{ -25 -34 -30 -31	{ -76	
<i>Hoboken—Miscellaneous.</i>				
1398	15th and Jefferson streets ^a ...	-86	{ -54	Sandstone.
1399	13th and Clinton streets.....	-64		
1400	Jefferson and Madison, between 8th and 9th streets.	-40	-35	Do.
1401	Monroe and 9th streets.....	-40	-35	Do.

^aNos. 1393-1401 by New York and New Jersey Well Co.; surface datum. Record of wells: No. 1398—black mud 16 feet, boulders 24, sand 40, gravel 6; No. 1399—black mud 16 feet, loam 30, sand 10, gravel 8; Nos. 1400 and 1401—black muck 12 feet, soft soil 20, rest sand with streak of gravel over top of white and red sandstone.

Summary of records of borings in New York and vicinity—Continued.

3. BORINGS IN THE OUTLYING BOROUGHS AND IN OTHER LOCALITIES NEAR NEW YORK—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
<i>Hoboken—Miscellaneous—Continued.</i>				
1402	Bavarian glass works ^a — Clinton street, between 10th and 11th.	— 80	.....	Red shale.
<i>Jersey City.</i>				
1403	Hudson street, between Morris and Essex. ^b	— 24	— 14	Gneiss.
1404	Grove street between 7th and 8th. Mathiesen & Wiecher sugar factory—	— 70	— 60	Dark sandstone.
1405	Foot of Washington street, south side Morris Canal. ^c	— 20	— 13	Gneiss and quartz.
1406	Marsh, corner of Montgomery and Henderson streets. ^d	— 15	— 5	Red sandstone.
1407	9th street, between Grove and Henderson.	— 70	— 60	Do.
<i>Pavonia Ferry—</i>				
1408	2,300 feet east of 1416	— 63	— 63	Serpentine
1409	2,850 feet east of 1416	—120	—120	Do.
1410	3,300 feet east of 1416	—179	—179	Do.
<i>Harsimus Cove—</i>				
1411	1,450 feet east of Green street, on a line halfway between 2d and 3d streets (produced).	—160	.....	No rock.
1412	Foot of Bartholdi avenue, 50 feet from street ^e —	— 66	.....	Trap.
1413	30 feet east of 1412	— 38	.....	Do.
1414	100 feet south of 1412	— 83	.....	Do.
1415	Pavonia avenue and Henderson street. ^f	— 70	.....	Sandstone.
1416	Ninth and Henderson streets	— 70	.....	Granite.

^aSchrenk and Company, Ann. Rept. State Geol. New Jersey, 1901, p. 120. Record of well No. 1402: Clay and sand 80 feet, red shale 120.

^bRussell, I. C. Annals New York Acad. Sci., vol. 2, pp. 66-77. Nos. 1403-1407, elevations estimated; borings 1408-1411 supposed to be referred to mean tide.

^cWhite sandstone and thin bands of slate occurring below 800 feet. A few feet of rock at surface, said to be serpentine.

^dRock penetrated for 200 feet, ended in whitish sandstone.

^eGreenville Brewing Company. Nos. 1412-1414, section: Fine sand, 50 feet; gravel, 5; trap rock, 2; sand, bowlders, and gravel mixed, 26; trap rock, 15; brown sandstone, 15; black "trap" rock (becoming bluish as depth increased) of a soft, almost talc-like character.

^fLembeck & Betz Brewing Company. Wells 1415 and 1416 at 150 feet struck soapstone, and at 700 feet struck granite.

Summary of records of borings made in New York and vicinity—Continued.

3. BORINGS IN THE OUTLYING BOROUGHS AND IN OTHER LOCALITIES NEAR NEW YORK—Continued.

Serial number.	Location.	Depth of boring to rock.		Kind of rock, if known.
		As given.	Referred to U. S. datum, Sandy Hook.	
	<i>Jersey City—Continued.</i>			
1417	Colgate & Co., near Pennsylvania R. R. station. ^a	-35	.....	Gneiss rock and mica.
1417a	Foot of 15th street on line of old Hudson River tunnel, 300 feet west of bulkhead line. ^b	-86	.....	Red sandstone.
1417b	Pier C, Pennsylvania R. R. bulkhead.	.....	.....	Mica schist.
1417c	Near Pier C	-40.59	-33	Do.
1418	Central Stock Yards, 500 feet back from Hudson shore. ^c	-70	.....	Sandstone.
1419	J. Mehl & Co., Jersey City heights. ^d	-20	.....	Trap.
1420	Consolidated Traction Company. ^d	-150	.....	Red sandstone.
	<i>Fort Lee, N. J.</i>			
1421	850-foot well	(<i>d</i>)		
	<i>Weehawken, N. J.</i>			
1422	Pier No. 7, Hudson River ^e	-75 to -110	-78 to -118	No rock.
	<i>Great Neck and Greenport, L. I.</i>			
1423	Hewlett Point, Great Neck (well) ^f	{ -230 -222 -244	-220	Soft granite.
1424	Greenport (well) ^f	-670			-670	Soft rock.

^a Conlan, P. H. and J., artesian wells. Ann. Rept. State Geol. New Jersey, 1896, p. 184. Sandstone and trap found in other wells near.

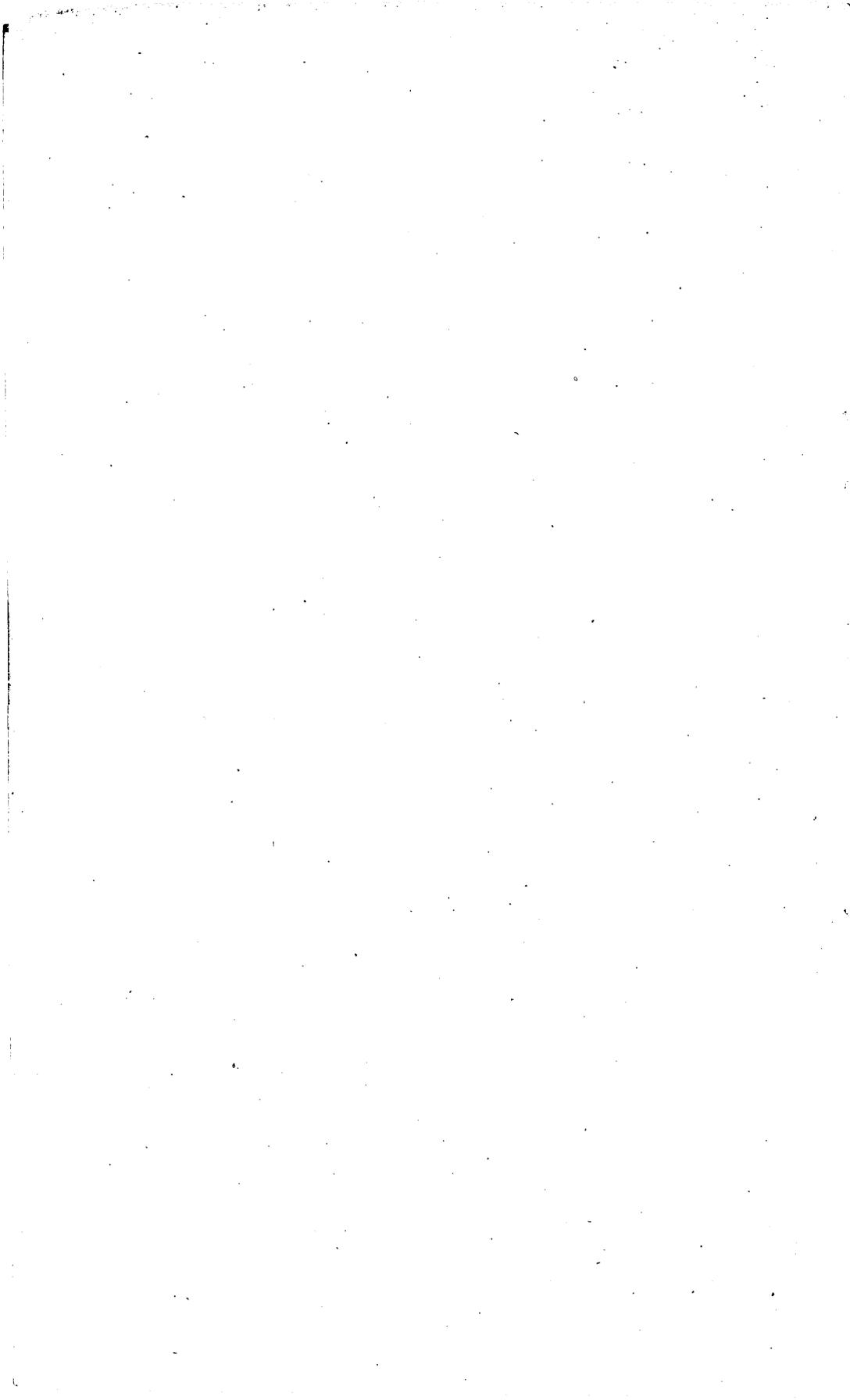
^b Records 1417a-1417c furnished by J. V. Davies, deputy chief engineer, 111 Broadway, New York. Rock in 1417c penetrated in shaft to a distance of 60 feet.

^c Cook, Geo. H., Ann. Rept. State Geol. New Jersey, 1882, p. 139. Record of well 1418: Mud, 70 feet; red sandstone, 145; gneiss, 240.

^d Smock, J. C., *idem*, 1897, p. 283. No. 1419, "trap as far as drilled;" No. 1420, "not finished at depth of 1,400 feet;" No. 1421, "through trap 850 feet and not finished" (1901). Mentions as curious fact that red sandstone outcrops at the surface a quarter of a mile distant.

^e Engineering Record, vol. 44, 1901, p. 620.

^f Veatch, A. C., U. S. Geol. Survey. Well 1423 reported as -230 by Stothoff Bros., as 220 by J. H. Herbert, who visited the well, and as 244 by Mr. Cole, who did the work. Record of well: 90 feet, light gray sand, with coarse seams 5-20 feet apart and from 6 inches to 2 feet thick and containing some clay; 140 feet, fine gray sand and quicksand; 230-512 feet, rock—soft, gray granite with mica veins. Well 1424 penetrated extremely soft rock 20 feet.



INDEX.

Page		Page.	
Acknowledgments to those aiding	21, 23	Fifty-ninth street, line of, bed rock on.....	41
Amethyst avenue, foundations on, bed rock in.....	72	First avenue, bed rock near.....	57-58, 74-75, 80-81
Amsterdam avenue, foundations on and near, bed rock in.....	74-76	Fort Lee, N. J., bed rock at.....	93
Anthony avenue, foundations on, bed rock in.....	71	Forty-second street, section of East River on line of, bed rock on.....	34
Aqueduct, new, section of Harlem River at, bed rock in.....	42	Foundations in Manhattan, bed rock in....	51- 55, 71-76
Assistance from others	21, 23	Fourth avenue, bed rock on.....	56, 58-59, 81
Bed rock, depth and nature of, study of....	20-21	Fulton avenue, foundations on, bed rock in.	71
depths to, tables of.....	30-93	Gale, L. D., on New York City geology.....	12
exposures of.....	21-22	Gneissoid "islands" in New York, location of.....	12, 21-22
form of.....	21-29	location of, figures showing	15
maps showing.....	11, 20, 22	Gratacap, L. P., on New York City geology.	16-17
sections of.....	25, 26, 28	Greatneck, N. Y., bed rock at	93
<i>See also names of localities, streets, etc., Foundations, etc.</i>		Greenport, N. Y., bed rock at	93
Bedloe Island, bed rock on, depth to.....	40	Harlem, bed rock in, character of.....	27-28
Boston road, foundations on, bed rock in..	72	depth to	23-24, 27
Broadway, bed rock on and near.....	44-45, 49-54, 57, 66-68, 73, 76, 81	Harlem River, channel of, bed rock in.....	41-44
buildings on and near, foundations of, bed rock in.....	52-54	sections across, figures showing	26
sections along, figures showing.....	28	Hell Gate, channel at, character of.....	21
Bronx, Borough of, bed rock in.....	87-89	Highbridge, section of Harlem River at, bed rock in.....	42
Brooklyn, bed rock in.....	83-86	Hobbs, W. H., on New York City geology..	19
Brooklyn-New York tunnel, bed rock in...	35	Hoboken, bed rock in.....	89-92
Buildings in Manhattan, foundations of, bed rock in	51-55, 71-76	water front of, bed rock at.....	89-91
Central bridge, sections of Harlem River at and near, bed rock in	43	Hudson River, area west of, bibliography of.....	19
Cozzens, Isaachar, on New York City geology.	12	channels of, bed rock in.....	6-41
Credner, Hermann, on New York City ge- ology	13	character of	21
Dana, J. D., on New York City geology.....	14	sections of.....	40-41
East River, channels of, bed rock in.....	30-35	Jackson avenue, foundations on, bed rock in.....	72
character of	21	Jersey City, bed rock in	92-93
sections across.....	32-35	Julien, A. A., on New York City geology...	17-18
East River bridge, approach to, bed rock at.	76	Kemp, J. F., on New York City geology ...	14-16
section at, bed rock in.....	32-34	Lenox avenue, foundations on and near, bed rock in.....	73, 81
East River Gas Company, tunnel of, bed rock in	32	section along, figure showing	28
East River reefs, bed rock in, depth to.....	34	Lexington avenue, bed rock on.....	45-48, 56, 58
Eckel, E. C., on New York City geology.....	16	Long Island City, bed rock in.....	16
Eighth avenue, bed rock near.....	55-57	McAdoo tunnel, bed rock in.....	40
Eleventh avenue, bed rock near	55, 68	Macomb's dam, section of Harlem River at, bed rock in	43
section along, figure showing	28	Madison avenue, bed rock near.....	56, 53, 63-69
Faulting, importance of.....	20	Madison avenue bridge, section of Harlem River at, bed rock in.....	44
Fifth avenue, bed rock on and near.....	56, 57, 68-70, 80-82	Manhattan Island, bed rock of, depth to..	22-24, 44-82
buildings on and near, foundations of, bed rock in.....	54-55	bed rock of, exposures of.....	21-22
		form of	21-29
		buildings on, foundations of, bed rock in	51-55, 71-76

	Page.		Page.
Manhattan Island, channels around, borings in.....	30-44	Riverside Park extension, bed rock on.....	59-66
engineering enterprises on.....	10	Riverside viaduct, bed rock at.....	66
geology of, study of.....	9-29	Rock basement. <i>See</i> Bed rock.	
maps of.....	15, 20, 22, 24	Russell, I. C., on New York City geology....	14
discussion of.....	9-10	School buildings, foundations of, bed rock in.....	71-76
sections of.....	25-29	Second avenue, bed rock on and near.....	57-58, 69, 73-74
figures showing.....	25, 26, 28	Second avenue bridge, section of Harlem River at, bed rock in.....	44
structure of.....	9-29	Sections, location of, map showing.....	24
water front of, bed rock on.....	30-44	Seventh avenue, bed rock near.....	56-57, 81
Manhattan viaduct, bed rock at.....	66-67	Sixth avenue, bed rock near.....	56-57, 68, 70
Mather, W. W., on New York City geology.	12	Southern boulevard, bed rock on.....	87-88
Merrill, F. J. H., on New York City geology.	15-16	Sputyen Duyvil bridge, section of Harlem River at, bed rock in.....	41
Newberry, J. S., on New York City geology.	13-14	Stevens, R. P., on New York City geology....	12-13
Ninth avenue, bed rock near.....	55-57, 81	Stock Exchange building, bed rock at, map showing.....	11
New York-Brooklyn tunnel, bed rock in...	35	Tenth avenue, bed rock near.....	56, 67, 75, 80-81
New York Central Railroad bridge, section of Harlem River at, bed rock in.	43	Third avenue, bed rock near.....	58, 69, 74, 79, 82
One hundred and forty-fifth street bridge, section of Harlem River at, bed rock in.....	43	Third Avenue bridge, section of Harlem River at, bed rock in.....	44
One hundred and tenth street, bed rock on.	48	Thirty-first street, bed rock on line of.....	55
Park avenue, bed rock on and near.....	80	Thirty-fourth street, bed rock on line of.	48-49, 58
Park avenue bridge, section of Harlem River at, bed rock in.....	44	Thirty-second street, bed rock on line of...	55-57
Pennsylvania, New York and Long Island Railroad Company, borings of, bed rock in.....	25-26	Thirty-third street, bed rock on line of.....	57-58
tunnel of, bed rock in.....	40-41	Twelfth avenue, bed rock near.....	55, 59-66
Pennsylvania Railroad, tunnel of, bed rock in.....	34-35	Viele, E. G., map of, character of.....	9
Peet, C. E., on New York City geology.....	19	Wadsworth avenue, foundations on, bed rock in.....	71
Queens, Borough of, bed rock in.....	86-87	Washington Bridge, section of Harlem River at, bed rock in.....	42
Randall's map, character of.....	9	Weehawken, N. J., bed rock in.....	93
Rapid transit commission, subway of, bed rock in.....	26-29, 44-49	Westchester avenue, bed rock on.....	87-88
tunnels of.....	10	section along, figure showing.....	28
bed rock in.....	35, 43	Willis avenue bridge, section of Harlem River at, bed rock in.....	44